

A1-H60BB-NFM-000



NATOPS FLIGHT MANUAL NAVY MODEL SH-60B HELICOPTER

**THIS PUBLICATION SUPERSEDES
A1-H60BB-NFM-000 DATED 15 JANUARY 2006.**



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

01 APRIL 2008

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization (NATOPS) Program is a positive approach toward improving combat readiness and achieving a substantial reduction in the aircraft mishap rate. Standardization, based on professional knowledge and experience, provides the basis for development of an efficient and sound operational procedure. The standardization program is not planned to stifle individual initiative, but rather to aid the commanding officer in increasing the unit's combat potential without reducing command prestige or responsibility.
2. This manual standardizes ground and flight procedures but does not include tactical doctrine. Compliance with the stipulated manual requirements and procedures is mandatory except as authorized herein. In order to remain effective, NATOPS must be dynamic and stimulate rather than suppress individual thinking. Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end, commanding officers of aviation units are authorized to modify procedures contained herein, in accordance with the waiver provisions established by 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.

A handwritten signature in black ink, appearing to read "S. R. Eastburg", written over the typed name and title.

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

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

| INTERIM CHANGE NUMBER(S) | REMARKS/PURPOSE |
|--------------------------|-------------------------|
| 1 thru 63 | Previously Incorporated |
| | |
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| | |

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

| INTERIM CHANGE NUMBER(S) | REMARKS/PURPOSE |
|--------------------------|---|
| 64 | Misc. H-60 Common Changes |
| 65 | Misc. Changes |
| 66 | Fuel Prime Checklist Procedure |
| 67 | Changes to Practice Autorotative Approach |
| | |

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 |
|-----------------------|--------------------------------------|---|--|
| 68 | 202000Z MAR 09 | 3-17, 7-1, 7-21, 7-32, 7-57, 8-15, 10-13, 10-33 | Tiedown Requirements |
| 69 | 262003Z AUG 09 | 10-67 | Revised Auto RPM Correct Chart (and re-issue of IC-68 for the Conference Revision Release). |
| 70 | 052000Z OCT 09 | 2-33/34, 7-21/32, 8-38, 9-13/ 14/ 15/27/28, 10-16/19/67 | New Operational Warnings & Engine Diaphragm Coupling Caution, correction of Autorotation RPM Correction Chart. |
| | | | |
| | | | |

P 052000Z OCT 09
FROM COMNAVAIRSYS COM PATUXENT RIVER MD//4.0P//
TO ALL SEAHAWK HELICOPTER ACTIVITIES
INFO COMNAVAIRSYS COM PATUXENT RIVER MD//4.0P/4.1/4.1.1.2/5.0F/5.1//
PEOASWASM PATUXENT RIVER MD//PMA299//
COMNAVAIRFOR SAN DIEGO CA//N455/N3C3/N421L//
COMNAVAIRFORES SAN DIEGO CA//N42/N52/N421D1//
COMNAVSAFECEN NORFOLK VA//11//
COMNAVSURFLANT NORFOLK VA//N42/N420//
COMNAVSURFPAC SAN DIEGO CA//N42//
FLTREADCENSOUTHEAST JACKSONVILLE FL//3.3.3//
HMX ONE QUANTICO VA//C148-11//
MSGID/GENADMIN/COMNAVAIRSYS COM/4.0P//
SUBJ/SH-60B AIRCRAFT NATOPS PUBLICATIONS INTERIM CHANGE//
REF/A/DESC:DOC/COMNAVAIRFOR/25SEP2009//
REF/B/DESC:DOC/COMNAVAIRSYS COM/03SEP2009//
REF/C/DESC:NA A1-H60BB-NFM-000/COMNAVAIRSYS COM/01APR2008//
REF/D/DESC:NA A1-H60BB-NFM-500/COMNAVAIRSYS COM/01APR2008//
REF/E/DESC:NA A1-H60BB-NFM-700/COMNAVAIRSYS COM/01APR2008//
NARR/REF A IS SH-60B COG COMMAND CONCURRENCE.
REF B IS AIRS NATOPS-2009-134 & 173.
REF C IS SH-60B NATOPS FLIGHT MANUAL (NFM).
REF D IS SH-60B NATOPS PILOTS POCKET CHECKLIST (PPCL).
REF E IS SH-60B NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL).//
GENTEXT/REMARKS/1. THIS MESSAGE IS ISSUED IN RESPONSE TO REFS A
AND B. THIS MESSAGE ISSUES INTERIM CHANGE (IC) NUMBER 70 TO REF C,
IC NUMBER 64 TO REF D, AND IC NUMBER 23 TO REF E.

2. SUMMARY.

- A. THIS MESSAGE INCORPORATES NEW OPERATIONAL WARNINGS AND ENGINE DIAPHRAGM COUPLING CAUTIONS IN REFS C AND E. THIS MESSAGE ALSO MAKES TYPOGRAPHIC (REFS C AND D) AND RPM CHART (REF C) CORRECTIONS INADVERTENTLY RELEASED WITH THE LAST IC.
 - B. REPLACEMENT PAGES CONTAINING THESE CHANGES FOR DOWNLOADING AND INSERTION INTO REFS C, D, AND E WILL BE ATTACHED TO THIS INTERIM CHANGE MESSAGE WHEN IT IS POSTED ON THE NATEC AND AIRWORTHINESS WEBSITES (SEE LAST PARA BELOW).
3. THESE CHANGES IMPACT THE FOLLOWING NATOPS CHECK LISTS. THE REPLACEMENT PAGE PACKAGE INCLUDES THE FOLLOWING PAGES:
- A. REF C (SH-60B NFM -000) 5/(6 BLANK), 2-33/34, 7-21/22, 7-31/32, 8-37/38, 9-13 TO 16, 9-27/28, 10-15/16, 10-19/20, AND 10-67/68.
 - B. REF D (SH-60B PPCL-500) PAGES B/(C BLANK), 29 AND 30.
 - C. REF E (SH-60B FCFCL-700) PAGES B/(C BLANK), 1-23 TO 28.
4. POINTS OF CONTACT:
- A. SH-60B NATOPS PROGRAM MANAGER:LT JAKE HAFF, HSL-40, TEL DSN 270-6332, OR COMM (904)270-6332 x222, EMAIL:JAKE.L.HAFF1@NAVY.MIL.
 - B. NAVAIR POCS:
 - (1) MARTY SCANLON, NATOPS IC COORDINATOR, TEL DSN 757-6045 OR COMM (301) 757-6045, EMAIL: MARTIN.SCANLON@NAVY.MIL
 - (2) LCDR WADE HARRIS, AIR-4.1.1.2, IN-SERVICE H-60 CLASS DESK, DSN 757-5343 OR (301)757-5343, EMAIL: BENJAMIN.W.HARRIS@NAVY.MIL.
 - (3) LCDR BEN KELSEY, 4.0P NATOPS OFFICER, DSN 995-2502, COM 301-995-2505, EMAIL: BEN.KELSEY@NAVY.MIL.

(4) AIRWORTHINESS GLOBAL CUSTOMER SUPPORT TEAM,
(301) 757-0187, EMAIL AIRWORTHINESS@NAVY.MIL.

5. OTHER REMARKS:

- A. THIS MESSAGE WILL BE POSTED ON THE AIRWORTHINESS WEBSITE, [HTTPS:AIRWORTHINESS.NAVAIR.NAVY.MIL](https://airworthiness.navair.navy.mil) WITHIN 48 HOURS OF RELEASE. INTERIM CHANGES MAY BE FOUND IN TWO PLACES ON THE WEBSITE:
- (1) IN THE NATOPS LIBRARY SORTED BY AIRCRAFT PLATFORM AND TMS.
 - (2) IN AIRS, SEARCH BY AIRS NUMBER FOUND IN REF B ABOVE.
- B. THIS MESSAGE WILL ADDITIONALLY BE POSTED ON THE NATEC WEBSITE, [WWW.MYNATEC.NAVY.MIL](http://www.mynatec.navy.mil). IF THE IC MESSAGE INCLUDES REPLACEMENT PAGES, THEY WILL BE PLACED WITHIN THE MANUAL AND REPLACED PAGES DELETED. IF UNABLE TO VIEW THIS MESSAGE ON EITHER THE AIRWORTHINESS OR NATEC WEBSITES, INFORM THE NATOPS GLOBAL CUSTOMER SUPPORT TEAM AT (301) 342-3276, DSN 342-3276, OR BY EMAIL AT NATOPS@NAVY.MIL.
- C. INFORMATION REGARDING THE AIRWORTHINESS PROCESS, INCLUDING A LISTING OF ALL CURRENT INTERIM FLIGHT CLEARANCES, NATOPS AND NATIP PRODUCTS ISSUED BY NAVAIR 4.0P, CAN BE FOUND AT OUR WEBSITE: [HTTPS:\(SLASH\)\(SLASH\)AIRWORTHINESS.NAVAIR.NAVY.MIL](https://(SLASH)(SLASH)airworthiness.navair.navy.mil).
- D. EPOWER FOLDER ID 876128, TRACKING NUMBER 35443.//

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BEN KELSEY, NATOPS OFFICER, 4.0P, 10/05/2009

P 262003Z AUG 09
 FROM COMNAVAIRSYS COM PATUXENT RIVER MD//4.0P//
 TO ALL SEAHAWK HELICOPTER ACTIVITIES
 INFO COMNAVAIRSYS COM PATUXENT RIVER MD//4.0P/4.1/4.1.1.2/5.0F/5.1//
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 FLTREADCENSOUTHEAST JACKSONVILLE FL//3.3.3//
 HMX ONE QUANTICO VA//C148-11//
 MSGID/GENADMIN/COMNAVAIRSYS COM/4.0P//
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 REF/D/DESC:DOC/COMNAVAIRSYS COM/05SEP2008//
 REF/E/DESC:NA A1-H60BB-NFM-000/COMNAVAIRSYS COM/01APR2008//
 REF/F/DESC:NA A1-H60BB-NFM-500/COMNAVAIRSYS COM/01APR2008//
 REF/G/DESC:NA A1-H60BB-NFM-700/COMNAVAIRSYS COM/01APR2008//
 REF/H/DESC:NA A1-H60BB-NFM-800/COMNAVAIRSYS COM/01APR2008//
 NARR/REF A IS SH-60B COG COMMAND CONCURRENCE.
 REF B IS AIRS NATOPS-2009-059.
 REF C IS AIRS NATOPS-2009-051.
 REF D IS AIRS NATOPS-2008-136.
 REF E IS SH-60B NATOPS FLIGHT MANUAL (NFM).
 REF F IS SH-60B NATOPS PILOTS POCKET CHECKLIST (PPCL).
 REF G IS SH-60B NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL).
 REF H IS SH-60B NATOPS AIRCREW POCKET CHECKLIST (APCL).//
 GENTEXT/REMARKS/1. THIS MESSAGE IS ISSUED IN RESPONSE TO REFS A, B, C,
 AND D. THIS MESSAGE ISSUES INTERIM CHANGE (IC) NUMBER 69 TO REF E, IC
 NUMBER 63 TO REF F, IC NUMBER 22 TO REF G, AND IC NUMBER 11 TO REF H.
 2. SUMMARY.
 A. THIS MESSAGE ADDRESSES CHANGES TO THE AUTOROTATION RPM
 CORRECTION CHART IN REFS E AND G, AND TO THE SONOBUOY
 LOADOUT QUICK MIX TABLE IN REF H.
 B. THIS MESSAGE ALSO RE-ISSUES THE TIEDOWN REQUIREMENTS IC
 CONTENT RELEASED VIA DTG 202002Z MAR 2009 TO THE POST
 CONFERENCE REVISION PUBLICATIONS.
 C. REPLACEMENT PAGES CONTAINING THESE CHANGES FOR DOWNLOADING
 AND INSERTION INTO REFS E THROUGH H WILL BE ATTACHED TO
 THIS INTERIM CHANGE MESSAGE WHEN IT IS POSTED ON THE NATEC AND
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 A. REF E (SH-60B NFM -000) PAGES 5/(6 BLANK), 3-17/18, 7-1/2,
 7-21/22, 7-31/32, 7-57/58, 8-15/16, 10-13/14, 10-33/34, 10-67,
 AND 10-68.
 B. REF F (SH-60B PPCL -500) PAGES B/(C BLANK), 11, 12, 29, 30,
 33, 34, 45, 46, 223, AND 224.
 C. REF G (SH-60B FCFCL -700) PAGES TITLE, A, B/(C BLANK),
 1-19/20, 1-45/46, 1-89/(1-90 BLANK), 2-4/5, AND 2-12.
 D. REF H (SH-60B APCL -800) PAGES B/(C BLANK) AND 69 THROUGH 70B.
 E. TO ENSURE THE PDF PAGES PRINT TO SCALE: SELECT PRINT

AND VIEWING PRINT SETUP WINDOW, ENSURE "NONE" IS
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4. POINTS OF CONTACT:

A. SH-60B NATOPS PROGRAM MANAGER: LT JAKE HAFF, HSL-40, TEL DSN
960-6332, OR COMM (904) 270-6332 X222,MAIL:JAKE.L.HAFF1@NAVY.MIL.

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OR COMM (301) 757-6045, EMAIL: MARTIN.SCANLON@NAVY.MIL
- (2) LCDR WADE HARRIS, AIR-4.1.1.2, IN-SERVICE H-60 CLASS DESK,
DSN757-5343OR(301)757-5343, EMAIL:BENJAMIN.W.HARRIS@NAVY.MIL.
- (3) KRISTIN SWIFT, 4.0P NATOPS CHIEF ENGINEER, TEL DSN 995-4193
OR COMM (301) 995-4193, EMAIL: KRISTIN.SWIFT@NAVY.MIL.
- (4) LCDR BEN KELSEY, 4.0P NATOPS OFFICER, DSN 995-2502,
COM 301-995-2505, EMAIL: BEN.KELSEY@NAVY.MIL.
- (5) AIRWORTHINESS GLOBAL CUSTOMER SUPPORT TEAM, (301)757-0187,
EMAIL AIRWORTHINESS@NAVY.MIL.

5. OTHER REMARKS:

A. THIS MESSAGE WILL BE POSTED ON THE AIRWORTHINESS WEBSITE,
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AND NATIP PRODUCTS ISSUED BY NAVAIR 4.0P, CAN BE FOUND AT
OUR WEBSITE: [HTTPS:\(SLASH\)\(SLASH\)AIRWORTHINESS.NAVAIR.NAVY.MIL](https://(SLASH)(SLASH)airworthiness.navair.navy.mil).

D. EPOWER FOLDER ID 847995, TRACKING NUMBER 32776.//

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Ben Kelsey, NATOPS Officer, 4.0P, 08/27/2009

Summary of Applicable Technical Directives

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

| CHANGE NUMBER | DESCRIPTION | DATE INC. IN MANUAL | VISUAL IDENTIFICATION |
|----------------------|--|----------------------------|------------------------------|
| AYC 1345 | MISSION FLEXIBILITY KIT, Incorporation of; (RAMEC CHPT 33-03). | 20 Dec 2005 | |

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

| CHANGE NUMBER | DESCRIPTION | DATE INC. IN MANUAL | VISUAL IDENTIFICATION |
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NATOPS Flight Manual

SH-60B

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LIST OF ABBREVIATIONS/ACRONYMS

A

A/A. Air-to-air.
A/C. Aircraft.
AC. Alternating current.
ACIP. Armament control-indicator panel.
ACP. Audio converter processor.
ACRT. Armament controller receiver-transmitter.
ACS. Air capable ship.
ADB. Aircraft discrepancy book.
ADF. Automatic direction finder.
ADHEELS. Advanced helicopter emergency egress lighting system.
ADIZ. Air defense identification zone.
ADS. Analyzer detection set.
AF. Adaptability/flexibility.
AFCS. Automatic flight control system.
AGB. Accessory gear box.
AGCA. Attitude gyroscope control assembly.
AGL. Above ground level.
AH SDC. Armed helo signal data converter.
AHS. Armed helo system.
AI. Attitude indicator.
ANI. Assistant NATOPS Instructor.
AOA. Angle of attack.
AOP. Avionics operational program.
APU. Auxiliary power unit.
ARA. Armament relay assembly.

AS. Assertiveness.
ASDC. Armament signal data converter.
ASE. Aircraft survivability equipment.
ASST. Anti-ship surveillance and targeting.
ASuW. Anti-surface warfare.
ASW. Anti-submarine warfare.
ATABS. Automated track and balance set.
ATF. Aircraft torque factor.
ATO. Airborne tactical officer.
AVT. Automatic video tracker.

B

BARALT. Barometric altimeter.
BDHI. Bearing-distance-heading indicator.
BHA. Battle hit assessment.
BIDS. Bridge indication display system.
BIM®. Blade Inspection Method.
BIT. Built-in-test.
BITE. Built-in test equipment.
BRC. Base recovery course.
BRKE. Brake.
BRU. Bomb rack unit.

C

C2W. Command and control warfare.
C3. Command, control and communications.
CAD. Cartridge activated device.
CAL. Confined area landing.
CASEVAC. Casualty evacuation.

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CATCC. Carrier air traffic control center.

CATM. Captive air training missile.

CB. Circuit breaker.

CCA. Carrier controlled approach.

CCM. Counter-countermeasures.

CCR. Closed-circuit refueling.

CDU. Central display unit.

CFIT. Controlled flight into terrain.

cg. Center of gravity.

CHAL. Challenge.

CHAL CC. Challenge correct code.

CHAN. Channel.

CIC. Combat information center.

CIG. Missile cloud ceiling.

CM. Communication.

COMREL. Communications relay.

COMSEC. Communications security.

CONREP. Connected replenishment.

CPU. Central processing unit.

CRM. Crew resource management.

CRP. Contingency range power.

CRRC. Combat rubber raiding craft.

CSAR. Combat search and rescue.

CSCG. Communication system control group.

D

DA. Density altitude.

DAFCS. Digital automatic flight control system.

DAME. Distance azimuth measuring equipment.

DC. Direct current.

DFG. Directional finding group, ARA-50.

DECR. Decrease.

DECU. Digital electrical control unit.

DESU. Digital electronic sequence unit.

DLQ. Deck landing qualification.

DM. Decision making.

DME. Distance measuring equipment.

DNA. Designated Naval Aviator.

DSP. Droop stop pounding.

E

ECA. Electronic control amplifier.

ECS. Environmental control system.

ECU. Electrical control unit.

EHE. Estimated horizontal error.

ELT. Emergency locator transmitter.

ELVA. Emergency low visibility approach.

EMCON. Emissions control.

EMI. Electromagnetic interference.

EOD. Explosive ordnance disposal.

EOT. Element-on-time; Blade de-ice system.

ESM. Electronic support measures.

ESP. Enhanced survivability package.

ESU. Electronic sequence unit; APU.

ETF. Engine torque factor.

EW. Electronic warfare.

F

FCP. Functional Checkflight Pilot.

FD. Free deck.

FDD. Flight deck director.
FHS. FLIR hellfire system.
FLIR. Forward-looking infrared.
FMCP. Fuel management control panel.
FOD. Foreign object damage.
FOV. Field of view.
fpm. Feet per minute.
fps. Feet per second.
FRS. Fleet replacement squadron.
FSII. Fuel system icing inhibitor.
FTP. Fly-to-point.

G

GCA. Ground controlled approach.
GCU. Generator control unit.
GPS. Global positioning system.
GRP. Grid reference point.

H

H2P. Helicopter Second Pilot.
HABD. Helicopter air breathing device.
HAC. Helicopter aircraft commander.
HARS. Heading attitude reference system.
HATS. Hover attack torpedo shot.
HCU. Hand control unit.
HCO. Helicopter control officer.
HEELS. Helicopter emergency egress lighting system.
HF. High frequency.

HFS. Hellfire system.
HIFR. Helicopter in-flight refueling.
HIGE. Hover in ground effect.
HIT. Health indicator test.
HMU. Hydromechanical unit.
HOGE. Hover out of ground effect.
HRS. Horizon reference system.
HTW. Helicopter threat warning.

I

IAS. Indicated air speed.
IB. Interconnecting box.
ICS. Intercommunication system.
IDECU. Improved digital electrical control unit.
IFF. Identification friend or foe.
IFOBRL. In-flight operable bomb rack lock.
IFR. Instrument flight rules.
IGE. In ground effect.
IGV. Inlet guide vanes.
IHEELS. Individual helicopter emergency egress lighting system.
IMC. Instrument meteorological conditions.
INCR. Increase.
IPL. Initial program load.
IPS. Inlet particle separator.
IRCM. Infrared countermeasures.
IRP. Intermediate range power.
ISD. Integrated self-defense.
ISO. Instructor Sensor Operator.
ITO. Instrument takeoff.

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J

JETT. Jettison.
JSO. Journeyman Sensor Operator.

K

KGS. Knots ground speed.
KIAS. Knots indicated airspeed.

L

LD. Leadership.
LDI. Leak detection/isolation.
LDS. Load demand spindle.
LEP. Laser eye protection.
LHEP. Left hand extended pylon.
LPU. Life preserver unit.
LRD. Laser range-finder and designator.
LSE. Landing signalman, enlisted.
LSO. Landing safety officer.
LTCH. Latch.
LTE. Loss of tail rotor effectiveness.
LVDT. Linear variable displacement transducer.
LZ. Landing zone.

M

MA. Mission analysis.
MAD. Magnetic anomaly detector.
MAF. Maintenance action form.
MAP. Missed approach point.
MAR. Mission avionics rack.
MARS. Mobile aircrew restraint system.
MEDEVAC. Medical evacuation.

MLA. Missile launcher assembly.
MLM. Marine location marker (smoke marker).
MPD. Multipurpose display.
MR. Main rotor.
MRC. Maintenance requirement card.
MSO. Master Sensor Operator.
MTMU. Magnetic tape memory unit.
MWS. Missile warning system.

N

NATIP. Naval Aviation Technical Information Product.
NATOPS. Naval Air Training and Operating Procedures Standardization.
NAVAIDS. Navigation aids.
N_g. Gas generator turbine speed.
NHC. NATO high capacity.
NI. NATOPS Instructor.
NOE. Nap of the earth.
NOTAM. Notice to airman.
N_p. Power turbine speed.
N_r. Main rotor speed.
NSFS. Naval surface fire support.
NSIU. Navigation switching interface unit.
NS-TL. Nose-tail.
NSV. Non synchronous vibrations.
NSW. Naval special warfare.
NTRP. Naval Technical Reference Procedures.
NTTP. Navy Tactics, Techniques, and Procedures.
NVD. Night vision device.

O

OAT. Outside air temperature.
ODV. Overspeed drain valve.
OEI. One engine inoperative.
OFT. Operational flight trainer.
OGE. Out of ground effect.
OLS. Optical landing system.
OOD. Officer of the deck.
ORIDE. Override.
ORM. Operational risk management.
ORT. Operational readiness test.
OTH. Over the horizon.
OTPI. On-top position indicator.

P

P₃. Compressor discharge pressure.
PA. Pressure altitude.
PAC. Pilot at the controls.
PAS. Power available spindle.
PBA. Pitch bias actuator.
PCL. Power control lever.
PCR. Pitch change rod.
PDB. Power distribution box.
PDI. Pressure differential indicator.
PDU. Pilot display unit.
PIC. Pilot in command.
PIM. Pulse interval modulation.
PIO. Pilot induced oscillations.
PNAC. Pilot not at the controls.

PPH. Pounds per hour.
PPS. Precise positioning system.
PQM. Pilot Qualified in Model.
PRF. Pulse repetition frequency.
PRI. Pulse repetition interval.
PTT. Push to talk.

R

RA. Recovery assist.
RADALT. Radar altimeter.
RAST. Recovery assist, secure and traverse system.
RAWS. Radar altimeter warning system.
RDP. Radar data processor.
RF. Radio frequency.
RLQ. RAST landing qualification.
RNS. Radar navigation system.
RSC. Remote switching console.
RSD. Rapid securing device.
R/T. Receiver/transmitter.
RTR. Rotor.

S

SA. Spectrum analyzer.
SAC. Standard airborne computer.
SAD. Safe/arm device.
SAR. Search and rescue.
SAS. Stability augmentation system.
SCA. Self-contained approach.
SDC. Signal data converter.
SDLM. Standard depot level maintenance.

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SGSI. Stabilized glide slope indicator.

SIF. Selective identification feature.

SLC. Sonobuoy launch container.

SLEP. Service life extension program.

SO. Sensor operator.

SPIE. Special purpose insertion extraction.

SPS. Standard precisioning system.

SRT. Standard rate turn.

STR. Specification torque ratio.

SUS. Signal underwater sound.

SUW. Surface warfare.

T

T₂. Compressor inlet temperature.

TAS. True air speed.

TDI. Transient droop improvment.

TERF. Terrain flight.

TFO. Temporary flight orders.

TGT. Turbine gas temperature.

TGT REF. Turbine gas temperature reference.

TGW. Tail guide winch.

THP. Tape handling package.

TR. Torque ratio.

TRQ. Torque.

TRQ ADJ. Torque adjusted.

TRQ MEAS. Torque measured.

TRVS. Traverse.

TST. Test.

TTV. Target torque value.

TU. Turret unit (infrared laser receiver-transmitter-converter).

U

UL. Unlock.

USW. Undersea warfare.

V

VATS. Vibration analysis testing system.

VCR. Video cassette recorder.

Vd. Doppler-measured drift velocity, lateral.

VERTREP. Vertical replenishment.

VG. Variable geometry.

V_h. Doppler-measured velocity in the direction of aircraft heading, longitudinal.

VIDS. Vertical instrument display system.

VIDS/MAF. Visual discrepancy system/maintenance action form

VLA. Vertical launch assembly; visual landing aid.

VMC. Visual meteorological conditions.

VNT. Vent.

VSI. Vertical speed indicator.

VSR. Voltage sensor relay.

Vz. Doppler-measured vertical velocity.

W

WCA. Warning/caution/advisory.

WST. Weapon system trainer.

WPN. Weapon.

WPS. Waveguide pressurization system.

WOW. Weight-on-wheels.

X

XFD. Crossfeed.

PREFACE

SCOPE

This **NATOPS** manual is issued by the authority of the Chief of Naval Operations and under the direction of Commander, Naval Air Systems Command in conjunction with the Naval Air Training and Operating Procedures Standardization (NATOPS) program. It provides the best available operating instructions for most circumstances, but no manual is a substitute for sound judgment. Operational necessity may require modification of the procedures contained herein. Read this manual from cover to cover. It's your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

NTRP 3-22.2-SH60B (NATIP)

NTRP 3-22.4-SH60B (NATIP)

NTPP 3-22.5-ASW (ASW Tactical Pocket Guide)

NAVAIR A1-H60BB-NFM-500 (Pilot's Pocket Checklist)

NAVAIR A1-H60BB-NFM-700 (Functional Checkflight Checklist)

NAVAIR A1-H60BB-NFM-800 (Aircrew Pocket Checklist)

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Note

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

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

Commanding Officer
ATTN: SH-60B NATOPS Model Manager
HSL-40
P.O. Box 280118
Jacksonville, FL 32228-0118

Commercial 904-270-6322 x222
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YOUR RESPONSIBILITY

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

NATOPS FLIGHT MANUAL INTERIM CHANGES

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

CHANGE SYMBOLS

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

WARNINGS, CAUTIONS, AND NOTES

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

**WARNING**

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

**CAUTION**

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

Note

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

WORDING

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

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

Note

This manual shall be carried in the aircraft at all times.

CHANGE RECOMMENDATIONS

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

DATE _____

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

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

Recommendation (Be specific.)

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Justification

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|-----------|------|-------|
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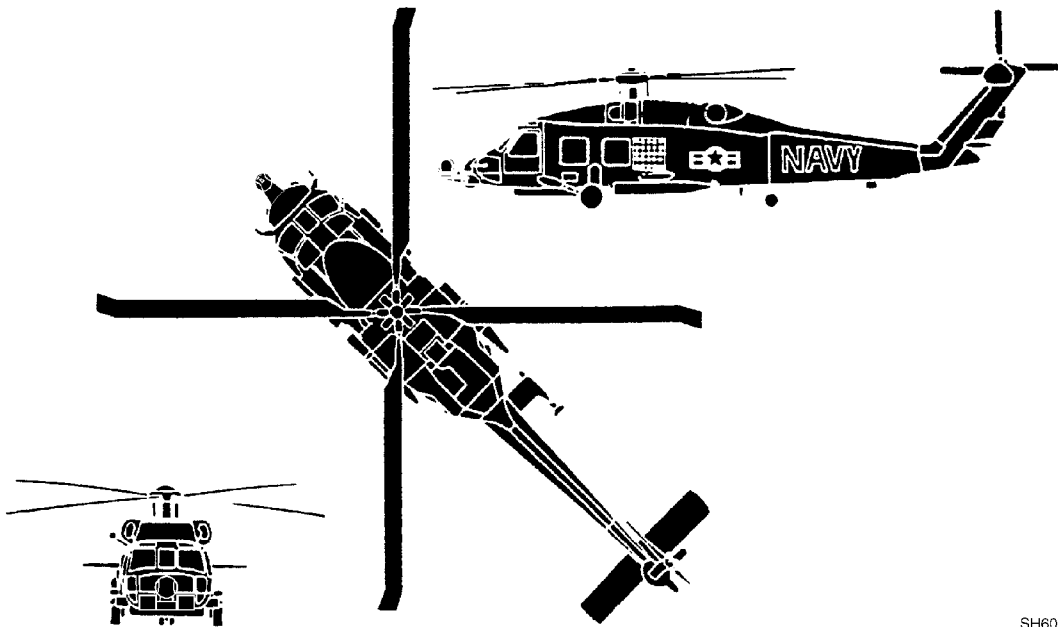
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(a) Your Change Recommendation Dated _____

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 |
|-------------------------|----------------|



SH60B-F003

PART I

The Aircraft

Chapter 1 — General Description

Chapter 2 — Systems

Chapter 3 — Servicing and Handling

Chapter 4 — Helicopter Operating Limitations

CHAPTER 1

General Description

1.1 THE HELICOPTER

The SH-60B (SEAHAWK) is a single main rotor, twin-engine helicopter, manufactured by United Technologies Corporation, Sikorsky Aircraft Division. The helicopter has a 20° tractor type canted tail rotor, a controllable stabilator, conventional fixed landing gear, an external cargo hook, a rescue hoist, and bomb racks for carrying and launching external stores. In addition, it is equipped with a flight-rated auxiliary power unit, a sonobuoy launch system, an anti-ice system, a fire-extinguishing system, an environmental control system, an automatic flight control system (AFCS), a single-point pressure refueling system, a helicopter in-flight refueling (HIFR) system, and the necessary avionics and instrumentation for instrument flight and mission accomplishment. The helicopter design is compatible with ships equipped with a recovery, assist, securing and traversing (RAST) system, and the main rotor blades and tail pylon can be folded for storage. In addition, the helicopter can operate from non-RAST equipped combatants and a variety of other naval ships.

1.2 DIMENSIONS

The overall aircraft dimensions and clearances (Figure 1-1 and Figure 1-2) are:

| | |
|---|--------------|
| Folded length (rotor/tail pylon) | 40 ft, 11 in |
| Folded length (rotor/tail pylon) (FHS equipped) | 42 ft, 10 in |
| Rotor folded length (pylon flight position) | 53 ft, 3 in |
| Length overall (rotors turning) | 64 ft, 10 in |
| Fuselage length | 50 ft, 0 in |
| Height | 17 ft, 0 in |
| Fuselage width | 7 ft, 9 in |
| Folded width | 10 ft, 7 in |
| Unfolded width (FHS equipped) | 13 ft, 0 in |
| Main rotor diameter | 53 ft, 8 in |
| Tail rotor diameter | 11 ft, 0 in |
| Ground clearance | 11.2 in |
| Ground clearance (FHS equipped) | 11 in |
| Ground to tail rotor clearance | 6 ft, 8 in |
| Turning radius | 41 ft, 7 in |
| Clearance for 180° | 84 ft, 0 in |

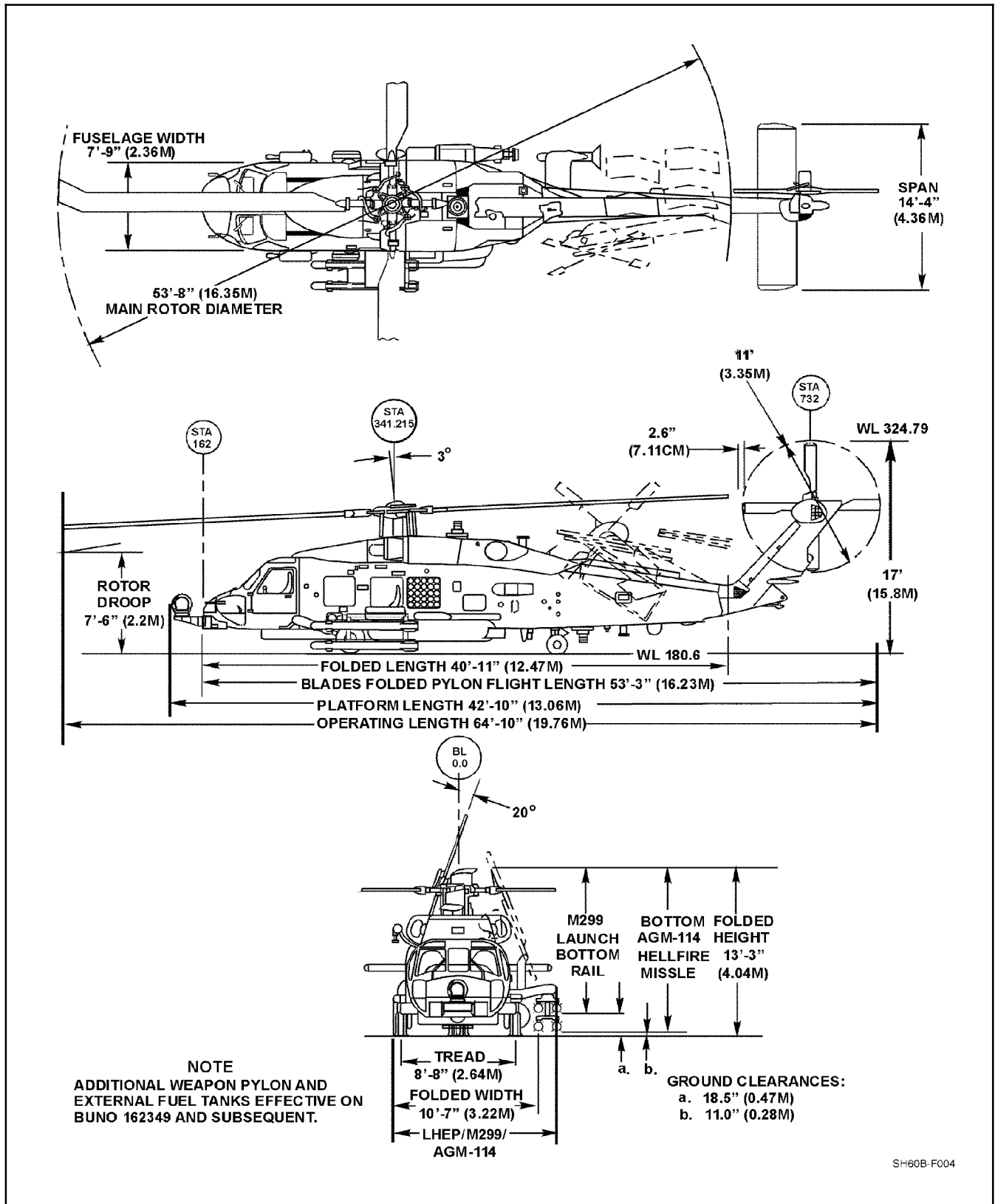


Figure 1-1. Principal Dimensions

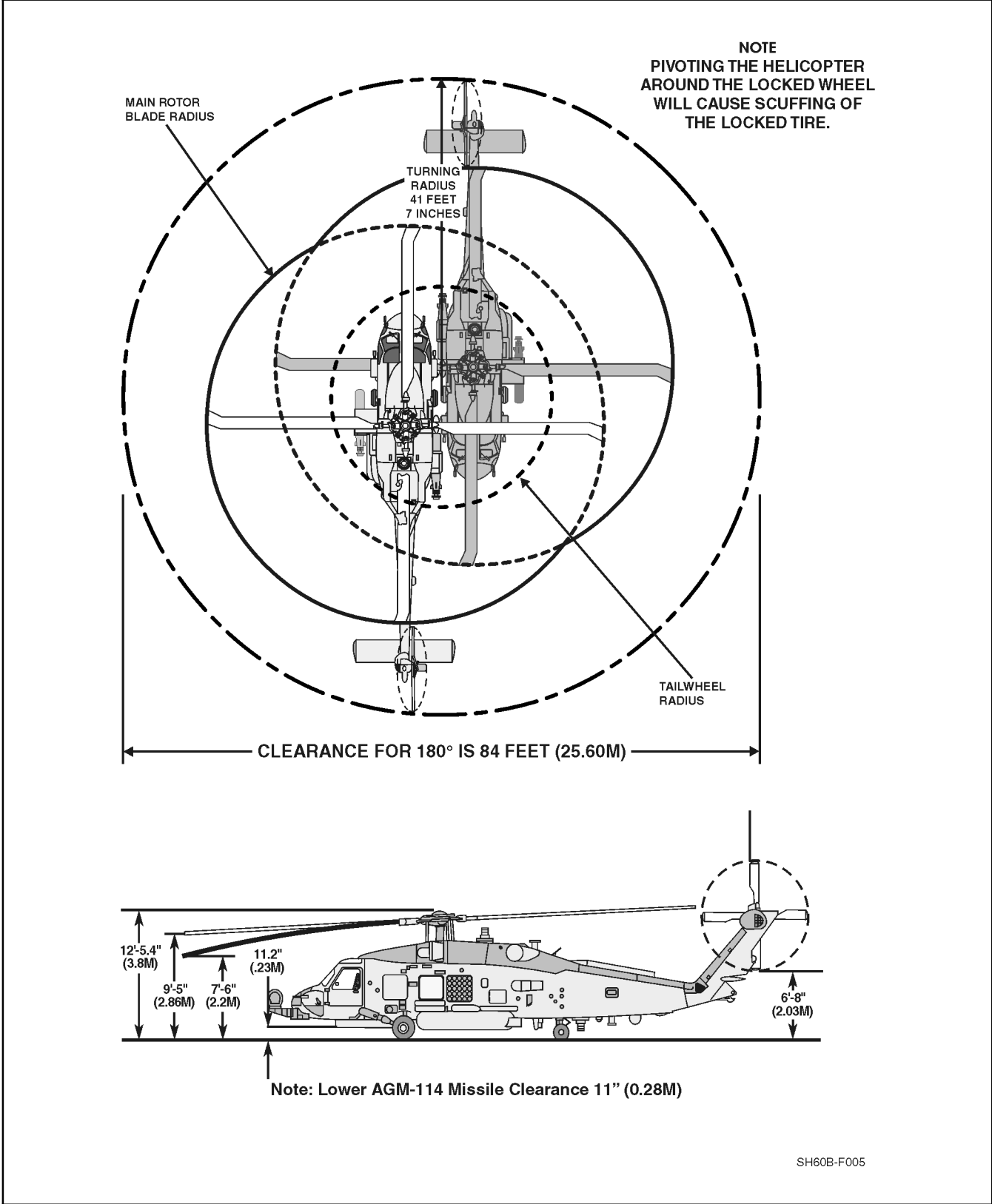


Figure 1-2. Ground Clearance and Turning Radius

A1-H60BB-NFM-000

1.3 THE ENGINES

The helicopter is equipped with two T700-GE-401C engines. The T700-GE-401C (Figure 2-1) is a front-drive turboshaft engine, manufactured by the General Electric Company, Aircraft Engine Group. Some of the features of the engine include an integral inlet particle separator and self-contained systems incorporating modular construction. At sea level and 59 °F (15 °C), the T700-GE-401C shaft horsepower ratings are:

| | |
|--|-------|
| Contingency: 2 1/2 Minute Duration | 1,940 |
| Intermediate: 30 Minute Duration | 1,800 |
| Max Continuous: No limit | 1,662 |

1.4 GENERAL ARRANGEMENT

The following subsections describe the exterior and interior arrangements of the aircraft.

1.4.1 Exterior Arrangement

The exterior arrangement of the aircraft is shown in Figure 1-3. Also shown are the locations of the aircraft antennas. There are two data link antennas: one forward and one aft on the underside of the aircraft. The search radar antenna is also located on the underside of the aircraft. Other antennas (UHF/VHF, HF, radar altimeter, TACAN, ESM, sonobuoy receivers, Doppler, ADF, IFF, and GPS) are located at various points on the helicopter (Figure 1-3).

The left inboard, left outboard, and right weapon pylons accommodate BRU-14/A weapon/stores racks. Fittings for torpedo parachute release lanyards are located on the fuselage aft of each weapon pylon. Effective on BuNo 162349 and subsequent, the left and right inboard pylons have wiring and tubing provisions for auxiliary fuel tanks. All pylons have wiring provisions to accommodate the Mk 50 torpedo. A FLIR turret may be mounted on the right hand pylon or nose mounted bracket. The left outboard weapon pylon can accommodate an M299 Launcher and up to four AGM-114 Hellfire missiles, or M36E1 CATMs.

The magnetic anomaly detector (MAD) towed body and reeling machine are mounted on a faired structure that extends from the forward tail-cone transition section on the right side of the aircraft. It is positioned above and aft of the right weapon pylon.

The sonobuoy launcher is located on the left side of the aircraft, above the left weapon pylon. The sonobuoy launcher is loaded from ground level outside the aircraft. Sonobuoys are pneumatically launched laterally to the left of the aircraft.

The airborne RAST system main probe and external cargo hook are on the bottom fuselage centerline, just aft of the main rotor centerline.

Fuel service connections, for both gravity and pressure refueling, are located on the left side of the aircraft, aft of the weapon pylons. Dual-engine waterwash is manifolded from a single-point selector valve connector on the left side of the aircraft above the window of the sensor operator (SO). A connector to service the sonobuoy launcher nitrogen bottle is located next to the waterwash connector.

The long strokes of both main and tail wheel oleos are designed to dissipate high-sink-rate landing energy. Axle and high-point tiedowns are provided at each main gear. Fuselage attachments are provided above the tail gear for connection to the RAST tail-guide winch system allowing aircraft maneuvering and straightening aboard ship and for tail pylon tiedown.

1.4.2 Interior Arrangement

Figure 1-4 shows the cockpit and cabin arrangement. Hinged doors on each side of the cockpit provide normal access to and from that station. A sliding door on the right side of the fuselage provides access to and from the cabin. The primary emergency escape routes are:

1. Pilot, right-hand jettisonable window.
2. ATO, left-hand jettisonable window.
3. SO, left-hand jettisonable window.
4. Instructor/passenger, jettisonable cabin door window.

The SO console (Figure 1-4) is located in the cabin, as well as provisions for a removable instructor/passenger seat, a passenger seat, and a litter.

Figure 1-5 shows a diagram of the pilot compartment. The ATO station is located on the left side of the aircraft cockpit. It is equipped with, or offers access to, a full complement of aircraft flight controls and instruments. Figure 1-8 illustrates the pilot and ATO instrument panel.

The overhead console (Figure 1-6), located above the pilot and ATO stations, contains aircraft system control panels involving circuit breakers, console/instrument light controls, external light controls, fire-extinguisher controls, engine controls, and several miscellaneous controls. The lower console (Figure 1-7) is located in the cockpit between the pilot and ATO stations. It contains the ATO avionics, AFCS, and communications controls. The lower console is accessible by either the ATO or the pilot.

The ATO keyset (Figure 1-7) is located on the lower console. The multipurpose display (MPD) is located on the instrument panel between the ATO flight instrument panel and a caution/advisory panel (Figure 1-8).

The collective on the ATO side telescopes to allow improved cockpit ingress and egress. In addition, locations are provided in the cabin for two fire extinguishers, two first aid kits, two canteens, a crash ax, a map case, and a backup messenger kit.

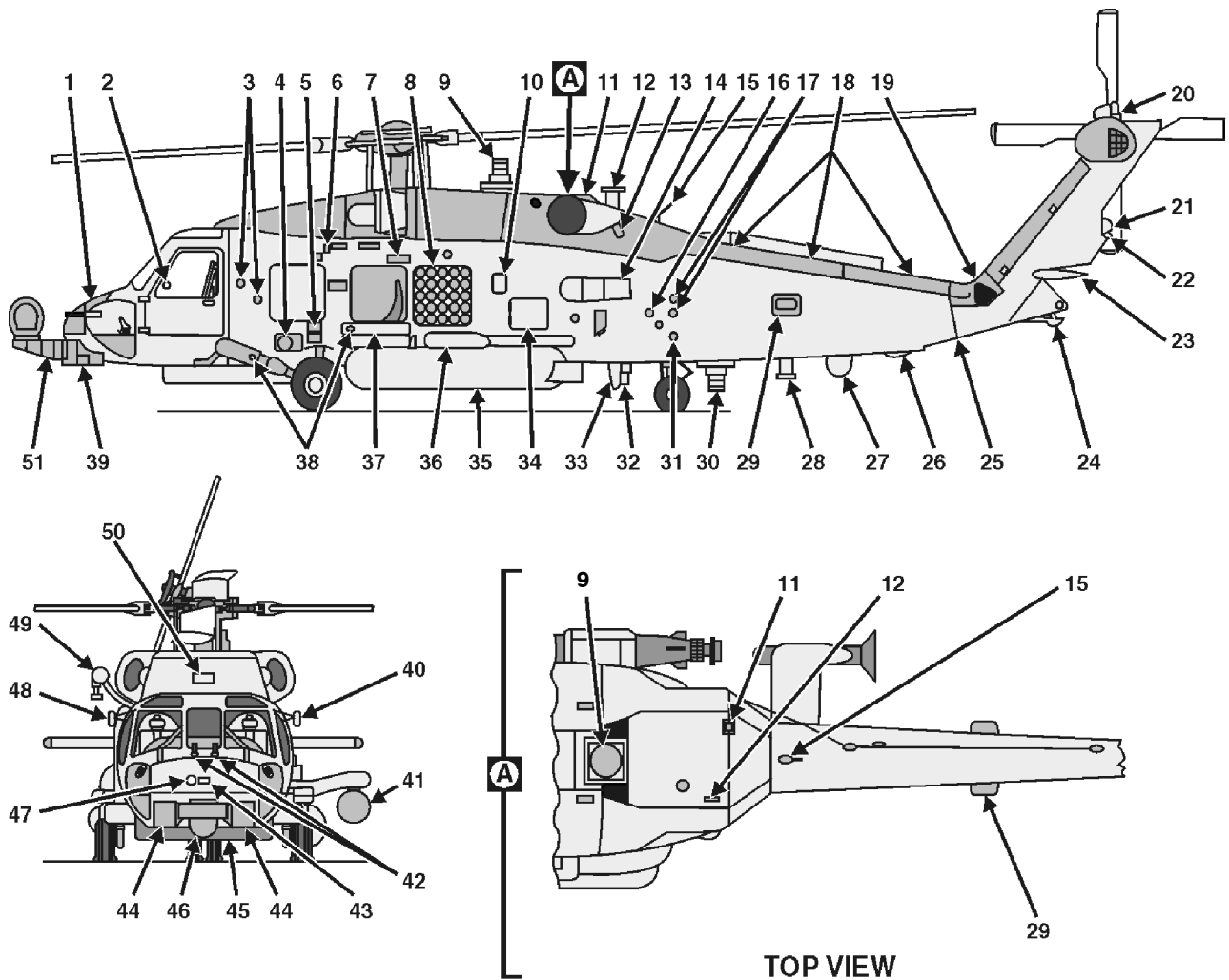
The cabin is arranged with the SO station on the left, facing forward (Figure 1-4). Most of the components of the avionics system are physically located in the SO console rack, situated aft of the ATO seat, and in the mission avionics rack (MAR), situated aft of the pilot seat. Figure 1-9 shows the location of the individual panels on the SO console and the SO keyset. The SO console contains the necessary controls and indicators for the SO to perform the missions of surface warfare (SUW) and undersea warfare (USW).

To the right of the SO station seat is a seat which accommodates an instructor or a passenger. The primary passenger seat is in the instructor seat position during single passenger flights. The hoist controls and hover-trim panel are located adjacent to the cabin door. The cargo hook hatch is located forward of the RAST probe housing.

1.5 MISSION OVERVIEW

LAMPS is the acronym for light airborne multipurpose system. The SH-60B helicopter is configured specifically in response to the LAMPS requirement of the U.S. Navy. The LAMPS MK III system has been designed to the Navy sea control mission. In fulfilling the mission, LAMPS MK III will encounter a threat that has many dimensions. The threat encompasses a hostile submarine fleet and missile-equipped surface ships. The system extends the search and attack capabilities of LAMPS MK III configured destroyer, frigate, and cruiser platforms, deploying helicopters directly from these ships.

The primary missions of the LAMPS MK III are those of SUW and USW. Aircraft prior to BuNo 162349 are capable of the antiship surveillance and targeting (ASST) and USW roles only. Effective with BuNo 162349 and subsequent, LAMPS MK III Block I aircraft equipped with the FLIR Hellfire system can be used in traditional SUW attack roles. Secondary missions include search and rescue (SAR), medical evacuation (MEDEVAC), vertical replenishment (VERTREP), naval surface fire support (NSFS), and communications relay (COMREL). Each of the primary and secondary missions will be discussed in the following subsections.



- | | | |
|--|------------------------------------|---|
| 1. LEFT PITOT TUBE | 18. TAIL ROTOR DRIVE SHAFT COVER | 36. INBOARD LEFT PYLON |
| 2. COCKPIT VENT WINDOW | 19. INTERMEDIATE GEAR BOX | 37. OUTBOARD LEFT PYLON |
| 3. STATIC PORTS | 20. UPPER ANTICOLLISION LIGHT | 38. POSITION LIGHT |
| 4. AVIONICS COOLING EXHAUST | 21. AFT MISSILE DETECTION SENSOR | 39. FORWARD MISSILE DETECTION SENSOR |
| 5. EXTERNAL ICS/ARM PANEL | 22. TAIL POSITION LIGHT | 40. REAR VIEW MIRROR |
| 6. MOORING SHACKLE | 23. STABILATOR | 41. TORPEDO |
| 7. ENGINE WASH/SONOBUOY LAUNCHER CHARGER PANEL | 24. TAIL BUMPER | 42. OUTSIDE AIR TEMPERATURE SENSORS (STBD - DE-ICE, PORT - AOP) |
| 8. SONOBUOY LAUNCHER | 25. PYLON FOLD ASSIST CONNECTION | 43. AVIONICS COMPARTMENT COOLING DAMPER DOOR |
| 9. UPPER IRCM TRANSMITTER | 26. REMOTE COMPASS | 44. FORWARD ESM ANTENNA |
| 10. GRAVITY REFUELING PORT | 27. AFT DATA LINK ANTENNA | 45. SEARCH RADAR ANTENNA |
| 11. GPS ANTENNA | 28. LOWER VHF/UHF/TACAN ANTENNA | 46. FORWARD DATA LINK ANTENNA |
| 12. UPPER VHF/UHF/IFF ANTENNA | 29. LEFT COUNTERMEASURES DISPENSER | 47. TACAN ANTENNA |
| 13. APU EXHAUST | 30. LOWER IRCM TRANSMITTER | 48. PILOT'S REAR VIEW MIRROR |
| 14. ESM ANTENNA | 31. MOORING SHACKLE | 49. RESCUE HOIST |
| 15. EMERGENCY LOCATOR ANTENNA | 32. LOWER ANTICOLLISION LIGHT | 50. HYDRAULIC BAY COOLING INLET |
| 16. FIRE EXTINGUISHER THERMAL PLUG | 33. SONOBUOY ANTENNA | 51. NOSE MOUNT PLATFORM |
| 17. TAIL WHEEL STRUT INSPECTION WINDOW | 34. PRESSURE REFUELING PORT | |
| | 35. EXTERNAL FUEL TANK | |

SH60B-F006

Figure 1-3. General Arrangement (Sheet 1 of 2)

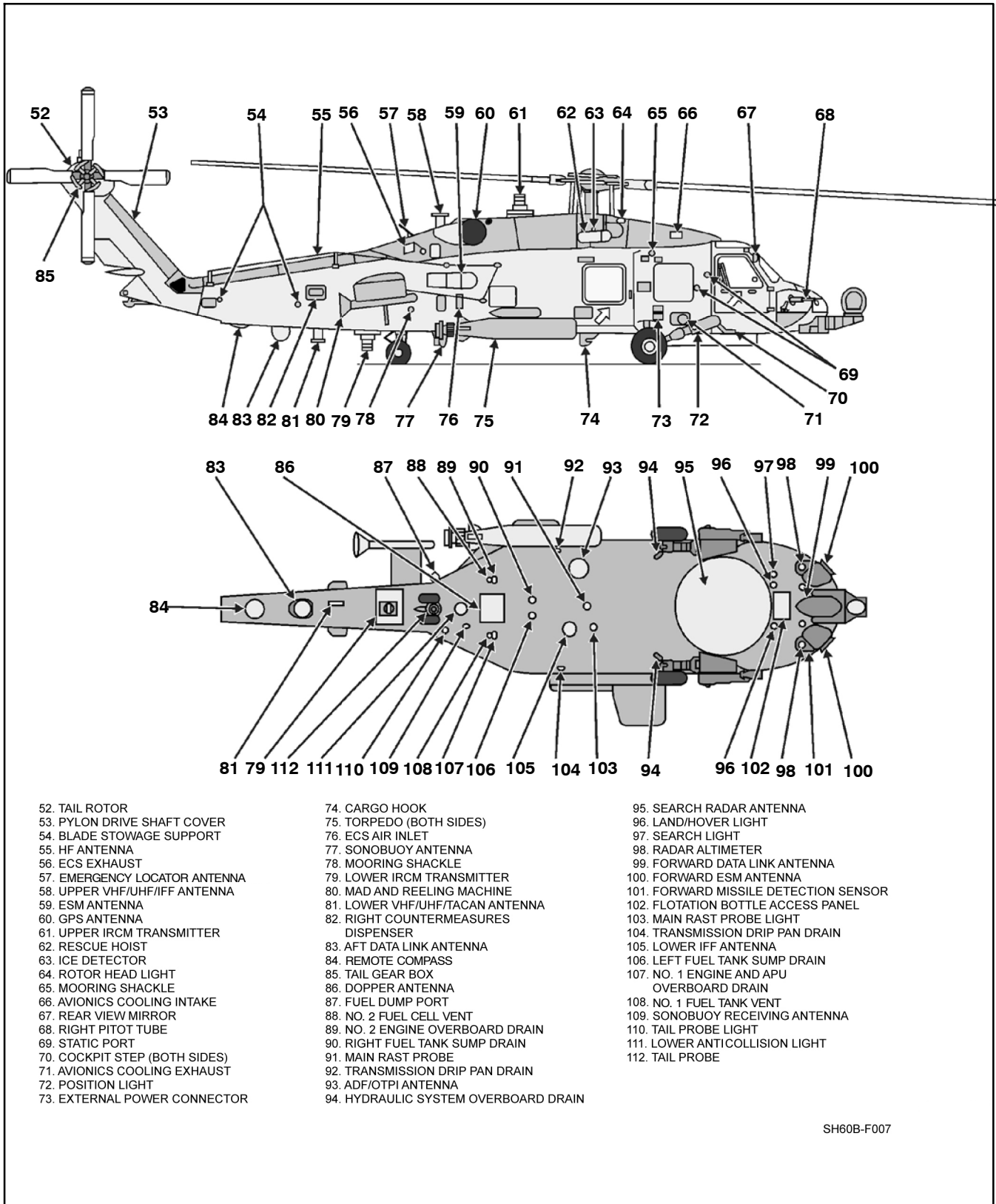


Figure 1-3. General Arrangement (Sheet 2)

1.5.1 Primary Missions

In a USW mission, the aircraft is deployed from the parent ship to classify, localize, and possibly attack a suspected threat that has been detected by the shipboard towed-array sonar, hull-mounted sonar, or by other internal or external sources.

When used in an [SUW](#) mission, the aircraft provides a mobile, elevated platform for observing, identifying, and localizing threat platforms beyond the parent shipboard radar and/or electronic support measure (ESM) horizon. When a suspected threat is detected, classification and targeting data are provided to the parent ship via the data link for surface-to-surface weapon engagement. Hellfire missile equipped aircraft may conduct independent or coordinated attack, dependent upon the threat and tactical scenario. Refer to NTRP 3-22.4-SH60B for further explanation of [USW](#) and SUW missions.

1.5.2 Secondary Missions

In the [VERTREP](#) mission, the aircraft is able to transfer material and personnel between ships, or between ship and shore. Refer to [Chapter 9](#).

In the [SAR](#) mission, the aircraft is designed to search for and locate a particular target/object/ship or plane and to rescue personnel using the rescue hoist. Refer to SAR Manual (NWP 3-50 Series), JCS 3-50, SAR TACAID [A1-SARBA-TAC-000](#). Refer to [Chapter 9](#).

In the MEDEVAC mission, the aircraft provides for the medical evacuation of ambulatory and litterbound patients.

In the [COMREL](#) mission, the aircraft serves as a receiver and transmitter relay station for over-the-horizon (OTH) communications between units. Refer to [Chapter 15](#).

In the NSFS mission, the aircraft provides a platform for spotting and controlling naval gunfire from either the parent ship or other units. Refer to NTTP 3-22.5-ASW.

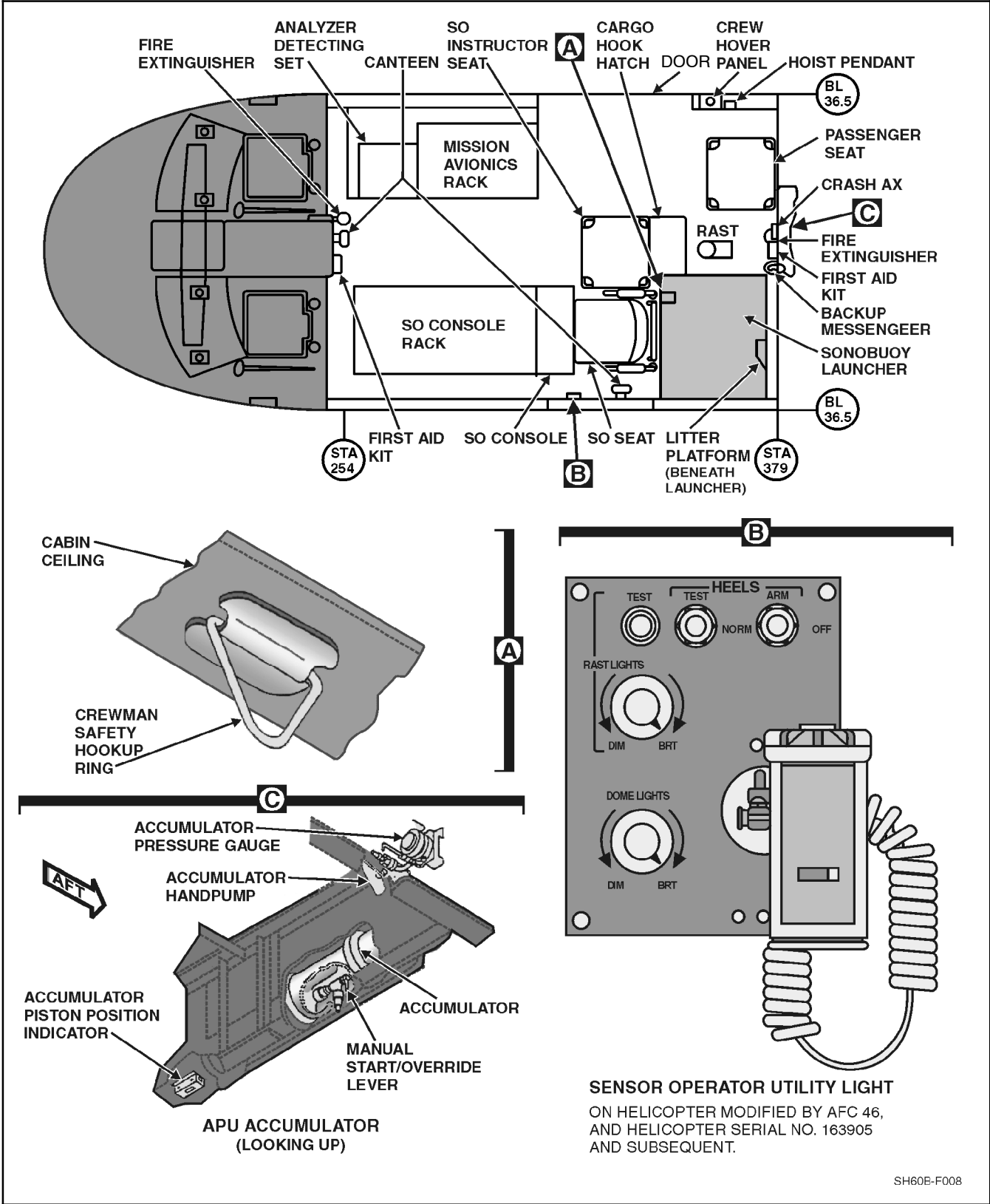
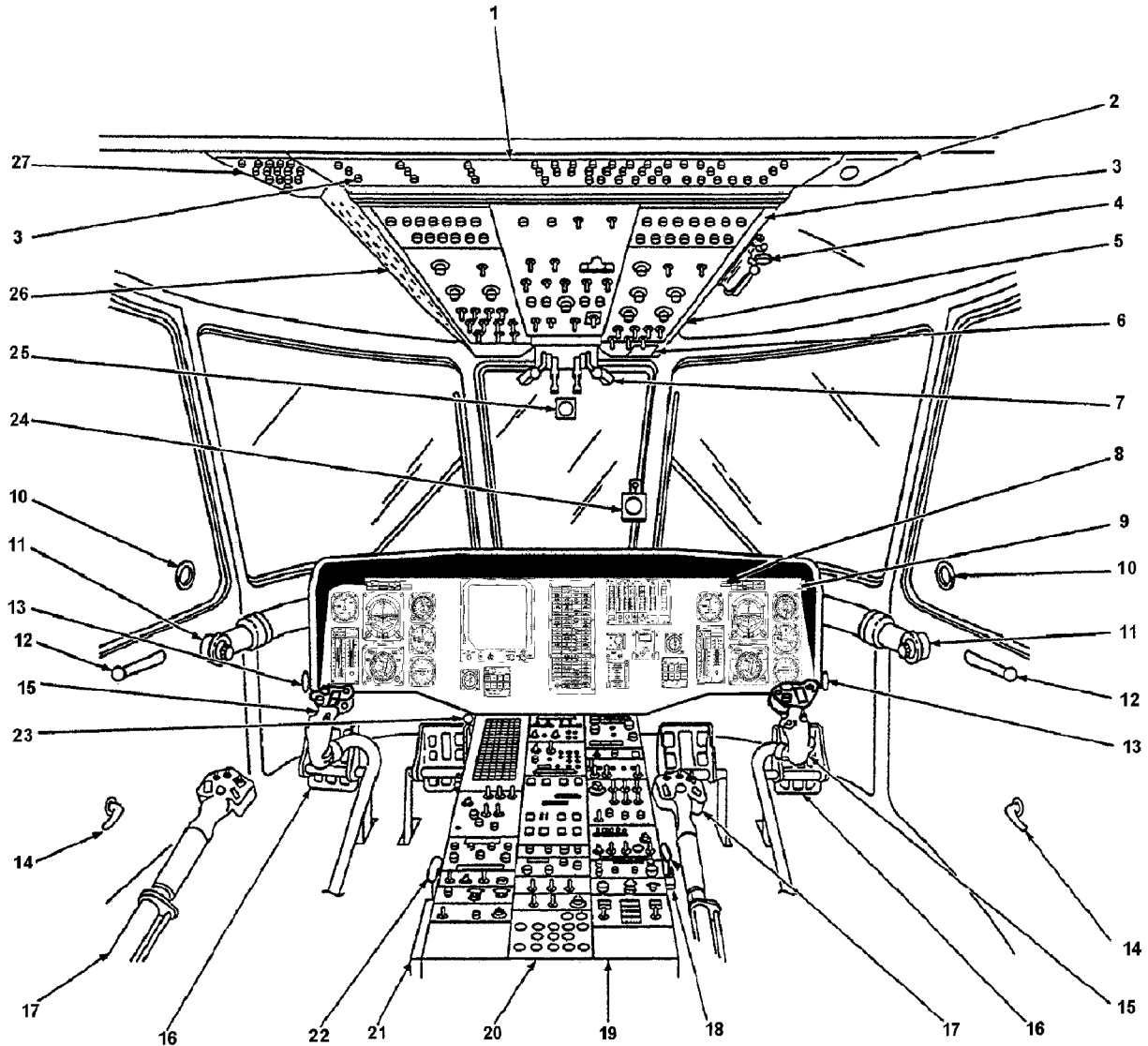
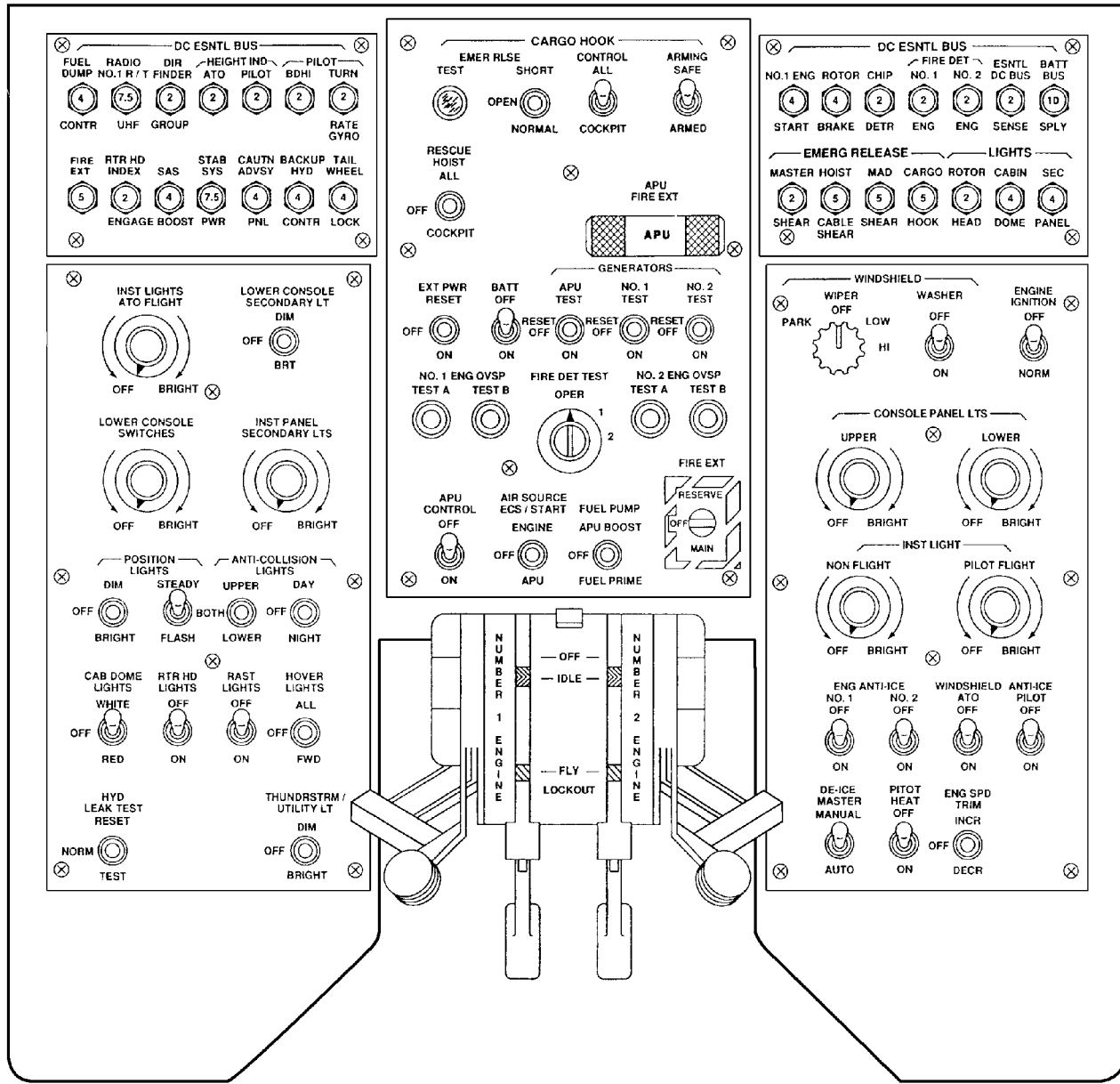


Figure 1-4. Cabin Arrangement



- | | | |
|--|---|---|
| 1. CENTER CIRCUIT BREAKER PANEL | 10. POPOUT AIR VENT | 20. BATT UTIL BUS CIRCUIT BREAKER PANEL |
| 2. COCKPIT SECONDARY/CONSOLE BREAKER PANEL | 11. AIRDUCT | 21. MAP CASE |
| 3. DC ESNTL BUS CIRCUIT BREAKER PANEL | 12. WINDOW EMERGENCY RELEASE HANDLE | 22. RAST EMERGENCY RELEASE HANDLE |
| 4. ROTOR BRAKE MASTER CYLINDER | 13. PEDAL ADJUST HANDLE | 23. NOSE DOOR COOLING DAMPER CONTROL |
| 5. UPPER CONSOLE | 14. INTERIOR DOOR HANDLE | 24. STANDBY COMPASS |
| 6. STANDBY COMPASS CORRECTION CARD | 15. CYCLIC GRIP | 25. FREE-AIR TEMPERATURE INDICATOR |
| 7. ENGINE CONTROL QUADRANT | 16. TAIL ROTOR PEDAL (TYPICAL) | 26. ATO CIRCUIT BREAKER PANEL |
| 8. THREAT INDICATOR | 17. COLLECTIVE GRIP (TYPICAL) | 27. CORNER CIRCUIT BREAKER PANEL |
| 9. INSTRUMENT PANEL | 18. PARKING BRAKE HANDLE/TAIL WHEEL LOCK SWITCH | |
| | 19. LOWER CONSOLE | |

Figure 1-5. Pilot Compartment



SH60B-F222

Figure 1-6. Overhead Console

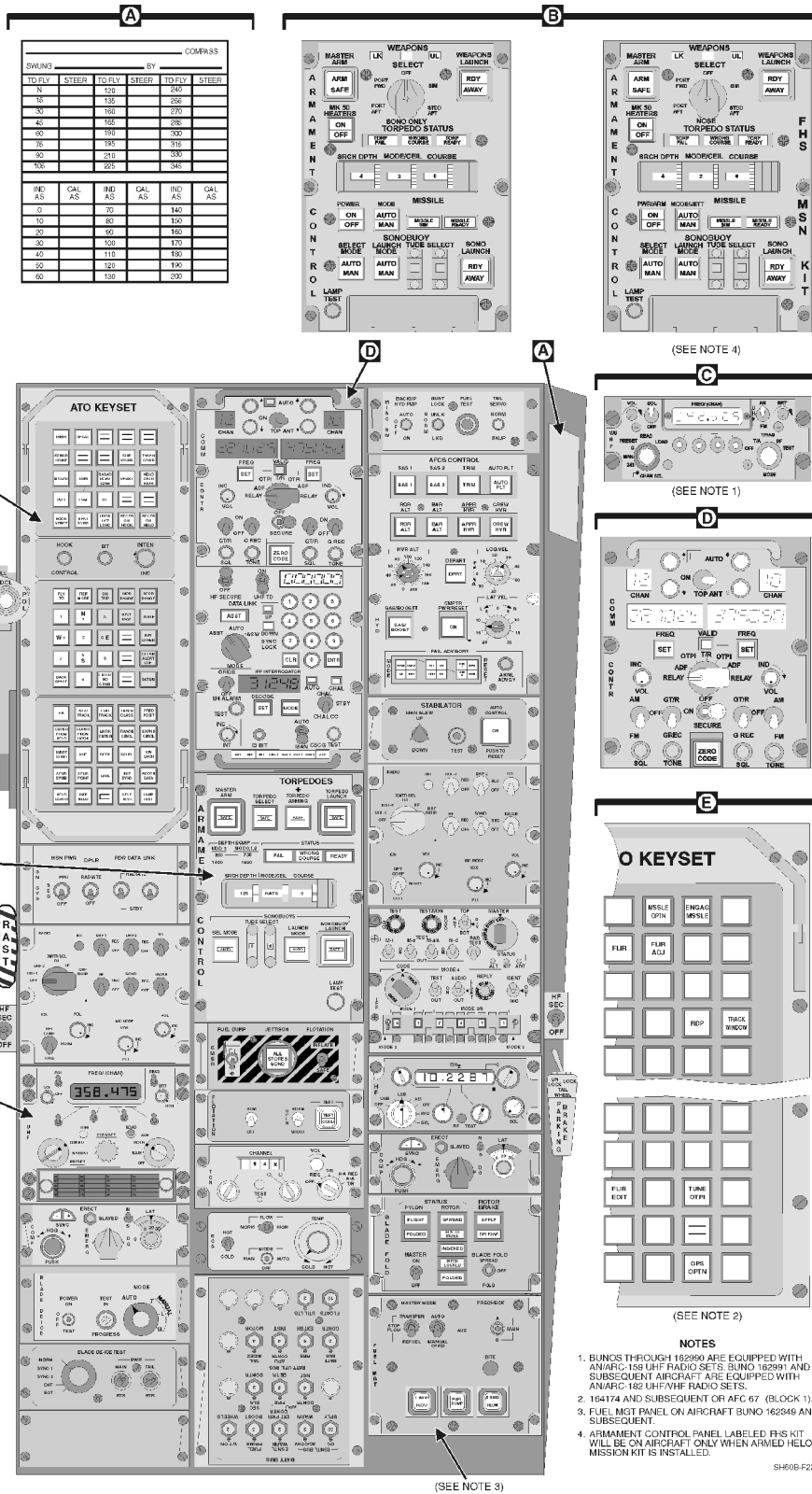
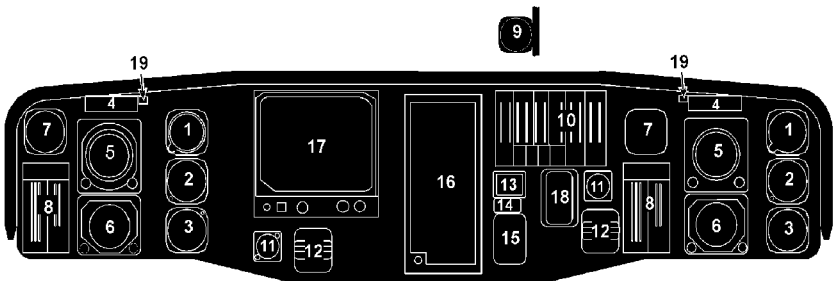
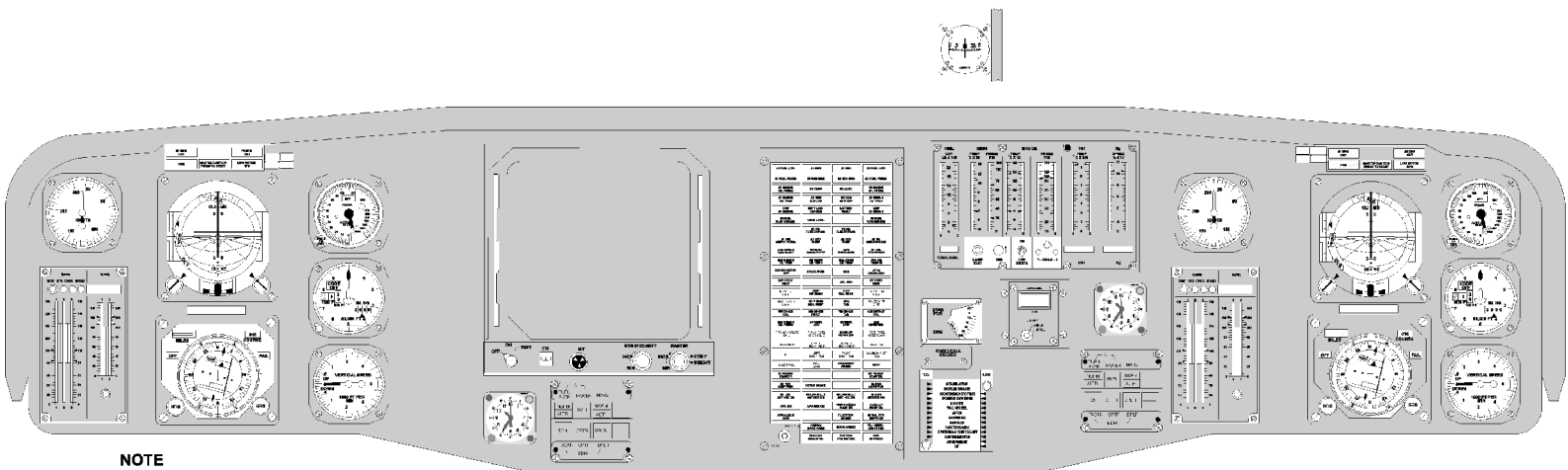


Figure 1-7. Lower Console



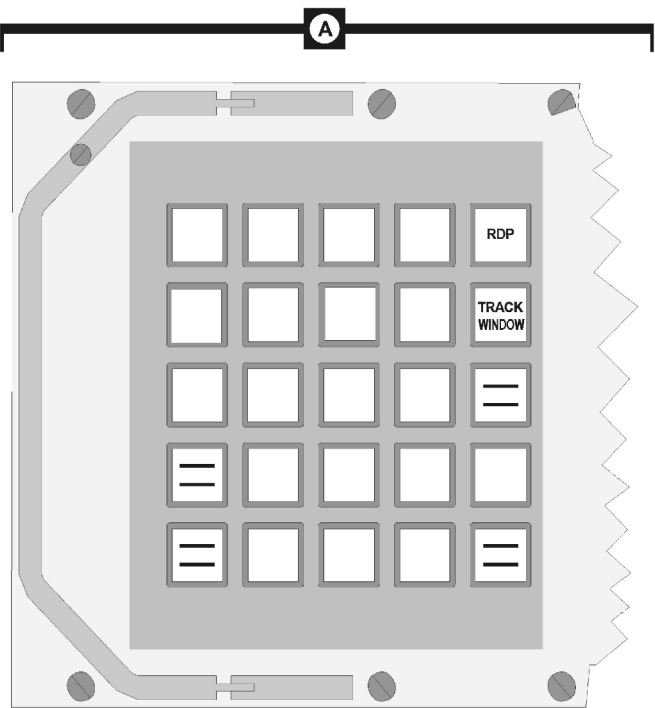
- | | |
|---|---------------------------------------|
| 1. RADAR ALTIMETER | 10. CENTRAL DISPLAY UNIT |
| 2. BAROMETRIC ALTIMETER | 11. CLOCK |
| 3. VERTICAL SPEED INDICATOR | 12. ADI/HSI MODE SELECTOR |
| 4. MASTER WARNING PANEL | 13. STABILATOR POSITION INDICATOR |
| 5. ATTITUDE INDICATOR (AI) | 14. RADIO CALL PLACARD |
| 6. BEARING, DISTANCE HEADING INDICATOR (BDHI) | 15. CHECKLIST |
| 7. AIRSPEED INDICATOR | 16. CAUTION/ADVISORY PANEL |
| 8. PILOT DISPLAY UNIT | 17. CONVERTER DISPLAY |
| 9. STANDBY COMPASS | 18. AUXILIARY FUEL QUANTITY INDICATOR |
| | 19. THREAT INDICATOR |



NOTE
AUX FUEL PANEL ON AIRCRAFT BUNO
162349 AND SUBSEQUENT

SH60B-F221

Figure 1-8. Instrument Panel



EFFECTIVITY
164174 AND SUBSEQUENT OR AFC 67 (BLOCK 1).

SH60B-224

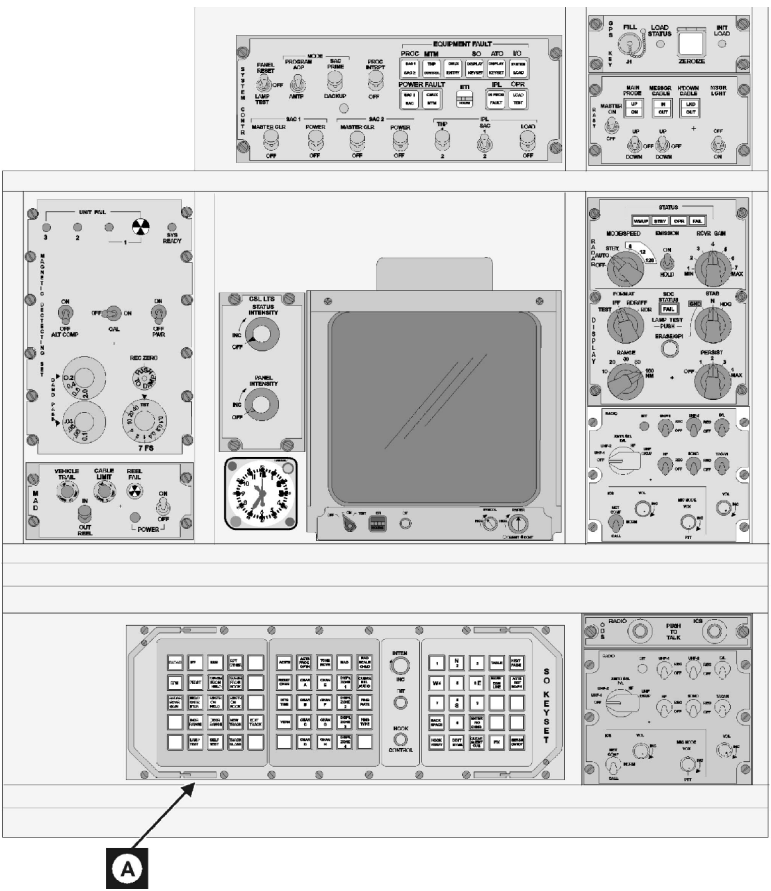


Figure 1-9. SO Console

CHAPTER 2

Systems

2.1 POWERPLANT SYSTEMS AND RELATED SYSTEMS

2.1.1 Engine

The T700-GE-401C engine ([Figure 2-1](#)) is a front-drive, turboshaft engine. It consists of five sections: inlet, compressor, combustor, turbine, and exhaust. The engine incorporates an integral waterwash manifold, inlet particle separator (IPS), a top-mounted accessory section, an engine-driven fuel boost pump, a hydro-mechanical control unit (HMU), an improved digital electronic control unit ([DECU](#)), a self-contained lubrication system, engine condition monitoring and diagnostics provisions.

2.1.1.1 Inlet Section

The inlet section includes the inlet cowling, swirl frame, front frame, main frame, accessory section, and scroll case. The waterwash manifold is an integral part of the swirl frame, which aims a series of jets into the compressor inlet area.

2.1.1.2 Inlet Air Flow

Ambient air first passes through the inlet cowling, the inside of which can be heated with fifth stage bleed air via the inlet anti-ice valve, to prevent ice from forming on the engine inlet. The inlet fairing is also perforated with small slits, to allow fifth stage bleed air to heat the exposed inlet surface for anti-icing purposes. Next, the intake airflow passes through the swirl vanes, which impart rotation to the airflow. The swirl vanes are hollow to permit passage of fifth stage bleed air via the engine anti-ice valve for anti-icing purposes.

2.1.1.3 Inlet Particle Separator

The Inlet Particle Separator (IPS) ([Figure 2-2](#)) prevents foreign particles from entering the compressor. The rotation of the airflow, imparted by the swirl vanes, causes the particles to be thrown outward into the collection scroll. Prior to being dumped overboard through the blower assembly, the IPS discharge airflow passes over the scroll vanes, which are contained in the collection scroll.

Clean air, free of foreign particles, then passes through the de-swirl vanes, which remove the rotation imparted by the IPS, providing smooth airflow to the compressor.

2.1.1.4 Compressor Section

The compressor section consists of a five-stage axial and a single-stage centrifugal rotor/stator assembly.

2.1.1.5 Combustion Section

The combustion section consists of a flow-through, annular combustion chamber, two igniters, and 12 fuel injectors that receive fuel via the Overspeed and Drain Valve (ODV), supplying atomized fuel for combustion.

2.1.1.6 Gas-Generator Turbine

The N_g turbine drives the compressor and accessory gearbox (AGB). It is a two-stage, air-cooled, high-performance axial design.

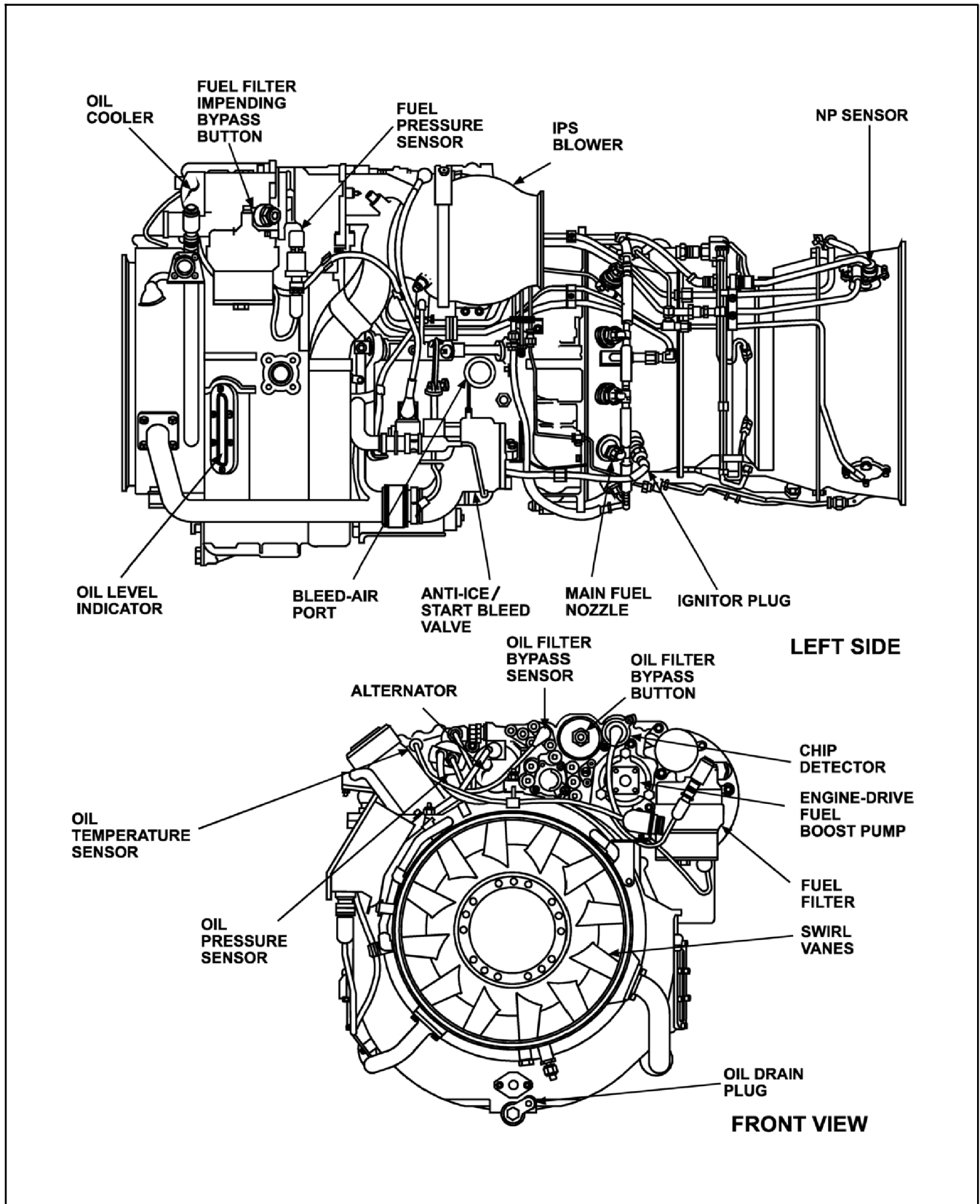


Figure 2-1. Engine, T700-GE-401C Profile (Sheet 1 of 3)

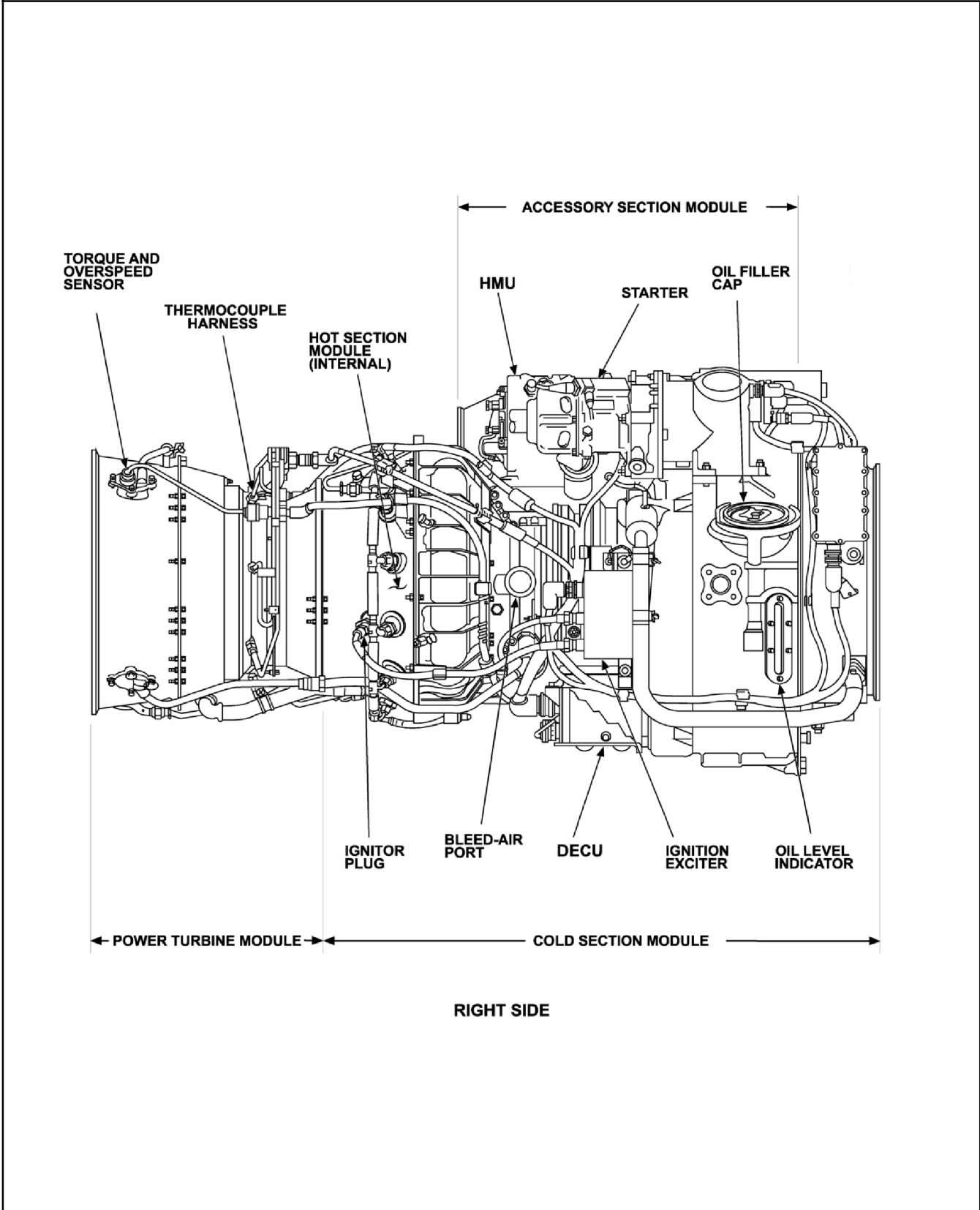


Figure 2-1. Engine, T700-GE-401C Profile (Sheet 2)

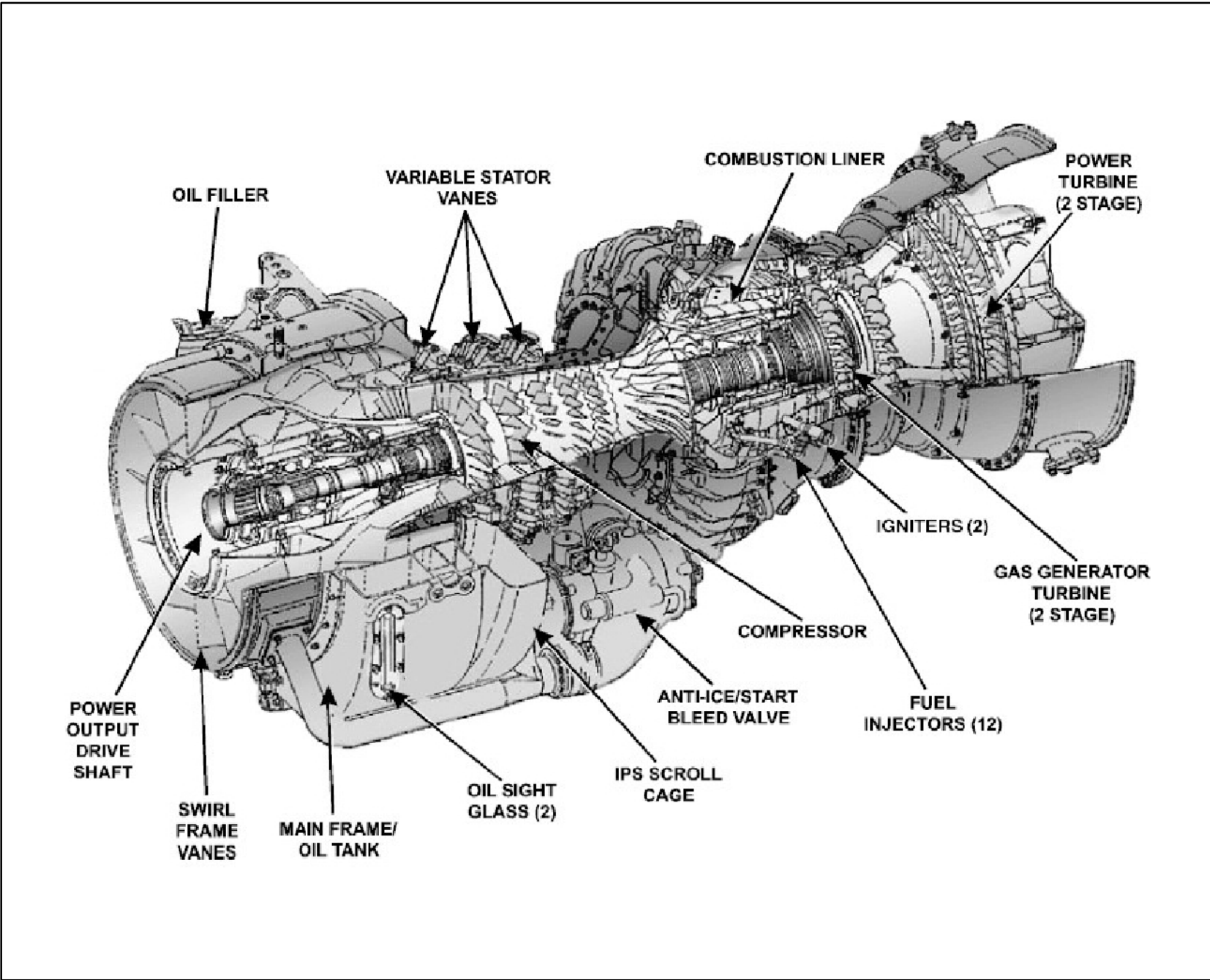


Figure 2-1. Engine, T700-GE-401C Profile (Sheet 3)

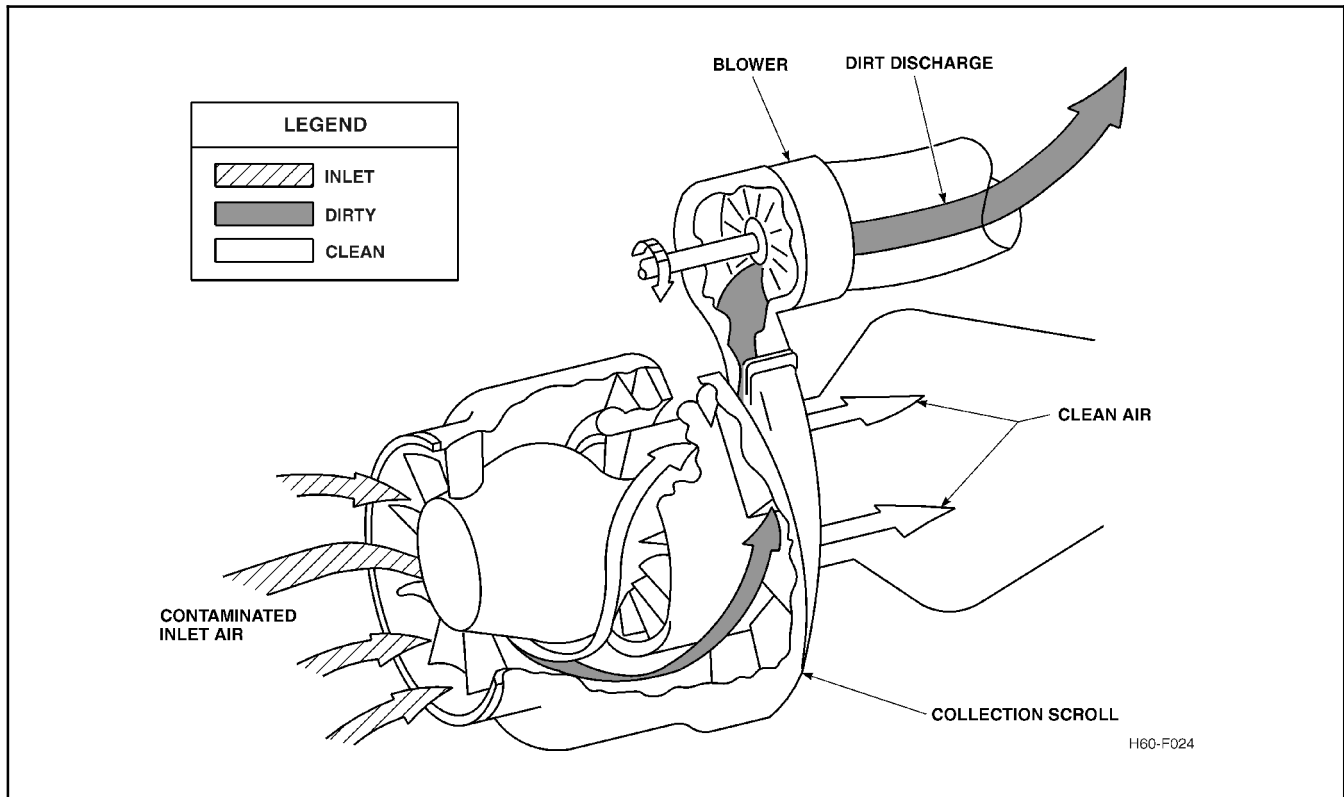


Figure 2-2. Inlet Particle Separator Airflow

2.1.1.7 Power Turbine

The N_p turbine has two stages that turn the power turbine drive shaft. The shaft is coaxial, turning inside the gas-generator turbine drive shaft. It extends through the front of the engine where it connects to the high speed shaft, which in turn connects to the input module. The power turbine is comprised of the power turbine rotors, power turbine drive shaft, power turbine case, and exhaust frame. Turbine Gas Temperature (TGT) is sensed between the gas-generator and power turbine.

2.1.1.8 Engine Airflow

Approximately 30 percent of the total airflow through the engine is used for the combustion process. The remainder is utilized for the following:

1. Compressor inlet temperature (T2) air.
2. Compressor discharge pressure (P3) air.
3. Combustor and turbine cooling.
4. Engine oil seal pressurization.

2.1.1.9 Main Frame and Accessory Section

The main frame contains the oil tank, oil level sight gauge, and accessory gearbox (AGB) supports. The accessory section mounts to the rear of the main frame at the 12 o'clock position, above the scroll case. The AGB is driven by a rotor via a radial drive shaft from the N_g turbine drive shaft. The rear face provides drive pads for the engine starter, HMU, IPS blower, and overspeed and drain valve (ODV). The front face provides drive pads for the alternator and engine-driven fuel boost pump. Mounting cavities are provided for the lube and scavenge pump and chip detector. Face-ported pads are supplied for the oil cooler, fuel filter, and oil filter. Cored passages in the AGB housing convey fuel and oil between components.

2.1.2 Engine Control System

The engine control system (Figure 2-3) includes all control units necessary for the proper and complete control of the engine to maintain a constant N_p/N_r . The major components are the hydromechanical control unit (HMU), overspeed and drain valve (ODV), digital electronic control unit (DECU), an engine-driven alternator, and a series of fuel flow control valves. Basic system operation is governed through the interaction of the DECU and HMU. In general, the HMU provides gas-generator control while the DECU trims the HMU to satisfy the requirements of the power turbine load and reduce pilot workload. The engine control system functions automatically, with no action required of the pilot after starting.

2.1.2.1 Engine Control Quadrant

The engine control quadrant (Figure 2-4) consists of two power control levers (PCL), two fuel selectors levers, two engine T-handles, and a rotor brake interlock. A starter button is located on each PCL. The PCL has four positions (OFF-IDLE-FLY-LOCKOUT).

With the PCL in the OFF position, the Power Available Spindle (PAS) mechanically shuts off fuel at the shutoff valve, within the HMU. Once the PCL is moved to the idle position, the HMU automatically controls start sequence fuel flow allowing the engine to achieve self-sustaining combustion. Placing the PCL in the FLY detent sets the maximum level of power that could be supplied, if demanded. If the PCL is momentarily advanced to LOCKOUT and then retarded, the PCL is used to manually control N_p and N_g . TGT limiting, N_p governing, and load sharing functions are deactivated and must be manually controlled. The N_p overspeed protection system is retained when in LOCKOUT via a direct link between the DECU and ODV. To return to automatic engine control, the PCL must be moved to IDLE, then returned to FLY.

A solenoid on the quadrant activates a mechanical locking device to prevent the PCLs from being advanced above IDLE with the rotor brake on. If the rotor brake is released, the solenoid energizes, and unlocks the PCLs. An override tab is provided on the quadrant, should the solenoid fail. This allows the PCLs to be advanced above ground idle by pulling down on the override tab.

2.1.2.2 Load Demand System

With the PCL in FLY, the HMU responds to collective position, through a load demand spindle (LDS) to automatically control engine speed and to provide required power. When the PCL is moved to LOCKOUT and then to some intermediate position, the engine will still vary power in response to collective position.

2.1.2.3 Engine Fuel System

The engine fuel system consists of the engine-driven fuel boost pump, fuel filter, HMU, and ODV.

2.1.2.4 Engine-Driven Fuel Boost Pump

The engine-driven fuel boost pump mounted on the forward side of the AGB is designed to:

1. Provide reliable suction feed from the aircraft fuel tank to the engine minimizing vulnerability and fire hazard in the event of damaged fuel lines.
2. Provide discharge pressure to satisfy the minimum inlet pressure requirement of the HMU or high-pressure fuel pump.

2.1.2.5 Engine Fuel Filter

The engine fuel filter provides filtration of solid particulate matter, but does not filter water. Fuel enters the filter inlet ports from the engine-driven fuel boost pump and is then routed to the HMU high-pressure fuel pump.

When a pressure differential across the fuel filter is sensed, the impending bypass pressure differential indicator (PDI) extends. The impending bypass PDI cannot be reset until the filter element and bowl are removed and the indicator is reset internally. The electrical bypass switch is activated by a pressure signal as the bypass valve opens. Once the filter is bypassed, the #1/#2 FUEL FLTR BYPASS caution will appear.

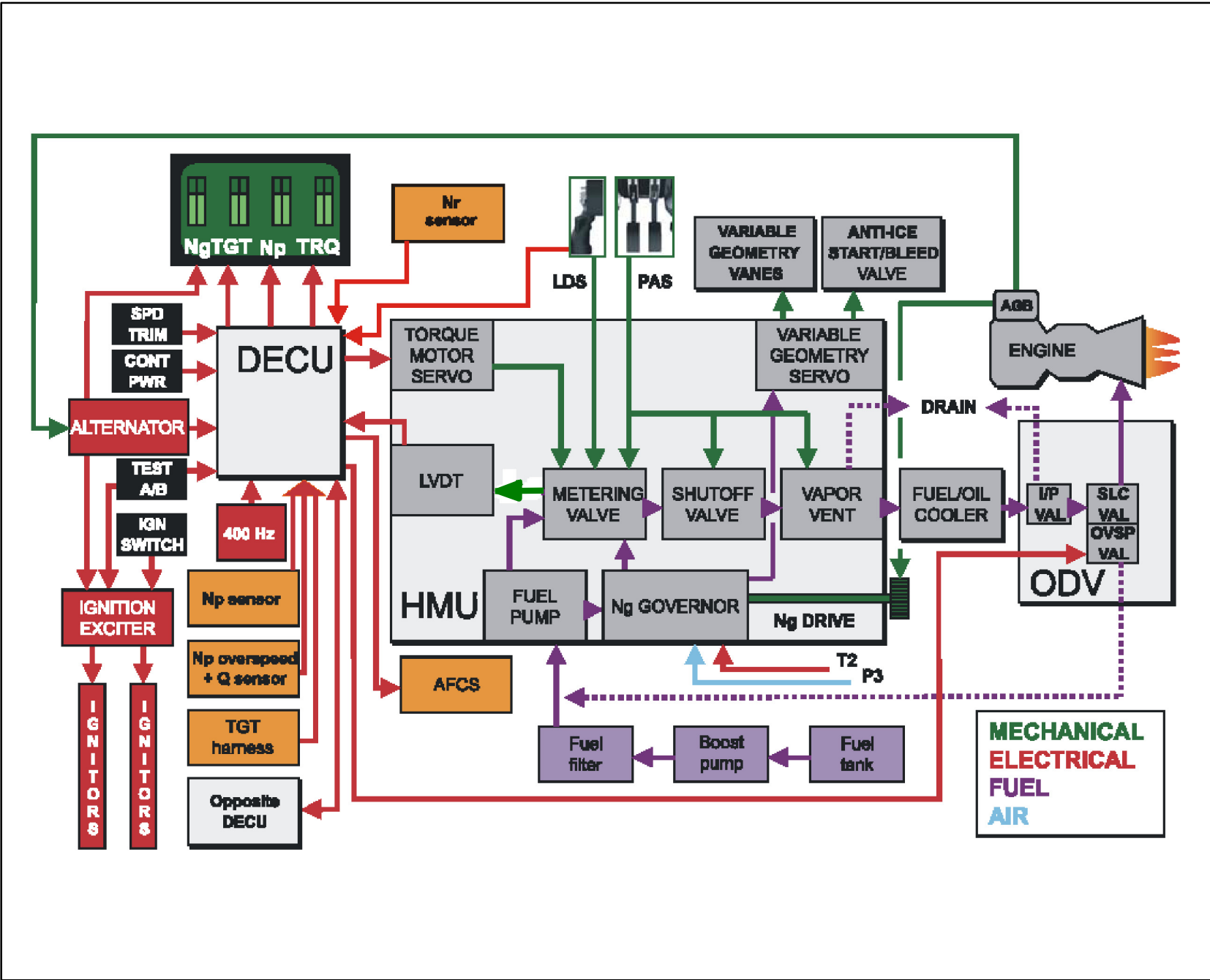


Figure 2-3. Engine Control Block Diagram

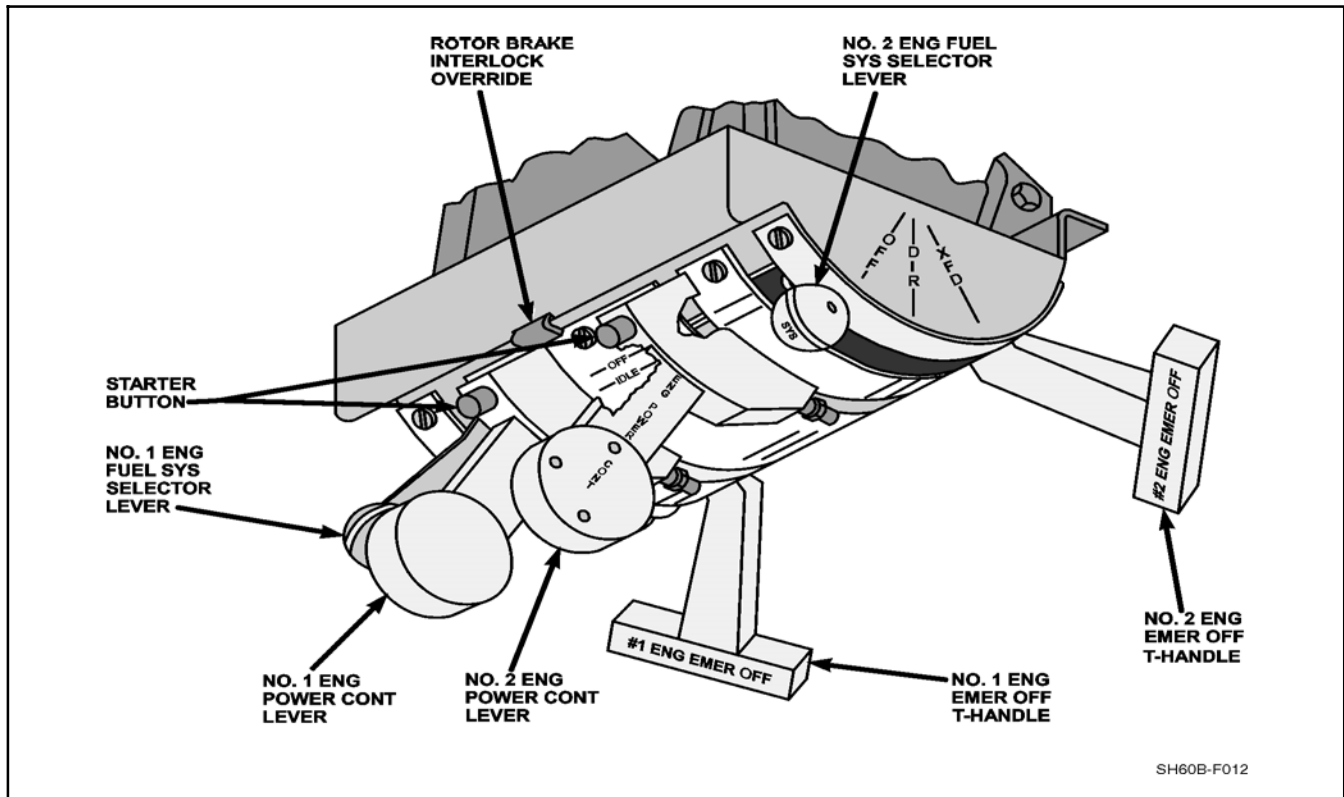


Figure 2-4. Engine Control Quadrant

2.1.2.6 Hydromechanical Control Unit

The Hydromechanical Control Unit (HMU), mounted on the aft center of the AGB, receives filtered fuel through a cored passage. It contains a high-pressure fuel pump, N_g governor, metering valve, linear variable displacement transducer (LVDT), torque motor servo, variable geometry vane servo, vapor vent, and shutoff valve.

The fuel enters the high-pressure engine-driven pump in the HMU, which provides high pressure fuel for efficient engine operation. The fuel leaves the pump and passes through the metering valve and shutoff valve, and is then directed through an external line to the oil-to-fuel heat exchanger. Some fuel is tapped off to operate various servos in the HMU for the following:

1. Positioning a metering valve to assure proper flow to the engine.
2. Positioning a servo piston that actuates the variable geometry vane servo and start bleed valve.
3. Amplifying various signals (T_2 , P_3 , N_g) which influence fuel flow and variable geometry servo position.

2.1.2.7 Inputs to the HMU

The HMU responds to two mechanical linkages from the cockpit and one electrical signal. The first mechanical input from the **LDS** directly coordinates N_g speeds to the approximate power required by the rotor system based on collective position. The second mechanical input is through the **PCL**. The position of the PCL manipulates the **PAS** at the HMU setting the desired power setting. A third input is in the form of an electrical signal from the DECU which actuates the torque motor servo in the HMU to precisely trim N_g speed for power turbine control and load sharing.

HMU receives cockpit inputs from the collective via the LDS and the PCL via the PAS. The HMU responds to the PCL for:

1. Fuel shutoff.
2. Setting engine start fuel flow with automatic acceleration to ground idle.

3. Setting permissible N_g up to maximum.
4. Fuel priming.
5. **DECU** override capability (LOCKOUT).

The HMU also responds to T2, P3, and N_g . These inputs aid the HMU in controlling variable stator vanes and anti-ice/start bleed valve position during engine start and normal operation, reducing the chance of compressor stall.

2.1.2.8 HMU Operation

The HMU operates as a conventional gas-generator power control when there is no input to the torque motor from the DECU. The HMU provides fuel scheduling for minimum flow, maximum flow, and variable stator vane control. Maximum and minimum metering valve stops provide absolute fuel flow limits.

The HMU fuel metering system controls fuel flow to the engine during all operating conditions. Fuel enters the high-pressure engine-driven fuel pump in the HMU, which provides adequate high pressure fuel for efficient engine operation. After fuel leaves the high pressure fuel pump, it is routed to the metering valve. The metering valve schedules engine fuel flow commensurate to current power demand and is trimmed to the required level by the torque motor servo in response to DECU signals. The HMU, via the **LVDT**, then provides a feedback signal to the DECU to null the torque motor servo input, stabilizing metering valve movement and preventing engine oscillation/hunting. Excess fuel is routed back to the pump inlet.

A nonadjustable topping setting controls maximum N_g during cold ambient operation and maximum TGT in the event of an electrical control system failure. If the N_g servo within the N_g governor reaches a position, corresponding to an overspeed, a spring-loaded ball valve ports fuel pressure causing the minimum pressure valve to secure flow to the engine. The N_g overspeed valve is set to trip at 110 percent ± 2 percent N_g .

The PAS sets a maximum available N_g . Placing the PCL in FLY allows N_g to reach a setting that provides intermediate power. Collective movement adjusts available N_g to a power level approximately equal to the rotor load demand power. The actual level of engine power in FLY is normally more than required by the helicopter. This schedule is intentionally placed at a higher-than-required power level for two reasons:

1. Fail-safe to high power. The torque motor, when energized, is designed to reduce the schedule to the desired power level. Therefore, loss of torque motor electrical current causes the schedule to return to the highest power level. A schedule that is biased high due to engine electrical failure does not cause power limiting and can be manually retarded to a more desirable level using the PCL. With all engine protection functions in the HMU operational, neither engine damage nor stall can occur during or following loss of electrical signal to the torque motor.
2. Power available with one engine inoperative (OEI). In the event of a failure of one engine, the remaining engine's gas generator can increase power sufficiently up to its limit (contingency power) to carry the load at the given LDS setting. A load demand signal is introduced to the HMU through the LDS. When the LDS is reduced from its maximum setting by adjusting the collective, the N_g is reset from the PAS setting to provide immediate and accurate gas generator response. This new N_g setting is trimmed by the DECU to satisfy the N_p governing and load sharing functions.

The HMU provides:

1. Rapid engine transient response through collective compensation.
2. Automatic fuel scheduling for engine start.
3. N_g overspeed protection. The HMU mechanically limits N_g to 110 percent ± 2 . If the N_g servo, within the N_g governor, reaches a position corresponding to an overspeed a centrifugal valve secures fuel flow to the engine. Once the overspeed condition has passed, the valve re-opens, allowing normal operation to resume once the engine is primed and restarted.
4. N_g governing. The HMU receives T2, P3, and N_g inputs from their respective sensors, which are used to schedule fuel for minimum flow, maximum flow, and variable geometry vane control.

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5. Acceleration limiting. The N_g governor ensures any PCL motion will result in safe engine operation and will not cause engine damage. Except for intentional shutoff of the PCL, an inadvertent shutdown will not occur during PCL motion.
6. Flameout and compressor stall protection. The HMU adjusts variable-geometry vane position and opens the anti-ice/start bleed valve to prevent compressor instability.

2.1.2.9 Overspeed and Drain Valve

When the PCL is advanced to IDLE during engine start, the shutoff valve in the HMU opens and allows metered fuel to flow to the Overspeed and Drain Valve (ODV) inlet. The ODV has four main functions:

1. Provides main fuel flow to the 12 fuel injectors during engine start and operation.
2. Purges the main fuel manifold overboard, after engine shutdown, through a shutoff and drain valve to prevent coking of the fuel injectors.
3. Traps fuel upstream, which keeps the fuel/oil heat exchanger full, so that system priming is not required prior to the next start.
4. Returns fuel back to the HMU if the N_p overspeed is energized or if the DECU hot start preventer is activated.

2.1.3 Engine Electrical System

2.1.3.1 Alternator

All essential engine electrical functions are powered by the alternator. The engine contains separate windings providing AC power to the Ignitor assembly, DECU, and N_g signal to the VIDS.

2.1.3.2 Digital Electronic Control Unit

The Digital Electronic Control Unit (DECU) resets the HMU within acceptable engine limits to maintain N_p governing while automatically limiting TGT.

The DECU is mounted below the compressor casing. The forward face of the DECU projects into the collection scroll case of the IPS where it is cooled by scavenge airflow. Four connectors provide for interconnection with the other engine control components, airframe systems, and the diagnostic equipment. The control parameters of the DECU are:

1. N_p sensing (governing).
2. N_p overspeed and torque sensing (load sharing, cockpit torque indication, and N_p overspeed protection).
3. TGT monitoring (temperature-limiting circuit).

The DECU receives the following inputs from the cockpit:

1. ENGINE SPD TRIM switch.
2. CONTGCY PWR switch.
3. ENG OVERSPEED TEST A and B buttons.

The DECU receives the following input signals from the helicopter:

1. Torque from the other DECU.
2. N_p demand.
3. 400-Hz backup power.
4. HMU (LVDT).

The DECU sends the following signals to the cockpit:

1. Torque.
2. N_p .
3. TGT.
4. Contingency power.

2.1.3.3 DECU Operation

During normal operations, the DECU performs the following functions:

1. N_p Governing - The N_p sensor located on the left side of the power turbine section provides an N_p signal to the DECU. Actual N_p is compared to a reference N_p to compute a speed error input signal for use in electrical control computation.
2. N_p Overspeed Protection - The N_p overspeed system is composed of redundant circuits, which rely on a signal from the N_p overspeed and torque sensor located on the right side of the power turbine section. The overspeed system is actuated at 120 percent N_p . When N_p exceeds 120 percent, a signal is sent from the DECU to the **ODV**, diverting fuel to the inlet of the HMU, causing engine flameout.

WARNING

A popped NO. 1 ENG OVSP or NO. 2 ENG OVSP circuit breaker shall not be reset in flight. Resetting a popped NO. 1 or NO. 2 ENG OVSP circuit breaker may initiate an engine overspeed signal and result in engine failure.

3. TGT Limiting - Measured TGT is compared to a fixed reference. When temperature is above the reference, a signal is generated to reduce fuel flow. When TGT approaches 851 °C, the DECU prevents any further increase in fuel flow to the engine. The intermediate range power (IRP) limiter will prevent this at 839 °C ±10 °C. If power demand is increased further, N_p/N_r will droop below 100 percent; N_p governing will be sacrificed to protect the engine against over temperature.
4. Engine Load Sharing - Torque signals are compared between the two engines via the respective DECUs. A torque error signal is generated if one engine torque is less than the other. The torque matching system operates by increasing power on the lower torque engine, while not directly affecting the higher torque engine.
5. Engine Speed Trim - An ENG SPD TRIM switch, located on the upper console, with positions **INCR** and **DECR**, controls the N_p of both engines simultaneously. There is no individual engine trim capability. The ENG SPD TRIM switch supplies a reference electrical signal to the DECUs for controlling N_p as required between 96 percent and 101 percent N_p .
6. Contingency Power - The TGT limit can be increased by placing the CONTGCY PWR switch on the collective to the ON position. This sends a signal to the DECU to allow TGT to increase to 903 °C however; the maximum contingency range power (CRP) limiter will prevent further increase in fuel flow to the engine at 891 °C ±10 °C. The #1/#2 ENG CONT PWR ON advisories indicate that contingency power has been selected. Placing the CONTGCY PWR switch to the ON position automatically deactivates the Environmental Control System (ECS).
7. N_p Overspeed Test - The test mode is activated by the ENG OVERSPEED TEST A and B buttons. When both switches are actuated, the N_p overspeed limit is re-referenced to 96 percent N_p . If power turbine speed decreases when either switch is pressed individually, the opposite test switch may be faulty.
8. DECU LOCKOUT operation capability - After being moved momentarily to LOCKOUT, the PCL is used to manually control N_g and N_p . As a result, engine power is no longer controlled by the DECU; it is set by PAS and LDS positions only. With the PCL in LOCKOUT the torque motor servo is disabled therefore deactivating TGT limiting, N_p governing, and load sharing. The N_p overspeed protection system is retained when in LOCKOUT. To regain automatic engine control, the PCL must be moved to IDLE then returned to FLY.

9. Cockpit Signals - Provides N_p , TGT, and torque signals to **SDC** for cockpit display.
10. Hot Start Prevention - Detects a hot start when TGT exceeds 900 °C with N_g below 60 percent and N_p below 50 percent and automatically stops fuel flow by tripping the ODV. Fuel flow is restored when TGT either decreases to 300 °C or after 25 seconds, whichever occurs first. Hot start prevention can be disabled by pressing and holding the ENG OVSP TEST A or B button for the duration of the start sequence. A self-test of the hot-start prevention system is performed while conducting a normal N_p overspeed system test.
11. Fault Diagnostic System - The DECU incorporates signal validation for selected input signals within the electrical control system. Signals are continuously validated when the engine is operating. If a failure has occurred, the failed component or related circuit will be identified by a pre-selected fault code. It is possible to have more than one fault code detected and each code should be treated as an individual fault. Fault codes will be displayed numerically on the engine torque indicator. Codes are displayed starting with the lowest code (4 seconds on and 2 seconds off), rotating through all codes, and then repeating the cycle. They can be suppressed/recalled by depressing either one of the ENG OVSP TEST buttons. Once the problem has been corrected, the codes will be cleared and may be verified after operating the engine at FLY. The fault codes displayed for approximately one minute when the following conditions are met:
 - a. N_g less than 20 percent.
 - b. N_p less than 35 percent.
 - c. Other engine is shutdown.
 - d. Aircraft 400 Hz power is available.

Note

If fault codes are not suppressed, **DAFCS** ground checks and blade fold will be inoperative.

12. 400-Hz airframe backup power capability - DECU functions receive 400-Hz AC power from the aircraft electrical system in the event of an alternator failure. A failure of either power supply by itself will have no impact on the DECU's ability to control the engine.
13. Transient Droop Improvement (TDI) - The TDI system is designed to initiate power turbine acceleration early by using anticipator signals from the TDI N_r sensor located on the left accessory module and a collective position sensor in the mixing unit. Circuits in the DECU increase fuel flow to the engine via the HMU torque motor servo at low torque settings when collective demand is increased rapidly or in the event of rapid N_r decay.
14. Auto Ignition System - When an N_p overspeed condition is reached and during the N_p Overspeed Test, the overspeed valve located in the ODV is opened to reroute fuel flow to the HMU inlet. When N_p drops below 120 percent, the auto ignition system closes the overspeed valve and turns on the igniters for 5 seconds to relight the engine. The N_p overspeed/auto-ignition system will continue cycling until N_p/N_r is controlled. A yaw kick may be experienced each time engine relights.
15. N_g Decay Rate Relight Feature - The auto-ignition system also includes an N_g -decay rate relight feature. If an engine flames out for any reason and exceeds a specified N_g deceleration rate, the auto-ignition system will turn on the igniters for five seconds in an attempt to relight the engine. The N_g -decay rate relight feature is disabled below 62 percent N_g .

2.1.3.4 Ignition System

The AC powered ignition system includes an ignition exciter unit, mounted on the right side of the engine main frame, and two igniter plugs. The ENGINE IGNITION switch, labeled OFF/NORM, is located on the upper console and serves both engines. When in the NORM position and either starter button depressed, the ignition system operates. Ignition is automatically shut off after the engine start motor is disengaged at starter dropout speed. In the OFF position, the system is de-energized, but engine motoring capability remains. Electrical power to the ignition exciter assembly is supplied by the engine-driven alternator during engine start or whenever the auto-ignition feature is activated.

2.1.4 Engine Operation Summary

2.1.4.1 Starting and Ground Idle

After engaging the starter, the shutoff valve in the HMU is opened by advancing the PCL to IDLE. Fuel is automatically scheduled by the HMU to a fixed flow at light-off and then an acceleration fuel flow as a function of N_g , P3, and T2 to idle. In idle, fuel flow is scheduled automatically. Power turbine speed is not governed with the PCL in IDLE since the engine will not produce enough power to drive the power turbine to 100 percent.

2.1.4.2 Takeoff and Climb

Before takeoff, the PCL is advanced from IDLE to the FLY detent. This allows the rotor head to accelerate to 100 percent N_p/N_r . N_g will increase as the PCL is advanced and will stabilize once the N_p governing speed of 100 percent is reached.

As collective pitch is increased, the LDS rotates within the HMU, demanding an increase in N_g to maintain 100 percent N_p/N_r . The DECUs adjust fuel flow to match torques and trim N_p/N_r to 100 percent. As N_g increases, the HMU schedule closes the anti-ice/start bleed valve, and the variable stator vanes open to increase airflow through the combustor and turbine. If collective pitch is increased significantly, TGT may approach the limiting value. When this occurs, the DECU prevents any further increase in fuel flow to the engine. If the power required is increased further, N_p/N_r will droop below 100 percent; N_p governing will be sacrificed to protect the engine against overtemperature.

2.1.4.3 Cruise and Descent

When collective pitch is reduced, the LDS will reduce fuel flow and N_g . The variable stator vanes will close slightly to optimize fuel consumption and preserve stall margin. Upon entering a descent, the same sequence of events reduces N_g to the point that the anti-ice/start bleed valve may begin to open. If the collective is fully lowered (e.g., autorotation power-off descent), both engine torque indications drop to zero by intervention of freewheeling units in the input modules. Once the engines are uncoupled from the rotor, N_r is free to accelerate above 100 percent. Both engines continue to govern N_p at 100 percent, ready to pick up the rotor load when collective is increased.

2.1.4.4 Summary

The engine control system functions automatically, with no action required of the pilot after starting. The system is functionally split between the HMU and DECU; the HMU provides functions essential to safe engine operation, while the DECU performs a fine trim to reduce pilot workload.

2.1.5 Engine Oil System

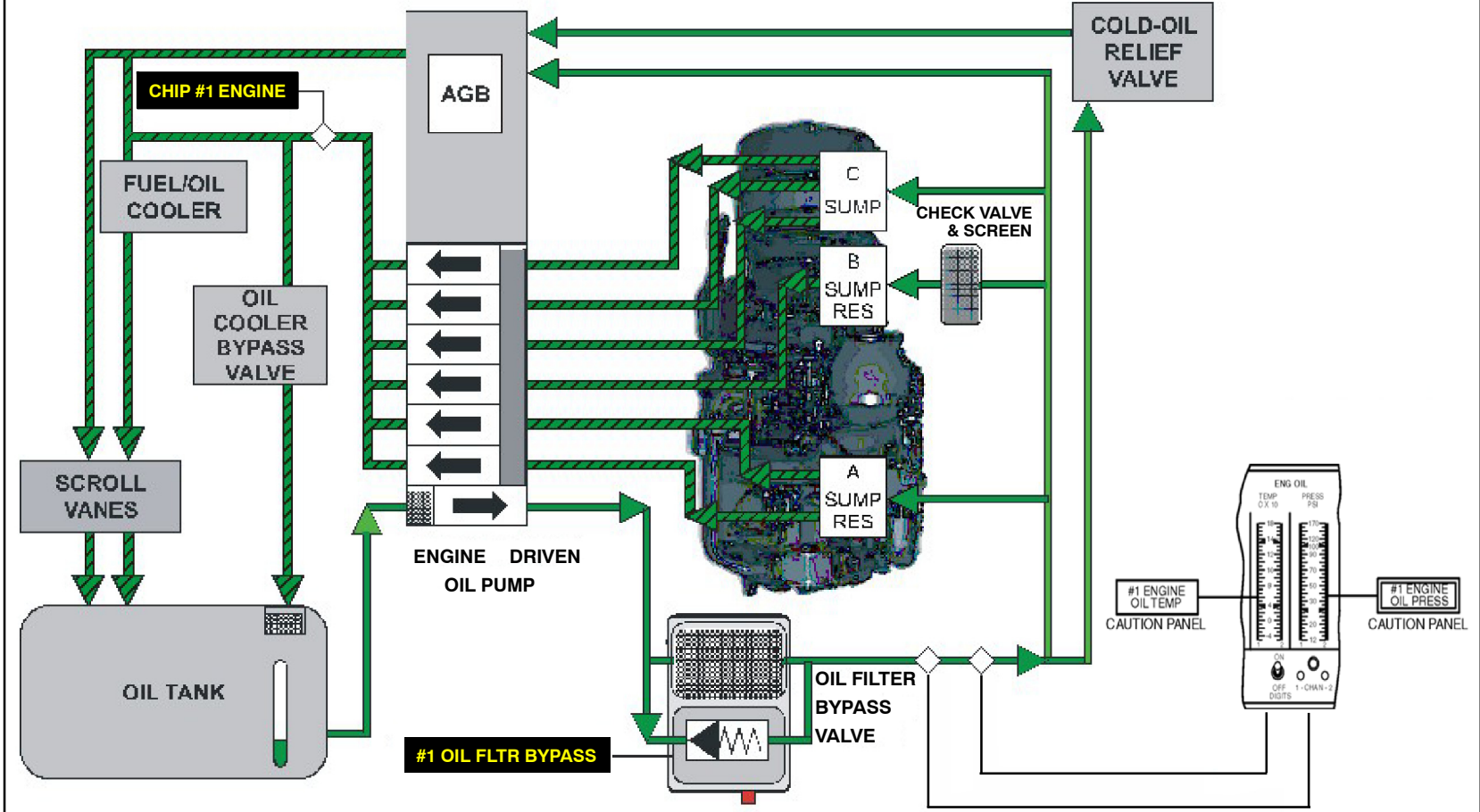
The engine oil system (Figure 2-5) is a self-contained, pressurized, recirculating, dry-sump system. It consists of the following systems and components:

1. Oil supply and scavenge system.
2. Oil filter and condition monitoring system.
3. Oil Tank.
4. Air/oil cooler (scroll vanes).
5. Fuel/oil cooler.
6. Chip detector.
7. Pressure and temperature indicators.

2.1.5.1 Oil Tank

The filler port is located on the right side of the engine (Figure 2-1). The oil level is indicated by a sight gauge on each side of the tank. Due to the design of the filler port, over-servicing is not possible. The scavenge pump returns oil from the sumps and AGB to the oil tank.

Figure 2-5. Engine Oil System



Note: The number of scavenge lines do not correlate to the number of bearings per sump.

2.1.5.2 Oil Supply and Scavenge System

Oil is picked up by suction created through the pressure element of the pump. It is then pressurized and flows through the oil filter into the passages in the AGB and the six main sump bearings. The engine is designed with two sets of oil jets to provide each main bearing with oil for lubrication and cooling. This redundancy provides for a brief period of operation following a malfunction or damage that totally interrupts the normal supply of oil. Scavenge oil flows through the pump inlet, electrical chip detector, fuel/oil cooler, the main frame, scroll vanes, and into the oil tank. If the oil pressure drops below limits, a caution, marked #1 or #2 ENGINE OIL PRESS will illuminate.

2.1.5.3 Oil Filter

Oil is discharged from the oil pump and routed to a disposable filter element. As the pressure differential across the filter increases, the impending bypass PDI will pop out, providing a visual indication that the filter element needs to be replaced. If the pressure differential continues to increase, the oil filter bypass sensor switch will activate the #1/#2 OIL FLTR BYPASS caution, indicating an oil filter bypass. When operating with a partially clogged filter, the high-pressure differential across the filter will cause the bypass valve to open and the caution to appear. The impending bypass PDI has a thermal lockout below 38 °C to prevent the indicator from popping during cold-weather starting.

2.1.5.4 Oil Cooler

Scavenge oil is cooled before it returns to the tank by a fuel/oil cooler mounted on the forward face of the AGB (Figure 2-5). As oil from the chip detector passes through the oil cooler, it is cooled by transferring heat from the oil to fuel.

After passing through the oil cooler, oil enters the top of the mainframe, where it flows through the scroll vanes that function as an air/oil cooler. This further cools the oil and heats the vanes for full-time anti-icing.

2.1.5.5 Engine Chip Detector

The chip detector consists of a housing with an integral magnet and electrical connector. The detector attracts ferrous metal particles at a primary chip-detecting gap. Chips are detected when this gap is bridged. A signal is then sent to the cockpit to illuminate the CHIP #1 ENGINE or CHIP #2 ENGINE caution.

2.1.6 Oil Temperature and Pressure Monitoring System

Engine oil system pressure and temperature sensors are mounted on the left forward face of the AGB. These sensors provide a signal to the VIDS for oil pressure and temperature indications. The #1/#2 ENGINE OIL PRESS and #1/#2 ENGINE OIL TEMP cautions are activated by the VIDS.

2.1.7 Engine Start System

The pneumatic start system (Figure 2-6) uses an air turbine engine start motor for engine starting. System components consist of an engine starter, start valve, check valves, controls, and ducting. One of two pneumatic sources may be selected as the source of air for engine starts: APU or engine crossbleed air.

The AIR SOURCE ECS/START switch is a three-position toggle switch that selects the source of air pressure for engine start and ECS operation. When the start button is pressed, air from the selected source is directed through the start valve to the engine starter. The #1/#2 ENGINE STARTER advisory will go on. The anti-ice/start bleed valve remains open to reduce backpressure and prevent compressor stall until N_g reaches approximately 90 to 94 percent (OAT-dependent). The #1/#2 ENG ANTI-ICE ON advisory will remain until the anti-ice/start bleed valve is energized closed.

As the engine alternator begins to turn, it supplies electrical power to the ignition exciter. Ignition will continue until starter dropout occurs (52 to 65 percent N_g). Once the starter drops out, the #1/#2 ENGINE STARTER advisory will disappear. If the starter fails to drop out automatically, it may be disengaged by pulling down on the PCL, pulling the circuit breaker or removing the air source. A malfunctioning starter may be overridden by manually holding in the starter button until N_g reaches 52 to 65 percent N_g .

2.1.7.1 Engine Start, APU

The APU provides bleed air and electrical power for engine starting. The APU will provide pneumatic power for engine start regardless of AIR SOURCE ECS/START switch position.

2.1.7.2 Engine Start, Crossbleed

Crossbleed engine starts are used when it is desired to start the other engine with the bleed air from the operating engine. The AIR SOURCE ECS/START switch must be placed to ENG and the operating engine must be at a minimum of 94 percent N_g or maximum N_g that can be safely attained. Pressing the starter button will simultaneously open the start valve on the engine not operating and the crossbleed valve on the operating engine.

2.1.8 Engine and Inlet Anti-Ice System

The engine and inlet anti-ice system (**Figure 2-7**), prevents ice buildup on the components of the engine inlet section. The system consists of the engine anti-ice start/bleed valve, mounted to the bottom of the compressor section, an inlet anti-ice valve and an inlet thermal switch, contained in the engine inlet cowling.

Hot air flow for anti-icing is distributed through two solenoid operated air valves. Both valves are held closed electrically and controlled by the ENGINE ANTI-ICE and DE-ICE MASTER switches on the upper console. When the engine inlet anti-ice valve is de-energized (valve open), bleed air is routed to a separate modulating valve in the engine inlet. When the DEICE MASTER switch is in the AUTO position, both solenoid valves are controlled by the ice detector.

There are three ways to anti-ice the engine:

1. Vent bleed air into the engine swirl vanes and engine inlet guide vanes (IGV) by the engine anti-ice/start bleed valve.
2. Vent bleed air into the airframe engine inlet by the engine inlet anti-ice valve.
3. Continuously pump engine oil through the scroll vanes.

2.1.8.1 Engine Anti-Ice/Start Bleed Valve

The engine anti-ice/start bleed valve provides 5th stage bleed air to the engine with anti-ice selected ON, and opens during engine starts. The valve remains open below approximately 90 percent N_g , to prevent compressor instability during starts. Above approximately 90 percent N_g , the anti-ice/start bleed valve closes, unless anti-ice is selected on, or the aircraft experiences a loss of electrical power. The temporary hang up of the engine variable geometry (VG) system at the anti-ice/start bleed valve may cause engine flameouts at low collective settings. The VG system is activated by fuel pressure from the HMU. To release the VG system quickly from any temporary hang-up condition while the collective is full down, the HMU will schedule maximum fuel flow to the VG actuator creating a diversion from the scheduled fuel flow to the engine. During these minimum fuel flow regimes, such as autorotations and quick stops, this diversion may be sufficient to flame out an engine.

A malfunctioning anti-ice/start bleed valve is indicated by any of the following:

1. Illumination of the ENG ANTI-ICE ON advisory light with above 90 percent N_g or above 94 percent N_g if OAT is 15° or greater.
2. No illumination of the ENG ANTI-ICE ON advisory light when N_g drops below approximately 88 percent N_g . (N_g may vary on a sliding scale depending on OAT).
3. No illumination of the ENG ANTI-ICE ON advisory light when the ENG ANTI-ICE switch is selected ON.
4. No rise in TGT when ENG ANTI-ICE switch is selected ON.

Note

With ENG ANTI-ICE ON, max torque available is reduced up to 18 percent per engine.

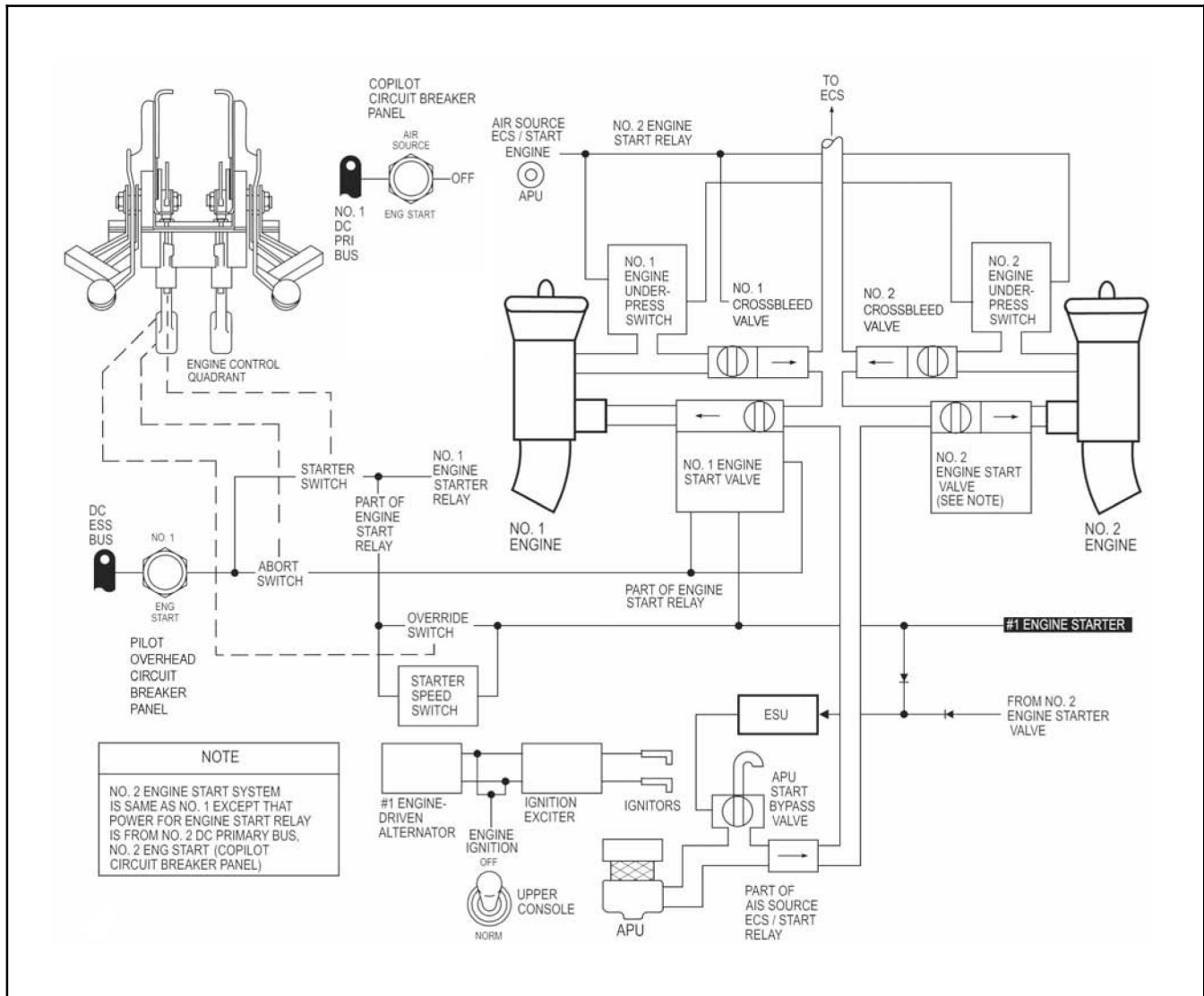


Figure 2-6. Engine Start Pneumatic/Electrical System, Block Diagram

2.1.8.2 Engine Inlet Anti-Ice Valve

The engine inlet anti-ice valve is a solenoid-actuated, modulating valve located in the engine inlet cowling. Bleed air is routed from the compressor, through the solenoid-actuated inlet anti-ice valve, then routed to the inlet cowling and inlet fairing.

The inlet thermal switch, mounted inside the engine inlet cowling, senses the air temperature inside the cowling. The NO. 1 or NO. 2 ENG INLET ANTI-ICE advisory will illuminate when bleed air heats the engine inlet to approximately 93 °C; however, full inlet anti-ice capability may not be available above 4 °C and will not be available above 13 °C. The inlet thermal switch does not have any input into or control over the inlet anti-ice valve or the Freon bellows.

With the NO. 1 and NO. 2 ENGINE ANTI-ICE switches OFF, the solenoid is energized and the valve is closed. With the NO. 1 and NO. 2 ENGINE ANTI-ICE switches ON, the engine inlet anti-ice valve is variably open based on OAT. With the NO. 1 and NO. 2 ENGINE ANTI-ICE switches OFF, the DE-ICE MASTER switch in AUTO, and ice is detected, the engine inlet anti-ice valve is variably open based on OAT.

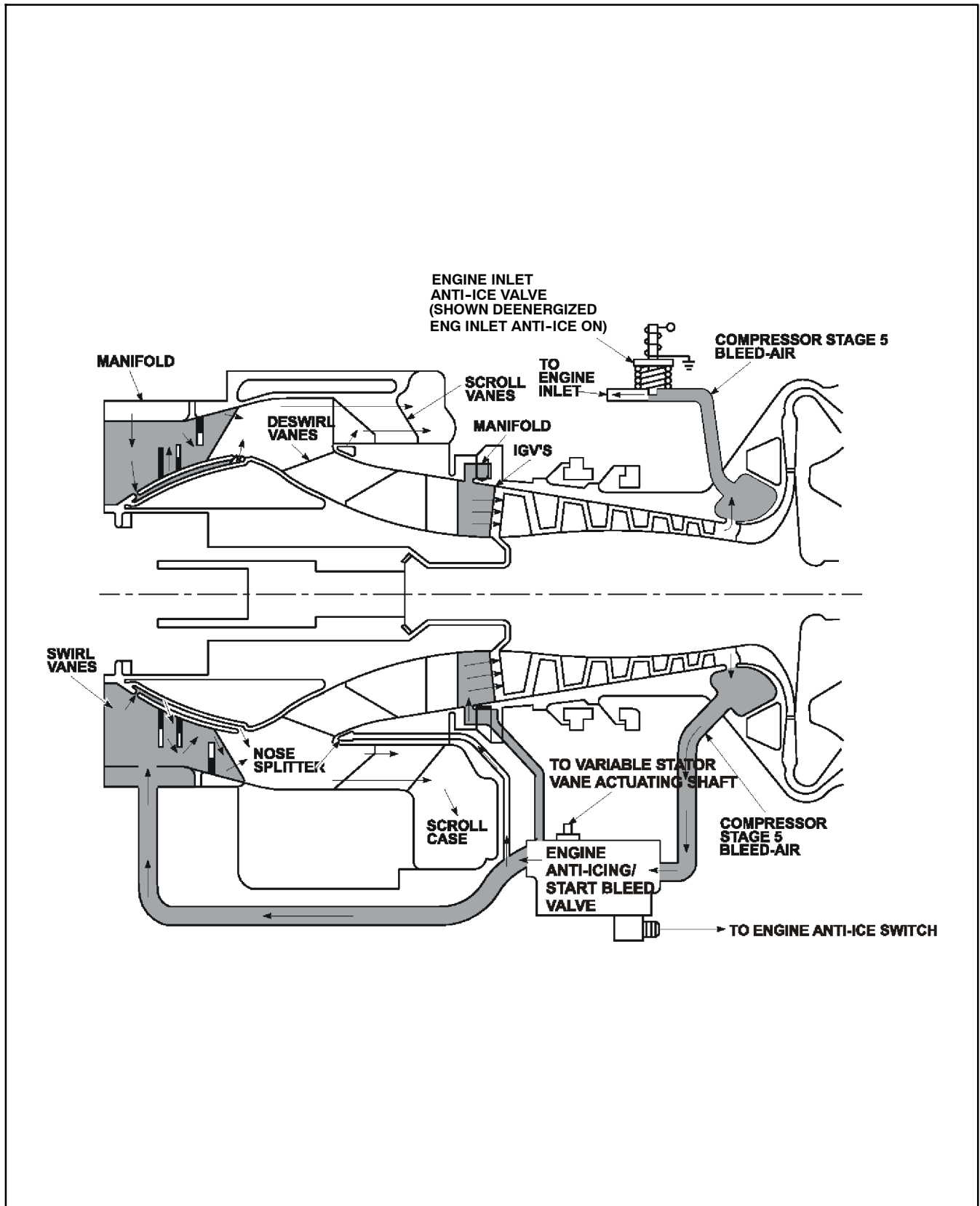


Figure 2-7. Engine and Inlet Anti-Ice System

Though the engine inlet anti-ice valve may be de-energized open, the release of fifth stage compressor bleed air into the engine inlet cowling and inlet fairing is ultimately controlled by the Freon-filled bellows, which reacts only to the ambient temperature. The bellows operates as follows:

1. Less than 4 °C, the valve is open and the ENG INLET ANTI-ICE ON advisories appear when inlet temperature reaches 93 °C.
2. Between 4 °C and 13 °C, the valve is controlled by a temperature compensating Freon-filled bellows. The bellows begin closing the valve when the OAT reaches 4 °C and should be completely closed by 13 °C.
3. Above 13 °C, the valve is closed and the ENG INLET ANTI-ICE ON advisories will extinguish when inlet cowling temperature drops below 93 °C.

WARNING

Illumination of the ENG INLET ANTI-ICE ON light when OAT is above 13 °C is an indication of a faulty engine inlet anti-ice modulating valve. The resultant loss of power could be a maximum of 49 percent when the engine anti-ice system is activated.

2.1.8.3 Engine Oil Circulation Through the Engine Scroll Vanes

An additional method of engine anti-ice protection is provided by the continual circulation of hot engine oil through the engine scroll vanes. The primary function of this circulation is to cool the hot engine oil providing anti-icing of the main frame. The air heated by the scroll vanes is vented overboard through the IPS and does not provide anti-ice protection to the air entering the compressor section of the engine.

2.1.9 Engine Parameter Sensing

2.1.9.1 N_p and Torque Sensing

Two N_p sensors are located on the top of the exhaust frame. The power turbine shaft is equipped with two pairs of teeth, which induce electrical pulses in the N_p sensors. These teeth permit measurement of the torsion or twist of the shaft, which is proportional to output torque, by producing a pulse of electrical current each time a shaft or reference tooth passes. The sensors are identical and interchangeable, but serve different functions. The left sensor provides an N_p signal to the DECU (used by the N_p governing circuitry) and the cockpit vertical instrument. The right sensor feeds the torque computation circuit and the N_p overspeed protection system. The electrical signal, which is conditioned in the DECU, provides a DC voltage proportional to the torque for cockpit indication and use by various engine subsystems.

2.1.9.2 N_g Sensing

The alternator supplies an N_g signal to the VIDS in the cockpit.

2.1.9.3 N_p Sensing

Two sensors are located in the exhaust frame. One sensor provides the N_p -governing and tachometer signal to the ECU. The other sensor feeds the torque computation circuit and the N_p overspeed protection system.

2.1.9.4 TGT Sensing

The thermocouple harness consists of seven thermocouples for measuring TGT. The thermocouples are joined in parallel and provide an average output that is provided to the DECU. The signal is relayed to the TGT VIDS from the DECU.

The T700-GE-401C engine TGT signal is biased — 71 °C when the engine alternator is operating (above approximately 28 percent N_g). The bias allows the higher rated T700-GE-401C TGT to be displayed on the VIDS.

2.1.10 Engine Instruments

2.1.10.1 Vertical Instrument Display System

The VIDS consists of a CDU and two Pilot Display Units (PDU) located on the instrument panel (Figure 1-8). The system furnishes all of the engine instrument readouts in the cockpit, including engine oil temperature and pressure, TGT, N_p , N_g , and torque. In addition, the system supplies instrument readouts for fuel quantity, transmission oil temperature and pressure, and N_r , which are discussed in applicable sections. These readings are shown by ascending and descending columns of multicolored lights (red, yellow, and green) measured against vertical scales. If the gauge contains red or yellow lights below the green lights, these lights will extinguish when the system indication reaches the lower green range segment. If the gauge contains yellow or red lights above the green range, the green as well as the yellow or red lights will stay illuminated when operating above the green range.

The CDU and PDUs contain photocells which automatically adjust the lighting of the indicators around a variable level set by the pilot with respect to ambient light level. If any of the three photocells should fail, the lights on the vertical scales of the PDUs and CDU will go out.

Note

The DIM knob on the CDU has a manual detent which will allow the pilot to set the lighting level to half intensity.

Two SDCs (Figure 2-8) take information from the NO. 1 and NO. 2 engines, N_r , transmission, and fuel quantity. The NO. 1 SDC receives:

1. NO. 1 engine sensor signals (oil pressure, oil temperature, turbine gas temperature, gas generator tachometer, torque, power turbine tachometer)
2. NO. 1 fuel quantity sensor signal
3. Main rotor speed sensor signal
4. NO. 2 engine power turbine tachometer signal
5. NO. 2 engine torque sensor signal.

The NO. 2 SDC receives:

1. NO. 2 engine sensor signals (oil pressure, oil temperature, turbine gas temperature, gas generator tachometer, torque, power turbine tachometer)
2. NO. 2 fuel quantity sensor signal
3. Main rotor speed sensor signal
4. NO. 1 engine power turbine tachometer signal
5. NO. 1 engine torque sensor signal
6. Main transmission oil temperature sensor signal
7. Main transmission oil pressure sensor signal.

Within each SDC, the associated sensor signals, except for NO. 1 and NO. 2 fuel quantity, main transmission oil temperature, and main transmission oil pressure, are conditioned to a common digital format for multiplexing. The fuel quantity and main transmission sensor signals are conditioned and multiplexed within the CDU. After the sensor signals have been conditioned and multiplexed, the sensor data is routed to latching circuits in the CDU and PDU. The latching circuits retain the last signal data until it is time to update. During update (twice per second), the latches activate lamp drivers that energize miniature lamps on the edge of the display modules. Light from the lamps is carried to the display panel face by fiber optic strips, giving visual analog and digital displays corresponding to the level of the sensed parameter. If either SDC fails, the applicable CHAN light on the CDU will illuminate, the pilot or ATO PDU will fail, and the corresponding instruments on the CDU will fail.

Both SDCs receive N_p and torque information from both engines as well as N_r ; therefore, if the NO. 1 SDC fails, the pilot PDU will have N_r , N_p , and torque for both engines. The SDC receives DC power from the NO. 1 and NO. 2 DC primary buses through circuit breakers marked NO. 1 and NO. 2 DC INST on the ATO circuit breaker panel and AC power from the NO. 1 and NO. 2 AC primary buses through circuit breakers marked NO. 1 and NO. 2 AC INST on the center and the corner circuit breaker panels, respectively.

The following are the controls for the CDU and PDUs (located on the CDU):

1. LAMP TEST. When pressed, all lights on the CDU and the overspeed lights on the PDUs will illuminate, the digital readouts will display 888, and the 1 CHAN 2 failure lights will illuminate. When released, all lights and digits return to original readings.
2. DIM. This knob is used to control the intensity of the vertical scales and digits on the CDU and PDUs. It contains an override switch at the extreme clockwise end of the control range, allowing the pilot to manually set the CDU and PDUs to half intensity if the auto dim system fails.
3. DIGITS. The DIGITS Control switch, marked ON and OFF, is used to turn on or off the CDU and PDU digital readouts.
4. 1 CHAN 2. If a failure is detected in either SDC, the corresponding SDC CHAN 1 or 2 fail light will light.

2.1.10.1.1 Central Display Unit

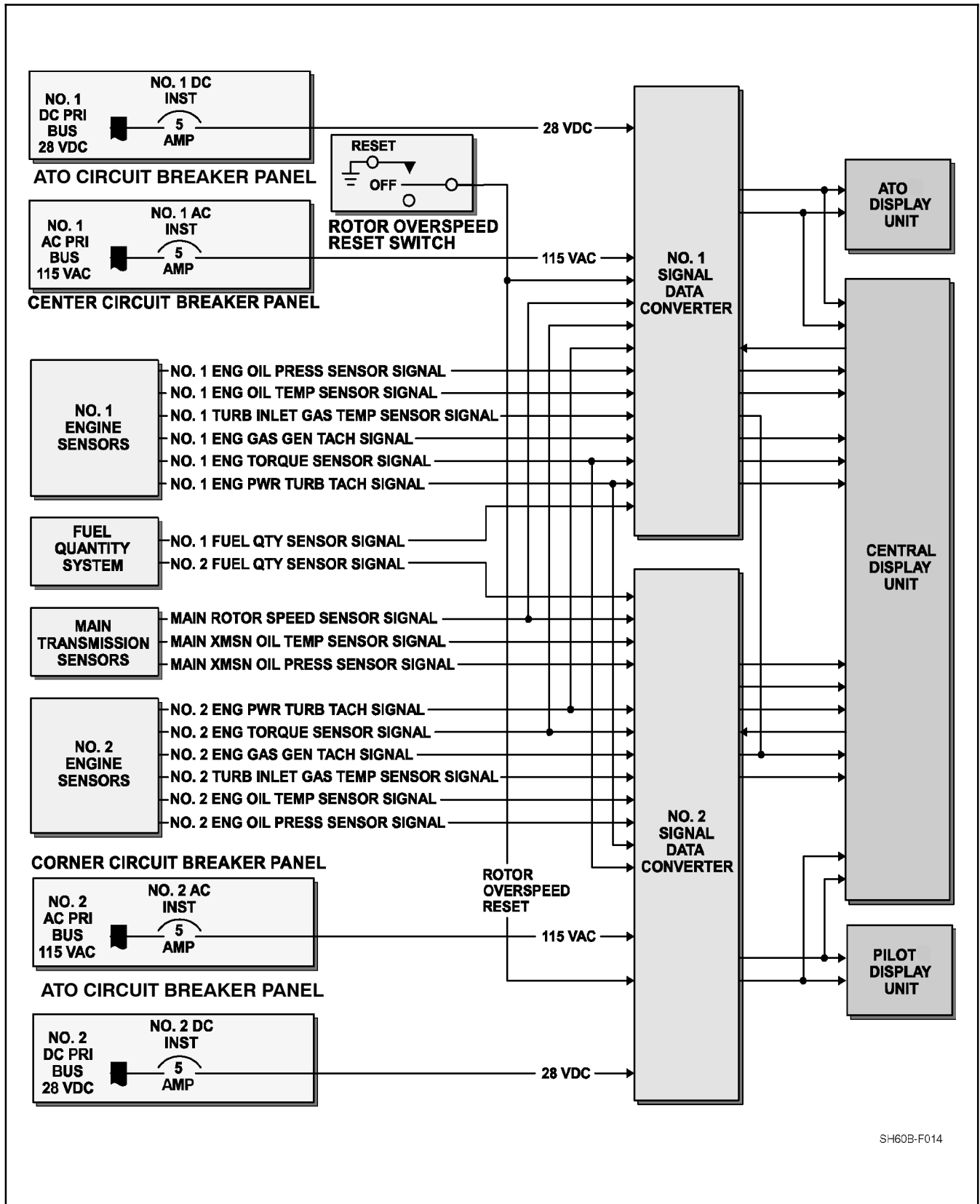
The CDU contains 12 analog displays, 5 digital displays, and 2 failure lights. The CDU receives signal and power inputs from both the NO. 1 and the NO. 2 SDC. The multiplexed data signals applied from the SDC to the CDU contain engine oil temperature, engine oil pressure, TGT, and N_g information and are displayed on the CDU gauge. These parameters are displayed on the CDU analog scales. The TGT and N_g information is also displayed on CDU digital readouts. NO. 1 and NO. 2 fuel quantity signals from the NO. 1 and NO. 2 SDC, respectively, and main transmission oil temperature and pressure signals from the NO. 2 SDC are conditioned and multiplexed by the CDU for display on analog scales. In addition, total fuel quantity information is displayed on a digital readout. The fuel quantity and transmission temperature and pressure gauges are discussed in applicable sections.

1. Engine Oil System Gauges. Engine oil temperature and pressure gauges are provided for each engine. The oil temperature gauge scales are nonlinear and read from -50 to 180 °C. Index marks define the normal operating range. The oil pressure gauge scales are nonlinear and read from 12 to 170 psi. Index marks define the normal operating range.
 - a. Engine Oil Temperature Gauge. The CDU displays oil temperature for both engines under the heading ENG OIL TEMP. The engine oil temperature gauge receives signals from the oil temperature sensor mounted on the front of the AGB.
 - b. Engine Oil Pressure Gauge. The CDU displays oil pressure for both engines under the heading ENG OIL PRESS. The engine oil pressure gauge receives signals from the oil pressure transmitter mounted on the front of the AGB.

Note

The engine oil caution lights are triggered by the VIDS oil gauge positions. Therefore, caution light and gauge indication cannot be used as secondary indications to each other.

2. Turbine Gas Temperature Gauge. The CDU displays turbine gas temperature for both engines under the heading TGT. The two TGT nonlinear gauges indicate the turbine gas temperature of each engine and read from 0 to 950 °C. There is an index at 925 °C. At the bottom of each TGT gauge is a digital readout for each engine. The TGT gauge receives signals from a thermocouple assembly located at the power-turbine inlet section of the engine.
3. Gas Generator, Turbine-Speed Gauge. The CDU displays gas generator, turbine-speed for both engines under the heading N_g SPEED. The gauges are nonlinear and read from 0 to 110 percent. Index marks define the normal operating range. At the bottom of each N_g gauge, there is a digital readout for each engine. The gas generator, turbine-speed gauge receives signals from the alternator mounted on the front of the AGB.



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Figure 2-8. Signal Data Converter

Note

The #1 and #2 ENG OUT warning lights, located on the master warning panels, are tripped by the N_g VIDS indication automatically when N_g indication decreases below 55 percent.

The CDU failure lights, CHAN 1 and CHAN 2, are part of the VIDS fault detection circuit. A failure of any SDC or CDU processing circuit, CDU or PDU display driver module, or SDC logic power supply will cause the associated display channel to turn off or switch to the remaining SDC and will light the associated CHAN failure light. Failure of a lamp power supply within an SDC will cause every second display light on the CDU as well as all display lights on the corresponding PDU to go off.

Power to operate the CDU is provided from the NO. 1 and NO. 2 DC primary buses through circuit breakers, marked NO. 1 and NO. 2 DC INST; NO. 1 and NO. 2 AC primary buses through the SDCs.

2.1.10.1.2 Pilot Display Units

Two PDUs, each identical and interchangeable, contain indicators that display engine power turbine speed (N_p), rotor speed (N_r), and torque readings (TRQ) for each engine (Figure 1-8).

Each unit contains five analog displays, two digital displays, three RTR OVERSPEED indicator lights, a TEST switch, and a photocell. Instrument readings are shown by ascending and descending columns of multicolored lights with tracking arrows along the analog scales from 96 to 112 percent on the percent rpm indicator and 0 to 10 percent on the percent TRQ indicator. The tracking arrows for each display go on one at a time to coincide with analog scale indication. As one tracking arrow lights, the other goes off. The percent rpm display contains bottom segment turnoff, which turns off lower red and yellow lights. When the lowest green segment is reached, all red and yellow segments below the normal range will go off. Three RTR OVERSPEED lights go on from left to right when rotor speed is over 127 percent, 137 percent, and 142 percent, respectively. The lights are latched on and remain on even if rotor speed falls below the specified overspeed limits. The latch mechanism, located in the nosebay, is not affected by power loss or power interruption. The TEST switch on each display unit is used to check all vertical scale lamps and digital readouts on the associated unit. The photocells on the PDUs are used for automatic light level adjustment. The PDUs are powered by the NO. 1 and NO. 2 SDCs.

2.2 ROTOR SYSTEMS

The aircraft is configured with a single four-bladed main rotor and a 20° canted, four-bladed tractor tail rotor. The fully articulated main rotor head incorporates elastomeric bearings. The tail rotor is a hingeless crossbeam rotor of composite construction. An automatic electrically actuated main rotor blade fold is incorporated.

2.2.1 Main Rotor System

The fully articulated main rotor system consists of four subsystems: main rotor blades, hub, flight controls, and the bifilar vibration absorber. The four main rotor blades attach to hinged spindles and are retained by elastomeric bearings contained in a one-piece titanium hub. The elastomeric bearings are laminated rubber and stainless steel and enable the blades to flap, lead, and lag, and also permit the blade to move about its axis for pitch changes. Two bearings are used per blade.

The main rotor vibration absorber is mounted on top of the hub and consists of a four-arm plate with attached weights. Main rotor dampers are installed between each of the main rotor spindle modules and the hub to restrain lead and lag motions of the main rotor blades during rotation and to absorb rotor head starting loads. Each damper is supplied with pressurized hydraulic fluid from a reservoir mounted inside the main rotor shaft. The reservoir has indicators to monitor the fluid level and nitrogen precharge pressure.

Rotor control is provided by flight control hydraulic servos tilting the swashplate assembly, which moves control rods attached to each spindle. When the rotor is not turning, the blades and spindles rest on hub-mounted droop stops. Upper restraints called antifrapping stops limit flapping motion at low rotor rpm. Both stops engage as the rotor slows down during engine shutdown. When the main rotor is rotating above 35 percent, centrifugal force pulls the antifrapping assemblies outward and holds them in that position to permit flapping and coning of the blades. When the main rotor head is rotating between 55 percent and 60 percent N_r , centrifugal force pulls the droop stops out and permits increased vertical movement of the blade.

2.2.1.1 Main Rotor Head

The main rotor head ([Figure 2-9](#)) transmits the movements of the flight controls to the four main rotor blades. The main rotor head is supported by the main rotor shaft extension. The lower pressure plate, in conjunction with the main shaft nut, secures the shaft extension to the main shaft. The lower pressure plate also provides attachment for the scissors.

1. Swashplate. The swashplate has stationary and rotating discs separated by a bearing. It transmits flight control movement to the main rotor head through the four pitch control rods. The swashplate is permitted to slide on the main rotor shaft around the Teflon-coated uniball and tilt in any direction following the motion of the flight controls.
2. Pitch Control Rods. Four pitch control rods extend from the rotating swashplate to the blade pitch horn on each spindle. The pitch control rods transmit all movement of the flight controls from the swashplate to the main rotor blades. Each rod is ground adjustable for blade tracking.
3. Bifilar Vibration Absorber. This unit absorbs vibrations and stresses. The bifilar vibration absorber is a cross-shaped aluminum forging. A tungsten weight pivots on two points at the end of each arm. The bifilar is bolted to the main rotor hub.

2.2.1.2 Main Rotor Blade

Four main rotor blades are installed on the main rotor head. Each blade has a pressurized titanium spar, honeycomb core, fiberglass graphite skin, nickel and titanium abrasion strips, electrothermal deicing mats, and a removable swept-back blade tip cap. The 20° swept tips provide both sound attenuation and increased rotor blade efficiency. An electrothermal blanket is bonded into the leading edge for de-ice protection. A pressure indicator and servicing valve are installed at the inboard end of the blade. A titanium cuff provides the attachment of the blade to the rotor head. The spar of the main rotor blade is pressurized with nitrogen. If the blade is damaged, impairing the structural integrity of the spar or if a seal should leak, nitrogen will escape. The pressure will drop below the minimum and cause the Blade Inspection Method (BIM®) pressure indicator ([Figure 2-10](#)) to show a black or unsafe indication. The nickel and titanium abrasion strips bonded to the leading edge of the spar extend the useful life of the blades. Each blade is statically and dynamically balanced. This permits replacement of individual blades. Balance strips painted around the blade locate the hoisting points.

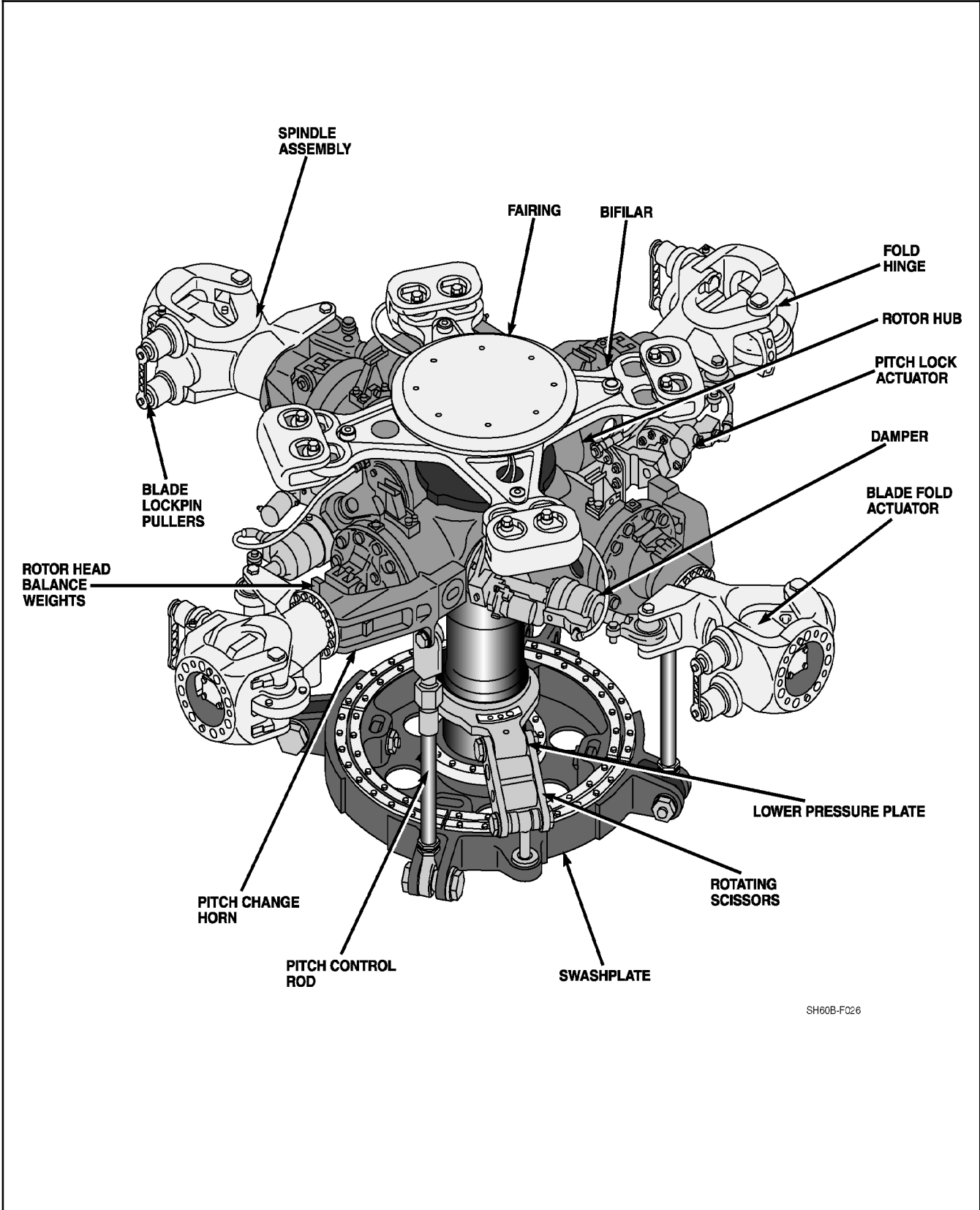


Figure 2-9. Main Rotor Hub Assembly

2.2.1.2.1 Pressure Indicator

The BIM® indicator (Figure 2-10) is installed in the back wall of the spar at the root of the blade. A color change indicates an unserviceable blade. The indicator compares a reference pressure built into the indicator with the pressure in the blade spar. When the pressure in the blade spar is within the required service limits, three white stripes are visible. If the pressure in the blade spar drops below the minimum permissible service pressure, the indicator will show three black stripes. A manual test lever is installed on each BIM® indicator to provide a maintenance check.

WARNING

If black is visible on the indicator, it may be an indication of blade damage that is a flight hazard. The cause of the black indication shall be determined prior to flight.

2.2.1.2.2 Blade Retention

Each rotor blade is connected to the rotor head spindle outboard of the blade-fold hinge and is attached by means of a bolted flange. The blade retention assembly provides means of attachment to the rotor hub, which allows interchangeability of the rotor blades. The retention assembly does not have to be removed to service or maintain the main rotor hub.

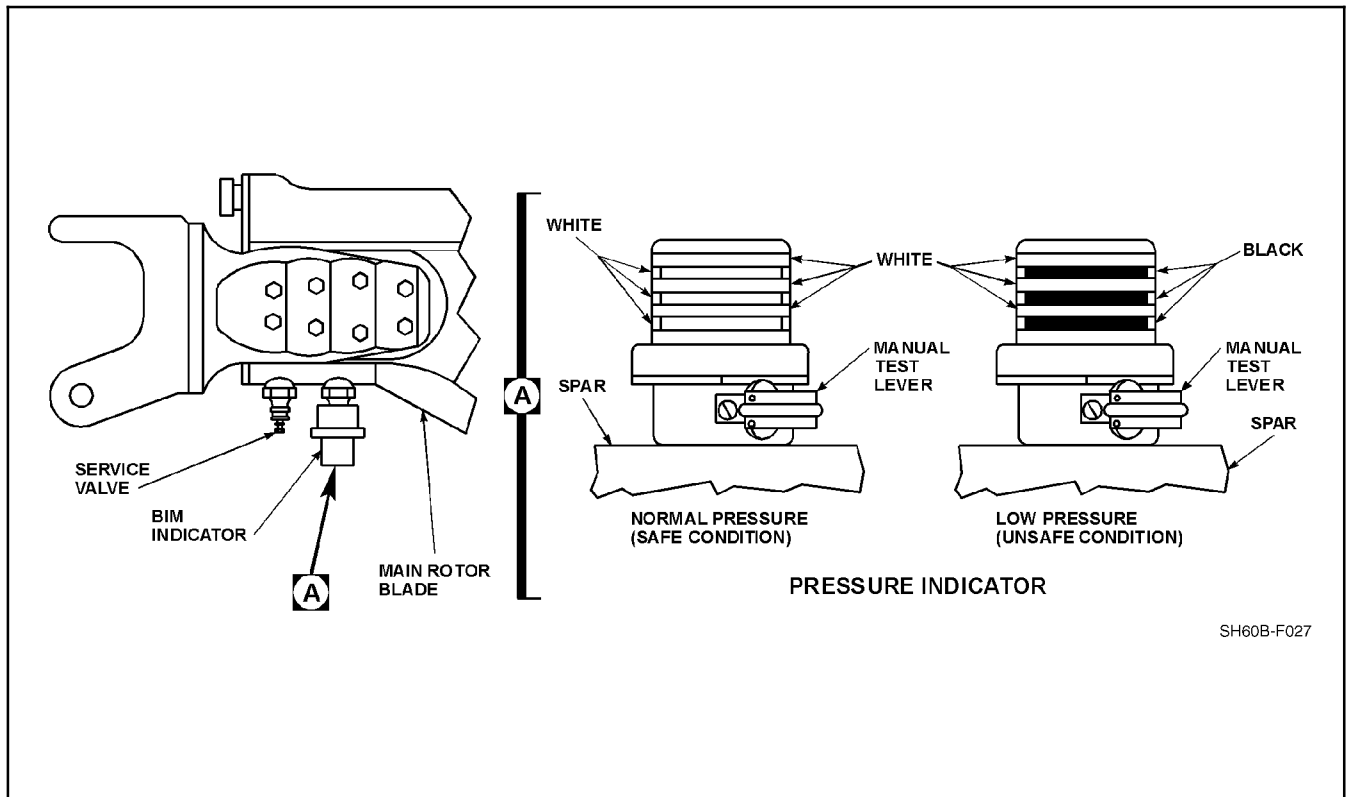


Figure 2-10. BIM® Indicator

2.2.1.2.3 Main Rotor rpm-Indicating System

The N_r gauge is located on each PDU on the instrument panel and indicates the speed at which the main rotor is turning. Three red warning lights on top of each PDU indicate varying degrees of rotor overspeed. The left light illuminates at 127 percent N_r , the middle at 137 percent N_r , and the right light at 142 percent N_r . Once the lights illuminate, they will remain on and must be manually reset on deck. Main rotor rpm is sensed in the right-hand accessory module of the main transmission and transmits a signal to each PDU which indicates speed in percent N_r . The N_r gauge is powered by the NO. 1 and NO. 2 DC primary buses through circuit breakers, marked NO. 1 and NO. 2 DC INST. Both circuit breakers are located on the ATO circuit breaker panel.

2.2.2 Tail Rotor System

A bearingless crossbeam tail rotor blade system provides antitorque action and directional control. The blades are of graphite and fiberglass construction. Blade flap and pitch-change motion are provided by deflection of the flexible graphite fiber spar, eliminating all bearings and lubrication. The spar is a continuous member running from the tip of one blade to the tip of the opposite blade. Electrothermal blankets are bonded into the blade-leading edge for deicing. The tail rotor head and blades are installed on the right side of the tail pylon, canted 20° upward. In addition to providing directional control and antitorque reaction, the tail rotor provides 2.5 percent of the total lifting force in a hover. With a complete tail rotor control failure, a centering spring in the tail rotor control system will provide a preset spring-loaded position for the tail rotor, equivalent to the antitorque requirements for a midposition collective power setting.

2.2.2.1 Tail Rotor Quadrant

The tail rotor quadrant (Figure 2-11), mounted on the tail gearbox, transmits tail rotor cable movements into the tail rotor servo. Two spring cylinders are connected to the quadrant. In the event a cable is broken, the spring tension allows the quadrant to operate normally. If a failure of a cable should occur, the quadrant then controls the opposite direction against spring tension and the related microswitch mounted on the quadrant will light the TAIL ROTOR QUADRANT light on the caution panel. The caution system for the tail rotor quadrant is powered by the NO. 1 DC primary bus through a circuit breaker marked TAIL ROTOR SERVO WARN and located on the ATO circuit breaker panel.

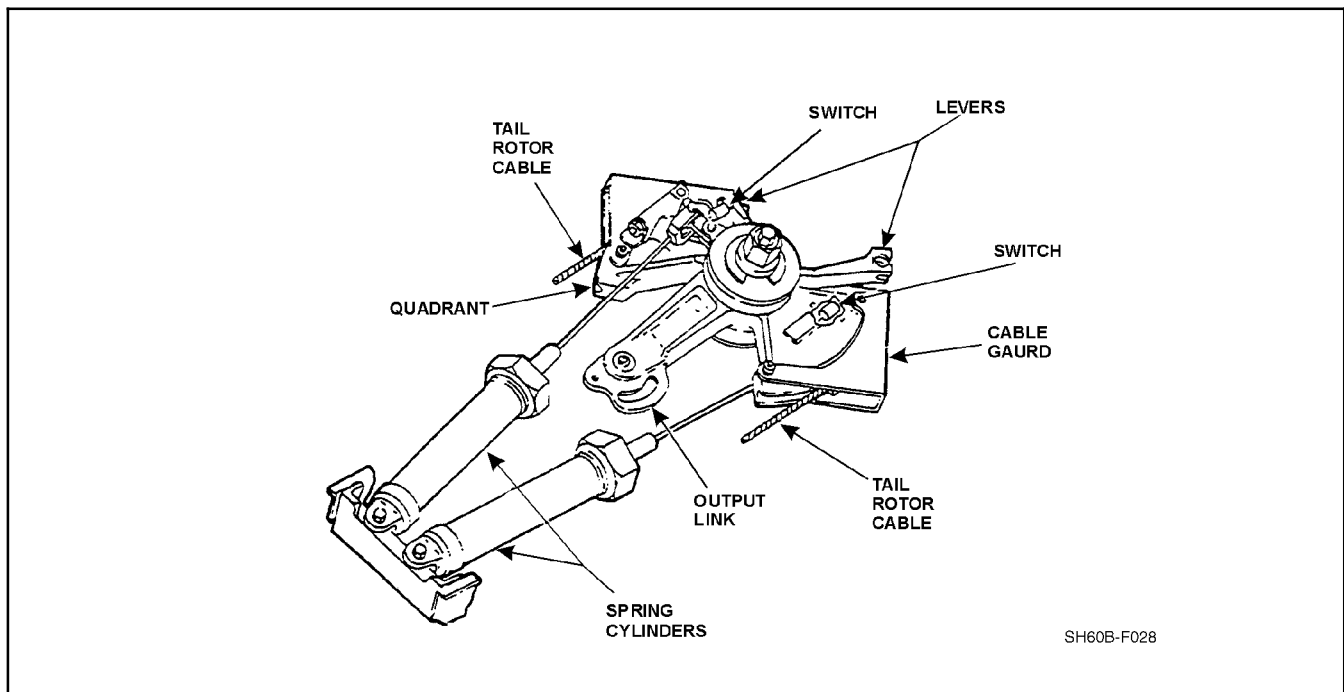


Figure 2-11. Tail Rotor Quadrant

2.2.2.2 Tail Rotor Head

The head consists of two titanium plates. The inboard plate forms a hub that is attached to the gearbox output shaft and retained by a shaft nut. The hub plates absorb axial thrust loads and bending moments and transmit torque to the rotor blades. The blade spars are clamped directly between the plates by retaining bolts. The pitch-control crossbeams are attached to a pitch-change actuating shaft, extending out from the center of the tail gearbox.

2.2.2.3 Tail Rotor Blades

The blades are built around two graphite composite spars, running from tip-to-tip and crossing each other at the center to form the four blades. The two spars are interchangeable and may be replaced individually. The blade spars are covered with cross-ply fiberglass to form the airfoil shape. Polyurethane and nickel abrasion strips are bonded to the leading edge of the blades. Blade-pitch changes are made by twisting the spar.

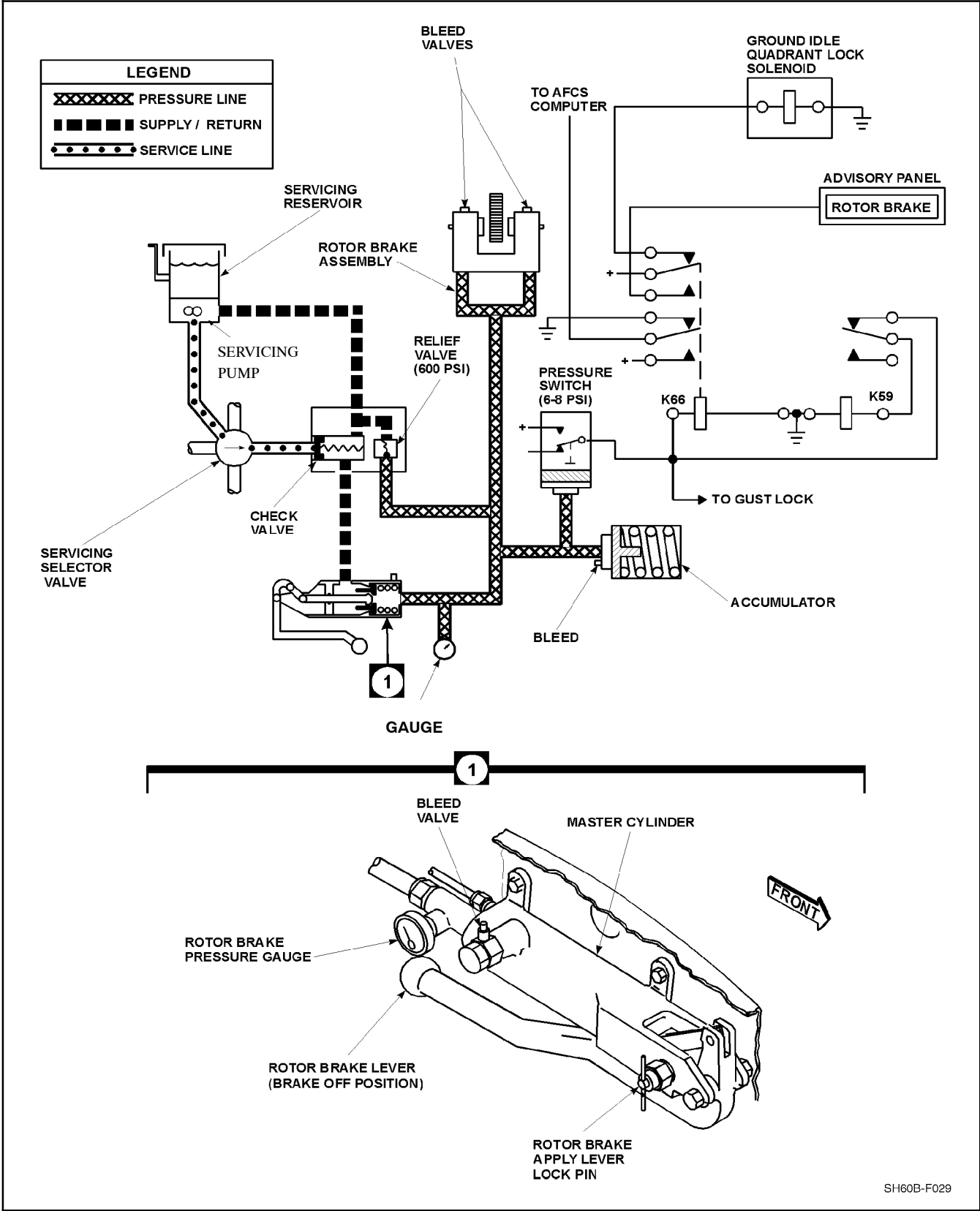
2.2.3 Rotor Brake System

The rotor brake system (**Figure 2-12**) is designed to hold the rotor during engine starting and with both engines at IDLE and to provide rotor shutdown. The system consists of a reservoir, master cylinder, gauge, relief valve assembly, accumulator, pressure switch, rotor brake advisory light, brake assembly, and disc. When the rotor brake is applied, the rotor brake interlock in the engine control quadrant prevents the ENG POWER CONT levers from being moved forward of the IDLE detent with the rotor brake on.

When the rotor brake lever is moved toward the apply position, pressure is built up in the lines and applied to the brake assembly. At the same time, pressure is applied to the rotor brake accumulator and a pressure switch (minimum 6 psi) to turn on the ROTOR BRAKE advisory light and set the ground IDLE quadrant lock. Back pressure in the accumulator is held by a spring as long as the rotor brake lever is in the applied position. For limited internal pressure leaks, the accumulator spring pressure will maintain the applied pressure to the brake pucks until the brake is released by returning the rotor brake lever to the off position, venting pressure back to the master cylinder reservoir. The rotor brake should not be applied with engine(s) operating and rotor head turning. The brake disc is mounted on the tail drive shaft output of the main gearbox. Teeth on the disc are utilized in the positioning cycle of the blade-fold system. The rotor brake advisory light system is powered by the DC essential bus through a circuit breaker marked ROTOR BRAKE on the overhead console circuit breaker panel.

2.2.3.1 Rotor Brake Master Cylinder

The rotor brake master cylinder, on the right side of the overhead console (**Figure 2-12**), provides pressure to the rotor brake assembly. With the master cylinder in the detent position (rotor brake lever off), the system is vented back to the reservoir. The hand pump reservoir serves as the rotor brake reservoir. A T-shaped rotor brake lever lock pin is provided to prevent inadvertent release once the brake has been applied. To set the pin, after the rotor brake lever is forward, rotate the pin 90° and push the pin inward until it seats into a hole on the lever arm. To release the pin, pull and rotate 90°. The lever arm is then free to release the pressure on the system.



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Figure 2-12. Rotor Brake System, Block Diagram

2.2.3.2 Main Rotor Gust Lock

A gust lock is provided as part of the blade indexing unit which is used in conjunction with the automatic main rotor blade-fold sequence.

The primary purpose of the gust lock gear is to index the main rotor head during blade-fold sequences. A secondary purpose is to lock the rotor disk in the spread indexed position. Should the rotor brake hydraulic pressure bleed off in a blade spread condition **Figure 2-41**, the gust lock may be engaged manually to act as a lock to hold the rotor head in place. This is done by means of the GUST LOCK switch on the miscellaneous switch panel. The GUST LOCK caution light indicates when the gust lock feature of the blade indexing motor has been engaged. The light will illuminate automatically during the blade-fold sequence or whenever the gust lock switch is actuated to the engaged position. The gust lock feature receives power from the DC essential and NO. 2 DC primary buses through circuit breakers marked RTR HD INDEX ENGAGE, on the overhead circuit breaker panel, and BLADE FOLD CONTR, on the SO circuit breaker panel.



Should the rotor brake hydraulic pressure bleed off in a blades folded condition, the gust lock will not prevent the rotor brake disc from turning.

2.3 TRANSMISSION SYSTEM

The primary function of the transmission system is to take the combined power from the two engines, reduce the rpm, and transfer it to the main and tail rotors. The secondary function is to provide a drive for electrical and hydraulic power generation. The powertrain (**Figure 2-13**) consists of the main transmission modules, drive shaft, an oil cooler, an intermediate gearbox, and a tail gearbox. The tail drive shaft consists of six sections joined by Thomas couplings, with a disconnect coupling at the fold hinge. Thomas couplings between sections eliminate the need for universal joints. The shafts are ballistically tolerant and are suspended at four points in viscous-damped bearings. The oil cooler drive is an integral part of the tail rotor drive shaft system. The intermediate gearbox, located at the base of the pylon, changes angle of drive and reduces tail drive shaft speed. The tail gearbox changes the angle of drive, reduces shaft rpm, and supports and drives the tail rotor. The intermediate and tail gearbox components are designed to be capable of approximately 60 minutes of operation without oil. All other transmission components are designed to be capable of approximately 30 minutes of operation without oil.

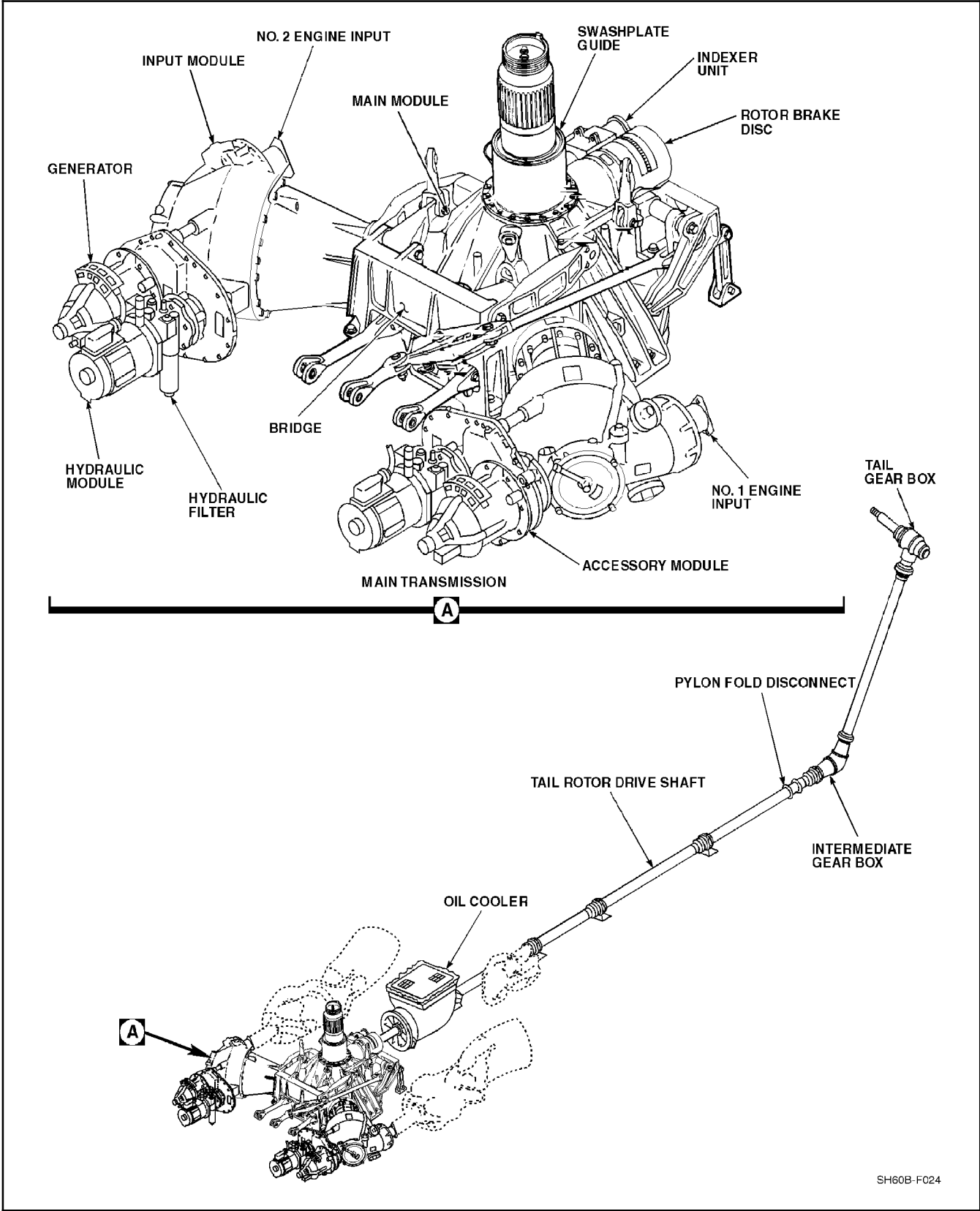
2.3.1 Main Transmission

The main gearbox drives and supports the main rotor. The main gearbox is of modular design and has a built-in 3° forward tilt.

The main transmission consists of five modules: two accessory modules, two input modules, and a main module. The left-hand input and accessory modules are identical to the right-hand modules and are interchangeable. A rotor brake is mounted on the tail takeoff, which provides the capability of stopping the rotor system. The rotor brake disc is toothed to provide the means for positioning the main rotor head for blade folding. The main gearbox is pressure lubricated and has oil pressure, oil temperature, low pressure warning, high temperature warning, and chip detector indicating systems incorporated.

2.3.1.1 Input Module

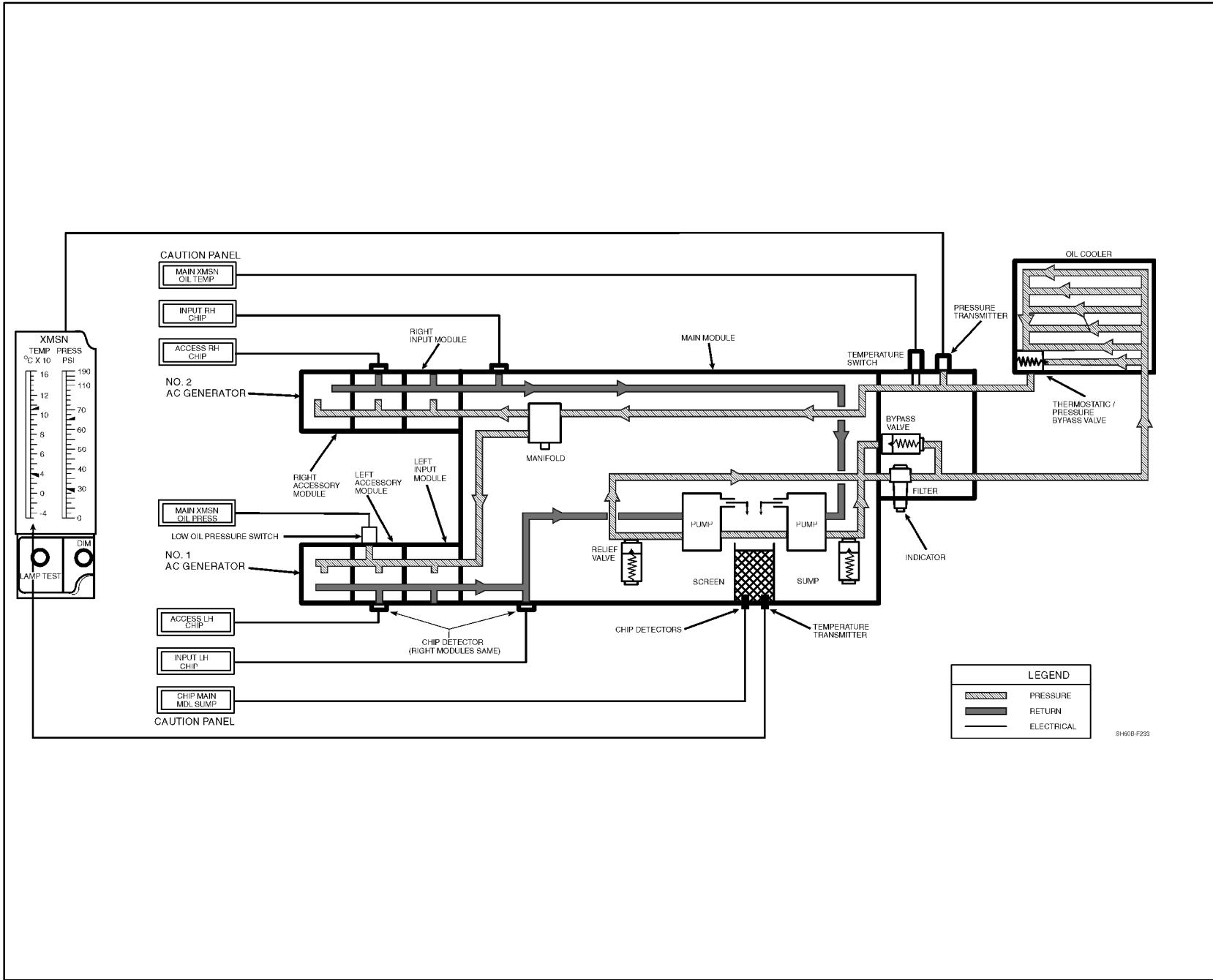
The input modules are mounted on the left and right front of the main module and support the front of the engines. They each contain an input bevel-pinion and gear, and a freewheel unit. The freewheeling unit allows engine disengagement during autorotations. In the case of an inoperative engine, the freewheeling unit allows the accessory module to continue to be driven by the main transmission. The input module provides the first gear reduction between engine and main module.



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Figure 2-13. Powertrain (Sheet 1 of 2)

Figure 2-13 Powertrain (Sheet 2)



2.3.1.2 Diaphragm Coupling and Engine Output Shaft

The engine output shaft provides drive from the engine to the input module via the diaphragm coupling. The diaphragm coupling is designed to allow for slight angular or axial misalignment of the engine output shaft during operation.



If an abnormal or loud whining noise is heard during engine startup, shut down engine immediately due to impending diaphragm coupling failure. Maintenance action is required prior to subsequent engine start.

2.3.1.3 Accessory Module

One accessory module is mounted on the forward section of each input module. Each accessory module provides mounting and drive for an AC electrical generator and a hydraulic pump package. A rotor speed sensor is mounted on the right accessory module and supplies rotor speed information to the VIDS. In aircraft with the helicopter emergency egress lighting system (HEELS) system, a left-hand sensor is incorporated which provides N_r information to this system. Additionally, the low oil pressure sensor is mounted on the left accessory module. The accessory modules are always driven by the main transmission.

2.3.2 Intermediate Gearbox

Mounted at the base of the tail pylon is the splash-lubricated, intermediate gearbox (Figure 2-13). It transmits torque and reduces shaft speed from the main gearbox to the tail gearbox.

2.3.3 Tail Gearbox

The splash-lubricated tail gearbox (Figure 2-13) is located at the top of the tail pylon and transmits torque to the tail rotor head. The gearbox mounts the tail rotor, changes the angle of drive, and provides gear reduction. It also enables pitch changes of the tail rotor blades through the flight control system.

2.3.4 Main Transmission Lubrication System

The transmission incorporates an integral wet sump lubrication system (Figure 2-13) that provides cooled, filtered oil to all bearings and gears. Oil is supplied to the hydraulic pump drive shaft and the AC generators for cooling and lubrication. Oil under pressure is supplied through internally cored oil lines, except for the pressure and return lines in and out of the oil cooler. The lubrication system includes two lubrication pumps that are combination pressure and scavenge types operating in parallel. Pressure-regulating and bypass valves protect the lubrication system by returning excess high-pressure oil back to the inlet side of the pump. A two-stage oil filter and various strainers in the sump prevent contamination. The oil filter has a visual impending bypass indicator (red button) that protrudes when the first-stage filter becomes contaminated. When the button pops, the filter element must be replaced to reset. A thermal lockout prevents button popping when oil is cold and thick. The oil cooler uses a blower driven by the tail rotor drive shaft to cool oil before it enters the various modules. The oil cooler has a thermostatic bypass valve that directs oil flow around the oil cooler when the oil temperature is below approximately 54 °C, or if the oil cooler becomes clogged. Other warning and monitoring systems on the main transmission are MAIN XMSN OIL TEMP and PRESS caution lights and XMSN TEMP and PRESS oil gauges. An oil pressure sensor on the left accessory module, the farthest point from the pumps, causes the MAIN XMSN OIL PRESS caution light to illuminate when pressure drops to 14 ±2 psi. The transmission oil temperature warning system is triggered by an oil temperature sensor at the oil cooler input to the main module, located near the tail takeoff drive shaft flange. A caution light marked MAIN XMSN OIL TEMP goes on when transmission oil temperature reaches 117 ±4 °C. Temperature for the gauge is sensed between the sump and the pump. Pressure readings for the gauge are taken at the main module manifold. Electrical power for the warning systems, except chip detection, is from the NO. 2 DC primary bus through the MAIN XMSN circuit breaker on the ATO circuit breaker panel.

2.3.5 Transmission Gauges

The main transmission gauge is located on the CDU as part of the VIDS system and is divided into oil temperature and pressure. The temperature gauge is nonlinear and reads from -50 to 170 °C. An index defines the normal operating range. The pressure gauge is nonlinear and reads from 0 to 190 psi. An index defines the normal operating

range. The transmission gauges are powered by the NO. 1 and NO. 2 DC primary buses through circuit breakers, marked NO. 1 and NO. 2 DC INST and located on the ATO circuit breaker panel, and by the NO. 1 and NO. 2 AC primary buses through circuit breakers marked NO. 1 AC INST and NO. 2 AC INST and located on the center and corner circuit breaker panels, respectively.

2.3.6 Transmission Chip Detector System

The transmission chip detector system (Figure 2-14) consists of fuzz-suppression chip detectors and caution lights, marked INPUT LH CHIP, INPUT RH CHIP, ACCESS LH CHIP, ACCESS RH CHIP, and CHIP MAIN MDL SUMP. Five chip detectors provide warning of chips in any of five areas of the main transmission system. Detectors in each module are wired, in parallel, to constantly monitor for metal contamination. Each chip detector can be removed for visual inspection without a loss of oil. A fuzz burnoff feature eliminates false warning due to fuzz and small particles. When a chip is detected and will not burn off, the metal particle triggers the detection system, and a caution light will illuminate. The fuzz burnoff feature will be deactivated when the gearbox oil temperature is above 140 °C to prevent electrical arcing with oil vapor in the gearbox; however, magnetic detection will remain in the main, input, and accessory modules. The main module sump chip detector will turn on the CHIP MAIN MDL SUMP caution light to warn of chips in the main module. The magnetic plugs of the chip detector system will attract ferrous metal chips at any of the detector locations. Should the chip be washed away from the detector, the light will extinguish. The chip detector for the main module sump rests in the lowest point of the oil system and incorporates a 30-second time delay circuit. The accessory module chip detectors are located at the lowest point on the modules themselves, whereas the input module chip detectors are located on the bottom of the main module adjacent to the input modules. The system is powered by the DC essential bus through a circuit breaker on the overhead console circuit breaker panel, marked CHIP DETR.

2.3.7 Intermediate and Tail Gearbox Chip/Temperature Systems

The intermediate and tail gearboxes contain identical chip/temperature sensors that indicate when the gearbox temperature is too high or a chip is present (Figure 2-14). The chip detectors incorporate a fuzz burnoff feature that eliminates false warning due to fuzz and small particles. The fuzz burnoff feature will be deactivated when the gearbox oil temperature light is lighted; however, magnetic detection will remain to light the caution light. When a chip is detected and will not burn off, a caution indicator on the caution/advisory panel will light, indicating CHIP INT XMSN or CHIP TAIL XMSN. The oil temperature sensor is a bimetal strip that reacts to temperatures. When the oil temperature reaches 140 °C, a switch closes to turn on a caution light in the cockpit, marked INT XMSN OIL TEMP or TAIL XMSN OIL TEMP. Power to operate the chip system is provided from the DC essential bus through a circuit breaker marked CHIP DETR. Power to operate the oil temperature system is from the NO. 2 DC primary bus through a circuit breaker marked MAIN XMSN and located on the ATO circuit breaker panel.

2.3.8 Chip-Detector Caution Lights Self-Test

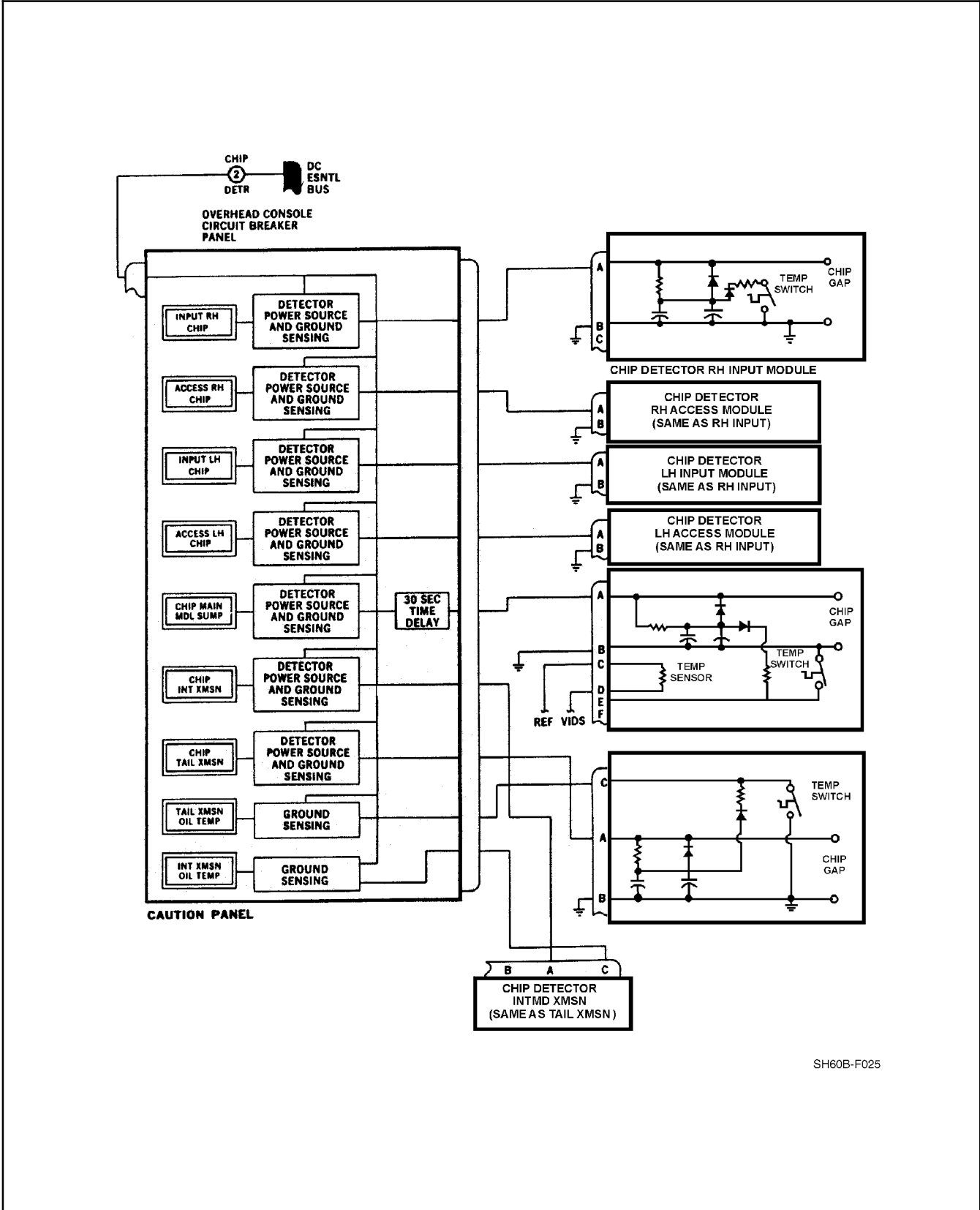
All the transmission modules and the intermediate gearbox and tail rotor gearbox chip detectors have self-test circuits for the caution lights. The test circuit is activated when the caution/advisory panel BRT/DIM, TEST is released after the caution/advisory panel test sequence. The self-test checks for both short and open circuit faults. If a short or open circuit is present, the appropriate chip caution light will flash at approximately 2 flashes per second for a total of 16 flashes, and the master caution light will remain illuminated. If there is no fault when the test switch is released, only the master caution capsule will flash.

Note

The self-test checks circuitry up through the fuzz burnoff module and does not check the ability of the detector to detect chips or if a detector is installed.

2.3.9 Main Gearbox Vibrations

The main gearbox contains many possible sources of high-frequency vibrations, such as the various gearbox-mounted accessories, the accessory gear train, oil-cooler blower, and the input-bevel gear and freewheeling units. These vibrations are generally heard rather than felt. Combinations of these high-frequency vibrations in extreme cases could result in the pilot sensing low- or medium-frequency vibrations. These would be detected as vibrations which are affected only by variation in main rotor speed and may be just as apparent in a ground run as in flight. There are also numerous gear clash sounds that occur under various conditions, the acceptability of which can only be determined by experience or measurements with instrumentation.



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Figure 2-14. Powertrain Chip Detector System

2.4 FUEL SYSTEM

The fuel supply system (Figure 2-15 prior to BuNo 162349, Figure 2-16 BuNo 162349 and subsequent) is a crashworthy, suction-type system consisting of two internal main cells interconnected to form a single tank, a fuel line network, firewall-mounted selector valves, prime/boost pump, engine-driven boost pumps, and engine fuel filters. The left internal cell has provisions for single-point refuel/defuel, gravity refuel, and the helicopter in-flight refueling (HIFR) system. It also contains two high-level shutoffs, two check valves, sump drain, and vent. The right internal cell contains two check valves, a sump drain, a vent, an APU fuel line, and the fuel jettison system. Total system capacity (usable) is 590 gallons internal. Additionally, BuNo 162349 and subsequent incorporate an auxiliary fuel system capable of supporting two external auxiliary fuel tanks containing a total of 240 gallons of fuel (120 gallons in each auxiliary tank).

2.4.1 Main Fuel Supply Operation

The prime/boost pump primes all fuel lines if prime is lost and also acts as an APU boost for APU starts and operations. A selector valve, driven by a cable from the fuel selector lever, permits the operation of either engine from either cell. All lines are routed in the most direct manner and include self-sealing breakaway valves that stop fuel flow in the event of fuel system damage. Fuel from both cells is drawn by suction to the engine-driven boost pump, then pumped through the engine fuel filter to the HMU high-pressure pump.

The engine fuel pressure warning system for each engine consists of a pressure switch that illuminates the caution lights, marked #1 or #2 FUEL PRESS, when fuel pressure drops below 8 to 10 psi from the respective engine-driven boost pump. This visually indicates a possible malfunction in the engine-driven fuel boost pump or an air leak in the fuel system.

The engine fuel-filter bypass warning system for each engine consists of an electrical switch, impending bypass popout button (located on the filter), and caution lights. Once the filter goes into bypass, the caution lights, marked #1 or #2 FUEL FLTR BYPASS, will light.

Note

The fuel filters are not sensitive to water contamination. Water-contaminated fuel may cause fluctuations/surges in one or both engines with no associated FUEL PRESS or FUEL FLTR BYPASS caution light.

The #1 and #2 FUEL FLTR BYPASS and the #1 and #2 FUEL PRESS caution lights are powered by the NO. 1 and NO. 2 primary DC buses, respectively, through circuit breakers marked NO. 1 ENG and NO. 2 ENG WARN LTS located on the ATO circuit breaker panel.

2.4.1.1 Fuel Selector Levers

There are two ENG FUEL SYS levers, one for each engine, located outboard of the ENG POWER CONT levers (Figure 1-6). The fuel selector levers manually position the fuel selector valves to any one of three positions: OFF, DIR, or XFD. The fuel selectors are connected to the fuel selector valves with low-friction, flexible push-pull cables. With the selectors at OFF, the fuel selector valves are closed, allowing no fuel to the engines. When the selectors are moved forward to DIR, the fuel selector valves are opened, providing fuel flow for each engine from its individual cell. Moving the selector to XFD provides fuel to the engine from the opposite cell through the crossfeed system. A check valve in each crossfeed line prevents air from the fuel line of an inoperative engine from crossing to the operating one. When either fire emergency control T-handle, located outboard of the fuel selector levers, is pulled aft, the respective fuel selector lever will be mechanically placed in the OFF position.

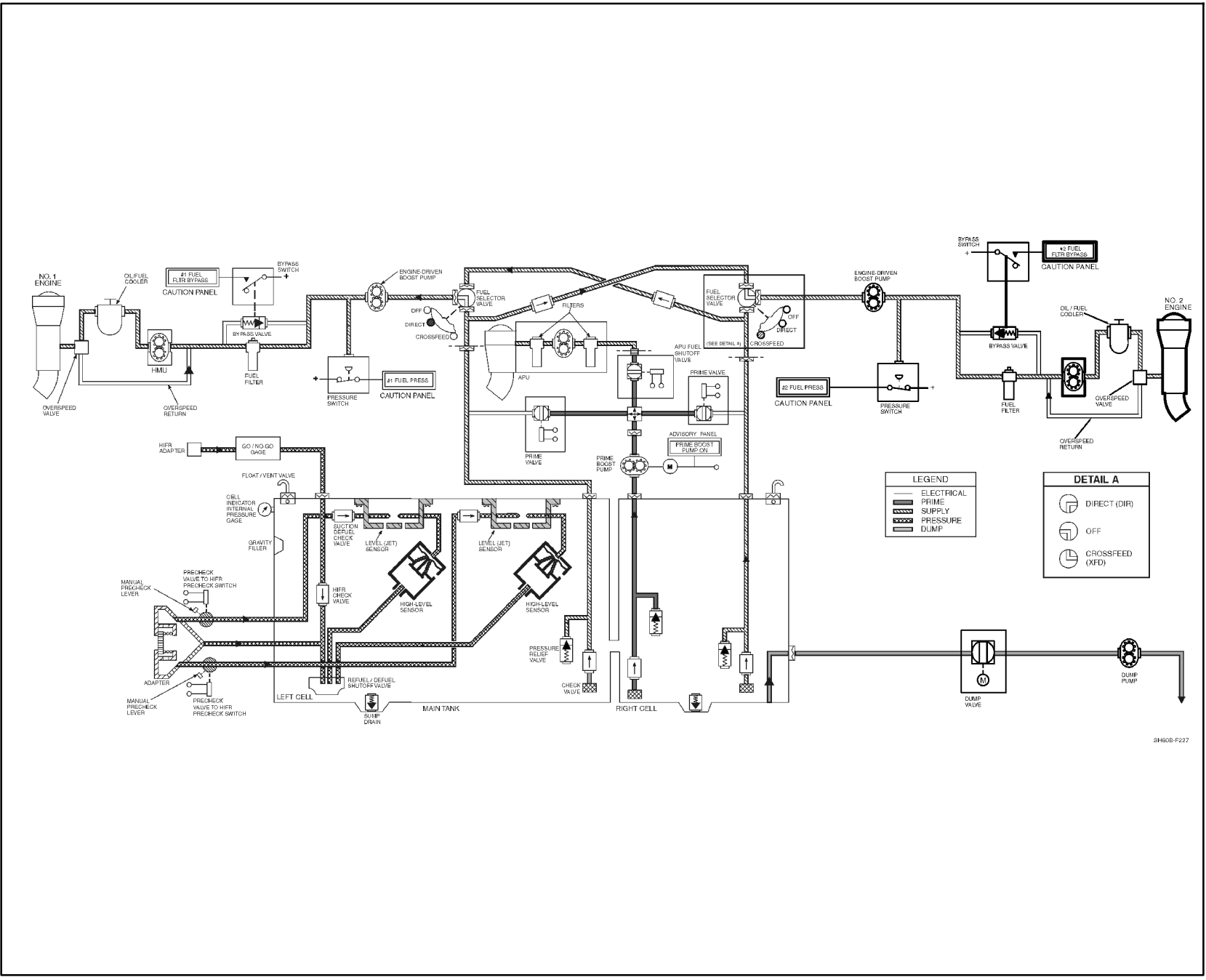
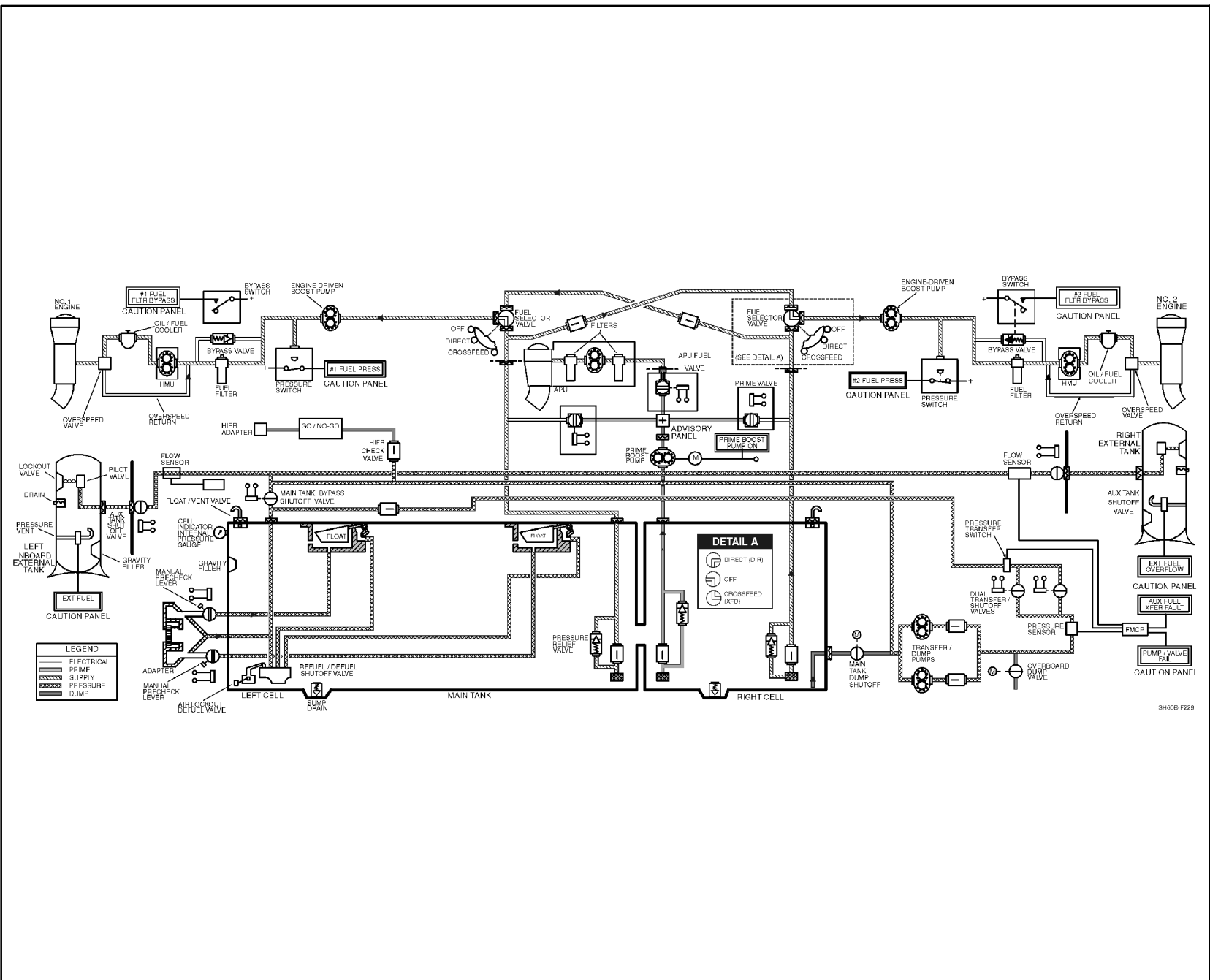


Figure 2-15. Fuel System Block Diagram — Prior to BuNo 162349



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Figure 2-16. Fuel System Block Diagram — BuNo 162349 and Subsequent

2.4.1.2 Engine/APU Boost/Fuel Prime System

The APU boost and engine prime system consists of a suction line located in the right fuel cell, a prime/boost pump (which is externally mounted on the tank), APU fuel shutoff valve, two engine fuel prime shutoff valves, and a selector switch located on the overhead console (Figure 1-6). The FUEL PUMP selector switch is a three-position switch, marked APU BOOST, OFF, and FUEL PRIME. Activation of the switch illuminates the PRIME BOOST PUMP ON advisory light. The FUEL PRIME position allows fuel to enter all fuel lines before engine start. Power to operate the prime-boost pump is from the battery bus through a circuit breaker marked FUEL PRIME BOOST and located on the center console circuit breaker panel.

2.4.1.2.1 Fuel Prime System Operation

Placing the APU BOOST/FUEL PRIME switch to APU BOOST opens the APU fuel shutoff valve and activates the fuel prime/boost pump. Placing the APU BOOST/FUEL PRIME switch to FUEL PRIME opens both engine prime shutoff valves and allows individual priming of the engines with the PCL in lockout.

2.4.2 Main Tanks Fuel Quantity System

The fuel quantity system (Figure 2-17) consists of a fuel probe mounted in each fuel cell and a fuel quantity signal conditioner. The system interconnects two SDCs to the VIDS CDU.

2.4.2.1 Fuel Low Level Warning System

The fuel low level warning system consists of a dual-channel, low-level warning conditioner; two fuel cell-sensing units; and associated caution lights. Each cell-sensing unit is placed at approximately the 200 to 225 pound fuel level. As long as the sensing unit is covered with fuel, the warning conditioner will keep the #1 and #2 FUEL LOW caution lights off. As fuel is consumed and its level drops below the 200 to 225 pound level, the fuel cell-sensing units sense the lack of fuel and signal the conditioner of a low fuel state. These lights will continue to illuminate and extinguish as long as fuel continues to wash on and off the sensors. This system is completely independent of the fuel quantity system. The conditioner then applies power to the appropriate FUEL LOW caution and MASTER CAUTION lights. Power to operate the fuel low level system warning is from the NO. 1 DC primary bus through a circuit breaker marked FUEL LOW WARN and located on the ATO circuit breaker panel.

2.4.3 Fuel Dump System

A fuel dump system (Figure 2-15 prior to BuNo 162349, Figure 2-16 BuNo 162349 and subsequent) is installed to allow for emergency rapid dumping of fuel at approximately 836 pounds per minute, but can exceed 1,000 pounds per minute. The system consists of a FUEL DUMP switch mounted on the lower console EMER panel and a standpipe and dump port in the right main fuel cell. Aircraft prior to BuNo 162349 have a dump valve and a pump/motor assembly in the transition section. Aircraft BuNo 162349 and subsequent have a main tank shutoff valve, an overboard dump shutoff valve, two transfer/dump pumps/motors, and Fuel Management Control Panel logic to control required valves. Power to operate the fuel dump system is from the DC essential bus through a circuit breaker marked FUEL DUMP CONTR, the NO. 1 AC primary bus through a circuit breaker marked FUEL DUMP PUMP, and, for BuNo 162349 and subsequent, the NO. 2 AC primary bus through a circuit breaker marked FUEL DUMP PUMP.

The circuit breakers are located on the overhead circuit breaker panel and the center circuit breaker panel, respectively, and, for BuNo 162349 and subsequent, the corner circuit breaker panel.

WARNING

After dumping, observe the fuel readout to ensure dumping has ceased.

Note

Fuel can be dumped when the helicopter is on the ground. The fuel dump system is not protected by the weight-on-wheels (WOW) switch.

2.4.3.1 System Operation

Placing the FUEL DUMP switch to the DUMP position opens the valve and closes the contacts in the pump/motor relay, operating the pump/motor. Fuel will dump out of both cells down to the level of the cell interconnect. Fuel will then continue to dump out of the right cell to the level of the standpipe. After total dump, approximately 270 pounds will remain in the left cell and 140 pounds in the right cell (prior to BuNo 162349). Fuel quantity remaining after dump can vary depending on aircraft pitch attitude.

2.4.3.2 System Operation (with FMCP)

With the FMCP MASTER and MODE switches set to TRANSFER and MANUAL OVERRIDE, placing the FUEL DUMP switch on the emergency control panel (Figure 1-7) to the DUMP position signals the FMCP, bypassing all of the FMCP operating modes. The FUEL DUMP indicator light on the FMCP illuminates, the auxiliary tank valves open, both transfer/shutoff valves close, the main tank bypass shutoff valve closes, the overboard dump valve opens, and both fuel transfer/dump pumps begin running. When the auxiliary tanks are empty, each auxiliary tank valve closes and the main tank dump valve opens.

The fuel transfer/dump pumps continue running and fuel will dump out of both main cells down to the level of the interconnect (approximately 270 pounds in each cell). Fuel will then continue to dump out of the right cell to the level of the low level sensor (approximately 210 pounds) when the dump signal is interrupted at the FMCP (BuNo 162349 and subsequent). The fuel quantity remaining in the right cell after dump could be lower at noseup attitudes associated with lower airspeeds. When the dump signal is interrupted, the main tank dump valve closes, the main tank bypass shutoff valve opens, and both fuel transfer/dump pumps stop. Placing the FUEL DUMP switch to OFF closes the overboard dump valve and restores FMCP control functions.

Note

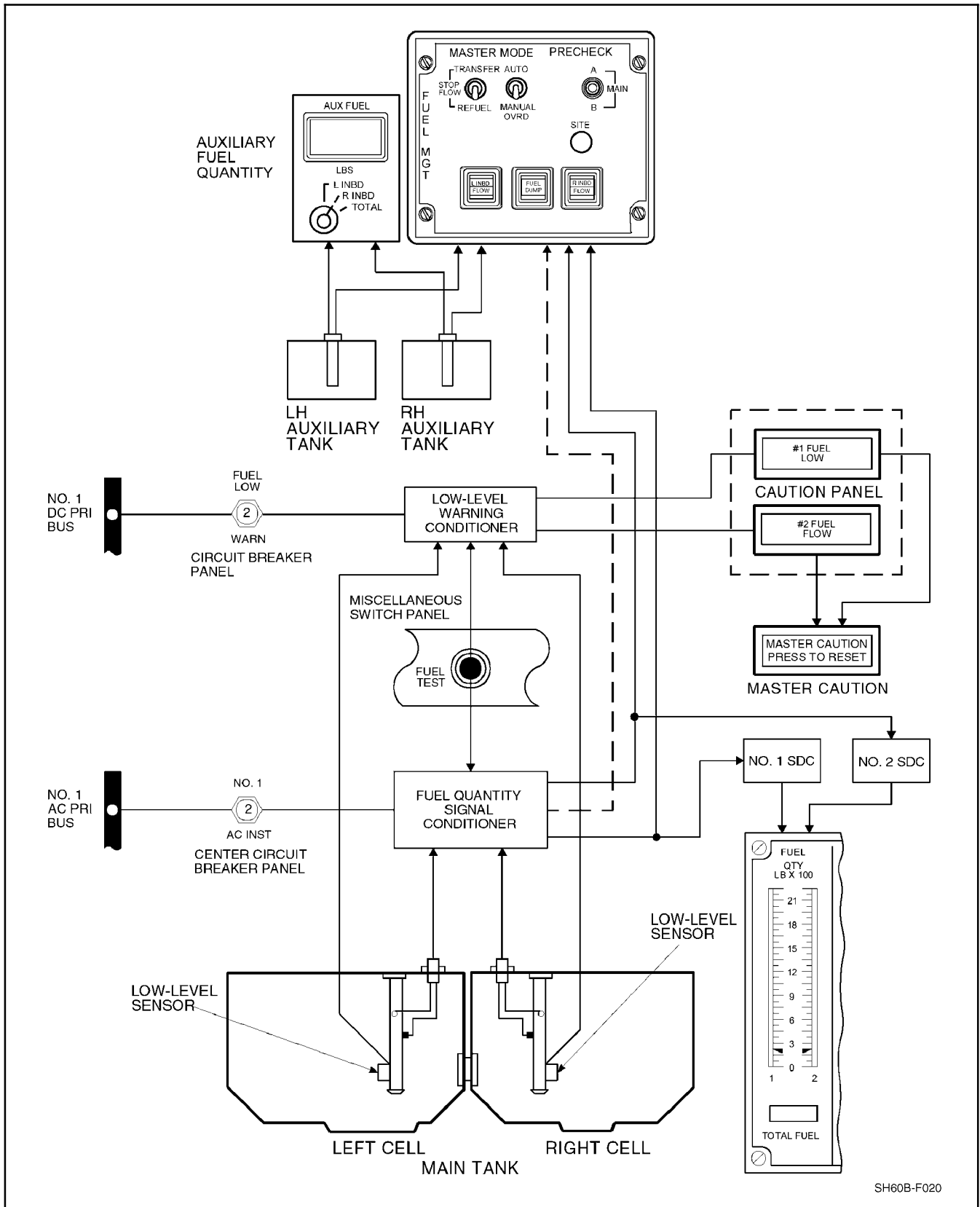
- Regardless of FMCP switch positions or whether auxiliary tanks are installed, selecting Fuel Dump on the Emergency Control Panel will enable emergency dumping from the main tank. FMCP switches need only be set to TRANSFER and MANUAL OVERRIDE if pilots desire to dump fuel from the auxiliary tanks. With no auxiliary tanks installed, fuel may be dumped from the main tank with the FMCP in any configuration, including STOP FLOW.
- For aircraft operating without a functional FMCP, refer to [paragraph 2.4.3.1](#).

2.4.4 Single-Point Pressure Refueling System

The single-point pressure refueling system is used to pressure refuel the fuel tanks on the ground. The fuel tanks may be serviced without electrical power. On aircraft BuNo 162349 and subsequent, without power applied to the aircraft, all tank valves are open and fuel enters all tanks randomly until the main tank high level sensor is reached and the mechanical shutoff float valve closes. During refueling with electrical power on, all auxiliary tank shutoff valves are closed and the main fuel tank is filled first. When the FMCP is signaled that the main tank is filled, the right inboard auxiliary and left inboard auxiliary tanks, if sensed as installed, are then filled by the same process in order.



During single-point pressure refueling, if the right cell fills faster than the left cell, monitor the fuel quantity gauges closely. If the difference in cell quantities persists, stop refueling before the right cell is full (approximately 1,700 pounds).



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Figure 2-17. Fuel Quantity System (with Auxiliary Tanks Installed)

Note

Fuel quantity indicators are not operable without AC electrical power and fuel quantity must be visually checked.

2.4.4.1 Pressure Refueling Panel

The pressure refueling panel (Figure 1-3, index NO. 34), located on the left side of the aft fuselage, provides a single point for refueling and defueling. The pressure refueling panel contains a connecting adapter, pressure gauge, and two manually operated precheck valves. Aircraft prior to BuNo 162349 have two jet sensors in the left fuel cell that will activate their respective shutoff valves when fuel in the cell immerses them. Either or both shutoff valves will in turn signal the pressure refuel/defuel valve to interrupt normal fueling.

The two high-level sensors in the left cell will cause fuel flow to be reduced to 5 gallons per minute when the cells are becoming full. When the precheck valves are pressed, jet sensor immersion is simulated and fuel flow is interrupted to indicate that the system is operating properly. Aircraft BuNo 162349 and subsequent incorporate two high-level float sensors in the top of the tank that will stop fuel flow when the main tank is full. When the precheck valves are pressed, fuel is redirected to raise the floats, which then stops the fuel flow to indicate that the system is operating properly. In all aircraft, the high-level sensors can also be tested during a HIFR from inside the aircraft. Pressure that may have built up in the tank, due to a clogged or malfunctioning vent, will register on the tank internal pressure gauge. Specific instructions for conducting a pressure refueling precheck are on a decal below the pressure refueling adapter and in the servicing chapter (Chapter 3).

2.4.4.2 Gravity Refueling

Gravity fueling ports are available for the main and external auxiliary fuel tanks. Tanks may be gravity fueled in any order.

2.4.4.3 Suction Defuel

All tanks can be suction defueled from the pressure refueling port, except the 270 pounds in the right main cell below the tank interconnect, which must be suction defueled through the cell sump drain valve.

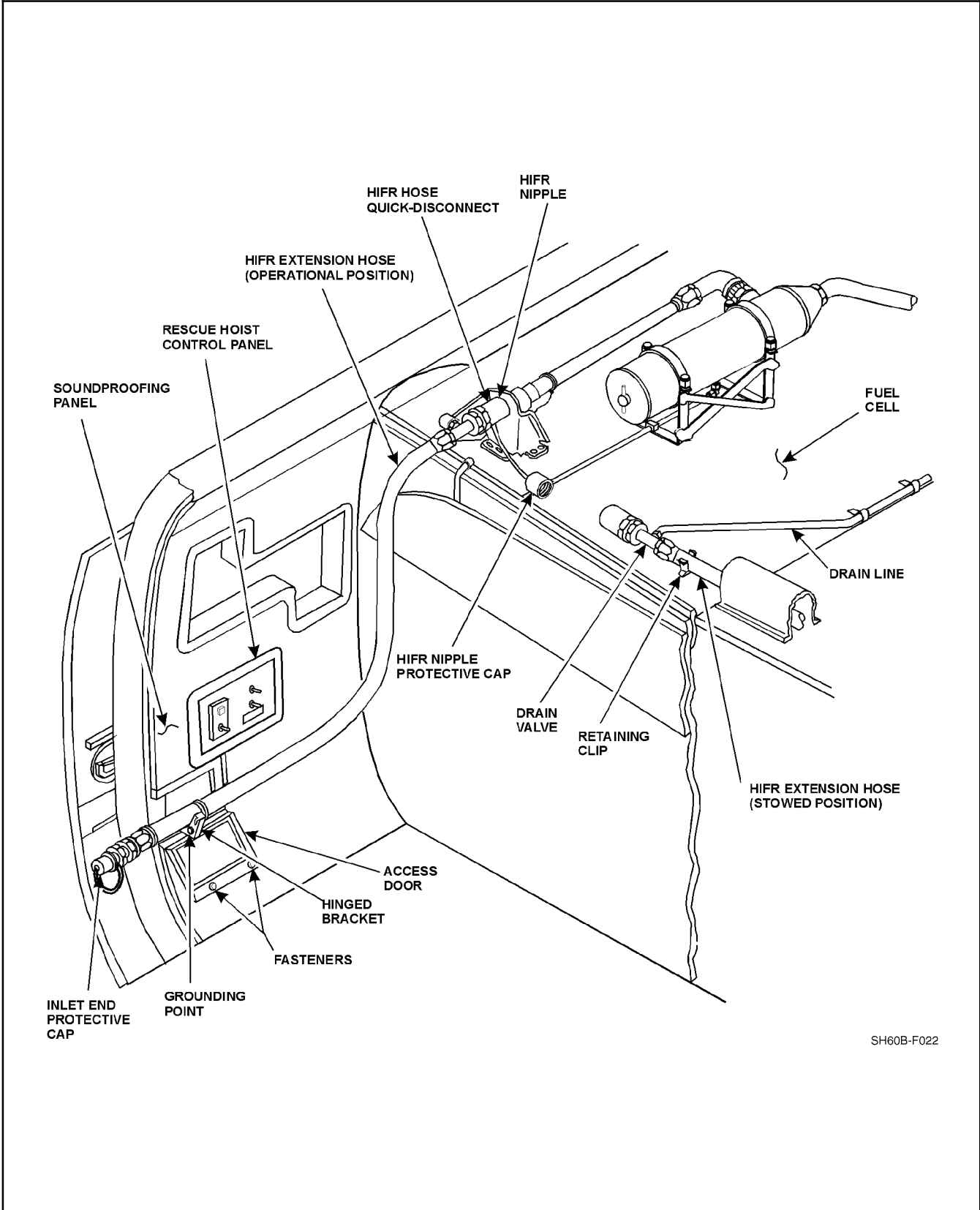
2.4.4.4 HIFR Refueling System

The HIFR system (Figure 2-18) consists of a Wiggins quick-disconnect pressure-refueling fitting, a pressure-refueling precheck switch, and a five-element (fuse) GO/NO-GO canister to pressure refuel the main fuel tanks. The Wiggins fitting is located above the right-hand fuel cell just forward of the GO/NO-GO canister. The GO/NO-GO canister is mounted above the right fuel tank and permits only acceptable fuel to pass. The elements are water sensitive and will shut off fuel flow at a 20 psi differential pressure. Flow is reduced to an extremely low level if the fuel is contaminated with water and particulate matter above a predetermined level.

Note

If the helicopter must be fueled when the quality of the fuel is in question, it should be refueled through the HIFR fitting. The HIFR filter is capable of removing both water and particulate matter from fuel.

Fuel spillage is collected in a drip pan located on top of the fuel tank and then drains overboard. The precheck panel contains a ground connector and a precheck switch. When the switch is moved to PRECHECK, 28 Vdc power is applied through the switch to the pressure refuel precheck valve in the refueling line to shut off fuel flow to the high-level sensor, testing the complete refueling system. Power to operate the precheck system is from the NO. 1 DC primary bus through a circuit breaker marked HIFR TEST and located on the SO circuit breaker panel.



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Figure 2-18. Helicopter In-Flight Refueling (HIFR) System (Sheet 1 of 2)

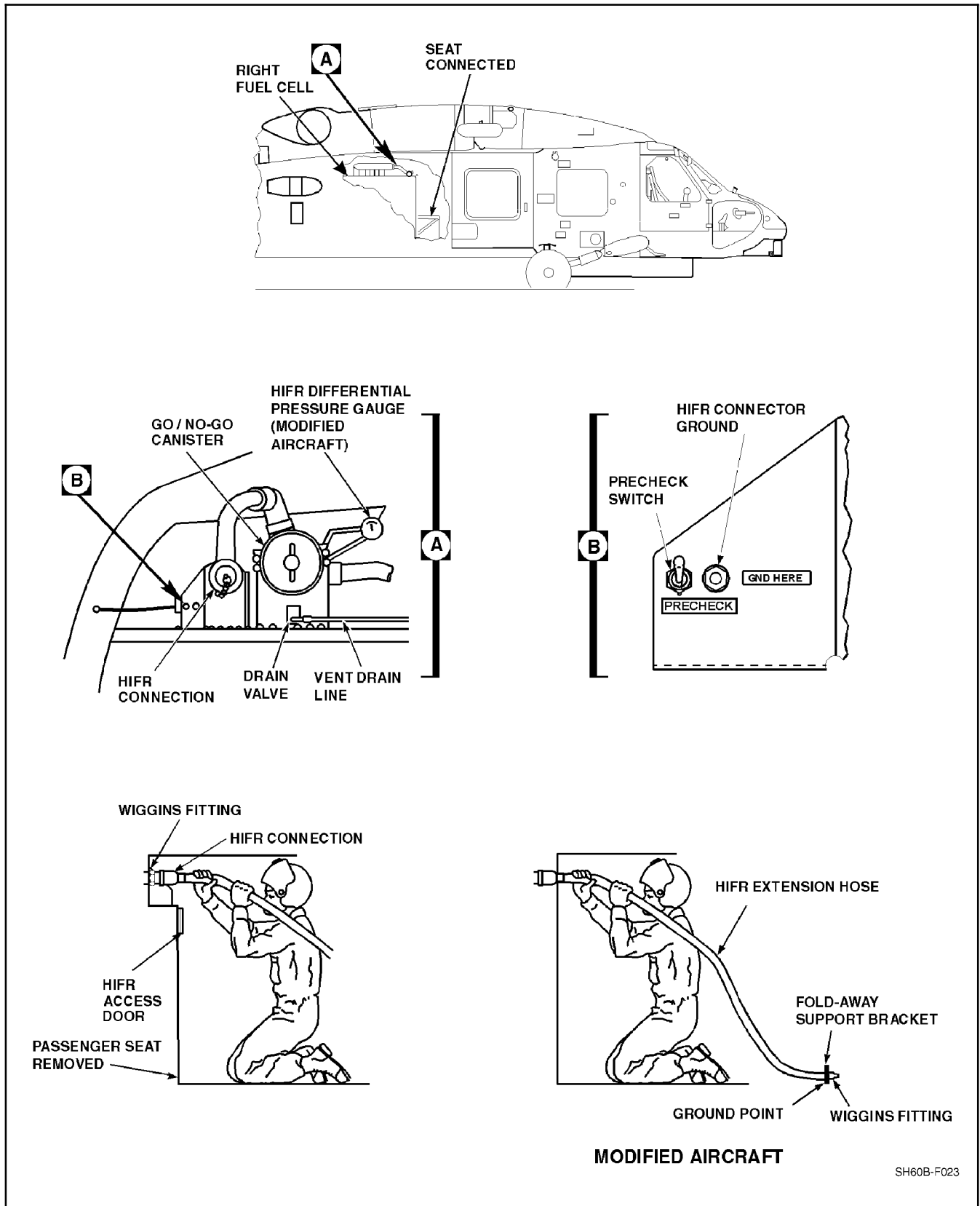


Figure 2-18 Helicopter In-Flight Refueling (HIFR) System (Sheet 2)

Some aircraft are modified to include a HIFR extension hose and a differential pressure gauge. The extension hose is stowed on top of the fuel cell and held in place with a retaining clip. For HIFR, the extension hose is connected to the HIFR connection, routed, and secured to a foldaway support bracket located aft of the personnel door below the rescue hoist control panel. The refueling hose is then connected to the extension hose Wiggins fitting at the support bracket. A grounding jack is located on the foldaway support bracket. The differential pressure gauge shows HIFR GO/NO-GO canister input and output pressure differential. A drain valve can be manually activated to clear the HIFR system of fuel.

If the left tank vent valve should malfunction and remain stuck in the closed position during HIFR, uneven filling of the main tank cells may occur. Once the fuel level has risen above the interconnect opening (approximately 600 pounds total), trapped air in the left cell will slow the rate at which the left cell fills with fuel to the point that the level will not rise while the right cell will continue to fill normally. If the fuel level remains below the high level shutoff sensor located in the left cell, the fuel flow will not stop. The fuel level in the right cell will rise to a level that will force the vent valve to close, resulting in an overpressure condition and possible cell rupture. See [Chapter 8](#), for HIFR procedure.



During HIFR, if the right cell fills faster than the left cell, monitor the fuel quantity gauges closely. If the difference in cell quantities persists, stop refueling before the right cell is full (approximately 1,700 pounds).

2.4.5 Auxiliary Fuel System

The auxiliary fuel system is comprised of two auxiliary tank locations, a fuel management system, and fuel quantity display information. Management is provided through the FMCP ([Figure 2-16](#) and [Figure 2-17](#)). The FMCP receives the sensor switch signal and provides logic to the control valves and pumps to control auxiliary fuel system functions.

2.4.5.1 Fuel Management Control Panel

The fuel management control panel (FMCP) functions are software controlled. The FMCP panel marked FUEL MGT is on the center console ([Figure 1-7](#)). The MASTER switch is a three-position switch marked TRANSFER, STOP FLOW, and REFUEL. At T

TRANSFER, the FMCP control logic enables the MODE switch and transfer operation. At STOP FLOW, power is removed from all FMCP switches, control logic is disabled, and auxiliary fuel system control is stopped, which closes all auxiliary tank shutoff valves. At REFUEL, when refueling with electrical power on, the aircraft the sequencing logic turns off all FMCP switches except precheck switches, all auxiliary tank shutoff valves are closed until the main internal tank is filled, and the auxiliary tank shutoff valves open one at a time to selectively fill the auxiliary tanks. The fuel system fill sequence is main tank, right inboard auxiliary tank, and left inboard auxiliary tank.

The MODE switch is a two-position switch marked AUTO and MANUAL OVRD. At AUTO, the fuel management logic is not initiated until the main fuel tank fuel level depletes to 2,700 to 2,580 pounds. If two auxiliary tanks are installed, the second tank will transfer after the main tank fuel level again drops enough to accommodate the complete auxiliary tank. When in MANUAL OVRD, auxiliary tank fuel is immediately transferred to the main tank until the high level sensor is reached, or until the auxiliary tanks are empty. Fuel tank transfer sequence is left inboard auxiliary tank then right auxiliary tank.

The PRECHECK switch is marked A, MAIN, and B and is spring loaded to the center (MAIN) position. The center position provides power to the precheck valves in the main fuel tank. When moved to A or B, power to the respective precheck valve is interrupted and fuel flow during refueling is immediately stopped, and fuel flow indication of the FMCP FLOW lights will go out.

Note

A malfunctioning FMCP (with electrical power applied) can cause activation of precheck valves preventing the ability to pressure refuel or HIFR. The FUEL MGMT circuit breakers on the ATO circuit breaker panel must be pulled to secure the precheck valves to allow fueling.

Three fuel flow indicators/selectors are marked L INBD FLOW, FUEL DUMP, and R INBD FLOW. The FUEL DUMP indicator lights when the EMER PNL FUEL DUMP switch is activated. The auxiliary tank indicators are split. L INBD and R INBD show at all times. FLOW lights independently when fuel is sensed flowing into or out of respective auxiliary fuel tank. The L INBD and R INBD selector switch function is a momentary pushbutton which when pressed, and MANUAL OVRD is selected, will initiate appropriate circuits to transfer fuel from an auxiliary tank to the main tank. When fuel level in the main tank reaches the high level shutoff, all manual transfer commands are stopped. When a selected auxiliary tank is emptied before the main tank high level shutoff is reached, the transfer circuits will shut off in 10 seconds.

Power to operate the FMCP is from the NO. 1 and NO. 2 DC primary buses through two circuit breakers marked FUEL MGMT and located on the ATO circuit breaker panel.

2.4.5.2 Fuel Transfer System

The fuel transfer system is controlled by the FMCP. It provides automatic or manual transfer of fuel from the auxiliary fuel tanks to the main fuel cells. Dual transfer/dump pumps suck fuel from the auxiliary fuel tanks through shutoff valves and deliver the fuel to the main tank. Pressure switches are provided as sensors to enable the FMCP to monitor fuel system operation. Fuel transfer is approximately 285 pounds per minute. When one pump fails to transfer fuel, and the second pump successfully transfers fuel, the PUMP/VALVE FAIL caution light illuminates. The FMCP receives fuel quantity status from main and auxiliary systems to properly schedule fuel transfer from auxiliary tanks to the main tank.



- During transfer of auxiliary fuel, if the right cell fills faster than the left cell, monitor the fuel quantity gauges closely. If difference in cell quantities persists, stop transferring fuel before the right cell is full (approximately 1,700 pounds).
- Do not initiate unmonitored manual transfer to the main tanks from auxiliary tanks until main tanks are below 3,200 pounds for an external auxiliary tank transfer. During manual auxiliary tank transfer, the main tank high level sensor (float valves) should prevent overflow of the main fuel tanks.

2.4.5.3 Manual Fuel Transfer Check

When main fuel tank capacity has decreased approximately 300 pounds, check the manual fuel transfer system to ensure proper transfer. Two short manual transfers will exercise both dual transfer pumps and transfer valves to ensure proper transfer.

2.4.5.4 Auxiliary Fuel Tanks

Each inboard weapons pylon is configured to accept a 120 gallon drop tank. The fuel level of each auxiliary fuel tank is internally monitored by a single gauge probe. Each probe provides a fuel quantity signal to the FMCP and the auxiliary fuel quantity indicator. Each auxiliary tank contains a low-level thermistor sensor which is exposed only when the tank is empty and then sends a signal to the FMCP. Each external auxiliary tank contains an overflow thermistor sensor which sends a signal to the FMCP if fuel is sensed in the external tank vent line. When fuel is sensed, a signal is sent to illuminate the EXT FUEL OVERFLOW caution light. Power to operate the auxiliary fuel tanks is from the NO. 2 DC primary bus through two circuit breakers marked FUEL LH INBD and FUEL RH INBD and located on the SO circuit breaker panel.

The auxiliary fuel quantity indicator marked AUX FUEL is on the pilot instrument panel (Figure 1-8). The window marked LBS provides a digital reading of the fuel quantity for the auxiliary tank or tanks selected with the selector switch. A selector switch marked L INBD–R INBD–TOTAL selects the fuel quantity in the left or right auxiliary tank or the total quantity of the two tanks. Power to operate the auxiliary fuel quantity indicator system is from the NO. 2 DC primary bus through a circuit breaker marked FUEL MGMT and located on the ATO circuit breaker panel.

Any combination of auxiliary tanks can be installed or removed from the aircraft. The software logic of the FMCP senses if an auxiliary tank gauge and low-level switch signal is absent. The FMCP commands automatically bypass an absent auxiliary tank station and go to the next occupied tank station.

A PUMP/VALVE FAIL caution light illuminates to show failure of any element(s) of the dual transfer/shutoff valves or dual transfer pumps. Normally, only a single valve and pump of the dual pump/valve system functions when fuel transfer is activated. Each valve and pump activates alternately with the other valve and pump to spread the use on the equipment. When a valve or pump fails and fuel flow is stopped, the PUMP/VALVE FAIL caution light will illuminate after approximately 40 seconds and the alternate valve will open. After an additional 40 seconds, if fuel flow has not begun, the alternate pump will start. After an additional 40 seconds, if fuel flow has still not started, the AUX FUEL XFER FAULT caution light illuminates to show total failure of the auxiliary fuel transfer system. The pressure sensor initiating the PUMP/VALVE FAIL light latches open and the light will not go out until the fault is repaired. An AUX FUEL XFER FAULT caution light illuminates when a transfer command in the FMCP for transfer to the main tank is received and auxiliary fuel transfer is not activated within approximately 120 seconds.

2.4.6 External Tank Jettison

The emergency panel marked EMER PNL (Figure 1-7) has a center switch marked ALL STORES SONO under the heading JETTISON. With weight-off-wheels, activating the switch will electrically fire all BRU-14 squib circuits, and all pylon external auxiliary bomb racks will release their stores.

2.5 AUXILIARY POWER UNIT SYSTEM

The APU system provides pneumatic power for starting the engines and operating the environmental control system (ECS). It incorporates a generator for ground and emergency in-flight electrical operations.

2.5.1 APU

The APU (Figure 2-19) is a gas turbine engine consisting of a power section, a reduction gearbox, appropriate controls, and accessories. The APU accessory gear box provides a mounting pad for the hydraulic starter and an output driver for the APU fuel assembly, oil pump, and air-cooled AC generator. The APU is lubricated by a self-contained oil system. Fuel consumption is 150 pounds per hour.

2.5.2 APU Accessories

APU system accessories include a prime/boost pump, hydraulic accumulator (with hand pump), hydraulic starter, and AC generator. The prime/boost pump is used to prime the engine or APU fuel lines and provides fuel under pressure to the APU during starting and operations at pressure altitudes at or above 8,000 feet. The hydraulic accumulator provides the hydraulic pressure for driving the APU starter. The minimum accumulator pressure required for starting the APU is approximately 2,650 psi. It can be recharged by using the accumulator hand pump. With AC power available, the accumulator is charged by the backup hydraulic pump.

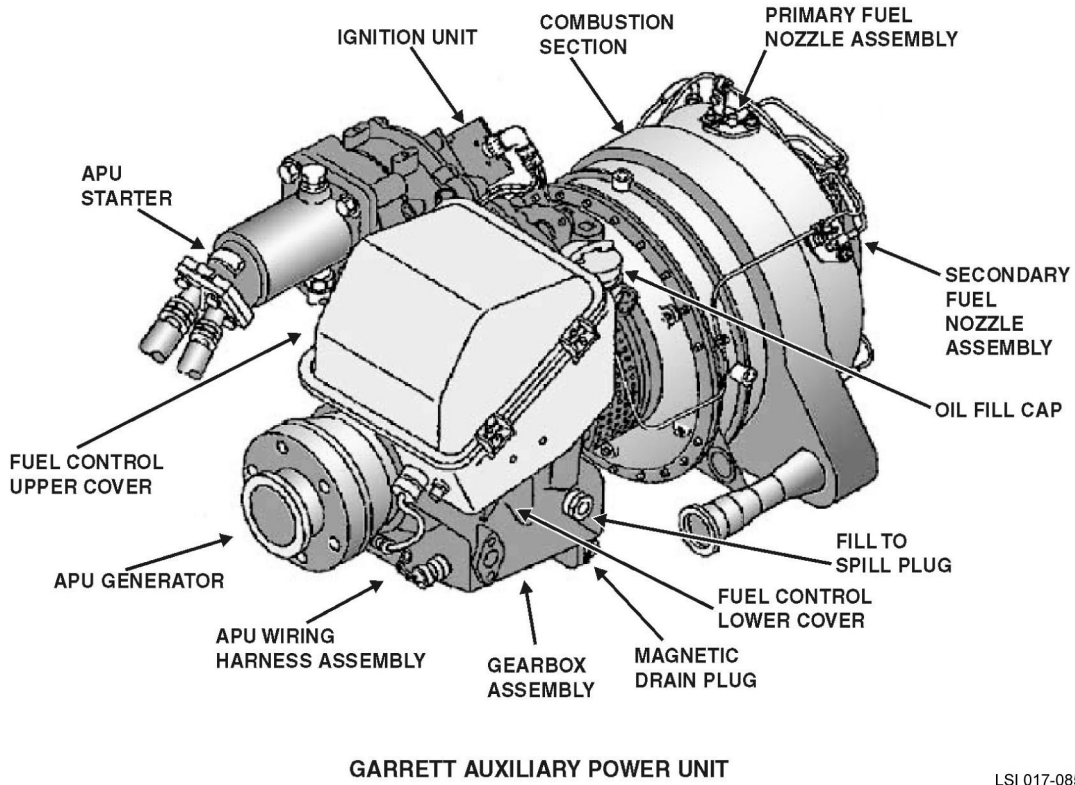
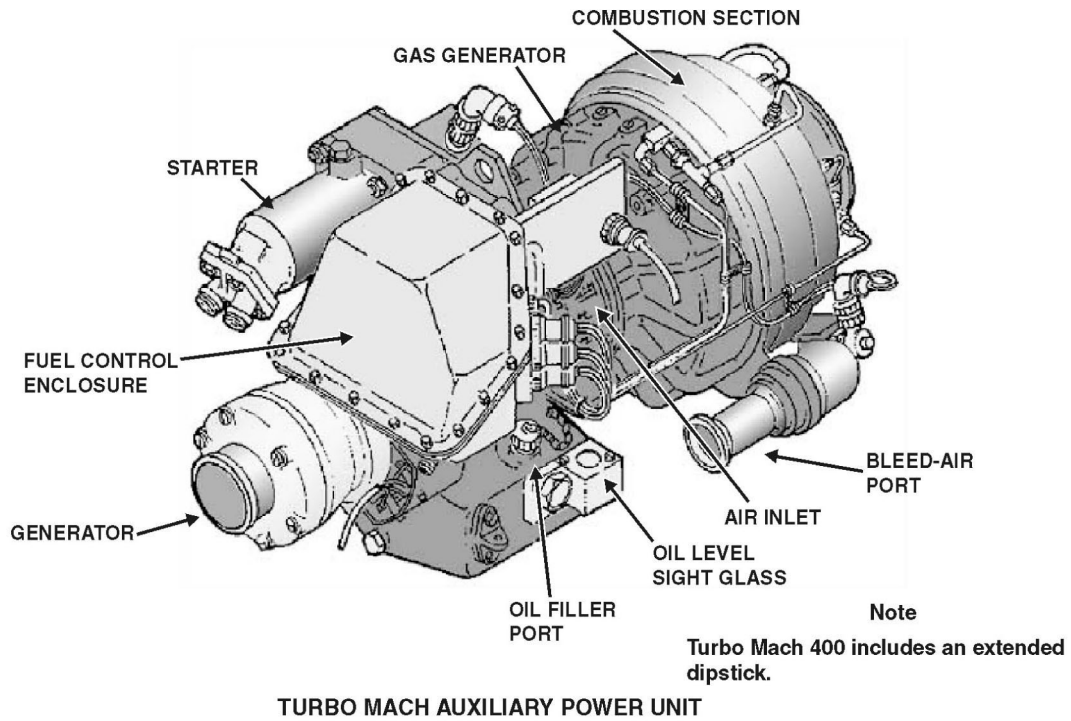
2.5.3 APU Controls

The APU CONTR switch, located on the upper console. ON opens the APU airframe fuel shutoff valve and sends a start signal to the APU electronic sequence unit (ESU) or digital electronic sequence unit (DESU). OFF removes electrical power from the system closing the airframe fuel shutoff valve.

2.5.4 APU Control and Monitoring

The APU is controlled and monitored by the ESU/DESU. If a start sequence fails or a monitored parameter is exceeded during operation (with the exception of APU OIL TEMP HI), the ESU/DESU will automatically shut down the APU.

The ESU/DESU displays APU faults using built-in-test (BIT) indicators. The BIT indicators are capable of displaying start sequence or operation status and specific reasons for APU shutdown. To maintain BIT codes after failure, DC power is required and the APU CONTR switch must remain in the ON position. Four caution/advisories (APU ON, APU FAIL, APU OIL TEMP HI, and APU ACCUM LOW) provide monitoring of APU operation. APU FAIL indicates the APU has failed due to high Ng, low Ng, high TGT, low TGT, low oil pressure, or start sequence failure. APU OIL TEMP HI indicates the APU has reached the maximum oil temperature for continuous operation. The DESU for the Turbomach APU has the added capability to control APU overtemps by regulating the main fuel valve and start bypass valve.



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Figure 2-19. Auxiliary Power Units

2.5.5 APU Start System

With the FUEL PUMP switch in the APU BOOST position, pressurized fuel is supplied from the right fuel tank by the prime/boost pump. The fuel control governs and meters fuel flow to the APU power section, permitting automatic starting under all ambient conditions and constant speed operation once the APU has accelerated to its normal speed.

Placing the APU CONTR switch to ON initiates the start sequence. The ESU/DESU sends a signal to open the APU start valve, releasing the hydraulic accumulator charge to the starter. As the accumulator pressure drops below 2,650 psi, the APU ACCUM LOW advisory appears, indicating that the accumulator pressure is low. The APU ON advisory appears when the APU is on and operating normally. Placing the APU GENERATOR switch to ON makes electrical power available. If the backup pump is cycled ON then to the OFF or AUTO position, it will remain on for one cycle of 90 seconds (180 seconds with winterization kit installed). Once the accumulator is recharged, the APU ACCUM LOW advisory will extinguish.

If the APU does not start and the APU ACCUM LOW advisory is not illuminated, a start may be attempted by simultaneously moving the APU CONTR switch to ON and actuating the manual START/OVERRIDE lever located on the accumulator manifold. APU accumulator pressure will be dumped to the starter to turn the compressor until the APU has reached a self-sustaining speed.

2.6 ELECTRICAL SYSTEM

The primary source of electrical power for the SH-60B is alternating current (AC). There are three AC sources for the aircraft. The primary sources are the two transmission-driven main generators. The secondary source is the APU-driven generator. External AC power can also be connected to the helicopter. DC electrical power is obtained by two converters which convert AC power to DC power and reduce the voltage. A battery is installed for use in starting the APU and as a secondary source of DC power. AC and DC power are distributed to individual components by means of a bus distribution system.

2.6.1 AC Electrical System

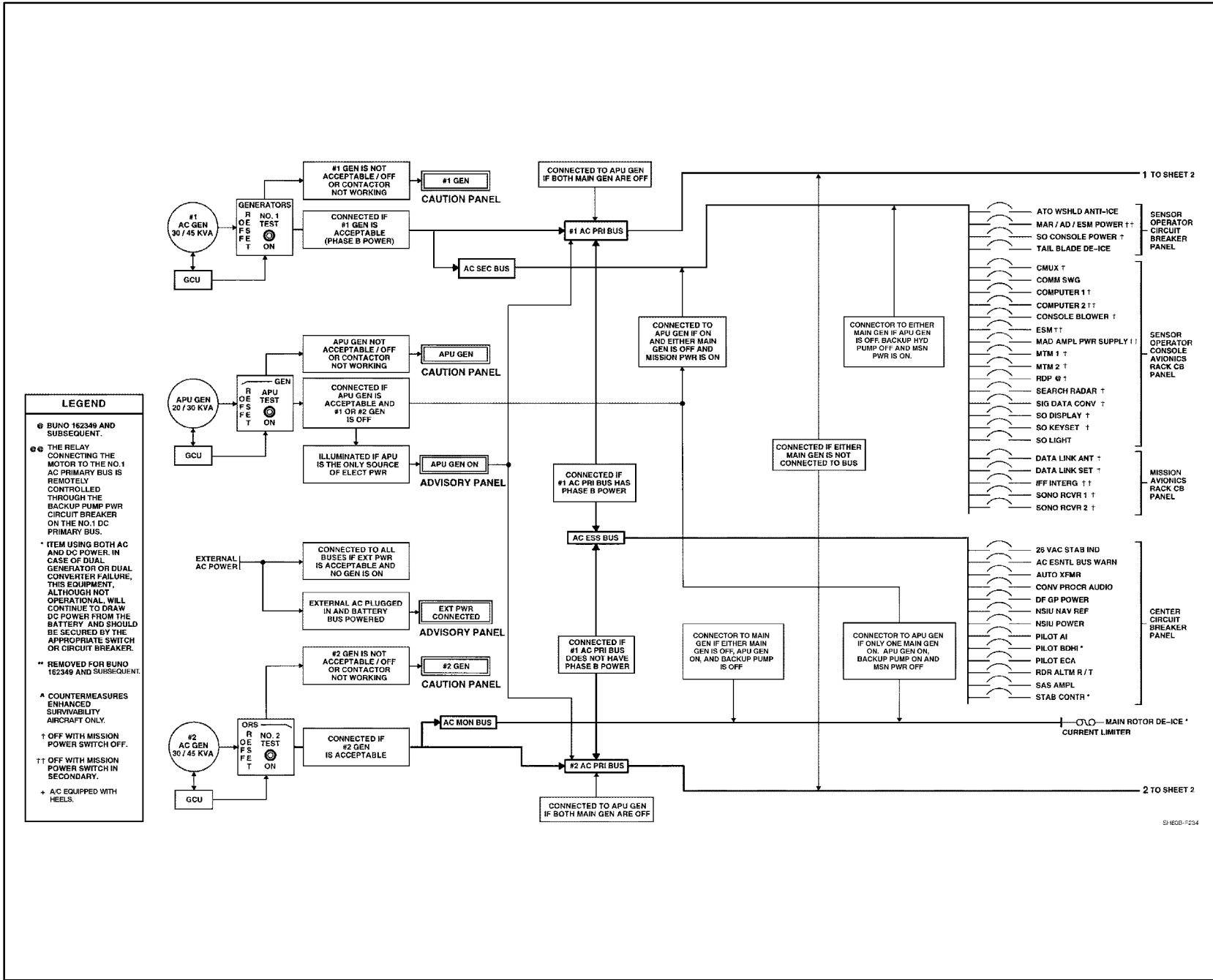
The primary AC electrical power is supplied by two oil-cooled 30/45 kVA, 115 Vac, 3 phase, 400 Hz brushless generators, driven by the transmission through the accessory modules. The generators share their oil supply with the accessory modules, input modules, and main transmission. A secondary electrical power source is supplied by an air-cooled, 20/30 kVA, 115 Vac, 3 phase, 400 Hz brushless generator mounted on and driven by the APU. The generators are controlled by generator control units (GCUs). The GCUs regulate generator output and protect against overvoltage, undervoltage, underfrequency on the ground, and feeder fault for detection of open or short circuited feeder lines. In flight, the generators will remain online until N_r decreases to approximately 80 percent. A minimum of 97 percent N_r is required for the GCU to connect the NO. 1 and NO. 2 generators to the AC distribution system. The external power receptacle, which may be used to supply external AC power to the electrical system, is located on the right side of the aircraft, forward of the cabin door near the main mount. External power is monitored by the external power monitor panel located in the right-hand junction box. The external power source is monitored for phase rotation, overvoltage, undervoltage, underfrequency, and overfrequency to determine if the source is acceptable.

There are five buses in the AC electrical distribution system: the NO. 1 and NO. 2 AC primary buses (NO. 1/2 AC PRI BUS), the AC essential bus (AC ESNTL BUS), the AC secondary bus (AC SEC BUS), and the AC monitor bus (AC MON BUS). AC bus distribution loads are illustrated in (Figure 2-20). With both main generators operating, the NO. 1 generator powers the NO. 1 AC primary, AC essential, and AC secondary buses, while the NO. 2 AC generator powers the NO. 2 AC primary and the AC monitor bus. If the APU generator is selected while both main generators are operating, the APU generator will not be connected to the AC bus distribution system.

Should either main generator fail, automatic bus switching compensates by limiting the AC load to the available generator output. If combined current demand exceeds the capability of the operating generator(s), the buses are redistributed to available generators so that major bus loads can be managed as follows:

1. The backup hydraulic pump is the major load for the NO. 1 AC primary bus and has the highest priority.
2. The mission avionics system is the major load on the AC secondary bus and is the next priority. Tail rotor de-ice power is also supplied from this bus.

Figure 2-20. Electrical System Block Diagram (AC, Sheet 1 of 3)



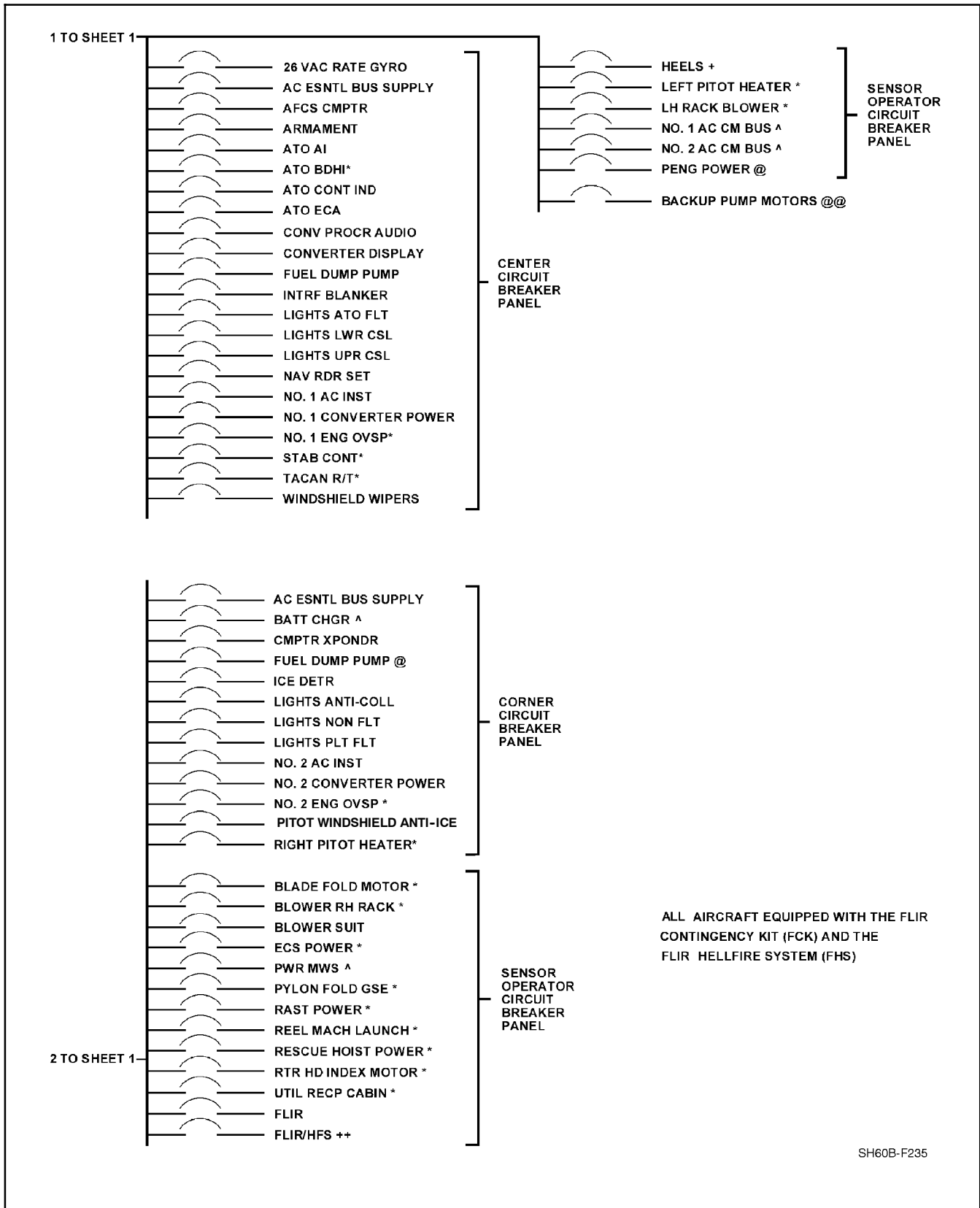
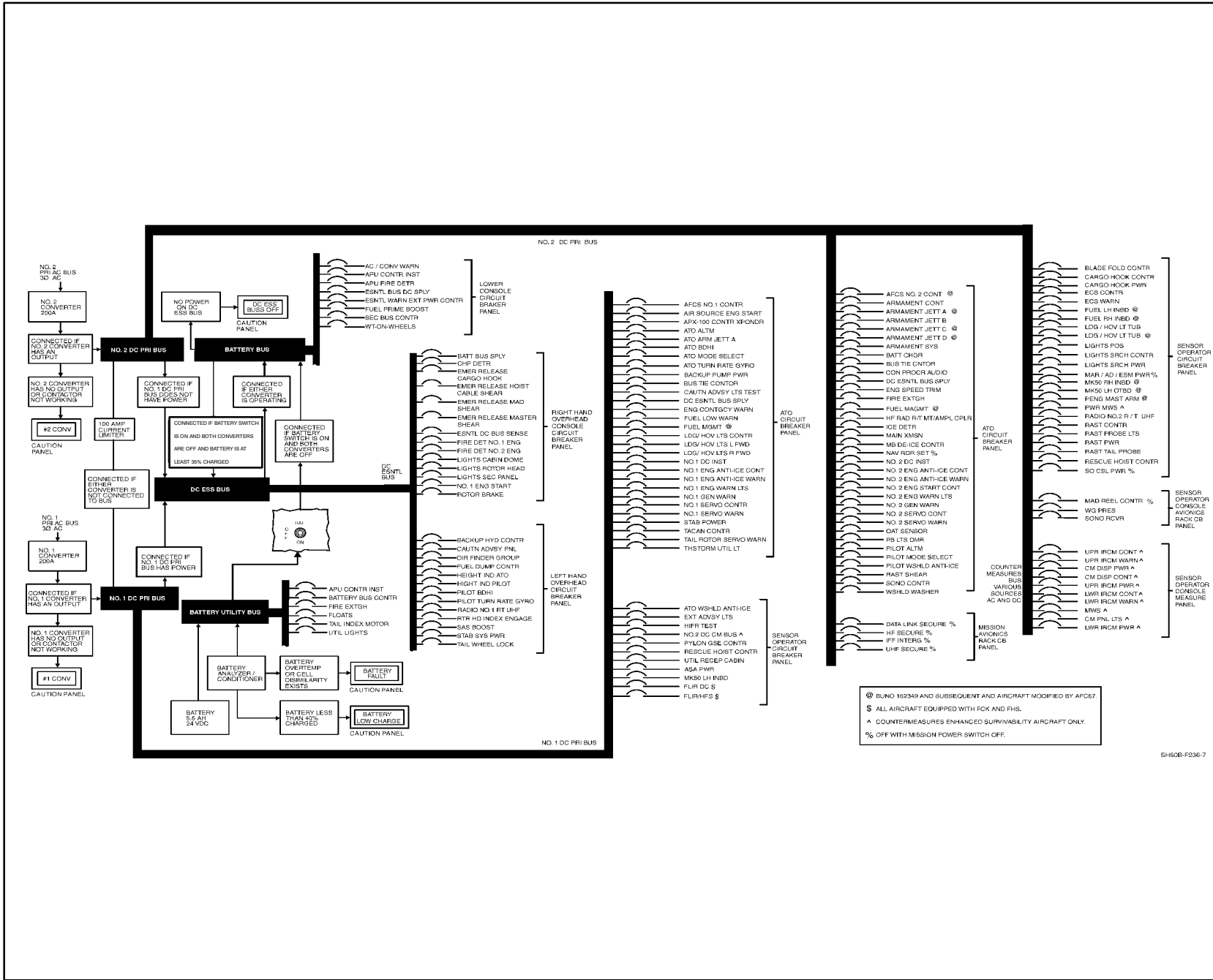


Figure 2-20. Electrical System Block Diagram (AC, Sheet 2)

Figure 2-20. Electrical System Block Diagram (DC, Sheet 3)



3. The main rotor de-ice system is the only system powered from the AC monitor bus and has the lowest priority of the major current drawing components. AC bus distribution during normal and degraded modes is illustrated in **Figure 2-21**.

Cockpit switches for control of the generators and external power are located in the center overhead console. The GENERATORS, APU, NO. 1, and NO. 2 switches are three-position switches, labeled ON, RESET OFF, and TEST. The ON position energizes the generator and permits connection of the generator AC output to the distribution system. The RESET OFF position deenergizes the generator and permits generator recycling if the generator was disabled or disconnected from the distribution system. The TEST position permits testing of the AC output of the generator without connecting it to the distribution system. If generator output is normal, the generator caution light will not be illuminated. The EXT PWR switch is a three-position switch, labeled ON, OFF, and RESET. The ON position permits connection of external AC power to the distribution system. The OFF position disconnects external AC power from the distribution system. The RESET position permits recycling if the AC external source was unacceptable. External power will automatically be dropped from the aircraft distribution system when either main generator or the APU generator is brought on line. Mission systems will be lost and secure electrical keys may be lost with only the APU generator on line.

Illumination of the #1 GEN, #2 GEN, or APU GEN caution light indicates a failure of the respective generator, GCU, generator contactor, or a fault in the respective distribution system due to an overvoltage, undervoltage, underfrequency on the ground, or feeder fault. Illumination of the #1 or #2 GEN BRG caution light indicates a worn or failed main bearing on the respective generator.

WARNING

If APU is unavailable or external power is not accepted when main generators are secured, a total loss of AC power will occur. Systems lost include ICS, VIDS display, and AFCS computer power. When AFCS computer power is interrupted, trim is disengaged and an unguarded cyclic will allow the rotor arc to dip to as low as four feet above the deck.

Power to illuminate the generator caution lights is provided from the NO. 1 and NO. 2 DC primary buses through the NO. 1 GEN WARN and NO. 2 GEN WARN circuit breakers, respectively. Both circuit breakers are on the ATO circuit breaker panel. Illumination of the AC ESS BUS OFF caution light indicates a power loss on the AC essential bus. The caution light is powered by any source of DC power through a circuit breaker marked AC ESNTL BUS WARN and located on the center circuit breaker panel. If the APU is the only source of AC power, illumination of the APU GEN ON advisory light indicates that the APU-driven generator is on and supplying power to the system. Illumination of the EXT PWR CONNECTED advisory light indicates that the external power cable is connected to the helicopter and DC power is on the battery bus. The advisory light is powered by the battery bus through a circuit breaker on the lower console circuit breaker panel marked ESNTL WARN EXT PWR CONTR.

| POWER SOURCE | #1 AC PRI | AC SEC | AC MONITOR |
|----------------------------|-------------|---------------|---------------|
| MAJOR LOAD ON BUS | BACKUP PUMP | MISSION POWER | BLADE DE-ICE |
| External Power | Available | Available | Available |
| Both Main Generators | Available | Available | Available |
| 1 Main and APU Generator | Note 1 | Note 1 | Note 1 |
| 1 Main Generator | Note 2 | Note 2 | Not Available |
| APU Generator | Available | Not Available | Not Available |
| Notes: | | | |
| 1. Combination of any two. | | | |
| 2. Either system. | | | |

Figure 2-21. AC Bus Distribution

2.6.2 AC Bus Tie System

The AC bus tie contactor/relay (K4) connects APU power or external power to the primary AC buses. In addition, the K4 allows the output from the #1 generator to power the buses of a failed #2 generator. With both main generators online and supplying output through K1 (#1 Gen) and K2 (#2 Gen), K4 is deenergized. It is by design that when one generator fails, the operating generator will inherit the required load via a relay. This is accomplished in two ways:

1. In the case of # 1 generator failure, the #2 generator has a direct feed (not K4) straight to the K1 contactor allowing the #1 generator buses to continue operation despite the failure of the generator.
2. When the #2 generator fails, output from the #1 generator is routed through the AC bus tie (K4), thus keeping the #2 generator buses powered.

With the loss of the AC bus tie, no caution light nor change in cockpit functionality exists that would alert crews to identify the failure. Identification will become apparent when a second failure such as a generator or converter failure occurs. The following shows two scenarios:

1. With the failure of both the K4 contactor and the #2 AC generator, the #2 primary AC bus will be lost. All other bus ties will remain functional.
2. With the loss of both the K4 contactor and the #1 AC generator, all bus ties will remain functional.

Note

In both cases, powering of the APU will result in the pickup of the AC Monitor bus only.

With the AC bus tie failure, indicated by a failed generator and no load pickup, the perceived correction is to start the APU and disconnect the operating generator. The perception here is that the APU powers the AC primary buses through the K4 feeder. If the AC bus fails, then the APU will not connect to the primary buses. Therefore, disconnecting of an operating generator will only compound the emergency from single generator operations to a self-induced total AC power failure.

WARNING

In the event of an AC bus tie failure, starting of the APU and disconnection of the operating generator has no effect in correcting the malfunction. Further, should the operating generator be taken off-line, a complete AC power failure is imminent.

2.6.3 DC Electrical System

DC power is supplied by two converters each rated at 28 Vdc, 200 amps continuous power. NO. 1 and NO. 2 converters are powered by the NO. 1 AC PRI BUS and NO. 2 AC PRI BUS through the NO. 1 CONVERTER POWER and NO. 2 CONVERTER POWER circuit breakers respectively. The NO. 1 converter is located in the left-hand junction box and the NO. 2 converter is located in the right-hand junction box. A 24 Vdc, 5.5 amp hours battery located in the ATO seat well provides a secondary or emergency source of DC power. A battery analyzer/conditioner located in the ATO seat well monitors the battery system for fault conditions and provides a battery charging capability. The analyzer system monitors battery charge, internal temperature, and cell conditions and will automatically disconnect DC loads from the battery or the battery from the charging circuit, as appropriate. The system charges the battery whenever AC power is available and the battery switch is on.

There are five buses in the DC electrical distribution system (Figure 2-20): the NO. 1 and NO. 2 DC primary buses (NO. 1/2 DC PRI BUS), the DC essential bus (DC ESNTL BUS), the battery bus (BATT BUS), and the battery utility bus (BATT UTIL BUS). Automatic bus switching provides maximum flexibility should a converter fail. The NO. 1 converter is the source of power for the NO. 1 DC primary bus, the DC essential bus, and the battery bus. The NO. 2 converter powers the NO. 2 DC primary bus. The battery powers the battery utility bus. Failure of one of the converters results in its loads being picked up by the other converter. If both converters fail, the battery provides a source of power to the battery utility bus, the battery bus (if the battery switch is on), and the DC essential bus (if the battery switch is on and the battery is above a 35 percent charge) through the circuit breaker marked ESNTL BUS DC SPLY and located on the lower console circuit breaker panel. The NO. 1 and NO. 2 DC primary buses are dropped.

Battery power is controlled by a two-position BATT switch located on the center overhead console labeled BATT with positions ON and OFF. The ON position connects the DC power output of the battery utility bus to the battery bus and provides input power to the analyzer/conditioner. When the helicopter converters are operating and BATT switch is ON, the charging circuit of the analyzer/conditioner receives AC and DC power. DC charging power is supplied from the NO. 2 DC primary bus through the BATT CHGR circuit breaker on the ATO circuit breaker panel. AC power is supplied from the NO. 2 AC primary bus through the BATT CHGR circuit breaker on the corner circuit breaker panel.

Indicator lights on the caution/advisory panel permit cockpit monitoring of the DC electrical system. Illumination of the #1 CONV or #2 CONV caution light indicates a failure of the respective converter or DC bus contactor. Power to light the CONV caution lights is provided from the battery bus through a circuit breaker marked ESNTL BUS AC/CONV WARN and located on the lower console circuit breaker panel. Illumination of the DC ESS BUS OFF caution light indicates a power loss on the DC essential bus. Illumination of the BATT LOW CHARGE caution light indicates that the battery is below a 40 percent state of charge. DC essential bus power is required to light this light.

Illumination of the BATTERY FAULT caution light indicates that a battery overtemperature or cell dissimilarity condition exists. When a battery overtemperature or cell dissimilarity condition exists, the battery is disconnected from the charging circuit. When the battery drops below a 35 percent state of charge, the DC essential bus will be disconnected from the battery to allow sufficient charge for APU starting. The DC essential bus will still be powered if either converter is on or external power is connected. Power to illuminate the BATTERY FAULT caution light is provided by the battery bus through the ESNTL WARN PWR CONTR circuit breaker.

WARNING

With no other source of DC power for the DC ESNTL BUS and the battery below 35 percent charge, the BATT LOW CHARGE light will not be on, battery power may not be sufficient to fire the fire extinguisher cartridge-activated device (CAD), and the fire warning system will not be operative for the main engines.

2.6.4 DC Bus Tie System

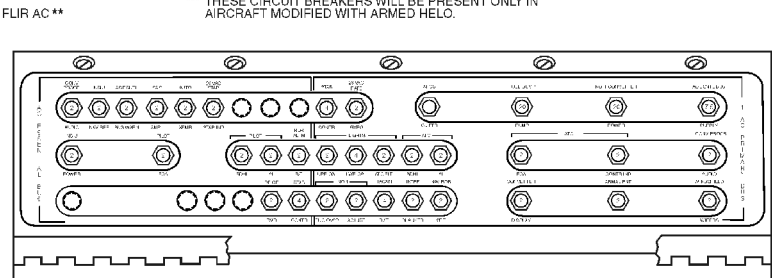
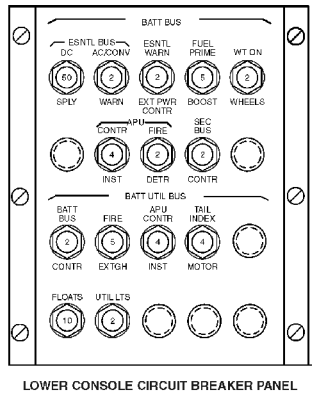
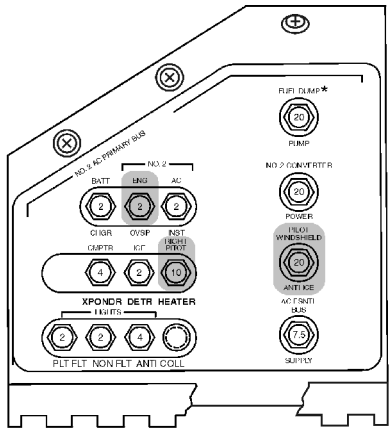
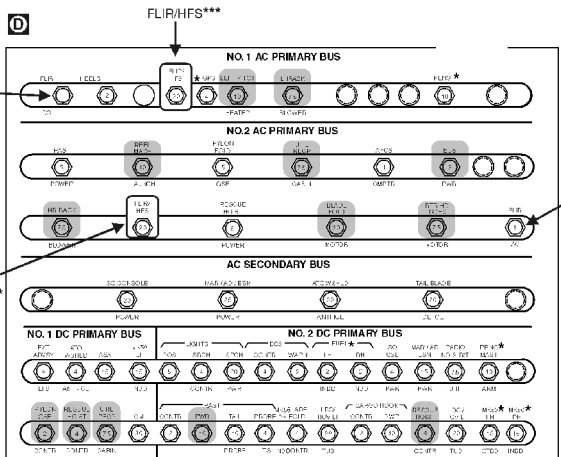
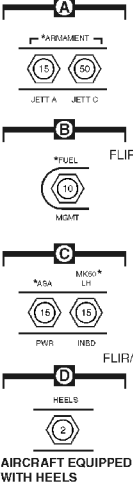
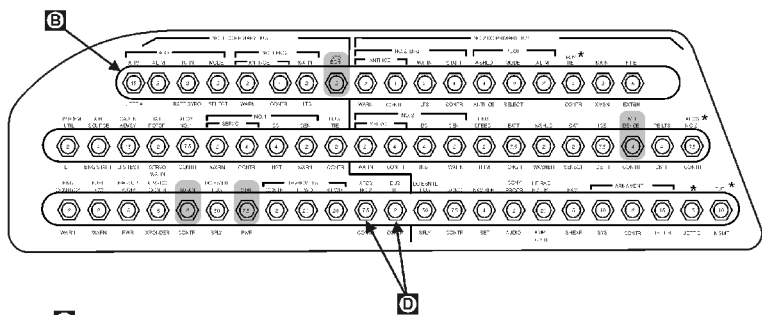
DC bus tie contactor (K7) provides a connection between the NO. 1 and NO. 2 DC primary buses. If one converter fails, the path is closed from the primary bus of the operating converter to energize the solenoid of the DC bus tie contactor. The energized contactor connects the output of the operating converter to the primary bus of the failed converter.

Regardless of the bus tie, no caution light nor change in cockpit functionality exists that would alert crews to identify the failure. Identification happens when another electrical component fails, such as a generator or converter, where the electrical load required is not picked up by the operating generator or converter.

2.6.5 Circuit Breaker Panels

Nine circuit breaker panels are located in the cockpit and cabin area (**Figure 2-22**). Two upper console (overhead) circuit breaker panels contain circuit breakers protecting the DC essential bus. The lower console circuit breaker panel contains circuit breakers protecting the battery bus and the battery utility bus. The corner circuit breaker panel contains circuit breakers protecting the NO. 2 AC primary bus. The ATO circuit breaker panel contains circuit breakers protecting the NO. 1 and NO. 2 DC primary buses. The center circuit breaker panel contains circuit breakers protecting the NO. 1 AC primary bus and the AC essential bus. The SO circuit breaker panel contains circuit breakers protecting the NO. 1 AC primary bus, the NO. 2 AC primary bus, the AC secondary bus, the NO. 1 DC primary bus, and the NO. 2 DC primary bus. The SO console avionics rack and the mission avionics rack circuit breaker panels contain circuit breakers protecting the AC secondary bus and the NO. 2 DC primary bus. See **Figure 2-23** for an alphabetical list of the circuit breakers.

Figure 2-22. Circuit Breaker Panels (Sheet 1 of 2)



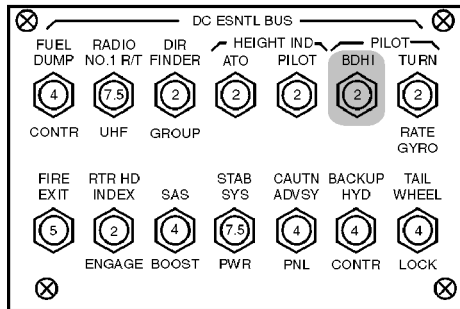
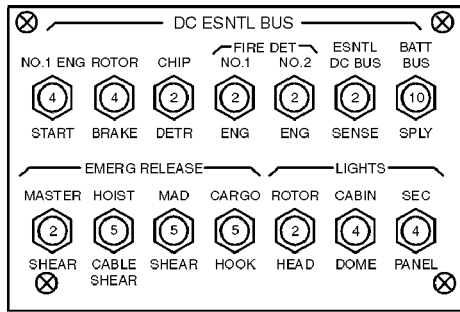
NOTE

* AIRCRAFT BUNO 162349 AND SUBSEQUENT.

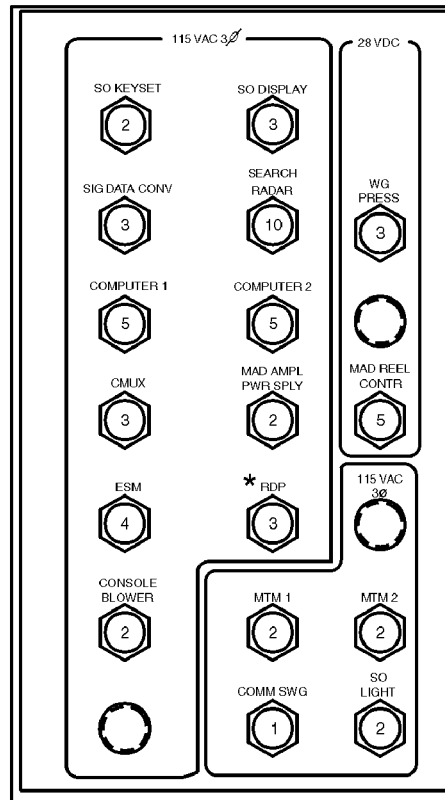
** THESE CIRCUIT BREAKERS WILL BE PRESENT FOR ALL AIRCRAFT NOT MODIFIED WITH ARMED HELO.

*** THESE CIRCUIT BREAKERS WILL BE PRESENT ONLY IN AIRCRAFT MODIFIED WITH ARMED HELO.

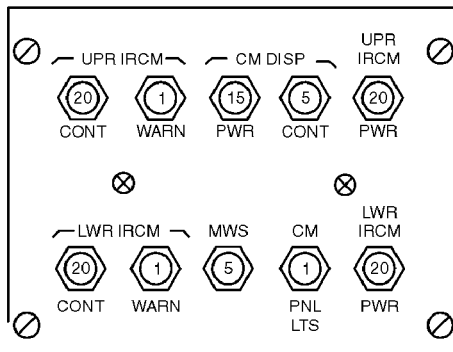
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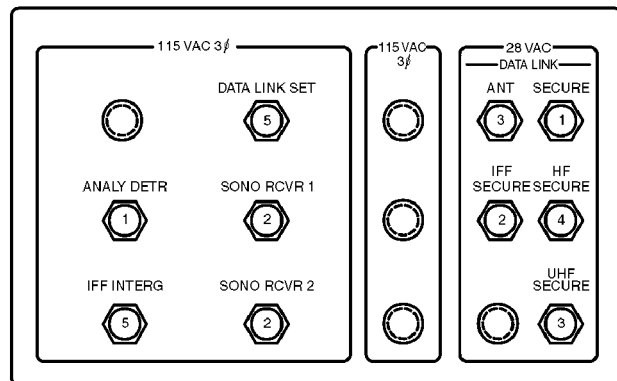
OVERHEAD CONSOLE CIRCUIT BREAKER PANELS



SO CONSOLE AVIONICS RACK CIRCUIT BREAKER PANEL



COUNTERMEASURES CONSOLE CIRCUIT BREAKER PANEL



MISSION AVIONICS CIRCUIT BREAKER PANEL

Figure 2-22. Circuit Breaker Panels (Sheet 2)

| CIRCUIT BREAKER | BUS | LOCATION |
|----------------------|------------------|------------------|
| AC ESNTL BUS SUPPLY | NO. 1 AC PRI BUS | CENTER |
| AC ESNTL BUS SUPPLY | NO. 2 AC PRI BUS | CORNER |
| AC ESNTL BUS WARN | AC ESS BUS | CENTER |
| AFCS CMPTR | NO. 2 AC PRI BUS | SO OVHD |
| AFCS CMTPR | NO. 1 AC PRI BUS | CENTER |
| AFCS NO. 1 CONTR | NO. 1 DC PRI BUS | ATO |
| AFCS NO. 2 CONTR | NO. 1 DC PRI BUS | ATO |
| AFCS NO. 2 CONTR | NO. 2 DC PRI BUS | ATO |
| AIR SOURCE ENG START | NO. 1 DC PRI BUS | ATO |
| ANALY DETR | AC SEC BUS | MISSION AVIONICS |
| APU CONTR INST | BATT UTIL BUS | LOWER CONSOLE |
| APU: CONTR INST | BATT BUS | LOWER CONSOLE |
| APU: FIRE DETR | BATT BUS | LOWER CONSOLE |
| APX-100 CONTR XPONDR | NO. 1 DC PRI BUS | ATO |
| ARMAMENT | NO. 1 AC PRI BUS | CENTER |
| ARMAMENT: CONTR | NO. 2 DC PRI BUS | ATO |
| ARMAMENT: JETT A | NO. 2 DC PRI BUS | ATO |
| ARMAMENT: JETT B | NO. 2 DC PRI BUS | ATO |
| ARMAMENT: JETT C | NO. 2 DC PRI BUS | ATO |
| ARMAMENT: SYS | NO. 2 DC PRI BUS | ATO |
| ASA | NO. 1 DC PRI BUS | SO OVHD |
| ASA PWR | NO. 1 DC PRI BUS | SO OVHD |
| ATO BDHI | NO. 1 DC PRI BUS | ATO |
| ATO WSHLD ANTI-ICE | NO. 1 DC PRI BUS | SO OVHD |
| ATO WSHLD ANTI-ICE | NO. 2 AC PRI BUS | SO OVHD |
| ATO: | NO. 1 AC PRI BUS | CENTER |
| ATO: ALTM | NO. 1 DC PRI BUS | ATO |
| ATO: ARM JETTA | NO. 1 DC PRI BUS | ATO |
| ATO: BDHI | NO. 1 AC PRI BUS | CENTER |
| ATO: CONTRIND | NO. 1 AC PRI BUS | CENTER |
| AUTO: EC | NO. 1 AC PRO BUS | CENTER |
| AUTO: MODE SELECT | NO. 1 DC PRO BUS | AUTO |
| AUTO: TURN RATE GYRO | NO. 1 DC PRO BUS | AUTO |
| AUTO FEMORA | AC ESS BUS | CENTER |
| BACKUP HYD CON TR | DC ESTEL BUS | OVHD CONSOLE |
| BACKUP PUMP PR | NO. 1 DC PRO BUS | AUTO |
| BATT BUS CON TR | BATT UT IL BUS | LOWER CONSOLE |
| BATT BUS SPLY | DC ESNTL BUS | OVHD CONSOLE |
| BATT CHGR | NO. 2 DC PRI BUS | ATO |

Figure 2-23. Circuit Breaker List (Sheet 1 of 7)

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| CIRCUIT BREAKER | BUS | LOCATION |
|----------------------------------|------------------|--------------------------|
| BATT CHGR | NO. 2 AC PRI BUS | CORNER |
| BLADE FOLD CONTR | NO. 2 DC PRI BUS | SO OVHD |
| BLADE FOLD MOTOR | NO. 2 AC PRI BUS | SO OVHD |
| BUS TIE CONTR | NO. 1 DC PRI BUS | ATO |
| BUS TIE CONTR | NO. 2 DC PRI BUS | ATO |
| CARGO HOOK: CONTR | NO. 2 DC PRI BUS | SO OVHD |
| CARGO HOOK: PWR | NO. 2 DC PRI BUS | SO OVHD |
| CAUTN ADVSY LTS TEST | NO. 1 DC PRI BUS | ATO |
| CAUTN ADVSY PNL | DC ESNTL BUS | OVHD CONSOLE |
| CHIP DETR | DC ESNTL BUS | OVHD CONSOLE |
| CM DISP: CONT | NO. 2 DC PRI BUS | SO COUNTERMEASURES |
| CM DISP: PWR | NO. 2 DC PRI BUS | SO COUNTERMEASURES |
| CM PNL LTS | NO. 2 DC PRI BUS | SO COUNTERMEASURES |
| CMPTR XPONDR | NO. 2 AC PRI BUS | CORNER |
| CMPTR XPONDR | NO. 1 DC PRI BUS | SO OVHD |
| CMUX | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| COMM SWG | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| COMPUTER 1 | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| COMPUTER 2 | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| CONSOLE BLOWER | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| CONV PROCR AUDIO | NO. 2 DC PRI BUS | ATO |
| CONV PROCR AUDIO | AC ESS BUS | CENTER |
| CONV PROCR AUDIO | NO. 1 AC PRI BUS | CENTER |
| CONVERTER DISPLAY | NO. 1 AC PRI BUS | CENTER |
| DATA LINK SET | AC SEC BUS | MISSION AVIONICS |
| DATA LINK: ANT | NO. 2 DC PRI BUS | MISSION AVIONICS |
| DATA LINK: SECURE | NO. 2 DC PRI BUS | MISSION AVIONICS |
| DC ESNTL BUS SPLY | NO. 1 DC PRI BUS | ATO |
| DC ESNTL BUS SPLY | NO. 2 DC PRI BUS | ATO |
| DF GP PWR | AC ESS BUS | CENTER |
| DIR FINDER GROUP | DC ESNTL BUS | OVHD CONSOLE |
| ECS PWR | NO. 2 AC PRI BUS | SO OVHD |
| ECS: CONTR | NO. 2 DC PRI BUS | SO OVHD |
| ECS: WARN | NO. 2 DC PRI BUS | SO OVHD |
| EMERG RELEASE: CARGO HOOK | DC ESNTL BUS | OVHD CONSOLE |
| EMERG RELEASE: HOIST CABLE SHEAR | DC ESNTL BUS | OVHD CONSOLE |
| EMERG RELEASE: MAD SHEAR | DC ESNTL BUS | OVHD CONSOLE |
| EMERG RELEASE: MASTER SHEAR | DC ESNTL BUS | OVHD CONSOLE |
| ENG CONTGCY WARN | NO. 1 DC PRI BUS | ATO |

Figure 2-23. Circuit Breaker List (Sheet 2)

| CIRCUIT BREAKER | BUS | LOCATION |
|--------------------------|------------------|--------------------------|
| ENG SPEED TRIM | NO. 2 DC PRI BUS | ATO |
| ESM | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| ESNTL BUS: AC/CONV WARN | BATT BUS | LOWER CONSOLE |
| ESNTL BUS: DC SPLY | BATT BUS | LOWER CONSOLE |
| ESNTL DC BUS SENSE | DC ESNTL BUS | OVHD CONSOLE |
| ESNTL WARN EXT PWR CONTR | BATT BUS | LOWER CONSOLE |
| EXT ADVSY LTS | NO. 1 DC PRI BUS | SO OVHD |
| FIRE DET: NO. 1 ENG | DC ESNTL BUS | OVHD CONSOLE |
| FIRE DET: NO. 2 ENG | DC ESNTL BUS | OVHD CONSOLE |
| FIRE EXIT | DC ESNTL BUS | OVHD CONSOLE |
| FIRE EXTGH | NO. 2 DC PRI BUS | ATO |
| FIRE EXTGH | BATT UTIL BUS | LOWER CONSOLE |
| FLIR AC | NO. 2 AC PRI BUS | SO OVHD |
| FLIR DC | NO. 1 AC PRI BUS | SO OVHD |
| FLIR/HFS | NO. 1 AC PRI BUS | SO OVHD |
| FLIR/HFS | NO. 2 AC PRI BUS | SO OVHD |
| FLOATS | BATT UTIL BUS | LOWER CONSOLE |
| FUEL DUMP CONTR | DC ESNTL BUS | OVHD CONSOLE |
| FUEL DUMP PUMP | NO. 1 AC PRI BUS | CENTER |
| FUEL DUMP PUMP | NO. 2 AC PRI BUS | CORNER |
| FUEL LOW WARN | NO. 1 DC PRI BUS | ATO |
| FUEL MGMT | NO. 2 DC PRI BUS | ATO |
| FUEL PRIME BOOST | BATT BUS | LOWER CONSOLE |
| FUEL: LH INBD | NO. 2 DC PRI BUS | SO OVHD |
| FUEL: RH INBD | NO. 2 DC PRI BUS | SO OVHD |
| GPS | NO. 1 AC PRI BUS | SO OVHD |
| HEELS | NO. 1 AC PRI BUS | SO OVHD |
| HEIGHT IND: ATO | DC ESNTL BUS | OVHD CONSOLE |
| HEIGHT IND: PILOT | DC ESNTL BUS | OVHD CONSOLE |
| HF RAD R/T MT AMPL CPLR | NO. 2 DC PRI BUS | ATO |
| HF SECURE | NO. 2 DC PRI BUS | MISSION AVIONICS |
| ICE DETR | NO. 2 DC PRI BUS | ATO |
| ICE DETR | NO. 2 AC PRI BUS | CORNER |
| IFF INTERG | AC SEC BUS | MISSION AVIONICS |
| IFF SECURE | NO. 2 DC PRI BUS | MISSION AVIONICS |
| INTRF BLANKER | NO. 1 AC PRI BUS | CENTER |
| JETT D | NO. 2 DC PRI BUS | ATO |
| LDG/HOV LT TUB | NO. 2 DC PRI BUS | SO OVHD |
| LDG/HOV LT TUB | NO. 2 DC PRI BUS | SO OVHD |

Figure 2-23. Circuit Breaker List (Sheet 3)

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| CIRCUIT BREAKER | BUS | LOCATION |
|----------------------------|------------------|--------------------------|
| LDG/HOV LTS: CONTR | NO. 1 DC PRI BUS | ATO |
| LDG/HOV LTS: L FWD | NO. 1 DC PRI BUS | ATO |
| LDG/HOV LTS: R FWD | NO. 1 DC PRI BUS | ATO |
| LEFT PITOT HEATER | NO. 1 AC PRI BUS | SO OVHD |
| LH RACK BLOWER | NO. 1 AC PRI BUS | SO OVHD |
| LIGHTS: ANTI COLL | NO. 2 AC PRI BUS | CORNER |
| LIGHTS: ATO FLT | NO. 1 AC PRI BUS | CENTER |
| LIGHTS: CABIN DOME | DC ESNTL BUS | OVHD CONSOLE |
| LIGHTS: LWR CSL | NO. 1 AC PRI BUS | CENTER |
| LIGHTS: NON FLT | NO. 2 AC PRI BUS | CORNER |
| LIGHTS: PLT FLT | NO. 2 AC PRI BUS | CORNER |
| LIGHTS: POS | NO. 2 DC PRI BUS | SO OVHD |
| LIGHTS: ROTOR HEAD | DC ESNTL BUS | OVHD CONSOLE |
| LIGHTS: SEC PANEL | DC ESNTL BUS | OVHD CONSOLE |
| LIGHTS: SRCH CONTR | NO. 2 DC PRI BUS | SO OVHD |
| LIGHTS: SRCH PWR | NO. 2 DC PRI BUS | SO OVHD |
| LIGHTS: UPR CSL | NO. 1 AC PRI BUS | CENTER |
| LWR IRCM PWR | NO. 2 DC PRI BUS | SO COUNTERMEASURES |
| LWR IRCM: CONT | NO. 2 DC PRI BUS | SO COUNTERMEASURES |
| LWR IRCM: WARN | NO. 2 DC PRI BUS | SO COUNTERMEASURES |
| MAD AMPL PWR SPLY | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| MAD REEL CONTR | NO. 2 DC PRI BUS | SO CONSOLE AVIONICS RACK |
| MAIN XMSN | NO. 2 DC PRI BUS | ATO |
| MAR/AD/ESM POWER | NO. 2 AC PRI BUS | SO OVHD |
| MAR/AD ESM PWR | NO. 2 DC PRI BUS | SO OVHD |
| MB DE-ICE CONTR | NO. 2 DC PRI BUS | ATO |
| MK50 LH INBD | NO. 1 DC PRI BUS | SO OVHD |
| MK50 LH OTBD | NO. 2 DC PRI BUS | SO OVHD |
| MK50 RH INBD | NO. 2 DC PRI BUS | SO OVHD |
| MK50 RH OTBD | NO. 2 DC PRI BUS | SO OVHD |
| MTM 1 | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| MTM 2 | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| MWS | NO. 2 DC PRI BUS | SO COUNTER MEASURES |
| NAV RDR SET | NO. 2 DC PRI BUS | ATO |
| NAV RDR SET | NO. 1 AC PRI BUS | CENTER |
| NO. 1 CONVERTER POWER | NO. 1 AC PRI BUS | CENTER |
| NO. 1 ENG START | DC ESNTL BUS | OVHD CONSOLE |
| NO. 1 ENG: ANTI-ICE: CONTR | NO. 1 DC PRI BUS | ATO |
| NO. 1 ENG: ANTI-ICE: WARN | NO. 1 DC PRI BUS | ATO |

Figure 2-23. Circuit Breaker List (Sheet 4)

| CIRCUIT BREAKER | BUS | LOCATION |
|----------------------------|------------------|--------------|
| NO. 1 ENG: WARN LTS | NO. 1 DC PRI BUS | ATO |
| NO. 1 AC INST | NO. 1 AC PRI BUS | CENTER |
| NO. 1 DC INST | NO. 1 DC PRI BUS | ATO |
| NO. 1 ENG OVSP | NO. 1 AC PRI BUS | CENTER |
| NO. 1 GEN WARN | NO. 1 DC PRI BUS | ATO |
| NO. 1 SERVO: CONTR | NO. 1 DC PRI BUS | ATO |
| NO. 1 SERVO: WARN | NO. 1 DC PRI BUS | ATO |
| NO. 2 CONVERTER POWER | NO. 2 AC PRI BUS | CORNER |
| NO. 2 ENG: ANTI-ICE: CONTR | NO. 2 DC PRI BUS | ATO |
| NO. 2 ENG: ANTI-ICE: WARN | NO. 2 DC PRI BUS | ATO |
| NO. 2 ENG: START CONTR | NO. 2 DC PRI BUS | ATO |
| NO. 2 ENG: WARN LTS | NO. 2 DC PRI BUS | ATO |
| NO. 2 AC INST | NO. 2 AC PRI BUS | CORNER |
| NO. 2 DC INST | NO. 2 DC PRI BUS | ATO |
| NO. 2 ENG OVSP | NO. 2 AC PRI BUS | CORNER |
| NO. 2 GEN WARN | NO. 2 DC PRI BUS | ATO |
| NO. 2 SERVO: CONTR | NO. 2 DC PRI BUS | ATO |
| NO. 2 SERVO: WARN | NO. 2 DC PRI BUS | ATO |
| NSIU NAV REF | AC ESS BUS | CENTER |
| NSIU POWER | AC ESS BUS | CENTER |
| OAT SENSOR | NO. 2 DC PRI BUS | ATO |
| P ENG | NO. 1 AC PRI BUS | SO OVHD |
| PB LTS CMR | NO. 2 DC PRI BUS | ATO |
| PILOT ECA | AC ESS BUS | CENTER |
| PILOT: AI | AC ESS BUS | CENTER |
| PILOT: ALTM | NO. 2 DC PRI BUS | ATO |
| PILOT: BDHI | AC ESS BUS | CENTER |
| PILOT: BDHI | DC ESNTL BUS | OVHD CONSOLE |
| PILOT: MODE SELECT | NO. 2 DC PRI BUS | ATO |
| PILOT: TURN RATE GYRO | DC ESNTL BUS | OVHD CONSOLE |
| PILOT: WSHLD ANTI-ICE | NO. 2 DC PRI BUS | ATO |
| PILOT WINDSHIELD ANTI ICE | NO. 2 AC PRI BUS | CORNER |
| PYLON FOLD GSE | NO. 2 AC PRI BUS | SO OVHD |
| PYLON GSE CONTR | NO. 1 DC PRI BUS | SO OVHD |
| R ENG MAST ARM | NO. 2 DC PRI BUS | SO OVHD |
| RADIO NO. 1 R/T UHF | DC ESNTL BUS | OVHD CONSOLE |
| RADIO NO. 2 R/T UHF | NO. 2 DC PRI BUS | SO OVHD |
| RAST POWER | NO. 2 AC PRI BUS | SO OVHD |
| RAST SHEAR | NO. 2 DC PRI BUS | ATO |

Figure 2-23. Circuit Breaker List (Sheet 5)

| CIRCUIT BREAKER | BUS | LOCATION |
|-----------------------|------------------|--------------------------|
| RAST: CONTR | NO. 2 DC PRI BUS | SO OVHD |
| RAST: PROBE LTS | NO. 2 DC PRI BUS | SO OVHD |
| RAST: PWR | NO. 2 DC PRI BUS | SO OVHD |
| RAST: TAIL PROBE | NO. 2 DC PRI BUS | SO OVHD |
| RATE GYRO 26 VAC | NO. 1 AC PRI BUS | CENTER |
| RDP | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| RDR ALTM R/T | AC ESS BUS | CENTER |
| REEL MACH LAUNCH | NO. 2 AC PRI BUS | SO OVHD |
| RESCUE HOIST CONTR | NO. 1 DC PRI BUS | SO OVHD |
| RESCUE HOIST CONTR | NO. 2 DC PRI BUS | SO OVHD |
| RESCUE HOIST POWER | NO. 2 AC PRI BUS | SO OVHD |
| RH RACK BLOWER | NO. 2 AC PRI BUS | SO OVHD |
| RIGHT PITOT HEATER | NO. 2 AC PRI BUS | CORNER |
| ROTOR BRAKE | DC ESNTL BUS | OVHD CONSOLE |
| RTR HD INDEX ENGAGE | DC ESNTL BUS | OVHD CONSOLE |
| RTR HD INDEX MOTOR | NO. 2 AC PRI BUS | SO OVHD |
| SAS AMPL | AC ESS BUS | CENTER |
| SAS BOOST | DC ESNTL BUS | OVHD CONSOLE |
| SEARCH RADAR | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| SEC BUS CONTR | BATT BUS | LOWER CONSOLE |
| SIG DATA CONV | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| SO CONSOLE POWER | NO. 2 AC PRI BUS | SO OVHD |
| SO CSL PWR | NO. 2 DC PRI BUS | SO OVHD |
| SO DISPLAY | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| SO KEYSET | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| SO LIGHT | AC SEC BUS | SO CONSOLE AVIONICS RACK |
| SONO CONTR | NO. 2 DC PRI BUS | ATO |
| SONO RCVR 1 | AC SEC BUS | MISSION AVIONICS |
| SONO RCVR 2 | AC SEC BUS | MISSION AVIONICS |
| STAB CONTR | AC ESS BUS | CENTER |
| STAB CONTR | NO. 1 AC PRI BUS | CENTER |
| STAB IND 26 VAC | AC ESS BUS | CENTER |
| STAB PWR | NO. 1 DC PRI BUS | ATO |
| STAB SYS PWR | DC ESNTL BUS | OVHD CONSOLE |
| TACAN CONTR | NO. 1 DC PRI BUS | ATO |
| TACAN R/T | NO. 1 AC PRI BUS | CENTER |
| TAIL BLADE DE-ICE | NO. 2 AC PRI BUS | SO OVHD |
| TAIL INDEX MOTOR | BATT UTIL BUS | LOWER CONSOLE |
| TAIL ROTOR SERVO WARN | NO. 1 DC PRI BUS | ATO |
| TAIL WHEEL LOCK | DC ESNTL BUS | OVHD CONSOLE |
| THSTORM UTIL LT | NO. 1 DC PRI BUS | ATO |
| UHF SECURE | NO. 2 DC PRI BUS | MISSION AVIONICS |

Figure 2-23. Circuit Breaker List (Sheet 6)

| CIRCUIT BREAKER | BUS | LOCATION |
|-------------------|------------------|--------------------------|
| UPR IRCM PWR | NO. 2 DC PRI BUS | SO COUNTERMEASURES |
| UPR IRCM: CONT | NO. 2 DC PRI BUS | SO COUNTERMEASURES |
| UPR IRCM: WARN | NO. 2 DC PRI BUS | SO COUNTERMEASURES |
| UTIL LTS | BATT UTIL BUS | LOWER CONSOLE |
| UTIL RECP CABIN | NO. 1 DC PRI BUS | SO OVHD |
| UTIL RECP CABIN | NO. 2 AC PRI BUS | SO OVHD |
| WG PRESS | NO. 2 DC PRI BUS | SO CONSOLE AVIONICS RACK |
| WINDSHIELD WIPERS | NO. 1 AC PRI BUS | CENTER |
| WSHLD WASHER | NO. 2 DC PRI BUS | ATO |
| WT ON WHEELS | BATT BUS | LOWER CONSOLE |

Figure 2-23. Circuit Breaker List (Sheet 7)

2.6.6 Utility and Test Receptacles

The utility and test receptacle panel is located on the left-hand bulkhead below the SO window. The panel contains 28 Vdc and 115 Vac utility power receptacles and the test receptacles for the NO. 1, NO. 2, and APU generators.

2.7 LIGHTING

2.7.1 Exterior Lighting

2.7.1.1 Anticollision Lights

The anticollision light system contains four strobes in two separate units, one beneath the aft fuselage and one on top of the aft pylon section (Figure 1-3). The lights are controlled by two switches on the overhead console (Figure 1-6) labeled ANTI COLLISION LIGHTS UPPER, BOTH, LOWER and DAY, OFF, NIGHT. The system consists of a dual power supply and two interchangeable day/night anticollision lights. The dual supply system provides separate outputs for the aft fuselage light and the pylon-mounted light. Each anticollision light assembly contains two lamps, a red lens for night operation, and a clear lens for day operation. The desired strobe(s) is selected by placing the switch at UPPER, LOWER, or BOTH. To discontinue operation of the anticollision light(s), the DAY-NIGHT switch is placed to OFF. Power to operate the anticollision light system is provided from the NO. 2 AC primary bus through a circuit breaker marked LIGHTS, ANTI COLL and located on the corner circuit breaker panel.

2.7.1.2 Position Lights

Position lights (Figure 1-3) are outboard of the left and right landing gear support and on the trailing edge of the tail vertical fin. The lights are red on the left, green on the right, and white on the tail. Control of the position lights is through the overhead console panel (Figure 1-6) containing two switches, marked POSITION LIGHTS, DIM-OFF-BRIGHT, and STEADY-FLASH. When the intensity switch is placed to DIM or BRIGHT, all three lights go on at once. If the STEADY-FLASH switch is placed to FLASH, the three lights flash between 70 and 90 times per minute. The STEADY position causes the lights to remain on continuously. Power to operate the position lights is provided by NO. 2 DC primary bus through a circuit breaker marked LIGHTS POS and located on the SO circuit breaker panel.

On aircraft BuNo 162349 and subsequent, the left position light functions on the left outboard pylon when it is installed. When the left pylon and its associated wiring receptacle are removed, the lighting function is automatically transferred to the left landing gear support.

2.7.1.3 Searchlight

The searchlight (Figure 1-3) is mounted on the right bottom of the nose section and is controlled from either collective.

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Except when the pilot SRCH LT switch is in the STOW position, the searchlight may be selected and operated from either collective regardless of opposite switch position. Selection of the STOW position by the pilot disconnects the ATO SRCH LT and four-way search light control switches. Should both the pilot and ATO attempt to slew the searchlight simultaneously, the light will freeze position until one of the four-way search light control switches is released. The 450 watt light can be moved forward through a 120° arc from the stow position. It can also be turned 360° in either a right or left direction on its axis. The light is operated by a switch labeled SRCH LT ON, OFF, and STOW. Directional control of the light is provided through the four-position searchlight control switch, labeled EXT (extend), RET (retract), L (left), and R (right). When the SRCH LT switch is placed ON, the lamp will go on, arming the control switch. Placing the control switch to EXT causes the light beam to move forward at a rate of approximately 12° per second. If SRCH LT switch is placed to OFF, the light will extinguish and remain in its present position. If the switch is held at STOW, the light will retract at a rate of approximately 30° per second to the stowed position in the searchlight well. When the light is fully retracted, power is automatically removed. Power to light and control the searchlight is provided from the NO. 2 DC primary bus through circuit breakers, marked LIGHTS SRCH PWR and SRCH CONTR, located on the SO circuit breaker panel.

2.7.1.4 Landing/Hover Lights

Two 450 watt fixed-position landing/hover lights (Figure 1-3) are installed on the left and right sides beneath the nose section, and a fixed-position hover/rescue light is installed on the right side lower tub below the hoist. All lights are primarily controlled from the cockpit through the toggle switch, marked HOVER LIGHTS, ALL, OFF, and FWD (Figure 1-6). In the ALL position, nose hover lights and rescue light are turned on. At FWD, only the nose lights are turned on. The rescue light may be operated from the crew hover panel through the toggle switch, marked RESCUE LIGHT, ON, and OFF. The rescue light can be operated from the crew hover panel only when the cockpit switch is selected to OFF or FWD. Power for the forward hover lights is from the NO. 1 DC primary bus through circuit breakers marked LDG/HOV LTS CONTR, L FWD, and R FWD and located on the ATO circuit breaker panel. The rescue hoist light receives power from the NO. 1 DC primary bus through a circuit breaker marked LDG/HOV LT, CONTR on the ATO circuit breaker panel, and the NO. 2 DC primary bus through a circuit breaker marked LDG/HOV LT TUB on the SO circuit breaker panel.

2.7.1.5 Rotor Head Light

A light on top of the main transmission cabin fairing illuminates the rotor head droop stops (Figure 1-3). The rotor head light is controlled by a switch marked RTR HD LIGHTS, OFF, and ON (Figure 1-6). The light allows the director to determine the position of the droop stops during rotor engagement and disengagement. Power for the light is from the DC essential bus through a circuit breaker marked LIGHTS ROTOR HEAD and located on the overhead console circuit breaker panel.

2.7.1.6 Recovery Assist Secure and Traverse Lights

Recovery Assist Secure and Traverse (RAST) lights are located forward of the RAST probe. The lights are controlled by a single two-position switch marked RAST LIGHTS, ON, and OFF and located on the overhead console (Figure 1-6). Power to operate the RAST lights is provided by the NO. 2 DC primary bus through a circuit breaker located on the SO circuit breaker panel, under the general heading RAST, marked PROBE LTS.

2.7.2 Interior Lighting

The interior lighting system consists of the flight instrument and console lights, secondary lights, thunderstorm utility lights, utility lights, and cabin dome lights. Both AC and DC sources of electrical power are used to operate the various interior lights.

2.7.2.1 Flight Instrument and Console Lights

The flight instrument and console lights are the primary means for illuminating cockpit gauges and control indicators. These lights consist of individual gauge lights and backlit instrument panels. Instrument lights are grouped into flight and nonflight instruments. The flight instrument lights are divided into pilot and ATO. These lights are controlled by individual rotary intensity controls (Figure 1-6) marked INST LIGHT PILOT FLIGHT, OFF-BRIGHT, and INST

LIGHTS ATO FLIGHT, OFF-BRIGHT. The dimming control for the pilot flight instrument lights switches the caution/advisory panel lights from a bright to dim intensity when the switch is rotated out of the OFF position.

Power for the ATO instrument lights is supplied by the NO. 1 AC primary bus through the LIGHTS ATO FLT circuit breaker on the center circuit breaker panel. The NO. 2 AC primary bus powers the pilot flight instrument lights and the nonflight instrument lights through circuit breakers marked LIGHTS, PLT FLT, and NON FLT, respectively. Both circuit breakers are on the corner circuit breaker panel.

The nonflight and console lights operate in the same manner as the flight instrument lights. Intensity of the nonflight instrument lights is controlled by a rotary control, marked INST LIGHT NON FLIGHT, OFF-BRIGHT. Illumination of the upper and lower consoles is controlled by two rotary switches marked CONSOLE PANEL LTS UPPER, OFF-BRIGHT, and LOWER, OFF-BRIGHT. Power to operate the console lights is provided by the NO. 1 AC primary bus through two circuit breakers marked LIGHTS UPR CSL and LIGHTS LWR CSL, both on the center circuit breaker panel. Illumination intensity of the backlit pushbutton switches on the AFCS CONTROL panel and the AI/BDHI mode select control panels (pilot and ATO) is controlled by the CONSOLE PANEL LTS LOWER, OFF-BRIGHT rotary knob located on the ATO side of the upper console. Power for the lower console light switches is provided from the NO. 2 DC primary bus through the PB LTS DMR circuit breaker on the ATO circuit breaker panel.

2.7.2.2 Secondary Lights

The secondary lights system consists of DC powered floodlights that augment the AC powered flight instrument and console lights. Secondary lights also provide light for gauges and the lower console in the event of a total loss of AC power. Secondary illumination of the instrument panel is provided by five light fixtures mounted below the glare shield. Each fixture has a mechanical shade that allows the pilot/ATO to manually dim the light once the light has been turned on. A rotary knob on the ATO side of the overhead console marked INST PANEL SECONDARY LTS, OFF-BRIGHT controls the reference brightness of all five light fixtures. A white floodlight located above and behind the pilot seat provides a secondary means to illuminate the lower console. This light is controlled by a switch marked LOWER CONSOLE SECONDARY LT, DIM-OFF or BRT. Power for the secondary lights system is from the DC essential bus through a circuit breaker marked LIGHTS SEC PANEL and located on the overhead circuit breaker panel.

2.7.2.3 Thunderstorm Utility Lights

The thunderstorm utility lights help prevent pilot disorientation during night flight in thunderstorm conditions. When set to the BRIGHT position, the THUNDRSTRM/UTILITY LT switch turns on the thunderstorm utility light to its full intensity and overrides the dimming controls, bringing all other cockpit lights to full intensity. In the DIM position, the thunderstorm utility light and the other cockpit lighting are set to half intensity. Power to operate the thunderstorm utility lights is provided by the NO. 1 DC primary bus through a circuit breaker marked THSTORM UTIL LT and located on the ATO circuit breaker panel.

2.7.2.4 Utility Lights

Portable utility lights with coiled cords are attached to the upper cockpit bulkhead behind the pilot and ATO, and to the upper cabin bulkhead beside the SO, by removable brackets. The lights may be adjusted on their mountings to direct the light beams or they may be removed and used portably. The utility lights are controlled by a rheostat or a pushbutton on the end of each casing. The lens casing of the light may be turned to change from white light to red and spot to flood. The utility lights operate from the battery utility bus through a circuit breaker marked UTIL LTS on the lower console circuit breaker panel.

Note

Ensure utility lights are off when not in use to preclude unnecessary battery drain.

2.7.2.5 Cabin Dome Lights

Three cabin dome lights for lighting the cabin section are controlled by a CAB DOME LIGHT panel switch. On aircraft BuNo 162092 and subsequent, the panel switch has a RED position which turns the forward aisle light to red. The intensity controls are in the cabin on the crew hover panel and overhead of the SO. The controls are marked DOME LIGHT, OFF-BRT. The light level control may be adjusted to any position between the two extremes. Power to operate the cabin dome light system is provided from the DC essential bus through a circuit breaker marked LIGHTS CABIN DOME and located on the overhead circuit breaker panel.

2.8 HYDRAULIC SYSTEMS

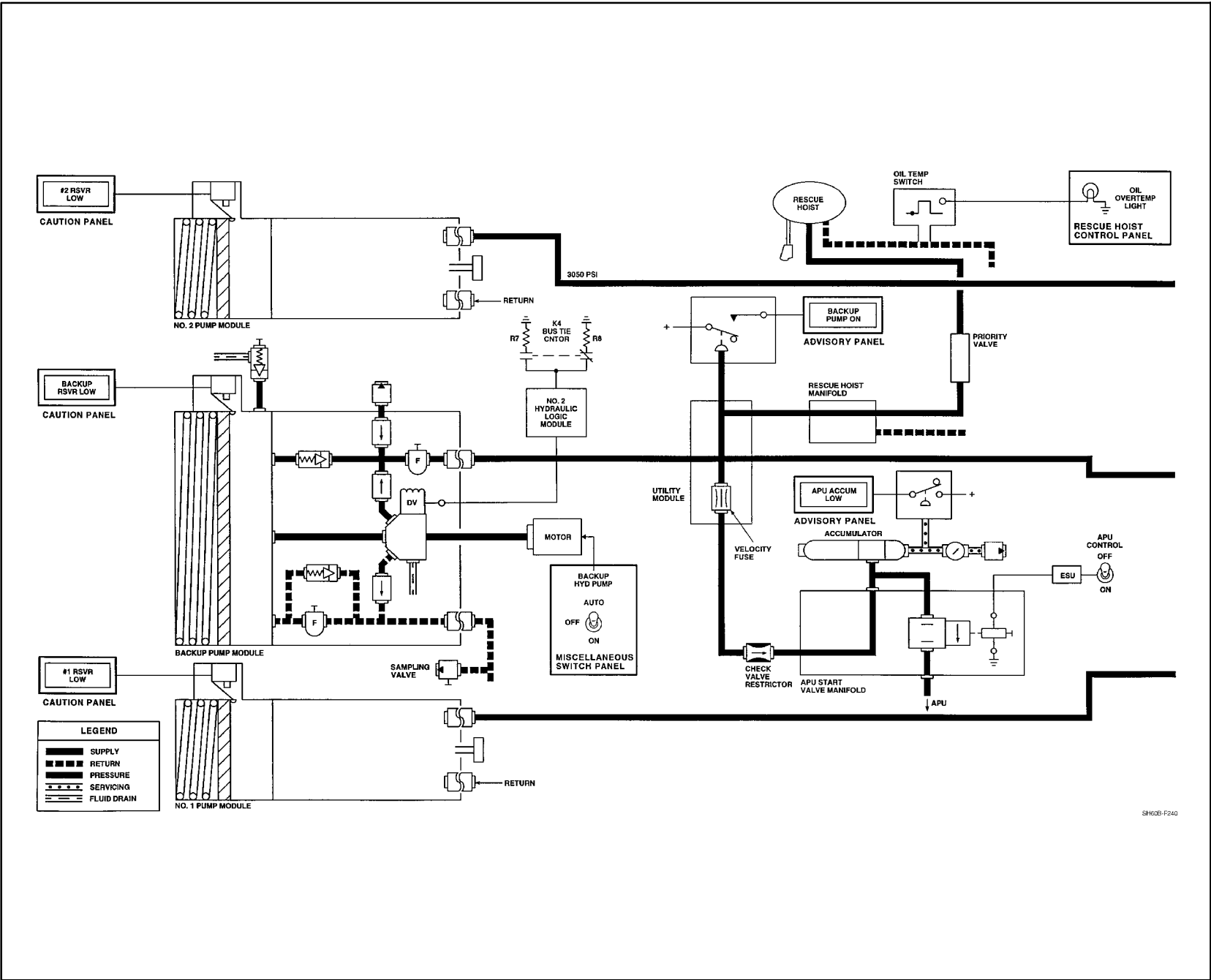
The three hydraulic systems (Figure 2-25) are designed to provide full-flight control pressure (3,000 to 3,100 psi). The components of the hydraulic systems are three hydraulic pump modules, two transfer modules, a utility module, three dual-stage primary servos, one dual-stage tail rotor servo, three pilot-assist (boost) servos, four pilot-assist (SAS) servos, two hydromechanical trim actuators, the rescue hoist, an APU accumulator, an APU hand pump, and a servicing hand pump (Figure 2-26). There are three hydraulic pressure supply systems: NO. 1, NO. 2, and backup. All are completely independent, and each is fully capable of providing essential flight control pressure (3,000 to 3,100 psi) for maximum system redundancy. Complete redundancy is accomplished by the backup pump, providing hydraulic power to both NO. 1 and/or NO. 2 systems if one or both pumps fail. If NO. 1 and NO. 2 systems lose pressure, there will be a slight restriction in the maximum rate of flight control movement due to the backup pump supplying both primary stages with hydraulic power. When the SERVO switch, located on the pilot/ATO collective grips, is moved to the 1st OFF or 2nd OFF position, that stage of the primary servos is turned off. A malfunction in the other stage will cause the stage that was turned off to automatically come back on, provided the backup pump does not take over the functions of the lost system. A hydraulic hand pump is provided for APU accumulator pressurization in the event the backup pump is unavailable.

Note

The caution lights shown below may flicker when the listed switch is activated (Figure 2-24).

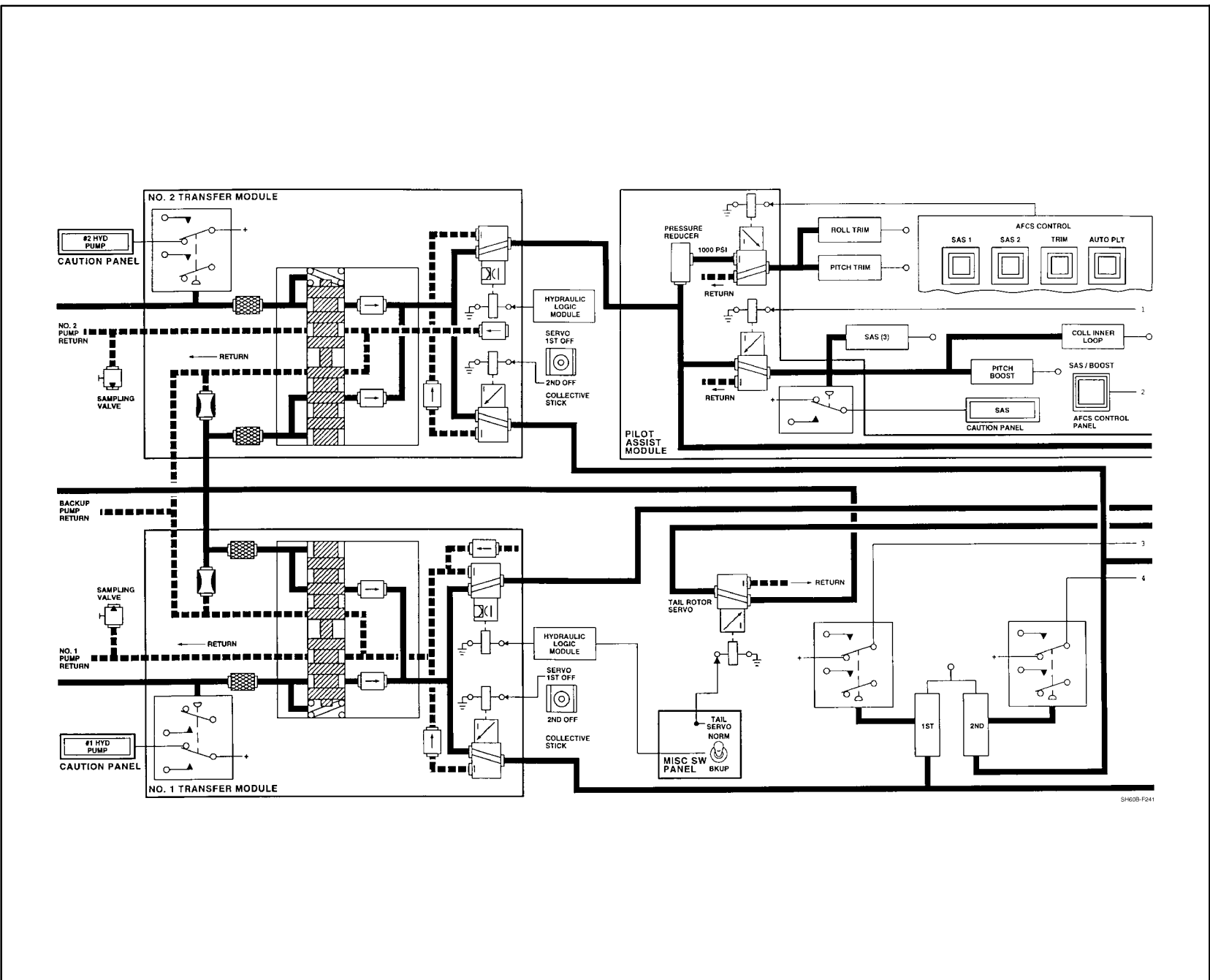
| SUBSYSTEM | CAUTION |
|--|--|
| SAS 1 or SAS 2 switch on | #2 PRI SERVO PRESS #2 HYD PUMP BOOST SERVO OFF |
| SAS/BOOST HYD switch on | #2 PRI SERVO PRESS #2 HYD PUMP SAS |
| TAIL SERVO switch BKUP | #1 PRI SERVO PRESS #1 HYD PUMP |
| HYD LEAK TEST switch NORM after RESET | #1 and #2 PRI SERVO PRESS #1 and #2 HYD PUMP |

Figure 2-24. Hydraulic System Activation



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Figure 2-25. Flight Control Hydraulic System (Sheet 1 of 3)



Sheet 2 of 2

Figure 2-25. Flight Control Hydraulic System (Sheet 2)

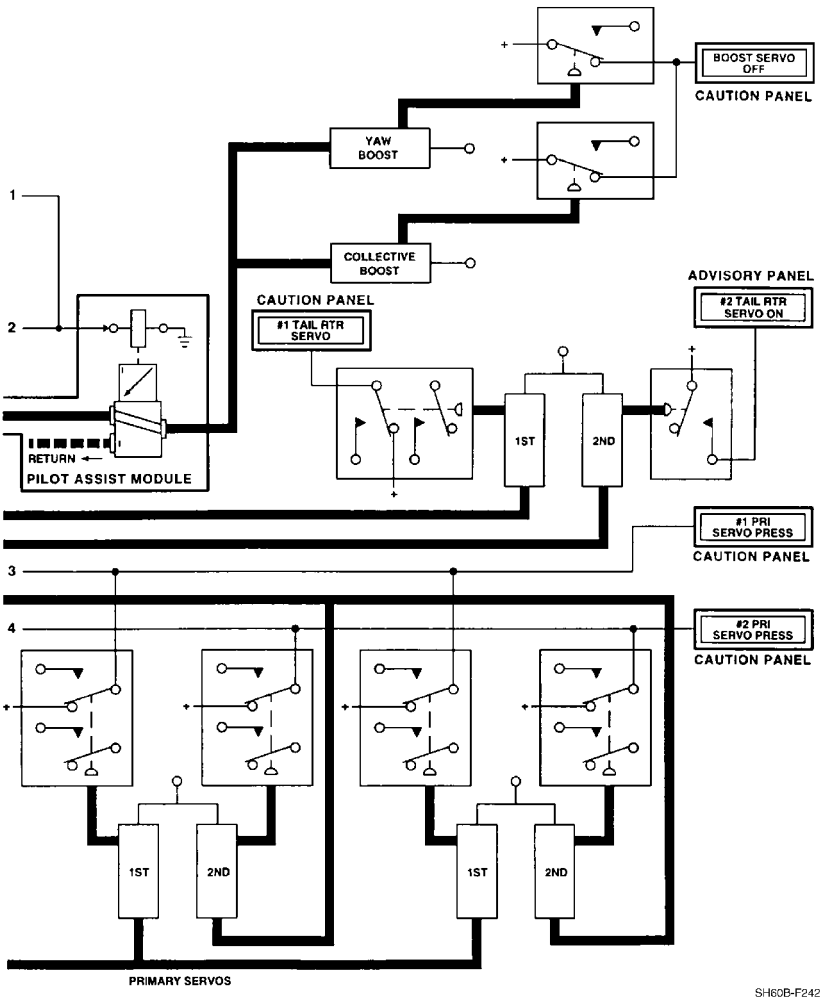
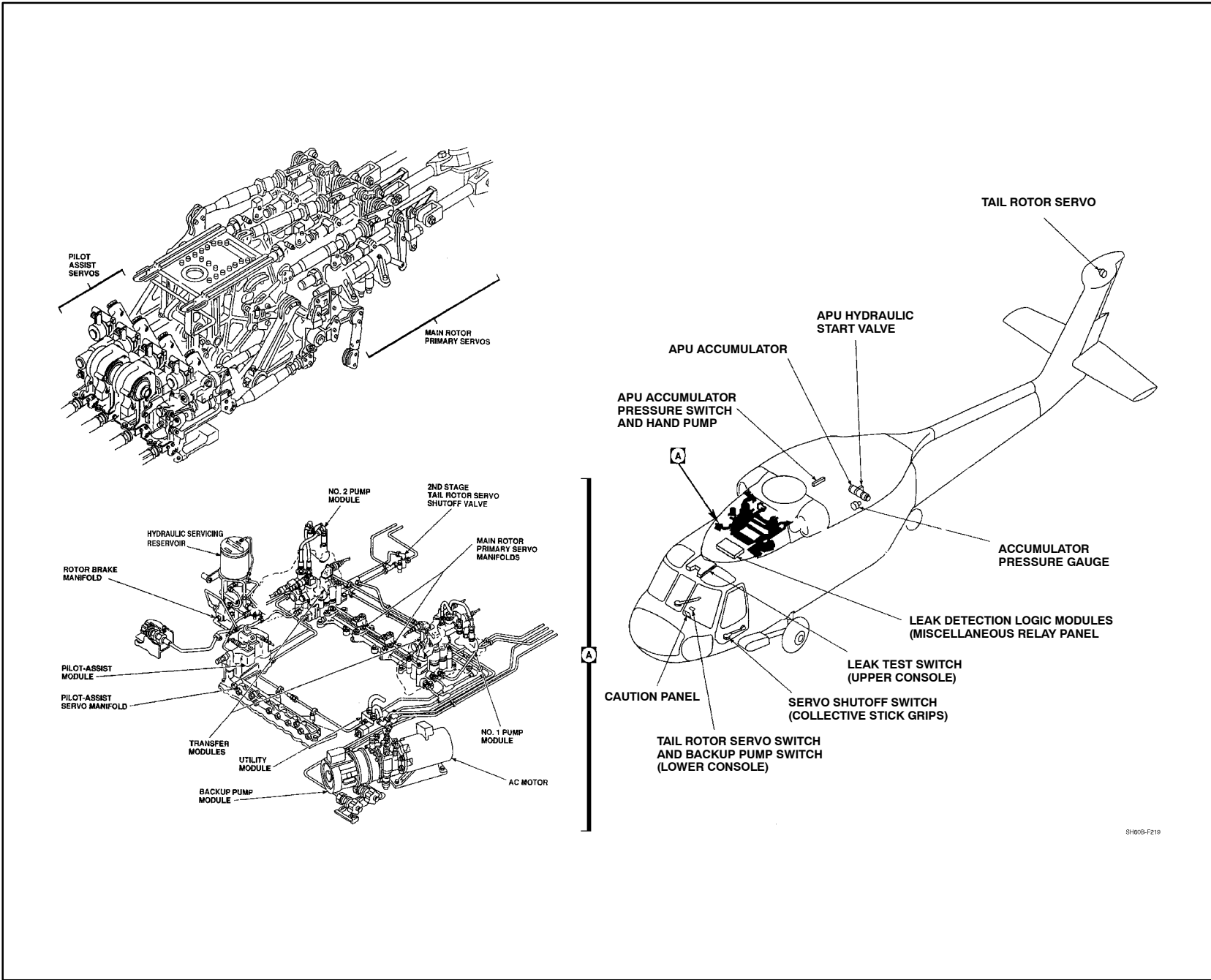


Figure 2-25. Flight Control Hydraulic System (Sheet 3)

Figure 2-26. Hydraulics Bay



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2.8.1 Hydraulic Pump Modules

The hydraulic pump modules are combination hydraulic pumps and reservoirs. The NO. 1, NO. 2, and backup pump modules are identical and interchangeable. The NO. 1 pump module is mounted on and driven by the left-accessory module of the main transmission. The NO. 2 pump module is mounted on and driven by the right-accessory transmission module. The backup pump module is mounted on and driven by an AC electric motor, powered by the NO. 1 AC primary bus. The reservoir part of each pump module has a level indicator. Markings correspond to underserviced, normal, and overserviced fluid levels. A pressure relief and bleed valve protects the pump from high pressure in the return system. Each pump has two filters: a pressure filter and a return filter. A red indicator button on each filter will pop out when pressure is 70 ± 10 psi for the pressure filter, and 100 ± 10 psi for the return filter. The pressure filter has no bypass. The return filter has a bypass valve that opens when return pressure reaches 100 ± 10 psi. Each pump has three check valves: one at the external ground coupling, one at the pressure side, and one at the return side. A low level fluid indicator switch, mounted on top of each pump module, senses fluid loss for that system. When the piston on the pump module reaches the REFILL mark, the piston closes the switch, turning on a caution light marked RSVR LOW.

2.8.1.1 NO. 1 Hydraulic System

The system operates with the rotor turning and supplies the first stage of all primary servos and the first stage of the tail rotor servo. The system components are an integrated pump module, a transfer module, first-stage primary servos and first-stage tail rotor servo. The primary servos are controlled by the SERVO switch, located on the pilot/ATO collective grips. The switch can turn off either first or second stage of the primary servos, but not both at the same time. First-stage tail rotor servo can be manually turned off by a two-position switch, marked TAIL SERVO, NORM and BKUP on the miscellaneous switch panel (Figure 1-7).

2.8.1.2 NO. 2 Hydraulic System

The NO. 2 hydraulic system, which also operates with the rotor turning, supplies the second-stage primary servos and the pilot-assist servos. System components are the integrated pump module, transfer module, second-stage primary servos, and pilot-assist modules. Second-stage primary servos can be manually turned off by the SERVO switch. The pilot-assist servos cannot be turned off collectively, but SAS, TRIM, and BOOST servos can be manually turned off by switches on the AFCS CONTROL panel.

2.8.1.3 Backup Hydraulic System

This system supplies emergency pressure to the NO. 1 and/or NO. 2 hydraulic systems whenever a pressure loss occurs. It also supplies pressure to the NO. 2 stage of the tail rotor servo in case of a loss of pressure in the first stage of the tail rotor servo or #1 RSVR LOW indication. This system supplies utility hydraulic pressure to all flight control components during ground checkout. The backup system also provides 3,000 to 3,100 psi hydraulic pressure for recharging of the APU start system accumulator and for rescue hoist operation. The backup hydraulic system pump module is driven by an electric motor, which can be powered by any adequate three-phase AC power source. An internal depressurizing valve in the backup pump module reduces the output pressure of the pump to about 700 psi to aid startup of the electric motor. This valve unloads the electric motor by reducing the torque requirement at low rpm. After up to 4 seconds on APU or external power or 0.5 seconds with either main generator on, the valve is closed and 3,000 to 3,100 psi pressure is supplied to the hydraulic system. This sequence reduces the current demand during backup system startup.



If the BACKUP PUMP PWR circuit breaker is out and a condition exists which requires the backup pump to operate, then either the hydraulic system must be configured so that the backup pump will not activate upon resetting the circuit breaker, or AC power must be secured prior to resetting the circuit breaker. Damage to the current limiters may occur and will be indicated by a loss of all loads on NO. 1 AC primary bus.

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Pressure-sensing switches in the NO. 1 and NO. 2 transfer modules constantly monitor the pressure output of the NO. 1 and NO. 2 pumps. Loss of pressure initiates the backup operation. The backup pump automatically operates when the BACKUP HYD PMP switch is in the AUTO position (or in any position while airborne) if any of the following criteria occurs:

1. NO. 1 hydraulic reservoir low.
2. NO. 1 tail rotor servo inoperative.
3. NO. 1 hydraulic pump failure.
4. NO. 2 hydraulic pump failure.

The system then provides emergency pressure to maintain full-flight control capability. A WOW switch on the left main landing gear provides automatic operation of the backup pump when the helicopter is in the air, regardless of BACKUP HYD PMP switch position. A pressure-sensing switch at the tail rotor monitors supply pressure to the first-stage tail rotor servo. The backup pump can supply pressure to either the first-stage or second-stage tail rotor servo if the NO. 1 pump loses pressure. This gives the pilot a backup tail rotor servo even with the loss of the primary hydraulic supply or #1 RSVR LOW. If a leak in a primary servo system depletes the backup system fluid, the backup reservoir-low level fluid indicator switch will turn on the BACK-UP RSVR LOW caution light.

The backup pump has a three-position toggle switch, located on the lower console (Figure 1-7). In the OFF position, the backup pump is not activated. In the AUTO position, the backup pump automatically maintains pressure in the NO. 1 or NO. 2 hydraulic systems as required and to the second-stage tail rotor servo. In the ON position with the NO. 1 and NO. 2 hydraulic modules operating normally, the backup pump recirculates hydraulic fluid to and from each transfer module and will maintain pressure in the APU accumulator. With the rotors turning and the APU accumulator low, once the backup pump is turned on it cannot be turned off until the accumulator is charged. With both hydraulic systems operating normally, once turned on, with the APU accumulator low, the backup pump will run for at least 90 seconds regardless of switch position (180 seconds with winterization kit installed). When airborne, with the BACKUP HYD PMP switch in any position, the backup pump maintains pressure in the NO. 1 or NO. 2 hydraulic systems and to the NO. 2 stage of the tail rotor servo as required. In the ON position in flight, the pump will remain on until secured.



Backup pump initiation with AFCS heading hold engaged (AFCS CONTROL TRIM switch ON, pedal microswitch NOT depressed) may cause AFCS Heading Hold failure, indicated by a compass fail flag, AFCS CONTROL panel HDG FAIL advisory, and a flashing AFCS DEGRADED caution light. Should this malfunction occur, system operation can be restored by pressing one of the fail advisory mode reset switches.

2.8.2 Transfer Modules

The NO. 1 and NO. 2 transfer modules connect hydraulic pressure from the pump modules to the flight control servos. Each interchangeable module is an integrated assembly of shutoff valves, pressure switches, check valves, and restrictor.

2.8.2.1 NO. 1 Transfer Module

This module has a transfer valve, a pressure switch, a first-stage primary shutoff valve, a first-stage tail rotor shutoff valve, a restrictor, and check valves. The transfer valve is spring loaded to the open or normal position. If the NO. 1 hydraulic system pressure is lost, the valve automatically transfers backup pump pressure to the NO. 1 system. The first-stage primary shutoff valve lets the pilot or ATO shut off first-stage pressure to the primary servos and prevents both stages from being shut off at the same time. The pressure switch lights the #1 HYD PUMP caution light on the caution/advisory panel when pressure drops to 2,000 psi and also sends a signal to a logic module that pressure is

lost in the NO. 1 hydraulic system. The restrictor allows fluid to circulate for cooling under no-flow conditions. If a fluid leak develops past the transfer module, the check valves prevent fluid loss on the return side of the transfer module.

2.8.2.2 NO. 2 Transfer Module

This transfer module is like the NO. 1 module, except that it supplies NO. 2 hydraulic system pressure. The pilot-assist shutoff valve turns off pressure to the pilot-assist module. The second-stage primary servo shutoff valve turns off pressure to the second stage of the primary servos. The pressure switch turns on the #2 HYD PUMP caution light on the caution/advisory panel when the system pressure is below 2,000 psi and also sends a signal to a logic module that pressure is lost in the NO. 2 hydraulic system.

2.8.2.3 Utility Module

The utility module connects hydraulic pressure from the backup pump to the NO. 1 and NO. 2 transfer modules, the second stage of the tail rotor servo, the rescue hoist, and the APU accumulator. A pressure switch on the module senses the backup pump operation and turns on the BACK-UP PUMP ON advisory light on the caution/advisory panel. If the flow rate through the module to the APU accumulator exceeds 1.5 gpm, a velocity fuse shuts off flow.

2.8.3 Primary Servo Shutoff

The purpose of the primary servo shutoff system is to allow the shutoff of an improperly operating servo system during flight and to test system operation before flight. The system is operated through a servo shutoff switch on each collective grip.

The system requires DC power for operation. The system is divided into a first-stage servo shutoff system and second-stage servo shutoff system. The first-stage system has a pressure switch on each first stage of the three primary servos. The same is true for the second-stage system. Each double-pole pressure switch has one switch for a caution light and another to route power to a servo system shutoff valve, when OFF is selected. The SERVO OFF switches on the pilot and ATO collectives do not control the tail rotor servos. The second stage tail rotor servo is controlled by a switch on the MISC SW panel marked TAIL SERVO, NORM, and BKUP, which should be used in the event of a mechanical failure of the first stage servo valve or linkage. With both servo systems pressurized, the pilot or ATO can shut down either servo stage. Due to an electrical interlock, both servo stages cannot be secured at the same time, nor can one be secured unless normal system conditions exist in the other. If the pilot selects the first-stage off, electrical power to the first-stage shutoff valve must pass through all three second-stage servo pressure switches to ensure the second stage is pressurized before shutdown can occur. As the first-stage pressure drops during shutoff, the first-stage pressure switches react to the decreasing pressure, causing the first-stage servo pressure caution light to illuminate and the control path for the second-stage shutoff to be interrupted. This prevents shutoff of the second stage during the time that the first stage is off. A selection of the second-stage off, in this example, would provide similar results. To close a servo shutoff valve, electrical power must be applied to the valve. When power is removed, the shutoff valve will open.

2.8.4 Hydraulic Leak-Detection/Isolation (LDI) System

The system protects the flight control hydraulic system by preventing loss of hydraulic fluid. The LDI system uses pressure switches and fluid level sensors for monitoring pump hydraulic fluid level, and pump pressure for primary, tail rotor, and pilot-assist servos. When a pump module reservoir fluid level switch detects a fluid loss, the logic module automatically operates the required shutoff valve(s) to isolate the leak and (with the exception of a leak at the pilot-assist servos) turns on the backup pump. In the cockpit, the RSVR LOW caution light for that system lights. Backup pump shutoff valve(s) operation is automatic through the logic module. If the leak continues, the pilot must place the SERVO switch to the appropriate OFF position. The heart of the LDI is composed of two logic modules.

2.8.4.1 Logic Modules

Two logic modules are used to control the operation of the hydraulic systems. The logic modules continually monitor the operation of the hydraulic systems by inputs received from pressure switches, fluid level switches, and control switch inputs. The outputs of the logic modules will turn on lights on the caution/advisory panel, notifying the pilot

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of a failure and/or turn off one or more valves due to a system malfunction to isolate a leak and maintain pressurization of the flight control system (Figures 2-27 and 2-28). All switching functions of the hydraulic logic modules are automatic, except as shown by Pilot Action on the logic diagrams.

2.8.4.2 Hydraulic Leak Test

The hydraulic leak test checks the complete hydraulic circuit with the exception of the transfer/shuttle valves. The HYD LEAK TEST switch is a three-position toggle switch located on the overhead console (Figure 1-6). The hydraulic leak test is a ground test and the following criteria must be achieved prior to initiating the test:

1. AC power.
2. Backup pump in AUTO position.
3. All hydraulic reservoirs full.
4. WOW.
5. Rotors turning.

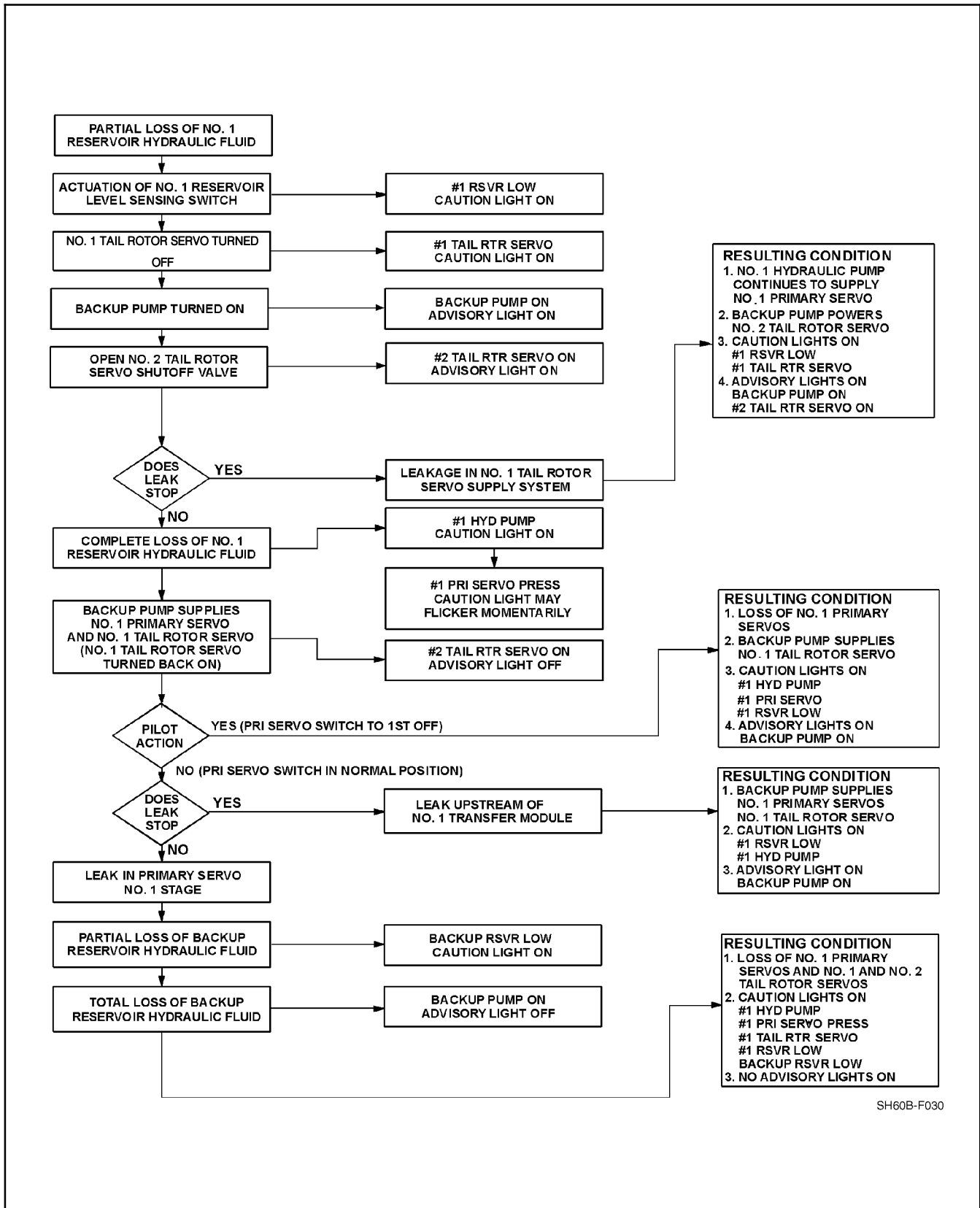
The switch positions are TEST, RESET, and NORM. In the TEST position, if the above criteria are met, the test function activates an electrical signal illuminating the three RSVR low lights. The hydraulic logic modules then take their normal action for this condition. The following caution/advisory lights will illuminate, indicating a satisfactory test:

1. #1 TAIL RTR SERVO.
2. BOOST SERVO OFF.
3. SAS.
4. AFCS DEGRADED.
5. #1 RSVR LOW.
6. #2 RSVR LOW.
7. BACK-UP RSVR LOW.
8. BACK-UP PUMP ON.
9. #2 TAIL RTR SERVO ON.
10. MASTER CAUTION.

After a leak test has been made, the HYD LEAK TEST switch must be moved to RESET momentarily to turn off caution and advisory lights that were on during the test. Except for the HYD LEAK TEST switch, the hydraulic leak system consists of components of the NO. 1, NO. 2, and backup hydraulic systems. A WOW switch contact prevents hydraulic leak tests from being made in flight. Power to operate the hydraulic leak test system is from the NO. 2 DC primary bus through a circuit breaker located on the ATO circuit breaker panel, marked NO. 2 SERVO CONTR, and from the DC essential bus through a circuit breaker located on the overhead circuit breaker panel, marked BACKUP HYD CONTR.

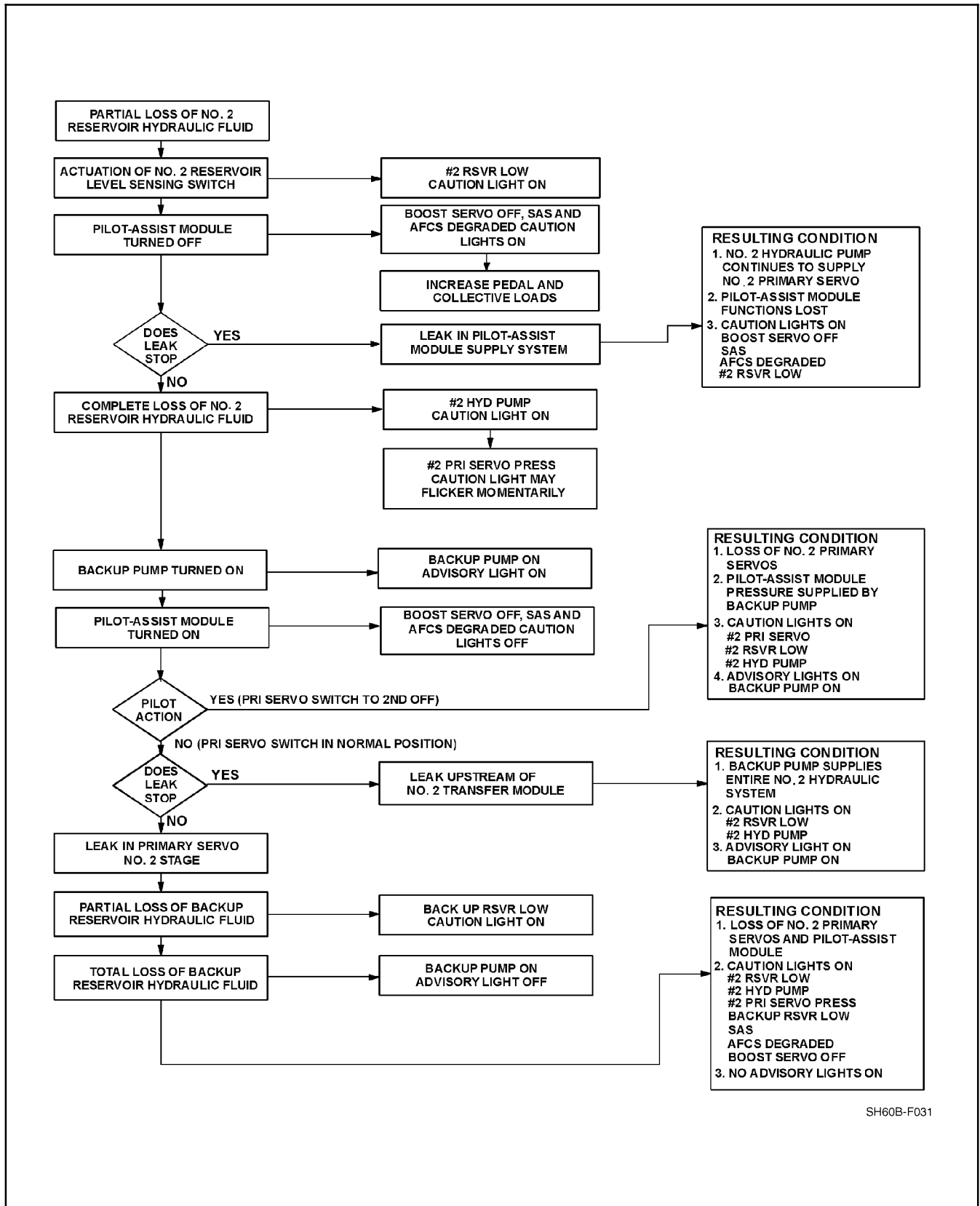
2.8.4.3 Reservoir Fill System

A hand pump and manual selector valve are on the right side, upper deck of the helicopter for system servicing. The three main hydraulic system reservoir levels can be seen from the fill-pump location. The hand pump reservoir contains a sight gauge above the hand pump crank. A low-level mark indicates a requirement for refill. The hand pump reservoir serves as the rotor brake reservoir.



SH60B-F030

Figure 2-27. Hydraulic Logic Module Functions for a Leak in #1 Hydraulic System



SH60B-F031

Figure 2-28. Hydraulic Logic Module Functions for a Leak in #2 Hydraulic System

2.9 FLIGHT CONTROL SYSTEM

The helicopter is controlled by varying and intermixing the control outputs from the cyclic, collective, and tail rotor pedals. Control movement is accomplished manually by either pilot or automatically by the AFCS. The flight control system can be divided into three sections:

1. Mechanical control system.
2. Flight control servo system.
3. Automatic flight control system

2.9.1 Mechanical Control System

The physical layout of the mechanical flight controls is presented in (Figure 2-29), and a simplified block diagram of the flight control system, including the AFCS components, is presented in (Figure 2-30). The cyclic, collective, and tail rotor pedal flight controls are routed aft and outboard of each pilot seat, vertically up each side of the aircraft, and are combined for each axis at the overhead torque shafts inside the hydraulics bay. The overhead torque shafts transfer inputs from the trim servos and flight controls through the pilot assist servos, and the mixing unit. From the mixing unit, fore, aft, and lateral inputs are transferred to the swashplate assembly via the primary servos and the bridge assembly. The yaw inputs to the tail rotor servo are transferred from the mixing unit aft to the tail rotor quadrant through the tail rotor cables.

Both pilot and copilot flight controls, control grips, and control grip function switches are identical and are presented in Figure 2-29. The copilot collective telescopes by twisting the grip and pushing the collective aft to improve access to the seat.

2.9.1.1 Tail Rotor Control System

The tail rotor control system provides directional control by varying the pitch of the tail rotor blades. The tail rotor servo is mechanically actuated, but requires hydraulic pressure to operate the pitch change shaft which moves the tail rotor pitch change beam, changing blade pitch angle through the pitch-change links.

The tail rotor servo is powered by either the NO. 1 hydraulic system or the backup hydraulic system. The tail rotor quadrant transmits tail rotor cable movement to the tail rotor servo. Two spring cylinders connected to the quadrant, allows cable tension to be maintained if either tail rotor cable becomes severed. Microswitches activate the TAIL ROTOR QUADRANT caution when either cable is broken. Directional control of the tail rotor is maintained by the remaining spring. If both cables are severed, two separate centering springs will counter the tail rotor servo pilot valve positioning the tail rotor to a neutral setting to provide a fly-home capability.

At the tail pylon fold area, the cables run through a series of pulleys that allow the tail pylon to be folded without disconnecting the control cables.

2.9.2 Flight Control Servo Systems

The flight control servo system (Figure 2-30) consists of the primary servos, tail rotor servos, and pilot-assist servos.

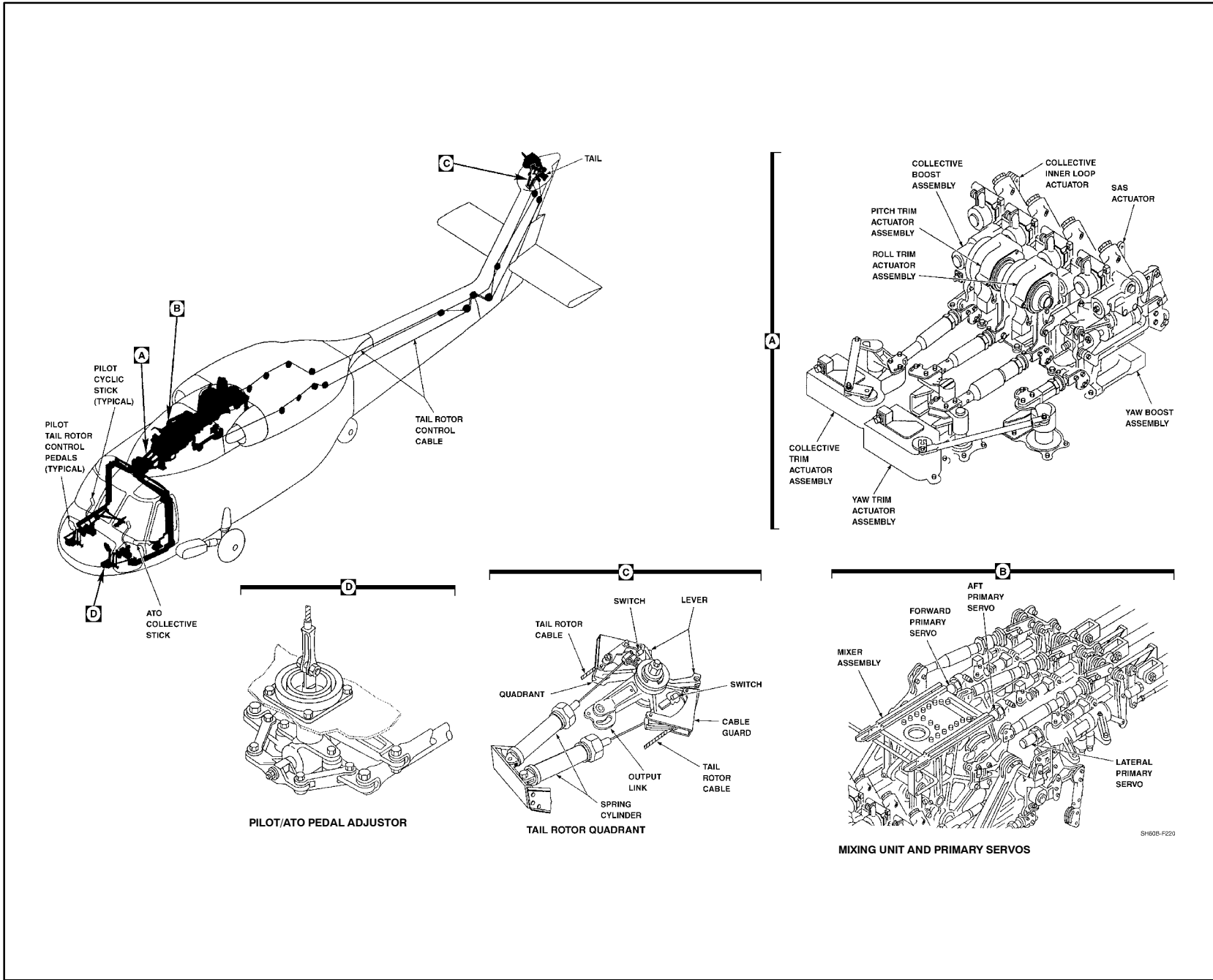
2.9.2.1 Primary Servos

There are three primary servos located in the hydraulics bay. Each primary servo has two stages that are independent and redundant with only the input linkage in common. Should one primary servo stage become inoperative due to pressure loss or a jammed input pilot valve, a bypass valve within the affected stage will automatically open, and the #1/#2 PRI SERVO PRESS caution will illuminate.

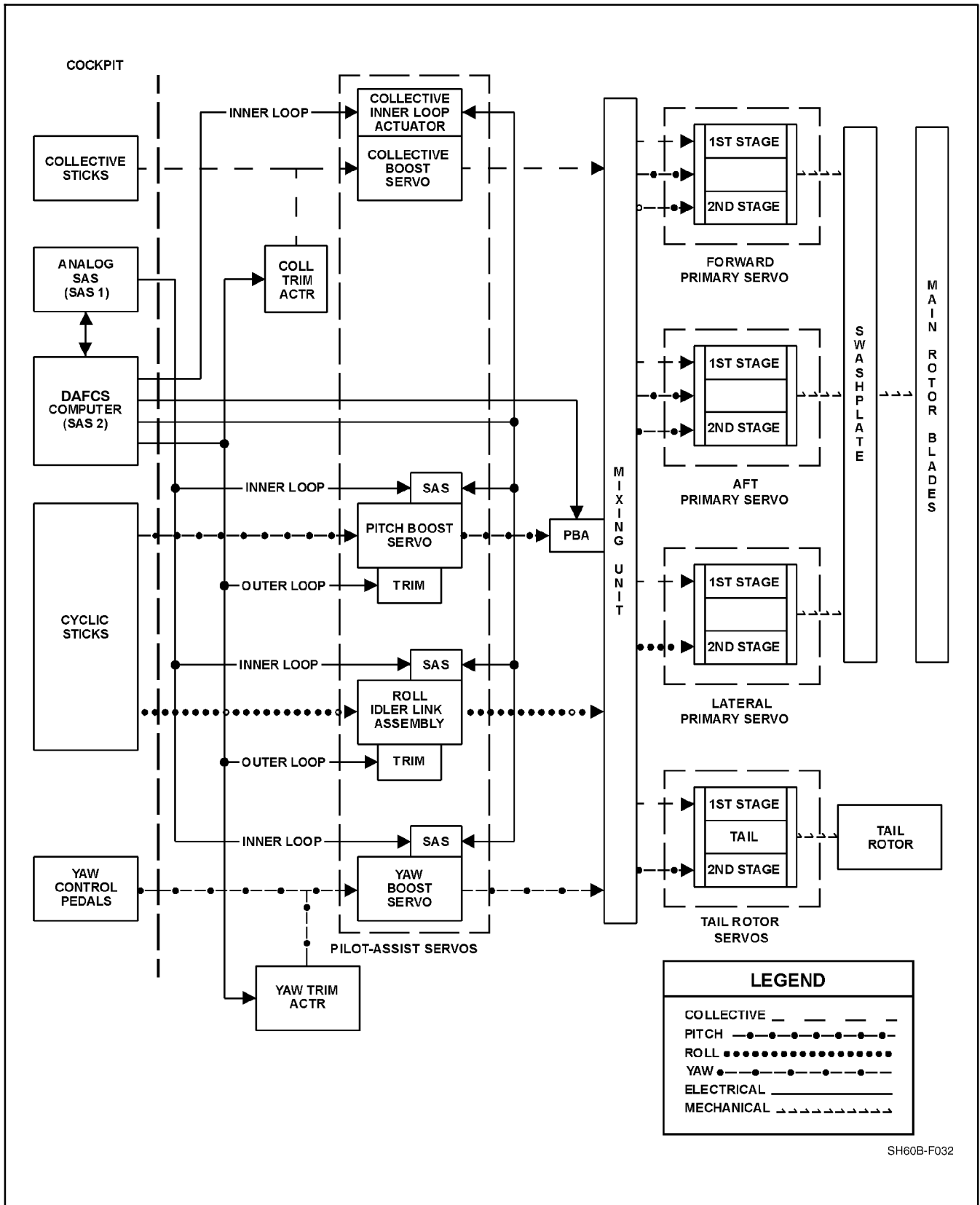
2.9.2.2 Tail Rotor Servo

The tail rotor servo has two independent stages. The first stage is powered by the NO. 1 hydraulic system with the TAIL SERVO switch in the NORM position. The second stage is powered by the backup hydraulic system with the TAIL SERVO switch in the BACKUP position. Should the first stage of the TAIL SERVO lose hydraulic pressure, the backup pump will automatically power the second stage of the tail rotor servo illuminating the #1 TAIL RTR SERVO caution, the #2 TAIL RTR SERVO ON advisory, and the BACKUP PUMP ON advisory.

Figure 2-29. Mechanical Flight Controls



SH605-F229



SH60B-F032

Figure 2-30. Flight Control System

2.9.2.3 Pilot Assist Servos

The pilot-assist servo assembly contains the boost servos, SAS actuators, and hydraulic (pitch and roll) trim actuators. Flight controls are operable without hydraulic pressure to the pilot-assist servos, but collective and yaw inputs will require considerable pilot effort. Hydraulic power is still required to move the primary servos.

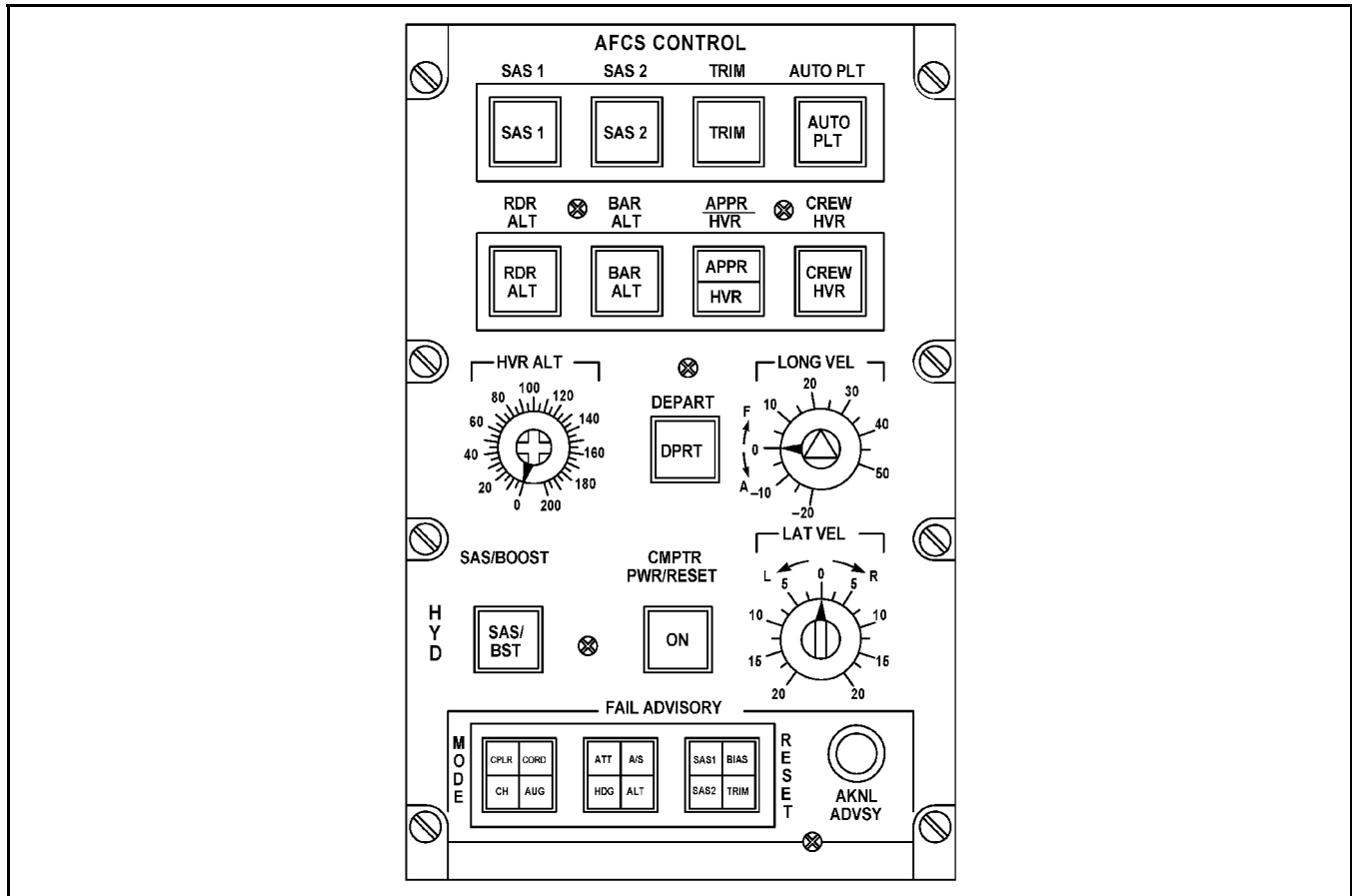
The pilot-assist servos, except pitch and roll trim, are turned on and off by pressing the SAS/BOOST pushbutton on the AFCS CONTROL panel (Figure 2-31). Hydraulic pressure to the pitch and roll trim actuators is turned on and off by the TRIM pushbutton on the AFCS CONTROL panel.

2.9.2.3.1 Boost Servos

There are three boost servos (collective, yaw, and pitch) located between the cockpit controls and the mixing unit, which reduce cockpit control forces and SAS system feedback. All boost servos and the roll channel incorporate a SAS actuator, which provides rate damping.

2.9.2.4 Control Mixing

The cyclic, collective, and pedal controls are mechanically combined in the mixing unit (Figure 2-32) to produce uncoupled airframe response characteristics. In addition to mechanical mixing, electrical (collective/airspeed-to-yaw) mixing is also present when trim is engaged.



| CONTROL | FUNCTIONAL DESCRIPTION |
|-----------------|--|
| SAS 1 | Pushbutton that applies electrical power to the SAS 1 system. SAS 1 illuminates when system is on. |
| SAS 2 | Pushbutton that applies electrical power to the SAS 2 system. SAS 2 illuminates when system is on. |
| TRIM | Pushbutton that applies electrical and/or hydraulic power to all control trim systems (pitch, roll, yaw, and collective). TRIM illuminates when trim systems are on. |
| AUTO PLT | Pushbutton that applies electrical power to the automatic pilot (SAS 1 or SAS 2 and TRIM must also be on). AUTO PLT illuminates when autopilot is on. |
| APPR/HVR | Pushbutton that engages either automatic approach or coupled hover mode, depending on flight regime. |
| CREW HVR | Pushbutton that activates crew hover mode while coupled hover mode is engaged. |
| DEPART | Light that illuminates when DEPART mode is selected via DEPART HOVER button on the cyclic grip. |
| LONG VEL | Rotary knob that permits the pilot to set a reference longitudinal velocity in coupled hover mode. |
| LAT VEL | Rotary knob that permits the pilot to set a reference lateral velocity during coupled hover mode. |
| CMPTR PWR/RESET | Guarded pushbutton that applies electrical power to the AFCC. Also provides power on/reset capability if the computer automatically shuts down due to a self-diagnosed malfunction. |
| SAS/BOOST | Guarded pushbutton that applies hydraulic power to the SAS actuators and boost servos. |
| HVR ALT | Rotary knob that permits the pilot to set a reference hover altitude during automatic approach and coupled hover mode. |
| RDR ALT | Pushbutton that engages and disengages radar altitude hold system. It is illuminated when engaged and flashes when the collective TRIM RLSE switch is depressed. Reference altitude is obtained from HVR ALT rotary knob only when coupled hover mode is on. When coupled hover mode is off, the reference altitude is established when the pushbutton is engaged and reset when the collective trim switch is depressed and released. |
| BAR ALT | Pushbutton that engages and disengages barometric altitude hold. It is illuminated when engaged and flashes when the collective TRIM RLSE switch is depressed. Altitude is referenced automatically when the pushbutton is engaged and reset when collective TRIM RLSE switch is depressed and released. |

Figure 2-31. Automatic Flight Control System (AFCS) Control Panel

| NAME | COMPENSATION | CAUSE | COMPENSATION REQUIREMENT |
|--------------------------------|---|---|--|
| MECHANICAL COMPENSATION | | | |
| Collective to yaw | Tail rotor thrust is increased | Main rotor torque | Nose yaws right when collective is increased |
| Collective to lateral | Rotor disc is tilted left | Lateral lead (tail rotor propeller effect) | Helicopter drifts right when collective is increased |
| Collective to longitudinal | Rotor disc is tilted forward | Rotor downwash on stabilator | Nose pitches up and helicopter drifts aft when collective is increased |
| Yaw to longitudinal | Rotor disc is tilted aft | Tail rotor lift vector | Nose pitches down and helicopter drifts forward when left pedal is applied |
| ELECTRONIC COMPENSATION | | | |
| Collective/airspeed to yaw | A portion of the main rotor torque compensation is provided by a trim input that is proportional to collective position and airspeed. The trim input is then progressively washed out as pylon side loads increase with airspeed. | Camber of tail rotor pylon varies side load with airspeed | Nose yaws left as airspeed increases |

Figure 2-32. Control Mixing

2.9.3 Automatic Flight Control System (AFCS)

The AFCS is an electrohydraulic system which provides inputs to the flight control system to assist the pilot in maneuvering and handling the helicopter. The AFCS is composed of three major subsystems: the SAS, the stabilator system, and the DAFCS. A schematic of the AFCS is presented in **Figure 2-33**. All engagement controls for the three subsystems are contained on the AFCS and stabilator control panels. Each subsystem operates independently of the other two subsystems and they all complement one another. Autopilot functions are engaged by the AUTO PLT pushbutton on the AFCS CONTROL panel. The AFCS RELEASE pushbutton on the cyclic will disengage SAS 1, SAS 2, and autopilot. The AFCS provides the following features:

1. Pitch, roll, and yaw stability augmentation.
2. Stabilator control.
3. Cyclic, collective, and pedal trim.
4. Pitch and roll attitude hold.
5. Airspeed hold.
6. Heading hold.
7. Barometric altitude hold.
8. Radar altitude hold.
9. Pitch and roll hover augmentation/gust alleviation.
10. Turn coordination.
11. Maneuvering stability.
12. Automatic approach to hover.
13. Hover coupler.
14. Automatic depart.

15. Crew hover.
16. Longitudinal stick gradient augmentation (pitch bias actuator).
17. Blade fold assist.
18. Automatic preflight check.
19. Diagnostics (mode failure display).

2.9.3.1 AFCS Control Panels

The AFCS is controlled from two panels: the AFCS CONTROL panel and the STABILATOR control panel. Both control panels are located on the lower console. Controls and functions of the AFCS CONTROL panel are summarized in Figure 2-31. Functional descriptions of the fail advisory lights displayed on the AFCS CONTROL panel are presented in Figure 2-34. The STABILATOR control panel contains all the operating controls for the stabilator and is shown in Figure 2-36. All the other AFCS controls are on the AFCS CONTROL panel. All detectable AFCS mode failures except for the stabilator illuminate the AFCS DEGRADED light on the caution/advisory panel and the appropriate mode failure capsule on the FAILURE ADVISORY section of the AFCS CONTROL panel. Stabilator failures illuminate the STABILATOR caution light on the caution/advisory panel and generate an aural warning tone in the pilot and ATO headsets.

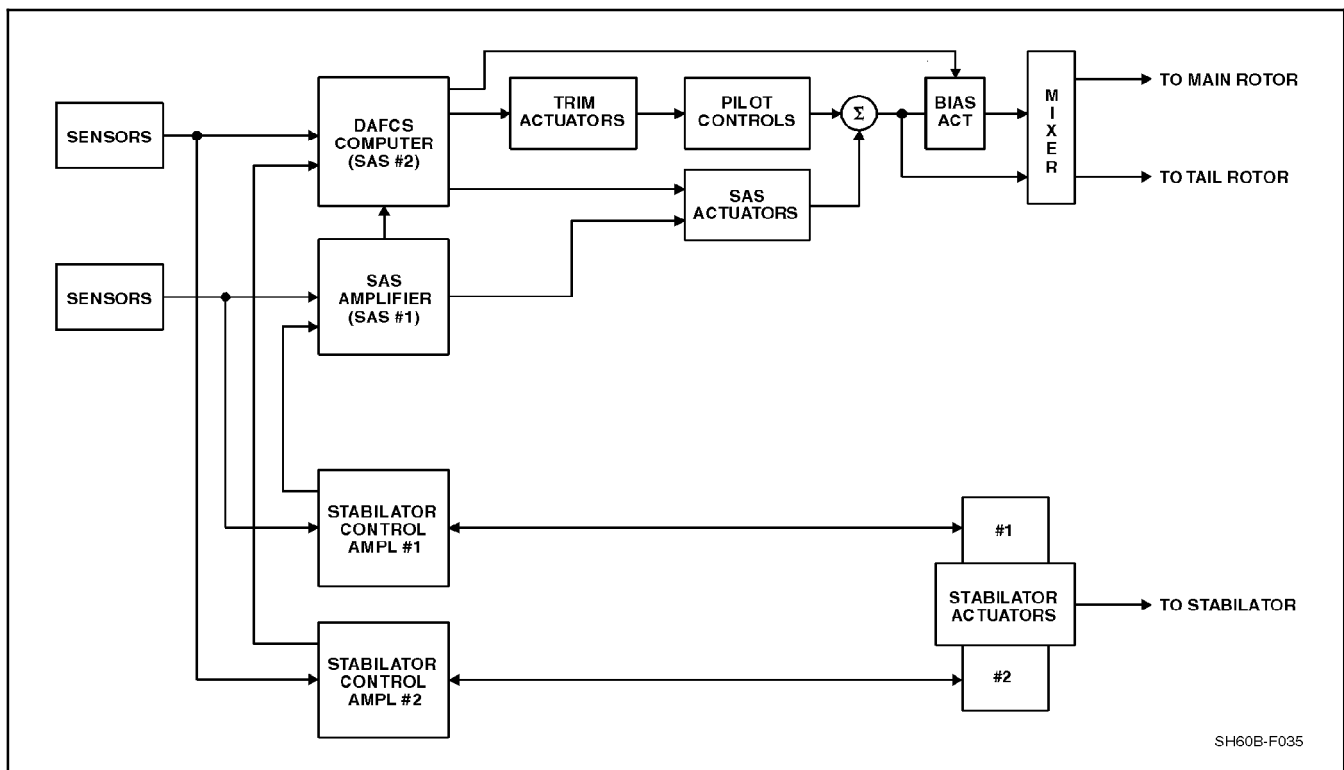


Figure 2-33. AFCS Input, Simplified Block Diagram

| FAIL ADVISORY LIGHT ON | SYSTEM | FUNCTIONAL DESCRIPTION |
|------------------------|---|---|
| CPLR | Approach/Hover Coupler | Approach/hover coupler capability loss. ATT, or A/S, or ALT light may also be on. |
| CORD | Turn Coordination | Turn coordination is lost if AUG or SAS 1 and SAS 2 or A/S light is on. |
| CH | Crew Hover | Loss of crew hover mode. |
| AUG | Longitudinal and Lateral Hover Augmentation | Loss of hover augmentation. A/S, ATT, or SAS 1, and SAS 2 light may also be on. |
| ATT | Pitch and Roll Attitude Hold | Pitch or roll autopilot attitude hold has been lost. If TRIM is also on, both pitch and roll attitude hold have been lost or malfunctioning. If pitch attitude failure occurs, the A/S light also goes on, indicating airspeed hold is also not available. |
| A/S | Airspeed Hold | Airspeed hold is lost. The autopilot may continue to hold pitch attitude unless a failure of pitch attitude hold occurs. In this case, ATT light would go on. |
| HDG | Heading Hold | Heading hold has been lost or the ability to synchronize heading hold has been lost, or collective to yaw electrical coupling has been lost. |
| ALT | Barometric or Radar Altitude Hold | If barometric altitude hold was engaged, altitude hold is lost. If radar altitude hold is desired, it must be selected. If radar altitude hold was engaged, barometric altitude hold will automatically engage, unless the type of failure prevents any altitude hold operation. |
| SAS 1 | SAS 1 Pitch, SAS 1 Roll, SAS 1 Yaw | A malfunction has occurred, causing improper pitch, roll, or yaw SAS 1 operation. SAS 1 should be disengaged to ensure proper SAS 2 operation. |
| BIAS | Pitch Bias | <p>Loss or modified operation of the pitch bias actuator occurs, if the BIAS light goes on.</p> <p>An airspeed transducer failure causes the pitch bias actuator to move to a position corresponding to 120 KIAS. The bias actuator continues to function about this 120 knot airspeed reference. The A/S light should also be on if airspeed is the cause of the BIAS light.</p> <p>A vertical gyro (pitch) failure causes the bias actuator to move to a center position. The bias actuator now stays at this center position. The ATT light should also be on, if attitude is cause of bias light. A dual pitch rate gyro failure will cause the bias actuator to lose its ability. However, the bias actuator will continue to function for attitude and airspeed inputs. The SAS 1 and SAS 2 lights should also be on if the pitch rate gyros are the cause of failure.</p> <p>The pitch bias actuator itself is not responding to computer commands. The bias actuator stops wherever it is at that time. No other fail advisory lights are coupled with the BIAS light for this problem.</p> |

Figure 2-34. Fail Advisory Light (Sheet 1 of 2)

| FAIL ADVISORY LIGHT ON | SYSTEM | FUNCTIONAL DESCRIPTION |
|--|--|---|
| SAS 2 | SAS 2 Pitch, SAS 2 Roll, SAS 2 Yaw | Any combination of SAS 2 axis failure causes the affected axis to be automatically disabled. If SAS 2 and SAS 1 fail advisory lights go on, turn off SAS 1. |
| TRIM | Pitch Trim Actuator, Roll Trim Actuator, Yaw Trim Actuator, Collective Trim Actuator | Cyclic pitch or roll trim, yaw pedal trim, or collective trim is lost or malfunctioning. Any combination of the above will cause the TRIM light to go on. |
| No fail advisory light on, AFCS DEGRADED caution light flashing | Unknown | A degradation has occurred that is not associated with a fail advisory light. |
| No fail advisory light on, AFCS DEGRADED caution light on steady | Primary power to the computer | A computer power sever has occurred. All DAFCS computer output signals are discontinued. To attempt to regain computer operation, press CMPTR PWR/RESET switch OFF then ON. Loss of all AFCS functions except SAS 1, boost, and Stabilator. |
| <p>Note</p> <ul style="list-style-type: none"> ● Use the AKNL ADVSY switch to acknowledge the failure of an AFCS system, so that MASTER CAUTION light will be reset for a subsequent failure. ● To reset the computer for any mode failure (except a power sever), press any one of the three FAIL ADVISORY MODE RESET switches. ● If the CMPTR PWR/RESET switch is on, and SAS 2 is off, pressing any of the three FAIL ADVISORY MODE RESET switches will cause SAS 2 to automatically go on. This is a backup means of engaging SAS. | | |

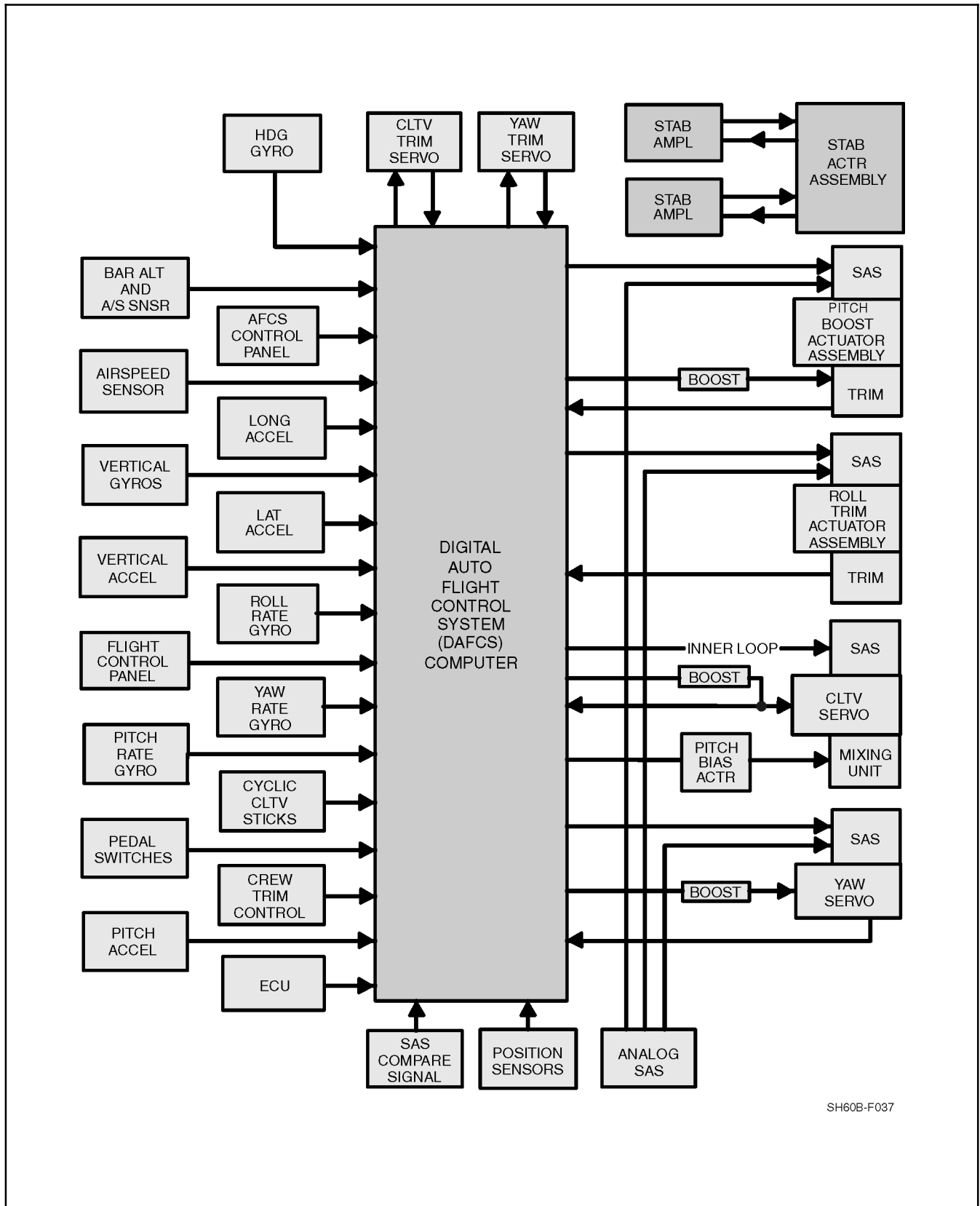
Figure 2-34. Fail Advisory Light (Sheet 2)

2.9.3.2 DAFCS

The central component of the DAFCS is the digital computer. The computer commands the pitch bias actuator (PBA), the inner-loop SAS actuators, and the outer-loop trim actuators in all four control channels. A system block diagram of the DAFCS is presented in **Figure 2-35**. The computer also provides self-monitoring, fault isolation, and failure advisory.

The DAFCS employs two types of control, identified as inner loop and outer loop. The inner loop (SAS) employs rate damping to improve helicopter stability. This system is fast in response, limited in authority, and operates without causing movement of the flight controls.

The outer loop (AUTOPILOT) provides long-term inputs by trimming the flight controls to the position required to maintain the selected flight regime. It is capable of driving the flight controls throughout their full range of travel (100 percent authority) at a limited rate of 10 percent per second. Both inner and outer loops allow for complete pilot override through the normal use of the flight controls.



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Figure 2-35. DAFCS Input/Output Block Diagram

WARNING

- When AFCS computer power is cycled, trim is disengaged and an unguarded cyclic will allow the rotor arc to dip as low as four feet above the deck, prior to full control deflection, without pounding the droop stops.
- AFCS computer power is interrupted with a total AC power failure. After AC power is restored, AFCS computer power must be cycled before resetting AFCS functions.

The DAFCS computer processes incoming information from various sensors aboard the aircraft and stores this information in its memory. The sensor information is used by the computer central processing unit (CPU) to compute required correction signals. Inner-loop correction signals are routed to the SAS actuators and outer-loop signals are routed to trim servos and actuators.

2.9.3.2.1 AFCS Voltage Sensor Relay

The function of the voltage sensor relay (VSR) is to select the source of three-phase, 115 Vac power to be applied to the DAFCS computer. The voltage sensor also supplies power to the Heading Attitude Reference System (HARS) via the ac essential bus relay. Power source selection is a function of the NO. 1 generator output integrity. When 3 phase power from the NO. 1 ac primary bus is sensed in the voltage sensor, the ac essential bus relay is energized and ac power is routed to the AFCS power switching assembly via the VSR.

When there is a phase disruption or fault occurrence on the NO. 1 ac primary bus supply, the VSR will automatically switch the power source of the AC Essential bus from the NO. 1 ac primary bus to the NO. 2 ac primary bus to retain basic HARS, SAS and TRIM functions. If the VSR switches power to the NO.2 AC primary bus, the DAFCS could fail and the AFCS, SAS and TRIM functions may be required to be reset. A malfunctioning VSR may cause a power failure of the DAFCS computer, multiple fail advisory lights, tumbling or precessing of either or both pilot or ATO AI or BDHI, or steady or intermittent OFF flags presented in the pilot or ATO AI or BDHI.

The AFCS voltage sensor is mounted overhead in the forward cabin area. Power to the VSR is supplied from both the NO. 1 ac primary bus through the AFCS CMPTR CB on the center circuit breaker panel and from the NO. 2 Primary bus through the AFCS CMPTR CB on the sensor operator circuit breaker panel. The voltage sensor for the VSR is the circuit breaker labeled AC ESNTL BUS SUPPLY (7.5 amp) on the NO. 1 AC Primary bus located on the center circuit breaker panel. Pulling the VSR CB (i.e. AC ESNTL BUS SUPPLY CB) will cause power to both the DAFCS and the AC Essential bus to be supplied from the NO. 2 AC Primary side. Caution should be taken to ensure the AC ESNTL BUS SUPPLY CB on the NO. 2 Primary Side located on the Corner Circuit Breaker Panel is pressed in before pulling the VSR CB.

2.9.3.3 Stabilator System

The stabilator system optimizes trim attitudes for cruise, climb, and autorotation and provides pitch stability augmentation to complement the SAS for additional redundancy. The stabilator system is completely independent of the other two AFCS subsystems except for common airspeed sensors, lateral accelerometers, and pitch rate gyros. The stabilator control system is a completely automatic fly-by-wire control system with a manual backup slew control. The primary purpose of the stabilator control system is to eliminate undesirable noseup attitudes caused by rotor downwash impinging on the horizontal stabilator during transition to a hover and during low-speed flight. The stabilator panel (Figure 2-36) contains an automatic control (AUTO CONTROL) switch, a TEST pushbutton, and a manual slew (MAN SLEW) switch. The AUTO CONTROL switch can only be used to engage the automatic mode or to reset the stabilator in the event of a stabilator failure. The switch is not an alternate action pushbutton. The pilot can manually position the stabilator to any position within the stabilator limits by moving the MAN SLEW switch. The TEST pushbutton, which is operational below 50 knots, is used to check the automatic mode fault detector. The stabilator is positioned by two electric jackscrew actuators acting in series. Each actuator provides one-half the input

to position the stabilator and is controlled by a separate and redundant stabilator amplifier. The stabilator travels from 42° trailing edge down for hover and low-speed flight below 30 knots to 10° trailing edge up for cruise and maneuvering flight. The stabilator electrical screw actuators receive power from the DC essential bus and NO. 1 DC primary bus through two circuit breakers marked STAB SYS PWR and STAB PWR, respectively. The circuit breakers are located on the overhead console and ATO circuit breaker panels, respectively. Four inputs are required to position the stabilator (**Figure 2-37**):

1. Airspeed.
2. Collective position.
3. Lateral acceleration.
4. Pitch rate.

The airspeed input aligns the stabilator with the main rotor downwash during slow-speed flight. The collective position input decouples aircraft pitch attitude with collective position. Pitch rate and lateral acceleration inputs improve the dynamic response of the aircraft, especially in gusty air conditions. The pitch rate input supplements the dynamic stability provided by the SAS and DAFCS, and the lateral accelerometer input decouples the aircraft pitch response with changes in the rotor downwash on the stabilator during out of balanced flight.

Each stabilator amplifier receives these four inputs but receives the inputs from independent sensors. The DAFCS computer monitors each of these sensors for malfunctions, and the stabilator control system monitors and compares the position of the two actuators. Any system malfunction caused by a difference between the two stabilator actuator positions results in stabilator remaining in the last position, an automatic power shutdown to both actuators, an aural tone to the pilots, and a STABILATOR caution light on the caution/advisory panel.

WARNING

It is possible for the stabilator to fail without illumination of the STABILATOR caution light and associated aural warning tone. In this case, the first indication of failure will be an uncommanded pitch change.

If a malfunction of the stabilator system occurs, the pilot has the ability to manually position the stabilator with the manual slew switch on the stabilator control panel. The manual slew switch bypasses the stabilator amplifier automatic mode and applies power directly to the actuators through relays in the amplifiers. A stabilator position indicator aids the pilot in positioning the stabilator to any position between the stabilator travel limits. However, the total travel is restricted if the malfunction is caused by an actuator failure. The stabilator travel is restricted to 35° if an actuator fails in the full-down position or 30° if an actuator fails in the full-up position. The stabilator control rate is limited to $\pm 6^\circ$ per second.

WARNING

Reengagement of the automatic mode after a shutdown occurs results in the automatic mode operating for one second. If a hardover signal to one actuator was the cause of the initial shutdown, and reengagement is attempted, that actuator will again cause the stabilator to move before another disengagement is commanded. In this case subsequent reengagement shall not be attempted since it may result in additional stabilator movement.

Note

Due to the loss of automatic fail safe features with the stabilator in the manual mode, intentional flight in the manual mode is not recommended.

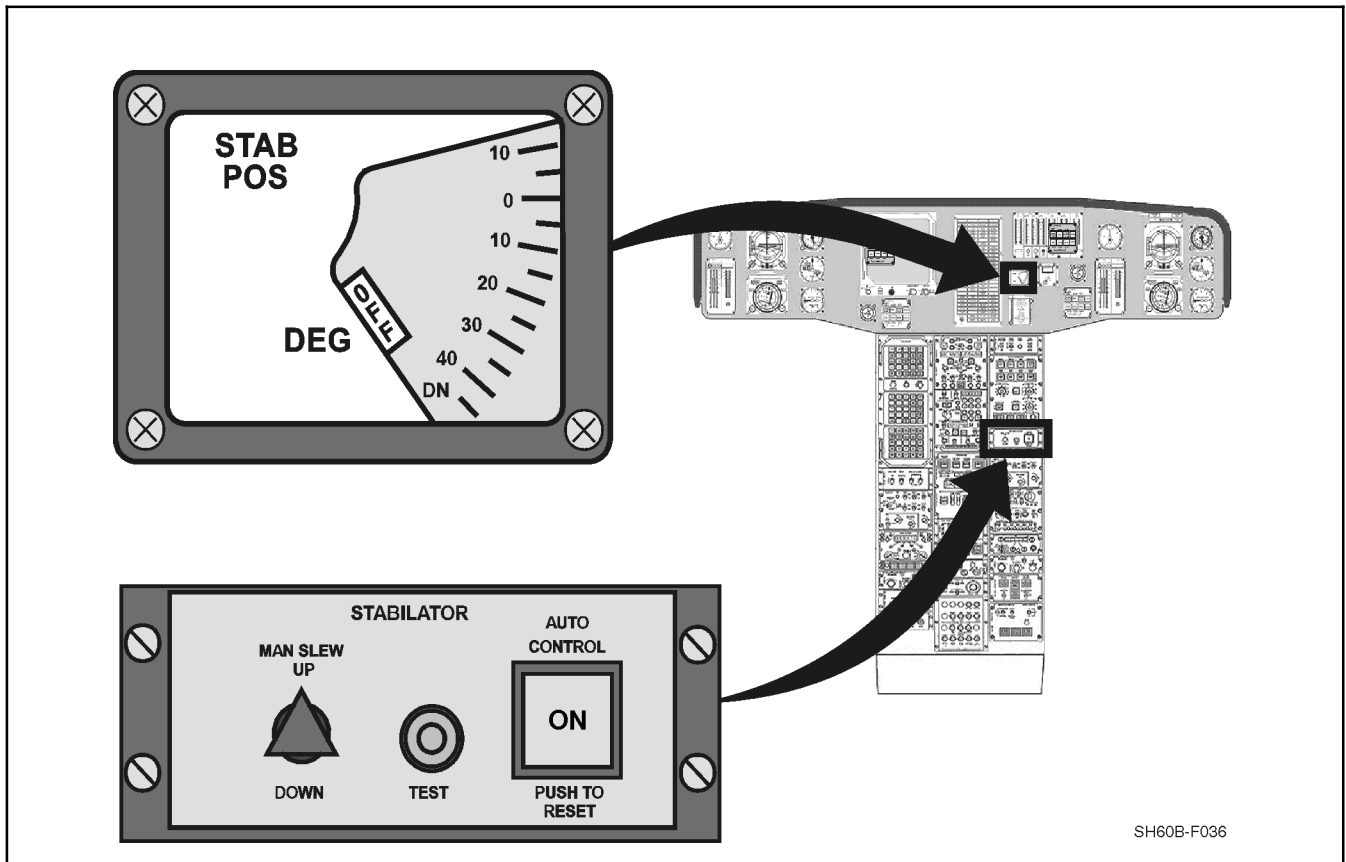


Figure 2-36. Stabilator Control Panel

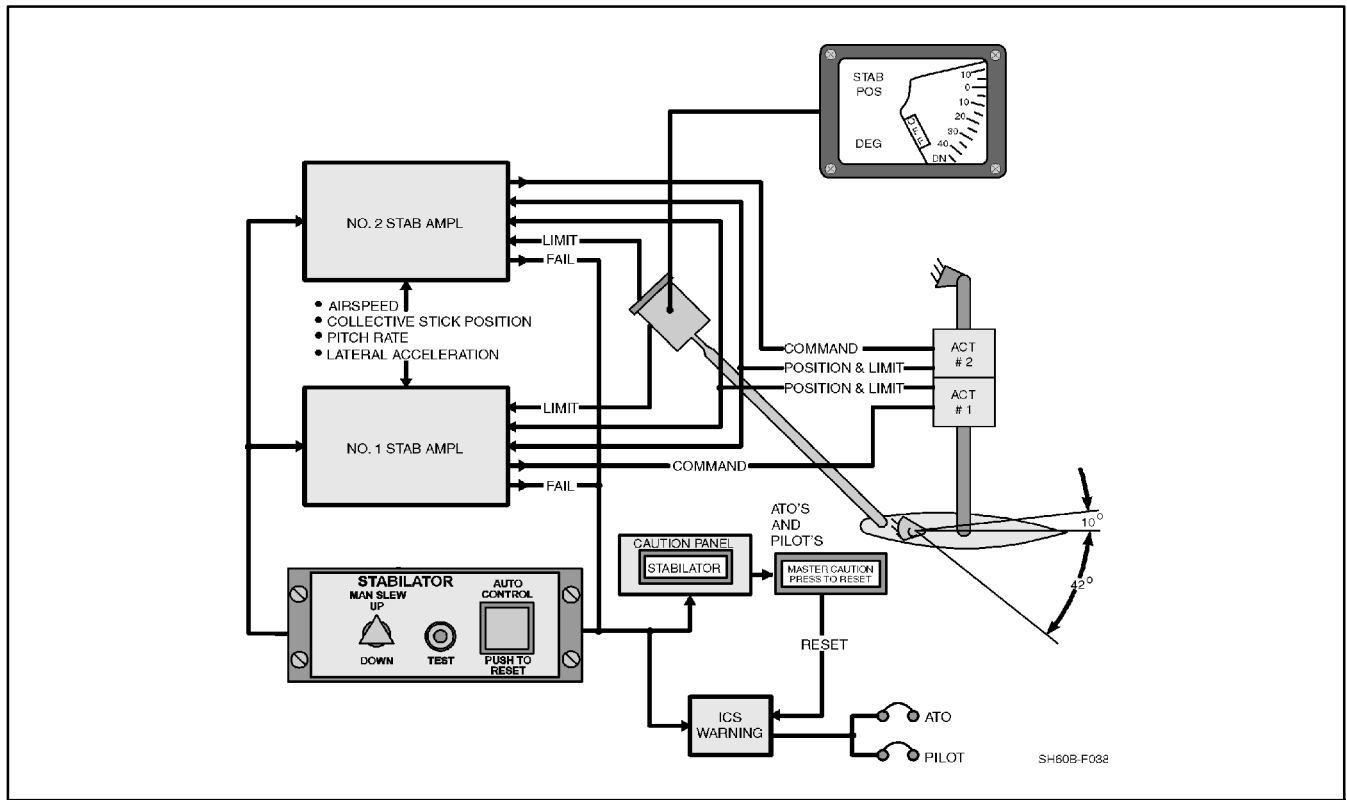


Figure 2-37. Stabilator Block Diagram

2.9.4 Stability Augmentation System

SAS provides improved stability by sensing acceleration in the pitch, roll, yaw and vertical axes, and by applying a control input to stop the acceleration and maintain a constant rate (Figure 2-38). The SAS is an inner-loop system with two separate and independent SAS channels. SAS channel NO. 1 is an analog system; SAS channel NO. 2 is a digital system and is part of the DAFCS computer. Both SAS channel functions are identical except for the hover augmentation/gust alleviation and hover coupler DAFCS features, which are incorporated only into SAS 2. SAS 2 also complements the DAFCS to provide turn coordination and roll attitude hold. With both channels engaged, the pitch, roll, and yaw SAS actuators have ± 10 percent control authority with each channel providing ± 5 percent.

Only SAS 2 commands the collective SAS actuator. The collective SAS only operates in RDR ALT, BAR ALT, APPR HVR, and DEPART modes and is limited to ± 10 percent control authority. A system block diagram of the SAS is presented in (Figure 2-38). Hydraulic pressure to the SAS actuators is turned on by the SAS/BOOST switch on the AFCS CONTROL panel. This controls power to the SAS shutoff valve on the pilot assist module. A loss of SAS actuator pressure is monitored by the SAS pressure switch which lights the SAS caution light. Either SAS 1 or SAS 2 may be operated separately or simultaneously.

Figure 2-38. Flight Control Hydraulic System (Sheet 1 of 2)

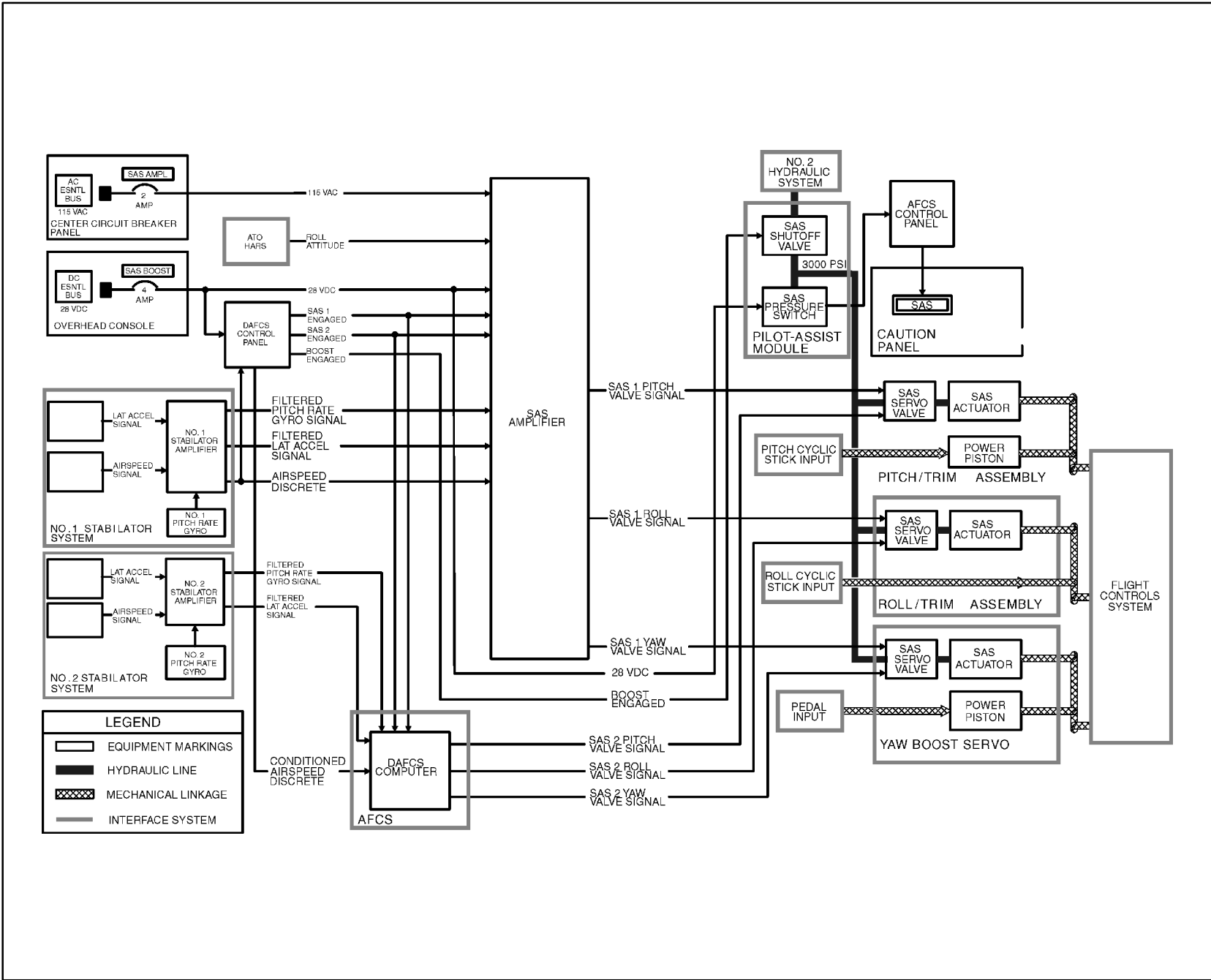
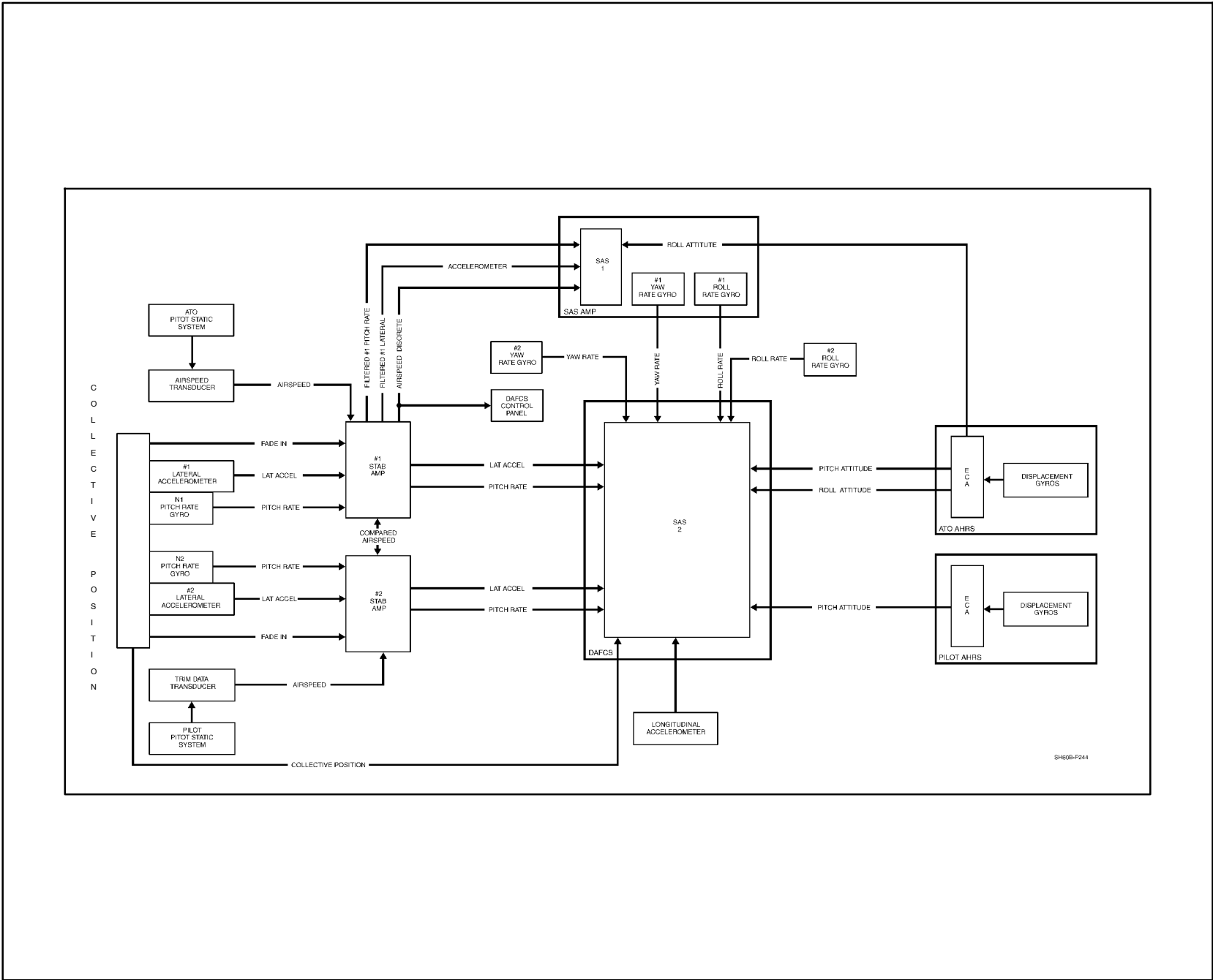


Figure 2-38 Flight Control Hydraulic System (Sheet 2)



For each control axis (except vertical), command signals from both SAS channels are applied simultaneously to separate coils of an electrohydraulic servo valve. The two signals are summed to provide a single input into the flight control system through a single series SAS actuator. The operation of the SAS channels is continuously monitored by the DAFCS. If either of the two SAS channels malfunctions, the AFCS DEGRADED caution light on the caution/advisory panel flashes and the appropriate SAS fail advisory light on the AFCS CONTROL panel is illuminated. If SAS 2 has failed, the computer will automatically disengage the affected axis. If SAS 1 has failed, the pilot must disengage the failed SAS 1 channel from the AFCS CONTROL panel. The remaining SAS channel is limited to ± 5 percent authority but operates at twice its normal gain to partially compensate for the failed SAS channel. Either SAS channel can be disengaged by pressing the appropriate SAS button on the AFCS CONTROL panel. Both SAS channels are disengaged by pressing the AFCS REL button on the cyclic. If both SAS 1 and SAS 2 lose power, are manually shut down, or hydraulic pressure is lost to the actuators, the SAS caution light will illuminate.

2.9.4.1 Trim System

The parallel trim actuator assemblies provide the flight control force gradients and detent positions and the outer-loop autopilot control functions. The trim actuators command full control authority in all four control channels but are rate-limited to 10 percent per second. Pressing TRIM REL switch (cyclic trim release, collective trim release, pedal release) disengages the respective trim function and allows free control motion. Releasing trim release switch reengages trim if the cyclic stick is not moving. For yaw trim release above 50 knots, the pedal microswitches and the cyclic trim switch must be pressed. Below 50 knots, only the pedal microswitches have to be pressed. If the trim system fails, the TRIM fail advisory light on the AFCS CONTROL panel will illuminate and the pilot can compensate for the failure. The pilot is able to override the trim control forces in all channels.

2.9.4.2 Autopilot

The autopilot maintains helicopter pitch and roll attitude, airspeed, and heading during cruise flight, provides maneuvering stability, and a coordinated turn feature at airspeeds above 50 KIAS. The autopilot function is engaged by pressing the control panel SAS 1 or SAS 2 switches, TRIM switch, and then pressing the control panel AUTO PLT pushbutton. The autopilot may be disengaged by pressing the AUTO PLT pushbutton on the AFCS panel or pressing the AFCS REL button on the cyclic. When engaged, 28 Vdc is supplied from the control panel to the computer. The computer also provides command signals to the trim actuators to reposition the flight controls using the trim system. With SAS 2, TRIM, and autopilot on, all DAFCS functions are available. With SAS 1, TRIM and autopilot on, all functions remain available except Hover Augmentation/Gust Alleviation and "Collective SAS" functions (i.e., coupled approach, altitude hold).

2.9.4.3 Attitude and Airspeed Hold

Attitude and airspeed hold are engaged with AUTO PLT. In the pitch channel, at airspeeds less than 50 knots, attitude changes are commanded by changing the cyclic position with the TRIM REL switch or use of the four-direction (beeper) TRIM switch. This causes the cyclic to move and the helicopter attitude to change approximately 5° per second. When cyclic movement is stopped, the autopilot stabilizes the helicopter around the new cyclic position and attitude. Above 50 knots and bank angles less than 30° , the system becomes airspeed sensitive in pitch. Actuating the four-direction TRIM switch will cause the cyclic to move and the helicopter to change airspeed reference at the rate of 6 knots per second. Because of variations in pitot-static systems during gusty conditions, an integrated longitudinal acceleration input is used for short-term corrections. The airspeed sensor is used for long-term updates through a 3 second filter. The roll channel autopilot holds roll attitude of the helicopter. Attitude information is supplied to the computer from the pilot and ATO A/A24G vertical gyros. The command signal is applied to roll SAS 1 and SAS 2 and the roll trim system. When the pilot actuates the four-direction TRIM switch, the helicopter roll attitude will change at approximately 6° per second. In addition to the attitude hold feature, an automatic wing-leveling capability is also included. During transitions from hover to airspeeds above 50 knots, this feature automatically retracts the aircraft from a left roll attitude in a hover to a wings level attitude at 50 knots. Once a level attitude is established, the attitude hold feature maintains that attitude until a new roll attitude is commanded by the pilot.

WARNING

Uninterrupted use of the four-way cyclic TRIM switch to increase speed may cause the aircraft to enter a descent with altitude hold engaged without an associated caution light. Manual input is required to arrest the descent.

2.9.4.4 Heading Hold

The yaw channel of the autopilot provides the heading hold feature for hover and forward flight and is engaged whenever the AUTO PLT pushbutton switch is illuminated. Heading hold is an outer-loop function operating through the yaw trim actuator, and therefore will only be operational whenever the yaw trim is engaged. Releasing all pedal switches at a given heading synchronizes the trim system to the established heading. A potentiometer in the yaw trim actuator applies a trim position feedback signal to the computer and then cancels the drive signal at the desired position, stopping the motor. The yaw autopilot also uses a collective position sensor to hold reference heading for yaw excursions caused by main rotor torque changes. The collective position sensor is controlled by an airspeed signal which reduces its gain as airspeed increases. When heading hold is engaged, the HDG TRIM (slew) switch on the collective allows the pilot to make heading changes without retrimming. Below 50 KIAS, the aircraft is slewed at 3° per second. Above 50 KIAS, actuation of the switch

for less than 1 second provides a 1° heading change and actuation for greater than 1 second provides a 1° per second coordinated turn. The heading hold is reengaged following a turn when the following conditions are maintained for 2 seconds:

1. Aircraft roll attitude is within 2° of wings level.
2. Yaw rate is less than 2° per second.

The heading hold is disengaged by the WOW switch when the aircraft is on the ground.

2.9.4.5 Altitude Hold

Either barometric or radar altitude hold is selectable from the AFCS CONTROL panel (but not simultaneously). When the altitude hold mode is selected, the DAFCS computer uses as a reference altitude the existing altitude from either the air data transducer if barometric altitude hold is selected or the radar altimeter if the radar altitude hold is selected. The computer commands both the collective SAS actuator and the collective trim actuator to maintain the reference altitude. The SAS actuator provides fast-response, limited-authority corrections, and the trim actuator provides limited-response (rate limited), full-authority corrections. The DAFCS computer uses altitude and rate from the barometric or radar altitude systems (depending on which hold mode is selected) and vertical acceleration to command the collective SAS and trim actuators. The computer also monitors engine torque to prevent dual-engine torque from exceeding 116 percent whenever the collective trim is positioning the collective. Barometric altitude hold is engaged at any altitude and airspeed by depressing the BAR ALT pushbutton switch with SAS 2 and autopilot engaged. Depressing the collective TRIM REL button temporarily disengages the mode. Upon release of the trim switch, barometer altitude hold automatically reengages and maintains the altitude at the time of reengagement. Radar altitude hold is engaged at any altitude from 0 to 5,000 feet AGL and at any airspeed by depressing the RDR ALT pushbutton with SAS 2 and autopilot engaged.

When in the hover coupler mode, altitude hold is referenced to the altitude selected on the AFCS CONTROL panel HVR ALT potentiometer. Depressing collective TRIM REL temporarily disengages the mode. Upon release of the trim switch, radar altitude hold automatically reengages to the altitude selected on the AFCS CONTROL panel HVR ALT potentiometer. When in the hover coupler mode, transition from one altitude to another is made with the HVR ALT knob on the AFCS CONTROL panel. Resulting climb/descent rates are limited to 1,000/500 feet per minute, respectively. If the radar altitude mode fails while engaged, barometric altitude hold is automatically engaged.

2.9.4.6 Hover Augmentation/Gust Alleviation

An additional feature of SAS, provided only through SAS 2, is hover augmentation/gust alleviation. It further improves aircraft stability at low airspeed using attitude retention and longitudinal and lateral acceleration to eliminate drift.

2.9.4.7 Turn Coordination

Automatic turn coordination is provided at airspeeds greater than 50 knots. Turn coordination allows the pilot to fly a coordinated turn with directional control provided by the AFCS. The AFCS uses lateral acceleration and roll rate to determine if the aircraft is out of balanced flight and provides the yaw SAS and yaw trim with the inputs necessary to maintain an automatic coordinated turn. Automatic turn coordination is engaged and heading hold disengaged when roll attitude is greater than 1° and any of the following conditions exists:

1. Lateral cyclic force greater than 3.0 percent of cyclic displacement.
2. Cyclic trim release is pressed.
3. Roll attitude is beeped beyond 2.5° bank angle.

2.9.4.8 Maneuvering Stability

Pitch control forces are increased to increase pilot effort required for a given pitch rate at bank angles greater than 30°. The higher pitch control forces help alert the pilot to G-loading during maneuvering flight and are provided through the longitudinal trim actuator. A linear longitudinal stick force gradient is provided by trimming 1 percent forward stick for each 1.5° angle of bank between 30° and 75°. At 75° angle of bank, the longitudinal stick force is equivalent to 30 percent of stick displacement. The maneuvering stability feature is engaged whenever the AUTO PLT pushbutton on the AFCS CONTROL panel is illuminated.

2.9.4.9 Auto Approach to a Hover

An automatic approach can be initiated from any airspeed and any altitude below 5,000 feet AGL. The approach should be initiated from level flight into the wind. If the approach is initiated in a banking turn, the AFCS will make a spiraling approach. Prior to the helicopter slowing to 60 KIAS, the pilot should level the wings and establish the desired heading.

WARNING

Initiating an automatic approach while in a trimmed turn may result in a spiraling approach which will continue through the selected altitude. Immediate pilot action will be required to avoid water impact.

The DAFCS provides the capability to perform an automatic approach to a zero longitudinal and any lateral groundspeed selected on the LAT VEL control knob on the AFCS CONTROL panel and to any radar altitude selected on the HVR ALT control knob, between 40 feet and 200 feet. If the HVR ALT is set below 40 feet, the approach will be made to 40 feet and then continued to the HVR ALT setting when the mode is switched from APPR to HVR. The helicopter will be commanded to the LONG VEL setting of the control when the mode is switched from APPR to HVR. The automatic approach can be initiated with SAS 2, TRIM, and AUTO PLT engaged by activating the automatic approach pushbutton (APPR/HVR) on the AFCS CONTROL panel. The automatic approach is an outer loop only function and commands the aircraft to decelerate or descend until the approach profile conditions are met. If the approach mode is selected when the aircraft conditions are below the approach profile, the DAFCS commands the aircraft through the longitudinal trim actuator to decelerate at 1 knot/second while in the radar altitude hold mode until the approach conditions are met. If the approach mode is selected when the aircraft is above the approach profile, the DAFCS commands the aircraft through the collective trim actuator to descend at 360 feet/minute while the aircraft is more than 50 feet above the approach profile or at 120 feet/minute when the aircraft is less than 50 feet above the profile, using the radar altimeter until the approach profile conditions are met. When the approach profile conditions are met, the aircraft simultaneously decelerates at 1 knot/second and descends at 120 feet/minute. This profile is maintained until the aircraft attains 1 knot of Doppler groundspeed and comes to within 1 foot of the selected radar altitude. If the selected altitude is below 40 feet, the aircraft flies to 40 feet and zero longitudinal groundspeed and then descends to the selected altitude. When groundspeed equals 1 knot or less and the aircraft altitude is within 2 feet of the selected altitude, the hover coupler mode automatically engages and the aircraft

accelerates to the selected longitudinal groundspeed. In very calm sea conditions where the Doppler return signal is unreliable and the Doppler goes into memory, a no-Doppler approach is possible. In this condition the pilot flies the cyclic control, and the AFCS controls the rate of descent. A summary of automatic approach malfunctions is contained in [Figure 2-39](#).

WARNING

Certain AFCS fail advisories during an automatic approach will cancel the automatic approach function. If this occurs when on or above the approach profile, the aircraft will remain trimmed in a descent with no altitude hold engaged. Immediate pilot action will be required to avoid water impact (see [Figure 2-39](#)).

2.9.4.10 Hover Coupler

The hover coupler provides longitudinal and lateral groundspeed control and stabilization about the selected groundspeed, and automatic altitude retention. The longitudinal and lateral groundspeed and the altitude are selectable on the AFCS CONTROL panel. Longitudinal and lateral groundspeed and the altitude are selectable on the AFCS and can also be beeped ± 10 knots with the cyclic TRIM switch about the groundspeed selected on the AFCS CONTROL panel. The hover coupler mode is engaged automatically at the termination of the automatic approach, or can be engaged manually when the aircraft is hovering with less than 5 knots longitudinal groundspeed by pressing the APPR/HVR button on the AFCS CONTROL panel with SAS 2, TRIM, and AUTO PLT engaged. After engagement, the aircraft accelerates to the longitudinal and lateral groundspeeds selected on the AFCS CONTROL panel. Radar altitude hold engages automatically when the aircraft altitude is within 2 feet of the altitude selected on the HVR ALT control knob. Pressing and releasing the cyclic TRIM REL will remove cyclic trim switch inputs, returning the aircraft to the LONG VEL and LAT VEL settings on the AFCS CONTROL panel. Because of the Doppler noise, short-term longitudinal and lateral groundspeed is obtained from integrated longitudinal and lateral inertial acceleration. Long-term correction is obtained from the Doppler sensor using a 7 second filter. See [paragraph 2.9.4.5](#) for a description of the altitude hold feature of the hover coupler.

2.9.4.11 Automatic Depart

The departure can be initiated at any time in the approach or from the coupled hover. The aircraft will assume an approximately 2° nosedown attitude to commence the acceleration.

Note

- The transition from a 5° noseup attitude in the final phases of the approach to a 2° nosedown attitude for departure acceleration may appear excessive to the pilot, but is normal and is no cause for concern.
- If yaw rates are in excess of 2.5° /second, AFCS will not roll the wings level at 60 knots. This is caused by the heading hold feature being unable to engage. The departure will continue in a flat turn.

The AFCS will initially maintain the track of the helicopter over the ground existing at the time the departure mode is selected. The AFCS stores the roll attitude occurring at the time the trim release button was last depressed, prior to or in the automatic approach. If the stored roll attitude is less than 4° angle of bank, the AFCS will level the wings and maintain heading as the aircraft accelerates through 60 KIAS. If the stored roll attitude is 4° angle of bank or greater, the AFCS will roll the helicopter to that attitude when 60 KIAS is exceeded and continue the departure in a spiral. Whether heading hold or coordinated turn mode is active in the departure, the aircraft will climb and accelerate to 500 feet AGL and 100 KIAS if not interrupted by the pilot.

| EVENTS | RAD ALT FAILURE | DOPPLER FAILURE |
|--|--|--|
| During approach | <p>Aircraft will continue in a descent all the way to the water (if on or above profile with RDR ALT light off).</p> <p>Flashing AFCS caution light and CPLR/ALT FAIL ADVISORY light. APPR disengages.</p> | <p>Approach will continue using airspeed and altitude. Pilot controls airspeed and wing attitude using beeper trim.</p> <p>Flashing AFCS caution light. HVR bars freeze. DOPP flag appears in .AI CPLR FAIL ADVISORY light.</p> |
| In a coupled hover or below descent Profile (RDR ALT HOLD ENGAGED) | <p>RDR ALT Hold switches to BAR ALT Hold. Automatic approach/coupled hover disengages. Altitude hold retained.</p> <p>Flashing AFCS caution light and CPLR/ALT FAIL ADVISORY light.</p> | <p>Coupled hover disengages. Attitude hold RDR ALT hold retained.</p> <p>Flashing AFCS caution light. HVR bars freeze. DOPP flag appears in AI. CPLR FAIL ADVISORY light.</p> |
| During departure | <p>Aircraft will climb through 500 feet. No altitude hold will engage. Airspeed will accelerate to 100 knots.</p> <p>Flashing AFCS caution light and CPLR/ALT FAIL ADVISORY light.</p> | <p>Aircraft will climb to 500 feet and RDR ALT hold will engage. Airspeed will increase to approximately 65–75 knots (dependent upon nose attitude when failure occurred).</p> <p>Flashing AFCS caution light. HVR bars freeze. DOPP flag appears in AI. CPLR FAIL ADVISORY light.</p> |
| <p>Notes:</p> <p>Doppler degradation can be classified as follows:</p> <ol style="list-style-type: none"> 1. Doppler power or transmitter fail — Bars center. 2. Doppler memory or receiver fail — Bars freeze. | | |

Figure 2-39. Automatic Approach Malfunction Matrix

The automatic depart mode provides the capability to perform an automatic departure from a coupled hover or from an automatic approach to a cruise airspeed of 100 KIAS and altitude of 500 feet. If the coupled hover or the automatic approach feature has already been engaged, the automatic depart mode is engaged by depressing the DEPART HOV button on the cyclic grip illuminating the green DEPART light on the AFCS CONTROL panel. Depressing the DEPART HOV button a second time will disengage the automatic depart mode and radar hold, returning aircraft control to the pilot. Radar altitude hold may be retained by depressing the collective trim switch prior to the second DEPART HOV button depression. Upon engagement, the aircraft accelerates at 2 knots/second and climbs at 480 feet/minute. During the departure, the DAFCS computer monitors engine torque to ensure it does not exceed 116 percent. At 100 KIAS, the airspeed hold automatically engages, and at a radar altitude of 500 feet, the radar altitude hold automatically engages. Any alternate cruise airspeed or altitude condition less than 100 KIAS and 500 feet can be attained by depressing the cyclic trim release, collective trim release at the desired airspeed and altitude respectively. If either TRIM REL button is depressed and released, the hold mode (airspeed or altitude) associated with that control axis is engaged, and the aircraft continues to follow the depart profile for the other axis until the final cruise condition for that axis is met.

Automatic depart mode is the outer-loop function operating through the pitch, roll, and collective trim actuators. As in the automatic approach mode, above 60 KIAS, roll attitude is maintained and below 60 KIAS the DAFCS commands roll to eliminate lateral drift.

WARNING

- If the DPRT button is not depressed during a waveoff from an automatic approach or departure from a coupled hover, the automatic approach will reengage after the cyclic and collective trim switches are released, causing the aircraft to resume a descending profile.
- It is necessary to depress the DPRT button twice during a manual waveoff to prevent torque limiting.

2.9.4.12 Crew Hover

The crew hover feature provides the crewman with the capability to position the helicopter during hoist and rescue operations. The crewman controls the aircraft from the crew hover-trim control panel. The panel is illustrated in **Figure 2-40**. The crew hover controller has a control authority of ± 5 knots laterally and longitudinally about the reference values selected on the AFCS CONTROL panel LONG VEL and LAT VEL control knobs plus the speeds beeped from the cyclic trim beep switch. The crew hover feature is activated from the AFCS CONTROL panel by depressing the CREW HVR button and can only be activated if the hover coupler mode is already engaged. If the automatic depart mode is activated while crew hover is engaged, crew hover will be disengaged and the automatic depart mode will be engaged.

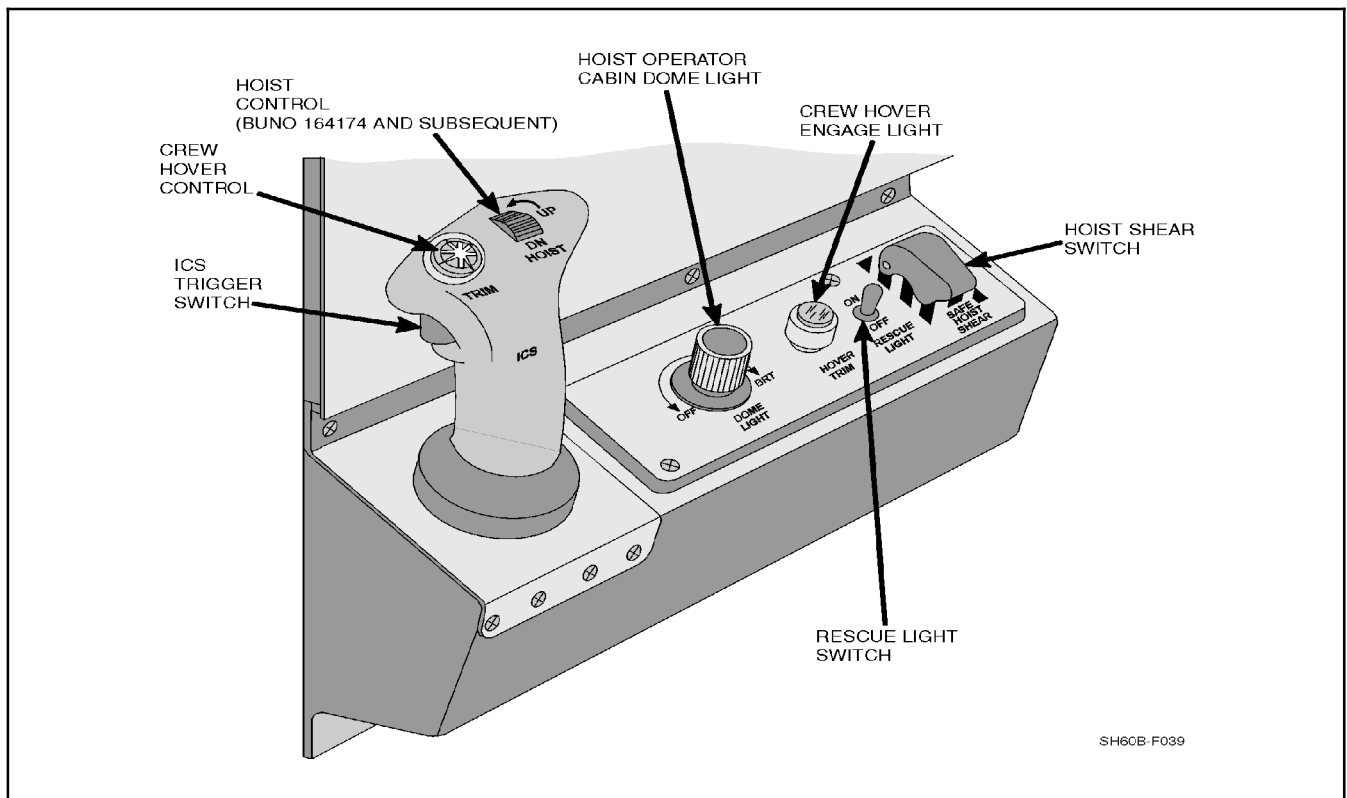


Figure 2-40. Crew Hover-Trim Control Panel

2.9.4.13 Pitch Bias Actuator

The Pitch Bias Actuator (PBA) provides longitudinal cyclic displacement proportional to airspeed. The DAFCS commands the PBA as a function of pitch attitude, pitch rate, and airspeed. The PBA is an electromechanical series actuator with ± 15 percent control authority and ± 3 percent per second rate limit. The PBA functions automatically upon application of power to the DAFCS computer and is not selectable on the AFCS CONTROL panel. The DAFCS computer monitors the PBA position to confirm correct response to the input commands. If the PBA fails, the DAFCS lights the BIAS advisory light on the AFCS CONTROL panel and flashes the AFCS DEGRADED light on the caution/advisory panel and commands the PBA to a predetermined position depending on the type of failure. PBA failure modes are:

1. Attitude failure: bias actuator centered.
2. Pitch rate failure: faded out pitch rate component.
3. Airspeed failure: actuator goes to 120 knot position and attitude and rate continues to function.
4. Actuator failure: power removed from actuator.

If the malfunction that caused the shutdown was of an intermittent nature, the actuator operation can be reset by pressing the appropriate MODE RESET button.

WARNING

When flying with the BIAS FAIL ADVISORY light on, up to 1 1/2 inches of forward or aft cyclic control authority may be lost.

2.9.4.14 Blade Fold System

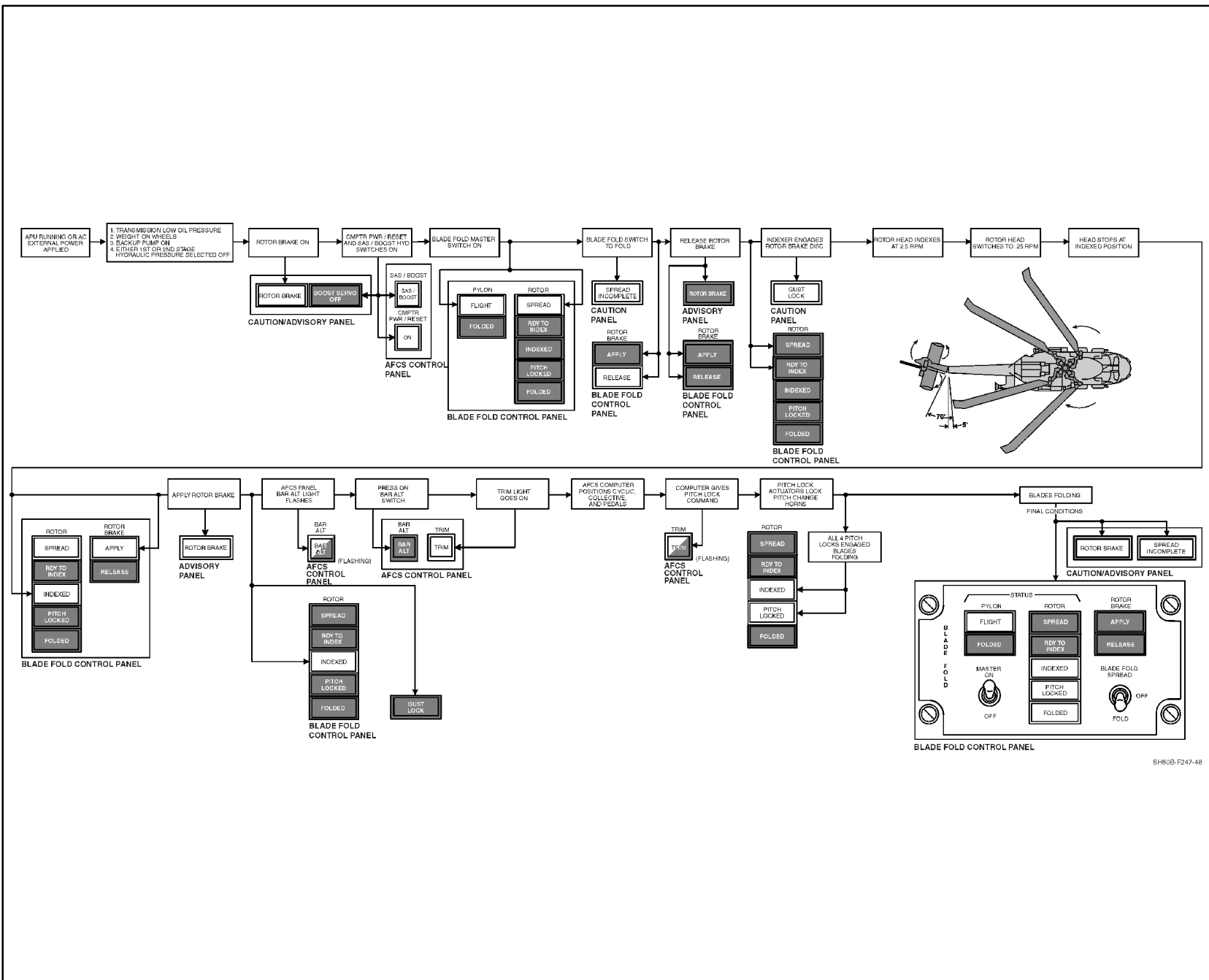
Automatic blade folding ([Figure 2-41](#)) is accomplished by an electromechanical fold mechanism. Pitch locks fix the pitch of the rotor blades in order to maintain clearance during the fold sequence. Two blade lockpin pullers, lock and unlock the hinge when folding and spreading the blades. Microswitches provide input signals to the blade fold electrical control system, which sequences blade folding, and also provides light indications to the BLADE FOLD control panel ([Figure 2-42](#)).

2.9.4.14.1 Blade Folding

Control switches and indications are located on the BLADE FOLD control panel. With the BLADE FOLD MASTER switch ON, the main rotor head will turn to the indexed position after the BLADE FOLD switch is placed to FOLD and the rotor brake is released. The INDEXED status light and the ROTOR BRAKE APPLY light will illuminate upon completion of the indexing cycle. Engaging CMPTR PWR/RESET and TRIM, and applying the rotor brake will permit the blade fold sequence to continue. The DAFCS commands the trim actuators to position the flight controls and allows the main rotor head pitch locks to engage. The blades are then permitted to move to their folded positions.

2.9.4.15 Pylon Fold System

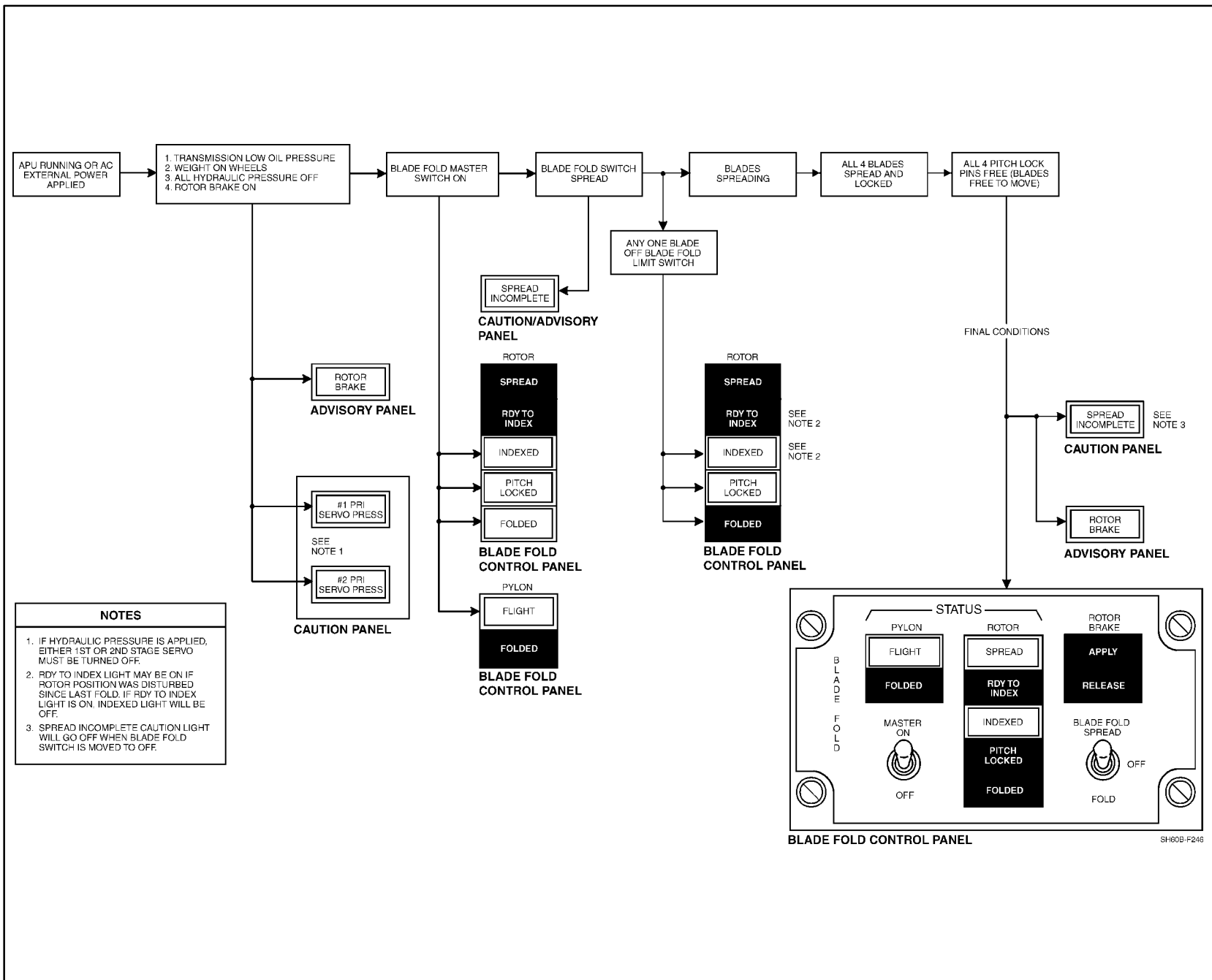
The tail pylon is manually folded and unfolded. PYLON FLIGHT and FOLDED lights, located on the BLADE FOLD control panel, indicate pylon fold status. There are five microswitches, which set the PYLON FLIGHT light: the pylon lockpin switch, 5° switch, tail rotor blade indexer switch, and two stabilator lockpin switches. With the BATT switch ON, the tail rotor will index and lock when the pylon has folded 5°.



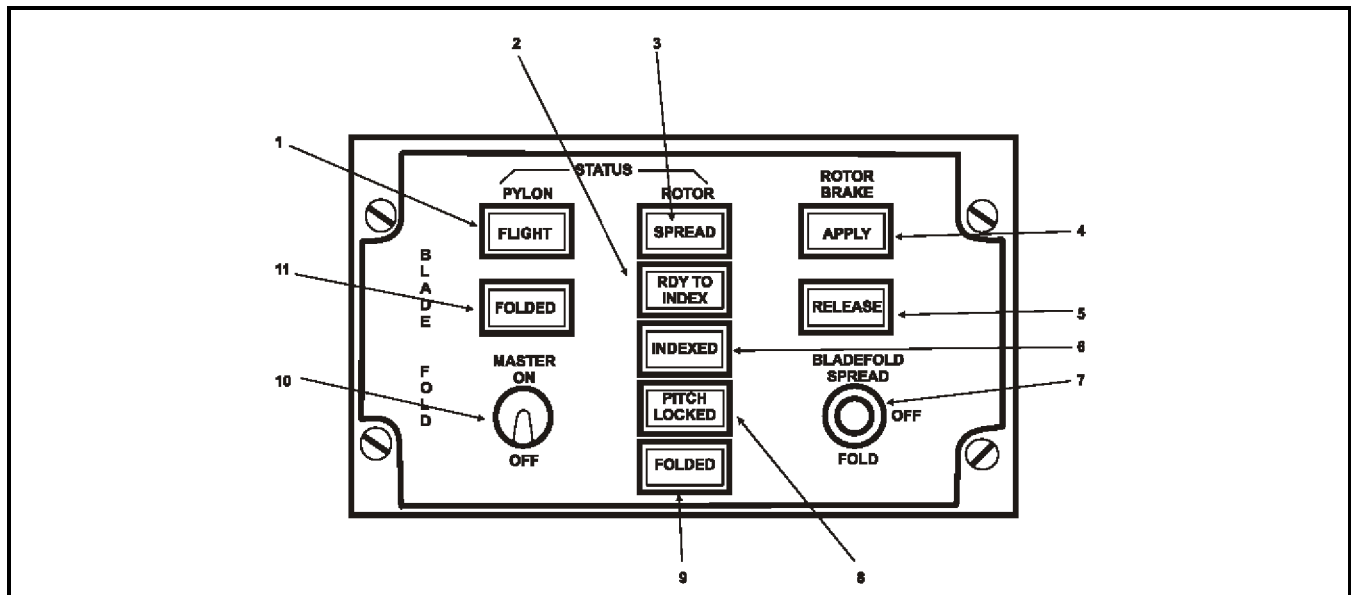
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Figure 2-41. Blade Fold/Spread System (Fold Sequence) (Sheet 1 of 2)

Figure 2-41 Blade Fold/Spread System (Spread Sequence) (Sheet 2)



- NOTES**
1. IF HYDRAULIC PRESSURE IS APPLIED, EITHER 1ST OR 2ND STAGE SERVO MUST BE TURNED OFF.
 2. RDY TO INDEX LIGHT MAY BE ON IF ROTOR POSITION WAS DISTURBED SINCE LAST FOLD. IF RDY TO INDEX LIGHT IS ON, INDEXED LIGHT WILL BE OFF.
 3. SPREAD INCOMPLETE CAUTION LIGHT WILL GO OFF WHEN BLADE FOLD SWITCH IS MOVED TO OFF.



| INDEX | CONTROL | FUNCTIONAL DESCRIPTION |
|-------|--------------------------|--|
| 1 | FLIGHT | All blade fold functions completed on tail pylon. Ready to Fly. |
| 2 | RDY TO INDEX | Main Rotor index pinion engaged in rotor brake disc. Index motor will drive rotor to index position when rotor brake is released. |
| 3 | SPREAD | Blade lockpins extended with main rotor index pinion retracted. Pitch locks are retracted. |
| 4 | APPLY | Commands rotor brake applied after rotor head is indexed. Blades are driven to the correct pitch for folding by engaging the CMPTR PWR/RESET and TRIM pushbuttons. |
| 5 | RELEASE | Commands rotor brake released. When released, main rotor rotates to index position. |
| 6 | INDEXED | Rotor head indexed. Main rotor index pinion remains engaged in rotor brake disc until rotor brake is applied. |
| 7 | BLADE FOLD switch | Selects mode of operation (SPREAD, OFF, FOLD). |
| | SPREAD | Initiates spread sequence. |
| | FOLD | Initiates fold sequence. |
| 8 | PITCH LOCKED | Pitch locks engaged. |
| 9 | FOLDED | All four main rotor blades are folded. |
| 10 | BLADE FOLD MASTER switch | Applies or removes blade-fold power (OFF or ON). |
| 11 | FOLDED | Stabilator lock pins out, tail rotor indexed, pylon folded. |

Figure 2-42. Blade Fold Controls


CAUTION

Unless external power is applied or the BATT switch is ON prior to folding the tail pylon, the tail rotor index actuator will not engage after starting the pylon fold sequence and uncontrolled tail rotor windmilling may result.

Note

Failure to suppress the DECU numerical fault codes on the PDU will prevent the automatic blade fold from operating due to the torque signal being relayed to the AFCS computer.

2.9.4.16 Automatic Preflight Checks

The DAFCS provides an automatic preflight check of the SAS components prior to flight. The automatic preflight is engaged using the SAS 1 switch with the following conditions:

1. Weight on wheels.
2. Rotor brake on.
3. Engine torques equal to zero.
4. CMPTR PWR/RESET engaged for at least 2 minutes (AFCS DEGRADED not illuminated).

Upon engagement, all rate gyros are automatically torqued to predetermined rates and checked for magnitude and polarity of rate gyro response. Simultaneously, the response of SAS 1 to rate gyro inputs is compared against a digital model. Failures are displayed on the fail status panel and stored in a **BIT** code display. CMPTR PWR/RESET switch has to be engaged at least 2 minutes to ensure gyros are up to speed. After gyros are up to speed, preflight requires approximately 10 seconds to complete.

2.10 LANDING GEAR

The landing gear (**Figure 1-3**) is a fixed main/tail, gear-type configuration. It consists of two single-wheel, main landing gears and a dual-wheel swivel-type tail gear. The long stroke of both main and tail wheel shock struts is designed to dissipate high-sink-speed landing energy without exceeding the ship deck strength limits. Wheel brakes are mounted on each main gear. Axle and high tiedowns are provided at each main gear, fuselage attachments are provided above the tail gear for tiedown, and connections to the shipboard tail-guide winch system are provided for RAST straightening and traversing.


WARNING

Flying with a stuck WOW switch will disable WOW functions including emergency jettison circuits, radar altimeter low altitude aural warning, Engine Out, and low rotor rpm lights. Pulling the WOW circuit breaker will not restore proper operation of some WOW functions in the air. Pulling the WOW circuit breaker in flight may disable the LOW ROTOR RPM light and the #1 and #2 ENG OUT warning lights.

2.10.1 Main Landing Gear

Each single-wheel main gear is mounted on a drag strut that trails aft from a pivot point mounted on the fuselage. A separated air/oil-type shock strut is mounted on the fuselage and to the aft end of the drag strut. A landing gear

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WOW switch is installed on the left landing gear to prevent or control operation of certain systems when the weight of the helicopter is on the landing gear. The equipment that uses the WOW switch is shown in [Figure 2-44](#).

2.10.1.1 Wheel Brake System

Main landing gear wheels have self-contained, self-adjusting disc hydraulic brakes ([Figure 2-45](#)). The wheel brake system consists of four master cylinder/reservoirs, two slave valves, a parking brake valve, and two wheel brake assemblies. A master cylinder is connected to each rudder pedal. The purpose of the slave valves is to give the pilot or ATO the ability to apply the brakes. Each wheel brake consists of a steel rotating disc, brake pucks, and a housing that contains the hydraulic pistons. The brakes have a visual brake-puck wear indicator. The parking brake handle, marked PARKING BRAKE, is located on the right side of the center console and allows the brakes to be locked by either the pilot or ATO after brake pressure is applied. The parking brakes are applied by pressing the toe brake pedals, pulling the parking brake handle up to its fully extended position, and then releasing the toe brakes while holding the handle up. The PARKING BRAKE ON advisory light will illuminate. The advisory light only indicates that the parking brake handle is up. Pressing either the pilot or ATO left brake pedal will release the parking brakes, the handle will return to the off position, and the advisory light will extinguish. Power is provided to this advisory system by the NO. 1 DC primary bus through a circuit breaker marked EXT ADVSY LTS and located on the SO circuit breaker panel.

2.10.2 Tail Landing Gear

The tail landing gear is of a cantilevered design, with an integral shock strut capable of swiveling 360°. The two tail gear wheels are mounted on a splined axle incorporated in the shimmy damper ([Figure 2-43](#)). The shimmy damper causes both of the tail gear wheels to rotate at the same rate, preventing aircraft tail oscillations during taxi, takeoff, and running landings. For helicopter guidance for traversing on the flight deck, a RAST tail probe and probe actuator are mounted on the tail gear.

2.10.2.1 Tail Wheel Lock

The tail wheel lock is extended and retracted by an electric motor-operated actuator located on the tail wheel shock strut housing. The tail wheel lock switch is located on the forward side of the parking brake handle in the cockpit. Unlocking the tail wheel illuminates the TAIL WHEEL UNLOCKED advisory light on the caution/advisory panel and unlocks the tail wheel lock pin. Power to operate the tail wheel lock motor is provided by the DC essential bus through a circuit breaker marked TAIL WHEEL LOCK on the overhead console. A manual lock release is located on the strut. In the down position, the tail wheel is manually unlocked. It cannot be controlled electrically. In the up position, the tail wheel lock is controlled by the switch on the parking brake handle. There is no manual locking feature.

2.10.2.2 Tail Bumper

A nitrogen-filled tail bumper ([Figure 1-3](#)), mounted on the underside of the tail pylon, prevents the stabilator from striking the ground when landing with nose-high attitudes.

2.11 RAST SYSTEM

The air vehicle portion of the RAST system ([Figure 2-46](#)) comprises a control panel, a main probe assembly, and a tail probe assembly. RAST is capable of:

1. Assisting the pilot in landing the helicopter on the flight deck.
2. Securing the helicopter to the deck.
3. Straightening the helicopter to a laterally centered position.
4. Traversing the helicopter into and out of the hangar.

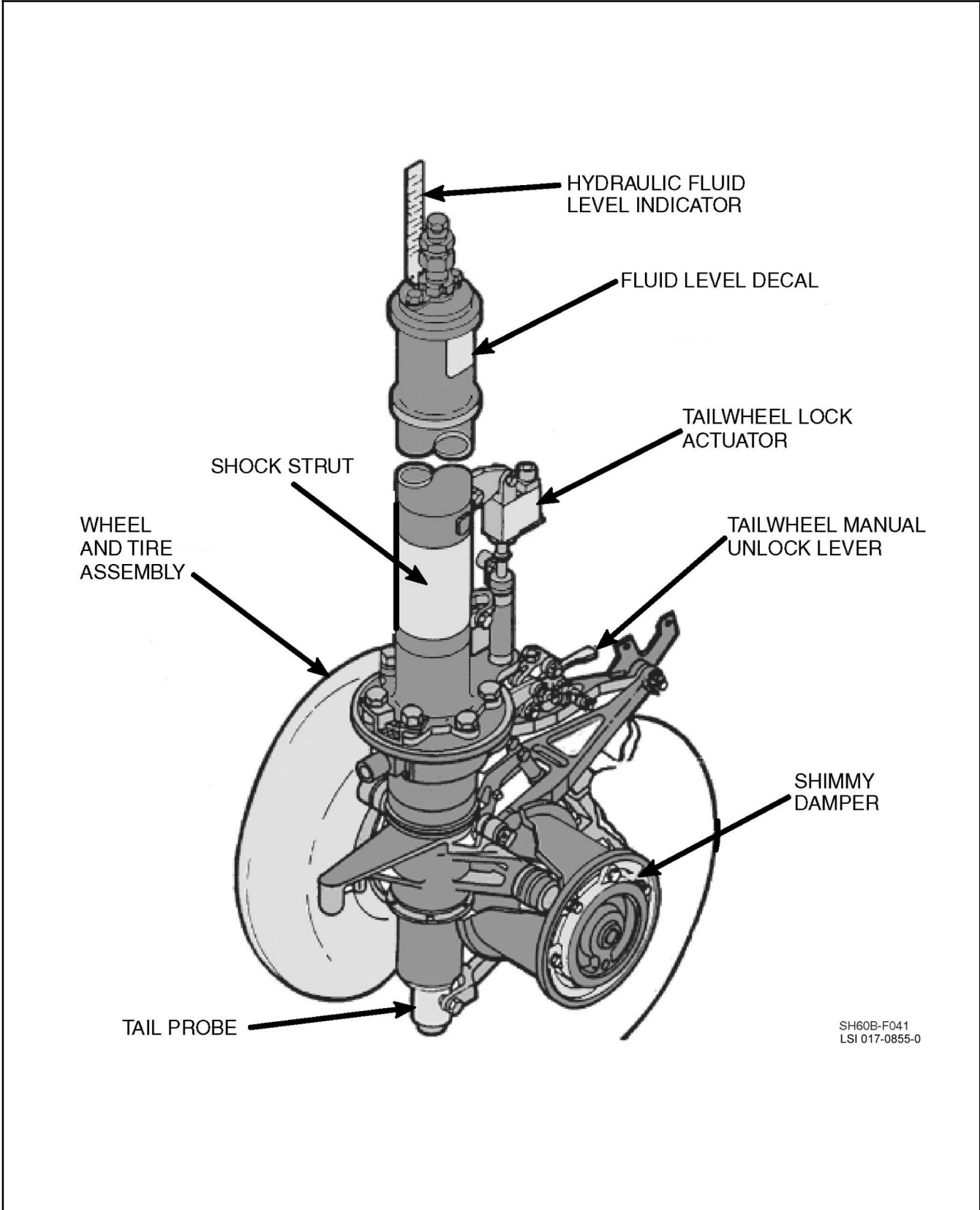


Figure 2-43. Tail Wheel Assembly

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| INTERFACE | FUNCTION AFFECTED | FLIGHT | GROUND |
|-----------------------------|---|---------------|----------------------------------|
| Blade fold | Blade fold actuators | Disabled | Enabled |
| AFCS | Pitch hold | Enabled | Disabled |
| | Heading hold | Enabled | Disabled |
| | Automatic preflight checks | Disabled | Enabled |
| Generator control unit | Underfrequency protection | Disabled | Enabled |
| Master shear | RAST shear | Enabled | Disabled |
| | Cargo hook emergency release | Enabled | Disabled |
| | MAD shear | Enabled | Disabled |
| | Rescue hoist | Enabled | Disabled |
| Sonobuoy launcher | Rotary valve to DECU circuitry | Enabled | Disabled |
| Hydraulics | U-1, U-2 logic modules | Enabled | Enabled with BACKUP HYD PMP-AUTO |
| | | | Disabled with BACKUP HYD PMP-OFF |
| | LDI test | Disabled | Enabled |
| Master caution panel | Engine out lights | Enabled | Disabled |
| | Low rotor rpm lights | Enabled | Disabled |
| Tail rotor blade positioner | Tail indexing | Disabled | Enabled |
| Radar altimeter | Height indicator low altitude aural warning | Enabled | Disabled |
| Armament | Master armament and jettison circuits | Enabled | Disabled |
| FLIR turret | LRD | Enabled | Disabled |
| M299 launcher | M299 launcher arming | Enabled | Disabled |
| SO console | Search radar (cannot be bypassed) | Enabled | Disabled |
| Mission avionics rack | KIT and KIR zeroize logic | | |
| | Mechanical hold | Disabled | Enabled |
| | Electrical hold | Enabled | Disabled |
| | Data-link transmitter | Enabled | Disabled |

Figure 2-44. Weight-On-Wheels Functions

2.11.1 RAST Control Panel Indicators

The RAST control panel is located on the SO console above the RADAR/DISPLAY control panel and provides control and status indication of the system (Figure 2-47). The cyclic grips have an electrical release button to free the recovery assist (RA) cable from the aircraft. An emergency release (EMER REL) button to shear the main probe messenger cable is located on the cyclic grip. A mechanical emergency release handle, located on the left side of the center console, is used to release the RA cable from the probe in the event of electrical release actuator failure.

The MASTER switch is a two-position switch and, when placed in the ON position, supplies power to the control portion of the system. The MAIN PROBE, UP/DOWN switch is a three-position switch, spring-loaded to the center. The MESSGR CABLE-UP/DOWN switch is spring loaded to the center position. When the switch is placed in the UP position, the messenger cable is reeled into the aircraft, and when it is placed in the DOWN position, the cable will reel out from the aircraft. The main probe must be extended before the messenger cable can be reeled out, and the messenger cable must be seated in order to retract the main probe.

Note

The DOWN light is not a positive down indication for the tail and main RAST probe (electrically actuated only).

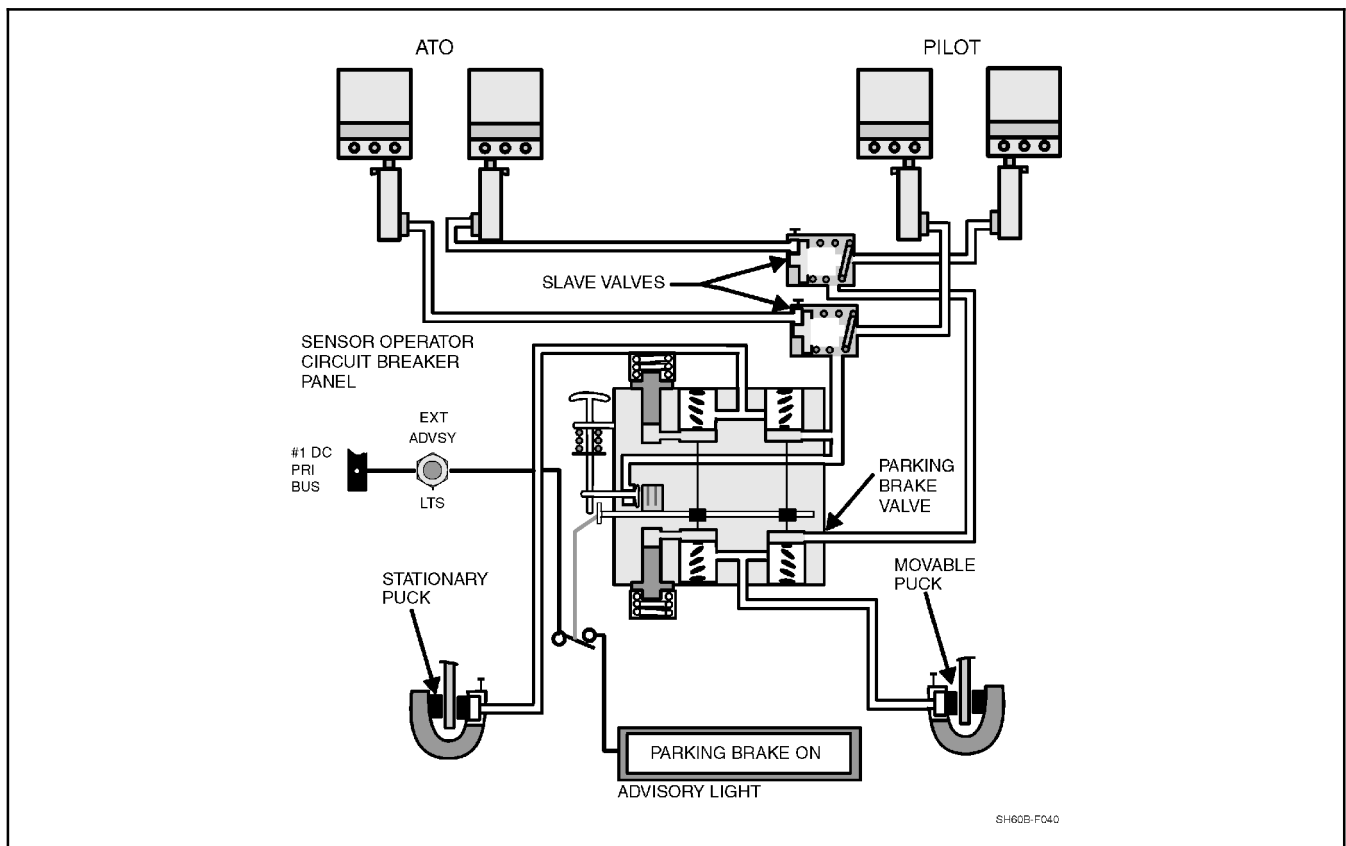
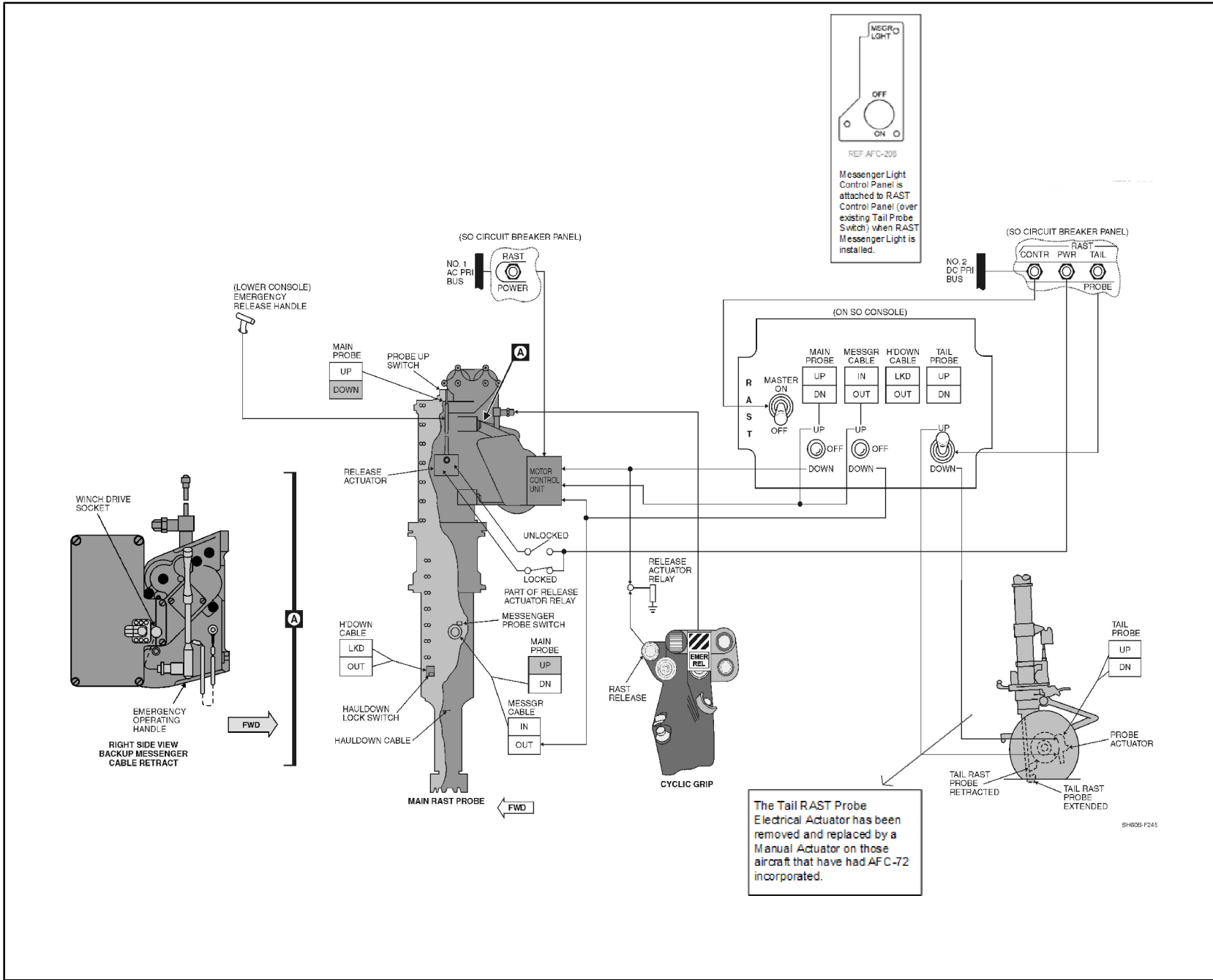
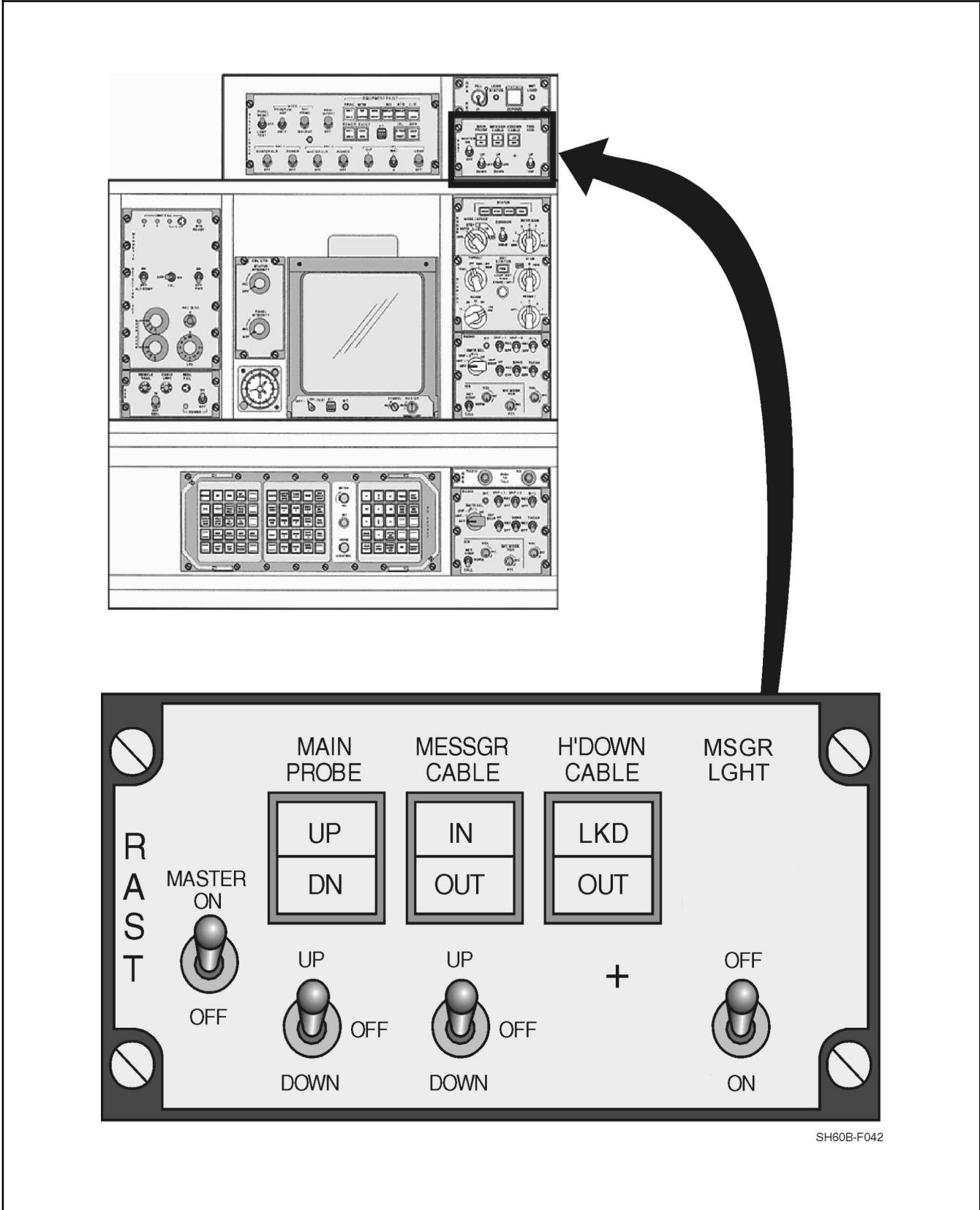


Figure 2-45. Wheel Brake Schematic

Figure 2-46. RAST Block Diagram



SH80B-F245



SH60B-F042

Figure 2-47. RAST Control Panel

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The MESSGR CABLE light gives the status of the cable. When it displays IN, the messenger cable is retracted fully into the main probe. When OUT is displayed, the messenger cable is extended. The H'DOWN light gives the status of the RA cable. A LKD indication is displayed when the RA cable from the surface ship is locked into the main probe. The OUT indication is displayed when the RA cable is free of the main probe. The main probe (Figure 2-46) contains a 3 phase, 115-Vac, 400-Hz electrically operated hoist, which lowers the probe, reels out the messenger cable, raises the RA cable, and retracts the probe. The hoist is powered by the NO. 2 AC primary bus through a circuit breaker marked RAST POWER. This circuit breaker is located on the SO circuit breaker panel. An electrically fired guillotine is provided to shear the messenger cable in an emergency. The guillotine is powered by the NO. 2 DC primary bus through a circuit breaker on the ATO circuit breaker panel marked RAST SHEAR. Attached to the probe is a release actuator, used to release the RA cable from the locks in the probe. It is also used to lock the probe in the retracted position. Three switches are mounted on the probe: the probe UP switch, the messenger probe switch, and the H'DOWN LKD switch.

2.11.2 Main RAST Probe

The airborne provision for the RA system is a fully retractable main probe (Figure 2-46). It is mounted on the centerline of the aircraft near the center of gravity. In a fully retracted position, it is held in an uplock. From there, it is spring loaded to a fully extended position for landings into the rapid securing device (RSD). The probe has an electrically powered hoist mounted to its outer housing. The hoist provides the messenger cable, deployed through the center of the probe, to retrieve the surface ship RA cable. The messenger cable end fitting provides a snap-in connection for the RA cable. After pulling the RA cable into the locked position, the messenger cable is automatically disconnected from the RA cable. The lower end of the extended probe is designed to be captured by the RSD after landing. With the probe secured within the RSD, the helicopter is held against horizontal and/or axial tension loads. A swiveling crenelated ring on the end of the probe is provided for axial loads. The main probe is powered by the NO. 2 DC primary bus through a circuit breaker on the SO circuit breaker panel marked RAST PWR.

2.12 FLIGHT INSTRUMENTS

The electrically operated instruments function on alternating current, direct current, or both and are protected by appropriately marked circuit breakers on the pilot and ATO circuit breaker panels.

2.12.1 Pitot Static System

The pitot-static system provides pressure for the operation of the differential pressure instruments (barometric altimeters and airspeed indicators). Two pitot tubes are mounted on the nose, forward of the cockpit. Two static ports are located on the fuselage sides, aft of each cockpit door (Figure 1-3). Each pitot head assembly consists of a baseplate with a strut and probe tube and an electrical connector, wired to two deicing heaters in the tube. Pitot pressure is sensed at the opening of the forward end of each tube. Static 1 and static 2 pressures are sensed through ports aft of the cockpit doors. Pitot pressure is supplied from the pitot tubes to the airspeed indicators, airspeed and air data transducers, and pitot-drain caps. To obtain a difference in the pressure for operation of the barometric differential pressure instruments, static air pressure (atmosphere) is supplied through the static ports to the altimeters, airspeed indicators, airspeed and air data transducers, and static drain caps.

2.12.1.1 Airspeed Indicator

Two airspeed indicators are installed on the instrument panel (Figure 1-8) for the pilot and the ATO. The indicators are differential pressure instruments, measuring the difference between impact pressure and static pressure. System error is noted on placards located below the instrument panel on each side of the lower console (Figure 1-7).

2.12.1.2 Barometric Altimeter/Encoder

The AAU-32/A Altimeter/Encoder functions as a barometric altimeter for the pilot and a pressure altitude sensor for the AN/APX-100 IFF Transponder. The altimeter/encoder is on the pilot side of the instrument panel (Figure 1-8). The operating range of the altimeter is from -1,000 to +50,000 feet. The barometric pressure-set knob permits altimeter settings from 28.10 to 31.00 inches Hg. A window in the lower right section of the altimeter displays the selected altimeter setting. The altimeter is equipped with a continuously operating DC-powered vibrator to improve altitude indicating accuracy. The encoder provides a digital output of pressure altitude in units of 100 feet to the IFF transponder, with mode C selected, for automatic pressure altitude transmission. The encoder operates throughout the operating range of the altimeter, but, unlike the altimeter, it reports altitude using a permanent altimeter setting of 29.92 inches Hg. If there is a loss of 115 Vac, 400 Hz power, the warning flag on the pilot altimeter indicator, marked CODE OFF, will be displayed. The NO. 2 DC primary bus furnishes power to the pilot altimeter through a circuit breaker on the ATO circuit breaker panel, marked PILOT ALTM. The NO. 1 DC primary bus furnishes power to the ATO altimeter through a circuit breaker marked ATO ALTM.

2.12.1.3 Barometric Altimeter

The AAU-31/A Altimeter, installed on the left side of the instrument panel (Figure 1-8), is identical to and operates in the same manner as the pilot AAU-32/A Altimeter/Encoder, except that there is no encoder associated with the altimeter, and there is no warning flag on the indicator.

2.12.1.4 Vertical Speed Indicators

Two indicators on the instrument panel (Figure 1-8) indicate vertical speed in thousands of feet per minute. The first 1,000 feet are marked in 100-foot gradations. Each vertical speed indicator (VSI) independently reads static cabin pressure through a port in the back of each gauge.

Note

- Vertical speed indicators are unreliable during transition to ground effect.
- The VSI may momentarily indicate a false rate of descent while opening the cargo hatch cover in flight.

2.12.1.5 Attitude Indicator

Identical Attitude Indicator (AIs) are located on the pilot and ATO instrument panel. These indicators furnish a visual display of aircraft attitude. Figure 2-48 shows the AI and describes the individual indicating elements. Power for the pilot AI is supplied from the AC essential bus and for the ATO from the NO. 1 AC primary bus, both through the center circuit breaker panel, marked PILOT AI and ATO AI, respectively.

2.12.2 Radar Altimeter, AN/APN-194

The radar altimeter (RAD ALT) (Figure 2-49) is a range-tracking radar that provides continuous measurement of height above land or water. It has a range of 0 feet to 5,000 feet, with an accuracy of ± 3 feet or ± 4 percent, whichever is greater; however, only a range of 0 feet to 1,000 feet is indicated on the instrument. Tracking above 1,000 feet is used by the operational navigation system and the AFCS. On deck, a reading of 0 to 7 on the navigation table is permissible. Moving either pilot or ATO height indicator control knob out of the OFF position will provide height indication to both radar altimeters.

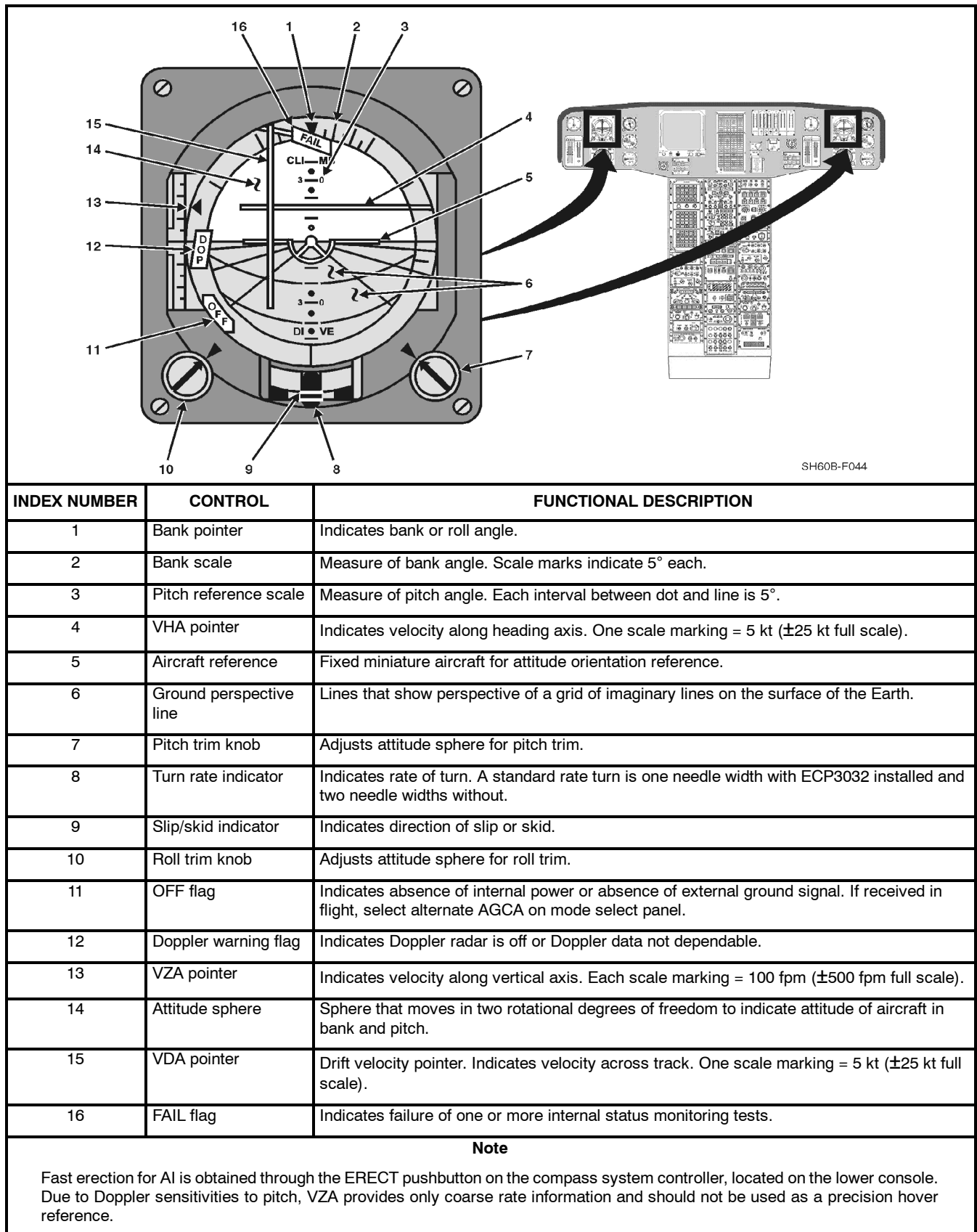


Figure 2-48. Attitude Indicator (AI)

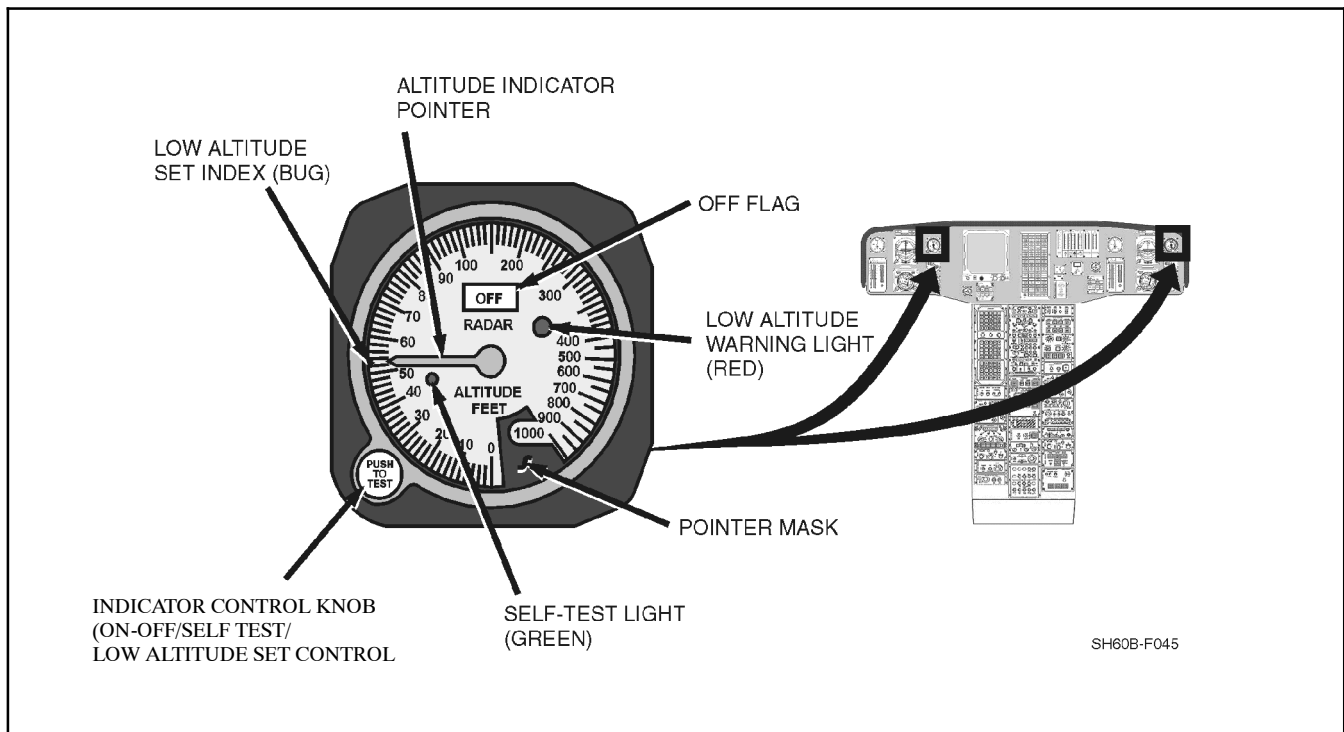


Figure 2-49. Radar Altimeter (Height Indicator)

The radar altimeter operates in two modes, search and track. In the search mode, the entire altitude range is searched for a ground return. In the track mode, the set locks onto the ground return and gives continuous altitude information to the height indicators. In addition, altitude data is sent to the data handling subsystem for processing. Each of the height indicators contains a complete radar altitude warning system (RAWS) function. The RAWS function provides a visual warning and an aural tone to the internal communications network. Even with RAD ALT switch off, pressing the test switch will provide a continuous beep in the headset.

Note

Pressing the RAD ALT TEST button above 5,000 feet activates a continuous beeping tone in both the pilot and ATO headsets. The tone can only be deactivated by turning off the RAD ALTs or descending below 5,000 feet AGL.

The RAWS feature of the AN/APN-194 is active when:

1. Fixed high altitude warning. When descending through 250 feet, the pilots will hear six beeps. This is disabled only if coupler is engaged.
2. Fixed low altitude warning (35 feet). When below the setting, the pilots will hear a continuous series of beeps. This is enabled only if coupler is engaged.
3. Variable altitude adjust. Each pilot will hear six beeps and the low altitude light will illuminate if the aircraft descends below his respective variable index.
4. Above 5,000 feet. If return is unreliable, height indicator will display OFF flag.
5. Power source failure to RAD ALT will cause height indicator to display OFF flag with continuous beeping tone.

The warning consists of a light on the indicator and a tone in the pilot and ATO headsets. The tone is a nominal 1,000-Hz signal, pulsed at a 2 cycle per second rate. Both stations will be alerted for the preset high and low altitude indices.

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The electronic altimeter set consists of a receiver/transmitter, height indicators (pilot and ATO) (two), and antennas (left and right) (two). Power is supplied from the AC essential bus through the center circuit breaker panel marked RDR ALTM R/T. The pilot and ATO height indicators are powered by the DC essential bus through the overhead circuit breaker panel, marked HEIGHT IND PILOT and HEIGHT IND ATO, respectively.

Note

The bearing–distance–heading indicators (BDHI) and the compass system are discussed in [Chapter 16](#).

2.12.3 Miscellaneous Flight Instruments

2.12.3.1 Standby Magnetic Compass

A lighted magnetic compass is installed above the instrument panel on the right-center windshield frame ([Figure 1-5](#)). The compass is used as a standby instrument for heading references. A compass correction card, with deviation errors, is installed on the forward right of the overhead console ([Figure 1-6](#)).

2.12.3.2 Outside Air-Temperature (OAT) Indicator

An ambient air–temperature indicator ([Figure 1-5](#)), marked FREE AIR, extends through the upper–center windshield panel. The direct reading instrument is marked in degrees Celsius.

2.12.3.3 Clock

Two 8–day clocks are installed on the instrument panel ([Figure 1-8](#)). The elapsed time knob is on the upper–right corner of the clock. The clock is wound and set with a knob on the lower–left corner. The SO is also provided with a clock.

2.13 WARNING, CAUTION, AND ADVISORIES

2.13.1 Master Warning System

Two amber, master caution warning lights ([Figure 1-8](#)), for the pilot and ATO, marked MASTER CAUTION PRESS TO RESET, are located on the master warning panel. They light whenever a caution light lights. These lights alert the pilot and direct attention to the caution lights on the caution/advisory panel. During caution/advisory panel test, when the switch is released from the test position, the master caution lights will flash 16 times to indicate that chip caution panel circuits are going through self–test. An existing malfunction within those circuits will prevent flashing of the master caution lights. The master caution warning lights should be reset at once to provide a similar indication if a second condition or malfunction occurs while the first condition is present. The master caution warning light can be reset from either pilot position. Power for both of the master caution warning lights is provided from the DC essential bus through a circuit breaker marked CAUTN ADVSY PNL and located on the overhead circuit breaker panel.

Four red warning lights, also located on the master warning panel, require immediate action if they light. The markings are #1 ENG OUT, #2 ENG OUT, FIRE, and LOW ROTOR RPM. The LOW ROTOR RPM warning light will flash at a rate of three to five flashes per second if rotor RPM drops below 96 percent. The ENG OUT warning lights will light at 55 percent N_g speed and below. Refer to [Figure 2-50](#) for a brief description of each fault.

Note

The ENG OUT and the LOW ROTOR RPM warning lights are disabled with weight on wheels, but may still be tested with the caution/advisory test switch.

| <table border="1" style="width: 100%; text-align: center;"> <tr> <td style="width: 33%;">#1 ENG OUT</td> <td style="width: 33%;"></td> <td style="width: 33%;">#2 ENG OUT</td> </tr> <tr> <td>FIRE</td> <td>MASTER CAUTION PRESS TO RESET</td> <td>LOW ROTOR RPM</td> </tr> </table> | | | #1 ENG OUT | | #2 ENG OUT | FIRE | MASTER CAUTION PRESS TO RESET | LOW ROTOR RPM |
|---|---|--------------------------|-----------------------|--|-----------------------|-------------|--|--------------------------|
| #1 ENG OUT | | #2 ENG OUT | | | | | | |
| FIRE | MASTER CAUTION PRESS TO RESET | LOW ROTOR RPM | | | | | | |
| SH60B-F046 | | | | | | | | |
| LEGEND | LIGHTING PARAMETER OR FAULT | | | | | | | |
| #1 ENG OUT | Indicates that the NO. 1 engine N_g speed is ≤ 55 percent. | | | | | | | |
| FIRE | Indicates that a fire detector has actuated a fire-warning circuit. | | | | | | | |
| MASTER CAUTION PRESS TO RESET | Indicates that a caution light on the caution panel has been actuated by a failed system. | | | | | | | |
| #2 ENG OUT | Indicates that the NO. 2 engine N_g speed is ≤ 55 percent. | | | | | | | |
| LOW ROTOR RPM | Indicates that the rotor speed is ≤ 96 percent N_r . | | | | | | | |

Figure 2-50. Master Warning Panel

2.13.2 Caution/Advisory Light System

The caution/advisory panel ([Figure 1-8](#)) is located on the instrument panel. The caution section (the upper two-thirds) of the panel indicates certain malfunctions or unsafe conditions with amber lights. The advisory section (the lower one-third) of the panel shows certain noncritical conditions with green lights. Each light has its own operating circuit and will remain lighted as long as the condition that caused it to light exists. The caution/advisory panel contains a self-test system for all engine and transmission drivetrain chip detector lights. During caution/advisory panel test when the switch is released from TEST position, the self-test is activated. If a malfunction exists in one of the engine and transmission drivetrain chip detect lights within the caution panel, that respective light will flash. The caution and advisory lights are powered by the DC essential bus through a circuit breaker marked CAUTN ADVSY PNL on the overhead panel. (Refer to the major systems for a complete description of the caution/advisory panel lights. (Refer to [Chapter 12](#) for a description of the caution/advisory legend.)

2.14 FIRE-DETECTION SYSTEM

The fire-detection system ([Figure 2-51](#)) provides a visual cockpit indication when infrared radiation, caused by a fire or extreme overheating, is detected in either engine compartment or the APU compartment. The system consists of three control amplifiers located in the left-hand junction box; five sensors (two in each engine compartment and one in the APU compartment); # 1 and # 2 ENG emergency off T-handle fire-warning lights located on the engine control quadrant; APU FIRE EXT T-handle fire-warning light and FIRE DET TEST switch located on the overhead console; and two FIRE warning lights on the pilot and ATO master warning panels.

When one of the sensors detects infrared radiation (fire), and no blue light (sunlight), it sends out a voltage to its associated control amplifier. Sunlight filtered through smoke or haze, or at sunrise or sunset, may trigger the flame detectors and cause a false fire indication. The control amplifier then provides a voltage to both master warning-panel FIRE lights and the proper T-handle lights. The FIRE DET TEST switch ([Figure 1-6](#)) on the overhead console is a three-position rotary switch used to check all components of the fire detection system except the flame detector (which must be tested with red light). In the OPER position, the fire sensors are connected up to their respective indicators. The NO. 1 test position checks the continuity of the wiring, amplifiers and monitoring lights for the firewall-mounted detectors, NO. 1 and NO. 2 engines, and the APU compartments. If operating properly, the master FIRE warning light, both ENG EMER OFF T-handles, and the APU FIRE EXT T-handle will illuminate. The NO. 2 test position checks the continuity of wiring, amplifiers, and monitoring lights for the NO. 1 and NO. 2 engine deck-mounted sensors. If operating properly, the master FIRE warning light and both ENG EMER OFF T-handles will illuminate. The APU FIRE EXT T-handle will be off. Electrical power for the engine compartment detectors is supplied by the DC essential bus through the FIRE DET NO. 1 and NO. 2 ENG circuit breakers on the overhead circuit breaker panel. The detector in the APU compartment is supplied by the battery bus through the APU FIRE DETR circuit breaker on the center console circuit breaker panel.

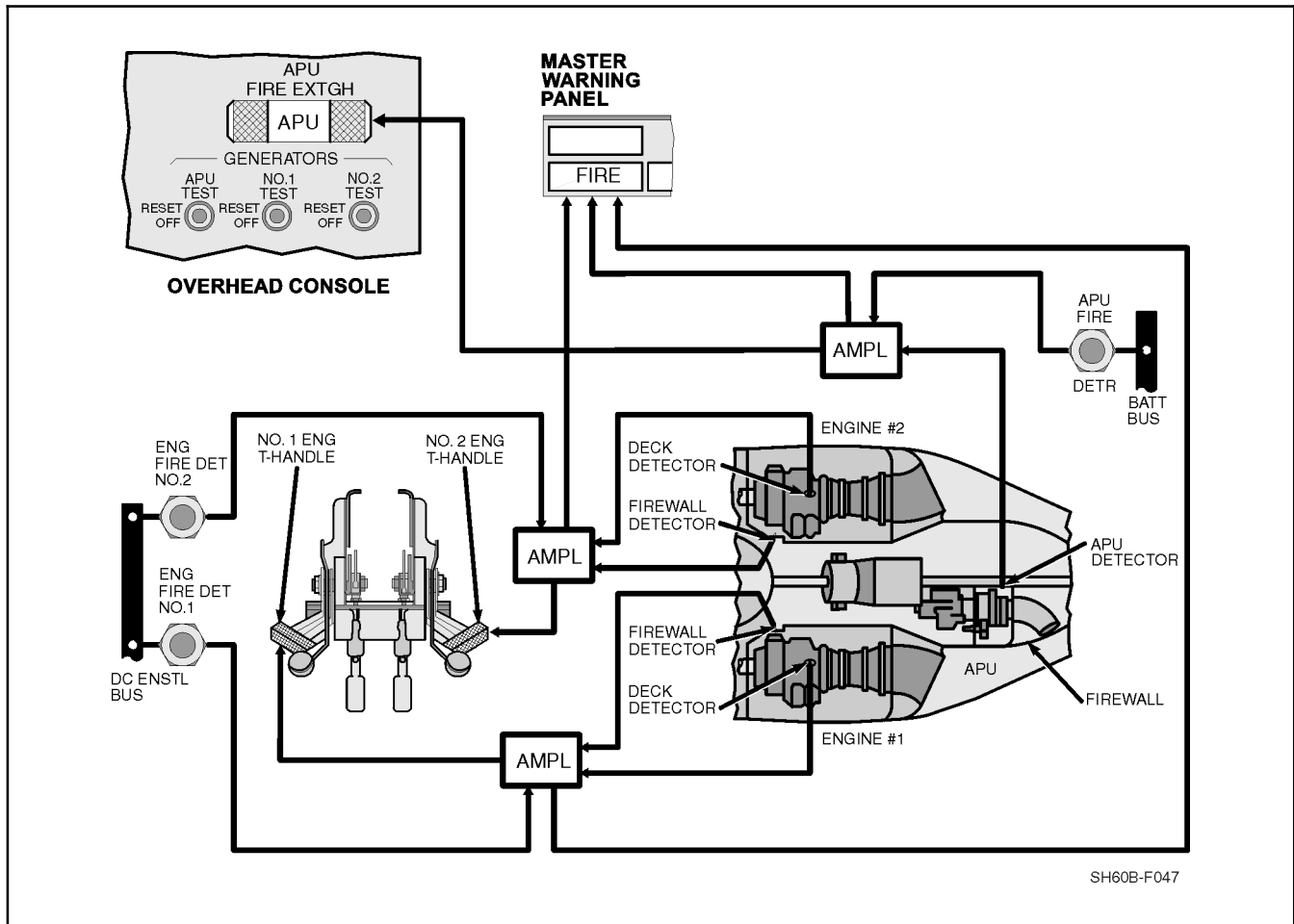
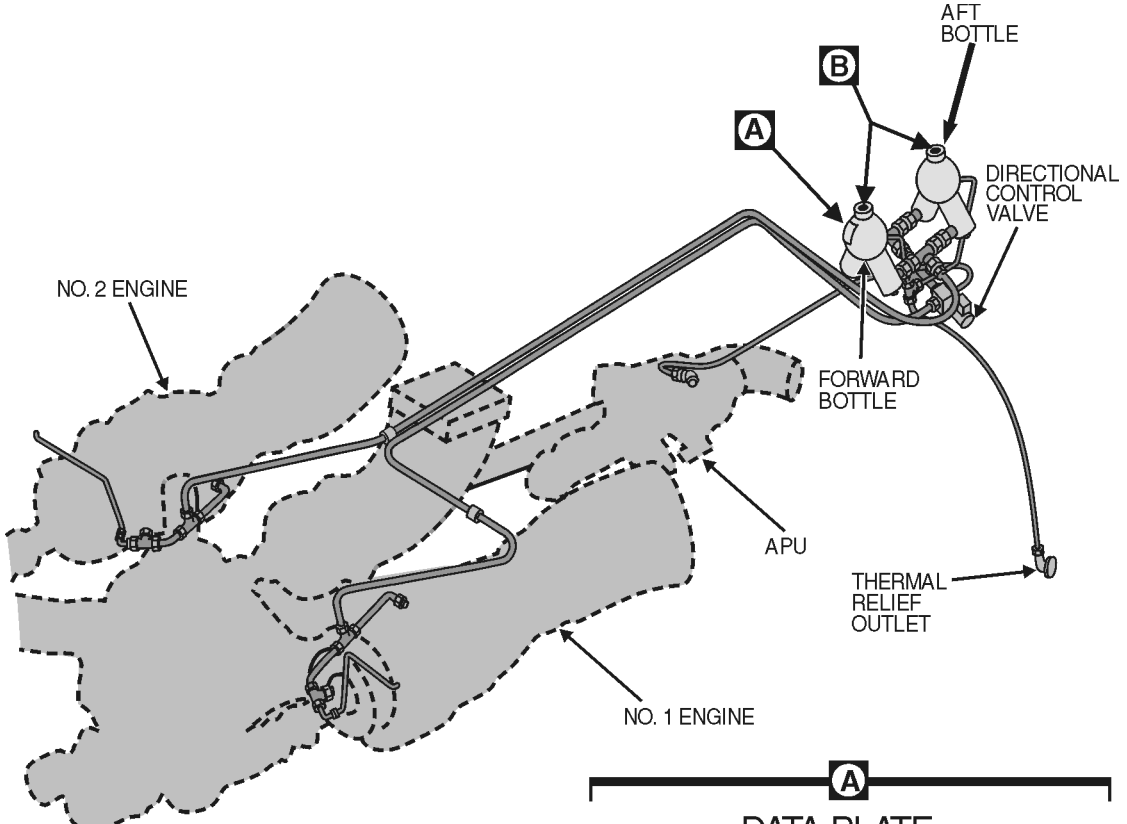


Figure 2-51. Fire-Detection System, Block Diagram

2.15 ENGINE/APU FIRE-EXTINGUISHING SYSTEM

The bromotrifluoromethane (CF₃ Br) high-rate discharge extinguishing system (Figure 2-52) provides a two-shot (main and reserve) capability to either the main engine compartments or the APU compartment. The system includes two containers that are filled with extinguishing agent and charged with nitrogen. The containers are mounted above the upper deck, aft of the APU compartment. Both containers have dual outlets, each outlet containing its own firing mechanism and CAD. Each container has a pressure gauge and a thermal discharge relief port. Thermal discharge is indicated by the loss of a red plastic disc on the left side of the aircraft. Electrical power to operate the system is supplied by the battery utility bus, the NO. 2 DC primary, and the DC essential bus through the FIRE EXTNGH circuit breakers on the lower console, the overhead console, and the ATO circuit breaker panels. Three T-shaped handles select the compartment to which the fire extinguishing agent is to be directed and shut off fuel to that engine or APU. The FIRE EXT switch on the overhead console has three positions marked RESERVE, OFF, and MAIN. The MAIN position of the switch sends fire extinguishing agent to NO. 1 engine or APU compartment from the forward fire extinguishing bottle M1 port. The R2 port is reserve for NO. 2 engine. The aft fire extinguisher bottle M2 port is main for the NO. 2 engine and the R1 port is reserve for NO. 1 engine or APU. The ports provide a second shot of extinguishing agent to be used if the actuation is not enough and the bottle was not previously discharged. The fire extinguisher selector switch is armed after one of the T-handles has been pulled. If two T-handles are pulled, whichever T-handle is pulled last will be armed. When placed to MAIN or RESERVE, it selects the container to be discharged.

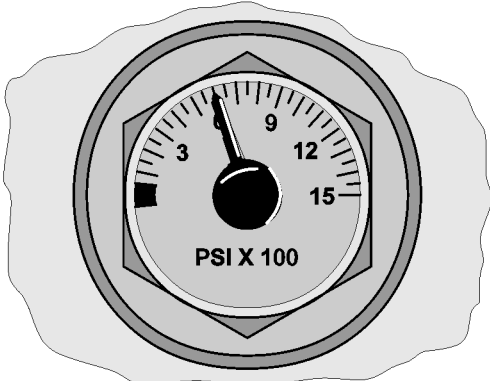


A

DATA PLATE
TEMP. - PRESSURE RANGE

| | | | | | |
|------|-------|-------|------|-------|-------|
| °F | -40 ° | -20 ° | 0° | +20° | +40° |
| PSIG | 292 | 320 | 355 | 396 | 449 |
| | 370 | 400 | 437 | 486 | 540 |
| °F | +60° | +70° | +80° | +100° | +120° |
| PSIG | 518 | 555 | 593 | 670 | 775 |
| | 618 | 660 | 702 | 748 | 885 |

B



NOTE

- GAUGE 0-1500 PSI IN 50 PSI INCREMENTS
- SAME BOTH BOTTLES

SH60B-F048

Figure 2-52. Fire-Extinguishing System (Sheet 1 of 2)

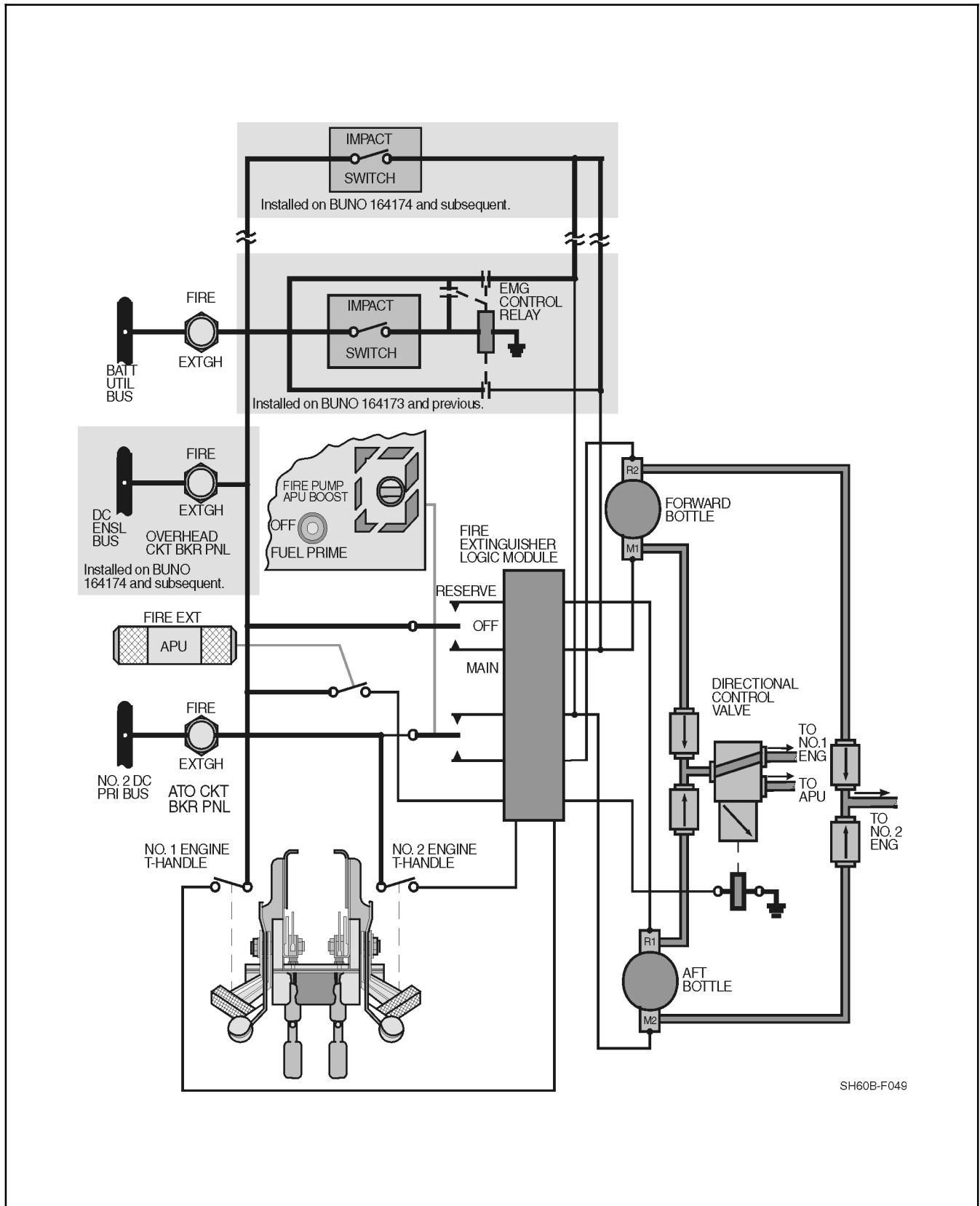


Figure 2-52. Fire-Extinguishing System (Sheet 2)

Note

- On aircraft BuNo 164173 and previous, if the NO. 2 DC primary bus is not energized (no AC power), the reserve position must be used to discharge the agent to the APU or NO. 1 engine compartment. The NO. 2 engine compartment has no fire extinguisher capability without AC power available.
- On aircraft BuNo 164174 and subsequent, if the NO. 2 DC primary bus is not energized (no AC power), the reserve position must be used to discharge the agent to the APU or NO. 1 or NO. 2 engine compartment.

2.15.1 Fire-Extinguishing System, Impact Switch Operation

A multiple-axis impact (10g) sensor ([Figure 2-52](#)), hard mounted to the airframe, will automatically discharge both fire bottles into both engine compartments when it senses crash forces. When the impact switch closes, power from the battery utility bus will be applied to the fire bottles, discharging the extinguishing agent into the NO. 1 and NO. 2 engine compartments. Electrical power for the impact switch is from the battery utility bus through a circuit breaker, marked FIRE EXTGH, on the lower console circuit breaker panel.

2.16 ENTRANCE AND EGRESS

A hinged door is located on each side of the cockpit. The sliding door on the right side of the cabin provides an opening 54 inches high by 44 inches wide. Emergency escape can also be accomplished through jettisonable features, provided on all cockpit and cabin windows.

Each cockpit door is equipped with a jettison system for emergency release of the window. Each window is jettisoned from inside or outside the cockpit by use of a handle marked EMERG EXIT — PULL. To provide emergency exit from the cabin, two jettisonable 24 inch by 24 inch windows are installed, one in the cabin door and the other at the SO station. To release the windows, a handle, marked EMERGENCY EXIT PULL AFT OR FWD, is moved in the direction of the arrow. The windows can then be pushed out. Exterior release of all windows is accomplished by a handle, below the window, marked PUSH TO RELEASE & TURN; Refer to [Chapter 12](#) for additional information.

2.17 ENVIRONMENTAL CONTROL SYSTEM

Cabin, cockpit, nose bay, and transition section environments are controlled by the Environmental Control System (ECS), which provides both heating and air conditioning. The ECS consists of an air-cycle machine (ACM), bleed-air ducting, necessary controls and valves, water separator, distribution system, air inlet, and heat-exchanger exhaust duct. The engines or APU can serve as bleed-air sources for the ECS. Air source selection is accomplished by means of the AIR SOURCE ECS/START switch on the upper console. In the ENG position, engine bleed-air is selected as the air source. In the APU position, APU bleed-air is used as the air source; however, the APU will provide bleed air to the ECS regardless of the AIR SOURCE ECS/START switch position if the APU is on.

With the ECS on and the FLOW switch in NORM, maximum torque available is reduced by 4 percent per engine and fuel flow to each engine will increase by approximately 8 pounds per hour. With the TEMP rotary switch in HOT and OAT below 15 °C, maximum torque available is reduced by 5 percent per engine. With the FLOW switch in HIGH, maximum torque available is reduced by 7 percent per engine and fuel flow increases approximately 12 pounds per hour per engine.

An overpressure switch, within the ECS, senses high air pressure. When an overpressure condition exists, the overpressure switch causes the ECS HI PRESS advisory to appear. System shutdown does not occur during an overpressure; the ECS components are capable of withstanding full bleed-air pressure.

2.17.1 ECS Control Panel

The ECS control panel, located on the lower console, contains three toggle switches and a rotary switch. The MODE toggle switch controls the ECS operating modes. In OFF, the system is secured. In AUTO, the temperature is set

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by the rotary temp switch, which can be dialed to any position between COLD to HOT. In MAN, temperature is set via a toggle switch labeled HOT and COLD, which is spring-loaded to an unlabeled, neutral position. Holding the switch in the HOT or COLD position causes the temperature control valve to move as long as the switch is held. The remaining toggle switch is labeled FLOW. The NORM position should be used for regular heating and cooling functions. The HIGH setting provides an increased volume of air and is used primarily for cooling components and environmental control.

Note

Use of the manual mode of the ECS requires pulsing of the HOT-COLD toggle switch followed by a waiting period to judge the magnitude of temperature change. Excessive manual input may cause ECS shutdown and/or APU failure.

The ECS will automatically shut down under the following conditions:

1. Engine contingency power is selected by either collective CONTGCY PWR switch.
2. NO. 1 or NO. 2 starter is engaged.
3. An ECS heating duct over-temperature exists.

When the AIR SOURCE ECS/START switch is placed to ENGINE, the ECS will also shut down when:

1. Actuation of IRP limiter (839 ± 10 °C).
2. Either ENG ANTI-ICE switch is placed ON.
3. The DE-ICE MASTER switch is placed to AUTO and ice is detected.
4. An ECS underpressure situation exists.

ECS shutdown will be indicated by an ECS SHUTDOWN caution light in all of the above situations except engine start and ECS underpressure.

2.17.2 Avionics Cooling

The total aircraft avionics system requires the dissipation of approximately 12 kilowatts of heat. Units cooled by the external air system are maintained at 15 to 27 °C. Units cooled by ambient cabin air require an ambient temperature below 29 °C.

Two fans provide cooling air for the mission avionics. One fan is located on the right side of the cabin at the base of the mission avionics rack, and the other is located on the left side of the cabin at the base of the SO console. Fan control is provided by the mission power (MSN PWR) switch, located on the center console on the mission systems (MSN SYS) panel (Figure 1-7), and by a 27 °C temperature-sensing switch, located at each fan inlet. When the MSN PWR switch is placed in either PRI or SEC position and the fan inlet temperature is above 27 °C, the fans run to bring in outside air for circulation through the respective avionics areas. Backup cooling for the avionics is provided by the ECS. If the ECS is operating, the modulating valve will automatically go to the full-open position when the temperature switches at the fan inlets sense a temperature of 55 °C or greater. Conditioned cabin air may be circulated through the avionics system by removing the thermal/acoustic panels for backup cooling. Power is supplied from the NO. 1 AC primary bus and NO. 2 AC primary bus through the SO circuit breaker panel (Figure 2-22) by two circuit breakers marked LH RACK BLOWER and RH RACK BLOWER.

2.18 DE-ICE/ANTI-ICE SYSTEMS

2.18.1 DE-ICE MASTER Switch

The DE-ICE MASTER switch is on the overhead console (Figure 1-6). Placing this switch to AUTO with the ENG ANTI-ICE switches, WINDSHIELD ANTI-ICE switches, and the BLADE DE-ICE POWER switch at OFF will automatically turn these systems on when ice accumulation is sensed by the ice detector. Whenever the ice detector

senses ice, the ICE DETECTED caution light will illuminate. Placing the DE-ICE MASTER switch to MANUAL disables the automatic function. In addition, placing the ENG ANTI-ICE switches, WINDSHIELD ANTI-ICE switches, or the BLADE DE-ICE POWER switch to the ON position with the DE-ICE MASTER switch at AUTO, disables the automatic function and the appropriate system will operate continuously.

2.18.2 Engine and Inlet Anti-Ice System

Refer to [paragraph 2.1.8](#).

2.18.3 Rotor Blade De-Ice System

The rotor blade de-ice system ([Figures 2-53, 2-54, 2-55 and 2-56](#)) consists of the following: system control panel, test panel, system controller, power distributor, main and tail slip rings, main and tail blade heating elements, caution lights, outside air temperature (OAT) sensor, a modified ambient sense line and an ice detector/signal converter subsystem.

The blade de-ice system provides controlled electrical power to integral heating elements in the main and tail rotor blades, causing the ice bond layer to weaken, allowing symmetrical ice shedding. The blade de-ice system, excluding an element-on-time (EOT) failure, may be ground-checked with the use of external power. AC power, is supplied through the blade de-ice distributor.

2.18.3.1 BLADE DE-ICE Control Panel

The controls for operating the rotor blade de-ice system are on the BLADE DE-ICE control panel. Controls are described in [Figure 2-54](#).



Leaving the blade DE-ICE power switch in the test position can lead to blade damage.

2.18.3.2 BLADE DE-ICE System Operation

The ice detector, mounted on the NO. 2 engine cowling, senses ice accumulation on a vibrating probe by measuring the change in probe frequency. When the ice detector senses an accumulation of ice, the ICE DETECTED caution will be illuminated. Simultaneously, an aspirator heater on the probe is turned on to heat the probe, shed the accumulated ice and reset it for another cycle. The severity of the icing environment is proportional to the rate at which the probe heater is cycled. If the BLADE DE-ICE POWER switch is turned on after the ICE DETECTED caution is illuminated, the caution will remain illuminated as long as there is ice. The OAT sensor, installed below the windshield, provides a signal to the controller to govern heating element on time (EOT). The lower the OAT the longer EOT will be. With the mode selector switch set to AUTO, the controller processes the ice rate signal to produce heater element-off-time, and the OAT signal to produce the heater EOT.

The controller then sends command signals through the main rotor slip rings to the system distributor. The system distributor then switches power in sequence to the main rotor blade heater zones. To reduce power requirements, the blades are deiced in cycles. Tail rotor blade power is switched directly by the controller and sent through the tail rotor slip rings to the tail rotor blades. A tail rotor blade distributor is not required since the power is applied to the four tail blades simultaneously ([Figure 2-53](#)).

During a single main generator failure, the AC Monitor bus, which contains the Main Rotor Blade De-Ice, will be dropped until the APU is started and the APU generator is placed on, picking up the AC monitor bus.

Droop stop heaters are provided for each of the four rotor head droop stops. The droop stop heaters supply heat to the droop stop pins and cams during icing conditions. The droop stops are continuously heated as long as the blade de-ice control panel power switch is in the POWER ON or TEST position.

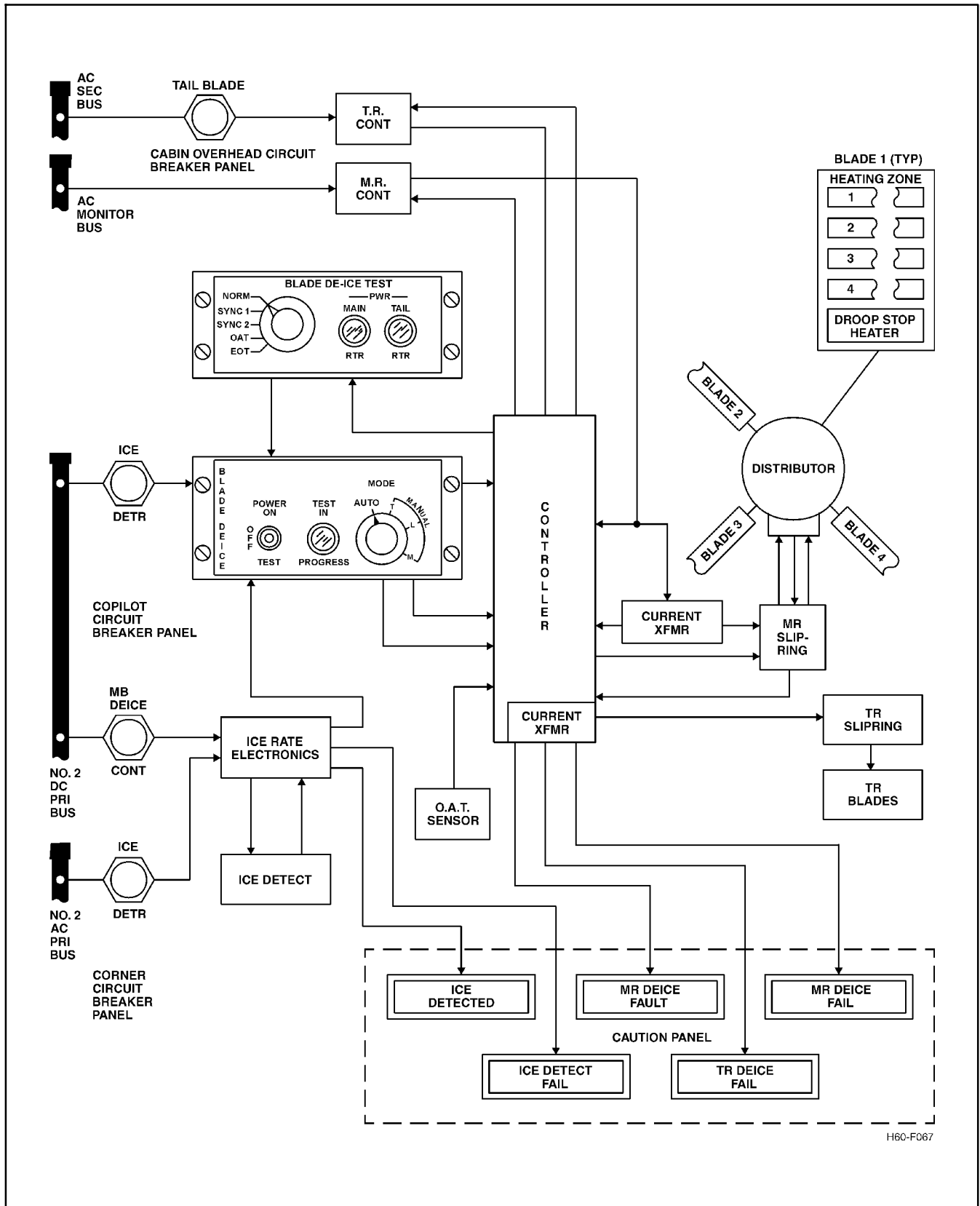


Figure 2-53. Blade De-Ice System Block Diagram

| CONTROL | FUNCTION |
|---|--|
| POWER SWITCH: ON OFF TEST | Turns on power to blade de-ice system. Turns off de-ice system. Electrically tests main and tail rotor de-ice and signal convertor for one test cycle. |
| TEST IN PROGRESS LIGHT | Green light goes on during test cycle. At end of test cycle, light should go off. |
| MODE Selector: AUTO MANUAL T L M | System off-time is controlled by ice rate signal. Gives pilot manual control of system off-time. Trace. Light. Moderate. |

Figure 2-54. Blade De-Ice Control Panel Functions

| CONTROL | FUNCTION |
|--------------------|--|
| NORM | Provides a signal path for normal operation. |
| SYNC 1 | Provides a test signal to verify operation of Main Blade De-Ice synchronization short circuit warning circuitry when POWER switch is at TEST. |
| SYNC 2 | Provides an open circuit to verify operation of Main Blade De-Ice synchronization open circuit warning circuitry when POWER switch is at TEST. |
| OAT | Short circuits the OAT sensor to check that BIT circuit senses a fault when POWER switch is at TEST. |
| EOT | Disables OAT sensor BIT circuits to simulate defects in primary EOT timing circuit, when POWER switch is ON and MODE select switch is at M (MODERATE). |
| PWR MAIN RTR light | Indicates a malfunction has occurred in the main rotor primary power when POWER switch is at OFF or ON. Also indicates test and normal operation when POWER switch is at TEST. |
| PWR TAIL RTR light | Indicates a malfunction has occurred in the tail rotor primary power when POWER switch is at OFF or ON. Also indicates test and normal operation when POWER switch is at TEST. |

Figure 2-55. Blade De-Ice Test Panel Functions

The system control panel contains a rotary switch, which allows automatic or manual control of blade heater off time. In AUTO the ice rate signal is passed onto the controller, which results in off-time variations proportional to the icing rate. In MANUAL, (T, L, or M) fixed signals are transmitted to the controller resulting in fixed off time. One of the three manual modes should be selected when an icing rate system malfunction is indicated by the illumination of the ICE DETECT FAIL caution. The MANUAL mode should also be used when there is no indication of failure, but any of these three conditions has occurred:

1. The pilot has determined by judgment of icing intensity that the ice rate system is inaccurate.
2. Torque required has increased to an unacceptable level.
3. Helicopter vibration has increased to an unacceptable level.

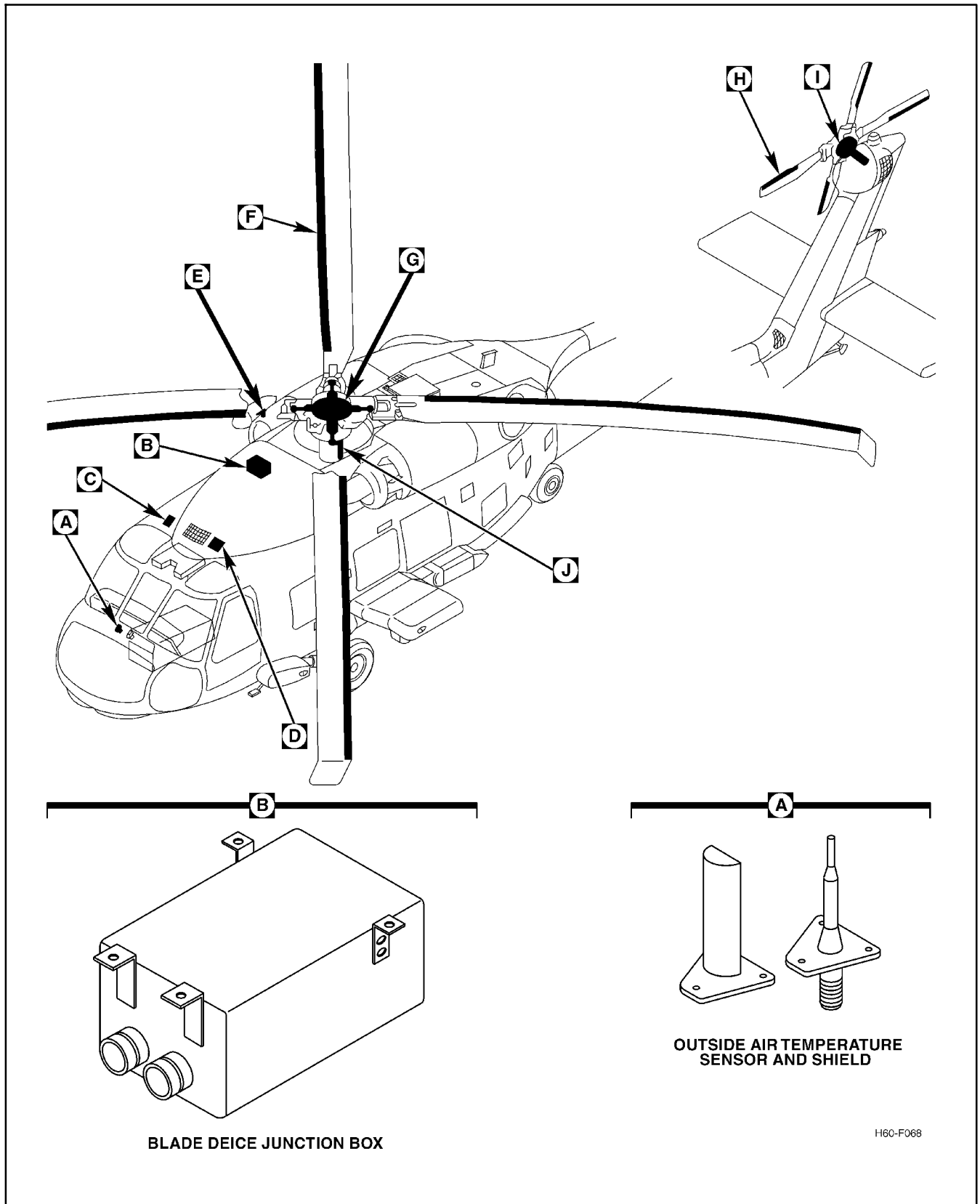
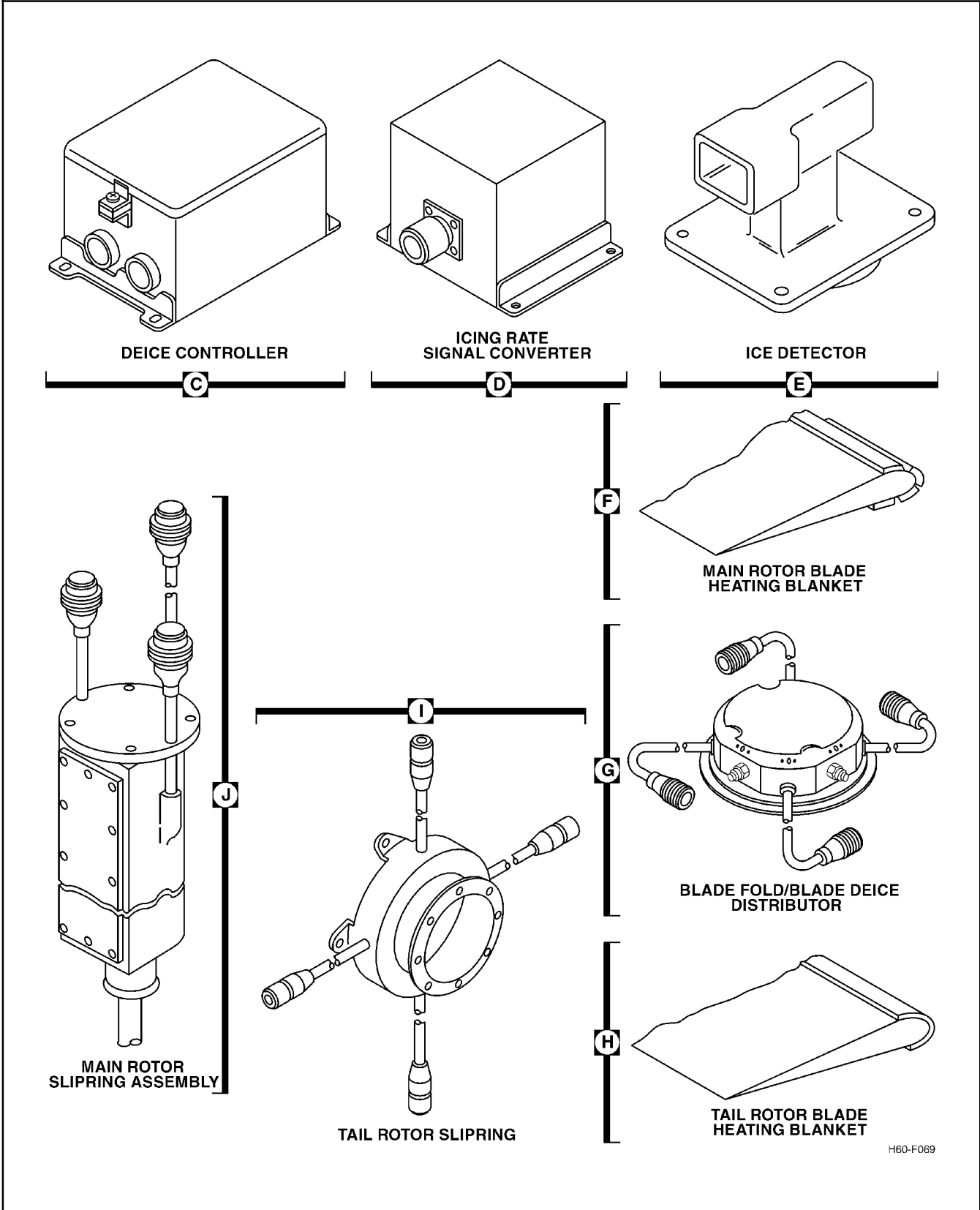


Figure 2-56. Blade De-Ice System (Sheet 1 of 2)



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Figure 2-56. Blade De-Ice System (Sheet 2)

2.18.3.3 BLADE DE-ICE TEST Panel

The control for checking de-ice caution lights and Built-in Test (BIT) circuitry is on the BLADE DE-ICE TEST panel (Figure 2-53). Two amber PWR lights on the panel warn of power malfunctions of the main and tail rotor de-ice system.

2.18.3.4 BLADE DE-ICE TEST System Operation

The BLADE DE-ICE TEST panel allows the pilot to check the blade de-ice system for failures that are otherwise dormant during the normal test mode. The panel accomplishes this by introducing selected failure signals into the system and requiring the de-ice controller BIT circuitry to function in a specific manner. Blade De-Ice Test Panel Functions (Figure 2-55) are contained in Chapter 7.

2.18.4 Windshield Anti-Ice System

The wind-shield anti-ice system is used to prevent ice and fog from forming on the windshields. The pilot and copilot windshields are electrically heated safety glass with heating elements and built-in temperature sensors. Both windshields have their own separate anti-ice system. Each system is operated by a separate switch on the upper console, (Figure 1-6), marked WINDSHIELD ANTI-ICE, and separate anti-ice controllers in the junction boxes. Placing either the COPILOT or the PILOT WINDSHIELD ANTI-ICE switch to the ON position sends power to the windshield-heating elements. Placing the DE-ICE MASTER switch in AUTO will turn both windshield anti-ice systems on, regardless of WINDSHIELD ANTI-ICE switch position, when the ice detector senses ice formation.

2.18.5 Pitot Heater System

Heaters, located in the pitot tubes and static ports keep ice from forming on the tubes and ports and help keep moisture out. The pitot-static heaters are controlled by the PITOT HEAT switch, labeled ON and OFF, located on the upper console. When the PITOT HEAT switch is ON, power is fed to the right and left pitot tube heaters and static ports causing the heaters to go on. When a low-heat or no-heat condition is sensed with the PITOT HEAT switch ON, the RIGHT and/or LEFT PITOT HEAT caution(s) will illuminate.



Pitot heat shall be turned on when visible moisture is present and/or the OAT is 5 °C or below. Failure to turn on pitot heat in these conditions may result in erratic stabilator programming.

Note

Pitot heaters are not to be used to warm flight equipment.

2.18.6 Windshield Wiper and Washer System

2.18.6.1 Windshield Wiper System

The electrically operated windshield wiper system consists of a two-speed motor and a control knob. The rotary-type knob is marked PARK, OFF, LOW, and HI and is located on the overhead console, marked WINDSHIELD WIPER. When the knob is placed in the LOW or HI position, the system is actuated, and the desired speed range is selected. When the knob is placed in the PARK position, the wipers are automatically positioned to the inboard edge of the windshields.



To prevent possible damage to the windshield surface, do not operate the windshield wipers on a dry windshield.

2.18.6.2 Windshield Washer System

The system consists of a reservoir, windshield washer motor, and a control switch. The reservoir, located to the right of the pilot's seat, gravity-feeds the windshield washer motor. The windshield washer motor is controlled by a switch on the overhead console, marked WINDSHIELD WASHER ON and OFF. Placing the switch in the ON position causes the windshield washer motor to pump fluid through the wiper spray bars to the windshield.

2.19 SEATS

2.19.1 Cockpit and Sensor Operator Seats

Each seat is a one-piece aluminum bucket attached to two energy absorption tubes and can be adjusted for leg length and height. Each seat is positioned on a track with the cockpit seat buckets directly above recesses in the cockpit floor. Crash loads are reduced by allowing the seat and occupant to move vertically as a single unit. Occupant restraint is provided by a shoulder harness, lap belts, and a crotch belt.

2.19.1.1 Seat Adjustment

Seat adjustment is controlled by levers on the front of the seat bucket (Figure 2-57). The levers return to the locked position when released. When the levers are pulled forward, the seat can move 5 inches vertically or horizontally and be locked at 1/2 inch intervals. Springs are installed to counterbalance the weight of the seat. The seat is designed to sustain a 14-g deceleration throughout the length of the seat stroke. Length of the stroke is a function of the seat height and at higher seat-height adjustments, higher crash loads can be absorbed.

2.19.1.2 Seat Belts

The seats each contain a shoulder harness, lap belt, and a crotch strap connected to a common buckle assembly. All belts and straps have adjustment fittings. The common attachment buckle has a single-point release. When turned in either direction, it simultaneously releases all belts and straps.

2.19.1.3 Shoulder Harness Lock Lever

A two-position shoulder harness lock lever is on the left side of each seat. When the lever is in the unlocked (rear) position, the dual-shoulder harness will extend 12 inches to allow the occupant to lean forward. The inertia reel will automatically lock if a force of 3 g's is encountered, allowing only harness retraction. When this occurs, the inertia reel lock will prevent further extension until the lever is cycled. When the lever is placed in the locked (forward) position, the reel lock prevents extension of the harness (Figure 2-57).

2.19.2 Sensor Operator Instructor and Passenger Seats

An SO instructor seat is provided for use during training or proficiency check flights. A passenger seat is located against the aft cabin bulkhead. Each seat is a cable-supported, steel-tube assembly with a fire-resistant, high-strength fabric seat and backrest. Each seat has a complete lap belt and dual torso-restraint shoulder harness, attached to a rotary release buckle. The seats are designed to protect the occupant in a crash. This is done by an attenuating system consisting of an energy-absorbing telescopic leg brace, combined with two rotary attenuators on the seat-back support cables.

2.19.3 RMU-42/A — Mobile Aircrew Restraint System

The mobile aircrew restraint system (MARS) in Figure 2-58 is designed to provide in-flight fall protection and prevent ejection of cabin aircrew in survivable crashes while minimizing the strike envelope within the cabin and to improve aircrew mobility while performing mission requirements. The MARS components consist of a webbing retractor assembly, a webbing strap assembly, and a ceiling retaining plate.

The crewmembers aircraft safety belt backstrap, in conjunction with the webbing strap assembly, will provide the crewmember with an approximate 7-foot perimeter when fully extended. The crewmembers aircraft safety belt should be worn over the flight equipment, high up on the chest and should be snug, without discomfort or breathing restriction. Proper wear of the belt will prevent inadvertent release of the latch mechanism and minimize personal injury.

WARNING

- Improper positioning of the crewmembers aircraft safety belt MS16070-21/A when donned could result in personal injury in the event of an aircraft emergency.
- The MARS is not designed to replace a crashworthy seat during controlled takeoff and landing. Always strap into the seat in accordance with current NATOPS procedures.
- Whenever possible, ensure the RMU-42/A retractor is in the locked position when performing the mission, especially when working in close proximity to the main cabin door.

2.20 RESCUE HOIST

The rescue hoist system (Figure 2-59) consists of a hoist assembly, hoist control panel, hover trim control panel, relays, circuit breakers, and necessary electrical wiring. The hoist is hydraulically powered from the backup pump, and its speed is variable from zero to 215 fpm for Breeze Eastern units or zero to 250 fpm for Lucas Western units. It is enclosed in a sheet metal fairing and is supported by a fixed tubular strut enclosed in a fiberglass fairing above the cabin door. The strut is bolted to a support fitting on the fuselage at station 335.75. The hoist and strut can be swung down as a unit, providing clearance for removal of the right engine intake without hoist disconnection or removal. The hoist contains 200 usable feet of cable and has a guillotine-type cable cutter and an automatic cable brake. The first and last 20 feet of the cable are bright orange to warn of end approach. The hoist hook is attached to the cable end by a ball bearing swivel. The hoist assembly comprises a winch, hydraulic drive motor, heat exchanger, fan, and control box.

2.20.1 Rescue Hoist Control Panel

The hoist control panel (Figure 2-59) is on the right side of the cabin, aft of the cabin door. It controls backup power, when needed in an emergency, by means of a BACKUP CONTROL POWER switch which, when pressed, turns on the switch light, indicating that backup control is activated. The hoist is then controllable by the HOIST UP-DOWN control switch only, at a fixed speed of 85 fpm. The hoist control panel also contains a NORMAL POWER light as an indication of power status and a HYD OVERHEAT light to indicate when the hydraulic oil temperature is over 116 °C.

Note

Backlighting for the hoist control panel is controlled by the lower console panel light rheostat.

2.20.2 Hover Trim Control Panel

The hover trim control panel (Figure 2-59) is in the cabin above the hoist control panel. It is used to control the hover position of the helicopter during a rescue operation within prescribed limits by means of a crewman-operated hand grip. This hand grip contains a pressure-activated thumb control for helicopter positioning and an ICS switch. The hand grip also contains a thumbwheel hoist control switch on BuNo 164174 and subsequent to allow coordinated hover positioning, communication, and hoist control from the hand grip. The panel also contains the crewman hoist shear switch, rescue light switch, hover trim light, and a rescue station dome light rheostat.

Note

Backlighting for the hover trim control panel is controlled by the lower console panel light rheostat.

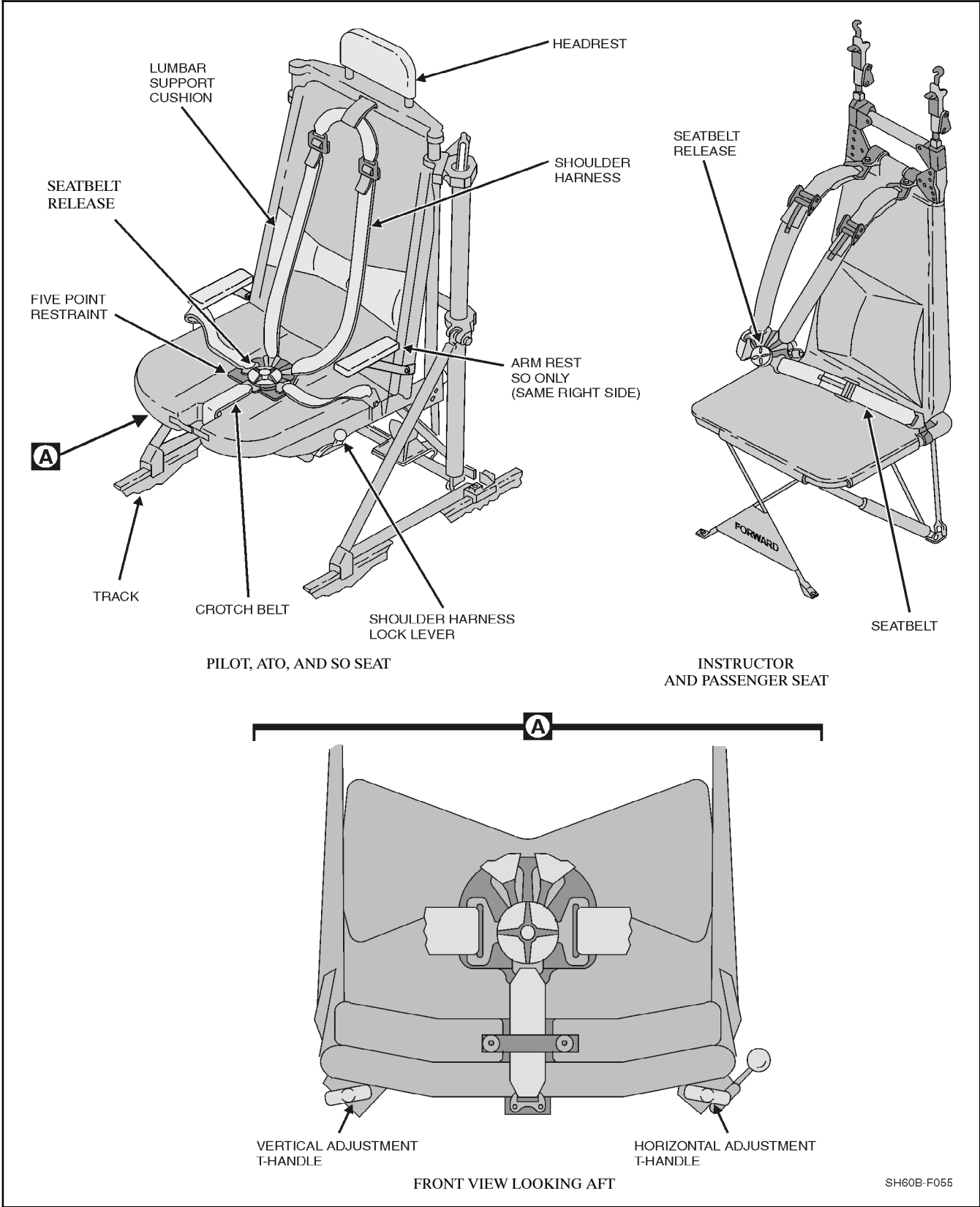


Figure 2-57. Personnel Seats

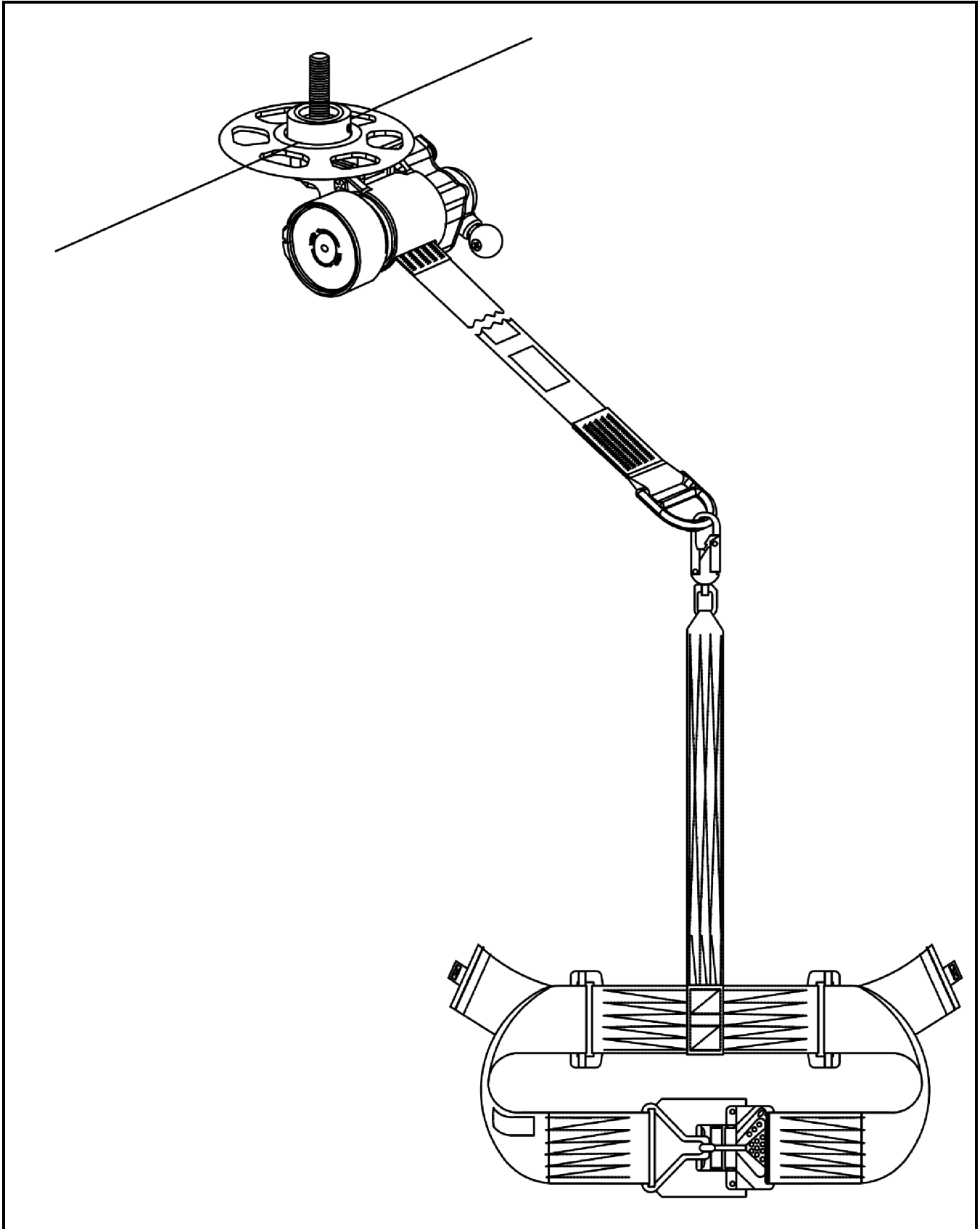


Figure 2-58. Mobile Aircrew Restraint System (MARS)

2.20.3 Hoist Operation

Hydraulic power at a flow rate of 5.5 gpm (normal) and 2,700 psi (minimum) pressure is supplied to the rescue hoist from the utility module via the rescue hoist manifold and pressure/return lines routed within the support strut fairing. The pressure line contains a priority valve that isolates the rescue hoist when hydraulic pressure decreases to 2,050 psi. The return line contains a temperature sensor switch that provides the signal to the HYD OVERHEAT warning light on the hoist control panel. Operation of the rescue hoist is controlled in either of three ways for BuNo 164173 and previous or four ways for BuNo 164174 and subsequent:

Note

- Selecting BACKUP HYD PMP ON with the SACs running will cause a restart of the AOP. The AOP may cause equipment faults to be indicated; however, no damage to equipment occurs, and the faults may be cleared by using CLEAR ALERT CUE or INIT TEST.
- Constant tension should be maintained on the hoist cable to prevent birdcaging.

1. The primary method is from the cabin by means of the crewman pendant.
2. The secondary method is by means of the crewman-operated hand grip (BuNo 164174 and subsequent only).

The pendant contains an ICS switch, a thumbwheel hoist control switch, and a CARGO HOOK RELEASE switch. The hoist can be raised or lowered at any speed up to 215 fpm, from either the hand grip or the pendant, depending on the thumbwheel pressure applied. The hoist control switch is spring loaded to the neutral position.

Note

Aircraft equipped with the Lucas-Western hoist are capable of hoist speeds up to 250 fpm. Lucas-Western hoists can be identified by a completely enclosed hoist cable drum.

3. The tertiary method is from the cockpit by means of the HOIST switches at the top of the pilot and ATO cyclic grips. These switches can raise or lower the hoist at a fixed speed of 100 fpm. When this mode is activated, it will override the primary pendant control of the crewman or the crewman-operated hand grip (BuNo 164174 and subsequent only). The cyclic grips also contain the EMER REL switches to shear the hoist.

Power for primary, secondary, and tertiary modes of operation is provided from the NO. 2 DC primary bus through a circuit breaker marked RESCUE HOIST CONTR on the SO circuit breaker panel and controlled through the RESCUE HOIST switch on the overhead control panel.

4. The quaternary (emergency) method is from the cabin by means of the RESCUE HOIST BACK-UP CONTROL POWER switch and HOIST UP-DOWN switch on the hoist control panel. These respectively provide emergency power and control the direction of the hoist at a fixed speed of 85 fpm. The BACK-UP CONTROL and HOIST UP-DOWN switches operate emergency up, down, and shutoff valves in the hoist, overriding failure or seizure on the normal control switches and normal up, down, and shutoff valves in the hoist.

Power for the backup control mode of operation is provided from the NO. 1 DC primary bus through a circuit breaker marked RESCUE HOIST CONTR on the SO circuit breaker panel.

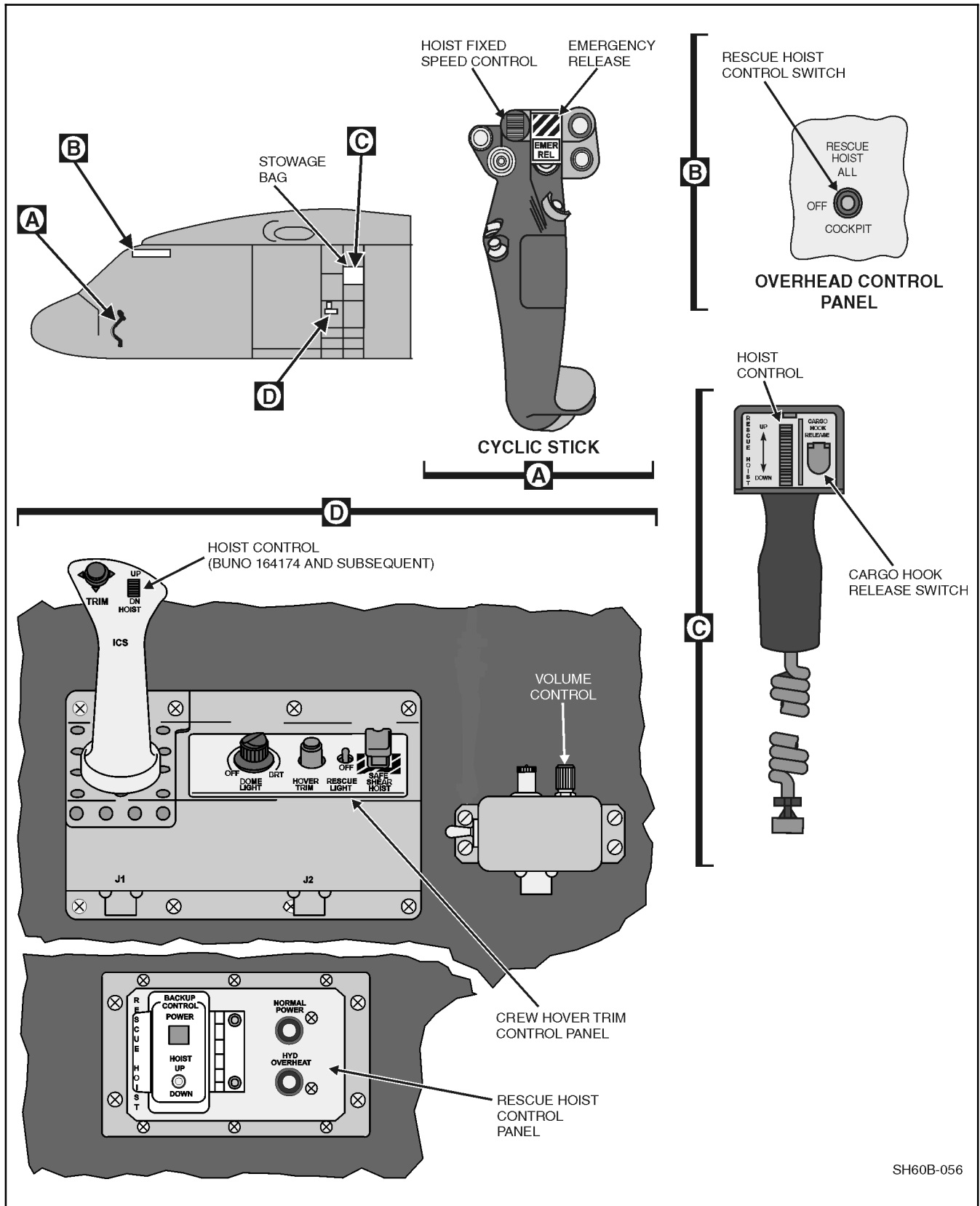
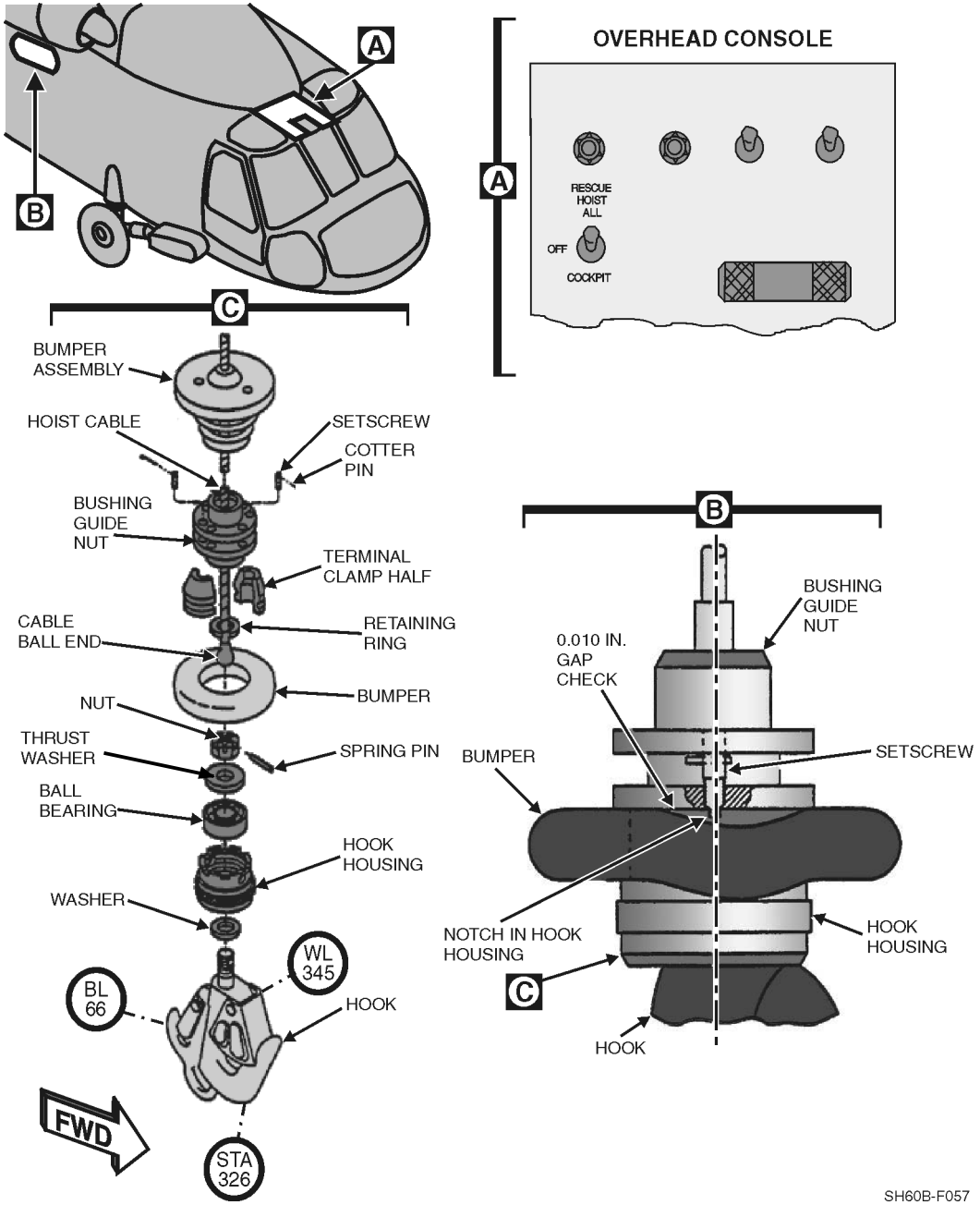


Figure 2-59. Rescue Hoist System (Sheet 1 of 2)



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Figure 2-59. Rescue Hoist System (Sheet 2)

If the overhead control panel RESCUE HOIST switch is OFF, neither the crewman pendant nor the cyclic grip HOIST controls are operative. If the overhead switch is at COCKPIT or ALL, the crewman pendant hoist switch and the cyclic grip hoist control switches are operative. The BACKUP CONTROL POWER switch and HOIST UP-DOWN switches are unaffected by the selection of the overhead control panel switch. When the hoist is being operated by the pendant switch or a cyclic grip switch, the hoist is automatically stopped at the fully up or fully down position by internal limit switches. If the primary down limit switch fails, a second limit switch is activated. Normal operation of the rescue hoist is no longer available. Backup (emergency) operations must be selected to bypass the failed switch. Once the cable has been moved beyond the failed switch, normal hoist operation is available; however, the limit switches are ineffective when the hoist is being operated by the BACKUP HOIST UP-DOWN switch. When the hoist is being raised or lowered at a speed exceeding 50 fpm, it will automatically decelerate to 50 fpm at approximately 10 feet from fully up position, or approximately 5 feet from fully lowered position.



When hoisting in backup control, the upper and lower electrical limit switches are inoperative. Continued operation after the hook is full up can severely damage the hoist. The cable may become disconnected from the cable reel when operating the hoist with the cable in the warning range (painted orange).

2.20.4 Hoist Cable Shear

Hoist cable shearing is by a guillotine cartridge controlled by the rescue hoist shear relay which can be energized either from the cabin HOVER TRIM panel SHEAR switch or the EMER REL switch on top of the pilot and ATO cyclic grips, which energizes the master shear relay when helicopter is airborne. When the helicopter weight is on the wheels, all jettison stations are inoperative. If the overhead RESCUE HOIST control switch is at OFF, neither the hover trim panel SHEAR HOIST switch nor the cyclic grip EMER REL switches are operative. If the RESCUE HOIST control switch is in the COCKPIT position, only the cyclic grip emergency release switches are operative. If the overhead RESCUE HOIST control switch is at ALL, the hover trim panel SHEAR HOIST switch and cyclic grip EMER REL switch are operative. Power is provided from the DC essential bus through a circuit breaker marked EMERG RELEASE HOIST CABLE SHEAR and located on the overhead console circuit breaker panel.



If the MAD, RAST, cargo hook, or rescue hoist are on, then their respective shear circuits are also activated and will fire if the EMER REL switch is depressed.

2.20.5 Hoist Auxiliary Cooling

The hoist assembly has an integral oil cooler in the aft cowling. Air is forced through by an electrically driven fan when hoist power is applied.



Failure to secure the RESCUE HOIST switch when not conducting hoist operations could result in the failure of the rescue hoist auxiliary cooling fan motor.

2.21 CARGO HOOK SYSTEM

The external cargo hook (Figure 2-60) has a rated capacity of 6,000 pounds and has a jaw opening of 2.12 inches. Its location on the bottom fuselage centerline, just aft of the main rotor centerline, was selected to provide ease of accessibility and to minimize aircraft pitch and roll reactions to cargo swing. The hook is installed in a semirigid mounting located in the cargo hook well underneath the cabin floor and below the aircraft center of gravity. When not in use, the hook is stowed horizontally in the well. Primary electrical release controls are provided for the pilot, ATO, and crew operator (Figure 2-60). A mechanical release is provided on the hook for groundcrew operation and is accessible from the cabin for aircrew operation in the event of aircraft electrical malfunction. Emergency release can be initiated from either EMER REL button located on the cyclic grips. When the CARGO HOOK EMER RLSE switch is in the NORM position and the CARGO HOOK SAFE/ARMED switch is ARMED, pressing the EMER REL button applies 28 Vdc to an explosive cartridge in the cargo hook. This causes the lock assembly to open and the weight of the cargo will cause the load arm to open. The lock assembly must be reset manually and a new explosive cartridge must be installed. Power to operate the emergency release system is from the DC essential bus through a circuit breaker, marked EMERG RELEASE CARGO HOOK. The circuit breaker is on the overhead circuit breaker panel.

2.21.1 Cargo Hook Electrical Release

The cargo hook control panel, located on the overhead console (Figure 1-6), consists of an EMER RLSE TEST switch, a TEST light, a CONTROL station selector switch (labeled COCKPIT and ALL), and an ARMING switch (marked SAFE and ARMED). Placing the ARMING switch to the ARMED position provides power to the release circuit and illuminates the HOOK ARMED light on the advisory panel. The pilot and ATO cyclic grip normal release switches will release the load when the CONTROL switch is at COCKPIT or ALL position. The crewman HOOK RELEASE switch, located on the crewman hoist pendant, releases the load when the CONTROL switch is at ALL position. When the load is released, the CARGO HOOK OPEN advisory light goes on. The power for the normal electrical release is supplied by the NO. 2 DC primary bus through two circuit breakers, marked CARGO HOOK PWR and CONTR, located on the SO circuit breaker panel.

2.21.2 Cargo Hook Emergency Release Test

The cargo hook emergency-release circuit tester, located on the overhead console, marked CARGO HOOK EMER RLSE, contains a test indicator and switch (Figure 2-60). The test light, marked TEST, goes on during circuit testing to indicate that the system is functioning properly.

The tester checks the pyrotechnic squib circuitry for an open circuit at the OPEN position and short circuits at the SHORT position. Electrical power is supplied by the DC essential bus through a circuit breaker marked EMERG RELEASE, CARGO HOOK. The circuit breaker is located on the overhead circuit breaker panel.

2.22 EMERGENCY PANEL

The emergency panel (EMER PNL) is located in the center section of the lower console as shown in Figure 2-61. It provides two separate functions. These are:

1. Fuel dump.
2. Stores jettison.

Fuel dump functions are discussed in this chapter and Chapters 12. The stores jettison function provides a single point, all stores release feature. Depressing the ring-guarded pushbutton activates the all stores jettison function. All stores jettison will jettison all stores and cycle the sonobuoy launcher through all tubes launching each sonobuoy/signal underwater sound (SUS) in sequence. Any armed weapon will be set to a safe state prior to jettison. The system does not allow jettison isolation of sonobuoys or weapons pylons. Signal inhibit boxes prevent the jettison of auxiliary fuel tanks when they contain less than approximately 272 pounds of fuel. The jettison operation is completed within four seconds. The stores jettison function is powered by the NO. 1 DC primary bus through a circuit breaker on the ATO circuit breaker panel marked ARMAMENT JETT A and by the NO. 2 DC primary bus through circuit breakers on the ATO circuit breaker panel marked ARMAMENT JETT B and ARMAMENT SYS on aircraft prior to BuNo 162349. Effective on aircraft BuNo 162349 and subsequent, stores jettison is powered by the NO. 1 DC primary bus through circuit breakers marked ARMAMENT JETT A and ARMAMENT JETT C, and by the NO. 2 DC primary bus through circuit breakers marked ARMAMENT JETT B and JETT D on the ATO circuit breaker panel. These circuit breakers provide dual redundancy in the jettison function of each configuration of the aircraft.

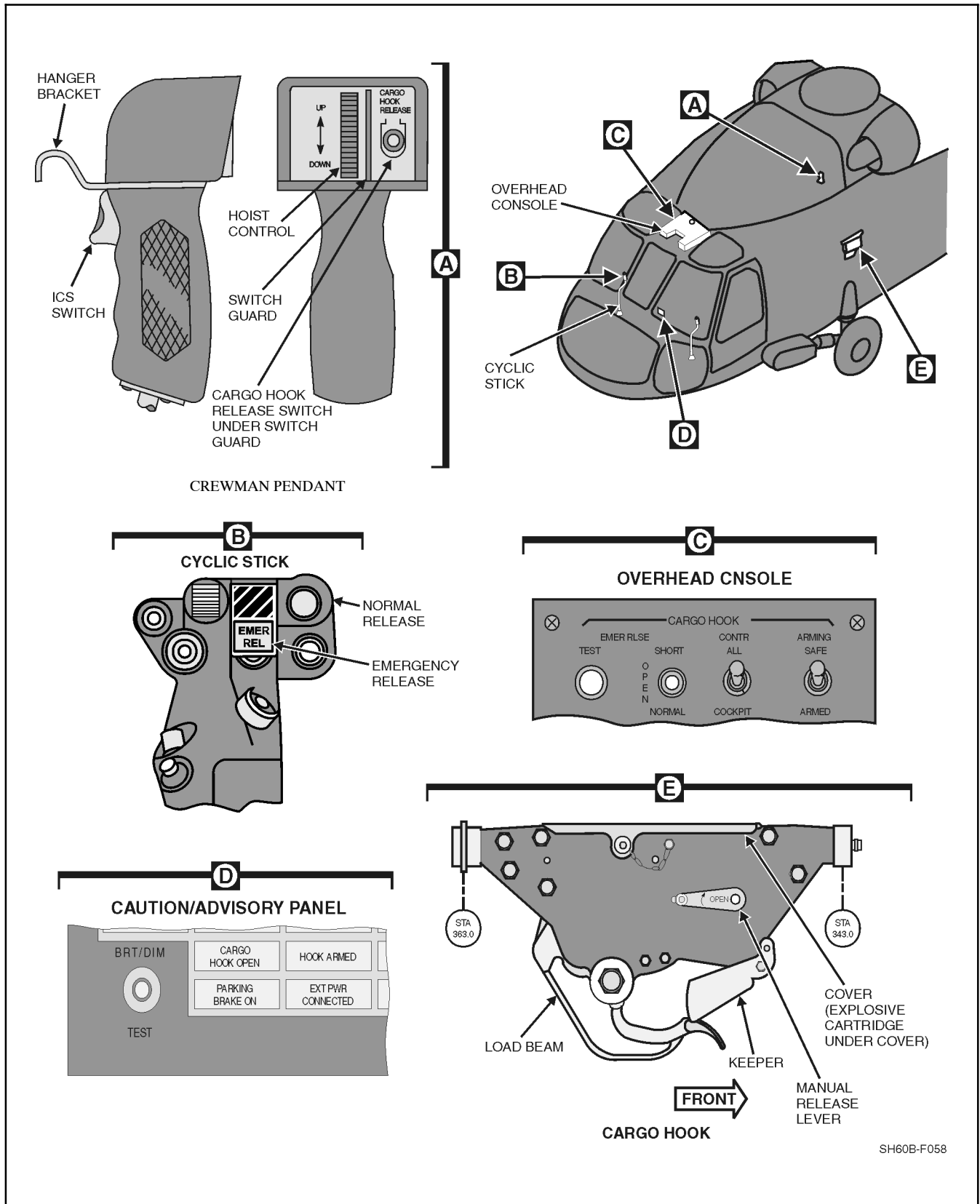


Figure 2-60. Cargo Hook System

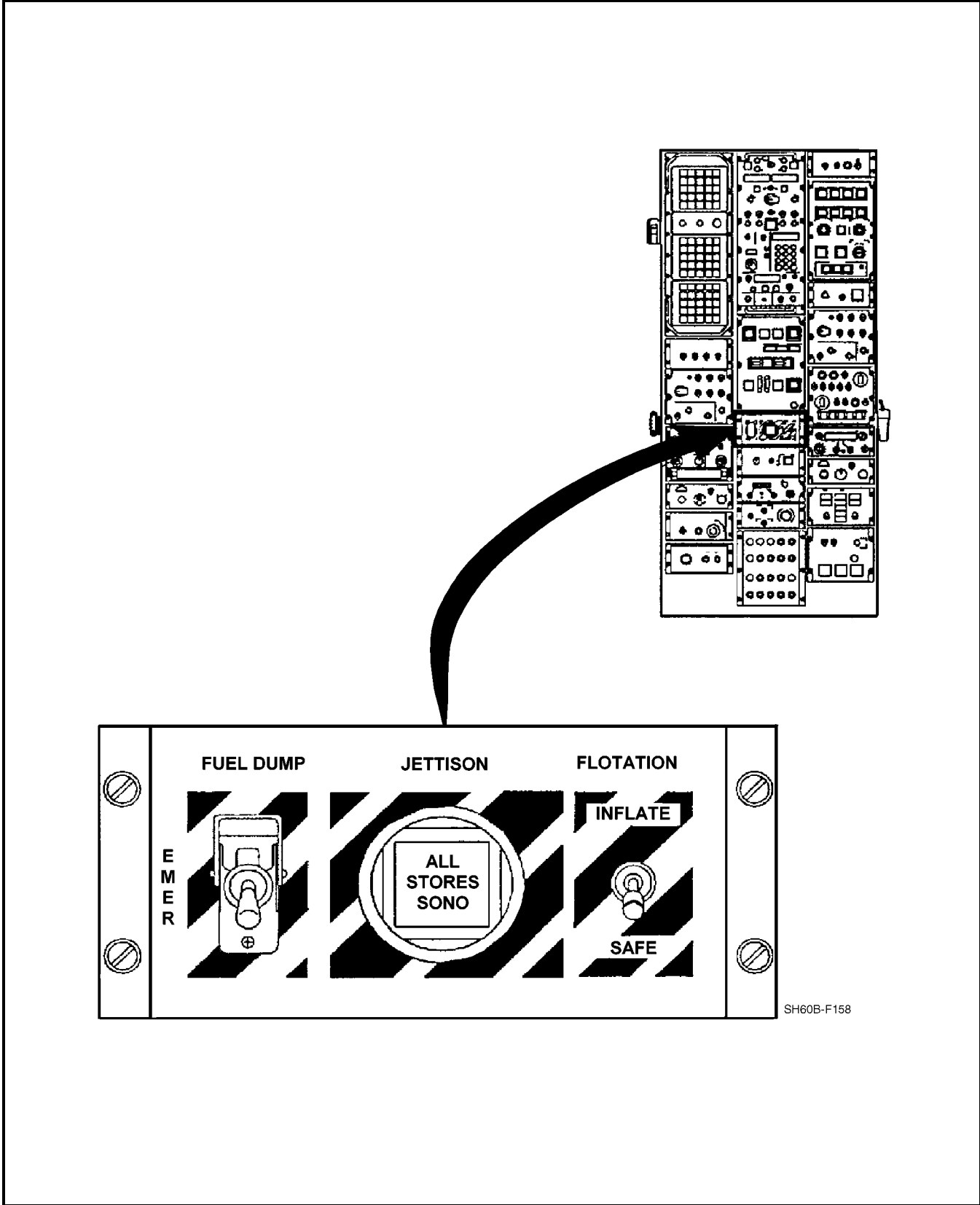


Figure 2-61. Emergency Panel (EMER PNL)

Note

- In the event of a total electrical failure, stores jettison is inoperative.
- If a weapon has been selected and armed, the jettison system will disarm the weapon before it is jettisoned.
- The stores may be emergency jettisoned in flight by the jettison system regardless of the position of the MASTER ARM pushbutton switches. If pressure is less than 900 psi, all sonobuoys may not jettison.
- The ARA controls port forward jettison regardless of ACI station selection. The forward station releases one second after the aft stations. The ARA power utilizes ARMAMENT JETT C and JETT D circuit breakers. ARMAMENT JETT A and ARMAMENT JETT B support ASDC jettison of aft stations and sonobuoys.
- The ARA supplies LK/UL status to the ACI.
- The ARA provides default locking of unselected port stations and simultaneous nose-tail arming for selected portside stations.

2.23 SURVIVAL AND EMERGENCY EQUIPMENT

2.23.1 Survival Equipment

Flight personnel shall be familiar with and utilize those items of flight clothing and survival and rescue equipment as prescribed in the current NATOPS General Flight and Operating Instructions (OPNAVINST 3710.7 series). In addition, the pilot in command of an aircraft engaged in carrying crewmen or passengers shall ensure their compliance with this instruction.

2.23.2 Emergency Equipment

Emergency equipment (Figure 2-62) includes two portable fire extinguishers, two first aid kits, a crash ax, two water canteens, and an emergency locator transmitter (ELT).

2.23.2.1 Emergency Locator Transmitter Systems

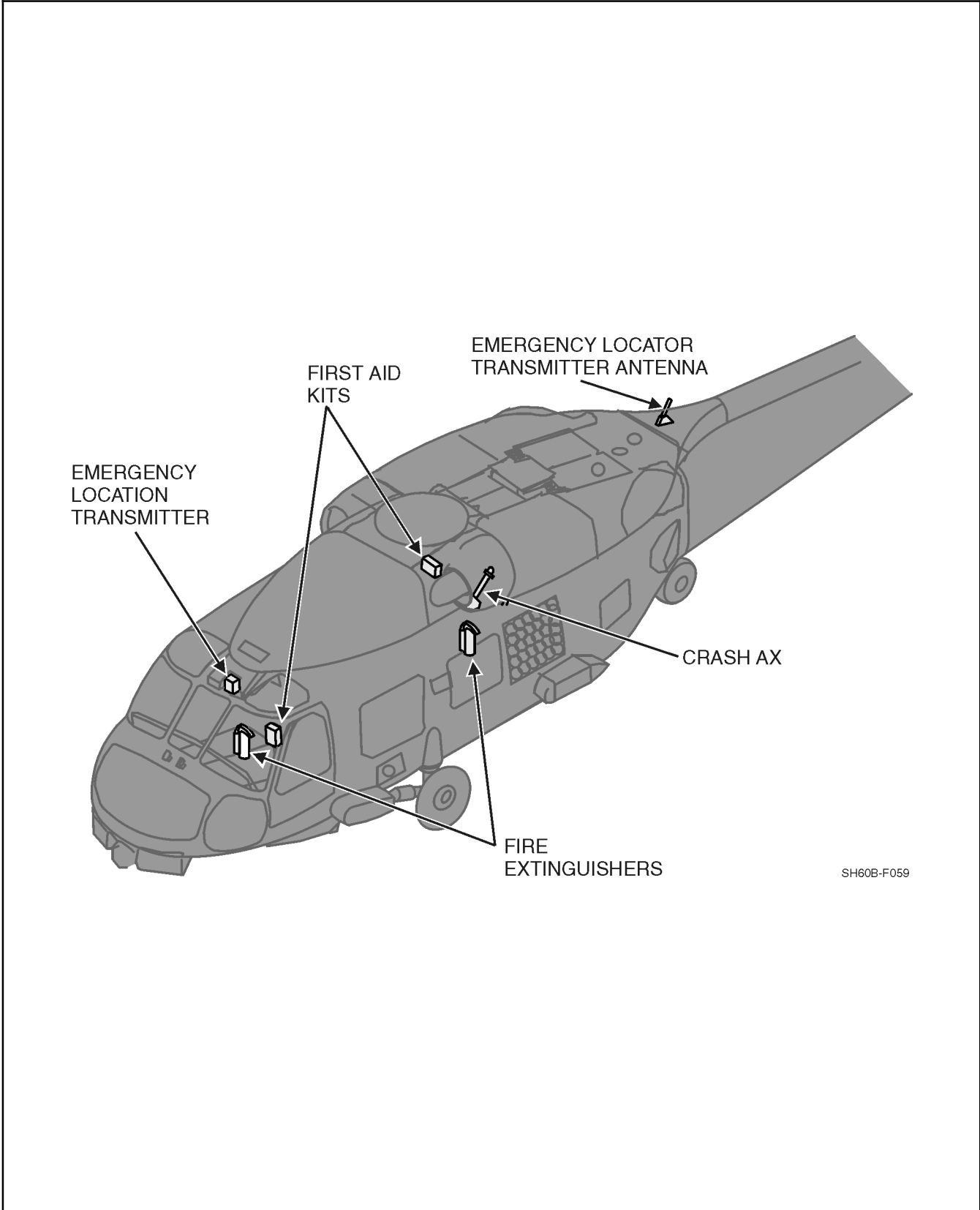
The Emergency Locator Transmitter (ELT) System consists of a transmitter (portable) and two antennas (one portable, collapsible, vertical monopole antenna and one monopole antenna with an interconnecting coaxial cable for aircraft antenna feed). The transmitter is mounted on the control-enclosure bulkhead behind the pilot seat. The transmitter is normally connected to the antenna in the transition section via the coaxial cable, but the collapsible antenna may be connected for portability. The transmitter is a self-contained, dry-cell, battery-operated unit. When turned on by an ON-OFF-ARM switch, it simultaneously transmits a distress signal on the international distress frequencies of 121.5 MHz and 243.0 MHz. The distress signal may travel as far as 100 miles, at a search altitude of approximately 10,000 feet. When the selector switch is placed to ARM, the transmitter will automatically activate upon a forward impact force of 5 g's. With the switch ON, the transmitter is activated. The signal emitted by the transmitter, when activated, is a tone that varies from 1,600 Hz to 300 Hz, at a rate of 2 to 3 times per second.

Testing of the transmitter is done by on-the-air operation in one of the two following methods:

1. A test may be made with a control tower after receiving permission to activate the transmitter. Placing the selector switch ON for not more than 5 seconds is enough to check operation. The tower will confirm transmitter operation.
2. A test may also be made with an onboard UHF or VHF radio monitoring GUARD frequency. The selector switch is placed to ON for 2 to 5 seconds and the radio receiver will confirm locator transmitter operations. The selector switch shall be returned to ARM if the operational check was satisfactory.

Note

On-air operational checks are to be done as quickly as possible, between on-the-hour and 5 minutes after-the-hour and for not more than 5 seconds.



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Figure 2-62. Emergency Equipment Location

2.23.2.2 Helicopter Emergency Egress Lighting System

The HEELS automatically provides emergency lighting of the cabin door and SO window (Figure 2-63). The system consists of four light tube assemblies, two control unit assemblies, one control panel, a signal conditioner, and an additional N_r sensor located on the left-hand accessory module. The SO window has one 5 foot light tube strip forming an inverted U over the window. The cabin door has three 30-inch light tube assemblies mounted on the sound-proofing arranged around the cabin door as an inverted U.

There are two control units, each containing a battery pack, a test switch, and an indicator light. One control unit is for the cabin door, and the other is for the SO window. The test switch tests the battery. The battery pack provides power to light the tubes during emergency operation. When activated, the batteries should illuminate the tubes for approximately 10 minutes.



HEELS is intended for emergency operation only and shall not be used for nonemergency lighting.

The arm switch located on the SO utility light panel allows for remote testing and arming of the HEELS. The test switch is a momentary position switch used in conjunction with the arm switch for preflight testing of the HEELS (Figure 2-63).

To test the control units, depress the test switch located on each unit for a minimum of 6 seconds. The green LED next to the test switch will illuminate and maintain intensity as long as the switch is depressed. If the light dims or does not illuminate, the batteries should be replaced.

The light assemblies are powered by two control units. The control units are activated by loss of an inhibit signal received from the rotor head speed signal conditioner (total loss of AC power or a drop of rotor N_r below 80 percent).

The system is powered by the NO. 1 DC primary bus 28 Vdc through a circuit breaker on the SO circuit breaker panel marked HEELS. Anytime the HEELS system is armed, the control units batteries are being charged.

2.23.2.3 Advanced Helicopter Emergency Egress Lighting System

Advanced Helicopter Emergency Egress Lighting System (ADHEELS) automatically provides emergency lighting of the cabin door and SO window. The system consists of 3 fiber light assemblies, a control module, remote test assembly, and a crash/inversion sensor. The cabin door control module and crash/inversion sensor are located aft of the rescue station. The SO window control module and crash/inversion sensor are located forward of the SO window.

ADHEELS operates independently of aircraft power and is activated when any of the following is detected by the crash/inversion sensor:

1. Water immersion.
2. Impact force of 11-13 g's or greater.
3. Attitude changes of $100 \pm 5^\circ$ or greater.

When one of the above conditions is met, the control module activates the fiber light assembly, which will remain illuminated for a minimum of 45 minutes. The ADHEELS system, when inadvertently activated, can be reset by momentarily depressing the remote test switch.

The remote test switch, when pressed and held in the down position, will perform the system built-in test function and the light strip assembly will illuminate within 6 seconds. The test switch automatically resets the system when released.

2.23.2.4 Individual Helicopter Emergency Egress Lighting System

Individual Helicopter Emergency Egress Lighting System (IHEELS) automatically provides emergency lighting of both the cabin door window and the SO window jettison handles. Each system consists of a light strip containing

the inversion sensor and a circuit module which contains the battery pack and the immersion contacts. Each light strip is powered by a battery and activated independently. Activation occurs when the inversion sensor detects one to the following:

1. Water immersion
2. Attitude changes of $100 \pm 5^\circ$ or greater.

When the test button is pressed, a brief flash of the light strip assembly indicates a successful system test. Both the test and reset buttons must be depressed with a pen-like object. Since a time delay inhibit is built into the system test circuitry, the operator must wait 5 minutes before performing an additional test.

2.24 MISCELLANEOUS EQUIPMENT

2.24.1 Rearview Mirrors

External rearview mirrors are installed on either side of the cockpit. The mirror permits the pilot to observe the MAD towed body deployment, recovery/docking, and hoist operations, and the ATO to observe sonobuoy deployment.

2.24.2 Drinking Water Container

Two standard water canteens are provided; one is located in the cockpit on the left side of the center console and another canteen is located on the port cabin bulkhead.

2.24.3 Crewman Safety Belt Anchor Points

The three crewman safety belt anchor points are located in the cabin overhead. One is above the SO seat and two are aft at the rescue seat attachment points.

WARNING

Crewman safety belts do not provide impact protection; therefore, use of those belts shall be restricted to only those occurrences when mission accomplishment requires persons to be out of their seats. Such belts shall not be worn when strapped into a seat.

2.24.4 Litter Installation Equipment

Litter installation equipment is located aft of the SO seat, under the sonobuoy launcher. It provides the necessary means to secure a litter for transportation of an injured person. The equipment includes the litter support assembly, the litter tiedown strap assembly, and the rescue equipment net assembly.

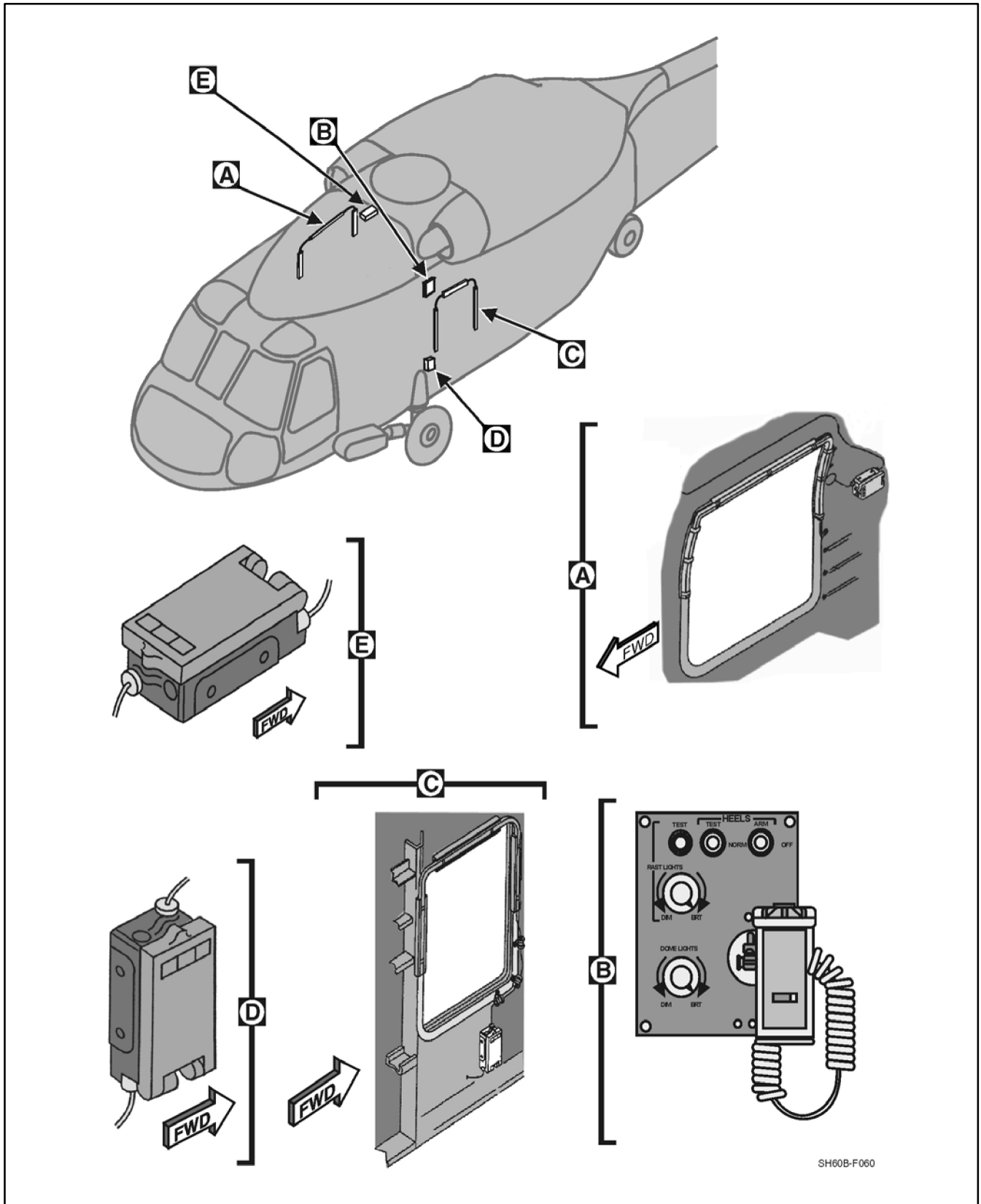


Figure 2-63. HEELS Equipment

CHAPTER 3

Servicing and Handling

3.1 SERVICING DATA

Servicing information is given by systems or components. Points used in frequent servicing and replenishment of fuel, oil, and hydraulic fluid are shown in [Figure 3-1](#). A listing of acceptable commercial and foreign fuel is shown in [Figure 3-2](#). Fuel and lubricant specifications and capacities are shown in [Figure 3-3](#).

All PQMs and aircrewmembers qualified in model are authorized to perform servicing and handling of the aircraft when qualified maintenance personnel are not available. All ground/taxi hand signals shall be in accordance with NAVAIR 00-80T-113.

3.2 FUEL SYSTEM SERVICING

Fueling equipment shall be operated only by qualified and authorized personnel. Using loose pyrotechnics, smoking, striking matches, working on aircraft, or using any device producing flame within 50 feet of the helicopter is strictly prohibited. The helicopter should not be parked in the vicinity of possible sources of ignition such as blasting, drilling, or welding operations. A minimum of 50 feet should be maintained from other aircraft or structures, and 75 feet should be maintained from any operating radar set. When the aircraft is being refueled, a check shall be made to ensure no electrical extension cords, droplights, floodlights, etc. are in or near the helicopter. Flashlights shall be used in place of helicopter landing/flood lights for night fueling operations. During all fueling operations, fire extinguishing equipment shall be readily available. Electrical power will have to be applied to the helicopter to obtain the fuel quantity gauge readings.

WARNING

- Flameouts may be encountered on the ground and in flight at certain fuel temperatures when restricted fuels JP-4 or JET B are used. Nose pitch attitudes, roll attitudes, and low power operations all contribute to the formation of vapor bubbles in the fuel lines of SH-60B aircraft due to fuel boost limitations. Prolonged on-deck operations such as refueling contribute significantly to this problem when using JP-4/JET B at any altitude.
- If JP-4 is used, the following operational restrictions apply: All takeoffs shall stabilize in a hover with no fuel pressure caution lights for a minimum of 10 seconds before commencing transition to forward flight. Single-engine training operations shall not be conducted while using JP-4/JET B.
- Due to the vapor qualities of mixed JP-4/JET B and JP-5/JET A, the next two refuelings with JP-5 or JET A shall be treated as if it were JP-4/JET B, that is, the same operational restrictions apply as for JP-4/JET B.

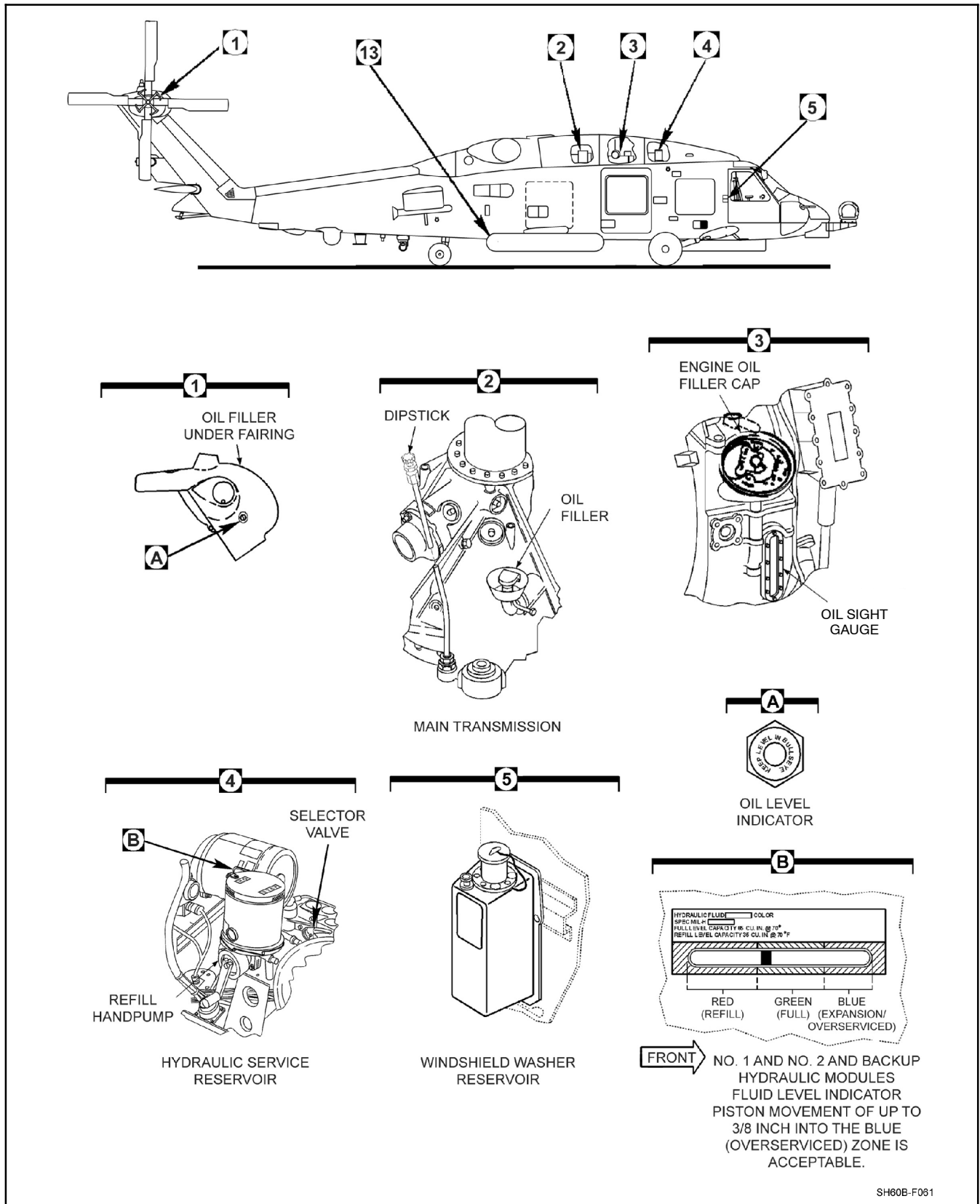


Figure 3-1. Aircraft Servicing (Sheet 1 of 3)

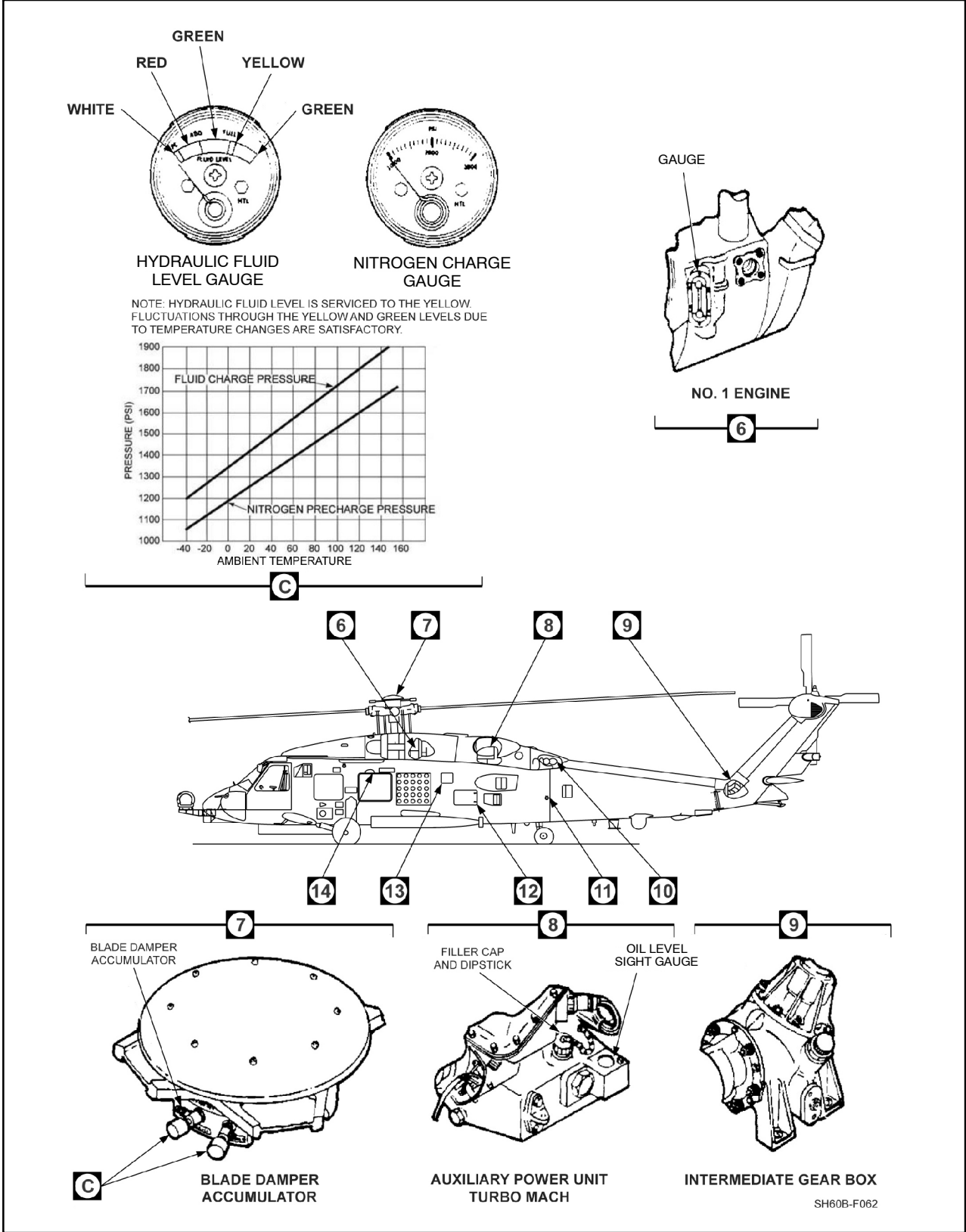


Figure 3-1. Aircraft Servicing (Sheet 2)

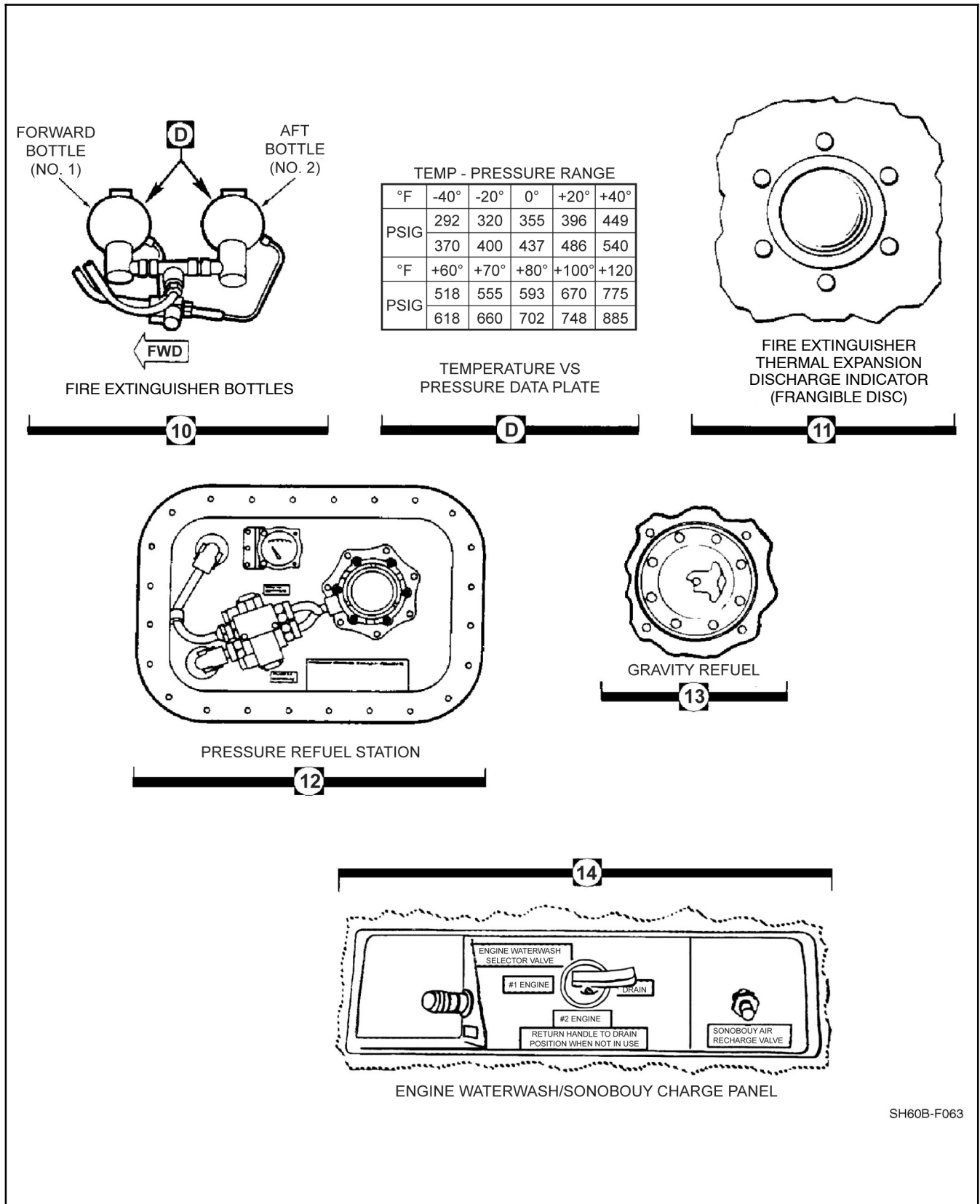


Figure 3-1. Aircraft Servicing (Sheet 3)

| | US MIL CODE | NATO CODE | US MILITARY SPECIFICATION | COMMERCIAL DESIGNATION (SPECIFICATION) | BRITISH DESIGNATION (SPECIFICATION) | WT (lbs/gal) | COMMENTS |
|------------------|-------------|-----------|---------------------------|--|--------------------------------------|--------------|-------------------|
| PRIMARY FUELS | JP-5 | F-44 | MIL-DTL-5624 | NONE | DEF STAN 91-86 (AVCAT/FSII) | 6.8 | 1A, 2 |
| | JP-8 | F-34 | MIL-DTL-83133 | | DEF STAN 91-87 (AVTUR/FSII) | 6.7 | 1A, 2, 5 |
| | NONE | F-35 | MIL-DTL-83133 | JET A-1 (ASTM D-1655) | DEF STAN 91-91 (AVTUR) | 6.7 | 1A, 3, 4, 5 |
| | NONE | NONE | NONE | JET A-1 (ASTM D-1655) | NONE | 6.7 | 1A, 3, 4, 5 |
| | NONE | NONE | NONE | GOST 10227 GRADE TS-1 | NONE | 6.7 | 1A, 3, 4, 5, 6 |
| RESTRICTED FUELS | JP-4 | F-40 | MIL-DTL-5624 | JET B (ASTM D-6615) | DEF STAN 91-88 (AVTAG/FSII) | 6.5 | 1B, 3, 4, 5, 7, 8 |
| EMERGENCY FUELS | JP-8 +100 | F-37 | MIL-DTL-83133 | NONE | DEF STAN 91-87 (AVTUR/FSII + S-1749) | 6.7 | 1C, 2, 5, 9, 10 |

WARNING

IN ORDER TO ENSURE THAT A HELICOPTER CAN BE SAFELY HANGARED ABOARD SHIP, THE HELICOPTER SHOULD BE FUELED WITH JP-5 (F-44) PRIOR TO FLYING ABOARD A SHIP. WHEN FUELING WITH JP-5 IS NOT POSSIBLE, HELICOPTERS SHALL NOT BE HANGARED UNTIL THE FLASHPOINT OF THE FUEL IN THE HELICOPTER FUEL TANKS IS ABOVE 120 °F.

NOTE

- FOR PLANNING PURPOSES, A FUEL MIXTURE OF 70% JP-5 (F-44) AND 30% JP-8 (F-34) OR JET A-1 (F-35) WILL ENSURE THAT THE MINIMUM FLASHPOINT OF THE FUEL MIXTURE IS ABOVE 120 °F.
- SHIP'S FUEL PERSONNEL HAVE TEST EQUIPMENT FOR MEASURING FUEL FLASHPOINT. FIGURE 4 OF MIL-HDBK-844A(AS) (AIRCRAFT REFUELING HANDBOOK FOR NAVY/MARINE CORPS AIRCRAFT) CAN BE USED WITH THE MEASURED FLASHPOINT TO DETERMINE MORE ACCURATELY THE PERCENTAGE OF JP-5 (F-44) REQUIRED TO RAISE THE FLASHPOINT OF JP-8 (F-34) OR JET A-1 (F-35) ABOVE 120 °F.
- NAVAIR 00-80T-109 (AIRCRAFT REFUELING NATOPS MANUAL) CONTAINS PROCEDURES THAT MUST BE FOLLOWED WHEN HANGARING HELICOPTERS CONTAINING FUEL OTHER THAN JP-5 (F-44).
- PILOTS/AIRCREW SHALL ENSURE THAT AIRCRAFT MAINTENANCE DEPARTMENTS ARE INFORMED WHEN AIRCRAFT ARE FUELED WITH THE EMERGENCY FUEL JP-8+100 (F-37).
- NAVAIR 00-80T-109 (AIRCRAFT REFUELING NATOPS MANUAL) CONTAINS SPECIAL PROCEDURES THAT MUST BE FOLLOWED WHEN IT BECOMES NECESSARY TO DEFUEL AIRCRAFT THAT HAVE BEEN FUELED WITH THE EMERGENCY FUEL JP-8+100 (F-37). SINCE THERE IS NO VIABLE FIELD TEST THAT CAN DETECT THE PRESENCE OF JP-8+100 (F-37), PILOTS/AIRCREW AND AIRCRAFT MAINTENANCE PERSONNEL SHALL ENSURE THAT FUELS PERSONNEL ARE INFORMED OF AIRCRAFT THAT HAVE BEEN FUELED WITH THE EMERGENCY FUEL JP-8+100 (F-37).

Figure 3-2. H-60 Series Common Fuel Reference Chart (Sheet 1 of 2)

COMMENTS


1. FUEL DEFINITIONS:
 - a. PRIMARY FUEL - A FUEL THAT THE AIRCRAFT IS AUTHORIZED TO USE FOR CONTINUOUS UNRESTRICTED OPERATIONS.
 - b. RESTRICTED FUEL - A FUEL WHICH IMPOSES OPERATIONAL RESTRICTIONS ON THE AIRCRAFT. THESE FUELS MAY BE USED ONLY IF NO PRIMARY MILITARY OR COMMERCIAL FUELS ARE AVAILABLE.
 - c. EMERGENCY FUEL - A FUEL WHICH MAY BE USED FOR A MINIMUM TIME WHEN A PRIMARY FUEL IS NOT AVAILABLE AND AN URGENT NEED EXISTS (SUCH AS HURRICANE EVACUATION OR URGENT MILITARY NECESSITY). PILOT APPROVAL SHALL BE OBTAINED BEFORE SERVICING AND THE AIRCRAFT SHALL BE CONSPICUOUSLY PLACARDED WITH THE EMERGENCY FUEL GRADE WHEN SERVICED.
2. ALL US MILITARY AND NATO FUELS, EXCEPT F-35, CONTAIN AN ADDITIVE PACKAGE WHICH INCLUDES FUEL SYSTEM ICING INHIBITOR (FSII).
3. COMMERCIAL FUELS ARE AVAILABLE WITH AND WITHOUT FSII.
4. PRIST. A COMMERCIAL FSII ADDITIVE, PRIST, MAY BE USED WITH COMMERCIAL JET FUEL (JET A/JET A-1/JET B). PRIST IS EQUIVALENT TO THE MILITARY FSII ADDITIVE. IT IS AVAILABLE IN TWO FORMS: (1) AEROSOL CANS WHICH ARE DISCHARGED INTO THE FUEL AS IT IS PUMPED INTO THE AIRCRAFT AND (2) PREMIXED INTO THE FUEL. WHEN PRIST IS PREMIXED WITH THE FUEL IT PROVIDES ANTI-ICING PROTECTION EQUIVALENT TO THAT PROVIDED BY MILITARY JET FUEL AND IS AUTHORIZED FOR USE. PRIST IN AEROSOL CANS IS NOT AUTHORIZED FOR USE SINCE IT DOES NOT MIX WELL WITH FUEL, HAS A TENDENCY TO SETTLE TO THE BOTTOM OF FUEL TANKS, AND MAY DAMAGE FUEL SYSTEM SEALS AND FUEL TANK MATERIALS.
5. JP-4, JP-8, TS-1, JP-8+100 AND ALL COMMERCIAL JET FUELS SHALL NOT BE DEFUELED INTO SHIPBOARD JP-5 FUEL STORAGE TANKS BECAUSE THE FLASH POINT OF THESE FUELS IS LESS THAN 140 °F.
6. TS-1 IS A COMMERCIAL AVIATION KEROSENE MADE TO THE RUSSIAN FUEL SPECIFICATION GOST 10227. IT IS VERY SIMILAR TO ASTM JET A-1 WITH THE EXCEPTION THAT THE FLASH POINT IS APPROXIMATELY 20 °C LOWER THAN JET A-1. THIS FUEL IS COMMONLY AVAILABLE IN RUSSIA, PARTS OF CENTRAL EUROPE, THE CENTRAL ASIAN REPUBLICS AND AFGHANISTAN.
7. JP-4 (F-40) HAS BEEN REPLACED BY JP-8 (F-34) IN US AND NATO SERVICE. JP-4 (F-40) AND JET B ARE NO LONGER WIDELY AVAILABLE WORLDWIDE BUT MAY STILL BE ENCOUNTERED IN SOME AREAS.
8. SEE SPECIFIC T/M/S NATOPS MANUALS FOR RESTRICTIONS APPLICABLE TO THE USE OF JP-4 (F-40)/JET B.
9. JP-8+100 (F-37) CONTAINS A THERMAL STABILITY ADDITIVE THAT AFFECTS THE ABILITY OF THE COALESCING FILTER-SEPARATORS AND CENTRIFUGAL PURIFIERS (FILTRATION EQUIPMENT USED IN SHORE STATION AND SHIPBOARD FUEL STORAGE/HANDLING SYSTEMS) TO REMOVE FREE WATER AND FINE PARTICULATE MATTER FROM FUEL. NAVAIR 00-80T-109 (AIRCRAFT REFUELING NATOPS MANUAL) CONTAINS ADDITIONAL INFORMATION ON JP-8+100 (F-37).
10. NO USN/USMC AIRCRAFT ENGINES REQUIRE THE USE OF JP-8+100 (F-37). USN/USMC AIRCRAFT ARE NOT AUTHORIZED TO USE JP-8+100 (F-37) EXCEPT IN EMERGENCY SITUATIONS.

FOR ADDITIONAL INFORMATION ON AVIATION FUELS, CONSULT THE FOLLOWING:

1. NAVAIR 00-80T-109, AIRCRAFT REFUELING NATOPS MANUAL.
2. MIL-HDBK-844A (AS), REFUELING HANDBOOK FOR NAVY/MARINE CORPS AIRCRAFT.

Figure 3-2. H-60 Series Common Fuel Reference Chart (Sheet 2)

| | | PRIMARY PRODUCT | | ACCEPTABLE SUBSTITUTE | |
|----------------------|------------------|-----------------|-----------|------------------------------|-----------|
| SYSTEM | CAPACITY | MIL SPEC | NATO CODE | MIL SPEC | NATO CODE |
| ENGINE OIL | 7.3 U.S. QUARTS | MIL PRF 23699 | O-156 | MIL PRF 7808 (Notes 1, 2) | O-148 |
| APU | 2.0 U.S. QUARTS | MIL PRF 23699 | O-156 | None | None |
| MAIN TRANSMISSION | 7.5 U.S. GALLONS | DOD PRF 85734 | None | None | None |
| INTERMEDIATE GEARBOX | 2.75 U.S. PINTS | DOD PRF 85734 | None | None | None |
| TAIL GEARBOX | 2.75 U.S. PINTS | DOD PRF 85734 | None | None | None |
| HYDRAULIC RESERVOIRS | 1.0 U.S. QUART | MIL PRF 83282 | H 537 | None | None |
| RESCUE HOIST | 1.16 U.S. QUARTS | MIL PRF 23699 | O-156 | None | None |
| ENGINE STARTER | 200 cc | MIL PRF 23699 | O-156 | None | None |



CAUTION

The engine shall be drained and flushed when changing from MIL-PRF-23699 to MIL-PRF-7808 prior to operations in ambient temperatures below -40 °C.

Notes:

1. When starting in ambient temperatures of -40 °C or below, lubricating oil MIL-PRF-7808 shall be used.
2. When adding one authorized oil to another at ambient temperatures above -40 °C, the engine shall be drained. It is not necessary to flush the engine under these conditions.

Figure 3-3. Lubricants and Hydraulic Fluids Reference Chart

3.2.1 Fueling with Fuel Susceptible to Icing

Utilize the following procedure to keep the bulk fuel temperature above 0 °C and prevent engine flameout caused by fuel icing:

1. If the aircraft has been in heated hangar areas, the aircraft should be launched within one hour after being moved to the flight deck or towed to a turn-up area.
2. If the aircraft is outside for more than one hour, bulk fuel temperature should be checked by draining aircraft fuel into a bottle which has been outside approximately 15 minutes, a thermometer inserted, and temperature read.
3. If fuel is 0 °C or below, aircraft should be hangared until bulk fuel temperature rises above 0 °C or partially defueled and refueled with warm fuel so that bulk temperature rises above 0 °C.

3.2.2 Pressure Refueling

The helicopter fuel tanks are pressure refueled through a fitting on the left side of the aircraft. Pressure refueling does not require electrical power. The system should automatically shut off when the tanks are full. Before refueling, the helicopter and refueling-unit grounding devices should be inspected by fueling personnel for proper ground.

The procedures described in the following paragraphs shall be followed during refueling operations.



WARNING

Ensure sonobuoy launcher lock pin is in the LOCK position prior to refueling with sonobuoys loaded and system pressurized.



CAUTION

Fueling pressure shall not exceed 55 psi.

3.2.2.1 Helicopter On Deck

Asterisked (*) items apply only when engines and rotors are operating.

Note

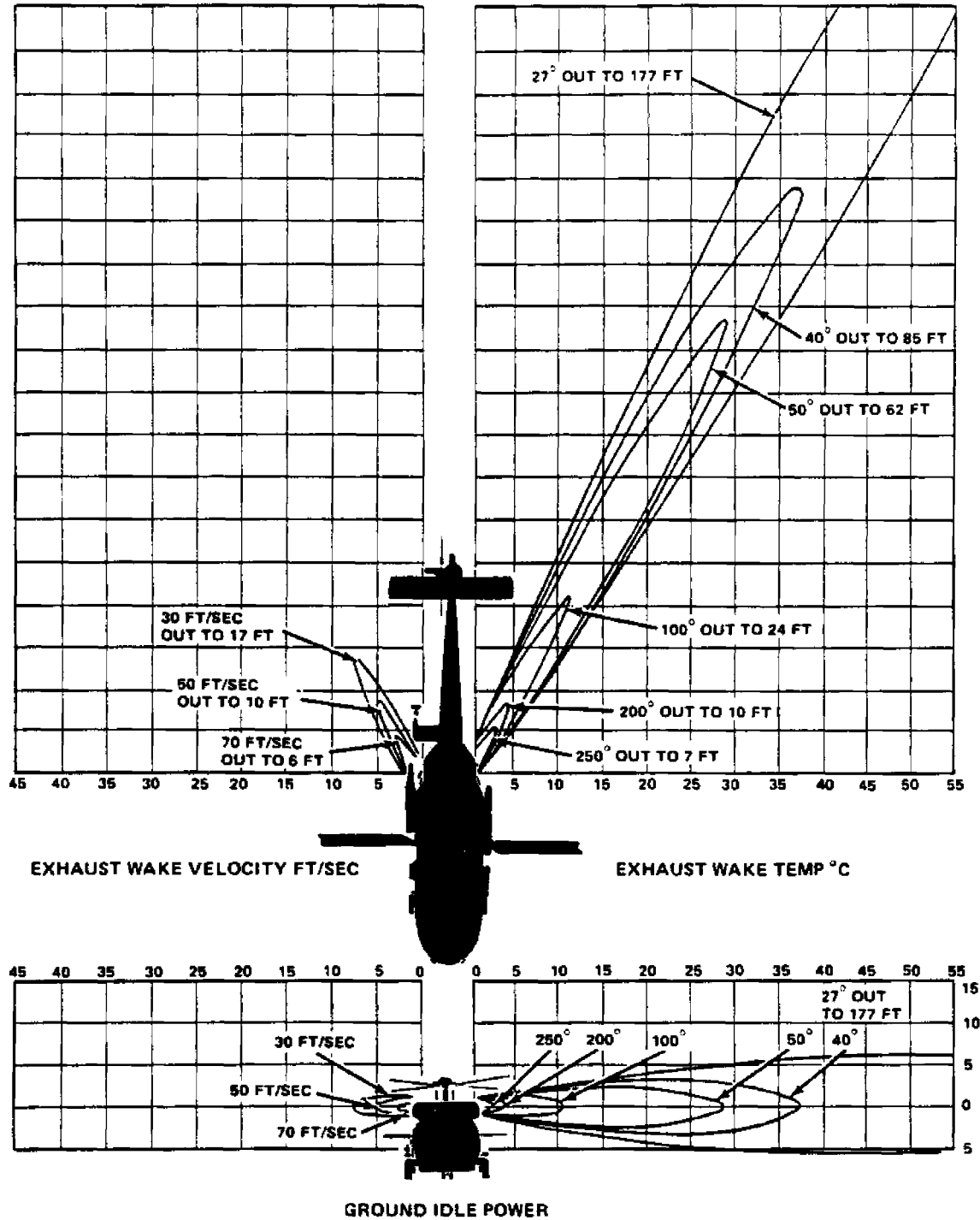
Aircraft exhaust patterns are shown in [Figure 3-4](#).

- *1. Pilot maintains UHF communication with [LSO](#), ground, or tower — As applicable.
- *2. ALE-39 arming handles ([ESP](#) only) — SAFE.
- *3. [IRCM](#)/HF — OFF.
- 4. Fuel management panel (BuNo 162349 and subsequent) — REFUEL as required.
- 5. Helicopter — Ground. Fuel vehicle (ashore only) — Ground to aircraft.
- 6. Fueling nozzle — Connect.
- 7. Fuel flow — Start (when directed by the pilot).



CAUTION

- Increase of intertank pressure as indicated by the tank pressure gauge entering the red band during pressure refueling denotes a clogged vent. Stop refueling immediately and investigate.
 - Flow of fuel when precheck valve is in precheck position indicates a shutoff system malfunction. If both precheck valves fail to stop fuel flow, stop refueling to prevent overflow from tank vents. As long as one precheck valve is operative, the aircraft can be refueled safely.
8. Hold precheck valves in precheck position, one at a time — Fuel flow will stop within 10 seconds.
 9. Release check valve and continue fueling until fuel flow stops.
 10. Fueling nozzle — Disconnect and replace cap, close panel door.



NOTES

1. CONDITIONS: STANDARD DAY
2. EXHAUST WAKE VELOCITY AND TEMP ARE SAME FOR BOTH ENGINES
3. ENGINE EXHAUST WAKE AND TEMP SHOWN ARE WITHOUT ROTOR DISTURBANCE

SH60B-F064

Figure 3-4. Aircraft Engine Exhaust Patterns

11. All grounding wires — Remove.
- *12. IRCM/HF (ESP only) — ON.
- *13. ALE-39 arming handles (ESP only) — ARM.

3.2.3 Gravity Fueling

The helicopter main tanks are gravity fueled through a filler cap on the left side of the helicopter. The external auxiliary fuel tanks are gravity fueled individually. Before fueling, grounding devices on the helicopter and on the fuel truck will be inspected by fueling personnel to be sure of proper ground. Before using a fuel hose, the hose nozzle must be grounded to grounding stations above or below the pressure refueling station. Before removing the filler cap, attach the hose nozzle grounding unit into the grounding jack. Replace the filler cap after filling tank.

WARNING

- Gravity fueling is not authorized with engines or APU operating. In addition to the hazard caused by the location of the tank openings relative to the engine exhaust, the rotors constantly build static electricity, creating an extremely dangerous spark potential.
- Internal tank pressure shall be checked prior to removal of the filler cap to prevent fuel spills.

3.2.4 Use of Different Fuels

When changing from one type of authorized fuel to another, it is not necessary to drain the fuel system before adding the new fuel. Fuels having the same NATO code number are interchangeable. Jet fuels conforming to the ASTM D-1655 specification may be used when MIL-T-5624 fuels are not available. When helicopters using NATO F-44 (JP-5) are refueled with NATO F-40 (JP-4) or commercial ASTM Type B fuels, the operating characteristics may change in that lower operating temperature, slower acceleration, easier starting, and shorter range may be experienced. The reverse is true when changing from F-40 (JP-4) fuel to F-44 (JP-5) or commercial ASTM Type A-1 fuels.

3.2.5 RAST Operations for Aircraft Configured with External Auxiliary Fuel Tank

RAST operations may be performed on aircraft configured with a 120 gallon external auxiliary fuel tank provided the following limits and conditions are met:

1. Main and tail landing gear tires and oleo struts have been serviced prior to flight.

CAUTION

Strut servicing shall not be performed while the aircraft is over/in the RSD.

2. The static vertical clearance between the deck and the lowest point on the auxiliary fuel tank shell (not including the fin) shall not be less than 12.0 inches.

Note

Static vertical clearance is measured following any maintenance or servicing involving main landing gear or oleo struts.

3. Aircraft gross weight during RAST operations shall not exceed the gross weight of the helicopter at the time of the static vertical clearance measurement.

3.3 OIL SYSTEM SERVICING

3.3.1 Engine Oil Servicing

Both engine oil tanks (Figure 3-1) are within the main frame. Add oil if oil level in sight glass is less than halfway between add and full marks. Service to approximately one inch below the full mark or adjacent to the top set of bolts. If oil is at operating temperature, wait 20 minutes before checking oil level or servicing engine.

WARNING

Lubricating oils MIL-L-23699, MIL-L-7808, and DOD-L-85734 contain materials hazardous to health. These lubricating oils can produce paralysis if swallowed. Long-term contact may irritate the skin. Wash hands thoroughly after handling as they may burn if exposed to heat or flames. Use only with proper ventilation.

CAUTION

The helicopter must be level to get accurate oil tank readings. When the helicopter is parked on a slope, the downslope engine will read a higher oil level than actual, and the upslope engine will read a lower oil level than actual.

Note

Commercial oils listed are approved for use in engines and gearboxes except as indicated.

3.3.2 Main Transmission Oil System Servicing

The transmission oil supply is in the sump case with the filler port and dipstick gauge located on the right rear of the main module. When filling is required, oil is poured through the filler tube on the main module case. The oil level is checked by a dipstick, marked FULL and ADD. When the oil level decreases to the ADD mark on the dipstick, approximately 2 quarts of oil will be needed to return the level to FULL. The dipstick has both hot and cold scales.

3.3.3 Tail and Intermediate Gearbox Servicing

The intermediate gearbox oil level sight gauge (Figure 3-1) is located on the left side of the gearbox. The tail gearbox oil level sight gauge is on the right side. Each sight gauge contains inner and outer circles. The gearboxes are full when the oil level is within the inner circle when the pylon is spread. The oil level should be replenished if the bottom of the outer circle can be seen. Some aircraft are equipped with improved visibility sight gauges on the tail gearbox. They are labeled with upper and lower horizontal lines. The gearbox is full when the oil level is between the two lines when the pylon is spread. The oil level should be replenished if the level is below the lower line.

Note

During shipboard operations, the gearbox oil level sight gauge may not indicate properly due to the slope of the flight decks on certain ship classes.

3.4 HYDRAULIC SYSTEM SERVICING

Reservoirs (**Figure 3-1**) for the hydraulic system are on the hydraulic pump modules. Fluid-level sight gauges are visible on the side of each pump. All hydraulic pump reservoir capacities are 1 U.S. quart at the FULL mark. When the indicator reaches the refill (red) point, two-thirds of a pint is required to return the indicator to the full (green) mark. The fluid level indication is the 1/8-inch wide white stripe at the outboard edge of the level piston. To refill the reservoirs, the fluid is supplied from the manual hand pump. After flight, fluid in hydraulic systems will be hot. Piston movement of up to 3/8 inch into the blue (overserviced) zone is acceptable. When piston is beyond this limit, bleed off enough fluid to bring piston back to 3/8 inch above full limit.

Note

After operation, the indicator may show an overserviced condition. Accurate readings may only be made after fluid temperature has cooled.

To replenish the pump reservoir fluid:

1. Turn the selector valve to the reservoir to be filled. OUT 1 is the left pump module, OUT 2 is the right pump module, OUT 3 is the backup pump module, and OUT 4 is the rotor brake (stow position).
2. While holding the selector valve handle down, crank the hand pump clockwise and fill desired hydraulic pump module until the forward end of the reservoir window piston is at the forward end of the green decal on the reservoir housing. At the same time, push in and turn the bleed valve, and bleed air from the pump module. Release button when air-free oil shows.
3. Check that reservoirs stay full (forward end of piston at forward end of green decal), with fluid at ambient temperature 1 hour after flight.
4. Make sure area remains clean during procedure.
5. Stow selector valve handle in OUT 4 position.
6. Turn on electrical power.
7. Check caution panel for #1 RSVR LOW, #2 RSVR LOW, and BACK-UP RSVR LOW lights off.

3.4.1 Hand Pump Reservoir Servicing

Servicing of the refill hand pump (**Figure 3-1**) is done when fluid level decreases to the refill line on the fluid-level sight gauge on the side of the pump tank. When the fluid level decreases to the refill line, service is necessary to avoid allowing air into the rotor brake hydraulic system.

3.5 BLADE DAMPER ACCUMULATOR

The blade damper accumulator is serviced with a combination of hydraulic fluid and nitrogen. After proper servicing, the fluid-level gauge (**Figure 3-1**) should be in the green or yellow area. The nitrogen charge gauge should indicate the pressure for the ambient temperature (degrees F) listed on the accompanying chart.

3.6 SONOBUOY LAUNCHER PNEUMATIC SYSTEM SERVICING

The sonobuoy launcher pneumatic bottle is serviced from the waterwash/sonobuoy charge panel above the SO window, located on the left side of the helicopter (**Figure 3-1**).

The system shall be disarmed at the control panel in the cockpit and the valve safety lockout engaged in the rotary valve (**Figure 3-5**) before starting servicing. Attach a high-pressure air supply hose to the charge valve. Apply 1,200 to 1,250 psi and open the charge valve. Close the valve when the air bottle is charged. Verify approximately 1,200 psi on supply manifold gauge, and disconnect the supply hose.

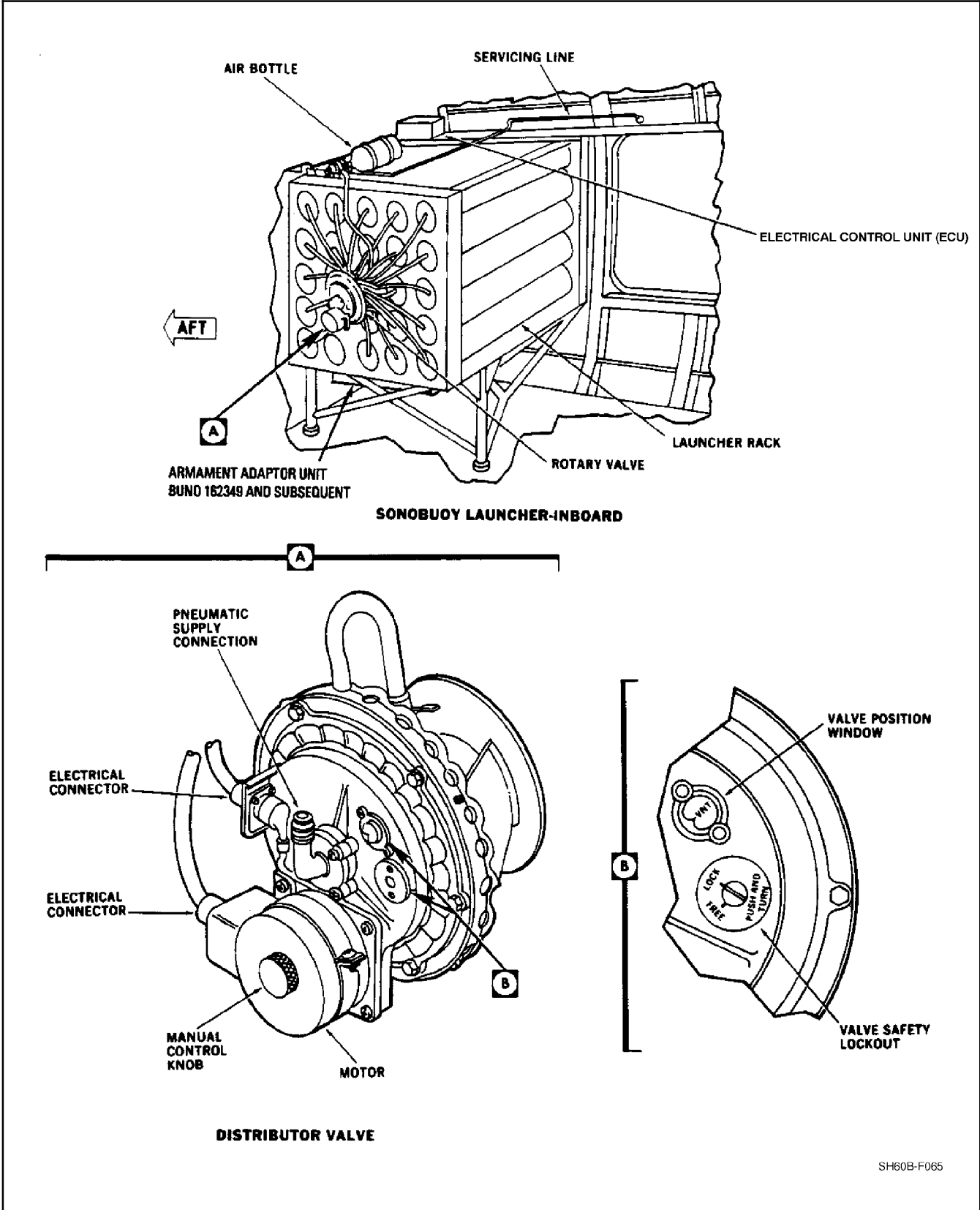


Figure 3-5. Sonobuoy Launch System Components and Servicing

3.7 WINDSHIELD WASHER SYSTEM SERVICING

The windshield washer system is serviced by filling the reservoir, located aft of the pump and behind the pilot seat.

Note

In weather where the temperature is above 0 °C, the reservoir may be serviced with water. When operating in areas where the temperature is below 0 °C, service the reservoir with equal parts of water and isopropyl alcohol.

3.8 FIRE EXTINGUISHER SYSTEM SERVICING

Fire extinguisher bottles that have lost their charge, for any reason, shall be replaced with fully serviced units.

3.9 APU OIL SYSTEM SERVICING

The APU oil supply is in the APU gearbox oil sump. The sump-filler/oil dipstick port (**Figure 3-1**) is located on the left side of the gearbox housing. The APU oil level can be accurately checked only by using the dipstick.

Note

The proper level for the Turbomach APU is halfway between full and refill. Filling the APU to the full line will cause the APU to overheat easily.

3.10 EXTERNAL POWER REQUIREMENTS

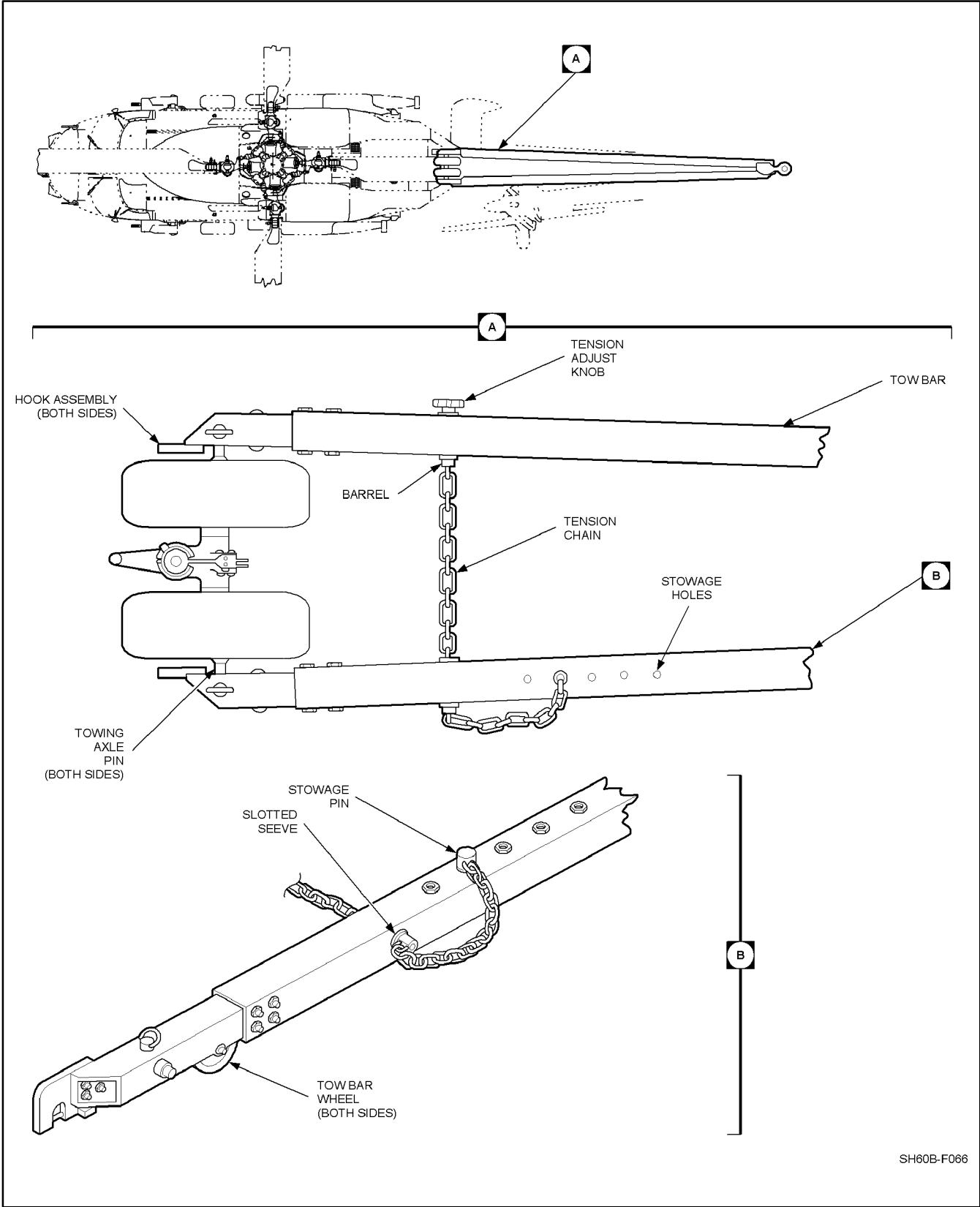
The helicopter requires 115/200V, 3 phase, 400 Hz external power. The AC external power receptacle is located on the right side of the helicopter, forward of the crew door near the main landing gear. The helicopter does not have a DC external power receptacle.

The following is a partial list of external power sources which provide 115/200V, 3 phase, 400 Hz AC power:

| USN | USAF | CANADIAN |
|------------|-------------|--------------------------|
| NC-2A | B-10 | CAN-C (Same as USN NC-5) |
| NC-5 | B-10A | |
| NC-6A | B-10B | |
| NC-7 | MD-3 | |
| NC-7A | MD-3A | |
| NC-7B | M32A-10 | |
| NC-7C | M32A-13 | |
| NC-8A | | |
| NC-10 | | |
| NC-10B | | |
| NC-12 | | |
| NC-12A | | |

3.11 AIRCRAFT TOWING

Due to the top-heavy configuration of the helicopter, precautions must be observed during all helicopter movements to prevent possible damage and dangerous conditions. The helicopter shall be moved with a tractor equipped with an SH-60 unique tow bar. Towing equipment (**Figure 3-6**) shall be operated only by qualified personnel who will be responsible for checking the approved towing couplings before towing. When towing a helicopter, three wingwalkers and a qualified brakereider shall be used. A wingwalker shall be stationed on each side of the helicopter, and one will be located near the tail rotor to ensure adequate clearance. In addition, towing shall be supervised by a director. Each person shall be equipped with a whistle. All stop signals shall be given by a whistle and hand signals. Whistle signals should be supplemented by hand signals whenever possible. Wheel brakes shall be applied as soon as a stop signal is received from the director.



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Figure 3-6. Aircraft Towing

WARNING

- Personnel shall position themselves abeam the mainmount at a distance greater than their personal height. Personnel shall never position themselves in line with the tires.
- Only essential personnel shall remain in an aircraft during ground movement. All such personnel shall be seated with seatbelts fastened. Personnel shall not enter or exit aircraft during movement.
- Towing speeds shall not be over 5 mph, and sudden stops and starts shall be avoided.
- When the tow bar is attached to the tail wheel, the tail wheel should be unlocked to prevent shearing of the lockpin.
- If pushing the aircraft up or pulling it down a short/steep incline, the nose may pitch up and cause the aft data link antenna to impact the tow bar.

3.12 PARKING

1. Short-term parking:

Note

During short-term parking, helicopter should be attended or monitored at all times.

- a. Locate helicopter more than one rotor blade length from other helicopters or objects.
- b. With winds 20 knots or more, park helicopter facing into the wind.
- c. Lower stabilator to full-down position.

Note

Battery power may be used to lower stabilator.

- d. Apply rotor brake.
- e. Center tail wheel and place tail wheel lockpin in the LOCKED position.
- f. Engage parking brake (handle up) and chock main wheels.
- g. Install protective covers.
- h. Connect low-resistance ground wire to aircraft.

2. Long-term parking:

Note

During long-term parking, helicopter will not be attended or monitored.

- a. Park helicopter the same as short-term parking.
- b. If winds of 45 knots or gusts to 60 knots are expected, fold and secure main rotor blades.
- c. Install helicopter and main rotor tiedowns.

3.13 AIRCRAFT TIEDOWN/SECURING

3.13.1 Aircraft Tiedown Instructions

1. When possible, head helicopter into wind.
2. Chock main landing gear wheels.
3. When ground tiedown rings are not available, move helicopter to an area where anchors or deadman type anchors (capable of sustaining a 12,500 pound per cable pull test) may be used.
4. Fasten 12,500 pound pull test chain to tiedown rings (Figure 3-7) and extend outward to round mooring points at 45° angles. Provide enough slack in chain or rope between anchor and tiedown ring to prevent tightening due to distortion or tire deflation on the opposite side.



Hellfire missile seeker covers should be installed (when available) before commencement of ground operations and all chocks and chains operations. Exercise extreme care when applying chocks and chains to the port mainmount to avoid damage to missile seeker or fins.

5. Install protection covers and plugs.
6. When main rotor blades are spread, engage rotor brake and install blade tiedowns.
7. After winds have subsided, check helicopter for damage from flying objects and buffeting.

3.13.1.1 Aircraft Tiedown Requirements

Aircraft tiedown requirements are divided into three categories as follows:



Deviating from a prescribed tiedown configuration is not authorized, as deviations may lead to oversight of tiedown removal, which may result in an attempt to launch with tiedowns attached. This condition may result in uncontrolled flight, dynamic rollover, or loss of aircraft and aircrew.

1. Initial Tiedown. Consists of four tiedowns, two on each main mount. This requirement exists just prior to and after shipboard aircraft movement, during shipboard aircraft startup, and immediately after landing aboard ship.
2. Permanent Tiedown. Consists of 12 tiedowns (two on each attachment point) and is required aboard ship when not at flight quarters.
3. Heavy Weather Tiedown. Consists of 18 tiedowns (three on each attachment point) and is required with weather conditions in which surface winds reach an average velocity of 35 knots or greater and/or sea state of eight feet; or wind over the deck exceeds 60 knots, pitch exceeds 4°, or roll exceeds 12°.



The aircraft should be moved into the hangar prior to the onset of heavy weather conditions.

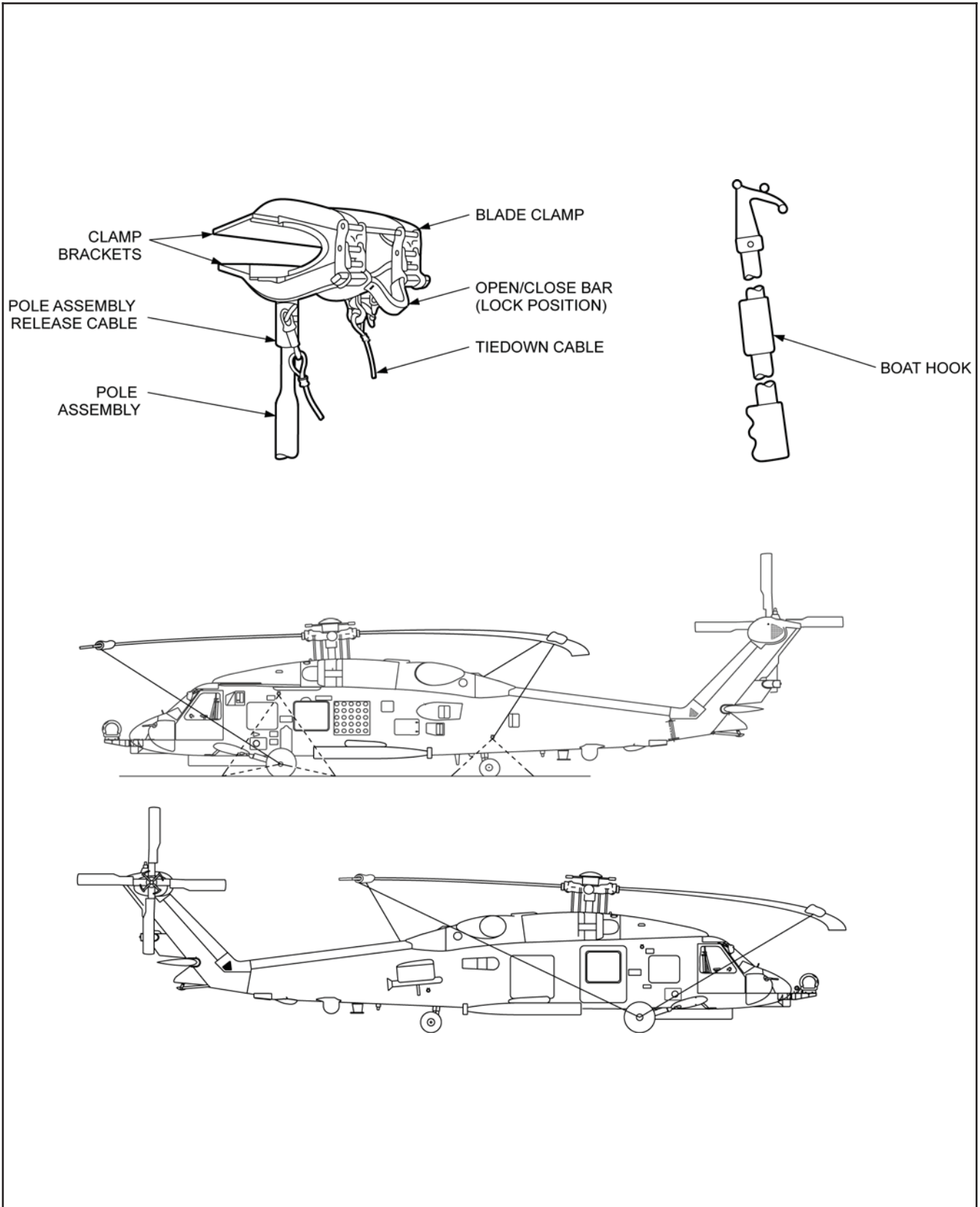


Figure 3-7. Helicopter Tiedown Fittings

3.13.1.2 Main Rotor Tiedown

To tie down the Main Rotor Blades in the spread position, do the following:

1. Attach tiedown ropes to blade clamps.



The use of blade boots is NOT authorized. Blade tiedowns may be used ONLY with the approved blade clamp.

2. Place blade clamps on blades approximately 2 1/2 feet inboard of the blade tip.
3. Turn rotor head to position blades to approximately a 45° angle to centerline of helicopter and engage rotor brake.



To prevent damage to blades, do not deflect main rotor blade tips below normal droop position when using tiedowns.

4. Attach tiedown ropes to helicopter as shown in [Figure 3-7](#).

Note

Aft starboard rotor blade will be secured to the starboard main mount.

3.14 FUSELAGE STATIONS AND JACK POINTS

To assist in locating, dimensioning, and referring to items of structure and equipment, a system of numbering structural stations is used ([Figure 3-8](#)). Those structural stations are the number of inches from a reference datum located ahead of the nose and designated station "0." Vertical measurements in inches are referenced to "water line" positions, again referenced to a datum below the aircraft designated "0." Horizontal positions are also measured in inches left or right of the aircraft "butt line" (centerline), which is designated "0." Jack pads are fittings attached to the helicopter structure which are used as jack points. There are six jack points on the helicopter: two at the tail wheel and two at each main landing gear. When landing gear jacking is required, a 5 ton minimum capacity jack shall be used. When helicopter jacking is required using the three fuselage jack points, three 12 ton minimum capacity tripod jacks shall be used.

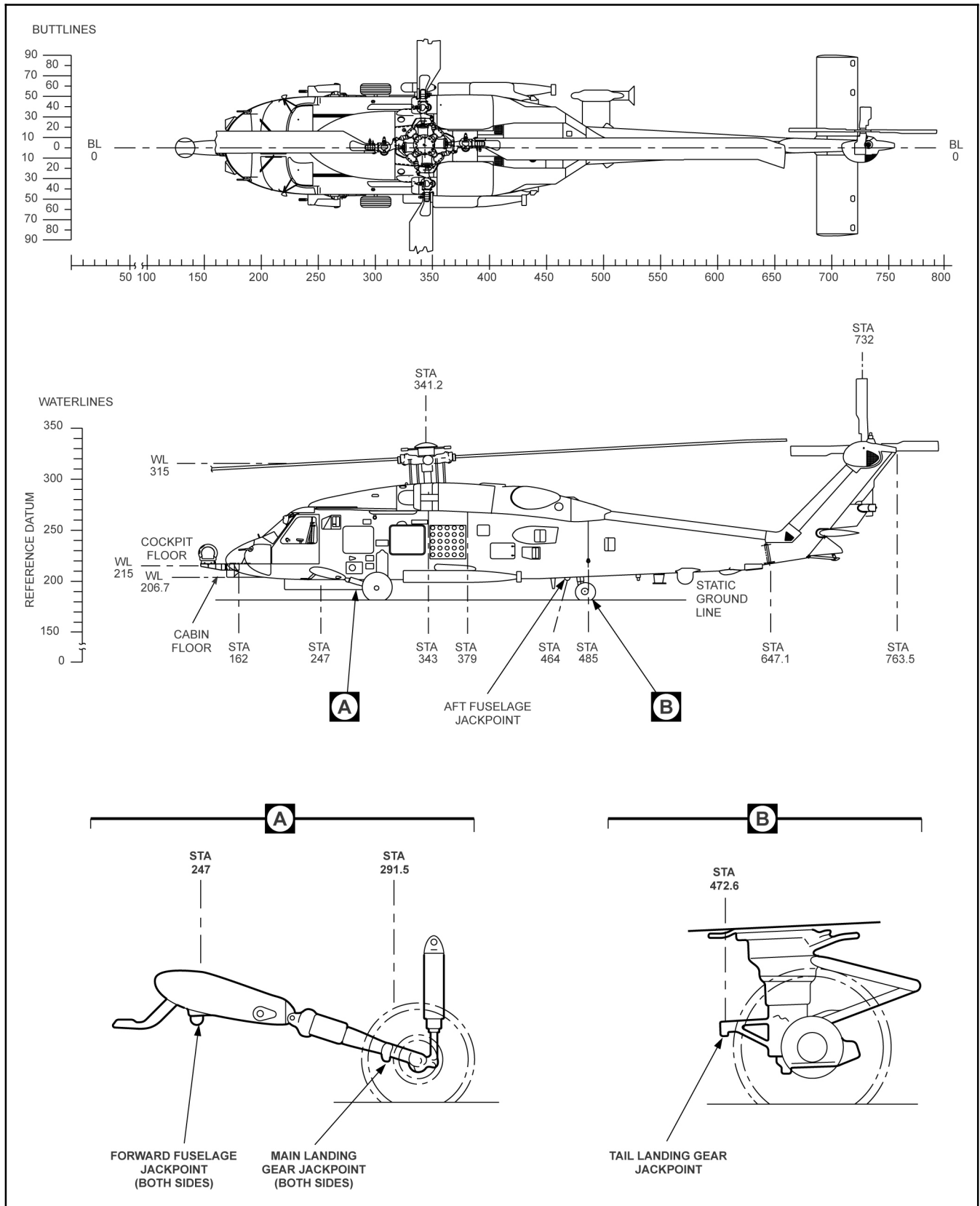


Figure 3-8. Fuselage Stations and Jack Points

CHAPTER 4

Helicopter Operating Limitations

4.1 GENERAL

This chapter covers all important operating limits and restrictions to be observed during ground and flight operations. Limitations in this part are the direct results of design analysis, tests, and operating experience. Compliance with these will allow the pilot to perform the assigned missions safely and to derive maximum use from the helicopter.

4.1.1 Exceeding Operational Limits

Any time an operational limit is exceeded, an appropriate entry shall be made on a visual discrepancy system/maintenance action form (VIDS/MAF). Entry shall state what limit or limits were exceeded, range, time beyond limits, and any additional data that would aid maintenance personnel in the inspection that may be required.

4.1.2 Instrument Range Markings

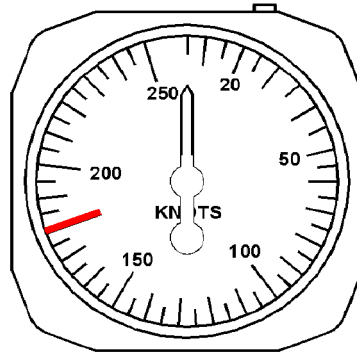
Operating limitations and ranges are illustrated by colored strips located on the instrument faces of engine, flight, and utility-system instruments (Figure 4-1). RED markings indicate the limit at which continued operation (above or below as appropriate) is likely to cause damage or shorten component life. GREEN indicates the normal or safe range of operation. AMBER markings indicate the range when special attention should be given to the operation covered by the instrument. Operation is permissible in the yellow range, but it is generally time limited.



Operation of the T700-GE-401C engine within the yellow light region of the VIDS may be limited to 2.5 minutes and operation below the high temperature level displayed on the VIDS may result in engine overtemperature. Operating temperature limits must be monitored on the digital readout.

Scales with green-coded light segments and amber-coded or red-coded segments above the green-coded segments operate in this manner: The segments will light in normal progression and remain on as the received-signal level increases. Those scales will go off in normal progression as the received-signal level decreases. Scales with red-coded and/or amber-coded segments below the green-coded segments operate in this manner: When the received signal is zero or on the bottom scale, the segments will light in a normal progression and will remain on. When the first segment above the red or amber range goes on, all red-coded or amber-coded segments will go off. These segments will remain off until the received-signal level indicates a reading at or within the red or amber range. At that time, all red-coded or amber-coded segments will go on and the scale display will either go on or off in a normal progression, depending upon the received-signal level. For an increasing indication, using a scale with side arrows, the following applies: When the first segment for which there is an associated side arrow lighting lights, the corresponding side arrow also lights. As the segments go on, the corresponding arrows will also go on, one at a time. Only the side arrow associated with the highest percent indication of the corresponding scale will be on.

MAXIMUM █ 180 KNOTS



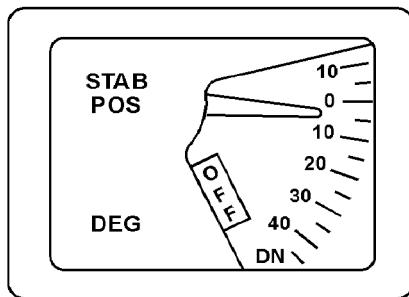
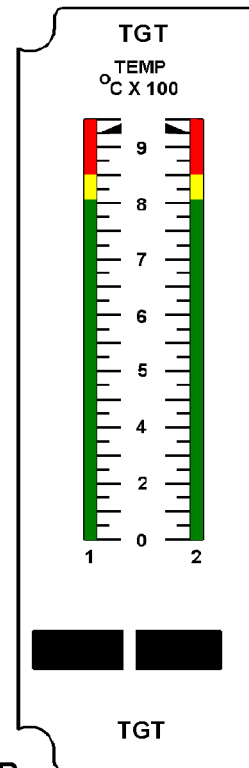
AIRSPEED

TURBINE GAS TEMPERATURE

DECU TGT Limiting:

Normal conditions: 839 °C ±10°
 With Contingency Power: 891 °C ±10°

| | | |
|--|---------------------------------------|--------------|
| 12-SECOND TRANSIENT | █ | 903 - 949 °C |
| 2.5-MINUTE TRANSIENT (CONTINGENCY POWER) | █ | 851 - 903 °C |
| 30-MINUTE LIMIT | █ | 810 - 851 °C |
| NORMAL | █ | 0 - 810 °C |
| DIGITAL READOUT IN AMBER | █ | TGT READOUT |



AIRSPEED LIMITS FOR FIXED STABILATOR

| DEG STAB (TRAILING EDGE) | KIAS LIMIT |
|--------------------------|------------|
| 0° | 150 |
| 10° | 100 |
| 20° | 80 |
| 30° | 60 |
| 40° | 45 |

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Figure 4-1. Instrument Range Markings (Sheet 1 of 4)

MAIN ROTOR N_r (% RPM)

POWER ON
 MAXIMUM █ 120%
 NORMAL █ 96% - 101%

POWER OFF (AUTOROTATION)
 MAXIMUM █ 120%
 NORMAL █ 90% - 105%

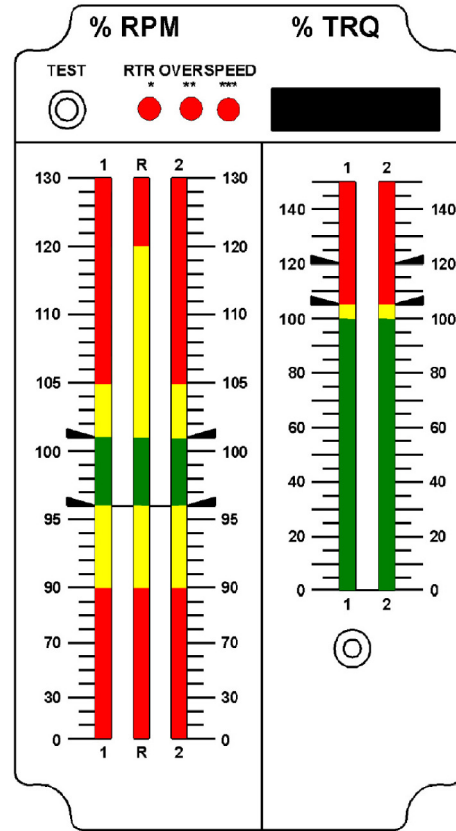
MAIN ROTOR OVERSPEED

* ● 127%
 ** ● 137%
 *** ● 142%

ENGINE N_p (% RPM)

MAXIMUM █ 120%
 CONTINUOUS █ 96% - 101%

AVOID OTHER THAN TRANSIENT OPERATION
 IN 20%-40% AND 60%-75% RANGE



| SINGLE-ENGINE TORQUE (Q) LIMITS | | |
|---------------------------------|-----------|----------------|
| DA(FT) | MAX CONT | 10 SEC TRANSIT |
| 0 - 13000 | 0% - 135% | 135% - 144% |

| DUAL-ENGINE TORQUE (Q) LIMITS | | |
|-------------------------------|----------|----------------|
| DA(FT) | MAX CONT | 10 SEC TRANSIT |
| 0 - 4000 | 106% | 127% |
| 4000 - 5000 | 103% | 127% |
| 5000 - 6000 | 100% | 127% |
| 6000 - 8000 | 94% | 127% |
| 8000 - 10000 | 88% | 127% |
| 10000 - 13000 | 78% | 127% |

NOTE: THE PA/OAT DUAL ENGINE TORQUE MATRIX CONTAINS MORE DETAILED LIMITS, WHERE THE DA DUAL ENGINE TORQUE TABLE IS PROVIDED FOR QUICK REFERENCES. THE USE OF EITHER TABLE IS VALID.

| DUAL ENGINE TORQUE LIMITS - % TORQUE | | | | | | | | | | | | |
|--------------------------------------|--------|-----|-----|-----|-----|-----|-----|-----|-----|--------|--------|--|
| OAT °C | -40 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 50 | OAT °C | | |
| P | 20 | 65 | 60 | 57 | 55 | 53 | | | | 20 | | |
| R | 18 | 72 | 66 | 63 | 60 | 58 | | | | 18 | | |
| E | 16 | 78 | 72 | 69 | 66 | 63 | 61 | | | 16 | | |
| S | 14 | 86 | 78 | 75 | 72 | 69 | 67 | | | 14 | | |
| S | 12 | 93 | 85 | 82 | 79 | 76 | 73 | 70 | | 12 | | |
| U | 10 | 102 | 92 | 89 | 85 | 82 | 79 | 75 | | 10 | | |
| R | 8 | | 101 | 97 | 94 | 90 | 87 | 84 | 81 | 8 | | |
| E | 6 | | | 105 | 101 | 98 | 94 | 91 | 88 | 6 | | |
| A | 5 | | | | 105 | 101 | 99 | 93 | 90 | 87 | 5 | |
| L | 4 | | | | | 105 | 101 | 98 | 95 | 92 | 4 | |
| T | 3 | | | | | | 105 | 101 | 97 | 95 | 3 | |
| | 2 | | | | | | | 105 | 102 | 99 | 2 | |
| | 1 | | | | | | | | | 99 | 1 | |
| | 0 | | | | | | | | | | 0 | |
| | OAT °C | -40 | -20 | -10 | 0 | 10 | 20 | 30 | 40 | 50 | OAT °C | |

NOTE: DUAL ENGINE TRANSIENT TORQUE IS LIMITED TO 127% FOR 10 SEC.

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Figure 4-1 Instrument Range Markings (Sheet 2)

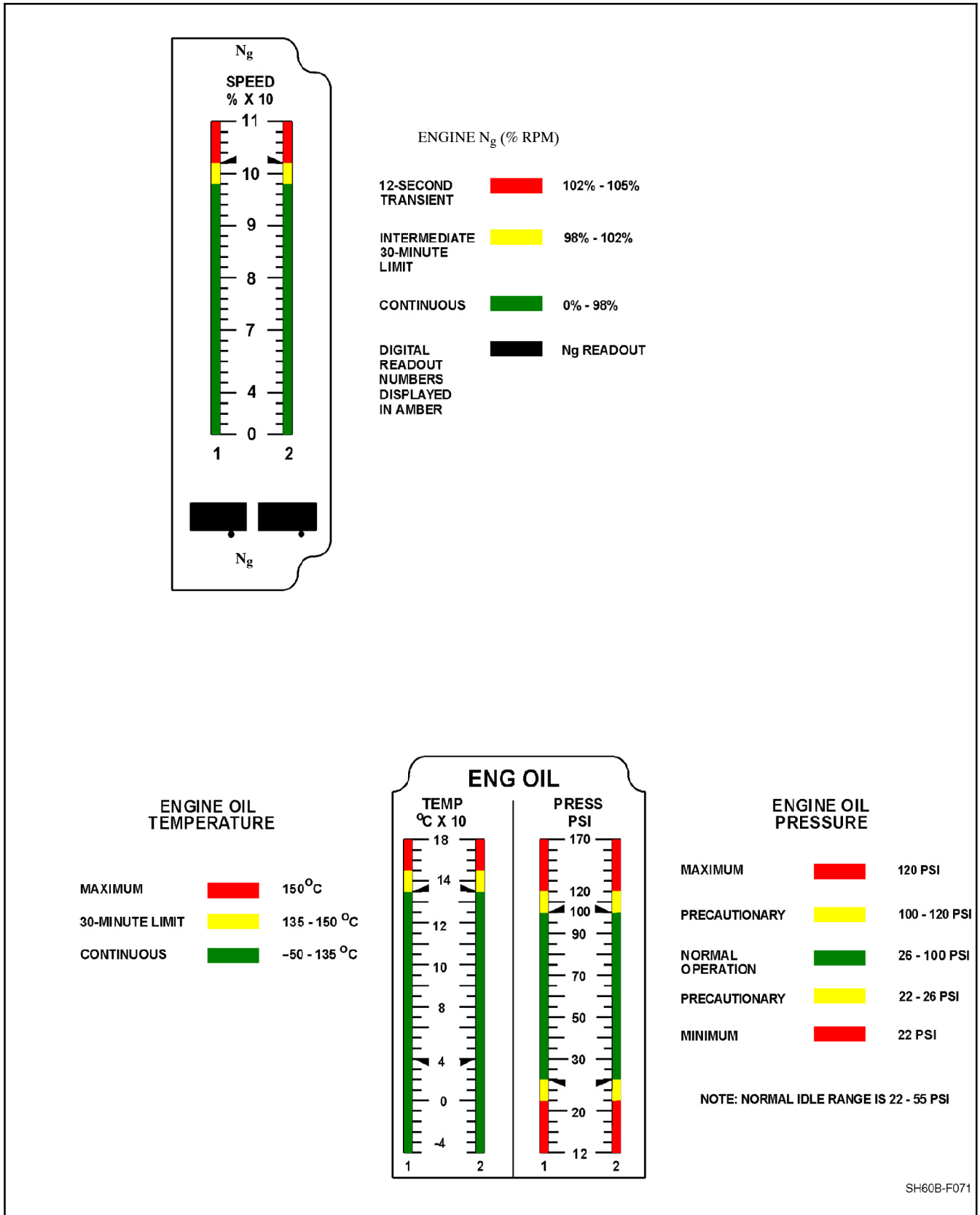


Figure 4-1 Instrument Range Markings (Sheet 3)

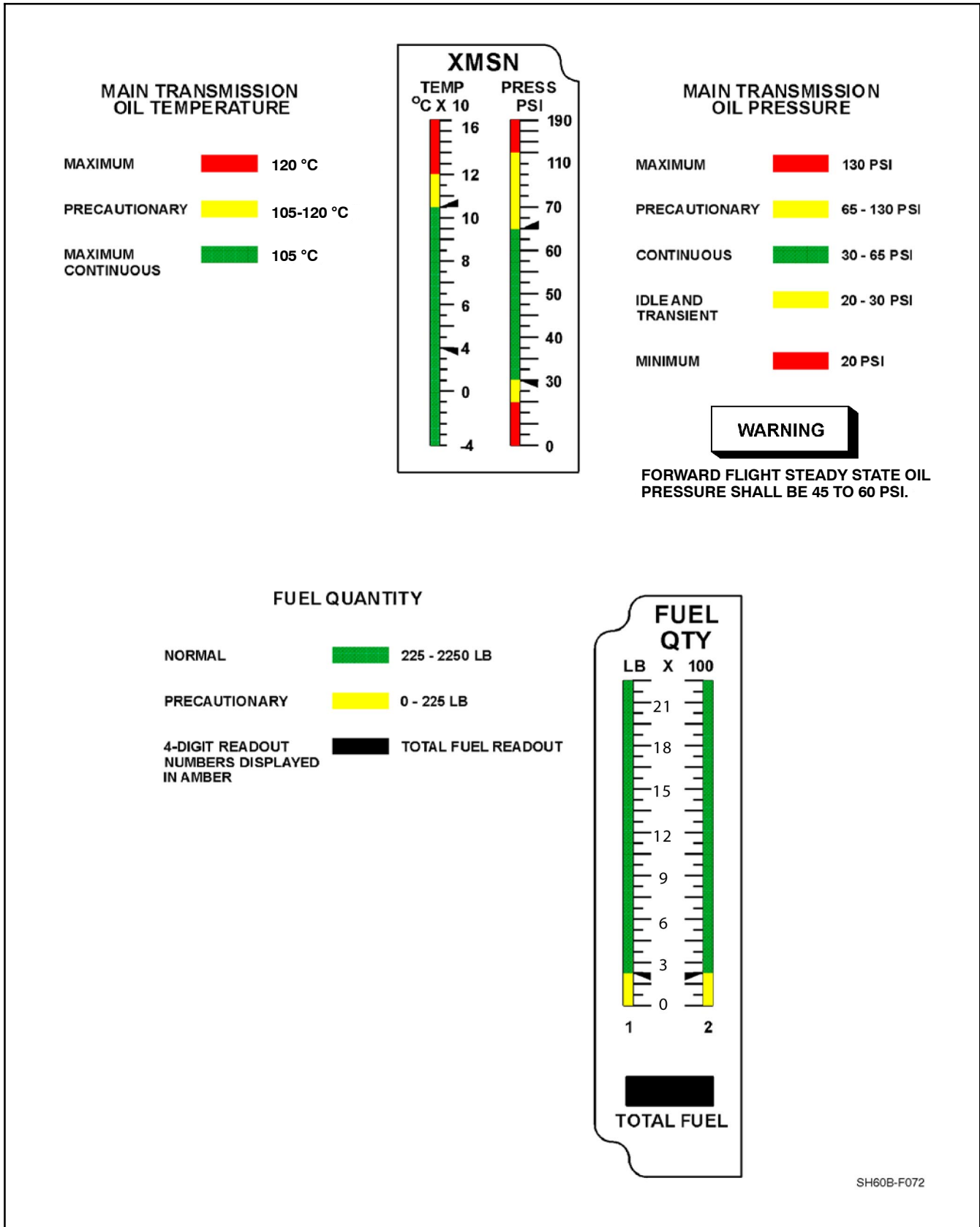


Figure 4-1 Instrument Range Markings (Sheet 4)

4.2 SYSTEM LIMITATIONS

4.2.1 Engine Limits

Limits presented in **Figure 4-1** represent absolute limitations, regardless of atmospheric conditions. For variations in power available with temperature and pressure altitude, refer to **Figures 4-4, 4-5, and 4-6**.

4.2.2 Engine Temperature Limitations

1. Refer to **Figure 4-1** for limitations.
2. The following situations can result in overtemperature:
 - a. Advancing ENG POWER CONT lever to IDLE with TGT above 80 °C.
 - b. Starter dropout prior to reaching lower starter cutout speed of 52 percent N_g .
 - c. Operation in DECU LOCKOUT.
 - d. Crossbleed starts with less than 90 percent N_g on operating engine.
 - e. Compressor stalls.

4.2.3 Engine Starter Limits

A start cycle is defined as starter initiation, acceleration of the output drive, and starter dropout. The 60-second delay between start attempts is required any time a start is aborted, except in emergencies. The engine starter limits as shown in **Figure 4-2**.

| AMBIENT TEMPERATURE (°C) | STARTER ON | STARTER OFF |
|---|--------------|-------------|
| LESS THAN 16 | First Cycle | 60 Seconds |
| | Second Cycle | 60 Seconds |
| | Third Cycle | 60 Seconds |
| | Fourth Cycle | 30 Minutes |
| 16 TO 52 | First Cycle | 60 Seconds |
| | Second Cycle | 30 Minutes |
| ANY TEMPERATURE (MOTORING/IGNITION OFF) | 2 Minutes | 5 Minutes |
| | 2 Minutes | 30 Minutes |
| Note | | |
| Times for motoring are cumulative times within a 5-minute period. | | |

Figure 4-2. Engine Starter Limits

4.2.4 Engine Start Limits

1. Single-engine starts using APU source may be attempted within the ambient conditions shown in **Figure 4-3**. When crossbleed starts are attempted, the operating engine must be operating at or above 94 percent N_g and rotor speed must be 99 to 101 percent N_r . Dual-engine starts using APU source may be attempted when within the range of outside air temperature (OAT) and pressure altitude of **Figure 4-3**.
2. Engine start with main rotor blades or tail pylon folded is prohibited.

4.2.5 Engine Idle Limits with Gust Lock Engaged

Engine operating with gust lock engaged is prohibited.

4.3 TRANSMISSION AND ROTOR LIMITS

4.3.1 Main Transmission Module Limitations

The transmission is limited in rpm, torque, oil pressure, and temperature. Operation is governed by whichever is reached first. If transmission oil pressure and/or temperature is in the precautionary range (amber), the helicopter shall not be scheduled for additional flights until maintenance action is taken. (Refer to **Figure 4-1** for limitations.)

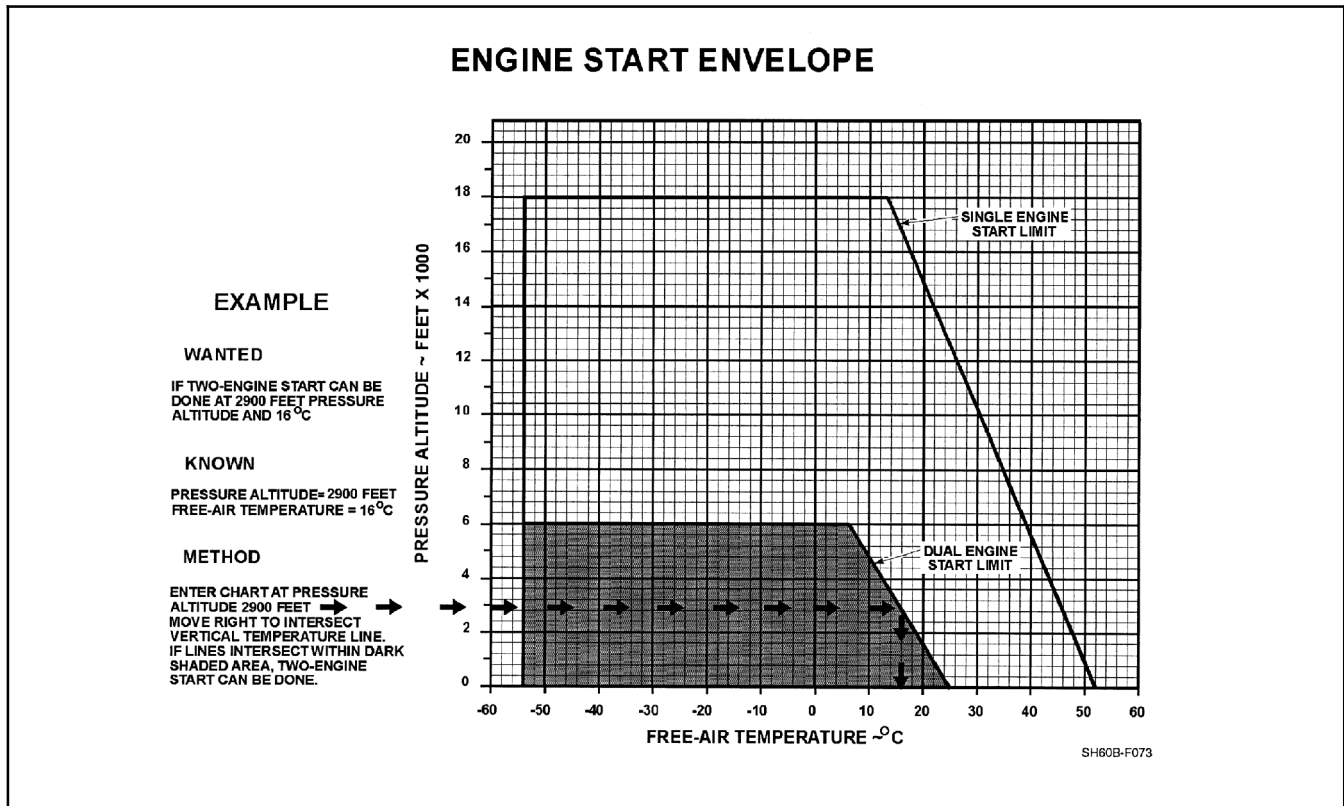


Figure 4-3. Engine Start Envelope

Main gearbox torque limitations for maximum service life under steady-state conditions are indicated by the range markings on the torquemeter; however, transient conditions in excess of the red line may occur during normal operations. Main gearboxes operated in excess of limits must be inspected by an overhaul facility.

A transient condition is herein defined as a temporary torquemeter reading above red line. Unless otherwise indicated, all torques referred to are matched engine torques.

Note

Prolonged hovering flight in hot weather 95 °F (35 °C) and higher gross weight may cause temperatures to rise in the yellow precautionary range. Hovering operations in the precautionary range for less than 30 minutes in any one flight under those conditions is considered normal.

4.3.2 Transmission Oil Pressure Limitations

Momentary fluctuations in transmission oil pressure may occur during transient maneuvers (i.e., pitch pulse during normal hover to check AFCS response or hover in gusty wind conditions), autorotations, or steady noseup hover. These fluctuations, including momentary drops into the yellow (below 30 psi), and transient drops not to exceed 1 second below 20 psi, are acceptable. The main transmission may be operated up to 30 minutes at a time with pressure fluctuations when the aircraft is known to be in a noseup attitude (slope landings or hover with extreme aft cg). In forward flight steady-state conditions, the transmission pressure shall be in the 45 to 60 psi range; fluctuations or pressure below 45 psi under these conditions requires maintenance action.

4.3.3 Rotor Start and Stop Limits

Maximum wind velocity for rotor start or stop is 45 knots from any direction.

4.3.4 Rotor Overspeed

All rotor overspeeds in excess of 120 percent N_r shall be reported on VIDS/MAF. (Refer to Figure 4-1 for additional overspeed limits.)

4.4 AERODYNAMIC LIMITATIONS

4.4.1 Airspeed Operating Limits

The maximum (redline) airspeed limit is 180 KIAS. Figure 22-3 presents the maximum airspeed as limited by blade stall. Other airspeed limits are:

1. Maximum airspeed for autorotation is 100 KIAS.
2. Maximum airspeed with one engine inoperative is 150 KIAS.
3. Sideward/rearward flight limit is 35 knots.
4. When stability augmentation system SAS-1 and SAS-2 are inoperative in instrument meteorological conditions (IMC), the limit is 125 KIAS.
5. When two hydraulic systems are inoperative in IMC, the limit is 125 KIAS.
6. Boost servo off limit is 140 KIAS in VMC, 125 KIAS in IMC.
7. Opening or closing cabin door limit is 60 KIAS.
8. Operation of windshield wipers limit is 130 KIAS.



At airspeeds of 130 KIAS and above, wipers can freeze in position with motor running, even in heavy precipitation. This condition can result in overheating of the wiper motor presenting a possible fire hazard.

4.4.2 Controllable Searchlight Airspeed Limits

1. When the searchlight is fixed in any position other than stowed, maximum forward airspeed is limited to 160 KIAS.
2. The maximum forward airspeed to move the searchlight is 100 KIAS.

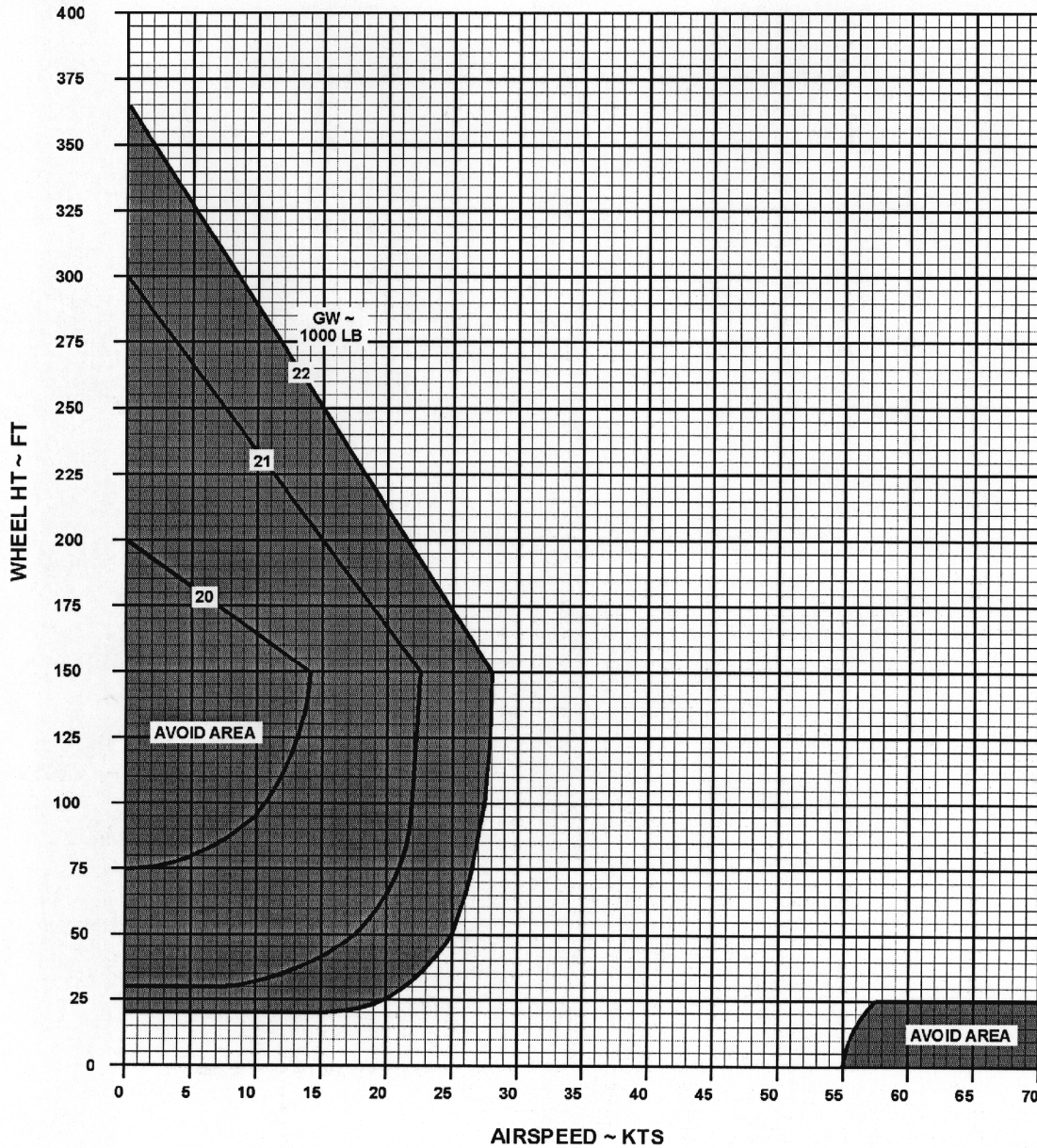
4.4.3 Minimum Height for Safe Landing After Single- or Dual-Engine Failure

The Height-Velocity diagrams (Figure 4-4) show the combinations of speed and wheel height that should be avoided during normal operations to provide for safe landing if single- or dual-engine failure should occur.

HEIGHT-VELOCITY SINGLE-ENGINE FAILURE SEA LEVEL ZERO WIND STANDARD DAY (15°C)

MODEL: SH-60
DATE: DECEMBER 1994
DATA BASIS: ESTIMATED (93% CONTGCY PWR)

ENGINE: (1) T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



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Figure 4-4. Height-Velocity Diagrams (Sheet 1 of 3)

Height-Velocity, Single-Engine Failure, Tropical

MODEL: BH-40
DATE: DECEMBER 1994
DATA BASIS: ESTIMATED @3% CONTING PWR)

SEA LEVEL ZERO WIND
TROPICAL DAY (32.2°C)

ENGINE: (1) T700-GE-401C
FUEL GRADE: JP4, JP5, JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

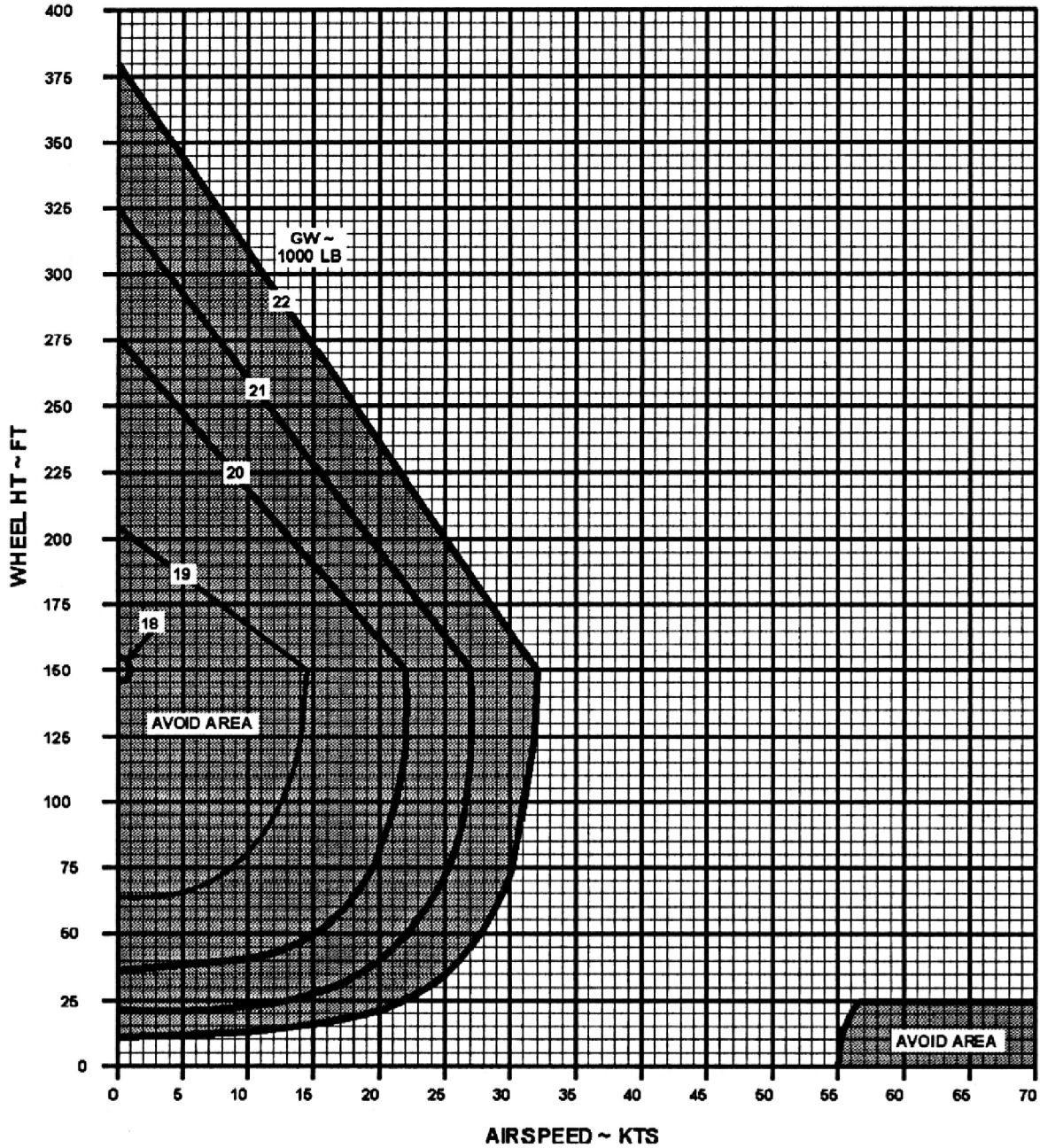
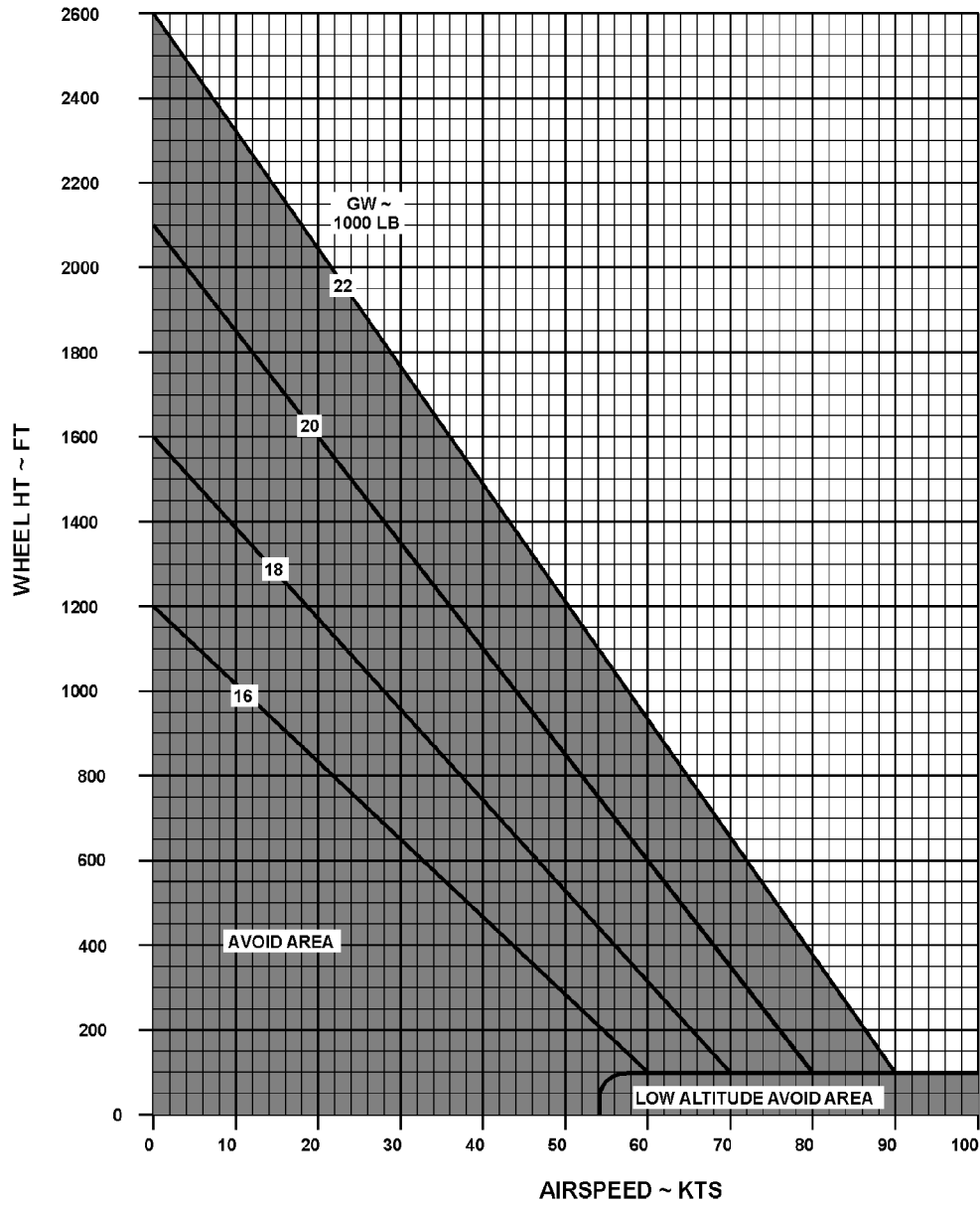


Figure 4-4. Height-Velocity Diagrams (Sheet 2)

HEIGHT-VELOCITY DUAL-ENGINE FAILURE SEA LEVEL ZERO WIND STANDARD DAY (15°C)

MODEL: SH-60
DATE: DECEMBER 1994
DATA BASIS: ESTIMATED

ENGINE: T700-GE-401C
FUEL GRADE: JP4, JP5, JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F076

Figure 4-4. Height-Velocity Diagrams (Sheet 3)

4.4.4 Autorotation

The Autorotation Chart (Figure 4-5) provides rates of descent and glide ratio in nautical miles per 1,000 feet of altitude loss. Airspeeds for maximum glide distance, maximum glide time, minimum rate of descent, and maximum allowable autorotation airspeed can be extracted from this chart.

4.5 MANEUVERING LIMITATIONS

Main rotor blade stall is indicated by an increase in 4-per-revolution vibrations and shall be avoided by adhering to the Airspeed for Onset of Blade Stall Chart (Figure 22-3). This chart is valid only within the guidelines of blade stall, Chapter 11.

4.5.1 Limitations for Maneuvering with Sling Loads

Refer to Figure 4-6.

4.5.2 Limitations for Maneuvering with Rescue Hoist Loads

Maneuvering limitations with a rescue hoist load are limited to a maximum of 20° angle of bank in forward flight (Figure 4-6). Sideward flight is limited by bank angle and is decreased as airspeed is increased. Rate of descent is limited to 1,000 feet per minute.

4.5.3 Bank Angles Limitation

Bank angles shall be limited to a maximum of 45° in normal operations, 30° when one PRI SERVO PRESS or BOOST SERVO OFF caution light is on, or above 10,000 feet density altitude.

4.5.4 Hovering

Prolonged rearward flight and downwind hovering should be avoided to prevent accumulation of exhaust fumes in the helicopter and heat damage to window on the open cargo door. Prolonged hovering in 20-knot, right-side wind should be avoided.

4.5.5 Altitude Limitation

Maximum operating density altitude is 13,000 feet.

4.5.6 Prohibited Maneuvers

The following maneuvers are prohibited:

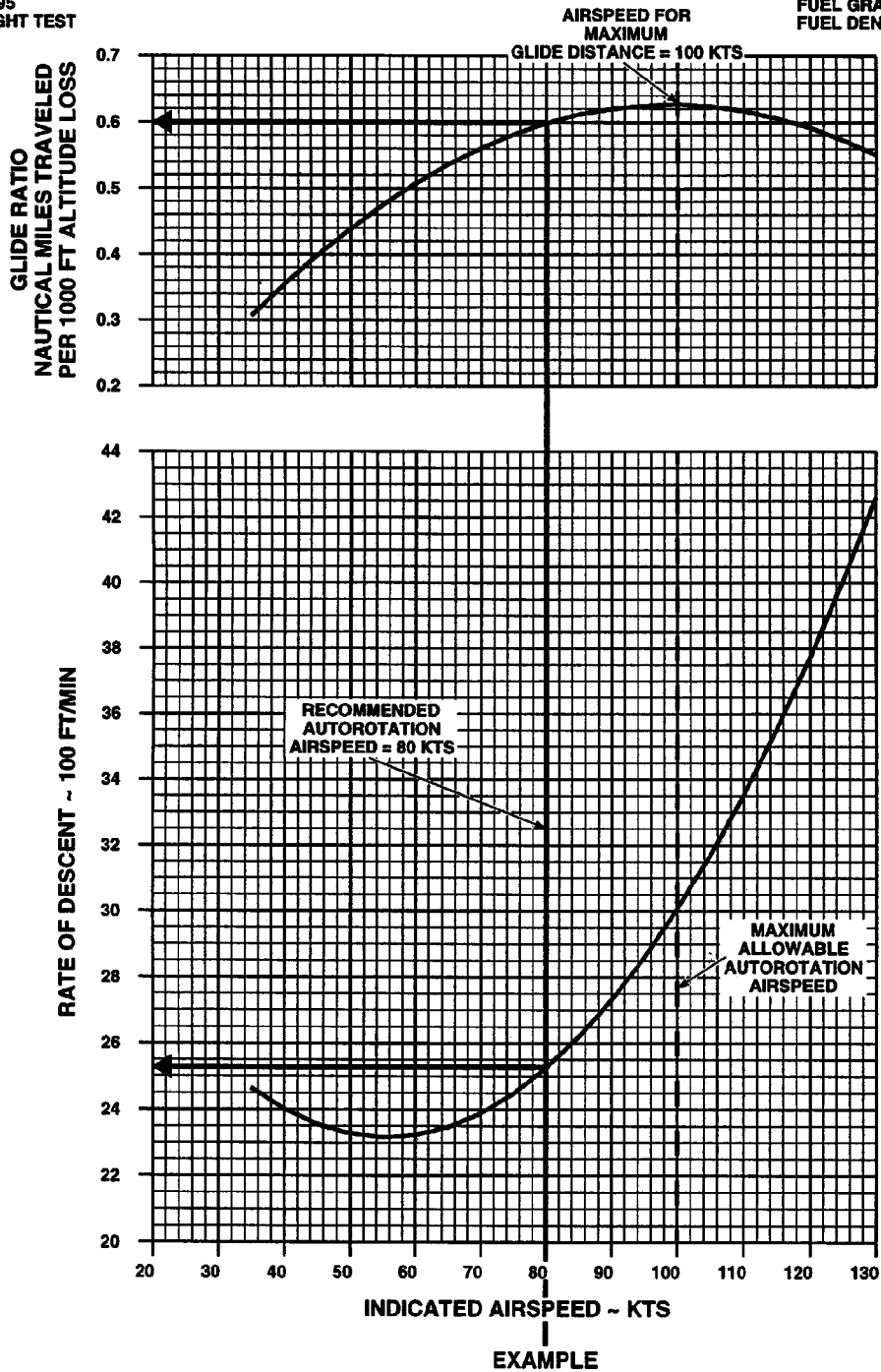
1. Aerobatic flight (e.g., rolls, loops, inverted flight).
2. Abrupt movement of the flight controls.
3. Bank angles greater than 45°.
4. Hovering turns at a rate in excess of 30° per second.
5. Practice full-autorotation landings.
6. Practice autorotation descents below 500 feet AGL and less than 40 KIAS over unprepared or rough terrain.
7. Intentional approaches to or inducement of retreating blade stall.

AUTOROTATION

100% Nr 5000 FT STD DAY

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

ENGINE: T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F077

Figure 4-5. Autorotation

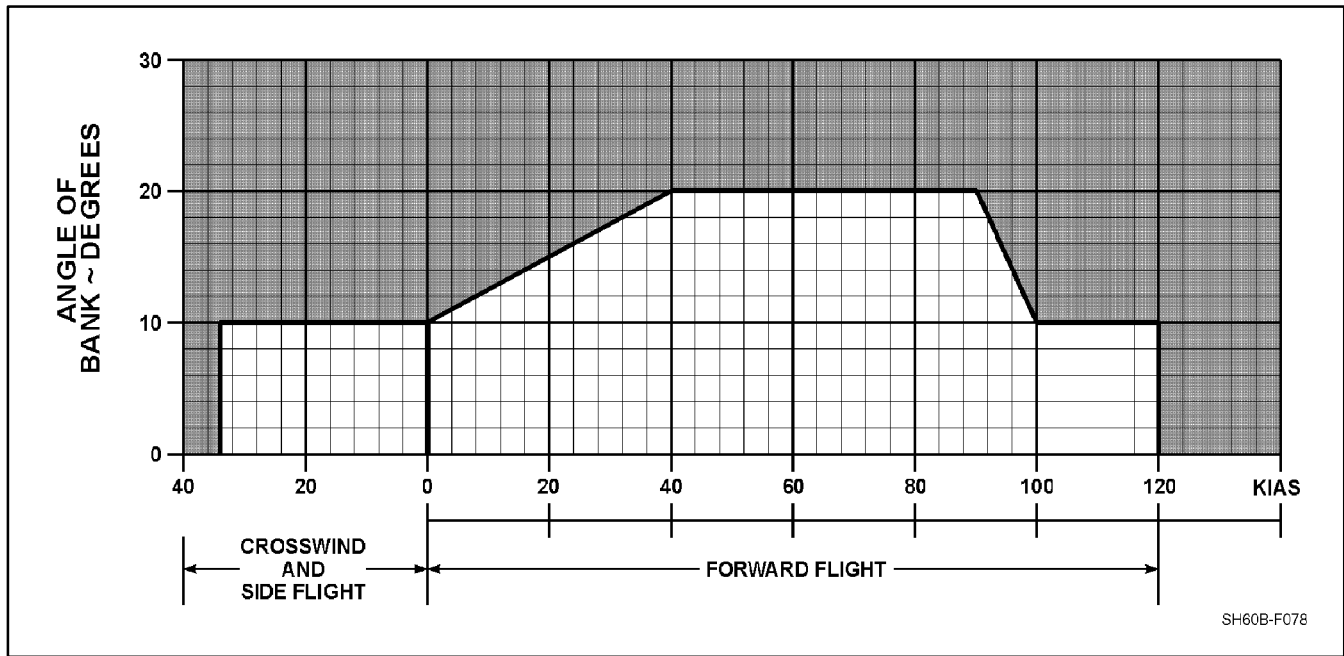


Figure 4-6. Sling/Rescue Hoist Load Maneuvering Limits

4.6 MISCELLANEOUS LIMITS

4.6.1 MAD Reeling Machine Operating Limits

The reeling machine duty cycle is 2 minutes operating and 15 minutes nonoperating.

1. MAD envelope:
 - a. Altitude: 200 feet AGL minimum
 - b. Deployment (cable payout):
Climb — 1,000 fpm; Descent — 0 fpm
Bank Angle — 0°
Airspeed — 40 to 90 KIAS.
2. Retrieval/docking:
 - a. For up to last 12 feet of cable: 40 to 90 KIAS in level flight. For last 12 feet of cable: 50 to 55 KIAS in level flight.
3. At full trail position:
 - a. Straight and level — 40 to 150 KIAS.
 - b. Level turns — Up to 45° angle of bank and between 40 to 120 KIAS.
 - c. Descents — 80 to 100 KIAS at up to 2,400 fpm.
 - d. Climbs — 80 to 100 KIAS up to max climb rate.
4. Recommended jettisoning profile — Straight and level, 0 to 60 KIAS.

4.6.2 Stores Limits

1. Release of the Mk 46 Torpedo (Mod 5, 5A, and 5A(S)) from the starboard pylon when the MAD is deployed is restricted to 80 KIAS.
2. Do not exceed the maximum sonobuoy launcher load weight of 800 pounds.

3. Minimum altitude for employment of sonobuoys is 100 feet AGL below 100 knots, or 150 feet AGL above 100 knots.
4. Minimum pressure to jettison all sonobuoys is 900 psi.

4.6.3 Rotor Brake Operating Limits

Maximum rotor speed for rotor brake application is 76 percent N_r . Routine rotor stops shall be done between 30 percent and 50 percent N_r . Routine rotor brake stops should be limited to 180 psi for extended rotor brake life.

4.6.4 Blade, Pylon/Stabilator Fold or Spread

Blades should not be folded or spread in winds of over 45 knots from any direction. Allow a 10-minute cooling period between a blade fold and spread evolution before recycling the blade-fold motors. Tail pylon/stabilator fold and spread operations are limited to a maximum windspeed of 45 knots.

4.6.5 Landing Limitations

Downwind landings should be avoided. Water landings are not permitted, except in an emergency. The following limitations apply:

1. Maximum rate of descent (sink rate) for level terrain shall not exceed 720 fpm (12 ft/s).
2. Maximum rate of descent for sloped terrain shall not exceed 360 fpm (6 ft/s).
3. Maximum forward touchdown speed shall not exceed 75 knots groundspeed, tail wheel locked, 20 knots with tail wheel unlocked.
4. Landing gear limitations: Maximum ground taxi speed is limited to 40 knots with aircraft equipped with tail gear shimmy damper, 20 knots for aircraft without shimmy damper.
5. Slope landing limitations: The following apply regardless of gross weight or cg:
 - a. 9° noseup slope
 - b. 6° nosedown slope
 - c. 12° cross slope.

4.6.6 Shipboard Wind Limitations

Wind limitations for shipboard operation are defined in the Pilot's Pocket Checklist (NAVAIR A1-H60BB-NFM-500) and Helicopter Operating Procedures for Air-Capable Ships NATOPS Manual NAVAIR 00-80T-122.

4.6.7 Emitter Hazard and Standoff Distances

See [Chapter 8](#) for emitter hazards and standoff distances.

4.7 WEIGHT LIMITATIONS

4.7.1 Weight Limits

The maximum gross weight of the helicopter is 21,700 pounds. The maximum gross weight internal load limit is 20,800 pounds. Maximum cargo floor loading is 225 pounds/square foot.

4.7.2 Center of Gravity Limitations

To ensure adequate control, the helicopter shall be loaded so that the center of gravity is between stations 346.8 and 364.0. Above 19,462 pounds gross weight, the center of gravity station limitations decrease with increasing weight. For a chart of these limitations and information on how to determine the center of gravity for any load condition, refer to the Weight and Balance Manual (NAVAIR 01-1B-40).

4.7.3 Cargo Hook Weight Limitation

The maximum weight that may be suspended from the cargo hook is limited to 6,000 pounds.

4.7.4 Rescue Hoist Weight Limitations

The maximum weight that may be suspended from the rescue hoist is 600 pounds.

4.8 MINIMUM EQUIPMENT

An **MPD** should be installed and functional at the sensor operator's station for the following operations and/or environments:

1. Unaided night flights without a visible horizon.
2. Any shipboard environment or operation.
3. AH/DM flights.

4.8.1 Minimum Equipment for Passengers

Flight without a functional seat for each occupant is prohibited, except in emergency situations.

4.8.2 Minimum Aircraft Equipment for Flights Into Forecast or Known Icing Conditions

All installed anti-ice/de-ice equipment (windshield, engine, rotor) shall be operational prior to flight. Refer to [Chapter 14](#) for specific information on flight in icing conditions.

Helicopters without blade de-ice equipment are prohibited from flight into icing conditions (ambient temperatures of +5 °C or below in visible moisture).

Helicopters equipped with operable anti-ice/de-ice equipment are permitted flight into forecast or known trace or light icing conditions.

WARNING

Flight into forecast or known moderate or severe icing conditions is prohibited.

4.8.3 Flight in Instrument Meteorological Conditions

The SH-60B is qualified for flight in instrument meteorological conditions (IMC).

4.8.3.1 Minimum Aircraft Equipment for Night or IMC Flight Over Land

1. Flight instruments:
 - a. Pilot and ATO attitude indicators
 - b. All pitot-static instruments (airspeed, vertical speed indicator (VSI), barometric altimeter (BARALT))
 - c. Pitot heat
 - d. One turn rate gyro
 - e. Pilot and ATO turn and slip indicators
 - f. One compass system
 - g. Standby compass with current calibration card
 - h. Radar altimeter
 - i. Clock.
2. All engine and transmission instruments

3. Adequate instrument, navigation, landing, cockpit, and cabin lighting
4. Radio equipment:
 - a. (1) UHF
 - b. ICS, all crewmembers
 - c. IFF, as required by Air Traffic Control (ATC) regulations.
5. Navigation systems:
 - a. NSIU
 - b. TACAN.
6. SAS-2, trim, autopilot
7. Two generators operable.

4.8.3.2 Minimum Aircraft Equipment for Night or IMC Flight Over Water

In addition to the equipment listed under [paragraph 4.8.3.1](#), the following equipment is required:

1. One of the following navigation systems must be operable:
 - a. Aircraft search radar
 - b. Tactical navigation system (SAC-1)
 - c. UHF/DF
 - d. Shipboard air search radar
2. Doppler (night SAR only)
3. Altitude hold (RADALT or BARALT).

4.9 ENVIRONMENTAL RESTRICTIONS

4.9.1 Temperature Limitations

Operations at temperatures below -40 °C (-40 °F) or above +60 °C (+140 °F) are prohibited.

4.9.2 Engine and Engine Inlet Anti-Ice Limitations

At engine power levels of 10 percent torque per engine and below, full anti-ice capability cannot be provided, due to engine bleed limitations. Avoid operation under conditions of extreme low power requirements such as high rate of descent (1,900 fpm or greater), or ground operation below 100 percent N_r, during icing conditions.

4.9.3 Backup Hydraulic Pump Hot Weather Limitations

Operation of the backup pump, without rotors engaged, is limited when OAT is +33 °C and above as depicted in [Figure 4-7](#). Limits do not apply to operation with rotors engaged.

| OAT (°C) | OPERATING TIME (MINUTES) | COOLDOWN TIME (MINUTES) |
|---------------|--------------------------|-------------------------|
| +33 to +38 | 24 | 72 |
| +39 and above | 16 | 48 |

Figure 4-7. Backup Pump Limits

4.9.4 APU Operating Limitations

To prevent APU overheating, APU operation at ambient temperature of 43 °C and above with engine and rotor operating is limited to 30 minutes. With engine and rotor not operating, the APU may be operated continuously up to an ambient temperature of 51 °C.

PART II

Indoctrination

Chapter 5 — Aircrew Training, Qualifications, and Requirements

CHAPTER 5

Aircrew Training, Qualifications, and Requirements

5.1 FLIGHTCREW QUALIFICATIONS

5.1.1 Qualifications

All aircrew meeting the following minimum qualifications are subject to NATOPS evaluation checks in the SH-60B.

5.1.2 Waiver of Requirements

Squadron Commanding Officers are authorized to grant written waivers of flight and/or training requirements when an individual's experience warrants such action.

5.2 PILOT QUALIFICATIONS

Pilots shall be designated in writing by the commanding officer in accordance with OPNAVINST 3710.7 (series) and this manual. Pilots shall be designated using the following classifications: H-60 Pilot Qualified in Model, SH-60B Helicopter Second Pilot, SH-60B Helicopter Aircraft Commander, and SH-60B Functional Checkflight Pilot. Tactical/mission qualifications shall be attained per applicable instructions.

5.2.1 H-60 Pilot Qualified in Model

In addition to completing the requirements specified in OPNAVINST 3710.7 (series) for personnel authorized to pilot naval aircraft, an H-60 Pilot Qualified in Model (PQM) shall:

1. Satisfactorily complete an H-60 Fleet Replacement Squadron (FRS) syllabus or other CNO-approved training syllabus for qualification as an H-60 PQM.

5.2.2 SH-60B Helicopter Second Pilot (H2P)

In addition to the requirements set forth for an H-60 PQM, an SH-60B Helicopter Second Pilot (H2P) shall:

1. Meet the requirements for H2P specified in OPNAVINST 3710.7 (series).
2. Satisfactorily complete an SH-60B Fleet Replacement Squadron (FRS) syllabus or other CNO-approved training syllabus.
3. Satisfactorily complete an approved SH-60B H2P syllabus.

5.2.3 SH-60B Helicopter Aircraft Commander

In addition to completing the requirements set forth for an SH-60B H2P, an SH-60B Helicopter Aircraft Commander (HAC) shall:

1. Meet the requirements for HAC specified in OPNAVINST 3710.7 (series).
2. Satisfactorily complete an approved SH-60B HAC PQS syllabus.

Note

Prior SH-60B HACs are not required to complete applicable H2P syllabus.

5.2.4 SH-60B Functional Checkflight Pilot

In addition to completing the requirements set forth for an SH-60B HAC, an SH-60B Functional Checkflight Pilot (FCP) shall:

1. Complete a squadron SH-60B FCP indoctrination program.
2. Be designated in writing by the Commanding Officer.

5.2.5 Airborne Tactical Officer

An ATO shall:

1. Satisfactorily complete an approved FRS SH-60B Airborne Tactical Officer (ATO) training syllabus or an approved equivalent.
2. Have 30 ATO hours in model and series or in an approved tactical trainer.
3. Satisfy all minimum qualification requirements set forth for pilot qualification in model.

5.2.6 NATOPS Instructor/Assistant NATOPS Instructor

In addition to the requirements set forth for HAC, a NATOPS Instructor/Assistant NATOPS Instructor (NI/ANI) shall:

1. Complete a squadron NI/ANI indoctrination program.
2. Participate in a TYCOM NATOPS evaluator standardization program where applicable.
3. Be designated in writing by the Commanding Officer.

5.2.7 Night Vision Device Pilot

1. Satisfy all minimum requirements set forth for PQM.
2. Satisfactorily complete a Type-Wing approved Night Vision Device (NVD) Pilot Syllabus.

5.2.8 Night Vision Device Pilot Instructor

1. Satisfy all minimum requirements set forth for PQM.
2. Satisfactorily complete a Type-Wing approved NVD Instructor Pilot Syllabus.

5.2.9 Minimum Pilot Currency Requirements

An SH-60B pilot must meet the following minimum requirements in order to be considered current in model:

1. Maintain a current NATOPS evaluation in model.
2. Maintain a current instrument rating in accordance with OPNAVINST 3710.7 (series).
3. Satisfy night and instrument minimum flying hours as set forth in OPNAVINST 3710.7 (series).

5.2.9.1 Pilot Currency Requirements

If currency has lapsed, currency shall be regained by the non-current pilot flying with a current HAC. At the discretion of the Commanding Officer, two non-current HACs may fly together to regain currency.

5.2.9.1.1 Night Currency Requirements

To be considered current, pilots shall have flown 2 hours of night time within the past 45 days. If night currency expires, pilots shall fly 2 hours of night time to regain currency. Unaided or aided night flight is considered night time.

5.3 PILOT SHIPBOARD QUALIFICATIONS

Pilots shall be familiar with the shipboard procedures contained in the CV NATOPS, LHA/LHD NATOPS, and NA 00-80T-122 publications. Initial qualification shall proceed in a build-up fashion. For initial qualification, day operations shall precede night operations, and unaided operations shall precede NVD operations.

5.3.1 Shipboard Landing Qualifications

A DLQ evolution consists of flight at pattern altitude, and approach, a transition to a hover, a landing to a ship deck, and a departure into the pattern again.

Note

Free deck (FD) landing refers to a landing into the RSD with main probe. Recovery Assist (RA) landing refers to a landing using the RA cable and RSD. Clear Deck (CD) landing refers to landing aboard either a non-RAST ship or a RAST-equipped ship without utilizing any RAST system features.

5.3.1.1 Initial Shipboard Landing Qualification

Initial landing qualification requirements are listed in Figure 5-1.

| TYPE | DAY | NIGHT (unaided) | NVD |
|-------------------------------|-----|-----------------|-----|
| Aviation Ship | 3 | 3 | 3 |
| Air Capable Ship (clear deck) | 6 | 6 | 6 |
| Air Capable Ship (free deck) | 6 | 6 | 6 |
| Air Capable Ship (RA) | 2 | 2 | 1 |

Note

- To facilitate completing RA/Free deck initial qualifications the approaches may be cut in half allowing one approach and two landings.
- Free deck qualification confers clear deck qualification.
- Free deck landings in lieu of RA landings are not acceptable for initial qualification.
- Initial night landing qualification shall be preceded by one day landing within the previous six days.
- At least one RA landing shall consist of a full approach, hookup, hover tension, and landing sequence.

Figure 5-1. Initial Shipboard Landing Qualifications

5.3.1.2 Shipboard Landing Currency and Requalification Requirements

The minimum landing currencies for air capable ships and aviation ships are presented in Figure 5-2. If currency has lapsed for more than 1 year, the requirements for the initial shipboard landing qualification shall be completed.

| TYPE | DAY | NIGHT (UNAIDED) | NVD |
|-------------------------------|-------|-----------------|------|
| Aviation Ship | 2/365 | 2/90 | 2/90 |
| Air Capable Ship (clear deck) | 4/180 | 4/60 | 4/90 |
| Air Capable Ship (free deck) | 4/180 | 4/60 | 4/90 |
| Air Capable Ship (RA) | 1/180 | 1/60 | 1/90 |

Note

- Free deck qualification confers clear deck qualification.
- Free deck landings into the RSD are acceptable to maintain currency if RA cable is not available.
- During requalification, night and/or NVD qualification confers day qualification, and air capable ship qualification confers aviation ship qualification.

Figure 5-2. Shipboard Landing Currency Requirements (Number of DLQ Evolutions Required/Currency Duration in Days)

5.3.2 Pilot VERTREP Qualifications

5.3.2.1 Initial VERTREP Qualification

Initial VERTREP qualification should be attained via a CNO-approved syllabus in the FRS.

5.3.2.2 Shipboard VERTREP Currency and Requalification Requirements

To maintain shipboard VERTREP currency, a pilot shall have completed:

1. Four day shipboard VERTREP evolutions within the last 365 days.

If currency has lapsed for more than 1 year, the requirements for initial VERTREP qualification shall be completed.

Note

During VERTREP requalification, night qualification confers day qualification.

5.3.3 Landing Safety Officer (LSO)

5.3.3.1 LSO Initial Qualifications

Satisfy the following initial qualification requirements:

1. Straightening/Traversing: Four evolutions.
2. Recoveries:
 - a. RA — Five Day/five night.
 - b. **FD** into the RSD — Five Day/five night.

Note

Qualified personnel authorized to perform traverse operations shall complete a squadron-approved training syllabus and be designated in writing by the commanding officer.

5.3.3.2 LSO Currency/Requalification

Two day RA recoveries and two day free deck recoveries are required every 90 days to satisfy day currency requirements. Two night RA recoveries and two night free deck recoveries are required every 90 days to satisfy night currency requirements.

If currency expires, requalification shall consist of a minimum of six day and six night recoveries, three of each shall be free deck into the RSD.

If an LSO has not maintained currency for 12 months or more, requirements for requalification shall be the same as for initial qualification with the exception of straightening/traversing evolutions not being required. Free deck landings into the RSD are acceptable as requalification or continuation of qualification if RA cable is not available.

Note

Satisfying night currency/requalification requirements fulfills day and night currency/requalification requirements.

5.3.3.3 LSO Instruction

If all currency requirements are met, the LSO may act as safety observer to instruct trainees. The LSO acting as safety observer will be credited for each type of evolution he/she instructs.

5.4 AIRCREWMAN QUALIFICATIONS

Helicopter aircrewman shall be qualified in accordance with OPNAVINST 3710.7 (series), NAVPERS INST, TYPE/WING Commander instructions, and pertinent sections of this manual. All aircrew designations shall be made by squadron Commanding Officers. All crewmembers meeting the following minimum qualifications are subject to NATOPS evaluation checks in the SH-60B. Aircrewmen are eligible for the following designations once meeting the listed requirements.

1. Sensor Operator (SO) LEVEL I.
 - a. Satisfactorily complete either an approved FRS SH-60B aircrewman or CNO approved equivalent syllabus.
 - b. Have a minimum of 50 flight hours actual or simulated experience as an SUW/ASW Sensor Operator.
 - c. Have a minimum of 20 flight hours actual experience in the SH-60B.
2. Journeyman Sensor Operator (JSO) LEVEL II.
 - a. Successfully complete applicable SH-60B PQS or approved Type/Wing equivalent syllabus.
3. Master Sensor Operator (MSO) LEVEL III.
 - a. Successfully complete applicable SH-60B PQS or approved Type/Wing equivalent syllabus.
4. Instructor Sensor Operator (ISO) LEVEL IV.
 - a. Successfully complete applicable SH-60B PQS or approved Type/Wing equivalent syllabus.
5. Aerial Door Gunner.
 - a. Successfully complete applicable SH-60B PQS or approved Type/Wing equivalent syllabus.
6. Search and Rescue Aircrewman.
 - a. Be fully qualified as a search and rescue swimmer in accordance with OPNAVINST 3710.7 (series).
7. Search and Rescue Medical Technician.
 - a. Be fully qualified Search and Rescue Medical Technician in accordance with OPNAVINST 3730.7 (series), OPNAVINST 3130.6 (series), and NAVMEDCOMINST 1510.17 (series).

5.4.1 Special Mission/Lookout Non-Aircrewman Initial Qualification

Each squadron is allowed temporary non-crewmember flight orders (TFO) to permit non-SUW/ASW aircrewmen (e.g., maintenance personnel) to fly as the commanding officer may direct.

1. Complete an approved squadron flight and ground training syllabus.
2. Fully qualify in:
 - a. Ground/line safety procedures.
 - b. ICS/radio voice procedures.
 - c. Lookout/safety procedures.
 - d. In-flight emergency procedures.
 - e. Refueling procedures.
 - f. Use of the pocket checklist.
3. Meet the requirements as set forth in NATOPS General Flight and Operating Instructions (OPNAVINST 3710.7 series).
4. Log a minimum of 10 flight hours experience in SH-60B.
5. Satisfactorily complete an SH-60B NATOPS evaluation.

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5.4.2 Night Vision Device (NVD) Aircrewman

1. Must satisfactorily complete a Type-Wing approved [NVD](#) Aircrewman Syllabus.

5.4.3 Night Vision Device (NVD) Aircrewman Instructor

1. Must satisfactorily complete a Type-Wing approved NVD Aircrewman Instructor Syllabus.

5.4.4 Aircrew Currency Requirements

Crewmembers meeting the requirements of OPNAVINST 3710.7 series and NTTP 3-50.1 will be considered current in all respects.

5.4.4.1 Special Mission/Lookout Non-Aircrewman

1. Crewmembers shall meet the requirements of OPNAVINST 3710.7 series while assigned to temporary flight duty.
2. A NATOPS evaluation will be administered if the individual is assigned temporary flight orders after a period of 120 days or more on non-flight duty.

5.4.5 Qualified Observer

A qualified observer is an individual who has met all of the minimum aeromedical and survival requirements for indoctrination flights set forth in NATOPS General Flight and Operating Instructions (OPNAVINST 3710.7 series) and has been thoroughly briefed in accordance with Qualified Observer Brief in [Chapter 6](#).

5.5 GROUND TRAINING REQUIREMENTS

The following minimum requirements are established for qualification in a non-tactical category. Additional qualification requirements for Surface Warfare/Anti-Submarine Warfare (SUW/ASW) tactical operation shall be the approved Fleet Readiness Squadron (FRS) Training Syllabus or an approved equivalent.

5.5.1 Flightcrew Ground Training

1. NAMTD Pilot's Course (or equivalent).
2. Ground school syllabus.
3. Flight operation lectures.
4. Flight manual and ground school exams.

5.5.2 Aircrewman Ground Training

1. Ground school syllabus.
2. SH-60B familiarization lectures.
3. Helicopter safety and survival equipment.
4. Flight manual and ground school exams.

5.6 MINIMUM FLIGHTCREW REQUIREMENTS

The minimum flightcrew requirements for specific flights and missions are:

1. Non-tactical/Familiarization flights — Two H2Ps or one HAC and a qualified observer.
2. Functional checkflights — One [FCP](#), one qualified observer, and one aircrewman or [TFO](#) crewmember.
3. Orientation flights — One HAC, one qualified observer, and one aircrewman.

4. Utility missions (passenger and cargo transport, ferry flights, etc.) — One HAC, one PQM, and one utility aircrewman.
5. SAR missions (One HAC, one PQM, one SH-60B aircrewman, and one H-60 rescue swimmer).

Note

Squadron commanding officers are authorized to grant waivers of aircrew qualification requirements when the experience of the individual warrants such action.

5.6.1 SUW/ASW Operational Missions

One HAC, one ATO, and one SUW/ASW sensor operator.

5.6.2 Flights from Air-Capable Ships

Day, VMC — Two H2Ps and one helicopter aircrewman; or one HAC, one qualified observer, and one helicopter aircrewman.

Night or IMC — One HAC, one PQM, and one helicopter aircrewman.

5.6.3 Instrument Flight

Flightcrew for planned instrument flight shall consist of one HAC and one Designated Naval Aviator (DNA) or two H2Ps. Flights in which IMC conditions are simulated through visually restrictive devices shall include a qualified observer in the cabin area. All pilots must hold a valid instrument rating with the exception of the DNA who is receiving instrument refresher training, or if on an instrument check flight.

5.7 RECOMMENDED REQUIREMENTS FOR TRANSITIONING NAVAL AVIATORS

The requirements for transitioning of non-helicopter designated pilots shall be governed by the provision of NATOPS General Flight and Operating Instructions (OPNAVINST 3710.7 series).

5.8 PERSONAL FLYING EQUIPMENT REQUIREMENTS

Flight personnel shall be familiar with and utilize those items of flight clothing and survival and rescue equipment as prescribed in the current NATOPS General Flight and Operating Instructions (OPNAVINST 3710.7 series). In addition, the pilot in command of an aircraft engaged in carrying crewmen or passengers shall ensure their compliance with this instruction.

PART III

Normal Procedures

[Chapter 6](#) — Flight Preparation

[Chapter 7](#) — Normal Procedures

[Chapter 8](#) — Shipboard Procedures

[Chapter 9](#) — Special Procedures

[Chapter 10](#) — Functional Checkflight Procedures

CHAPTER 6

Flight Preparation

6.1 MISSION PLANNING

Mission Planning shall be conducted in compliance with OPNAVINST 3710.7 (Series) Publications.

Note

Exact values for each aircraft weight and moment are found on the DD Form 365-F and shall be used for Flight Planning.

6.2 BRIEFING/DEBRIEFING

6.2.1 General Briefing

Planning and flight briefings will be conducted by the PIC or flight leader. A briefing guide or syllabus card may be used to conduct the brief. The brief should be clear, concise, and accurate; allowing input from all crewmembers. The brief shall include, but is not limited to, the following items:

1. General.
 - a. Flight crew assignments/currency.
 - b. Crew/Mission Operational Risk Management (ORM).
 - c. Aircraft, call sign(s), Aircraft Discrepancy Books (ADB).
 - d. Timeline (preflight, manning, takeoff, hot seat, land).
2. Mission.
 - a. General tasking (FAM/INST/TERF/NSW/etc.).
 - b. Operating area.
 - c. Bingo.
 - d. Terminate/"Knock it off".
 - e. SAR capability.
3. Flight Planning.
 - a. Weather.
 - (1) Current conditions.
 - (2) Forecast (OPAREA/recovery).
 - b. Abort criteria.
 - c. Notice To Airmen (NOTAM).
 - d. Aircraft performance calculations.
 - e. Fuel availability.
 - f. Nav-bag/fuel packet/flight gear.
4. Communication/Navigation.
 - a. Frequencies/NAVAIDS.
 - b. Radio procedures.

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- c. Lost Comm.
- d. IFF/Air Defense Identification Zone (ADIZ).
- 5. Flight Crew Coordination/CRM.
 - a. Control transfer.
 - b. Lookout procedures.
 - c. Night/IMC considerations.
 - d. Vertigo/disorientation.
 - e. Altitude/Airspeed warnings.
 - f. Dual-concurrence/call items.
- 6. Emergency Procedures.
 - a. Aircraft control.
 - b. IMC/VMC emergencies.
 - c. Fires.
 - d. Loss of tail rotor control/drive.
 - e. Engine Failure Hover/Forward Flight.
 - f. Ditching/egress.
 - g. Simulated emergencies.

6.2.2 Mission-Specific Briefing

Conducted, as applicable, when performing a mission. White board brief may be used to supplement the mission-specific brief for safety of flight issues. The mission-specific brief shall be incorporated for safety of flight issues and CRM for each applicable mission.

- 1. Functional Checkflight.
 - a. Test requirements (profile/system evaluated).
 - b. CRM.
- 2. Confined Area Landing (CAL)/Landing Zone (LZ).
 - a. Location (MGRS/lat-long).
 - b. Depiction (chart/drawing/photo).
 - c. Site evaluation.
 - d. Orientation.
 - (1) Magnetic heading.
 - (2) Landing point.
 - e. Markers (panels/smoke).
 - f. Waveoff procedures.
 - (1) General heading.
 - (2) Obstacles.
 - (3) Effects of wind/dust/snow/debris.
 - (4) Reentry procedure.

3. Formation.
 - a. Number of aircraft, call signs.
 - (1) Flight lead.
 - (2) Responsibilities.
 - b. Type of formation (parade/cruise/combat).
 - c. Positioning requirements (bearing/distance).
 - (1) Takeoff/landing.
 - (2) En route.
 - d. Formation maneuvers.
 - e. Lead change.
 - (1) Comm/visual.
 - (2) Lost comm.
 - f. Emergency procedures.
 - (1) Aircraft emergencies.
 - (2) Inadvertent IMC.
 - (3) Loss of visual contact.
 - (4) Waveoff (flight/individual).
4. Logistics.
 - a. Cargo/personnel manifest and brief.
 - b. CG/weight limitations.
 - c. Internal cargo security/tiedown.
5. NVDs.
 - a. Comfort level/safety.
 - b. Area/route.
 - c. Light level/weather effects.
 - d. Minimum altitude.
 - e. Lighting (internal/external/LZ).
 - f. Maneuvers.
 - g. Emergency procedures.
 - (1) Aircraft emergencies.
 - (2) NVD Failures.
 - (3) Inadvertent IMC.
6. Terrain Flight (TERF).
 - a. Comfort level/safety.
 - b. Area/routes/LZ.
 - c. Light level/effects/weather.
 - d. Minimum altitude to be flown.

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- e. Airspeed to be flown.
 - f. Power check requirements.
 - g. Minimum essential equipment.
 - h. Lighting (internal/external/LZ).
 - i. Maneuvers (bunt/roll/externals/guns/Electronic Warfare [EW]/etc.).
 - j. Low attitude emergencies.
 - (1) Aircraft emergencies.
 - (2) Inadvertent IMC.
7. SAR.
- a. Scenario.
 - b. Lookout.
 - c. Equipment preparation.
 - d. Smoke/matrix light use.
 - e. Hover coordination (crew hover/verbal).
 - f. Swimmer deployment.
 - g. Aircraft emergency procedures.
 - h. Lost ICS procedures.
 - i. Bingo/Red Light fuel and location.
8. Shipboard operations.
- a. Unit, type, hull number, TACAN, call sign.
 - b. Certification/compatibility.
 - c. DLQ patterns.
 - d. Comm/visual signals.
 - (1) Waveoff.
 - (2) Fouled deck.
 - e. Emergency procedures.
9. VERTREP.
- a. Ship certification/deck utilization.
 - b. VERTREP patterns.
 - c. Comm/visual signals.
 - (1) Waveoff.
 - (2) Fouled deck/load.
 - d. External load hookup/release.
 - e. External load flight (airspeed/bank angle).
 - f. Emergency procedures.

10. Weapons.
 - a. Weapon type/configuration.
 - b. Operating area.
 - c. Target location/type.
 - d. Control procedures.
 - (1) Loading/unloading.
 - (2) Voice procedures.
 - (3) Weapon conditions (hold/tight/free).
 - (4) Release authority.
 - e. Emergency procedures.
 - (1) Aircraft emergencies.
 - (2) Weapon malfunctions.
 - (3) Lost ICS.
11. ASW.
 - a. Environmental conditions.
 - b. Assets available.
 - c. Target Characteristics.
 - d. Weapons/Stores.
 - e. Tactical coordination.
 - f. Comm coordination.
 - g. Tactics.
 - (1) Search.
 - (2) Detect.
 - (3) Attack.
 - (4) Lost Contact.
 - h. BHA.
 - i. Contingencies.
 - j. Emergency procedures.
12. ASuW.
 - a. Environmental conditions.
 - (1) FLIR performance.
 - (2) LASER performance.
 - (3) Other.
 - b. Assets available.
 - c. Target Characteristics.
 - (1) Recognition features.
 - (2) Aim Points.

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- d. Stand-off ranges.
 - e. LASER considerations.
 - (1) Safety.
 - (2) Octal Codes.
 - (3) Spot Size.
 - (4) Backscatter.
 - f. Weapons/Stores.
 - g. Weaponeering.
 - (1) Mission Kill.
 - (2) Hard Kill.
 - h. Tactics.
 - (1) Search.
 - (2) Detect.
 - (3) Track.
 - (4) Attack.
 - (a) Autonomous.
 - (b) Remote.
 - i. BHA.
 - j. Communication Coordination.
 - k. Contingencies.
 - l. Emergency procedures.
13. Integrated Self-Defense (ISD)/Aircraft Survivability Equipment (ASE) Gear.
- a. Hazards/Threats.
 - b. Defense.
 - c. Radar Warning System.
 - (1) Indications.
 - (2) Setting.
 - d. Infrared Countermeasures (IRCM).
 - (1) Setting.
 - e. Chaff/Flare Dispenser.
 - (1) Setting.
14. Naval Special Warfare (NSW)/Embarked troop operations.
- a. Unit, call sign, frequency.
 - b. Rendezvous location/operating area.
 - c. Equipment (Special Purpose Insertion Extraction [SPIE]/Rappel/Combat Rubber Raiding Craft[CRRC]).
 - d. Aircraft rigging/responsibilities.
 - e. Embark/debark procedures.

- f. Troop weapons discipline.
- g. Execution.
 - (1) Altitude.
 - (2) Airspeed.
 - (3) Rope length.
 - (4) Visual signals.
 - (5) Cabin configuration/coordination.
- h. Emergency procedures.
 - (1) Aircraft emergencies.
 - (2) Waveoff/abort.
 - (3) MEDEVAC/CASEVAC.

6.2.3 Gunner Brief

- 1. Airborne/en route phase.
 - a. Position of aircraft in flight.
 - b. Sectors of fire (primary and secondary locations).
 - c. Lock and load (geographic location).
 - d. Test fire (location), if applicable.
 - e. Types of targets anticipated.
 - f. Clearance points for WEAPONS FREE, WEAPONS TIGHT, and WEAPONS HOLD.
 - g. Estimated airspeed and altitude (for lead and lag estimates).
 - h. Voice calls (e.g., taking fire, small arms).
 - i. Clearance for troops on board and sectors of fire.
 - j. Position of escorts.
- 2. Landing/assault phase.
 - a. Sectors of fire (primary and secondary).
 - b. Landing position (primary and secondary).
 - c. Last known position of friendly and enemy units.
 - d. Expected employment of embarked troops (e.g., perimeter around landing zone).
 - e. Escort procedures while in landing zone.
 - f. Destruction of weapons if needed.

6.2.4 Qualified Observer Brief

- 1. Cockpit procedures.
 - a. Checklist.
 - b. Communications (external/internal).
 - c. Switches and levers (cockpit familiarization).

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2. Assistance during actual emergencies.
 - a. Engine failure (hover/forward flight).
 - b. Engine fire.
 - c. Tail rotor loss of control/drive.
3. Emergency egress.

6.2.5 Passenger Brief

It shall be the responsibility of the PIC to ensure all passengers are adequately briefed before flight (**Figure 6-1**). The brief shall contain the following:

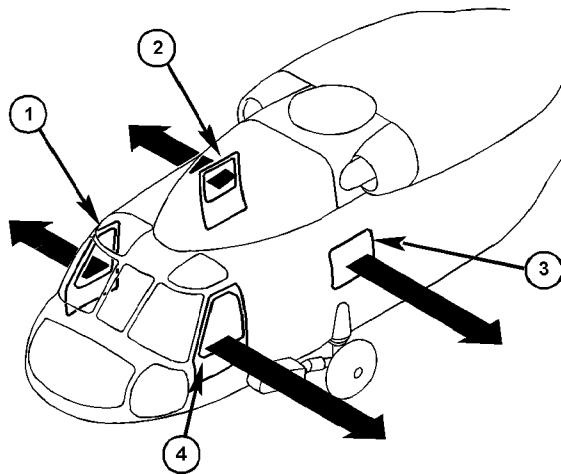
1. Survival equipment (proper wear and use).
2. Entry and exit procedures.
3. Aircraft side number.
4. Hoisting procedures utilizing rescue sling.
5. Gear/equipment stowage.
6. Emergency procedures.
 - a. Ditching/egress.
 - (1) Overland.
 - (2) Overwater.
 - b. Emergency exits.
 - (1) Doors.
 - (2) Jettisonable windows.

6.2.6 Debriefing

A proper debriefing should contain constructive criticism and be conducted in such a manner that all concerned can participate and present their ideas on the conduct of the flight. Each flight shall be thoroughly debriefed as soon as practical upon return by the Pilot in Command/Flight Lead. The debrief should contain the following:

1. Roll call.
2. Brief/mission planning.
 - a. Mission objectives.
 - b. Smartpack.
 - c. Intelligence.
 - d. Items missed in brief.
 - e. Adequate force composition.
 - f. Asset positioning and flow.
 - g. Navigation route.
3. Mission administration.
 - a. Adequate timeline.
 - b. Weather.
 - c. Emergencies/equipment problems.
 - d. Safety of flight issues.
 - e. Communications plan.

4. Mission specific (as applicable).
 - a. CSAR/NSW.
 - (1) Formation.
 - (2) Mission profile (tasking/C3).
 - (3) Search/location/authentication.
 - (4) Ingress (navigation/altitude/timing).
 - (5) Objecting area.
 - (a) Landing zone (selection/approach/landing).
 - (b) Insertion/extraction method.
 - (c) Threats.
 - (6) Egress (navigation/altitude/timing).
 - (7) Weapons employment (target/BHA).
 - b. ASW.
 - (1) Environmental conditions.
 - (2) Mission profile (tasking/C3).
 - (3) Datum.
 - (4) Sensor utilization (sensor depth/type).
 - (5) Search phase (area assigned/pattern).
 - (6) Tracking phase.
 - (7) Attack phase.
 - (8) Weapons employment (target/BHA).
 - c. ASuW.
 - (1) Environmental conditions (effects on FLIR).
 - (2) Mission profile (tasking/C3).
 - (3) Search phase.
 - (4) Location/classification/rigging.
 - (5) Target characteristics.
 - (6) LASING procedures.
 - (7) Weapons employment.
 - d. SAR.
 - (1) Notification.
 - (2) Preparation (Cabin/TACNAV setup).
 - (3) Search.
 - (4) Survivor recovery.
 - (5) Survivor delivery.
5. Determine mission success.



1. PILOT JETTISONABLE WINDOW — PULL HANDLE FORWARD.
2. CABIN DOOR WITH JETTISONABLE WINDOW — PULL HANDLE FORWARD.
3. SENSOR OPERATOR JETTISONABLE WINDOW — PULL HANDLE AFT.
4. ATO JETTISONABLE WINDOW — PULL HANDLE FORWARD.

1. KEEP YOUR SEATBELT FASTENED TIGHTLY UNTIL READY TO DEPART THE AIRCRAFT. STAY STRAPPED IN UNTIL DIRECTED BY THE CREWMAN.
2. KEEP YOUR CRANIAL AND LIFEVEST ON AT ALL TIMES.
3. ORIENT YOURSELF WITH RESPECT TO THE EMERGENCY EXITS IN AIRCRAFT DIAGRAM.
4. ALL EXITS CAN BE JETTISONED BY PUSHING FORWARD THE YELLOW HANDLE EXCEPT THE SENSOR OPERATOR, WHICH MUST BE PULLED AFT. THE WINDOWS CAN THEN BE PUSHED OUT.

IN CASE OF A CRASH OR DITCHING:

1. REMAIN STRAPPED IN UNTIL ALL MOTION HAS STOPPED.
2. IF THE AIRCRAFT REMAINS UPRIGHT, REMAIN STRAPPED IN AND WAIT FOR INSTRUCTIONS FROM THE CREW.
3. GRAB A REFERENCE POINT.
4. AFTER THE AIRCRAFT ROLLS OVER IN THE WATER AND ALL VIOLENT MOTION HAS STOPPED, UNSTRAP AND EXIT THE AIRCRAFT IMMEDIATELY BY THE NEAREST EXIT. DO NOT INFLATE YOUR FLOTATION EQUIPMENT UNTIL YOU ARE OUTSIDE THE AIRCRAFT. DO NOT KICK.
5. REMAIN CLEAR AND UPWIND OF THE HELICOPTER. DON'T PANIC.

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Figure 6-1. Passenger Briefing Card

CHAPTER 7

Normal Procedures

7.1 LINE OPERATIONS

Observe flight line safety practices in accordance with NAV-SOP-2455 (series).

7.2 FLIGHT SCHEDULING

Specific requirements are listed in OPNAVINST 3710.7 (series).

7.3 PREFLIGHT

Prior to flight, the PIC shall ensure that a complete visual check of the helicopter has been conducted. The preflight inspection should be divided among the pilot, copilot, and aircrewmembers.

7.3.1 General

Note

- In each location (Figure 7-1), inspect for corrosion, Foreign Object Damage (FOD), condition, and security.
- Check that all securing hardware is safety-wired, cotter-keyed, and/or slipmarked.
- Plastic caps on avionics present a FOD hazard; check for security.

1. Chocks/Tiedowns — IN PLACE (as required).
2. Underside of all main rotor blades and tip caps.
3. All inlet/exhaust plugs and pitot-static tube covers — REMOVE.

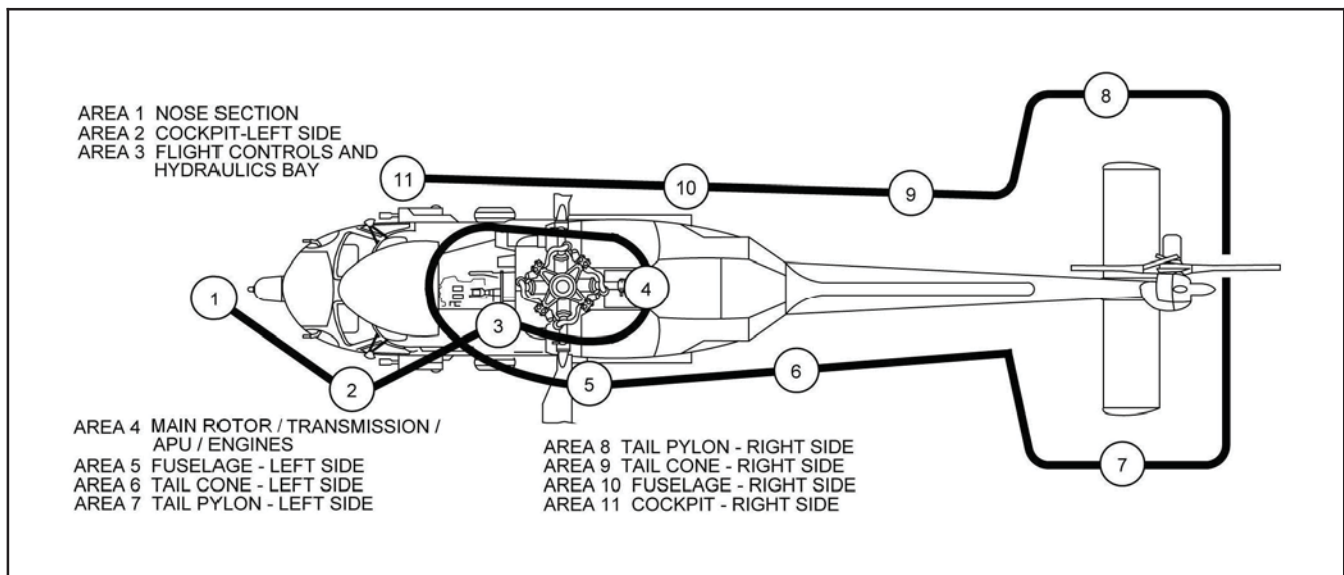


Figure 7-1. Inspection Diagram

4. Sonobouy launcher valve safety lockout in the LOCK position. FREE position if no sonobouys installed.

WARNING

Sonobouy launcher valve safety lockout shall be in the SAFE position when sonobouys are installed while in the vicinity of ground personnel.

5. If weapons are loaded, refer to technical manual, Airborne Weapons/Stores Loading Manual (A1-H60BB-LWS-720), for appropriate weapon preflight instructions.

7.3.2 Nose Section (Area 1)

1. Windshield, wipers, OAT gauges/probes, and pitot tubes.
2. Avionics compartment.

CAUTION

Care must be taken when opening the nose avionics compartment to prevent water intrusion damage.

- a. LASER ENABLE/DISABLE switch — AS REQUIRED.

Note

If LASER ENABLE/DISABLE switch is in the DISABLE position, the LASER DISABLED advisory will be continuously illuminated.

- b. GIMBAL switch — ENABLE (as required).
3. Antennas.
4. Searchlight — STOWED.
5. FLIR (if installed).
 - a. FLIR turret — STOW POSITION.
 - b. FLIR turret cables — CONNECTED.
 - c. FLIR nose mount — SECURE.
 - d. FLIR nose mount grounding straps — SECURE.
 - e. Bore sight module — REMOVED.

7.3.3 Cockpit - Left Side (Area 2)

1. Door.
2. Seat and harness.

WARNING

Do not stow articles or equipment under seats or in seat wells. These objects can interfere with proper seat stroking and reduce their energy-absorbing performance during impact.

3. Battery/Avionics well.
4. Flight controls.
5. **WPS** — SELECT A or B.
6. Radar pressure pop-out button — NOT POPPED.
7. FLIR **HCU**.
8. Verify AN/ASQ-198 weapon type selection switches are in appropriate position for proper ordnance loaded.

WARNING

If weapon type selection switch does not match actual ordnance loaded, weapon malfunction may occur.

7.3.4 Flight Controls and Hydraulics Bay (Area 3)

1. Engine inlets.

WARNING

With gusty or sustained wind conditions in excess of 10 knots, nearby jet blast or rotor wash, the hydraulics bay cover can be blown off when in transit or in the open position and may cause loss of the door and/or personnel injury.

2. Pilot-assist module PDI — FLUSH.
3. Mixing unit.
4. Collective bias tube/LDS cable.

WARNING

Improper installation of the LDS roll pin may result in an engine overspeed. Proper installation is indicated by the LDS roll pin protruding from both sides of the LDS control cable rod and the collective bias tube with the safety wire intact.

5. Hydraulic pump modules — FLUID LEVEL, FILTER, PDIs FLUSH AND QUICK DISCONNECT LINES SECURE.
6. Primary servos.
7. Ensure hydraulic lines are secure by Adel clamps and not contacting each other or any structure of the helicopter.
8. Accessory and input modules.
9. Generators.

10. LDS roll pins and mounts.

WARNING

Improper LDS installation may result in an engine overspeed or other engine malfunctions.

11. Hydraulic hand pump service reservoir:
 - a. Fluid level.
 - b. Hydraulic service valve selector pointed toward reservoir (#4 position).
 - c. Cap secure.

7.3.5 Main Rotor/Transmission/APU/Engines (Area 4)

1. Main rotor system, accumulator level/pressure, dampers, blades, BIM® indicators, elastomeric bearings, droop stops, flap restraints, centering sockets, **PCRs** and scissor bearings.

WARNING

- If black is visible on the BIM® indicator, it may be an indication of blade damage. The cause of the black indication shall be determined prior to flight.
 - Do not exceed open engine cowling work platform weight limits. Excess weight may cause failure of the composite rib hinge assembly and result in serious injury to personnel.
2. MRB lockpins and pitch locks.
 - a. Blades spread — MRB LOCKPINS ENGAGED, PITCH LOCKS RETRACTED, FLAP RESTRAINT CAMS DO NOT BIND AND ARE FREE TO ROTATE.
 - b. Blades folded — MRB LOCKPINS FULLY RETRACTED, PITCH LOCKS ENGAGED.
 3. Engine oil filler caps — SECURE.
 4. NO. 1/NO. 2 engines — OIL LEVEL.
 5. Engine oil/fuel filter PDIs — FLUSH.
 6. Engine compartments.
 7. Deswirl duct clamps — SECURE.
 8. Transmission oil level — CHECK, SECURE DIPSTICK.
 9. Rotor brake/gust lock — CHECK POSITION.
 10. Ensure hydraulic lines are secure by Adel clamps and not contacting each other or any structure of the helicopter.
 11. APU oil level — CHECK, SECURE DIPSTICK.
 12. ECS compartment — J-TUBE SECURE.
 13. Tail drive shaft/viscous dampers — CONDITION.

14. Fire-extinguisher bottles — CORRECT CHARGE.
15. Upper antennas.
16. IRCM Transmitter.



Handling covert windows with bare hands may cause damage to components.

17. All topside access panels — SECURE.



Failure to properly secure all panels and doors may result in damage to equipment and catastrophic control failure.

7.3.6 Fuselage - Left Side (Area 5)

1. Avionics cooling exhaust.
2. Landing gear, step, WOW switch.
3. Position light, grounding wire, float bag fairing, and static port.
4. Tire and brake indicator pins.
5. Junction box panel.
6. Pylon/stores — AS REQUIRED.



Do not attempt to lift **LHEP** when the M299 Launcher is installed. Damage to the launcher, pylon, sway braces, or BRU-14/A bomb rack may occur.

- a. Left Hand Extended pylon (LHEP) umbilical to M299 launcher — Connected.
 - (1) Breakaway lanyard for M299 launcher umbilical attached to hard point.
- b. M299 launcher.
 - (1) SAFE/ARM switch — SAFE.



If missile is loaded, missile seeker head covers shall be installed, if available, during all ground operations and before all chock and chain operations to prevent damage to the seeker head.

7. Cabin window.
8. Water wash connector access panel.

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9. Sonobouy launcher cover/sonobouys — AS REQUIRED.
10. Fueling compartments.
11. Fire extinguisher thermal plug — IN PLACE.
12. ESM antenna housing.
13. ALQ-205 IR transmitter.
14. Engine exhaust.
15. APU exhaust.
16. Underside of helicopter — ANTENNAS/PANELS.

7.3.7 Tail Cone - Left Side (Area 6)

1. Tail wheel.
 - a. Manual unlock lever — UP POSITION.
 - b. Slip mark — ALIGNED.
2. Tail probe — CHECK IN UP POSITION.
3. Chaff/Flare dispenser — SAFE (note loadout).
4. Antennas.
5. Anti-collision light.
6. Drive shaft cover and hinge pins.
7. Pylon-fold hinge fittings.
8. Intermediate gearbox — OIL LEVEL/FILLER CAP.

7.3.8 Tail Pylon - Left Side (Area 7)

1. Stabilator locking pin and keeper — FULL EXTENSION AND LOCKED.
2. Position light.
3. ASE sensors and housing.
4. Tail bumper — STRUT EXTENSION, PAD WEAR.

7.3.9 Tail Pylon - Right Side (Area 8)

1. Stabilator locking pin and keeper — FULL EXTENSION AND LOCKED.
2. Tail rotor blades, bonding wires, pitch-change links.
3. Tail rotor indexer — RETRACTED.
4. Tail rotor de-ice harness and cannon plugs — SECURE.
5. Anti-collision light.
6. Tail gearbox — OIL LEVEL/FILLER CAP.

WARNING

- Ensure oil filler cap is secure by pulling out on cap while turning clockwise to ensure it is seated in locked position. Failure to secure properly may cause cap to depart, causing binding in tail rotor controls and/or loss of TGB oil.
- An over-serviced TGB and/or a red tint to TGB oil are possible signs of contamination with hydraulic fluid. Failure of the TGB is possible.

7. Tail gearbox cowling — SECURE.
8. Pylon access steps — STOW.

7.3.10 Tail Cone - Right Side (Area 9)

1. Pylon fold locking pin and keeper — FULL EXTENSION AND LOCKED.
2. Drive shaft sections, viscous dampers, quick disconnect and covers.
3. Chaff/Flare dispenser — SAFE (note loadout).
4. MAD towed body, reeling machine, and support.

7.3.11 Fuselage - Right Side (Area 10)

1. ECS exhaust/engine exhaust.
2. Antennas.
3. Fuel dump port.
4. Transition section.
 - a. Avionics.
 - b. Tail rotor cables — ROUTING AND CHAFFING.
5. Pylon/external stores/FLIR if installed — AS REQUIRED.
6. Cabin door.
7. Rescue hoist.
8. Ice detector.
9. Junction box panel.
10. Landing gear, step.
11. Avionics cooling exhaust/inlet.
12. Position light, grounding wire, float bag fairing, and static port.
13. Tire and brake indicator pins.
14. External power access panel.

7.3.12 Cockpit - Right Side (Area 11)

1. Door.
2. Seat and harness.

WARNING

Do not stow articles or equipment under seats or in seat wells. These objects can interfere with proper seat stroking and reduce their energy-absorbing performance during impact.

3. Avionics well.
4. Flight controls.
5. **ELT** — ARM.
6. Windshield washer reservoir — FLUID LEVEL/FILLER CAP.
7. Rotor brake handle lockpin — RELEASE.

7.3.13 AGM-114 Hellfire Preflight Checklist

1. Port forward weapons station quick release pins — INSTALLED/HANDLES LOCKED.
2. M299 launcher.
3. M299 umbilical to launcher — Connected.
 - a. Breakaway lanyard for launcher umbilical attached to hard point.
4. M299 SAFE/ARM switch — SAFE.
5. AGM-114 Hellfire missile (if installed).
 - a. Correct Hellfire missiles loaded.
 - b. Missiles correctly loaded.
 - c. M299 launcher latch handle(s) — AFT. Any excessive movement of latch handle should be reported to qualified personnel.



Correct missile loading may be tested by grasping the missile just aft of the seeker head and pulling with both hands. The release handle should be rigid and the holdback release will be canted aft. If the handle moves freely, the mechanism is not latched. Notify qualified personnel.

- d. Hellfire missile seeker head covers — ON (if available).

7.3.14 Mk 46 Torpedo Preflight Checklist

1. Armament switches — OFF/SAFE/NORMAL.
2. Weapon loaded sign — On cyclic stick.
3. BRU-14 — SAFE.
4. Weapon — Secure on pylon.
5. Inboard stations.
 - a. 42-inch band release wire — Through groove in aft/inboard sway brace pad; connected to snaphook.
 - b. Arming wire — Connected to tail arming solenoid and seawater battery arming lanyard.
 - c. Seawater battery arming lanyard — Cut and deburred.
 - d. Preset cable — Connected; forward slack removed; secured to aft outboard sway brace.
 - e. Preset cable pullout lanyard — Connected to armament bracket snaphook.
 - f. Parachute band release wire and static line — Attached to armament bracket snaphook.
 - g. Snaphook opening — Facing aft.
 - h. Parachute band release wire — Cut and bent.
6. Outboard stations.
 - a. 42-inch release wire — Through groove in aft/inboard sway brace pad; connected to armament bracket snaphook.
 - b. Arming wire — Connected to tail arming solenoid and seawater battery lanyard.
 - c. Seawater battery arming lanyard — Cut and deburred.

- d. Preset cable — Connected; forward slack removed; secured to aft outboard sway brace.
 - e. Preset cable pullout lanyard — Connected to swing arm snaphook.
 - f. Parachute band release wire — Cut and bent.
7. Stabilizer — Not damaged, clamp installed.
 8. Nose cover — Installed.
 9. All tape — Removed.
 10. Pylon door — Secured.

Note

The following steps shall be performed after engine turnup.

11. (REXTORP/EXTORP) Nose cover, ballast safety strap, and air stabilizer clamp — Remove.
12. (WARSHOT) Nose cover, air stabilizer clamp — Remove.

7.3.15 Mk 50 Torpedo Preflight Checklist

1. Armament switches — OFF/SAFE/NORMAL.
2. Weapon loaded sign — On cyclic stick.
3. BRU-14 — SAFE.
4. (WARSHOT) Exploder ARM/SAFE — SAFE.
5. 53-inch release wire — Secured by aft outboard sway brace or inboard of sway brace pad.
6. Weapon — Secure on pylon.
7. (EXERCISE) Scuttle safing — ARM.
8. Arming wire — Connected to tail solenoid and lanyard start assembly.
9. Lanyard start assembly — Cut at red mark and deburred.
10. Preset cable — Connected; forward slack removed; secured to aft/outboard sway brace.
11. (Inboard station) Preset cable pullout lanyard/static line — Connected to aircraft and torpedo.
12. (Outboard station) Static line — Connected to armament bracket.
13. (Outboard station) Preset cable pullout lanyard — Connected to swing arm.
14. Nose cap — Installed; not damaged.

Note

Nose protective cap shall remain installed during flight. It is a breakaway type and will shatter upon water entry. Do not remove before flight.

15. All tape — Removed.
16. Pylon door — Secured.

Note

The following step shall be performed after engine turnup.

17. (WARSHOT) ARM/SAFE indicator — ARM.

7.3.16 Cabin Inspection

1. M60D/M240D/GAU-16/A Gun-mount.



WARNING

To facilitate cabin egress, all crew-served weapons and their support equipment should be removed during missions not requiring weapons installations.



CAUTION

Visually inspect quick release pin for excessive wear or damage and the presence of proper plastic zip ties.

2. HIFR connections/fittings.
3. Rescue Station.
 - a. All switches — OFF/NORMAL.
 - b. Hoist shear switch — SHEARWIRED.
 - c. Hoist pendant.
 - d. Hover grip.
 - e. ICS cord.
4. Fire extinguishers.
5. First aid kits.
6. Crash ax.
7. APU accumulator pressure gauge — 2,650 psi minimum.
 - a. APU pump handle.
8. Sonobuoy launcher — 900 psi minimum (with sonobuoys installed).
 - a. Sonobuoys loaded — **VNT** indication.
 - b. Valve safety lockout — AS REQUIRED.
9. MAD AMP POWER supply switches — ON (Block I).
 - a. Mad AMP is located in the SO Rack Block 0.
10. Litter tray — INSTALLED.
11. Transmission oil filter impending bypass indicator.

12. RAST.
 - a. Ratchet with adapter.
 - b. Backup messenger assembly — INSTALLED.
13. Cabin door window — SHEARWIRED.
14. Cabin door HEELS battery/[ADHEELS/IHEELS](#) — TEST.
15. Mission avionics racks/panels.
 - a. [ADS POWER](#) — ON.
16. [THP-1](#) and [THP-2](#) — INSTALLED.
17. [PDB](#).
 - a. Circuit breakers — IN.
 - b. HELLFIRE PWR switch — OFF.
18. Mobile Aircrew Restraint System (MARS), if applicable.

WARNING

Only the modified crewmember's aircraft safety belt, P/N MS16070-21/A, will be used with the RMU-42/A retractor, mobile aircrew webbing. Use of unmodified belts is unauthorized; use of MS16070-21, MS16070-3, or MS16070-2 could result in serious injury in the event of a fall or aircraft mishap.

CAUTION

Do not let go of an extended retractor strap. Slowly guide it back for stowage so it does not slam into the retractor or cause personal injury.

- a. Visually check the entire assembly for general condition.
- b. Ensure ceiling retaining plate is flush against the cabin overhead soundproofing. Any movement of the webbing strap assembly mounting bolt is not allowed. Webbing strap assembly shall rotate freely.
- c. Place the control handle in the auto lock position.
- d. Extend the strap approximately eight inches and jerk the strap until the retractor locks. There shall be no further extension of the strap when it is pulled.
- e. While still locked, release pull on the strap. The strap shall retract automatically. Cycle the control handle.
- f. Extend the strap approximately eight inches; place the control handle in the manual lock position.
- g. There shall be no further extension of the strap when pulled and the strap shall automatically retract when guided back in.

19. Instructor/passenger seat/belts — Condition and security.
20. SO seat, inertial reel, and seat track — Condition and security.
 - a. Under seat area.

WARNING

The area directly under each seat shall be clear of any stowed articles. Failure to keep this area clear may preclude full vertical stroke of seat bucket in a crash.

21. SO station.
 - a. All switches — OFF/NORMAL.
 - b. ICS cords.

Note

Ensure the FLIR ICS cord is connected to either the SO or instructor ICS station.

- c. FLIR HCU.
 - d. FLIR **VCR** mounting plate — IF INSTALLED.
22. SO window emergency release handle — SHEARWIRED.
23. Lower SO console (ESP only).
 - a. All switches — OFF/NORMAL.
24. Survival gear, loose equipment, cargo, internal stores — Properly stowed.
25. Circuit breakers — VERIFY.
26. NATOPS Manual — INSTALLED.

7.4 START CHECKLIST

Note

Daggered (†) steps need not be accomplished on subsequent flights on the same day.

7.4.1 Prestart Checks

CAUTION

- Moving flight controls without first or second-stage pressure on the primary servos may cause damage to the flight controls.
- During high wind conditions (greater than 30 knots) and with AC power supplied, the stabilator can automatically program. If the stabilator is folded, damage may occur. Consideration should be given to disengaging stabilator auto mode while the stabilator is folded.

1. Seats, belts, pedals, mirrors — ADJUSTED.
2. Cockpit window emergency release handles — AFT AND SHEARWIRED.
3. Left collective — EXTENDED AND LOCKED.
4. Circuit breakers and switches — CHECKED AND OFF.

Switches not having an OFF position should be checked as follows:

- a. RDR, DATA LINK — STBY.
 - b. ATO ICS — NORM.
 - c. DATA LINK MODE — AUTO.
 - d. GUARD REC — ON.
 - e. COMM CONTR mode select — T/R.
 - f. GUST LOCK — NORM.
 - g. TAIL SERVO — NORM.
 - h. Pilot ICS — NORM.
 - i. CARGO HOOK ARMING — SAFE.
 - j. CARGO HOOK EMER RLSE — OPEN.
 - k. FIRE DET TEST — OPER.
 - l. DE-ICE MASTER — MANUAL.
 - m. MODE 4 AUDIO/LIGHT/OUT — AUDIO.
 - n. Transponder ANT — DIV.
 - o. COMP panel — SLAVED, LAT CHECKED.
 - p. FUEL MGT panel, MASTER/MODE switches — STOP FLOW/AUTO.
 - q. SERVO SHUTOFF SWITCH — CENTER.
5. Parking brake — RESET.
 6. TAIL WHEEL — LOCK.
 7. Aircrewman Prestart Checklist — COMPLETE.
 8. Engine T-handles — FORWARD.
 9. APU T-handle — IN.
 10. Rotor brake — ON.

WARNING

Do not release rotor brake if blades are folded unless secured in place by blade crutches/clamps. Releasing the rotor brake with unsecured folded blades may result in damage to aircraft injury to nearby personnel, and/or all four blades rotating together, which may result in aircraft rollover.

11. BATT switch — ON (#1/#2 CONV, AC ESS BUS OFF, STABILATOR, and AFCS DEGRADED caution, WOW and ROTOR BRAKE advisory — ILLUMINATE).
12. UHF backup — SET.

13. Fire detector system — TEST.
 - a. FIRE DET TEST knob — POSITION 1 (APU T-handle, engine T-handles, and master warning panel FIRE lights illuminate).
 - b. FIRE DET TEST knob — POSITION 2 (engine T-handles and master warning panel FIRE lights illuminate).
 - c. FIRE DET TEST knob — OPER (all fire warning lights extinguished).
14. Fire guard — POSTED, AREA CLEAR.
15. Internal/Exterior/NVD Lighting — AS REQUIRED.
16. APU — START.
 - a. ECS — OFF.
 - b. AIR SOURCE ECS/START switch — APU.
 - c. FUEL PUMP switch — APU BOOST.
 - d. APU CONTR switch — ON.



- APU exhaust flow may affect other aircraft equipment and cause possible heat damage. Proper clearance should be checked prior to APU start.
- Only the RESERVE position of the FIRE EXTGH switch will operate without AC power.
- To prevent an APU exhaust fire, wait at least 2 minutes after APU shutdown to attempt a restart to allow residual fuel to vaporize.

Note

- Do not cycle the BATT switch or turn off the APU CONTROL switch if the APU shuts down during start or after it is running. This removes the cause of the shutdown from the APU BITE indicator.
- When mission avionics COMSEC gear is loaded with external power, use of the APU generator may zeroize the codes.

17. APU GENERATOR switch — ON (as required).
18. ICS/RADIO — CHECK.
19. ECS — AS REQUIRED.
20. Blade/pylon spread — AS REQUIRED.



- Should the blade fold system stall during spread, cycling the BLADE FOLD switch to FOLD should return the rotor blades to the folded position.
- Shut down the APU immediately if a rotor blade remains stalled in the APU exhaust.
- When the ROTOR SPREAD light is not illuminated, pressing the AFCS CONTROL panel RDR ALT pushbutton during blade fold system operations may cause failure of the system. Press this pushbutton only if flashing and after the blade spread evolution has been completed.

- a. Area — CLEAR (wing walkers positioned as required).
- b. CMPTR PWR/RESET pushbutton — ON.
- c. BLADE FOLD MASTER switch — ON.
- d. BLADE FOLD switch — SPREAD.
- e. PYLON FLIGHT and ROTOR SPREAD lights — ILLUMINATED.

WARNING

Illumination of the ROTOR SPREAD light may not be an accurate indication of the blades being properly spread. Rotor engagement with improperly spread blades may result in catastrophic rotor failure. A head check shall be conducted any time the BLADE FOLD switch is moved from the OFF position.

- f. RDR ALT pushbutton — PRESS (if flashing).

Note

If RDR ALT pushbutton is flashing, pressing will update flight control position to AFCS.

- g. BLADE FOLD switch — OFF.
 - h. BLADE FOLD MASTER switch — OFF.
 - i. Proceed to step 22, Head Check.
- †21. Lockpins status — CHECK.
- a. BLADE FOLD MASTER switch — ON.
 - b. ROTOR SPREAD and PYLON FLIGHT lights — ILLUMINATED.

WARNING

If the PYLON FLIGHT light is not illuminated, the pylon and stabilator lockpins and the tail rotor indexer shall be visually inspected prior to flight. Failure to do so may cause separation of the tail pylon.

CAUTION

Tail rotor damage may occur if indexer is not fully retracted.

- c. If ROTOR SPREAD light not illuminated:
 - (1) CMPTR PWR/RESET pushbutton — OFF.
 - (2) BACKUP HYD PMP switch — OFF.

- (3) BLADE FOLD switch — SPREAD (5-7 seconds).

WARNING

Illumination of the ROTOR SPREAD light may not be an accurate indication of the blades being properly spread. Rotor engagement with improperly spread blades may result in catastrophic rotor failure.

CAUTION

- With a malfunctioning micro switch or blade fold logic module, keeping the BLADE FOLD switch in SPREAD longer than 5-7 seconds may cause the blade fold lockpins to fully retract, resulting in an uncommanded blade fold and possible damage to the aircraft.
- If uncommanded blade fold occurs when the BLADE FOLD switch is placed to SPREAD, the BLADE FOLD MASTER switch should be placed in the OFF position. Do not secure electrical or hydraulic power until blades are respread using blade fold test set.

d. If ROTOR SPREAD light remains off:

- (1) BLADE FOLD switch — OFF.
- (2) BLADE FOLD MASTER switch — OFF.
- (3) Head check — PERFORM.

Note

- If the ROTOR SPREAD light remains off, there may or may not be a SPREAD INCOMPLETE caution. The aircraft can be safely flown as long as a proper head check is performed.
- If a documented discrepancy exists in the blade lockpin/microswitch indicating system, the BLADE FOLD switch may be left in the OFF position if the blade lockpins were visually checked on preflight.

e. If ROTOR SPREAD light illuminated:

- (1) BLADE FOLD switch — OFF.
- (2) SPREAD INCOMPLETE caution — DOES NOT APPEAR.
- (3) BLADE FOLD MASTER switch — OFF.

†22. Head check — AS REQUIRED.

- a. Blade Lock Pins Engaged.
- b. Pitch Lock Pins Retracted.
- c. Gust Lock Disengaged.

Note

A head check shall be conducted any time the BLADE FOLD switch is moved from the OFF position.

- †23. IGB/TGB Oil Level Check — AS REQUIRED (after Pylon Spread).
- 24. CMPTR PWR/RESET pushbutton — CYCLE, ON.
- 25. SAS/BOOST pushbutton — ON.
- 26. BACKUP HYD PMP switch — ON.

Note

If electrical loads are introduced (e.g., backup hydraulic pump) while operating from APU generator or external power, an AFCS power sever may occur, indicated by appearance of the AFCS DEGRADED caution. To restore AFCS computer power, press CMPTR PWR/RESET pushbutton on AFCS CONTROL panel.

7.4.2 Systems Checks

- †1. DIGITS — ON; CDU and PDU — TEST.
 - a. CDU LAMP TEST button — PRESS AND HOLD. All lights and RTR OVERSPEED lights go on. CDU digital displays read all 8's. Release button, all lights go off and digital displays return to original reading.
 - b. PDU TEST buttons — PRESS AND HOLD. All display lights illuminate and torque reads 188. Release buttons, all lights go off, and digits return to original reading.
- 2. Fuel quantity and readouts — CHECK.

Note

The maximum difference between the fuel quantity indicators on the VIDS, and total fuel digital readout shall not be more than 200 pounds.

- a. Press and hold the FUEL TEST pushbutton. Indicators move to zero and digital display reads 0 - 20. #1 and #2 FUEL LOW cautions lights, plus the MASTER CAUTION light, illuminate. Release pushbutton. Indicators and digital readout return to previous quantity.
- 3. Caution, advisory, warning lights — CHECK.
 - a. The following caution and advisory lights should be on:
 - (1) #1 and #2 GEN.
 - (2) #1 and #2 FUEL PRESS.
 - (3) #1 and #2 ENGINE OIL PRESS.
 - (4) #1 and #2 HYD PUMP.
 - (5) SAS.
 - (6) AFCS DEGRADED.
 - (7) MAIN XMSN OIL PRESS.
 - (8) WOW.
 - (9) ROTOR BRAKE.
 - (10) #1 and #2 ENG ANTI-ICE.
 - (11) APU ON.
 - (12) APU GEN ON.
 - (13) PRIME BOOST PUMP.

(14) BACK-UP PUMP ON.

(15) PARKING BRAKE ON.

b. BRT/DIM-TEST — TEST. All caution/advisory lights go on. All warning lights on master warning panels go on and LOW ROTOR RPM lights flash. All pushbutton legends on AI/BDHI mode selector panels go on. The AFCS CONTROL panel, STABILATOR, BLADE FOLD control panel, FMCP, and crew HOVER TRIM engage panel lights illuminate.

c. BRT/DIM-TEST — RELEASE. MASTER CAUTION lights should flash 16 times. Note that no CHIP cautions are on.

4. RAD ALT, BAR ALT, clocks — SET.

5. TACAN — REC.

6. IFF MASTER — STBY.

†7. Primary servos — CHECK.

a. SAS 1, SAS 2 pushbuttons — OFF.

b. SAS/BOOST and CMPTR PWR/RESET — Check ON.

c. Servo Interlock Check:

(1) Pilot's SERVO switch — 1ST OFF. No allowable flight control movement. #1 PRI SERVO PRESS caution and both MASTER CAUTION lights illuminate. Copilot's SERVO switch 2ND OFF and back to center. No change in lights.

(2) Pilot's SERVO switch — 2ND OFF. No allowable flight control movement. #2 PRI SERVO PRESS caution and MASTER CAUTION warnings on. Copilot's SERVO switch 1ST OFF and back to center. No change in lights.

(3) Pilot's servo switch back to center. Repeat steps (1), and (2), beginning with copilot's servo switches.

Note

During the Servo Interlock check, proper operation of the system will prevent the #2 Primary servo from being shut off with the #1 PRI SERVO PRESS caution on; and the #1 Primary servo from being shut off with the #2 PRI SERVO PRESS caution on.

d. Pilot's SERVO switch — 1ST OFF.

e. Pitch lockpin status — CHECK. While holding the collective fixed in the full up position and with the tail rotor pedals neutral, the cyclic shall be moved in a square pattern. Any restriction to the full range of cyclic motion may be indicative of an extended pitch lock.

f. Check for binds and restrictions while slowly moving cyclic and collective through full range.

g. Move collective full travel (up and down) in approximately 2 seconds. Ensure no longitudinal or lateral cyclic control feedback is felt, and that the #2 PRI SERVO PRESS light does not illuminate while the collective is in motion.

Note

- During control checks, the pilot's or copilot's cyclic may contact a portion of the glare shield padding or instrument panel knobs which is usually obtained with mid-collective, full left pedal, and full forward cyclic, which is not a normal in-flight control combination.
- With the collective control in the full up position and the cyclic stick at the forward left corner of its movement envelope, a ratcheting may be felt through the cyclic control and airframe and heard in the cockpit as the cyclic control is moved to the right. This normal ratcheting of the swash plate uniball bearing on the star guide assembly will occur at the specific flight control orientation and movement listed above only. Ratcheting or binding noted with the flight controls orientation at any other position or direction of movement must be assumed to be an unassociated control problem or deterioration of the Teflon coating on the uniball bearing.

h. Pilot's SERVO switch — 2ND OFF.

i. Check for binds or restrictions while slowly moving cyclic and collective through full range.

j. Move collective full travel (up and down) in approximately 2 seconds. Ensure no longitudinal or lateral cyclic control feedback is felt, and that the #1 PRI SERVO PRESS light does not illuminate while the collective is in motion.

k. Pilot/copilot SERVO switches — CENTER. #1/#2 PRI SERVO PRESS caution lights OFF.

†8. Boost servos — CHECK.

a. Collective and Pedals — MIDPOSITION and RIGHT PEDAL SLIGHTLY FORWARD OF NUTRAL.

Note

Slight pedal control deflection may be necessary to prevent excessive collective movement.

b. SAS/BOOST pushbutton — OFF. BOOST SERVO OFF and AFCS DEGRADED cautions appear and MASTER CAUTION lights illuminate.

c. Move flight controls through full range of travel. Note increase in control forces (except lateral).

d. Collective and Pedals — MIDPOSITION and RIGHT PEDAL SLIGHTLY FORWARD OF NEUTRAL.

e. SAS/BOOST pushbutton — ON. BOOST SERVO OFF and AFCS DEGRADED cautions disappear.

f. Collective — FULL DOWN.

†9. Tail rotor servo — CHECK.

a. TAIL SERVO switch — BKUP. #1 TAIL RTR SERVO caution, #2 TAIL RTR SERVO ON advisory and MASTER CAUTION lights illuminate. Check for binds and restrictions while moving tail rotor pedals through full range.

b. TAIL SERVO switch — NORM. #1 TAIL RTR SERVO caution and #2 TAIL RTR SERVO ON advisory disappear.

†10. AFCS ground check.

a. SAS — CHECK.

(1) CMPTR PWR/RESET (2-minute warm-up) and SAS/BOOST pushbuttons — Check ON.

(2) TRIM and AUTO PLT pushbuttons — Check OFF.

(3) SAS 1 pushbutton — ON for at least 10 seconds, then OFF. SAS fail advisory lights and AFCS DEGRADED caution should not appear during self-test.

- (4) SAS 1 pushbutton — ON, then OFF. No movement should occur in either main rotor blades or flight controls.
 - (5) Repeat step (4) for SAS 2.
- b. Trim — CHECK.

Note

Do not depress trim release switches during gradient force checks.

- (1) TRIM pushbutton — ON, then OFF. No movement should occur in flight controls.
 - (2) TRIM pushbutton — ON.
 - (3) Move cyclic fore, aft, and laterally checking for symmetrical gradient force increase with control and pedal displacement.
 - (4) Center pedals and place collective at midposition. Check for gradient force increase with collective and pedal displacement.
- c. Autopilot — CHECK.
- (1) SAS 1, SAS 2, and TRIM pushbuttons — ON.
 - (2) AUTO PLT pushbutton — ON and OFF. No movement should occur in flight controls.
 - (3) AUTO PLT pushbutton — ON.
 - (4) Move controls through full range. Check for restrictions, control feedback, and rotor blade chatter.

Note

If any restricting control feedback or rotor blade chatter is detected, repeat step with SAS/Trim/Autopilot individually disengaged to determine the channel and axis where the discrepancy exists.

- (5) Pilot AFCS RELEASE switch — CHECK. SAS 1, SAS 2 and AUTO PLT lights off. SAS caution and MASTER CAUTION warning on.
 - (6) SAS 1, SAS 2, TRIM and AUTO PLT pushbuttons ON.
 - (7) Repeat steps (5) and (6) for copilot.
11. Stabilator — CHECK.
- a. Indicator should read between 34° and 42° trailing edge down; STABILATOR caution should not appear. STABILATOR AUTO CONTROL pushbutton ON.

WARNING

Helicopter shall not be flown if any part of the stabilator check fails.

Note

Observe plane captain hand signals. If ground crew is unavailable, visually check stabilator after each step.

- b. Press the STABILATOR control panel TEST button until stabilator movement stops. Indicator should move 5° to 12° less than in step a. STABILATOR caution appears and MASTER CAUTION warning illuminates. A beeping warning tone sounds in pilot and ATO headsets.

- c. STABILATOR AUTO CONTROL pushbutton — ON. Warning tone stops, the stabilator moves to between 34° and 42° trailing edge down and STABILATOR caution disappears.
 - d. Hold STABILATOR control panel MAN SLEW switch UP until stabilator stops. Stabilator position should indicate between 5° and 10° trailing edge up in 4 to 8 seconds. STABILATOR caution appears, MASTER CAUTION warning illuminates and a beeping warning tone sounds in pilot and copilot headsets. Silence tone as required.
 - e. Hold MAN SLEW switch DOWN until indicator reads 0°.
 - f. STABILATOR AUTO CONTROL pushbutton — ON. Indicator moves to between 34° and 42° trailing edge down. STABILATOR caution should not appear.
- †12. Rescue Hoist Preoperational Check — AS REQUIRED (see paragraph 7.16.2.1).
- †13. Cargo Hook Preoperational Check — AS REQUIRED (see paragraph 7.16.2.2).

7.4.3 Starting Engines and Rotor Engagement

1. High Points and Tail Tiedowns — VERIFY REMOVED.



N_p shaft rub occurs when the engines are online and the rotor brake is released. The N_p shaft impacts the N_g shaft, which causes the compressor blades to impact the compressor casing. Over time, this will cause the engine to lose power and possibly catastrophically fail. The only way to ensure N_p shaft rub will not occur is to use the No Rotor Brake Start Procedure. The No Rotor Brake Start Procedure shall be utilized for routine engine start and rotor engagement ashore.

7.4.3.1 No Rotor Brake Start Procedure

1. Fireguard posted, area clear.
2. Doors, inertia reels — LOCK.
3. SAS 1, SAS 2, TRIM, and AUTO PLT pushbuttons — ON.

WARNING

When AFCS computer power is cycled, trim is disengaged. An unguarded cyclic will allow the rotor arc to dip as low as 4 feet above the ground, without droop-stop pounding, prior to full control deflection.

4. Rotor brake — OFF. Check pressure 0 psi, and ROTOR BRAKE advisory out.
5. ENGINE IGNITION switch — NORM.
6. Fuel selectors — XFD.
7. Lights — AS REQUIRED.
8. Flight controls — POSITION AND HOLD.
 - a. Cyclic and pedals — CENTERED.
 - b. Collective — DOWN AND HOLD.


CAUTION

During engine start and runup, adjust the cyclic as required to maintain the tip path plane in a neutral position, maintain the collective full down and the pedals centered until N_r reaches 50 percent minimum to prevent damage to anti flap assembly. If droop stop pounding occurs, an cyclic adjustment alone does not alleviate the pounding, then raise collective to alleviate this condition, but not to exceed 1/2 inch. Maintain the new collective position until N_r reaches 50 percent minimum.

9. BACKUP HYD PMP switch — OFF.
10. Engines — START.


CAUTION

- If start is attempted with ENGINE IGNITION switch OFF, do not place switch to NORM until the Abort-Start emergency procedure has been completed. If the ENGINE IGNITION switch is placed to NORM while start is in progress, a hot start may occur.
- If ENG STARTER advisory disappears after advancing the PCL to IDLE, do not reengage the starter due to a possible engine over-temperature.

Note

It is normal for an OIL FLTR BYPASS caution and/or high engine oil pressure to appear when starting an engine below normal operating temperatures because of the relatively high oil viscosity. When the engine oil temperature reaches 38 °C, the caution should disappear.

- a. Starter button — Press until N_g increases.
- b. TGT — LESS THAN 80 °C.

Note

With certain DECU/VIDS SDC installations, prestart TGT may read a constant 150 °C to 175 °C. This indication is a result of the -71 °C bias in effect when the DECU is powered with 400Hz airframe power. When it is known that the engine is cold, a normal start may be continued. TGT should indicate normally upon engine light off.

- c. PCL — IDLE.
- d. System indications — CHECK.

Abort start if any of the following indications occur:

- (1) N_g does not reach 14 percent within 6 seconds after starter initiation.
- (2) No oil pressure within 30 seconds after starter initiation (Do not motor engine).
- (3) No light off within 30 seconds after moving PCL to IDLE.
- (4) ENG STARTER advisory disappears prior to reaching 52 percent N_g .

- (5) TGT reaches 851 °C before idle speed is attained.



If engine experiences a hot start and a subsequent start is attempted, motor the engine for 60 seconds prior to advancing PCL to idle.

Note

If engine fails to start consideration should be given to executing Fuel Priming Checklist (see [paragraph 7.17.5](#)).

- e. Repeat steps a. through d. for other engine. If conducting crossbleed start (see [paragraph 7.17.16.1](#)).
11. Engine oil pressure — CHECK.
 12. ENG STARTER advisories — OUT.

Note

Starter normally drops out at 52 percent to 65 percent N_g . If starter does not drop out, perform ENGINE STARTER advisory emergency procedure.

13. Engine Idle N_{gs} — CHECK, 63 percent or greater and matched within 3 percent.



Ground idle N_g split greater than 3 percent is an indication of possible LDS roll pin failure. Do not fly the helicopter until maintenance action is performed.

14. Check #1 HYD PUMP and #2 HYD PUMP cautions — OUT.
15. XMSN oil pressure — CHECK.
16. N_p/N_r — CHECK WITHIN LIMITS.



Loss of the collective boost servo through either intentional shutoff or loss of NO. 2 hydraulic pressure will cause the collective to move rapidly from the down position to the midposition if it is not held by hand. This movement can be enough to cause the helicopter to become airborne. During ground operations with engines operating, the flight controls shall be guarded.

17. PCLs — PULL OUT OF IDLE DETENT AND SMOOTHLY ADVANCE TO FLY.



Do not move the PCLs rapidly when the tail wheel lockpin is not engaged.

18. Droop stops — OUT.

Note

If all droop stops are not out by 100 percent N_r , shut down and investigate.

19. PCLs — FLY.
20. Fuel selectors — DIR.
21. BACKUP HYD PMP switch — AUTO.
22. TRQs — MATCHED within 5 percent.
23. N_p/N_r — 100 percent.

WARNING

With rotors turning, all personnel shall enter and exit the rotor arc at the 3 and 9 o'clock positions. Personnel shall enter and exit only upon direction from the plane captain/LSE after clearance is received from the PAC.

24. NO. 1 and NO. 2 GENERATOR switches — ON.

WARNING

Power transfer from the APU generator or external power to the NO. 1 generator may cause disengagement of SAS 1, SAS 2, TRIM, AUTO PLT, and Stabilator. An unguarded cyclic will allow the rotor arc to dip as low as 4 feet above the ground.

25. APU GENERATOR switch — ON (as required).
26. External Power — OFF (as required).

7.4.3.2 Rotor Brake Start Procedures

1. Fireguard posted, area clear.
2. Doors, inertia reels — LOCK.
3. SAS 1, SAS 2, TRIM, and AUTO PLT pushbuttons — ON.

WARNING

When AFCS computer power is cycled, trim is disengaged. An unguarded cyclic will allow the rotor arc to dip as low as 4 feet above the ground, without droop-stop pounding, prior to full control deflection.

4. Rotor brake — CHECK PRESSURE 450 PSI MIN.
5. ENGINE IGNITION switch — NORM.
6. Fuel selectors — XFD.
7. Lights — AS REQUIRED.

8. Flight controls — POSITION AND HOLD AS REQUIRED.
- a. Cyclic and pedals — CENTERED.
 - b. Collective — DOWN AND HOLD.



Loss of the collective boost servo through either intentional shutoff or loss of NO. 2 hydraulic pressure will cause the collective to move rapidly from the down position to midposition if it is not held down by hand. This movement can be enough to cause the helicopter to become airborne. During ground operations with engines operating, the flight controls shall be guarded.

9. Engines — START.



- If start is attempted with ENGINE IGNITION switch OFF, do not place switch to NORM until the Abort Start emergency procedure has been completed. If the ENGINE IGNITION switch is placed to NORM while start is in progress, a hot start may occur.
- If ENG STARTER advisory disappears after advancing the PCL to IDLE, do not reengage the starter due to a possible engine over-temperature.

Note

- If the rotor head moves due to rotor brake slippage, the pilot may immediately secure both engines, or if prebriefed, release the rotor brake.
- It is normal for an OIL FILTER BYPASS caution to appear and/or high engine oil pressure when starting an engine below normal operating temperatures because of the relatively high oil viscosity. When the engine oil temperature reaches approximately 38 °C during warmup, the caution should disappear.

- a. Starter button — Press until N_g increases.
- b. TGT — Less than 80 °C.

Note

With certain DECU/VIDS SDC installations, prestart TGT may read a constant 150 °C to 175 °C. This indication is a result of the -71 °C bias in effect when the DECU is powered with 400Hz airframe power. When it is known that the engine is cold, a normal start may be continued. TGT should indicate normally upon engine lightoff.

- c. PCL — IDLE.
- d. System indications — CHECK.

Abort start if any of the following indications occur:

- (1) N_g does not reach 14 percent within 6 seconds after starter initiation.
- (2) No oil pressure within 30 seconds after starter initiation (Do not motor engine).

- (3) No light off within 30 seconds after moving PCL to IDLE.
- (4) ENG STARTER advisory disappears prior to reaching 52 percent N_g .
- (5) TGT reaches 851 °C before idle speed is attained.



If engine experiences a hot start and a subsequent start is attempted, motor the engine for 60 seconds prior to advancing PCL to idle.

Note

If engine fails to start consideration should be given to executing Fuel Priming Checklist ([paragraph 7.17.5](#)).

- e. Repeat steps a. through d. for other engine. If conducting crossbleed start (see [paragraph 7.17.16.1](#)).
10. Engine oil pressure — CHECK.
 11. ENG STARTER advisories — OUT.

Note

Starter normally drops out at 52 percent to 65 percent N_g . If starter does not drop out, perform ENGINE STARTER advisory emergency procedure.

12. Engine idle N_{gs} — CHECK, 63 percent or above and matched within 3 percent.



Ground idle N_g split greater than 3 percent is an indication of possible LDS roll-pin failure. Do not fly the helicopter until maintenance action is performed.

13. Area — CLEAR.
14. Lights — AS REQUIRED.
15. Rotor — ENGAGE.
 - a. Rotor brake — OFF. Check 0 psi, and ROTOR BRAKE advisory out.
 - b. PCLs — PULL OUT OF IDLE DETENT AND SMOOTHLY ADVANCE TO FLY.



Do not move the PCLs rapidly when the tail wheel lockpin is not engaged.

Note

Should conditions dictate, releasing the rotor brake and allowing N_p/N_r to stabilize before advancing the PCLs.

- c. CHECK #1 HYD PUMP and #2 HYD PUMP cautions — OUT.
- d. XMSN oil pressure — CHECK.

e. Droop stops — OUT.

Note

If all droop stops are not out by 100 percent N_r , shut down and investigate.

16. PCLs — FLY.
17. Fuel selectors — DIR.
18. BACKUP HYD PMP switch — AUTO.
19. TRQs — MATCHED WITHIN 5 PERCENT.
20. N_p/N_r — 100 PERCENT.

WARNING

With rotors turning, all personnel shall enter and exit the rotor arc at the 3 and 9 o'clock positions. Personnel shall enter and exit only upon direction from the plane captain/LSE after clearance is received from the PAC.

21. NO. 1 and NO. 2 GENERATOR switches — ON.

WARNING

Power transfer from the APU generator to the NO. 1 generator may cause disengagement of SAS 1, SAS 2, TRIM, AUTO PLT, and Stabilator. An unguarded cyclic will allow the rotor arc to dip as low as 4 feet above the ground.

22. APU GENERATOR switch — ON (as required).
23. External Power — OFF (as required).

7.4.3.3 Post Engagement Checks

- †1. Engine overspeed system and Auto-Ignition — CHECK.

WARNING

Engine overspeed check shall not be performed in flight. Possibility of flameout exists on the engine being checked. Additionally, a popped NO. 1 and/or NO. 2 ENG OVSP circuit breaker shall not be reset in flight. Resetting the circuit breaker may initiate an engine overspeed signal and result in engine flameout.

CAUTION

Engine TGT must be monitored during overspeed test. If TGT rises above 851 °C, shut engine down immediately to avoid over-temperature and perform the Abort Start emergency procedure.

Note

- A failure while testing A or B individually will give the same indications as a normal test of A and B simultaneously.
- When OVSP TEST A and B are pressed simultaneously, the overspeed protection system is operating correctly if an N_g cut-back is noted.
- Failure of an engine to automatically relight when both OVSP TEST A and B are pressed simultaneously is possible. The engine should be restarted using normal procedures and the check should be performed again. If the engine automatically relights on the second attempt, the engine is acceptable. If the engine fails the test twice consecutively, maintenance action is required.
- When pressing OVSP TEST A and B simultaneously, do not press and hold buttons continuously as this may result in a sub-idle relight and engine overtemperature.

- a. NO. 1 N_g — NOTE.
 - b. NO. 1 ENG OVSP TEST A — PRESS AND HOLD.
 - c. NO. 1 N_g — REMAINS CONSTANT.
 - d. NO. 1 ENG OVSP TEST A — RELEASE.
 - e. NO. 1 ENG OVSP TEST B — PRESS AND HOLD.
 - f. NO. 1 N_g — REMAINS CONSTANT.
 - g. NO. 1 ENG OVSP TEST B — RELEASE.
 - h. NO. 1 ENG OVSP TEST A and B — PRESS SIMULTANEOUSLY AND IMMEDIATELY RELEASE.
(Note decrease in NO. 1 N_g).
 - i. NO. 1 N_g returns to speed noted in step a.
 - j. Repeat steps a. through i. for NO. 2 engine.
- †2. Contingency power — CHECK.
- a. Pilot CONTGCY PWR switch — ON.
 - b. Confirm normal engine parameters; #1 and #2 ENG CONTGCY PWR ON advisories, ECS SHUTDOWN caution (if ECS operating), and MASTER CAUTION lights appear.
 - c. Pilot CONTGCY PWR switch — OFF. Advisories and caution disappear.

Note

Upon selecting CONTGCY PWR, a rapid change in TGT may be indicative of an engine control system malfunction.

- d. Repeat steps a. through c. for copilot CONTGCY PWR switch.

†3. Hydraulic leak test — CHECK.

- a. Flight controls — LEFT PEDAL SLIGHTLY FORWARD OF NEUTRAL.
- b. HYD LEAK TEST switch — TEST. #1 TAIL RTR SERVO, BOOST SERVO OFF, SAS, AFCS DEGRADED, #1 RSVR LOW, #2 RSVR LOW, and BACK-UP RSVR LOW cautions appear and MASTER CAUTION warning illuminates. BACK-UP PUMP ON and #2 TAIL RTR SERVO ON advisories appear. During this check, it is normal for collective and tail rotor pedals to move slightly.
- c. HYD LEAK TEST switch — RESET.

- d. Associated cautions and advisories — Disappear. BACKUP PUMP ON advisory remains for approximately 90 seconds or until cycled OFF.
 - e. BACKUP HYD PMP switch — CYCLE, OFF THEN AUTO.
- †4. Backup tail rotor servo — CHECK.
- a. Flight controls — LEFT PEDAL SLIGHTLY FORWARD OF NEUTRAL.
 - b. TAIL SERVO switch — BKUP. #1 TAIL RTR SERVO caution appears, #2 TAIL RTR SERVO ON and BACK-UP PUMP ON advisories appear within 0.5 seconds.
 - c. TAIL SERVO switch — NORM. #1 TAIL RTR SERVO caution and #2 TAIL RTR SERVO ON advisory disappear. BACK-UP PUMP ON advisory remains for approximately 90 seconds or until cycled OFF.
 - d. BACKUP HYD PMP switch — CYCLE, OFF THEN AUTO.
- 5. Engine anti-ice check — AS REQUIRED (see [paragraph 7.17.10](#)).
 - 6. Blade de-ice systems check — AS REQUIRED (see [paragraph 7.17.9](#)).
 - 7. HIT check — AS REQUIRED (see [paragraph 7.17.1](#)).
 - 8. ENGINE ANTI-ICE, PITOT HEAT, BLADE DE-ICE, WINDSHIELD ANTI-ICE, DE-ICE MASTER switches — AS REQUIRED.
 - 9. FMCP — AS REQUIRED.
 - 10. APU — SHUTDOWN.
 - a. AIR SOURCE ECS/START switch — ENG.
 - b. APU CONTR switch — OFF.
 - c. FUEL PUMP switch — OFF.

7.4.4 Mission/Weapons System Checklist

- 1. MSN PWR — PRI.
 - 2. DPLR, RDR, DATA LINK — AS REQUIRED.
 - 3. ALQ-205 — AS REQUIRED.
 - 4. AAR 47 — AS REQUIRED (2-minute warm-up).
- †5. Mission systems — IPL and key.
- a. SO — IPL.
 - b. ATO MPD — TEST.
 - c. Secure equipment — KEY.
 - d. ATO MPD — ON (after test pattern appears).
 - e. Secure communications — CHECK.
- 6. Mode select panels, BDHI, AI — AS REQUIRED.
 - 7. BDHIs and AIs — CHECK.
- †8. TACAN/IFF — TEST, Set.
- a. TACAN check:
 - (1) Ensure the TACAN has warmed up for 90 seconds.
 - (2) Select TCN on BDHI mode select panel.
 - (3) Adjust BDHI CRS control for a course of 180° or 000°.

- (4) Set TACAN control mode selector to T/R.

Note

A partial test of the TACAN may be accomplished while the mode select switch is in the REC position. However, the transmitter (DME) functions are not fully tested.

- (5) Momentarily press TACAN TEST button and observe BDHI and TEST indicator for the following:
- (a) TEST indicator flashes momentarily indicating TEST indicator is operational.
 - (b) Distance shutter and NAV flag on BDHI come into view for approximately 15 seconds, if not already in view.
 - (c) Distance shutter and NAV flag go out of view.
 - (d) Distance indication is 000.0 ± 0.5 nm and bearing indication is $180 \pm 3^\circ$. A distance indication of 399.9 is equal to a negative 0.1 nm, and a distance indication of 399.5 is equal to negative 0.5 nm. The 399.9 to 399.5 indications are not malfunctions, but an indication of negative distance.
 - (e) Course deviation indicator is centered within $\pm 1/2$ dot and TO/FROM indicator indicates TO (if a course of 180° is selected) or FROM (if a course of 000° is selected).
 - (f) Distance shutter and NAV flag come into view until the system reacquires a usable signal.
 - (g) Observe TEST indicator. If indicator illuminates during test and remains illuminated, there is a TACAN system malfunction and all information should be disregarded until repairs are made.

b. IFF check:

- (1) MASTER — NORM.
- (2) Individual mode switches — TEST; Verify steady green light.
- (3) MASTER — STBY.

Note

- IFF Mode 4 may also be tested by placing the mode 4 TEST/ON/OUT switch to the TEST position.
- If Mode 3/A or Mode C fails, IFR flight under ATC control is not permitted.

- (4) Codes — AS REQUIRED.

9. AOP — INITIALIZE.

†10. NAV — INITIALIZE.

If GPS is to be used as a the primary navigation mode:

- a. GPS — KEY.
- b. GPS — INIT/TEST (via equipment status table once GPS is available).



Options 1 (Get GPS PRESET) and 8 (Send Init Data) of the GPS Data Table should not be performed when the aircraft NAV mode is GPS, as large and unpredictable aircraft LAT/LONG errors may occur.

Note

Performance of INIT SYNC to initialize the GRP is strongly recommended. This will avoid problems such as uncapturable fly-to points. See NTRP 3-22.2-SH60B for establishing a data link with the ship.

- †11. Initialize FHS — AS REQUIRED.
- a. FLIR EU PWR — ON.

WARNING

When the FLIR EU PWR switch is ON, the FLIR Turret automatically moves to the STOW position. Ensure personnel and equipment are clear of the FLIR Turret area before applying power.

- b. Hellfire PWR — ON (as required)
- c. ACRT/FLIR/M299 — INIT/TEST (via equipment status table).
- d. FLIR Turret — VERIFY OPERATION.
- e. Hellfire Attack Menu — SELECT. Verify correct missile symbology.

If missile symbology incorrect:

- f. RESET LAUNCHER — SELECT.
- g. FLIR Turret — STOW.
- h. Hellfire PWR — OFF.

12. RAD ALTs — TEST. Press and hold the RAD ALT PUSH-TO-TEST (PTT) button.

Note

Note altitude indicator pointers indicate 100 ± 10 feet, the green self-test light illuminates, and aural radar altitude warning system (RAWS) tone heard in pilot and ATO headsets. Release the PTT button and indicator should return to zero.

13. EMCON, as required:
- a. Transponder - Unnecessary modes — OFF (as required).
 - b. TACAN — AS REQUIRED.
 - c. Data link — AS REQUIRED.
 - d. Radar altimeter — AS REQUIRED.
14. External power/Data link hardwire — DISCONNECT (as required).
15. Ordnance pins/covers — REMOVE (as required).
- a. ALE-39 external arming handles (ESP only) — AS REQUIRED.
 - b. AGM-114 Hellfire missile seeker head cover(s) — REMOVE.
 - c. Mk46 REXTORP/EXTORP nose cover, air stabilizer clamp, ballast safety strap — REMOVE.
 - d. Mk 46 WARSHOT nose cover, air stabilizer clamp — REMOVE.
 - e. Mk 50 nose cover — INSTALLED.
 - f. Mk 50 WARSHOT ARM/SAFE indicator — ARM.

WARNING

Inadvertent launch of chaff/flares may occur from the ALE-39 when the external arming handles are in the ARM position regardless of the position of the SAFE/ARM switch on the arming control panel.

7.5 TAXI CHECKLIST

1. Crew — SET FOR TAXI.
2. Lights — AS REQUIRED.
3. Ordnance/Pins/Covers — ARM/REMOVE (as required).
4. Chocks — OUT.

WARNING

With missiles uploaded, exercise extreme care when chocking and chaining to avoid damage to missile seeker, fins, or injury to personnel.

5. Brakes — RELEASE AND CHECK.
6. TAIL WHEEL switch — UNLOCK.
7. BDHI, standby compass, AIs, turn and slip — CHECK.

7.6 TAKEOFF CHECKLIST

1. Lights — AS REQUIRED.
2. AFCS — AS REQUIRED.
3. STABILATOR AUTO CONTROL pushbutton — ON.
4. CONTGCY PWR switch — AS REQUIRED.
5. PCLs — FLY.
6. Instruments, Caution/Advisories — CHECK.
7. Communication and navigation — AS REQUIRED.
 - a. Transponder — AS REQUIRED.
 - b. TACAN — AS REQUIRED.
8. FLIR turret — STOW, AS REQUIRED.
9. TAIL WHEEL switch — LOCK.
10. HARNESS — LOCKED.
11. Aircrewman Pretakeoff Checklist — COMPLETE.
12. Ordnance/Pins/Covers — ARM/Remove (as required).
13. Chocks/Chains (Main, High Points, and Tail) — REMOVED.

WARNING

With missiles uploaded, exercise extreme care when chocking and chaining to avoid damage to missile seeker, fins, or injury to personnel.

14. Brakes — AS REQUIRED.
15. RDR/BAR ALT pushbutton — AS REQUIRED.

Note

Do not engage RDR ALT HOLD until clear of deck edge.

7.7 POST TAKEOFF CHECKLIST

1. Instruments, Caution/Advisories — CHECK.
2. RDR/BAR ALT pushbutton — AS REQUIRED.
3. CONTGCY PWR switch — AS REQUIRED.
4. Lights — AS REQUIRED.
5. Aircrewman Post Takeoff Checklist — COMPLETE.
6. COMP controllers — SLAVED and ALIGNED.
7. Manual fuel transfer — CHECK (as required). (Short manual transfers from each auxiliary fuel tank should be checked. Main fuel level shall be 3,700 pounds or less prior to each transfer.)
8. HIT check — AS REQUIRED (see [paragraph 7.17.1](#)).

Note

At a minimum, the HIT check shall be performed on the first flight of the day.

9. Engine anti-ice check — AS REQUIRED (see [paragraph 7.17.10](#)).
10. Power Available — CHECK (as required).
 - a. ECS/ANTI-ICE and CONTGCY PWR switches — OFF.
 - b. Stabilize aircraft at intended operating altitude, level the VSI, ball centered, 100 to 130 KIAS. Airspeed is dependent on environmental conditions and gross weight.
 - c. Gradually increase collective until N_p begins to droop on either engine or maximum dual-engine torque limits are reached. Stabilize for 5 seconds and record indicated torque.
11. Tactical/Combat Checklist — AS REQUIRED (see [paragraph 7.8](#)).

7.8 TACTICAL/COMBAT CHECKLIST

1. Fuel — Check mission capable and bingo.
2. CONTGCY PWR — AS REQUIRED.
3. Fire power/weapons check.
 - a. Machine gun — RIG AND TEST FIRE (as required).
 - b. FLIR — AS REQUIRED.
 - c. Hellfire system — ON; check ACRT/SDC/missile status.
 - d. LASER — ENABLE (if required).
 - e. Torpedoes and missiles checklist — PERFORM (as required).
 - f. Sonobuoy inventory — CHECK.

4. Emitters/EMCON.
 - a. Radar — AS REQUIRED.
 - b. IFF unnecessary modes — OFF.
 - c. TACAN — AS REQUIRED.
 - d. Data link — AS REQUIRED.
 - e. MAD — AS REQUIRED.
 - f. Doppler — AS REQUIRED.
 - g. Radar altimeter — AS REQUIRED, variable index as required.
 - h. BARALT HOLD — ENGAGE IF REQUIRED.
 - i. External lights — AS REQUIRED.
 - j. Internal lights — SELECT MINIMUM INTENSITY (as required).
5. Navigation.
 - a. Sensor horizon RADAR or MAD — AS REQUIRED.
 - b. SO/ATO option controls — SET (as required).
6. Communications — CHECK (as required).
7. Electronic Countermeasures.
 - a. AAR-47 — Verify ON.

Note

Inadvertent firing of chaff/flares may occur if the ALE-39 is armed prior to applying power to the AAR-47.

- b. ALQ-205 — AS REQUIRED.
- c. ALE-39 programmer — Check settings.
- d. Chaff dispenser control panel — AS REQUIRED.
- e. Countermeasure dispenser control panel — ON; check settings.
- f. Arm control indicator unit — ARM.

WARNING

Do not arm the ALE-39 system until clear of ship/takeoff environment. Inadvertent firing of chaff/flares is a potential danger to ground personnel and property.

- g. ESM — Update library; set [HTW](#).

7.9 RETURN TO FORCE CHECKS

1. MASTER ARM — SAFE.
2. LASER — DISABLE.
3. HELLFIRE PWR — OFF.
4. Machine gun — CLEAR, SAFE, AND STOW.
5. AAR-47 — OFF.
6. ALE-39 — SAFE.
7. ALQ-205 — OFF.
8. Transponder modes 1, 2, 3, 4, and C — ON (as required).
9. External lights — ON (as required).
10. Radar altimeter — ON.
11. RADALT hold — AS REQUIRED.
12. DPLR — ON.
13. TACAN — T/R.
14. Radar — AS REQUIRED.
15. MAD — STOW.

7.10 LANDING CHECKLIST

1. CONTGCY PWR switch — AS REQUIRED.
2. Lights — AS REQUIRED.
3. Brakes — AS REQUIRED.
4. TAIL WHEEL switch — LOCK.
5. Instruments, Caution/Advisories — CHECK.
6. BAR ALT/RAD ALT — AS REQUIRED.
7. HF Radio — OFF.
8. Armament — SAFE.
9. Harness — LOCKED.
10. Aircrewman Landing Checklist — COMPLETE.
11. FLIR — STOW.
12. Return to Force Checks — AS REQUIRED.

7.11 POST LANDING CHECKLIST

1. Lights — AS REQUIRED.
2. Tail Wheel/Brakes — AS REQUIRED.
3. CONTGCY PWR switch — OFF.
4. Ordnance pins/covers — DE-ARM/SAFE/INSTALL (as required).



Install Hellfire missile seeker covers (if available) before all ground operations and before all chock and chain operations.

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5. ALE-39 External Arming handles — SAFE.
6. M299 launcher SAFE/ARM switch — SAFE.
7. Chocks and Chains — AS REQUIRED.

WARNING

With missiles uploaded, exercise extreme care when chocking and chaining to avoid damage to missile seeker or fins or injury to personnel.

8. Transponder — STBY.
9. ENG ANTI-ICE/PITOT HEAT/BLADE DE-ICE — OFF.

WARNING

The pitot and static ports become extremely hot during operation. Care should be taken to prevent ground personnel from touching these surfaces. Failure to turn off pitot heat could burn personnel whenever external power is applied.

7.11.1 Hot Refuel Checklist

1. RADIOS — MONITOR; transmit only for essential communications.
2. RADALT — OFF.
3. DOPPLER — OFF.
4. TACAN — RECEIVE.
5. HF — OFF.
6. IFF — STANDBY.
7. FMCP — AS REQUIRED.
8. PRE-CHECK switches — AS REQUIRED.
9. Fuel quantity — MONITOR.

At completion of fueling:

10. FMCP — AS REQUIRED.
11. RADALT, DOPPLER, TACAN, HF, IFF — AS REQUIRED.

7.12 SHUTDOWN

1. TAIL WHEEL switch — LOCK.
2. Parking brake — SET.
3. Chocks — IN.
4. APU — START.
 - a. ECS — OFF.
 - b. AIR SOURCE ECS/START switch — APU.

- c. FUEL PUMP switch — APU BOOST.
- d. APU CONTR switch — ON.
- 5. APU GENERATOR switch — ON.
- 6. IFF MODE 4 CODE — HOLD (as required).
- 7. Avionics.
 - a. DOPPLER — OFF.
 - b. MPDs — OFF.
 - c. SAC POWER — OFF.
 - d. FLIR POWER — OFF.
 - e. MSN POWER — OFF.
 - f. RDR — STBY.
 - g. DATA LINK — STBY.
 - h. TACAN — OFF.
 - i. IFF MASTER — OFF.
 - j. RAD ALTs — OFF.
- 8. BACKUP HYD PMP switch — ON.
- 9. Flight controls — POSITION AND HOLD (as required).
- 10. NO. 1 and NO. 2 GENERATOR switches — OFF.

WARNING

Power transfer from Main Generators or External Power to the APU generator may cause disengagement of SAS 1, SAS 2, TRIM, and Stabilator. An unguarded cyclic will allow the rotor arc to dip as low as 4 feet above the ground.

- 11. ENGINE IGNITION switch — OFF.
- 12. Lights — AS REQUIRED.
- 13. PCLs — IDLE.

CAUTION

Engines should be cooled for 2 minutes at an N_g of 90 percent or less before moving PCLs to OFF. If an engine is shut down without being cooled, it should not be restarted for 4 hours unless restart is performed within 5 minutes.

- 14. NO. 2 PCL and fuel selector — OFF.
- 15. Droop stops — IN.
- 16. NO. 1 PCL and fuel selector — OFF.
- 17. Rotor brake — ON (between 30 percent and 50 percent N_r).

18. GT — MONITOR.



If TGT rises above 540 °C, perform Post Shutdown Engine Fire emergency procedure.

19. DECU codes — CHECK.

20. Engine cleaning — AS REQUIRED (see [paragraph 7.17.12](#)).

Note

If engine cleaning is required, proceed to step 14. of Engine Cleaning Procedures.

21. Blade fold — AS REQUIRED.



- Should the blade fold system stall during fold, cycling the BLADE FOLD switch to SPREAD should return the rotor blades to the spread position.
- Shut down the APU immediately if a rotor blade remains stalled in the APU exhaust.
- When the ROTOR SPREAD light is not illuminated, pressing the RDR ALT pushbutton during blade fold system operations may cause failure of the automatic system. Do not press this pushbutton during blade fold operations.
- Simultaneous folding of main rotor blades and tail pylon is prohibited.

Note

Failure to suppress the DECU numerical fault codes on the PDU will prevent the automatic blade fold from operating due to the torque signal being relayed to the AFCS computer. Codes can be suppressed by pressing either OVSP TEST A or B buttons for the affected engine.

- a. Area — CLEAR (wing walkers positioned, as required).
- b. BACKUP HYD PMP switch — ON.
- c. STABILATOR AUTO CONTROL pushbutton — OFF.
- d. SAS 1 and SAS 2 pushbuttons — OFF, TRIM pushbutton — ON, AUTO PLT pushbutton — OFF.
- e. SERVO switch — 1ST OFF or 2ND OFF.
- f. BLADE FOLD MASTER switch — ON.
- g. BLADE FOLD switch — FOLD.
- h. Rotor brake — OFF.
- i. ROTOR INDEXED light — ILLUMINATED.

Note

Blades may be manually indexed if the main rotor indexer gust lock fails. Cycling the BLADE FOLD switch OFF, pulling the RTR HEAD INDEX MOTOR circuit breaker (NO. 2 AC PRI, CABIN), and cycling the BLADE FOLD switch to FOLD may disengage the indexer. Rotate the rotor system until the INDEXED light illuminates, then continue with the Blade Fold Checklist.

- j. Rotor brake — APPLY.
- k. BAR ALT — FLASHING.
- l. Collective, cyclic, and pedals — FREE TO POSITION.

Note

If computer is unable to null after 30 seconds, the AFCS DEGRADED caution will appear. To attempt another cycle, turn BLADE FOLD switch OFF, press any FAIL ADVISORY MODE RESET pushbutton, and repeat blade fold sequence.

- m. BAR ALT pushbutton — PRESS.

Note

The following blade status panel light sequence indicates proper operation of the fold cycle: TRIM light flashing (blades positioned for pitch lock insertion) and PITCH LOCKED light illuminated (last pitch lock in). Blades will begin folding following the illumination of the PITCH LOCKED light. Should the INDEXED light flicker or extinguish during folding (indicating a loss of index), the blade fold sequence will stall. Cycling the BLADE FOLD switch to SPREAD should clear the stall. When the SPREAD light illuminates, the rotor head may be re-indexed and another fold cycle attempted.

- n. ROTOR FOLDED light — ILLUMINATED.
 - o. BLADE FOLD switch — OFF.
 - p. BLADE FOLD MASTER switch — OFF.
 - q. SERVO switch — CENTER.
22. BACKUP HYD PMP switch — OFF.
 23. ECS — OFF.
 24. Interior/Exterior/NVD lights — OFF.
 25. APU GENERATOR switch — OFF.
 26. APU — SHUTDOWN.
 - a. AIR SOURCE ECS/START switch — OFF.
 - b. APU CONTR switch — OFF.
 - c. FUEL PUMP switch — OFF.
 27. BATT switch — OFF.

7.13 POST FLIGHT CHECKS

1. Interior equipment.
2. Tires/struts.
3. Leaks.
4. Missing panels.

7.14 NVD LIGHTING CHECKLIST

1. CDU, PDU, and master caution panel filters — Installed.
2. RADALT — Green.
3. Master warning panel — Down.
4. AAR-47 indicator lights — Out.
5. IFF test/no go catseye lights (red/green) — Closed.
6. BLADE DE-ICE catseye lights (2 amber/1 green) — Closed.

Note

ALQ-205 must remain uncovered for 15 minutes to allow cooldown.

7. Anticollision lights — As required (off for shipboard takeoff/landing).
8. Position lights — As required.
9. RAST lights — As required (on for FD/RA landings).
10. Infrared searchlight — As required.
11. Instrument panel secondary lights — ON.
12. Lower console secondary lights — Bright.
13. Utility lights — ON/green.
14. AUX fuel totalizer — Covered.
15. ASE status lights — Covered.
16. **CSCG** status annunciators — Covered.
17. Armament control panel switches (AN/ASQ-198) — Covered.
18. Wet compass lighting — OFF.
19. Nonflight instrument lights — OFF.
20. Pilot/ATO flight instrument lights — OFF.
21. Upper/lower console panel lights — OFF.
22. Aided cockpit lighting evaluation — Conduct.

7.15 WHITE LIGHTING CHECKLIST

1. CDU, PDU, and master caution panel filters — Removed.
2. RADALT — Red.
3. Master warning panel — Up.
4. AAR-47 indicator lights — In.
5. Wet compass — ON.
6. IFF test/no go catseye lights (red/green) — Open.
7. BLADE DE-ICE catseye lights (2 amber/1 green) — Open.

8. Anticollision lights — ON.
9. Position lights — ON.
10. RAST lights — As required (on for FD/RA landings).
11. Infrared searchlight — OFF.
12. Instrument panel secondary lights — As desired.
13. Upper/lower console panel lights — ON.
14. Lower console secondary lights — OFF.
15. Pilot/ATO flight instrument lights — ON.
16. Nonflight instrument lights — ON.
17. Utility lights — As desired.
18. AUX fuel totalizer — As desired.
19. ASE status lights — As desired.
20. CSCG status annunciators — Uncovered.
21. Armament control panel switches (AN/ASQ-198) — As desired.

7.16 AIRCREWMAN'S CHECKLISTS

7.16.1 Aircrewman Prestart Checklist

1. CLOCK — WIND, SET.
2. RADIO panel — SECURE.
 - a. Switches — AS DESIRED.
 - b. UHF 1 and 2 receivers — AS REQUIRED.
 - c. D/L — AS REQUIRED.
 - d. SONO — OFF.
 - e. TACAN — OFF.
 - f. HF — OFF.
3. MAD detecting set control box — SECURE.
 - a. PWR — OFF.
 - b. UNIT 1 mechanical fault indicator — BLACK.
 - c. ALT COMP — OFF.
 - d. CAL — OFF.
 - e. BAND PASS — Low 0.04, high 0.6.
 - f. γ FS — TST
4. MAD reeling machine control panel — SECURE.
 - a. POWER — OFF.
 - b. REEL — CENTERED.
 - c. REEL FAIL mechanical fault indicator — BLACK.
5. System control panel — SECURE.
 - a. PANEL — OFF.
 - b. PROGRAM MODE — AOP.

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- c. SAC MODE — PRIME.
- d. PROC INTRPT — OFF.

Note

To restart SACs, place SAC 1 and SAC 2 MASTER CLR in OFF position.

- e. SAC 1 POWER — OFF.
 - f. MASTER CLR — ON.
 - g. SAC 2 POWER — OFF.
 - h. MASTER CLR — ON.
 - i. IPL THP — 1.
 - j. IPL SAC — 2.
 - k. IPL LOAD — OFF.
- 6. RAST panel — SECURE.
 - a. MASTER — OFF.
 - 7. FLIR controls.
 - a. FLIR PWR — OFF.
 - b. LASER — DISABLE.
 - c. GIMBAL — DISABLE.
 - 8. RADAR/DISPLAY panel — SECURE.
 - a. MODE/SPEED — OFF.
 - b. EMISSION — HOLD.
 - c. RCVR GAIN — 1.
 - d. FORMAT — TEST.
 - e. STAB — N.
 - f. RANGE — 10.
 - g. PERSIST — OFF.
 - 9. MPD — OFF.
 - 10. PANEL INTENSITY — CCW.
 - 11. STATUS INTENSITY — CCW.
 - 12. Floodlights — OFF.
 - 13. Lower sensor operator console (applies to ESP-equipped aircraft only).
 - a. ALQ-205 control panel — SECURE.
 - (1) POWER — OFF.
 - b. CM select panel — SECURE.
 - (1) CM select — AS DESIRED.
 - c. AN/ALE-39 control panel — SECURE.
 - (1) POWER — OFF.
 - (2) Payloads remaining/mode select — AS DESIRED.

- d. DISP ARM panel — SECURE.
 - (1) ARM/SAFE — SAFE.
- e. AN/ALE-39 programmer — SECURE.
 - (1) Thumbwheels — AS DESIRED.
- f. CM DIMMER CONT panel — SECURE.
 - (1) Control knob — AS DESIRED.
- g. ECM control panel — Secure.
 - (1) POWER — OFF.
 - (2) PUSH FOR STANDBY STATUS — DEPRESSED.
 - (3) TEST FLARE — OFF/guard closed.
- h. Countermeasures circuit breaker panel — SECURE.
 - (1) Circuit breakers — CHECK.
- 14. Seats and belts — ADJUSTED/LOCKED.
- 15. Prestart Checklist — COMPLETE (report when requested).

7.16.2 Aircrewman's Utility Systems Checks

7.16.2.1 Rescue Hoist Preoperational Check

- 1. Rescue station ICS — ADJUST.
- 2. BACKUP PUMP — VERIFY ON.
- 3. RESCUE HOIST — ALL.
- 4. HOIST PWR light — VERIFY ON.



Tension should be maintained on the hoist cable to prevent possible birdcaging.

- 5. Rescue hook — LOWER.
- 6. Rescue hook — Operational/rotates freely.
- 7. Bushing guide — Set screws/cotter pins (Breeze Eastern hoists only).
- 8. Bumper assembly — Grommet/cable beneath (Breeze Eastern hoists only).
- 9. Hoist cable — No kinks/broken strands.
- 10. Lower/raise hoist at all electrical stations. Select BACKUP — Check for light and ability to lower/raise hoist — DESELECT.
- 11. Rescue hook — ELECTRICALLY STOW.
- 12. Report hoist status — “CHECKS GOOD/BAD ALL STATIONS”.
- 13. RESCUE HOIST — OFF.

14. HOIST PWR light — VERIFY OFF.
15. BACKUP HYD PUMP — AS REQUIRED.

WARNING

Personnel hoisting shall not be attempted with a damaged cable.

7.16.2.2 Cargo Hook Preoperational Check

1. Cargo hook — OPERATIONAL POSITION.
2. CARGO HOOK ARMING switch — ARM.
3. CARGO HOOK EMERGENCY RELEASE switch — NORMAL.
4. CARGO HOOK CONTROL switch — ALL.
5. Report ready for cargo hook check.
6. Apply downward pressure to cargo hook jaw.
7. Pilot — Press CARGO RELEASE.
8. Hook open — Verify CARGO HOOK OPEN advisory light ON.
9. Close hook — Verify CARGO HOOK OPEN advisory light OFF.
10. Repeat steps 6. through 9. for ATO and crewman.
11. Cargo hook manual release — CHECK.
12. CARGO HOOK EMERGENCY RELEASE switch — OPEN.
13. CARGO HOOK ARMING switch — SAFE.
14. Cargo hook — STOWED.
15. Report cargo hook check — COMPLETE.

7.16.3 Aircrewman Pretakeoff Checklist

1. HELLFIRE PWR — VERIFY OFF.
2. STATUS INTENSITY — AS DESIRED.
3. PANEL INTENSITY — AS DESIRED.
4. MPD — TEST.
5. Initialize SYSTEM CONTR panel.
 - a. SYSTEM CONTR PANEL — LAMP TEST. Verify all status annunciators illuminated.
 - b. SYSTEM CONTR PANEL — RESET.
 - (1) Verify all status annunciators — OFF.
 - (2) Release switch.
 - (3) Verify SAC-1 and SAC-2 POWER FAULT annunciators illuminated.
6. SAC POWER.
 - a. SAC-2 POWER — ON.
 - b. SAC-1 POWER — ON.
7. MPD — ON; RASTER — ADJUSTED.

8. Load SAC-2 — AS REQUIRED.
 - a. IPL LOAD — ON.
 - b. SAC-2 MASTER CLR — OFF.
 - c. Verify IPL IN PROG annunciator illuminates.
 - d. IPL LOAD — OFF.
9. MAGNETIC DETECTING SET PWR — ON.
10. MAD reeling machine POWER — ON.
 - a. VEHICLE TRAIL light — TEST.
 - b. CABLE LIMIT light — TEST.
 - c. MAD reeling machine POWER — OFF.
11. Radar/display panel.
 - a. MODE/SPEED — AUTO.
12. RAST.
 - a. Lamp TEST.
 - (1) RAST panel power — ON.

Note

Maintain power to light for 5 minutes to properly energize luminescent hose on messenger cable.

- b. RAST MSGR LGHT — AS REQUIRED.
13. HEELS — ARM.

Note

Steps 13. and 14. apply to HEELS-equipped aircraft only.

14. HEELS TEST — NOT ILLUMINATED.
15. Keyset — LAMP TEST.
16. Verify SAC-2 LOAD — COMPLETE.

For aircraft equipped with 99-channel sonobuoy receivers:

- a. If using THP 20 or previous, sonobuoy receiver circuit breakers — Pull.
- b. If using THP 21 or subsequent, sonobuoy receiver circuit breakers — In.
17. Load SAC-1 — AS REQUIRED.

Note

SAC-2 IPL will occasionally fail if the spectrum analyzer (SA) is already loaded. To avoid SAC IPL failure, cycle SA power or MSN PWR to SEC and back to PRI before performing SAC IPL.

- a. IPL SAC switch — 1.
- b. IPL LOAD — ON.

- c. SAC-1 MASTER CLR — OFF.
 - d. Verify IPL IN PROG annunciator illuminates.
 - e. IPL LOAD — OFF.
 - f. Verify SAC-1 LOAD — COMPLETE.
 - g. Verify all annunciators extinguished and report — “IPL COMPLETE”.
18. Data link — Verify KG-45 LOAD STATUS.

Note

Equipment status table D/L BIT status word 1 (word 2 for THP 21 and subsequent) high order digit EVEN (XXXX) implies KG-45 passed BIT and code was accepted. Devices shown on the Equipment Status Table that are not in the aircraft (e.g., FLIR, RDP, MLA, GPS) should be I/O inhibited.

19. Initialize FHS — AS REQUIRED.
- a. FLIR PWR — ON (if applicable).

WARNING

When the FLIR PWR switch is ON, the FLIR turret automatically moves to the STOW position. Ensure personnel and equipment are clear of the FLIR turret area before applying power.

Note

After power on, an A/C 1553 FAIL alert is displayed. This is a normal indication that the FLIR is conducting the BIT.

- b. HELLFIRE PWR — ON (if applicable).
- c. Initialize FLIR — AS REQUIRED.
- d. LASER — DISABLE.
- e. GIMBAL — ENABLE.
- f. Verify FLIR video displayed on MPD.

Note

FLIR video may take up to 10 minutes to be displayed on the MPD.

- g. Slew FLIR turret to ensure turret gimbal is enabled.
- h. Attack page — SELECT (if applicable).
- i. Launcher — RESET (if applicable).
- j. Launcher and missile status — VERIFY (if applicable).
- k. HELLFIRE PWR — OFF.
 - l. FLIR turret — STOW.
- m. FLIR VCR POWER — ON (if applicable).
- n. FLIR VCR — Set date and time.

- o. FLIR VCR time set to 2 h or 6 h.
 - p. FLIR VCR tape — INSERT (as required).
20. GPS Key — VERIFY LOAD STATUS/INIT TEST via EQUIPMENT STATUS TABLE.
 21. Device reinitialization — AS REQUIRED.
 - a. Monitor equipment status.
 - b. Select lines/options desired.
 - c. Repeat as necessary.
 22. SO **ORT** — PERFORM.

Note

- If it is necessary to transmit the antisubmarine warfare (ASW) ORT acoustic data to the ship, the SO must ask the ATO to select Helo Control ASW mode for data link.
- If it is necessary to transmit the RADAR/CMUX test results to the ship, the SO must ask the ATO to select Helo Control **ASST** mode for the data link.

23. SO table — UP/LOCKED.
24. SONO launcher lockout pin — FREE.
25. AAR-47 — ON (2-minute warmup).
26. ALQ-205 — AS REQUIRED.
27. Seat/harness — UP/LOCKED.
28. Aircrewman Pretakeoff Checklist — “COMPLETE” (report when requested).

7.16.4 Aircrewman Post Takeoff Checks

1. MAIN PROBE — UP.
2. MSGR LGHT — OFF.
3. RAST panel power — OFF.
4. Aircrewman After-Takeoff Checklist — “COMPLETE” (report when requested).

7.16.5 Aircrewman Before Landing Checklist

1. FLIR — STOW.
2. LASER — DISABLE.
3. HELLFIRE PWR — OFF (if applicable).
4. Machine guns — CLEAR, SAFE AND STOW.
5. MAD — STOWED.
 - a. REEL switch — CENTERED.
 - b. MAD reeling machine power — OFF.
6. MAGNETIC DETECTING SET PWR — AS REQUIRED.
7. Radar display controls.
 - a. EMISSION — HOLD.
8. ALQ-205 — OFF.

9. ALE-39 — SAFE.

Note

To properly safe the ALE-39 system, ensure the Control Indicator ARM/SAFE switch is set to SAFE and the countermeasures dispenser control panel SALVO FLARE switch is set to OFF at the SO station.

10. AAR-47 — OFF.
11. RAST.
 - a. Panel power — AS REQUIRED.

Note

Energize the messenger light a minimum of 2 minutes prior to paying out the messenger cable.

- b. MSGR LIGHT power — AS REQUIRED.
12. MAIN PROBE — AS REQUIRED.
13. Seat/harness — UP/LOCKED.
14. SO table — UP/LOCKED.
15. Aircrewman Before Landing Checklist — “COMPLETE” (report when requested).

7.16.6 RAST Recovery Checklist

1. Messenger cable — Lower when directed.
2. Messenger cable — Stop lowering when directed.

WARNING

Too much slack in the messenger cable may entangle flight deck personnel. If a STOP LOWERING command is not received from the LSO after 20 seconds, stop lowering the messenger cable and verify the cable status.

3. Messenger cable — Raise when directed.
4. Report to pilot — “THREE GREEN”.

7.16.7 Aircrewman Post Landing Checks

1. Radar MODE/SPEED — OFF.
2. FLIR system.
 - a. FLIR PWR — OFF.
 - b. VCR TAPE — EJECT.
 - c. VCR PWR — OFF.
 - d. GIMBAL — DISABLE.
3. MPD — OFF.
4. RAST.
 - a. MSGR LGHT power — AS REQUIRED.
 - b. RAST panel — OFF when H'DOWN CABLE OUT light comes ON.

5. Sonobuoy launcher.
 - a. VNT indication.
 - b. Valve safety lockout — LOCK (FREE position if no sonobuoys installed).
6. ALE-39 arming handles — SAFE.
7. M299 launcher SAFE/ARM switch — SAFE (if applicable).
8. Ordnance pins/covers — On (if available).

WARNING

With missiles uploaded, exercise extreme care when chocking and chaining to avoid damage to missile seeker or fins or injury to personnel.

9. System control panel.
 - a. SAC-1 POWER — OFF.
 - b. SAC-2 POWER — OFF.
10. MAGNETIC DETECTING SET PWR — OFF.
11. HEELS — DISARM (if applicable).
12. RAST MASTER — ON.
13. MAIN PROBE — AS REQUIRED.

Note

ALQ-205 must remain uncovered for 15 minutes to allow cooldown.

14. Aircrewman Post Landing Checklist — “COMPLETE” (report when requested).

7.16.8 Aircrewman Post Flight Checklist

1. SO station.
 - a. All switches — OFF/normal.
 - b. DOME LIGHTS — OFF.
 - c. Utility light — OFF.

Note

The utility lights operate from the battery utility bus. A dead battery may result from not placing the utility light switch in the OFF position.

2. Loose equipment — STOWED/SECURE.
3. FOD — REMOVED.
4. Discrepancies — NOTED/REPORTED.
5. Debrief — WHEN REQUIRED.

7.17 SPECIAL PROCEDURES

7.17.1 Health Indicator Test (HIT) Check

Note

- If icing conditions exist, consideration should be given to performing HIT Check on deck.
- HIT Check shall be performed on the first flight of the day and recorded on locally reproduced copies of [Figure 10-3](#) for trends in engine performance.

1. ENG ANTI-ICE switches — OFF.



If icing conditions exist, do not keep engine anti ice off longer than necessary to perform check.

2. ECS — OFF.
3. BAR ALT — SET TO 29.92.
4. N_r — 100 PERCENT.
5. PCL (Engine not being checked) — IDLE, if performing HIT check on ground.
6. Collective — INCREASE TO MAINTAIN 60 PERCENT [TRQ](#) FOR AT LEAST 30 SECONDS.
7. Record OAT, [PA](#), and TGT.
8. PCL (Engine not being checked) — FLY (as required).
9. Repeat steps 5. to 8. for opposite engine.
10. Determine table TGT from HIT TGT Reference [Figure 7-2](#) for recorded OAT and PA.

Note

- When using HIT TGT Reference table, round up temperature to the nearest value.
- Ensure HIT checks are calculated and recorded using the appropriate HIT power check log (ground or flight).
- During operational checks, HIT TGT margin should be within upper and lower limits or a VIDS/MAF shall be initiated.

| FAT °C | PRESSURE ALTITUDE-FT | | | | | |
|-----------|----------------------|------|-----|-----|------|------|
| | -1000 | -500 | 0 | 500 | 1000 | 1500 |
| 55 | 736 | 740 | 744 | 748 | 753 | 758 |
| 53 | 730 | 734 | 738 | 742 | 747 | 751 |
| 51 | 724 | 728 | 732 | 736 | 740 | 745 |
| 49 | 718 | 721 | 725 | 729 | 734 | 738 |
| 47 | 712 | 715 | 719 | 723 | 727 | 732 |
| 45 | 706 | 709 | 713 | 717 | 721 | 725 |
| 43 | 701 | 703 | 707 | 711 | 715 | 719 |
| 41 | 695 | 698 | 702 | 706 | 710 | 713 |
| 39 | 690 | 692 | 696 | 700 | 704 | 707 |
| 37 | 684 | 687 | 690 | 694 | 698 | 702 |
| 35 | 679 | 681 | 685 | 689 | 692 | 696 |
| 33 | 673 | 676 | 679 | 683 | 687 | 690 |
| 31 | 668 | 670 | 674 | 677 | 681 | 685 |
| 29 | 662 | 665 | 668 | 671 | 675 | 679 |
| 27 | 657 | 659 | 662 | 666 | 670 | 673 |
| 25 | 651 | 654 | 657 | 660 | 664 | 667 |
| 23 | 645 | 648 | 651 | 655 | 658 | 662 |
| 21 | 639 | 642 | 645 | 649 | 652 | 656 |
| 19 | 634 | 636 | 640 | 643 | 647 | 650 |
| 17 | 628 | 631 | 634 | 638 | 641 | 644 |
| 15 | 623 | 625 | 629 | 632 | 635 | 638 |
| 13 | 617 | 620 | 623 | 626 | 630 | 633 |
| 11 | 612 | 614 | 618 | 621 | 624 | 627 |
| 9 | 606 | 609 | 612 | 616 | 619 | 622 |
| 7 | 600 | 603 | 607 | 610 | 613 | 616 |
| 5 | 595 | 598 | 601 | 605 | 608 | 611 |
| 3 | 589 | 592 | 595 | 599 | 602 | 605 |
| 1 | 584 | 586 | 590 | 593 | 597 | 600 |
| -1 | 577 | 579 | 583 | 586 | 590 | 593 |
| -3 | 571 | 574 | 577 | 581 | 584 | 587 |
| -5 | 566 | 568 | 572 | 575 | 578 | 581 |
| -7 | 560 | 563 | 566 | 569 | 573 | 576 |
| -9 | 554 | 557 | 560 | 564 | 567 | 570 |
| -11 | 549 | 552 | 555 | 558 | 561 | 564 |
| -13 | 543 | 546 | 549 | 553 | 556 | 559 |
| -15 | 538 | 540 | 544 | 547 | 550 | 553 |
| -17 | 532 | 535 | 538 | 541 | 544 | 547 |
| -19 | 526 | 529 | 532 | 536 | 539 | 542 |
| -21 | 521 | 523 | 527 | 530 | 533 | 536 |
| -23 | 515 | 518 | 521 | 524 | 527 | 530 |
| -25 | 510 | 512 | 515 | 519 | 522 | 524 |
| -27 | 504 | 507 | 510 | 513 | 516 | 519 |
| -29 | 498 | 501 | 504 | 507 | 510 | 513 |
| -31 | 492 | 495 | 498 | 501 | 504 | 507 |
| -33 | 487 | 490 | 493 | 496 | 499 | 501 |
| -35 | 482 | 484 | 487 | 490 | 493 | 496 |
| -37 | 476 | 478 | 481 | 484 | 487 | 490 |
| -39 | 470 | 473 | 476 | 479 | 482 | 484 |
| -45 | 453 | 456 | 459 | 462 | 465 | 467 |
| -50 | 439 | 441 | 444 | 447 | 450 | 453 |
| -55 | 425 | 427 | 430 | 433 | 436 | 438 |

| FAT °C | PRESSURE ALTITUDE-FT | | | | | | |
|-----------|----------------------|------|------|------|------|------|--|
| | 2000 | 2500 | 3000 | 3500 | 4000 | 4500 | |
| 55 | 763 | 769 | 775 | 781 | 787 | 792 | |
| 53 | 757 | 762 | 768 | 774 | 780 | 785 | |
| 51 | 750 | 756 | 761 | 767 | 773 | 779 | |
| 49 | 744 | 749 | 755 | 761 | 767 | 772 | |
| 47 | 737 | 743 | 748 | 754 | 760 | 766 | |
| 45 | 731 | 736 | 741 | 747 | 753 | 759 | |
| 43 | 725 | 729 | 734 | 740 | 746 | 752 | |
| 41 | 718 | 723 | 728 | 733 | 739 | 745 | |
| 39 | 712 | 716 | 721 | 726 | 732 | 738 | |
| 37 | 706 | 710 | 714 | 720 | 725 | 731 | |
| 35 | 700 | 704 | 709 | 713 | 719 | 724 | |
| 33 | 694 | 698 | 703 | 707 | 712 | 717 | |
| 31 | 689 | 692 | 697 | 702 | 707 | 711 | |
| 29 | 683 | 687 | 691 | 696 | 701 | 705 | |
| 27 | 677 | 681 | 685 | 690 | 695 | 700 | |
| 25 | 671 | 675 | 680 | 684 | 689 | 694 | |
| 23 | 666 | 669 | 674 | 678 | 683 | 688 | |
| 21 | 660 | 664 | 668 | 672 | 677 | 682 | |
| 19 | 654 | 658 | 662 | 667 | 671 | 676 | |
| 17 | 648 | 652 | 656 | 661 | 665 | 670 | |
| 15 | 642 | 646 | 650 | 655 | 659 | 664 | |
| 13 | 636 | 640 | 644 | 649 | 654 | 658 | |
| 11 | 631 | 634 | 638 | 643 | 647 | 652 | |
| 9 | 625 | 629 | 633 | 637 | 641 | 646 | |
| 7 | 620 | 623 | 627 | 631 | 635 | 640 | |
| 5 | 614 | 618 | 621 | 625 | 630 | 634 | |
| 3 | 609 | 612 | 616 | 620 | 624 | 628 | |
| 1 | 603 | 607 | 610 | 614 | 618 | 622 | |
| -1 | 596 | 600 | 603 | 607 | 611 | 615 | |
| -3 | 591 | 594 | 598 | 602 | 606 | 609 | |
| -5 | 585 | 589 | 592 | 596 | 600 | 604 | |
| -7 | 579 | 583 | 587 | 590 | 594 | 598 | |
| -9 | 574 | 577 | 581 | 585 | 589 | 592 | |
| -11 | 568 | 571 | 575 | 579 | 583 | 586 | |
| -13 | 562 | 566 | 569 | 573 | 577 | 581 | |
| -15 | 556 | 560 | 564 | 567 | 571 | 575 | |
| -17 | 551 | 555 | 558 | 562 | 565 | 569 | |
| -19 | 545 | 549 | 552 | 556 | 559 | 563 | |
| -21 | 539 | 543 | 546 | 550 | 554 | 557 | |
| -23 | 534 | 537 | 540 | 544 | 548 | 551 | |
| -25 | 528 | 531 | 535 | 538 | 542 | 545 | |
| -27 | 522 | 526 | 529 | 532 | 536 | 539 | |
| -29 | 516 | 520 | 523 | 526 | 530 | 534 | |
| -31 | 511 | 514 | 517 | 521 | 524 | 528 | |
| -33 | 505 | 508 | 511 | 515 | 518 | 522 | |
| -35 | 499 | 502 | 506 | 509 | 512 | 516 | |
| -37 | 493 | 497 | 500 | 503 | 506 | 510 | |
| -39 | 487 | 491 | 494 | 497 | 500 | 504 | |
| -45 | 470 | 473 | 476 | 479 | 483 | 486 | |
| -50 | 456 | 459 | 462 | 465 | 468 | 471 | |
| -55 | 441 | 444 | 447 | 450 | 454 | 457 | |

| FAT °C | PRESSURE ALTITUDE-FT | | | | | | | |
|-----------|----------------------|------|------|------|------|------|-------|--|
| | 5000 | 5500 | 6000 | 7000 | 8000 | 9000 | 10000 | |
| 55 | 796 | 801 | 805 | 814 | 825 | 835 | 846 | |
| 53 | 790 | 796 | 800 | 809 | 819 | 830 | 840 | |
| 51 | 785 | 791 | 795 | 804 | 814 | 825 | 835 | |
| 49 | 778 | 785 | 789 | 799 | 808 | 819 | 829 | |
| 47 | 771 | 778 | 782 | 794 | 803 | 814 | 824 | |
| 45 | 764 | 771 | 776 | 788 | 798 | 808 | 818 | |
| 43 | 757 | 764 | 769 | 781 | 792 | 803 | 813 | |
| 41 | 751 | 757 | 762 | 775 | 786 | 797 | 807 | |
| 39 | 744 | 750 | 755 | 768 | 780 | 792 | 802 | |
| 37 | 737 | 743 | 748 | 761 | 773 | 787 | 796 | |
| 35 | 730 | 736 | 741 | 754 | 766 | 779 | 791 | |
| 33 | 723 | 729 | 735 | 746 | 759 | 772 | 786 | |
| 31 | 716 | 722 | 727 | 739 | 752 | 765 | 779 | |
| 29 | 710 | 715 | 720 | 732 | 745 | 758 | 771 | |
| 27 | 704 | 709 | 714 | 725 | 737 | 750 | 764 | |
| 25 | 698 | 703 | 707 | 718 | 730 | 743 | 756 | |
| 23 | 692 | 697 | 701 | 711 | 723 | 736 | 749 | |
| 21 | 686 | 691 | 695 | 705 | 715 | 728 | 742 | |
| 19 | 680 | 685 | 689 | 699 | 709 | 721 | 734 | |
| 17 | 674 | 679 | 683 | 693 | 703 | 714 | 727 | |
| 15 | 668 | 673 | 677 | 686 | 697 | 708 | 719 | |
| 13 | 662 | 666 | 671 | 680 | 690 | 701 | 712 | |
| 11 | 656 | 660 | 665 | 674 | 684 | 695 | 706 | |
| 9 | 650 | 654 | 659 | 668 | 678 | 689 | 699 | |
| 7 | 644 | 648 | 652 | 662 | 671 | 682 | 693 | |
| 5 | 637 | 642 | 646 | 656 | 665 | 676 | 687 | |
| 3 | 631 | 636 | 640 | 649 | 659 | 669 | 680 | |
| 1 | 626 | 629 | 634 | 643 | 653 | 663 | 674 | |
| -1 | 618 | 622 | 626 | 635 | 645 | 655 | 666 | |
| -3 | 613 | 617 | 620 | 629 | 639 | 649 | 659 | |
| -5 | 607 | 611 | 615 | 623 | 632 | 642 | 652 | |
| -7 | 601 | 605 | 609 | 617 | 626 | 636 | 646 | |
| -9 | 596 | 599 | 603 | 611 | 620 | 630 | 639 | |
| -11 | 590 | 594 | 597 | 606 | 614 | 623 | 633 | |
| -13 | 584 | 588 | 591 | 600 | 608 | 617 | 627 | |
| -15 | 578 | 582 | 586 | 594 | 602 | 611 | 620 | |
| -17 | 572 | 576 | 580 | 588 | 596 | 605 | 614 | |
| -19 | 566 | 570 | 574 | 582 | 591 | 599 | 608 | |
| -21 | 560 | 564 | 568 | 577 | 585 | 593 | 602 | |
| -23 | 555 | 558 | 562 | 571 | 579 | 587 | 596 | |
| -25 | 549 | 552 | 556 | 565 | 573 | 581 | 589 | |
| -27 | 543 | 547 | 550 | 559 | 567 | 575 | 583 | |
| -29 | 537 | 541 | 545 | 553 | 561 | 569 | 577 | |
| -31 | 531 | 535 | 539 | 547 | 554 | 563 | 571 | |
| -33 | 525 | 529 | 533 | 541 | 548 | 556 | 565 | |
| -35 | 519 | 523 | 527 | 535 | 542 | 550 | 558 | |
| -37 | 513 | 517 | 521 | 529 | 536 | 544 | 552 | |
| -39 | 507 | 511 | 515 | 523 | 530 | 538 | 546 | |
| -45 | 489 | 493 | 497 | 505 | 512 | 519 | 527 | |
| -50 | 475 | 478 | 482 | 490 | 497 | 504 | 512 | |
| -55 | 460 | 464 | 467 | 475 | 481 | 489 | 496 | |

Figure 7-2. HIT TGT Reference

7.17.2 Automatic Approach Checklist

WARNING

Aircrews of helicopters equipped with ALE-39 launchers shall ensure the ARM/SAFE switch on the arming control panel is in the SAFE position prior to commencing rescue approach.

Note

Approaches to or hovers in the vicinity of a Mk 25/58 MLM may cause the AN/AAR-47 to sense a threat and command the AN/ALE-39 to fire.

1. MAD — STOWED.
2. APS-124 — STBY (as required).
3. Rig for Rescue Checklist — AS REQUIRED.
4. PITOT HEAT — ON.
5. ALE-39 arming control panel — SAFE (as required).
6. RDR ALT pushbutton — ON.
7. RAD ALT/BAR ALT — MATCHED.
8. Radar altimeter — SET DH.
9. AFCS CONTROL panel:
 - a. HVR ALT rotary knob — SET.
 - b. LAT/LONG VEL rotary knobs — SET.
10. CONTGCY PWR switch — ON.
11. BACKUP HYD PMP — AS REQUIRED.
12. Mode select panel — DPLR/HVR.
13. DOP flag — CHECK.
14. Wind direction and velocity — NOTE.
15. TGT/torque — CHECK IN A HOVER.

7.17.3 Alert Launch Checklist

When the helicopter is to be placed in an alert condition, or started embarked or ashore with external power, the following checklist should be used in place of the normal Start, Systems Check, Starting Engines, Rotor Engagement, Pretaxi, and Taxi checklists:

1. Seats, belts, pedals, and mirrors — ADJUSTED.
2. Cockpit window emergency releases — AFT AND SHEARWIRED.
3. Left collective — EXTENDED AND LOCKED.
4. Circuit breakers and switches — CHECKED AND OFF.

Switches not having an OFF position should be checked as follows:

- a. RDR, DATA LINK — STBY.
- b. ATO ICS — NORM.
- c. DATA LINK MODE — AUTO.
- d. G REC — ON.
- e. COMM CONTR mode select — T/R.
- f. GUST LOCK — NORM.
- g. TAIL SERVO — NORM.
- h. Pilot ICS — NORM.
- i. CARGO HOOK ARMING — SAFE.
- j. CARGO HOOK EMER RLSE — OPEN.
- k. FIRE DET TEST — OPER.
- l. DE-ICE MASTER — MANUAL.
- m. MODE 4 AUDIO/LIGHT/OUT — AUDIO.
- n. Transponder ANT — DIV.
5. Parking brake — RESET.
6. TAIL WHEEL — LOCK.
7. Aircrewman Prestart checklist — COMPLETE.
8. Exterior/Interior/NVD lights — AS REQUIRED.
9. ENG T-handles — FORWARD, APU T-handle — IN.
10. ROTOR BRAKE — ON.
11. BATT — ON.
- †12. UHF backup — SET.
13. Fire detector system — TEST.
14. EXT PWR — ON.
15. ICS — CHECK.
- †16. Blade/pylon spread — AS REQUIRED.



- Should the blade fold system stall during spread, cycling the BLADE FOLD switch to FOLD should return the rotor blades to the folded position.
- Shut down the APU immediately if a rotor blade remains stalled in the APU exhaust.
- When the ROTOR SPREAD light is not illuminated, pressing the AFCS CONTROL panel RDR ALT pushbutton during blade fold system operations may cause failure of the system. Press this pushbutton only if flashing and after the blade spread evolution has been completed.

- a. Area — CLEAR (wing walkers positioned as required).
- b. CMPTR PWR/RESET pushbutton — ON.
- c. BLADE FOLD MASTER switch — ON.
- d. BLADE FOLD switch — SPREAD.
- e. PYLON FLIGHT and ROTOR SPREAD lights — ILLUMINATED.

WARNING

Illumination of the ROTOR SPREAD light may not be an accurate indication of the blades being properly spread. Rotor engagement with improperly spread blades may result in catastrophic rotor failure. A head check shall be conducted any time the BLADE FOLD switch is moved from the OFF position.

- f. RDR ALT pushbutton — PRESS (if flashing).

Note

If RDR ALT pushbutton is flashing, pressing will update flight control position to AFCS.

- g. BLADE FOLD switch — OFF.
 - h. BLADE FOLD MASTER switch — OFF.
 - i. Head check — PERFORM.
17. Lockpin status — CHECK.
- a. BLADE FOLD MASTER — ON.
 - b. STATUS PYLON FLIGHT light — ON.

WARNING

If STATUS PYLON FLIGHT light is not illuminated, pylon and stabilator lockpins and the tail rotor index actuator shall be visually checked prior to flight.

- c. STATUS ROTOR SPREAD light — ON.

If ROTOR SPREAD light not ON:

- d. CMPTR PWR/RESET — OFF.
- e. BACKUP HYD PMP — OFF.
- f. BLADE FOLD — SPREAD.

WARNING

Blade lockpins may indicate engaged with blades not fully spread. If the BLADE FOLD switch is placed in the spread position, a visual check shall be performed prior to rotor engagement to ensure all rotor blade lockpins are engaged and all pitchlock pins are retracted.


CAUTION

If uncommanded blade fold occurs when BLADE FOLD switch is placed to SPREAD, the BLADE FOLD MASTER switch should be placed to the OFF position. Do not secure electrical or hydraulic power until blades are respread using BLADE FOLD test set.

Note

If a documented discrepancy exists in the blade lockpin/microswitch indicating system, the BLADE FOLD switch may be left in the OFF position if the blade lockpins were visually checked on preflight.

If ROTOR SPREAD light on:

- g. BLADE FOLD — OFF.
- h. BLADE FOLD MASTER — OFF.
- 18. CMPTR PWR/RESET — CYCLE/ON.
- 19. SAS/BOOST — ON.
- 20. BACKUP HYD PMP — ON.
- 21. MSN PWR — PRI.
- 22. DPLR, RDR, DATA LINK — RADIATE.

Note

With data link hardware installed, difficulty may be experienced in loading SAC-1 or SAC-2 if the ship is trying to uplink data. To alleviate this problem, place the DATA LINK switch to STBY until SAC-1 and SAC-2 have completed their load.

- 23. SO — IPL.
- 24. Initialize FHS — AS REQUIRED.


WARNING

When the FLIR PWR switch is ON, the FLIR turret automatically moves to the STOW position. Ensure personnel and equipment are clear of the FLIR turret area before applying power.

- a. FLIR PWR — ON.
- b. HELLFIRE PWR — ON.
- 25. ATO MPD — ON.
- 26. Secure equipment — KEY.
- 27. INIT NAV.

A1-H60BB-NFM-000

If GPS is to be used as the primary navigation mode:

- a. GPS — KEY.
- b. GPS — INIT/TEST (via equipment status table once GPS is available).
28. RAD ALT, BAR ALT, clocks — SET.
29. Secure communications — CHECK.
30. DIGITS — ON; CDU and PDU — TEST.
31. Fuel quantity and readout — Check (maximum differential of 200 pounds).
32. Caution, advisory, warning lights — CHECK.
33. TACAN/IFF — REC, STBY.
- †34. Primary servos/pitch lockpin — CHECK.
- †35. Boost servos — CHECK.
- †36. Tail rotor servo — CHECK.
- †37. AFCS — Check.
- †38. STABILATOR — CHECK.

WARNING

Helicopter shall not be flown if any part of stabilator check fails.

- †39. Rescue Hoist Preoperational Check — AS REQUIRED.
- †40. Cargo Hook Preoperational Check — AS REQUIRED.

If required, the aircraft may be secured indefinitely at this point by performing the following:

1. BACKUP HYD PMP — OFF.
2. SAC POWER — OFF.
3. FLIR PWR — OFF.
4. HELLFIRE PWR — OFF.
5. MSN PWR — OFF.
6. EXT PWR — OFF.
7. BATT — OFF.

Note

If mission power is secured for more than 2 minutes, the KG-45 will require rekeying after mission power is reenergized.

When ready to launch, perform the following:

1. BATT — ON.
2. EXT PWR — ON.
3. BACKUP HYD PMP — ON.
4. SAS-1, SAS-2, TRIM, AUTO PLT — ON.
5. MSN PWR — PRI/SEC (as required).
6. FLIR PWR — ON.
7. KG-45 — KEY.
8. INIT NAV.

7.17.3.1 Starting APU and Engines

1. High Points and Tail Tiedowns — VERIFY REMOVED.
2. Fireguard posted, area clear.
3. ECS — OFF.
4. Lights — AS REQUIRED.
5. AIR SOURCE ECS/START — APU.
6. FUEL PUMP — APU BOOST.
7. APU CONTROL — ON.

Note

When mission avionics COMSEC gear is loaded with external power, the use of the APU generator may zeroize the codes.

8. Doors, inertia reels — LOCKED.
9. ECS — AS DESIRED.
10. ROTOR BRAKE — 450 psi minimum.
11. ENGINE IGNITION — NORM.
12. Fuel selectors — XFD.
13. Engines — START.
14. Engine oil pressure — CHECK.
15. Starter lights — OUT.
16. ENGINE IDLE Ng — CHECK, 63 percent or greater and matched within 3 percent.

7.17.3.2 Engagement

1. Area — CLEAR.
2. Flight controls — POSITION (as required).
 - a. Cyclic/pedals — CENTERED.
 - b. Collective — DOWN AND HOLD.
3. Lights — AS REQUIRED.

Note

Operation other than transient in the 20 percent to 40 percent and 60 percent to 75 percent Np range shall be avoided.

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4. Rotor — ENGAGE.
 - a. Rotor brake/advisory light — OUT.
 - b. ENG POWER CONT levers — Smoothly advance to FLY.
 - c. #1 and #2 HYD PUMP caution lights — OUT.
 - d. Droop stops — OUT.

Note

If all droop stops are not out by 100 percent Nr, shut down and investigate.

- e. Transmission oil pressure — CHECK.
5. ENG POWER CONT levers — FLY.
6. Fuel selectors — DIR.
7. BACKUP HYD PMP — AUTO.
8. Torques — Matched within 5 percent.
9. Engines — 100 percent Np/Nr.
10. SAC POWER — OFF.
11. NO. 1 and NO. 2 GENERATORS — ON.
12. APU GENERATOR — ON.
13. External power — OFF.
14. Engine overspeed system and autoignition — CHECK.
15. Hydraulic leak system — CHECK.
16. Backup tail rotor servo — CHECK.
 - a. BACKUP HYD PMP — OFF, then AUTO.
 - b. TAIL SERVO — BKUP.
 - c. TAIL SERVO — NORM.
17. SAC POWER — ON.
18. ALQ-205 — AS REQUIRED.
19. AAR-47 — ON (2-minute warmup).
20. Mode select panel, BDHIs and AIs — CHECK.
21. TACAN/IFF — TEST, set.
22. BLADE DE-ICE — AS REQUIRED.
23. ENG ANTI-ICE, PITOT HEAT, DE-ICE MASTER — AS REQUIRED.
24. RAD ALT — TEST.
25. External power and data link hardwire — DISCONNECT.
26. HELLFIRE PWR — OFF.
27. ALE-39 arming handles — AS REQUIRED.

WARNING

- Inadvertent launch of chaff/flares may occur from the ALE-39 when the external arming handles are in the ARM position regardless of the position of the SAFE/ARM switch on the arming control panel.
- Ensure AAR-47 2-minute warmup period and BIT checks have concluded before arming the ALE-39 arming handles.

Continue with the normal Takeoff Checklist.

7.17.4 Fuel Dump Checklist**WARNING**

- Fuel dumping should be manually terminated at no less than 600 pounds total fuel. With less than 600 pounds of fuel, fuel starvation may occur when balanced flight is not maintained and/or pitch attitudes exceed 15° nose up or nose down.
- Internal wear of the fuel dump switch guard may not move the switch to the OFF position. Aircrew must verify switch position when completing dumping procedures.

1. Determine the amount of fuel to be dumped.
2. BuNo 162349 and subsequent, FUEL MGMT panel — TRANSFER/MANUAL OVRD.
3. ALE-39 power — OFF.
4. FUEL DUMP switch — DUMP.
5. FMCP — FUEL DUMP light — Illuminated (as applicable).

After the desired quantity has been dumped:

6. FUEL DUMP switch — OFF.
7. Observe the fuel readout to ensure that dumping has ceased.

If fuel dumping continues:

8. FUEL DUMP circuit breakers — PULL.
 - a. FUEL DUMP NO. 1 (CENTER, NO. 1 AC PRI, ROW 1, CB 13).
 - b. FUEL DUMP PUMP (CORNER, NO. 2 AC PRI, ROW 1, CB 1).
 - c. FUEL DUMP CONTR (ATO OVHD, DC ESSNTL, ROW 3, CB 1).

9. FUEL DUMP switch — CYCLE.

10. **Land as soon as practical.**

7.17.5 Engine Fuel System Priming Checklist**Note**

Helicopter prime/boost pump capacity is not sufficient to prime an engine when the Opposite engine is running. Therefore, engines should be primed individually with both engines OFF.

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1. Fuel selector — DIR.
2. PCL — Hold in LOCKOUT.
3. FUEL PUMP switch — FUEL PRIME. Hold until plane captain reports steady flow of fuel coming from overboard drain.
4. Repeat steps 2. and 3. with fuel selector in XFD.
5. FUEL PUMP switch — APU BOOST.
6. PCL — OFF.

7.17.6 Rig for Rescue Checklist

WARNING

Radiation hazard exists to rescue swimmer and survivor from the APS-124 radar. Ensure RADAR is set to STBY prior to swimmer deployment and/or hoisting.

Note

Crewman shall utilize approved hoisting glove(s) during hoisting evolutions.

1. SAC POWER — OFF.
2. BACKUP HYD PMP — ON.
3. SAC POWER — ON.
4. Report — “UNSTRAPPING”.
5. Safety Belt — DON.
6. Rescue station ICS — ADJUST (as required).
7. Cabin area — PREPARE.
8. RAST MASTER, CARGO HOOK CONTROL, Magnetic Detecting Set — OFF, SAFE.
9. Cabin door — OPEN (at or below 60 knots).
10. RESCUE HOIST control — ALL.
11. Rescue hoist NORMAL POWER light — VERIFY ON.
12. Rescue hoist check — VERIFY, if required.

WARNING

Personnel hoisting shall not be attempted with a damaged cable.

13. Report — “RIGGED FOR RESCUE”.

7.17.7 Litter Platform Setup Procedures

1. Break down the instructor seat and stow forward.
2. Slide the SO seat down and full forward.

3. Break out and unfold the platform, the end with the leg extension toward the cabin door.
4. Center the platform between the launcher and SO seat. Squarely position and hook the feet end over the left SO seat track. Lower the platform so that the two edge tabs slide over the outboard edge of the right seat track and extend the support leg.
5. Slide the litter all the way in against the left bulkhead.
6. Secure the litter/platform with the two straps that you have anchored to the cabin floor at the four attachment points.

Note

Helicopters modified with the ALE-39 chaff and flare dispenser will no longer accommodate the rescue/Stokes litter and allow for cabin door closure. Modified helicopters should use a SAR MEDEVAC litter for patient/crewman safety and comfort. When closing the cabin door with the SAR MEDEVAC litter in the cabin and ALE-39 installed, it may be necessary to slightly lift the head of the litter to allow the cabin door to pass.

7.17.8 VERTREP Operations Checklist

1. Landing Checklist — COMPLETE.
2. Crewman — RIG FOR CARGO OPERATIONS.
3. MAD reeling machine, RAST panel, and RESCUE HOIST POWER — OFF.
4. Cargo Hook Preoperational Checklist — COMPLETE.
5. CARGO HOOK CONTR — ARMED/ALL.
6. CARGO HOOK EMERG REL — NORM.
7. Radar Altimeter — SET DH.

After external cargo operations:

8. CARGO HOOK CONTR — SAFE.
9. CARGO HOOK EMERG REL switch — OPEN.
10. Cargo Hook — STOW, SECURE ACCESS PANEL.

7.17.9 Blade De-Ice System Check

Note

A TR DE-ICE FAIL caution may appear during the blade de-ice test while in an electromagnetic environment.

1. BLADE DE-ICE TEST selector switch — NORM.
2. BLADE DE-ICE POWER switch — TEST.



Leaving the BLADE DE-ICE POWER switch in the TEST position may cause blade damage.

3. PWR MAIN RTR and TAIL RTR lights — CHECK. PWR MAIN RTR light may illuminate for 2 to 4 seconds.


CAUTION

If PWR MAIN RTR or TAIL RTR lights remain on for more than 10 seconds, main rotor or tail rotor damage may result. Turn BLADE DE-ICE POWER switch OFF. If either light remains illuminated, pull the appropriate circuit breaker. If either light remains illuminated, secure electrical power.

4. TEST IN PROGRESS light — CHECK. The light should illuminate for 2 minutes. The ICE DETECTED caution will appear for approximately 6 seconds. No other blade de-ice system cautions should appear. PWR MAIN RTR and TAIL RTR lights should illuminate for 2 to 4 seconds near end of test. The TEST IN PROGRESS light should then extinguish.
5. BLADE DE-ICE POWER switch — OFF.
6. BLADE DE-ICE TEST selector switch — SYNC 1.
7. BLADE DE-ICE POWER switch — TEST. MR DE-ICE FAIL caution appears.
8. BLADE DE-ICE POWER switch — OFF. MR DE-ICE FAIL caution disappears.
9. BLADE DE-ICE TEST selector switch — SYNC 2.
10. BLADE DE-ICE POWER switch — TEST. MR DE-ICE FAIL caution appears.
11. BLADE DE-ICE POWER switch — OFF. MR DE-ICE FAIL caution disappears.
12. BLADE DE-ICE TEST selector switch — OAT.
13. BLADE DE-ICE POWER switch — TEST. MR DE-ICE FAIL and TR DE-ICE FAIL cautions appear.
14. BLADE DE-ICE POWER switch — OFF. MR DE-ICE FAIL and TR DE-ICE FAIL cautions disappear.


CAUTION

EOT test should not be performed at ambient temperatures above 38 °C. Between 22 °C and 38 °C, allow 5 minutes at 100 percent N_r before this test is attempted. Between 10 °C and 22 °C, rotor must be turning at 100 percent. Exceeding temperature parameters may cause blade damage.

15. BLADE DE-ICE TEST selector switch — EOT.
16. BLADE DE-ICE MODE selector switch — MANUAL (M).
17. BLADE DE-ICE POWER switch — ON. TR DE-ICE FAIL caution appears after approximately 15 to 30 seconds. MR DE-ICE FAIL caution appears after approximately 50 to 70 seconds. PWR MAIN RTR and/or PWR TAIL RTR lights may flash.
18. BLADE DE-ICE POWER switch — OFF. TR DE-ICE FAIL and MR DE-ICE FAIL cautions disappear.
19. BLADE DE-ICE TEST selector switch — NORM.
20. BLADE DE-ICE POWER switch — OFF.
21. BLADE DE-ICE MODE selector switch — AUTO.
22. APU GENERATOR backup — CHECK.
 - a. NO. 1 or NO. 2 generator — OFF. Applicable GEN caution light should be on.
 - b. BLADE DE-ICE MODE SELECT — MANUAL (M).

- c. APU GENERATOR — ON.
- d. BLADE DE-ICE POWER — ON. Wait 30 seconds, no de-ice lights should be on.
- e. Generator turned off in step a. — ON. (Applicable GEN caution light should go off.)
- f. BLADE DE-ICE POWER — OFF.
- g. BLADE DE-ICE MODE — AUTO.

7.17.10 Engine Anti-Ice Check

1. PCL (engine not being checked) — AS REQUIRED.

WARNING

Failure of the ENG ANTI-ICE ON advisory to illuminate when the ENG ANTI-ICE switch is selected to ON, or when the N_g is below approximately 88 percent regardless of the switch position; or constant illumination of the ENG ANTI-ICE ON advisory with N_g greater than 90 percent (94 percent if OAT is 15 °C or greater) and the ENG ANTI-ICE switch OFF are indicative of a malfunctioning anti-ice/start bleed valve. This condition may cause engine flameout during low power settings such as quick stops and autorotative flight.

Note

- Engine Anti-ice Check should be performed into the wind on deck, in a hover over a suitable landing pad, or in a stable, level-flight regime.
- On deck or in a hover, it may be necessary to retard the PCL on the engine not being checked to prevent a vertical climb.

2. ENG ANTI-ICE switch (engine being checked) — OFF.
3. Collective — Raise to increase N_g of engine being checked to 90 percent or above (94 percent if OAT is above 15 °C).
4. ENG ANTI-ICE ON advisory (engine being checked) — Does not appear.
5. ENG ANTI-ICE switch (engine being checked) — ON.

Confirm:

- a. ECS SHUTDOWN caution (if ECS on and AIR SOURCE ECS/START switch — ENG).
- b. TGT increases 30° to 100 °C.
- c. ENG ANTI-ICE ON advisory appears.
- d. ENG INLET ANTI-ICE ON advisory:
 - (1) OAT above 13 °C — DOES NOT APPEAR.
 - (2) OAT above 4° up to 13 °C — MAY APPEAR.
 - (3) OAT 4 °C and below — APPEARS.

WARNING

A TGT increase greater than 100 °C and/or appearance of either ENG INLET ANTI-ICE ON advisory when OAT is above 13 °C may result in a loss in available torque at intermediate power up to 49 percent when the engine anti-ice system is activated. If any part of the engine anti-ice check fails, maintenance action is required prior to flight into icing conditions.

6. ENG ANTI-ICE switch (engine being checked) — OFF.

Confirm:

- a. TGT decreases.
 - b. ENG ANTI-ICE ON advisory — DISAPPEARS.
 - c. ECS — ON (if ECS on and AIR SOURCE ECS/START switch — ENG).
 - d. ENG INLET ANTI-ICE ON advisory — DISAPPEARS (after approximately 90 seconds).
7. PCL (engine not being checked) — FLY.
 8. Repeat steps 1. to 7. for other engine.

7.17.11 Accelerometer Null Procedures

Accelerometers are normally nulled during AFCS maintenance ashore. Ship motions and accelerations will often prevent the completion of a successful accelerometer null operation while deployed. The following procedure will allow the flight crew to perform the accelerometer null operation in flight when an on-deck null cannot be successfully accomplished.

1. CMPTR PWR/RESET pushbutton — CYCLE.
2. SAS 1, SAS 2, TRIM and AUTO PLT pushbuttons — ON.
3. Wait at least 2 minutes.
4. Fly at 100 KIAS in straight and level, unaccelerated flight.
5. ACCEL NULL switch — NULL FOR 0.5 TO 2.0 SECONDS.

Note

Null will fail if ACCEL NULL switch is held for more than two seconds.

6. If the null is accepted TRIM and AUTO PLT pushbuttons will extinguish approximately 2 seconds after ACCEL NULL switch is released.
7. Repeat steps 1. through 6. until a null is accepted.

7.17.12 Engine Cleaning Procedures

Note

The following engine cleaning procedures are to be performed when engine cleaning is performed independent of the SHUTDOWN checklist. For engine cleaning during the SHUTDOWN checklist, proceed to step 14.

1. Water wash connector — CONNECTED.
2. Circuit breakers and switches — CHECKED and OFF.

3. Rotor brake — ON.

WARNING

Do not release rotor brake if blades are folded unless secured in place by blade crutches/clamps. Releasing the rotor brake with unsecured folded blades may result in damage to aircraft, injury to nearby personnel, and/or all four blades rotating together, which may result in aircraft rollover.

4. BATT — ON.

5. Fire detector system — TEST.

6. Fire guard — POSTED, AREA CLEAR.

7. Interior/Exterior /NVD lighting — AS REQUIRED.

8. APU — START.

a. ECS — OFF.

b. AIR SOURCE ECS/START — APU.

c. FUEL PUMP — APU BOOST.

d. APU CONTROL — ON.

9. APU GENERATOR — ON.

10. ECS — AS REQUIRED.

11. Blade/pylon spread — AS REQUIRED (refer to Prestart Checks).

12. Lockpins status — CHECK.

13. BACKUP HYD PMP — ON.

14. ENGINE IGNITION — OFF.

CAUTION

- Engine must be allowed to cool to a TGT of 80 °C or below, by motoring engine starter (if necessary), before water or cleaning solution is sprayed into engine.
- Engine PCL and ignition switch must be off while motoring engine.
- Do not exceed starter limits (Refer to [Chapter 4](#), Operating Limits).
- If N_g decreases below 16 percent during engine cleaning, secure starter to prevent engine damage.

Note

The T-700-GE-401C Performance Recovery Wash (60 hour) requires both Compressor and Hot Section cleaning. Hot Section cleaning is required following operation in sandy, dusty, and dirty environments. Hot Section cleaning entails removing engine igniter plugs and injecting cleaning solution through the igniter ports. Compressor cleaning entails injecting cleaning solution through the water wash connector.

15. Hot Section cleaning procedure — AS REQUIRED.

WARNING

To prevent electrical shock to maintenance personnel, ensure ENGINE IGNITION switch is in the OFF position and both NO. 1 and NO. 2 engine overspeed circuit breakers are pulled (open) during engine cleaning.

- a. NO. 1 and NO. 2 ENG OVSP circuit breakers — PULL.
- b. NO. 2 engine starter — ENGAGE. Motor to maximum starter speed.
- c. TGT below 80 °C, dispense cleaner for 60 seconds.
- d. NO. 2 engine starter — DISENGAGE.
- e. Repeat steps b. through d. for NO. 1 engine.

If performing Hot Section cleaning only:

- f. Allow cleaner to soak for 10 minutes and then proceed to Water Wash Procedures (step 17.).

If performing Performance Recovery Wash:

- g. Proceed to Compressor cleaning (step 16.).

16. Compressor cleaning — AS REQUIRED.

- a. NO. 2 engine starter — ENGAGE. Motor to maximum starter speed.
- b. When TGT below 80 °C, dispense cleaner for 60 seconds.
- c. NO. 2 engine starter — DISENGAGE.
- d. Repeat steps a. through c. for NO. 1 engine.
- e. Allow cleaner to soak for 10 minutes.

17. Water Wash procedure — PERFORM.

- a. NO. 2 engine starter — ENGAGE. Motor to maximum starter speed.
- b. When TGT below 80 °C, rinse engine for 60 seconds (90 seconds if cleaner used, observing starter duty cycle, until clean water is observed coming out of engine exhaust).
- c. NO. 2 engine starter — DISENGAGE.
- d. Repeat steps a. through c. for NO. 1 engine.

CAUTION

Engine dry-out cycle will be performed with the rotor brake ON. The PCLs should not be advanced above IDLE during engine dry-out. If ashore and rotor engagement is required following engine dry-out cycle, the engines should be shut down from IDLE and restarted with the rotor brake off.

Engine Dry-out:

- 18. Water Wash connector — REMOVE.
- 19. NO. 1 and NO. 2 ENG OVSP circuit breakers — RESET (as required).

20. Fireguard — POSTED, AREA CLEAR.
21. Doors, inertia reels — LOCKED.
22. SAS 1, SAS 2, TRIM, and AUTO PLT — ON.
23. Rotor brake — CHECK PRESSURE 450 PSI MINIMUM.
24. ENGINE IGNITION — NORM.
25. Fuel selectors — XFD.



Start the NO. 2 engine first to preclude exceeding NO. 1 engine starter limitations.

26. Lights — AS REQUIRED.
27. Engines — START.
 - a. Starter — ENGAGE AT MAXIMUM STARTER SPEED FOR 30 SECONDS.
 - b. PCL — IDLE.
28. Engine oil pressures — CHECK.
29. ENG STARTER advisories — OUT.
30. Engines — RUN AT IDLE FOR 6 MINUTES.

After 5 minutes:

- a. ENG ANTI-ICE — OFF.
- b. AIR SOURCE ECS/START — ENG.
- c. ECS — OFF.

Note

Leaving ECS ON may lead to APU failure.

After 1 minute:

- d. ENGINE IGNITION — OFF.
31. PCLs and fuel selectors — OFF.
32. TGT — MONITOR.
33. Blade fold — AS REQUIRED (refer to Shutdown Checks).
34. BACKUP HYD PMP — OFF.
35. STABILATOR MAN SLEW — SLEW to 0° (as required).
36. ECS — OFF.
37. Interior/Exterior/NVD lighting — OFF.
38. APU GENERATOR — OFF.
39. APU — SHUTDOWN.
 - a. AIR SOURCE ECS/START — OFF.
 - b. APU CONTR — OFF.
 - c. FUEL PUMP — OFF.

40. BATT — OFF.
41. Utility Lights — OFF.

7.17.13 Sonobuoy Launching

7.17.13.1 Automatic Sonobuoy Launching

1. System circuit breakers — IN.
2. Sonobuoy ECU — Verify AU displayed.
3. WEAPONS SELECT (AN/ASQ-198) — AS REQUIRED.
4. MASTER ARM — ARM.

Note

- When using the AN/ASQ-165, sonobuoys may be launched with TORPEDO SELECT in any position except OFF.
 - When using the AN/ASQ-198, sonobuoys may be launched with WEAPONS SELECT in any position.
5. TORPEDO SELECT (AN/ASQ-165) — AS REQUIRED.



- When using the AN/ASQ-165, failing to SELECT SAFE with the TORPEDO SELECT switch may lead to unintended weapon or auxiliary tank launch.
 - When using the AN/ASQ-198, failing to select SONO ONLY with the WEAPONS SELECT switch may lead to unintended weapon or auxiliary tank launch.
6. SONO SELECT MODE — AUTO.
 7. SONO LAUNCH MODE — AUTO.
 8. Observe RDY INDICATION on SONO LAUNCH button.

Note

- Sonobuoy will be launched automatically when the fly-to-point (FTP) is captured.
- A successful launch will be indicated by the SONO LAUNCH button indicating AWAY for approximately 3 seconds. SONO LAUNCH RDY will illuminate again if an additional FTP is active.

7.17.13.2 Manual Sonobuoy Launching

1. System circuit breakers — IN.
2. Sonobuoy ECU — Verify AU displayed.

3. WEAPONS SELECT (AN/ASQ-198) — AS REQUIRED.
4. MASTER ARM — ARM.

Note

- When using the AN/ASQ-165, sonobuoys may be launched with TORPEDO select in any position except OFF.
- When using the AN/ASQ-198, sonobuoys may be launched with WEAPONS select in any position.

5. TORPEDO SELECT (AN/ASQ-165) — AS REQUIRED.



- When using the AN/ASQ-165, failing to SELECT SAFE with the TORPEDO SELECT switch may lead to unintended weapon or auxiliary tank launch.
- When using the AN/ASQ-198, failing to select SONO ONLY with the WEAPONS SELECT switch may lead to unintended weapon or auxiliary tank launch.

6. SONO SELECT MODE — MAN.
7. SONO LAUNCH MODE — MAN.
8. TUBE SELECT — AS REQUIRED.
9. Observe READY or RDY INDICATION on SONO LAUNCH button.
10. Press SONO LAUNCH button to launch selected sonobuoy.

Note

A successful launch will be indicated by the SONO LAUNCH button going to AWAY.

7.17.14 Torpedo Launching

7.17.14.1 Torpedo Launching (with AN/ASQ-165A) Except for Mk 46 MOD 5A (SW) SLEP Torpedo

Note

Refer to NTTP 3-22.5-ASW (ASW Tactical Pocket Guide) for torpedo launch envelope and tactical employment.

1. System circuit breakers — IN.
2. SRCH DPTH — SELECT.
3. MODE/CEIL — SELECT.
4. COURSE — SELECT.



Any subsequent changes to the thumbwheel selectors should be done by first returning MASTER ARM to SAFE. Verify MASTER ARM goes to SAFE before resetting thumbwheel selectors to prevent possible presetting malfunctions.

5. MASTER ARM — ARM.
6. TORPEDO SELECT — AS REQUIRED.



To prevent possible damage to the ASDC and improper torpedo presetting, allow at least a 10-second interval between depressions of the TORPEDO SELECT pushbutton.

7. TORPEDO ARMING — NS-TL.
8. STATUS READY light — CHECK ON.
9. READY INDICATION on TORPEDO LAUNCH — CHECK.
10. TORPEDO SELECT — AS REQUIRED.



To prevent possible damage to the ASDC and improper torpedo presetting, allow at least a 10-second interval between depressions of the TORPEDO SELECT pushbutton.

11. READY INDICATION on TORPEDO LAUNCH — CHECK.

Upon capture of weapon [FTP](#):

12. TORPEDO LAUNCH — PRESS.



Subsequent actuation of the TORPEDO LAUNCH pushbutton after an attempted launch will enable a secondary launch release regardless of time between initial and subsequent actuation. This initiates a secondary launch sequence resulting in the CAD firing. The BRU-14A bomb rack will be damaged and require intermediate-level repair. Prevention of CAD firing can only be achieved by setting the MASTER ARM switch to the SAFE position prior to actuation of the TORPEDO LAUNCH pushbutton after an attempted launch.

13. AWAY INDICATION on TORPEDO LAUNCH — CHECK.

Note

A successful launch will be indicated by the TORPEDO LAUNCH going to AWAY for approximately 3 seconds. Visually confirm weapon is away.

14. TORPEDO SELECT — SAFE.

15. TORPEDO ARM — SAFE.

16. MASTER ARM — AS REQUIRED.

7.17.14.2 Torpedo Launching (with AN/ASQ-198) Except for Mk 46 MOD 5A (SW) SLEP Torpedo



Mk 54 MOD 0 torpedo can only be used with AN/ASQ-198 configured aircraft.

Note

- Refer to NTTP 3-22.5-ASW (ASW Tactical Pocket Guide) for torpedo launch envelope and tactical employment.
- Refer to Torpedo Programming Conversion Table ([Figure 7-3](#)) when setting SRCH DPTH, MODE/CEIL, and COURSE thumbwheel selector switches.
- Refer to NAWCD China Lake prepared preliminary checklists for the Mk 54 aircraft release and control, weapon inspection, and loading prior to any Mk 54 MOD 0 mission.

1. System circuit breakers — IN.

2. SRCH DPTH — SELECT.

3. MODE/CEIL — SELECT.

4. COURSE — SELECT.

5. Mk 50 heaters — ON or OFF (as required).

6. WEAPONS SELECT — PORT AFT, PORT FWD, or STBD AFT (as required).

7. MASTER ARM — ARM.

8. Observe [IFOBRL](#) status indicator — UL.

Note

The in-flight operable bomb rack lock (IFOBRL) status indicator will transition from LK (Lock) to UL (Unlock) within 5 seconds after pressing MASTER ARM if the bomb rack is functioning properly. Transition time greater than 5 seconds indicates a malfunctioning bomb rack.

| SRCH DPTH SWITCH TRANSLATION | | | | MODE/CEIL SWITCH TRANSLATION | | | | COURSE SWITCH TRANSLATION | | | |
|------------------------------|----------------|----------------|----------------|------------------------------|----------------|---------------|---------------|---------------------------|----------------|----------------|----------------|
| SWITCH LABEL | Mk 46 PRO-GRAM | Mk 50 PRO-GRAM | Mk 54 PRO-GRAM | SWITCH LABEL | Mk 46 PRO-GRAM | Mk 50 PROGRAM | Mk 54 PROGRAM | SWITCH LABEL | Mk 46 PRO-GRAM | Mk 50 PRO-GRAM | Mk 54 PRO-GRAM |
| 1 | 125 | 12 | 60/SWT | 1 | A20 | 20 | STD PDA ON | 70L | P70 | 70L | P70 |
| 2 | 80 | 55 | 125 | 2 | A50 | 60 | STD PDA OFF | 35L | P35 | 35L | P35 |
| 3 | 275 | 375 | N375 | 3 | HATS | HATS | HATS | 0 | 0 | 0 | 0 |
| 4 | 500 | D375 | D375 | 4 | P20 | ST20 | PDT | 35R | S35 | 35R | S35 |
| 5 | 850 | 850 | 700 | 5 | P50 | D60 | BOTTOM | 70R | S70 | 70R | S70 |
| 6 | 1400 | 1600 | 1600 | 6 | SNKE | SVTT | — | 95R | S95 | 95R | S95 |
| — | — | — | — | — | — | — | — | 120R | S120 | 120R | S120 |
| — | — | — | — | — | — | — | — | 150R | S150 | 150R | S150 |
| — | — | — | — | — | — | — | — | 180 | 180 | 180 | 180 |
| — | — | — | — | — | — | — | — | 150L | P150 | 150L | P150 |
| — | — | — | — | — | — | — | — | 120L | P120 | 120L | P120 |
| — | — | — | — | — | — | — | — | 95L | P95 | 95L | P95 |

Figure 7-3. AN/ASQ-198 ACI Panel Torpedo Programming Conversion Table

Note

If operating with an armament adapter installed, the IFOBRL status indicators will be inoperative; however, the bomb rack will function normally.

- 9. TORPEDO STATUS TORP READY light — ON.



Any subsequent changes to the thumbwheel selectors should be done by first returning MASTER ARM to SAFE. Verify MASTER ARM goes to SAFE before resetting thumbwheel selectors to prevent possible presetting malfunctions.

- 10. WEAPON LAUNCH RDY light — ON.

Upon capture of weapon FTP:

- 11. WEAPON LAUNCH — PRESS.



If WEAPON LAUNCH is pressed and the bomb rack is malfunctioning, a secondary launch release is automatically enabled. The secondary launch release initiates an emergency launch sequence resulting in CAD firing. The BRU-14A bomb rack will be damaged and require intermediate-level repair.

12. AWAY INDICATION on WEAPON LAUNCH — CHECK.

Note

A successful launch will be indicated by the WEAPON LAUNCH going to AWAY for approximately 3 seconds. Visually confirm weapon is away.

13. WEAPONS SELECT — OFF.

Note

Selecting any new position with WEAPONS SELECT will cause MASTER ARM to go SAFE.

14. MASTER ARM — AS REQUIRED.

7.17.14.3 Mk 46 MOD 5A (SW) SLEP Torpedo Launching (With AN/ASQ-165A)**Note**

Refer to NTTP 3-22.5-ASW (ASW Tactical Pocket Guide) for torpedo launch envelope and tactical employment.

1. System circuit breakers — IN.
2. Course thumbwheel — Set any position except P120.



Damage to presetter may occur if COURSE thumbwheel is in P120 position.

Note

The launching procedure shall be discontinued and restarted at step 1. If at any time during the presetting process, MASTER ARM is placed to SAFE, the other Weapons Station (PORT/STBD) is selected, electrical power is lost, or any steps are performed out of order.

3. MASTER ARM — ARM.
4. TORPEDO SELECT — AS REQUIRED.



Once weapon station selection is made and the MASTER ARM pushbutton is in ARM, the torpedo will be ready for armed release. Due care shall be exercised to avoid inadvertent release.



To prevent damage to the ASDC and avoid improper torpedo presetting, allow a 10-second interval between depressions of the TORPEDO SELECT pushbutton.

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- 5. STATUS READY light — CHECK ON.
- 6. RDY INDICATION on TORPEDO LAUNCH pushbutton — CHECK.
- 7. SRCH DPTH — 1,400.

Note

After 1,400 is selected, wait at least 1.2 seconds before continuing the checklist while tactical floor presetting functions are enabled.

- 8. MODE/CEIL — [HATS](#).
- 9. Tactical floor — Course wheel set.



Selecting or dialing through P120 may cause presetting malfunctions/damage to presetter.

| FOR TACTICAL FLOOR | SET COURSE WHEEL |
|--------------------|------------------|
| 125 | P70 |
| 225 | P35 |
| 325 | 0 |
| 425 | S35 |
| NO FLOOR | S70 |

- 10. SRCH DPTH — Select in accordance with normal [ACIP SELECTIONS](#).

Note

- Do not select a search depth below the tactical floor.
- Do not reselect or allow SRCH DPTH thumbwheel to pass through 1,400 or tactical floor setting will be erased.

- 11. MODE/CEIL — Select in accordance with normal [ACIP SELECTIONS](#).
- 12. COURSE — Select in accordance with normal [ACIP SELECTIONS](#).



Selecting or dialing through P120 may cause presetting malfunctions/damage to presetter.

- 13. Torpedo arming — NS-TL.

Note

The launching procedure shall be discontinued and restarted at step 1. If at any time during the presetting process, MASTER ARM is placed to SAFE, the other Weapons Station (left/right) is selected, electrical power is lost, or any steps are performed out of order.

Upon capture of weapon FTP:

14. TORPEDO LAUNCH — PRESS.



Unless the MASTER ARM pushbutton has been set to SAFE after the TORPEDO LAUNCH pushbutton has been pressed, CAD firing and damage to BRU-14A bomb rack will occur if the torpedo launch pushbutton is again actuated when a READY INDICATION is present.

15. AWAY INDICATION on TORPEDO LAUNCH pushbutton — CHECK.

Note

AWAY will appear on the TORPEDO LAUNCH pushbutton in approximately 3 seconds, indicating a successful launch. Visually confirm weapon is away.

16. TORPEDO SELECT — SAFE.
17. TORPEDO ARM — SAFE.
18. MASTER ARM — AS REQUIRED.

7.17.14.3.1 Mk 46 MOD 5A (SW) SLEP Torpedo Launching (With AN/ASQ-198)

Note

Refer to NTTP 3-22.5-ASW (ASW Tactical Pocket Guide) for torpedo launch envelope and tactical employment.

1. System circuit breakers — IN.
2. Course thumbwheel — Set any position except 120L.



Damage to presetter may occur if course thumbwheel is in 120L position.

3. WEAPONS SELECT — PORT AFT, PORT FWD, or STBD AFT (as required).

Note

The launching procedure shall be discontinued and restarted at step 1. If at any time during the presetting process, MASTER ARM is placed to SAFE, WEAPONS SELECT knob is rotated out of current position, electrical power is lost, or any steps are performed out of order.

4. MASTER ARM — ARM.

WARNING

Once weapon station selection is made and the MASTER ARM pushbutton is in ARM, the torpedo will be ready for armed release. Due care shall be exercised to avoid inadvertent release.

- 5. Observe IFOBRL status indicator — UL.
- 6. TORPEDO STATUS TORP READY light — ON.
- 7. WEAPON LAUNCH READY light — ON.
- 8. SRCH DPTH — 6.

Note

After 6 is selected, wait at least 1.2 seconds before continuing checklist while tactical floor presetting functions are enabled.

- 9. MODE/CEIL — 3.
- 10. Tactical floor — Course wheel set.

CAUTION

Selecting or dialing through 120L may cause presetting malfunctions/damage to presetter.

| FOR TACTICAL FLOOR | SET COURSE WHEEL |
|--------------------|------------------|
| 125 | 70L |
| 225 | 35L |
| 325 | 0 |
| 425 | 35R |
| NO FLOOR | 70R |

- 11. SRCH DPTH — Select in accordance with normal ACIP SELECTIONS.

Note

Do not reselect or allow SRCH DPTH thumbwheel to pass through 6 or tactical floor setting will be erased.

| FOR SEARCH DEPTH | SET SEARCH DEPTH WHEEL |
|------------------|------------------------|
| 80 | 2 |
| 125 | 1 |
| 275 | 3 |
| 500 | 4 |
| 850 | 5 |
| 1400 | 6 |

Note

Do not select a search depth below the tactical floor.

12. MODE/CEIL — Select in accordance with normal ACIP SELECTIONS.

| FOR MODE/CEILING | SET THUMBWHEEL |
|------------------|----------------|
| A20 | 1 |
| A50 | 2 |
| HATS | 3 |
| P20 | 4 |
| P50 | 5 |
| SNAKE | 6 |

13. COURSE — Select in accordance with normal ACIP SELECTIONS (0 for circle search).



Selecting or dialing through 120L may cause presetting malfunctions/damage to presetter.

Note

The launching procedure shall be discontinued and restarted at step 1. If at any time during the presetting process, MASTER ARM is placed to SAFE, WEAPONS SELECT knob is rotated out of current position, electrical power is lost, or any steps are performed out of order.

Upon capture of weapon FTP:

14. WEAPON LAUNCH — PRESS.
 15. AWAY INDICATION on WEAPON LAUNCH pushbutton — CHECK.

Note

AWAY will appear on the WEAPON LAUNCH pushbutton in approximately 3 seconds, indicating a successful launch. Visually confirm weapon is away.

16. WEAPONS SELECT — OFF (as required).
 17. MASTER ARM — AS REQUIRED.

7.17.14.4 AGM-114 Hellfire Missile Launch/Training Procedure

1. System circuit breakers — IN.
2. HELLFIRE PWR — ON.
3. ACRT — Clear equipment status table faults/test (after system on for 15 seconds).

Note

- Displayed ACRT faults on the equipment status table may cause erroneous communication between AOP and the AHS, resulting in incorrect inhibits and constraints while in remote launch mode.
- Ensure VERSN 2002 is displayed in the Equipment Status Table beside ACRT/SDC prior to Hellfire launch operations. If VERSN 2002 is not displayed, initiate AOP test of the ACRT/SDC.

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4. LASER CODES — ENTER/SELECT.
5. VCR — ON (tape inserted) and recording.
6. Laser eye protection (LEP) — VISORS DOWN.

For remote launch:

7. Select tactical page.
 - a. Assign target.
 - b. Assign remote designator.

For remote or autonomous launch:

8. FLIR main menu — SELECT.
 - a. Laser code — CONFIRM.
 - b. Laser select — AS REQUIRED.
9. FLIR attack page — SELECT.
 - a. Launch mode —SELECT.
 - b. CIG — SELECT.
 - c. CCM — AS REQUIRED.
 - d. Launch mode — Select REMOTE or AUTONOMOUS (as required).
 - e. Priority missile/laser code — SELECT/VERIFY.

Note

- Occasionally, selection of a PIM code for an AGM-114K missile will result in failed missile symbology and an AOP “M299 Keyword Error” alert. This condition occurs when the keyword is corrupted during transmission to the M299 and is normally cleared by resetting the launcher.
- PIM codes require an installed and properly operating ACRT. Selection of a PIM code without an installed and operating ACRT will result in the LRD designating at the rangefinding PRF and weapon guidance failure.

- f. AUTO TRK mode — AS REQUIRED.
10. AVT lock on target — AS REQUIRED.
11. LASER ENABLE — AS REQUIRED.
12. WEAPON SELECT — PORT FWD.
13. MASTER ARM — ARM.
14. AOP ARM LRD cue — AS REQUIRED.
15. PWR/ARM — ON.

Note

M299 SAFE/ARM switch will move to arm position and CANNOT be reset to safe in flight.

16. MODE/JETT — AUTO.



Do not select MISSILE MODE/JETT-MAN unless operator intends to jettison M299 launcher.

17. Verify attack page alerts.

- a. WPN ARM.
- b. LASER ARMED — AS REQUIRED.
- c. Priority missile — SELECTED AND READY.

18. Position reticle.

19. Range find — AS REQUIRED.

After weapon release authority is obtained:

Note

For LOBL engagements, designate target prior to weapon launch.

20. RELEASE CONSENT — DEPRESS.

21. Designate target — AS REQUIRED.

 A rectangular warning icon with a solid black border and a 3D effect. The word "WARNING" is written in bold, uppercase letters in the center.

WARNING

Ensure LASING alert disappears when laser trigger released. If the LASING alert remains displayed, refer to Uncommanded Lasing procedure.

Note

- The LASE NOW prompt will not appear if more than 10 seconds have elapsed since last valid range.
- Next Hellfire missile is available within 2 to 3 seconds of previous launch.

Upon completion of lasing or engagement:

22. AN/ASQ-198 WEAPON SELECT switch — OFF.
23. MASTER ARM — VERIFY SAFE.
24. PWR/ARM — OFF.
25. LASER — DISABLE.
26. VCR — OFF (as required).
27. HELLFIRE PWR — OFF.

7.17.14.5 Remote Lasing Checklist

1. System circuit breakers — IN.
2. HELLFIRE PWR — ON (if a PIM code is required).

3. ACRT — Clear EQUIPMENT STATUS TABLE FAULTS/TEST (after system on for 15 seconds).

Note

- Displayed ACRT faults on the equipment status table may cause erroneous communication between AOP and the AHS.
- Ensure VERSN 2002 is displayed in the equipment status table beside ACRT/SDC prior to Hellfire launch operations. If VERSN 2002 is not displayed, initiate AOP test of the ACRT/SDC.

4. Laser code — ENTER AND SELECT.
5. VCR — ON and recording.
6. LEP — VISORS DOWN.
7. ATO/SO FLIR — SELECT.
8. FLIR main menu select — Confirm laser code.
9. LASER — ENABLE.
10. AN/ASQ-198 WEAPON SELECT switch — NOSE.

Note

Laser will arm if the weapon select switch is in any position other than OFF.

11. MASTER ARM — ARM.
12. AOP ARM LRD cue — SELECT YES.

Note

- Certain keyset functions can interrupt live FLIR video. If the laser operator live FLIR video is interrupted, the laser will be disarmed. Thus, the MASTER ARM must be cycled (i.e., to SAFE and back to ARM) and the MPD ARM LRD cue must be selected to YES in order to rearm the laser.
- If repeat other is selected after the LRD is armed, the LRD will temporarily disarm while the operator is not viewing live FLIR video. In this case, returning to live FLIR video will automatically rearm the LRD.

13. AVT — LOCK ON TARGET.
14. Reticle — POSITION.
15. Laser status — Ensure LASER ARMED is displayed on the MPD.
16. Designate target laser trigger to 2nd detent — LASING DES alert is displayed on the MPD.

WARNING

Ensure the LASING alert disappears when the laser trigger is released. If the LASING alert remains displayed, refer to Uncommanded Lasing procedure.

Upon completion of lasing:

17. AN/ASQ-198 WEAPON SELECT switch — OFF.
18. MASTER ARM — SAFE.
19. LASER — DISABLE.
20. HELLFIRE PWR — OFF.

7.17.15 MAD Operational Checklists

7.17.15.1 MAD Deployment



MAD operations with FLIR pod mounted on the starboard weapons pylon are not recommended. Turbulence due to proximity of FLIR pod may impede safe recovery of magnetic anomaly detector.

1. MAGNETIC DETECTING SET PWR — ON.
2. MAD reeling machine POWER — ON.
3. Verify no fail lights, SYS READY light — ON.
4. Verify straight and level.
5. Verify airspeed 40 to 90 KIAS.
6. Verify altitude 200 feet AGL minimum.
7. Report — “READY TO DEPLOY MAD”.
8. (When directed) REEL — OUT, commence timing.
9. Observe VEHICLE TRAIL light ON and report — “MARK TIME, VEHICLE TRAIL”.
10. Verify CABLE LIMIT light — ON (within 61 seconds).



If MAD bird is lost in flight, MAD cable shall be cut immediately at the reeling machine by activation of the EMER REL button.



MAD reeling machine power shall be secured after 61 seconds with no CABLE/MAD LIMIT light.

Note

- Some pitching and longitudinal surging of the MAD towed body can be expected within five feet of the pylon.
- If the MAD towed body stops at an intermediate position during deployment, the CABLE LIMIT light on the MAD reeling machine control panel and the MAD LIMIT light on the caution/advisory panel should flash continuously.
- If reeling machine power is lost or secured with MAD towed body deployed, MAD jettison circuits are inoperative.

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11. Recenter REEL switch and report — “CABLE LIMIT”.
12. Conduct MAD operations.

7.17.15.1.1 MAD Altitude Compensation Procedure

1. Pilot — Climb to minimum of 2,000 feet.

Note

Higher altitude will produce better results due to less interference from geological sources.

2. Deploy the MAD.
3. Tune the compensator dial on the MAD amplifier for current part of the world.
4. Set the following controls to the given values:
 - a. γ FS — 1.
 - b. BANDPASS settings — .04 and .6.
 - c. ALT COMP switch — ON.
5. Observe the displayable noise.
6. Make small adjustments to the compensator dial to attain minimum noise.
7. Pilot — Make small altitude excursion (± 100 feet) to ensure no excessive noise exists.
8. Retrieve the MAD.

7.17.15.2 MAD Retrieval

1. γ FS — TST.
2. Verify straight and level.
3. Verify airspeed 40 to 90 KIAS (50 to 55 KIAS for last 12 feet).
4. REEL — IN.
5. Verify CABLE LIMIT light — OFF and report - “RETRIEVING, CABLE LIMIT LIGHT OFF”.

Note

- Some pitching and longitudinal surging of the MAD towed body can be expected within five feet of the pylon.
 - If the MAD towed body stops at an intermediate position during retrieval, the CABLE LIMIT light on the reeling machine control panel and the MAD LIMIT light on the caution/advisory panel should flash continuously.
6. Verify VEHICLE TRAIL light — OFF.
 7. MAD reeling machine POWER — OFF.
 8. Report — “MAD STOWED, POWER SECURED”.
 9. Secure from MAD operations.

7.17.16 Alternate Engine Start Procedures

7.17.16.1 Crossbleed Start

WARNING

- At 94 percent N_g , the aircraft will be light on it's wheels. Be vigilant for signs of dynamic rollover; maintain a centered cyclic and be prepared to lower collective quickly. Sideward tip path may increase possibility of dynamic rollover.
- The WOW switch may trigger, enabling AFCS functions associated with flight; keep collective trim switch depressed. Fuel Dump, Rescue Hoist shear, and Cargo Hook shear functions are enabled; keep personnel clear of the aircraft.
- For shipboard operations, request amber deck and slacken Main Landing Gear chains. Ensure chains do not become taut; dynamic instability may result.

CAUTION

- When attempting engine crossbleed starts with the engine intake cowling removed, a hot start may be experienced if the bleed air plug is not installed in the anti-ice bleed air line.
- Donor N_g less than 94 percent may result in hot starts.

Note

A full fuel load is recommended when conducting a crossbleed start to mitigate effects of a high power setting on deck.

1. Fireguard — Posted/area clear.
2. AIR SOURCE ECS/START switch — ENG.
3. ENG IGN switch — NORM.
4. Fuel Selectors — XFD/DIR (as required).
5. Collective — Increase to set minimum 94 percent N_g on operating engine.
6. Opposite Eng — START, normal procedures apply.
7. Collective — FULL DOWN.
8. PCL — FLY.
9. Fuel selectors — DIR.
10. Back up Hyd Pump — AUTO.
11. Check Torques matched within 5 percent.
12. Post Engagement — CHECKLIST PERFORM.

7.17.17 APU Turn-Up Checklist

1. Circuit breaker and switches — CHECKED AND OFF.
2. Rotor brake — ON.
3. BATT switch — ON.
4. Fire detector system — CHECK.
5. Fire guard posted, area clear.
6. Interior/Exterior/NVD lighting — AS REQUIRED.
7. APU — START.
 - a. ECS — OFF.
 - b. AIR SOURCE ECS/START switch — APU.
 - c. FUEL PUMP switch — APU BOOST.
 - d. APU CONTR switch — ON.
8. APU GENERATOR switch — ON.
9. Blade/pylon spread — AS REQUIRED.



- Should the blade fold system stall during spread, cycling the BLADE FOLD switch to FOLD should return the rotor blades to the folded position.
 - Shut down the APU immediately if a rotor blade remains stalled in the APU exhaust.
 - When the ROTOR SPREAD light is not illuminated, pressing the AFCS CONTROL panel RDR ALT pushbutton during blade fold system operations may cause failure of the system. Press this pushbutton only if flashing and after the blade spread evolution has been completed.
- a. Area — CLEAR (wing walkers positioned, as required).
 - b. CMPTR PWR/RESET pushbutton — ON.
 - c. BLADE FOLD MASTER switch — ON.
 - d. BLADE FOLD switch — SPREAD.
 - e. PYLON FLIGHT and ROTOR SPREAD lights — ILLUMINATED.



Illumination of the ROTOR SPREAD light may not be an accurate indication of the blades being properly spread. Rotor engagement with improperly spread blades may result in catastrophic rotor failure. A head check shall be conducted any time the BLADE FOLD switch is moved from the OFF position.

- f. RDR ALT pushbutton — PRESS (if flashing).

Note

If RDR ALT pushbutton is flashing, pressing will update flight control position to AFCS.

- g. BLADE FOLD switch — OFF.
 - h. BLADE FOLD MASTER switch — OFF.
 - i. IGB/TGB oil levels — Check, after pylon spread.
10. BACKUP HYD PMP switch — AS REQUIRED.
 11. Conduct maintenance checks.
 12. Blade fold — AS REQUIRED.



- Should the blade fold system stall during fold, cycling the BLADE FOLD switch to SPREAD should return the rotor blades to the spread position.
- Shut down the APU immediately if a rotor blade remains stalled in the APU exhaust.
- When the ROTOR SPREAD light is not illuminated, pressing the RDR ALT pushbutton during blade fold system operations may cause failure of the automatic system. Do not press this pushbutton during blade fold operations.
- Simultaneous folding of main rotor blades and tail pylon is prohibited.

Note

Failure to suppress the DECU numerical fault codes on the PDU will prevent the automatic blade fold from operating due to the torque signal being relayed to the AFCS. Codes can be suppressed by pressing either ENG OVSP TEST A or B button for the affected engine.

- a. Area — CLEAR (wing walkers positioned, as required).
- b. BACKUP HYD PMP switch — ON.
- c. STABILATOR AUTO CONTROL pushbutton — OFF.
- d. SAS 1 and SAS 2 pushbuttons OFF, TRIM pushbutton ON, AUTO PLT pushbutton OFF.
- e. SERVO switch — 1ST OFF or 2ND OFF.
- f. BLADE FOLD MASTER switch — ON.
- g. BLADE FOLD switch — FOLD.
- h. Rotor brake — OFF.
- i. ROTOR INDEXED light — ILLUMINATED.

Note

Blades may be manually indexed if the main rotor indexer/gust lock fails. Cycling the BLADE FOLD switch OFF, pulling the RTR HD INDEX MOTOR circuit breaker (NO. 2 AC PRI, SO OVHD, ROW 3 CB 5), and cycling the BLADE FOLD switch to FOLD may disengage the indexer. Rotate the rotor system until the INDEXED light illuminates, then continue with the Blade Fold Checklist.

- j. Rotor brake — APPLY.
- k. BAR ALT pushbutton — FLASHING.
- l. Collective, cyclic, and pedals — FREE TO POSITION.

Note

If computer is unable to null after 30 seconds, the AFCS DEGRADED caution will appear. To attempt another cycle, turn BLADE FOLD switch OFF, press any FAIL ADVISORY MODE RESET pushbutton, and repeat blade fold sequence.

- m. BAR ALT pushbutton — PRESS.

Note

The following blade status panel light sequence indicates proper operation of the fold cycle: TRIM light flashing (blades positioned for pitch lock insertion) and PITCH LOCKED light illuminated (last pitch lock in). Blades will begin folding following the illumination of the PITCH LOCKED light. Should the INDEXED light flicker or extinguish during folding (indicating a loss of index), the blade fold sequence will stall. Cycling the BLADE FOLD switch to SPREAD should clear the stall. When the SPREAD light illuminates, the rotor head may be re-indexed and another fold cycle attempted.

- n. ROTOR FOLDED light — ILLUMINATED.
 - o. BLADE FOLD switch — OFF.
 - p. BLADE FOLD MASTER switch — OFF.
 - q. SERVO switch — CENTER.
- 13. BACKUP HYD PMP switch — OFF.
 - 14. Lights — OFF.
 - 15. STABILATOR MAN SLEW switch — SLEW TO 0° (as required).
 - 16. APU GENERATOR switch — OFF.
 - 17. APU — SHUTDOWN.
 - a. AIR SOURCE ECS/START switch — OFF.
 - b. APU CONTR switch — OFF.
 - c. FUEL PUMP switch — OFF.
 - 18. BATT switch — OFF.

7.17.18 No APU Shutdown Procedures

- 1. TAIL WHEEL switch — LOCK.
- 2. Parking Brake — SET.
- 3. Chock(s) — IN.
- 4. BACKUP HYD PMP switch — ON.
- 5. MSN Power — OFF.

If External Power is available:

6. External Power Cord — CONNECT.
7. External Power Source — VERIFY ENERGIZED.
8. External Power Switch — RESET, THEN ON.

Note

If the external power source is energized, and the EXT PWR Switch is placed to RESET, then ON, the external power circuit will be energized, and power to the aircraft system busses will be immediately available upon securing the main generators. External Power will NOT supply power to any of the aircraft system busses while any source of airframe power is energized. The EXT PWR CONNECTED Annunciator light only verifies that an acceptable external power source is connected to the aircraft. There is no means of verifying the external power circuit is energized prior to securing main generators.

9. NO. 1 and NO. 2 GENERATOR switches — OFF.
10. Proceed with step 6. of Normal Shutdown Checklist.

If External Power is not available:

11. ECS — OFF.
12. STABILATOR MAN SLEW switch — SLEW to 0 (as required).
13. APU GENERATOR switch — OFF.
14. ENGINE IGNITION switch — OFF.
15. Flight controls — POSITION (as required)
16. Lights — AS REQUIRED.

Note

At night, consideration should be given to configuring battery-powered lighting in the cockpit before securing interior lights.

17. Area — CLEAR.
18. NO. 1 and NO. 2 GENERATOR switches — OFF.

WARNING

With no AC Power, AFCS TRIM will be lost. An unguarded cyclic will allow the rotor arc to dip as low as four feet above the ground, without droop stop pounding, prior to full control deflection. This condition is exacerbated at night by the loss of aircraft lighting to aid in tip path placement.

CAUTION

After shutdown of the second engine as N_r drops below approximately 92-97 percent, the main generators will drop off line and the VIDS will not be available to monitor for Post Shutdown Engine Fire, and engine starter will be unavailable. Personnel should be standing by with a fire extinguisher due to this possibility.

Note

During shutdown at night, the rotor head light will not be available if battery charge is below 35 percent. During shutdown, loss of hydraulic pressure will occur as N_r decreases resulting in loss of control to the rotor system. Ensure personnel are well clear prior to commencing shutdown.

19. PCLs — IDLE.
20. NO. 2 PCL and fuel selector lever — OFF.
21. Droop stops — IN.
22. NO. 1 PCL and fuel selector lever — OFF.
23. Rotor brake — ON (between 30 percent and 50 percent N_r).
24. BATT switch — OFF.

7.18 NORMAL MANEUVERS

The AFCS of the SH-60B helicopter is designed to significantly reduce pilot workload in all regimes of flight. Attitude, altitude, airspeed, and yaw control can be performed by the AFCS, when desired.

7.18.1 Taxi

With the tail wheel unlocked, place the cyclic forward of neutral and increase collective to start forward movement. Minimize forward cyclic movement to prevent droop-stop pounding. Reduce collective to the minimum required to maintain forward movement. Soft or rough terrain may require additional collective. Regulate taxi speed with collective and control heading with pedals while checking heading indicators and turn needles. Cyclic should be displaced in the direction of turns. Use brakes as required.

7.18.2 Takeoff

The pilot not at the controls (PNAC) shall monitor all systems (e.g., stabilator, engines, transmissions) during takeoff to alert the pilot at the controls (PAC) of malfunctions.

7.18.2.1 Takeoff to Hover

With cyclic slightly aft of neutral, increase collective until desired hovering altitude is reached (normally a 10-foot wheel height). Use pedals to maintain heading as collective is increased. The normal hover attitude is 4° to 5° nose up and 2° to 3° left wing down.

Perform the following checks in a hover:

1. Flight controls — NOTE CORRECT RESPONSE.
2. System and flight instruments — CHECK.
3. Power — CHECK. The power check will determine if enough power is available for the mission. It is accomplished by comparing the indicated torque required to hover with the predicted values from performance charts.

7.18.2.2 Hovering Turns

Hovering turns may be accomplished in one of two ways. The conventional flight control system may be used by applying pressure on the desired tail rotor pedal to begin the turn, using pressure and counter pressure on pedals as necessary to hold the desired rate of turn. The pilot may also turn by depressing the HDG TRIM switch in the desired direction and a turn will be effected at 3 degrees per second. In either case, coordinate cyclic and collective as required to hold desired attitude and altitude.

7.18.2.3 Sideward and Rearward Flight

From a stabilized hover, apply cyclic pressure in the desired direction of flight to begin sideward or rearward movement. Maintain desired heading with pedals and altitude with collective. To return to a stationary hover, apply cyclic pressure opposite to the direction of movement by coordinating collective and pedal. The RADALT hold and heading-hold feature of the AFCS may be used to hold desired altitude and heading.

7.18.2.4 Air Taxi

From a stabilized hover, apply forward cyclic pressure to begin forward movement. Desired heading may be retained with pedals or the HDG TRIM and altitude with collective. Changes in direction should be made primarily with pedal control or the HDG TRIM switch, and altitude with collective. Changes in direction should be made primarily with pedal control or the HDG TRIM switch to avoid excessive bank angles. To stop forward movement, apply aft cyclic pressure while coordinating collective and pedals to hold desired altitude and heading.

7.18.2.5 Normal Takeoff

Align the helicopter with the desired takeoff course in a stabilized 10-foot hover or an altitude permitting safe obstacle and terrain clearance. Smoothly apply forward cyclic pressure to begin acceleration into effective translational lift. As the helicopter transitions from hovering to forward flight, the change in direction of the main rotor thrust vector will result in a loss of lift, which tends to cause the helicopter to settle. As airspeed increases through translational lift (approximately 15 knots), the power requirements to maintain level flight will decrease and more power will be available to climb. Refer to the Height-Velocity Diagrams (Figure 4-4) for avoid areas.

7.18.2.6 Running Takeoff

Running takeoffs should be used under conditions of high-gross weight and high-density altitude where the power available may not be sufficient to make a vertical takeoff. Contingency power should be selected. Move the cyclic slightly forward of neutral and apply enough collective to start a forward roll while maintaining heading with pedals. Maintain cyclic and collective settings until passing through effective translational lift. Apply enough power for the helicopter to leave the ground. Continue to climb and accelerate, transitioning to a normal climb.

7.18.2.7 Maximum Performance Takeoffs

A takeoff that demands maximum performance from the helicopter may be necessary because of various combinations of heavy helicopter loads, restricted performance due to high density altitudes, barriers that must be cleared, and other terrain features. The decision to use the following takeoff techniques must be based on an evaluation of the conditions and helicopter performance. Contingency power may be selected if required.

7.18.2.7.1 Obstacle Clearance Takeoff

From a hover, a vertical climb is initiated using coordinated cyclic, pedals, and collective up to TGT or torque limiting. Once the desired altitude is reached, transition to forward flight/climb as desired. Maintaining clearance from obstacles is the most important aspect of this takeoff, not rapidity. Crewmen should be positioned at the cabin doors to ensure tail rotor clearance. Do not exceed TGT or torque limitations.

7.18.2.7.2 Maximum Gross Weight Takeoff

The decision to use the following takeoff technique shall be based on an evaluation of the conditions and helicopter performance. Contingency power should be selected if required. Position aircraft into the wind, and apply power smoothly by increasing collective pitch to raise the helicopter to a low hovering altitude. While slowly increasing forward cyclic, maximum power shall be smoothly applied to continue the takeoff, gradually accelerating and maintaining the low hover altitude. As translational lift is attained, adjust the nose to begin an accelerating climb. The critical period is over when translational airspeed is attained; accelerated through. However, the climbout should remain shallow until airspeed has increased to 50 knots KIAS to ensure best single-engine performance characteristics.

7.18.3 Climb Procedures

The procedures for establishing a climb will vary depending on when the climb was initiated (i.e., transition to forward flight, running takeoff, obstacle clearance). Regardless of the type of climb desired, refer to the climb charts to obtain the profile that will yield best rate-of-climb speed.

7.18.3.1 Initial Climb to Altitude

This will normally start after the helicopter has transitioned to forward flight and the desired climb speed is approached. Adjust the collective and cyclic to obtain the airspeed that will produce the best rate of climb for the specific gross weight, pressure altitude, and OAT conditions. Maintain directional control with the tail rotor pedals.

7.18.3.2 Maximum Performance Climb

The climb is usually made to gain altitude in the least amount of time, or when gross weight and density altitude prohibit a normal climb with associated power. Apply maximum power while simultaneously applying cyclic to transition to the airspeed that will produce the best rate of climb for the existing gross weight, pressure altitude, and OAT. Directional control should be maintained on all maximum performance climbs with tail rotor pedals.

7.18.3.3 Cruise Climb

This type of climb may be varied by sacrificing rate of climb for airspeed, or airspeed for rate of climb, depending on the time and horizontal distance desired before reaching the newly selected altitude. After determining the desired rate of climb and associated speed, adjust the collective and cyclic to produce the results for specific gross weight, pressure altitude, and OAT conditions.

7.18.4 Cruise

To obtain specific power settings and fuel consumption rates, refer to the cruise charts.

7.18.5 Descent

The factors governing the type of descent to be made are gross weight, pressure altitude, OAT, condition of landing site and terrain, and the amount of time desired in which to accomplish the descent.

7.18.5.1 Cruise Descent

Descents from an established to newly selected altitude are made by lowering the collective to obtain the power reduction that will produce the desired rate of descent.

7.18.5.2 Autorotative Descent

The autorotative descent is used whenever a rapid descent is desired. An autorotative descent is made by lowering the collective to minimum and entering autorotation, then using collective to control N_p . 75 KIAS will produce the minimum sink rate and 95 KIAS will produce the maximum glide distance. To recover, slowly raise the collective at approximately 200 feet above the selected altitude to resume powered flight and slow the rate of descent, then adjust the cyclic to resume desired cruise airspeed. The autorotative descent should not be used in Instrument Meteorological Conditions (IMC) except in an emergency.

Note

A transient N_p rise of up to 109 percent following entry into an autorotation is possible. This is acceptable as long as it does not exceed the N_p limitations.

To obtain specific power settings and fuel consumption rates, refer to the cruise charts.

7.18.6 Night/IMC Descent Over Water

Operational Risk Management (ORM) analysis, Controlled Flight Into Terrain (CFIT) prevention efforts, and mishap data have identified low altitude night/IMC descents over water as a high-risk maneuver that demands undivided aircrew attention and precise aircrew coordination. The following procedures are recommended for all night/IMC descents over water at 1,000 ft AGL and below:

WARNING

Failure to follow night/IMC descent procedures over water may lead to a loss of situational awareness and result in water impact.

Note

- Prior to commencing night/IMC descents over water, barometric altimeters should be synced to the radar altimeter.
- Descents should be commenced and conducted in a wings-level attitude when circumstances allow.
- Altitude hold shall be used in level flight at 500 ft AGL and below.
- **RAWS** tones shall be verbally acknowledged by pilot and copilot.

Descent:

1. The PAC reports “ON INSTRUMENTS” and states the leaving altitude, intended altitude, and variable RAWS/LAWS index position (i.e., set below the intended altitude).
2. The **PNAC** acknowledges descent commencement, intended altitude, and RAWS variable index position.
3. The aircrewman acknowledges the intended altitude. (During the descent, the aircrewman should monitor the altitude via the NAV PARAMETERS table or the altitude display, to the maximum extent permitted by the tactical situation).

Level-off:

1. As the helicopter nears the intended altitude, the PNAC reports “RAWS tones,” 200 ft and 100 ft prior.
2. When level, the PAC reports “LEVEL” and “ALTITUDE HOLD ENGAGED.”

7.18.7 Approach to Landing

An approach should be a precise maneuver. Approaches should not be made so low that the PAC loses sight of the landing point nor so high that a very low power setting with a high rate of descent is required. Approach speed will depend on weight, altitude, and wind conditions. Maintain translational lift as long as possible while avoiding excessive flares and abrupt, large power inputs. The PNAC shall monitor all systems (e.g., stabilator, engines, transmission) during the approach and landing to alert the PAC of malfunctions.

CAUTION

Nose attitudes in excess of 13° nose-up at altitudes less than or equal to 15 feet will cause the tail bumper/stabilator to impact the ground.

7.18.7.1 Normal Approach

Before commencing a normal landing, ensure the Landing Checklist is complete. The landing is approached from an abeam position of approximately 500 feet AGL at an airspeed of 75 to 100 KIAS, so as to arrive at the 90° position at approximately 300 feet AGL and 60 to 80 KIAS. Continue the descent to roll wings-level into the wind with approximately 1,000 feet of straightaway at 150 to 200 feet AGL and 50 to 70 KIAS. Initiate a decelerating attitude and maintain this attitude until the airspeed decreases to 20 KIAS and 30 feet on the radar altimeter.

At 30 feet, adjust the nose attitude (15° nose-up maximum) and increase collective to achieve a hover at approximately 10 feet. Maintain heading and attitude using the tail rotor pedals and cyclic. When transition to a hover is not possible and running landings are not feasible, normal approach procedures may be used for a no hover landing.

7.18.7.2 Steep Approach

A normal approach is flown until reaching the final inbound course to the landing site. Level off at approximately 200 feet AGL, transition to approximately 40 KGS, and intercept the glide slope (approximately 20 to 30°). Reduce power to begin the descent. While descending, do not exceed 700 fpm and maintain translational lift until reaching ground effect. Should rate of descent become excessive or the approach angle become excessively steep, execute a waveoff. The approach may be flown to a hover or no-hover landing as desired. Refer to [Chapter 11](#) for a detailed discussion on vortex-ring state and [Chapter 9](#) for a detailed discussion on mountain and rough-terrain flying.

7.18.8 Landings

WARNING

Extreme aft cyclic in conjunction with low or decreasing collective settings may cause droop stop pounding (DSP) or contact with the ALQ-144A/205. Rapid aft cyclic movement in conjunction with low collective settings may also cause main rotor blades to strike the tail pylon, resulting in loss of tail rotor drive.

7.18.8.1 Crosswind Landing

When a crosswind approach is necessary, it is best to bring the helicopter to a hover and perform a hovering turn into the wind before landing. When this cannot be done, execute a flare and hover as though making a normal approach into the wind. Arrest all drift before touching down. In strong wind, it will be necessary to hold the helicopter in a slip using cross control to touch down first on the upwind wheel and tail wheel. After touchdown, allow the helicopter to settle on the other wheel.

7.18.8.2 Vertical Landing from a Hover

The most important consideration in making a vertical landing is arresting lateral drift. Commence a vertical descent. The aircraft will touch down tail wheel first, then left main mount, and last, right main mount due to the normal nose up, left wing down hover attitude. As the collective is lowered, the tip path will tend to move right wing down due to control mixing.

7.18.8.3 Running Landing

Running landings are usually made from a shallow approach when the helicopter cannot hover due to insufficient power available or loss of tail rotor control. Adjust collective as necessary to maintain the desired approach angle; dissipate speed gradually throughout the approach so the landing can be made while maintaining translational lift. A running landing should not be attempted on rough terrain. Establish a straight track over the ground and a shallow approach with a slow rate of descent. Use tail rotor pedals to maintain heading in the direction of track and cyclic to control drift. Eliminate all lateral drift before touchdown. As the helicopter approaches the ground, increase collective slightly to reduce rate of descent and adjust airspeed to a value compatible with gross weight. Do not exceed groundspeed limitations. As the wheels contact the ground, tail wheel first then main gear, move the cyclic to the neutral position and slowly decrease collective to minimum. Stop the helicopter with the wheel brakes. Avoid overbraking, especially at high gross weights.


CAUTION

Rapid divergent tail wheel oscillations can occur at certain ground speeds and collective combinations with a malfunctioning or unlocked tail wheel. If a running landing is required, maintain 20 KGS or less on touchdown. If oscillations occur, the aircraft should be brought into a hover or stopped with minimum collective and maximum braking.

To prevent rotor head damage and to extend dynamic component life, excessive aft cyclic should be avoided after touchdown. To avoid this during a running landing:

1. Control airspeed prior to the main wheels touching down. Avoid aerodynamic braking with cyclic.
2. Be aware of the tip path plane; excessive aft cyclic will place the tip path unusually high in the field of view.
3. Consciously reposition the cyclic forward prior to lowering collective.

7.18.8.4 No-Hover Landing

A no-hover landing is accomplished in the same manner as a normal approach to a hover. Continue descent through the hovering altitude to touchdown on the tail wheel with little or no forward roll. Maintain the landing attitude (approximately 5° nose-up) with collective and aft cyclic until all forward movement is stopped, then lower the main landing gear to the ground.

7.18.8.5 Unprepared Site Landing

This maneuver may be required under many different circumstances, regardless of the mission. The first step is a thorough study of the landing environment. Refer to [Chapter 9](#) for a discussion of landing site evaluation.

Once it has been determined that a safe landing can be made, the PIC should decide whether or not to use a no-hover landing. Although a no-hover landing will minimize brownout/whiteout, a hover to a landing will better afford the crew the opportunity to clear the aircraft of all obstacles before touchdown. Both options should be considered.


CAUTION

The helicopter shall be continually cleared throughout the approach until collective reduction after touchdown. Helicopter damage may result after contact with foreign objects following collective reduction.

7.18.8.6 Confined Area Landing (CAL)

This maneuver is conducted to allow the helicopter to land in a Landing Zone (LZ) not accessible to a standard tactical/no-hover landing profile due to obstructions. The CAL maneuver will afford the helicopter the safest available route of approach for landing as well as the capability to safely takeoff and depart the LZ. The maneuver starts by aligning the aircraft on final approach to the confined area intended for landing. Slow the aircraft to 20 KGS or less by the time it crosses the last obstruction on the approach end of the LZ. When the aircraft is cleared to descend, simultaneously use aft cyclic and decreasing collective to stop forward motion and begin the descent. Drift in both the fore/aft and left/right directions must be controlled throughout the maneuver.


CAUTION

The helicopter shall be continually cleared throughout the approach until collective reduction after touchdown. Helicopter damage may result after contact with foreign objects following collective reduction.

7.18.9 Practice Autorotative Approach

Practice autorotations with power recovery below 500 feet AGL shall be accomplished at approved landing areas or airfields. Always plan an autorotation to an area that will permit a safe landing in the event of an actual emergency; preferably a hard, flat, smooth surface clear of approach and takeoff obstructions. Practice autorotations should not be attempted in conditions of high grossweight and critical CG loadings. Under conditions of high gross weight, the flare is very critical.

Deviations from straight-in autorotations should be practiced to ensure full utilization of the helicopter capabilities and improve pilot proficiency. These deviations include the use of 100 KIAS autorotations for maximum range and turns to establish precision maneuvering to arrive over a predetermined spot on the ground. Practice autorotations should begin at an altitude that will permit a power-off approach to the desired landing spot. The recommended altitude for practice autorotations is no lower than 500 feet AGL. After the completion of the Landing Checklist and at selected cruising speed, smoothly bottom the collective. Maintain 100 to 105 percent N_T and 80 KIAS in the descent.

Commence a flare at approximately 200 feet AGL to slow forward airspeed and stop rate of descent. The power recovery is initiated at the end of the flare no lower than 60 feet AGL by rotating the nose forward to hover attitude and subsequently increasing the collective to stop the rate of descent by 20 to 30 feet, with 15 to 20 KGS and zero drift. Avoid abrupt applications of power.

Note

- During practice autorotations, the pilot not at the controls should provide 200 feet AGL altitude calls. Recovery or waveoff shall be initiated prior to descent below 60 ft AGL.
- A transient N_p rise of up to 109 percent following entry into an autorotation is possible and acceptable as long as N_p limitations are not exceeded.

Simulated emergencies over unprepared surfaces may be executed wherein an autorotative state is entered; however, recovery shall be made at not less than 500 feet AGL and not less than 40 KIAS. These simulated emergencies are primarily for the purpose of developing sound judgment in the selection of the best available landing site in an emergency situation.

7.18.10 NOE Quickstop

The NOE quick stop is used to slow or stop the aircraft in the NOE flight regime. If performed properly, the quick stop effectively slows the helicopter, while balancing the need to maintain safe tail clearance against the tactical requirement to keep the aircraft masked. The maneuver is a level speed change with the point of rotation about the tail rotor, not the aircraft's aerodynamic center.

1. Maneuver description:

- a. The PAC announces intention to crew by stating, "QUICK STOP." The PAC begins the maneuver by increasing collective slightly while positively applying aft cyclic. This will induce the aircraft rotation about the tail rotor.
- b. Right gunner acknowledges with "TAIL CLEAR" as gunners scan forward and under the aircraft to aid the PAC in clearing the tail.
- c. After initial rotation, PAC reduces the collective to prevent ballooning. If power reduction is too abrupt, this will tend to build N_T and cause the engines to uncouple. It is imperative to maintain some power on the aircraft. Since uncoupled engines require time to spool up, the undesirable results can be N_T droop, degraded aircraft control, and loss of tail rotor effectiveness while attempting to maintain HOGE. If uncoupling occurs, lead the recovery with collective to re-couple the engines and prevent N_T droop.
- d. To complete the maneuver, nose attitude and collective reduction are adjusted dependent on the rate of deceleration desired.

2. Common errors include:
 - a. An overly aggressive flare, causing ballooning.
 - b. Failure to lead recovery from the maneuver, causing abrupt power changes or loss of N_r .
 - c. Not rotating about the tail rotor, allowing the tail to come close to impacting the ground.
 - d. Not maintaining altitude/allowing the aircraft to settle with a nose-up attitude.



The PAC shall ensure that the engines remain coupled throughout the maneuver in order to prevent excessive rotor droop resulting in altitude loss and/or loss of tail rotor effectiveness.

7.18.11 Practice Single-Engine Failure in an HOGE (Cut and Run/Cut Gun)

This maneuver shall be conducted over a prepared surface into the wind. Commence maneuver from a hover with a minimum altitude of 70 feet AGL. The PAC and PNAC must monitor nose attitude, N_r , torque, rate of descent, altitude, and airspeed until aircraft reaches safe conditions. If it appears the aircraft is going to make contact with the ground, the PAC shall take action to ensure the aircraft touches down in a level attitude with no yaw or drift.

If simulating HOGE power sufficient to execute a Cut and Run, PAC should use coordinated cyclic and collective inputs to transition to forward, descending flight while maintaining heading. The goal is to increase airspeed while descending into ground effect in order to achieve single-engine airspeed.

If simulating HOGE power not sufficient to execute a Cut and Run (Cut Gun), PAC should arrest drift and adjust collective as required to preserve N_r while descending into ground effect. This maneuver may be completed by executing a max gross weight style takeoff from the [HIGE](#).

CHAPTER 8

Shipboard Procedures

8.1 GENERAL

This chapter highlights specific shipboard procedures and is not intended to replace procedures found within respective CV NATOPS, LHA/LHD NATOPS, and NAVAIR 00-80T-122 (Helicopter Operating Procedures for Air-Capable Ships) manuals. Aviation ships refer to aircraft carriers (CV/CVN) and amphibious assault ships (LHA/LHD). All other ship classes having the ability to support helicopter operations are referred to as air-capable ships.

8.1.1 Introduction

Shipboard procedures encompass operations involving all ships having a helicopter landing capability. Ships utilizing helicopter services normally provide a helicopter landing area, but numerous variations exist with regard to support facilities such as hangars, unprotected platforms, and nonstandard fuel and power facilities.

Pilots must refer to the CV and LHA/LHD NATOPS Manuals prior to operations involving aviation ships. Pilots must refer to the Air-capable Ships Helicopter Facilities Resume (NAEC-ENG 7576), Helicopter Operating Procedures for Air-Capable Ships (NA 00-80T-122), and Helicopter Operations from Ships other than Aircraft Carriers (HOSTAC APP 2) prior to operations involving air-capable ships. Individual ship procedures are delineated in NA 00-80T-122 and Underway Replenishment (NWP 4.01.4) series.

8.1.2 Shipboard Landing Qualification/Currency

Pilot and aircrew shipboard landing initial qualification, subsequent qualification, and currency requirements are defined in [Chapter 5](#).

8.2 GENERAL SHIPBOARD OPERATIONS

8.2.1 Flight/Hangar Deck Procedures

8.2.1.1 Movement of Helicopter

Size, weight, and fuselage structure do not permit safe ground handling of the helicopter aboard ships where the only available method is to move the aircraft by hand. In the case of an emergency or when the appropriate mechanized means are not available it may be necessary to move the helicopter by hand while underway. In the event of a situation that requires the helicopter to be moved by hand, it shall be done IAW the procedures found in this manual and all applicable pubs (PLANE CAPTAIN MANUAL A1-H60BB-000, A1-H60BB-GAI-010, CV NATOPS NAVAIR-00-80T-105, LHA/LPH/LHD NATOPS NAVAIR-00-80T-106, and HELICOPTER OPERATING PROCEDURES FOR AIR-CAPABLE SHIPS NATOPS MANUAL NAVAIR-00-80T-122).

WARNING

Helicopter movement by hand, while underway, is inherently dangerous. Sea state, winds, and unexpected flight deck motion shall all be carefully evaluated prior to helicopter movement.

Note

If operating from a ship that does not have mechanized means available to move the helicopter, Squadrons shall coordinate with their Type Wing to ensure the equipment required to move the aircraft by hand is available.

8.2.1.2 Blade/Pylon/Stabilator Folding and Spreading

The maximum safe, non-turbulent wind relative to the helicopter for rotor folding/spreading and for tail pylon/stabilator folding/spreading is 45 knots, except in emergency situations. The safety nets shall be lowered prior to fold/spread evolution (as required).



- Unless external power is applied or the BATT switch is ON prior to folding the tail pylon, the tail rotor indexer will not engage after starting the pylon fold sequence and uncontrolled tail rotor windmilling may result.
- When connected to host ship's 400 Hz power only, activation of the B/U pump may cause a surge in the ship's power and cause the ship's converter box to blow its fuses and damage the helicopter's external power system.
- At any time blades are to be spread or folded aboard ship, personnel shall act as blade walkers while the blades are in motion to prevent excessive blade flapping, which could result in the blade tips striking the deck.

8.2.1.3 Engine Start and Rotor Engagement

Requirements for engine start and rotor engagement consist of the following:

1. Rotor blade restraints removed.
2. Main mount tiedowns secured with 2 to 3 inches of slack and chocks in place.
3. Flight deck area clear of unnecessary personnel.
4. Tail wheel locked, parking brake set.
5. Winds less than 45 knots.
6. Ship maintains steady course throughout engagement/disengagement.

Note

The Rotor Brake Start procedure shall be used for shipboard engine starts and rotor engagements.

8.2.1.4 General Safety Precautions

1. Secure the helicopter with two chocks and a minimum of four tiedowns. Fueling personnel shall not approach the helicopter until it is properly chocked and chained.
2. Personnel shall enter the rotor arc near the 9 and 3 o'clock positions when directed. Movements within the rotor arc shall be around the nose. Under no circumstances shall personnel work in close proximity to a turning tail rotor.
3. For air capable ships, helicopter rotors shall not be engaged/disengaged or the aircraft launched/recovered while the ship is turning.
4. For aviation ships, helicopter rotors should not be engaged/disengaged or the aircraft launched/recovered while the ship is turning.

WARNING

When the helicopter is on the flight deck with the rotors engaged, the cyclic should be held in the neutral position. Attempting to maintain the tip-path plane parallel to the horizon on a rolling, pitching deck can be hazardous to flight deck personnel and may cause droop stop pounding. Personnel shall remain outside the rotor arc during engagement/disengagement.

8.2.2 Visual Landing Aids

Signals should be in accordance with the Aviation Signals NATOPS Manual (NAVAIR 00-80T-113). Shipboard Visual Landing Aid (VLA) lighting equipment consists of a homing beacon, deck edge lights, line-up lights, floodlights and special lighting for air-capable ships (special-purpose floodlights, extended line-up lights, vertical drop-line lights, wave-off lights, Horizon Reference Systems [HRS] and a Stabilized Glide Slope Indicator [SGSI]). Whereas all VLA lighting equipment should be operative for all night operations, night operations in VMC can continue with some degradation in lighting equipment availability.

8.3 AVIATION SHIP HELICOPTER OPERATIONS**8.3.1 Aviation Ship Launch and Recovery Procedures**

1. Each helicopter shall be under the positive control of a director or signalman for all flight deck evolutions. Standard helicopter signals shall be used and acknowledged.

WARNING

In crosswind conditions, relative to the ship's fore and aft axis, the indicated winds often vary from those winds actually experienced at the flight deck level. This variance will affect velocity, turbulence, and direction, all of which are critical for safe launches and recoveries.

2. Optimum wind and deck conditions should be provided. The term takeoff is defined as the action of lifting from the deck culminating in hovering, forward or sideward flight. The terms takeoff, liftoff, and launch are synonymous. The term landing is the maneuver of physically positioning the helicopter on the deck following forward or hovering flight. The terms landing and recovery are synonymous. The helicopter shall be launched and recovered within the relative wind limits. The upwind helicopter should be launched first.
3. On launching from a CV, the helicopter should be rolled forward slightly to make sure chocks/tiedowns are removed. Lift into a hover about 10 feet above the deck, and transition to forward flight. Helicopters should clear the ship expeditiously to reduce hazards to flight deck personnel.
4. Chocks and tiedowns shall not be installed upon landing without the pilot's knowledge. Normally, this will be done by an exchange of signals between the pilot and the LSE.

8.3.2 Shipboard Launch/Recovery Limitations

Wind limitations for launch and recovery operations are defined by ship class and are delineated in the NATOPS Pocket Checklists. Helicopters shall be launched and recovered within the limits of the prescribed wind envelope to preclude damage or loss.

8.3.3 Launch and Recovery Signals

Refer to the CV NATOPS, LHA/LHD/MCS NATOPS and NAVAIR 00-80T-113 AIRCRAFT HANDLING SIGNALS MANUAL for guidance.

All signals from the LSE are advisory in nature except "WAVEOFF" and "HOLD."

8.3.4 Waveoff Procedures

Compliance with a waveoff signal is mandatory at all times. Pilots must use extreme caution to avoid overflying aircraft parked or turning on deck. Reentry into the landing pattern shall be prescribed by the controlling authority.

8.3.5 Shutdown

After chocks and tiedowns have been attached, the helicopter will be shut down and folded upon signal from the LSE.

8.3.6 Night and IMC Operations

8.3.6.1 Deck Conditions

Standard deck spotting (centerline only) shall be used. Such spacing shall provide a minimum rotary wing to tail rotor clearance of 20 feet. Deck edge and centerline lights of required spacing and brilliance are required for unaided helicopter operations. Night and IMC operations from aviation ships shall be conducted from authorized spots. Aided departures are permitted from authorized spots with acceptable NVD deck lighting conditions.

Note

Before applying external power or turning the battery switch on, pilots and/or maintenance personnel shall make sure that all helicopter light switches are OFF.

8.3.6.2 Night Launches

The radar altimeter variable index should be set 10 to 15 feet above flight deck height to warn of low altitude after takeoff. Following the night takeoff, the pilot should hold cockpit functions to a minimum until the helicopter is established in level cruising flight. For CV night launches, aided sidestep departures are permitted from authorized spots with acceptable NVD deck lighting conditions. The aircraft shall slide out laterally to clear all obstacles before climbing. Helicopters shall climb straight ahead to at least 150 feet and 60 KIAS before beginning any turn. The PNAC shall ensure positive rates of climb. Altitude hold is required for all night overwater operations.

8.3.6.3 CV NIGHT APPROACHES

If NVDs are used during a flight, the NVD configuration for landing (goggles on/goggles off) shall be set at least 5 minutes before commencing the approach. Crews aided with NVDs may make a visual approach to spot rather than a Carrier Controlled Approach (CCA) provided they prebrief such an approach, are not IMC, and have sufficient illumination/visibility.

For NVD centerline visual approaches, during VMC and using NVDs, the PIC may accept a visual approach to the fantail and proceed along the centerline for landing on authorized spots. After the last fixed wing aircraft on final is identified by the Air Boss/CATCC, the helicopter will take interval and land visually.

For NVD slide-in visual approaches, at the PIC's discretion, the helicopter may slide in to a landing on authorized spots. Visual contact with the ship and NVD usage shall be required.

For mirror/optical landing system approaches, the helicopter should enter the glide path about 2 miles astern of the carrier, on the landing axis. At about 3/4 of a mile distance astern of the carrier, a speed transition should begin to arrive at the ramp in a stabilized flight condition with about 10 feet altitude above the flight deck. The helicopter may then be air-taxed to an assigned spot at a safe closure rate, with pilot reference to visual signals from LSE. Night and IMC approaches shall be conducted as published in the CV and LHA/LHD/MCS NATOPS Manuals.

8.4 AIR-CAPABLE SHIP HELICOPTER OPERATIONS

Air-capable ships are characterized by significantly smaller flight decks than aviation ships. By the nature of their size, air-capable ships are also more susceptible to pitch, roll, and turbulence created by wind interaction with the ship's superstructure. Additionally, personnel on these ships generally have less operational familiarity and receive less training than those on aviation ships. Pilot precaution is required during flight operations with air-capable ships, particularly during night and IMC.

8.4.1 Air-Capable Ship Launch and Recovery Procedures

Single-spot shipboard launches should be executed utilizing the following launch procedure to the maximum extent possible. Intentional deviation shall be thoroughly briefed and assessed utilizing **ORM** principles. Takeoffs should normally be performed by the pilot who is nearest the ship's superstructure, as determined by the relative winds and the desired takeoff direction.

1. The PAC lifts the aircraft into a stable hover, approximately 10-15 feet above the deck or eye level with the **HARS** bar while the PNAC crosschecks all performance instruments and reports good check of gauges.



- Initial hover height over the deck shall be sufficient to provide adequate tail clearance during heavy seas and to allow sufficient clearance to slide aft.
 - During operations from a Flight II DDG, hover height at less than eye level with the HARS bar may result in a stabilator strike when sliding aft.
2. PAC maneuvers the aircraft aft as required to ensure obstacle clearance. Helicopter mainmounts should remain over the flight deck. Once the helicopter is in a stable hover, the PAC calls nose coming left or right and makes a pedal turn as required to at least approximately 45 degrees off ship's heading in direction of relative wind, and stabilizes. With commencement of pedal turn, PNAC shifts to an instrument scan. The PAC maintains an outside scan outside to ensure obstacle clearance. Once stabilized, PNAC crosschecks and reports good check of gauges.
 3. PAC reports pulling power and transitions to forward flight by increasing collective. PNAC reports three rates of climb. Once a positive rate of climb is attained, and obstruction clearance is assured, PAC transitions to instrument scan and positions the nose 5 degrees below the horizon.



- Failure to stabilize prior to power pull may result in spatial disorientation and **CFIT**.
- Transition from a visual scan to an instrument scan while in a dynamic flight regime can result in vertigo. The transition of scan from visual to instrument should take place after obstacle clearance is assured.
- The pilot should avoid multi-axis head movement by using peripheral vision to ensure obstacle clearance and to reduce susceptibility to vertigo.



On FFG-7 class ships, the takeoff should be performed in the aft part of the flight deck. A pedal turn of at least 45 is required to ensure clearance from the hangar and aft whip antennas.

4. PAC maintains departure heading until desired altitude and safe single engine airspeed is attained and RADALT hold is engaged. The crew shall not perform non-emergency checklists or other duties until level off altitude is reached and RADALT hold is verified to be engaged.

5. Once a safe flight regime is established, PAC reports “OPS NORMAL.” Both PAC and PNAC shall maintain an instrument scan until attaining pre-briefed level off altitude, at which point PAC centers the VSI and PNAC verifies RADALT is engaged.

Following takeoff, the PAC shall establish single-engine airspeed and climb to a safe operating altitude. The PNAC shall ensure positive rates of climb. During night VMC, the helicopter should climb to 150 feet AGL and 60 KIAS prior to commencing a turn. Altitude hold is required for all night over water operations.

Note

Radio transmissions by both the ship and other helicopters should be kept to a minimum when a helicopter is established in a hover over the flight deck during launch/recovery until an “OPS NORMAL” report is given or the helicopter is safely on deck.

8.4.2 Shipboard Launch/Recovery Limitations

Launch and recovery operations, signals, and procedures shall be in accordance with NAVAIR 00-80T-122 and NA 00-80T-117. Wind limitations for launch and recovery operations are defined by ship class and are delineated in the NATOPS Pocket Checklists, and NAVAIR 00-80T-122. Helicopters shall be launched and recovered within the limits of the prescribed wind envelope to preclude damage or loss.

8.4.3 Approach Procedures

There are four types of approaches for shipboard landings:

1. Visual approach.
2. Instrument approach.
3. Emergency Low Visibility Approach (ELVA) when the weather is below instrument approach minimums and the helicopter does not have adequate fuel to bingo to a [GCA/CCA](#)-equipped airfield or aviation ship.
4. Offset approach or ordnance lineup approach, when the helicopter has a hangfire or misfire missile emergency.

During day VMC approaches, the PNAC shall back up the PAC in maintaining glide path/altitude control and closure rate. Throughout all night/IMC approaches, one pilot shall be responsible for maintaining an instrument scan at all times. Both pilots shall verbally acknowledge their scan responsibility whenever it changes.

During all approaches, the PNAC and the aircrew, as briefed, shall verbally complement the scan of the PAC by providing altitude, range, lineup, and speed information while on approach. One pilot should maintain an instrument scan until able to distinguish flight deck features. Closure should be controlled via reference to flight instruments until it can be judged visually. The PAC must control closure such that when closure does become visually apparent it is slow enough that a comfortable deceleration can be maintained to arrive in a hover over the flight deck.

WARNING

- If the [SGSI](#) appears amber or green below the minimum altitude for the corresponding range, disregard the SGSI and continue the approach using standard altitude vs. range glide path control.
- If the red light on the [HRS](#) comes on, the HRS is unreliable or has failed.

Note

At night the searchlight or hover light is flashed on short final to signal the [HCO](#) to set the line-up strobes steady and reduce their intensity.

Both pilots should scan the radar altimeter for primary altitude information, even when using the SGSI or ship gunfire control radar for glide path information. The radar altimeter should be continuously crosschecked against the barometric altimeter. Rate of descent should not exceed 500 fpm throughout the approach. The PNAC should be prepared to take control of the helicopter in the event that normal altitude/range/rate of descent parameters are exceeded without sufficient response by the pilot at the controls to verbal warnings.

8.4.3.1 Visual Approach

Inbound to the ship, intercept the final approach course at approximately 200 feet and 0.5 nm to achieve 3 degree glide slope. Maintain the approach course and glide path (Figure 8-1) using the line-up line. A slow controlled closure rate is essential in order to maintain obstruction clearance. Begin a coordinated descent and deceleration maintaining glide slope. The pattern may be adjusted during day VMC to intercept the glide path commensurate with pilot proficiency and flight deck conditions or as the final part of an instrument approach.

During the visual approach phase, the approach line is maintained using the lineup lines on the ship deck as well as visual cues from the ship structure and wake. At night, the approach line is maintained using the lighted lineup and extended lineup lines, vertical dropline lights, and any other available visual cues from the ship lighting.

Note

At night, the lower anti-collision light should be secured, RAST lights on, and position lights set to dim prior to commencing approach. On those ships with SGSI, the glide path should be maintained by visual reference to the tricolor beam and cross-checked with the radar altimeter to ensure standard altitude vs. range glide path control.

8.4.3.2 Instrument Approach

An instrument approach procedure shall be utilized during IMC until sufficient visual cues are available to proceed visually (approximately 0.5 DME). The standard TACAN Instrument Approach Procedure is contained in Helicopter Operating Procedures for Air-Capable Ships NATOPS Manual (NAVAIR 00-80T-122). The Alternate Instrument Approach Procedure (Figure 8-1) reduces aircrew workload by eliminating the requirement to maintain a constant rate of descent throughout the approach.

The approach is commenced from a position at least 1.5 miles astern on BRC, at no less than 200 feet AGL and approximately 80 KIAS. When established on final approach course inbound, a descent and deceleration may be commenced to arrive at 0.5 DME (MAP) at no less than 200 feet and approximately 50 KIAS. If visual contact is not made by 0.5 DME, a missed approach shall be executed. If visual contact is established, the descent and deceleration may be continued utilizing the normal approach profile to arrive approximately 15 feet above the flight deck with a controlled rate of closure.

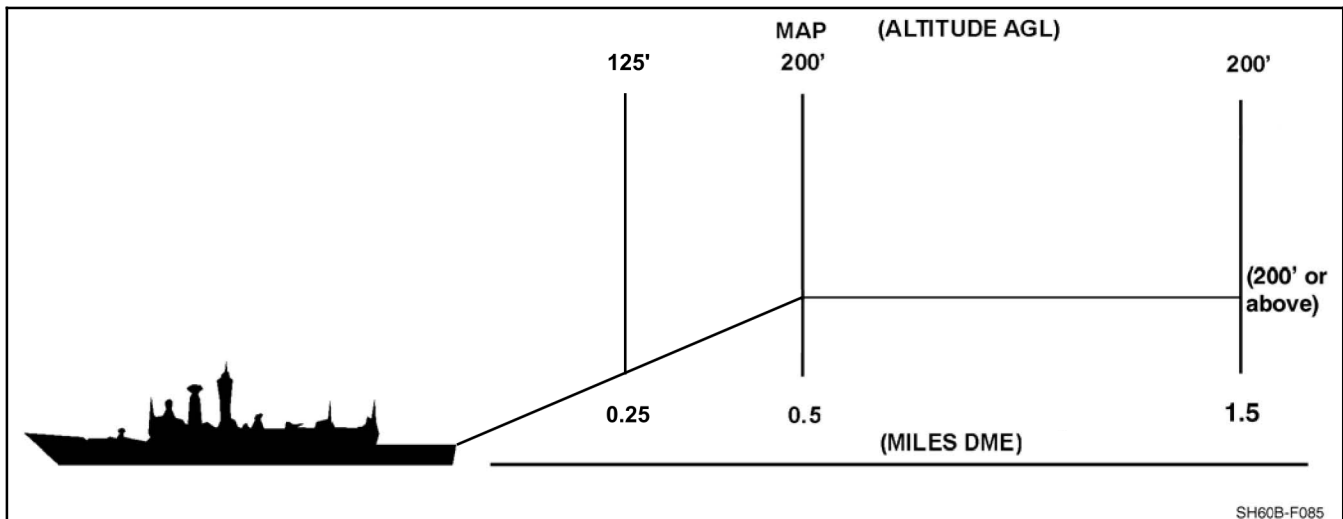


Figure 8-1. Visual and Instrument Approach Profile

8.4.3.3 Self-Contained Approach Procedures

The systems of the SH-60B enable aircrews to conduct shipboard instrument approaches independent of external aids to navigation, known as the Self-Contained Approach (SCA). The SCA is specifically for approaches to ships at night or IMC when TACAN is not available. The SCA is conducted as follows:

Note

Operations to a ship without an operable TACAN are only permitted with a visible natural horizon.

1. Establish a refined radar track on ship, ensuring ship's reported GPS true course and speed through the water are matched with helo generated track.

Note

Weather conditions permitting, a Mark On Top of vessel may provide the most accurate position for ship's track symbology.

2. Both pilots switch to Computer mode.
3. ATO establish Fly-to Point slaved to ship's track.
4. Fly to arrive 2.0 NM astern the ship at 80 KIAS and 200 feet AGL on Fox Corpen. SO make final update of radar track.
5. PAC follow course arrow to FTP. Use Range to FTP in place of TACAN DME to conduct approach.
6. SO switch MPD to Nav Parameters Table and call closure and monitor altitude for duration of approach.
7. Fly to arrive at 0.5 NM astern the ship at 50 knots at 200 feet AGL on Fox Corpen. (Missed Approach Point).
8. Begin descent and deceleration to arrive at .25NM astern the ship at 125 feet AGL on Fox Corpen with closure rate well under control.
9. Continue descent and deceleration to arrive approximately 15 feet above the flight deck with a controlled rate of closure.

WARNING

- If GPS data or aircraft symbology is suspected to be unreliable, consideration should be given to securing GPS prior to commencing approach.
- When able, the PAC must transition to visual cues for the terminal portion of the approach to landing. The range to FTP in computer mode any not be as reliable as DME if the same approach were conducted in TACAN mode.

Note

While in computer mode, the course arrow will show course to Fly-to Point in degrees true. This may differ significantly from the same approach conducted in TACAN mode.

8.4.3.4 Landing Transition

The transition from the missed approach point (0.5 DME) to landing requires deceleration below minimum power required airspeed. As the aircraft slows below minimum power required airspeed, more power is needed to maintain the glide path.

WARNING

Failure to increase power appropriately during the landing transition can result in high rates of descent at low altitude and potential water impact.

The transition from the approach phase to the landing phase begins at approximately .25 nm from the ship, with the aircraft at approximately 125 feet and closure rate well under control. The PNAC should call altitude every 10 feet and advise the pilot of adverse closure rate trends with FAST or SLOW calls.

If a waveoff is initiated during the landing phase, the PAC shall provide obstacle clearance. The PNAC shall resume a full instrument scan. A waveoff may be initiated at any time prior to landing. Compliance is mandatory. The pilot shall release the RA cable (if required) and depart the ship when “ALL CLEAR” is received.

WARNING

Activation of the waveoff lights may temporarily blind both pilots and could result in spatial disorientation and loss of helicopter. Unless there is no other method available to communicate the waveoff command, use of the waveoff lights is not recommended.

The PNAC, Aircrewman, or LSO can provide the PAC with positional information over the RSD (conning).

8.5 RAST EQUIPPED AIR-CAPABLE SHIPS

Flight deck operations on a RAST equipped ship differ from those on a non-RAST ship. RAST flight operations require an LSO, a Landing Signalman Enlisted (LSE) and two hookup men. During RAST flight deck evolutions, the LSO controls flight operations with the Helicopter Control Officer (HCO) acting as a safety observer. The LSE and the hookup men are the only personnel required on deck during the landing sequence, and only for the short time it takes to connect the messenger cable to the Recovery Assist (RA) cable. Once the aircraft lands and is secured in the RSD, the LSO will direct the LSE onto the flight deck for aircraft shutdown or personnel transfer. Chocks and chains are not required when secured in the RSD for personnel transfers, but may be considered, based upon sea state, winds, ship maneuverings, and length of time on deck. The Flight Deck Director (FDD) will assist the LSO during straightening and traversing into the hangar; the FDD and the LSO must work as a team with the FDD being the eyes on the flight deck.

CAUTION

- No maintenance shall be performed which can change the static vertical clearance between the external aux fuel tanks and the flight deck. If such maintenance is necessary, deck clearance shall be checked by appropriate maintenance personnel before continued operations.
- Pilots and LSO shall exercise due caution when conducting traversing, straightening, and launch/recovery operations with an external tank equipped H-60 aircraft in the RSD. Avoid abrupt aircraft and RSD motions to minimize potential tank/RSD contact.

8.5.1 LSO Console Preoperational Checklist

1. RSD — OFF.
2. Tail guide winch (TGW) — UNLOAD.
3. Traverse lever — TRAVERSE SELECT.
4. RA tension lever — RA SELECT.
5. Remote control (in stop position) — Obtain.

WARNING

Once remote control of the RAST system has been received, the RSD beams will respond to commands from the LSO station regardless of START/STANDBY status. Ensure that personnel keep well clear of RSD beams at all times.

6. LAMP TEST/RA METER TEST — Complete.
7. RAST machinery room — Clear of all personnel.
8. Proper RSD selected — PORT/STBD.

WARNING

Failure to ensure the proper RSD is selected can lead to activation of the wrong RSD, which can result in damage to a hangared aircraft or injury to flight deck personnel.

9. START/STANDBY — As required.

CAUTION

- Pilots and LSOs shall exercise caution when conducting launch/recovery, straightening, and traversing operations with an external auxiliary tank-equipped aircraft in the RSD. Avoid abrupt aircraft or RSD motions to minimize potential for tank/RSD contact.
- If aircraft gross weight exceeds weight at which last vertical clearance was measured, another measurement must be taken to ensure adequate tank/RSD clearance.

Note

Engagement of the START/STANDBY pushbutton is not required for operation of the RSD beams during takeoff and free deck evolutions.

10. RSD pressure light:
 - a. If START/STANDBY engaged — OFF.
 - b. If START/STANDBY not engaged — ON.

8.5.2 RSD Unlatched Procedure

WARNING

Toggling the RSD switch from OFF to CLOSED to OFF with the RSD beams already in the closed position may allow the beams to become unlatched, potentially resulting in aircraft rollover in heavy seas. If the beams cannot be visually confirmed latched, perform RSD Unlatched procedure and visually confirm latched condition.

1. Chocks and chains — On.
2. Beams — Open (verify by OPEN light on console).
3. RSD — CLOSED.
4. Latched condition — Visually verify beams closed conditions.

Note

Beams can be visually confirmed latched by a latched light, witnessing the RSD flags in the up position, or noting no more than a quarter inch separation at the ends of the RSD beams.

8.5.3 Traversing Checklist

WARNING

Toggling the RSD switch from OFF to CLOSED to OFF with the RSD beams already in the closed position may allow the beams to become unlatched, potentially resulting in aircraft roll over in heavy seas. If the beams cannot be visually confirmed latched, chock & chain the A/C, open the beams fully, (verify by OPEN light on console), select RSD CLOSED and visually verify beams to be closed with latch light.

Note

Beams can be visually confirmed latched by a latched light, witnessing the RSD flags in the up position, or noting no more than a quarter inch separation at the ends of the RSD beams.

1. LSO Console Preoperational Checklist — Complete.
2. **FDD** communication check — Complete.
3. Traverse clearance — Obtain.

WARNING

Should the ship maneuver, cease all aircraft movements, call for aircraft brakes and chains as necessary, to prevent injury to personnel and/or helicopter damage. Contact the pilot house to resolve the situation.

4. FDD — Confirm:
 - a. Hangar door — Open and pinned.
 - b. Track slot seals — Removed.

Note

Track slot seals should be placed in the slot whenever operationally feasible.

- c. Hangar door/deck bridge — Removed (CG).
 - d. Left-handed extended pylon — Up and pinned.
 - e. Hangar and flight deck gear — Stowed.
 - f. RSD safety bar — Installed.
 - g. RAST probe to deck clearance — Check.
 - h. Tail probe — In track slot.
 - i. Brakerider — In aircraft.
 - j. Tail wheel — LOCKED.
 - k. Blade/pylon fold restraints — In place.
 - l. All access panels/cowling/LHEP — Secure.
 - m. Bellmouth plug — Removed and stowed.
5. Control console — Check:
 - a. Proper RSD — PORT/STBD.
 - b. RSD lights — CTR, **LTCH**, **BRKE** lights on.
 - c. Traverse lever — TRAVERSE SELECT position.
6. Chocks/chains — Remove.
7. Traverse — Select, check TRVS light.
8. Personnel — Clear of aircraft.
9. Aircraft brakes — Off.

WARNING

The FDD shall remain in sight of the LSO at all times while traversing the aircraft.



- The aircraft should be moved at slow speed when the tail wheel is within the confines of the hangar.
- Ship rolls of 16° and above will consistently generate aircraft relative roll angles of 10° when aircraft is secured only by the RSD. The aircraft will occasionally reach relative roll angles of 10° with as little as 10° of ship roll. During traversing on the FFG 7 class, these relative roll angles of 10° could result in the forward lower tail rotor blade impacting the port door frame of either hangar while the rescue hoist and outboard main rotor blade could impact the starboard door frame of either hangar. During traversing, wait to obtain a relatively quiescent period (less than 8° of ship roll) or until the ship is rolling away from the direction of possible impact before moving the MRB, hoist, or TRB areas past the hangar door frame using fast speed if required.
- Ship motion may cause the tail probe to pop out of the RAST track. If this happens, stop traversing and install chocks and tiedowns. Straightening-qualified personnel should determine appropriate actions to be taken to reseat probe in track.
- During traversing on CG 47 and class ships, traverse slowly over the elevated hangar door tracks.
- If the aircraft is to be straightened/traversed with the external power cable attached, the FDD shall assign a person to tend the power cable and keep it clear of the aircraft path to prevent damage to the cable.

Note

Sideloads can develop while traversing the helicopter, as evidenced by a lateral strain on the tires. This can result in the RSD jamming in the track slot or in excessive side forces applied to the aircraft landing gear. Reverse the direction of traversing until the sideload dissipates, then continue with normal procedures.

10. Traverse lever — Desired direction/speed.
11. FDD directions — Follow.



Should communication or visual contact with FDD be lost, traversing shall be stopped immediately.

12. Traversing — Stop.
 - a. SNUB button — Press, or
 - b. Traverse lever — TRAVERSE SELECT, or
 - c. START/STANDBY — Press, or
 - d. STOP — Press.

Note

Traversing may be stopped before the aircraft reaches the takeoff position to permit tail pylon spread.

13. Aircraft brakes — Set.
14. Chocks/chains — As required.
15. Notify bridge — Deselect **TRVS** on **BIDS**.

8.5.4 Prelaunch Checklist

1. Communication check with HCO, bridge, and **CIC** — Complete.
2. FOD walkdown — Complete.
3. Deck gun mounts (if applicable) — Stowed/secured.
4. All nets — Down.
5. LSO Console Preoperational Checklist — Complete.
6. RSD/aircraft — In takeoff position.
7. RSD safety bar — Remove.
8. RSD Chock (If applicable) — Remove.
 - a. Personnel — CLEAR.
 - b. RSD Beams — Open.
 - c. RSD Chock — Remove.
 - d. Personnel — CLEAR.
 - e. RSD Beams — Closed.
9. Tail probe — Manually retract.
10. HRS and SGSI — As required.
11. Night lighting — As required.
12. UHF COMM with HCO or CIC or aircraft (EMCON permitting) — Check.
13. HELO CRASH alarm — Permission from bridge and check as required.
14. HCO transfers control to LSO when flight quarters set — Complete.
 - a. Deck status lights — Obtain from HCO and check.
 - b. Deck status lights — Red.
 - c. Helo waveoff lights — Test.

Note

During EMCON the data link hardwire or external IB may be used for deck maneuvers, in addition to deck status and aircraft lights. The LSO should use wands to communicate visually as necessary.

8.5.5 Aircraft Startup

| Aircraft Startup | Deck Status |
|--|-------------|
| 1. Spread clearance — Obtain. | |
| 2. Relative wind — Within limits for spread. | |
| 3. Spread sequence — Clear FDD to proceed. | |
| 4. UHF COMM check with aircraft (EMCON permitting) — Complete | |
| 5. Hangar doors — Fully closed. | |
| 6. High Points and Tail Tiedowns — Verify removed with LSE. | |
| 7. ENGINE START/ENGAGE clearance — Obtain. | Red |
| 8. Aircraft engines started — Notify bridge. | |
| 9. Flight deck — Clear except LSE, safety observer, and chock and chain personnel. | |
| 10. Relative wind — Within limits for engagement. | |
| 11. Aircraft engage (EMCON — Position lights flashing to request). | Amber |
| 12. Engaged — Notify bridge. | Red |

WARNING

Lateral cyclic displacement during high sea states may endanger deck personnel and will not maintain a level aircraft attitude.

8.5.6 Launch Procedures

| Launch Procedures | Deck Status |
|---|-------------|
| 1. Main probe — Check position in RSD, inform pilot. | |
| Note | |
| Ensure the main probe tip will clear the inside edges of the RSD and RSD beams when the beams are opened. | |
| 2. Tail probe — Check up. | |
| 3. Pass to aircraft: | |
| a. Altimeter. | |
| b. True wind. | |
| c. BRC. | |
| d. Pitch. | |
| e. Roll. | |
| f. Relative winds. | |
| 4. Launch clearance — Obtain (EMCON — position lights steady to request). | Amber |
| 5. Electrical/data link cords/tiedowns — Verify removed. | |
| 6. Aircraft — Signals ready to lift. | |
| a. Pilot — (EMCON) Flash searchlight or hover lights. | |
| 7. Flight deck/Airspace — Clear. | |

| Launch Procedures | Deck Status |
|---|-------------|
| 8. Relative winds — Check within limits for launch. | |
| 9. LSO (when deck is steady) RSD beams — Open. | |
| a. RSD red flags — Down. | |
| b. RSD beam position light — Open. | |
| c. RSD BRKE light — ON. | |
| 10. LSO — “BEAMS OPEN, GREEN DECK, LIFT”. | Green |
| 11. Aircraft lifts into hover: | |
| a. LSO — “ALL CLEAR,” or | Green |
| b. LSO — “AIRCRAFT FOULED.” | Amber |
| 12. Ops normal — Received. | Red |
| 13. Post Launch Checklist — Complete. | |

8.5.7 Post Launch Checklist

1. After first launch of the day and if immediate landing not intended:
 - a. Close RSD and check:
 - (1) OPEN and BRKE lights — Out.
 - (2) Beams — Close within 4 seconds.
 - (3) LTCH light — ON.
 - (4) RSD beam flags — Up.
 - (5) RSD — OFF; BRKE light — ON.
 - b. Open RSD and check:
 - (1) LTCH and BRKE lights — Out.
 - (2) Beams — Open within 4 seconds.
 - (3) OPEN light — ON.
 - (4) RSD beam flags — Down.
 - (5) RSD — OFF; BRKE light — ON.
 - c. RSD safety bar — Install if immediate landing not intended.
 - d. Pull 3 to 4 feet of cable out — Complete (hold RA cable switch to OUT).
 - (1) 2 FPS light — ON.
 - (2) Personnel — Clear.
 - e. Tension lever — RA SELECT.
 - f. RA SELECT — Select:
 - (1) STBY light — OUT.
 - (2) RA light — ON.
 - (3) Cable reels in at 2 FPS.
 - (4) When seated — SEAT and STBY LIGHT ON.
 - g. RSD safety bar — Install.
 - h. STOP — Press, and go to local control.

8.5.8 Recovery Checklist

WARNING

Toggling the RSD switch from OFF to CLOSED to OFF with the RSD beams already in the closed position may allow the beams to become unlatched, potentially resulting in aircraft roll over in heavy seas. If the beams cannot be visually confirmed latched, chock and chain the A/C, open the beams fully, (verify by OPEN light on console), select RSD CLOSED and visually verify beams to be closed with latch light.

Note

Beams can be visually confirmed latched by a latched light, witnessing the RSD flags in the up position, or noting no more than a quarter inch separation at the ends of the RSD beams.

| Recovery Checklist | Deck Status |
|---|-------------|
| 1. Communication check with HCO, bridge, and CIC — Complete. | |
| 2. FOD walkdown — Complete. | |
| 3. Deck gun mounts (if applicable) — Stowed/secured. | |
| 4. All nets — Down. | |
| 5. LSO Console Preoperational Checklist — Complete. | |
| 6. RSD — In landing position or clear of landing area. | |
| 7. RA cable switch — Hold in the OUT position while 20 to 30 feet of cable is faked in a figure 8 on the inboard side of the RSD. | |
| 8. RSD safety bar — Remove and stow. | Red |
| 9. HRS and SGSI — As required. | |
| 10. Night lighting — Permission from bridge and check as required. | |
| 11. UHF communication with HCO or CIC (EMCON permitting) — Check. | |
| 12. HELO CRASH alarm — Permission from bridge and check as required. | |
| 13. HCO transfers control to LSO when FLT QTRS set — Complete. | |
| a. Deck status lights and BIDS — Obtain from HCO and check. | Red |
| 14. RECOVERY clearance — Obtain. | |

8.5.9 Recovery Assist (RA) Procedures

Note

- An RA landing can be made with or without the RSD in the landing position. Landing without the RSD utilizes the same procedure as landing with the RSD and provides increased safety over normal clear deck landings. Use clear deck wind envelopes for limitations. The RAST control panel MASTER switch is in the ON position and the main probe is locked in the down position as part of the shipboard landing checklist. The pilot should continue down the approach line and position the aircraft slightly inboard of the RSD. The aircrewman will then lower the messenger cable. After allowing some slack to compensate for ship/helicopter movement, the LSO will signal the aircraft to stop lowering. The messenger cable is grounded and attached to the RA cable. On signal from the hookup man, the LSO shall signal the aircraft to raise the messenger. The aircrewman then raises the messenger while the pilot flying maintains a steady hover. When the MESSGR CABLE IN and H'DOWN CABLE LKD indications are present on the RAST control panel, the aircrewman will inform the pilot, who will then request hover tension. The LSO will apply hover tension and inform the pilot. The pilot will inform the LSO when he/she is ready to land. The LSO, aircrewman, or pilot not at the controls will give the pilot the necessary corrections to position the aircraft over the RSD. When the deck is steady and the aircraft is over the RSD, the LSO will give the preparatory order LAND NOW, followed by the execution order DOWN, DOWN, DOWN, while simultaneously increasing tension to maximum. Once the aircraft is on deck and the main probe is in the RSD, the LSO will close the RSD beams and inform the pilot TRAPPED.
- Until the LSO begins conning, the non-flying pilot or the aircrewman will provide the pilot with conning to maintain position for hookup and establish a good position for landing.

Once the aircraft is trapped, the RA cable shall be released prior to shutdown or free deck yo-yos. The pilot will call or signal for release and the LSO will ensure zero tension and clear the pilot to release. For EMCON this may be arranged on the hardwire/external IC. It is acceptable to use the pickle signal by day (depress thumb on clenched fist). If NIGHT/EMCON or LOST COMM, alternate red/amber deck status lights.

WARNING

The RA cable is not designed to secure the aircraft to the flight deck. For RAs and free deck landings, failure to secure the aircraft with the RSD may result in the aircraft exceeding dynamic/static rollover limits during a large ship roll and allow the main rotor blades to impact the flight deck. Both pilot and LSO shall consider current and transient flight deck conditions (sea state, wind, ship pitch, and roll) to determine the necessity for securing the RSD after each recovery.

Recovery Assist (RA) Procedures

Deck Status

WARNING

When the helicopter is using NVDs on short final, to include over the deck, the waveoff lights shall not be used due to the effects of NVD blooming. The aircrew will be temporarily blinded and lose sight of the ship.

1. LSO — Green deck for RA Recovery. Green
 - a. PORT/STBD RSD.
 - b. Altimeter.
 - c. True wind.
 - d. BRC.
 - e. Pitch.
 - f. Roll.
 - g. Relative wind.

Note

For EMCON recoveries, this information may be passed on data link and the recovery carried out using light signals.

2. Pilot — Landing Checklist — Complete.

A Degraded Control RA recovery is a technique that may be employed when the aircraft is suffering from a flying quality degradation such as a main rotor damper system malfunction. The approach and hookup are the same as for a normal RA recovery. After receiving a report of three green, the pilot will request MINIMUM TENSION vice HOVER TENSION. The LSO uses RA Select to place 850 lb of tension on the hauldown cable. The pilot will position the aircraft over the RSD and will report READY TO LAND. The LSO steadily increases tension to 4,000 lb. The pilot should refrain from fighting against the centering action of the tensioned cable and use collective to control rate of descent. Once the aircraft is safe on deck, proceed with appropriate emergency procedures. Any time that a Degraded Control RA recovery is considered, the aircrew should weigh the relative merits of a standard clear-deck or free-deck landing.

3. Pilot — On short final, flash searchlight or hover lights (night).
4. HCO — Line-up lights steady/dim (night).
5. Pilot (crossing deck edge) — LOWER THE MESSENGER.
6. Aircrewman — LOWERING.
7. LSO — STOP LOWERING. Amber

WARNING

If a STOP LOWERING command is not received from the LSO after 20 seconds, stop lowering the messenger and verify the messenger status.

8. Aircrewman — STOPPED.
9. LSO — HOOKUP MEN ON DECK.

WARNING

- One of the hookup men shall maintain eye contact with the aircraft. The other shall maintain eye contact with the LSO. If, in their opinion, the deck is unsafe or they are signaled by the LSO, they shall clear the deck immediately.
- Too much slack in the messenger cable may entangle flight deck personnel and result in serious injury.

10. LSO — PERSONNEL CLEAR, RAISE THE MESSENGER.
11. Aircrewman — RAISING.

Green

Note

If the RA cable falls away from the messenger cable, the LSO should alternate green/amber deck status lights and call the fall away. If a second attempt to hook up is possible, a steady green deck status light should be given and the procedure reverts to step 5. If the hookup is not feasible, but a safe free deck landing can be made, a steady amber deck status light should be shown and the procedures should follow step 4. of the Free Deck Landing Checklist. If an unsafe deck condition exists, a red deck should be indicated and a waveoff initiated.

12. Aircrewman — THREE GREEN.
13. Pilot — THREE GREEN, HOVER TENSION.
 - a. Flash searchlight or hover lights (EMCON).
14. LSO — STANDBY:
 - a. Check 2 FPS light ON.
 - b. Activate RA and ensure RA selected.

Recovery Assist (RA) Procedures

Deck Status


CAUTION

To prevent the slack RA cable from becoming fouled under the RSD, the LSO should ensure the aircraft remains in a hover inboard the RSD until the cable becomes taut. Should the cable become caught under a corner of the RSD, the LSO shall place the system in standby, change deck status light to red, and have the pilot release the RA cable and move aft, and have flight deck personnel clear the cable.

Note

The use of full RA tension in a high density altitude environment may result in transient N_T drooping and excessive rates of descent.

- c. Cable reels in at 2 fps to minimum tension (850 pounds).
 - d. Select 2,000 pounds.
15. LSO — HOVER TENSION.
16. Pilot (positions aircraft over RSD) — READY TO LAND.
- a. Flash searchlight or hover lights (EMCON).

Amber


CAUTION

- The aircraft will translate slightly forward as the nose is lowered for landing following tail wheel contact during an RA landing. An aft cyclic input to arrest the perceived forward movement of the aircraft will result in droop stop pounding of the blade retention assembly and high structural loads on the rotor head assembly.
 - Aircraft rolls up to 17°, in addition to the roll of the ship, can be experienced while in the RSD due to the RAST probe design.
17. LSO, PNAC, or Aircrewman — Conns aircraft into position.
- a. LSO — Select 4,000 pounds. LAND, NOW, DOWN, DOWN, DOWN (until aircraft is on deck).
 - b. Verify aircraft in the trap. For mistrap, refer to Mistrap Procedures.
 - c. If LTCH light fails to illuminate or RSD BEAM LTCH flags do not indicate proper latching of the RSD beams, refer to RSD Fails to Latch procedure.
 - d. If conducting consecutive landing practice while attached to the RA cable, refer to Consecutive Landing Practice (RA Yo-Yos or Free Deck Bounces) procedure.
 - e. If intentions are to shut down or release RA cable for the purpose of continuing flight operations:

Green

| Recovery Assist (RA) Procedures | Deck Status |
|---|-------------|
| (1) LSO — IN THE TRAP, HOOKED ON MAX TENSION. (2) RSD beams — CLOSE. (3) LTCH light — ON. (4) BRKE light — ON. (5) RSD beam flags — UP. 18. LSO — TRAPPED. | Amber |



Failure to keep the Officer of the Deck (OOD) informed of the aircraft status may result in the ship maneuvering prior to chocks and chains being installed. Ensure the OOD is aware of whether or not the aircraft is properly secured. Deck status lights alone do not provide this information.

| | |
|--|------------------------|
| 19. Chocks and chains — Install as required. | Red |
| 20. Pilot — REQUEST ZERO TENSION RELEASE. (EMCON — Flash searchlight or hover lights). | |
| 21. LSO — PREPARE RA CABLE FOR RELEASE: <ul style="list-style-type: none"> a. Minimum Tension — Select. b. Standby — Press. ENSURE ZERO TENSION. | |
| 22. LSO — CLEARED FOR ZERO TENSION RELEASE (pickle signal). | Alternate Red/Amber |
| 23. Pilot — Release RA cable by depressing RAST release button on cyclic. <ul style="list-style-type: none"> a. Aircrewman — Verify H'DOWN CABLE OUT light ON. b. PILOT — SHOW GOOD RELEASE. | |
| 24. LSO — Verify cable released: <ul style="list-style-type: none"> a. Check for 2 FPS status light illumination. b. Select RA cable in. c. Check for SEAT light — On. | |



Any time the RA cable is released with tension on the system, the machinery room shall be checked for fouled cable prior to reselecting RA.

| | |
|--|--|
| 25. LSO — Inform bridge RECOVERY COMPLETE. | |
|--|--|

8.5.9.1 Mistrap

| Mistrap | Deck Status |
|--|--------------------------|
| 1. Simultaneously the LSO: | Amber |
| a. Calls — UP, UP, UP. | |
| b. Minimum tension — Select. | |
| 2. Pilot can release RA cable or return to hover while still hooked on. | |
| a. If pilot releases: | |
| (1) LSO — ALL CLEAR. | Green |
| b. If pilot remains hooked on: | |
| (1) LSO — HOOKED ON, MINIMUM TENSION. | Alternate Amber/Green |
| 3. LSO awaits pilot request: | |
| a. If hooked on — For hover tension. | |
| b. If not hooked on — Aircraft must clear deck to fake out cable or proceed with free deck landing procedures. | |

8.5.9.2 RSD Fails To Latch

| RSD Fails to Latch | Deck Status |
|---|--------------------|
| 1. LSO — Maintain 4,000 pounds. | Red |
| 2. LSO — IN THE TRAP MAXIMUM TENSION. | |
| 3. RSD beams — CYCLE. | Green |
| 4. If unlatched indication persists, or RSD beams cannot be closed, chocks and chains shall be applied as soon as possible. | |
| 5. RSD — OFF. | |

8.5.9.3 Airborne Release

| Airborne Release | Deck Status |
|--|--------------------|
| 1. Pilot — STANDBY RELEASE, RELEASING NOW, NOW, NOW: | |
| a. Releases on third now. | |
| 2. LSO, prior to third now: | |
| a. Minimum tension — Select. | |
| b. Standby — Select. | |
| 3. LSO (aircraft clear) — ALL CLEAR. | Green |
| 4. If release was accomplished with Tension on the cable: | |
| a. RAST machinery room — Check prior to further use of any RAST machinery. | |

8.5.9.4 Free Deck Landing

| Free Deck Landing | Deck Status |
|---|-------------|
| 1. LSO — GREEN DECK FOR FREE DECK RECOVERY. | Green |
| a. PORT/STBD RSD. | |
| b. Altimeter. | |
| c. True wind. | |
| d. BRC. | |
| e. Pitch. | |
| f. Roll. | |
| g. Relative wind. | |
| 2. Pilot — Landing Checklist — Complete. | |
| Note | |
| For EMCON recoveries, this information may be passed on data link and the recovery carried out using light signals. | |
| 3. Pilot — On short final flash searchlight or hover lights (night). | |
| 4. HCO — Lineup lights steady/dim (night). | |
| 5. LSO — Aircraft over deck. | Amber |
| 6. Pilot (positions aircraft over RSD) — READY TO LAND: | |
| a. Searchlight or hover lights — Flash (EMCON). | |
| 7. LSO, PNAC, or Aircrewman — Conns aircraft into position: | |
| a. “LAND NOW, DOWN, DOWN, DOWN” (until aircraft on deck). | Green |
| 8. LSO — IN THE TRAP. | |
| a. RSD beams — CLOSE. | |
| b. LTCH light — ON. | |
| c. BRKE light — ON. | |
| d. RSD beam flags — UP. | |
| 9. LSO — TRAPPED. | Amber |
| a. For mistrap, refer to Mistrap Procedures. | |

Free Deck Landing
Deck Status

WARNING

Failure to keep the Officer of the Deck (OOD) informed of the aircraft status may result in the ship maneuvering prior to chocks and chains being installed. Ensure the OOD is aware of whether or not the aircraft is properly secured. Deck status lights alone do not provide this information.

10. Once chocked and chained — Inform bridge. Red

8.5.9.5 Consecutive Landing Practice (RA Yo-Yos or Free Deck Bounces)

Consecutive Landing Practice (RA Yo-Yos or Free Deck Bounces)
Deck Status

Note

- Clearance from the bridge to conduct yo-yos is necessary, but not for each evolution.
 - EMCON yo-yos are performed using normal EMCON procedures. Preflight briefing or the data link, if available, should be used to coordinate evolutions.
1. For RA, normal procedures are used except:
 - a. Aircraft does not need to be secured in the RSD after every landing; however, the RSD beams should be closed if any delay is anticipated.
 - b. When not secured with the RSD, maximum tension is left applied and LSO (upon landing) calls **IN THE TRAP, HOOKED ON MAXIMUM TENSION**. Amber
 - c. Pilot calls — **READY TO LIFT**, LSO ensures minimum tension selected and calls — **BEAMS OPEN, GREEN DECK, LIFT**. Green
 - d. Upon takeoff, LSO calls **ALL CLEAR. HOOKED ON, MINIMUM TENSION**.
 2. For free deck, normal procedures are used. The aircraft does not need to be secured in the RSD after every landing; however, the RSD beams should be closed if any delay is anticipated.

8.5.9.6 Post Recovery

Post Recovery
Deck Status

1. LSO — Disengagement clearance — Obtain (EMCON — Aircraft position lights flashing).
2. LSO — Before clearing aircraft to disengage, ensure:
 - a. LSE — On deck.
 - b. Relative wind — Within limits. Amber
3. LSO — Disengagement complete — Notify bridge. Red

8.5.9.7 Straightening Checklist



- The aircraft shall not be straightened with the blades or pylon folded.
- Aircraft should not be refueled until straightening sequence is completed to reduce loads on the tail landing gear.
- Strong winds and high sea states may exceed tail guide winch cable authority.
- The aircraft is not to be straightened with the external power cable attached.
- If the aircraft is to be traversed with the external power cable attached, the FDD shall assign a person to tend the power cable and keep it clear of the aircraft path to prevent damage to the cable.

Note

If RAST probe slippage occurs during straightening and line-up line mark does not line up with track slot, consideration should be given to restarting the straightening procedures.

1. LSO Console Preoperational Checklist — Complete.
2. FDD communication check — Complete.
3. Safety bar (if installed) — Remove.
4. RSD beams — OPEN.
5. Main probe to deck clearance and main probe position in RSD — Check.

Note

To ensure receipt of latched light indication and proper alignment of helicopter during straightening evolutions, main probe should be centered (as indicated by yellow RSD line-up) in RSD.

If probe needs to be raised or centered in RSD:

- a. RSD beams — OPEN
- b. Main probe — RAISE, if necessary.
- c. Traverse — SELECT, if necessary.
- d. Traverse lever — Desired direction to center main probe in RSD, if necessary.



Under certain conditions, the aircraft main probe may contact the deck, resulting in a small amount of main probe compression. The amount of compression, if observed in the upper barrel, shall be subtracted from the 1 inch allowable on the upper barrel.

Note

If main probe to deck clearance is inadequate, the main probe can be beeped up a maximum of 1 inch as measured from the bottom of the aircraft to a point 1 inch down on the upper barrel of the main probe.

6. RSD Chock — INSTALL (if available).
7. RSD beams CLOSED — Check LTCH and BRKE lights.
 - a. RSD beam flags — UP.
 - b. LTCH light — ON.
 - c. BRKE light — ON.

WARNING

Toggling the RSD switch from OFF to CLOSED to OFF with the RSD beams already in the closed position may allow the beams to become unlatched, potentially resulting in aircraft roll over in heavy seas. If the beams cannot be visually confirmed latched, chock and chain the A/C, open the beams fully, (verify by OPEN light on console), select RSD CLOSED and visually verify beams to be closed with latch light.

Note

Beams can be visually confirmed latched by a latched light, witnessing the RSD flags in the up position, or noting no more than a quarter inch separation at the ends of the RSD beams.

8. All nets — Down.
9. Brakerider — In aircraft.
10. Flight deck — Clear.
11. Proper RSD — PORT/STBD.
12. Straighten clearance — Obtain.

WARNING

Should the ship maneuver, cease all aircraft movements, call for aircraft brakes and chains as necessary, to prevent injury to personnel and/or helicopter damage. Contact the pilot house to resolve the situation.

13. **TGW** — UNLOAD.
 - a. TGW cables — Install.
14. Tail probe — Verify up.
15. TGW cables — Clear.
16. TGW — AUTO.
17. Center probe in RSD — As required.

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18. Tail wheel — Manually unlock.
19. Safety bar (if installed) — Remove.
20. SEAT light — ON.
21. Chocks/chains — Remove.
22. Aircraft brakes — Off.
23. If main probe is forward of bellmouth:
 - a. RSD beam brakes — Release position and hold.



Failure to hold the RSD beam brake switch in the release position in accordance with the Straightening Checklist will result in excessive side loading of the aircraft.

- b. Traverse main probe aft of bellmouth — Complete.



The FDD shall remain in sight of the LSO at all times when traversing the aircraft.

24. Straightening procedures — Complete.
 - a. See **Figure 8-2** if aircraft main landing gear is on, or starboard of, alignment line.
 - b. See **Figure 8-3** if aircraft main landing gear is port of alignment line.



Ensure all flight deck personnel are clear of TGW cables to prevent injury, especially in the event of cable failure.



Failure to ensure all slack is removed from the tail guide winch cables prior to any twisting evolution may cause damage to the fuel dump tube.

| STEP | RSD BRAKE SWITCH | TRAVERSE LEVER | TGW HANDLE | RESULT |
|--|---------------------------|----------------|---------------|--|
| 1. | RELEASE position and hold | Fwd (Note) | Twist to Port | Move main probe to port limit (PORT light ON). |
| 2. | ON | Aft | — | Move port aircraft alignment mark over track slot. |
| 3. | AUTO position and hold | Fwd (Note) | Twist to STBD | Center RSD beams (CTR light ON). |
| <div style="border: 2px dashed black; padding: 5px; display: inline-block;">CAUTION</div> | | | | |
| During step 3., failure to limit forward movement to six inches could result in tail guide wire hooks penetrating the aircraft skin. | | | | |
| 4. | ON | Fwd | — | Move tail probe over track slot. |
| 5. | — | — | — | Aircraft brakes — ON. |
| 6. | — | — | — | Install chocks/chains. |
| 7. | — | — | — | Lower tail probe full down. |
| 8. | — | — | — | Remove chocks/chains. |
| 9. | — | — | — | Aircraft brakes — OFF. |
| 10. | — | — | — | Complete Post Straightening checklist. |
| Note Traversing provides for tail wheel caster. Limit to six inches. | | | | |

Figure 8-2. Straightening Procedures, Aircraft Main Landing Gear on Alignment Line or Starboard of Line


| STEP | RSD BRAKE SWITCH | TRAVERSE LEVER | TGW HANDLE | RESULT |
|---|---------------------------|----------------|---------------|---|
| 1. | RELEASE position and hold | Fwd (Note) | Twist to STBD | Move main probe to STBD limit (STBD light ON). |
| 2. | ON | Aft | — | Move starboard aircraft alignment mark over track slot. |
| 3. | AUTO position and hold | Fwd (Note) | Twist to PORT | Center RSD beams (CTR light ON). |
|  <p>CAUTION</p> <p>During step 3., failure to limit forward movement to six inches could result in tail guide wire hooks penetrating the aircraft skin.</p> | | | | |
| 4. | ON | Fwd | — | Move tail probe over track slot. |
| 5. | — | — | — | Aircraft brakes — ON. |
| 6. | — | — | — | Install chocks/chains. |
| 7. | — | — | — | Lower tail probe full down. |
| 8. | — | — | — | Remove chocks/chains. |
| 9. | — | — | — | Aircraft brakes — OFF. |
| 10. | — | — | — | Complete Post Straightening checklist. |
| <p>Note</p> <p>Traversing provides for tail wheel caster. Limit to six inches.</p> | | | | |

Figure 8-3. Straightening Procedures, Aircraft Main Landing Gear Port of Alignment Line

8.5.9.8 Post Straightening Checklist

1. Tail wheel — LOCK.
2. START/STANDBY — STBY.
3. Aircraft brakes — ON.
4. Chocks/chains — As required.



Using only the main RAST probe to secure the aircraft in high sea states may result in damage to the probe.

5. RSD safety bar — Install.
6. TGW — UNLOAD.
7. TGW cables — Remove.
8. TGW — AUTO for stow, then UNLOAD after complete.
9. STOP button — Press to obtain PRESS light.
10. Notify bridge — Straightening complete.
11. Fold blades/pylon — As required.

WARNING

Ensure external power is applied or battery switch is on prior to folding the tail pylon to ensure the tail index actuator engages immediately after starting pylon fold sequence. Uncontrolled tail rotor windmilling may result if tail index actuator is not engaged.

- a. Fold clearance — Obtain.
- b. Fold cycle — Complete.

CAUTION

Unsecured folded main rotor blades can flap enough in high winds or high sea states to strike the upper UHF antenna. To prevent damage to the rotor blades and antenna, blade crutches shall be applied when the blades are folded and the ambient conditions are conducive to blade flapping.

12. Notify bridge — Fold complete.

8.6 EMITTER HAZARDS

An electromagnetic interference (EMI) hazard exists to all SH-60B aircraft operating in the vicinity of CG-47 or DDG-51 class ships.

CAUTION

Due to the adverse effects of EMI on aircraft operating in the vicinity of SPY-1 radar, SH-60B aircraft should not close within 2 nm of CG-47 or DDG-51 class ships unless SPY-1 is operating at low power, the controller has broken data link, and the helicopter track has been dropped. Prior to takeoff on these class of ships, aircraft commanders should ensure that Hawk Link is in standby (following removal of the hardwire) and not placed to radiate until the aircraft is 2 nm clear of own ship.

Lot 1 SH-60B aircraft, BuNo 161553 to 161570, not incorporating ECP-3013R5 (AFC-24) shall not approach or remain within the minimum standoff distances of radiating shipboard and/or shore-based emitters as shown in [Figure 8-4](#). Lot 1 aircraft carrying torpedoes shall remain outside the standoff distances when operating with ships, whether emitters are radiating or not. If the aircraft is on the deck, emission restrictions apply only if maintenance or preflight actions are being performed.

WARNING

Failure to maintain standoff distances may cause degradation to flight controls and/or inadvertent actuation of electroexplosive devices.

Note

Transponder MODE IV AUDIO/LIGHT/OUT control may induce static feedback in ATO and pilot headsets when set to AUDIO in an EMI environment.

| EMITTER | STANDOFF | EMITTER | STANDOFF | EMITTER | STANDOFF |
|------------|-----------------------|------------|----------|----------|----------|
| HF COMM | 55 FT (100 FT FOR CV) | STIR | 1500 FT | MK 29 | 1500 FT |
| MK 91 | 1500 FT | MK 92 | 1500 FT | CCA | 2800 FT |
| EX 3 CWCS | 2800 FT | FPN 63 | 2800 FT | MK X11 | 2800 FT |
| MD 15 CLWS | 2800 FT | MK 24 | 2800 FT | MK 37 | 2800 FT |
| MK 38 | 2800 FT | MK 86 | 2800 FT | SPG 51 | 2800 FT |
| SPG 60 | 2800 FT | SLQ 32 | 2800 FT | SPN 35 | 2800 FT |
| SPN 41 ILS | 2800 FT | SPN 41 T-4 | 2800 FT | SPN 42 | 2800 FT |
| SPN 43 | 2800 FT | SPN 44 | 2800 FT | SPQ 9 | 2800 FT |
| SPS 40 | 2800 FT | SPS 48 | 2800 FT | SPS 49 | 2800 FT |
| SPS 65 | 2800 FT | SPS 67 | 2800 FT | SPY 1A/B | 2 NM |

Figure 8-4. Emitter Standoff Distances (Lot 1 Aircraft)

8.7 HELICOPTER IN-FLIGHT REFUELING

8.7.1 General

Helicopter In-Flight Refueling (HIFR) is intended to extend the aircraft on-station time. It should be initiated with sufficient fuel remaining to BINGO to a suitable landing site if unsuccessful. Night HIFR operations are extremely demanding, and are only permitted for operational necessity.



The PIC shall ensure that the Landing Checklist is completed prior to commencing an approach, HIFR, transfer, etc., to any aviation/air-capable ship.

8.7.2 HIFR Systems

All HIFR-capable ships are equipped with one of two different rigs for helicopter inflight refueling.

8.7.2.1 Wiggins/North Island HIFR Rig

The Wiggins/North Island (NI) rig (Figure 8-5) is composed of a ship’s hose (>100 feet in length) and a HIFR assembly (10-foot section of a 1.5-inch hose outfitted with a saddle for hoisting). Both ends of the HIFR assembly are equipped with female closed-circuit refueling (CCR) fittings (also referred to as Wiggins fittings). One Wiggins fitting is connected to the ship’s hose and the other Wiggins fitting is connected to the male Wiggins fitting in the helicopter. A manual emergency disconnect lanyard (emergency release T-handle) is located near the Wiggins fitting, which connects to the male Wiggins fitting in the helicopter.

8.7.2.2 NATO-Compatible High Capacity HIFR Rig

The NATO-Compatible High Capacity (NHC) rig (Figure 8-6) features a 2-inch lightweight hose, unisex couplings, automatic emergency breakaway, and facilitates the use of either a Wiggins nozzle or a Parker nozzle for HIFR operations. The NHC rig is composed of two major assemblies: the 100-foot HIFR hose and the 10-foot HIFR assembly.

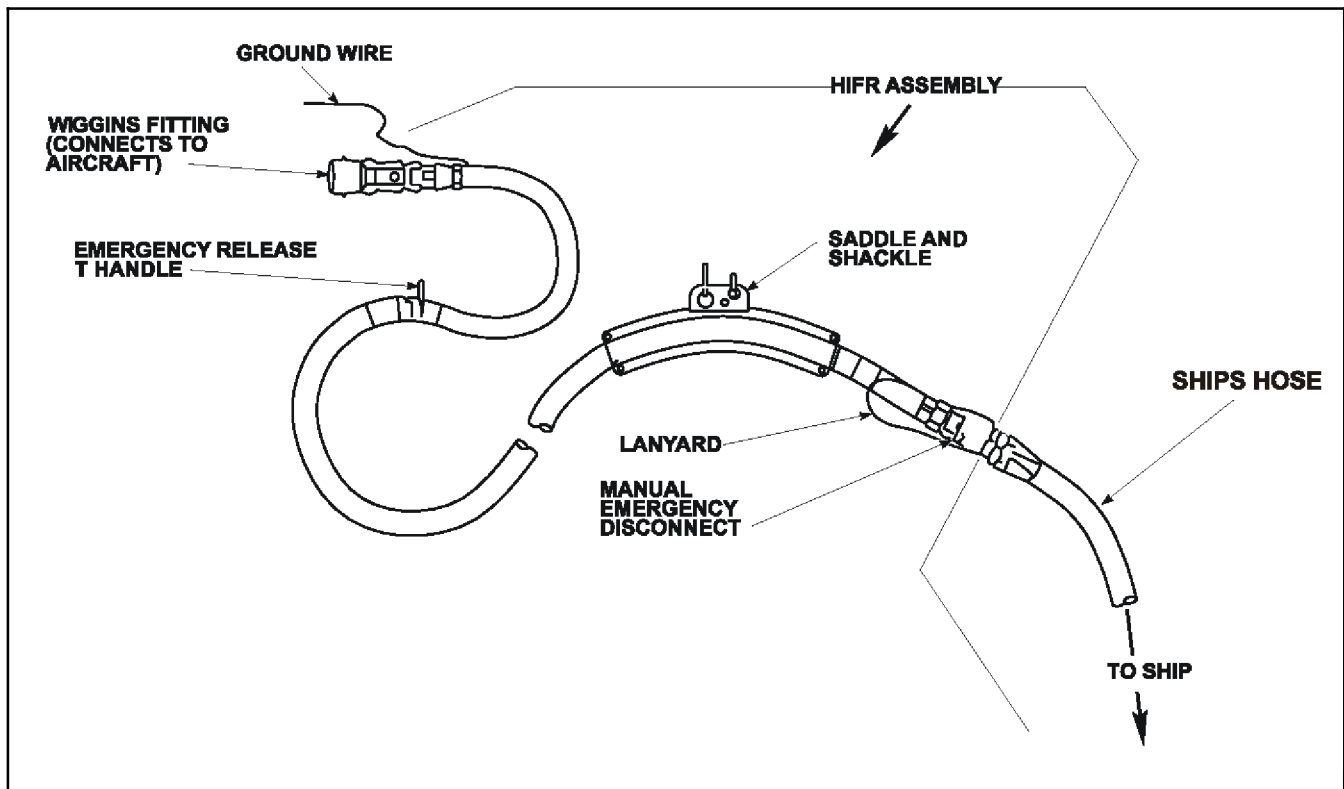


Figure 8-5. Wiggins/North Island (NI) HIFR Rig

The NHC nozzle has a built-in 45-psi pressure regulator and an on/off flow control handle. Emergency breakaway is initiated when 450 +/-50 lbs of straight tensile pull is exerted on the automatic breakaway coupling.

WARNING

When using an NHC assembly, the hose shall be secured to the deck of the ship to ensure proper functionality of the break away system.

Note

- Emergency breakaway occurs automatically as the helicopter moves away from the ship. No action by the aircrew is necessary.
- Most US helicopters are configured with a Wiggins-type connection for HIFR refueling, while all other NATO countries with HIFR capability use a Parker connection. If a US helicopter performs a HIFR with the NATO ship, it will be given a Parker nozzle. An adapter to convert the nozzle to a Wiggins type connection will be required.

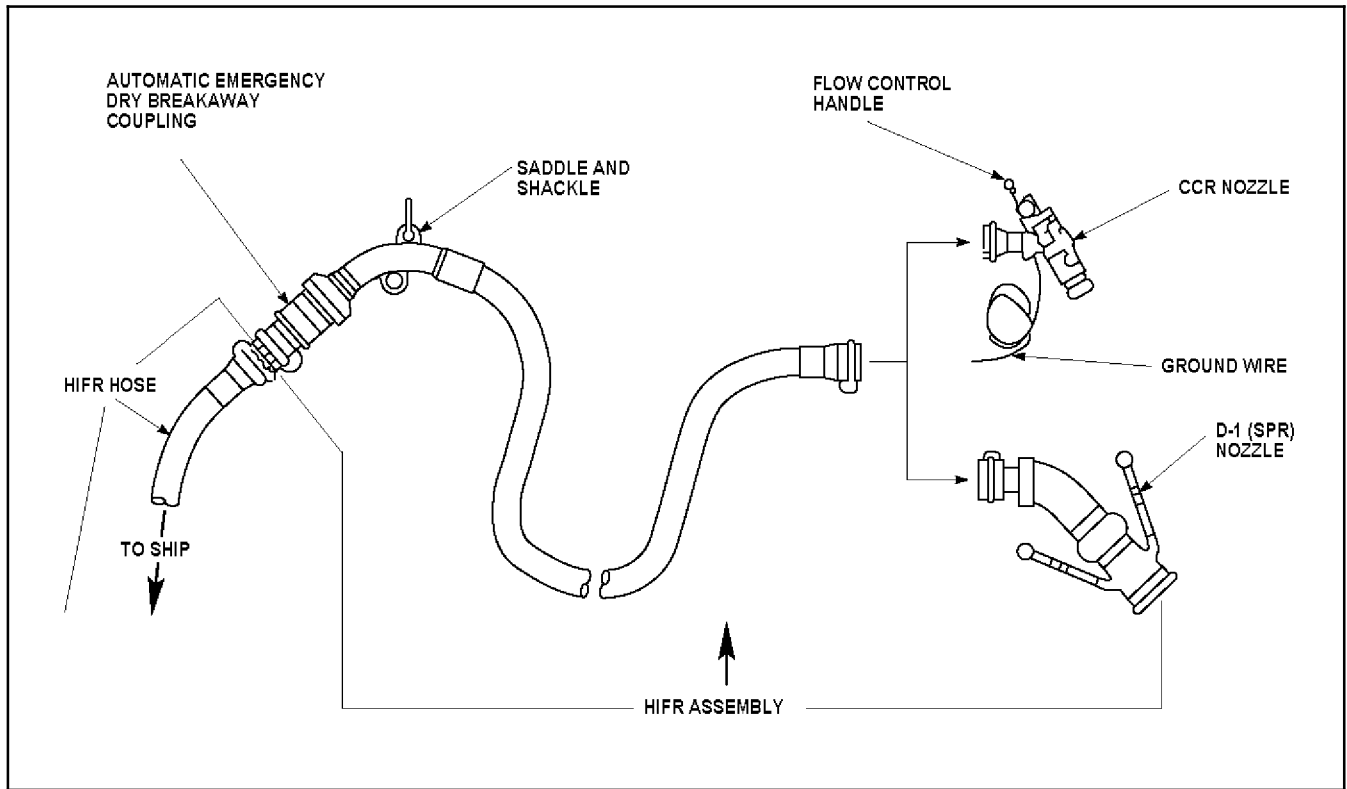


Figure 8-6. NATO High Capacity (NHC) HIFR Rig

8.7.3 Normal Operations

The ship's course and speed should be adjusted to provide relative winds from 10 to 30 knots, 300° to 360°, and minimum pitch and roll. Higher winds may be desired in high DA/gross weight/OAT conditions. The helicopter will make an approach hovering into the relative wind over the HIFR H deck marking. The fueling hose will be attached and hoisted aboard under the direction of the helicopter crewman. When the refueling hose is hoisted, the helicopter will then slide to port. The crewman shall attach the grounding wire to the airframe and the nozzle to the refueling receptacle. The helicopter will then move to a slightly lower altitude and the crewman will signal to commence pumping fuel.



A low hover while wind is less than 10 knots may cause excessive salt spray, which can decrease engine performance and reduce pilot field of view.

When refueling is complete, the crewman will signal for the pumping to stop and disconnect the hose. The helicopter will then be repositioned over the deck and the hose will be lowered.

8.7.3.1 HIFR Procedure

CAUTION

- Ensure HIFR assembly is grounded to aircraft before connecting hose to refueling fitting.
 - The Wiggins/NI HIFR assembly can be installed backwards. The aircrewman must ensure the emergency release T-handle is located near the Wiggins fitting that attaches to the aircraft fitting. Opposite connection is possible and will force the helicopter to shear the hoist to affect an emergency breakaway.
1. Landing checklist — Complete.
 2. Rescue Hoist Preoperational check — As required.
 3. Lower the hoist and obtain fuel sample taken from nozzle of HIFR rig. Confirm fuel is acceptable.
 4. Lower hoist cable for pickup of refueling rig.

WARNING

- Both the NHC and NI HIFR hoses shall be hoisted to the helicopter unpressurized, but full of fuel. Air in the HIFR hose will create an electrical charge on the helicopter internal fuel filter elements and may damage equipment. An NHC hose not filled with fuel poses a hazard to flight deck crew and the helicopter.
 - When using an NHC assembly, the hose shall be secured to the deck of the ship to ensure proper functionality of the break away system.
5. Raise attached refueling rig to full seated position.

WARNING

- Should waveoff be required before HIFR rig is connected, the hoist cable should be cut immediately.
 - The HIFR saddle must be raised as near as possible to the hoist seat position to permit proper and safe operation of the emergency breakaway on either rig.
6. Check the emergency breakaway handle for correct attachment (if applicable).
 7. Connect the grounding wire.
 8. Connect Wiggins nozzle (NHC rig) or the Wiggins fitting (NI rig) to the receptacle in the helicopter.
 9. Signal ship to start pumping.
 10. Depress locking tab on the NHC rig's SPR nozzle and slowly move the flow control handle to ON (forward) position.

Note

The Wiggins fitting (nozzle) on the NI rig does not have a flow control handle.

11. Once the hose is pressurized, direct pilot to conduct precheck.



- Flow of fuel when precheck valve is in precheck position indicates a shutoff system malfunction. If neither precheck switch will secure the fuel flow, fueling should be continued only if necessary. If fueling is required, proceed with caution in order to prevent rupture of the main fuel cell. One pilot shall monitor fuel quantity on the flight or mission displays.
- During HIFR if right cell fills faster than the left cell, monitor the fuel quantity gauges closely. If the difference in cell quantities persists, stop refueling before the right cell is full (approximately 1,700 pounds) to prevent rupture of the fuel cell.

Note

- Low fuel flow may be the result of low pressure from the ship's pump, aircraft altitude, or contamination in the HIFR filter canister.
- The crewman has the ability to stop fueling with the flow control handle on the NHC rig. Additionally, the SPR nozzle will automatically stop flow and the red pin behind the flow control handle will extend if pressure has exceeded 45 psi and/or the tanks are full.
- If fuel pumping rate appears to be negligible or too slow, a decrease in helicopter altitude will increase pumping rate.

12. Signal ship to stop pumping.
13. Move NHC SPR nozzle flow control handle to CLOSED (aft) position.
14. Disconnect NHC Wiggins nozzle or NI Wiggins nozzle/fitting from aircraft fuel fitting.
15. Remove grounding wire.
16. Reposition helicopter over flight deck. Lower rig once over deck.
17. Raise hoist after confirming HIFR assembly is disconnected and report, "CLEAR FOR FORWARD FLIGHT."

Note

- The HIFR fuses in the go/no-go canister should be capable of handling approximately 10,000 pounds of fuel. The actual capacity of the fuses depends on the quality of the fuel received. If a pressure differential occurs across the fuses, fuel will not be taken and the fuse must be replaced. The HIFR filter should be replaced after each flight involving in-flight refueling.
- The Go/No-Go canister is sensitive to both water and particulate contamination.

8.7.4 Communications

Signals to start and stop pumping shall be exchanged between the helicopter crewman and the LSE, with the radios as the backup means of communication. In addition to normal hover positioning reports, standard HIFR terminology and visual signals shall be used (Figure 8-7). The visual signals will be the same at night, except a red-lens flashlight shall be used.

| FROM | TO | WHEN | REPORT/VISUAL SIGNAL | RESPONSE |
|----------------|----------------|--|--|-------------------------|
| Hoist Operator | Pilot | HOIST IS GOING DOWN | HOIST GOING DOWN | |
| Hoist Operator | Pilot | HOIST IS ON THE DECK | HOIST IS ON DECK | |
| Hoist Operator | Pilot | HOSE CONNECTED TO HOIST | HOSE COMING UP | |
| Hoist Operator | Pilot | HOSE IS IN THE CABIN, CLEAR TO SLIDE LEFT | HOSE IS IN THE CABIN, CLEAR TO SLIDE LEFT | ROGER, SLIDING LEFT |
| Hoist Operator | Pilot | HOSE CONNECTED AND READY TO RECEIVE FUEL | HOSE CONNECTED | ROGER, COMMENCE PUMPING |
| Hoist Operator | Ship | DIRECT TO COMMENCE PUMPING | HOIST OPERATOR MAKES CIRCULAR MOTION WITH HAND | |
| Hoist Operator | Pilot | HOSE IS PRESSURIZED | READY FOR PRECHECK | |
| PAC | Hoist Operator | DESIRED QUANTITY OF FUEL HAS BEEN RECEIVED | STOP PUMPING | ROGER, STOP PUMPING |
| Hoist Operator | Ship | STOP FUELING | HOIST OPERATOR MAKES CUTTING MOTION ACROSS THROAT | |
| Hoist Operator | Pilot | FUELING HAS STOPPED, HOSE DISCONNECTED, CLEAR TO SLIDE RIGHT | FUELING STOPPED, HOSE DISCONNECTED, CLEAR TO SLIDE RIGHT | ROGER, SLIDING RIGHT |
| Hoist Operator | Pilot | READY TO LOWER HOSE | HOSE GOING DOWN | |
| Hoist Operator | Pilot | HOSE ON DECK | HOSE IS ON THE DECK | |
| Hoist Operator | Pilot | HOSE DISCONNECTED FROM HOIST AND HOIST IS BEING RAISED | HOIST CLEAR | |
| Hoist Operator | Pilot | SECURED AFT | CLEARED FOR FORWARD FLIGHT | |

WARNING

Anyone may give the command "BREAKAWAY". The crewman shall immediately pull the emergency disconnect lanyard (if installed) and report "HOSE CLEAR".

Figure 8-7. HIFR Communications

8.7.5 HIFR Emergency Procedures

When an emergency condition is observed or when the command BREAKAWAY is received, the following emergency breakaway procedures should be followed (depending on the type of HIFR rig used):

Note

If emergency breakaway is necessary with either rig attached, the HIFR assembly, which includes the saddle and 10-foot section of hose, will remain attached to the helicopter.

1. NI HIFR rig. The crewman shall pull the emergency release T-handle. Allow the released HIFR hose to fall back to the ship. The PAC then flies away from the ship.
2. NHC HIFR rig. This rig incorporates an automatic emergency breakaway. Crewman action is not necessary to disconnect system. Once the NHC rig has been attached, the PAC can effect an emergency breakaway at any time by flying away from the ship.

WARNING

- All slack hose between aircraft and deck tiedown point near HIFR “H” will be pulled taut upon flyaway. Injury may result if deck crew becomes tangled in the HIFR hose.
- If either rig fails to disconnect when an emergency breakaway is attempted, it will be necessary for the crewman to quickly disengage the nozzle and grounding wire from the aircraft and cut the hoist cable.
- If the hoist cable is cut with either HIFR rig connected to the aircraft fitting, the possibility exists that the HIFR rig or aircraft fitting could rupture, causing pressurized fuel to leak into the cabin.

8.7.6 Night HIFR Procedures

WARNING

Due to the hazards associated with night operations and the increased potential for mishap, night HIFR operations shall not be conducted except for reasons of operational necessity.

Night HIFR employs the same procedures as day HIFR. Use all available navigation and reference aids (TACAN, ADF, SGSI, etc.) to execute an approach to arrive in a hover positioned into the relative wind over the HIFR H deck marking. When stabilized in a hover, conduct normal HIFR operations.

Note

- A chemical light should be connected to the hoist during night operations to provide visual reference to the hook position at all times.
- On final approach to the ship, the lower anticollision light and search/landing lights should be OFF and the position lights set to DIM to prevent temporarily blinding or disorienting the flight deck crew, LSE, or HCO.

Upon completion of the refueling evolution, make a turn to the left. After receiving a CLEAR FOR FORWARD FLIGHT report from the crewman, slide clear of the ship to port. Use standard departure procedures to climb to desired altitude.

CHAPTER 9

Special Procedures

9.1 INTRODUCTION

9.1.1 Definitions

The following definitions and general descriptions apply to [Chapter 9](#), Special Procedures. For detailed discussion of aircrew responsibilities, see [Chapter 19](#), Crew Resource Management.

9.2 SEARCH AND RESCUE (SAR)

The H-60 is capable of a wide variety of Search and Rescue (SAR) missions. Since each SAR mission presents a different set of circumstances, specific procedures cannot be given to cover all situations. The PIC must assess each situation and evaluate parameters such as weather, turbulence, sea state, terrain, condition of the survivor, and aircraft performance capabilities. Often there is no communication with the survivor or ground rescue party to assist in evaluating the situation. In the face of extreme pressure to complete a difficult rescue, the PIC must exercise caution and utilize sound judgment to avoid placing the aircraft and crew in an unnecessarily dangerous position.

Good lookout doctrine is mandatory for successful SAR operations. Because the pilots' primary concern is flight safety, most of the responsibility lies with the aircrewmembers. The crewmembers should be assigned specific lookout stations; one at each side of the aircraft.

9.2.1 SAR Equipment

A complete SAR kit must be readily available. It should be recognized that, because of the limitations imposed by space available and maximum gross weight, a SAR kit must be tailored to the environment in which the crew anticipates SAR operations. Helicopters designated as primary SAR vehicles shall carry the equipment required in NTTP 3-50.1. For specific information regarding SAR equipment refer to NTTP 3-50.1.

9.2.2 Safety Precautions

ICS directing procedures are contained in [Figure 9-1](#). Always try to keep the cockpit informed of the pickup's position and any possible danger to the helicopter, using standard terminology and any other words that are concise and clearly understandable.

9.2.3 Rescue Precautions

WARNING

- Helicopters create static electricity which must be discharged by grounding the hoist on the surface prior to commencing a pickup. The surface in the immediate vicinity of a crash site may be covered with fuel. Avoid discharging static charge or deploying smoke markers in that zone.
- With starboard 120 gallon external fuel tank installed, hoist devices, including rescue swimmer/survivor and MEDEVAC litter, may contact the forward part of the fuel tank potentially causing equipment damage and personnel injury.
- If a parachute remains in the area of the survivor, maintain a minimum of 1 rotor diameter separation between parachute canopy and rotor downwash.

WARNING

- The rescue hoist cable must be kept clear of all parts of the aircraft and free from other external obstacles when operating the hoist. Cable abrasion during hoist operations can lead to cable failure. If cable contact or snagging occurs, suspend hoist operations and inspect the cable for damage in accordance with applicable procedures.
- Swimmer shall not be required to enter the water to affect the recovery of inanimate objects.
- There shall be a hoist operator in the cabin if a swimmer is deployed.
- Personnel hoist shall not be attempted with a damaged hoist cable.
- The hoist operator shall wear a heavy-duty glove during all rescue hoist operations.
- Any time the cabin door is open during flight, all occupants of the cabin shall wear crewman's safety harness or remain strapped in a seat. The crewman's safety harness must be thoroughly checked for secure attachment to the airframe.
- The Mk 25 shall not be launched while in hover because of valve plug possibly striking aircraft or personnel.
- The red phosphorus composition in the Mk 25/Mk 58 procedures smoke, which is highly caustic to the moist tissues of the nose and throat. Do not breathe this smoke.
- Removal of the marker pull ring from the Mk 58 exposes the battery cavity. Entrance of seawater in this cavity will immediately activate the marker. This ring shall not be removed until launching is to be accomplished.
- After the tear strip is removed from the Mk 58, use care to avoid cutting hands on the sharp edges of the can.
- Aircraft should not fly at low altitude over a burning Mk 58 marker. Ignition of the second candle can be forceful, with flame occasionally ejecting up to 50 feet.

Note

- During the pickup phase of a rescue, the PAC shall keep the survivor on the right side of the aircraft to allow the crewman to complete the pickup.
- Search and hover altitudes should be determined by existing conditions. Recommended altitude for hovering is 70 ft. Prolonged low overwater hover with little or no head-wind shall be avoided due to engine salt ingestion.
- If a lost ICS situation occurs during a SAR evolution, the COPILOT shall be notified via the cabin tunnel. All advisory hand signals shall be given via tunnel to the COPILOT/LEFT Seat Pilot.

9.2.3.1 Swimmer Deployment and Survivor Assistance

The swimmer shall enter the water and assist the survivor on all rescues except when the PIC determines that circumstances will unnecessarily expose the swimmer to danger. Conditions existing at the scene of the rescue (water temperature, sea state, condition of the survivor, proximity of other units, etc.) will dictate procedures to be followed.

Note

In sea states of three or above, it is recommended that the swimmer deploy on the hoist.

| DESIRED PILOT CONTROL INPUT OR INFORMATION TO PILOT | ICS TERMINOLOGY | LOST ICS* |
|--|--------------------------|---|
| 1. Slow rate of movement precedes basic command. | EASY | NONE REQUIRED |
| 2. Direction of movement — STRAIGHT AHEAD. | FORWARD | ELBOW BENT 90 DEG FINGERS EXTENDED POINTING UP |
| 3. Direction of movement — STRAIGHT BACK. | BACK | ELBOW BENT 90 DEG FINGERS EXTENDED POINTING DOWN |
| 4. Direction of movement — RIGHT. | RIGHT | ELBOW BENT 90 DEG, FINGERS EXTENDED UP AND PERFORM WAVING MOTION |
| 5. Direction of movement — LEFT. | LEFT | LEFT ARM EXTENDED, FINGERS EXTENDED |
| 6. Increase helicopter altitude. | UP | PALM UP MOTIONING UP |
| 7. Decrease helicopter altitude. | DOWN | PALM DOWN MOTIONING DOWN |
| 8. Maintain steady hover. | STEADY | CLINCHED FIST |
| 9. Hoist cable direction. | HOIST COMING UP/ DOWN | THUMB UP/ DOWN |
| 10. Lost ICS communications (NOTIFY PILOT/COPILOT) VIA TUNNEL. | NONE | POINT TO MOUTH/ EAR THUMB DOWN |
| 11. I desire crew hover. | REQUEST CREW HOVER | TAP HELMET, POINT AFT |
| 12. Secure crew hover. | S/S CLEAR OF WATER | TAP HELMET, POINT FORWARD |
| 13. READY FOR FORWARD FLIGHT. | S/S ABOARD/ SECURE | CIRCULAR MOTION, POINT FORWARD |
| Note | | |
| If a lost ICS situation occurs during a SAR evolution, the COPILOT shall be notified via the cabin tunnel. All advisory hand signals shall be given via tunnel to the COPILOT/LEFT Seat Pilot. | | |

Figure 9-1. SAR ICS Terminology

| MANUAL APPROACH AND/OR DAY/VMC PROCEDURES | | |
|---|---|--|
| STATION | ACTION | ICS CALL |
| 1. PAC | Signify intention to commence a manual approach to a hover. | AUTOMATIC APPROACH CHECK-LIST, CREW RIG FOR RESCUE |
| 2. HOIST OPERATOR | Together with swimmer, prepare for rescue. | UNSTRAPPING |
| 3. PNAC | Complete Automatic Approach checklist. | CHECKLIST COMPLETE |
| 4. HOIST OPERATOR | Complete rescue station preparation, strap into gunners belt, ensure swimmer is also strapped in. | RESCUE STATION MANNED AND READY |
| 5. ANY CREWMAN | Locate survivor. | SURVIVOR IN SIGHT ___ O'CLOCK, ___ YARDS |
| 6. ANY CREWMAN | Direct PAC to survivor using SAR ICS terminology. | (FIGURE 9-1) |
| 7. PAC | Commence manual approach once survivor is in sight. | SURVIVOR IN SIGHT COMMENCING MANUAL APPROACH |
| 8. PNAC | Report altitude and groundspeed throughout the approach. | ___ FEET, ___ KTS |
| 9. PAC | Continue approach to survivor, wings level on final. At 30 ft AGL, report: | STANDBY TO DEPLOY SWIMMER |
| <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">WARNING</div> <p>Hoist operator shall maintain grasp of swimmer's rescue harness with one hand and signal swimmer to remove gunners belt with other hand.</p> | | |
| 10. HOIST OPERATOR | Tap swimmer once on chest. | |
| 11. SWIMMER | Disconnect gunners belt. | |
| 12. HOIST OPERATOR | Observe swimmer is disconnected. | SWIMMER READY |
| 13. PAC | Confirm a 15-foot/0 KGS hover or 10-foot /10 KGS creep. If confirmed, order swimmer deployment. | JUMP, JUMP, JUMP |
| <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">WARNING</div> <p>It is extremely difficult to accurately judge height above water; therefore, the swimmer shall not jump into the water until the PAC positively gives the JUMP command to the hoist operator.</p> | | |
| 14. HOIST OPERATOR | Check area clear of debris, tap swimmer on shoulder three times, and release hold on swimmer. | |
| 15. SWIMMER | After third tap, jump when clear. | |

Figure 9-2. Day/VMC SAR Procedures (Manual Approach) (Sheet 1 of 3)

| MANUAL APPROACH AND/OR DAY/VMC PROCEDURES (cont.) | | |
|---|---|------------------------------------|
| STATION | ACTION | ICS CALL |
| <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 10px;">WARNING</div> <p>To assure safe swimmer deployment, the pilot shall remain at jump altitude until hoist operator reports swimmer away.</p> | | |
| 16. HOIST OPERATOR | Observe swimmer deployment and water entry. | SWIMMER AWAY |
| 17. PAC | Fly the helicopter to the desired hoisting altitude. | ENGAGE HOVER MODE |
| 18. PNAC | Press APPR/HVR pushbutton, observe HVR light. | ENGAGED |
| 19. SWIMMER | Signal condition to hoist operator. | |
| 20. HOIST OPERATOR | Observe swimmer signal and report condition. | SWIMMER OKAY or SWIMMER IN TROUBLE |
| 21. HOIST OPERATOR | Direct PAC left and aft to maintain visual contact with the survivor and swimmer using SAR ICS terminology. | (FIGURE 9-1) |
| <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 10px;">WARNING</div> <p>Do not lose sight of the survivor. Keep pilot informed of swimmer's progress, cable position, debris, etc.</p> | | |
| 22. PNAC | Conduct hover checks. | HOVER CHECKS COMPLETE |
| 23. If crew hover is used: | | |
| a. HOIST OPERATOR | Direct PAC to maintain a steady hover. | STANDING BY FOR CREW HOVER |
| b. PAC | maintain steady hover. | ENGAGE CREW HOVER |
| c. PNAC | Press CREW HVR pushbutton, and observe CREW HVR light. | ENGAGED |
| d. HOIST OPERATOR | Observe HOVER TRIM light illuminated on the HOVER TRIM CONTROL panel. | I HAVE A LIGHT |
| e. PAC | Monitor flight controls. | YOU HAVE CONTROL |
| f. HOIST OPERATOR | Assume control of aircraft and position helicopter over swimmer/survivor. | I HAVE CONTROL (FIGURE 9-1) |
| 24. If crew hover is not used: | | |
| a. PAC | Verbally pass directional control. | YOU HAVE VERBAL CONTROL |
| b. HOIST OPERATOR | Accept verbal control. | I HAVE VERBAL CONTROL |
| c. HOIST OPERATOR | Verbally position helicopter over swimmer/survivor. | (FIGURE 9-1) |
| 25. HOIST OPERATOR | Lower and ground hoist. | HOIST GOING DOWN |

Figure 9-2. Day/VMC SAR Procedures (Manual Approach) (Sheet 2)

| MANUAL APPROACH AND/OR DAY/VMC PROCEDURES (cont.) | | |
|--|---|---|
| STATION | ACTION | ICS CALL |
| 26. SWIMMER | Signal ready for pickup. | |
| 27. HOIST OPERATOR | Acknowledge swimmer's signal. | I HAVE A PICKUP SIGNAL |
| 28. If crew hover is used: | | |
| a. HOIST OPERATOR | Position helicopter over swimmer/survivor. | (FIGURE 9-1) |
| 29. If crew hover is not used: | | |
| a. HOIST OPERATOR | Verbally position helicopter over swimmer/survivor. | (FIGURE 9-1) |
| 30. HOIST OPERATOR | Observe swimmer/survivor approaching hook and hooking up. | SWIMMER/SURVIVOR APPROACHING RESCUE HOOK /HOOKED UP |
| 31. SWIMMER | Signal ready to be hoisted. | |
| 32. HOIST OPERATOR | Observe swimmer/survivor giving ready to be hoisted signal. | I HAVE A HOIST SIGNAL |
| 33. HOIST OPERATOR | Raise the swimmer/survivor. | SWIMMER/SURVIVOR CLEAR OF WATER |
| 34. If crew hover is used: | | |
| a. HOIST OPERATOR | Stabilize the aircraft and pass control to pilot. | YOU HAVE CONTROL |
| b. PNAC | Press CREW HVR pushbutton and observe CREW HVR light OUT. | CREW HOVER DESELECTED |
| c. PAC | Assume control of aircraft. | I HAVE CONTROL |
| 35. HOIST OPERATOR | Continue the hoist evolution. | HALFWAY UP, AT THE CABIN DOOR, ABOARD |
| 36. HOIST OPERATOR | Secure rescue station. | RESCUE STATION SECURE, CLEAR FOR FORWARD FLIGHT |
| 37. PAC | Disengage coupled hover using DEPART pushbutton. | DEPARTING |
| 38. PNAC | Observe DPRT light illuminated. | DEPART LIGHT |
| 39. HOIST OPERATOR | Report survivor's injuries and treat as required. | |

Figure 9-2. Day/VMC SAR Procedures (Manual Approach) (Sheet 3)

9.2.3.2 Night/IMC Search and Rescue Procedure

Commence search based on data concerning location, number, and condition of survivors. Wind must be considered while performing a search, but the pattern entry angle in relation to the wind is not critical. Selection of a rescue procedure is based on prevailing visibility, winds and sea state, crew training, aircraft systems status, and crew fatigue. The night/IMC procedure and pattern described below permits the helicopter crew to affect a rescue in minimum time with proper margins for flight safety. The altitudes and airspeeds shown are not mandatory and may be modified for the existing conditions.

| NIGHT/IMC SEARCH AND RESCUE PROCEDURE | | |
|--|--|---|
| STATION | ACTION | ICS CALL |
| 1. PAC | Signify intention to commence an automatic approach to a hover. | AUTOMATIC APPROACH CHECKLIST, CREW RIG FOR RESCUE |
| 2. PNAC | Adjust landing light and searchlight as required. | |
| 3. HOIST OPERATOR | Together with swimmer, prepare for rescue. | UNSTRAPPING |
| 4. PNAC | Complete Automatic Approach checklist. | CHECKLIST COMPLETE |
| 5. HOIST OPERATOR | Complete rescue station preparation (three smokes or matrix lights), strap into gunners belt, ensure swimmer is also strapped in. | RESCUE STATION MANNED AND READY |
| <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">WARNING</div> <p>The rescue swimmer, rescue strop and rescue hook shall all be illuminated by a chemical light before lowering.</p> | | |
| 6. ANY CREWMAN | Locate survivor. | SURVIVOR IN SIGHT ___ O'CLOCK, ___ YARDS |
| 7. ANY CREWMAN | Direct PAC over survivor using SAR ICS terminology: | (FIGURE 9-1) ON TOP, NOW, NOW, NOW |
| 8. HOIST OPERATOR | Deploy the smokes or matrix lights. | SMOKES/MATRIX LIGHTS AWAY |
| 9. PAC | Commence wind line rescue pattern. | (FIGURE 9-4 and 9-5) |
| 10. PNAC/HOIST OPERATOR | Indicate survivor/marker relationship using turn rate commands. | (FIGURE 9-1) |
| 11. PNAC | Direct PAC as helicopter approaches windline. | STANDBY TO ROLL OUT |
| 12. PNAC | Direct PAC to roll out when lineup is achieved into the windline. | ROLL OUT |
| 13. PNAC | Verify wings level and into the windline with less than 5° angle of bank. | STANDBY FOR AUTOMATIC APPROACH |
| 14. PNAC | Commence automatic approach to arrive in hover just prior to the smokes/matrix lights, press APPR/HVR pushbutton, and observe APPR light. Note The distance to complete the approach will vary depending on altitude, ground speed, and water current | APPROACH ENGAGED |
| 15. PNAC | After aircraft has finished the automatic approach, verify the APPR/HVR pushbutton changes to HOVER and conduct hover checks. | HOVER MODE, CONDUCTING HOVER CHECKS |

Figure 9-3. Night/IMC SAR Procedure (Sheet 1 of 4)

| NIGHT/IMC SEARCH AND RESCUE PROCEDURE (cont.) | | |
|--|---|--|
| STATION | ACTION | ICS CALL |
| 16. PAC | At approximately 50 yards downwind of survivor, establish a steady hover. Verifies hover checks are completed and aircraft is established in a steady/stable hover. | STEADY HOVER, HOVER CHECKS COMPLETE |
| 17. HOIST OPERATOR | Ensure swimmer is in cabin door, with rescue harness on and attached to rescue hook. Perform final check of swimmer's equipment, tap swimmer on chest as signal to remove gunners belt: | SURVIVOR IN SIGHT |
| 18. If crew hover is used: | | |
| a. HOIST OPERATOR | Request crew hover. | STANDING BY FOR CREW HOVER |
| b. PAC | Order crew hover mode selection. | ENGAGE CREW HOVER |
| c. PNAC | Press CREW HVR pushbutton and observe CREW HVR light. | ENGAGED |
| d. HOIST OPERATOR | Observe CREW HVR TRIM light illuminated on the HOVER TRIM CONTROL. | I HAVE A LIGHT |
| e. PAC | Monitor flight controls while maintaining an instrument scan. | YOU HAVE CONTROL |
| f. HOIST OPERATOR | Assume control of aircraft and position helicopter over the swimmer/survivor. | I HAVE CONTROL (FIGURE 9-1) |
| 19. If crew hover is not used: | | |
| a. PAC | Verbally pass directional control. | YOU HAVE VERBAL CONTROL |
| b. HOIST OPERATOR | Accept verbal control. | I HAVE VERBAL CONTROL |
| c. HOIST OPERATOR | Verbally position helicopter over swimmer/survivor. | (FIGURE 9-1) |
| Once control is established: | | |
| 20. HOIST OPERATOR | Standby to lower swimmer. | PERMISSION TO LOWER SWIMMER |
| 21. PAC | Ensure safe condition. | LOWER SWIMMER |
| 22. HOIST OPERATOR | Place tension on cable and lower swimmer. | LOWERING SWIMMER, SWIMMER HALFWAY DOWN, SWIMMER IN THE WATER |
| 23. SWIMMER | Signal condition. | |
| 24. HOIST OPERATOR | Observe swimmer signal and report condition. | SWIMMER OK or SWIMMER IN TROUBLE |

Figure 9-3. Night/IMC SAR Procedure (Sheet 2)

| NIGHT/IMC SEARCH AND RESCUE PROCEDURE (cont.) | | |
|---|---|---|
| STATION | ACTION | ICS CALL |
| 25. HOIST OPERATOR | Verbally position helicopter so as not to interfere with swimmer while maintaining visual contact. Keep PAC advised of swimmer's progress, position, etc. | (FIGURE 9-1) |
| <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">WARNING</div> <p>During a night rescue, selection of the FWD or OFF position on the flood/hover light will permit the hoist operator to cycle the rescue light in case of lost visual contact with the swimmer and/or survivor.</p> <p style="text-align: center;">Note</p> <p>In the event of loss of visual contact with swimmer, the hoist operator shall cycle the rescue light. The swimmer shall illuminate the strobe light or ignite a flare to aid in reestablishing visual contact.</p> | | |
| 26. SWIMMER | Signal ready for pickup. | |
| 27. HOIST OPERATOR | Acknowledge swimmer's signal. | I HAVE A PICKUP SIGNAL |
| 28. HOIST OPERATOR | Position helicopter over swimmer/survivor (verbally or via crew hover). | (FIGURE 9-1) |
| 29. HOIST OPERATOR | Observe swimmer/survivor approaching hook and hooking up. | SWIMMER/SURVIVOR APPROACHING RESCUE HOOK /HOOKED UP |
| 30. SWIMMER | Signal ready to be hoisted. | |
| 31. HOIST OPERATOR | Observe swimmer/survivor giving ready to be hoisted signal. | I HAVE A HOIST SIGNAL |
| 32. HOIST OPERATOR | Raise the swimmer/survivor. | SWIMMER/SURVIVOR CLEAR OF WATER |
| 33. If crew hover is used: | | |
| a. HOIST OPERATOR | Stabilize the aircraft and pass control to PAC. | YOU HAVE CONTROL |
| b. PNAC | Press CREW HVR pushbutton and observe CREW HVR light OUT. | CREW HOVER DESELECTED |
| c. PAC | Assume control of aircraft. | I HAVE CONTROL |
| 34. HOIST OPERATOR | Continue the hoist evolution. | HALFWAY UP, AT THE CABIN DOOR, ABOARD |

Figure 9-3. Night/IMC SAR Procedure (Sheet 3)

| NIGHT/IMC SEARCH AND RESCUE PROCEDURE (cont.) | | |
|---|---|---|
| STATION | ACTION | ICS CALL |
| <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-bottom: 10px;">WARNING</div> <p>If cable oscillation occurs, crewman shall notify the pilots and stabilize the cable.</p> | | |
| 35. HOIST OPERATOR | Secure rescue station. | RESCUE STATION SECURE, CLEAR FOR FORWARD FLIGHT |
| 36. PAC | Disengage coupled hover using DEPART pushbutton. | DEPARTING |
| 37. PNAC | Observe DPRT light illuminated and monitor the flight instruments for positive rate of climb. | DEPART LIGHT, POSITIVE RATE OF CLIMB |
| 38. HOIST OPERATOR | Report survivor's injuries and treat injuries as required. | |

Figure 9-3. Night/IMC SAR Procedure (Sheet 4)

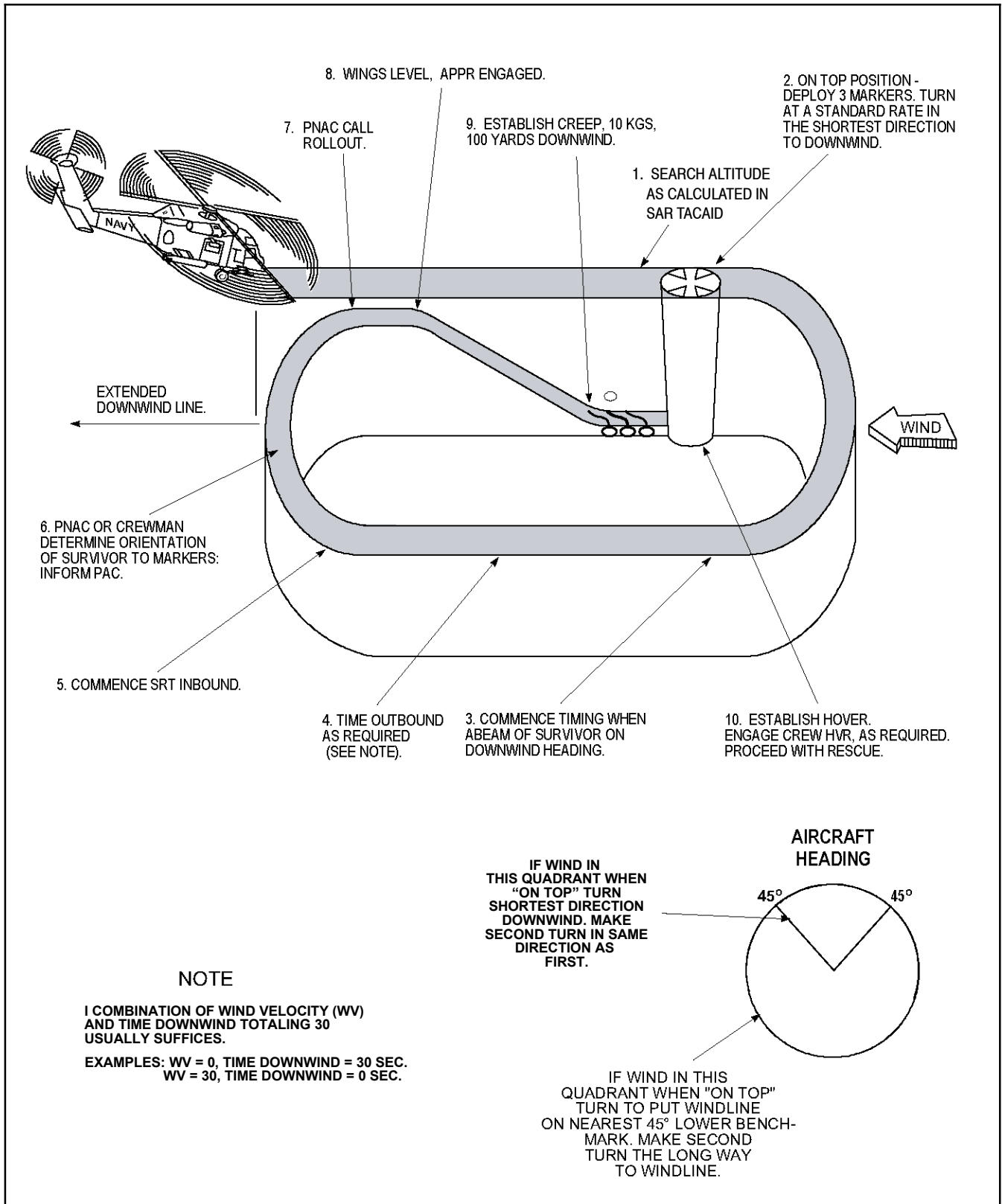


Figure 9-4. Windline (Racetrack) Rescue Pattern

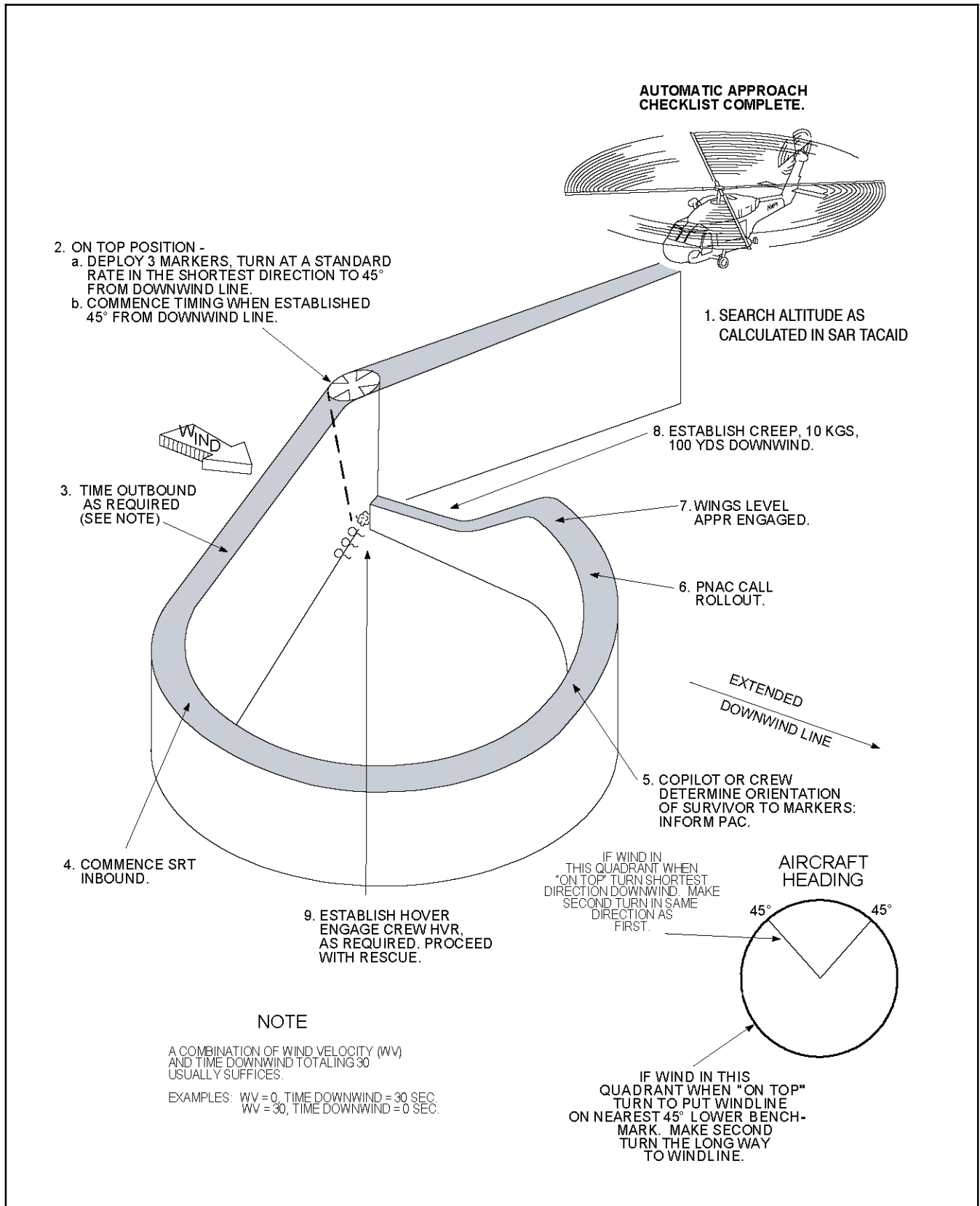


Figure 9-5. Windline (Teardrop) Rescue Pattern

9.2.4 Overland SAR

While naval SAR-capable units have traditionally operated within the maritime environment, it is becoming increasingly necessary for those units to also operate inland. Many of the procedures used in the maritime region also apply when operating inland, however, aircrew must understand and be familiar with the procedures unique to the inland environment. Prior to executing search and rescue operations in the inland environment, pilots and aircrew shall be familiar with the appropriate sections of the following documents: SH-60B NFM, NTRP 3-22.4-SH60B, NTTP 3-50.1, and OPNAV 3130.6 (series).

9.2.4.1 Rescue/Recovery Methods

There are five basic rescue methods that can be utilized in order of preference:

1. Landing to effect a rescue.
2. Rescue via one or two wheels.
3. Rescue via hoist.
4. Rappelling.
5. Direct Deployment.

WARNING

Power requirements vary significantly based upon winds, escape route and the size and slope of the landing zone. Power greater than HOGE may be required to land and takeoff. Utilize appropriate preflight planning and techniques in this chapter to ensure power margins are maintained.

CAUTION

Loss of tail rotor effectiveness is characterized by uncommanded right yaw. It is encountered when operating at high density altitudes in high power regimes. Arresting high rates of descent outside of translational lift and attempting approaches out of the wind increase the likelihood of encountering loss of tail rotor effectiveness. Immediate reduction of collective, selection of contingency power, and transition to forward flight or a right turn to drop off (if available) is required to restore directional stability.

9.2.4.2 Landing to Effect a Rescue

Landing to effect a rescue is the preferred method of rescue in the overland environment as it is more expeditious, reduces pilot/crew fatigue, and is the safest method of recovery. Prior to commencing an approach to a landing zone, pilots shall complete a SWEEP check, set up for the appropriate approach profile and announce wave off intentions. Utilize the procedures in Figure 9-6 for overland rescue. Refer to Chapter 11 for a detailed discussion of slope landing/takeoffs and dynamic rollover.

WARNING

Aft cyclic positions, in conjunction with low or decreasing collective pitch, may cause rotor blades to contact the tail pylon resulting in loss of tail rotor drive.

Note

- When landing site is a combination of cross slope and up or down slope, use the most restrictive slope landing limit. Be prepared to execute a combination of control inputs to maintain stability.
- Depending on slope and helicopter configuration, the tail wheel may touch down prior to the upslope wheel.

9.2.4.3 Rescue Via One or Two Wheels**WARNING**

Due to the increased pilot workload associated with one or two wheel landings and the increased potential for mishap, one or two wheel landing operations shall not be conducted except for reasons of operational necessity.

When the landing site is not suitable for a normal landing, consideration should be given to performing a one or two wheel landing. Landing via one or two wheels significantly increases pilot workload and requires increased crew coordination. Extreme caution must be used as the aircraft is in a dynamic rollover envelope anytime a wheel is in contact with the ground. Utilize the procedures in Figure 9-6.

9.2.4.3.1 Landing Considerations for One or Two Wheel Landings

When the landing site is not suitable for a normal landing, four landing configurations may be possible. Landings may be attempted on one main mount, both main mounts, on one main mount and tail wheel, and tail wheel only. Consideration should be given to CAL, slope landing, and unprepared surface procedures as applicable.

Set the parking brake prior to making a shallow approach into the wind. Make a shallow approach to a hover over the intended landing area. From a hover, descend slowly making smooth, coordinated control inputs. Aircrewmembers shall maintain sight of the landing area at all times and continuously clear and direct the helicopter for landing gear placement. The pilot shall treat the helicopter as if it were completely airborne for the entire evolution. The controls should be continually adjusted to maintain a stable attitude and position.

WARNING

- When conducting one or two wheel landings, the helicopter can develop unintentional roll rates. Constant attention by the crew is necessary to prevent dynamic roll over conditions. When landing or taking off with one or two wheels touching the ground, use smooth collective motion to maintain low roll rates. Do not allow the helicopter to drift during ground maneuvers. Dynamic rollover may result in loss of helicopter and crew.
- If there are no suitable visual references for the PAC, consideration should be given to selecting an alternate landing site or hover area. This will prevent unintentional drift into obstacles or obstructions and possible loss of the helicopter and crew.



Depending on the site and the helicopter position, reduced clearances may cause helicopter components to strike the ground/structure.

Note

If encountering a situation where only one wheel is in contact with the ground and a rolling moment is present, smooth reduction of the collective is the most effective corrective action the pilot can take to prevent dynamic rollover.

The departure should be a smooth, controlled liftoff to a hover followed by the appropriate departure maneuver. Throughout the evolution the aircrew shall continue clearing the helicopter until clear of all obstacles.

9.2.4.4 Rescue Via Hoist

If unable to land, rescue via the hoist is another option. Rescue via hoist is very similar to overwater rescue techniques. The aircrew must be aware of hazards and power requirements (to include the weight of the people being rescued) needed to conduct a rescue via hoisting. Prior to commencing a rescue via hoist, the HAC shall conduct a SWEEP check and announce waveoff intentions. The aircrewman shall ensure that the aircraft remains clear of all obstacles throughout the rescue. Utilize the procedures in Figure 9-7 for overland rescue via hoisting.

9.2.4.5 Rappelling



Due to the hazards associated with rappelling and the increased potential for mishap, rappelling operations shall not be conducted except for reasons of operational necessity. Rappelling shall only be conducted by a qualified Helicopter Inland Rescue Aircrewman.

If a landing site is unavailable and the situation does not allow hoisting, consideration should be given to rappelling the rescuer into the zone. Rappelling allows the rescuer to control his rate of descent to avoid obstacles. Rappelling also allows the rescuer to quickly disconnect from the line should entanglement occur. Prior to rappelling, the HAC shall conduct a power check, site evaluation, and announce wave off intentions. The aircrewman shall ensure that the aircraft remains clear of all obstacles throughout the rescue.

Note

Rigging, ICS voice calls and terminology for Rappelling, Belay, and Overland Direct Deployment are found in the NTTTP 3-50.1. Pilots and aircrew shall be intimately familiar with these procedures and properly qualified per OPNAVINST 3130.6 (series) before performing these types of rescue/recovery methods.

9.2.4.6 Direct Deployment

In certain overland situations when a landing site is unavailable, it may be advisable for the rescuer to remain connected to the hoist line throughout the rescue. Rescue operations to steep cliffs, canyon walls, towers or balconies are some examples. In these cases, the rescuer should use direct deployment techniques. The crew shall brief hoist entanglement procedures thoroughly prior to attempting direct deployment overland. The crew shall set up for the direct deployment rescue using the same procedures for rescuing via hoist.

| OVERLAND PROCEDURES (LANDING) | | |
|-------------------------------|---|--|
| STATION | ACTION | REPORT |
| 1. PAC | Signify intention to commence an overland rescue. | LANDING CHECKLIST, CREW RIG FOR RESCUE |
| 2. PNAC | Complete Landing Checklist. | CHECKLIST COMPLETE |
| 3. HOIST OPERATOR | Complete rescue station preparation. | RESCUE STATION MANNED AND READY |
| 4. ANY CREWMAN | Locate survivor and landing zone. | SURVIVOR IN SIGHT, ___ O'CLOCK, ___ YARDS |
| 5. ANY CREWMAN | Direct PAC to survivor using SAR ICS terminology. | UTILIZE TERMINOLOGY IN FIGURE 9-1. |
| 6. PAC | After sighting survivor, mark on top survivor and begin zone evaluation. | SURVIVOR IN SIGHT. |
| 7. PAC | After marking on top, conduct a power check, wind finding and zone evaluation (SWEEP checks). | ON TOP NOW, NOW, NOW. |
| 8. PNAC | Compute HOGE torque. | POWER REQUIRED TO HOGE IS - _____. |
| 9. PAC | Announce type of approach, power available, wave-off torque, winds, and waveoff route. | POWER AVAILABLE IS _____, WAVE OFF TORQUE IS _____ WINDS ARE _____, AND WAVEOFF ROUTE WILL BE _____. |
| 10. PAC | Set up for an approach into the wind while maintaining clearance of all obstacles. | ON FINAL FOR A HOVER/NO HOVER LANDING. |
| 11. CREWMAN | Conduct ICS check, and provide airframe clearance. | RIGHT'S UP/LEFT'S UP |
| 12. PAC | Announce that the landing zone is disappearing underneath the nose of the aircraft. | NOSE IN ZONE |
| 13. CREWMAN | Provide final clearance to land. Ensure that aircraft will remain clear of all obstacles. To direct PAC to remain clear of obstacles, utilize terminology in FIG 9-1. | CLEAR RIGHT, CLEAR LEFT, CLEAR TO LAND OR HOLD |
| 14. PNAC | Calls torque, altitude and groundspeed. | |
| 15. CREWMAN | Ensure aircraft is established on solid ground after touchdown | CLEAR TO REDUCE |
| 16. PAC | Reduce collective. | REDUCING |
| 17. CREWMAN | Embark personnel being rescued. When complete, notify PAC. | RESCUE STATION SECURE, CLEAR RIGHT, CLEAR LEFT, CLEAR TO LIFT |
| 18. PAC | Perform final check of instruments and takeoff. | LIFTING |

Figure 9-6. Overland Procedures (Landing)

| OVERLAND PROCEDURES (HOIST) | | |
|-----------------------------|---|---|
| STATION | ACTION | REPORT |
| 1. ANY CREWMAN | Locate survivor and pickup zone. | SURVIVOR IN SIGHT, ___ O'CLOCK, ___ YARDS |
| 2. ANY CREWMAN | Complete Landing Checklist. | UTILIZE TERMINOLOGY IN FIGURE. 9-1. |
| 3. PAC | After sighting survivor, mark on top survivor and begin zone evaluation. | ON TOP NOW, NOW, NOW. |
| 4. PAC | After marking on top, conduct a power check, wind finding and zone evaluation (SWEEP checks). | |
| 5. PNAC | Compute HOGE torque. | POWER REQUIRED TO HOGE IS _____. |
| 6. PAC | Signify intention to commence an overland hoist rescue. | LANDING CHECKLIST, CREW RIG FOR RESCUE. |
| 7. PNAC | Complete Landing Checklist. Turn on the Backup Pump and arm the Rescue Hoist, as required. | ON TOP NOW, NOW, NOW. |
| 8. HOIST OPERATOR | Complete rescue station preparation. | RESCUE STATION MANNED AND READY. |
| 9. PAC | Announce type of approach, power available, waveoff torque, winds, and waveoff route. | POWER AVAILABLE IS _____, WAVE OFF TORQUE IS _____, WINDS ARE _____, AND WAVEOFF ROUTE WILL BE _____. |
| 10. PAC | Set up for an approach into the wind while maintaining clearance of all obstacles. | ON FINAL FOR A ___ ft HOVER. |
| 11. CREWMAN | Direct PAC to pickup zone and remain clear of obstacles. | UTILIZE TERMINOLOGY IN FIGURE. 9-1. |
| 12. PAC | Establish steady hover. Confirm power required and wave-off intentions. | STEADY HOVER |
| 13. PAC | After the steady hover and hover references has been established. | STAND BY TO HOIST RESCUER |
| 14. HOIST OPERATOR | Connect Rescue Aircrewman to double rescue hook. | |
| 15. CREWMAN | Disconnect gunner's belt. | |
| 16. HOIST OPERATOR | Observe Rescue Aircrewman is clear of the gunner's belt. | RESCUER STANDING BY |
| 17. HOIST OPERATOR | Check area clear of debris and over pickup spot. | PERMISSION TO HOIST RESCUER |
| 18. PAC | Steady hover and instrument check. | HOIST RESCUER |
| 19. HOIST OPERATOR | Position Rescue Aircrewman into position to be hoisted. | RESCUER OUTSIDE OF CABIN |
| 20. HOIST OPERATOR | Lower Hoist cable/Rescuer. | HOIST/RESCUER GOING DOWN |
| 21. HOIST OPERATOR | Hoist cable/Rescuer on deck. | HOIST/RESCUER ON DECK |
| 22. HOIST OPERATOR | Observe ready for pickup from the rescue aircrewman and or survivor. | I HAVE A PICKUP SIGNAL |
| 23. HOIST OPERATOR | Slack in. cable coming out. | STAND BY FOR WEIGHT ON AIRCRAFT |
| 24. HOIST OPERATOR | Raise hoist cable. | RESCUE AIRCREWMEN/SURVIVOR CLEAR OF THE DECK, HALFWAY UP, AT CABIN DOOR, ABOARD |
| 25. HOIST OPERATOR | Secure rescue station. | RESCUE STATION SECURE, CLEAR FOR FORWARD FLIGHT |
| 26. PAC | Perform final check of instruments and takeoff. | DEPARTING |

Figure 9-7. Overland Procedures (Hoist)

9.3 VERTICAL REPLENISHMENT (VERTREP) OPERATIONS

VERTREP involves the use of helicopters to resupply ships at sea while underway through external cargo transport. With the external cargo hook installed, the aircraft is capable of rapid transport of cargo. Approved lifting equipment and associated procedures are described in NA-80T-122, NWP 4-01.4.

The actual payload-lifting capability of the aircraft is a function of prelift gross weight, DA, and prevailing winds. Power available and maximum payload, using applicable charts, shall be completed prior to commencing external cargo transport. The crew must also be aware of the effect of the load on the moment of the aircraft. **Figure 9-8** provides the cargo moments associated with weight on the cargo hook.

WARNING

Under high power-required conditions, due to flight control mixing, pedal position is not necessarily indicative of tail rotor authority remaining. In particular, under high DA and aircraft gross-weight conditions, it is possible to achieve maximum tail rotor pitch without obvious indications from pedal position (e.g., relatively neutral pedal position or no contact of left pedal stop). This condition will manifest in one of two ways: no yaw response despite left pedal input or uncommanded right yaw.

The PIC shall brief the copilot, crewmen, and, if practicable, hook-up personnel. Hook-up procedures, release procedures, and any special instructions shall be included in the brief.

WARNING

- Light or irregularly shaped external loads may swing, oscillate, or "fly" unpredictably. Should excessive load oscillations develop, an immediate reduction in airspeed is mandatory to prevent loss of control or imposing excessive loads on the helicopter. Extreme care must be exercised with such loads during pickup or delivery to avoid damage to the aircraft or damage/injury to facilities, equipment, or personnel near the drop zone. Unstable loads may have to be jettisoned in forward flight because of severe adverse effects on aircraft flight performance or if loads threaten to impact the aircraft.
- Avoid overflying buildings, personnel, livestock, vehicles, and aircraft with an external load attached due to the possibility of inadvertent load release.
- Particular care must be taken during cargo pickup/drop-off due to the increased rotor downwash and its effect on loose equipment and debris near the helicopter. Ground personnel shall wear approved eye protection and headgear.

CAUTION

- External loads may cause erratic and unreliable radar altimeter indications while in a hover and low-speed flight.
- While carrying external cargo, monitor the HOOK OPEN annunciator. If it appears, set the load down as soon as possible and discontinue the mission.

CARGO MOMENTS - CARGO HOOK

EXAMPLE

WANTED

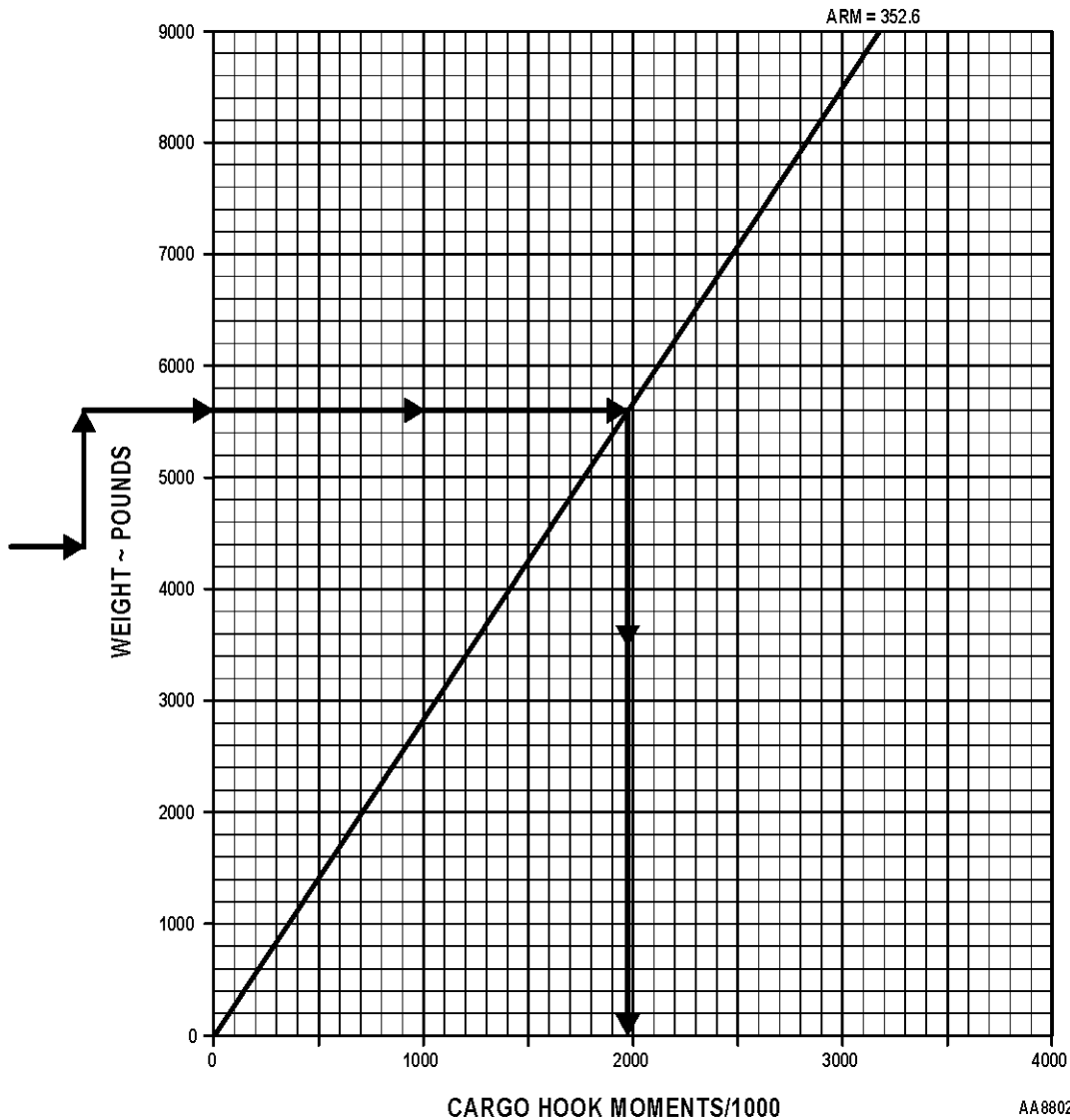
MOMENT OF CARGO ON CARGO HOOK

KNOWN

CARGO = 5600 POUNDS

METHOD

ENTER WEIGHT AT 5600 POUNDS. MOVE RIGHT TO LINE. MOVE DOWN AND READ MOMENT / 1000 = 1975



AA8802

Figure 9-8. Cargo Hook Moments

9.3.1 Flight with External Loads

It is important that the PAC know the flying characteristics of various loads and associated flight control applications. All maneuvers that are made with external cargo loads should be gradual and well coordinated. Care must be taken when flying with external loads that have aerodynamic characteristics (wings, tail sections, sheet metal, plywood, etc.). The aerodynamic lift capabilities of these loads may amplify any oscillation and cause the load to contact the helicopter. Some helicopter oscillation may be noticed with low-density bulky cargo when in level flight. This oscillation can be minimized by the use of smooth control movements. When making turns at higher airspeeds, opposite lateral cyclic displacement may be necessary to prevent excessive rolling motion in the direction of turn. This tendency increases with airspeed and requires a slightly larger turning radius than would be required at the same gross weight with an internal cargo load. More than normal cyclic displacement is necessary to overcome the external cargo inertia when initiating or stopping sideward flight. Experience has shown that for any type of external cargo load, there is an airspeed best suited for that particular load. There is no one rule for flying with external loads; the combination of weight, dimension, and shape all have a direct bearing on the action of the load during flight. Increased power will be required to carry large, flat loads. If control movements are smoothly applied to preclude oscillation and airspeed is slowly increased to determine the riding characteristics of the load, external cargo can be satisfactorily flown. If high airspeeds or turbulence should cause a load to oscillate, decreasing airspeed and properly applying inputs to the flight controls can control the oscillation.

Careful attention to altitude, visual monitoring of the load by the crewman, and crew coordination are necessary to avoid load impact with obstacles or premature contact with the drop zone surface, especially when using long lifting slings.

The PAC shall be responsible for observing deck status, LSE signals, and maintaining rotor clearance. The PNAC shall monitor instruments, actively listen to the radios, and observe rotor clearance.

9.3.2 Cargo Pickup

As the aircraft proceeds inbound for a pickup, the PAC will advise the crew of load position and which pilot (seat) will be executing the pickup maneuver. The crewman will acknowledge and make the "Hook up" report.

Note

- "HOOK UP AND LOCKED" reports may be made immediately after latching/re-latching or inbound prior to load pickup, according to preflight brief. In any case, "HOOK UP" checks and reports shall occur between each hook latch/re-latch and the next load pickup.
- The procedures for external cargo pickup and delivery described in this manual are specified for operations where external load slings are attached directly to the cargo hook. These procedures may require modification when load slings are attached to remotely operated extensions from the cargo hook.

Check windline, helicopter weight, and power required charts prior to pickup. If necessary, a decrease in load or helicopter internal weight may be required for a safe takeoff. The height and movement to the pickup point will be determined by visual reference to the load, LSE signals, and crewman calls. The PAC can best control the approach until the aircraft is at a point (approximately 50 feet from the pickup spot) where the crewman can visually acquire the pickup spot and can begin to give directions utilizing proper voice terminology (**Figure 9-9**) to direct the helicopter over the load. Extreme caution must be used to avoid hitting the load.

As soon as the load is securely attached to the cargo hook, all personnel on the ground will clear the area directly beneath the helicopter. The crewman, along with the LSE, will notify the PAC that the load is ready to lift. Lift the helicopter vertically until the cargo is clear of the deck and the helicopter is in a stable hover. The PNAC will check Ng, TGT, torque, and Nr prior to transitioning to forward flight. If engines are torque limited and rotor rpm is drooping, do not attempt forward flight. When the phrase "CLEAR TO GO" is given by the crewman and signaled by the LSE, a transition to forward flight may be commenced. The PAC must ensure that safe engine limits can be maintained.

The signals received from the LSE and crewman are advisory in nature with the exceptions of “HOLD” and “WAVEOFF.” The crewman's advisories for positioning the aircraft over the load should take priority over those of the LSE. Collective and cyclic coordination is essential in maintaining position to ensure that a vertical, no-drift, no-swing pickup is accomplished.

WARNING

Extreme care shall be taken to ensure that loads are not flown over aircraft, lowered elevators, or personnel due to the possibility of inadvertent load release.

9.3.3 Cargo Delivery

The procedures for cargo delivery are similar to those used for pickup. The approach to the drop point should be higher than normal to prevent dragging the load on the deck. The PAC can best control the approach until the aircraft is at a point (approximately 50 feet from the drop spot) where the crewman can visually acquire the drop spot and can begin to give directions utilizing proper voice terminology (Figure 9-9). The helicopter should come to a hover with the load approximately 10 feet above the drop spot. A momentary hover will allow the load to stabilize and enable the crewman to direct the aircraft over the drop spot with precision and without damage to the cargo. Upon instructions from the crewman that the load is "Over the spot, easy down," reduction of power will allow the load to settle gently on the deck. Release of the load will be performed by the crewman or PAC electrically, the crewman manually, or, in case of emergency, by use of the cyclic EMER REL button.

Note

- The crewman shall notify the PAC whenever the load is spinning, swinging, or trailing aft. The PAC shall position the controls accordingly until the condition is corrected.
- After the instruction “LOAD ON DECK, HOOK CLEAR, CLEAR TO GO” is received from the crewman, forward flight may be established.

9.3.3.1 Electrical Release

Normal release of external cargo is accomplished by pressing the CARGO HOOK RELEASE button on the utility pendant or the CARGO REL button on either cyclic grip after placing the CARGO HOOK CONTR switch to the ARMED/ALL position. With the CARGO HOOK CONTR switch in the ARMED/CKPT position, only the CARGO REL button on either cyclic grip will release the cargo hook. A HOOK ARMED advisory will appear informing the pilots that electrical power is applied to the control circuit.

When the CARGO REL button is pressed and the release solenoid begins to move, a switch activates the HOOK OPEN annunciator. The load arm will swing open, releasing the cargo. When the load is released from the load beam, spring tension on the arm will cause the load beam to close and relatch. The normal release system is a one-time cycle; once the solenoid travel begins and the load arm relatches, the release cycle can again be initiated.

9.3.3.2 Manual Release

Manual release of external cargo can be accomplished from the cabin or by ground personnel. Turning the manual release control on the hook clockwise will cause the latching mechanism to release the load beam. The load beam will not open unless a downward pressure is exerted. With power applied to the helicopter and the CARGO HOOK CONTR switch in the ARMED/ALL or ARMED/CKPT position, the HOOK OPEN advisory will appear at the start of release control turning and will remain until the load beam is closed and latched.

9.3.3.3 Emergency Release

Emergency release of an external cargo load is activated by an electrically fired CAD, initiated from either cyclic EMER REL button. The emergency release is used when the electrical and manual releases are inoperative, and the load must be jettisoned. With the CARGO HOOK EMERG REL switch in the NORM position, power will be applied to the EMER REL button. Depressing the button applies 28 Vdc power to the CAD. A piston in the lock assembly, driven by high gas pressure, will release the load arm lock. The weight of the load will cause the load arm to open. Once the emergency release is used, the hook will remain open and the HOOK OPEN advisory will remain until the CAD is replaced. When the CAD is replaced, the load arm will close, the HOOK ARMED advisory will appear, and the emergency release mode is returned to operation. Power to operate the emergency release system is provided by the DC essential bus through a circuit breaker labeled CARGO HOOK EMER RELEASE.

Note

Once the emergency hook release has been activated, the cargo hook cannot be used until the CAD is replaced, because the hook load beam will not close and lock.

9.3.3.4 Cargo Hook Preflight

When external loads are to be carried, the following checks shall be performed:

1. Cargo hook — Proper installation and freedom of rotation.
2. CAD installed.
3. Manual release — Ensure no binding in the lever, load beam, or keeper.

| MEANING | ICS CALL |
|---|---|
| Discontinue approach. Immediately stop all movement. | WAVEOFF** HOLD** |
| PICK-UP | |
| Pilot reports on approach. | INBOUND FOR RIGHT/LEFT SEAT PICK |
| Crewman rogers report and acknowledges hook has been checked up and locked. | ROGER, RIGHT/LEFT SEAT PICK; HOOK UP AND LOCKED |
| Pilot reports presence of HOOK ARMED annunciator | HOOK ARMED |
| Deck in sight, begin voice calls. | DECK IN SIGHT |
| Move in specific direction. | RIGHT* - LEFT* - FORWARD* - BACK*- UP* - DOWN* |
| Slow rate of movement. (Precedes basic command.) | EASY |
| Stop movement. (Precedes basic command.) | STOP |
| Maintain present position. | STEADY |
| Load is attached. Maintain present position. | LOAD HOOKED UP |
| Hookup man is in a safe area. | HOOKUP MAN IS CLEAR |
| Tension is coming on the pendant and aircraft. | WEIGHT COMING ON |
| Problem with the load. Maintain present position. | LOAD FOULED |
| Load is clear of the deck. | LOAD IS CLEAR |
| Load is clear of the deck and obstructions. | CLEAR TO GO |
| Load is not swinging, shifting, or oscillating. | LOAD RIDING WELL |
| Load is swinging, oscillating, spinning, or trailing aft. | LOAD UNSTABLE |
| Jettison immediately. Load endangering safety of flight. | PICKLE, PICKLE, PICKLE |
| DROP-OFF | |
| Pilot reports on approach. | INBOUND FOR RIGHT/LEFT SEAT DROP |
| Crewman Rogers report. | ROGER, RIGHT/LEFT SEAT DROP |
| Deck in sight, begin voice calls. | DECK IN SIGHT |
| Move in specific direction. | RIGHT* - LEFT* - FORWARD* - BACK* - UP*- DOWN* |
| Slow rate of movement. (Precedes basic command.) | EASY |
| Stop movement. (Precedes basic command.) | STOP |
| Maintain present position. | STEADY |
| Maintain position, slight tension on pendant. | LOAD ON DECK |
| Pendant clear of cargo hook. | HOOK CLEAR |
| Cargo not released from hook. | NO RELEASE |
| Pilot or copilot - release the load. | PILOT RELEASE HOOK |
| Aircraft cleared to depart. | CLEAR TO GO |

* Give distance in feet (up 10, right 5, etc.)

** Compliance with call is mandatory

Figure 9-9. VERTREP ICS Terminology

9.3.3.5 Crewman Cargo Procedures

1. Remove cargo hatch cover and release hook from stowed position.
2. Direct PAC over the load using standard voice procedures (Figure 9-9).
3. Monitor the hookup and keep the PAC informed of the status.
4. Report when load is clear of the deck.
5. Monitor the load during transit for excessive angle or motion and keep the PAC informed of status.
6. Direct PAC over the spot for drop-off using standard voice procedures (Figure 9-9).
7. Electrically release the load and keep the PAC informed of the status.
8. Utilize manual release as required.
9. Stow cargo hook and replace cargo hatch cover.

WARNING

Gunners belts have been known to fail. Aircrew and/or passengers shall not hang feet out of cabin door except when necessitated by mission requirements. Determination if a mission requirement exists shall be the responsibility of the aircraft commander.

9.3.3.6 In-flight Procedures

When external loads are to be carried, the following checks shall be performed:

CAUTION

To prevent damage to the cargo hook keeper, the PAC should not exceed a 30° cone angle with cargo suspended from the cargo hook.

9.3.3.7 90° Sidflare Pattern

1. Once the aircraft is stabilized in a 10-foot hover over the load, the PAC shall follow the directions of the LSE and the crewman to ensure that the hook is centered directly over the load (Figure 9-10).
2. On signal from the LSE and the crewman, the collective shall be increased slowly until tension on the cargo pendant is felt. This will tend to center the aircraft over the load. At this point, smoothly increase collective to lift the load off the deck or until reaching a torque 6% less than maximum available. If the load fails to come off the deck within maximum VERTREP torque limits, maintain the hover and slowly decrease the collective until the load is on the deck. Loads should never be lifted using maximum allowable torque.
3. After clearing the deck, increase collective and place the nose 5° to 7° below the horizon. The aircraft will be placed on a climb schedule of approximately 1 foot of altitude for 1 knot of airspeed. Maintain a constant power setting, as necessary to establish the climb. This attitude should be held until the aircraft reaches approximately 60 to 80 KIAS, at which time the nose should be raised to maintain airspeed while climbing to a minimum altitude of 150 ft AGL.

4. A turn downwind shall be made with a shallow angle of bank (**Figure 9-10**). Abeam the drop point, commence a turn and slight descent on a racetrack pattern to intercept the final approach course into the wind (directly astern for shipboard training) at approximately 150 ft AGL and 60 to 80 KIAS.
5. The final approach is to be flown in such a manner as to position the aircraft in a hover over the drop spot. While on final approach heading, maintain a constant bearing to the intended point of pickup and position the aircraft on a glide slope approximately 500 ft horizontally from the pickup spot. Reduce collective to maintain glide slope and raise the nose above the horizon as necessary to dissipate airspeed.
6. As the aircraft reaches approximately 40 KIAS at a position 150 to 200 ft from the spot, begin to turn the aircraft and execute a 90° sideflare while maintaining a constant bearing and glide slope to the spot. This is accomplished by applying a small amount of forward and lateral cyclic in the direction of flight and opposite directional pedal. Do not exceed the 35-knot sideward flight limit. Arrive 25 to 50 ft from the spot with the aircraft perpendicular to the ship's centerline and on glideslope. Utilize power in conjunction with lateral cyclic in order to cross the deck with the load 10 ft above deck height. Altitude in the hover will depend greatly on the length of the cargo pendant, the height of the cargo, and the height of the obstructions in the vicinity of the drop spot.

9.3.3.8 45°/135° Sideflare Pattern

This pattern is accomplished in much the same manner as the 90° sideflare; however, the approach will be flown from a wider abeam position on a final course 45° off the windline (ship's course for shipboard training) (**Figure 9-11**).

1. Continue the approach past the abeam position and commence a turn to arrive on final approach heading 45° off the windline at approximately 150 ft AGL and 60 to 80 KIAS. The final approach is to be flown in such a manner as to position the aircraft in a hover over the drop spot. While on final approach heading, maintain a constant bearing to the intended point of pickup and position the aircraft on a glide slope approximately 500 feet horizontally from the pickup spot. Reduce collective to maintain glide slope and raise the nose above the horizon as necessary to dissipate airspeed.
2. As the aircraft reaches approximately 40 KIAS at a position 150 to 200 feet from the spot, begin to turn the aircraft and execute a 45° or 135° sideflare while maintaining a constant bearing and glide slope to the spot. This is accomplished by applying a small amount of forward and lateral cyclic in the direction of flight and opposite directional pedal. Do not exceed 35-knot sideward flight limit. Arrive 25 to 50 feet from the spot with the aircraft perpendicular to the ship's centerline and on glideslope. Utilize power in conjunction with lateral cyclic in order to cross the deck with the load 10 feet above deck height. Altitude in the hover will depend greatly on the length of the cargo pendant, the height of the cargo, and the height of the obstructions in the vicinity of the drop spot.

9.3.4 Day VERTREP Operations

1. Once communications have been established between the receiving ships, transferring ship, and the aircraft; the receiving ships will set flight quarters as defined in NA-80T-122.
2. Prior to each approach to the flight deck for any pickup or drop-off, the following factors should be considered:
 - a. Relative winds and flow characteristics around the ship with respect to turbulence and null areas.
 - b. Path of ship exhaust gases that result in turbulence and warm air.
 - c. Green deck status light.
 - d. Appropriate LSE signals.
 - e. Drop area clear of people and loose gear.
 - f. Proper placement of load relative to the VERTREP/hover deck markings.



The aircrewman shall ensure proper placement of the load, relative to the VERTREP hover area markings.

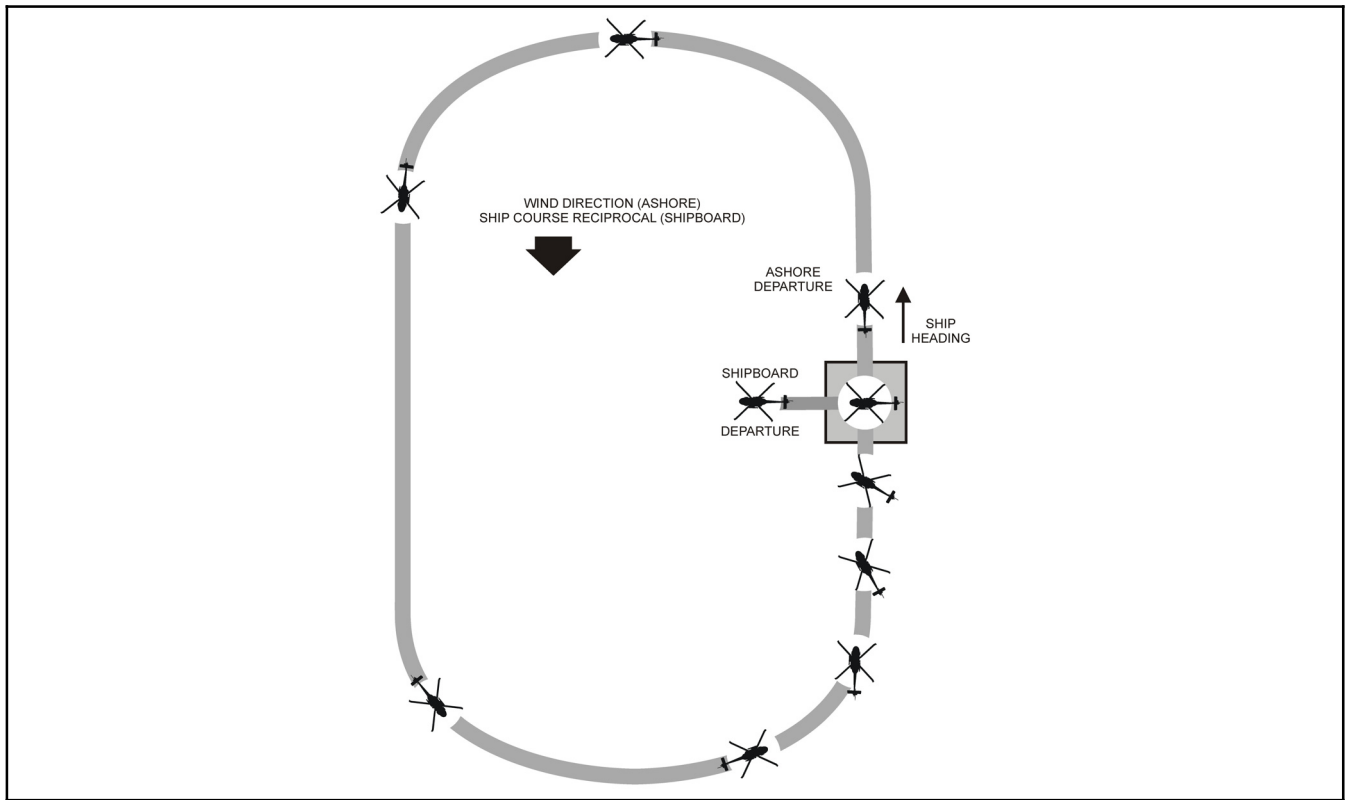


Figure 9-10. 90° Sideflare Pattern

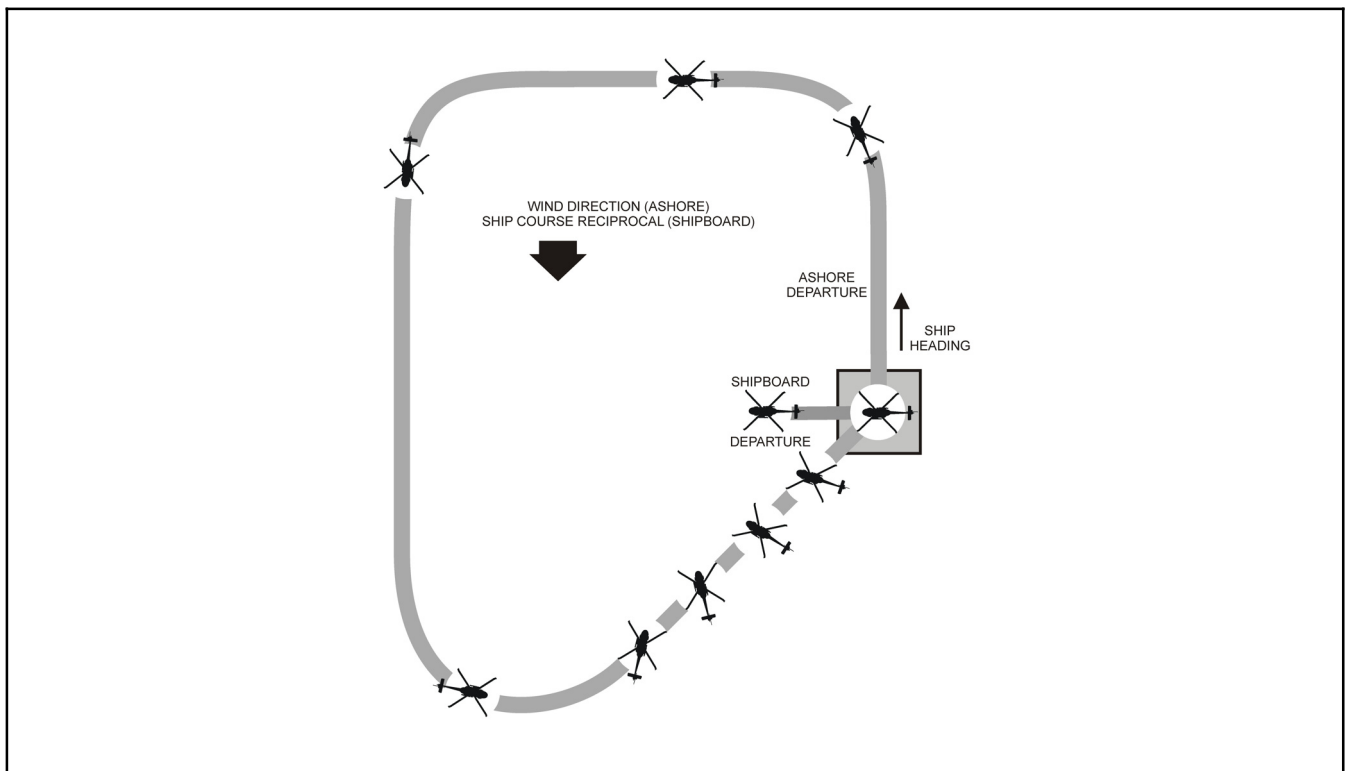


Figure 9-11. 45°/135° Sideflare Pattern

9.3.4.1 VERTREP Safety

Care must be exercised while conducting VERTREP. Various conditions such as high sea state, over-sized loads, various length lifting slings, and small drop zones may reduce available visual cues and stability/control of external loads. Reducing the maximum VERTREP torque further below the 6% margin may provide an extra measure of control and safety.

WARNING

- Prior to conducting VERTREP/external lift operations utilizing the forward TEE VERTREP/external lift line-up line markings, pilots shall verify with the ship or ships resume that the forward TEE VERTREP/external lift line-up line markings have been relocated for H-60 T/M/S operations. If the line has not been relocated, refer to VERTREP/external lift limitations as directed in NA-80T-122.
- Adequate rotor clearance does not exist to stage double stacked loads on single spot flight decks.
- There are no VERTREP flight deck markings to provide adequate obstruction clearance on a CV(N), LHA or LHD. Therefore, all hands participating in a night VERTREP evolution must be particularly alert to ensure that adequate clearance is maintained between the aircraft and obstructions in the vicinity of the flight deck. Crews should be aware that a combination of a staged flight deck, high-velocity and/or gusty winds, and ship pitch and roll may create less than adequate landing clearance for an aircraft experiencing an inflight emergency.

Note

During VERTREP, loss of visual contact with the LSE while picking up or dropping a load requires a hold until visual contact is regained.

9.3.5 Night VERTREP Operations

WARNING

Due to the hazards associated with night operations and the increased potential for mishap, night shipboard external cargo operations shall not be conducted except for reasons of operational necessity.

Night VERTREP is an inherently demanding and fatiguing evolution that requires particularly high levels of planning and coordination. One or more of the following conditions shall exist prior to conducting night VERTREP operations:

1. A natural horizon exists.
2. The ships are alongside in connected replenishment (CONREP) position.
3. The drop-off/pickup zone of the receiving/ delivery ship is clearly visible from the cockpit when over the drop-off/pickup zone of the delivery/receiving ship.

9.3.5.1 Night VERTREP Safety

Particular care must be exercised while conducting night VERTREP. Adverse environmental conditions such as fog, precipitation, sea state, horizon, and aircrew proficiency, profoundly affect the safe conduct of the mission. Altitude

hold shall be used for all night ship flights with the exception of VERTREP operations in the CONREP position. In the shipboard landing and VERTREP pattern, altitude hold shall be turned off only after the PAC has visual reference of the landing environment/drop zone. Operational commanders must, whenever necessary, augment published operating rules with directives addressing local circumstances.



When carrying external loads, erratic radar altimeter indications can result in an AFCS DEGRADED caution.

9.3.5.2 Procedures

Night VERTREP patterns should be chosen based on the type of loads, the decks that they are being transferred between, and the distance that they will be carried. The normal pattern will be a racetrack type between the delivery ship and the receiving ships. Excessive maneuvering should be avoided, when able, to help avoid vertigo inducing maneuvering. Altitudes and checkpoints should be based on the type of ship being serviced, relative position of ship being worked, and maintaining safe clearance.

1. On pickup, the PNAC will monitor all instruments and note the torque. The PAC will commence lifting the load following hand signals from the LSE and voice calls from the crewman.



All night VERTREP climb-outs away from the immediate vicinity of the flight deck should be conducted on instruments.

2. The PAC will transition to 60 to 80 KIAS and climb to a minimum altitude of 150 ft AGL prior to turning. The PNAC shall call "POSITIVE RATE OF CLIMB". The PNAC shall notify the PAC if more than 20° angle of bank is attained, altitude descends below 100 ft AGL, or a fast rate of descent is not corrected. If the aircraft descends through 75 ft AGL or a fast rate of descent develops, the PNAC shall assume control of the aircraft and correct the situation. Control changes should be accomplished with wings level and a positive, verbal acknowledgement. Both radar altimeters shall be set to illuminate at altitudes determined in the brief, but not less than 40 feet. Determination of radar altimeter settings should be based upon, but not limited to: type of ships, relative position of ships, and altitudes required to transition from one ship to another.



Oscillations caused by the load and felt through the rotor blades and/or fuselage can cause vertigo at night. Should extreme oscillations and/or unsafe flight due to spatial disorientation/vertigo occur, consideration should be given to jettisoning the load immediately.

3. When the aircraft is properly positioned to commence an approach, the PNAC should inform the PAC to begin the turn. The PAC may then turn toward final and begin the descent once established on final. When the PAC has visually acquired the drop area and established that adequate visual reference exists to afford a safe approach, the approach is continued to arrive over the drop area. If the PAC has transitioned from instrument flight to visual flight, a verbal statement to the PNAC is made that there is adequate visual reference to continue the approach.

9.3.5.3 Lighting

Receiving and transferring ships shall have their decks illuminated to conform with the criteria for certification set forth by the Shipboard Aviation Facilities Resume.

Note

Night VERTREP to ships that do not conform to the minimum certification criteria set forth in the Shipboard Aviation Facilities Resume shall not be attempted.

Aircraft lighting configuration is at the discretion of the PIC, but various aspects of aircrew limitations must be taken into account to allow visual reference with the load and the deck. Additionally, care must be taken to ensure external lighting does not interfere with the LSE's ability to see the aircraft and the load.

9.3.6 Lost Communication Procedures with a VERTREP Load

In the event of lost ICS with an external load, the following procedures are recommended:

1. The crewman operating the cargo hook will direct the aircraft via hand signals (Figure 9-12).

Note

At night, it may be necessary to turn on the cabin lights to increase visibility.

2. The PNAC will relay the direction signals to the PAC. The signals may be relayed by utilizing hand signals or by applying pressure to the PAC's shoulder or elbow in relation to the desired aircraft movement (i.e., gentle forward pressure to the back of the PAC's shoulder to indicate FORWARD, gentle pressure to the bottom of the PAC's elbow to indicate UP, and pushing or pulling on the PAC's shoulder to indicate LEFT or RIGHT).

The following is an alternate method for dropping an external load with lost ICS:

3. The crewman operating the hook will direct the aircraft via hand signals (Figure 9-12).
4. The crewman not operating the cargo hook will take a position forward between the pilot seats and relay the signals to the PAC by applying pressure to the PAC's shoulder or elbow in relation to the desired aircraft movement (i.e., gentle forward pressure to the back of the PAC's shoulder to indicate FORWARD, gentle pressure to the bottom of the PAC's elbow to indicate UP, and pushing or pulling on the PAC's shoulder to indicate LEFT or RIGHT).
5. The PNAC will continue the normal scan for VERTREP operations.

Note

Pickups shall not be accomplished during lost ICS situations.

| VOICE COMMAND | HAND SIGNAL FROM AIRCREWMAN | LOST ICS SIGNAL FROM PNAC TO PAC |
|----------------------|--|---|
| WAVEOFF* | VIGOROUS CROSSING OF HANDS | VIGOROUS CROSSING OF HANDS |
| HOLD* | DOUBLE CLENCHED FISTS | FIRM GRASP OF SHOULDER |
| FORWARD | ELBOW BENT 90 DEG FINGERS EXTENDED POINTING UP | FORWARD PRESSURE |
| BACK | ELBOW BENT 90 DEG FINGERS EXTENDED POINTING DOWN | BACK PRESSURE |
| LEFT | LEFT ARM EXTENDED, FINGERS EXTENDED | LEFT PRESSURE |
| RIGHT | ELBOW BENT 90 DEG, FINGERS EXTENDED UP AND PERFORM WAVING MOTION | RIGHT PRESSURE |
| UP | PALM UP MOTIONING UP | UPWARD PRESSURE |
| DOWN | PALM DOWN MOTIONING DOWN | DOWNWARD PRESSURE |
| STEADY | CLINCHED FIST | NO PRESSURE |
| CLEARED TO GO | TAP HELMET, POINT FORWARD | THREE TAPS ON THE SHOULDER |
| HOIST GOING DOWN | CLINCHED FIST, THUMB DOWN | CLINCHED FIST, THUMB DOWN |
| HOIST GOING UP | CLINCHED FIST, THUMB UP | CLINCHED FIST, THUMB UP |
| * Mandatory | | |

Figure 9-12. Lost Communications Procedures

9.4 FORMATION FLYING

9.4.1 General

The following is a general discussion of safe formation flying basics.

Helicopter formation flight is conducted for the following reasons:

1. Improved operational capability. When properly executed, the flight leader can expect complete flexibility of operation within the limitations of helicopter maneuverability without danger of creating unsafe conditions within his formation (free cruise) or the encumbrance of delay while intentions are passed, via signal or radio.
2. Mutual safety and accountability. The danger of mid-air collision is greatly reduced when every flight member knows where they is supposed to be, and remains in their designated space.

Certain helicopter characteristics which should be considered in formation flight are:

1. Formation flying may be performed in a step-up position to avoid rotor-wash, improve visibility, and provide a greater safety margin between the main rotor and the helicopter ahead. By adjusting altitude to place the top of the rotor head of the helicopter in front on the horizon, a sufficient step-up will be maintained. A step-down position may provide the wingman better visual references at night over well lit populated areas.
2. At night, it is more difficult to ascertain when the lead helicopter changes direction and altitude. (Refer to NIGHT FORMATION in this chapter.)

9.4.2 Formation Composition

9.4.2.1 Section

The section will consist of two helicopters and will constitute the basic unit of a formation.

9.4.2.1.1 Parade

The wing aircraft will fly at a 45° bearing behind and on the appropriate side of the section leader. The horizontal helicopter-to-helicopter separation will be a minimum of one rotor diameter between rotor tips. The wingman's position in the parade section is fixed. (See [Figure 9-13](#).)

9.4.2.1.2 Free Cruise

The wingman will fly approximately 60° behind the section leader. The horizontal helicopter-to-helicopter separation will be approximately two to three rotor diameters. Normally, the free-cruise wing aircraft maintains a position 60° off the axis of the lead helicopter during straight and level flight. During turns, wing crosses over from one side of the section leader to the other to maintain position with minimum changes of power. In free cruise, helicopters in the formation are not to be considered bound to a fixed position. Rather, they are assigned a segment of airspace behind lead in which they are free to move as necessary to maintain constancy of horizontal and vertical separation. Wing should avoid continued flight directly behind lead. (See [Figures 9-14](#) and [9-15](#).)

9.4.2.2 Division

A division will consist of two sections. The general rules applying to section formations may be expanded to apply to divisions within the limits of safety and capability. The side of the division on which the section is placed will be known as the heavy side of the formation. When a flight consists of more than four helicopters, any amount over four will form subsequent divisions. The last division may be comprised of less than four helicopters.

9.4.2.2.1 Parade

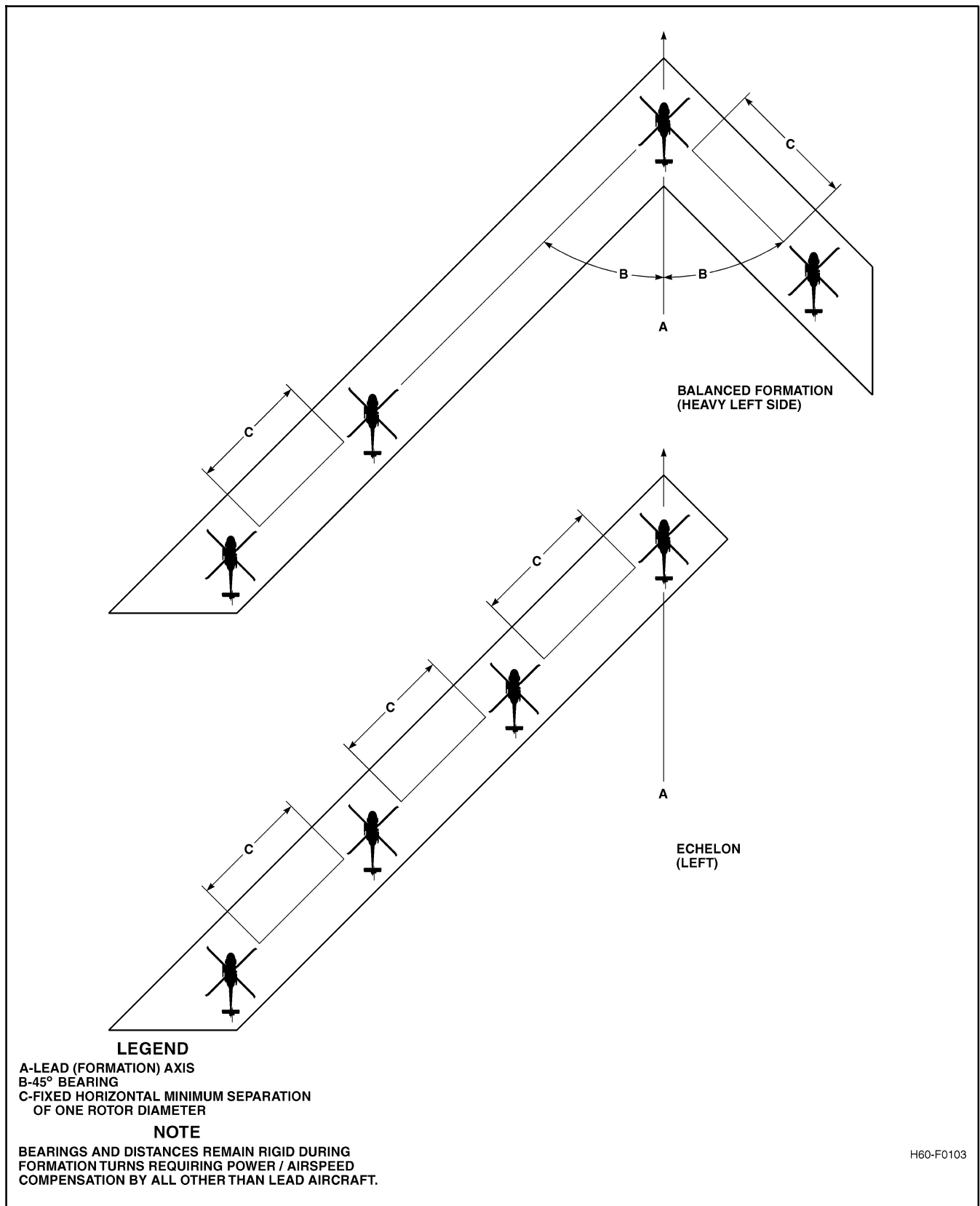
The second section lead is the number three aircraft in the division. Parade position may be flown in echelon left/right or heavy left/right.

9.4.2.2.2 Free Cruise

The second section lead is the number three aircraft in the division. The second section lead is free to cross over the section from side to side of the division lead to maintain horizontal clearance with minimum changes of power.

9.4.3 Rendezvous

Normally, the running rendezvous will be employed. Lead will fly on course at slow cruise, and the flight will take position as briefed. When the flight is joined, the lead aircraft will proceed at cruise speed. An orbiting rendezvous may be used. The lead will fly a right or left circular pattern at normal cruise speed around a designated point until the flight is joined. In an orbiting rendezvous, helicopters will join in column formation using the free cruise principle until lead rolls out on departure heading. All rendezvous helicopters should pass across the designated point, pick up altitude separation, and join on the helicopter ahead. Any overshoot tendency should be taken to the outside of the turn. Normally, thereafter, the flight will continue to maintain free cruise formation at cruise speed, unless otherwise directed by the flight lead. Extreme caution should be exercised during night rendezvous, due to reduction of perception of relative motion.



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Figure 9-13. Parade

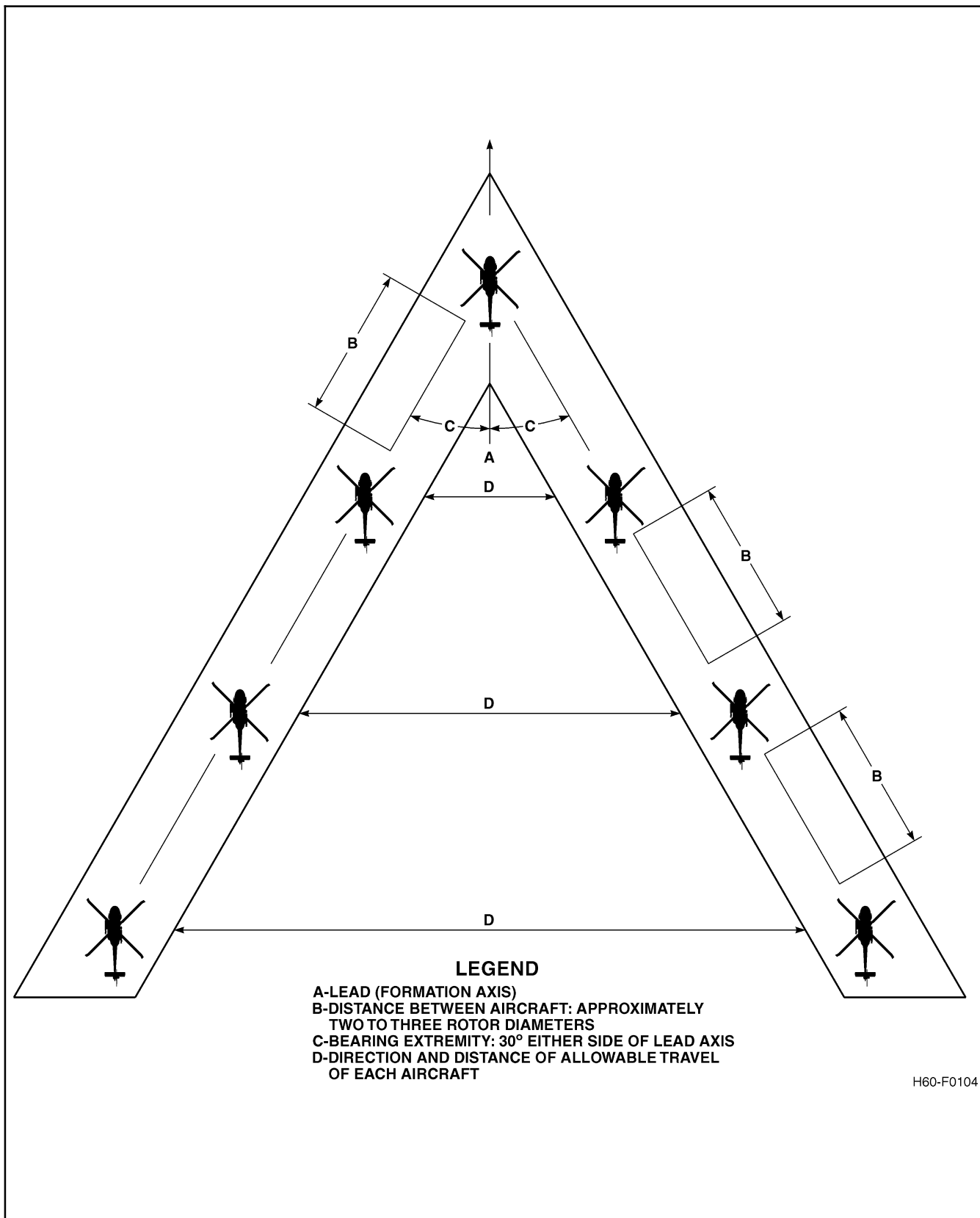


Figure 9-14. Free Cruise — Straight and Level

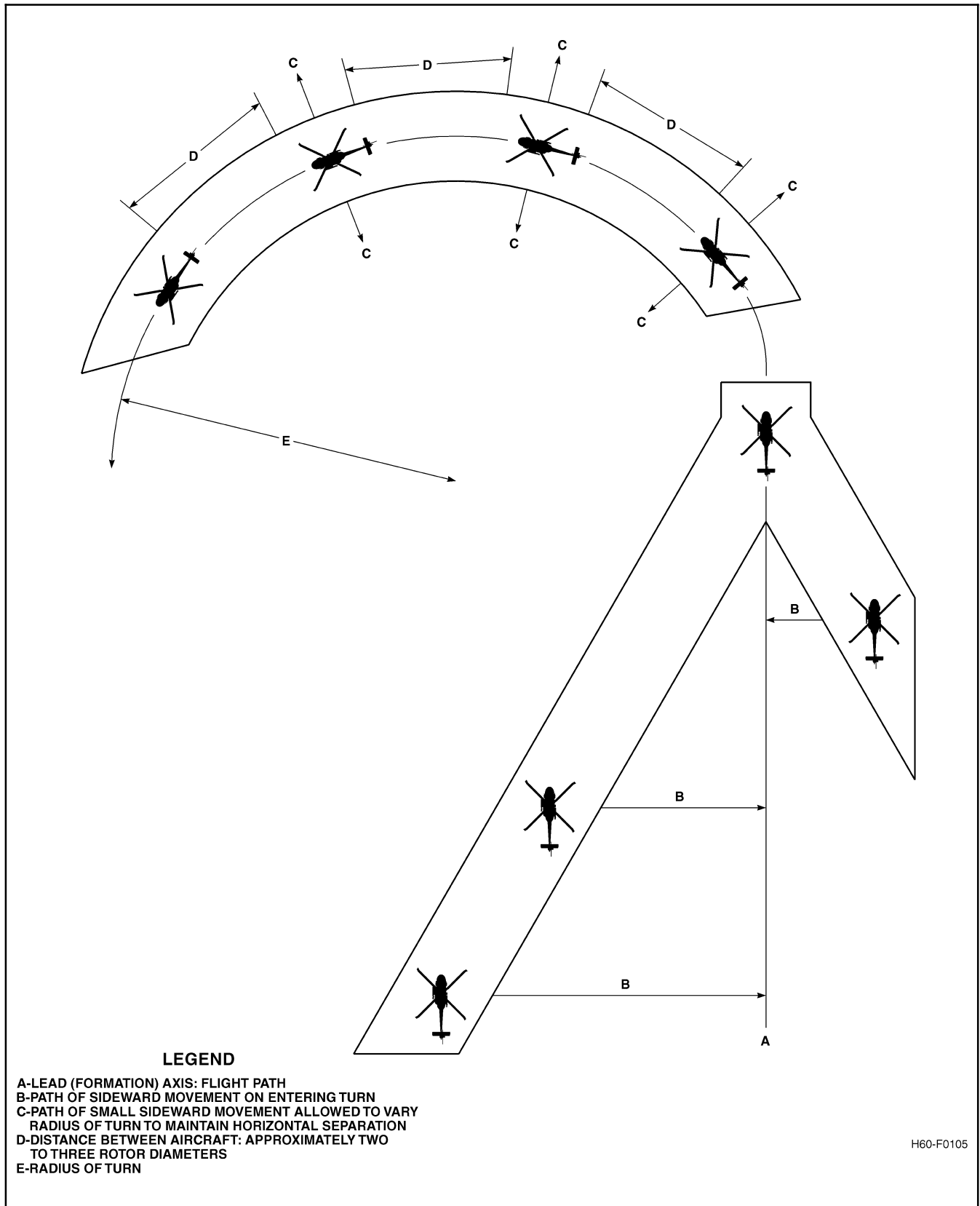


Figure 9-15. Free Cruise Turn

9.4.3.1 Breakup and Rendezvous Procedures

From a parade position, lead starts a 180° turn away from wing by executing a 30° angle of bank, maintaining altitude and airspeed. When the wing notes the lead passing through 45 relative degrees of turn, the wing will break the same direction for 180° using a 30° angle of bank turn initially and then adjusting the turn rate to arrive approximately 1,000 yards astern of the lead. The wing will then call "IN POSITION." When the "IN POSITION" call is received, lead establishes a 10° angle of bank for 180° of turn to a parade position. This turn is conducted in the opposite direction of the initial 180° turn so that the rendezvous is not conducted by the cross-cockpit pilot. The wing establishes a 15° to 20° angle of bank turn to close the lead using radius of turn without adjusting airspeed. If the rendezvous cannot be executed in 180° of turn, wing should inform lead to keep the turn in. Cardinal headings can be used for quick reference to a 180° position.

9.4.4 Conduct of Flight

Formation flight will be practiced in accordance with this doctrine during all normal, multiple helicopter movements to improve proficiency. Free cruise formation will be used for most operations. Parade formation is normally used only for special occasions such as air shows, authorized fly-bys, etc. Nothing in this instruction shall be construed as prohibiting qualified crews from flying in tactical formation (TACFORM) or performing TACFORM maneuvers.

9.4.5 Responsibility

9.4.5.1 Flight/Form/Division Lead

The flight lead is responsible for the flight brief, formation brief, conduct, and discipline of the flight. Form lead will normally handle navigation, radio transmissions, and ATC clearances for the flight. Division leaders are responsible for the conduct of their division. All aircrew are responsible for maintaining positions as outlined. No deviation of position, such as change of lead, will be made until appropriate signals have been given and acknowledged.

9.4.5.2 Wing

Wing aircraft are responsible for safe flight separation with lead or any other aircraft. In addition, wing aircraft are responsible for maintaining formation integrity and other tasks that Lead may assign.

9.4.6 Lead Change

When changes of lead are made, the wing will increase horizontal separation to at least two rotor diameters and move forward to a position abeam the lead. The lead will then be passed by appropriate pre-briefed signal. The new wing (old lead) will then drift back to the appropriate position on the new formation. Safety will govern all actions.

9.4.7 Night Formation

Night formation should be flown only when complete visual reference between helicopters can be maintained and in the same manner as day formation. This is normally construed to mean that NVDs are required for safe night formation flight. Separation between helicopters may be adjusted as deemed prudent by members of the flight and as directed by visibility conditions. Caution should be exercised to avoid unnecessarily extending the formation to the extent of limiting its operational capability, mutual safety, or ability to maintain firm visual contact with other formation members. For wing to accurately verify distance and bearing, TACAN air to air mode, formation electro-luminescent lights, or installed IR chemical lights should be used. At any time that complete visual contact cannot be maintained between helicopters or silhouette definition is lost, discontinue the formation flight and execute pre-briefed lost contact procedures. For normal operations, the last aircraft in the formation should have anti-collision lights ON.

9.4.7.1 Lost Wingman VMC

These procedures should be commenced anytime during VMC flight when a member of the flight loses sight of the aircraft forward of them or when deemed necessary by the lead. Any member may initiate these procedures by calling “BLIND”. Lost wingman procedures shall be pre-briefed to all members of the formation and should include:

1. Lead calls base heading and wing aircraft make pre-briefed coordinated turns away from lead.
2. Lead calls base altitude and wing aircraft make pre-briefed coordinated climbs/descents away from lead’s altitude.
3. All aircraft ensure applicable sensors are operational to assist in vertical and lateral separation.
4. All aircraft make clear and concise communications as to their position, altitude, and intent during the maneuvers. If any deviations to the pre-briefed plan are made, they shall be communicated over the radio.

If VMC and able to maintain VMC both aircraft should ensure vertical and lateral separation from each other and coordinate a rendezvous. In all cases clear radio transmissions, air to air TACAN, and/or other sensors should be used to the maximum extent practicable to avoid collision.

9.4.8 Instrument Flight Conditions In Formation

Normally formation flying will not be flown when the visibility is so low that helicopters are likely to lose sight of one another. When situations can be anticipated, the leader will take such action as necessary to ensure formation integrity or safely break apart the formation for IFR flight.

9.4.8.1 Inadvertent IMC Procedures

These procedures (**Figures 9-16 and 9-17**) should be commenced anytime a member of the flight loses sight of the aircraft directly ahead of them due to IMC or when deemed necessary by the lead. Any member can initiate these procedures by calling “INADVERTENT IMC” and executing the pre-briefed flight profile. The following options are not a complete safety net to ensure safe flight in inadvertent IMC conditions, but are intended as a discussion of known methods to enhance safe flight in an inadvertent IMC situation. Inadvertent IMC procedures shall be pre-briefed to all members of the formation and should include:

1. Lead calls base heading and wing aircraft make pre-briefed coordinated turns away from lead.
2. Lead calls base altitude and wing aircraft make pre-briefed coordinated climbs/descents away from lead’s altitude.
3. All aircraft ensure applicable sensors are operational to assist in vertical and lateral separation.
4. All aircraft make clear and concise communications as to their position, altitude, and intent during the maneuvers. If any deviations to the pre-briefed plan are made, they shall be communicated over the radio.

If either aircraft is able to regain and maintain VMC flight during inadvertent IMC procedure they should maintain VMC and attempt coordinate Lost Wingman VMC procedures. Extreme caution shall be used when the possibility exists for IMC conditions to develop in mountains. Inadvertent IMC in mountainous environments is extremely dangerous and can develop rapidly. In mountainous terrain, it may or may not be possible to climb above the MSA. The primary concern is for all aircraft to turn away from the rising terrain and fly in a safe direction. Inadvertent IMC breakup will require lead to provide a detailed brief of procedures and all members to have a thorough understanding of the expected topography. In addition to the previous discussion on inadvertent IMC procedures, the following options may assist in safe flight for mountainous environments.

1. Lead and wing execute maximum performance climbs at pre-briefed different airspeeds. Lead should climb at a faster airspeed than wing to assist in separation.
2. Both aircraft should climb to deconflicted altitudes above the MSA if possible.
3. If the MSA is above operational parameters a detailed understanding of the topography will be required so that aircraft can execute a turn toward a safe direction that will allow for obstacle clearance.
4. If section or division aircraft are unable to regain VMC and rejoin safely, lead shall ensure all aircraft are assigned deconflicted altitudes for IFR clearances.

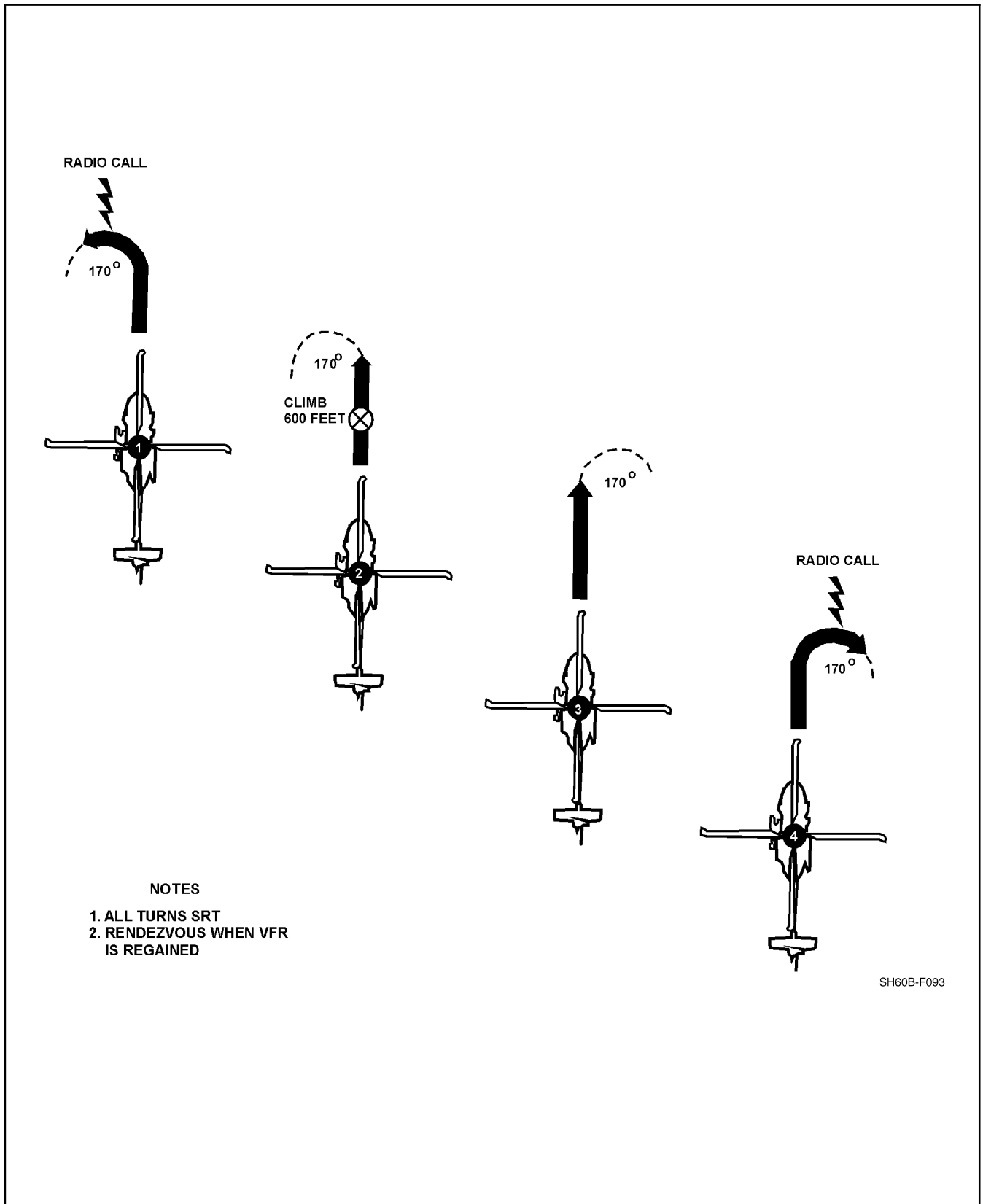


Figure 9-16. IMC Breakup Procedures (Four Plane)

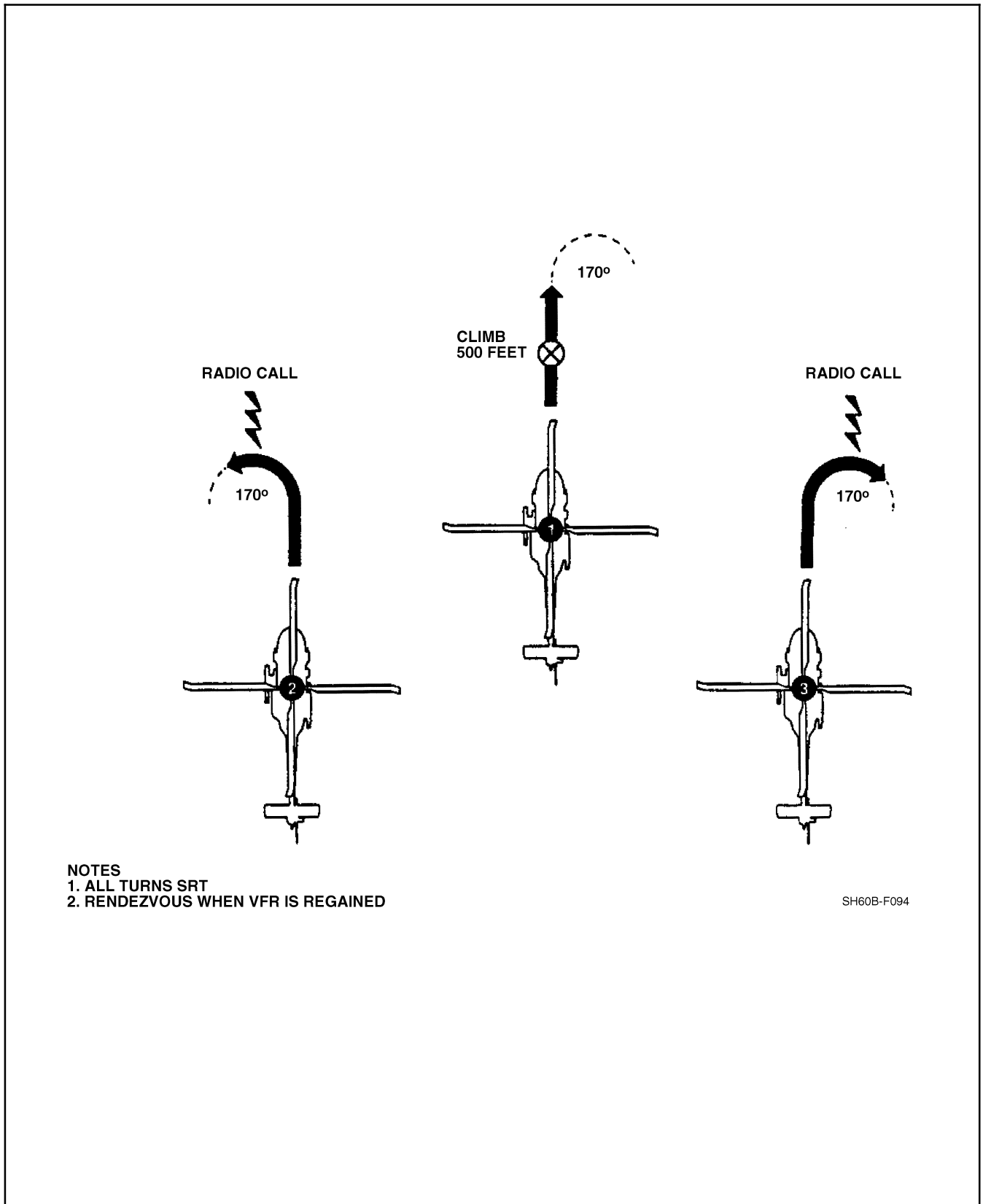


Figure 9-17. IMC Breakup Procedures (Three Plane)

9.5 TERRAIN FLYING

9.5.1 General

Consult appropriate manuals for procedures and techniques for terrain flying. The three types of terrain flying are:

1. Low level flight: Flight at a preselected altitude below 500 feet along a prescribed route, usually in straight line segments at constant airspeed.
2. Contour flight: Flight at low altitude conforming generally to the contours of the earth, with varying airspeed and altitude as vegetation and obstacles dictate.
3. Nap of the Earth (NOE) flight: Flight as close to the earth's surface as vegetation/obstacles permit. NOE is similar to contour flight but is conducted at lower altitudes and is characterized by airspeeds from a hover/air taxi to dashes of 60 to 70 Knots Ground Speed (KGS).

The close proximity to obstacles, rapid attitude adjustment, and many power changes with frequent high power demands, put a great stress on airframe and dynamic components. These same parameters demand increased attention from individual crewmembers as well as the crew as a whole. Proper crew coordination is essential. Detailed individual tasking of duties must be pre-briefed and rigidly enforced. Standard phraseology should be used to avoid confusion during critical segments of flight. Emergencies are more critical at low altitude and corrective actions must be completed expeditiously. Aircraft performance should be calculated prior to flight utilizing worst condition parameters of density altitude, gross weight and winds. The aircraft should be performance checked in flight to ensure that the calculated performance is available before terrain flying is attempted. Aircraft and pilot reaction times in all flight regimes must be considered when determining route of flight and altitude.

Note

Terrain following flights shall be accomplished only when properly scheduled, planned and briefed for that specific mission. When conducted, they should be flown no lower than is necessary to accomplish the mission.

9.6 SPECIAL WARFARE SUPPORT OPERATIONS

Special warfare support operations require maximum flexibility on the part of the aircrew. A wide variety of methods and equipment may be used to deploy and recover special warfare personnel. Therefore, it is incumbent upon the aircraft commander to ensure that all personnel are thoroughly briefed and familiar with a specific operation prior to its conduct. Although this section covers numerous operations, it is not all inclusive. Operations not addressed must be approached with maximum caution and prior planning to ensure a safe evolution. Special warfare equipment descriptions, authorizations, limitations and rigging procedures are found in NTRP 3-22.2-SH60B and NTRP 3-22.2-SH60B. Additional information concerning special warfare support operations can be found in the Air NTTP 3-22.1-SH60B/Air NTTP 3-22.1-HH60H, Naval Special Warfare Command Air Operations Manual (COMNAV-SPECWARINST 3000.3) and Special Operations Infiltration/Exfiltration Operations (USSOCOM Manual 350-6), and appropriate NSAWC publications.

9.7 NIGHT VISION DEVICE (NVD) PROCEDURES

9.7.1 General

Night vision goggles provide a significant increase in visual cues and situational awareness during night operations while greatly expanding operational capabilities. The benefits of NVDs, however are only maximized through training, thorough mission planning and proper crew coordination. Competency on NVDs begins with a firm foundation in the execution of basic helicopter pilotage skills. The importance of good crew coordination cannot be overemphasized. For additional information on NVDs and their usage, refer to the MAWTS-1 USN/USMC NVD Manual or NVD operators manual.



Do not assume that personnel operating in and around taxiing helicopters are capable of detecting hazards with the same level of situational awareness as can be attained with NVDs.

9.7.2 NVD Physiology

Flying with NVDs has a significant impact on physiology. The most obvious visual limitation of NVDs is the reduced field of view (FOV). Compared to the 188° field of view normally available, NVD FOV is reduced to 40°. This reduction necessitates an active and aggressive scan. Additionally, a reduction in visual acuity (resolution) occurs with NVDs. As a result, the ability to perceive fine details such as electrical power lines, unlighted towers, poles, antennas, and all types of wires, is significantly degraded. Brownout/Whiteout will greatly degrade visual acuity even further. Distance estimation is significantly altered with NVDs. This is caused by the inherent reduction in visual acuity and minification, which may be the result of improper preflight focus procedures. Depth perception is not lost with NVDs. Wearing NVDs for an extended period of time can cause extreme eye fatigue. This can result in converging/diverging vision, headache and eyestrain. Proper NVD preflight and adjustment procedures are critical. Improper focus procedures will compound the adverse effects of NVDs. NVD adjustment and focus procedures shall be conducted in accordance with the MAWTS-1 USN/USMC NVD Manual or the Operators manual.



Depth perception is adversely affected by NVDs. Weather may appear much further away than it actually is and closure rates are not immediately noticeable. Brownout/whiteout will greatly degrade visual acuity which could result in impact with ground other aircraft.



Flight operations involving NVDs are inherently more stressful and demanding than day flying and VMC. The resultant fatigue may have a profound physiological effect upon mission capability. Mission planners should take this physiological threat into account in making modifications to normal crew rest/crew day guidelines.

9.7.3 Lighting Considerations

NVD enhancement is inversely proportional to altitude and airspeed, i.e. the lower and slower you fly; the better your visual acuity. However, in low illumination conditions, the low/slow altitude and airspeed combinations required to adequately see may prohibit the conduct of safe NVD operations. Haze, smoke, low illumination due to overcast conditions or lack of cultural lighting can also diminish the effectiveness of NVDs.

9.7.4 NVD Operations Over Water

Procedures for operating on NVDs over water shall be the same as those for operating over water at night unaided and in accordance with applicable wing directives.

9.7.5 NVD Shipboard Operations

All NVD shipboard operations to include takeoff, goggle/degoggle procedures shall be thoroughly briefed and handled in accordance with applicable directives. When it has been decided to goggle or degoggle, it shall be completed on deck or in straight and level flight.

9.8 MOUNTAIN TERRAIN FLYING

Many helicopter missions require flight and landing in rough and mountainous terrain. A thorough knowledge of mountain flying procedure and aircraft performance parameters is essential for successful operations. Along with the adverse effects of high-density altitudes on helicopter performance, pilots must overcome severe visual illusions and operate in winds with large vertical components. Mountain winds are dramatically affected by terrain and convection cooling and heating; it is not unusual to encounter 2,000 - 5000 fpm up or downdrafts. In non-mountainous flying, the horizon is the primary spatial reference. In mountain flying, there is often no defined horizon and spatial cues are derived from vertical and sloping terrain. These two factors, wind and illusion, combined with high-density altitudes and confined landing sites, make mountain flying a demanding flight regime. Flight in mountainous terrain requires thorough preflight planning with aircraft performance parameters being carefully calculated for all segments of the flight.

Power requirements drop quickly with increased wind, especially up-flowing wind; however, local winds are difficult to predict and it is not advisable to use wind in performance calculations. Predicting winds should be used in route planning and alternate routes selected in the event adverse winds are encountered. Prior to all landings, the landing site must be evaluated and winds determined.

9.9 LANDING SITE EVALUATION BRIEF

The five major considerations that the aircrew should use when evaluating a potential landing area are summed up by the acronym SWEEP.

1. S — Size, slope, suitability, surface (grass, snow, rocks, dust, etc.).
2. W — Winds (Direction, demarcation, turbulence, loss of effect due to obstacles).
3. E — Escape routes (Dropoff, waveoff).
4. E — Elevation of LZ (PA and DA).
5. P — Power (Available vs required. Includes takeoff power after taking on additional weight.)

The transition period is the most difficult part of any approach. As helicopter performance decreases, the transition period becomes more critical, requiring a shallower, gradual approach. Therefore, as the height of obstacles increases, larger areas will be required. As wind velocity increases, so does helicopter performance. However, when the helicopter drops below an obstacle, a loss of lift generally occurs as a result of the aircraft being unable to immediately negotiate the change. This is prevalent at the upwind side of the landing zone, where a virtual null area exists. This null area extends toward the downwind side of a clearing and will become larger as the height of obstacles and wind velocity increases. In the landing phase, it is increasingly important that this null area be avoided if marginal performance capabilities are anticipated. The null area is of particular concern when performing a takeoff from a confined area. Under heavy load or limited power conditions, it is desirable to achieve forward velocity and translational lift before transitioning to a climb so that performance will be improved. If the takeoff is not commenced from the most downwind portion of the area and translational lift is not achieved before arrival in the null area, a significant loss in lift may occur during the most critical portion of the takeoff. It must also be noted that in the vicinity of the null area a nearly vertical downdraft may be encountered, which will further reduce the actual climb rate of the helicopter. It is feasible 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. Although this is a departure from the cardinal rule of takeoff into the wind, it may well be the proper solution when all factors are taken into perspective. Never plan an approach to a confined area from which there is no reasonable route of departure. The terrain within the site is determined from an evaluation of vegetation, surface characteristics, and slope. Care must be taken to avoid placing the rotors in low brush or branches. Obstacles covered by grass may be located by flattening the grass with rotorwash before landing. Power should be maintained so that an immediate takeoff may be made should the helicopter begin rolling due to soft earth, a hidden hole, or a depression.



Cabin windows shall not be installed or removed in flight, except during actual aircraft emergencies.

Note

Consideration may be given to removing the port cabin window, drop tanks, and extended pylon for unprepared landings. This will assist in landing zone evaluation and obstacle clearance during approach and landing.

9.9.1 Illusions

Mountainous low level flight represents an unusual visual environment. The horizon may not be visible, and we are surrounded with vertical and sloping visual cues. These visual cues cause illusions that if not recognized lead to:

1. Misjudging the relative height of an LZ due to upsloping or downsloping terrain, resulting in climbing above or descending below approach glideslope.
2. Climbing and losing airspeed when flying into rising terrain.
3. Descending and accelerating when flying away from falling terrain.
4. Misjudging the relative height of ridges with higher terrain in the background.

Pilots must develop the ability to maintain an instrument scan while flying VFR at low level in rugged terrain. This skill is essential to maintaining good basic airwork, and mountain flying techniques and procedures cannot be accomplished without it.

9.9.2 Mountain Winds, Turbulence and Topography

9.9.2.1 Winds

Most pilots' understanding of wind is limited to movement over a flat surface or at altitude, unobstructed by terrain. Under these conditions, wind flows horizontally, in one direction, at a relatively constant velocity. In fact, aircraft performance charts are based on horizontal winds. Prior to each flight, preflight performance calculations are computed using the prevailing winds as the reference. Mountain winds are three-dimensional; wind not only flows across mountainous and rough terrain, it also flows up, down, and around terrain and obstacles. The vertical component can dramatically improve or reduce aircraft performance. A 30-knot wind flowing up a 45° slope can produce an updraft in excess of 1,500 fpm. Conversely, the same wind flowing down-slope can produce a downdraft in excess of 1,500 fpm. Another critical concept in mountain flying is boundary layer air. As an air mass moves across rising terrain, a blanket of vertically moving air forms a boundary layer. Mountain operations should be conducted in this boundary layer in order to optimize the performance capabilities of the helicopter. This is because airflow tends to be laminar in the boundary layer. The boundary layer normally occurs at altitudes less than 100 feet AGL, but may extend up to 200 feet AGL in higher wind velocities. An understanding of the type of winds associated with mountain operations, where the winds will most likely be encountered, and how the winds affect mountain operations, is critical to the safe completion of mountain flying. The most common winds associated with mountain and rough terrain operations are prevailing winds and local winds. Local winds are further broken down into local mountain winds, anabatic, katabatic, and land-sea breezes.

9.9.2.1.1 Prevailing

Prevailing wind is the movement of air from an area of high pressure to an area of low pressure, which is deflected by the rotation of the earth. Prevailing winds have relatively constant direction and velocity and are associated with a geographic region. When the boundary layer is formed by light prevailing winds, strong, steady gradient winds may often bend the boundary layer winds as much as 180°.

9.9.2.1.2 Local Winds

9.9.2.1.3 Local Mountain Winds

Local mountain winds are created by the formation and movement of high or low-pressure systems and frontal winds. In the northern hemisphere these systems generally move from west to east. Low-pressure winds are usually moderate to heavy and move either northeasterly or southeasterly. High-pressure winds are usually light and variable and circulate in a clockwise direction. These systems usually flow in the opposite direction in the southern hemisphere. Flying conditions, although poor in low-pressure regions, are always at their optimum when regions of high pressure are dominant.

9.9.2.1.4 Anabatic

Anabatic winds, also referred to as gradient convection winds, are created as the mountain slopes or valleys are heated by the sun. As the surface is heated, the resultant warm air rises, causing a gradient of up-flowing wind. As the heated air rises, cooler air descends and the process repeats. If the rate at which the surface air is being heated is slow, there will be pauses in the gradient winds. During periods of intense solar heating (mid-afternoon) the surface air is rapidly heated, producing steady and possibly strong gradient winds. Anabatic winds are strongest from late spring to early autumn or when a warm high-pressure system dominates a region for a long period of time.

9.9.2.1.5 Katabatic

Katabatic winds, or cool descending gradient winds, are created when cool air descends down gradients, causing cool, steady, and sometimes gusty gradient winds. Katabatic wind usually occurs during periods when solar heating has slowed, such as in the evening. It is strongest at the base of glaciers or snowfields situated on a gradient.

9.9.2.1.6 Land-Sea Breezes

Land-sea breezes are breezes that blow due to temperature differences between bodies of water and land. They affect mountain ranges that are in proximity to large bodies of water. The cooler, heavier air flows toward the warmer water, creating a land breeze. Conversely, sea breezes occur when the water is cooler than the land surface and the breeze flows from the water to the land. Sea breezes are common during the day whereas land breezes usually occur at night. Land-sea breezes will be strongest when the temperature differential is greatest.

9.9.2.2 Turbulence

Turbulence encountered during mountain operations is much different than turbulence encountered at altitude. Except for sheer-zone turbulence, the topography of mountainous regions and wind results in many different types of orographic turbulence. Determining and understanding where turbulence may exist and where smooth air separates from turbulent air, commonly referred to as the demarcation line is critical to the safe completion of mountain operations. In general, turbulence will always be present under the following conditions: down-flowing air; up-flowing air associated with mechanical, air mass, or sheer-zone turbulence; and where wind of different types/directions mix. Additionally, low-pressure systems are often turbulent and unstable. Flying techniques that will assist in determining where turbulence may exist will be discussed in the section for procedures and techniques. Orographic turbulence can be broken down into the following categories: mechanical, down-flow, air-mass, and sheer-zone turbulence.

9.9.2.2.1 Mechanical

Mechanical turbulence is formed as the wind flows over rugged terrain and obstacles. Ripples of turbulence form on the leeward side of boulders/rocks and mix with the up-flowing air. As wind velocity increases, the severity of turbulence increases.

9.9.2.2.2 Convective

Rising air currents created by uneven surface heating forms convective turbulence. Convective turbulence is normally found at a relatively low height above terrain, generally less than 2,000 feet AGL. Under certain conditions, it may reach as high as 8,000 feet AGL. It is most prevalent over barren terrain and during periods of low wind conditions. Pilots should anticipate turbulence when transitioning from these areas to terrain covered by vegetation or snow. Convective turbulence seldom gets severe enough to cause structural damage.

9.9.2.2.3 Down-Flow

Down-flow turbulence is created by the wind tumbling, once it breaks the top of the hill. As wind flows up a mountain, a region of high pressure forms across it. The leeward side is sheltered by the mountain creating an area of lower pressure. As the wind flows over the mountain, high-pressure air naturally flows toward the area of low pressure resulting in a downflow of swirling turbulence, which can be extremely dangerous to an aircraft flying in this region. Again, as wind velocity and terrain gradient increases, the severity of the turbulence increases.

9.9.2.2.4 Backlash

Backlash is similar to down-flow turbulence. It is caused by wind rushing up a steep face with an abrupt, sharp-cornered top. Backlash can exist at the top of any mountain that has a severe slope with a fairly abrupt top. In high prevailing wind (above 15 knots), severe backlash can be expected. As the wind velocity increases, the backlash will move closer to the windward edge of the ledge and its severity will increase.

9.9.2.2.5 Air-Mass

Air mass turbulence is the result of severe high- or low-pressure systems moving across mountain ranges. As the air-mass moves over the range, the prevailing wind accelerates as it moves up and down the mountains. The constant vertical movement of the mountain winds mixes with the prevailing winds at altitude, resulting in turbulence. The wind continues flowing across the mountain range and carries the turbulence created along its path. Air-mass turbulence is of concern to pilots because it can exist up to hundreds of miles downwind from a mountain range.

9.9.2.2.6 Sheer Zone

Sheer zone turbulence occurs when two or more winds meet, but are traveling in different directions. A common cause of this sheer-zone turbulence is a region of low pressure riding over a region of high pressure. A line of turbulence will exist where the two fronts overlap. The larger the pressure differential between the two regions, the more intense the turbulence. The most concerning form of sheer-zone turbulence occurs when two local air masses meet (i.e., down-flow from a slope converges with perpendicular winds traveling up a valley).

9.9.2.3 Topography

9.9.2.3.1 Ridges

Ridges are crests of mountains that normally run in a straight line parallel to a valley. Usually ridge summits are rounded, smooth, and barren. In some instances, ridges have narrow, jagged, comb-shaped tops caused by constant prevailing winds and harsh weather. Pilots can expect up sloping winds on the windward side of a ridge and down sloping winds on the leeward side. If the wind is strong and the slope is steep and sharp, turbulence can be expected immediately after the break in the crest.

9.9.2.3.2 Crowns

Crowns are the tops of a round conical hill or ridge and usually have gentle slopes. Wind tends to be up sloping on the windward side and hug the side slope to the leeward side where down slope air will be encountered.

9.9.2.3.3 Shoulders

Shoulders are protrusions usually found on sloping ridgelines and the side slopes of mountains. Small shoulders on long side slopes are commonly referred to as nubbins. Shoulders and nubbins often have gentle tapering slopes surrounding them and often present severe illusions. Winds associated with shoulders may emulate winds associated with ridges or crowns depending on topography and wind type/velocity.

9.9.2.3.4 Ledges

Ledges are very similar to shoulders in that they are protrusions found on ridges and mountains. Instead of having a gentle, tapering slope surrounding the area, ledges have a steep side leading to a nearly vertical step. Like shoulders, winds associated with ledges may emulate winds associated with ridges or crowns depending on topography and wind type/velocity.

9.9.2.3.5 Saddles

Saddles are U-shaped passes typically found between adjacent crowns in mountain formations. Saddles are usually developed through years of glacial and normal erosion. The lay of the terrain and direction of erosion create a grain, which may indicate a dominant wind direction associated with the saddle. As wind flows through a saddle it is compressed and accelerated, which may produce a venturi effect. During high wind conditions (in excess of 25 knots), the venturi effect may create a dangerous situation to aircraft flying on the leeward side of the saddle.

9.9.2.3.6 Canyons and Ravines

Canyons and ravines are long narrow valleys formed by erosion between high steep cliffs and often contain a stream or creek running through them. In addition to possible up-flowing or down-flowing local mountain winds, anabatic wind usually flows up canyons, becoming stronger as daytime heating increases. When upper level air cools or a cooler air mass passes into the region, wind will tend to flow down the canyon.

9.9.2.3.7 Alpine Meadows

Found at high altitudes, alpine meadows occur where the tree line begins thinning out. Vegetation consists of small bushes, short grass, and sporadic trees. Meadows may be fully confined, partially confined, or wide open with the terrain; they generally vary from a gentle to medium slope. Winds associated with alpine meadows are dependent upon the effects of the surrounding topography; however, pilots can usually expect a boundary layer to exist.

9.9.2.3.8 Pinnacles

Pinnacles are steep spires that usually terminate in a small plateau type summit. Pinnacles are the result of years of glacial erosion and are generally associated with high altitudes. Prevailing or local winds are usually dominant over pinnacles; however, they may be affected by anabatic wind during periods of daytime heating.

9.9.2.3.9 Cirques

Cirques are recessed, bowl-shaped regions at the head of valleys, created through years of glacial erosion. As a glacier melts, the coarse erosion causes piles of rock and gravel to remain at the base of the cirque near the headwall. Cirques are generally found in high altitudes, with bases starting at 6,500 feet and rims rising in excess of 10,000 feet. It is not uncommon to find rapid variations in wind direction in cirques, especially at the base and near the headwall where landings are expected to be made. Even in moderate winds, severe turbulence can be expected in these regions. If these conditions are present, landings are not recommended.

9.9.3 Aircraft Performance

Of all the factors to be considered when contemplating mountain/rough-terrain flight, preflight planning is the most critical. An analysis of ambient conditions at the expected operating altitudes is indispensable in determining the likelihood of success, operating envelope, and power margins a pilot can expect to encounter. The two methods for determining power available are:

1. Performance Calculations:
 - a. Power required vs. Power available.

Consult the appropriate charts (Maximum Power Available, Engine Performance, Ability to Maintain Level Flight, HIGE, HOGE, and Bladestall) before flight, and then perform power checks to confirm that the power calculated is actually available. The Maximum Power Available chart determines if the performance of the engine under specified ambient conditions is acceptable. The Engine Performance illustrates the manufacturer specifications on how the engine should perform and is not based on flight test data. The Ability to Maintain Level Flight chart is used to determine the single-engine torque that can be expected at a given gross weight, temperature, airspeed, and altitude.

- b. Procedures:

- (1) Calculate density altitude at takeoff and at all expected landing elevations. If only takeoff ambient conditions are available, extrapolate high-altitude temperatures using the standard adiabatic lapse rate of -2°C per 1,000 feet.

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- (2) Calculate maximum power available and engine performance for takeoff and all expected landing density altitudes.
- (3) Calculate indicated torque required to hover in and out of ground effect (HIGE and HOGE) at takeoff and all expected landing density altitudes.
- (4) Calculate maximum airspeed as limited by blade stall for expected operating altitudes and angles of bank.

Use no wind scenario when developing all calculations.

Power available shall be equal to or greater than HIGE power required. HOGE power required shall be less than or equal to the dual-engine torque transmission limit for the LZ.

9.9.3.1 In Flight Power Available Check

Perform In Flight Power Available Check as follows:

1. ECS/ANTI-ICE and CONTGCY PWR switches — OFF.
2. Stabilize aircraft at intended operating altitude, level the VSI, ball centered, 100 to 130 KIAS. Airspeed is dependent on environmental conditions and gross weight.
3. Gradually increase collective until N_p begins to droop on either engine or maximum dual-engine torque limits are reached. Stabilize for 5 seconds and record indicated torque.

9.9.3.2 Power Required

1. When making a landing to a surface area smaller than your rotor diameter such as a pinnacle or ridgeline, power greater than HOGE may be required to arrest descent.
2. When landing to an area where the flat surface is not at least two rotor diameters, power greater than HOGE may be required to arrest descent.
3. If the chosen path of an approach does not afford a clear escape route, HOGE plus 5 percent may be required.
4. If sufficient power is not available, either lighten the helicopter or locate a more suitable landing site.

9.9.4 Mountain Flying Procedures and Techniques

The best method to avoid terrain-generated turbulence is to acquire sufficient altitude or alter flight plans when transiting mountainous regions. If a route around or well above the region is impractical due to mission considerations, certain flying techniques must be used in order to traverse the region. Turbulence will be found near the middle and downwind side of a canyon or ravine. When a helicopter is operated at or near its service ceiling and a downdraft of more than 100 fpm 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 aboard that side of the pass or canyon that affords an up sloping wind. This procedure not only provides additional lift, but also provides a readily available means of exit in case of emergency.



- Loss of tail rotor effectiveness is characterized by uncommanded right yaw. It may be encountered when operating at high-density altitudes in high-power regimes. Arresting high rates of descent outside translational lift and attempting approaches out of the wind increase the likelihood of encountering loss of tail rotor effectiveness. Immediate reduction of collective, selection of contingency power, and transition to forward flight or a right turn to drop-off is required to restore directional stability.
- The technique of flying through the middle of a pass or canyon to avoid mountains invites disaster. This is frequently the area of greatest turbulence, and in case of emergency, the pilot has little or no opportunity to turn back because of insufficient turning space.

9.9.4.1 Wind Finding

Determining the direction of the wind is the key to safely executing an approach and landing in mountainous areas. The most reliable method is the use of smoke generators; however, hand-held day/night distress signals and smoke hand grenades are a serious fire hazard in areas covered by combustible vegetation. Observation of foliage may indicate the direction of the wind, but is of limited value in determining wind velocity. The greater the velocity, the more accurately the direction may be defined. Doppler and instantaneous hover displays in the H-60 will give an indication of wind direction, velocity, and ground speed. These winds are unreliable in contour and terrain flying due to vertical and shifting wind components and should not be used as the primary method of determining wind direction and velocity.

9.9.4.2 Contour Crawl

The contour crawl is an invaluable flight technique used to determine wind direction within the boundary layer. This flight technique is accomplished by flying as close to the mountainside as the terrain will safely permit; generally one to two rotor disks is considered optimal. Fly at a constant barometric altitude and indicated airspeed while monitoring power (torque) settings. The characteristics of the boundary layer wind are determined by comparing torque settings and observing aircraft crab angles and apparent relative groundspeed. The purpose of the contour crawl is to safely determine the characteristics of the airflow in the boundary layer for the area in which the aircraft is operating. Flight should be conducted in up-flowing air to the maximum extent possible. The contour crawl provides information about the terrain and boundary layer winds. This information is the building block for landing site reconnaissance. The five types of landing site reconnaissance are the figure eight, crossover, circle, cirque and canyon recce. It is important to note that LZs that initially appear to be workable may not be suitable for landing and an alternate LZ selection will be required.

The contour crawl is flown in the boundary layer at 60 KIAS level and balanced flight. Determine baseline torque by flying outside the boundary layer at 60 KIAS level and balanced flight at the approximate altitude you plan to work. Note the indicated torque. The baseline torque is generally between 45 and 55 percent. Begin the contour crawl by flying inside the boundary layer at 50 to 100 feet below the mountaintop, as close to the terrain as safety will permit. The boundary layer extends anywhere from one to four rotor diameters (50 to 200 feet), dependent on wind velocity and terrain. It is recommended that the PAC maintain one to two rotor diameters from terrain to accurately assess its full effect. Diligently maintain airspeed and altitude; deviations caused by poor airwork will produce erroneous power settings, making it difficult to determine wind direction. The illusions created by mountainous terrain require a frequent scan of airspeed and altitude. Compare indicated torque to baseline in order to determine if the aircraft is in up-flowing air or down-flowing air.

The characteristics of boundary layer air are:

1. UP-FLOWING.
 - a. Torque settings lower than baseline.
 - b. Smooth buoyant air.

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- c. The aircraft will have a solid feeling with airspeed easily maintained.
- d. At higher wind velocities, the aircraft will crab away from the terrain in balanced flight.

2. DOWN-FLOWING AIR.

- a. Torque settings higher than baseline.
- b. Turbulent air.
- c. At higher wind velocities, the aircraft will crab into the terrain in balanced flight.

9.9.4.3 Mountain Recce

The purpose of the mountain recce procedure is to identify and pinpoint the landing site elevation, touch down position, and to determine wind direction through torque setting, trim, and a comparison of apparent ground speed. The type of mountain recce procedure conducted is based on terrain and may require a combination of different recce passes to determine the safest approach path for the landing site and wind conditions. The standard mountain landing evolution should consist of a recce procedure, an overshoot approach, and an overshoot approach to landing.

9.9.4.4 Figure Eight Recce

The figure-eight recce is the basic LZ evaluation method. The figure-eight recce can be used to evaluate landings to ridges, crowns, shallow set saddles, shoulders, ledges, pinnacles, and alpine meadows. The contour crawl provides a general look at areas that are suitable for landing, determines up-flowing and down-flowing air, and the approximate elevation of selected zones.

The figure-eight recce consists of a minimum of two 60 KIAS passes in opposite directions with the LZ at eye level. On the basis of the information gathered in the contour crawl, set up for eye-level passes on the side of the terrain with up-flowing air and a suitable drop-off. Drop-off is the area below and away from the terrain suitable for the aircraft to descend and accelerate, returning to a safe flight regime if a power deficit is encountered for any reason. Eye-level passes must be made at constant indicated airspeed and altitude in balanced flight. Using wing-down/top rudder will disguise crosswind drift, making it difficult to assess the wind line. Gather information on groundspeed by looking straight ahead. Throughout the recce make all turns away from the terrain to allow for drop-off.

1. Eye-level pass #1.
 - a. Fly past the intended landing area at eye level and note the exact barometric altitude.
 - b. Determine the most level part of the landing area.
 - c. Pinpoint the LZ and identify references (i.e., trees, rock formations) to mark zone.
 - d. Evaluate the approach and departure path to the zone.
 - e. Note torque setting.
 - f. Note apparent groundspeed.
 - g. Note crab angle and drift while maintaining balanced flight.
2. Eye-level pass #2.
 - a. Fly a second pass parallel to the first, in the opposite direction.
 - b. Note torque setting and compare it to the previous pass.
 - c. Double check zone elevation (BAR ALT).
 - d. Note crab angle and drift. Compare with previous pass.
 - e. Note apparent ground speed relative to last pass. (This will assist in determining the horizontal wind component.)
 - f. Estimate the wind direction based on crab angles and apparent relative ground speed.
 - g. Determine precisely where you intend to place the main mounts in the zone, verbalize for crew concurrence.

3. Indications of a downwind recce or approach.
 - a. Rapid decay in airspeed when deceleration attitude is set.
 - b. High torque is required over the LZ.
 - c. Poor airspeed recovery following an overshoot.
 - d. Difficulty in maintaining basic airwork.
 - e. Tail-low attitude and fishtailing.
 - f. High apparent ground speed.
 - g. Minimum crab angle required to maintain track.
4. Indications of an upwind recce or approach.
 - a. Smooth decay of airspeed when deceleration attitude is set.
 - b. Low torque is required over the LZ.
 - c. Rapid airspeed recovery following an overshoot.
 - d. Low apparent groundspeed.

9.9.4.5 Crossover Recce

Deep set saddles may not be suited for the figure-eight recce. The crossover recce should be used instead. Helicopters with multiple aircrewman may use the crossover recce in place of the figure-eight recce.

1. Crossover recce.
 - a. Contour crawl in the area of the saddle. Determine the up-flowing and down-flowing sides of the saddle and the elevation of the LZ.
 - b. Based on relative apparent ground speed, torque settings and crab angles during the contour crawl, determine the most probable direction of the wind.
 - c. Fly through the saddle at 150 feet above the LZ from the upflowing side to the downflowing side. Make the crossover at an angle less than 45° while maintaining drop-off.
 - d. Make multiple crossover passes until the wind direction has been confirmed by comparing ground speed, torque, and crab.

9.9.4.6 Circle Recce

The circle recce is suited for no or low wind conditions around prominent crowns, pinnacles or large confined areas away from higher terrain. Size, slope and suitability are easy to judge but will be seen only out one side of the aircraft unless the circle recce is flown in both clockwise and counterclockwise.

1. Circle recce.
 - a. Maintain a 60 KIAS constant distance circle from the LZ at eye level.
 - b. Wind direction is determined by noting the angle of bank required to maintain constant distance throughout the circle. The side of the circle with the highest angle of bank required is the downwind side.

Note

It is not recommended that you use the circle recce in high winds, as it may expose you to unnecessary excessive downflow.

9.9.4.7 Cirque Recce

The cirque recce is suited for cirques and confined bowl-shaped terrain where standard figure eight recce passes would not be effective.

1. Cirque recce.
 - a. Fly the first pass above the ridge of the cirque checking for obstructions and down-flow conditions within the cirque.
 - b. Subsequent passes will utilize modified figure eight recce passes along the sides of the cirque walls to determine up-flow and down-flow areas.
 - c. Fly each additional pass by descending 150-300 feet per pass.
 - d. Maintain drop-off to max extent possible. If the torque margin is minimal and up-flowing air or upwind approach conditions are not available, consideration should be given to a more suitable landing site.

9.9.4.8 Canyon Recce

When landing in canyons or narrow valleys, the canyon recce should be used. Visual horizons are severely disrupted in canyons and illusions can present a serious problem. Basic airwork and instrument scan should be emphasized. Avoid flying in the center of the crevasse so that drop-off can be maintained.

1. Canyon recce.
 - a. Fly the first pass above the ridge of the canyon checking for wires, trees or other obstructions within the canyon.
 - b. The second and subsequent passes will utilize modified figure eight recce passes along both sides of the canyon walls in order to determine the region of up-flow.
 - c. Once the up-flow region has been determined the pilot shall fly each additional pass by descending no more than half the distance to the canyon floor until within 200 ft AGL of the canyon floor.
 - d. Once the elevation of the landing site can be estimated and the wind direction determined an overshoot pass shall be conducted to determine landing site suitability and precise elevation.
 - e. Maintain drop-off to the maximum extent possible. If the torque margin is minimal and up-flowing air or upwind approach conditions are not available, consideration should be given to finding a more suitable landing site.

9.9.5 Standard Mountain Approach and Landing

A flat approach with a loaded disk and minimum rate of descent is required in mountainous terrain. Power requirements are reduced by eliminating the need to arrest a high rate of descent. The mountain approach should be made to a spot in up-flowing air whenever possible. Up-flowing air in the LZ is generally found at the forward edge of the zone nearest the windward side of the terrain. Contingency power shall be on for all overshoot approaches.

1. Overshoot approach.
 - a. Commence approach into the wind at 50 feet above LZ elevation as determined during recce passes with CONTGY PWR on.
 - b. Fly a smooth accurate shallow approach simulating an approach to landing to 10-20 feet above LZ. Do not slow below translational lift (approximately 20 knots).
 - c. Note crab angle and drift while maintaining balanced flight.
 - d. Monitor torque throughout the approach.
 - e. Note relative groundspeed.
 - f. Ensure your flightpath takes advantage of any drop-off at the terminal stage of the approach to waveoff if necessary.
 - g. Multiple overshoot passes should be flown prior to final landing.

2. Landing.

- a. Fly the overshoot approach to a 2 - 3 foot hover.
- b. From the hover the aircraft should be lowered to touchdown.
- c. Once the main mounts are on the deck, slowly reduce collective while ensuring the ability of the terrain to support the aircraft.



Snow landings at unfamiliar sites should be avoided unless underlying ground conditions can be determined. If a landing is attempted maintain sufficient power to remain light on the landing gear. A normal reduction of power may result in a sudden drop through the crust of the snow resulting in damage due to hidden obstacles or sloping terrain.

9.9.6 Mountain Takeoff and Departure

Mountain takeoffs should be executed with no lateral drift and minimum time spent in a hover. Takeoffs with the wind outside the forward 45° region may be attempted when it is determined that up-flowing air and drop-off will permit a crosswind or downwind take off. Establish a stable low hover ensuring the wheels are free of rocks, bushes, etc. Once power is checked, smoothly ease the cyclic forward in the desired takeoff direction. Fly the aircraft in the desired direction until translational lift is achieved. Steadily increase airspeed until maximum climb airspeed is reached. When attempting a takeoff from a confined area under a heavy load or limited power conditions, it is desirable to attain forward velocity and translational lift before transitioning to a climb so that the overall climb performance of the helicopter will be improved. Never plan an approach to a confined area from which there is no reasonable route of departure.

9.9.7 Guidelines

The following guidelines are considered to be most important for mountain terrain flying:

1. Make a continuous check of wind direction and estimated velocity.
2. Plan your 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 in order to take full advantage of any possible wind effect.
4. The standard mountain landing evolution should consist of a recce procedure, an overshoot approach, and an overshoot approach to landing.
5. Give all cloud formations a wide berth.
6. When evaluating a landing site in non-combat operations, execute as many passes as necessary (at least one high and one low) before conducting operations into an unfamiliar landing area.
7. Fly as smoothly as possible and avoid steep turns.
8. Cross mountain peaks and ridges high enough to stay out of downdrafts on the leeward side of the crest at approximately a 45° angle.
9. Evaluate the obstacles in the landing site and consider possible null areas and routes of departure.
10. Avoid downdrafts prevalent on leeward slopes.
11. Plan your flight to take advantage of the updrafts on the windward slopes.

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12. Landing site selection should not be based solely on convenience, but consideration should be given to all relevant factors.
13. Whenever possible, approaches to ridges should be along the ridge rather than perpendicular.
14. Determine ability to hover out of ground effect prior to attempting a landing.
15. Avoid high rates of descent when approaching landing sites.
16. Watch for rpm surges during turbulent conditions. Strong updrafts will cause rpm to increase, whereas downdrafts will cause rpm to decrease. When heavy turbulence is encountered, a 5 to 15 knot reduction in airspeed is recommended.
17. Know your route and conduct a thorough brief before flying in these areas. (See **Figures 9-18 to 9-21.**)

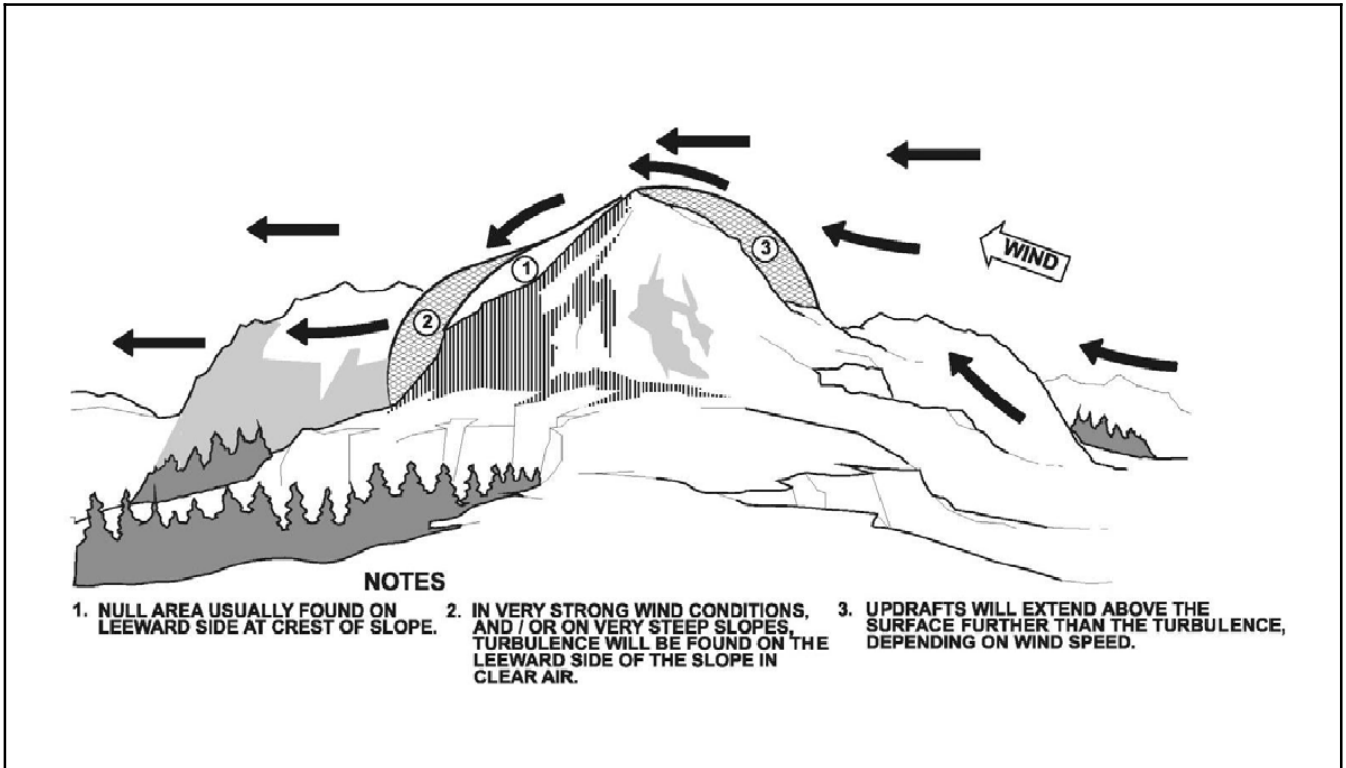


Figure 9-18. Windflow Over and Around Peaks

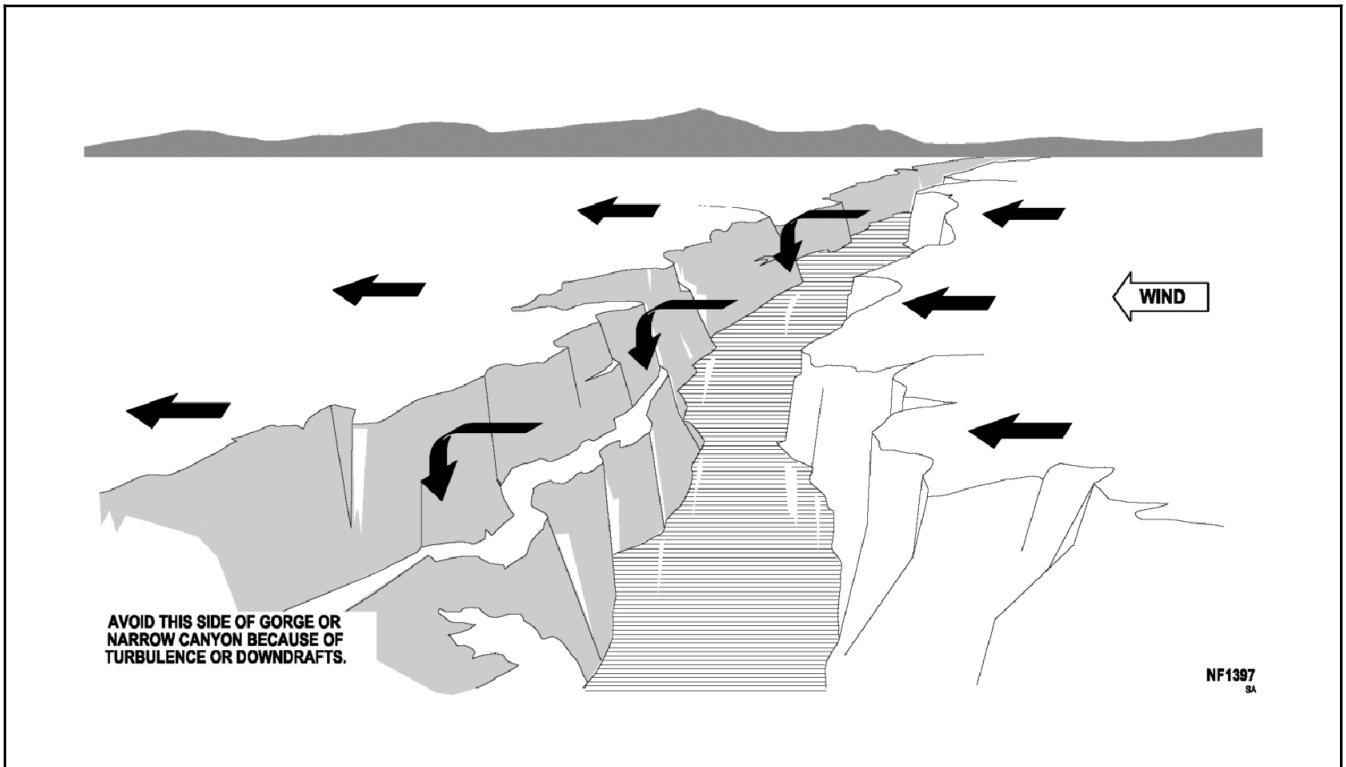


Figure 9-19. Windflow Over Gorge or Canyon

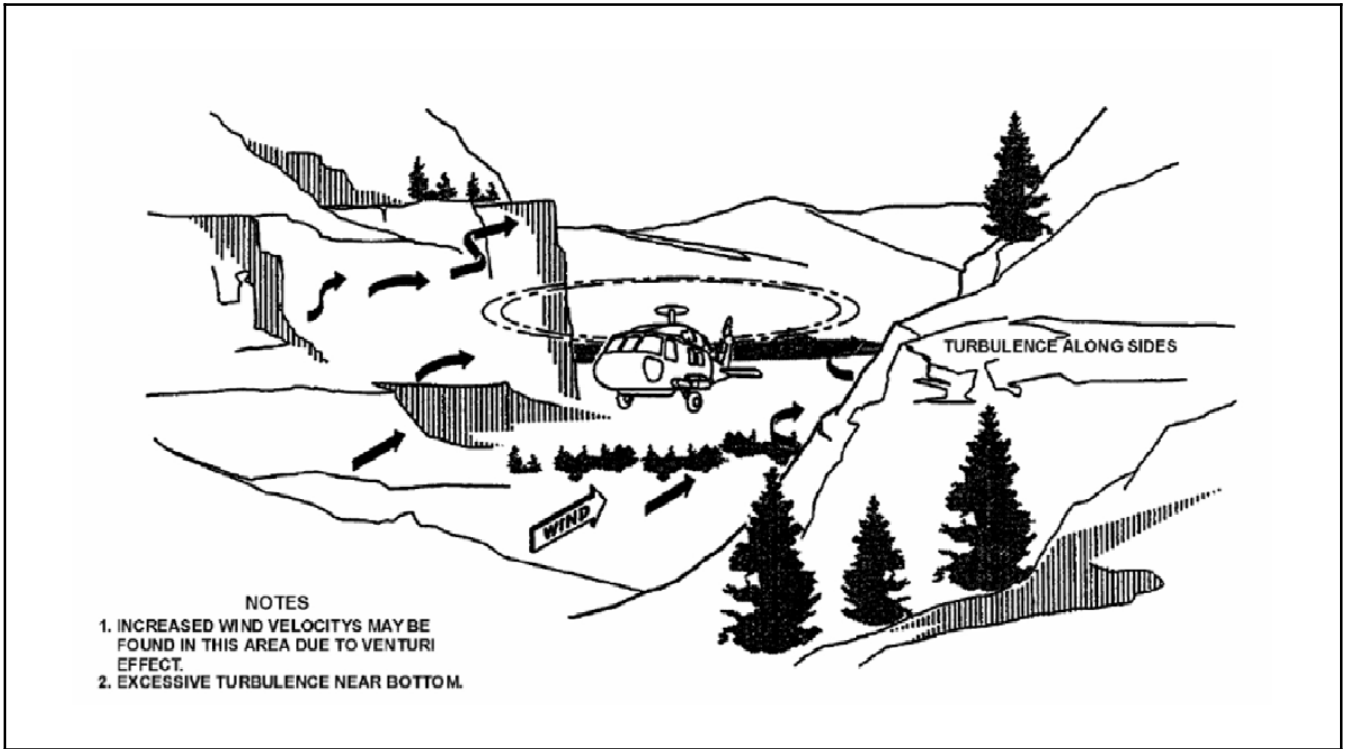


Figure 9-20. Windflow in Valley or Canyon

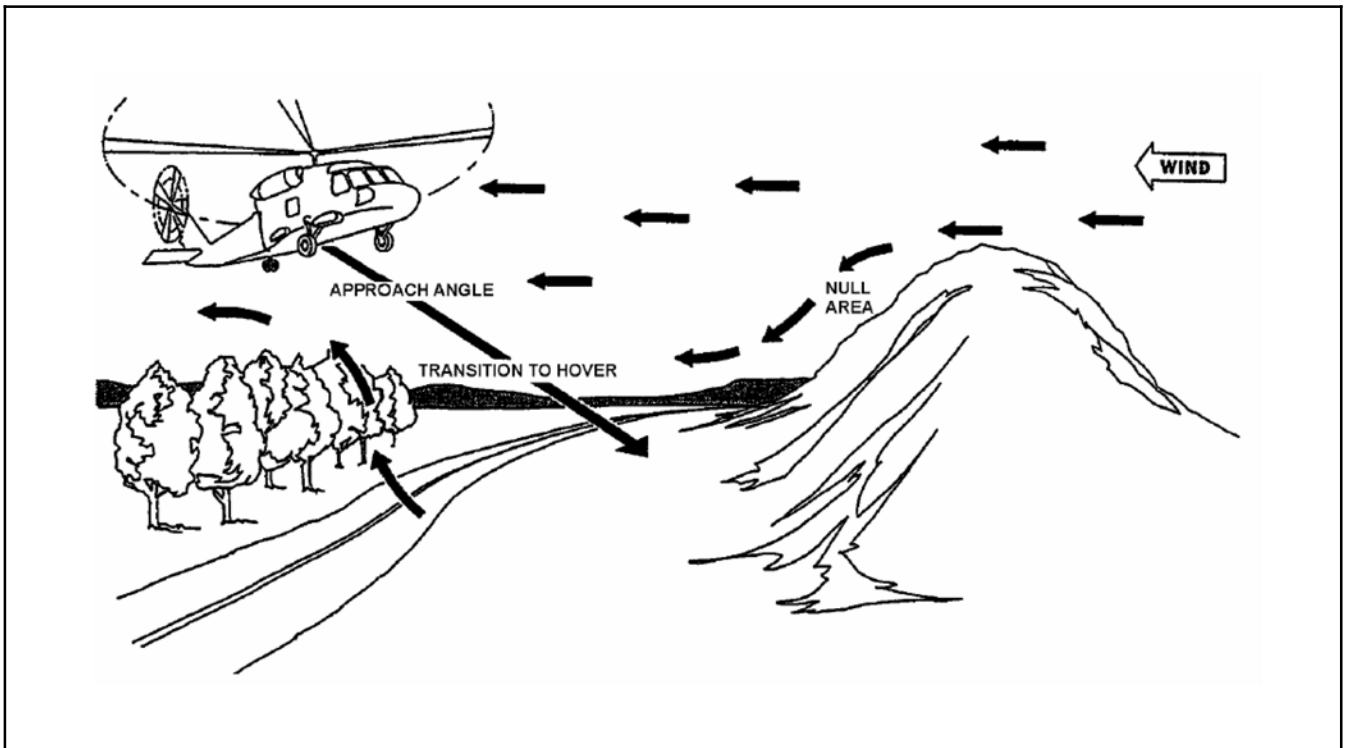


Figure 9-21. Wind Effect in a Confined Area

9.10 CREW SERVED WEAPON PROCEDURES

9.10.1 M60D/M240D Machine Gun

9.10.1.1 M60D/M240D Aircraft Preparation/Inspection

Each machine gun is air cooled, gas operated, and automatic. They each fire the standard 7.62 mm NATO cartridge from the open bolt position at firing rates of up to 550 rounds per minute (rpm) for the M60D and 650 to 950 rpm for the M240D. Barrel headspace and timing of both weapons are fixed, allowing for quick barrel changes for cooling and maintenance. The M60D incorporates a rear ring and barrel-mounted post sighting system, whereas the M240D incorporates a rear sight leaf and a barrel-mounted post sighting system. The M60D/M240D machine gun subsystems (Figure 9-22) are mounted on a pintle mounting system and are held on by a quick-release pin. The weapon mounts are on rotating arm assemblies which allow the weapons to be locked outboard in the firing position, or stowed inside the aircraft when the rotating arms are locked in the inboard position. The weapons can be removed easily from the helicopter and, if needed, may be used for ground defense. For more detail on each weapon, refer to NAVAIR 11-95M60-1 for the M60D and to NAVAIR 11-95M240D1-1 for the M240D.

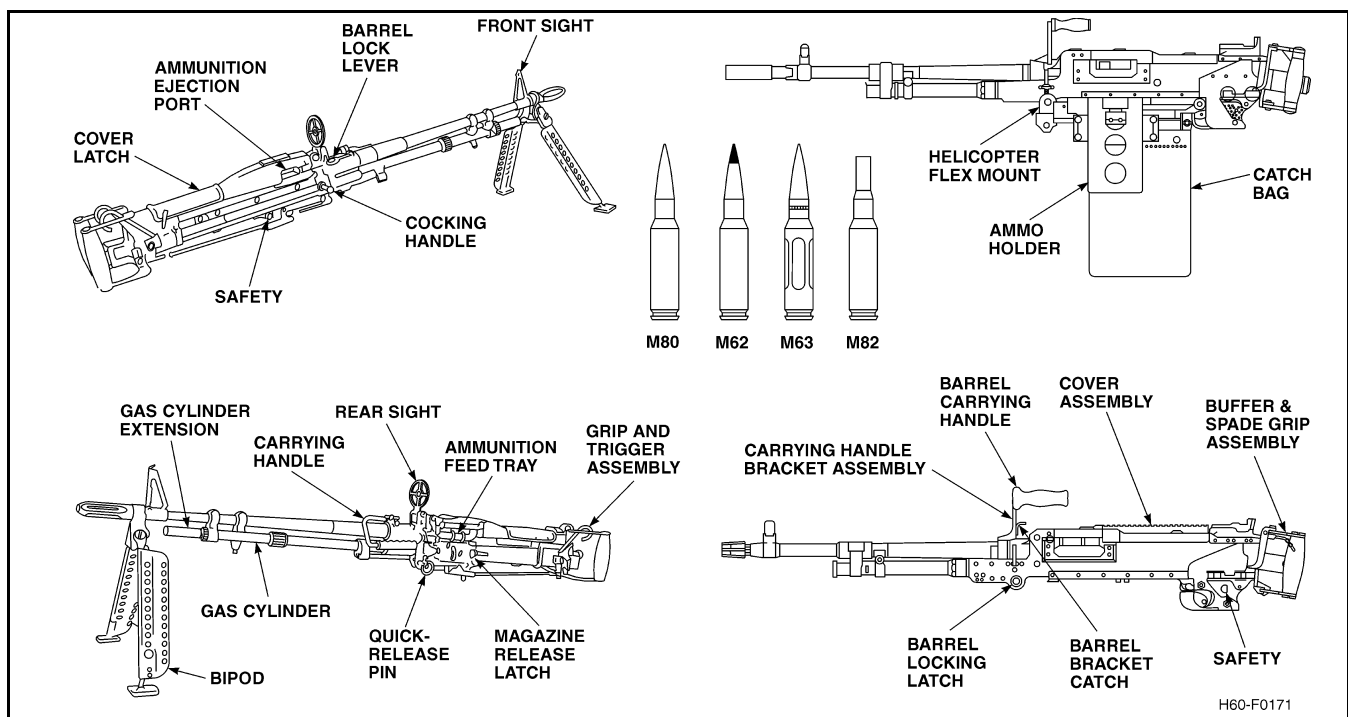


Figure 9-22. M60D/M240D Machine Gun Components

1. Gun secured to mount.

Note

In order to properly install pintle mount, attach weapon to pintle with quick-release pin. Secure with an appropriate plastic tie or 0.032 inch safety wire through the quick-release ring and around the pintle.

2. Ejector control bag installed.
3. Raise cover assembly/feed tray and verify clear of ammunition and links.
4. Place gun in the FIRE (F) position.
5. Pull charging handle rearward and return handle to forward locked position. Place gun in SAFE (S) position.
6. Visually inspect barrel chamber, ammunition feed tray, and inside of receiver. Verify ammunition is not present in the gun barrel or in position to be fed into the gun barrel.

7. Close feed tray and cover assembly.
8. Ensure gun barrel is securely attached and locked to gun receiver.
9. Check weapon for freedom of movement through azimuth, elevation, and depression positions.
10. Pull charging handle rearward, place safety in the (F) position, and ease bolt and operating rod assembly forward into the battery position.
11. Stow weapon inside cabin.
12. Report weapon status.



- Expanded brass and links present a potential FOD hazard. Inspect lower main landing gear strut cowling and cabin door tracks for expended brass after a live fire evolution.
- No restraint is provided for 7.62 mm ammunition with the M240D feed can. When operating the M240D at maximum depression, loss of 7.62 mm ammunition from the feed will occur.

9.10.2 M60D/M240D Rigging Procedures



Ensure barrel is positively locked into the receiver assembly before attempting to fire.

1. Cabin door — Open.
2. Pilot commands — “CLEAR TO RIG.”
3. Crewman pulls detent handle to release, swings mount to extended position, and pushes detent handle to lock weapon.



Failure to ensure detent handle is locked will result in loss of weapon controllability.

4. Crewman removes vertical stop pin, places gun in the horizontal position, and replaces vertical stop pin.
5. Crewman reports — “WEAPON RIGGED.”

9.10.3 M60D/M240D Field of Fire Check

1. Safety switch — SAFE.
2. Pintle — OUT and LOCKED.

Note

The field of fire check should be performed with rotors engaged.

3. Position weapon in all extremes of travel — check for rotor or airframe interference.

9.10.4 M60D/M240D Lock and Load Procedures

WARNING

- The weapon shall not be loaded unless cleared by the helicopter aircraft commander (HAC) and then only in a cleared range or operational area or during a potentially hostile situation.
 - Observe all safety precautions for loading ammunition in accordance with applicable directives. All loading and clearing shall be done with the weapon in the rigged position.
1. Pilot commands — “LOCK AND LOAD.”
 2. Open feed cover latch and raise feed cover assembly.
 3. Open the ejector control bag and pull cocking handle fully to rear.
 4. Push cocking handle full forward to locked position.

WARNING

Cocking handle must be returned to full forward (locked) position before firing. Always cock the gun underhanded to preclude cutting thumb on the feed cover.

5. Press safety button to (S) position.
6. Insert link belt with open side of links down on tray assembly.
7. Close feed cover and latch in place.
8. Crewman reports — “WEAPON READY, SAFE.”

9.10.5 M60D/M240D Machine Gun Firing Procedures

WARNING

- Although stops are provided, extreme care must be taken to prevent firing the weapon into the rotor blades or airframe.
- Any crewmember may call a cease-fire in an unsafe condition.

CAUTION

Do not fire machine gun unless the ejector control bag is mounted in place with bottom zipper closed.

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1. With machine gun positioned, loaded, and aimed, press safety button to firing (F) position.
2. To fire gun automatically, pull trigger fully and hold.



Dumping brass should be conducted while in a hover to prevent possible damage to aircraft or equipment.

Note

- The M60D/M240D low cyclic rate of fire allows firing of a single round or short bursts. The trigger must be quickly released for each shot.
- When ammunition is exhausted, the last link will remain in the tray assembly. The link assembly can be removed by hand after the feed cover assembly is opened.

9.10.6 M60D/M240D Barrel Change Procedures

1. Ensure weapon is clear of ammunition.
2. Crewman removes vertical stop pin, places gun barrel down, and replaces vertical stop pin.
3. Crewman pulls detent handle to release, swings mount inside cabin, and pushes detent handle to lock weapon.
4. Wearing asbestos gloves, grasp barrel.



Weapon barrel will become very hot. Exercise extreme care while handling barrel.

5. Pivot barrel release lever up and remove hot barrel.
6. Insert spare barrel and lock in place by pivoting barrel release lever down.



Ensure barrel is positively locked into the receiver assembly before attempting to fire.

9.10.7 M60D/M240D Stowing Procedures

1. Pilot commands — “STOW WEAPON.”
2. Crewman ensures weapon is clear of ammunition.
3. Crewman removes vertical stop pin, swings gun barrel down, and replaces vertical stop pin.
4. Crewman pulls detent handle to release, swings mount inside cabin, and pushes detent handle to lock weapon.
5. Crewman reports — “WEAPON CLEAR/STOWED.”

9.10.8 Voice Commands

Exact procedures may vary according to the tactical situation; however, the voice commands shown in [Figure 9-23](#) should be used.

9.10.9 Hand Signals

In the event of ICS problems, the following hand signals may be used by the pilot to command the crewman to open fire or cease fire:

1. OPEN FIRE — The pilot extends his hand in the shape of a pistol, index finger extended, thumb pointed up.
2. CEASE FIRE — The pilot extends his hand in the shape of a pistol, index finger extended, thumb pointed down.

9.11 GAU-16/A MACHINE GUN

The GAU-16/A Airborne Machine gun is a crew-served weapon mounted in the starboard door of the helicopter. The GAU-16/A has a firing rate of 750 to 850 rounds per minute, 100-round ammunition can supply mount for a right-hand feed to the weapon, and a flash suppressor which reduces bloom out of the NVD. The GAU-16/A mount assembly is equipped with a shock absorber that significantly reduces recoil loads transferred to the aircraft. The adapter assembly allows the GAU-16/A to be placed in the inboard stow position, outboard stow position, or the firing position. The inboard stow position allows the cabin door to be closed, whereas the outboard stow position allows ease of entry and egress.

9.11.1 GAU-16/A Headspace Adjustment

9.11.1.1 Definition

Headspace for the machine gun is the distance between the front of the bolt and the rear end of the barrel. Headspace is correct when the distance is between 0.202 and 0.206 inch. Unless this distance is properly adjusted, the cartridge, when chambered, will not be properly seated against the shoulder of the chamber. No procedures for adjustment without headspace and timing gauge are authorized.

| FROM | TO | WHEN | REPORT/VISUAL SIGNAL — RESPONSE |
|--|---------|--|---|
| Pilot | Crewman | 60 KIAS or below | CLEAR TO RIG — WEAPON RIGGED |
| Pilot | Crewman | Firing is imminent | LOCK AND LOAD — WEAPON READY, SAFE |
| Pilot | Crewman | Helicopter is steady on target bearing | ROLLING ON TARGET — ROGER |
| Pilot | Crewman | Permission to unsafe weapon and open fire when target within range | OPEN FIRE — ROGER, OPEN FIRE |
| Crewman | Pilot | Target is within range | ON TARGET — ROGER |
| Crewman | Pilot | Target is out of range | OFF TARGET — ROGER |
| Crewman | Pilot | Current ammunition can is empty | WEAPONS DRY — ROGER, RELOAD |
| Crewman | Pilot | All ammunition is expended | WINCHESTER — ROGER, WINCHESTER |
| Pilot | Crewman | Permission to fire rescinded | CEASE FIRE — ROGER, WEAPON READY, SAFE |
| Pilot | Crewman | Firing is no longer probable | CLEAR THE WEAPON — WEAPON CLEAR |
| Pilot | Crewman | 60 KIAS or below | STOW THE WEAPON — WEAPON CLEAR, WEAPON STOWED |
| Note | | | |
| The machine gun can be rigged at any airspeed. The 60 KIAS limitation pertains to the cabin door only. | | | |

Figure 9-23. Machine Gun Operations ICS Terminology

9.11.2 GAU-16/A Headspace Adjustment Checklist



WARNING

Improper headspace and timing will cause cartridge round to split and jam the weapon. Injury or death of crewman may result.



CAUTION

Headspace and timing shall be performed prior to each firing and upon completion of cleaning weapon to ensure weapon does not malfunction.

Note

No procedures for adjustment without headspace and timing gauge are authorized.

1. Weapon clear and safe.
2. Retract recoiling parts until barrel extension is separated from trunnion block.
3. Insert the GO end of the headspace gauge into the T-slot between face and bolt and breech end of the barrel. Adjust as necessary.

Note

This weapon is set up for a right-hand feed; remove the left-hand rear cartridge stop assembly for ease in screwing the barrel into the barrel extension.

4. Attempt to adjust the NO-GO end of the headspace gauge in T-slot. Adjust as necessary.
5. If NO-GO required an adjustment, repeat steps 3. and 4. until headspace adjustments are within tolerance.



CAUTION

Never release the firing pin with the headspace and timing gauge in place. Damage to the firing pin can occur.

6. Remove gauge, place the safe switch to (F) and release the firing pin.
7. Place safety back to (S).

9.11.3 GAU-16/A Timing Adjustment

Timing is the point at which the firing pin is released after the recoiling parts reach the battery position during counter recoil. This point is determined by measuring the distance between the front face of the barrel extension and the rear face of the trunnion block. The gun must fire when this distance is between 0.202 and 0.116 inch. Timing must be checked and adjusted each time headspace is checked and adjusted, and whenever incorrect timing is suspected. If the timing is early, recoil will start before the extractor is far enough forward to engage the next cartridge in the belt. In this condition, the gun will stop firing after two rounds. If the timing is late, the barrel extension will strike the trunnion block as the recoiling parts reach the battery position during counter recoil. The gun will continue to fire, but the barrel extension will be damaged as it strikes the trunnion block.

9.11.3.1 GAU-16/A Timing Adjustment Checklist

WARNING

Improper headspace and timing will cause cartridge round to split and jam the weapon. Injury or death of crewman may result.

CAUTION

Headspace and timing shall be performed prior to each firing and upon completion of cleaning weapon to ensure weapon does not malfunction.

1. Weapon clear and safe.
2. Retract recoiling parts 1/4 inch and insert NO-FIRE gauge between barrel and trunnion block.
3. Allow barrel extension to close slowly until stopped by timing gauge.
4. Pull trigger. Firing pin should not release.

If firing pin does release:

5. Make timing adjustments until firing pin does not release.

If firing pin does not release:

6. Remove gauge and allow recoiling parts to go forward to battery position.
7. Retract recoiling parts until barrel extension is about 1/4 inch from trunnion block.
8. Insert FIRE timing gauge between barrel extension and trunnion block.
9. Allow barrel extension to close slowly until stopped by contracting gauge.
10. Release trigger housing safety. Attempt to release firing pin by operating firing mechanism once. The firing pin should release with the gauge in place.

If firing pin does not release:

11. Make timing adjustments until firing pin does release.

If firing pin does release:

WARNING

Bolt shall be in the battery position before back plate is removed. Do not attempt to release firing pin or charge weapon with the back plate off.

12. Retract recoiling parts, remove the gauge, and cock the weapon.

9.11.3.2 GAU-16/A Rigging Procedures

1. Cabin door — Open.
2. Pilot commands — “CLEAR TO RIG.”
3. GAU-16/A — Rig in firing position.

4. Crewman reports — “WEAPON RIGGED.”

WARNING

The outboard stowed position is not an authorized in-flight position. It is only authorized for ingress/egress while on the ground or in a hover during hoisting evolutions.

9.11.3.3 GAU-16/A Lock and Load Procedures

1. Pilot commands — “LOCK AND LOAD.”
2. Safety — SAFE.
3. Ammunition can support lid — Open Tilt standard 100 round ammunition can forward, slide ammunition can forward under lid, and lock support lid.
4. Feed cover assembly — Open.
5. Ammunition — Insert.
6. Feed cover assembly — Close.
7. Weapon — Charge twice to load.
8. Crewman reports — “WEAPON READY, SAFE.”

WARNING

All loading and clearing shall be done with the weapon in the firing position.

9.11.3.4 GAU-16/A Firing Procedures

WARNING

The only authorized position for firing the GAU-16/A is with the crossbeam secured to both the forward and aft brackets.

1. Pilot commands — “OPEN FIRE.”
 - a. As required — “CLEARED TO LAZE.”
2. Crewman responds — “ROGER, OPEN FIRE.”
 - a. As required — “ROGER, CLEARED TO LAZE.”
3. Safety — FIRE.
4. AN/PEQ-3 laser reducer covers (if required) — Rotate off.
5. AN/PEQ-3 laser mode selector (if required) — ON.
6. AN/PEQ-3 laser deadman switch — Press and hold.
7. Trigger — Pull.

9.11.3.5 GAU-16/A Clear Weapon Procedures

WARNING

- Do not disassemble the GAU-16/A while attempting to clear weapon.
 - Barrel must be pointed in a safe, uninhabited direction at all times.
1. Safety — SAFE.
 2. PEQ-3 mode selector switch — OFF (if installed).
 3. PEQ-3 lens covers — Rotate on (if installed).
 4. Feed cover — Open.
 5. Ammunition — Remove from feed tray.
 6. Feed cover — Close.
 7. Charging handle — Charge.
 8. Feed cover — Open.

WARNING

Chamber may be hot. Use caution while inspecting T-slot.

9. Weapon — inspect T-slot/chamber, ensure weapon is clear.

WARNING

If chamber is not clear, repeat steps 4. through 7. once and remove any remaining rounds. If unable to clear weapon, execute hung ordnance procedures in accordance with local directives.

10. Weapon status — Report.

CHAPTER 10

Functional Checkflight Procedures

10.1 FUNCTIONAL CHECKFLIGHT

The purpose of an FCF is to determine if the airframe, engines, accessories, and other items of equipment are functioning in accordance with predetermined requirements while subjected to the intended operating environment. These flights should normally be conducted within autorotative distance of a landing field when feasible and during daylight hours under VMC. However, if necessary to accomplish the assigned mission, the unit commander may authorize functional checkflights under conditions other than the above, if, in the commander's opinion, the flight can be conducted with an acceptable margin of safety under the existing conditions. This authority may not be delegated. Those portions of the flight that are considered critical shall be conducted in the vicinity of a suitable landing area. At the discretion of commanding officers, or detachment officers-in-charge when deployed, functional checkflights may be performed in combination with operational flights provided the operational portion is not conducted until the flight inspection requirements have been satisfied by a designated Functional Check Pilot (FCP). The appropriate checkflight checklist shall be used. This section contains detailed checkflight procedures, sequenced in the order in which they should be done. See COMNAVAIRFORINST 4790.2 (series) for additional information.

Note

These procedures are intended for use by designated FCPs only and shall not be performed or used as troubleshooting procedures by squadron pilots. The FCP shall approach preflight inspections with diligence. Since work is being checked that directly affects safety of flight, close scrutiny must be exercised during inspections.

10.1.1 Designation of Pilots

The aircraft maintenance officer shall recommend to the commanding officer, via the operations officer, designated HACs that have completed the squadron FCP syllabus and meet all applicable OPNAV 3710.7 (series) and COMNAVAIRFORINST 4790 (series) requirements. The operations officer shall forward recommendations, with appropriate comments, to the commanding officer.

10.1.2 Ground Checks

Ground checks are defined as checks accomplished on the ground to ensure that equipment has been adjusted, reassembled, repaired, and inspected satisfactorily. These checks shall be accomplished after the helicopter system or components have been inspected following maintenance or repair operations.

10.1.3 General Information

This chapter contains detailed checkflight procedures, sequenced in the order in which they should be performed. The functional checkflight shall be conducted using the checkflight record in conjunction with normal NATOPS procedures. For the purpose of functional checkflights only, this chapter satisfies all the requirements of the Pilot's Pocket Checklist from "Interior Inspection" through "Postflight Checks." Crew requirements are specified in [Chapter 5](#).

10.1.4 Special Instructions

1. Passengers are prohibited on FCFs.
2. Forms and records will be checked before the FCF to determine maintenance performed and the flight profile required.
3. Record information where indicated by a line _____. Where a box is shown, use a ✓ for satisfactory or an X for unsatisfactory.
4. Check and go. Combination of an FCF with an operational flight is specifically prohibited when a post-depot checkflight attesting to the airworthiness of the aircraft has not been previously performed.

10.1.5 FCF Record Cards

A record card shall be used for all FCFs. When an FCF is required to determine if specific equipment or systems are operating properly, completion of only that portion of the FCF applicable to the specific equipment or systems being evaluated is required. The FCF record card may be locally reproduced. Continuation sheets may be used when necessary. Items that prove to be unsatisfactory during flight and require corrective action shall be listed in the remarks block during flight and transferred to a Visual Discrepancy System/Maintenance Action Form VIDS/MAF immediately after termination of the flight.

10.1.6 FCF Profile

The FCF altitude profile (Figure 10-1) is recommended for all checkflights.

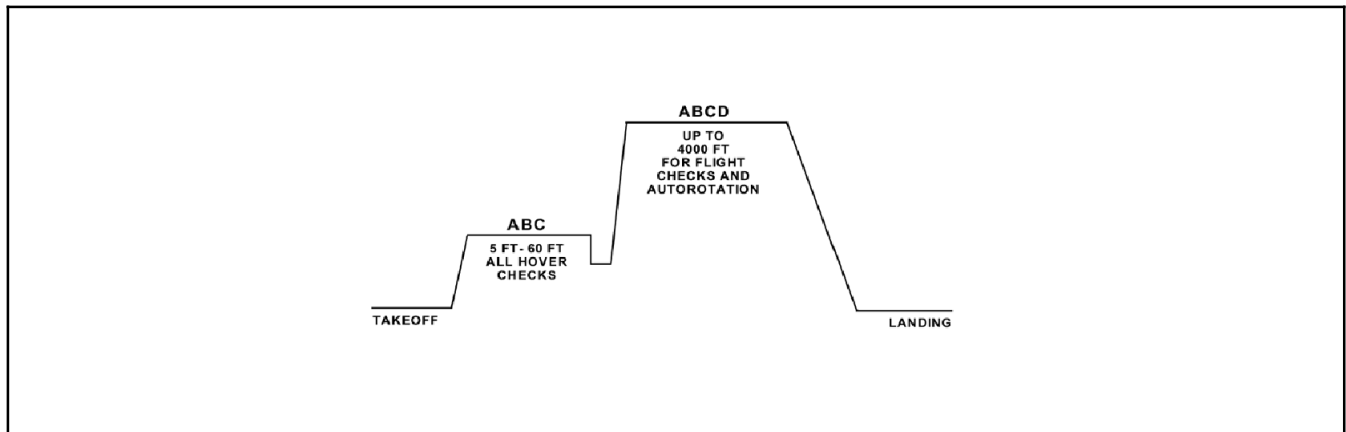


Figure 10-1. FCF Altitude Profile

A daily and turnaround inspection is required before the checkflight. Perform all normal checklist items for all checkflights. Perform applicable flight profile checks in accordance with COMNAVAIRFORINST 4790.2 (series) under the following guidelines:

1. Functional checkflights are conducted when it is not possible to determine proper operation by ground checks (e.g., aerodynamic reaction, air loading, or signal propagation).
2. Functional checkflights are not required upon the completion of phase inspections, unless the corrective action(s) resulting from a discrepancy discovered during the inspection requires a checkflight or the item inspected requires removal, disassembly, adjustment, alignment, reinstallation or reassembly of any items in the following paragraphs. The maintenance requirement cards (MRC) will indicate the phase packages requiring a partial system functional checkflight.

3. Although the following conditions requiring FCFs are minimal and mandatory, this does not preclude operational commanders from imposing additional requirements of the scope and frequency deemed necessary. Perform applicable flight profile associated checks in accordance with COMNAVAIRFORINST 4790.2 (series), NAVAIR A1-H60CA-VIB-100, H-60 (series) IETMS, and applicable Wing directives under the following checkflight conditions:
 - a. A PROFILE — Full system checks.
 - b. B PROFILE — Engine checks.
 - c. C PROFILE — Controllability/drive train check.
 - d. D PROFILE — AFCS check.

10.1.7 Limited FCF

A limited FCF is required when it is necessary to prove proper functioning of a specific item or component. Duration of the FCF need only be enough to verify performance of the item(s) being tested.

PROFILE

A B C D

A B C D

A

A

10.2 FUNCTIONAL CHECKFLIGHT CHECKLIST

10.2.1 Preflight Check

- 1. Exterior.
- 2. Interior.
- 3. Seats, belts, shoulder harnesses, and shoulder harness locks.
 - a. Tail rotor pedal adjustment — 6 INCHES OF TRAVEL.
 - b. Seat height adjustment.
 - c. Seat forward/aft adjustment.
 - d. Inertia reel check.
- 4. Compass correction cards — CURRENT AND LEGIBLE.

10.2.2 Start Checks

Note

Daggered (†) steps need not be accomplished on subsequent flights on the same day.

10.2.2.1 Prestart Checks



Moving flight controls without first or second-stage pressure on the primary servos may cause damage to the flight controls.

- 1. Seats/belts/pedals/mirrors — ADJUSTED.
- 2. Cockpit window emergency release handles — AFT AND SHEARWIRED.
- 3. Left collective — EXTENDED AND LOCKED.
- 4. Circuit breakers and switches — CHECKED AND OFF.

Switches not having an OFF position should be checked as follows:

- a. RDR, DATA LINK — STBY.
- b. ATO ICS — NORM.
- c. DATA LINK MODE — AUTO.
- d. GUARD REC — ON.
- e. COMM CONTR mode select — T/R.
- f. GUST LOCK — NORM.
- g. TAIL SERVO — NORM.
- h. Pilot ICS — NORM.

PROFILE

- i. CARGO HOOK ARMING — SAFE.
 - j. CARGO HOOK EMER RLSE — OPEN.
 - k. FIRE DET TEST — OPER.
 - l. DE-ICE MASTER — MANUAL.
 - m. MODE 4 AUDIO/LIGHT/OUT — AUDIO.
 - n. Transponder ANT — DIV.
 - o. COMP panel — SLAVED, LAT CHECKED.
 - p. FUEL MGT panel, MASTER/MODE switches — STOP FLOW/AUTO.
 - q. SERVO SHUTOFF SWITCH — CENTER.
5. Parking brake — RESET.
 6. TAIL WHEEL — LOCK.
 7. Aircrewman Prestart Checks — COMPLETE.
 8. Engine T-handles — FORWARD.
 9. APU T-handle — IN.
 10. Rotor brake — ON.
 11. BATT switch — ON. (#1/#2 CONV, AC ESS BUS OFF, STABILATOR, and AFCS DEGRADED caution, WOW and ROTOR BRAKE advisory lights — ILLUMINATE.)
 12. UHF backup — SET.
 13. External Power — As required, RESET then ON.
 14. Fire detector system — TEST.
 15. Fire guard — POSTED, AREA CLEAR.
 16. Interior/exterior/NVD lighting — AS REQUIRED.
 17. APU — START.
 - a. ECS — OFF.
 - b. AIR SOURCE ECS/START switch — APU.
 - c. FUEL PUMP switch — APU BOOST.
 - (1) PRIME BOOST PUMP ON advisory light — ON.
 - d. APU CONTROL switch — ON.
 - (1) APU ON advisory light — ON.

Note

Do not cycle the BATT switch or turn off the APU CONTROL switch if the APU shuts down during start or after it is running. This removes the cause of the shutdown from the APU BITE indicator.

PROFILE

18. APU GENERATOR switch — ON.
 - a. APU GEN ON advisory light — ON.
19. External Power — OFF (disconnect as required).
20. ICS/RADIO — CHECK.
21. ECS — AS REQUIRED.
- †22. Blade/pylon spread — AS REQUIRED.
 - a. Area — CLEAR (wing walkers positioned as required).
 - b. CMPTR PWR/RESET pushbutton — ON.
 - c. BLADE FOLD MASTER switch — ON.
 - d. BLADE FOLD switch — SPREAD.
 - e. PYLON FLIGHT and ROTOR SPREAD lights — ILLUMINATED.
 - f. RDR ALT pushbutton — PRESS (if flashing).
 - g. BLADE FOLD switch — OFF.
 - h. BLADE FOLD MASTER switch — OFF.
 - i. Proceed to step 24, Head Check.
- †23. Lockpins status — CHECK.
 - a. BLADE FOLD MASTER switch — ON.
 - b. ROTOR SPREAD and PYLON FLIGHT lights — ILLUMINATED.
 - c. If ROTOR SPREAD light not illuminated:
 - (1) CMPTR PWR/RESET pushbutton — OFF.
 - (2) BACKUP HYD PMP switch — OFF.
 - (3) BLADE FOLD switch — SPREAD (5 to 7 seconds).
 - d. If rotor SPREAD light remains off:
 - (1) BLADE FOLD switch — OFF.
 - (2) BLADE FOLD MASTER switch — OFF.
 - (3) Head check — PERFORM.
 - e. If ROTOR SPREAD light illuminated:
 - (1) BLADE FOLD switch — OFF.
 - (2) SPREAD INCOMPLETE caution — DOES NOT APPEAR.
 - (3) BLADE FOLD MASTER switch — OFF.

PROFILE

- †24. Head check — AS REQUIRED.
 - a. Blade lock pins engaged.
 - b. Pitch lock pins retracted.
 - c. Gust lock disengaged.
- †25. IGB/TGB Oil Level Check — AS REQUIRED (after Pylon Spread).
- 26. CMPTR PWR/RESET pushbutton — CYCLE, ON.
- 27. SAS/BOOST pushbutton — ON.
- 28. BACKUP HYD PMP switch — ON.

Note

If electrical loads are introduced (e.g., backup hydraulic pump) while operating from APU generator or external power, an AFCS power sever may occur, indicated by appearance of the AFCS DEGRADED caution. To restore AFCS computer power, press CMPTR PWR/RESET pushbutton on AFCS CONTROL panel.

10.2.3 Systems Check

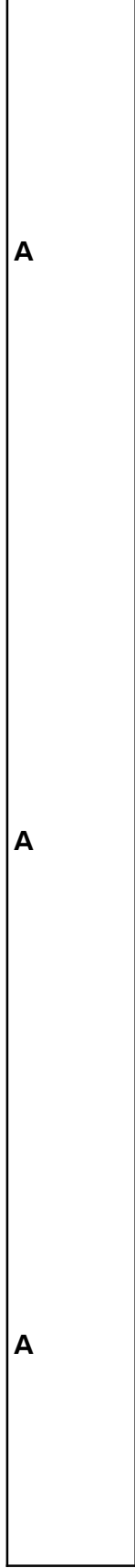
- †1. DIGITS — ON; CDU and PDU — TEST.
- 2. Fuel quantity and readouts — CHECK.

Note

The maximum difference between the fuel quantity indicators on the VIDS, and total fuel digital readout shall not be more than 200 pounds.

- 3. Caution/advisory/warning lights — CHECK.
 - a. The following caution/advisory lights should be ON:
 - (1) #1 and #2 GEN.
 - (2) #1 and #2 FUEL PRESS.
 - (3) #1 and #2 ENGINE OIL PRESS.
 - (4) #1 and #2 HYD PUMP.
 - (5) SAS.
 - (6) AFCS DEGRADED.
 - (7) MAIN XMSN OIL PRESS.
 - (8) WOW.
 - (9) ROTOR BRAKE.
 - (10) #1 and #2 ENG ANTI-ICE ON.

PROFILE



- (11) APU ON.
- (12) APU GEN ON.
- (13) PRIME BOOST PUMP ON.
- (14) BACK-UP PUMP ON.
- (15) PARKING BRAKE ON.

- 4. Caution/advisory/warning lights and dimming — CHECK.
 - a. BRT/DIM – TEST switch — TEST.
 - b. All caution/advisory lights go on. All warning lights on master warning panels go on and LOW ROTOR RPM lights flash. Legends on mode selector panels go on. The AFCS control panel, FUEL MGT panel, STABILATOR panel and BLADE FOLD control panel lights go on, and RAWES tones audible.
 - c. BRT/DIM–TEST switch — DIM. All lights on the caution/advisory panel should decrease in intensity.
 - d. BRT/DIM–TEST switch — BRT. All lights on caution/advisory panel should return to normal intensity.
 - e. While holding BRT/DIM–TEST switch at TEST, turn INST LIGHTS PILOT FLIGHT CONTROL switch from OFF. All lights should decrease in intensity. Turn INST LIGHTS PILOT FLIGHT CONTROL switch to OFF. All lights on panel should return to normal intensity.
 - f. BRT/DIM-TEST switch — RELEASE. MASTER CAUTION WARNING lights should flash 16 times. Note that no transmission chip caution lights are on.
- 5. Photocell sensitivity — CHECK.
 - a. Lamp test buttons — PRESS AND HOLD.
 - b. DIM control on CDU — TURN (full clockwise).
 - c. All segments on CDU and PDU will go to 1/2 intensity.
 - d. DIM control on CDU — TURN (counterclockwise just below detent).
 - e. Apply light from outside source (such as utility light) to one photocell at a time. Note intensity of segments on CDU and PDU increases.

Note

If sunlight is shining on one or more photocells, covering those photocells should cause segment lights to dim.

- f. DIM control — ADJUST (to desired intensity).
- 6. INTERIOR/EXTERIOR LIGHTS — CHECK. Instrument lights, secondary lights, cockpit flood, and cabin dome lights, landing/hover lights, position and anticollision lights, and controllable searchlight — CHECK. SET AS DESIRED.
- 7. RAD ALT, BAR ALT, clocks — SET.
- 8. TACAN — AS REQUIRED.
- 9. IFF MASTER — STBY.

PROFILE

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10. Cyclic forward stop — CHECK.
- SAS 1 and SAS 2 pushbuttons — OFF.
 - Move collective to midposition with full left pedal.

Note

Due to control mixing, maximum forward cyclic position is achieved with full left pedal and the collective at midposition.

- Move cyclic full forward and center laterally against forward stop.
- The cyclic should not touch the instrument panel. (Distance from instrument panel to cyclic should be approximately 3/4 to 2-1/4 inches). Cyclic may contact instrument bezel/knobs.
- Return cyclic to center position and collective to full down.

†11. Primary servos — CHECK.

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†12. BOOST servos — CHECK.

- Collective and pedals — MID-POSITION and RIGHT PEDAL SLIGHTLY FORWARD OF NEUTRAL.

Note

Slight pedal control deflection may be necessary to prevent excessive collective movement.

- SAS/BOOST pushbutton — OFF. BOOST SERVO OFF and AFCS DEGRADED cautions appear and MASTER CAUTION lights illuminated.
- Move flight controls through full range of travel. Note increase in control forces (except lateral). Left/right cyclic force should be about half the fore/aft force for equal displacement.
- Check for not more than 1-1/2 inches of free play in controls. If free play is felt, visually inspect boost servo for failed piston link.
- Collective and pedals — MID-POSITION AND RIGHT PEDAL SLIGHTLY FORWARD OF NEUTRAL.
- SAS/BOOST pushbutton — ON. BOOST SERVO OFF caution disappears.
- Collective — FULL DOWN.

†13. Tail rotor servo — CHECK.

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†14. AFCS ground check.

- SAS — CHECK.
 - CMPTTR PWR/RESET 2-minute warm-up and SAS BOOST pushbuttons — CHECK ON.
 - TRIM and AUTO PLT pushbuttons — CHECK OFF.
 - SAS 1 pushbutton — ON for at least 10 seconds, then OFF. SAS 1 fail advisory light, SAS and AFCS DEGRADED cautions should not appear during self-test.

PROFILE

- (4) SAS 1 pushbutton — ON, then OFF. No movement should occur in either main rotor blades or flight controls.
- (5) Repeat step (4) for SAS 2.
- (6) SAS 1 and SAS 2 pushbuttons — ON.
- (7) Move controls through full range. Check for restrictions, control feedback and rotor blade chatter. If any are detected, repeat step with each SAS disengaged separately to determine in which SAS channel and axis discrepancy exists.
- (8) SAS 1 and SAS 2 pushbuttons — OFF.
- b. Trim — CHECK.
 - (1) TRIM pushbutton — ON, THEN OFF. No movement should occur in flight controls.
 - (2) TRIM pushbutton — ON.
 - (3) Cyclic Trim — CHECK.
 - (a) Move cyclic fore, aft, and laterally checking for symmetrical gradient force increase with control displacement.
 - (b) Without depressing the cyclic TRIM REL button, displace cyclic from trim position and release. Cyclic should return to trimmed position.
 - (c) Depress the cyclic TRIM REL button. Slowly displace cyclic fore/aft and note a resisting force. Move the cyclic fore/aft at a faster rate and note an increase in resisting force. Do the same using left/right cyclic movement. Note the force/velocity characteristics with longitudinal cyclic are twice as great as lateral cyclic.
 - (d) Center the pedals and place collective at midposition. Trim cyclic full aft. Using four-way TRIM switch, move cyclic full travel forward. Operation should be smooth and full travel should take 15 ± 3 seconds. Repeat in opposite direction.
 - (e) Lower collective, trim cyclic full left. Using four-way TRIM switch, move cyclic full travel right. Full travel should take 18 ± 3 seconds. Repeat in opposite direction.
 - (f) Pilot and copilot cyclic four-way TRIM switches — CHECK (fore/aft/lateral).
 - (4) Cyclic and collective trim release buttons — CHECK. Move cyclic and collective with buttons depressed to ensure proper operation.
 - (5) Collective trim — CHECK.
 - (a) Collective — TRIM TO MID-POSITION.
 - (b) Without pressing collective trim release switch, displace the collective full up noting increase in gradient force. Release, collective should return smoothly to mid-position.
 - (c) Repeat step (b) for collective full down.
 - (6) Yaw pedal trim — CHECK.
 - (a) Pedals — TRIM TO MID-POSITION.
 - (b) Without pressing pedal trim switch, displace one pedal full forward and release. Pedals should return smoothly to trimmed position.

PROFILE

- (c) Repeat step (b) for other pedal.
- (d) Move pedals back and forth at a slow constant rate and note a resisting force. Move pedals at a faster rate and note an increase in resisting force.

c. Autopilot — CHECK.

- (1) SAS 1, SAS 2 and TRIM pushbuttons — ON.
- (2) AUTO PLT pushbutton — ON, THEN OFF. No movement should occur in flight controls.
- (3) AUTO PLT pushbutton — ON.
- (4) Move flight controls through full range without depressing cyclic, collective, or pedal trim switches. Check for restrictions, control feedback, and rotor blade chatter.

Note

If any restricting control feedback or rotor blade chatter is detected, repeat step with SAS/Trim/Autopilot individually disengaged to determine the channel and axis where the discrepancy exists.

- (5) Press BAR ALT pushbutton — BAR ALT hold should engage.
- (6) Press RDR ALT pushbutton — RDR ALT hold should engage.
- (7) Radar Altimeters — OFF. RDR ALT hold switches to BAR ALT hold, AFCS DEGRADED caution, CPLR and ALT fail advisory lights, and MASTER CAUTION lights illuminated.
- (8) BAR ALT pushbutton — PRESS OFF.
- (9) RDR ALT and APPR/HVR pushbuttons — PRESS. RADALT hold and hover coupler should not engage.
- (10) Radar altimeters — ON.
- (11) Pilot and ATO AFCS RELEASE switch — CHECK. SAS 1, SAS 2, and AUTO PLT lights OFF. SAS caution light and MASTER CAUTION WARNING lights ON.
- (12) SAS 1, SAS 2, TRIM, AUTO PLT — ON.

†15. Stabilator — CHECK.

†16. Rescue Hoist Preoperational Check — AS REQUIRED (see [paragraph 7.16.2.1](#)).

†17. Cargo Hook Preoperational Check — AS REQUIRED (see [paragraph 7.16.2.2](#)).

†18. Cargo hook emergency release circuit — TEST.

WARNING

Personnel shall remain clear of cargo hook during short and open circuit tests in case of inadvertent CAD firing.

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PROFILE



To prevent unintentional discharge of the cargo hook CAD, the pilot shall call off each procedural step of the emergency release circuit test before that step is performed. The station being checked shall reply to each command.

- a. CARGO HOOK EMERG REL TEST light — PRESS (light illuminates).
 - b. RESCUE HOIST PWR/ARMED switch — OFF.
 - c. EMER RELEASE HOIST CABLE SHEAR circuit breaker (DC ESNTL BUS, OVHD, ROW 2, CB 2) — PULL.
 - d. CARGO HOOK CONTR switch — ARMED/ALL or ARMED/COCKPIT.
 - e. SHORT test.
 - (1) CARGO HOOK EMERG REL switch — SHORT.
 - (2) Pilot cyclic EMER REL button — PRESS. CARGO HOOK EMERG REL TEST light illuminates.
 - (3) ATO EMER REL button — PRESS. CARGO HOOK EMERG REL TEST light illuminates.
 - f. OPEN test.
 - (1) CARGO HOOK EMERG REL switch — OPEN.
 - (2) Pilot cyclic EMER REL button — PRESS. CARGO HOOK EMERG REL TEST light illuminates.
 - (3) ATO cyclic EMER REL button — PRESS. CARGO HOOK EMERG REL TEST light illuminates.
 - g. EMER RELEASE HOIST CABLE SHEAR circuit breaker — RESET.
 - h. CARGO HOOK CONTR switch — SAFE.
19. Pitot heat system — CHECK.
- a. PITOT HEAT switch — ON. Check both pitot-static tubes and static ports for increasing temperature.
 - b. LEFT PITOT HEAT and RIGHT PITOT HEAT cautions do not appear — CHECK.
 - c. Pull RIGHT PITOT HEATER (NO. 2 AC PRIMARY, CORNER, ROW 3, CB 3) and LEFT PITOT HEATER (NO. 1 AC PRI, SO's OVERHEAD, ROW 1, CB 6) circuit breakers — RIGHT PITOT HEAT and LEFT PITOT HEAT cautions appear.
 - d. Reset circuit breakers — cautions disappear.
 - e. PITOT HEAT switch — OFF.
20. Airspeed — Red line/slipmarked.

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PROFILE

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21. VSI — 0.

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22. Windshield washer and wipers — CHECK.



To prevent scratching the windshield, do not operate the wipers on dry glass.

- a. WINDSHIELD WASHER switch — ON. Note that washer provides enough water and a stream is properly directed on windshield.
- b. WINDSHIELD WIPER knob — HI. Wiper blades should remain in contact with windshield over its entire sweep area.
- c. WINDSHIELD WIPER knob — LOW. Wiper blades should sweep at a slower speed.
- d. WINDSHIELD WASHER switch — OFF.
- e. WINDSHIELD WIPER knob — PARK (CONSTANT PRESSURE REQUIRED). Wiper blades should move to windshield center posts and stop.
- f. WINDSHIELD WIPER knob — OFF.

10.2.4 Starting Engines and Rotor Engagement

1. High Points and Tail Tiedowns — VERIFY REMOVED.



- For shore-based operations only: If the engine is started with the rotor brake on to facilitate maintenance, the PCLs should not be advanced above IDLE. If rotor engagement is required following the required maintenance checks, the engine(s) should be shut down from IDLE and restarted with the rotor brake off to avoid the possibility of engine power turbine shaft rub.
- N_p shaft rub occurs when the engines are online and the rotor brake is released. The N_p shaft impacts the N_g shaft, which causes the compressor blades to impact the compressor casing. Over time, this will cause the engine to lose power and possibly catastrophically fail. The only way to ensure N_p shaft rub will not occur is to use the No Rotor Brake Start Procedure. The No Rotor Brake Start Procedure shall be utilized for routine engine start and rotor engagement ashore.

PROFILE



Note

- After an engine installation, the initial engine start should be done against the rotor brake to check for engine leaks. During and after the run, check for oil and fuel leaks. All subsequent engine starts should be conducted with the rotor brake off.
- Engine start data collected from either the No Rotor Brake Start Procedure or the Rotor Brake Start Procedure satisfies applicable FCF requirements. It is not necessary to complete both types of starts.

10.2.4.1 No Rotor Brake Start Procedure

Note

This procedure shall be utilized for routine FCF engine start and rotor engagements ashore.

1. Fire guard posted, area clear.
2. Doors, inertia reels — LOCK.
3. SAS 1, SAS 2, TRIM and AUTO PLT pushbuttons — ON.

WARNING

When AFCS computer power is cycled, trim is disengaged. An unguarded cyclic will allow the rotor arc to dip as low as 4 feet above the ground, without droop-stop pounding, prior to full control deflection.

4. Engine control quadrant — CHECK.
 - a. PCLs — PULL DOWN AND PRESS FORWARD. Note no movement past IDLE detent.
 - b. Rotor brake interlock override tab — PULL.
 - c. PCLs — MOVE THROUGH FULL RANGE. Check for no binding, note positive detents, then OFF.
 - d. Fuel selectors — DIR, XFD, THEN OFF. Check for no binding and note positive detents.
5. Engine fuel system priming (if required).

Note

Helicopter prime/boost pump capacity is not sufficient to prime an engine when the opposite engine is running. Therefore, engines should be primed individually with both engines OFF.

- a. Fuel selector — DIR.
- b. PCL — HOLD IN LOCKOUT.
- c. FUEL PUMP switch — FUEL PRIME. Check FUEL PRIME advisory appears, hold until plane captain reports steady flow of fuel coming from overboard drain.

PROFILE

A B

- d. Repeat steps b. and c. with fuel selector in XFD.
 - e. FUEL PUMP switch — APU BOOST.
 - f. PCL — OFF.
- 6. Rotor brake — Pressure, check 450 psi minimum.
 - 7. Engine Starter/Air Start Valve/ECS dropout — CHECK.

Note

This check is required whenever a starter motor or start valve has been replaced. Check should be performed no less than three times.

- a. ENGINE IGNITION switch — OFF.
 - b. ECS MODE switch — AUTO.
 - c. PCL — OFF.
 - d. Engine starter button — PRESS AND HOLD UNTIL N_g BEGINS TO INCREASE. Note that appropriate STARTER advisory appears.
 - e. ECS vent airflow — STOPS.
 - f. Record maximum N_g (minimum N_g should be 24 percent).
 - g. Abort start by pulling down on PCL.
 - h. ENG STARTER advisory — DISAPPEARS.
 - i. Repeat steps c. to h. for other engine as required.
- 8. Rotor brake — OFF. Check pressure 0 psi, and ROTOR BRAKE advisory out.
 - 9. ENGINE IGNITION switch — NORM.
 - 10. Fuel selector — XFD.
 - 11. Lights — AS REQUIRED.
 - 12. Flight controls — POSITION AND HOLD.
 - a. Cyclic and pedals — CENTERED.
 - b. Collective — DOWN AND HOLD.


CAUTION

During engine start and runup, adjust the cyclic as required to maintain the tip path plane in a neutral position and maintain the collective full down and the pedals centered until N_r reaches 50 percent minimum to prevent damage to anti-flap assembly. If droop stop pounding occurs, raise collective to alleviate this condition, but not to exceed 1/2 inch. Maintain the new collective position until N_r reaches 50 percent minimum.

PROFILE

A B

13. BACKUP HYD PMP switch — OFF.
14. Engines — START.

CAUTION

If an abnormal or loud whining noise is heard during engine startup, shut down engine immediately due to impending diaphragm coupling failure. Maintenance action is required prior to subsequent engine start.

Note

Checking of time to idle should not be done on the initial start of a newly installed engine.

- a. Monitor N_g and TGT.
 - b. Record the following:
 - (1) Time to lightoff (time from PCL to IDLE until first rise in TGT).
 - (2) Time to idle (time from PCL to IDLE until N_g at ground idle).
 - (3) Starter dropout speed.
 - (4) Maximum TGT.
 - (5) At ground idle note TGT, N_g , oil pressure, and OAT.
 - c. Verify time to IDLE and minimum idle speed are within parameters (Figure 10-2).
15. Engine oil pressures — CHECK.
 16. ENG STARTER advisories — OUT.
 17. Engine idle N_{gs} — CHECK, 63 percent or above and matched within 3 percent.

WARNING

Ground idle N_g split greater than 3 percent is an indication of possible LDS roll-pin failure. Do not fly the helicopter until maintenance action is performed.

18. Check #1 HYD PUMP and #2 HYD PUMP cautions — OUT.
19. XMSN oil pressure — CHECK.
20. N_p/N_r — CHECK within limits.

CAUTION

Loss of the collective boost servo through either intentional shutoff or loss of NO. 2 hydraulic pressure will cause the collective to move rapidly from the down position to midposition if it is not held by hand. This movement can be enough to cause the helicopter to become airborne. During ground operations with engines operating, the flight controls shall be monitored.

PROFILE

21. PCLs — PULL OUT OF IDLE DETENT AND SMOOTHLY ADVANCE TO FLY.

WARNING

Do not move the PCLs rapidly when the tail wheel lockpin is not engaged.

22. Droop stops — OUT.
23. PCLs — FLY.
24. Fuel selector — DIR.
25. BACKUP HYD PMP switch — AUTO.
26. TRQs — MATCHED within 5 percent.
27. N_p/N_r — 100 percent.
28. NO. 1 and NO. 2 GENERATOR switches — ON.

WARNING

Power transfer from the APU generator to the NO. 1 generator may cause disengagement of SAS 1, SAS 2, TRIM, AUTO PLT, and Stabilator which may cause rotors to dip as 4 feet.

10.2.4.2 Rotor Brake Start Procedure

1. Fire guard posted — area clear.
2. Doors, inertia reels — LOCK.
3. SAS 1, SAS 2, TRIM and AUTO PLT pushbuttons — ON.
4. Engine control quadrant — CHECK.
 - a. PCLs — PULL DOWN AND PRESS FORWARD. Note no movement past IDLE detent.
 - b. Rotor brake interlock override tab — PULL.
 - c. PCLs — MOVE THROUGH FULL RANGE. Check for no binding, note positive detents, then OFF.
 - d. Fuel selector levers — DIR, XFD, THEN OFF. Check for no binding and note positive detents.
5. Engine fuel system priming (if required).

Note

Helicopter prime/boost pump capacity is not sufficient to prime an engine when the opposite engine is running. Therefore, engines should be primed individually with both engines OFF.

A B

A B

PROFILE



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- a. Fuel selector — DIR.
 - b. PCL — Hold in LOCKOUT.
 - c. FUEL PUMP switch — FUEL PRIME; Check FUEL PRIME advisory appears, hold until plane captain reports steady flow of fuel coming from overboard drain.
 - d. Repeat steps b. and c. with fuel selector lever in XFD.
 - e. FUEL PUMP switch — APU BOOST.
 - f. PCL — OFF.
6. Rotor brake — CHECK (pressure 450 psi minimum).
7. Engine starter/air start valve/ECS dropout — CHECK.

Note

This check is required whenever a starter motor or start valve has been replaced. Check should be performed no less than three times.

- a. ENGINE IGNITION switch — OFF.
 - b. ECS MODE switch — AUTO.
 - c. PCL — OFF.
 - d. Engine starter button — PRESS AND HOLD UNTIL N_g BEGINS TO INCREASE. Note that appropriate STARTER advisory appears.
 - e. ECS vent airflow — STOPS.
 - f. Record maximum N_g (minimum N_g should be 24 percent).
 - g. Abort start by pulling down on PCL.
 - h. ENG STARTER advisory — DISAPPEARS.
 - i. Repeat steps c. to h. for other engine (as required).
8. ENGINE IGNITION switch — NORM.
9. Fuel selectors — XFD.
10. Lights — AS REQUIRED.
11. Flight controls — POSITION AND HOLD.
- a. Cyclic and pedals — CENTERED.
 - b. Collective — DOWN AND HOLD.



Loss of the collective boost servo through either intentional shutoff or loss of NO. 2 hydraulic pressure will cause the collective to move rapidly to midposition if it is not held down by hand. This movement can be enough to cause the helicopter to become airborne. During ground operations with engines operating, the flight controls shall be guarded.

PROFILE

A B

12. Engines — START.

CAUTION

If an abnormal or loud whining noise is heard during engine startup, shut down engine immediately due to impending diaphragm coupling failure. Maintenance action is required prior to subsequent engine start.

Note

Checking of time to idle should not be done on the initial start of a newly installed engine.

- a. Monitor N_g and TGT.
 - b. Record the following:
 - (1) Time to lightoff (time from PCL to IDLE until first rise in TGT).
 - (2) Time to idle (time from PCL to IDLE until N_g at ground idle).
 - (3) Starter dropout speed.
 - (4) Maximum TGT.
 - (5) TGT, N_g , oil pressure, and OAT at ground idle.
 - c. Verify time to IDLE and minimum idle speed are within parameters (Figure 10-2).
13. Engine oil pressures — CHECK.
14. ENG STARTER advisories — OUT.
15. Engine idle N_g s — CHECK, 63 percent or above and matched within 3 percent.

WARNING

Ground idle N_g split greater than 3 percent is an indication of possible LDS roll-pin failure. Do not fly the helicopter until maintenance action is performed.

16. Area — CLEAR.
17. Lights — AS REQUIRED.
18. Rotor — ENGAGE.
 - a. Rotor brake — OFF. Check 0 psi, and ROTOR BRAKE advisory OUT.
 - b. PCLs — PULL OUT OF IDLE DETENT AND SMOOTHLY ADVANCE TO FLY.

WARNING

Do not move the PCLs rapidly when the tail wheel lockpin is not engaged.

- c. Check #1 HYD PUMP and #2 HYD PUMP cautions — OUT.
- d. XMSN oil pressure — CHECK.
- e. Droop stops — OUT.

PROFILE

19. PCLs — FLY.
20. Fuel selectors — DIR.
21. BACKUP HYD PMP switch — AUTO.
22. TRQs — MATCHED WITHIN 5 PERCENT.
23. N_p/N_r — 100 percent.
24. NO. 1 and NO. 2 GENERATOR switches — ON.

WARNING

Power transfer from the APU generator to the NO. 1 generator may cause disengagement of SAS 1, SAS 2, TRIM, AUTO PLT, and Stabilator which may cause rotors to dip as low as 4 feet.

10.2.4.3 Post Engagement Checks

- †1. Engine overspeed system and Auto-Ignition — CHECK.

Note

Failure of an engine to automatically relight when both OVSP TEST A and B are pressed simultaneously is possible. The engine should be restarted using normal procedures and the check should be performed again. If the engine automatically relights on the second attempt, the engine is acceptable. If the engine fails the test twice consecutively, maintenance action is required.

- †2. Contingency power — CHECK.
- †3. Hydraulic leak test — CHECK.
- †4. Backup tail rotor servo — CHECK.
5. DECU lockout — CHECK.

Note

- DECU LOCKOUT is recognized by a loss of torque matching and a rise in N_r and N_p above 100 percent. Monitor TGT.
- After an HMU, fuel filter, filter element, fuel pressure switch, or engine(s) has been replaced or reinstalled and the installed HMU is manufactured by Woodward, perform this check five times.

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- a. N_r — 100 percent. PARKING BRAKE set and TAIL WHEEL LOCK, or both main mounts chocked.
- b. Momentarily advance PCL to LOCKOUT. Immediately retard PCL to near vertical (6 o'clock) position. Slowly advance PCL to a position where TRQ is matched at 100 percent N_r . Continue to advance PCL slowly above 100 percent N_r .
- c. Reengage DECU by moving the PCL back to IDLE then slowly to FLY, while monitoring N_p/N_r and torque to verify DECU is reengaged.
- d. Repeat steps b. and c. for other engine.
6. Acceleration/deceleration — CHECK.

WARNING

- The tail wheel may slide laterally on wet or icy surfaces as a result of the engine and rotor surge encountered during the engine acceleration/deceleration check. Ensure the helicopter is clear of ground support personnel/equipment and the tail wheel is locked or both main mounts chocked before performing the engine acceleration/deceleration check.
- Care should be taken not to move the ENG PCLs rapidly, either forward or rearward, when the tail wheel lock pin is not engaged. Overly rapid application of PCLs can result in turning of the helicopter on spot.

- a. PCLs — FLY.
- b. NO. 1/NO. 2 N_p — 100 percent.
- c. Retard PCL of engine being checked to IDLE and rapidly advance it until N_g peaks; then rapidly retard to IDLE.
- d. Check that there is no acceleration or deceleration stall.
- e. PCL — FLY.
- f. Repeat steps b. to e. for other engine (as required).
7. ENG SPD TRIM switch — CHECK.
- a. Full DECR — Minimum 96 percent to 97 percent N_r .
- b. Full INC — Maximum 100 percent to 101 percent N_r .
- c. Adjust to 100 percent N_r .
8. Engine crossbleed start — CHECK.

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WARNING

- At 94 percent N_g , the aircraft will be light on its wheels. Be vigilant for signs of dynamic rollover; maintain a centered cyclic and be prepared to lower collective quickly. Sideward tip path may increase possibility of dynamic rollover.
- The WOW switch may trigger, enabling AFCS functions associated with flight; keep collective trim switch depressed. Emergency jettison and fuel dump functions are enabled; keep personnel clear of the aircraft.
- For shipboard operations, request amber deck, open RSD beams and slacken Main Landing Gear chains. Ensure chains do not become taut; dynamic instability may result.

CAUTION

- When attempting engine crossbleed starts with the engine intake cowling removed, a hot start may be experienced if the bleed air plug is not installed in the anti-ice bleed air line.
- For a crossbleed start, the good engine should indicate the maximum N_g safely attainable. Donor N_g less than 94 percent may result in hot starts.

Note

A full fuel load is recommended when conducting a crossbleed start to mitigate effects of a high power setting on deck.

- a. Fireguard posted, area clear.
- b. AIR SOURCE ECS/START switch — ENG.
- c. APU CONTR switch — OFF.
- d. ENGINE IGNITION switch — NORM.
- e. Fuel Selectors — XFD/DIR (as required).
- f. Collective — Increase to set 94 percent N_g on operating engine.
- g. ENG — START (normal procedures apply).
- h. Collective — FULL DOWN.

PROFILE

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- i. PCL — FLY.
 - j. Fuel selectors — DIR.
 - k. Repeat steps f. to j. for opposite engine, as required.
9. Windshield anti-ice operation/interlock — CHECK.

Note

APU GEN must be ON to provide AC power for the following checks.

- a. APU — START.
- b. NO. 1 and NO. 2 GENERATOR switches — OFF.
- c. PILOT/COPILOT WINDSHIELD ANTI-ICE switches — ON.
- d. Note increase in temperature only on the pilot windshield.
- e. NO. 1 or NO. 2 GENERATOR switches — ON.
- f. Note increase in windshield temperature on copilot windshield and pilot windshield remains heated.

Note

When windshield anti-ice is turned on, it may take up to 60 seconds until a noticeable change in windshield temperature can be detected.

- g. PILOT/COPILOT WINDSHIELD ANTI-ICE switches — OFF.
 - h. NO. 1 and NO. 2 GENERATOR switches — ON.
10. Electrical systems — CHECK.

A

WARNING

Power transfer from the APU generator to the NO. 1 generator may cause disengagement of SAS 1, SAS 2, TRIM, AUTO PLT, and Stabilator which may cause rotors to dip as low as 4 feet.

Note

The APU GEN must be on to ensure power is supplied to the VIDS in the event of generator dropoff.

- a. APU — VERIFY ON.
- b. APU generator — VERIFY ON.

PROFILE



- c. Underfrequency protection — TEST.
 - (1) NO. 1 and NO. 2 PCLs — RETARD SLOWLY.
 - (2) #1 GEN and #2 GEN cautions — Appear between 92 percent and 97 percent N_r . Allow a 3-second time delay. Note N_r .
 - (3) NO. 1 and NO. 2 PCLs — FLY. Note #1 GEN and #2 GEN cautions are OUT.
- d. AC system bus tie connector — TEST.
 - (1) NO. 1 GENERATOR switch — OFF.
 - (a) #1 GEN caution — APPEARS.
 - (b) #1 CONV caution — REMAINS OFF.
 - (c) AC ESS BUS OFF caution — REMAINS OFF.
 - (2) NO. 1 GENERATOR switch — ON, #1 GEN caution OUT.
 - (3) Repeat steps (1) and (2) for NO. 2 generator.
- e. DC system bus tie connector — TEST.
 - (1) NO. 1 CONVERTER POWER circuit breaker (CENTER, NO. 1 AC PRI BUS, ROW 1, CB 14) — PULL.
 - (a) SAS 1 pushbutton — NOTE OFF, THEN RESET ON.
 - (b) #1 CONV caution — APPEARS.
 - (c) DC ESS BUS OFF caution — REMAINS OFF.
 - (d) COPILOT Mode selector panel lights — ON.
 - (2) NO. 1 CONVERTER circuit breaker — RESET. #1 CONV caution OUT.
 - (3) Repeat steps (1) and (2), pulling NO. 2 CONVERTER POWER circuit breaker (CORNER, NO. 2 AC PRI BUS, ROW 2, CB 4). SAS 1 pushbutton should remain ON.
- f. AFCS voltage relay check.

Note

During this check, it is acceptable for some AFCS fail advisory lights to illuminate.

- (1) AC ESNTL BUS SUPPLY circuit breaker (NO. 1 AC PRI, CORNER, ROW 1, CB 12) — PULL, pilot's AI OFF flag should remain out of view.
 - (2) CMPTR PWR/RESET pushbutton — CHECK ON.
 - (3) AC ESNTL BUS SUPPLY circuit breaker — RESET.
11. Flight controls — CHECK.
- a. Disengage AUTO PLT, TRIM, SAS 2, and SAS 1 pushbuttons noting no jump in cyclic or tip-path plane.
 - b. Engage SAS 1, SAS 2, TRIM, and AUTO PLT pushbuttons.

A C D

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A B C D

12. Ground vibration analysis (tail, oil cooler, input, [NSV](#)) — AS REQUIRED.
13. Alternate tooth wear — AS REQUIRED.

WARNING

- Be vigilant for signs of dynamic rollover; maintain a centered cyclic and be prepared to lower collective quickly. Sideward tip path may increase possibility of dynamic rollover.
- Maintain a centered cyclic equivalent to a level tip path on level ground. Forward tip path may allow tail wheel to become light and allow tail wheel to slide sideways.
- The WOW switch may trigger, enabling AFCS functions associated with flight; keep collective trim switch depressed. Fuel Dump, Rescue Hoist, Rescue Hoist Shear, and Cargo Hook Shear functions are enabled; keep personnel clear of the aircraft.
- Tie-downs should be removed prior to pulling torque.

Note

- The following procedures are for shore-based operations only. No attempt should be made to perform these procedures aboard ship.
- A full fuel load is recommended when conducting these procedures to mitigate the effects of a high power setting on deck.
- Collect [ATABS](#) data in accordance with the A1-H60CA-VIB-100 manual.

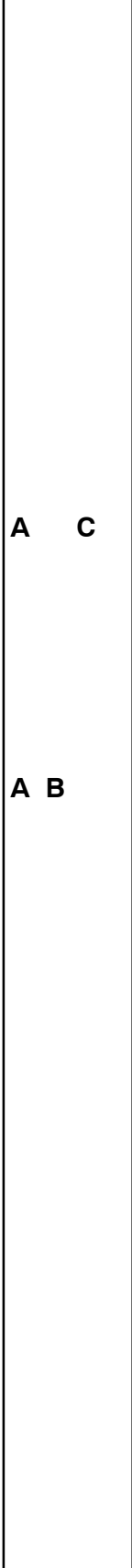
With the NO. 1 ENG operating in FLY and NO. 2 ENG shutdown:

- a. Allow 5 min for stabilization at 100 percent N_r , flat pitch.

After 5 min:

- b. Collective — INCREASE TORQUE TO 75-80 percent.
- c. ATABS — COLLECT DATA.
- d. Collective — FULL DOWN.
- e. Ignition switch — NORM.
- f. NO. 2 Fuel Selector — DIR.
- g. NO. 2 ENG — START.
- h. NO. 2 PCL — FLY.
- i. Allow 5 min for stabilization at 100 percent N_r , flat pitch.

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After 5 min:

- j. Collective — INCREASE TORQUE TO 35-40 percent.
- k. ATABS — COLLECT DATA.
- l. Collective — FULL DOWN.
- m. NO. 1 ENG — SHUTDOWN.
 - (1) ENG IGNITION switch — OFF.
 - (2) NO. 1 PCL and Fuel Selector — OFF.
- n. Allow 5 minutes for stabilization at 100 percent N_r , flat pitch.

After 5 min:

- o. Collective — INCREASE TORQUE TO 75-80 percent.
- p. ATABS — COLLECT DATA.
- q. Collective — FULL DOWN.

A C

- 14. Main rotor track and balance — AS REQUIRED.



Care must be taken when reseating struts. Helicopter damage may occur if excessive control inputs are made.

A B

- 15. Engine anti-ice system — CHECK (as required).
 - a. PCL (engine not being checked) — AS REQUIRED.



Failure of the ENG ANTI-ICE ON advisory to illuminate when the ENG ANTI-ICE switch is selected to ON, or when the N_g is below approximately 88 percent regardless of the switch position; or constant illumination of the ENG ANTI-ICE ON advisory with N_g greater than 90 percent (94 percent if OAT is 15 °C or greater) and the ENG ANTI-ICE switch OFF are indicative of a malfunctioning anti-ice/start bleed valve. This condition may cause engine flameout during low power settings such as quick stops and autorotative flight.

Note

- Engine Anti-ice Check should be performed into the wind on deck, in a hover over a suitable landing pad, or in a stable, level-flight regime.
- On deck or in a hover, it may be necessary to retard the PCL on the engine not being checked to prevent a vertical climb.

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- b. ENG ANTI-ICE switch (engine being checked) — OFF.
- c. Collective — RAISE TO INCREASE N_g OF ENGINE BEING CHECKED TO 90 PERCENT OR ABOVE (94 percent or above if OAT is above 15 °C).
- d. ENG ANTI-ICE ON advisory (engine being checked) — OFF.
- e. ENG ANTI-ICE switch (engine being checked) — ON.

Confirm:

- (1) ECS SHUTDOWN caution (if ECS on and AIR SOURCE ECS/START switch — ENG).

Note

ECS will not shut down if AIR SOURCE ECS/START switch is in APU.

- (2) TGT increases 30 °C to 100 °C.
- (3) ENG ANTI-ICE ON advisory appears.
- (4) ENG INLET ANTI-ICE ON advisory:
 - (a) OAT above 13 °C — OFF.
 - (b) OAT above 4 °C up to 13 °C — May appear.
 - (c) OAT 4 °C and below — Appears.

WARNING

A TGT increase greater than 100 °C and/or appearance of either ENG INLET ANTI-ICE ON advisory when OAT is above 13 °C may result in a loss in available torque at intermediate power up to 49 percent when the engine anti-ice system is activated. If any part of the engine anti-ice check fails, maintenance action is required prior to flight into icing conditions.

Note

ENG INLET ANTI-ICE ON advisory illuminates when engine inlet temperature reaches 93 °C which may take approximately 90 seconds.

- f. ENG ANTI-ICE switch (engine being checked) — OFF.

Confirm:

- (1) TGT decreases.
- (2) ENG ANTI-ICE ON advisory — DISAPPEARS.

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- (3) ECS — ON (if ECS on and AIR SOURCE ECS/START switch — ENG).
- (4) ENG INLET ANTI-ICE ON advisory — DISAPPEARS (after approximately 90 seconds).
- g. PCL (engine not being checked) — ADVANCE TO FLY (as required).
- h. Repeat steps a. to g. for other engine.

†16. Blade de-ice system — CHECK (as required).

Note

A TR DE-ICE FAIL caution may appear during the blade de-ice test while in an electromagnetic environment.

- a. BLADE DE-ICE TEST selector switch — NORM.
- b. BLADE DE-ICE POWER switch — TEST.



Leaving the BLADE DE-ICE POWER switch in the TEST position may cause blade damage.

- c. PWR MAIN RTR and TAIL RTR lights — CHECK. PWR MAIN RTR light may illuminate for 2 to 4 seconds.



If PWR MAIN RTR or TAIL RTR lights remain on for more than 10 seconds, main rotor or tail rotor damage may result. Turn BLADE DE-ICE POWER switch OFF. If either light remains illuminated, pull the appropriate circuit breaker (DE-ICE CONTR MB, COPILOT/TAIL BLADE DE-ICE). If either light remains illuminated, secure electrical power.

- d. TEST IN PROGRESS light — CHECK. The light should illuminate for 2 minutes. The ICE DETECTED caution will appear for approximately 6 seconds. No other blade de-ice system cautions should appear. PWR MAIN RTR and TAIL RTR lights should illuminate for 2 to 4 seconds near end of test. The TEST IN PROGRESS light should then extinguish.
- e. BLADE DE-ICE POWER switch — OFF.
- f. BLADE DE-ICE TEST selector switch — SYNC 1.
- g. BLADE DE-ICE POWER switch — TEST. MR DE-ICE FAIL caution appears.
- h. BLADE DE-ICE POWER switch — OFF. MR DE-ICE FAIL caution disappears.

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- i. BLADE DE-ICE TEST selector switch — SYNC 2.
- j. BLADE DE-ICE POWER switch — TEST. MR DE-ICE FAIL caution appears.
- k. BLADE DE-ICE POWER switch — OFF. MR DE-ICE FAIL caution disappears.
- l. BLADE DE-ICE TEST selector switch — OAT.
- m. BLADE DE-ICE POWER switch — TEST. MR DE-ICE FAIL and TR DE-ICE FAIL cautions appear.
- n. BLADE DE-ICE POWER switch — OFF. MR DE-ICE FAIL and TR DE-ICE FAIL cautions disappear.



EOT test should not be performed at ambient temperatures above 38 °C. Between 22 °C and 38 °C, allow 5 minutes at 100 percent N_r before this test is attempted. Between 10 °C and 22 °C, rotor must be turning at 100 percent. Exceeding temperature parameters may cause blade damage.

- o. BLADE DE-ICE TEST selector switch — EOT.
- p. BLADE DE-ICE MODE selector switch — MANUAL (M).
- q. BLADE DE-ICE POWER switch — ON. TR DE-ICE FAIL caution appears after approximately 15 to 30 seconds. MR DE-ICE FAIL caution appears after approximately 50 to 70 seconds. PWR MAIN RTR and/or PWR TAIL RTR lights may flash.
- r. BLADE DE-ICE POWER switch — OFF. (TR DE-ICE FAIL and MR DE-ICE FAIL cautions disappear).
- s. BLADE DE-ICE TEST selector switch — NORM.
- t. BLADE DE-ICE POWER switch — OFF.
- u. BLADE DE-ICE MODE selector switch — AUTO.
- v. APU generator backup — CHECK.
 - (1) NO. 1 or NO. 2 GENERATOR — OFF. (Applicable GEN caution light should be on).
 - (2) BLADE DE-ICE MODE SELECT — MANUAL (M).
 - (3) APU GENERATOR — ON.
 - (4) BLADE DE-ICE POWER — ON. (Wait 30 seconds, no de-ice lights should be on).
 - (5) Generator turned off in step (1) — ON. (Applicable GEN caution light should go off).
 - (6) BLADE DE-ICE POWER — OFF.
 - (7) BLADE DE-ICE MODE — AUTO.

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17. HIT baseline check (on deck) — AS REQUIRED.

Note

- HIT baseline should be established on deck or in flight. Subsequent HIT checks should be done in the same regime as HIT baseline.
- If icing conditions exist, consideration should be given to performing HIT Check on deck.
- HIT Checks shall be performed on the first flight of the day and recorded on the HIT/Power Check Log (Figure 10-3) for monitoring trends in engine performance.

a. ENG ANTI-ICE switches — OFF.



If icing conditions exist, do not keep ENG ANTI-ICE OFF longer than necessary to perform check.

b. ECS — OFF.

c. BAR ALT — SET TO 29.92.

d. N_r — 100 percent.

e. PCL (Engine not being checked) — IDLE.

f. Collective — Increase to maintain 60 percent TRQ for at least 30 seconds.

g. Record OAT, PA, and TGT.

Note

When using HIT TGT Reference Table, round up temperature to the nearest value.

h. Repeat steps f. and g. resetting TRQ for a total of three times.

i. PCL — FLY.

j. Repeat steps e. to i. for the other engine as required.

k. Calculate average indicated of three indicated TGT readings.

l. Determine table TGT from TGT Reference Table (Figure 10-4) for recorded OAT and pressure altitude. Record TGT on baseline worksheet.

Note

When using HIT table, round OAT up, and pressure altitude to the nearest value.

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- m. Subtract average indicated TGT from table TGT to establish TGT margin.
 - n. Establish TGT upper and lower limits by adding 20 °C to TGT margin and subtracting 20 °C from TGT margin (step m.). Record upper and lower limits on HIT/Power Check Log (Figure 10-3) in helicopter ADB.
18. HIT CHECK — AS REQUIRED (see paragraph 7.17.1).
 19. ENGINE ANTI-ICE, PITOT HEAT, BLADE DE-ICE, WINDSHIELD ANTI-ICE, DE-ICE MASTER switches — AS REQUIRED.
 20. FMCP — AS REQUIRED.
 21. APU — SHUTDOWN (as required).

10.2.5 Mission/Weapons Systems Checklist

1. MSN PWR — PRI.
2. DPLR, RDR, DATA LINK — RADIATE, as required.
3. ALQ 205 — AS REQUIRED.
4. AAR 47 — AS REQUIRED (2-minute warm-up).
5. Mission systems — IPL and key.
 - a. SO — IPL.
 - b. ATO MPD — TEST.
 - c. Secure equipment — KEY.
 - d. ATO MPD — ON (after test pattern appears).
 - e. Secure communications — CHECK.
6. Mode select panels, BDHI, AI — AS REQUIRED.
7. BDHIs and AIs — CHECK.
- †8. TACAN/IFF — TEST, SET.
9. AOP — INITIALIZE.
- †10. NAV — INITIALIZE.

If GPS is to be used as the primary navigation mode:

 - a. GPS — KEY.
 - b. GPS — INIT/TEST (via equipment status table once GPS is available).



Options 1 (Get GPS PRESET) and 8 (Send Init Data) of the GPS Data Table should not be performed when the aircraft NAV mode is GPS, as large and unpredictable aircraft LAT/LONG errors may occur.

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Note

Performance of INIT SYNC to initialize the GRP is strongly recommended. This will avoid problems such as uncapturable fly-to points. See NTRP 3-22.2-SH60B for establishing a data link with the ship.

†11. Initialize FHS — AS REQUIRED.

a. FLIR EU PWR — ON.

WARNING

When the FLIR EU PWR switch is ON, the FLIR Turret automatically moves to the STOW position. Ensure personnel and equipment are clear of the FLIR Turret area before applying power.

b. Hellfire PWR — ON (as required).

c. ACRT/FLIR/M299 — INIT/TEST (via equipment status table).

d. FLIR Turret — Verify operation.

e. Hellfire Attack Menu — SELECT. Verify correct missile symbology.

If missile symbology incorrect:

f. RESET LAUNCHER — SELECT.

g. FLIR Turret — STOW.

h. Hellfire PWR — OFF.

12. RAD ALTs — TEST. Press and hold the RAD ALT PUSH-TO-TEST (PTT) button.

Note

Note altitude indicator pointers indicate 100 ±10 feet, the green self-test light illuminates, and aural radar altitude warning system (RAWS) tone heard in pilot and ATO headsets. Release the PTT button and indicator should return to zero.

13. EMCON — AS REQUIRED.

14. External power/data link hardware — DISCONNECT (as required).

10.2.6 Taxi Checklist

1. Crew — SET FOR TAXI.

2. Lights — AS REQUIRED.

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3. Ordnance/Pins/Covers — ARM/REMOVE (as required).
4. Chocks — OUT.

WARNING

With missiles uploaded, exercise extreme care when chocking and chaining to avoid damage to missile seeker or fins or injury to personnel.

5. Brakes — RELEASE AND CHECK.
6. TAIL WHEEL switch — UNLOCK.
7. BDHI, standby compass, AIs turn and slip — CHECK.

10.2.7 Takeoff Checklist

1. Lights — AS REQUIRED.
2. AFCS — AS REQUIRED.
3. STABILATOR AUTO CONTROL pushbutton — ON.
4. CONTGCY PWR switch — AS REQUIRED.
5. PCLs — FLY.
6. Instruments, Caution/Advisories — CHECK.
7. Communication and navigation — AS REQUIRED.
 - a. Transponder — AS REQUIRED.
 - b. TACAN — AS REQUIRED.
8. FLIR turret — STOW (as required).
9. TAIL WHEEL switch — LOCK.
10. Harness — LOCKED.
11. Aircrewman Pretakeoff Checklist — COMPLETE.
12. Ordnance/pins/covers — ARM/REMOVE (as required).
13. Chocks/chains (Main, High Points, and Tail) — REMOVED.

WARNING

With missiles uploaded, exercise extreme care when chocking and chaining to avoid damage to missile seeker or fins or injury to personnel.

14. Brakes — AS REQUIRED.

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15. RDR/BAR ALT pushbutton — AS REQUIRED.

Note

Do not engage RDR ALT HOLD until clear of deck edge.

10.2.8 Hover Checks

1. Torque matching — CHECK. Note any abnormal torque matching on initial collective pull to a hover. Abnormal torque matching is indicated by a torque split of 5 percent to 10 percent, which may match in a stable hover.



Abnormal torque matching may be indicative of an LDS malfunction. Do not fly the helicopter until maintenance action is performed.

2. Hover controllability — CHECK.
 - a. Hover into wind.
 - b. Cyclic position approximately centered.
 - c. Left pedal should be slightly forward of neutral.
3. AFCS hover — CHECK.
 - a. SAS — CHECK.

Note

Properly functioning SAS will dampen induced pitch/roll rates, but will not necessarily return aircraft to trimmed attitude. The tendency to return to trimmed position should not be confused with a damped response.

Cyclic control inputs should be rapid, smooth, and produce desired change in approximately one second. While guarding cyclic, make input against trim and allow cyclic to return to trimmed position.

- (1) SAS 2, AUTO PLT pushbuttons — OFF. SAS 1, TRIM, and SAS/BOOST pushbuttons — ON.
- (2) Controllability — CHECK.
 - (a) Apply cyclic pulse to induce $\pm 3^\circ$ pitch attitude change. The helicopter should exhibit a damped response to the change.
 - (b) Apply cyclic pulse to induce $\pm 5^\circ$ roll attitude change. The helicopter should exhibit a damped response to the change.
 - (c) Make a ± 20 percent torque change. The helicopter should exhibit a dampened response in yaw. (The helicopter should maintain heading within $\pm 15^\circ$.)

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(d) SAS 2 pushbutton — ON. SAS 1 pushbutton — OFF.

(e) Repeat steps (a) to (c). Damped responses of the helicopter should be noticeably increased due to addition of hover augmentation of SAS 2.

b. Autopilot — CHECK.

(1) SAS/BOOST, SAS 1, SAS 2, TRIM, and AUTO PLT pushbuttons — ON.

(2) Momentarily remove hands and feet from flight controls and monitor. Attitude retention in pitch and roll should be $\pm 1^\circ$ (calm wind). Heading hold should be $\pm 2^\circ$.

(3) Induce cyclic pulse $\pm 5^\circ$ in pitch. Helicopter should return to trimmed attitude with no more than one overshoot of 3° .

(4) Repeat step (3) for cyclic roll pulse of $\pm 10^\circ$.

(5) With feet off pedals, make a ± 20 percent torque change. Helicopter should retain heading within $\pm 2^\circ$.

4. Generator underfrequency — CHECK.

WARNING

Power transfer from the APU generator to the NO. 1 generator may cause disengagement of SAS 1, SAS 2, TRIM, AUTO PLT, and Stabilator which may cause rotors to dip as low as 4 feet.

Note

The APU generator should be on to ensure power is supplied to the VIDS in the event of generator dropoff.

a. APU — START, AS REQUIRED.

b. Retard NO. 1 and NO. 2 PCLs to slowly reduce N_r to 90 percent. Allow a 3-second time delay and note LOW ROTOR RPM warning light flashing below 96 percent N_r .

c. #1 GEN and #2 GEN cautions should not appear.

d. PCLs — FLY.

e. APU — SHUTDOWN (if not required).

5. Main Transmission oil pressure — RECORD (minimum 45 PSI).

6. RAST system main probe — CHECK.

a. Crewman open cargo hook door.

b. RAST MASTER — ON.

c. MAIN PROBE — DOWN. Status light indicates DN.

d. MESSENGER CABLE — DOWN. Status light indicates OUT.

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- e. Crewman verify main probe down, messenger cable out.
- f. Raise messenger cable. Position switch to OFF when status light indicates messenger cable IN.
- g. MAIN PROBE — UP. Status light indicates UP.
- h. RAST MASTER — OFF.
- i. Crewman close cargo hook door.

7. Main rotor track and balance — AS REQUIRED.

10.2.9 Climb Checks

1. Stabilator position — CHECK. PNAC shall monitor and call out stabilator indicator position versus airspeed.

- a. STAB POS indication should begin moving up at approximately 30 KIAS.
- b. STAB POS indication should be approximately 25° by 60 KIAS.

2. Flight instruments — CHECK.

- a. Airspeed indicators — CHECK PILOT AND COPILOT INDICATORS. Maximum difference between indicators should not be over 5 knots. Note difference.
- b. VSIs — CHECK.
- c. Altimeters — CHECK.
- d. BDHIs and compasses — CHECK.

10.2.10 Post Takeoff Checks

- 1. Instruments, Caution/Advisories — CHECK.
- 2. RDR/BAR ALT pushbutton — AS REQUIRED.
- 3. CONTGCY PWR switch — AS REQUIRED.
- 4. Lights — AS REQUIRED.
- 5. Aircrewman Post Takeoff Checklist — COMPLETE.
- 6. COMP controllers — SLAVED and aligned.
- 7. Manual fuel transfer — CHECK AS REQUIRED. (Short manual transfers from each auxiliary fuel tank should be checked. Main fuel level shall be 3,700 pounds or less prior to each transfer.)
- 8. HIT check — AS REQUIRED (see [paragraph 7.17.1](#)).

Note

- At a minimum, the HIT check shall be performed on the first flight of the day.
- For FCFs, HIT check is not required if performing HIT Baseline check.

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9. Engine anti-ice check — AS REQUIRED (see [paragraph 7.17.10](#)).
10. Power Available — CHECK (as required).
 - a. ECS/ANTI-ICE and CONTGCY PWR switches — OFF.
 - b. Stabilize aircraft at intended operating altitude, level the VSI, ball centered, 100 to 130 KIAS. Airspeed is dependent on environmental conditions and gross weight.
 - c. Gradually increase collective until N_p begins to droop on either engine or maximum dual-engine torque limits are reached. Stabilize for 5 seconds and record indicated torque.
11. Tactical/Combat Checklist — AS REQUIRED (see [paragraph 7.8](#)).

10.2.11 Flight Checks

1. In-flight controllability — CHECK.
 - a. Increase airspeed to 100 KIAS and stabilize.
 - (1) Cyclic position — APPROXIMATELY CENTERED.
 - (2) Pedals — RIGHT PEDAL, CENTERED TO SLIGHTLY FORWARD OF NEUTRAL.
 - b. Airspeed indicators — CHECK PILOT AND COPILOT INDICATORS. Difference in indicators should not be over 5 KIAS. Note difference.
 - c. Vibrations — NOTE ANY ABNORMAL VIBRATION LEVEL.
 - d. VSI — CHECK FOR DIFFERENCES.
 - e. Hold a steady state autorotative descent at 100 KIAS with collective full down. Stabilator position should be 3° to 7° trailing-edge up. Record position.
2. Engine power checks.

Note

Rapid reduction in PCL may result in rapid N_r decay.

- a. Intermediate range power (IRP) limiter check/pre-maximum power check.

Note

- If N_r droops before $839^\circ \pm 10^\circ \text{C}$, the engine is N_g /fuel flow limited.
- If N_g /fuel flow or torque limited, the ENG ANTI-ICE switch for the engine being checked may be turned ON to increase TGT and verify limiter operation.
- The $839^\circ \pm 10^\circ \text{C}$ limiter should be obtainable in OATs above -10°C . If TGT exceeds 851°C , discontinue IRP limiter and maximum power check.

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- (1) Set altimeter to 29.92; establish level flight at a convenient 1,000-foot interval.
 - (2) Verify ENG ANTI-ICE, CONTGCY PWR, AIR SOURCE/ECS START, and ECS switches OFF.
 - (3) Retard PCL on engine not being checked to 20 percent TRQ or less.
 - (4) While maintaining altitude, slowly increase collective until 2 percent N_r droop is obtained. Airspeed should be adjusted to maintain level flight. Ensure torque of engine not being checked remains below 20 percent as collective is increased.
 - (5) Stabilize for 10 seconds; TGT limit is $839^\circ \pm 10^\circ \text{C}$.
 - (6) Note TGT for IRP limiter check.
 - (7) With ENG ANTI-ICE switch OFF, record maximum TGT and maximum N_g for maximum power check.
- b. Maximum power check.
- (1) Maintain level flight at current altitude.
 - (a) If TGT limited, reduce collective to regain 100 percent N_r . Increase airspeed as necessary to obtain maximum TGT noted during step a.(7) while maintaining 100 percent N_r .
 - (b) If N_g /fuel flow limited, reduce collective to regain 100 percent N_r . Increase airspeed as necessary to obtain maximum N_g noted during step a.(7) while maintaining 100 percent N_r .
 - (2) Stabilize for 10 seconds and record PA, OAT, TRQ, TGT, N_g , and engine oil pressure and temperature.
- c. Contingency range power (CRP) limiter check.
- (1) CONTGCY PWR switch — ON.
 - (2) Increase airspeed as necessary; altitude may vary.
 - (3) Slowly increase collective until 2 percent N_r droop is obtained.

Note

- If N_r droops before $891^\circ \pm 10^\circ \text{C}$, the engine is N_g /fuel flow limited.
- If N_g /fuel flow or torque limited, the ENG ANTI-ICE switch for the engine being checked may be turned ON to increase TGT and verify TGT limiter operation.

- (4) Stabilize for 10 seconds; TGT limit is $891^\circ \pm 10^\circ \text{C}$.

Note

The $891^\circ \pm 10^\circ \text{C}$ limiter should be obtainable in OATs above -10°C . If TGT exceeds 903°C , discontinue the CRP limiter check.

- (5) Record TGT.
- (6) Advance PCL to FLY.

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- (7) Reduce collective, check TGT below IRP limiter, CONTGCY PWR switch — OFF.
- (8) ENG ANTI-ICE switch — OFF (as required).
- (9) AIR SOURCE ECS/START switch — ENG.

Note

If contingency power is secured with TGT greater than $839^{\circ} \pm 10^{\circ} \text{C}$, N_r will droop.

- d. Repeat steps a. to c. for other engine as required.
- e. Engine calculations.
 - (1) Determine torque adjusted (TRQADJ):
 - (a) For OAT greater than -20°C , $\text{TRQADJ} = \text{TRQMEAS}$. (Torque measured during Max Power Check).
 - (b) For OAT less than -20°C , $\text{TRQADJ} = \text{TRQMEAS} + [0.2 \times (\text{TGTREF} - \text{TGTMEAS})]$. TGTREF is obtained from the Torque Factor TGT Reference Chart (Figure 10-5) for the OAT recorded during the maximum power check.
 - (2) Determine the target torque value (TTV) using the Maximum Power Check Chart (Figure 10-6) for the OAT and pressure altitude recorded during the maximum power check.
 - (3) Specification torque ratio (STR) = $\text{TRQADJ} \div \text{TTV}$.
 - (4) Determine engine torque factor (ETF). Enter Torque Factor Chart (Figure 10-7) with calculated STR and OAT recorded during maximum power check.
 - (a) If OAT is below -5°C , use the -5°C line.
 - (b) If OAT is above 35°C , use the 35°C line.
 - (c) If STR is greater than 1.0, then ETF equals 1.0.
 - (5) If ETF is at or above .90, engine performance is satisfactory. If ETF is below .90, engine performance is unsatisfactory.
 - (6) Record ETF on FCF record card and HIT/Power Check Log (Figure 10-3).

3. HIT baseline check (in flight) — AS REQUIRED.

Note

- HIT baseline may be established on deck or in flight. Subsequent HIT checks should be done in the same regime as HIT baseline.
- If icing conditions exist, consideration should be given to performing HIT Check on deck.
- HIT Checks shall be performed on the first flight of the day and recorded on the HIT/Power Check Log (Figure 10-3) for monitoring trends in engine performance.

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- a. ENG ANTI-ICE switches — OFF.

CAUTION

If icing conditions exist, do not keep ENG ANTI-ICE OFF longer than necessary to perform check.

- b. ECS — OFF.
- c. BAR ALT — SET TO 29.92.
- d. N_r — 100 Percent.
- e. Collective — INCREASE TO MAINTAIN 60 PERCENT TRQ FOR AT LEAST 30 SECONDS.
- f. Record OAT, PA, and TGT.
- g. Repeat steps e. and f. resetting TRQ for a total of three times.
- h. Repeat steps e. to g. for the other engine as required.
- i. Calculate average indicated of three indicated TGT readings.
- j. Determine table TGT from the HIT TGT Reference Table (Figure 10-4) for recorded OAT and pressure altitude. Record TGT on baseline worksheet.

Note

When using HIT table, round OAT up, and pressure altitude to the nearest value.

- k. Subtract average indicated TGT from table TGT to establish TGT margin.
 - l. Establish TGT upper and lower limits by adding 20 °C to TGT margin and subtracting 20 °C from TGT margin (step k.). Record upper and lower limits on HIT/Power Check Log (Figure 10-3) in helicopter ADB.
4. ENG ANTI-ICE system — CHECK (as required).
 - a. PCL (engine not being checked) — AS REQUIRED.

WARNING

Failure of the ENG ANTI-ICE ON advisory to illuminate when the ENG ANTI-ICE switch is selected to ON, or when the N_g is below approximately 88 percent regardless of the switch position; or constant illumination of the ENG ANTI-ICE ON advisory with N_g greater than 90 percent (94 percent if OAT is 15 °C or greater) and the ENG ANTI-ICE switch OFF are indicative of a malfunctioning anti-ice/start bleed valve. This condition may cause engine flameout during low power settings such as quick stops and autorotative flight.

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Note

- Engine Anti-ice Check should be performed into the wind on deck, in a hover over a suitable landing pad, or in a stable, level-flight regime.
 - On deck or in a hover, it may be necessary to retard the PCL on the engine not being checked to prevent a vertical climb.
- b. ENG ANTI-ICE switch (engine being checked) — OFF.
- c. Collective — RAISE TO INCREASE N_g OF ENGINE BEING CHECKED TO 90 PERCENT OR ABOVE. (94 percent or above if OAT is above 15 °C).
- d. ENG ANTI-ICE ON advisory (engine being checked) — OFF.
- e. ENG ANTI-ICE switch (engine being checked) — ON.

Confirm:

- (1) ECS SHUTDOWN caution (if ECS on and AIR SOURCE ECS/START switch — ENG).

Note

ECS will not shut down if AIR SOURCE ECS/START switch is in APU.

- (2) TGT increases 30 °C to 100 °C.
- (3) ENG ANTI-ICE ON advisory appears.
- (4) ENG INLET ANTI-ICE ON advisory:
- (a) OAT above 13 °C — OFF.
 - (b) OAT above 4 °C up to 13 °C — MAY APPEAR.
 - (c) OAT 4 °C and below — APPEARS.

WARNING

A TGT increase greater than 100 °C and/or appearance of either ENG INLET ANTI ICE ON advisory when OAT is above 13 °C may result in a loss in available torque at intermediate power up to 49 percent when the engine anti-ice system is activated. If any part of the engine anti-ice check fails, maintenance action is required prior to flight into icing conditions.

Note

ENG INLET ANTI-ICE ON advisory illuminates when engine inlet temperature reaches 93 °C which may take approximately 90 seconds.

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- f. ENG ANTI-ICE switch (engine being checked) — OFF.
 Confirm:
 - (1) TGT decreases.
 - (2) ENG ANTI-ICE ON advisory — DISAPPEARS.
 - (3) ECS — ON (if ECS on and AIR SOURCE ECS/START switch — ENG).
 - (4) ENG INLET ANTI-ICE ON advisory — DISAPPEARS (after approximately 90 seconds).
- g. PCL (engine not being checked) — Advance to FLY (as required).
- h. Repeat steps a. to g. for other engine.
- 5. ECS — CHECK.
 - a. AIR SOURCE ECS/START switch — ENG.
 - b. APU CONTROL switch — OFF.
 - c. ECS MODE switch — AUTO.
 - d. ECS TEMP knob — COLD. (Cold air should flow from vents.)
 - e. ECS TEMP knob — HOT. (Hot air should flow from vents.)
 - f. NO. 1 or NO. 2 ENG ANTI-ICE switch — ON.
 - g. ECS SHUTDOWN caution — APPEARS. (No airflow from vents.)
 - h. ENG ANTI-ICE switch — OFF. (ECS SHUTDOWN caution OUT and hot air flows from vents.)
 - i. ECS MODE switch — MAN.
 - j. ECS HOT/COLD switch — COLD. Hold until cold air flows from vents, then switch to HOT. Hold until hot air flows from vents, then release.
 - k. CONTGCY PWR switch — ON.
 - l. ECS SHUTDOWN caution and #1 ENG CONT PWR and #2 ENG CONT PWR advisories — ON. No airflow from vents.
 - m. CONTGCY PWR switch — OFF. ECS SHUTDOWN caution and #1 ENG CONT PWR ON and #2 ENG CONT PWR ON advisories OUT. Hot air flows from vents.
 - n. ECS MODE switch — AS DESIRED.
- 6. Main rotor track and balance (120 KIAS) — AS REQUIRED.
- 7. Vibration analysis (cabin health, nose absorber) (120 KIAS) — AS REQUIRED.
- 8. Stabilator — CHECK.
 - a. Trim 120 KIAS in level flight.
 - b. Check stabilator position 1° to 7° trailing-edge down.
 - c. Enter a sideslip by applying left pedal against trim until ball is displaced one ball width to the right. Check stabilator position moves down 3° from trimmed position.

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- d. Release pedals and check that ball returns to one-half ball width of center, and helicopter returns to within $\pm 1^\circ$ of trimmed heading.
- e. Repeat step c. with right pedal and one ball width to the left. Check stabilator position moves up 3° from trimmed position.
- f. With fixed collective in balanced flight and feet off pedals, roll into a 45° AOB turn against trim. Maintain 120 KIAS (this check will result in a loss of altitude).

Check:

- (1) Maneuvering stability – aft cyclic is required to maintain 120 KIAS.
- (2) Stabilator position moves 1° down from trim.

- g. Release cyclic and allow aircraft to return to straight and level flight.

Check:

- (1) No adverse pitch movements.
- (2) Stabilator returns to trimmed position.

9. AFCS in-flight check.

- a. Trim 120 KIAS in level flight.
- b. SAS check.

Note

- This check should be performed in smooth air. Cyclic control inputs should be rapid, smooth, and produce desired attitude change in approximately 1 second. While guarding cyclic, make input against trim and allow cyclic to return to trim position.
- Properly functioning SAS will dampen induced rates, but will not necessarily return aircraft to trimmed attitude. The tendency to return to trimmed position should not be confused with a damped response.

- (1) SAS/BOOST, SAS 1, and TRIM pushbuttons — ON.
- (2) SAS 2 and AUTO PLT pushbuttons — OFF.
- (3) Apply cyclic pulse to induce $\pm 3^\circ$ pitch attitude changes against trim. Helicopter attitude should exhibit a damped response.
- (4) Repeat step (3) for 5° roll attitude changes against trim.
- (5) Repeat steps (3) and (4) with SAS 2 pushbutton ON and SAS 1 pushbutton OFF. Note an improved response with SAS 2 pushbutton ON attributed to the addition of gust alleviation.
- (6) SAS 1 and AUTO PLT pushbuttons — ON.

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c. Autopilot check.

- (1) Attitude and heading retention — CHECK.

Note

Steady state attitude/heading retention tolerance in smooth air should be $\pm 1^\circ$ pitch, roll, and heading. Airspeed retention should be ± 10 KIAS.

- (a) Apply a forward cyclic pulse against trim to change pitch attitude 5° .
- (b) Attitude should return to trim with no more than one overshoot.
- (c) Repeat steps (a) and (b) for aft cyclic.
- (d) Apply a right cyclic pulse against trim to change roll attitude 10° .
- (e) Attitude should return to trim with no more than one overshoot.
- (f) Repeat steps (d) and (e) for left cyclic.
- (g) Without pressing trim release switches, press pedals to displace ball one width from center.
- (h) Release pedals. Ball should return to 1/2 ball width of center and heading should return within $\pm 1^\circ$ of trimmed heading.
- (i) Repeat steps (g) and (h) for opposite direction.
- (j) With pedal trim switches depressed and no force on pedals, roll helicopter against trim into a 30° AOB and release. Helicopter should return to its original attitude with only a slight overshoot and without adverse pitch.
- (k) Repeat step (j) for opposite direction. Response should be the same.

d. Coordinated turn check.

- (1) With feet off pedals, roll helicopter into a 45° AOB.
- (2) Ball should stay within 1/2-width of center.
- (3) Roll wings level.
- (4) Ball should return to center.
- (5) Repeat steps (1) to (4) for opposite direction.

e. Cyclic and yaw trim check.

- (1) Using the four-way trim switch, roll helicopter into 30° AOB.
- (2) Roll should be smooth at approximately 6° per second.
- (3) Release the four-way trim switch at 30° AOB. Helicopter should retain this AOB with a slight overshoot, cyclic should return to center, and ball should stay within 1/2 ball-width of center.
- (4) Return helicopter to level attitude using four-way trim switch, noting smooth response.
- (5) Repeat steps (1) through (4) in opposite direction.

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- (6) Beep cyclic forward for 2 seconds. Airspeed should increase 12 ± 5 KIAS.
 - (7) Beep cyclic aft for 2 seconds. Airspeed should decrease 12 ± 5 KIAS.
 - (8) Apply collective HDG TRIM switch to change helicopter heading 5° . The first degree should be a flat turn for 1 second. The remaining 4° should be coordinated at 1° per second.
 - (9) Repeat step (8) for opposite direction. Response should be the same.
- f. Airspeed hold check.
- (1) Trim aircraft to 120 KIAS.
 - (2) Slowly increase airspeed 10 KIAS by pushing cyclic against trim.
 - (3) Note force required and release cyclic to trim position.
 - (4) Airspeed should return to 120 ± 5 KIAS with no more than one overshoot.
 - (5) Decrease airspeed 10 KIAS by pulling slowly aft on cyclic against trim.
 - (6) Note force required and release cyclic to trim position.
 - (7) Airspeed should return to 120 ± 5 KIAS with no more than one overshoot.
 - (8) Press cyclic trim release to increase airspeed to 130 KIAS. When airspeed reaches 130 KIAS, release cyclic trim release.
 - (9) Airspeed should hold at speed when trim release is released.
 - (10) Repeat steps (8) and (9) decreasing airspeed to 120 KIAS.
- g. Barometric and radar altimeter hold/heading hold check.
- (1) SAS/BOOST, SAS 1, SAS 2, TRIM, and AUTO PLT pushbuttons — ON.
 - (2) BAR ALT pushbutton — ON.
 - (3) Steady-state altitude retention should be ± 10 feet.
 - (4) Enter a standard-rate turn for 180° . Steady-state altitude retention should be ± 10 feet with ± 30 foot transient.
 - (5) Increase AOB to at least 30° . Steady-state altitude retention should be ± 30 feet with ± 60 foot transient.
 - (6) Repeat steps (4) and (5) in opposite direction.
 - (7) With helicopter in trimmed straight and level flight, enter a 500-fpm rate of descent against collective and release. Heading retention should be $\pm 1^\circ$. Helicopter should return to within ± 10 feet of initial altitude.
 - (8) Repeat step (7) for climb.
 - (9) Press collective TRIM RELEASE and establish a 500-fpm rate of descent.
 - (10) Release collective TRIM RELEASE. Note BAR ALT pushbutton is ON and altitude is within ± 10 feet of designated altitude.
 - (11) BAR ALT pushbutton — OFF, RDR ALT pushbutton — ON.

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- (12) Repeat steps (3) to (10) using RDR ALT hold. Altitude retention tolerances are the same as with the BAR ALT.
- (13) RDR ALT/BAR ALT pushbutton — OFF.
- 10. Flight checks (140 KIAS):
 - a. Increase airspeed to 140 KIAS and stabilize.
 - b. Airspeed indicators — CHECK. Pilot and copilot indicator difference should not be more than 5 KIAS. Note difference.
 - c. Vibrations — NOTE ANY ABNORMAL VIBRATIONS.
- 11. Main rotor track and balance (140 KIAS) — AS REQUIRED.
- 12. Vibration analysis (4-per, cabin absorbers) (140 KIAS) — AS REQUIRED.
- 13. Flight checks (**Vh**):
 - a. Increase airspeed in level flight to Vh (106 percent TRQ or 839 °C ±10 TGT, whichever occurs first).
 - (1) Cyclic — CENTERED LATERALLY. (At least 2 inches of forward cyclic should remain.)
 - (2) Pedals — RIGHT PEDAL. (Should be no more than 1 inch forward of neutral.)
 - (3) Collective — Should not be against upper stop.
 - b. Stabilator position – 0° to 4° — Trailing-edge down.
 - c. Vibrations — NOTE ANY ABNORMAL VIBRATIONS.
 - d. Airspeed indicators — CHECK. Pilot and copilot indicator difference should not be more than 5 KIAS. Note difference.
- 14. Main rotor track and balance (**Vh**) — AS REQUIRED.
- 15. Absorber Tuning — AS REQUIRED.



Do not exceed Torque, N_p , or TGT limitations.

Note

Collect ATABS data in accordance with the A1-H60-CA-VIB-100 Manual.

- a. Increase airspeed to 140 KIAS and stabilize.
- b. ENG SPD Trim switch — SET N_g to 97 percent.
- c. ATABS — Collect Data.
- d. Repeat steps b. and c. for 98, 99, 99.5 100 and 100.5 percent N_r .
- e. Decrease airspeed to within the calculated single engine envelope.

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- f. ENG SPD trim switch — SET N_r to 98 percent.

WARNING

Adjustment of the PCLs outside of the helicopter single engine envelope may result in an unrecoverable loss of N_r following an engine malfunction.

- g. PCL (engine with lowest **ETF**) — MOMENTARILY ADVANCE TO LOCKOUT. RETARD TO SET 100 PERCENT N_r .
- h. Increase airspeed to 140 KIAS and stabilize.
- i. PCL — ADJUST AS REQUIRED TO MAINTAIN N_r AT 100 PERCENT.
- j. ENG SPD Trim switch — SET N_r TO 101 PERCENT.
- k. ATABS — COLLECT DATA.
- l. Repeat steps j. and k. for 102 percent N_r .
- m. Decrease airspeed to within the calculated single engine envelope.
- n. PCL (engine in Lockout) — RETARD TO IDLE THEN ADVANCE TO FLY.
- o. ENG SPD Trim switch — SET N_r TO 100 PERCENT (as required).

16. Automatic approach, hover coupler, and departure check.

- a. Automatic approach — CHECK.
- (1) Automatic Approach Checklist — COMPLETE. HVR ALT rotary knob set to 80 feet, LONG VEL and LAT VEL controls set to 0, and SAS 2, TRIM, AUTO PLT pushbuttons — ON.
 - (2) Trim helicopter for 100 KIAS and 200 feet altitude, heading into wind.
 - (3) Automatic approach — ENGAGE. Check for steady RDR ALT hold light. Helicopter should decelerate at 1 knot per second.
 - (4) As helicopter decelerates below 80 knots groundspeed, radar altitude hold disengages and a 120 feet-per-minute rate of descent will be commanded.
 - (5) At 60 KIAS, transition is made from heading hold to Doppler mode, eliminating lateral drift.
 - (6) Helicopter should approach a hover at 80 feet and approximately 10 knots longitudinal groundspeed.
 - (7) At ± 2 feet of HVR ALT setting, RADALT hold engages.
 - (8) At 1 KGS, HVR mode engages. HVR pushbutton illuminates.

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Note

If water is smooth, the Doppler may go into memory mode and deceleration and drift will have to be controlled manually. As the helicopter approaches 80 feet, the radar altimeter hold will engage. When approaching a hover, the rotor wash will disturb the water surface enough to receive a Doppler return, however, pilot must reengage Approach/ Hover.

b. Hover coupler — CHECK.

- (1) Helicopter should hover within ± 4 feet of HVR ALT setting and ± 2 KGS with the LONG VEL and LAT VEL rotary knobs set at 0.
- (2) Start a 10-knot lateral drift against trim. Cross-check with hover bars and Doppler. Release cyclic.
- (3) Helicopter should return to a stable hover.
- (4) Repeat steps (2) and (3) for opposite lateral and longitudinal drift directions.
- (5) LAT VEL rotary knob — Set to establish a 10-knot drift. Cross-check with hover bars and Doppler. Return LAT VEL rotary knob to 0. Helicopter should return to and maintain previously established hover.
- (6) Repeat step (5) for LAT VEL rotary knob in opposite direction.
- (7) Repeat steps (5) and (6) for LONG VEL in forward and aft directions.
- (8) Repeat steps (5) to (7) using four-way TRIM switch. Cross-check with hover bars and Doppler. Once 10-knot drift is established press cyclic TRIM REL button and release. Helicopter should return to a stable hover.
- (9) Move collective HDG TRIM switch to L and hold.
- (10) Helicopter should change heading to the left at 3° per second. When switch is released, helicopter should synchronize on the heading when released within $\pm 2^\circ$.
- (11) Repeat steps (9) and (10) to the right.
- (12) Reestablish a stable hover into the wind.
- (13) HVR ALT rotary knob — 150 FT.
- (14) Helicopter should climb to 150 ± 4 feet with only one overshoot. Rate of climb should not exceed 1,000 fpm. Upward collective movement should cease when torque reaches a maximum of 116 percent; however, transients above 116 percent are possible.
- (15) RADAR ALTIMETER variable index — SET TO 80 FT.
- (16) HVR ALT rotary knob — 70 FT. Check for RAWS tone descending through 80 feet (check for both pilot and copilot).
- (17) Helicopter should descend to 70 ± 4 feet with only one overshoot and torque limits as shown above. Rate of descent should not exceed 250 fpm.

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- (18) HVR ALT control — 30 feet. Check for continuous RAWs tone and light below 35 feet.
- (19) HVR ALT control — RESET to desired altitude.

c. Crew hover — CHECK.

- (1) CREW HVR pushbutton — ON.
- (2) HOVER TRIM light on Crew Hover Control Panel should illuminate.
- (3) Hover trim grip TRIM switch — PRESS FOR FORWARD DRIFT.

Note

The control authority of the crewman is limited to 5 knots of groundspeed in longitudinal and lateral directions in either axis around the lateral and longitudinal velocity set on the AFCS control panel. The HOVER TRIM switch output is pressure sensitive. Increase pressure to command an increase in groundspeed.

- (4) Release switch pressure. Helicopter should return to stable hover.
- (5) Repeat steps (3) and (4) for aft, left, and right.
- (6) CREW HVR pushbutton — OFF.
- (7) HOVER TRIM light on Crew Hover Control Panel should extinguish.

d. Departure — CHECK.

- (1) HVR pushbutton — ILLUMINATED.
- (2) Cyclic DEPART HOVER button — PRESS. DPRT light on AFCS CONTROL panel should illuminate.
- (3) Helicopter should make smooth transition to 480 feet-per-minute rate of climb and 2 knots-per-second acceleration, and fly to 500 feet altitude for RDR ALT hold and 100 KIAS for airspeed hold trimmed.
- (4) Automatic Approach — ENGAGE.
- (5) During deceleration, beep cyclic aft for 2 seconds to verify deceleration increase of 1 knot/second.
- (6) At airspeed less than 50 KIAS, press cyclic DEPART HOVER button.
- (7) Prior to reaching 500 feet AGL and 100 KIAS, momentarily press collective TRIM RELEASE switch and cyclic TRIM RELEASE button. The AFCS should stabilize the helicopter at the altitude and airspeed at the point of release. RAD ALT hold remains ON.

17. Navigation, mission, and communication equipment — TEST/CHECK OPERATION.

- a. UHF-1 and -2.
- b. UHF backup (pilot/copilot).
- c. HF.
- d. TACAN.

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- e. UHF/ADF.
 - f. Doppler navigation.
 - g. IFF/interrogator.
 - h. MAD.
 - i. RADAR.
 - j. Equipment status table.
 - k. GPS.
18. Fuel dump — CHECK.

WARNING

Fuel dumping should be manually terminated at no less than 600 pounds total fuel. With less than 600 pounds of fuel, fuel starvation may occur when balanced flight is not maintained and/or pitch attitudes exceed 15° nose up or nose down.

- a. Determine the amount of fuel to be dumped.
- b. BuNo 162349 and subsequent, FUEL MGT control panel — TRANSFER/MANUAL OVRD.
- c. ALE-39 power — OFF.
- d. FUEL DUMP switch — DUMP.
- e. FMCP — FUEL DUMP light illuminated, as applicable.

After the desired quantity has been dumped:

- f. FUEL DUMP switch — OFF.

WARNING

Internal wear of the fuel dump switch guard may not move the switch to the OFF position. Aircrew must verify switch position when completing dumping procedures.

- g. Observe the fuel readout to ensure that dumping has ceased.

If fuel dumping continues:

- h. FUEL DUMP circuit breakers — PULL.
 - (1) FUEL DUMP NO. 1 (CENTER, NO. 1 AC PRI, ROW 1, CB 13).
 - (2) FUEL DUMP PUMP (CORNER, NO. 2 AC PRI, ROW 1, CB 1).
 - (3) FUEL DUMP CONTR (ATO OVERHEAD, DC ESNTL, ROW 3, CB 1).

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- i. FUEL DUMP switch — CYCLE.
 - j. **Land as soon as practical.**
19. FUEL MGT control panel — CHECK. (Short manual transfer from each auxiliary fuel tank should be checked if installed. Main fuel level shall be 3,700 pounds or less prior to each transfer.)
- a. FMCP MASTER/MODE switches — TRANSFER/MANUAL OVRD.
 - b. External AUX tank pushbutton — SELECT.
 - c. Confirm FMCP FLOW light illuminates for selected tank.
 - d. FMCP MASTER — STOP FLOW.
 - e. Confirm FMCP FLOW light extinguishes.
 - f. Repeat steps a. to e. for remaining AUX tanks.
 - g. FMCP MASTER/MODE switches — AS REQUIRED.

A C

20. Autorotation rpm check.
- a. Climb to a suitable autorotation altitude.
 - b. When climbing through check altitude, record OAT, pressure altitude (set 29.92 on BAR ALT), and gross weight.
 - c. Level off and stabilize at 75 KIAS.

WARNING

- Transient N_p up-speeds of several seconds duration are typically encountered during autorotation entry and recovery. During entry, the N_p should split (decrease) away from N_r prior to reaching 109 percent and reduce to a value of 100-103 percent N_p (PCLs in FLY). When the main rotor has split away from N_p , transient values as high as 110-114 percent N_p may be seen when collective pull is initiated. This behavior is normal. If the N_p follows N_r in a steady manner for N_r values exceeding 109 percent, or recovery N_p peak exceeds 114 percent, an LDS malfunction is indicated. Discontinue further autorotational flight. Lowering the collective to minimum with an engine LDS malfunction will cause N_p and N_r to rise rapidly and may cause activation of N_p overspeed resulting in engine shutdown.
- Conduct autorotation rpm check at an altitude that will allow for power recovery at a safe altitude. If possible, have a suitable forced landing area within range.

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- d. Slowly reduce collective to minimum and maintain 75 KIAS in balanced flight.


CAUTION

If N_r is less than 90 percent or greater than 120 percent, initiate a power recovery.

- e. Vibrations — NOTE ANY ABNORMAL LEVEL.
- f. Airspeed indicators — CHECK. Note difference. Pilot and copilot difference should not be greater than 5 KIAS.
- g. Record N_r when passing through the desired pressure altitude.
- h. Execute a power recovery and verify proper N_p/N_r response.
- i. Compute DA at which stabilized N_r was recorded (Figure 10-8).
- j. Verify autorotational N_r satisfies requirements of Autorotation RPM Correction Chart within 2 percent (Figure 10-9).

10.2.12 Landing Checklist

1. CONTGCY PWR switch — AS REQUIRED.
2. Lights — AS REQUIRED.
3. Brakes — AS REQUIRED.
4. TAIL WHEEL switch — LOCK.
5. Instruments, Caution/Advisories — CHECK.
6. BAR ALT/RAD ALT — AS REQUIRED.
7. HF Radio — OFF.
8. Armament — SAFE.
9. Harness — LOCKED.
10. Aircrewman Before Landing Checklist — COMPLETE.
11. FLIR — STOW.
12. Return to Force Checklist — AS REQUIRED.

10.2.13 Post Landing Checklist

1. Lights — AS REQUIRED.
2. Tail Wheel/Brakes — AS REQUIRED.
3. CONTGCY PWR switch — OFF.
4. Ordnance pins/covers — DEARM/SAFE/INSTALL (as required).


CAUTION

Install Hellfire missile seeker covers (if available) before all ground operations and before all chock and chain operations.

PROFILE

5. M299 launcher SAFE/ARM switch — SAFE.
6. Chocks and Chains — AS REQUIRED.

WARNING

With missiles uploaded, exercise extreme care when chocking and chaining to avoid damage to missile seeker or fins or injury to personnel.

7. Transponder — STBY.
8. ENGINE ANTI-ICE/PITOT HEAT/BLADE DE-ICE — OFF.

WARNING

The pitot and static ports become extremely hot during operation. Care should be taken to prevent ground personnel from touching these surfaces. Failure to turn off pitot heat could burn personnel whenever external power is applied.

10.2.14 Shutdown

1. TAIL WHEEL switch — LOCK.
2. Parking brake — SET.
3. Chocks — IN.
4. APU — START.
 - a. ECS — OFF.
 - b. AIR SOURCE ECS/START switch — APU.
 - c. FUEL PUMP switch — APU BOOST.
 - d. APU CONTR switch — ON.
5. APU GENERATOR switch — ON.
6. IFF MODE 4 CODE — HOLD (as required).
7. Avionics.
 - a. DOPPLER — AS REQUIRED.
 - b. MPDs — AS REQUIRED.
 - c. SAC power — OFF.
 - d. FLIR power — OFF.
 - e. MSN power — OFF.

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- f. RDR — STBY.
 - g. Data link — STBY.
 - h. TACAN — OFF.
 - i. IFF MASTER — OFF.
 - j. RADALTs — OFF.
8. BACKUP HYD PMP switch — ON.

Note

FLIR EU PWR should be secured prior to cycling the BACKUP HYD PMP switch because the associated power surge may cause a gimbal lock.

9. Flight controls — POSITION AND HOLD.
10. NO. 1 and NO. 2 GENERATOR switches — OFF.

WARNING

Power transfer from the APU generator to the NO. 1 generator may cause disengagement of SAS 1, SAS 2, TRIM, AUTO PLT, and Stabilator which may cause rotors to dip as low as 4 feet.

11. ENGINE IGNITION switch — OFF.
12. Lights — AS REQUIRED.
13. PCLs — IDLE.

CAUTION

Engines should be cooled for 2 minutes at an N_g of 90 percent or less before moving PCLs to OFF. If an engine is shut down without being cooled, it should not be restarted for 4 hours unless restart is performed within 5 minutes.

14. NO. 2 PCL and fuel selector — OFF.
15. Droop stops — IN.
16. NO. 1 PCL and fuel selector — OFF.
17. Rotor brake — ON (between 30 percent and 50 percent N_r).
18. TGT — MONITOR.

CAUTION

If TGT rises above 540 °C, perform Internal Engine Fire emergency procedure.

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A B

19. DECU codes — CHECK.
20. Engine cleaning — AS REQUIRED (see [paragraph 7.17.12](#)).

Note

If engine cleaning is required, proceed to step 14 of Engine Cleaning Procedures.

21. Blade fold — AS REQUIRED.



- Should the blade fold system stall during fold, cycling the BLADE FOLD switch to SPREAD should return the rotor blades to the spread position.
- Shut down the APU immediately if a rotor blade remains stalled in the APU exhaust.
- When the ROTOR SPREAD light is not illuminated, pressing the RDR ALT pushbutton during blade fold system operations may cause failure of the automatic system. Do not press this pushbutton during blade fold operations.
- Simultaneous folding of main rotor blades and tail pylon is prohibited.

Note

Failure to suppress the DECU numerical fault codes on the PDU will prevent the automatic blade fold from operating due to the torque signal being relayed to the AFCS computer. Codes can be suppressed by pressing either OVSP TEST A or B buttons for the affected engine.

- a. Area — CLEAR (wing walkers positioned as required).
- b. BACKUP HYD PMP switch — ON.
- c. STABILATOR AUTO CONTROL — OFF.
- d. SAS 1 and SAS 2 — OFF, TRIM — ON, AUTO PLT — OFF.
- e. SERVO switch — 1ST OFF or 2ND OFF.
- f. BLADE FOLD MASTER switch — ON.
- g. BLADE FOLD switch — FOLD.
- h. Rotor brake — OFF.
- i. ROTOR INDEXED light — ILLUMINATED.

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Note

Blades may be manually indexed if the main rotor index actuator/gust lock fails. Cycling the BLADE FOLD switch OFF, pulling the RTR HEAD INDEX MOTOR circuit breaker (NO. 2 AC PRI, SO OVHD, ROW 3, CB 5), and cycling the BLADE FOLD switch to FOLD may disengage the indexer. Rotate the rotor system until the INDEXED light illuminates, then continue with the Blade Fold Checklist.

- j. Rotor brake — APPLY.
- k. BAR ALT — FLASHING.
- l. Collective, cyclic, and pedals — FREE TO POSITION.

Note

If computer is unable to null after 30 seconds, the AFCS DEGRADED caution will appear. To attempt another cycle, turn BLADE FOLD switch OFF, press any FAIL ADVISORY MODE RESET pushbutton, and repeat blade fold sequence.

- m. BAR ALT pushbutton — PRESS.

Note

The following blade status panel light sequence indicates proper operation of the fold cycle: TRIM light flashing (blades positioned for pitch lock insertion) and PITCH LOCKED light illuminated (last pitch lock in). Blades will begin folding following the illumination of the PITCH LOCKED light. Should the INDEXED light flicker or extinguish during folding (indicating a loss of index), the blade fold sequence will stall. Cycling the BLADE FOLD switch to SPREAD should clear the stall. When the SPREAD light illuminates, the rotor head may be re-indexed and another fold cycle attempted.

- n. ROTOR FOLDED light — ILLUMINATED.
 - o. BLADE FOLD switch — OFF.
 - p. BLADE FOLD MASTER switch — OFF.
 - q. SERVO switch — CENTER.
- 22. BACKUP HYD PMP switch — OFF.
 - 23. ECS — OFF.
 - 24. Exterior/interior/NVD lights — OFF.

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25. APU GENERATOR switch — OFF.
26. APU — SHUTDOWN.
 - a. AIR SOURCE ECS/START switch — OFF.
 - b. APU CONTR switch — OFF.
 - c. FUEL PUMP switch — OFF.
27. BATT switch — OFF.

10.2.15 Post Flight Checks

1. Interior equipment.
2. Tires/struts.
3. Leaks.
4. Missing panels.

10.3 ENGINE POWER CHECKS

The Engine Torque Factor method provides an accurate indication of available power by incorporating ambient temperature effects into the power available calculation. An in-flight check will be made under the following conditions:

1. When a new engine is installed.
2. When an engine is reinstalled.
3. When an engine fails the HIT check for other than a faulty anti-icing start/bleed valve or a dirty compressor.

10.3.1 Torque Factor Terms

The following terms are used when determining the maximum torque available:

1. Torque Ratio (TR): The ratio of torque available to specification torque at the desired ambient temperature.
2. Engine Torque Factor (ETF): The ratio of an individual engine's torque available to specification torque at a reference temperature of 35 °C.
3. Aircraft Torque Factor (ATF): The ratio of an individual aircraft's power available to specification power at a reference temperature of 35 °C. The ATF is the average of the ETFs of both engines.
4. Specification Torque Ratio (STR): The ratio of the adjusted actual torque to the specification torque or target torque at ambient conditions.

10.3.2 Maximum Power Check Chart

The Maximum Power Check Chart (**Figure 10-6**) presents the Target Torque Value (TTV) at 120 KIAS and 100 percent N_T for the operational range of PA and OAT. The single- and dual-engine transmission limits for continuous operation are shown and should not be exceeded.

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10.3.3 Torque Factor Chart

The Torque Factor Chart (Figure 10-7) is used for obtaining the ETF by normalizing the STR to a referenced temperature of 35 °C. For temperatures below -5 °C use -5 °C, and for temperatures above 35 °C use 35 °C.

10.3.4 Torque Factor TGT Reference

The Torque Factor TGT Reference Chart (Figure 10-5) is used to compute TRQ adjusted when OAT is below -20 °C.

10.3.5 Torque Factor Procedure

The objective of the torque factor procedure is to obtain an ETF for each engine. This is accomplished by taking data during an in-flight maximum power check and then using this data along with the Torque Factor charts to calculate an ETF. The ETF is then displayed on the HIT/Power Check Log (Figure 10-3) for use by operational pilots and maintenance personnel.

10.3.6 Torque Factor Procedure In Flight

The inflight check will be conducted to establish/reestablish the ETF and to ensure that the engine meets minimum power requirements. Performance data will be taken at an engine-limiting condition, while maintaining constant altitude and adjusting airspeed as required. The ENG ANTI-ICE, ECS, and AIR SOURCE ECS/START switches must be OFF and the altimeter will be set at 29.92 In-Hg. Data will be taken one engine at a time. If the maximum power check is being performed because of a single engine installation/reinstallation or failed HIT check, it is at the maintenance officer's discretion to obtain new ETF data for the other engine.

PROFILE

10.3.7 Sample Problem 1

1. Recorded during maximum power check, N_g limited. SH-60B.
 - a. PA = 2,000 feet.
 - b. OAT = $-30\text{ }^\circ\text{C}$.
 - c. TGT measured = $790\text{ }^\circ\text{C}$.
 - d. TRQ measured = 126 percent.
 - e. From **Figure 10-6** TTV = 130 percent.
 - f. From **Figure 10-5** TGT ref = $802\text{ }^\circ\text{C}$.
 - g. Calculate TRQ adj:
 - (1) $\text{TRQ adj} = \text{TRQ measured} + 0.2 (\text{TGT ref}) - 0.2 (\text{TGT measured})$.
 - (2) $\text{TRQ adj} = 126 + 0.2 (802 - 790)$.
 - (3) $\text{TRQ adj} = 126 + 2.4$.
 - (4) $\text{TRQ adj} = 128.4$ percent.
 - h. Calculate STR:
 - (1) $\text{STR} = \text{TRQ adj} / \text{TTV}$.
 - (2) $\text{STR} = 128.4 / 130$.
 - (3) $\text{STR} = 0.987$.
 - i. Determine ETF:
 - (1) From **Figure 10-7** (using $-5\text{ }^\circ\text{C}$ line) $\text{ETF} = 0.957$ (satisfactory performance).

10.3.8 Sample Problem 2

1. Recorded during maximum power check, N_g limited. SH-60B.
 - a. PA = 1,000 feet.
 - b. OAT = $20\text{ }^\circ\text{C}$.
 - c. TGT measured = $840\text{ }^\circ\text{C}$.
 - d. TRQ measured = 112 percent.
 - e. From **Figure 10-6**, TTV = 122 percent.
 - f. Calculate TRQ adj:
 - (1) $\text{TRQ adj} = \text{TRQ measured}$.
 - (2) $\text{TRQ adj} = 112$.

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g. Calculate STR:

(1) $STR = TRQ \text{ adj}/TTV.$

(2) $STR = 112/122.$

(3) $STR = 0.918.$

h. Determine ETF:

(1) From **Figure 10-7** (using 20 °C line), $ETF = 0.878$ (unsatisfactory performance).

10.4 FUNCTIONAL CHECKFLIGHT CHARTS AND TABLES

| TEMPERATURE—°C | | -40 | -30 | -20 | -10 | 0 | +10 | +20 | +30 | +40 | +50 |
|--|-----------|------|------|------|------|------|------|------|------|------|------|
| TIME TO IDLE- SECONDS USING MIL-L-23699 (*USING MIL-I-7808) | 10,000 FT | 55 | 49 | 45 | 42 | 40 | 40 | 40 | 40 | 43 | 48 |
| | | *50 | *46 | *44 | | | | | | | |
| | SL | 45 | 40 | 36 | 32 | 30 | 30 | 30 | 32 | 34 | 38 |
| | | *50 | *46 | *44 | | | | | | | |
| IDLE SPEED ($N_g\%$) | MAXIMUM | 66.1 | 66.7 | 67.1 | 67.6 | 68.0 | 68.5 | 68.9 | 69.4 | 69.8 | 70.3 |
| | MINIMUM | 63.2 | 63.7 | 64.1 | 64.7 | 65.1 | 65.5 | 65.9 | 66.2 | 66.7 | 67.0 |

NOTE

- Prior to flight. Idle N_g speed must be greater than the minimum value listed for the current OAT.
- This is the maximum time allowed between advancing the PCL to IDLE and N_g leveling off at idle speed.
- N_g idle speed higher than the maximum limit may be an indication of LDS roll pin failure or misrigging. Flight with N_g idle speed higher than the maximum limit is authorized provided the high N_g idle speed troubleshooting procedures are completed satisfactorily.

Figure 10-2. Time to Idle/Idle Speed Chart

| | | | |
|------------|---|---|---|
| Engine S/N | | | |
| Date | | | |
| Hours | | | |
| ETF * | | | |
| ATF | | | |
| HIT Limits | / | / | / |

| | | | |
|------------|---|---|---|
| Engine S/N | | | |
| Date | | | |
| Hours | | | |
| ETF * | | | |
| ATF | | | |
| HIT Limits | / | / | / |

| HIT Date | Pres Alt | OAT | Table (1) | Actual (2) | 1-2 |
|----------|----------|-----|-----------|------------|-----|
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| HIT Date | Pres Alt | OAT | Table (1) | Actual (2) | 1-2 |
|----------|----------|-----|-----------|------------|-----|
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*** NOTE**
ENGINE POWER CHECKS AT OAT BELOW 0°C ARE NOT REPRESENTATIVE FOR HOT WEATHER OPERATIONS. WHEN RETURNING FROM LONG TERM COLD WEATHER OPERATIONS, REPEAT MAX POWER CHECKS.

Figure 10-3. HIT/Power Check Log

Figure 10-4. HIT TGT Reference Table

| FAT °C | PRESSURE ALTITUDE-FT | | | | | | FAT °C | PRESSURE ALTITUDE-FT | | | | | | FAT °C | PRESSURE ALTITUDE-FT | | | | | | | |
|-----------|----------------------|------|-----|-----|------|------|-----------|----------------------|------|------|------|------|------|-----------|----------------------|------|------|------|------|------|-------|--|
| | -1000 | -500 | 0 | 500 | 1000 | 1500 | | 2000 | 2500 | 3000 | 3500 | 4000 | 4500 | | 5000 | 5500 | 6000 | 7000 | 8000 | 9000 | 10000 | |
| 55 | 736 | 740 | 744 | 748 | 753 | 758 | 55 | 763 | 769 | 775 | 781 | 787 | 792 | 55 | 796 | 801 | 805 | 814 | 825 | 835 | 846 | |
| 53 | 730 | 734 | 738 | 742 | 747 | 751 | 53 | 757 | 762 | 768 | 774 | 780 | 785 | 53 | 790 | 796 | 800 | 809 | 819 | 830 | 840 | |
| 51 | 724 | 728 | 732 | 736 | 740 | 745 | 51 | 750 | 756 | 761 | 767 | 773 | 779 | 51 | 785 | 791 | 795 | 804 | 814 | 825 | 835 | |
| 49 | 718 | 721 | 725 | 729 | 734 | 738 | 49 | 744 | 749 | 755 | 761 | 767 | 772 | 49 | 778 | 785 | 789 | 799 | 808 | 819 | 829 | |
| 47 | 712 | 715 | 719 | 723 | 727 | 732 | 47 | 737 | 743 | 748 | 754 | 760 | 766 | 47 | 771 | 778 | 782 | 794 | 803 | 814 | 824 | |
| 45 | 706 | 709 | 713 | 717 | 721 | 725 | 45 | 731 | 736 | 741 | 747 | 753 | 759 | 45 | 764 | 771 | 776 | 788 | 798 | 808 | 818 | |
| 43 | 701 | 703 | 707 | 711 | 715 | 719 | 43 | 725 | 729 | 734 | 740 | 746 | 752 | 43 | 757 | 764 | 769 | 781 | 792 | 803 | 813 | |
| 41 | 695 | 698 | 702 | 706 | 710 | 713 | 41 | 718 | 723 | 728 | 733 | 739 | 745 | 41 | 751 | 757 | 762 | 775 | 786 | 797 | 807 | |
| 39 | 690 | 692 | 696 | 700 | 704 | 707 | 39 | 712 | 716 | 721 | 726 | 732 | 738 | 39 | 744 | 750 | 755 | 768 | 780 | 792 | 802 | |
| 37 | 684 | 687 | 690 | 694 | 698 | 702 | 37 | 706 | 710 | 714 | 720 | 725 | 731 | 37 | 737 | 743 | 748 | 761 | 773 | 787 | 796 | |
| 35 | 679 | 681 | 685 | 689 | 692 | 696 | 35 | 700 | 704 | 709 | 713 | 719 | 724 | 35 | 730 | 736 | 741 | 754 | 766 | 779 | 791 | |
| 33 | 673 | 676 | 679 | 683 | 687 | 690 | 33 | 694 | 698 | 703 | 707 | 712 | 717 | 33 | 723 | 729 | 735 | 746 | 759 | 772 | 786 | |
| 31 | 668 | 670 | 674 | 677 | 681 | 685 | 31 | 689 | 692 | 697 | 702 | 707 | 711 | 31 | 716 | 722 | 727 | 739 | 752 | 765 | 779 | |
| 29 | 662 | 665 | 668 | 671 | 675 | 679 | 29 | 683 | 687 | 691 | 696 | 701 | 705 | 29 | 710 | 715 | 720 | 732 | 745 | 758 | 771 | |
| 27 | 657 | 659 | 662 | 666 | 670 | 673 | 27 | 677 | 681 | 685 | 690 | 695 | 700 | 27 | 704 | 709 | 714 | 725 | 737 | 750 | 764 | |
| 25 | 651 | 654 | 657 | 660 | 664 | 667 | 25 | 671 | 675 | 680 | 684 | 689 | 694 | 25 | 698 | 703 | 707 | 718 | 730 | 743 | 756 | |
| 23 | 645 | 648 | 651 | 655 | 658 | 662 | 23 | 666 | 669 | 674 | 678 | 683 | 688 | 23 | 692 | 697 | 701 | 711 | 723 | 736 | 749 | |
| 21 | 639 | 642 | 645 | 649 | 652 | 656 | 21 | 660 | 664 | 668 | 672 | 677 | 682 | 21 | 686 | 691 | 695 | 705 | 715 | 728 | 742 | |
| 19 | 634 | 636 | 640 | 643 | 647 | 650 | 19 | 654 | 658 | 662 | 667 | 671 | 676 | 19 | 680 | 685 | 689 | 699 | 709 | 721 | 734 | |
| 17 | 628 | 631 | 634 | 638 | 641 | 644 | 17 | 648 | 652 | 656 | 661 | 665 | 670 | 17 | 674 | 679 | 683 | 693 | 703 | 714 | 727 | |
| 15 | 623 | 625 | 629 | 632 | 635 | 638 | 15 | 642 | 646 | 650 | 655 | 659 | 664 | 15 | 668 | 673 | 677 | 686 | 697 | 708 | 719 | |
| 13 | 617 | 620 | 623 | 626 | 630 | 633 | 13 | 636 | 640 | 644 | 649 | 654 | 658 | 13 | 662 | 666 | 671 | 680 | 690 | 701 | 712 | |
| 11 | 612 | 614 | 618 | 621 | 624 | 627 | 11 | 631 | 634 | 638 | 643 | 647 | 652 | 11 | 656 | 660 | 665 | 674 | 684 | 695 | 706 | |
| 9 | 606 | 609 | 612 | 616 | 619 | 622 | 9 | 625 | 629 | 633 | 637 | 641 | 646 | 9 | 650 | 654 | 659 | 668 | 678 | 689 | 699 | |
| 7 | 600 | 603 | 607 | 610 | 613 | 616 | 7 | 620 | 623 | 627 | 631 | 635 | 640 | 7 | 644 | 648 | 652 | 662 | 671 | 682 | 693 | |
| 5 | 595 | 598 | 601 | 605 | 608 | 611 | 5 | 614 | 618 | 621 | 625 | 630 | 634 | 5 | 637 | 642 | 646 | 656 | 665 | 676 | 687 | |
| 3 | 589 | 592 | 595 | 599 | 602 | 605 | 3 | 609 | 612 | 616 | 620 | 624 | 628 | 3 | 631 | 636 | 640 | 649 | 659 | 669 | 680 | |
| 1 | 584 | 586 | 590 | 593 | 597 | 600 | 1 | 603 | 607 | 610 | 614 | 618 | 622 | 1 | 626 | 629 | 634 | 643 | 653 | 663 | 674 | |
| -1 | 577 | 579 | 583 | 586 | 590 | 593 | -1 | 596 | 600 | 603 | 607 | 611 | 615 | -1 | 618 | 622 | 626 | 635 | 645 | 655 | 666 | |
| -3 | 571 | 574 | 577 | 581 | 584 | 587 | -3 | 591 | 594 | 598 | 602 | 606 | 609 | -3 | 613 | 617 | 620 | 629 | 639 | 649 | 659 | |
| -5 | 566 | 568 | 572 | 575 | 578 | 581 | -5 | 585 | 589 | 592 | 596 | 600 | 604 | -5 | 607 | 611 | 615 | 623 | 632 | 642 | 652 | |
| -7 | 560 | 563 | 566 | 569 | 573 | 576 | -7 | 579 | 583 | 587 | 590 | 594 | 598 | -7 | 601 | 605 | 609 | 617 | 626 | 636 | 646 | |
| -9 | 554 | 557 | 560 | 564 | 567 | 570 | -9 | 574 | 577 | 581 | 585 | 589 | 592 | -9 | 596 | 599 | 603 | 611 | 620 | 630 | 639 | |
| -11 | 549 | 552 | 555 | 558 | 561 | 564 | -11 | 568 | 571 | 575 | 579 | 583 | 586 | -11 | 590 | 594 | 597 | 606 | 614 | 623 | 633 | |
| -13 | 543 | 546 | 549 | 553 | 556 | 559 | -13 | 562 | 566 | 569 | 573 | 577 | 581 | -13 | 584 | 588 | 591 | 600 | 608 | 617 | 627 | |
| -15 | 538 | 540 | 544 | 547 | 550 | 553 | -15 | 556 | 560 | 564 | 567 | 571 | 575 | -15 | 578 | 582 | 586 | 594 | 602 | 611 | 620 | |
| -17 | 532 | 535 | 538 | 541 | 544 | 547 | -17 | 551 | 555 | 558 | 562 | 565 | 569 | -17 | 572 | 576 | 580 | 588 | 596 | 605 | 614 | |
| -19 | 526 | 529 | 532 | 536 | 539 | 542 | -19 | 545 | 549 | 552 | 556 | 559 | 563 | -19 | 566 | 570 | 574 | 582 | 591 | 599 | 608 | |
| -21 | 521 | 523 | 527 | 530 | 533 | 536 | -21 | 539 | 543 | 546 | 550 | 554 | 557 | -21 | 560 | 564 | 568 | 577 | 585 | 593 | 602 | |
| -23 | 515 | 518 | 521 | 524 | 527 | 530 | -23 | 534 | 537 | 540 | 544 | 548 | 551 | -23 | 555 | 558 | 562 | 571 | 579 | 587 | 596 | |
| -25 | 510 | 512 | 515 | 519 | 522 | 524 | -25 | 528 | 531 | 535 | 538 | 542 | 545 | -25 | 549 | 552 | 556 | 565 | 573 | 581 | 589 | |
| -27 | 504 | 507 | 510 | 513 | 516 | 519 | -27 | 522 | 526 | 529 | 532 | 536 | 539 | -27 | 543 | 547 | 550 | 559 | 567 | 575 | 583 | |
| -29 | 498 | 501 | 504 | 507 | 510 | 513 | -29 | 516 | 520 | 523 | 526 | 530 | 534 | -29 | 537 | 541 | 545 | 553 | 561 | 569 | 577 | |
| -31 | 492 | 495 | 498 | 501 | 504 | 507 | -31 | 511 | 514 | 517 | 521 | 524 | 528 | -31 | 531 | 535 | 539 | 547 | 554 | 563 | 571 | |
| -33 | 487 | 490 | 493 | 496 | 499 | 501 | -33 | 505 | 508 | 511 | 515 | 518 | 522 | -33 | 525 | 529 | 533 | 541 | 548 | 556 | 565 | |
| -35 | 482 | 484 | 487 | 490 | 493 | 496 | -35 | 499 | 502 | 506 | 509 | 512 | 516 | -35 | 519 | 523 | 527 | 535 | 542 | 550 | 558 | |
| -37 | 476 | 478 | 481 | 484 | 487 | 490 | -37 | 493 | 497 | 500 | 503 | 506 | 510 | -37 | 513 | 517 | 521 | 529 | 536 | 544 | 552 | |
| -39 | 470 | 473 | 476 | 479 | 482 | 484 | -39 | 487 | 491 | 494 | 497 | 500 | 504 | -39 | 507 | 511 | 515 | 523 | 530 | 538 | 546 | |
| -45 | 453 | 456 | 459 | 462 | 465 | 467 | -45 | 470 | 473 | 476 | 479 | 483 | 486 | -45 | 489 | 493 | 497 | 505 | 512 | 519 | 527 | |
| -50 | 439 | 441 | 444 | 447 | 450 | 453 | -50 | 456 | 459 | 462 | 465 | 468 | 471 | -50 | 475 | 478 | 482 | 490 | 497 | 504 | 512 | |
| -55 | 425 | 427 | 430 | 433 | 436 | 438 | -55 | 441 | 444 | 447 | 450 | 454 | 457 | -55 | 460 | 464 | 467 | 475 | 481 | 489 | 496 | |

| OAT °C | TGTref °C | OAT °C | TGTref °C |
|--------|-----------|--------|-----------|
| -20.5 | 839 | -21 | 837 |
| -22 | 834 | -23 | 829 |
| -24 | 825 | -25 | 821 |
| -26 | 817 | -27 | 814 |
| -28 | 810 | -29 | 806 |
| -30 | 802 | -31 | 798 |
| -32 | 795 | -33 | 791 |
| -34 | 788 | -35 | 784 |
| -36 | 781 | -37 | 777 |
| -38 | 774 | -39 | 770 |
| -40 | 767 | -41 | 764 |
| -42 | 761 | -43 | 757 |
| -44 | 754 | -45 | 751 |
| -46 | 748 | -47 | 745 |
| -48 | 742 | -49 | 739 |
| -50 | 736 | -51 | 734 |
| -52 | 731 | -53 | 728 |
| -54 | 725 | | |

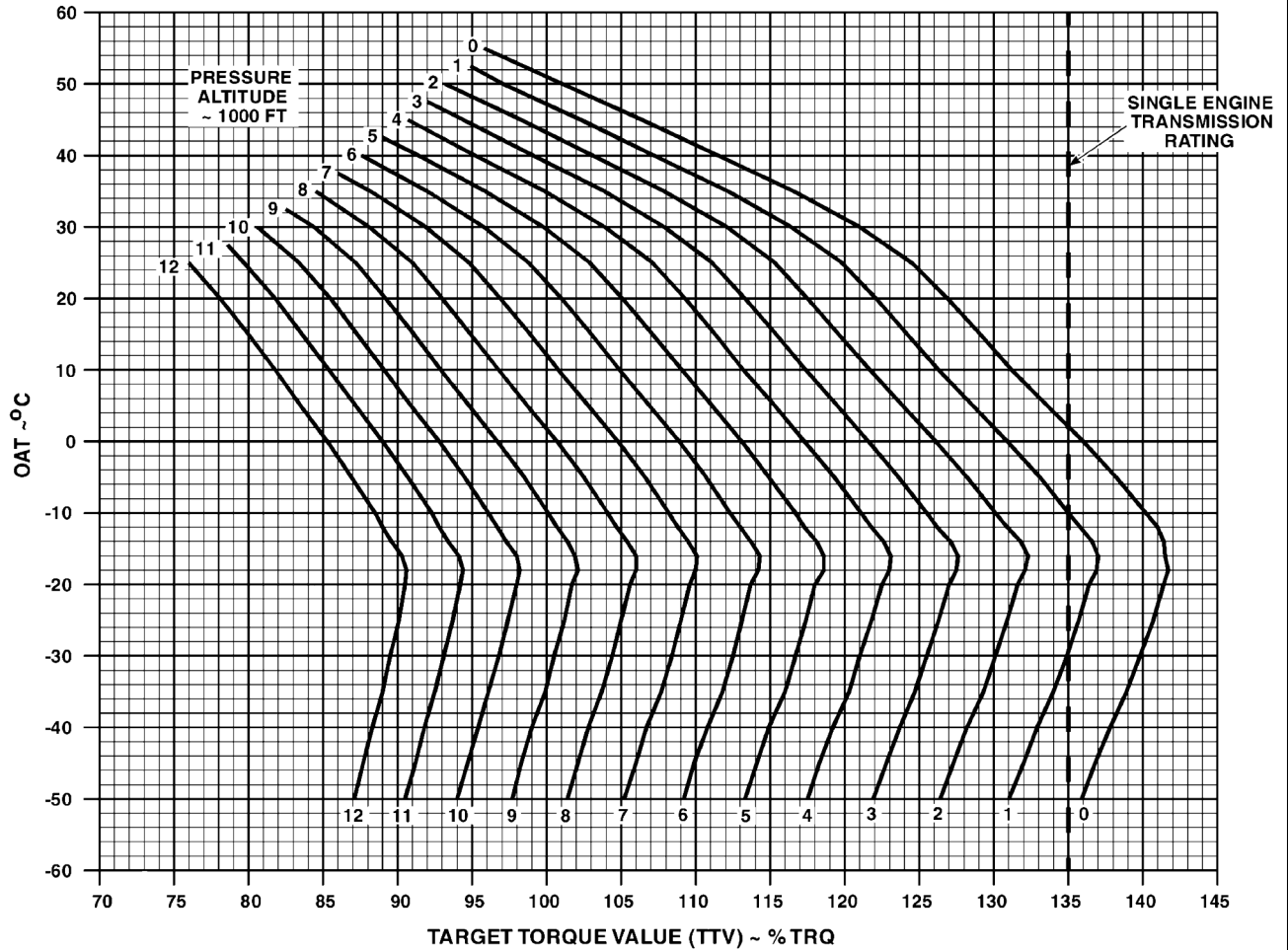
H60-F0118A

Figure 10-5. Torque Factor TGT Reference Chart

MAXIMUM POWER CHECK
INTERMEDIATE (30 MINUTE) POWER
839°C LIMITER TGT 120 KIAS
100% Np ECS & ANTI-ICE OFF

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: ENG. MFR. SPEC

ENGINE:(1) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



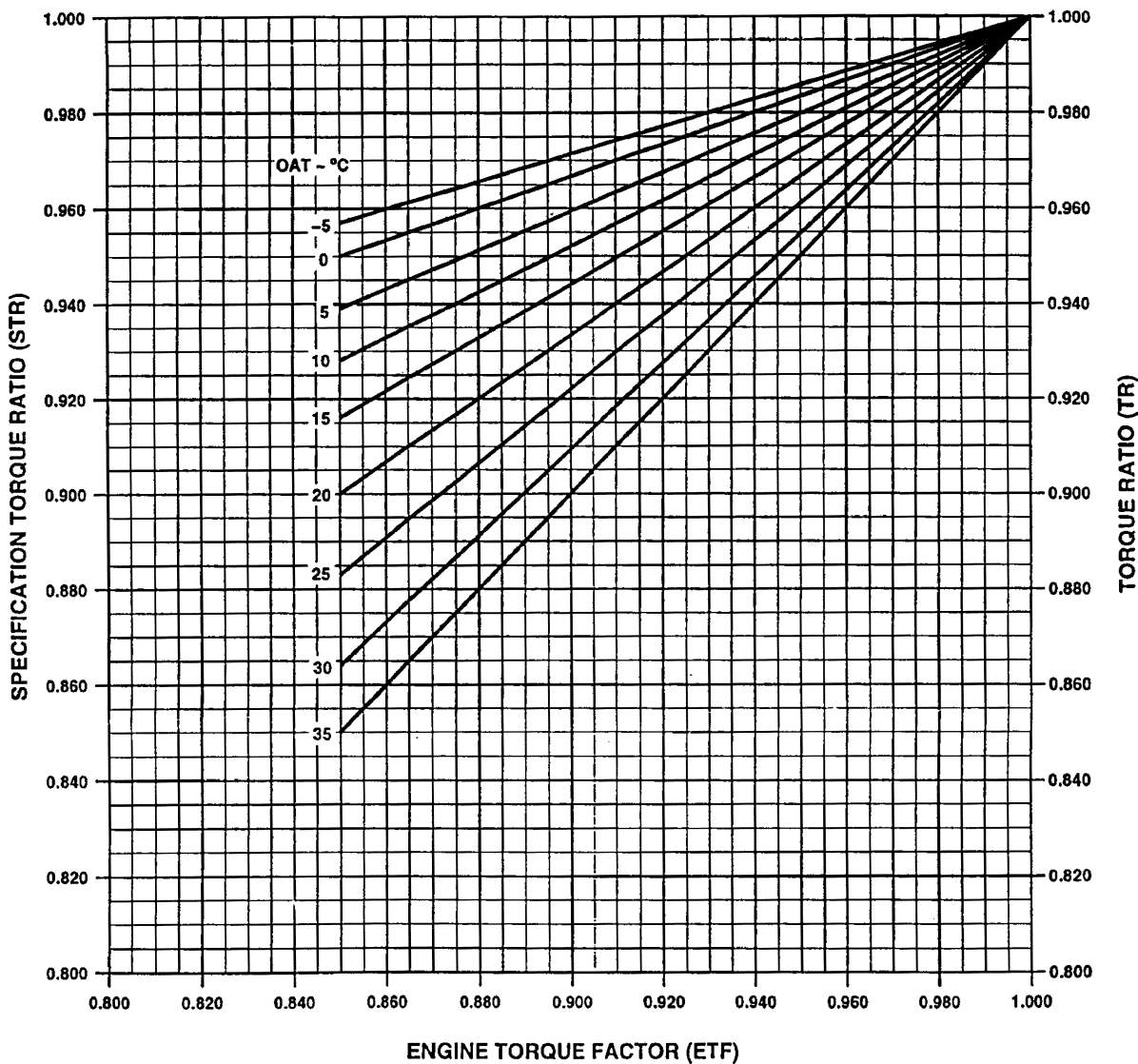
SH60B-F178

Figure 10-6. Maximum Power Check Chart

**TORQUE FACTOR
100% N**

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: ENG. MFR. SPEC

ENGINE: (1) T700-GE-401C
 FUEL GRADE: JP4, JP5, JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F105

Figure 10-7. Torque Factor Chart

DENSITY ALTITUDE CHART

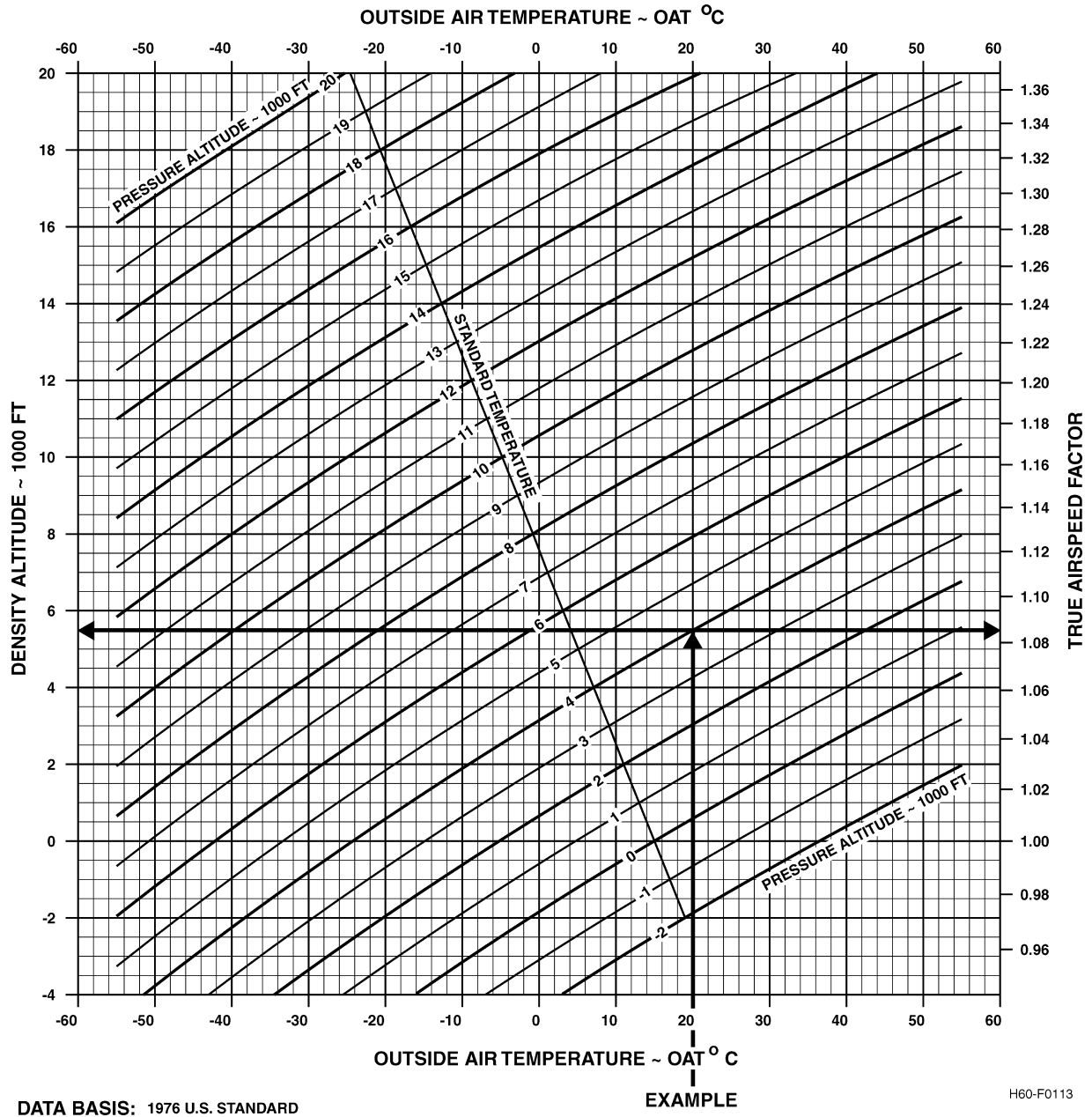
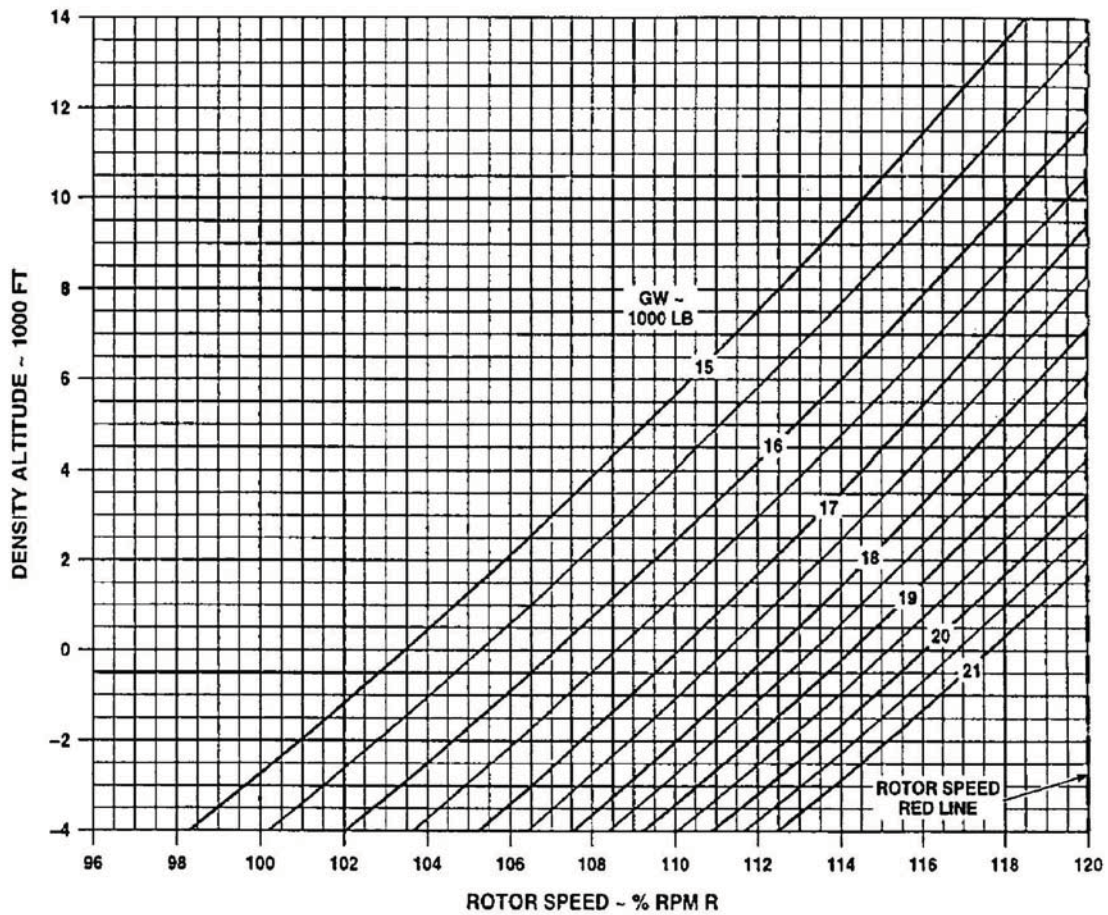


Figure 10-8. Density Altitude Chart

FUNCTIONAL CHECKFLIGHT AUTOROTATION RPM CORRECTION CHART

MODEL: SH-60B
DATE: DECEMBER 1994
DATA BASIS: FLIGHT TEST



NOTES

1. FULL/LOW COLLECTIVE
2. TEST AIRSPEED TO BE 75 KIAS PILOT IND (± 5 KTS)
3. AUTOROTATION TEST TOLERANCE IS 2% Nr.
4. ROTOR SPEED INCREASES 1% Nr FOR EVERY 5 INCHES OF C.G. FORWARD OF 356 INCHES.

SH60B-F104

Figure 10-9. Autorotation RPM Correction Chart

10.5 VIBRATION ANALYSIS

GROUND RUNS

FCP

QAR

Date Completed

- 1. TAIL ROTOR BALANCE
- 2. TAIL HEALTH (STA.685)
- 3. AXIAL FAN
- 4. NO. 1 ENG INPUT MOD
- 5. NO. 2 ENG INPUT MOD
- 6. NO. 1 H.S.S. (if required)
- 7. NO. 2 H.S.S. (if required)
- 8. RH ENGINE N.S.V.
- 9. LH ENGINE N.S.V.
- 10. ALT TOOTH (if required)

| | FCP | QAR | Date Completed |
|-------------------------------|-------|-------|----------------|
| 1. TAIL ROTOR BALANCE | _____ | _____ | _____ |
| 2. TAIL HEALTH (STA.685) | _____ | _____ | _____ |
| 3. AXIAL FAN | _____ | _____ | _____ |
| 4. NO. 1 ENG INPUT MOD | _____ | _____ | _____ |
| 5. NO. 2 ENG INPUT MOD | _____ | _____ | _____ |
| 6. NO. 1 H.S.S. (if required) | _____ | _____ | _____ |
| 7. NO. 2 H.S.S. (if required) | _____ | _____ | _____ |
| 8. RH ENGINE N.S.V. | _____ | _____ | _____ |
| 9. LH ENGINE N.S.V. | _____ | _____ | _____ |
| 10. ALT TOOTH (if required) | _____ | _____ | _____ |

INFLIGHT RUNS

- 1. MAIN ROTOR TRACK & BALANCE
- 2. COCKPIT 4 PER
- 3. ABSORBER TUNING
- 4. CABIN HEALTH (STA. 347)

| | | | |
|-------------------------------|-------|-------|-------|
| 1. MAIN ROTOR TRACK & BALANCE | _____ | _____ | _____ |
| 2. COCKPIT 4 PER | _____ | _____ | _____ |
| 3. ABSORBER TUNING | _____ | _____ | _____ |
| 4. CABIN HEALTH (STA. 347) | _____ | _____ | _____ |

PART IV

Flight Characteristics

Chapter 11 — Aerodynamic Characteristics and Techniques in Various Regimes



CHAPTER 11

Aerodynamic Characteristics and Techniques in Various Regimes

11.1 GENERAL FLIGHT CHARACTERISTICS

The normal speed range extends from a rearward/lateral speed of 35 knots to a maximum forward speed of 180 KIAS. Normally, with the stabilator in the full trailing-edge-down position, the aircraft will hover approximately 4° to 5° noseup and 2° to 3° left wing down. During approach or slow flight (approximately 15 knots), a translational lift-induced vibration will be felt.

11.1.1 Hover/Slow Speed Flight (At or Below Translational Lift)

In a steady, no-wind hover, the main rotor experiences a symmetrical distribution of lift dictated by the rotational velocity and constant pitch of the rotor blades. The blade tips are moving at 725 feet per second or Mach 0.65 (65 percent of the speed of sound). Since the airflow is subsonic, the movement of the blades through the air is felt upstream (Figure 11-1), resulting in an upward movement of air prior to coming in contact with the blade. This induced flow causes the lifting force to be shifted aft, resulting in the generation of a drag component referred to as induced drag.

11.1.1.1 Ground Effect

A helicopter is said to be in ground effect when the rotor disk is within one rotor diameter of the ground. Ground effect causes the main rotor thrust vector to shift forward so that it is more vertical (more lift/less induced drag). Therefore, less power is required to hover in ground effect than at higher altitudes. These effects are strongest close to the ground and dissipate rapidly as altitude above the ground is increased. The SH-60B is considered to be hovering in ground effect at radar altimeter altitudes at or below 45 feet.

For an SH-60B at the gross weight of 21,700 pounds on a standard sea level day, downwash below the rotor can exceed 150 knots. This results in the generation of a ground vortex that surrounds the aircraft just outside the rotor arc. It is important to consider the effects of rotor downwash and the ground vortex on personnel and other aircraft, particularly much lighter civil aircraft.

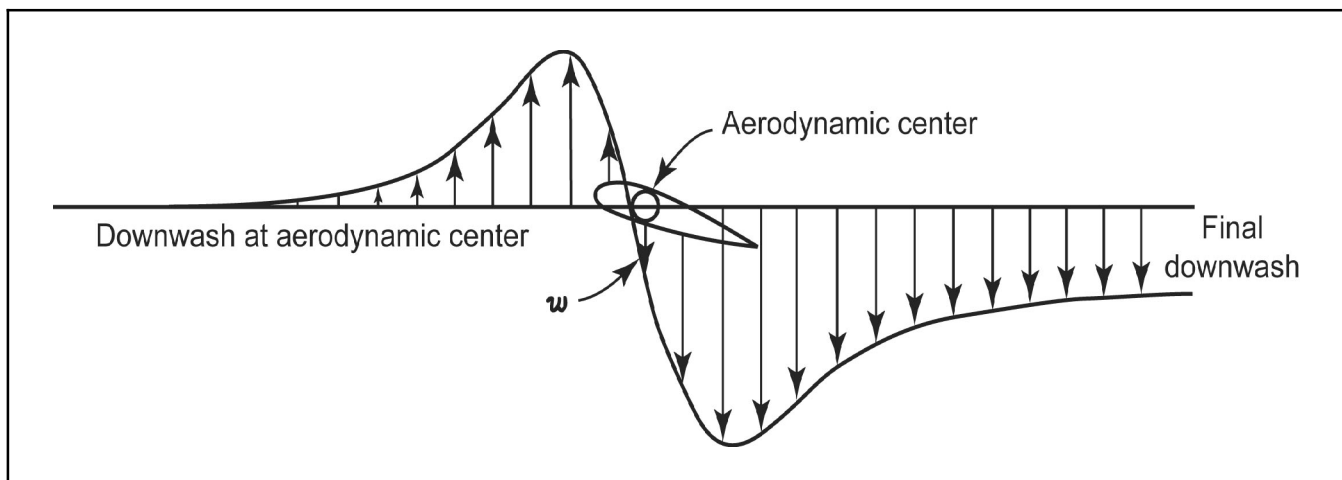


Figure 11-1. Induced Flow

11.1.1.2 Transition to Forward Flight

In flight regimes other than a hover, the rotor blades, as they move around the rotor head, experience different relative velocities. Hence, an asymmetrical distribution of lift is created. To compensate for this dissymmetry, the blades on the advancing side of the rotor disk rise (flaps up), decreasing the AOA and reducing the lift generated. The retreating blade flaps down, increasing the AOA and generating additional lift. This process of flapping causes the pitch of the blade to be continuously changing in a cyclic manner.

The flapping nature of the rotor system results in approximately 90° of phase lag between where inputs are made and their effects are felt.

11.1.1.3 Blowback

When hovering in a windless environment, the main rotor disk will be level. If the aircraft is exposed to a headwind gust, the retreating blade sees less relative wind velocity and the advancing blade sees more relative wind velocity. This causes the rotor disk to be tilted aft or blown back. Blowback of the main rotor disk tilts the main rotor thrust vector aft, causing the nose of the helicopter to pitch up. This reaction is countered by pilot input in the long term and by the hover augmentation and gust alleviation feature of SAS-2, and attitude hold feature of the autopilot, in the short term. When transitioning to forward flight, blowback results in more forward cyclic being required to continue helicopter acceleration. The magnitude of blowback is proportional to airspeed and lift.

11.1.2 Slow-Speed Flight

11.1.2.1 Stabilator Effect in a Hover/Slow Speed Flight Below 30 Knots

Below 30 knots, the stabilator is full trailing edge down. Increasing collective in a hover increases the amount of downwash on the stabilator and pushes the nose up. The effect of varying collective position on nose attitude during hover is compensated for by collective-to-longitudinal mechanical control mixing. The airspeed, collective position, lateral acceleration, and pitch rate inputs to the stabilator system have no effect below 30 knots. In transition to forward flight, the full-down position of the stabilator will cause a nosedown pitch until programming begins at 30 knots. Aft cyclic will be required to counter this pitching moment until programming begins.

11.1.2.2 Translational Lift

Forward flight is initiated by displacing the cyclic forward. This tilts the rotor thrust vector forward. Tilting the main rotor thrust vector forward reduces the vertical lift component. Therefore, additional increase in collective pitch may be necessary as the helicopter begins to translate forward to keep it from descending. With further increase in forward speed, the mass flow rate of air through the rotor system increases, resulting in greater lift production and a rapid decrease in induced power required for level flight. Although profile power (power required to spin the blades) and parasite power (power required to drag nonlifting parts of the helicopter through the air) are both steadily increasing, the reduction in induced power required results in an overall reduction in total power required. Maintaining hover power will result in approximately a 500 foot-per-minute rate of climb at 80 KIAS.

As the airspeed reaches approximately 17 knots, a noticeable vibration will be felt as the aircraft encounters its own ground vortex. The ground vortex is rolled up under the aircraft as speed continues to increase and dissipates as the aircraft reaches approximately 30 knots.

11.1.2.3 Tail Winds in Transition to Forward Flight

Normally, a helicopter transitioning to forward flight from a hover is moving toward a state of less power required. This is not the case for an aircraft transitioning to forward flight with a tailwind. When the helicopter is motionless over a spot, the rotor disk does not care which direction the wind is coming from. Therefore, a helicopter with a tailwind requires less power to hover than one in calm winds. As the helicopter moves forward, the rotor will reach a condition of zero relative wind when helicopter speed matches tailwind speed. The helicopter moves into a state of more power required for level flight. Therefore, even if the aircraft had enough power to hover in a tailwind, it may not have enough power to continue in forward flight and reach translational lift.

11.1.3 Forward Flight

Following translational lift, the aircraft will accelerate through 30 KIAS, at which point the stabilator will begin programming the trailing edge upward, requiring forward cyclic movement to continue the helicopter acceleration.

When the aircraft passes through 50 KIAS, the DAFCS will level the wings to maintain heading in balanced flight. Above 50 KIAS, the beeper trim or trim release button must be used to establish the desired forward airspeed. The directional control pedals will automatically move toward the position required to maintain balanced flight. Forces opposing incorrect pilot directional flight control input will be felt. An increase in speed is accomplished by using the beeper trim switch, or depressing the trim release button and displacing the cyclic forward until the desired airspeed is attained. This, in turn, tilts the rotor disc forward. As it tilts forward, a greater percentage of the lift being produced by the main rotor is being used to increase the forward airspeed of the helicopter. An increase in power is required to restore the vertical lift component to maintain altitude. The stabilator programs to counter the nosedown attitude experienced as the rotor disc and fuselage tilt forward and will maintain an approximately level nose attitude up to approximately 130 KIAS. The automatic flight control system (AFCS) will maintain the heading, altitude, and airspeed in balanced flight as selected by the pilot.

11.2 BLADE STALL

11.2.1 Blade Stall Causes

The tendency of the retreating blade to stall in forward flight limits the high-speed potential of the helicopter, increases component stresses, and decreases component life. The retreating blade has a tendency to stall because the blade tip is traveling at the rotational velocity minus the forward speed of the helicopter. As the in-air velocity of the retreating blade decreases, the blade angle of attack must be increased to equalize lift to provide stabilized flight. As the angle of attack increases, the blade will eventually stall (lost lift and increased drag). The increased drag will cause loss of rotor speed, unless power is increased. The advancing blade, on the other hand, is traveling at a substantially higher speed, has relatively uniform low angles of attack, and is not subject to blade stall. Blade stall will first occur at the blade root and is most likely to occur when operating at high values of speed, gross weight, density altitude, and power. Any of these conditions is especially aggravated by low rotor rpm. Maneuvers, acceleration, or turbulent air, all of which increase G-load factors, will induce blade stall by reducing the airspeed at which blade stall will occur. The blade stall chart in [Chapter 22](#) portrays the airspeeds at various pressure altitudes, temperatures, gross weights, rotor speeds, and load factors (angle of bank), as limited by blade stall. The blade stall chart establishes the maximum airspeeds to allow for turbulence, mild maneuvers, and necessary control inputs to maintain the desired flight attitude. At these speeds, roughness is encountered, but reasonable maneuvers or mild turbulence can be tolerated. Severe turbulence or abrupt control maneuvers at this point will increase the severity of the stall, and the helicopter will become more difficult to control. In the blade stall condition, each main rotor blade will stall as it passes through the stall region and create vibrations per revolution equal to the number of blades. If a stall is allowed to develop fully, loss of control will be experienced, and the helicopter will pitch upward and to the left. The use of forward cyclic to control this pitch up is ineffective and may aggravate the stall as it increases the blade angle of attack of the retreating blade.

11.2.2 Methods of Eliminating Roughness Caused by Blade Stall

If blade stall is causing roughness in the helicopter during high-speed flight or when maneuvering, either condition may be eliminated by accomplishing one or any combination of the following:

1. Decrease collective pitch.
2. Decrease severity of maneuver.
3. Gradually decrease airspeed.
4. Increase rotor rpm.
5. Decrease altitude.
6. Decrease gross weight.

11.3 SH-60B TAIL ROTOR CHARACTERISTICS

11.3.1 Tractor Tail Rotor

A tractor tail rotor is mounted on the side of the vertical fin where the rotor slipstream is directed away from the vertical fin, thus pulling the tail and providing an antitorque reaction for helicopter directional control. Additionally, the tail rotor is designed to provide 2.5 percent of the total lift in hovering flight. This is required due to the SH-60B having a relatively aft center of gravity. Having 2.5 percent of the total lift aft of the center of gravity helps lower aircraft nose attitude in a hover. To provide this lift, the tail rotor is canted 20° from the vertical plane. The effect of varying tail rotor thrust on aircraft nose attitude is compensated for by yaw-to-longitudinal control mixing.

11.3.2 Tail Rotor Considerations in Low-Speed Flight

11.3.2.1 Loss of Tail Rotor Authority

Tail rotor authority is limited by the maximum pitch available on the tail rotor, DA and N_r . At high torque settings and/or high DA, the maximum pitch on the tail rotor blades may only be sufficient to provide sluggish left pedal response. If N_r droops, the maximum tail rotor thrust available decreases rapidly, potentially leading to uncontrolled right yaw. Maximum tail rotor authority is proportional to the square of N_r , that is at 90 percent N_r , tail rotor thrust at maximum pitch/left pedal will be 81 percent of that at 100 percent N_r and maximum pitch/left pedal.

11.3.2.2 Loss of Translational Lift

Loss of translational lift results in increased power demand and additional antitorque requirements. If the loss of translational lift occurs when the aircraft is in a right turn, the right turn rate will be accelerated if corrective action is not taken. When operating near maximum power available, the increased power demand could result in rotor rpm decay. Insufficient attention to wind direction and velocity can lead to unexpected loss of translational lift. Aircraft heading, ground track, and groundspeed must be evaluated continually.

11.3.2.3 Hover/Air Taxi

Right, sideward flight, or a right crosswind, increases airflow across the tail, resulting in a reduction in angle of attack (AOA) for a set pedal position and a reduction in tail rotor thrust. If increased left pedal is applied, a right yaw will occur. Yaw rate will be further amplified by increased airflow over the tail pylon, which will tend to streamline the aircraft. When the aircraft is operated at low wheel heights, main rotor tip vortex can produce an area of downwash turbulence that may interact with the tail rotor. Tail rotor thrust variations may require rapid pedal inputs to maintain directional control.

11.3.2.4 Loss of Tail Rotor Effectiveness

Although the SH-60B tail rotor system is a fairly robust rotor against loss of tail rotor effectiveness (LTE), an understanding of the principles is important to safe helicopter operation and diagnosis of tail rotor system modes of failure. Tail rotor loss of effectiveness is caused by various relative wind conditions acting on the tail rotor blades. The regions of tail rotor loss of effectiveness are shown in [Figure 11-2](#) and are described below.

11.3.2.5 Factors Increasing the Likelihood of Loss of Tail Rotor Effectiveness

Recovery from a high yaw rate is more difficult in conditions requiring higher main rotor power (e.g., high gross weight, high DA, or arresting a high descent rate).

Low airspeeds require more power to maintain flight and increased antitorque requirements. Also, streamlining effect is reduced at lower airspeeds. Rapid application of collective may cause transient rotor rpm droop to occur. A decrease in main rotor rpm causes a greater proportional decrease in tail rotor rpm/thrust. Low N_r with left pedal application can cause loss of directional control as tail rotor rpm decays.

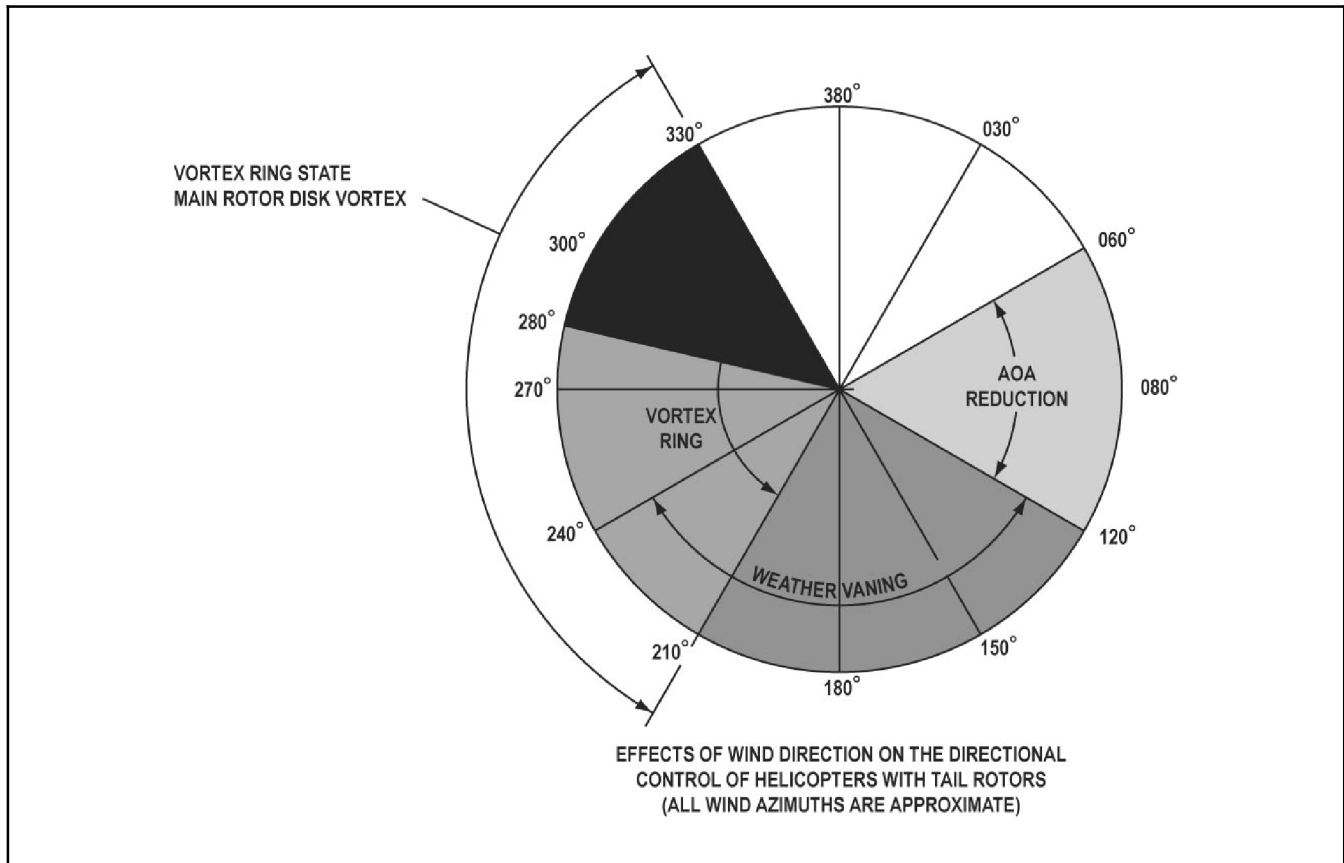


Figure 11-2. Wind Effects on the Tail Rotor

11.3.2.6 Recovery from LTE

Should LTE occur, correct and timely response is critical. If the response is incorrect or slow, the yaw rate may accelerate to a point where it is extremely difficult to recover. One or more complete revolutions may be experienced. The appropriate responses to LTE can be achieved by:

1. Altitude permitting, lowering the collective to reduce torque and assist in arresting right yaw; however, if a significant rate of descent is established, the additional power required to arrest the rate of descent may aggravate or reinitiate loss of tail rotor effectiveness.
2. Using forward cyclic to increase airspeed and, if necessary, turning in the direction of rotation. This results in a reduction in tail rotor thrust required and produces a streamlining effect.
3. At very low speeds or in a hover, application of full left pedal may arrest the right yaw. Understand that the control inputs may take several seconds/revolutions to take effect partially due to the effects of momentum and ambient conditions. Neutralizing the pedals, adding right pedal, or increasing collective will only accelerate the yaw rate.

11.3.2.6.1 Angle of Attack (AOA)

Reduction region (060° to 120° relative). Relative winds in this region decrease the effective AOA on the tail rotor blade element, thereby decreasing tail rotor thrust and resulting in the nose spinning to the right. This condition can be demonstrated in sideward flight to the right, which requires more left pedal input as sideslip speed increases. Also, the right-wing down attitude required for sideslip makes the plane of the tail rotor blades more vertical so that more of the relative wind is perpendicular to the tail rotor disk.

11.3.2.6.2 Weather Vaning (120° to 240° relative)

Relative winds in this region can blow on the tail pylon and cause the helicopter to spin right or left in an attempt to place relative wind on the nose. This condition can be demonstrated in rearward flight where the nose appears to swing randomly left and right and it is difficult to keep heading constant.

11.3.2.6.3 Vortex Ring State (210° to 330° relative)

Relative winds in this region can cause the tail rotor to ingest its own vortex (as in the main rotor at high rates of descent and low forward airspeed). This causes a loss of tail rotor thrust and the helicopter will spin to the right. The 20° tilt of the tail rotor disk tends to help prevent this problem because the relative wind would need an upward component to blow the vortex directly on the plane of the blades. This effect is not very apparent in sideward flight to the left because the left-wing-down attitude required places the plane of the tail rotor blades flatter with respect to the horizon. The vortex is blown off the right side of the tail rotor disk.

11.3.2.6.4 Main Rotor Disk Vortex (280° to 330° relative)

Relative winds in this region can cause the main rotor disk retreating blade vortex to impinge on the tail rotor blades. This can result in sudden losses and surges to tail rotor thrust at a constant pedal setting. It can result in the helicopter spinning right without enough left pedal authority to stop it. Surges in tail rotor thrust are easily controlled by reducing left pedal input during the surge.

11.4 MANEUVERING FLIGHT

11.4.1 Maneuvering Flight Characteristics

Maneuvering flight is accomplished by moving the cyclic in the direction of the desired turn. Above 50 KIAS, the AFCS will assist in moving the directional control pedals as required to maintain balanced flight. Above 30° angle of bank, aft cyclic will be required to maintain the desired airspeed. In a decelerating turn, the AFCS will switch from a turn coordination mode to a heading hold mode as the aircraft passes through 50 KIAS. Normal maneuvers are restricted to the maneuvers and airspeed limitations as depicted in [Chapter 4](#). A portion of the information in this section particularly applies to highly dynamic maneuvering flight such as might be executed during evasive maneuvering.

11.4.2 Coordinated Flight

The slip/skid indicator (ball) is designed to indicate lateral acceleration on the aircraft due to sideslip in steady zero-net-acceleration flight. In slow speed (less than 60 KIAS), high AOB (greater than 25°), nonsteady (transient) turns, the predominant component of lateral acceleration is the weight vector, not sideslip-induced acceleration. During slow speed, high AOB, transient turns, balanced flight (minimal sideslip) can best be maintained by maintaining pedal position that centers the ball. Intentional sideslip within limits is permissible during maneuvering flight; however, to prevent occurrence of high tail rotor component loads, left pedal application beyond that required for balanced flight should only be attempted at midposition or lower collective settings.



Centering the ball in slow speed, high AOB, and transient turns induces large values of aircraft sideslip and may cause high tail rotor component loads in left turns.

Note

When a requirement to achieve a slow-speed, high-rate turn to the left exists, such as during evasive maneuvering, lowering the collective may be necessary to reduce main rotor torque; associated tail rotor antitorque requirement will greatly facilitate the turn, resulting in higher turn rates.

11.4.3 Tail Rotor Spar Loads in Maneuvering Flight

Counterclockwise turning single main rotor helicopters exhibit transient torque increases in forward flight with roll rates to the left. Left roll rate increases retreating blade AOA, driving torque up, and main rotor precession loads contribute further to this effect. Left roll rates (above approximately 30° per second in forward flight above 75 KIAS) can combine with induced tail rotor gyroscopic and flapping loads to cause excessive tail rotor spar loading.

CAUTION

When executing high roll rate maneuvers to the left, collective should be lowered concurrently with maneuver initiation to control transient torque increases and reduce high tail rotor spar loads. Left roll rates in excess of 30° per second should be avoided in forward flight above 75 KIAS to prevent damage to the tail rotor spar.

11.4.4 Main Rotor Vertical 4/Rev Vibration Cueing

During maneuvering flight, main rotor component fatigue damage occurs simultaneously with an increase in main rotor vertical 4/rev vibration level. As an increasing G level is placed on the aircraft, the 4/rev onset will appear and is noticed as an increase in aircraft roughness similar to that of the 4/rev shudder experienced when flying the aircraft through transitional lift. The 4/rev vibration onset is an indication that the lift-generating capability of the main rotor has been exceeded and that a main rotor stall region has been created. Further attempts to increase load factor will only increase the blade stall region, resulting in reduced maneuverability and increased component fatigue damage. If a noticeable increase in main rotor 4/rev vibration level is observed, relax G level slightly until 4/rev vibrations decrease to a normal level. The most effective method of reducing the stall-related main rotor 4/rev vibration level is to reduce collective.

CAUTION

Significant increased main rotor 4/rev vibration level during maneuvering flight indicates the onset of retreating blade stall. Main rotor component life is being reduced and aircraft maneuvering performance degraded.

11.4.5 Main Rotor Flapping Margin

Main rotor flapping margin, a measurement of the amount of blade spindle displacement remaining in the flapping (vertical) axis before blade motion stops are contacted, may be reduced to zero by maneuvers involving large and rapid application of forward cyclic. Main rotor flapping margin is especially reduced when rapid forward cyclic is coupled with low collective settings and/or aft longitudinal cg.

CAUTION

Inducement of less than 1 g flight by rapid application of forward cyclic will result in decreased cyclic authority and may result in exceeding main rotor flapping margin limits and droop stop pounding.

11.4.6 High AOB Turns

Figure 11-3 shows how the vertical (lift) component of main rotor thrust decreases with increasing AOB. In order for the aircraft to maintain level flight, main rotor thrust must be increased so that lift will remain equal to weight. For example, if a pilot does not apply additional collective in a 45° AOB turn at 300 feet, the aircraft will crash in less than five seconds. Application of additional collective or a reduction of airspeed pitch allows the aircraft to perform level turns.

11.4.7 G-Loading in Turns

Accelerated or turning flight (G-loads) can be established by using aft cyclic and/or collective control. Cyclic maneuvering provides a transient maneuvering capability because forward airspeed will decrease. As airspeed decreases, transient rotor thrust decays as a result of less mass flow through the rotor disk; therefore, there is less energy to complete the maneuver. Sustained maneuvering must be accomplished by application of collective power so that the aircraft speed and energy are conserved. Transient G-loads applied using aft cyclic result in airspeed bleed and eventual flight at speed less than bucket speed. Sustained G-loads applied with collective increase power required for level flight at that airspeed (due to AOB), which results in a decrease in excess power. Maneuvers at slow speeds are incapable of resulting in structural damage because the aircraft will encounter an aerodynamic limit of rotor thrust. High-speed maneuvering can result in main rotor transient (cyclic) and sustained (collective) power exceeding structural limitations. G-loads encountered in level coordinated turns at various AOB are presented in [Figure 11-4](#).

11.4.8 Rolling Pullouts

Another situation where an aircraft can generate high G-loading is during a rolling pullout ([Figure 11-5](#)). Due to centrifugal acceleration (G-loading), the weight vector of the aircraft increases. Lift produced by the rotor system must be increased proportionally to the G-load to arrest the descent and establish level flight. Power can be applied by transient power input (aft cyclic) and sustained power input (collective). This can result in a situation where power required for recovery greatly exceeds total power available in the rotor system and “mushing” occurs. During “mushing,” the aircraft will continue to descend rapidly even though maximum power may be applied; longitudinal cyclic control will feel sluggish, a noticeable increase in Main Rotor Vertical 4/Rev Vibrations (see [paragraph 11.4.4](#)), and retreating blade stall may occur.

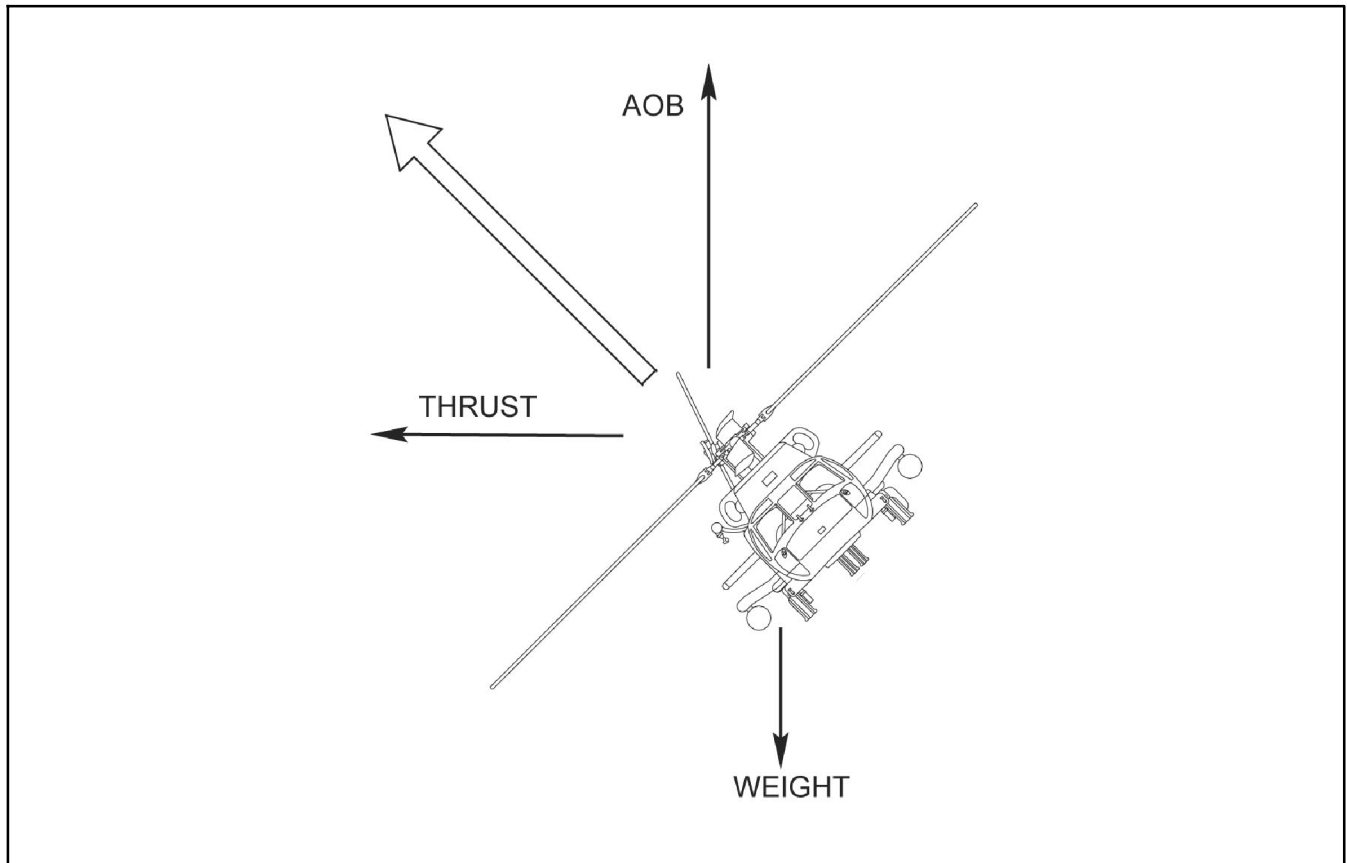


Figure 11-3. Main Rotor Thrust vs. AOB

| AOB (°) | G-Load |
|---------|--------|
| 0 | 1.00 |
| 10 | 1.02 |
| 30 | 1.15 |
| 45 | 1.41 |
| 60 | 2.00 |
| 75 | 3.86 |
| 85 | 11.50 |
| 99 | 58.82 |

Figure 11-4. G-Load while Maintaining Altitude and Airspeed at Listed AOB

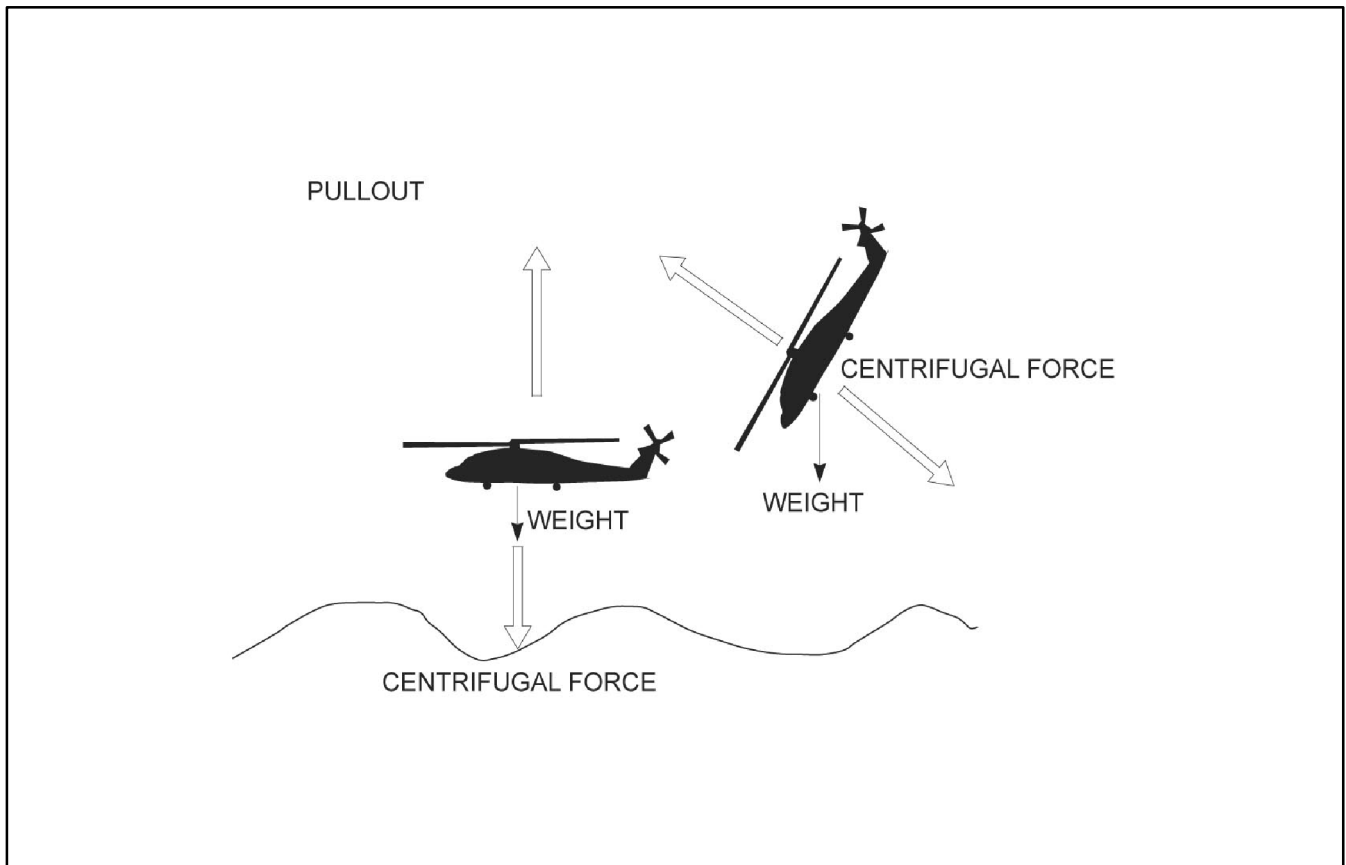


Figure 11-5. The Rolling Pullout

11.4.9 High AOB (High-G) Maneuvering Effects on Lateral cg Margin

Helicopter center of gravity limits are based on non-accelerated flight (1 g). This is particularly true of lateral center of gravity limits. High angle-of-bank turns narrow the lateral cg margin. With an excessive asymmetrical load (i.e., all stores and/or auxiliary tank on one side), a high AOB turn into the stores-heavy side can reduce the lateral cg margin to the point where there is not enough cyclic authority to roll back out of the turn. This can occur even though the lateral cg position is within static (1 g) limits. The result is an uncontrolled spiral into the deck.

WARNING

In situations where loss of lateral control is experienced in a steep turn and asymmetrical stores load/shift in lateral cg is the suspected cause, consideration should be given to jettisoning the stores. This should shift the lateral cg sufficiently to provide enough control authority to recover from the turn.

11.4.10 Power Required Exceeds Power Available

At high density altitudes, high gross weights, or when operating with reduced power, power required may exceed power available. It may not be possible to maintain level flight due to lack of power, which will cause settling to occur. The attendant loss of altitude is of minor consequence except in certain situations where sufficient altitude is not available to achieve the airspeed necessary to maintain level flight. Careful preflight analysis of engine performance and hover charts in [Chapters 22, 23, 24, 25, 26, and 27](#) will aid in avoiding extreme situations. To recover from this condition, complete the Emergency Malfunction In Flight procedures.

Note

The NATOPS density altitude calculation chart and charts indexed for pressure altitude corrected to nonstandard temperature do NOT account for the effect of humidity. High humidity has negligible effect on power available, but a great effect on power required. The effects of humidity on power required become apparent above 40 percent relative humidity. A good rule of thumb is to add 100 feet to DA for every 10 percent of relative humidity above 40 percent. Some weather briefs use “virtual temperature” or temperature corrected for humidity to calculate density altitude. In this case, no correction is necessary.

NTRP 3-22.2.4-SH60B contains a detailed description of Energy Maneuverability. Also included are a series of charts relating speed, bank angle, and rate of climb/descent for various combinations of aircraft weight and environmental conditions. These charts provide an invaluable preflight guide to maneuvering limitations.

11.5 DESCENDING FLIGHT AND AUTOROTATION

There are four flow states of a rotor system: Normal Thrusting, Vortex Ring, Autorotative, and Windmill Brake. Each flow state represents a larger rate of descent relative to the induced velocity of the rotor system. In the normal thrusting state of the rotor system, vortices are concentrated at the blade tips. The velocity profile of air relative to the rotor is downward across the entire rotor disk. This is the condition encountered in hover, forward flight, climbing flight, and slow rates of descent.

11.5.1 Vortex Ring State/Power Settling

Vortex ring state describes an aerodynamic condition where a helicopter may be in a vertical descent with maximum power applied and little or no cyclic authority. The term “power settling” comes from pilot observations that the helicopter keeps settling even though full engine power is used. In a normal, out of ground effect hover, the helicopter is able to remain stationary by propelling a large mass of air down through the main rotor. Near the tips of the blades, some of the air is recirculated, curling up from the bottom of the rotor system and rejoining the air entering the rotor from the top. This phenomenon is common to all airfoils and is known as tip vortices. Tip vortices consume engine power but produce no useful lift. As long as the tip vortices are small, their only effect is a small loss in rotor efficiency; however, when the helicopter begins to descend vertically, it settles into its own downwash, which greatly enlarges the tip vortices. This is the vortex ring state where most power developed by the engines is wasted in accelerating the air in a doughnut pattern around the rotor while N_r remains at 100 percent.

The effect is measurable at descent rates greater than 700 fpm and airspeeds between 0 and 20 KIAS and is the worst at descent rates of approximately 1,500 fpm with airspeeds of 5 to 10 KIAS. Fully developed vortex ring state is characterized by an unstable condition where the helicopter experiences uncommanded pitch and roll oscillations, has little or no cyclic authority, and achieves a descent rate that may approach 6,000 fpm. It is accompanied by increased levels of vibration.

WARNING

Flight conditions causing vortex ring state should be avoided at low altitudes because of the attendant loss of altitude necessary for recovery. Recovery from fully developed vortex ring state may require entering autorotation before regaining airspeed.

Note

Vortex ring state may also be entered during any dynamic maneuver which places the main rotor in condition of high upflow and low longitudinal airspeed. This condition is frequently seen during “quick stop” type maneuvers or during autorotational recoveries.

To recover from this condition:

1. Decrease collective pitch.
2. Move cyclic forward.
3. Enter autorotation if altitude permits. A considerable loss of altitude may occur before the condition is recognized and recovery is completed. During approach for landing, conditions causing vortex ring state should be avoided.

11.5.2 Autorotative State

The autorotative state of the rotor system results in a lift-producing rotor with sufficient steady-state driving forces. The autorotative state can be achieved at descent velocities between approximately 3,125 fpm and 4,450 fpm at 19,000 pounds gross weight. A rotor disk in a steady-state autorotation is shown in [Figure 11-6](#). The prop region is 30 percent of the rotor disk, the autorotative region is 45 percent, and the stall region is 25 percent. The prop region creates usable lift. The auto region produces forward-tilting force that creates both lift and a pro-rotational force that overcomes blade drag and keeps the rotor spinning at a constant rpm. The stall region creates only drag ([Figure 11-6](#)). A steady-state autorotation is a balance between lift, drag, and rotational forces on the rotor system. An autorotation is a dynamic exchange of potential and kinetic energies. Energy needed to keep the rotor turning at 100 percent N_r and producing useful lift and rotational forces is gained from a decrease in helicopter potential energy (i.e., descending flight).

11.5.3 Autorotational Entry

The major variables affecting autorotational entry are altitude, airspeed, N_r , power state before entry, AOB, balanced flight, yaw, and rotor inertia. The SH-60B has relatively low rotor inertia. Slow pilot reaction time can lead to N_r decaying to unrecoverable levels in as little as two seconds. N_r decay rate will be greater when the helicopter is at a high power condition before entry (i.e., climbing or at high speed). In general, more airspeed on entry is better up to the maximum autorotational airspeed of 100 KIAS because the kinetic energy of forward flight can be translated into spinning the rotor system as the aircraft slows down. The higher the altitude, the more time is available to establish a steady-state autorotation.

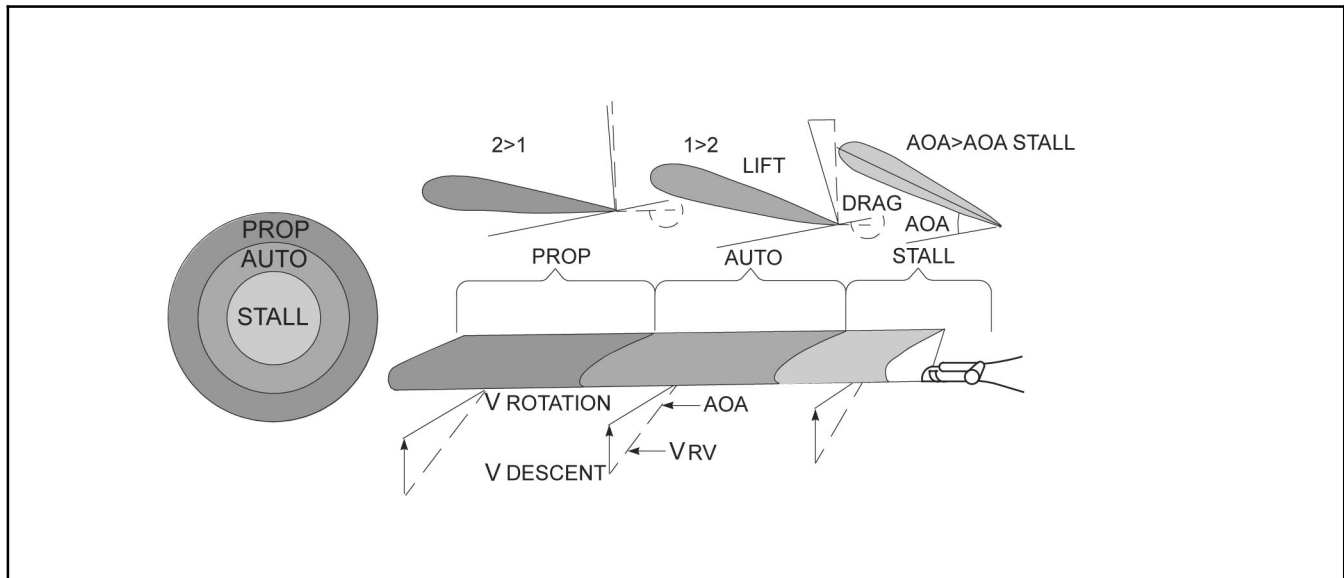


Figure 11-6. Stall Region in an Autorotative Descent

11.5.3.1 Autorotational Descent

The major variables affecting autorotational descent are airspeed, N_p , AOB, yaw, gross weight, and density altitude. Minimum rate of descent airspeed in an autorotation is approximately 75 KIAS. A decrease or increase in airspeed from this value results in an increase in rate of descent. Increasing airspeed above 75 KIAS increases glide distance up to the maximum glide airspeed of approximately 95 KIAS. Practice autorotations are typically shot at five knots faster than the optimum descent and distance values. This allows the aircraft speed to slow toward an ideal condition instead of away from it. For a given gross weight, there is one ideal rotor rpm that will provide the minimum rate of descent. As rotor rpm is allowed to build above ideal, rate of descent increases. This is because the increase in rotor speed comes at the expense of aircraft potential energy (i.e., a higher rate of descent). As rotor rpm decreases from ideal, the rate of descent increases. A heavy aircraft actually will descend slower in a steady-state autorotation than a lighter one. This is because a heavier aircraft can have a greater rate of exchange of potential energy (altitude and weight) into kinetic energy (rpm) of the rotor system. A rotor system with more kinetic energy needs more collective pitch to govern it to the optimum rpm. More collective pitch means more lift, therefore a smaller rate of decent for heavier aircraft. AOB increases G-loading, which equates to a larger weight vector. A larger weight vector means that more potential energy can be traded for rotor system kinetic energy. Rotor rpm will increase in a turn. Governing N_r at optimum will require more collective pitch (more lift); however, the lift vector is not vertical, so rate of descent will still increase in the turn. Yaw attitude affects autorotation due to the amount of energy transferred to or taken from the drive system due to relative wind effects on the tail rotor blades. A higher density altitude allows the blades to spin with less resistance; therefore, more collective pitch is required to govern to a given rpm at a higher density altitude.

Note

Aircraft descend at a higher rate at lower gross weights. Executing an autorotation at lower gross weight allows management of momentum (mass times velocity) during the recovery and lowers the power required to hover upon completion. A heavier aircraft has more momentum (both downward and forward) than a lighter aircraft, requiring more power to arrest aircraft rate of descent and velocity during the final flare and collective pull, as well as requiring more power to maintain hover at recovery altitude.

11.5.4 Autorotational Recovery

When executing a flare at the bottom of an autorotation, rotor rpm increases due to the trading of aircraft forward kinetic energy (airspeed) for rotor system kinetic energy (N_r). This increase in rpm is governed to optimum by

adjusting collective pitch. The flare slows the rate of descent and since the rotor is now tilted aft, it helps slow the forward speed of the aircraft. The aircraft attitude presents a more blunt cross section to the relative wind which also helps slow the forward speed. In addition, the stabilator programs down, which helps slow the aircraft even more. Final recovery is made by leveling the aircraft and applying collective pitch to cushion a tail wheel-first landing at slow to zero groundspeed.

Note

In an actual autorotational flare, the pilot may choose to allow N_T to increase above optimum for descent. The higher the N_T when executing the final recovery, the more kinetic energy is available in the rotor system for the collective pull that will cushion the landing as N_T decays.

11.6 ROLLOVER CHARACTERISTICS

11.6.1 Static Rollover

Static rollover angle is the angle at which the helicopter will tip over on its side if it is parked on a very steep embankment. The static rollover angle of the SH-60B is approximately 28°. It occurs when the cg of the helicopter is directly over the longitudinal axis passing through the tail gear and either main gear ground contact points.

11.6.2 Critical Rollover

Critical rollover angle is the maximum lateral angle of slope that can be negotiated in a takeoff or landing. At this angle, full lateral cyclic input is required to trim the wheels level with the slope without sliding. With left wheel uphill and brakes on, this angle is approximately 12°.

11.6.2.1 Dynamic Rollover

Dynamic rollover is an insidious dynamic condition that can occur during takeoff or landing with one wheel on the ground and can result in destruction of the helicopter. It is not definable by a single number, nor is it simply a function of slope angle or lateral control authority. These will aggravate a rollover condition, but the main contributor to dynamic rollover is the buildup of angular velocity of the helicopter cg about the wheel touching the ground. When the angular velocity about the wheel is greater than can be countered with full opposite cyclic, the helicopter will roll over. This situation can happen in less than two seconds. This is illustrated in [Figure 11-7](#).

In this condition, the upsetting rolling moment is caused by the helicopter acting about the wheel ground-contact point. Thus, the wheel restraint converts the lateral translation (drift) into an angular motion (roll rate) or angular momentum. The roll rate can be very large depending on sink and drift speeds and the degree of wheel restraint. In addition, a rolling motion to the right will be made worse by the thrust produced from the tail rotor. Conversely, a roll to the left will decrease as the tail rotor thrust acts to provide deceleration. Upon contact with the ground, the roll center is transferred from the helicopter cg to the touchdown wheel, resulting in higher roll inertia. The roll inertia about the ground contact wheel can be five times greater than the roll inertia about the cg. The resulting roll rate can be checked with opposite lateral cyclic, but lateral control will be only 1/5 of fully airborne, and the aircraft response will be sluggish and limited by maximum cyclic displacement. If lateral cyclic cannot be displaced far enough to tilt the rotor lift vector outside the wheel tread, then rotor lift adds to the rolling moment. Since rotor lift opposes the only restoring force remaining, lift should be reduced.

Note

If encountering a situation where only one wheel is in contact with the ground and a rolling moment is present, smooth reduction of collective is the most effective corrective action the pilot can take to prevent dynamic rollover.

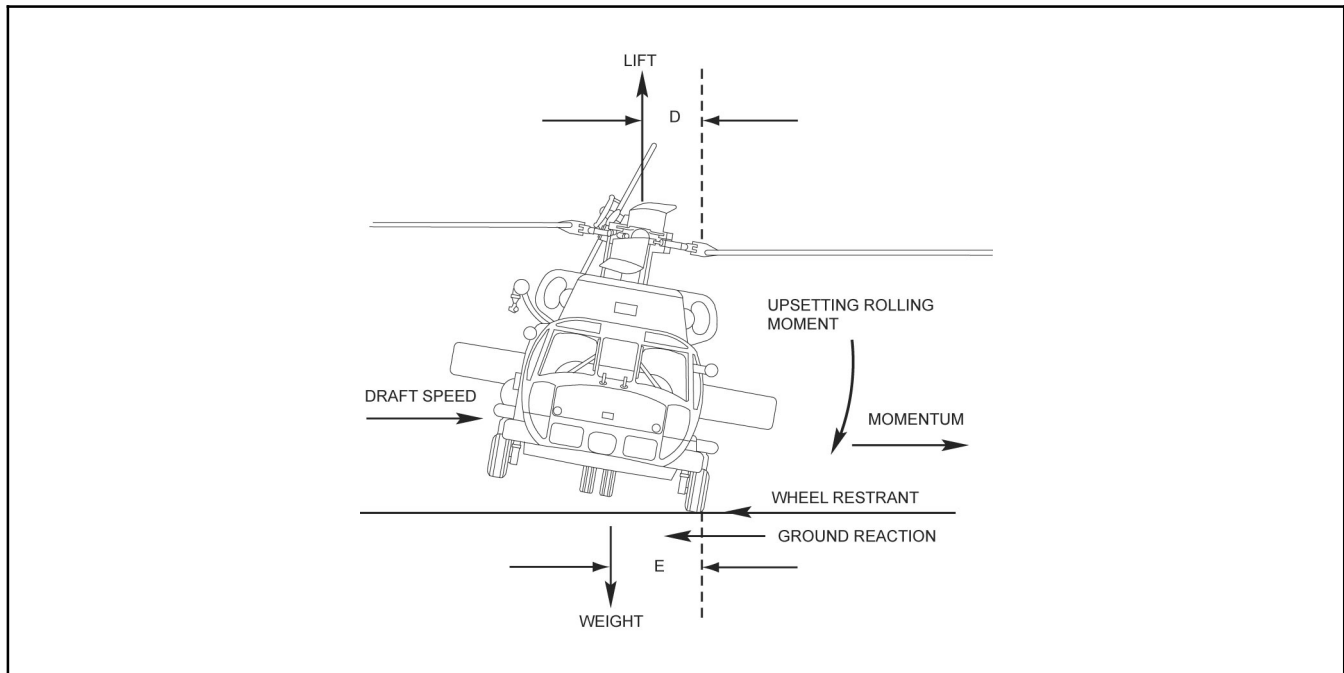


Figure 11-7. Dynamic Rollover

11.6.3 Slope Landing/Takeoff Considerations

There are three major forces in slope landings and takeoffs (Figure 11-8). These major forces are helicopter weight, rotor lift, and ground reaction (normal and friction forces). In general, the helicopter is controlled using collective to balance weight with rotor lift and tilting the rotor lift into the slope, this adds to wheel friction and prevent sliding. Slope landings can be grouped into three separate classifications: cross-slope, up-slope and down-slope.

Consideration should be given to setting the parking brake prior to landing. With the parking brake applied, an increased potential exists for dynamic rollover; without applying the parking brake, increased potential exists for the helicopter to slide from the landing site. Fly the appropriate approach to a hover. From a hover the aircrew should continuously clear and direct the helicopter for landing gear placement. Slope landings should be executed as slow, controlled, vertical descents. The PAC should descend slowly, placing the up-slope wheel on the ground first.

From the moment the up-slope wheel touches the ground and until it is lifted from the ground, the principal control is collective. Attempt to maintain the rotor disc level with the horizon throughout the landing and takeoff. As collective is decreased cyclic must be displaced toward the up-slope side. As collective is increased cyclic must be moved toward the neutral position. Balance between the two controls is indicated by a rotor disc that is level with respect to the horizon.

WARNING

Aft cyclic positions, in conjunction with low or decreasing collective pitch, may cause rotor blades to contact the tail pylon resulting in loss of tail rotor drive.

Note

- When landing site is a combination of cross-slope and up- or down-slope, use the most restrictive slope landing limit. Be prepared to execute a combination of control inputs to maintain stability.
- Depending on slope and helicopter configuration, the tail wheel may touch down prior to the up-slope wheel.

11.6.3.1 Cross-Slope Landing

In a cross-slope environment, lateral cyclic still provides roll control, but the control power is reduced to 1/5 of its airborne value.

Once the up-slope wheel touches the ground slowly lower the collective, coordinating lateral cyclic into the slope until the down-slope wheel is also on the ground. The controls should always be positioned to keep the helicopter from drifting. Continue coordinated movement of the collective and lateral cyclic until all of the helicopter weight is resting firmly on the ground. If lateral cyclic control contacts the stop, or if rotor-to-ground clearance becomes marginal before the down-slope wheel is firmly on the ground, return to a hover by slowly raising collective and centering cyclic. Select another landing site with a shallower slope. After the slope landing is completed, ensure that the helicopter will not slide or sink while smoothly lowering the collective to a full down position. As collective is lowered, adjust lateral cyclic input to maintain the rotor disc as level as possible. This has the effect of maintaining the CG on the up-slope side of the helicopter.

WARNING

During cross-slope landings, rotor clearance is decreased on the up-slope side. Personnel should traverse the rotor arc on the down-slope side of the helicopter.

CAUTION

During cross-slope landings, avoid rapid collective reductions to prevent blades from striking the ground and high roll rates about the up-slope wheel.

11.6.3.2 Up-Slope Landings

For up-slope landings where main mounts touch first, longitudinal cyclic (either forward or aft) may be required with coordinated collective movement to safely lower the tail wheel to the ground. If the tail wheel touches down first, the PAC shall make smooth, coordinated cyclic inputs similar to a normal landing. A more forward than normal cyclic position may be required to prevent rolling down the slope backwards. With the tail wheel on the ground, smooth coordinated cyclic and collective movements are required to control pitch rate and aircraft position until main mounts are on deck. As the helicopter nears max up-slope nose attitude, the PAC should arrest pitching moment to ensure limit is not exceeded.

11.6.3.3 Down-Slope Landings

Once the tail wheel touches the ground, slowly lower the collective, coordinating aft cyclic until the main mounts are on deck.

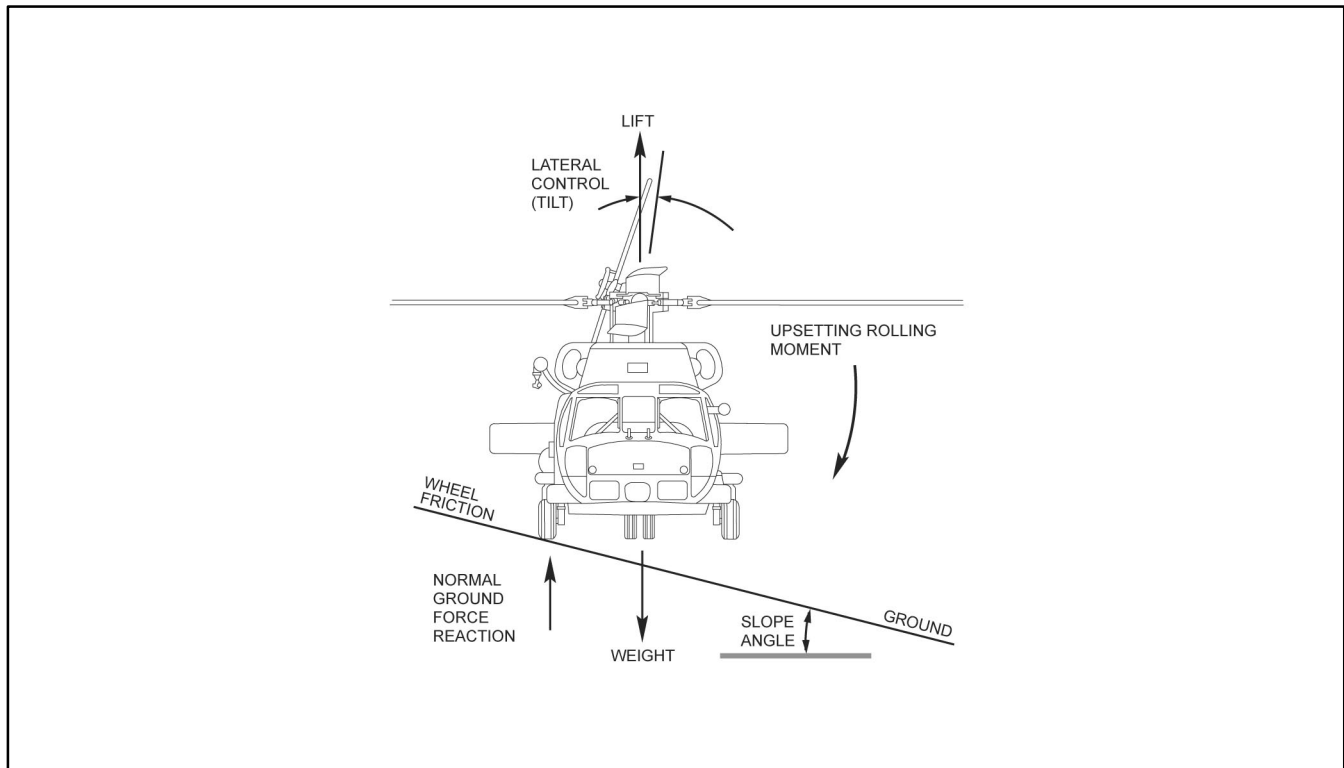


Figure 11-8. Slope Landing Takeoff Forces

11.6.3.4 Take Off

Slope take offs should be made by first moving cyclic into the slope to prevent drift. Using coordinated collective and cyclic, increase power while adjusting cyclic to raise the downhill wheel first until the helicopter becomes level and lifts off the ground. Avoid large cyclic inputs when the helicopter becomes airborne, because the roll center will now shift back to the helicopter's CG and full control authority will be restored. If the helicopter rolls past level (into the slope) during takeoff, lower collective rapidly but smoothly to avoid dynamic rollover - check for a blocked or hung-up wheel.

WARNING

When taking off or landing on a sloping or rough surface, the helicopter can be subjected to conditions which, with the slightest inattention by the pilot to developing roll rates, can result in almost certain destruction by dynamic rollover. Keep the helicopter under control at all times. When landing or taking off with one wheel touching the ground, use smooth collective motion to maintain low roll rates.

The following procedures shall be observed to ensure safe landing/take off in a slope environment:

1. Execute all landings/take offs smoothly and maintain low roll rates.
2. Take off slowly so that induced roll rates can be easily controlled.
3. Maintain wheels-level during all landings/take offs.

4. Always lift the downhill wheel first during take off.
5. Do not allow helicopter to drift.
6. If lateral control feels sluggish, reduce collective and check for obstructions.
7. To control roll rate, reduce collective smoothly. Avoid fast collective reductions to prevent blade strike or induced high rates of roll about up-slope wheel.

11.7 SALTWATER POWER DETERIORATION

Salt spray ingestion in the engine may result in a loss in performance. This deterioration will be noticed as an increase in TGT for a given torque. The circumstances under which power deterioration may occur during saltwater operation vary with a number of factors. The flight regime, gross weight, wind direction and velocity, pilot technique, duration of maneuver, salinity of the water, and the relative density of the salt spray all have a bearing on performance deterioration, though wind velocity and hover altitude have the most significance. Intermittent operation in moderate salt spray conditions could expose the engines to enough salt spray to cause noticeable performance deterioration. During prolonged operations, power deterioration will be readily apparent. Maneuvers such as hovering close to the water in light winds, or low flights at low speeds, will generate maximum rotor downwash spray conditions. The amount of spray observed on the windshield is the best indication of spray ingestion.

WARNING

While operating in a salt spray environment for any period of time, a TGT rise of 20 °C or more for constant torque is an indication of engine performance degradation and possible salt encrustation. A TGT rise of greater than 40 °C for a constant torque is an indication of engine performance degradation which may result in compressor stall(s).

CAUTION

- Take note of windshield spray deposits. The amount of saltwater spray observed on the windshield is usually the best indication of the salt spray environment to which the engines are being subjected. If the spray on the windshield is sufficient to require use of the windshield wipers, the engines are ingesting a very significant amount of salt water. In this condition, there is a probability of performance degradation thus, an increase in altitude is recommended.
- In the event that hovering is necessary in the above conditions, the best indication of performance loss is the relationship between TGT and torque.

Note

Continued engine operation in clean air may dissipate some of the salt buildup, but this cannot be assured. Flight through rain may also be beneficial in reducing salt buildup, thereby improving performance.

11.8 FLIGHT WITH EXTERNAL LOADS

It is very important that the pilot know the riding characteristics of certain loads and the associated flight control applications. All maneuvers that are made with external cargo loads should be gradual and well coordinated. Care must be taken when flying with external loads that have aerodynamic characteristics (i.e., light aircraft, wings, tail sections, sheet metal, plywood, etc.). The aerodynamic lift capabilities of these loads may amplify any oscillation and cause the load to contact the helicopter. Hovering and turns while hovering present no unusual problems; however, some helicopter oscillation may be noticed with low density bulky cargo when in level flight. This oscillation can be minimized by the use of smooth control movements. When making turns at higher airspeeds, more than the normal opposite lateral cyclic displacement is necessary to prevent excessive rolling motion into the direction of turn. This tendency increases with airspeed and requires a slightly larger turning radius than would be required at the same gross weight with an internal cargo load. More than normal amounts of cyclic displacement are necessary to overcome the external cargo inertia when initiating or stopping sideward flight; however, slow steady sideward flight presents no problems. Experience has shown that for any type of external cargo load, there is an airspeed best suited for that particular load. This speed may vary from very low speeds with some loads to cruise speeds or above for others. There is no one rule for flying external loads as the combination of weight, dimension, and shape all have a direct bearing on the action of the load during flight. Increased power requirements will be necessary to hover large flat loads that create a vertical drag factor than to hover loads of the same weight but smaller configuration. However, if control movements are smoothly applied to preclude oscillation, and airspeed is slowly increased to determine the riding characteristics of the load and the best airspeed for it to be flown, external cargo can be flown satisfactorily. If high airspeeds or turbulence should cause a load to oscillate, the oscillation can be reduced by decreasing airspeed and increasing collective.

Note

The parasitic drag of an external load will increase fuel consumption significantly.

11.9 HELICOPTER VIBRATION

The inherent vibrations in any helicopter are those created by the mechanical functions of the engines and transmission systems, dynamic action of the main and tail rotors, and aerodynamic effects on the fuselage. The overall vibration level is influenced by the many individual frequencies of vibration and combinations thereof. Many multiples of a basic frequency are felt, and often two or more different superimposed frequencies create beats. The overall magnitude is the resultant of the amplitudes of all the frequencies and it would be difficult for the pilot to completely separate all the types of vibrations encountered. Generally, these are divided into three categories: low, medium, and high frequencies. Varying magnitudes of all three types of vibrations are often present in an individual helicopter. Only through experience will the pilot be able to judge what is normal to the model and what is abnormal and correctable. Excessive or abnormal vibration levels should be noted on a VIDS/MAF.

11.9.1 Main Rotor Specific Vibrations

11.9.1.1 One-Per-Revolution (4.3 Hz)

This vibration emanates from the main rotor system and is generally caused by main rotor head or blade imbalances. It produces a rotary excitation of the fuselage which feels like a lateral oscillatory roll to the pilot. At high speeds, one-per-revolution vibration will most likely be felt as a vertical vibration. The most probable causes are:

1. Main rotor blades out of track. A blade track adjustment is not warranted even though the blades visually appear to be slightly out of track if a one-per-revolution vibration is not present. Out-of-track condition could be caused by:
 - a. Damaged main rotor blade trailing edges.
 - b. Main rotor blade dynamic balance beyond tolerances.

2. Worn or loose control rod end bearings. If the vibration is present in a hover only, the cause could be the same as above, plus:
 - a. Main rotor blade static balance beyond tolerances.
 - b. Rotor head out of balance.
3. Malfunctioning blade damper.

11.9.1.2 Ground One-per-Revolution

This is a one-per-revolution lateral roll of the helicopter which often occurs during rotor engagement and is due to the in-place misalignment of the main rotor blades, causing an out-of-balance condition in the main rotor system. When the rotor attains flying speed, centrifugal force normally aligns the blades and the vibrations disappear. If the vibration continues with the rotor up to speed at flat pitch but disappears when the helicopter is lifted into a hover, the cause could be one of the following:

1. Static imbalance of the main rotor blades or rotor head.
2. Improper servicing of the landing gear strut.

11.9.1.3 One-per-Revolution (6.5 Hz)

This vibration is most probably caused by an initial aerodynamic upset which is amplified and maintained as a result of an SAS and pilot-induced oscillation (PIO) in the longitudinal cyclic.

This vibration will most likely be encountered during autorotations over 100 KIAS at approximately 3,500 fpm rate of descent, turns above 45° AOB, diving recoveries, or sideslips.

11.9.1.4 Four-per-Revolution (17.2 Hz)

This most common inherent vibration is caused by the dynamic response of the main rotor blades to asymmetrical blade loading. Its intensity is greatest at low-forward speeds and during transition to a hover. It is felt as a lateral/roll shake caused by the main rotor blades traversing the downwash of preceding blades. This vibration normal to the helicopter when felt at the point where the collective pitch is increased to sustain a hover, or when air taxiing the helicopter just prior to applying collective pitch, and by planning the approach so that the hover can be attained with a slow rate of final pitch application. At high speeds, the difference in the lift distribution between the advancing and retreating main rotor blades results in heavy vibratory loads on the rotor head. It is felt as a combination of vertical and lateral shake at the same frequency. The primary sources of excessive four-per-revolution vibrations are loose or worn vibration absorbers, main rotor head pressure plates, swashplate and associated hardware, damper servicing, loose stabilator, and loose cabin equipment and main landing gear struts (if experienced on deck only).

Note

- Adjusting the engine rpm switch will result in changes to four-per-revolution vibration levels.
- A longitudinal reversal of the cyclic at low speeds (60 to 90 knots) may result in momentary increase in four-per-revolution vibration.

11.9.2 Ground Resonance

Ground resonance is a phenomenon of multibladed helicopters like the SH-60B and is due to the cg of the rotating blades traversing off center. Typically, it can happen during startup, takeoff, or landing. For the condition to occur, there must be some abnormal lead/lag blade condition that would cause the cg of the rotors to progress outward, causing further outward movement of cg. Ground resonance can be caused by a blade being badly out of track, a peculiar set of landing conditions, or a malfunctioning damper. Ground resonance can be pilot induced and may occur when a landing is made with a large descent coupled with lateral drift. When a wheel reaction occurs, such as a hard one-wheel landing that would cause out-of-phase main rotor blades to be aggravated to the point where maximum lead and lag blade displacement is realized, ground resonance can occur. If ground resonance should occur, primary consideration should be given to getting the helicopter airborne. If this is impossible, immediately reduce collective pitch, place the PCLs to OFF, and apply the rotor and wheel brakes.

11.9.3 Tail Rotor Specific Vibrations

11.9.3.1 Tail Shake (Five Cycles per Second)

Tail shake is an aerodynamic excitation of the first lateral bending mode of the tail pylon in certain flight regimes. This vibration will be felt as a random impulse around the yaw axis and may be more apparent with an aft center of gravity.

11.9.3.2 Tail Rotor Drive Shaft Vibrations (High Frequency)

Generally, these vibrations are caused by an unbalanced drive shaft, bad bearings, or a failing tail/intermediate gearbox. These vibrations can be identified during a ground run by feeling the tail cone and can also be felt as a buzz in the pedals or a tickling in the nose similar to that of a feather.

11.9.3.3 One Times Tail Rotor Speed (20 Hz)

This vibration (1,189 cycles per minute at 100 percent) may be due to tail rotor imbalance, damage, loose hardware, pitch change link bearing wear, or loose tail or intermediate gearbox, and is not easily isolated by the pilot. Since this frequency is close to four per revolution (1,032 cycles per second), the vibration may be difficult to distinguish from a four per revolution. Also, they may modulate at a frequency of 170 cycles per minute and be hard to distinguish from a one per revolution (258 cycles per minute).

PART V

Emergency Procedures

Chapter 12 — Emergency Procedures

CHAPTER 12

Emergency Procedures

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12.1 INTRODUCTION

The emergency situations and procedures outlined in this chapter cover the common types of emergencies encountered; however, the procedures used during an actual emergency must result from careful consideration of the complete situation. Compound emergencies may require departure from the normal corrective procedures set forth by any specific emergency. Due to the varied types of equipment installed, pilots and aircrewmembers must be thoroughly familiar with the emergency procedures in this chapter. The terms **land as soon as practical**, **Land As Soon As Possible**, and **LAND IMMEDIATELY**, refer to the degree of urgency with which a landing must be made and are not meant to preclude the use of sound judgment during these situations.

The PAC shall complete the immediate action items that do not require releasing the flight controls.

The PNAC shall:

1. Assist in ensuring the continued safe flight of the aircraft.
2. Perform the immediate action items that do not involve the flight controls.
3. Use the pocket checklist to complete non-immediate action items.
4. Troubleshoot as required.

The aircrewman shall:

1. Provide the pilots with verbal calls as necessary to ensure the continued safe flight of the aircraft.
2. Complete the applicable immediate action items.
3. Utilize the pocket checklist to complete the remaining non-immediate action items.
4. Back up the pilots with the pocket checklist to the maximum extent possible.
5. Assist the PNAC with troubleshooting.

Note

The urgency of certain emergencies requires immediate and instinctive action by the PAC. The most important single consideration is helicopter control. All procedures are subordinate to this requirement.

The following should be performed for all emergencies:

1. Maintain control of the aircraft.
2. Alert Crew.
3. Determine the precise nature of the problem.
4. Complete the applicable emergency procedure or take action appropriate for the problem.
5. Determine landing criteria and land as required.

Due to possibility of rapid degradation or loss of aircraft control during certain emergencies, the PIC should ensure all aircrew are strapped into their seats with shoulder harnesses locked at all times during ground or flight operations, except when release of the seat belt is required to perform mission- or flight-related functions.

**CAUTION**

A thorough analysis should be conducted prior to resetting circuit breakers in flight. Energizing faulty electrical circuits may induce further degradation, failure, or loss of flight and mission displays.

Note

In an NVD operating environment, it is recommended that the entire crew remain goggled and initiate the required immediate action procedures.

12.1.1 Explanation of Terms

Procedures indicated by an asterisk (*) are considered Critical Memory Items (CMIs). These steps must be performed immediately, without reference to the checklist.

LAND IMMEDIATELY: Execute a landing without delay. The primary consideration is to ensure the survival of the occupants.

Land As Soon As Possible: Execute a landing at the first site at which a safe landing can be made.

Land as soon as practical: Extended flight is not recommended. The landing site and duration of flight are at the discretion of the PIC.

12.1.2 WARNING, CAUTIONS and ADVISORIES

Warning, caution and advisory (WCA) information is provided visually to the pilots by a red warning, amber caution and green advisory lights. These lights are located on the master warning and caution/advisory panels on the instrument panel. See [Figure 12-1](#) through [Figure 12-4](#).

12.1.3 Master Caution Light

The MASTER CAUTION light ([Figure 12-4](#)) illuminates to alert the pilots of a caution activation. In response to the light, the pilot will note the applicable caution and press the MASTER CAUTION light to reset it.

Note

- Reset MASTER CAUTION after each malfunction to allow the systems to respond to subsequent malfunctions.
- MASTER CAUTION light illumination with no corresponding caution light may be an indication of a malfunctioning intermediate transmission and/or tail gearbox chip detector.

12.1.4 Pocket Checklists (PCLs)

The Pilot PCL (A1-H60BB-NFM-500) and Aircrew PCL (A1-H60BB-NFM-800) include selected emergency procedures, cautions, and advisories from this chapter. These PCLs contain only the text listed under the LEGEND column and the CORRECTIVE ACTION columns of this chapter. Text located in the CAUSE/REMARKS column of this chapter does not appear in the PCLs.

12.1.5 Circuit Breaker Numbering Convention

All circuit breakers referenced in emergency procedures have a labeling convention that reads top to bottom, left to right with circuit breaker NO. 1. beginning at the left of the respective panel and includes any missing or covered circuit breaker spaces as part of the count.

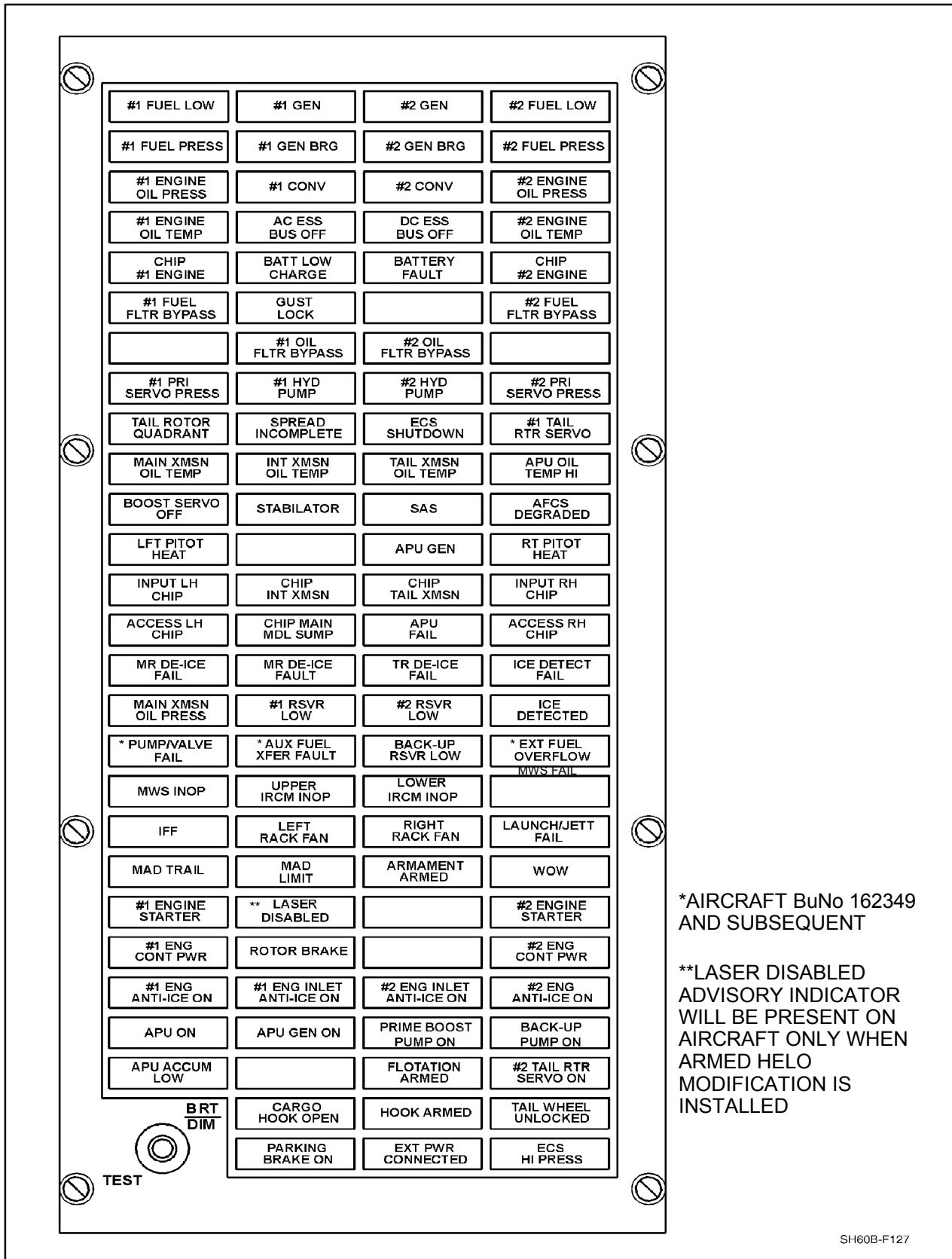


Figure 12-1. Caution/Advisory Panel

| LEGEND | DESCRIPTION |
|--|---|
| #1 FUEL LOW (or) #2 FUEL LOW | Low fuel state (200 to 225 pounds) in respective fuel cell. |
| #1 FUEL PRESS (or) #2 FUEL PRESS | Low fuel pressure from respective engine-driven boost pump (faulty pump or air leak). |
| #1 FUEL FLTR BYPASS (or) #2 FUEL FLTR BYPASS | Respective fuel filter is in bypass. |
| #1 OIL FLTR BYPASS (or) #2 OIL FLTR BYPASS | Respective engine oil filter is bypassing. |
| #1 ENGINE OIL TEMP (or) #2 ENGINE OIL TEMP | Respective engine oil temperature is high. |
| #1 ENGINE OIL PRESS (or) #2 ENGINE OIL PRESS | Low oil pressure at outlet of respective engine oil filter. |
| CHIP #1 ENGINE (or) CHIP #2 ENGINE | Chip or metal particles in respective engine. |
| APU OIL TEMP HI | APU oil temperature has exceeded limits. |
| APU FAIL | APU has failed to start due to a start sequence failure or has automatically shut down due to a monitored parameter being exceeded during operation with the exception of high oil temperature or a shorted thermocouple probe. |
| GUST LOCK | Blade indexing motor has been engaged. |
| SPREAD INCOMPLETE | SPREAD status light is ON and (1) pylon and/or stabilator panel not spread and locked and/or (2) tail indexer not retracted and/or (3) AC power routed to slibrings. |
| MAIN XMSN OIL PRESS | Main transmission oil pressure is low. |
| MAIN XMSN OIL TEMP | Main transmission oil temperature is high. |
| CHIP MAIN MDL SUMP | Chip in main gearbox sump. |
| ACCESS LH CHIP (or) ACCESS RH CHIP | Chip is detected in applicable accessory module. |
| INPUT LH CHIP (or) INPUT RH CHIP | Chip is detected in applicable input module. |
| TAIL ROTOR QUADRANT | One or both cables leading to tail rotor quadrant is broken. |
| #1 TAIL RTR SERVO | Low pressure at first stage pressure switch on tail rotor servo. |
| CHIP TAIL XMSN | Chip detected in tail gearbox. |
| CHIP INT XMSN | Chip detected in the intermediate gearbox. |
| TAIL XMSN OIL TEMP | High oil temperature in tail gearbox. |
| INT XMSN OIL TEMP | High oil temperature in the intermediate gearbox. |
| #1 RSVR LOW (or) #2 RSVR LOW | Fluid level in applicable hydraulic pump module is low. |
| #1 HYD PUMP (or) #2 HYD PUMP | Low pressure at outlet of applicable hydraulic pump. |
| BACK-UP RSVR LOW | Fluid level in backup pump module is low. |
| #1 PRI SERVO PRESS (or) #2 PRI SERVO PRESS | Low pressure or servo jam at any or all primary servos of applicable stage. |
| BOOST SERVO OFF | Collective and/or yaw boost servo pressure is low or boost servo is jammed. |
| SAS | Loss of hydraulic pressure to SAS actuators or loss of electrical power to both SAS-1 and SAS-2. |
| STABILATOR | Stabilator reverted to manual mode. |
| AFCS DEGRADED | Failure of one or more modes of DAFCS computer (flashing) or DAFCS computer power loss (steady). |

Figure 12-2. Caution Light Matrix (Sheet 1 of 2)

| LEGEND | DESCRIPTION |
|-----------------------------------|--|
| ECS SHUT DOWN | ECS has shut down due to CONTGCY PWR being selected, heating duct overtemperature, or one of the following with the AIR SOURCE ECS/START switch in ENGINE position: (1) either engine TGT approximately 839 ± 6 °C, (2) either ENG ANTI-ICE switch on, (3) ICE detected with DE-ICE MASTER in AUTO, or (4) when an underpressure situation exists. |
| #1 GEN (or) #2 GEN (or) APU GEN | Respective generator not supplying power to buses. Operative generator selected OFF; failure of generator, GCU, contactor, or wiring fault. |
| #1 GEN BRG (or) #2 GEN BRG | Generator main bearing is worn or has failed. |
| AC ESS BUS OFF | AC ESS BUS not powered. |
| #1 CONV (or) #2 CONV | Failure of AC source(s) or respective converter or DC bus. |
| DC ESS BUS OFF | DC ESS BUS not powered. |
| BATT LOW CHARGE | Battery is at or below a 40 percent state of charge. |
| BATTERY FAULT | Battery overtemperature or cell dissimilarity. |
| ICE DETECTED | Ice has been detected by ice detector. |
| ICE DETECT FAIL | Ice detector or icing rate signal converter has failed. |
| RT PITOT HEAT (or) LFT PITOT HEAT | Low heat or no heat on pitot tubes. |
| MR DE-ICE FAULT | Loss of electrical power (any phase) or open circuit on any MRB heating zone element (system will operate in degraded mode). |
| MR DE-ICE FAIL | Open circuit to any MRB heating element or a short circuit from phase to phase of the blade de-ice power lines (system will automatically turn off). |
| TR DE-ICE FAIL | Total open circuit to TRB heating elements or a short circuit from phase to phase of the blade de-ice power lines (TR DE-ICE will automatically turn off). |
| LEFT RACK FAN (or) RIGHT RACK FAN | High temperature in SO console or in MAR. |
| LAUNCH/JETT FAIL | Armament component has failed power-on BIT. Armament may not be able to be armed/launched. Additionally, jettison functions may also be inoperative. |
| IFF | Flashing — Transponder has not responded to a valid Mode 4 interrogation. Steady — KIT 1 series not keyed. |
| MWS INOP | System not used in this configuration. Illuminates during test only. |
| UPPER IRCM INOP | Upper ALQ-205 IRCM transmitter is inoperative (ESP only). |
| LOWER IRCM INOP | Lower ALQ-205 IRCM transmitter is inoperative (ESP only). |
| MWS FAIL | System not used in this configuration. Illuminates during test only. |
| PUMP/VALVE FAIL | Failure of element(s) of dual transfer/shutoff valves or dual transfer pumps. |
| AUX FUEL XFER FAULT | Total failure of dual transfer/shutoff valves, or dual transfer pumps, or FMCP logic. |
| EXT FUEL OVERFLOW | Fuel in external tank vent line. |

Figure 12-2. Caution Light Matrix (Sheet 2)

| LEGEND | DESCRIPTION |
|----------------------------|--|
| MAD TRAIL | Indicates when the MAD towed body is not in the stowed position (MSN PWR is set to PRI), or when MAD reeling machine control power switch is set to ON (MSN PWR is set to OFF or SEC). |
| MAD LIMIT | Steady illumination when the MAD bird is deployed to maximum limit. Flashes if the MAD stops inadvertently at any intermediate position. Light is extinguished when the MAD is traveling normally between limits. The MAD Limit capsule on will appear dimmer than other capsules when the panel is in DIM mode. |
| ARMAMENT ARMED | Lighted when aircraft has weight off wheels and MASTER ARM switch ON. |
| WOW | Aircraft has weight on wheels. |
| LASER DISABLED | Indicates the Interlock Switch Assembly LASER ENABLE/ DISABLE switch, located in the nose bay, is in the DISABLE position. |
| #1 or #2 ENG CONT PWR | Indicates contingency power has been selected. |
| ROTOR BRAKE | Rotor brake ON. |
| #1 or #2 ENG ANTI-ICE ON | The respective engine anti-ice valve has opened. Lights will be on during start to approximately 90 percent N _g or when ENG ANTI-ICE switch is turned ON. |
| #1 or #2 INLET ANTI-ICE ON | Engine bleed air has heated the engine inlet to 93 °C or greater. |
| #1 or #2 ENGINE STARTER | Respective engine starter valve is open. |
| APU ON | The APU is ON and operating normally. |
| APU GEN ON | The APU AC electrical generator is on and operating normally and is the only supply of power to the AC distribution system. |
| PRIME BOOST PUMP ON | The FUEL PUMP switch is in the APU BOOST or FUEL PRIME position. |
| BACK-UP PUMP ON | Indicates the backup pump is operating and at normal pressure. |
| APU ACCUM LOW | Indicates the APU accumulator pressure is below 2,650 ±50 psi. |
| FLOTATION ARMED | System not used in this configuration. Illuminates during test only. |
| #2 TAIL RTR SERVO ON | The second stage of the tail rotor servo is on and at normal pressure. |
| CARGO HOOK OPEN | Indicates the cargo hook load beam is not latched. |
| HOOK ARMED | Indicates the cargo hook electrical release system is armed. |
| TAIL WHEEL UNLOCKED | Indicates the tail wheel lockpin has disengaged from the tail wheel lock assembly. |
| PARKING BRAKE ON | Indicates the parking brake handle has been pulled up. |
| EXT PWR CONNECTED | Indicates AC external power is connected to the aircraft and DC power is on the battery bus. |
| ECS HI PRESS | Indicates the overpressure switch in the bleed-air line is sensing a high-pressure condition to the air-cycle machine. |

Figure 12-3. Advisory Light Matrix

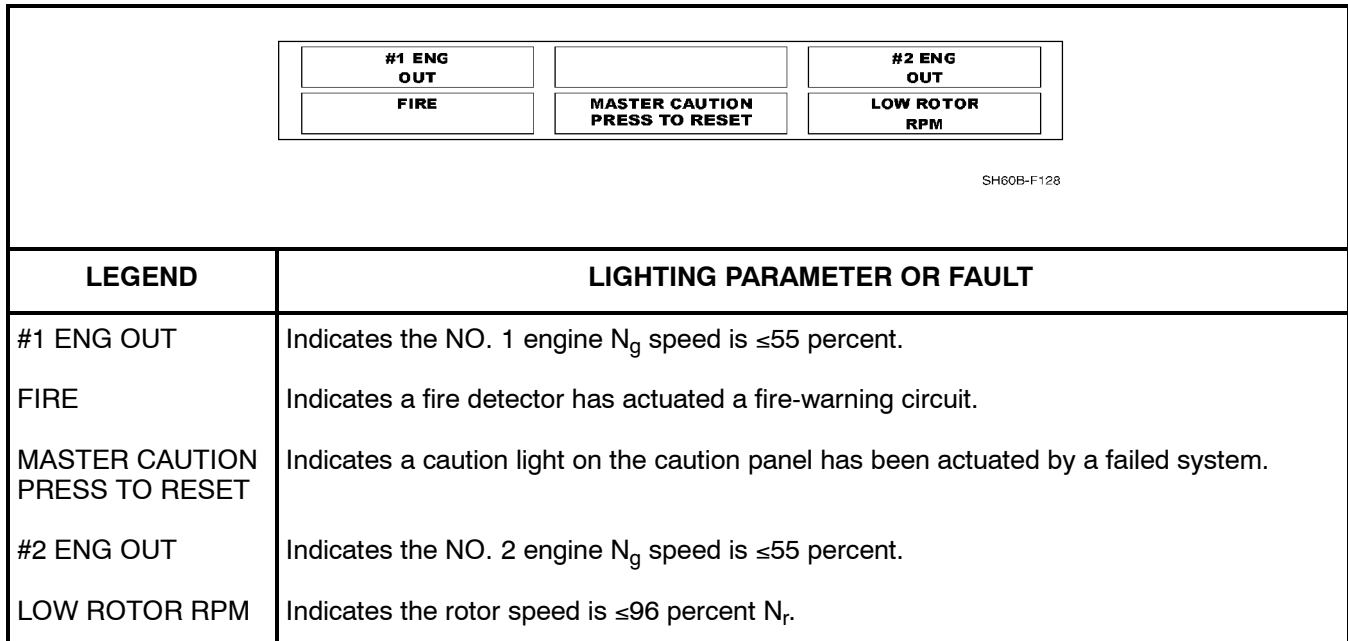


Figure 12-4. Master Warning Panel

12.2 ENGINE MALFUNCTIONS

A thorough preflight brief, discussing immediate actions and engine performance computations, will significantly increase the flight crew's ability to respond to an engine malfunction.

The engine instruments often provide ample warning of a malfunction before actual engine failure. Indications of an engine failure include changes in engine torque, N_g , TGT, N_p , and the ENG OUT warning light. Pilot action following a single-engine malfunction will depend upon altitude, airspeed, gross weight, phase of flight, single-engine capability, and environmental conditions. The term single-engine condition is defined as a flight regime that permits sustained flight with one engine inoperative (OEI). Establishing single-engine conditions may include increasing power available (turning contingency power on and engine anti-ice off), decreasing power required (dumping fuel and jettisoning cargo), and achieving single-engine airspeed. This envelope must be maintained until landing.

Additionally, establishing single-engine conditions may require various flight control adjustments as dictated by the flight regime when the engine malfunction occurs. For example, a high DA/low airspeed flight envelope may require the collective to be lowered to control N_r .

If an engine fails while hovering in ground effect, the helicopter should be kept in a level attitude with collective position maintained. Forward flight at low altitudes, where single-engine capability is not possible, may require setting a decelerating attitude to decrease airspeed and build N_r to cushion the landing. If airspeed is low and altitude permits, an attempt to achieve single-engine airspeed may be made by lowering the nose; however, extreme nose low attitudes should be avoided due to the high rates of descent that may develop.

During night overwater operations when adequate altitude or visual cues are lacking, a deliberate water landing may be preferable to inadvertent impact and should be considered. During flight regimes that permit a significant reduction in collective, N_r can be restored to 100 percent before landing. Airspeed should be optimized for the existing conditions (single-engine flight or autorotational descent). Power requirements for level flight are minimized when the aircraft is established at approximately 70 KIAS in a wings-level attitude. Refer to the Height-Velocity Diagram (Figure 4-4) and the Ability to Maintain Level Flight, Single Engine Chart (Figure 27-1).

Execute the Immediate Landing/Ditching emergency procedure when sustained single-engine flight capability does not exist.

WARNING

A decrease in N_r will reduce the efficiency of the tail rotor, potentially resulting in an uncommanded right yaw.

12.2.1 Engine Malfunction In Flight

Any suspected engine malfunction that manifests itself with fluctuations in N_p , N_r , and/or torque should be handled initially with the Engine Malfunction in Flight emergency procedure. Following malfunction identification, refer to the appropriate emergency procedure. Establishing single-engine conditions involves placing the aircraft in the optimum configuration and flight regime to operate with one engine inoperative (OEI). This includes, but is not limited to, establishing single-engine airspeed and reducing angle of bank.

| Engine Malfunction In Flight | | |
|-------------------------------------|----------------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Engine Malfunction In Flight | | <p>*1. Control N_r.</p> <p style="text-align: center;">WARNING</p> <p>Flying at an airspeed greater than 105 KIAS with one engine inoperative may result in unrecoverable decay of N_r in the event of a dual-engine failure.</p> <p>*2. CONTGCY PWR switch — ON.</p> <p>*3. Single-engine conditions — Establish.</p> <p>*4. ENG ANTI-ICE switches — OFF, as required.</p> <p style="text-align: center;">WARNING</p> <p>With engine anti-ice on, up to 18 percent torque available is lost. Torque may be reduced as much as 49 percent with improperly operating engine inlet anti-ice valves.</p> <p>*5. External cargo/stores/fuel — JETTISON/DUMP, as required.</p> <p>*6. Identify malfunction.</p> |

12.2.2 Engine Power Control Failure

Engine control system malfunctions may produce high or low torque conditions. This can result in N_r increasing or decreasing from normal selected speed. It is possible that the malfunction can also result in loss of or erroneous torque, N_g , TGT and/or N_p indication on the malfunctioning engine.

12.2.2.1 Engine High-Side Failure In Flight

If N_p and N_r increase above normal selected speed, identify the malfunctioning engine by comparing N_g 's, TGTs, and torques. It is possible that one or more of these indications may be erroneous or absent. The engine with the higher N_g , TGT, or torque should be manually controlled using the following procedure.


| Engine High-Side Failure In Flight | | |
|------------------------------------|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Engine High-Side Failure In Flight | <p style="text-align: center;">CAUTION</p> <p>If an N_p overspeed condition is reached (120 percent), the overspeed system will flameout the engine and the autoignition system will relight the engine. If N_r is not controlled and N_p accelerates back to 120 percent, the N_p overspeed system will flameout the engine again and the autoignition system will reset the ignitor five-second timer. The N_p overspeed/ autoignition system will continue cycling until N_r/N_p is controlled. A yaw kick may be experienced each time the engine relights.</p> <p style="text-align: center;">Note</p> <p>With high collective settings, N_r may increase slowly, making high-side failure confirmation difficult. Reducing collective will reveal increasing N_r and verify high-side failure.</p> | <p>*1. Engine Malfunction in Flight emergency procedure — PERFORM.</p> <p>*2. PCL (malfunctioning engine) — RETARD TO SET:</p> <ol style="list-style-type: none"> a. Torque 10% below good engine or b. Matched N_g or c. Matched TGT. <p>3. Land as soon as practical.</p> |

12.2.2.2 Engine High-Side Failure On Deck

| Engine High-Side Failure On Deck | | |
|----------------------------------|---------------|-------------------|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Engine High-Side Failure On Deck | | *1. PCLs — IDLE. |

12.2.2.3 Engine Low-Side Failure In Flight

If torque of one engine decreases significantly below the torque of the other engine or N_r decreases below normal selected speed, identify the malfunctioning engine by comparing both engine's N_g 's, TGTs and torques. One or more of the indications may be erroneous or absent. If torque is not indicated for both engines, the engine with low N_g should be controlled manually. The malfunctioning engine should be manually controlled after selecting LOCKOUT to increase power using the following procedures.

| Engine Low-Side Failure In Flight | | |
|-----------------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Engine Low-Side Failure In Flight | <div style="text-align: center;">  <p>CAUTION</p> </div> <p>When an engine is manually controlled with the ENG POWER CONT lever in LOCKOUT, the engine response is much faster and the TGT-limiting system is inoperative. Care must be taken to prevent exceeding TGT limits and keeping N_r and N_p in their operating ranges; however, the N_p overspeed system will still be operative.</p> | <p>*1. Engine Malfunction in Flight emergency procedure — PERFORM.</p> <p>2. PCL (malfunctioning engine) — Momentarily advance to LOCKOUT, then retard to set:</p> <ol style="list-style-type: none"> a. Torque 10% below good engine or b. Matched N_g or c. Matched TGT. <p>3. Land as soon as practical.</p> |

12.2.2.3.1 Engine Torque or TGT Spiking/Fluctuations

Various failures/malfunctions in engine electronic circuitry or components may cause fluctuations or spiking in torque and TGT. Spiking is an instantaneous, momentary excursion of an engine instrument that may or may not be accompanied by an associated response in N_g , N_p , and/or N_r . If one engine appears to be driving the fluctuation or is exceeding a limitation, treat that engine as the malfunctioning engine. If expeditious identification of the malfunctioning engine is not possible, treat either engine as the malfunctioning engine.

Fluctuations of the N_r , torque, and N_g VIDs, and other engine instruments on either or both engines, may be indicative of water-contaminated fuel. Audible power surges may be observed before power loss. Engine fuel filters are not water sensitive and will not give any indication in the cockpit of engine malfunction or impending engine flameout.

| Engine Torque or TGT Spiking/Fluctuations | | |
|---|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Engine Torque or TGT Spiking/Fluctuations | | <p>If an engine instrument is spiking/fluctuating and inducing secondary indications in N_g, N_p, and/or N_r:</p> <ul style="list-style-type: none"> *1. Engine Malfunction in Flight emergency procedure — Perform. <p>If fuel contamination is suspected:</p> <ul style="list-style-type: none"> *2. Land As Soon As Possible. <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>PCL movement during engine fluctuations may precipitate an engine failure. Consider performing APU Emergency Start procedure prior to manipulating the PCL. Maintaining a low power setting when moving the PCL will minimize the N_r decay rate if the malfunctioning engine fails.</p> <p>If engine electronic circuitry is suspected:</p> <ul style="list-style-type: none"> 3. PCL (malfunctioning engine) — Momentarily advance to LOCKOUT, then retard to set: <ul style="list-style-type: none"> a. Torque 10 percent below good engine or b. Matched N_g or c. Matched TGT. <p>If fluctuations persist:</p> <ul style="list-style-type: none"> 4. PCL (engine in LOCKOUT) — Retard to IDLE, then return to FLY. 5. Repeat steps 3. and 4. for the other engine, as required. <p>If an engine instrument is spiking/fluctuating with no secondary indications:</p> <ul style="list-style-type: none"> 6. Land as soon as practical. |

12.2.2.3.2 Compressor Stall


A compressor stall is caused by an aerodynamic disturbance of the smooth airflow pattern through the engine. Susceptibility to stall is influenced by blade or vane angle and airfoil shapes, which can be distorted by compressor damage, improper stator vane schedule, compressor fouling, loss of blade or vane material by erosion, salt encrustation, or ice ingestion. Indications of a stall are: rapid increase in TGT, hang-up or rapid decrease in N_g , loss of power, or a change in engine noise level varying from barely audible to muffled explosions.

| Compressor Stall | | |
|------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Compressor Stall | <div style="border: 2px dashed black; padding: 5px; display: inline-block; text-align: center;"> CAUTION </div> <p>If the N_g decay relight feature attempts to relight the engine, subsequent compressor stalls may occur and damage the engine. A yaw kick may be experienced each time the engine relights. The engine must be manually shutdown.</p> | <p>*1. Engine Malfunction in Flight emergency procedure — PERFORM.</p> <p>*2. PCL (malfunctioning engine) — IDLE.</p> <p>If TGT decreases and stall clears:</p> <p>3. PCL — SLOWLY ADVANCE TO FLY.</p> <p>If stall remains cleared:</p> <p>4. Land as soon as practical. Avoid rapid collective movement.</p> <p>If TGT continues to rise, N_g decreases below normal idle speed, or any other malfunction is indicated:</p> <p>5. Engine Shutdown in Flight emergency procedure — PERFORM.</p> |

12.2.3 Engine High Speed Shaft Failure

An impending high-speed shaft failure may manifest itself as a high-intensity, medium- to high-frequency vibration that may be felt throughout the aircraft. A howl may accompany the vibration. The intensity of the vibration and howl may vary with collective or PCL movement and the resultant loading and unloading of the high-speed shaft. The aircrewmembers can assist in identifying the affected engine by comparing the vibration and noise levels between the two sides of the aircraft. Cockpit indications may initially remain normal; however, if the high-speed shaft seal at the input module is damaged and transmission oil is lost, secondary indications of impending failure (transmission oil pressure and temperature) may be present.

If medium- to high-frequency vibrations/noises are identified and can be isolated to an impending high speed shaft malfunction, consideration should be given to securing the engine, thereby precluding catastrophic failure of the high-speed shaft. Extreme care must be taken to positively determine which engine is malfunctioning, since retarding the PCL of the unaffected engine may further load the affected shaft and accelerate the shaft failure. The possibility exists that a high-speed shaft failure may occur with little or no advance warning.

| Engine High Speed Shaft Failure | | |
|---|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>Engine High Speed Shaft Failure</p> | <p>Indicates failure of the high-speed shaft. N_p is greater than N_r by more than 3 percent and engine torque is below 10 percent.</p> | <div style="text-align: center;">  <p>CAUTION</p> </div> <p>Following a high-speed shaft failure, the engine will overspeed, the N_p over-speed system will flameout the engine, and the auto-ignition system will activate the relight feature. The engine N_p governor will eventually bring N_p down towards 100 percent. A yaw kick may be experienced each time the engine relights. The engine must be manually shut down to prevent further damage.</p> <ul style="list-style-type: none"> *1. Engine Malfunction in Flight emergency procedure — PERFORM. *2. PCL (malfunctioning engine) — OFF. 3. Land as soon as practical. <p>Consideration should be given to performing the following:</p> <ul style="list-style-type: none"> 4. Engine Shut down in Flight emergency procedure. 5. Single-Engine Landing emergency procedure. |

12.2.3.1 Load Demand System Malfunction

It is possible for a malfunction to occur in the LDS; notably a shear-pin/roll-pin failure or LDS cable malfunction. A shear-pin/roll-pin failure will result in the maximum LDS input to the HMU, regardless of collective position. This condition may result in excess power driving the main rotor during an autorotative descent because the DECU will not have enough down-trimming authority to reduce torque to zero. Depending on the severity of the malfunction, the DECU's ability to match engine torques under most flight conditions may conceal the malfunction. If the collective is raised slowly to lift into a hover, no torque split would be evident. The rate and magnitude of collective changes will determine the amount of torque split.

In general, in-flight diagnosis of an LDS malfunction is determined by the dynamic response of torque to collective inputs. The malfunctioning engine will lag the good engine for several seconds. The lag will have a greater magnitude and duration at higher rates of collective application or reduction.

A jammed or stuck cable may result in the minimum LDS input to the HMU regardless of collective position. This condition may restrict maximum power available from the affected engine. Operation in LOCKOUT will not clear this low-power condition.

The following indications are symptomatic of LDS malfunction:

| Load Demand System Malfunction Symptoms | |
|---|---|
| CONDITION | ENGINE INDICATIONS |
| ON DECK | |
| PCLs in IDLE. | N_g of malfunctioning engine 3% to 4% higher than other engine. |
| During rotor engagement. | Engine with the failed LDS will indicate a higher torque as PCLs are evenly advanced to FLY. Good engine may not indicate any torque until its PCL is in FLY. |
| PCLs in FLY. | Matched torque (no indications of failure). |
| IN FLIGHT | |
| Initial collective increase during take-off. | Torque split. Torque of the engine with the failed LDS will be lower than good engine. |
| Stable hover. | Matched torques (no indications of failure). |
| Collective increases (collective below approx 75% of its full up position). | Torque split. Torque of the engine with the failed LDS will be lower than good engine. |
| Collective increases (collective above approx 75% of its full up position). | No torque split. Both LDS are at their maximum setting. |
| Collective decreases (to positions below approx 75% of full up collective). | Torque split. Torque of the engine with the failed LDS will be above the good engine. |
| Stable flight. | Matched torques (no indications of failure). |
| Autorotation. | Rapid N_p/N_r rise. Engine with failed LDS may show a residual torque of approx 12% with collective full down. |

| Load Demand System Malfunction | | |
|--------------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Load Demand System Malfunction | | <p>On ground:</p> <ol style="list-style-type: none"> 1. Shutdown. <p>In flight:</p> <ol style="list-style-type: none"> 2. Land as soon as practical. 3. Perform a normal approach, avoiding low-power/autorotative descents. <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>During low-power or autorotative descents with an engine LDS malfunction, N_p/N_r may rise rapidly and activate N_p overspeed protection (120 percent).</p> |

12.2.4 Engine Caution Lights

12.2.4.1 #1 or #2 OIL FLTR BYPASS Caution Lights On

| Oil Filter Bypass Caution Lights On | | |
|-------------------------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| OIL FLTR BYPASS (#1/#2) | Respective engine oil is bypassing the filter. | <ol style="list-style-type: none"> 1. Engine Malfunction in Flight emergency procedure — Perform. 2. PCL (affected engine) — Retard, then return to FLY in an attempt to clear. <p>If secondary indications are present or light does not clear:</p> <ol style="list-style-type: none"> 3. Engine Shutdown in Flight emergency procedure — Perform. <p style="text-align: center;">Note</p> <p>Consideration may be given to restarting the engine if required for landing.</p> |

12.3 ENGINE OIL TEMPERATURE HIGH

| Engine Oil Temperature High | | |
|------------------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Engine Oil Temperature High | Engine oil temperature is exceeding limits. | <ol style="list-style-type: none"> 1. Land as soon as practical. 2. Check for secondary indications (caution lights, temperature, pressure, etc.). <p>If secondary indications are present:</p> <ol style="list-style-type: none"> 3. Engine Malfunction in Flight emergency procedure — Perform. 4. PCL (affected engine) — Idle. <p>If indication remains above maximum limit:</p> <ol style="list-style-type: none"> 5. Engine Shutdown in Flight emergency procedure — Perform. <p style="text-align: center;">Note</p> <p>Consideration may be given to restarting the engine if required for landing.</p> <ol style="list-style-type: none"> 6. Single-Engine Landing emergency procedure — Perform. <p>If no secondary indications are present:</p> <ol style="list-style-type: none"> 7. Monitor affected engine instruments for signs of failure. |
| ENG OIL TEMP (#1/#2) | <p style="text-align: center;">Note</p> <p>The engine oil pressure and temperature caution lights are triggered by the vertical instrument. Therefore, caution light and gauge indications cannot be used as secondary indications for each other.</p> | |


12.3.1 Engine Chip/Engine Oil Pressure Low Caution Lights On

| Engine Chip/Engine Oil Pressure Low Caution Lights On | | |
|---|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ENG CHIP (#1/#2) | Metal particles or chips detected in respective engine. | <ol style="list-style-type: none"> 1. Land as soon as practical. 2. Check for secondary indications (caution lights, temperature, pressure, etc.). If secondary indications are present: <ol style="list-style-type: none"> 3. Engine Malfunction in Flight emergency procedure — Perform. If engine failure is imminent: <ol style="list-style-type: none"> 4. Engine Shutdown in Flight emergency procedure — Perform. 5. Single-Engine Landing emergency procedure — Perform. If no secondary indications are present: <ol style="list-style-type: none"> 6. Monitor affected engine instruments for signs of failure. |
| OR | Low oil pressure in respective engine. | |
| ENGINE OIL PRESS (#1/#2) | Note The engine oil pressure caution lights are triggered by the vertical instrument. Therefore, caution light and gauge indications cannot be used as secondary indications for each other. | |

12.3.1.1 ECS Shutdown Caution Light On

| ECS Shutdown Caution Light On | | |
|-------------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ECS SHUTDOWN | ECS has shut down due to CONTGCY PWR being selected, heating duct over temperature, or the AIR SOURCE ECS/START switch in ENG position and one of the following: <ol style="list-style-type: none"> 1. Either ENG ANTI-ICE switch ON. 2. Ice detected with DE-ICE MASTER switch in AUTO. 3. TGT limiting has been reached. | If ECS SHUTDOWN caution appears due to high TGT: <ol style="list-style-type: none"> 1. Reduce power requirements (if possible). |

12.3.2 Abort Start

| Abort Start | | |
|-------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Abort Start | <p>Abort engine start if any of the following limits are exceeded:</p> <ol style="list-style-type: none"> 1. N_g does not reach 14 percent within 6 seconds after starter initiation. 2. No oil pressure within 30 seconds after starter initiation (Do not motor engine). 3. No light-off within 30 seconds after moving PCL to IDLE. 4. ENG STARTER advisory disappears before reaching 52 percent N_g. 5. TGT reaches 851 °C before idle is attained. <div style="text-align: center;">  <p>CAUTION</p> </div> <p>For aborted starts, fuel flow must be stopped immediately (PCL — OFF) to prevent engine overtemperature.</p> | <p>To abort start:</p> <ol style="list-style-type: none"> *1. PCL — OFF. *2. ENGINE IGNITION switch — OFF. *3. Starter — Engage. 4. Starter — Disengage after 30 seconds and TGT below 540 °C. |

12.3.3 Engine Malfunction During Hover/Takeoff

| Engine Malfunction During Hover/Takeoff | | |
|---|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Engine Malfunction During Hover/Takeoff | | <ol style="list-style-type: none"> *1. Control N_r. *2. CONTGCY PWR switch — ON. <p>If a suitable landing site exists or unable to transition to forward flight:</p> <ol style="list-style-type: none"> *3. Set level attitude, eliminate drift, cushion landing. <p>If able to transition to forward flight:</p> <ol style="list-style-type: none"> *4. Engine malfunction in Flight emergency procedure — Perform. |

12.3.4 Dual-Engine Failure in Flight/Hover

WARNING

- Rotor rpm decays rapidly following a dual-engine failure or the loss of the second engine after a single-engine failure. Delay in lowering the collective will result in loss of rotor rpm and may cause catastrophic failure of the rotor system due to dynamic instability at low rpm.
- Entering an autorotation at low airspeeds (below 50 KIAS), where the vertical sink rate is high in proportion to the horizontal speed, will result in an airspeed indication that is considerably higher than actual. A positive nosedown attitude should be held until 80 to 85 KIAS is indicated, after which pitch attitude may be adjusted to maintain the desired airspeed.
- Altitude hold will remain engaged unless deselected. If the collective TRIM RLSE switch is not depressed, the AFCS will attempt to maintain aircraft altitude. AFCS commanded collective movement could result in a catastrophic loss of N_r .
- Flying at an airspeed greater than 105 KIAS, with one engine inoperative, may result in unrecoverable decay of N_r in the event of a dual-engine failure.
- If the engine fails in a hover in ground effect, do not decrease the collective. This will cause the helicopter to settle more rapidly. The helicopter should be held in a landing attitude. The landing can be cushioned by increasing the collective as the helicopter approaches the ground.

12.3.5 Autorotation

With a dual-engine failure, rotor rpm will decay rapidly and left yaw may result. At altitude, it is imperative that an autorotation be established immediately. External cargo/stores should be jettisoned as soon as possible in order to reduce gross weight and drag, thus improving autorotational performance and decreasing the chance of damage to the helicopter upon landing. The collective must be reduced immediately to full down in order to regain N_r and then adjusted to control N_r . Cyclic should be adjusted as necessary to achieve desired airspeed. At airspeeds above 80 KIAS, there is an increase in rate of descent; however, airspeeds up to 100 KIAS will also increase glide distance. Should both engines fail at altitude, an attempt may be made to restart one or both engines. Approximately 5,000 ft AGL will be required to accomplish an engine restart, based on APU and engine start cycles, and typical autorotative rates of descent.

Autorotating the helicopter out of balanced flight will increase rate of descent and decrease glide distance. Therefore, ball control immediately after a dual-engine failure and during the descent is important. Balanced flight should be maintained, except when a higher rate of descent is required to prevent an overshoot of the intended landing site.

Throughout the descent, adjust collective as necessary to maintain N_r in the normal range. At high gross weights, the rotor may tend to over-speed and application of collective will be required. Autorotative rpm varies with DA, gross weight, and airspeed. Adjusting the collective pitch to maintain 100 percent N_r will result in an extended glide. N_r above 100 percent will result in an increased rate of descent.

Upon reaching an altitude of approximately 200 ft AGL, establish a flare. This decreases both airspeed and rate of descent, and increases N_r . The amount and rate at which N_r increases will depend upon the amount and rate of the flare. At approximately 60 ft AGL: set a level attitude, eliminate drift, and cushion the landing.



Should the helicopter balloon or level off during the flare, freeze collective and cyclic positions until the rate of descent increases again. Lowering the collective could result in an unrecoverable sink rate and a harder than desired landing.

Note

With both engines secured, the cushioning collective pull at the bottom of the autorotation will result in left yaw vice the right yaw associated with practice (power-on) autorotations.

Ground contact should be made with some forward airspeed, terrain permitting. If a rough landing area is selected or if over water, a steeper flare and a touchdown speed as close to zero KGS as possible shall be used.

12.3.6 Single-Engine Failure

The various conditions under which engine failure may occur prevent a standard procedure. A thorough knowledge of emergency procedures and flight characteristics will enable the pilot to respond correctly and automatically in an emergency.



Engine failure accompanied by an explosion or unusual noise indicates damage to the engine. There is a possibility that any attempt to restart the engine may result in a fire. Under such circumstances, do not try to restart the engine unless it is needed to maintain level flight.

Action to be taken after failure of one engine will depend upon altitude, airspeed, gross weight, phase of flight, single-engine capability, and environmental conditions. In addition, these factors should be taken into consideration should the functioning engine fail and a dual-engine failure result. The unshaded area of Height - Velocity Diagram of Figure 4-4 shows airspeed and wheel height combinations from which a safe landing can be made at different gross weights if one or two engines should fail.

| Single-Engine Failure | | |
|--|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Single Engine Failure ENG OUT (#1/#2) | Warning light is activated by the vertical instrument when N_g decreases below 55 percent. In the event of an isolated N_g signal failure, the ENG OUT light will be illuminated with the engine operating normally. | *1. Engine Malfunction in Flight emergency procedure — Perform. 2. Land as soon as practical. Consideration should be given to performing the following: 3. Engine Shutdown in Flight emergency procedure. 4. Engine Air Restart emergency procedure. 5. Single-Engine Landing emergency procedure. |

12.3.7 Engine Shutdown In Flight

| Engine Shutdown In Flight | | |
|---------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Engine Shutdown In Flight | | <ol style="list-style-type: none"> 1. Single-engine conditions — Establish. 2. PCL (malfunctioning engine) — OFF. 3. Fuel Selector lever (malfunctioning engine) — OFF. 4. Monitor TGT. 5. Land as soon as practical. 6. Single Engine Landing emergency procedure — Perform. |

12.3.8 Engine Air Restart

An engine restart may be attempted anytime after shutdown, if there is no indication of a mechanical malfunction or engine fire. If time permits, TGT should be reduced to 80°C before restart by motoring the engine with the PCL off. If the APU is unavailable and a crossbleed restart is necessary, maximum torque available (good engine) will be reduced during start.

During a dual-engine failure; without any evidence of damage, mechanical failure, or engine fire, an engine air restart may be attempted if time and altitude permits. Approximately 5,000 feet will be required based on APU and engine start cycles and typical autorotative rates of descent. Without other evidence, the most probable cause of a dual-engine failure is fuel starvation. In this case the fuel system must be primed. If abnormal indications are noted during the restart attempt, abort the restart immediately.

Note

In the event of an alternator failure, the N_g signal may be unavailable. Engine start will not be possible without ac power provided to the ignition exciter.

| Engine Air Restart | | |
|--------------------|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Engine Air Restart | <p style="text-align: center;">WARNING</p> <p>Engine failure accompanied by an explosion or unusual noise indicates damage to the engine. There is a possibility that any attempt to restart the engine may result in a fire. Under such circumstances, do not try to restart the engine unless it is needed to maintain level flight.</p> <p style="text-align: center;">CAUTION</p> <p>For a crossbleed start, the good engine should indicate the maximum N_g safely obtainable. N_g less than 94% may result in hot starts.</p> <p style="text-align: center;">Note</p> <p>Either a single or dual-engine restart may be attempted following dual-engine failure. Decision should be based on applicability of respective start envelopes and considerations of longer time to idle when executing a dual-engine restart.</p> | <p>*1. APU Emergency Start procedure — As required.</p> <p>*2. ENGINE IGNITION switch — NORM.</p> <p>*3. Fuel selector lever(s) — DIR or XFD.</p> <p>*4. PCL(s) — OFF.</p> <p>*5. Starter(s) — ENGAGE, motor engine.</p> <p>*6. PCL(s) — IDLE (TGT 80 °C or less, if time permits).</p> <p>*7. PCL(s) — Advance to FLY after starter dropout.</p> <p style="text-align: center;">WARNING</p> <p>If APU is unavailable, and a crossbleed start is necessary, maximum torque available will be reduced during the start sequence. Depending on operating conditions, level flight may not be possible. Ensure AIR SOURCE ECS/START switch is in Engine for Crossbleed starts.</p> |

12.3.9 Single-Engine Landing

The helicopter may be flown safely in forward flight and landed with a single engine, provided that proper techniques and safety precautions are observed. When performing a single-engine landing; maintain single-engine airspeed, 100 percent N_r , and observe single-engine limitations. When the good engine is operating at TGT limiting, further increase of the collective will only result in N_r decrease. Due to an increase in power required, steep turns should be avoided, particularly at low altitudes. Under conditions of low gross weight, light fuel load, low DA, and appreciable winds (10 to 20 knots), a normal approach to a hover and a vertical landing may be made on a single engine. With conditions of high gross weight, heavy fuel load, high DA, and little or no wind; a running landing must be made to prevent a high rate of descent. Consideration should be given to dumping fuel to reduce weight. All single-engine landings should be to a smooth, hard surface. Fly the approach at an airspeed and altitude that places the helicopter in the safe area of the Height-Velocity Diagram.

A single-engine waveoff should be accomplished when a single-engine landing cannot be safely executed. Increase the collective to maximum power available while placing the nose on the horizon and leveling the wings. If necessary, trade altitude for airspeed and remain in ground effect until a single-engine climb can be executed.

For landing on a runway, at approximately 150 to 200 feet altitude, reduce airspeed and rate of descent. At approximately 50 feet, begin a deceleration to touchdown above translational lift.

For landing on a spot, at 150 to 200 feet AGL, reduce airspeed as necessary. Maintain translational lift. At 20 to 30 feet AGL, decelerate to touch down tail wheel first at zero groundspeed.

| Single-Engine Landing | | |
|-----------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Single-Engine Landing | <div style="border: 2px dashed black; padding: 5px; display: inline-block; margin-bottom: 10px;">CAUTION</div> <ul style="list-style-type: none"> ● Nose attitudes in excess of 13° nose-up at altitudes of 15 ft or less will cause the tail bumper/stabilator to impact the ground. ● The procedure described is for a typical single-engine landing and is also applicable to single-engine landings in confined areas, such as non-aviation ships with small landing areas and unprepared sites. The dangers of excessive speed, excessive sink rates, extreme tail wheel low touchdown, and the tendency to use aft cyclic shall be emphasized when making landings of this type. <p style="text-align: center;">Note</p> <p>In order to maximize single-engine flight capability at lower airspeeds, consideration should be given to jettisoning fuel prior to landing. However, fuel dumping prior to assured landing could result in a critical fuel situation.</p> | <ol style="list-style-type: none"> 1. Landing Checklist — Complete. <ol style="list-style-type: none"> a. CONTGCY PWR — As required. b. Lights — As required. c. Brakes — As required. d. Tail wheel — Lock. e. Instruments, Cautions, Advisories — Check. f. BAR/RADALT HOLD — As required. g. HF Radio — OFF. h. Armament — SAFE. i. Harnesses — Locked. j. Aircrewman Landing Checklist — Complete. k. FLIR — Stowed. l. Return to force checklist. 2. Maximum Power check — Complete. <ol style="list-style-type: none"> a. Increase collective until N_r droops 2 percent (do not exceed torque or TGT limits). b. Note torque. 3. APU Emergency Start procedure — Perform, as required. 4. Establish a rate of descent not to be over 1,000 fpm and reduce to 500 fpm on final approach. |

12.3.10 Engine Advisories

12.3.10.1 Engine Anti-Ice/Start Bleed Valve Malfunction

The temporary hang-up of the engine variable geometry (VG) system at the engine anti-ice/start bleed valve may cause engine flameout at low collective settings. The VG system is activated by fuel pressure from the HMU. As the system is quickly released from any temporary hang-up condition while the collective is full down, the HMU will schedule maximum fuel flow to the VG actuator, creating a diversion from the scheduled fuel flow to the engine. In minimum fuel flow flight regimes such as during autorotations and quick stops, this diversion is sufficient to flame out an engine. The ENG ANTI-ICE advisory lights will normally be on during start to approximately 90 percent, or when ENG ANTI-ICE is selected ON. Malfunctioning anti-ice/start bleed valve cockpit indications include any one of the following:

1. Constant illumination of the ENG ANTI-ICE ON advisory light above approximately 90 percent N_g or above, 94 percent N_g if OAT is 15 °C or greater.
2. No illumination of the ENG ANTI-ICE ON advisory light when N_g drops below approximately 88 percent (N_g may vary on a sliding scale depending on OAT).
3. No illumination of the ENG ANTI-ICE ON advisory light with ENG ANTI-ICE selected ON.
4. No rise in TGT when the ENG ANTI-ICE switch is selected ON.

Note

With ENG ANTI-ICE ON, max torque available is reduced up to 18 percent per engine.

| Engine Anti-Ice/Start Bleed Valve Malfunction | | |
|---|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>Engine Anti-Ice/Start Bleed Valve Malfunction</p> <p>ENG ANTI-ICE ON (#1/#2)</p> | <p>The respective engine anti-ice/start bleed valve has opened. Advisories will appear during start to approximately 90 percent N_g or when the ENG ANTI-ICE switch is turned ON.</p> <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">WARNING</div> <p>Loss of electrical power to the engine will result in engine anti-ice activation regardless of engine anti-ice or de-ice master switch position, reducing max torque available by up to 18 percent.</p> | <p>If a malfunctioning engine anti-ice/start bleed valve is suspected:</p> <ol style="list-style-type: none"> 1. Engine Malfunction in Flight procedure — Perform. 2. Avoid low engine power requirements and rapid collective movements. 3. Land as soon as practical. <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">WARNING</div> <p>A malfunctioning engine anti-ice/start bleed valve may cause engine flameouts during flight when the collective is full down, such as during quick stops and autorotative flight.</p> |

12.3.10.2 ENGINE STARTER #1 or #2 Advisory Light On

| Engine Starter #1/#2 Advisory Light On | | |
|--|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ENGINE STARTER (#1/#2) | <p>The engine start valve is open.</p> <p style="text-align: center;">Note</p> <p>Pulling the ENG START CB will deenergize the engine ignition system.</p> | <p>If the ENGINE STARTER advisory remains after 65 percent N_g or appears in flight:</p> <ol style="list-style-type: none"> 1. PCL (affected engine) — PULL. <p>If ENGINE STARTER advisory remains:</p> <ol style="list-style-type: none"> 2. Affected ENG START CB — Cycle. <ol style="list-style-type: none"> a. NO. 1 ENG START. (CENTER, DC ESNTL, ROW 1, CB 8). b. NO. 2 ENG START. (ATO, NO. 2 DC PRI, ROW 1, CB 12). <p>If ENGINE STARTER advisory remains:</p> <ol style="list-style-type: none"> 3. AIR SOURCE — Remove. <p>If crossbleed start:</p> <ol style="list-style-type: none"> a. AIR SOURCE ECS/START switch — OFF. <p>If APU is on:</p> <ol style="list-style-type: none"> b. APU CONTR switch — OFF. <p>If ENG STARTER advisory remains:</p> <ol style="list-style-type: none"> 4. Land as soon as practical. |

12.3.10.3 ENG INLET ANTI-ICE ON (#1/#2) Advisory Light On

| ENG INLET ANTI-ICE ON (#1/#2) Advisory Light On | | |
|---|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ENG INLET ANTI-ICE ON (#1/#2) | <p>Engine bleed air has heated the engine inlet to 93 °C or greater.</p> | <p>If inlet anti-ice malfunction is suspected:</p> <ol style="list-style-type: none"> 1. Land as soon as practical. <div style="text-align: center; margin: 10px 0;"> <div style="border: 1px solid black; padding: 2px 10px; display: inline-block;">WARNING</div> </div> <p>Appearance of the ENG INLET ANTI-ICE ON advisory when OAT is greater than 13 °C is an indication of a malfunctioning engine inlet anti-ice valve. The resultant loss of torque could be a maximum of 49 percent when the anti-ice valves are open.</p> |


12.4 APU EMERGENCIES

12.4.1 APU Emergency Start

| APU Emergency Start | | |
|---------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| APU Emergency Start | | *1. ECS — OFF. *2. AIR SOURCE ECS/START switch — APU. *3. FUEL PUMP switch — APU BOOST. *4. APU CONTROL switch — ON. *5. APU GENERATOR switch — ON. |

12.4.2 APU Caution Lights


12.4.2.1 APU FAIL Caution Light On

| APU FAIL Caution Light On | | |
|---------------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| APU FAIL | The APU was shut down by the ESU. <p style="text-align: center;">Note</p> <ul style="list-style-type: none"> In order to check ESU BIT indicators, do not secure BATT or APU CONTR switches. In order to restart APU, BATT and APU CONTR switches should be reset. | 1. APU — Restart (if required). <div style="text-align: center;">  </div> <p>To prevent an APU exhaust fire, wait at least 2 minutes after APU shutdown before attempting a restart.</p> |

12.4.2.2 APU Generator Caution Light On

| APU Generator Caution Light On | | |
|--------------------------------|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| APU Generator Caution Light On | May indicate one of the following: 1. Failure of APU generator, GCU, contactor, or wiring fault. 2. APU GENERATOR switch has been turned off while APU is operating. 3. APU GENERATOR switch selected ON, APU started, but has not reached operating speed. | 1. APU GENERATOR switch — RESET, then ON. If APU GEN caution remains: 2. APU GENERATOR switch — OFF. If APU generator was the only source of AC Power: 3. All nonessential electrical equipment — OFF. 4. Land as soon as practical. |
| APU GEN | | |

12.4.2.3 APU OIL TEMP HI Caution Light On

| APU OIL TEMP HI Caution Light On | | |
|----------------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| APU OIL TEMP HI | <p>APU oil temperature has reached a prescribed limit, which may be caused by high ambient temperature and/or low oil level.</p> <div style="text-align: center;">  <p>CAUTION</p> </div> <p>During ground operation at high ambient temperatures, the APU OIL HOT caution may appear. The APU should be shut down immediately to prevent damage. After allowing APU to cool for 60 minutes, check oil level. If within limits, APU may be restarted.</p> | <p>1. APU CONTROL switch — OFF (if not required).</p> |

12.5 MAIN ROTOR SYSTEM EMERGENCIES

12.5.1 Unusual Vibrations

The inherent vibrations in any helicopter are those created by the mechanical functions of the engines and transmission systems, dynamic action of the main and tail rotors, and aerodynamic effects on the fuselage. The overall vibration level is influenced by the many individual frequencies of vibration and combinations thereof. Many multiples of a basic frequency are felt, and often two or more different superimposed frequencies create beats. The overall magnitude is the resultant of the amplitudes of all the frequencies and it would be difficult for the pilot to completely separate all the types of vibrations encountered. Generally, these are divided into three categories: low, medium and high frequencies. Varying magnitudes of all three types of vibrations are often present in an individual helicopter. Only through experience will the pilot be able to judge what is normal to the model and what is abnormal and correctable. Excessive or abnormal vibration levels should be noted on a VIDS/MAF.

12.5.1.1 Ground Resonance

Ground resonance is a phenomenon of multi-bladed helicopters like the H-60, and is due to the CG of the rotating blades traversing off center. Typically, it can happen during start-up, takeoff, or landing. For the condition to occur, there must be some abnormal lead/lag blade condition that would cause the CG of the rotors to progress outward, causing further outward movement of CG. Ground resonance can be caused by a blade being badly out of track, a peculiar set of landing conditions, or a malfunctioning damper. Ground resonance can be pilot induced, and may occur when a landing is made with a large descent coupled with lateral drift. When a wheel reaction occurs, such as a hard one wheel landing that would cause out-of-phase main rotor blades to be aggravated to the point where maximum lead and lag blade displacement is realized, ground resonance can occur. If ground resonance should occur, immediately reduce collective pitch, place the PCLs to OFF, and apply the rotor and wheel brakes.

12.5.1.2 Damper Failure

Malfunction or failure of a rotor damper causes a dynamically unbalanced rotor condition that will be felt as a low-frequency (1/rev, 2/rev, possible 2 to 3/rev) lateral or vertical vibration. The magnitude of the vibration may increase with flight time. As hydraulic fluid is depleted from the damper system, the characteristics of the vibration

will change. With one damper inoperative, relatively minor vibrations may be experienced. With two or more inoperative dampers, vibrations may be severe and an engine/rotor system interaction may result in fluctuating N_p/N_r .

12.5.1.3 Unusual Vibrations In Flight

Pilot landing criteria and technique will vary depending on the flight regime, onset, frequency and severity of the vibration and/or rotor system instability. The aircraft will be more susceptible to pilot-induced oscillations (PIO) and the magnitude of the vibration is dependent on flight conditions. The effects of turbulence will increase vibration as will control inputs. Rotor blades normally stay in track. It is recommended that a landing be made as soon as practical since the vibration may affect other systems and components. It is desirable to fly the aircraft at an airspeed that will minimize vibrations (typically 80 KIAS). Select a landing site in the following order of precedence:

1. Runway/pad ashore.
2. Large deck/multi-spot ship.
3. Small deck/single-spot ship.

WARNING

- A Running Landing is not recommended due to rotor instability and possible loss of helicopter control.
- Some conditions of severe vibrations may dictate a more timely approach to a no-hover landing.

| Unusual Vibrations In Flight | | |
|------------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Unusual Vibrations In Flight | | <ol style="list-style-type: none"> 1. Airspeed — Adjust to minimize vibrations (approximately 80 KIAS). Use small, smooth control inputs. 2. APU Emergency Start procedure — Perform. 3. Land as soon as practical. 4. Landing: <ol style="list-style-type: none"> a. Conduct a smooth, controlled approach for landing. b. If vibrations become severe, perform a no-hover landing. If vibrations subside and a stable hover can be achieved, perform a smooth vertical descent to land. <p>For shipboard landing:</p> <ol style="list-style-type: none"> c. Obtain minimum wind over deck. d. Consider RA landing. <p style="text-align: center;">CAUTION</p> <p>Advise LSO to slowly apply tension so as not to aggravate vibrations.</p> <ol style="list-style-type: none"> 5. Upon touchdown, shut down engines. <p style="text-align: center;">CAUTION</p> <ul style="list-style-type: none"> • Some conditions of severe vibrations may dictate a more timely approach to a no-hover landing. • Attempt to use light control grip to reduce the possibility of PIO. • Ensure PNAC's hand is physically on PCLs to ensure rapid retardation upon touchdown. • Applying the rotor brake will aggravate lead/lag conditions and may cause a mechanical failure. |

12.5.1.4 Unusual Vibrations On Deck

| Unusual Vibrations On Deck | | |
|----------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Unusual Vibrations On Deck | The cause of unusual vibrations cannot be discerned. The pilot's primary concern is to reduce the vibrations. If the vibrations are severe, the PCLs should be retarded to OFF. | <ol style="list-style-type: none"> *1. Collective — Lower. *2. PCLs — OFF. *3. Rotor brake — Apply as required. |

12.5.2 Hung Droop Stop(s)

| Hung Droop Stop(s) | | |
|--------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Hung Droop Stop(s) | | *1. Re-engage rotor to greater than 75 percent N_r . 2. Slightly displace cyclic in an attempt to dislodge the jammed droop stop. If after several attempts the droop stop(s) do not engage: 3. Cyclic — Neutral position. 4. Engine shutdown — Perform. If conditions permit: 5. Rotor brake — Do not apply. |


12.5.3 Main Rotor Warning Light

12.5.3.1 LOW ROTOR RPM

| LOW ROTOR RPM Warning Light On | | |
|--------------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| LOW ROTOR RPM | Warning light is activated by the vertical instrument when N_r is 95 percent or less. | *1. Control N_r . 2. Determine cause of low N_r condition. |

12.5.4 Main Rotor System Caution/Advisory Lights

12.5.4.1 Gust Lock

| GUST LOCK Caution Light On | | |
|----------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| GUST LOCK | Blade indexing motor has been engaged. <div style="text-align: center;">  </div> Whenever locking or unlocking the gust lock, the GUST LOCK switch shall be held in the LKD or UNLK position for a minimum of 5 seconds to enable the actuator mechanism to complete its cycle. Failure to do so may result in a partially engaged gust lock without a GUST LOCK caution, causing damage when the rotor is engaged. | 1. GUST LOCK switch — UNLK (hold switch for 5 seconds minimum). If caution remains: 2. RTR HEAD IDX ENGAGE CB — PULL. (Overhead Console, DC ESNTL, ROW 4, CB 2). |

12.5.4.2 Spread Incomplete Light

| SPREAD INCOMPLETE Light | | |
|--------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| SPREAD INCOMPLETE | <p>SPREAD status light on and one of the following conditions exists:</p> <ol style="list-style-type: none"> 1. Pylon of stabilator not spread and locked. 2. Tail rotor indexer not retracted. 3. AC power routed to sliprings. | <ol style="list-style-type: none"> 1. BLADE FOLD MOTOR CB — Pull. (SO OVHD, NO. 2 AC PRI, ROW 3, CB 4) <p>If SPREAD INCOMPLETE caution light remains ON:</p> <ol style="list-style-type: none"> 2. Land as soon as practical. |

12.5.4.3 Rotor Brake Advisory Light On

| ROTOR BRAKE Advisory Caution Light On | | |
|---------------------------------------|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ROTOR BRAKE | <p>Hydraulic pressure greater than 6 to 8 psi is registered at pressure switch.</p> <p style="text-align: center;">Note</p> <ul style="list-style-type: none"> • Consideration should be given to performing the applicable steps of the Immediate Landing/Ditching emergency procedure. • A minimum-power air-speed and low-altitude flight profile is recommended (approximately 80 feet and 80 KIAS) to permit a quick flare followed by ditching should fire occur. • Secondary indications include smoke, fire, and noises. | <ol style="list-style-type: none"> 1. ROTOR BRAKE handle — Check in detent. 2. Rotor Brake Gauge Pressure — Check zero. 3. Check for evidence of disk dragging (noise, smells, smoke, fire). <p>If secondary indications are present:</p> <ol style="list-style-type: none"> 4. Land As Soon As Possible. <p>If no secondary indication are present:</p> <ol style="list-style-type: none"> 5. Land as soon as practical. |

12.5.4.4 Rotor Overspeed

| Rotor Overspeed | | |
|------------------------|---------------------------------|---------------------------------------|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Rotor Overspeed | N_r greater than 127/137/142. | *1. Land as soon as practical. |

12.6 TRANSMISSION SYSTEM MALFUNCTIONS

12.6.1 Main Transmission Malfunction

Main transmission malfunctions can be grouped into two categories: chip or lubrication.

If a chip is indicated in one of the modules of the main transmission, consideration should be given to reducing the load on that module. This could include moving the affected PCL to IDLE to reduce the stress on an input module or securing a main generator to reduce the load on an accessory module. If a lubrication problem is indicated, the main generators may be affected since they use transmission oil for cooling. In this case, consideration should be given to securing the main generators after turning the APU generator on.

An impending failure of an accessory module may be first indicated by an input chip caution light, due to the routing of the internal transmission oil and the location of the input module chip detectors. An accessory drive failure will be indicated by loss of the hydraulic pump and generator associated with that module.

Instruments shall be monitored closely for secondary indications such as a pressure and temperature relationship and/or transmission chip cautions. Abnormal noises, an unusual amount of power required to maintain the same flight regime, and/or yaw kicks with spiking torque are indications of possible transmission failure.

| Main Transmission Malfunction | | |
|--------------------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Main Transmission Malfunction | Loss of cooling oil supply will lead to electrical and/or mechanical failure of the main generators. If oil pressure decays slowly, the generators may fail before the MAIN XMSN OIL PRESS or MAIN XMSN OIL TEMP caution light illuminates. Consideration should be given to performing applicable steps of emergency landing/ditching procedure. | If failure is imminent: *1. LAND IMMEDIATELY. If secondary indications are present: *2. Land As Soon As Possible. 3. APU Emergency Start procedure — PERFORM. 4. NO. 1 and NO. 2 GENERATOR switches — OFF, AS REQUIRED. If no secondary indications are present: 5. Land as soon as practical. |
| MAIN XMSN OIL TEMP | | |
| OR | Consideration should be given to performing applicable steps of emergency landing/ditching procedure. | <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-bottom: 10px;">WARNING</div> <p>Catastrophic transmission failure will result in loss of helicopter control. Consideration should be given to transiting at minimum power airspeed and a low altitude flight profile (approximately 80 ft and 80 KIAS) to permit a quick flare followed by an immediate landing/ditching. Applicable steps of the Immediate Landing/Ditching emergency procedure should be completed.</p> |
| MAIN XMSN OIL PRESS | High oil temp in the main transmission. | |
| OR | Low oil pressure in the main transmission. | |
| ACCESS LH CHIP | Chip or metal particles detected in applicable accessory module or main gearbox sump. | |
| OR | | |
| ACCESS RH CHIP | | |
| OR | | |
| CHIP MAIN MDL SUMP | | |

12.6.2 INPUT MODULE CHIP Caution Lights On

| INPUT MODULE CHIP Caution Lights ON | | |
|-------------------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| INPUT LH CHIP | Chip or metal particles detected in applicable input module. | *1. Main Transmission Malfunction emergency procedure — Perform. If engine secondary indications are present: 2. Engine Malfunction in Flight emergency procedure — Perform. 3. PCL (engine with affected input module) — Idle. |
| OR | Note | |
| INPUT RH CHIP | Consideration should be given to returning the engine to FLY for landing. | |

12.6.3 Tail/Intermediate Transmission Malfunction

When tail and intermediate transmission cautions are accompanied by strong medium-frequency vibrations, hot metal fumes, or any other associated indications, tail rotor failure is imminent. A running or no-hover landing should be executed as conditions dictate.

| Tail/Intermediate Transmission Malfunction | | |
|---|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Tail/Intermediate Transmission Malfunction | Indication of Metal Particles in respective gearbox. High Oil temperature in the intermediate gearbox. High oil temperature in the tail gearbox. | If failure is imminent: *1. LAND IMMEDIATELY. If failure is not imminent: 2. Land As Soon As Possible. <div style="border: 1px solid black; padding: 2px; display: inline-block; margin: 5px 0;">WARNING</div> <ul style="list-style-type: none"> • High power settings require maximum performance of the tail rotor drive system and may precipitate ultimate drive failure. • Consideration should be given to transiting at an altitude sufficient to enter an autorotation and performing the applicable steps of the Immediate Landing/Ditching emergency procedure. |
| OR | | |
| CHIP INT XMSN | | |
| OR | | |
| CHIP TAIL XMSN | | |
| OR | | |
| INT XMSN OIL TEMP | | |
| OR | | |
| TAIL XMSN OIL TEMP | | |

12.7 TAIL ROTOR SYSTEM MALFUNCTIONS

12.7.1 Loss of Tail Rotor Drive

Failure of the tail rotor gearbox, intermediate gearbox, or tail rotor drive shaft will result in a loss of tail rotor thrust. The nose of the helicopter will yaw right regardless of the airspeed at which the failure occurs. Continued level flight may not be possible following this type of failure. Loss of tail rotor thrust at low airspeeds will result in rapid right yaw. At higher airspeeds, right yaw may develop more slowly but will continue to increase. While the yaw rate may vary, the immediate recognition of the malfunction is critical, and an autorotation should be entered promptly if altitude permits. Every effort should be made to establish an autorotative glide at or above minimum rate of descent


airspeed. This will maximize the effectiveness of the deceleration during the landing sequence. If autorotation is delayed, large sideslip angles can develop causing low indicated airspeed with the stabilator programming down. This can make it more difficult to establish or maintain adequate autorotative airspeed. Airspeed, altitude and terrain below at the time of failure will determine if an attempt to verify the failure is warranted. A tendency to yaw with the application of slight right pedal may indicate a functioning tail rotor. Do not confuse the tendency to yaw right with the pitching moment generated by control mixing. Should a functioning tail rotor be discovered during the autorotation, apply collective and utilize loss of tail rotor control technique, if required. If the loss of tail rotor drive is verified, or if environmental conditions preclude an attempt at verification, set up for an immediate landing. Autorotations should be conducted to minimize descent rate and groundspeed at touchdown. Failure of tail rotor drive at altitudes and airspeed not sufficient to establish autorotation require immediate reduction in collective to control yaw rate. Maintain a level attitude and attempt to achieve zero surface speed utilizing flight instruments and visible horizon. Rate of rotation is directly proportional to main rotor torque, therefore decreased collective will reduce main rotor torque and thus rate of rotation. At low hover altitudes, an immediate landing to arrest the accelerating rotation should be considered prior to shutting off the PCLs. Experience has shown that cockpit centrifugal forces on the pilot may be of such strength as to make an attempt to secure the PCLs physically impossible. Trying to maintain hover altitude with an uncontrolled yaw, though possible, might place the aircraft in a more critical flight environment.

If unable to enter autorotation or quickly reduce airspeed/groundspeed to zero, large yaw angles relative to the aircraft's flight path will induce extreme pitch and roll deviations which will require large cyclic inputs to control aircraft attitude. With any amount of airspeed (which may not be indicated due to large sideslip angles), attitude deviations and control inputs will become more dynamic as the aircraft rotates along its flight path. Attempting to continue flight with uncontrolled yaw rates and forward speed will result in a total loss of aircraft control regardless of PAC inputs.

12.7.1.1 Loss of Tail Rotor Drive Altitude and Airspeed Sufficient to Establish Autorotation

| Loss of Tail Rotor Drive Altitude and Airspeed Sufficient to Establish Autorotation | | |
|---|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>Loss of Tail Rotor Drive Altitude and Airspeed Sufficient to Establish Autorotation</p> | <p>Loss of tail rotor drive may be the result of a loss of tail rotor rotation or tail pylon separation with a possible right rotation. Attempt to verify rotation as a result of drive failure rather than flight control jam or yaw boost hardover.</p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Altitude hold will remain engaged unless deselected. If the collective trim release button is not depressed, the DAFCS will attempt to maintain aircraft altitude through the collective trim servo. AFCS commanded collective movement can result in an accelerated yaw rate.</p> | <ul style="list-style-type: none"> *1. PAC call — AUTO, AUTO, AUTO. *2. Autorotation — ESTABLISH. CENTER TAIL ROTOR PEDALS. *3. Drive failure — ATTEMPT TO VERIFY. *4. Immediate Landing/Ditching emergency procedure — PERFORM. *5. PCLs — OFF WHEN DIRECTED (Prior to the flare). |

12.7.1.2 Loss of Tail Rotor Drive Altitude and Airspeed Not Sufficient to Establish Autorotation

| Loss of Tail Rotor Drive Altitude and Airspeed NOT Sufficient to Establish Autorotation | | |
|---|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Loss of Tail Rotor Drive and Airspeed NOT Sufficient to Establish Autorotation | Loss of tail rotor drive may be the result of a loss of tail rotor rotation or pylon separation with a possible right rotation. <div style="text-align: center;">  </div> Altitude may have to be adjusted based on rate of yaw and/or turn. | *1. PAC call — HOVER, HOVER, HOVER. *2. Collective — LOWER. *3. PNAC — HAND ON PCLs. *4. PCLs — OFF WHEN DIRECTED (approximately 20 to 30 feet). |

12.7.2 Loss of Tail Rotor Control Malfunctions

Tail rotor control malfunctions in the H-60 can generally be grouped into three categories:

1. Tail rotor control cable failures.
2. Tail rotor servo failures.
3. Restricted flight controls.

In general, the first indication of loss of tail rotor control will be an uncommanded yaw of the helicopter, either left or right, while changing airspeed or collective setting. The aircrew should attempt to diagnose the category of malfunction, analyze the aircraft’s controllability, and perform an approach and landing as appropriate.

12.7.2.1 Tail Rotor Control Cable Failures

Loss of one tail rotor control cable will be indicated by a caution light, marked TAIL ROTOR QUADRANT. No change in handling qualities will occur; however, a landing should be made as soon as practical. If both tail rotor cables fail, tail rotor control will be lost. The tail rotor will assume a preset spring loaded position setting. For a gross weight of approximately 19,500 pounds, in level flight (not climbing or descending) and for flight out of ground effect, this fixed pitch setting will provide balanced level flight at about 35 and 133 KIAS. These level flight airspeeds will vary with gross weight, density altitude, rotor speed, and ground effect. At other airspeeds the helicopter will yaw either left or right depending on torque and speed. For a gross weight of approximately 19,500 pounds, airspeeds below 35 KIAS and above 133 KIAS, the tail rotor does not produce enough thrust to counteract main rotor head torque; therefore, the helicopter will have a tendency to yaw to the right. Right yaw can be controlled by reducing the collective and/or adjusting airspeed into the appropriate range. For airspeeds between 35 and 133 KIAS, the tail rotor provides too much thrust for the given rotor torque setting; therefore, the helicopter will have a tendency to yaw to the left. Left yaw can be controlled by increasing collective and/or adjusting airspeed toward either balanced flight airspeed (gross weight dependent).

12.7.2.2 Tail Rotor Servo Failures

Loss of both the NO. 1 hydraulic pump and backup pump results in both stages of the tail rotor servo being unpressurized. With this malfunction, the yaw boost servo is still pressurized and the mechanical control system is intact. Normal yaw control is available between approximately 35 and 133 KIAS. At airspeeds lower than 35 and higher than 133 KIAS, the aerodynamic loads on the tail rotor cannot be overcome by the yaw boost servo. As airspeed is decreased toward 35 or increased toward 133 KIAS, yaw response at larger pedal inputs will be observed. Elongation and/or failure of the tail rotor cables may occur if there is no yaw response with pedal inputs. If airspeed

decreases below 35 KIAS, a loss of tail rotor control will likely occur. A roll-on landing above 35 KIAS is recommended for this category of failure. Once the aircraft is on deck and torque is reduced, the aerodynamic loads on the tail rotor are reduced and yaw control should be regained.

12.7.2.3 Restricted Flight Controls

Mechanical malfunctions may result in varying degrees of restrictions or binding in flight controls. Some examples are jammed flight controls due to FOD, mechanical failure of the tail rotor servos, or a servo hardover. The possibilities of failure modes and aircraft response, based on existing conditions, cannot lead to a single standardization procedure for executing a safe landing.

If pedal drive, binding, or restriction occurs with no associated caution lights, the cause may not be apparent. A yaw trim malfunction, induced by the AFCS computer, can produce about 30 pounds of force at the pedal. An internally jammed yaw trim actuator can produce up to 80 pounds of forced until clutch slippage relieves this force. The pilot can override and yaw trim force by applying opposite pedal firmly and then turning off trim. A malfunction within the yaw boost servo or tail servos can produce much higher forces at the pedals. The affected servo must be turned off. Hardover failure of the yaw boost servo will increase control forces as much as 250 pounds on the pedals. In any case, the pitch of the tail rotor may become fixed at any position within the range of yaw authority. Depending on the actual pitch setting at the tail rotor when the failure occurs, the nose of the aircraft may exhibit a tendency to yaw either left or right.

12.7.2.4 Loss of Tail Rotor Control Approach and Landing Technique

With degraded tail rotor control, landing speed is determined by the tail rotor fixed position and gross weight. For a loss of both tail rotor cables, touchdown speed is dependent on gross weight. If tail rotor pitch becomes fixed during decreased power situations (right pedal applied) the nose of the helicopter will yaw to the right when power is applied, possibly even greater than a complete loss of tail rotor thrust. Some conditions may require entry into an autorotation to control yaw rate. Other fixed-pitch right conditions may result in a minimum power required situation, which will require a run-on landing, perhaps as high as the minimum power-required (i.e., bucket) airspeed. Fixed-pitch left will result in an increase in power required, which allows for slower airspeed or even an approach to a normal hover. A loss of hydraulic pressure to both tail rotor servos will require a landing above approximately 40 KIAS.

Prior to attempting an approach and landing, controllability checks should be performed at an altitude that will permit a safe recovery should an undesirable yaw rate develop. To determine the minimum controllable airspeed, establish a level-flight condition. If a stuck-right condition is suspected, slowly reduce airspeed while maintaining level flight. Note the airspeed at which the nose yaws to the right beyond the balanced flight (ball-centered) airspeed. At this airspeed, collective and longitudinal cyclic inputs will control the yaw rate and heading. This airspeed is the approximate minimum speed to be maintained on final approach. The actual landing speed may be slightly lower due to ground effect, translational lift, and/or wind conditions that differ from the controllability check conditions. If a stuck-left condition is suspected or evident and a left yaw develops during controllability checks, collective will have to be increased to control yaw.

With sufficient fuel, multiple practice approaches should be performed to determine the sight picture and control strategies required to execute a safe touchdown. Additionally, practice approaches determine the aircraft response, stability characteristics, and control strategies for safely executing a waveoff. During the approach, maintain a centered pedal position to prevent unwanted pedal inputs from the heading hold function and pitch input from control mixing.

12.7.2.5 Insufficient Tail Rotor Thrust

During a loss of tail rotor control approach with insufficient tail rotor thrust to achieve a hover, a running landing technique is recommended. The precise touchdown speed will vary based on many factors (the nature of the failure, gross weight, wind speed/gusts, and the influences of ground effect, translational lift, and the effectiveness of the vertical pylon, etc.). With tail rotor at the fixed pitch setting (i.e., dual cable failure), analysis indicates touchdown speeds can range from approximately 10 knots for light gross weight and steady winds to over 50 knots for high gross weight conditions. Other types of failures (i.e., stuck left or right) will require an approach and landing strategy that is situation dependent. In these cases, the up-and-away controllability checks will help define the aircraft response

and techniques required for approach and landing. Therefore, approach and landing techniques cannot be defined by precise numbers, but rather an adaptive control strategy (namely collective and longitudinal cyclic) to execute a touchdown aligned with the aircraft's flight path.

Establish sufficient airspeed to allow for shallow, controlled approach. Once established on glideslope, a left yaw will be present. The left yaw can be controlled with the addition of collective or a reduction in airspeed. Gradually reduce the airspeed while increasing collective and controlling descent rate. During deceleration and final approach to the landing environment, care must be taken to prevent excessive yaw rates to the right, or to allow the airspeed to become so slow that an uncontrolled right yaw develops.

WARNING

If an uncontrolled right yaw develops at too low of an airspeed, loss of waveoff capability may result. Increasing collective may increase the yaw to unrecoverable rates. Performing loss of tail rotor drive (altitude and airspeed insufficient to enter an autorotation) procedures may be required.

As the collective is increased prior to touchdown, the nose should begin to yaw right. Careful adjustment of collective and longitudinal cyclic should allow a tail wheel touchdown with approximate runway alignment. When the landing is attempted, extreme care must be taken to not lower the collective immediately upon touchdown.

After touchdown, reduction in power, loss of tail rotor lift and thrust effect, and loss of weathervaning effect can induce yaw incursions. Generally, a reduction in collective will cause the nose to yaw to the left (because the fixed tail rotor thrust exceeds the antitorque requirement). With the PCLs in FLY, an excessive left yaw can be arrested by increasing collective; however, care should be taken to avoid excessive right yaw or becoming airborne. With the main-mounts on the deck, heading can be controlled by gradually retarding the PCLs as the collective is positioned as required to control yaw (increasing collective will bring the nose right; decreasing collective will cause the nose to yaw left, possibly beyond control). The PNAC should gradually retard the PCLs as the PAC continues to decelerate and carefully position the collective as required to control heading. If necessary, retarding the PCLs to IDLE while increasing collective will permit torque to be applied to the airframe at power levels less than required to become airborne. Close crew coordination is required to ensure that collective and PCL reduction are proportional. Use of differential braking at lower speeds will also assist in heading control after touchdown.

If stuck-right conditions (including landing at high gross weight) require a landing at higher speeds, a mild flare, coupled with a slight reduction in collective, may be executed; however, airspeed should not be allowed to decrease below the airspeed identified during the minimum controllable airspeed check conducted up and away. With higher landing speeds, aircraft response on roll-out will be even more sensitive to collective reduction.



12.7.2.6 Excess Tail Rotor Thrust

If a tail rotor pitch becomes fixed in a high power situation (let pedal applied), the nose of the helicopter will turn left when collective is decreased. Under these conditions, powered flight to a prepared landing site may be possible since the sideslip angle will probably be corrected when power is applied for touchdown. Because the nose will yaw left with collective reduction, descent rate must be carefully controlled to prevent an uncontrolled left yaw. Except in extreme cases, however, collective application should always be able to arrest a left yaw. If the tail rotor thrust is so high that zero groundspeed cannot be achieved without climbing, a reduction in N_T will be required. In this situation, very close coordination between PCL manipulation by the PNAC and collective positioning by the PAC will be required. Once (or before) a landing is achieved, the PNAC should retard one or both PCLs to IDLE while the PAC maintains a high collective setting. This will reduce the tendency to yaw left.


WARNING

- Following the appearance of the #1 TAIL RTR SERVO caution without the associated BACKUP PUMP ON and #2 TAIL RTR SERVO ON advisories, the aircraft will demonstrate normal yaw responses in flight regimes that do not require excessive tail rotor performance. However, at slower airspeeds, below approximately 40 KIAS, more pronounced effects of loss of tail rotor control may become more apparent.
- Servo Hardovers in the yaw channel may result in loss of Tail Rotor Control. Consideration should be given to securing the SAS/BOOST and/or TRIM as necessary.
- After touchdown, rapid reduction of collective or PCLs may cause excessive and uncontrollable yaw rates.
- An uncommanded right yaw of at least 20 to 30 degrees will occur when the tail rotor servo switches from normal to backup in a hover.

12.7.2.7 Loss of Tail Rotor Control

| Loss of Tail Rotor Control | | |
|--|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>Loss of Tail Rotor Control</p> | <div style="text-align: center; margin-bottom: 10px;">  </div> <p>If the helicopter is shut down and/or hydraulic power is removed with one tail rotor cable failure, disconnect of the other tail rotor cable will occur when force from the boost servo cannot react against control cable quadrant spring tension. The quadrant spring will displace the cable and servo piston enough to unlatch the quadrant cable.</p> | <p>*1. Collective/airspeed — Adjust as required to control yaw.</p> <p>2. If hydraulic malfunction is evident:</p> <ul style="list-style-type: none"> a. TAIL SERVO switch — BKUP. b. BACKUP HYD PMP switch — Check ON. <div style="text-align: center; margin: 10px 0;">  </div> <p>If the tail rotor control cables are damaged, the hydraulic transients associated with switching the tail rotor servo from NORM to BACK UP may cause catastrophic damage to the tail rotor controls.</p> <ul style="list-style-type: none"> 3. External cargo/stores/fuel — Jettison/dump, as required. 4. APU Emergency Start procedure — Perform. 5. Land as soon as practical. 6. PCLs — As required. |

12.7.3 TAIL ROTOR QUADRANT Caution Light On

| TAIL ROTOR QUADRANT Caution Light On | | |
|--------------------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| TAIL ROTOR QUADRANT | <p>One or both cables leading to tail rotor quadrant are broken.</p> <div style="text-align: center;">  <p>CAUTION</p> </div> <p>If the helicopter is shut down and/or hydraulic power is removed with one tail rotor cable failure, disconnect of the other tail rotor cable will occur when force from the boost servo cannot react against control cable quadrant spring tension. The quadrant spring will displace the cable and servo piston enough to unlatch the quadrant cable.</p> | <p>1. Check for tail rotor control.</p> <p>If tail rotor control is available:</p> <p>2. Land as soon as practical.</p> <p>If tail rotor control is not available:</p> <p>3. Loss of Tail Rotor Control emergency procedure — PERFORM.</p> |

12.8 HYDRAULIC SYSTEM MALFUNCTIONS

The backup hydraulic pump is activated automatically by the Leak Detection/Isolation (LDI) system. If the backup hydraulic pump fails to come on due to a malfunction of the LDI system or pump circuitry, check BACKUP HYD PMP ON and circuit breakers in.



If the BACKUP PUMP PWR circuit breaker is out and a condition exists that requires the backup pump to operate, then either the hydraulic system must be configured so that the backup pump will not activate upon resetting the circuit breaker, or ac power must be secured prior to resetting the circuit breaker. Damage to the current limiters may occur and will be indicated by a loss of all loads on NO. 1 AC primary bus.

12.8.1 Hydraulic System Caution Lights

12.8.1.1 #1 and #2 HYD PUMP Failure

| #1 and #2 HYD PUMP Failure | | |
|-----------------------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 HYD PUMP | Low pressure at outlet of hydraulic pumps. | 1. Restrict flight control movement. 2. Land As Soon As Possible. |
| AND | | |
| #2 HYD PUMP | | |
| AND | | |
| BACK UP PUMP ON | | |

12.8.1.2 #1 or #2 HYD PUMP Failure

| #1 or #2 HYD PUMP Failure | | |
|----------------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 HYD PUMP | Low pressure at outlet of applicable hydraulic pumps. | If no other hydraulic malfunctions are present: 1. Land as soon as practical. |
| OR | | |
| #2 HYD PUMP | | |
| AND | | |
| BACK UP PUMP ON | | |

12.8.1.3 #1 or #2 PRI SERVO PRESS Caution Light On

| #1 or #2 PRI SERVO PRESS Caution Light On | | |
|--|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 PRI SERVO PRESS | Low pressure or servo jam at any or all primary servos of applicable stage. | 1. Pilot and Copilot SERVO switches — Verify centered. If primary SERVO light remains on: 2. SERVO switch — Turn OFF affected stage. 3. Land as soon as practical. |
| OR | | |
| #2 PRI SERVO PRESS | | |

12.8.1.4 BACKUP RSVR LOW Caution Light On

| BACKUP RSVR LOW Caution Light On | | |
|----------------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| BACKUP RSVR LOW | Fluid in the backup pump module is low. | If no other hydraulic caution lights are present: 1. Stop hoisting as soon as practical. 2. BACKUP HYD PMP switch — OFF. 3. Land as soon as practical. |

12.8.2 NO. 1 Hydraulic System Malfunction

When a NO.1 hydraulic system malfunction exists, the first indication is the #1 RSVR LOW caution followed by the #1 TAIL RTR SERVO caution, BACK-UP PUMP ON advisory, and the #2 TAIL RTR SERVO ON advisory. If the BACK-UP PUMP ON and the #2 TAIL RTR SERVO ON advisories do not appear, the PAC must execute the Loss of Tail Rotor Control emergency procedure.

If the hydraulic leak continues, the #1 HYD PUMP cautions will appear. The #1 TAIL RTR SERVO caution and the #2 TAIL RTR SERVO ON advisory will disappear. To prevent any further fluid loss, the SERVO switch must be placed to 1ST OFF.

If the SERVO switch is not placed to 1st OFF and the leak continues, the BACK-UP RSVR caution will appear. When the BACK-UP PUMP ON advisory disappears, the #1 PRI SERVO and #1 TAIL RTR SERVO cautions will appear and both stages of the tail rotor servo are unpressurized. Loss of both the NO. 1 hydraulic pump and the backup pump results in both stages of the tail rotor servo being unpressurized. The yaw boost servo is still pressurized to 800 psi and the mechanical control system is intact, allowing yaw control above approximately 40 KIAS. Be prepared for loss of tail rotor control below 40 KIAS. A run-on landing above 40 KIAS is recommended.

If a NO. 2 hydraulic system malfunction should occur with depleted NO. 1 and backup hydraulic systems, the result will be a loss of hydraulic pressure to the primary servos.



Switching the BACKUP PUMP switch to OFF with weight on wheels and the #1 HYD PUMP caution present will result in loss of tail rotor directional control.

12.8.2.1 #1 Tail Rotor Servo Leak

| #1 Tail Rotor Servo Leak | | |
|--------------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 Tail Rotor Servo Leak | Fluid level in hydraulic pump module is low. Indicates potential leak in #1 Hydraulic system. | <p>1. Land as soon as practical.</p> <p>If the #1 HYD PUMP caution appears:</p> <p>2. #1 Primary Servo or #1 Transfer Module Leak Emergency Procedure — PERFORM.</p> |
| #1 RSVR LOW | Leak at first stage pressure switch on tail rotor servo. | |
| AND | | |
| #1 TAIL RTR SERVO | The second stage of the tail rotor servo is ON and at the normal pressure. | |
| AND | | |
| #2 TAIL RTR SERVO ON | The leak detection isolation system should continue to operate normally, powering the #1 hydraulic system with the back up pump. | |
| AND | | |
| BACKUP PUMP ON | | |

12.8.2.2 #1 Primary Servo or #1 Transfer Module Leak

| #1 Primary Servo or #1 Transfer Module Leak | | |
|---|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 Primary Servo or #1 Transfer Module Leak | <p>After the #1 RSVR LOW caution light and #1 HYD PUMP caution light illuminate, the pilot positions the servo switch to 1st OFF. The servo switch is positioned to 1st OFF to prevent any further fluid leakage in the event the leak is in NO. 1 primary servos. The LDI system should continue to operate normally, powering the NO. 1 hydraulic system with the backup pump.</p> | <p>*1. SERVO Switch — 1st OFF.</p> <p>*2. Land as soon as practical.</p> <p>If the BACKUP RSVR LOW caution appears or the backup pump fails:</p> <p>*3. Land As Soon As Possible.</p> <p>If the #2 PRI SERVO caution and/or HYD warning appears:</p> <p>*4. LAND IMMEDIATELY.</p> <div style="text-align: center; border: 2px dashed black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>CAUTION</p> </div> <p>Switching the BACK UP HYD PMP to OFF with weight on wheels and #1 HYD PUMP caution light illuminated will result in loss of tail rotor directional control when the backup pump secures.</p> |
| #1 RSVR LOW | | |
| AND | | |
| #1 HYD PUMP | | |
| AND | | |
| BACKUP PUMP ON | | |

12.8.2.3 #1 TAIL RTR SERVO Leak without #1 RSVR LOW Caution Light

| #1 TAIL RTR SERVO Leak without #1 RSVR LOW Caution Light | | |
|--|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 TAIL RTR SERVO Leak without #1 RSVR LOW Caution Light | Low pressure at 1st stage pressure switch on tail rotor servo. #1 TAIL RTR SERVO caution and the BACKUP PUMP ON and #2 TAIL RTR SERVO ON advisories appear. | 1. Land as soon as practical. If BACKUP PUMP ON and #2 TAIL RTR SERVO on advisories do not appear: 2. Loss of Tail Rotor Control emergency procedure — Perform. |
| #1 TAIL RTR SERVO | | |
| AND | | |
| BACKUP PUMP ON | | |
| AND | | |
| #2 TAIL RTR SERVO ON | | |

12.8.3 NO. 2 Hydraulic System Malfunction

When a NO. 2 hydraulic system malfunction exists, the first indication is the #2 RSVR LOW caution followed by the BOOST SERVO OFF, SAS, and AFCS DEGRADED cautions.

If the hydraulic leak continues, the #2 HYD PUMP caution and the BACK-UP PUMP ON advisory will appear. The BOOST SERVO OFF, SAS, and AFCS DEGRADED cautions will disappear.

If the SERVO switch is not placed to the 2nd OFF and the leak continues, the BACKUP RSVR LOW caution will appear. When the BACKUP PUMP ON advisory disappears, it will result in a loss of the pilot-assist servos.

If a NO. 1 hydraulic system malfunction should occur with a depleted NO. 2 and backup hydraulic systems, the result will be a loss of hydraulic pressure to the tail rotor servo.

12.8.3.1 Pilot Assist Servo Leak

| Pilot Assist Servo Leak | | |
|--|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Pilot Assist Servo Leak #2 RSVR LOW AND BOOST SERVO OFF AND SAS AND AFCS DEGRADED | Fluid level in hydraulic pump module is low. Indicates potential leak in #2 Hydraulic system. | <ol style="list-style-type: none"> 1. Land as soon as practical. <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> WARNING </div> <p>In conditions where the LDI logic secures pressure to the Pilot Assist Servos requiring a boost off landing, consideration should be given to manually securing the Pilot Assist Servos prior to disengaging rotors. Failure to secure the SAS/BOOST, SAS 1, SAS 2, and TRIM switches OFF before the #2 HYD PUMP caution light illuminates upon rotor disengagement will cause the logic module to sense a drop in hydraulic pressure and assume the leak is continuing. The logic module will continue the isolation sequence to locate the leak. This will reopen the pilot assist servos and thus continue the original leak, which will deplete all of the hydraulic fluid from the NO. 2 and backup systems.</p> <p>Before rotors are disengaged:</p> <ol style="list-style-type: none"> 2. SAS/BOOST/SAS 1, SAS 2, and TRIM switches — OFF. 3. BACKUP PUMP — OFF. <p>If the #2 HYD PUMP caution appears:</p> <ol style="list-style-type: none"> 4. #2 Primary Servo or #2 Transfer Module Leak Emergency Procedure — PERFORM. |

12.8.3.2 #2 Primary Servo or #2 Transfer Module Leak

| #2 Primary Servo or #2 Transfer Module Leak | | |
|---|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #2 Primary Servo or #2 Transfer Module Leak #2 RSVR LOW AND #2 HYD PUMP AND BACKUP PUMP ON | After the #2 RSVR LOW caution light and #2 HYD PUMP caution light illuminate, the pilot positions the servo switch to 2nd OFF. The servo switch is positioned to 2nd OFF to prevent any further fluid leakage in the event the leak is in NO. 2 primary servos. The LDI system should continue to operate normally, powering the NO. 2 hydraulic system with the backup pump. | <ol style="list-style-type: none"> *1. SERVO Switch — 2nd OFF. *2. Land as soon as practical. <p>If the BACKUP RSVR LOW caution also appears or the backup pump fails:</p> <ol style="list-style-type: none"> *3. Land As Soon As Possible. <p>If the #1 PRI SERVO caution and/or HYD warning appears:</p> <ol style="list-style-type: none"> *4. LAND IMMEDIATELY. |

12.8.3.3 Pilot Assist Servo Malfunction

| Pilot Assist Servo Malfunction | | |
|---|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Pilot Assist Servo Malfunction BOOST SERVO OFF AND SAS AND AFCS DEGRADED | <p>Collective and/or yaw boost servo pressure is low or boost servo is jammed. BOOST SERVO OFF, SAS, and AFCS DEGRADED caution lights with no associated #2 RSVR LOW caution light may be an indication of a malfunctioning LDI system. Cycling the HYD LEAK TEST switch to RESET may restore the boost servos/pilot assist module.</p> <p>A failure of the collective or yaw boost servo may result in high cockpit control forces. The failure may be a hard over condition or jammed servo.</p> | <p>Before rotors are disengaged:</p> <ol style="list-style-type: none"> 1. Minimize flight control movement. 2. SAS/BOOST — RESET. <p>If SAS/BOOST is restored:</p> <ol style="list-style-type: none"> 3. Continue flight. <p>If SAS/BOOST is not restored:</p> <ol style="list-style-type: none"> 4. Land as soon as practical. 5. Make a shallow approach to a hover, maximum 15 knots crosswind. Taxi no more than necessary. <div style="text-align: center;"> <div style="border: 2px solid black; padding: 5px; width: fit-content; margin: 10px auto;">WARNING</div> <p>Inadvertent selection of the TEST position on the HYD LEAK TEST switch will result in activation of the hydraulic leak test upon touchdown.</p> <div style="border: 2px dashed black; padding: 5px; width: fit-content; margin: 10px auto;">CAUTION</div> </div> <ul style="list-style-type: none"> • Up to 75 pounds of left pedal force will be required when hovering with boost servos off with starboard crosswinds. This value is significantly reduced with port crosswinds. • Landings with BOOST SERVO OFF on all Air capable ships should only be attempted if there is no large landing platform (LPD or larger) or shore base available. |

12.8.4 BACKUP HYD PUMP Fails to Operate

| BACKUP HYD PUMP Fails to Operate | | |
|----------------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| BACKUP HYD PUMP FAILS TO OPERATE | | <p>1. BACKUP HYD PUMP switch position — Check.</p> <p>2. BACKUP PUMP PWR (ATO, NO.1 DC PRI BUS, ROW 3, CB 3) and BACKUP HYD CONTR CB (ATO OVHD CONS, DC ESENTL, ROW 2, CB 6) — Check.</p> <p style="text-align: center;">CAUTION</p> <p>If the BACKUP PUMP PWR circuit breaker is out and a condition exists that requires the backup pump to operate, then either the hydraulic system must be configured so that the backup pump will not activate upon resetting the circuit breaker, or ac power must be secured prior to resetting the circuit breaker. Damage to the current limiters may occur and will be indicated by a loss of all loads on the NO. 1 AC Primary bus.</p> <p>If a BACKUP PUMP PWR CB is out and BACKUP PUMP is required:</p> <p>3. BACKUP HYD CONTR CB — Pull.</p> <p>4. BACKUP HYD PMP switch — OFF.</p> <p>5. BACKUP PUMP PWR CB — Attempt to reset only once.</p> <p style="text-align: center;">CAUTION</p> <p>To prevent damage to current limiters, do not hold BACKUP PUMP PWR CB in while resetting.</p> <p>6. BACKUP HYD CONTR CB — Reset.</p> <p>7. BACKUP HYD PMP switch — As required.</p> <p style="text-align: center;">Note</p> <p>Without an operable BACKUP PUMP, #2 T/R SERVO will be inoperative and LDI functions will be degraded.</p> <p>If operation is not restored:</p> <p>8. Land as soon as practical.</p> |

12.8.5 Boost Servo Hardover

| Boost Servo Hardover | | |
|-----------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Boost Servo Hardover | A failure of the collective or yaw boost servo may result in high cockpit control forces. The control loads resulting from a hard over condition can be immediately eliminated by shutting off the boost servos. Resulting cockpit control loads will then be the same as for inflight boost servos off. The control freeplay noted will be about 1/2 inch. | *1. SAS/BOOST pushbutton — OFF. 2. Minimize flight control movements. 3. Land as soon as practical. 4. Make a shallow approach to a hover, maximum 15 knots crosswind. Taxi no more than necessary. |

12.9 AFCS EMERGENCIES

12.9.1 Coupler Emergencies

During an IFR coupled approach or hover emergencies, malfunctions (**Figure 12-5**) must be diagnosed quickly and correctly. A flashing AFCS DEGRADED light must be thoroughly investigated prior to completing an approach. A flashing AFCS DEGRADED light with a flashing CPLR and CH light is normal during an approach with little or no Doppler return. A flashing AFCS DEGRADED light with a flashing ALT light is a serious malfunction and steps must be taken immediately to prevent possible water impact. If the flashing AFCS with ALT light is experienced during approach, the automatic approach will be discontinued, altitude hold released and the aircraft will remain trimmed in a descent. Unless pilot action is initiated, the aircraft will continue its descent into the water. If the same conditions occur in a hover, the coupled hover will be disconnected, and altitude hold will switch to BAR ALT. The aircraft will then be in an uncoupled hover in IFR conditions.

| EVENTS | RAD ALT FAILURE | DOPPLER FAILURE |
|--|--|--|
| During approach | <p>Aircraft will continue in a descent all the way to the water (if on or above profile with RDR ALT light off).</p> <p>Flashing AFCS caution light and CPLR/ALT FAIL ADVISORY light. APPR disengages.</p> | <p>Approach will continue using airspeed and altitude. Pilot controls airspeed and wing attitude using beeper trim.</p> <p>Flashing AFCS caution light. HVR bars freeze. DOPP flag appears in .AI CPLR FAIL ADVISORY light.</p> |
| In a coupled hover or below descent Profile (RDR ALT HOLD ENGAGED) | <p>RDR ALT Hold switches to BAR ALT Hold. Automatic approach/coupled hover disengages. Altitude hold retained.</p> <p>Flashing AFCS caution light and CPLR/ALT FAIL ADVISORY light.</p> | <p>Coupled hover disengages. Attitude hold RDR ALT hold retained.</p> <p>Flashing AFCS caution light. HVR bars freeze. DOPP flag appears in AI. CPLR FAIL ADVISORY light.</p> |
| During departure | <p>Aircraft will climb through 500 feet. No altitude hold will engage. Airspeed will accelerate to 100 knots.</p> <p>Flashing AFCS caution light and CPLR/ALT FAIL ADVISORY light.</p> | <p>Aircraft will climb to 500 feet and RDR ALT hold will engage. Airspeed will increase to approximately 65–75 knots (dependent upon nose attitude when failure occurred).</p> <p>Flashing AFCS caution light. HVR bars freeze. DOPP flag appears in AI. CPLR FAIL ADVISORY light.</p> |
| <p>Notes:</p> <p>Doppler degradation can be classified as follows:</p> <ol style="list-style-type: none"> 1. Doppler power or transmitter fail — Bars center. 2. Doppler memory or receiver fail — Bars freeze. | | |

Figure 12-5. Automatic Approach Malfunction Matrix

12.9.2 AFCS Caution Lights

12.9.2.1 AFCS DEGRADED Caution Light On

| AFCS DEGRADED Caution Light On | | |
|--------------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| AFCS DEGRADED | <p>Indicates failure of one or more modes of DAFCS computer operation. If the AFCS DEGRADED caution light is illuminated steady, computer power has been lost.</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p style="text-align: center; margin: 0;">WARNING</p> </div> <p>Certain failure modes of the AFCS will cause the altitude hold functions to disengage. After clearing the Fail Advisory, ensure either RDR ALT or BAR ALT hold is engaged as desired.</p> | <p>If AFCS DEGRADED caution light is flashing:</p> <ol style="list-style-type: none"> 1. FAIL ADVISORY MODE RESET — Press. <p>If the malfunction is not eliminated, or AFCS DEGRADED caution light is steady:</p> <ol style="list-style-type: none"> 2. CMPTR PWR/RESET — Cycle. 3. AFCS CMPTR circuit breaker — Check: <ol style="list-style-type: none"> a. NO. 1 AC PRIMARY BUS marked AFCS CMPTR (CENTER, ATO, ROW 1 CB 3). 4. Accelerometer null — As required. <p>If operation is not restored:</p> <ol style="list-style-type: none"> 5. Land as soon as practical. |

12.9.2.2 AFCS FAIL Advisory Lights

Figure 2-34 describes the AFCS FAIL ADVISORY lights hierarchy. Pilot action is dependent on associated lights and system performance.

12.9.2.2.1 Flashing AFCS DEGRADED Caution Light

| Flashing AFCS DEGRADED Caution Light (Night/IMC) | | |
|---|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Flashing AFCS DEGRADED Caution Light (Night/IMC) | <p style="text-align: center;">Note</p> <p>AFCS DEGRADED caution light will illuminate when APPR is engaged with no Doppler return.</p> | <p>During automatic approach (Night/IMC):</p> <ol style="list-style-type: none"> *1. Initiate waveoff. 2. AFCS DEGRADED Caution Light On procedures— Perform. 3. Troubleshoot radar altimeter system and Doppler system. 4. If AFCS DEGRADED light illuminated because of no Doppler return, a no-Doppler approach may be attempted. |
| AFCS DEGRADED | | |

12.9.2.2.2 Flashing AFCS DEGRADED Caution Light with ALT Fail Advisory Light On

| Flashing AFCS DEGRADED Caution Light with ALT Fail Advisory Light On (Night/IMC) | | |
|---|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Flashing AFCS DEGRADED Caution Light with ALT Fail Advisory Light On (Night/IMC) | | In a coupled hover (night/IMC): *1. Initiate a waveoff using ITO technique. 2. AFCS DEGRADED Caution Light On procedures— Perform. 3. Troubleshoot radar altimeter system. |
| AFCS DEGRADED | | |
| AND | | |
| ALT | | |

12.9.2.3 SAS Caution Light On

| SAS Caution Light On | | |
|----------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| SAS | Indicates loss of pressure at the SAS actuator(s), loss of electrical power to both SAS 1 and SAS 2, erratic flight (loss of damping), or hardover. | 1. SAS 1 — OFF. 2. Land as soon as practical. |

12.9.3 Stabilator Malfunctions

12.9.3.1 Stabilator Auto Mode Failure

| Stabilator Auto Mode Failure | | |
|---|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>Stabilator Auto Mode Failure</p> <p>STABILATOR</p> | <p>Stabilator Reverted to manual mode.</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <ul style="list-style-type: none"> It is possible for the stabilator to fail without illumination of the stabilator caution light and associated aural warning tone. In this case, the first indication of failure will be an uncommanded pitch change. Re-engagement of the automatic mode after a shutdown results in the automatic mode operating for one second. If a hard over signal to one actuator was the cause of the initial shutdown, and re-engagement is attempted, the actuator will move before another dis-engagement is commanded. In this case subsequent re-engagement shall not be attempted since it may result in additional stabilator movement. If acceleration is continued with the stabilator in the full down position, longitudinal control will be lost. The stabilator shall be slewed to 0° as airspeed increases above 40 KIAS. | <ul style="list-style-type: none"> *1. PAC Call — STAB, STAB, STAB. *2. Cyclic — Arrest pitch rate. *3. Collective — Do not reduce. *4. MAN SLEW SWITCH — Adjust to 0°. <p>When at a safe altitude and airspeed (below 70 KIAS):</p> <ul style="list-style-type: none"> 5. Stabilator CBs — CHECK. <ul style="list-style-type: none"> a. STAB PWR (ATO, NO. 1 DC PRI, ROW 3, CB 7). b. STAB SYS PWR (ATO OVHD, DC ESNTL, ROW 2, CB 4.) c. STAB CONTROL (CENTER, NO. 1 AC PRI, ROW 1 CB 10). d. STAB IND (CENTER, AC ESNTL, ROW 1, CB 6). e. STAB CONT (CENTER, AC ESNTL, ROW 3, CB 6). 6. STABILATOR AUTO CONTROL pushbutton switch — Press once. <p>If automatic control is not regained and manual mode is operable:</p> <ul style="list-style-type: none"> 7. MAN SLEW Switch — Adjust as required. Do not exceed Stabilator versus airspeed limits shown below. <p style="text-align: center;">Note</p> <p>In Manual Mode, the following are not advisable:</p> <ul style="list-style-type: none"> Swimmer deployments lower than 15 feet AGL. Night shipboard takeoffs, approaches, and landings (except one time landing following failure). Automatic approaches to a hover. Practice autorotations. |

| Stabilator Auto Mode Failure (cont) | | | | | | | | | | | | | | |
|--|---|--|---------------------------------|------------|----|-----|-----|-----|-----|----|-----|----|-----|----|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION | | | | | | | | | | | | |
| Stabilator Auto Mode Failure (Cont.) STABILATOR | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> WARNING </div> <ul style="list-style-type: none"> With large fixed stabilator angles, reduction in collective pitch results in increased aft cyclic requirements. Collective reduction during recovery from a trailing edge down stabilator flight condition should be minimal. If the stabilator becomes fixed at or near 0°, nose high attitudes may occur at slow speeds. A combination of high airspeed/low altitude coupled with a runaway down stabilator (indicated by a significant uncommanded nose down pitch change) will necessitate immediate pilot action to maintain control of the aircraft. Primary consideration is to disengage the automatic mode by activating manual mode slewing as required. At high airspeeds, immediate recognition and flight control input are essential to avoid an unrecoverable attitude. It is essential for the PNAC to slew the stabilator to 0° immediately to gain control of the aircraft. If acceleration is continued with the stabilator in the full down position, longitudinal control will be lost. | <p>If automatic control is not regained and manual mode is NOT operable:</p> <p>8. Fly at or below speed shown:</p> <table border="1" style="margin: 10px auto;"> <thead> <tr> <th>STAB ANGLE (TRAILING-EDGE DOWN)</th> <th>KIAS LIMIT</th> </tr> </thead> <tbody> <tr> <td>0°</td> <td>150</td> </tr> <tr> <td>10°</td> <td>100</td> </tr> <tr> <td>20°</td> <td>80</td> </tr> <tr> <td>30°</td> <td>60</td> </tr> <tr> <td>40°</td> <td>45</td> </tr> </tbody> </table> <p>9. Land as soon as practical.</p> | STAB ANGLE (TRAILING-EDGE DOWN) | KIAS LIMIT | 0° | 150 | 10° | 100 | 20° | 80 | 30° | 60 | 40° | 45 |
| STAB ANGLE (TRAILING-EDGE DOWN) | KIAS LIMIT | | | | | | | | | | | | | |
| 0° | 150 | | | | | | | | | | | | | |
| 10° | 100 | | | | | | | | | | | | | |
| 20° | 80 | | | | | | | | | | | | | |
| 30° | 60 | | | | | | | | | | | | | |
| 40° | 45 | | | | | | | | | | | | | |

12.9.3.2 Stabilator Indicating System Failure

| Stabilator Indicating System Failure | | |
|--------------------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Stabilator Indicating System Failure | | If stabilator indicating system operation is questionable in the automatic mode: 1. Stabilator — Check position visually. If indication is erratic and/or lost: 2. STABILATOR AUTO CONTROL pushbutton — Do not disengage. 3. STAB IND CB — Cycle (CENTER, AC ESNTL, ROW 1, CB 6). If normal operation is not restored: 4. Land as soon as practical. |

12.9.4 Unusual Attitude Recovery

| Unusual Attitude Recovery | | |
|---------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Unusual Attitude Recovery | Unusual attitudes are considered to be attitudes of over 30° pitch and/or 60° bank. There are three general unusual attitudes: nose-low, nose-high, and high-bank angles. During all unusual attitude recoveries, the nose-low attitude is the desired condition from which to complete all recoveries. | *1. Level wings. *2. Nose on horizon. *3. Center ball. *4. Stop rate of climb/descent. *5. Control airspeed. |

12.10 ELECTRICAL SYSTEM MALFUNCTIONS

Total loss of AC power will result in the loss of both pilot and copilot attitude indicators and BDHIs. In addition, the copilot turn needle will be inoperative. All primary cockpit lighting will be inoperative. Only the pilot will have turn needle: both pilot and copilot will have all barometric instruments, secondary and utility lights, and wet compass.

In the event of total loss of AC power, the pilot turn needle will only be available until battery power drops below 35 percent. Aircrews must endeavor to gain VMC as soon as possible. Without the pilot turn needle, the only instrument available to provide turn rate information will be the wet compass.

WARNING

- During any emergency where generators are secured intentionally or inadvertently, severe repercussions could result. In any case, actual flight conditions (night/IMC/power required) will dictate the immediate procedures to be followed. It may not be advisable to secure electrical power, which will result in the loss of AFCS, normal ICS, and flight and mission displays, prior to achieving VMC or landing/ditching.
- Without electrical power to the dc Primary buses, the engine and inlet anti-ice valves are automatically opened. With an improperly operating engine inlet anti-ice system, a loss of up to 49 percent power available per engine is possible.

A failed main generator could be a preliminary indication of a subsequent transmission malfunction or vice versa. When dealing with main generator malfunctions, due consideration should be given to actual or potential transmission chip, oil temperature, or oil pressure lights, and the rate of decay of aircraft systems.

The items listed in **Figure 12-6** use both AC and DC power. In case of dual generator or dual converter failure, this equipment, although not operational, will continue to draw DC power from the battery and should be secured by the appropriate switch or circuit breaker.

| CIRCUIT BREAKER | LOCATION |
|--|--|
| PILOT BDHI | Overhead console circuit breaker panel |
| STAB PWR ATO BDHI TACAN CONTR MAIN ROTOR DE-ICE | ATO circuit breaker panel |
| LEFT PITOT HEATER LH RACK BLOWER BLADE FOLD MOTOR RH RACK BLOWER ECS POWER PYLON GSE CONTR RAST POWER REEL MACH LAUNCH RESCUE HOIST CONTR (2) RTR HD INDEX MOTOR UTIL RECP CABIN (2) | SO circuit breaker |
| NO. 2 ENG OVSP PILOT WINDSHIELD ANTI-ICE RIGHT PITOT HEATER | Corner circuit breaker |

Figure 12-6. Equipment Drawing DC Power from the Battery

12.10.1 Total AC Power Failure/Dual Generator Failure

| Total AC Power Failure/Dual Generator Failure | | |
|---|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Total AC Power Failure/Dual Generator Failure #1 CONV AND #2 CONV AND AC ESS BUS OFF AND AFCS DEGRADED AND STABILTOR | <p>Failure of AC source(s) or respective converter or DC bus connector.</p> <p>Battery life may be no more than 14 minutes: therefore, the electrical equipment remaining on should be only that required for prevailing conditions, e.g. night, IMC.</p> <p style="text-align: center;">Note</p> <p>The capability of slewing the stabilator is retained via the DC Essential bus using battery power. Travel is limited to 35° if full down or 30° if full up when a power failure occurs.</p> | <p>*1. Safe Altitude and Airspeed — Establish.</p> <p>*2. Stabilator — CHECK POSITION, SLEW AS REQUIRED.</p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p style="text-align: center; margin: 0;">WARNING</p> </div> <p>Ensure airspeed vs. stabilator angle limits are not exceeded. Stabilator automatic mode is inoperative.</p> <p style="text-align: center;">Note</p> <p>The stabilator position indicator will be inoperative with no power to the AC essential bus. Attempt to check visually.</p> <p>*3. APU Emergency Start Procedure — PERFORM.</p> <p>4. AFCS/SAS — Check Status.</p> <p>If AC electrical failure:</p> <p>5. NO. 1 and NO. 2 GENERATOR switches — RESET, THEN ON.</p> <p>If DC electrical failure:</p> <p>6. Converter CBs — RESET.</p> <p style="margin-left: 20px;">a. NO. 1 CONVERTER (ATO, NO. 1 AC PRI, ROW 1, CB 14).</p> <p style="margin-left: 20px;">b. NO. 2 CONVERTER (PILOT, NO. 2 AC PRI, ROW 2, CB 4).</p> <p>If AC and/or DC electrical power is not restored:</p> <p>7. Land as soon as practical.</p> <p>8. Nonessential electrical equipment — OFF.</p> |

12.10.2 Electrical System Caution Lights

| #1 or #2 Generator Caution Light | | |
|----------------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 GEN | Respective generator not supplying power to buses. Operative generator selected OFF: failure of generator, GCU, contactor or wiring fault. | 1. Affected GENERATOR switch — RESET, THEN ON. If caution light remains on: 2. Affected GENERATOR switch — OFF. If IMC: 3. APU Emergency Start procedure — PERFORM. If icing conditions encountered/anticipated: 4. BACKUP PUMP — OFF. 5. DE-ICE MASTER — AUTO. 6. ENG ANTI-ICE — ON. 7. PITOT HEAT — CHECK ON. |
| OR | | |
| #2 GEN | | |

12.10.2.1 GEN BRG (#1/#2) Caution Lights

| GEN BRG (#1 or #2) Caution Lights | | |
|-----------------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 GEN BRG | Generator main bearing worn or has failed. If caution remains for more than 1 minute, a MAF is required. The generator may continue to operate normally for 10 hours. <p style="text-align: center;">Note</p> A mechanical failure of the generator bearing may cause transmission chip cautions to appear. When the light illuminates, it may be disregarded if it occurs either as an intermittent or a steady (less than 1 minute) light, or as any combination of the two. <p style="text-align: center;">Note</p> Consideration may be given to starting the APU and turning on the APU generator. | 1. Check for transmission secondaries. 2. Note time. If caution remains steady on for more than one minute: 3. Land as soon as practical. |
| OR | | |
| #2 GEN BRG | | |

12.10.2.2 AC ESS BUS OFF Caution Light

| AC ESS BUS OFF Caution Light | | |
|------------------------------|----------------------------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| AC ESS BUS OFF | AC essential bus is not powered. | <ol style="list-style-type: none"> 1. AC ESS BUS SPLY CBs — Check. <ol style="list-style-type: none"> a. CENTER, NO. 1 AC PRI, ROW 1, CB 15. b. CORNER, NO. 1 AC PRI, ROW 4, CB 5. 2. Note lost equipment. |

12.10.2.3 DC ESS BUS OFF Caution Light

| DC ESS BUS OFF Caution Light | | |
|------------------------------|----------------------------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| DC ESS BUS OFF | DC essential bus is not powered. | <ol style="list-style-type: none"> 1. DC ESS BUS SPLY CBs — Check. <ol style="list-style-type: none"> a. ATO, NO. 1 DC PRI, ROW 3, CB 6. b. ATO, NO. 2 DC PRI, ROW 3, CB 13. 2. Note lost equipment. |

12.10.3 CONV (#1/#2) Caution Lights

| CONV (#1/#2) Caution Lights | | |
|-----------------------------|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 CONV OR #2 CONV | Failure of AC source(s) or respective converter or DC bus. | <ol style="list-style-type: none"> 1. Affected converter circuit breakers — Reset. <ol style="list-style-type: none"> a. NO. 1 AC PRIMARY BUS marked NO. 1 CONVERTER POWER (CENTER, NO. 1 AC PRI, ROW 1, CB 14). b. NO. 2 AC PRIMARY BUS marked NO. 2 CONVERTER POWER (CORNER, NO. 2 AC PRI, ROW 2, CB 4). <p>If caution light remains on:</p> <ol style="list-style-type: none"> 2. Land as soon as practical. |

12.10.4 BATTERY FAULT Caution Light

| BATTERY FAULT Caution Light | | |
|-----------------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| BATTERY FAULT | <p>Possible over temperature/internal malfunction.</p> <p>Note</p> <p>If the APU Generator is the only source of AC power and it is secured with the battery OFF, the APU will shut down.</p> | <ol style="list-style-type: none"> 1. BATT switch — Cycle a maximum of two times. <p>If light remains on:</p> <ol style="list-style-type: none"> 2. BATT switch — OFF. 3. Land as soon as practical. |

12.10.5 BATTERY LOW CHARGE Caution Light

| BATTERY LOW CHARGE Caution Light | | |
|----------------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| BATT LOW CHARGE | <p>Battery is at or below 40 percent of a fully charged state.</p> <p style="text-align: center;">Note</p> <p>With the battery below 35 percent charge, the DC Essential bus will be dropped from the Battery bus and the BATT LOW CHARGE light will extinguish.</p> <div style="text-align: center; border: 2px dashed black; padding: 5px; width: fit-content; margin: 10px auto;"> CAUTION </div> <p>With no other source of DC power for the DC Essential bus and the battery below 30 percent charge, battery power may not be sufficient to activate the fire extinguisher CAD.</p> | <p>If caution appears on ground after APU start with APU generator on:</p> <ol style="list-style-type: none"> 1. BATT switch — Cycle (allow 30 minutes to charge battery). <p>If caution appears in flight:</p> <ol style="list-style-type: none"> 2. BATT switch — OFF. 3. Circuit breakers — Check. <ol style="list-style-type: none"> a. BATT CHGR (ATO, NO. 2 DC PRI, ROW 2, CB 16). b. BATT CHGR (ATO, NO. 2 AC PRI, ROW 2, CB 1). 4. BATT switch — ON. |

12.11 DE-ICE MALFUNCTIONS

12.11.1 PWR MAIN RTR and/or PWR TAIL RTR Light On

| PWR MAIN RTR and/or PWR TAIL RTR Light ON | | |
|---|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| PWR MAIN RTR | Indicates a malfunction has occurred in the main rotor and/or tail rotor primary power when the power switch is in OFF or ON. Indicates TEST and NORMAL operation when power switch is in TEST. | <p>If a rotor power light on the Blade De-Ice Panel is illuminated with the BLADE DE-ICE POWER switch ON:</p> <ol style="list-style-type: none"> 1. BLADE DE-ICE POWER switch — OFF. <p>If the PWR MAIN RTR light remains illuminated:</p> <ol style="list-style-type: none"> 2. MR DE-ICE CONTR circuit breaker — PULL. (ATO, NO. 2 DC PRI, ROW 2, CB 20) <p>If the PWR MAIN RTR monitor light remains illuminated:</p> <ol style="list-style-type: none"> 3. NO. 1 or NO. 2 GENERATOR switch — OFF. 4. APU GENERATOR switch — OFF (if in use). 5. Land as soon as practical. <p>Tail:</p> <ol style="list-style-type: none"> 6. BLADE DE-ICE POWER switch — OFF. <p>If PWR TAIL RTR monitor light remains illuminated:</p> <ol style="list-style-type: none"> 7. TAIL BLADE DE-ICE circuit breaker (SO OVHD, AC Secondary, ROW 1, CB 5) — PULL. <p>If PWR monitor light remains illuminated:</p> <ol style="list-style-type: none"> 8. APU Emergency Start Procedure — Complete. 9. NO. 1 and NO. 2 GENERATOR — OFF. 10. Land as soon as practical. |
| AND/OR | | |
| PWR TAIL RTR | | |

12.11.2 DE-ICE System Caution Lights

12.11.2.1 ICE DETECTED Caution Light

| ICE DETECTED Caution Light | | |
|----------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ICE DETECTED | Ice has been detected by the ice detector. It is possible to receive false ice detector indications due to blowing sand/dirt entering the ice detector. | <ol style="list-style-type: none"> 1. PITOT HEAT switch — ON. 2. WINDSHIELD ANTI-ICE — ON. 3. ENG ANTI-ICE — ON. 4. BLADE DE-ICE POWER — ON. 5. Monitor surfaces for ice buildup. |

12.11.2.2 ICE DETECT FAIL Caution Light

| ICE DETECT FAIL Caution Light | | |
|-------------------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ICE DETECT FAIL | Indicates a failure of the detector unit or the icing rate signal converter. | 1. BLADE DE-ICE POWER switch — OFF. 2. Torque required and vibration — Monitor. If torque required and/or vibration increases: 3. MODE —Select higher setting. If ice buildup continues: 4. Land As Soon As Possible. |

12.11.2.3 LEFT or RIGHT PITOT HEAT Caution Lights

| LEFT or RIGHT PITOT HEAT Caution Lights | | |
|---|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| LFT PITOT HEAT | Low heat or no heat in right and/or left pitot tube. | 1. Stabilator — Check, MANUAL mode as required. 2. Pitot heat circuit breakers — Check. a. LFT PITOT HEATER (SO OVHD, NO. 1 AC PRI, ROW 1, CB 6). b. RIGHT PITOT HEATER (CORNER, NO. 2 AC PRI, ROW 3, CB 4). 3. Icing conditions or visible moisture — Exit. |
| OR | | |
| RT PITOT HEAT | | |
| | | <div style="border: 1px solid black; padding: 2px; text-align: center; width: fit-content; margin: 10px auto;">WARNING</div> <p>The possibility exists for erratic stabilator programming due to erroneous indications from the pitot-static system. If icing conditions exist, expect to lose respective airspeed indication.</p> |

12.11.2.4 MR DE-ICE FAIL Caution Light

| MR DE-ICE FAIL Caution Light | | |
|------------------------------|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| MR DE-ICE FAIL | <p>Open circuit to any MRB heating element or a short circuit from phase to phase of the blade de-ice power lines. System will automatically turn off.</p> <p>Pilots must be aware of increased vibration levels and torque requirements that could result from ice buildup.</p> | <div style="text-align: center;">WARNING</div> <p>Ice accumulation resulting in a 20 percent torque increase indicates that normal autorotational rotor rpm may not be attainable should dual-engine failure occur.</p> <ol style="list-style-type: none"> DE-ICE MASTER switch — MANUAL. BLADE DE-ICE POWER switch — OFF, then ON. DE-ICE MASTER switch — AUTO. <p>If caution remains in icing conditions:</p> <ol style="list-style-type: none"> Icing conditions — Exit. <p>If unable to exit icing conditions:</p> <ol style="list-style-type: none"> Land As Soon As Possible. |

12.11.2.5 MR DE-ICE FAULT Caution Light

| MR DE-ICE FAULT Caution Light | | |
|-------------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| MR DE-ICE FAULT | <p>Loss of electrical power or open circuit on any Main Rotor Blade (MRB) heating zone element. System will operate in degraded mode.</p> <p>Pilots must be aware of increased vibration levels and torque requirements that could result from ice buildup.</p> | <div style="text-align: center;">WARNING</div> <p>Ice accumulation resulting in a 20 percent torque increase indicates that normal autorotational rotor rpm may not be attainable should dual-engine failure occur.</p> <ol style="list-style-type: none"> BLADE DE-ICE POWER switch — OFF, then ON. <p>If caution remains in icing conditions:</p> <ol style="list-style-type: none"> Icing conditions — Exit. <p>If unable to exit icing conditions:</p> <ol style="list-style-type: none"> Land As Soon As Possible. |

12.11.2.6 TR DE-ICE FAIL Caution Light

| TR DE-ICE FAIL Caution Light | | |
|------------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| TR DE-ICE FAIL | <p>Open circuit to Tail Rotor Blade (TRB) heating elements or a short circuit from phase to phase of the blade de-ice power lines. Tail rotor de-ice will automatically turn off. Main rotor de-ice will remain on.</p> | <ol style="list-style-type: none"> Icing conditions — Exit. <p>When out of icing conditions:</p> <ol style="list-style-type: none"> BLADE DE-ICE POWER switch — OFF. <p>If unable to exit icing conditions:</p> <ol style="list-style-type: none"> Land As Soon As Possible. |

12.12 FUEL SYSTEM MALFUNCTIONS

12.12.1 Fuel System Caution Lights

12.12.1.1 #1 or #2 FUEL FLTR BYPASS or #1 or #2 FUEL PRESS Caution Lights

| #1 or #2 FUEL FLTR BYPASS or #1 or #2 FUEL PRESS Caution Lights | | |
|---|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 FUEL FLTR BYPASS | Fuel Filter is bypassing. | *1. Fuel selector lever (affected engine) — XFD (DIR if currently in XFD). 2. Land as soon as practical. If affected engine indications are abnormal: 3. Engine malfunction in Flight procedure — Perform. |
| OR | <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-bottom: 5px;">WARNING</div> Low fuel pressure from the respective engine-driven boost pump. Intermittent appearance of a FUEL PRESS caution may be an indication of air leaking into the fuel supply lines, which could cause momentary fluctuation in engine power or flameout. | |
| #2 FUEL FLTR BYPASS | | |
| OR | | |
| #1 FUEL PRESS | Low fuel pressure from the respective engine-driven boost pump. | |
| #2 FUEL PRESS | | |

12.12.1.2 #1 and #2 FUEL FLTR BYPASS or #1 and #2 FUEL PRESS Caution Lights

| #1 and #2 FUEL FLTR BYPASS or #1 and #2 FUEL PRESS Caution Lights | | |
|---|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 FUEL FLTR BYPASS | Fuel Filter is bypassing. | *1. Land As Soon As Possible. *2. APU Emergency Start procedure — Perform. <div style="border: 1px solid black; padding: 2px; display: inline-block; margin: 10px auto; width: 100px; text-align: center;">WARNING</div> Be prepared for dual-engine failure. Recommended airspeed profile is 80 KIAS to minimize N _r droop should dual-engine failure occur. <p style="text-align: center;">Note</p> Consideration should be given to performing applicable steps of the Immediate Landing/Ditching emergency procedure. |
| AND | <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-bottom: 5px;">WARNING</div> Fuel Filter is bypassing. Low fuel pressure from the respective engine-driven boost pump. Intermittent appearance of a FUEL PRESS caution may be an indication of air leaking into the fuel supply lines, which could cause momentary fluctuation in engine power or flameout. | |
| #2 FUEL FLTR BYPASS | | |
| OR | | |
| #1 FUEL PRESS | Low fuel pressure from the respective engine-driven boost pump. | |
| #2 FUEL PRESS | | |

12.12.1.3 (#1/#2) FUEL LOW Caution Lights

| (#1/#2) FUEL LOW Caution Lights | | |
|---------------------------------|------------------------------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| #1 FUEL LOW | Low fuel state in respective cell. | 1. Land as soon as practical. <div style="border: 1px solid black; padding: 2px; display: inline-block;">WARNING</div> With less than 600 pounds of fuel, fuel starvation may occur when balanced flight is not maintained and/or pitch attitudes exceed 15° noseup or nosedown. |
| AND | | |
| #2 FUEL LOW | | |

12.12.1.4 AUX FUEL XFER FAULT Caution Light

| AUX FUEL XFER FAULT Caution Light | | |
|-----------------------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| AUX FUEL XFER FAULT | FMCP automatic transfer logic has failed, both transfer pumps have failed, or both transfer/shutoff valves have failed. | 1. FMCP circuit breakers — Cycle. <ul style="list-style-type: none"> a. FUEL MGMT (ATO, NO. 1 DC PRI, ROW 1, CB 1), if installed. b. FUEL MGMT (ATO, NO. 2 DC PRI, ROW 3, CB 23), if installed. 2. FUEL XFER/DUMP circuit breakers — Cycle. <ul style="list-style-type: none"> a. FUEL DUMP CONTR (OVERHEAD, DC ESNTL, ROW 3, CB 1). b. FUEL DUMP PUMP (CENTER, NO. 1 AC PRI, ROW 1, CB 13). c. FUEL DUMP PUMP (CORNER, NO. 2 AC PRI, ROW 1, CB 1). 3. Fuel XFER mode — MANUAL. 4. Appropriate FMCP fuel flow indicator/selecter switch — Press and hold for a minimum of 10 seconds. |

12.12.1.5 PUMP/VALVE FAIL Caution Light

| PUMP/VALVE FAIL Caution Light | | |
|-------------------------------|--|--------------------|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| PUMP/VALVE FAIL | Failure of main transfer valve or transfer/dump pumps. | 1. Note condition. |

12.12.2 Refueling Hose Jettison (HIFR)

| Refueling Hose Jettison (HIFR) | | |
|--------------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Refueling Hose Jettison (HIFR) | | <p style="text-align: center;">WARNING</p> <p>Anyone may give the command "BREAKAWAY." The crewman shall immediately pull the emergency disconnects lanyard (NI/Wiggins) and report, "HOSE CLEAR."</p> <p>If a T-handle is present:</p> <p>*1. When emergency breakaway command is received — Pull T-handle and report "HOSE CLEAR."</p> <p>If no T-handle is present:</p> <p>*2. When emergency breakaway command received — Report "HOSE CLEAR."</p> <p style="text-align: center;">WARNING</p> <p>Hose snapback on breakaway may impact the crewman depending on direction of aircraft motion.</p> |

12.12.3 NO HIFR/Stuck Main Tank Shutoff Valve

A stuck main tank shutoff valve will prevent fueling by HIFR when the FMCP is powered. The FMCP controls sequencing of fuel to the tanks, and the main tanks must be filled first. Removing power to the FMCP will remove power from the auxiliary tank shutoff valves and place them in the open position. HIFR can then fill the auxiliary tanks. Returning power to the FMCP will allow fuel to then be transferred manually to the main tanks.

| NO HIFR/Stuck Main Tank Shutoff Valve | | |
|---------------------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| NO HIFR/Stuck Main Tank Shutoff Valve | | <p>If no HIFR due to stuck main tank shutoff valve:</p> <ol style="list-style-type: none"> 1. FUEL MGMT circuit breakers — Pull. FUEL MGMT (ATO, NO. 1 DC PRI, ROW 1, CB 1), if installed FUEL MGMT (ATO, NO. 2 DC PRI, ROW 3, CB 23), if installed. 2. HIFR — FILL AUXILIARY TANKS. 3. FUEL MGMT circuit breaker — RESET. 4. FMCP transfer of auxiliary tanks — AS DESIRED. 5. Sequence can be repeated. |

12.12.4 Uncommanded Fuel Dumping

| Uncommanded Fuel Dumping | | |
|--------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Uncommanded Fuel Dumping | | 1. FUEL DUMP — Verify OFF. If fuel dumping continues: 2. FUEL DUMP CBs — PULL. <ol style="list-style-type: none"> FUEL DUMP PUMP (CENTER, NO. 1 AC PRI, ROW 1, CB 13). FUEL DUMP PUMP (CENTER, NO. 1 AC PRI, ROW 1, CB 1). FUEL DUMP CTRL (OVHD, DC ESNTL, ROW 3, CB 1). 3. Land as soon as practical. |

12.13 FIRE EMERGENCIES

If the helicopter is airborne when a fire occurs, the most important single action that can be taken by the pilot is to land the helicopter safely as soon as possible. On the ground, it is essential that the engines be shut down, crew and passengers evacuated, and the fire fighting begun immediately.

12.13.1 External Engine Fire

| External Engine Fire | | |
|----------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| FIRE (#1/#2 ENG) | Indicates that a fire detector (#1 ENG/#2 ENG) has actuated a fire warning circuit. (Note light in appropriate T-handle). The safety of the helicopter's occupants is the primary consideration when a fire occurs. If airborne, the most important single action can be taken by the pilot is to land the helicopter safely. <p style="text-align: center;">Note</p> HF transmissions, sunlight filtered through smoke, haze, water, or at sunrise or sunset may trigger the fire detectors and cause a false fire indication. | *1. Confirm Fire. *2. Engine Malfunction in Flight emergency procedure — Perform. *3. PCL (affected engine) — OFF. *4. Engine T-Handle (affected engine) — PULL. *5. FIRE EXT switch— MAIN (RESERVE if required or AC Power is off). If airborne and fire continues: *6. LAND IMMEDIATELY. If fire appears extinguished: *7. Land As Soon As Possible. 8. Single Engine Landing emergency procedure — Perform. On ground: 9. Fire Extinguisher — Discharge into engine compartment. |

12.13.2 Internal Engine Fire

| Internal Engine Fire | | |
|-----------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Internal Engine Fire | An Internal Engine Fire is indicated by a rise in TGT above 540 °C after engine shutdown. | *1. Starter — Engage. Motor Engine. 2. Portable Fire Extinguisher — As Required. 3. Starter — Secure (once TGT decreases below 540 °C). |

12.13.3 APU Fire

APU exhaust fires are most commonly the result of pooled fuel in the combustion chamber prior to start (a wet start). This often occurs when attempting to restart following an APU failure. Since the exhaust fire is confined to the exhaust section, activation of the fire extinguishing system without an illuminated APU fire T-handle may be ineffective. In most cases, continued operation of the APU will extinguish the flame.

| APU Fire | | |
|-------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| FIRE (APU) | <p>Indicates that a fire detector (APU) has actuated a fire warning circuit. The safety of the helicopter's occupants is the primary consideration when a fire occurs. If airborne, the most important single action can be taken by the pilot is to land the helicopter safely as soon as possible.</p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p style="text-align: center; margin: 0;">WARNING</p> </div> <p>Severity of the fire and conditions present will dictate whether an immediate landing/ditching is required.</p> <p style="text-align: center;">Note</p> <p>HF transmissions, sunlight filtered through smoke, haze, water, or at sunrise or sunset may trigger the fire detectors and cause a false fire indication.</p> | <p>*1. APU T-Handle — PULL.</p> <p>*2. Confirm Fire.</p> <p>*3. FIRE EXT switch — RESERVE (MAIN if required and available).</p> <p>If airborne and fire continues:</p> <p>*4. LAND IMMEDIATELY.</p> <p>If fire appears extinguished:</p> <p>*5. Land As Soon As Possible.</p> <p>If on ground:</p> <p>*6. Fire extinguisher — As required.</p> <p>7. FUEL PUMP switch — OFF.</p> <p>8. APU CONTR switch — OFF.</p> |

12.13.4 Cockpit Fire/Cabin Fire

| Cockpit Fire/Cabin Fire | | |
|-----------------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Cockpit Fire/ Cabin Fire | <p style="text-align: center;">WARNING</p> <ul style="list-style-type: none"> Severity of the fire and conditions present will dictate whether an immediate landing/ditching is required. Vapors from the portable fire extinguisher agent, although not poisonous, can cause asphyxiation by displacement of oxygen in a confined space. The cabin should be ventilated as soon as practical. It may not be advisable to secure all electrical power, thus losing AFCS, ICS, and flight instruments prior to achieving VMC or landing/ditching. <p style="text-align: center;">CAUTION</p> <p>If source of fire is unknown, consideration should be given to securing Mission Power immediately when securing unnecessary electrical equipment to prevent system damage.</p> | <p>If source is known:</p> <ul style="list-style-type: none"> *1. Affected power switches and CBs — Secure. *2. Portable Fire Extinguisher — As required. <p>If fire continues or source is unknown:</p> <ul style="list-style-type: none"> *3. Cabin/doors/vents/ECS — CLOSE/OFF, as required. *4. Unnecessary electrical equipment and CBs — SECURE. <p>If fire continues:</p> <ul style="list-style-type: none"> *5. Land As Soon As Possible. <p style="text-align: center;">WARNING</p> <p>Without AC power, the engine and inlet anti-ice valves are automatically opened. With an improperly operating engine inlet anti-ice system, a loss of up to 49 percent power available per engine is possible.</p> <ul style="list-style-type: none"> 6. Stabilator — Manually slew to zero. 7. NO. 1 and NO. 2. GENERATOR switches — OFF, as required. 8. BATT switch — OFF, as required. <p>If fire is extinguished:</p> <ul style="list-style-type: none"> 9. Smoke and Fumes Elimination emergency procedure — Perform. 10. Land as soon as practical. |

12.13.5 Sonobuoy Lithium Battery Venting

| Sonobuoy Lithium Battery Venting | | |
|----------------------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Sonobuoy Lithium Battery Venting | Lithium battery failure can result in the release of sulfur dioxide gas. | <p>If the pungent odor and rusty metallic taste characteristic of SO₂ fumes are detected, execute the following procedure:</p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">WARNING</div> <p>Portable fire extinguishers shall not be used to extinguish burning lithium fires since a violent reaction may occur.</p> <p>*1. Alert crew; sonobuoys — Jettison.</p> <p style="text-align: center;">Note</p> <p>If jettison of weapon pylon stores is not desired, sonobuoys must be launched manually.</p> <p>*2. Smoke and Fumes Elimination emergency procedure — Perform.</p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">WARNING</div> <p>Sulfur dioxide exposure in low concentrations can result in lightheadedness, dizziness, headache, difficulty in breathing, and possible loss of consciousness. An indication of the presence of a venting sonobuoy may be an acidic taste in the mouth or a distinct odor similar to that of an electrical fire.</p> |

12.13.6 Smoke and Fumes Elimination

| Smoke and Fumes Elimination | | |
|-----------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Smoke and Fumes Elimination | | <p>*1. Airspeed — Adjust, as required.</p> <p>*2. Doors/windows/vents — Open.</p> <p>*3. Aircraft — Yaw, as required.</p> |

12.13.7 Immediate Landing/Ditching

The sequence of events necessary to successfully conduct an immediate landing/ditching demand prior coordination and briefing. After a water landing, the aircraft tends to sink nose down and roll unpredictably to either side within 10 seconds. Depending on available power and rotor speed, the PAC may not be able to arrest these motions with collective or cyclic application. The aircraft may maintain some degree of buoyancy in the fuel cell transition section (approximately 2 to 5 minutes) after water landing.

Water pressure may prevent opening the emergency egress windows until the aircraft fills with water. For minimum loads on impact and to minimize the possibility of immediate rollover on touchdown, a ditching should be made into the prevailing winds and into or just past the crest on the backside of a wave.

Activate the jettison handle, then push out, down, and forward on the lower forward corner of the window to free it from the upper retention pins. The windows should be jettisoned prior to water entry and, if time permits, the cabin doors should be opened to optimize safe crew egress.

For overland flights, terrain along the route should be considered in an immediate landing scenario. Consideration should be given to closing cabin doors and windows prior to landing to maximize aircrew survivability.

Emergency exit from or entrance into the helicopter is provided through jettisonable windows and cabin doors. Emergency exits are shown in [Figure 12-7](#).

WARNING

- During any emergency egress, particular care must be taken to avoid being struck by the rotor blades
- Remain strapped in until rotors and all violent motion have stopped.

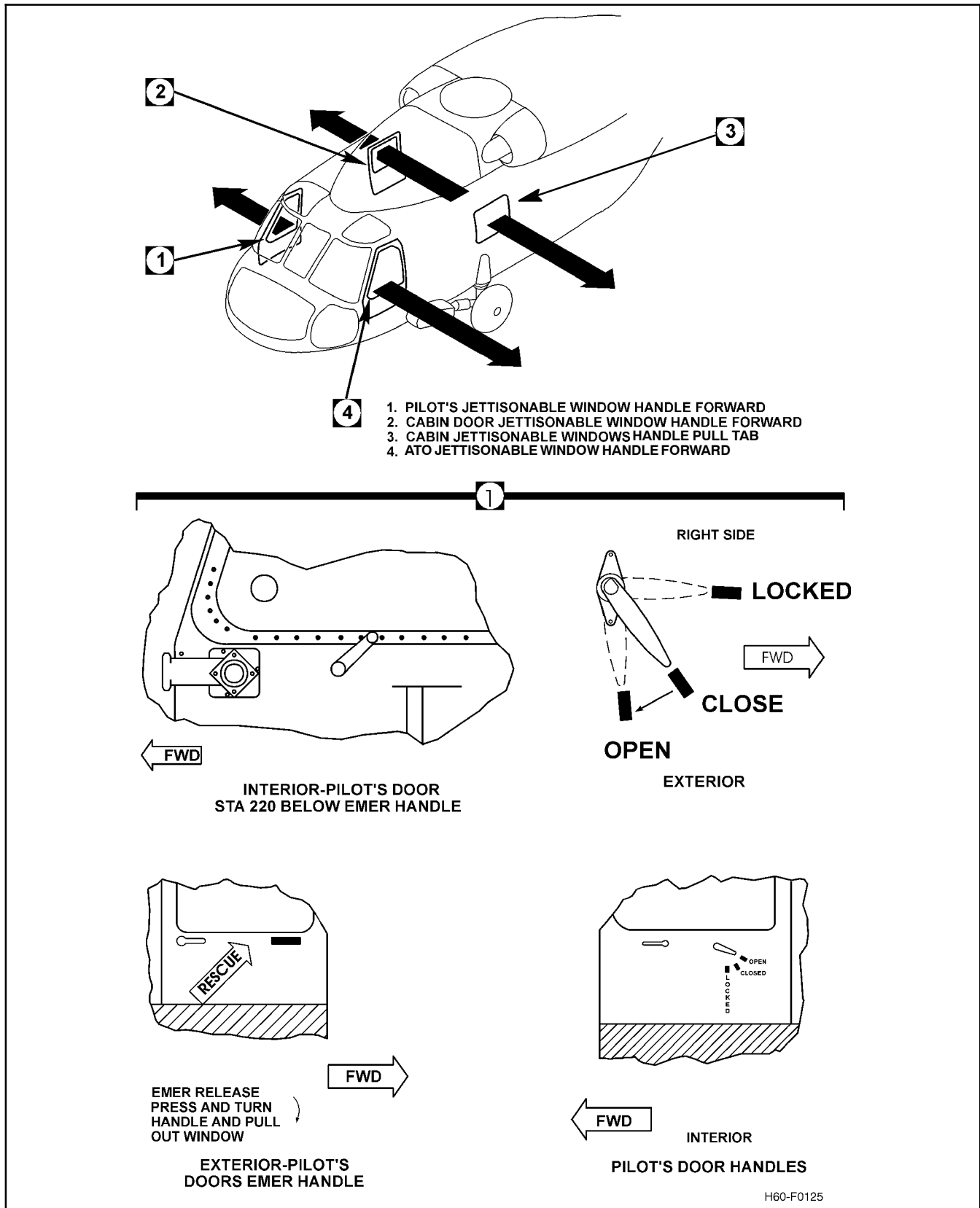


Figure 12-7. Emergency Exits (Sheet 1 of 3)

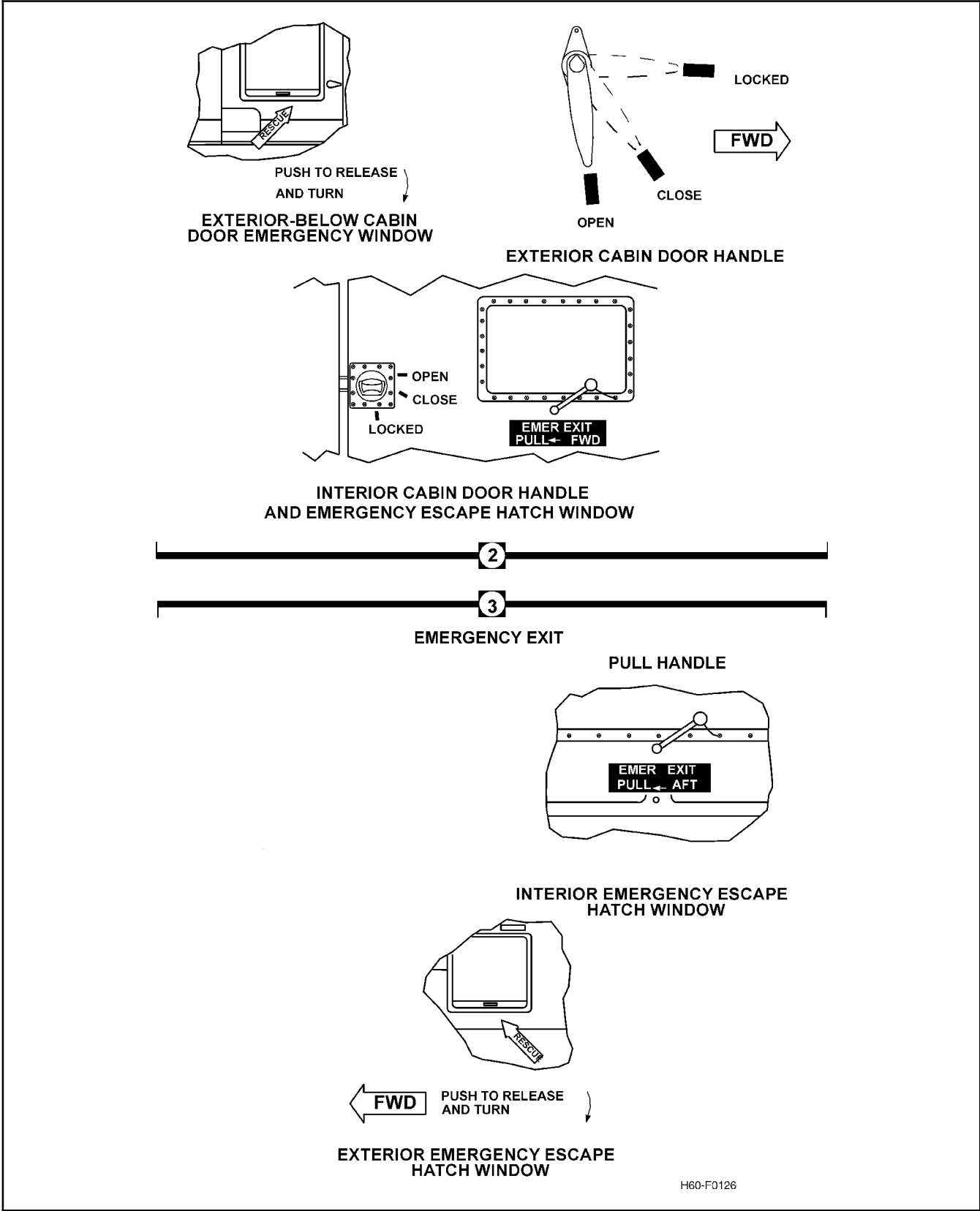
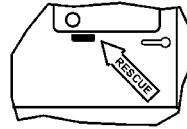
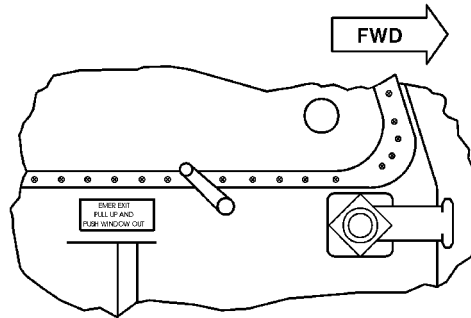


Figure 12-7. Emergency Exits (Sheet 2)

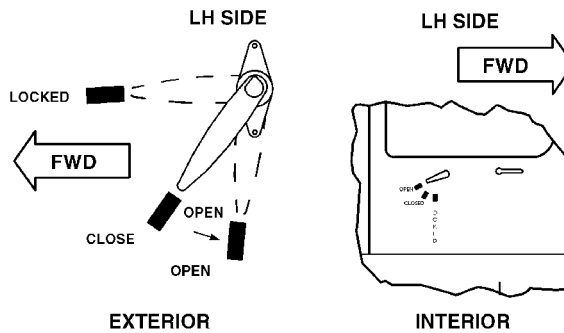
4



EMERGENCY RELEASE
PUSH AND TURN
EXTERIOR - ATO'S DOOR
BELOW EMERGENCY HANDLE



INTERIOR - ATO'S DOOR HANDLES
STA 220 BELOW EMERGENCY HANDLE



ATO'S DOOR HANDLES

H60-F0127

Figure 12-7. Emergency Exits (Sheet 3)

12.13.8 Planned Ditching

When an emergency situation dictates a water landing, the crew shall execute the Immediate Landing/Ditching procedures.

Note

- Time permitting, crew and passengers should check survival gear and jettison all unnecessary equipment/cargo, especially articles that may impede egress.
- Prior to ditching, consider activating the ADHEELS manually. ADHEELS will remain on for approximately 45 minutes.

The selection of ditching heading should be determined by evaluation of sea and wind conditions. It is recommended that the aircraft ditch parallel to and near the crest of the swell, if there is a crosswind of 25 knots or less.

If there is a strong crosswind, ditch into the wind, making contact on the upslope of the swell near the top. Wave motion is indicative of wind direction, but swell does not necessarily move with the wind. Conditions of water surface are indicative of wind speed. If visibility is restricted, ditch heading may be determined from forecast data.

12.13.9 Emergency Crash Position

The risk of personal injury during an autorotative landing or ditching can be significantly reduced by properly positioning oneself for the landing. All aircrew should position their seats up and aft in order for the seat stroke to absorb more of the crash loads. Aircrew should sit erect with head firmly against the headrest, elbows tucked in tightly, arms crossed in front of body, and feet flat on the deck.

WARNING

The downward stroke of the seat will change the frame of reference needed for egress. Extended handles, hatches, and controls within the cockpit will not be located in the same familiar places. Keep legs clear of under seat area. Downward travel of seat may cause injury or entrapment.

12.13.10 Immediate Landing/Ditching (Pilot)

| Immediate Landing/Ditching (Pilot) | | |
|--|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>Immediate Landing/Ditching (Pilot)</p> | <p>Emergency exit from or entrance into the helicopter is provided through jettisonable windows and cabin doors. Emergency exits are shown in Figure 12-7.</p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <ul style="list-style-type: none"> • In order to minimize the potential for serious injury, instructor seat occupant should assume crash position and lower head until their chin touches their chest prior to an emergency landing or ditching. • Stores jettisoned at descent rates greater than those listed in the NATIP have not been tested. Aircraft/rotor system impact from jettisoned stores may be possible. | <ul style="list-style-type: none"> *1. Crew and passengers — Alert. *2. Shoulder harness — Locked. *3. External cargo/stores/fuel — JETTISON/DUMP as required. *4. Searchlight — As required. *5. MAYDAY/IFF — TRANSMIT/EMER. <div style="border: 2px dashed black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>CAUTION</p> </div> <p>Time permitting, consideration should be given to executing APU Emergency Start procedure to maintain electrical and hydraulic power upon rotor disengagement.</p> <p>In the flare:</p> <ul style="list-style-type: none"> *6. Windows — Jettison, as required. <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>After actuation, the position of the emergency jettison window lever may cause snagging of personal survival gear, impeding egress. Time permitting, reset jettison handle to the aft position prior to egress.</p> <p>After landing:</p> <ul style="list-style-type: none"> *7. PCLs — OFF. *8. Rotor Brake — ON. *9. ATO Collective — STOW. <p>After all violent motion stops:</p> <ul style="list-style-type: none"> *10. EGRESS. <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Failure to remain strapped in aircraft until all violent motion or intruding water stops may result in injury or incapacitation.</p> |

12.13.11 Immediate Landing/Ditching (Aircrewmen)

| Immediate Landing/Ditching (Aircrewmen) | | |
|---|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>Immediate Landing/Ditching (Aircrewmen)</p> | <p>Emergency exit from or entrance into the helicopter is provided through jettisonable windows and cabin doors. Emergency exits are shown in Figure 12-7.</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>In order to minimize the potential for serious injury, instructor seat occupant should assume crash position and lower head until their chin touches their chest prior to and emergency landing or ditching.</p> | <ul style="list-style-type: none"> *1. Harness — Locked. *2. Seat — Up and aft. *3. Windows — Jettison, as required. *4. ASO Table — UP AND LOCKED. *5. Assume crash position. <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Attaining and maintaining a proper crash position in a seat is the most critical step that can be taken prior to impact. Aircrew shall not delay in assuming a seated crash position or leave a seated crash position to accomplish other tasks on this checklist.</p> |

12.13.12 Lost Aircraft Procedures (Open Ocean)

| Lost Aircraft Procedures (Open Ocean) | | |
|---|-------------------------------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>Lost Aircraft Procedures (Open Ocean)</p> | <p>Note Remain calm.</p> | <ul style="list-style-type: none"> 1. Confess. 2. Climb. 3. Conserve fuel. 4. Communicate. 5. Maintain adequate fuel to allow for landing or controlled ditch. 6. Utilize the following aircraft sensors as appropriate: <ul style="list-style-type: none"> a. TACAN. b. Radar. c. IFF. d. ESM. e. Data link. f. UHF Homer. |

12.13.13 Underwater Egress

| Underwater Egress | | |
|-------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Underwater Egress | <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto 10px auto;">WARNING</div> <ul style="list-style-type: none"> ● The downward stroke of the seat will change the frame of reference needed for egress. Extended handles, windows, and controls will not be located in the same relative position. Keep legs clear from under seat area. Downward travel of seat may cause injury or entrapment. ● Do not inflate LPU until outside helicopter. ● Water pressure may prevent opening the emergency egress windows until the cabin fills with water. The windows should be jettisoned prior to water entry to optimize the ability of the crew to safely egress. ● Failure to disconnect ICS cord can impede egress. Personal gear may snag during egress, notably on collectives, FLIR HCU's, Parking Brake and RAST release handles, PCLs/Fuel Selector Levers/Fire T-Handles, or extended Emergency Jettison Window handles. ● If entanglement or disorientation delays egress, hold onto a reference point with one hand. Using the other hand, place HABD in your mouth, clear water from your mouthpiece, and continue with egress. ● To prevent injury while ascending to the surface and breathing from the HABD, continually exhale to vent the expanding air from your lungs. | <ul style="list-style-type: none"> *1. HABD — As required. *2. ICS Cords — Disconnect. *3. Door/Window — Open/Jettison. *4. Place hand on known reference point. *5. Harness — RELEASE. *6. Exit Helicopter. <p>After egress:</p> <ul style="list-style-type: none"> *7. Swim clear of helicopter and inflate LPU. |

12.14 MISSION EQUIPMENT/WEAPON SYSTEM EMERGENCIES

12.14.1 Cargo Hook Emergency Release

| Cargo Hook Emergency Release | | |
|------------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Cargo Hook Emergency Release | | 1. RESCUE HOIST — OFF. 2. RAST MASTER — OFF. 3. MAD reeling machine POWER — OFF. <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">WARNING</div> Use of emergency release may cause injury to crewman. 4. Cyclic stick EMER REL — Press. |

12.14.2 RAST Main Probe Messenger Failure

| RAST Main Probe Messenger Failure | | |
|-----------------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| RAST Main Probe Messenger Failure | | If the messenger cable winch should fail/jam while raising or lowering and sufficient cable is deployed to attach the hauldown cable or cable is attached, proceed as follows: <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">WARNING</div> Injury to crewmen may result if RAST power is applied during the following procedure. 1. RAST MASTER — OFF. 2. Remove the quick release pin from the messenger light and remove the messenger light assembly. 3. Pull in messenger cable until the haul-down cable is locked in the main probe and the messenger is disconnected. 4. Secure messenger cable. 5. RAST MASTER — ON. 6. H-DOWN LKD and MESSGR IN lights — ON. <p style="text-align: center;">Note</p> If the haul down cable cannot be attached and the RA landing must be made, proceed with RAST Messenger Jettison and Back-up Messenger Cable Employment. |

12.14.3 RAST Messenger Jettison

| RAST Messenger Jettison | | |
|-------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| RAST Messenger Jettison | | <ol style="list-style-type: none"> 1. RAST MASTER — ON. 2. CARGO HOOK ARMING — SAFE. 3. RESCUE HOIST — OFF. 4. MAD reeling machine power — OFF. 5. Cyclic stick EMER REL — PRESS. |

12.14.4 RAST Backup Messenger Cable Employment

| RAST Backup Messenger Cable Employment | | |
|--|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| RAST Backup Messenger Cable Employment | <p>Note</p> <p>The RAST hauldown cable-normal release and the RAST messenger cable emergency shear (EMER REL) are disabled when the RAST MASTER switch is OFF.</p> | <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto;">WARNING</div> <p>Injury to crewmen may result if RAST power is applied during the following procedure.</p> <ol style="list-style-type: none"> 1. RAST MASTER — OFF. 2. Remove the quick release pin from the messenger light and remove the messenger light assembly. 3. Messenger cable — Remove from probe. 4. Secure line to a point on the probe. 5. Insert backup assembly adapter into main probe from top. Guide with tube assembly. 6. Push messenger adapter through detents on probe and pay out line until instructed to stop. 7. Deck crew will connect RA cable. 8. Pull in line until hauldown cable is locked in the main probe and the backup messenger cable is disconnected. 9. RAST MASTER — ON. |

12.14.5 RAST Cable Emergency Release

| RAST Cable Emergency Release | | |
|---|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| RAST Cable Emergency Release | Note The RAST hauldown cable emergency release T-handle is a mechanical system which will operate regardless of RAST MASTER switch position. | 1. RAST emergency release T-handle — PULL. |

12.14.6 RAST Main Probe Fails to Extend

| RAST Main Probe Fails to Extend | | |
|---------------------------------|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| RAST Main Probe Fails to Extend | <p>Note</p> <ul style="list-style-type: none"> • Ensure cable release is in the up position before attempting manual extension of main RAST probe. • Inadvertent extension of the RAST main probe is possible when the adapter is inserted into the shaft hole. • When retrieving cable into hoist manually, two positive clicks will be felt. Do not retract any further. This indicates messenger in and hauldown cable locked. | <p>If the main probe fails to extend electrically:</p> <p style="text-align: center;">WARNING</p> <p>Injury to crewmen may result if RAST power is applied prior to manual main probe extension.</p> <ol style="list-style-type: none"> 1. RAST MASTER — OFF. 2. Pull pip pin from under the manual cable tension release. Lower the manual cable tension release arm to relieve cable tension. 3. Remove ratchet with adapter from its stowed position. <p style="text-align: center;">WARNING</p> <p>Inserting the adapter with the ratchet attached while the main probe is in the up position may cause serious injury to crewman.</p> <ol style="list-style-type: none"> 4. Remove adapter from ratchet, slide shaft lock away from shaft hole. Insert adapter shaft and lock into place with shaft lock slide. 5. Raise the manual cable tension release arm and replace pip pin. <p style="text-align: center;">WARNING</p> <p>Check area beneath the aircraft to be sure it is clear of personnel and obstructions.</p> <ol style="list-style-type: none"> 6. Push down on the release lever to unlock probe. Probe will extend rapidly to extended position. 7. Remove ratchet adapter from shaft hole and attempt normal RAST procedures. <p>If unsuccessful:</p> <ol style="list-style-type: none"> 8. Insert ratchet and pay out cable to ship deck. The full 90 feet of cable can be extended in one minute. 9. After hauldown cable has been connected, retrieve by reversing ratchet and reel up until cable is locked in probe. 10. RAST MASTER — ON. 11. H'DOWN LKD and MSGR IN lights — ON. |

12.14.7 RAST Main Probe Fails to Retract

| RAST Main Probe Fails to Retract | | |
|--|---|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>RAST Main Probe Fails to Retract</p> | <p>Note RAST main probe must be in the up position in order to receive accurate OTPI information.</p> | <ol style="list-style-type: none"> 1. RAST LAMP TEST — Press. 2. MSGR IN light — On. 3. Main probe — Visually check. 4. MAIN PROBE — DOWN, then UP. <div style="border: 2px dashed black; padding: 5px; text-align: center; margin: 10px 0;"> <p>CAUTION</p> </div> <ul style="list-style-type: none"> ● Running landing shall not be attempted with main probe extended. ● Do not attempt to retract probe with ratchet. Damage will occur. ● Ground taxi is not recommended with main probe extended. |

12.14.8 MAD Reel Failure with Towed Body Deployed

| ASQ-81 MAD Reel Failure with Towed Body Deployed | | |
|--|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ASQ-81 MAD Reel Failure with Towed Body Deployed | | <div style="text-align: center; border: 2px dashed black; padding: 5px; width: fit-content; margin: 0 auto;">CAUTION</div> <p>With less than 12 feet of cable unrecoverable, maintain 50 to 55 KIAS until on final approach.</p> <ol style="list-style-type: none"> 1. Day or night VMC recovery procedure: <ol style="list-style-type: none"> a. Coordinate assistance with ground personnel. b. MAD reeling machine POWER — ON. c. MAGNETIC DETECTING SET PWR — OFF. d. Position crewman in cargo door to inform pilot of towed body position and altitude. e. Establish hover so as to keep MAD towed body clear of deck. f. Lower aircraft until towed body is on deck. g. Ground personnel maintain tension on cable, land aircraft on prepared surface. h. Recover cable, proceed with mission or to aircraft parking area. 2. Night/IMC jettison procedure: <ol style="list-style-type: none"> a. CARGO HOOK ARMING — SAFE. b. RESCUE HOIST — OFF. c. RAST MASTER — OFF. d. MAD reeling machine POWER — ON. e. Cyclic stick EMER REL — Press. <div style="text-align: center; border: 2px solid black; padding: 5px; width: fit-content; margin: 10px auto;">WARNING</div> <p>If the MAD bird is lost in flight, the MAD cable shall be cut immediately.</p> |

12.14.9 ASQ-81 Towed Body Down Limit Switch Malfunction

| ASQ-81 Towed Body Down Limit Switch Malfunction | | |
|---|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ASQ-81 Towed Body Down Limit Switch Malfunction | <p>Note</p> <p>If the MAD towed body stops at an intermediate position during deployment, the CABLE LIMIT light on the MAD reeling machine control panel and the MAD LIMIT light on the caution/advisory panel should flash continuously.</p> | <div style="border: 1px solid black; padding: 5px; text-align: center; width: fit-content; margin: 0 auto;"> WARNING </div> <p>Towed body jettison is possible. Avoid populated areas.</p> <p>*1. if no cable limit light within 61 seconds — Cease MAD reeling operations.</p> <p>*2. Alert crew.</p> <p>3. REEL — IN.</p> |
| MAD LIMIT | | |

12.14.10 ASQ-81 Towed Body Fails to Seat Properly

| ASQ-81 Towed Body Fails to Seat Properly | | |
|--|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| ASQ-81 Towed Body Fails to Seat Properly | | <ol style="list-style-type: none"> 1. REEL — Out (5 seconds). <ol style="list-style-type: none"> a. Deploy towed body approximately 20 feet from the pylon. <div style="border: 2px dashed black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> CAUTION </div> <p>Do not attempt to reseat if the Unit 3 FAIL light has illuminated as a result of a failure to seat properly.</p> <ol style="list-style-type: none"> 2. REEL — IN. 3. Pilot observe proper seating of the MAD towed body. 4. Land as soon as practical, and avoid populated areas. |

12.14.11 Rescue Hoist Failure

| Rescue Hoist Failure | | |
|----------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Rescue Hoist Failure | | <p>*1. Cease hoisting.</p> <p>*2. Visually inspect hoist.</p> <p>*3. Verify:</p> <ul style="list-style-type: none"> b. HYDRAULIC BACKUP PUMP caution lights — OFF. c. HYDRAULIC BACKUP PUMP switch — ON. d. RESCUE HOIST switch — ALL. e. RESCUE HOIST circuit breakers — IN. <ul style="list-style-type: none"> a RESCUE HOIST CTRL (SO OVHD, NO. 2 DC PRI, ROW 6, CB 13). (1) RESCUE HOIST CTRL (SO OVHD, NO. 1 DC PRI, ROW 6, CB 2). (2) RSQ HOIST POWER (SO OVHD, NO. 2 AC PRI, ROW 2, CB 3). <p>If a bird's nest or Lucas Western, proceed to step 6.</p> <div style="border: 1px solid black; padding: 2px; text-align: center; width: fit-content; margin: 10px auto;">WARNING</div> <p>If a bird's nest is suspected, do not attempt to raise or lower the hoist to avoid further damage to the rescue hoist/cable or cable separation.</p> <p>*4. Check normal raise/lower at all stations.</p> <p>*5. BACKUP CONTROL — Select.</p> <div style="border: 1px solid black; padding: 2px; text-align: center; width: fit-content; margin: 10px auto;">WARNING</div> <ul style="list-style-type: none"> ● Operation of rescue hoist in BACK-UP CONTROL mode will bypass limit switches. Cable separation may occur. ● If hoist jams, do not attempt to RAISE/LOWER any further as this could shear the cable. <p>6. Attempt to set personnel/cargo on deck/water.</p> <p>If unable:</p> <p>7. Cable grip — Rig.</p> |

12.14.12 Cable Grip Rigging Procedures

| Cable Grip Rigging Procedures | | |
|-------------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Cable Grip Rigging Procedures | | <ol style="list-style-type: none"> 1. Attach cable grip shackle to crewman safety belt. 2. Attach crewman safety belt to rescue hoist boom. 3. Connect cable grip to hoist cable by placing the cable between the jaws of the cable grip, shackle end up. 4. Pull up on crewman safety belt to slacken hoist cable. <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> WARNING </div> <p>Ensure altitude is sufficient to keep survivor/swimmer clear of the water.</p> <ol style="list-style-type: none"> 5. Report ready for forward flight. |

12.14.12.1 Runaway Hoist

| Runaway Hoist | | |
|---------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Runaway Hoist | | <p>*1. BACKUP CONTROL. — Select.</p> <div style="text-align: center; border: 2px dashed black; padding: 2px; width: fit-content; margin: 10px auto;"> CAUTION </div> <p>Operation of rescue hoist using BACKUP CONTROL inhibits limit switches.</p> <p>If payout continues:</p> <ol style="list-style-type: none"> *2. Hydraulic pump — Secure. 3. Attempt to set person/cargo on deck/water. <p>If unable:</p> <ol style="list-style-type: none"> 4. Cable grip — Rig. |

12.14.12.2 Rescue Hoist Fouled Cable

| Rescue Hoist Fouled Cable | | |
|---------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Rescue Hoist Fouled Cable | | <ol style="list-style-type: none"> *1. Pay out cable and attempt to free hangup. <p>If unable:</p> <ol style="list-style-type: none"> *2. Cut/shear cable — As required. |

12.14.12.3 Rescue Hoist Cable Cut

| Rescue Hoist Cable Cut | | |
|------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Rescue Hoist Cable Cut | | *1. Emergency shear switch — SHEAR. If unable: *2. Direct pilot to press EMER REL button. |

12.14.12.4 Rescue Hoist Cable Separation

| Rescue Hoist Cable Separation | | |
|-------------------------------|---|--------------------------------------|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Rescue Hoist Cable Separation | <p style="text-align: center;">Note</p> For proper Quick Splice procedures, refer to NTTP 3-50.1 series. | 1. Quick Splice procedure — Perform. |

12.15 MISCELLANEOUS CAUTION/ADVISORY LIGHTS

12.15.1 IFF Flashing Caution

| IFF Flashing Caution Light | | |
|----------------------------|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| IFF Flashing Caution Light | Indicates IFF mode 4 is not responding to interrogation. | 1. MODE 4 TEST/ON/OUT switch — TEST. 2. Observe GO indicator light ON. If GO indicator light does not illuminate or TEST/MON NO GO or a STATUS light illuminates: 3. MODE 4 TEST/ON/OUT switch — OUT. |
| IFF | | |

| |
|----------------|
| WARNING |
|----------------|

The helicopter may be viewed as a potential foe. Proceed in accordance with local directives.

12.15.2 LEFT or RIGHT RACK FAN Caution Light On

| LEFT or RIGHT RACK FAN Caution Light On | | |
|---|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| LEFT RACK FAN | | 1. Check applicable circuit breaker — RH RACK, LH RACK BLOWER (SO circuit breaker panel). 2. Acoustic paneling — Remove. |
| RIGHT RACK FAN | | |

12.15.3 WOW Advisory Light On In Flight

| WOW Advisory Light On In Flight | | |
|---------------------------------|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| WOW | <p>Illumination of the WOW light in flight indicates that the aircraft Weight on Wheels switch is stuck or malfunctioning.</p> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">WARNING</div> <p>Flying with a stuck Weight on Wheels (WOW) switch will disable WOW functions including emergency jettison circuits, radar altitude low altitude aural warning, Engine Out and Low Rotor RPM lights. Pulling the WOW circuit breaker will not restore proper operation of some WOW functions in the air. Pulling the WOW circuit breaker in flight may disable the Low Rotor RPM lights and the #1 and #2 Engine Out warning lights.</p> <p>If the light is illuminated in flight:</p> <ol style="list-style-type: none"> Land as soon as practical. |

12.15.4 Hellfire Missile Emergencies

12.15.5 Hellfire Missile Aborted Launch

This condition exists if the ATO depresses the HCU RELEASE CONSENT button but the system subsequently aborts the launch before a firing pulse is sent to any of the Hellfire missile squibs. An ACRT BIT status word for the affected Hellfire missile will be set stating the launch was aborted. If that occurs, perform the following steps:

| Hellfire Missile Aborted Launch | | |
|--|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Hellfire Missile Aborted Launch | <p style="text-align: center;">Note</p> <ul style="list-style-type: none"> If the RELEASE CONSENT button is depressed within 2 seconds following an attempted launch, the ACRT will ignore any attempts to launch another Hellfire missile and will display an "INV TRIG" alert on the MPD. No special recovery or Hellfire missile handling procedures are required. | <ol style="list-style-type: none"> Alert crew. <p>If a new Hellfire priority missile is selected by the ACRT:</p> <ol style="list-style-type: none"> Proceed with the AGM-114 Hellfire Missile Launch checklist. <p>If a new Hellfire priority missile is not selected:</p> <ol style="list-style-type: none"> PWR/ARM — OFF. MASTER ARM — SAFE. LAUNCHER RESET — INITIATE. ACRT BIT status words — CHECK. <p>If no critical faults:</p> <ol style="list-style-type: none"> Proceed with the AGM-114 Hellfire Missile Launch checklist. <p>If critical BIT status exists or Hellfire missile launch portion of the mission is complete:</p> <ol style="list-style-type: none"> PWR/ARM — OFF. WPN SELECT — OFF. MASTER ARM — Verify SAFE. FLIR OPERATIONAL PAGE — SELECT. HELLFIRE PWR — OFF. |


12.15.5.1 Hellfire Missile Hangfire

This condition exists if the ATO depresses the RELEASE CONSENT button but the Hellfire missile remains on the rail after the squib firing pulses have been sent to both the Hellfire missile and rocket motor squibs. The rocket motor may or may not ignite. A Hellfire missile hangfire condition is noted on the MPD by displaying the text HNG beneath the Hellfire missile fail symbol.

Note

Normal rocket motor burn time is less than 3 seconds. A rocket motor failure may cause the motor to slow burn or smolder and smoke for more than 3 seconds.

| Hellfire Missile Hangfire | | |
|---------------------------|--|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Hellfire Missile Hangfire | <p>Note</p> <p>The missile thermal battery does not provide the voltage for the rocket motor fire train. Aircraft power via the Signal Data Converter (AH SDC) is required to fire the rocket motor squibs. If motor squibs have not fired within 1.5 seconds after launch attempt, the missile Safe and Arm Device (SAD) will mechanically return to the safe condition. This will disconnect the firing circuit from the rocket motor squibs.</p> | <p>If rocket motor ignites and aircraft yaws:</p> <ol style="list-style-type: none"> 1. Adjust controls as required to maintain straight and level flight. 2. Alert crew. <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>The Hellfire missile thermal battery produces voltage for up to 30 minutes after the Hellfire missile squib is automatically fired during the launch sequence. If continued flight is possible, the aircraft should remain airborne with Hellfire missile pointed in a safe direction for a minimum of 30 minutes to allow the thermal battery to become inert.</p> <p>If a new priority Hellfire missile is selected by the ACRT:</p> <ol style="list-style-type: none"> 3. Proceed with the AGM-114 Hellfire Missile Launch checklist. <p>If a new priority Hellfire missile is not selected:</p> <ol style="list-style-type: none"> 4. PWR/ARM — OFF. 5. WPN SELECT — OFF. 6. MASTER ARM — SAFE. 7. LAUNCHER RESET — Initiate. 8. ACRT BIT status words — Check. <p>If no critical faults:</p> <ol style="list-style-type: none"> 9. Proceed with the AGM-114 Hellfire Missile Launch checklist. <p>If critical BIT status exists or Hellfire missile launch portion of the mission is complete:</p> <ol style="list-style-type: none"> 10. FLIR OPERATION PAGE — Select. 11. HELLFIRE PWR — OFF. |

| Hellfire Missile Hangfire (cont) | | |
|----------------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Hellfire Missile Hangfire (Cont) | | <p>If fuel/time permits:</p> <p>12. Keep Hellfire missile pointed in safe direction for 30 minutes.</p> <div style="text-align: center;">  <p>CAUTION</p> </div> <p>EOD personnel, usually located aboard aviation ships, are specially trained to properly handle and dispose of hung ordnance. Personnel should not handle hung ordnance for at least 30 minutes after attempted launch.</p> <p>If shore facility not available:</p> <p>13. Proceed to aviation ship, if available.</p> <p>14. Proceed to own ship — Use offset approach procedures.</p> <p>If shipboard recovery with hung ordnance not an option:</p> <p>15. Execute Selective Jettison of M299 Launcher emergency procedure.</p> |

12.15.5.2 Hellfire Missile Misfire

| Hellfire Missile Misfire | | |
|--|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| <p>Hellfire Missile Misfire</p> | <p style="text-align: center;">Note</p> <p>The missile thermal battery does not provide the voltage for the rocket motor fire train. Aircraft power via the Signal Data Converter (AH SDC) is required to fire the rocket motor squibs. If motor squibs have not fired within 1.5 seconds after launch attempt, the missile Safe and Arm Device (SAD) will mechanically return to the safe condition. This will disconnect the firing circuit from the rocket motor squibs.</p> | <p>1. Alert crew.</p> <div style="text-align: center; border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>The Hellfire missile thermal battery produces voltage for up to 30 minutes after the Hellfire missile squib is automatically fired during the launch sequence. If continued flight is possible, the aircraft should remain airborne with Hellfire missile pointed in a safe direction for a minimum of 30 minutes to allow the thermal battery to become inert.</p> <p>If a new priority Hellfire missile is selected by the ACRT:</p> <p style="padding-left: 40px;">2. Proceed with the AGM-114 Hellfire Missile Launch checklist.</p> <p>If a new priority Hellfire missile is not selected:</p> <p style="padding-left: 40px;">3. PWR/ARM — OFF. 4. WPN SELECT — OFF. 5. MASTER ARM — SAFE. 6. LAUNCHER RESET — Initiate. 7. ACRT BIT status words — Check.</p> <p>If no critical faults:</p> <p style="padding-left: 40px;">8. Proceed with the AGM-114 Hellfire Missile Launch checklist.</p> <p>If critical BIT status exists or Hellfire missile launch portion of the mission is complete:</p> <p style="padding-left: 40px;">9. FLIR OPERATION PAGE — Select. 10. HELLFIRE PWR — OFF.</p> <p>If fuel/time permits:</p> <p style="padding-left: 40px;">11. Keep Hellfire missile pointed in safe direction for 30 minutes.</p> |

12.15.5.3 Hellfire Missile Unlatched

| Hellfire Missile Unlatched | | |
|----------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Hellfire Missile Unlatched | | <p>If this occurs, an AOP alert message "XXX MISSILE UNLATCHED" will be displayed.</p> <ol style="list-style-type: none"> 1. Inform the crew. 2. Slow helicopter (70 to 80 KIAS preferable), reduce/limit maneuvering. Avoid flying over populated areas. 3. Perform visual inspection of launcher/missiles. <ol style="list-style-type: none"> a. If the missile appears uploaded normally, land as soon as practical. b. If missile does not appear to be properly seated, land as soon as practical and only fly over uninhabited areas. |

12.15.6 FLIR Uncommanded Lasing

| FLIR Uncommanded Lasing | | |
|-------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| FLIR Uncommanded Lasing | | <p>If the FLIR/LRD continues to lase after the SO or ATO releases the Laser Trigger and LASING alert is visible on the MPD without operator command:</p> <ul style="list-style-type: none"> *1. WEAPON SELECT (AN/ASQ-198) — OFF. *2. MASTER ARM — Verify SAFE. *3. LASER — DISABLE. <p>If lasing continues:</p> <ul style="list-style-type: none"> *4. FLIR PWR — OFF. *5. FLIR circuit breakers — Pull (SO circuit breaker panel, SO OVHD: FLIR AC, FLIR/HFSAC, FLIR/HFS AC) . |

12.15.7 Torpedo Emergencies

12.15.7.1 Hung Torpedo

| Hung Torpedo | | |
|--------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Hung Torpedo | | <p>If a torpedo launch is initiated, and the torpedo remains attached to the BRU-14/A:</p> <ol style="list-style-type: none"> 1. MASTER ARM — SAFE. 2. Point aircraft in a safe direction. 3. Land as soon as practical. |

12.15.8 Stores Emergencies

12.15.8.1 Selective Jettison of M299 Launcher

| Selective Jettison of M299 Launcher | | |
|-------------------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Selective Jettison of M299 Launcher | | <ol style="list-style-type: none"> 1. HELLFIRE PWR — OFF. 2. WPN SELECT — PORT FWD. 3. MASTER ARM — ARM. 4. PWR/ARM — ON. 5. MISSILE MODE/JETT — MAN. 6. Verify the WEAPON LAUNCH switch indicates RDY. <p style="text-align: center;">Note</p> <p style="text-align: center;">Missile Ready indicator light will illuminate.</p> <ol style="list-style-type: none"> 7. WEAPON LAUNCH — Depress. 8. Verify the WEAPON LAUNCH switch indicates AWAY. 9. WPN SELECT — OFF. 10. MASTER ARM — SAFE. 11. PWR/ARM — OFF. 12. Record aircraft position (latitude/longitude). 13. Land as soon as practical. |

12.15.8.2 Hung Sonobuoy/SLC

| Hung Sonobuoy/SLC | | |
|-------------------|---|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| Hung Sonobuoy/SLC | <p style="text-align: center;">Note</p> <p>If a hung SLC is experienced, manual refiring will only move the SLC assembly slightly and bleed down the launcher pressure, thereby losing emergency capability to jettison all sonobuoys.</p> | <ol style="list-style-type: none"> 1. Airspeed — Adjust to 80 KIAS. 2. Visually inspect spider assembly and plumbing for damage. 3. Attempt to dislodge by manually refiring sonobuoy tube. <p>If sonobuoy fails to launch:</p> <ol style="list-style-type: none"> 4. Avoid autorotative flight. 5. Sono Launcher safety valve — SAFE. 6. MASTER ARM — SAFE. 7. Maintain balanced flight and avoid steep turns to the left. 8. Land as soon as practical and avoid populated areas. |

12.15.8.3 LAUNCH/JETT FAIL Caution Light On

| LAUNCH/JETT FAIL Caution Light On | | |
|-----------------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| LAUNCH/ JETT FAIL | | 1. Armament circuit breakers — Pull: <ul style="list-style-type: none"> a. NO. 1 DC PRIMARY BUS marked ARMAMENT JETT A (ATO, ROW 3, CB 11). b. NO. 2 DC PRIMARY BUS marked ARMAMENT JETT B (ATO, ROW 3, CB 21). c. NO. 2 DC PRIMARY BUS marked ARMAMENT SYS (ATO, ROW 3, CB 19). d. NO. 2 DC PRIMARY BUS marked ARMAMENT JETT, JETT D (ATO, ROW 3, CB 22) (BuNo 162349 and subsequent only). 2. Armament circuit breakers — Reset. |


12.16 CREW-SERVED WEAPONS

12.16.1 M60D/M240D Emergencies

A malfunction or stoppage is any interruption in the cycle of operation caused by the faulty action of the gun or ammunition. These malfunctions/stoppages can be further defined as:

1. Hangfire: A delay in the functioning of the cartridge propelling charge.
2. Misfire: A complete failure to fire.

12.16.1.1 M60D/M240D Cook-Off

| M60D/M240D Cook-Off | | |
|------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| M60D/M240D Cook-Off | | *1. Barrel — SAFE DIRECTION. *2. Weapon — ALLOW TO COOL (min 5 minutes). *3. Chamber — INSPECT AND CLEAR. <div style="text-align: center;">  </div> <p>A barrel is considered hot if the gunner has fired 200 or more rounds within 2 minutes (rapid rate of fire). The barrel will become hot enough to cause a cook-off.</p> |

12.16.1.2 M60D/M240D Failure to Fire/Jammed Gun

| M60D/M240D Failure to Fire/Jammed Gun | | |
|---------------------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| M60D/M240D Failure to Fire/Jammed Gun | | <p>*1. Barrel — SAFE DIRECTION. *2. Wait 5 Seconds. *3. Charging Handle — RETRACT AND LOCK. *4. Safety — TO SAFE. *5. Chamber — INSPECT AND CLEAR.</p> <p style="text-align: center;">WARNING</p> <p>If chamber cannot be cleared in 10 seconds a possibility for cook-off exists, close feed tray cover and allow to cool for 5 minutes then re-inspect and clear.</p> <p style="text-align: center;">Note</p> <p>Gun will jam if collection bag is not emptied often.</p> |

12.16.1.3 M60D/M240D Runaway Gun

| M60D/M240D Runaway Gun | | |
|------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| M60D/M240D Runaway Gun | | <p>*1. Barrel — SAFE DIRECTION. *2. Ammo Belt — BREAK BY TWISTING.</p> <p>If weapon does not stop firing:</p> <p>*3. Continue pointing in safe direction until ammo is expended. *4. Chamber — INSPECT AND CLEAR.</p> <p style="text-align: center;">WARNING</p> <p>To avoid further damage, continued firing of weapon shall not be conducted until weapon is inspected.</p> <p>*5. Weapon status — REPORT.</p> |

12.16.1.4 M60D/M240D Clear Weapon Procedures

| M60D/M240D Clear Weapon Procedures | | |
|------------------------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| M60D/M240D Clear Weapon Procedures | | 1. Charging Handle — RETRACT AND LOCK. 2. Safety — TO SAFE. 3. Feed tray cover — OPEN. 4. Ammo — REMOVE. 5. Chamber — INSPECT AND CLEAR. <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">WARNING</div> Failure to ensure no live/expended cartridges remain in the chamber, feed tray, or receiver may result in accidental discharge. Utilize a flashlight if necessary to ensure weapon is clear. 6. Weapon status — REPORT. |

12.16.2 GAU-16/A Emergencies

12.16.2.1 GAU-16/A Cook-Off

| GAU-16/A Cook-Off | | |
|-------------------|---------------|---|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| GAU-16/A Cook-Off | | *1. Barrel — SAFE DIRECTION. *2. Weapon — ALLOW TO COOL (min 5 minutes). <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">WARNING</div> Avoid opening the feed cover of a hot gun. If cook-off occurs, there may be a pause between firings. Allow to cool for 5 minutes after last round has fired. *3. Chamber/T-slot — INSPECT AND CLEAR. |

12.16.2.2 GAU-16/A Jammed Gun

| GAU-16/A Jammed Gun | | |
|---------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| GAU-16/A Jammed Gun | | *1. Barrel — SAFE DIRECTION. *2. Wait 5 seconds. *3. Charging handle — CHARGE ONCE. *4. Attempt to fire. If weapon does not fire: *5. Chamber/T-slot — INSPECT AND CLEAR. |

12.16.2.3 GAU-16/A Runaway Gun

| GAU-16/A Runaway Gun | | |
|----------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| GAU-16/A Runaway Gun | | <p>*1. Barrel — SAFE DIRECTION. *2. Charging handle — PULL DOWN.</p> <p style="text-align: center;">WARNING</p> <p>Avoid opening the feed cover of a hot gun. If cook-off occurs, there may be a pause between firings. Allow to cool for 5 minutes after last round has fired.</p> <p>*3. Feed tray cover — OPEN. *4. Ammo — REMOVE. *5. Feed tray cover — CLOSE. *6. Charging handle — CHARGE ONCE. *7. Chamber/T-slot — INSPECT AND CLEAR.</p> <p style="text-align: center;">WARNING</p> <p>To avoid further damage, continued firing of weapon shall not be conducted until weapon is inspected.</p> |

12.16.2.4 GAU-16/A Clear Weapon Procedures

| GAU-16/A Clear Weapon Procedures | | |
|----------------------------------|---------------|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| GAU-16/A Clear Weapon Procedures | | <ol style="list-style-type: none"> 1. Safety — SAFE. 2. AN/PEQ-3 — OFF. 3. AN/PEQ-3 lens covers — ON. 4. Feed tray cover — OPEN. 5. Ammo — REMOVE FROM FEED TRAY. 6. Feed tray cover — CLOSE. 7. Charging handle — CHARGE ONCE. 8. Feed tray cover — OPEN. 9. Chamber/T-slot — INSPECT AND CLEAR. <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">WARNING</div> <ul style="list-style-type: none"> ● Chamber may be hot. Use caution while inspecting T-slot. ● If chamber is not clear, repeat steps 6. through 9. once and remove any remaining rounds. If unable to clear weapon, execute hung ordnance procedures IAW local directives. <div style="border: 2px dashed black; padding: 2px; width: fit-content; margin: 10px auto;">CAUTION</div> <p>Do not disassemble the GAU-16 while attempting to clear weapon in flight.</p> <ol style="list-style-type: none"> 10. Weapon status — REPORT. |

12.16.2.5 AN/PEQ-3 Uncommanded Lasing

| AN/PEQ-3 UNCOMMANDED LASING | | |
|-----------------------------|--|--|
| LEGEND | CAUSE/REMARKS | CORRECTIVE ACTION |
| AN/PEQ-3 Uncommanded Lasing | <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 0 auto 10px auto;">WARNING</div> <p>The AN/PEQ-3 Laser is a class 3B non-eyesafe laser with a NOHD of 263 meters.</p> | <ol style="list-style-type: none"> *1. AN/PEQ-3 — OFF. *2. AN/PEQ-3 lens covers — ON. *3. Batteries — REMOVE. |

PART VI

All-Weather Operations

[Chapter 13](#) — Instrument Procedures

[Chapter 14](#) — Extreme Weather Operations



CHAPTER 13

Instrument Procedures

13.1 INSTRUMENT FLIGHT PROCEDURES

With the exception of some repetition necessary for continuity, the procedures and techniques contained in this chapter are only those that differ or are in addition to normal operating procedures. Prior to conducting instrument flying, careful preflight planning is necessary. Refer to the NATOPS Instrument Flight Manual for detailed instrument flight procedures.

13.1.1 Instrument Takeoff (ITO)

During a full ITO (no external visual reference), the hover bars will provide the only indication of stability over the ground.

The following general procedures are recommended:

1. Select hover bars.
2. Smoothly increase collective to takeoff power and maintain a hover attitude by referencing the AI. Allow AFCS to maintain heading (feet off pedal trim microswitches once airborne).
3. Smoothly increase collective to climbout power. As the helicopter passes through 20 feet on the radar altimeter, position the cyclic forward to establish a 5° nose down attitude and accelerate into forward climbing flight.
4. As the helicopter accelerates, crosscheck radar altimeter and VSI for positive rates of climb. Rate of climb should be 500 fpm or greater.
5. Maintain a smooth acceleration up to 90 KIAS, referencing the AI and airspeed indicator.

13.1.2 Instrument Crew Coordination

In order to prevent possible pilot task saturation, the flight crew shall discuss and assign cockpit responsibilities prior to instrument flight. The responsibilities shall include complying with clearances, making radio calls, switching navigation aids and radios, monitoring navigation, reviewing approach procedures, maintaining a visual/instrument scan during an approach, and landing procedures. Prior to commencing an instrument approach, the pilots should review approach publication information. The PAC shall comply with clearances and should make radio calls. The PNAC should notify the PAC of deviations from published or assigned procedures, call the field in sight, and backup the PAC during visual transition following an approach. The aircrewmembers should monitor the radios and maintain a good lookout.

13.1.2.1 Instrument Climbs and Descents

The PAC shall verbalize his intentions to vacate one altitude for another. The PNAC shall monitor flight instruments and provide "100 FEET PRIOR" (or as briefed) call. Upon reaching intended altitude, the PNAC shall verbally note that RDRALT/BARALT pushbutton is latched/steady.

13.1.3 Instrument Approach Procedure

Two methods for ensuring cockpit coordination and instrument scan responsibility are recommended: change of scans or change of controls. Instrument scan responsibility shall be specifically briefed.

Note

Pilots shall verbally acknowledge a change of scan responsibility by use of phrases such as "I'M ON INSTRUMENTS," or "I'M VISUAL".

13.1.3.1 Change of Scans

In this procedure, the PAC flies the instrument approach and makes the landing. The PAC maintains an instrument scan until the landing phase commences. The PNAC backs up the PAC on instruments and scans outside for the landing environment. Once the PNAC has the landing environment in sight, and can safely continue the approach, the PACE will provide the PAC with a brief description of the visual approach (e.g., glideslope, line-up) and then assume instrument scan responsibilities. The PAC shall commence a visual scan outside and continue the approach to a landing. The PNAC maintains an instrument scan until landing is assured. If a missed approach is initiated, the PAC will ensure obstacle clearance and then assume instrument scan responsibilities. The PNAC will provide backup instrument scan.

13.1.3.2 Change of Controls

In this procedure, the PAC flies the instrument approach and switches controls to the PNAC for landing. Once the PNAC has the landing environment in sight, and can safely continue the approach visually, the PNAC shall inform the PAC, take the flight controls and continue the approach to landing. The initial PAC continues an instrument scan until landing is assured. If a missed approach is initiated, the initial PAC reassumes control of the aircraft and the initial PNAC provides backup instrument scan and obstruction clearance.

13.2 SIMULATED INSTRUMENT FLIGHTS

13.2.1 Lookout Procedures

The possibility of a midair collision requires continuous caution when engaged in simulated instrument flights. When the PAC's attention is directed toward controlling the aircraft on instruments, the area of surveillance for which the PAC is responsible shall be covered by a lookout familiar with aviation, instructed in specific duties, and provided with direct communication to the pilots.

13.2.2 Safety Precautions

Since the PAC will be devoting total attention to instrument flying, the PNAC will operate the navigation equipment and assume lookout responsibility. When engaged in simulated instrument flights, the crew is responsible for knowledge of and compliance with the following safety precautions:

1. The lookout shall be indoctrinated thoroughly in the nature and importance of specific duties and shall not be distracted from the assigned duties.
2. ICS shall be operable between both pilots and lookout during simulated instrument flight.

13.3 UNUSUAL ATTITUDES

13.3.1 Unusual Attitudes

Unusual attitudes are considered to be pitch attitudes in excess of 30° and/or roll attitudes in excess of 60°. Unusual attitudes will mostly likely be encountered following an AFCS malfunction, AI degradation, vertigo or poor instrument scan.

13.3.2 Unusual Attitude Recovery

If the pilot uses information presented by the AI correctly, a recovery from an unusual attitude can be executed quickly. If AI degradation is suspected, the importance of crosschecking the operable AI must be stressed. If both AI indications are erroneous, the PAC shall immediately switch to a partial panel instrument scan and commence recovery.

While reducing airspeed during recovery from an unusual attitude is important, the recovery can be expedited by decreasing the angle of bank while simultaneously applying aft cyclic. As soon as the angle of bank is corrected, the airspeed indicator and altimeter become the primary pitch instruments. Airspeed should be crosschecked with the AI to obtain an instant indication of pitch attitude. High sink rates can be experienced with no change in attitude.

Therefore, the radar altimeter and VSI should be given strong emphasis. Do not chase the VSI upon recovery. When a diving spiral is experienced, excessive aft cyclic may aggravate the maneuver, tighten the turn, and result in blade stall.



During unusual attitude recoveries, avoid excessive forward airspeed and conditions of flight near a hover where vortex ring state conditions may occur.

See [Chapter 12](#) for the Unusual Attitude Recovery emergency procedure.

CHAPTER 14

Extreme Weather Operations

14.1 COLD-WEATHER OPERATIONS

14.1.1 General

Extreme cold temperatures and conditions cause adverse effects on aircraft materials. Rubber, plastic, and fabric material stiffen, and may crack or even shatter, when loads are applied. Oils congeal and grease hardens. Dissimilar metals contract differentially. Moisture, usually from condensation or melted ice, freezes in critical areas. Tire, landing gear strut, and accumulator air pressures decrease as the temperature decreases. Refer to [Chapter 3](#) for specific cold-weather servicing requirements. Extreme diligence on the part of both ground and flight crews is required to ensure successful cold weather operations. Since it is not usually practical to completely cover an unhangared aircraft, those parts not protected by covers require particular attention. If hangar space is available, the aircraft should be kept in a heated hangar when OAT is forecast below 0 °C (32 °F).

For cold-weather flights, use the normal procedures in [Chapter 7](#), with the exceptions or additions in the following paragraphs.

14.1.2 Cold-Weather Preflight Check

14.1.2.1 Exterior Inspection

1. Check the fuel drains for ice. Blockage of the drains may be an indication of water in the fuel tanks.
2. Check engine inlets for ice or snow, specifically at the lowest point up to the front swirl vanes. If ice or snow is found, remove as much as possible by hand and then thaw the engine out with heated air or deicing fluid before attempting start.

**CAUTION**

- Ice removal shall never be done by scraping or chipping. Remove ice by applying heat or approved de-icing fluids.
 - Failure to remove ice and snow will cause engine damage.
3. Check main rotor head and blades, tail rotor, and flight controls for ice and snow.

**CAUTION**

Failure to remove snow and ice accumulations can result in serious aerodynamic and structural effects in flight.

4. Check the following vents/ports for ice blockage:

**CAUTION**

Failure to ensure vents/ports are free from ice can cause false and erratic instrument indications and equipment malfunctions.

A1-H60BB-NFM-000

- a. Fuel tank vents.
 - b. Engine oil tank vents.
 - c. Transmission vents.
 - d. Battery vent.
 - e. Pitot-static tubes and ports.
5. Check that tires are not frozen to the ground.
 6. Check landing gear struts and hydraulic accumulator for proper servicing.
 7. Apply preheat if available.

14.1.2.2 Interior Inspection

1. Check PCL's for freedom of movement before engine start.



A PCL that is difficult to move may be indicative of a frozen power available spindle (PAS) or PAS cable. Do not force PCL movement as this may damage the PAS cable.

2. Flight controls may be difficult to move after the aircraft has been cold soaked. If the controls are not sufficiently free for a safe start and low power warm-up, heat the affected controls.
3. Install THPs in the [MTMU](#) just prior to engine start.

14.1.3 Engine Oil System Characteristics

1. It is normal to observe high engine oil pressure during initial starts when oil is cold. Run engine at IDLE until oil pressure is within limits. Oil pressure should return to the normal range after operating 5 minutes. However, time required for warm-up will depend on temperature of the engine and lubrication system before start.
2. During starts in extreme cold weather (near -40°C), the following oil pressure characteristics are typical:
 - a. Oil pressure may remain at zero for about the first 20 to 30 seconds after initiating the start. Abort the start if there is no oil pressure within 1 minute after initiating a start.
 - b. Once oil pressure begins to indicate, it will increase rapidly and exceed the prescribed 100-psi limit. The pressure will decrease below 100 psi 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 occur within 5 minutes after starting the engine. Do not advance the PCL to FLY until engine oil pressure is indicating normal.
 - c. Oil pressure may increase above the maximum pressure limit if the engine is accelerated above idle while oil temperature is below normal operating range. The pressure will decrease to within the normal operating range as the oil temperature increases. The impending bypass indicator has a thermal lockout below 38°C to prevent the PDI button from popping. The OIL FILTER BYPASS caution may appear during cold starts. When engine oil temperature reaches approximately 38°C , the caution should disappear.

14.1.4 Engine Starting

Although cold weather does not generally affect normal engine operation, it may result in problems such as ice in fuel lines, control valves and fuel sumps, possibly preventing a successful cold weather start. Consideration should be given to preheating fuel components prior to flight operations.


CAUTION

When starting an engine that has been exposed to low temperatures overnight, watch for a rise in TGT within 40 seconds. If no TGT rise is evident, abort the start. Prime the engine and attempt another engine start. If there is no overboard fuel flow during prime, inspect for ice in the sumps and filters. During cold weather operation, allow longer warm-up period to bring transmission oil temperature up to desired operating range. Monitor oil pressure and temperature closely.

Note

When on an icy surface, it is advisable to utilize No-Rotor Brake Start Procedures to prevent possible aircraft rotation caused by the rapid increase in torque experienced during a Rotor Brake Start Procedure and engagement.

14.1.4.1 Engine Warmup and Control Exercise

1. At temperatures between -17°C and -31°C , warm up engine at IDLE for 3 minutes. During engine warm-up, position cyclic control 1 inch forward of neutral and move tail rotor pedals alternately $3/8$ inch.
2. At temperatures between -31° and -40°C , warm up engine at IDLE for 3 minutes. During engine warm-up, position cyclic control $5/8$ inch forward, gradually increasing cyclic movement to 2 inches. Move each tail rotor pedal $1/8$ inch, and gradually increase movement to $1/2$ inch.

Note

Consideration should be given to using the ROTOR BRAKE START procedure during engine warm-up.

14.1.4.2 Taxiing

The helicopter should not be taxied until all engine temperatures and system pressures are within normal limits. Taxiing in soft snow or on ice offers special problems. All taxiing should be done at low speeds, with wide-radius turns. The distance from obstructions and other aircraft should be as large as possible. Taxiing in snow usually requires higher than normal taxi power, which reduces visibility from blowing snow. If this should occur, taxi at a slower ground speed or have the helicopter towed to a takeoff position. A buildup of snow may occur in front of tires; after passing snow buildup, taxiing will be normal. Do not exceed 15 KGS.

14.1.4.3 Takeoff

Cold weather presents no particular takeoff problems unless the cold weather is accompanied by snow. A slight yawing motion, induced by light pedal application, should break the tires free when they are frozen to the surface. The problem of restricted visibility, due to blowing or swirling snow (from the rotor wash) can be acute and may require use of ITO procedures. Minimum time should be spent in a hover prior to transition to forward flight. If the takeoff area is surrounded by a large expanse of smooth, unbroken snow, there is danger that the pilots may become disoriented because of the absence of visible ground reference objects. In this case, use any available fixed objects for reference. The distances used will depend on the size and color of the objects and the type of takeoff.

14.1.4.4 Cruise

During cruise, use the APU for ECS operation, as required. If the flight is over large, unbroken expanses of snow, the helicopter should be flown entirely on instruments at a safe altitude. Another important factor that should not be overlooked is the effect of low temperatures upon true airspeeds, DA, and fuel consumption.

With ECS on, maximum torque available is reduced by approximately 7 percent per engine. Fuel flow will increase by approximately 45 pounds per hour per engine. With engine anti-ice on, maximum torque available is reduced by up to 18 percent per engine and can be reduced by up to 49 percent if the inlet anti-ice valve has malfunctioned. Using the APU to power the ECS will increase fuel consumption by approximately 150 pounds per hour.

14.1.4.5 Landing

During normal operations, helicopters are often required to land or maneuver in areas other than prepared airfields. During cold-weather operations, 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 no drift effect. The snow depth is usually greater on the downward side of ridges and wooded areas. Whenever possible, the crew should familiarize themselves with the type of terrain under the snow (tundra, brush, marshland, etc.). Running landings are recommended when landing on loose snow. Maintain enough ground speed to remain ahead of a snow cloud, but not over 15 KGS on touchdown.

On all snow landings, anticipate the worst conditions; restricted visibility due to loose swirling 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 the rotorwash on the snow. If possible, use prominent ground-reference objects during the approach and landing. If no such objects are available, a reference marker dropped from the helicopter will suffice. After contacting the surface, slowly decrease collective until the aircraft is firmly on the ground. Be ready to take off immediately. If, while decreasing collective, one wheel should hang up or break through the crust; do not reduce power until it is positively determined that the aircraft will not settle. If possible, have a crewmember visually check the surface before reducing power.

Note

When shutting down on an icy surface, it is advisable to allow the rotor to coast down to prevent possible aircraft rotation caused by a rapid application of the rotor brake.

14.1.5 Before Leaving the Helicopter

1. Protect the wheels from freezing to the ground by towing/taxiing on to planks or sandbags.
2. Leave the parking brake off.
3. Open the scuppers on cockpit windows. This will permit sufficient air circulation to retard frost formation and reduce cracking of transparent areas due to differential contraction.
4. Drain moisture accumulations from sumps and strainers as soon as possible.
5. Install engine inlet plugs after shutdown to prevent accumulation of ice and snow in engines.
6. Remove the THPs from the MTMU to prevent them from freezing. Keep them in a heated space until needed.

14.2 SNOW PRECAUTIONS

The problems encountered when operating from covered surfaces are significant. The restricted visibility caused by blowing snow can be partially overcome by placing smoke grenades or colored objects, such as pine boughs, a painted drum, or a panel marker in the landing area for visual reference. The smoke grenade will indicate the wind direction and allow an estimate of the wind direction and velocity. The pilot should be aware of the fact that there is no horizon reference when flying over large, unbroken expanses of snow. If this situation exists, fly at a safe instrument altitude and use the attitude indicator for a horizon reference. When preparing to land, select an area devoid of loose or powdery snow to minimize the restrictions to visibility from blowing snow. Takeoffs into fog or low clouds when the temperature is at or near freezing could result in engine air inlet icing. Climb speeds should be higher than normal under such conditions.

Running takeoffs are permitted if groundspeed is held to 60 knots or below on level terrain before leaving the ground. Running landings are recommended when landing on loose snow. Maintain enough groundspeed to remain ahead of a snow cloud but not to be over approximately 15 knots at touchdown.

14.3 ICE PRECAUTIONS

Icing conditions will affect aircraft in numerous different manners dependent on the OAT and level of the icing conditions encountered. If unanticipated icing conditions are encountered, your first consideration should be to exit the icing environment. If unable to exit the icing environment, it is necessary to have an understanding of the icing severity levels and factors that affect ice accumulation rates in addition to the possible degradations that may occur in aircraft performance.

WARNING

- Flight into known icing conditions without de-ice equipment is prohibited.
- Flight into forecasted or known moderate or severe icing conditions is prohibited.
- OAT gauges are not calibrated instruments and may provide false information.
- Ice shed from the rotor blades and/or other rotating components presents a hazard to personnel during landing and shutdown.

CAUTION

- Ice shed from the main rotor may strike the tail rotor during rapid descents following flight in icing conditions.
- Ice formation on the lower hub assembly of the main rotor head may prevent droop-stop engagement on shutdown.

14.3.1 Engine/Inlet Anti-Icing

The engine inlet has a tub area forward of the swirl vanes with no provision to drain water which may collect. Water pooled in the intake ducting will freeze in cold weather and may result in foreign object damage (FOD). Since it can only be removed using approved de-ice fluid or hot air, pooled water must be removed prior to freezing. Intakes shall also be checked for ice on preflight.

When the engines are operating and the OAT reaches 5 °C or below in visible moisture, the engine inlet guide vanes and the inlet are susceptible to icing. The ENG ANTI-ICE switches shall be turned on when OAT is 5 °C or below in visible moisture.

CAUTION

Ice damage to the T700 engine may be characterized by a high pitched noise with no associated power loss or secondary indication.

Note

Significant power available losses and increased fuel consumption can be expected as a result of the actuation of the engine and engine inlet anti-ice systems.

14.3.2 Helicopters Not Equipped with Blade De-Ice

If icing conditions are encountered or the ICE DETECTED caution appears due to suspected icing conditions, immediately turn on all anti-icing equipment, seek a condition where icing is not present, and land as soon as practical (Refer to [Chapter 12](#) for emergency procedure). Initial ice accumulation will be noted on the windshield wiper arms, mirror support brackets, main landing gear and external stores. The main rotor blades may undergo periodic shedding of ice that will result in light to moderate vibrations felt through the controls and the airframe. Ice shedding from the main and tail rotor may strike each other and the fuselage causing dents in the blades and the airframe.

Ground personnel should remain well clear of the helicopter during landing and shutdown, and passengers and crewmembers should not exit the helicopter until the rotor has stopped. The aircraft should be closely inspected following flight in icing conditions.

14.3.3 Ice Rate Detector

The ice rate detector, mounted on the NO. 2 engine cowling, senses the accumulation of ice and activates the ICE DETECTED caution. Correspondingly, an aspirate heater on the probe is activated to heat the probe and shed the ice. As the ice melts, the ICE DETECTED caution will disappear. The frequency at which the ICE DETECTED caution cycles on and off may give an indication of the icing severity level.

14.3.4 Helicopters Equipped with Blade De-Ice

Flight is permitted in forecast or known trace or light icing conditions. All anti-ice/de-ice systems shall be turned on prior to entering visible moisture (including clouds) at ambient temperatures of 5 °C or less. When icing is unexpectedly encountered, turn on all anti-icing and de-ice equipment immediately.

Refer to [Chapter 22](#) for torque available. An additional torque increase up to 14 percent per engine may be experienced due to ice build-up during normal operation of the blade de-ice system. The crew should closely monitor engine instruments to prevent exceeding limits and/or rotor droop.



Ice accumulation resulting in a 20 percent torque increase indicates that normal autorotational rotor rpm may not be attainable should dual-engine failure occur.

The main rotor hub and blades may accumulate ice prior to initiation of a de-ice cycle. Moderate vibration levels of short duration can be expected in the controls and airframe during normal de-ice cycles. The torques should be carefully monitored for any constant torque increase over clear air torque. An increase of over 10 percent matched torque should result in urgent consideration to vacate the environment, unless the task is considered essential.

Should unacceptable vibration levels and excessive torque requirements persist, the pilot should leave the icing environment as soon as possible.

If torque required increases 20 percent above that required for level flight, at the airspeed being maintained prior to entering icing, exit the icing environment or land the aircraft as soon as possible. Some impact damage to the aircraft can be expected during flight into icing conditions.

If the blade de-ice system is not operating, asymmetric shedding of ice may cause imbalances, which may result in severe vibrations. These vibrations will normally subside after 30-60 seconds when ice from other blades is shed. Some impact damage to the aircraft can be expected during flight into icing conditions.

Icing of the droop stops and anti-flapping restrainers during extended flight in icing conditions may prevent their normal operation during rotor shutdown. When the droop stops fail to engage, the main rotor blades may droop to within four feet of the ground during shutdown. Strong, gusty winds may also cause excessive flapping of the main rotor blades, presenting the additional hazard of potential contact with the aft fuselage. If the droop stops are suspected to be stuck in the flight position, caution must be exercised during shutdown to ensure personnel remain clear and flight controls are positioned to avoid excess main rotor blade flapping. Refer to [Chapter 12](#) for the appropriate emergency procedure.



- The potential exists for incomplete blade fold following flight in icing conditions. Visually ensure all blade fold micro-switch contact surfaces are free of ice accumulations prior to attempting a blade fold sequence.
- The potential exists for the anti-flapping devices to remain in the open position following flight in icing conditions.

14.3.5 Pitot-Static Tube Heater

Pitot heat shall be turned on when OAT is 5 °C or below and/or visible moisture is present.



Failure to turn on pitot heat in icing conditions may cause erroneous airspeed indications, which may lead to downward programming of the stabilator and loss of control of the aircraft.

14.4 THUNDERSTORMS AND TURBULENCE

14.4.1 Thunderstorms

Avoid flight through or near thunderstorms. If thunderstorms are encountered during flight, consider the option of landing and waiting for the storm to pass, if possible.

A severe lightning strike to the aircraft is likely to result in the loss of all electrical power sources, except the battery (including the APU generator even if it is not operating at the time), and in damage to a majority of electronic circuits. Due to electrical system design, battery power may only be available for operation of components associated with the battery utility bus following a lightning strike. With the loss of all electrical power, the only remaining instruments still available to the pilots for an emergency landing would be the standby instruments. A lightning strike that induces voltages in the engine wiring harness would significantly damage the DECU's and possibly other related components.

14.4.2 Turbulence

The aircraft should not be flown in a manner that will result in deviations from the normal limitations. Use the following techniques when operating in turbulent air.

14.4.2.1 When Encountering Turbulent Air

The following procedures are recommended:

1. Crew — Alert.
2. Airspeed — Adjust as follows:
 - a. For moderate turbulence, limit airspeed to blade stall speed minus 15 knots.
 - b. For light turbulence, limit airspeed to blade stall speed minus 10 knots.
3. Loose equipment — Secure.

14.4.2.2 In Turbulent Air

The collective position, when adjusted for the airspeeds mentioned above, should not be adjusted and the AI should be used as the primary pitch instrument. The pitot static instruments may vary excessively in turbulence and should not be relied upon. Airspeed indications may vary as much as 40 KIAS. By maintaining a constant collective position and a level flight attitude on the AI, airspeed will remain relatively constant even when erroneous readings are presented by the airspeed indicator.

14.4.2.3 Starting Rotors

Position the helicopter into the wind. Hold the cyclic into the wind and increase the rotor rpm immediately to prevent excessive flapping of the blades. (Refer to [Chapter 4](#) for maximum wind velocities for engaging rotors).

14.4.2.4 Descending

A long, fairly flat approach with power on will afford better handling characteristics than will a steep, slow, or low-power approach.

14.4.2.5 Stopping Rotors

Position the helicopter into the wind. Use the normal procedure for stopping rotors. Hold the cyclic into the wind to reduce the tendency of blades to bump against the droop stops. Apply the rotor brake when the rotor speed is reduced below 40 percent.

14.5 RAIN PRECAUTIONS

Pitot heat shall be turned on when visible moisture is present to reduce water accumulation in the pitot static system.

Note

Water intrusion into nose bay avionics compartment can lead to AFCS computer failure.

14.6 HOT WEATHER AND DESERT OPERATIONS

More power will be required to hover during hot weather than on a standard day. Hovering altitude will be lower for the same gross weight and power settings on a hot day. Plan the flight thoroughly to compensate for existing conditions by using the Performance Charts in [Part XI](#). When weather conditions permit, leave scupper vents and cabin doors open on the ground to ventilate the helicopter.

Note

- Fuel densities will decrease as the ambient temperature rises, resulting in a decrease in operating range.
- High humidity increases the DA and effectively reduces the efficiency of the rotor system. For every 10 percent increase in relative humidity the DA increases approximately 100 feet. Thus a high relative humidity, close to 100 percent, can effectively increase the DA by as much as 1,000 feet.

During ground operations, if engine oil pressure falls into the red range when the PCL lever is in the IDLE position and/or the ENGINE OIL PRESS caution light comes on when the PCL lever is in the idle position, slightly advance the PCL lever. If the engine oil pressure returns to the yellow range and the ENGINE OIL PRESS caution light extinguishes, engine oil pressure is acceptable.

14.6.1 Desert Procedures

Desert operations generally involve operating in a very hot, dry, dusty, often windy atmosphere. Under such conditions, sand and dust will often be found in vital areas. Severe damage may be caused by sand and dust. Consider towing the helicopter into takeoff position. If possible, takeoff should be on a hard, clean surface, free from sand and dust.

Note

Operations in extremely dusty conditions for extended periods may cause the ICE DETECTED caution light to illuminate due to particle buildup on the detector.

14.6.2 Preflight Inspection

Plan the flight thoroughly to compensate for existing conditions by using the Performance Charts in [Part XI](#). Check for sand and dust in control hinges, actuating linkages, and inspect tires for proper inflation. High temperatures may cause over-inflation. Check oleo struts for sand and dust, especially in the area next to the cylinder seal, and remove any accumulation with a clean, dry cloth. Inspect for and remove any sand and dust deposits on the instrument panel, switches, flight controls, and the engine control quadrant.

14.6.3 Engine Starting

If possible, engine starting and ground operations should be made from a hard, clean surface with aircraft positioned into the wind.

14.6.4 Taxi

When it is absolutely necessary to taxi in sand and dust, get the helicopter airborne as quickly as possible to lessen sand and dust intake by the engines and erosion of the main rotor blades.

14.6.5 Takeoff

Execute takeoff and climb as rapidly as possible.

14.6.6 Cruise

Avoid flying through sand or dust storms, when possible. Excessive dust and grit in the air will cause considerable damage to internal engine parts and erosion of the main rotor blades.

14.6.7 Landing

The best procedure to lessen blowing sand and dust during landing is a steep approach with a no-hover landing.

14.6.8 Engine Shutdown

Shut down the engine as soon as practical, to lessen the intake of sand and dust.

14.6.9 Postflight Inspection

Install all protective covers and shields. Except when sand and dust are blowing, leave scupper vents and cabin doors open to ventilate the helicopter.

PART VII

Communications and Navigation

[Chapter 15](#) — Communication Equipment and Procedures

[Chapter 16](#) — Navigation



CHAPTER 15

Communication Equipment and Procedures

15.1 COMMUNICATIONS

15.1.1 Introduction

The communication subsystem handles the transfer of sensor and tactical data between the helicopter and ship and also routes internal communication among helicopter crewmembers. The communication subsystem has the following capabilities:

Note

- Aircraft BuNo through 162990 are equipped with ARC-159 UHF radio sets. Aircraft BuNo 162991 and subsequent are equipped with ARC-182 UHF/VHF radio sets. VHF and UHF FM are additional capabilities provided by the ARC-182 UHF/VHF radio sets.
- To prevent hot mike of other selected transmitters and loss of VOX ICS, ensure the ANDVT (USC-43/KYV-5) HF SECURE toggle switches are OFF when not in use. The toggle switches are mounted on the side of the center console, one on the pilot side and one on the ATO side.

1. Two-way clear or secure voice (UHF or UHF/VHF) between the helicopter and other units (KY-58 and ARC-159 or ARC-182).
2. Two-way clear or secure, over-the-horizon voice (HF) between the helicopter and other units (KYV-5 and ARC-174).
3. Two-way secure computer-to-computer data link for data and voice transfer (KG-45 and ARQ-44).
4. Transmission of sonobuoy command tones.
5. Communications relay (UHF or UHF/VHF).
6. IFF/SIF interrogation and identification of friendly or hostile targets and response to interrogations from friendly forces. THP 21 permits IFF interrogation from ATO and SO keysets.

The communication subsystem performs five major functions:

1. Communications control.
2. Data link between ship and helicopter.
3. Voice communications.
4. IFF.
5. Intercommunications.

15.1.1.1 Communications System Control Group

The communications system control group (CSCG) provides a central control and interface capability for internal and external communications in the LAMPS MK III System.

The CSCG consists of:

1. Audio-converter processor (ACP).
2. Communications control panel (COMM CONTR).
3. Radio control panels (remote switching control (RSC)) for pilot, ATO, SO, and observer.
4. Hoist operator position and maintenance interconnecting boxes (IB).

Communication signals are routed through the CSCG in order to provide a single point of control for selection and routing of radio and intercommunications signals. The ATO or pilot controls the operating mode and tuning of UHF or UHF/VHF radios, selection of clear or secure-voice communications, and IFF interrogation from the COMM CONTR. The CSCG collects equipment status information from communications units and displays failures by means of status lights located on the COMM CONTR Panel. CSCG reports overall status over the 1553 data bus to digital data computer 1 (AYK-14) (SAC-1). The CSCG also receives and distributes audible warning tones as follows:

1. Low altitude:
 - a. High index (250 feet) — Approximately 6 tone pulses at both pilot stations.
 - b. Variable index (set on the RAD ALT) — Approximately 6 tone pulses and a steady red light at each pilot station corresponding to the individually set variable index.
 - c. Low index (35 feet with coupler engaged) — Continuous tone and light pulses at both pilot stations.
2. RAD ALT failure — A continuous beeping tone at both pilot stations indicating a loss of track.
3. Helicopter threat warning — Three tones which may be initiated by the AOP are addressable via the 1553 bus (for use on BuNo 162991 and subsequent only).

Note

The aural alert will occur only if the aircraft is equipped with a -29 Audio Converter-Processor.

4. Stabilator failure — A unique beeping tone at both pilot stations.
5. Missile warning — A unique audible warning can be heard at each pilot station when a missile plume is detected or the system is tested.

The CSCG also performs automatic UHF radio switching under software control to send signals to command activated sonobuoys. The actual sonobuoy commands are generated by the acoustic subsystem.

Power is supplied from the NO. 2 DC primary, NO. 1 AC primary, and AC essential buses through three circuit breakers, all marked CONV PROCR AUDIO. They are located on the ATO and center circuit breaker panels.

15.1.1.1.1 Audio Converter-Processor

The ACP is located under the lower console and performs switching, processing, and routing of command and control data for the following:

1. UHF or UHF/VHF receiver/transmitters.
2. Speech security equipment.
3. Direction finder group.
4. Data link.
5. IFF interrogator.
6. Sonobuoy receivers.
7. ICS.

If the frequency display on the COMM CONTR Panel goes to all zeros (0) and does not return, this may be cleared utilizing the following procedure:

1. Set CSCG AUTO/MAN to MAN.
2. Depress and release TEST.
3. After approximately 5 seconds, depress and release TEST again.
4. System should now be in normal operation. If not, cycle PWR to the affected UHF radio. (Radio NO. 1 R/T UHF on DC ESS BUS; radio NO. 2 R/T UHF on NO. 2 DC PRI BUS.)
5. If the problem is still not cleared, cycle CONV PROCR AUDIO (NO. 1 AC PRI BUS). System should now be in normal operation. Return AUTO/MAN to AUTO.

Note

In an emergency, selection of BKUP will allow immediate use, following backup procedures.

15.1.2 Communications Control Panel

Primary control of the communication subsystem is through the communications control (COMM CONTR) panel, located on the cockpit lower console. Individual controls and indicators are described in [Figure 15-1](#) for ARC-159 radio sets or [Figure 15-2](#) for ARC-182 radio sets. The COMM CONTR panel provides control for UHF-1, UHF-2, HF Secure, Data Link, intercommunication, and IFF Interrogator, along with certain associated navigation functions. The primary functions of the COMM CONTR panel are:

1. UHF and VHF mode, channel, and frequency selection.
2. UHF, VHF, and HF clear/secure mode selection.
3. IFF interrogator mode and code selection.
4. CSCG automatic or manual mode selection.
5. OTPI selection and tuning.
6. Self-test initiation.

Note

All aircraft communications will be interrupted for approximately 45 seconds during a CSCG self-test. If initiated while airborne by inadvertent depression of the CSCG TEST pushbutton, selection of test from the equipment status table of the data handling/data display subsystem or reinitialization of the CSCG, place the CSCG mode switch to manual and press the CSCG self-test pushbutton to abort the test.

7. Status display.

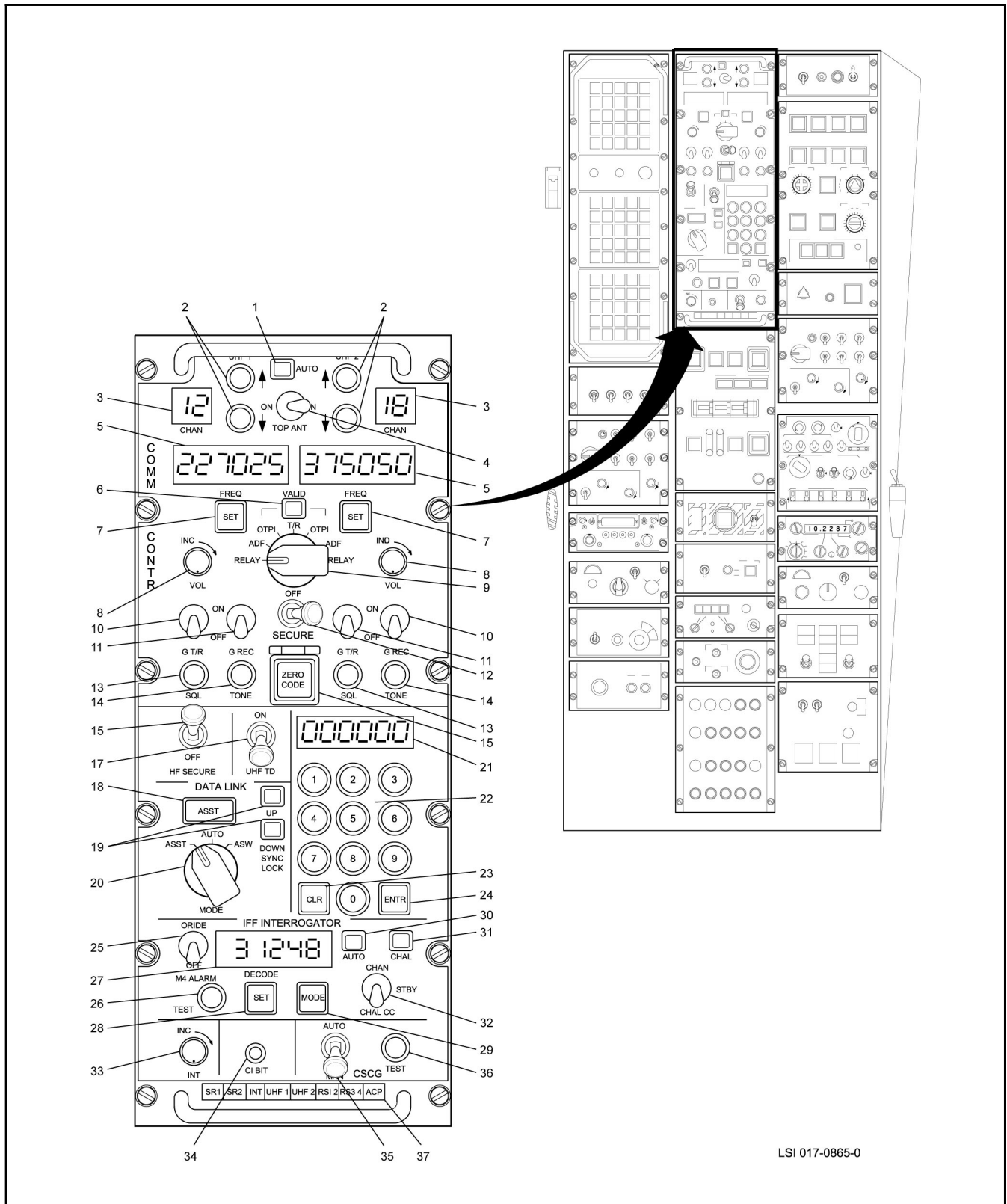


Figure 15-1. Communications Control Panel (BuNo through 162990) (Sheet 1 of 5)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|---|--|
| | COMM CONTR | The communications control panel allows manual or computer control of the communications subsystem. |
| 1 | AUTO | Indicates software control of CSCG functions. Not currently implemented in the SH-60B. |
| 2 | UHF-1, UHF 2 (Channel Select-up/down) | Four pushbutton switches, two switches for each UHF/VHF radio. Upper switch increases channel number by one for each actuation; lower switch decreases the channel number by one for each actuation. |
| 3 | CHAN | Channel, two-digit, numeric display indicating UHF or OTPI channel being used. Two displays, one for UHF-1 and one for UHF-2. Displays 00 to 20 for normal UHF; 01 to 31 for OTPI. Channel selection accomplished by operating UHF-1, UHF-2 pushbuttons. If G T/R is selected, CHAN is blanked. |
| 4 | TOP ANT ON (Right) ON (Left) | Top antenna, two-position, left-right toggle switch. UHF-2 assigned to top antenna; UHF-1 to bottom antenna. UHF-1 assigned to top antenna; UHF-2 to bottom antenna. |
| 5 | FREQ | Two, six-digit, numeric displays, one for UHF-1 and one for UHF-2. Indicates active frequency corresponding to channel selected, frequency spans 225.000 to 399.975 MHz in 25 kHz steps. 243.000 MHz displayed, if G T/R ON is selected. Not affected by OTPI selection. |
| 6 | VALID Black Green | Two-position, magnetic flag indicator which indicates OTPI strength. Data not valid. Indicates weak OTPI signal. Data valid. Indicates OTPI is receiving signal of sufficient strength to provide reliable pointing. |
| | Red/White | Indicates control indicator switch settings conflict. |
| 7 | SET | Two white-illuminated momentary pushbutton switches, one for each UHF/VHF radio. Used to change the frequency of the selected channel. |
| 8 | VOL INC | Volume, 12 position rotary switch. Increase, clockwise rotation increases audio output (30 db range). Two switches, one for each UHF radio. Inoperative while in secure voice. |
| 9 | Mode selector switch RELAY | Seven-position rotary switch selects UHF-1 and UHF-2 radio modes. Receipt/retransmission, reception on one UHF radio will automatically key and modulate the other radio. (Frequencies must be at least 50 MHz apart for BuNos prior to 162106 and at least 10 MHz apart for BuNo 162106 and subsequent.) |
| | ADF | Automatic direction finding mode on the selected UHF/VHF radio. |
| | OTPI | On-top position indicator (OTPI) is activated. OTP channel is displayed in the corresponding UHF CHAN display. |
| | T/R | Both radios in transmit/receive mode (normal position). |
| 10 | G T/R OFF ON | Guard transmit/receive two-position toggle. Two switches, one for each UHF radio. UHF radio is tuned by normal channel selection. Respective UHF radio is automatically tuned (main receiver and transmitter) to guard frequency (243.000 MHz) and clear voice. Overrides all other UHF modes including secure voice, OTPI, ADF, RELAY, and sonobuoy commands. |

Figure 15-1. Communications Control Panel (BuNo through 162990) (Sheet 2)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|-----------------------------------|--|
| 11 | G REC OFF ON | Guard receiver, two-position toggle switch. Two switches, one for each UHF radio. Allows monitoring of main receiver only. Allows simultaneous monitoring of main and auxiliary guard receivers. |
| 12 | SECURE ON (left) ON (right) | Three-position, lever-lock, left-right throw, center-off toggle switch. Secure voice operation of UHF-1 radio. Inhibits plain reception. Secure voice operation of UHF-2 radio. Inhibits plain reception. |
| 13 | SQL | Squelch, alternate action, non-illuminated pushbutton switch. Successive depression causes release to inactivated state. Two switches, one for each UHF radio. |
| 14 | TONE | Tone, momentary, non-illuminated pushbutton switch. Commands UHF radio to transmit 1020 Hz audio tone for the duration of the depression. Two switches, one for each UHF radio. |
| 15 | ZERO CODE | Pushbutton with spring-loaded guard, illuminated when activated. Used to zeroize HF and UHF Speech Security Equipment. |
| 16 | HF SECURE/ON | Two-position, lever-lock toggle switch. Locked in ON position, all HF transmissions are encrypted, reception can be either plain or secure. The ARC-182 VHF Radio, installed in ESP Mod Aircraft as an aftermarket kit, is inoperable with this switch in the ON position. |
| 17 | UHF TD/ON | UHF Time Delay, two-position, lever-lock toggle switch. Commands KY-58 to insert a time delay prior to transmission or retransmission of UHF signals. |
| 18 | Magnetic Flag | When data link mode selector switch is in AUTO, indicator is driven by data bus software. Two-position, magnetically actuated flag annunciator, edge light illuminated. |
| 19 | ASW | Data link is in ASW mode. Acoustic data and ESM is downlinked. |
| 19 | ASST | Data link is in ASST mode. RADAR data and ESM is downlinked. |
| 19 | SYNC LOCK | Synchronization locked, two-position flag annunciator. Red color indicates sync loss. Green indicates sync lock. |
| | | Note |
| 19 | UP | Sync Lock does not indicate valid data transfer or proper crypto keying. |
| 19 | DOWN | Data link RF signal from ship to helicopter. |
| 20 | MODE | Data link mode selector three-position rotary switch (intended for maintenance/troubleshooting). |
| 20 | AUTO | Enables data bus control of data link ASST/ASW mode. |
| 20 | ASST | Commands data link operation in ASST mode, link channel 01. |
| 20 | ASW | Commands data link operation in ASW mode, link channel 01. |
| 21 | Display | Six-digit numeric display. Used for setting UHF/VHF channel frequency and IFF Interrogator code. As number is keyed, it appears in the right display position. Subsequent keyings cause selected digits to shift to the left. |

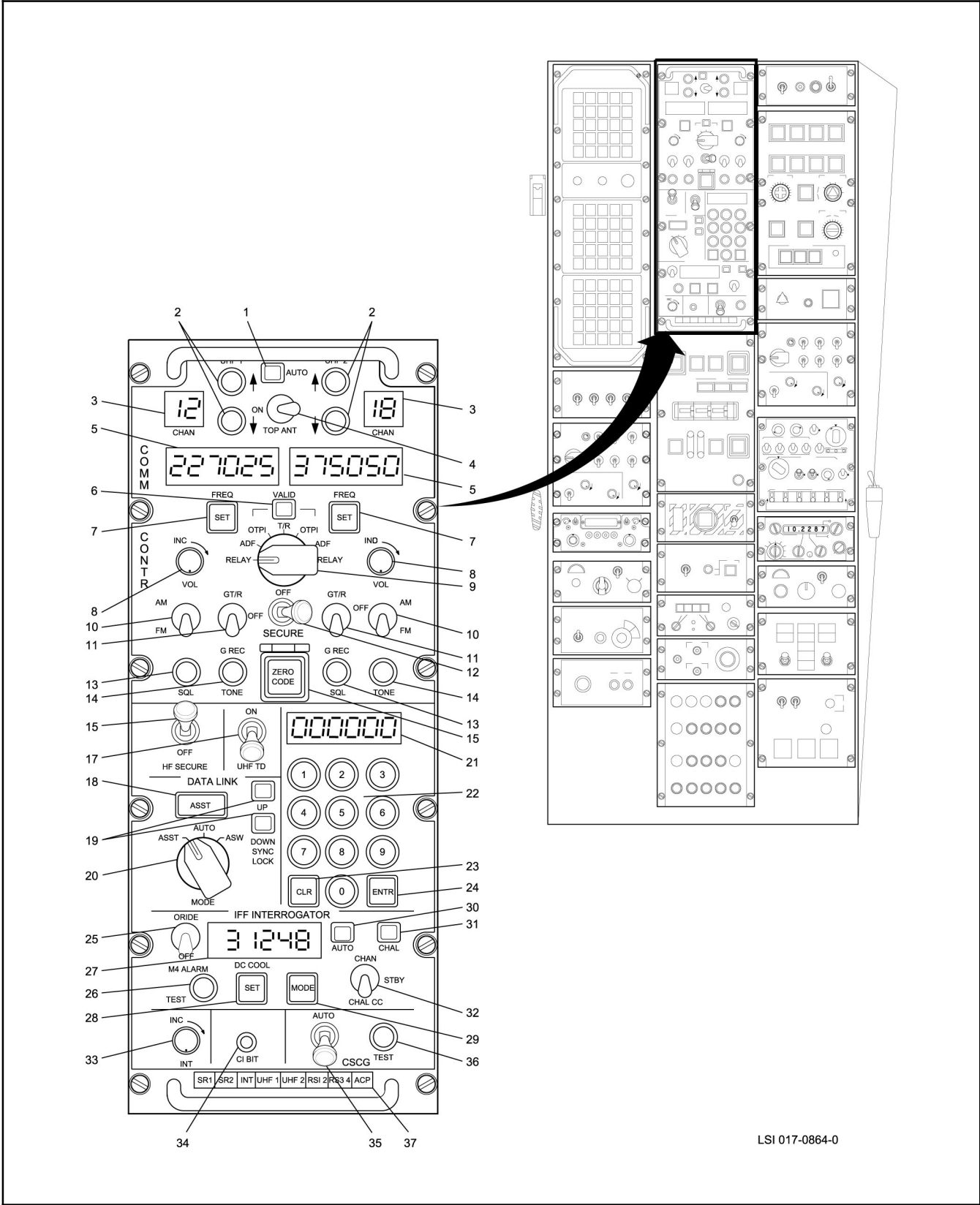
Figure 15-1. Communications Control Panel (BuNo through 162990) (Sheet 3)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|---|---|
| 22 | 0,1,2,3,4,5,6,7,8,9 Keyboard | Numeric keyboard, 10 momentary pushbuttons. Proper number of digits MUST be entered (i.e., 6 for UHF, 2 or 4 for IFF). |
| 23 | CLR | Clear momentary pushbutton, clears display of any selected series of digits so that a new series of digits can be selected. Set must be pressed again to reenter. |
| 24 | ENTR | Enter momentary pushbutton, enters displayed frequency or code into system, display returns to an all blank state. |
| 25 | M4 ALARM ORIDE | Mode 4 Alarm two-position toggle switch. Override, IFF interrogator computer overrides the Mode 4 (M4) alarm and allows the ATO to force a challenge. Using this feature may compromise the M4 code. |
| 26 | TEST | Momentary, non-illuminated pushbutton switch commands a transponder/interrogator loop test. Transponder must be in NORMAL. |
| 27 | DECODE | Six-digit numeric display. The four digits on the left display interrogator code. Two characters on the right display IFF mode (1,2,3,4a, and 4b), set via sequential pushes of the MODE pushbutton. In M4 all digits in the left display area are blanked. |
| 28 | SET | White-illuminated, momentary pushbutton switch, allows changing of code by the keyboard display. |
| 29 | MODE | White-illuminated, momentary pushbutton switch, causes the IFF mode and code to advance. |
| 30 | AUTO GREEN BLACK | Two-position, magnetic status flag annunciator IFF control modes. IFF interrogator is being controlled by software. IFF interrogator is being controlled manually by the CSCG panel. |
| 31 | CHAL GREEN BLACK RED | Three-position, magnetic status flag annunciator, indicates interrogator status when CHAL switch is activated. CHAL switch activated signals being transmitted from the interrogator. CHAL switch released. CHAL switch activated, interrogator 'no go' is received by the CSCG ACP indicating challenge may be unsuccessful. ORIDE activation may change the flag to green. If the annunciator remains red after ORIDE activation, M4 challenges are disabled. |
| 32 | Challenge Switch CHAL STBY CHAL CC | Three-position toggle switch momentary in up-and-down positions. Causes interrogator to transmit an interrogation with the mode of interrogation determined by the mode display setting. Challenge, momentary up position. ACP sends a challenge-enable command to the Interrogator to accept a correct mode reply. Correct mode replies will display a single bar. Correct mode and code will display a double bar. Standby, normal inactive position. Challenge correct code momentary down position. ACP sends a challenge command which enables interrogator to accept only a correct code and mode reply. A double bar will be displayed. |

Figure 15-1. Communications Control Panel (BuNo through 162990) (Sheet 4)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|---|--|
| 33 | INT INC | Intensity, 10 position variable potentiometer. Increase, clockwise rotation increases luminous intensity of all COMM CONTROL numeric displays from minimum intensity upward. Full counterclockwise position is a LAMP test. All '8s will be displayed and all fault lights except ACP. |
| 34 | CI BIT | Control indicator built-in test black and white magnetic flag annunciator. White indicates that the COMM CONTR panel has failed. |
| 35 | CSCG MAN AUTO | Communications system control group ACP two-position, lever-lock, toggle switch. Manual, COMM CONTR panel controls CSCG units. Automatic, COMM CONTR functions are controlled by software, via data bus interface. |
| 36 | TEST | CSCG self-test momentary, non-illuminated pushbutton switch. Pressing of button starts an interruptive self-test only when AUTO/MAN switch is in MAN position. TEST is aborted if the TEST button is pressed again. In AUTO, TEST may be initiated through software. |
| 37 | Status Annunciators SR1 SR2 INT UHF 1 UHF 2 RS1 2 RS3 4 ACP | Eight yellow-illuminated annunciators that display non-availability of CSCG and other units. Illuminates when equipment is not available because of failure or power off. Lack of coding of security equipment controlled by CSCG (KY-58) will cause the ACP annunciator to illuminate. The annunciator legends in left to right sequence are defined as follows: Sonobuoy receiver, NO. 1. Sonobuoy receiver, NO. 2. IFF interrogator. UHF, NO. 1 radio. UHF, NO. 2 radio. Pilot and ATO Radio panels. SO and observer Radio panels. Audio converter-processor (light is not tested when Lamp Test is selected but tested when CSCG TEST is initiated). |

Figure 15-1. Communications Control Panel (BuNo through 162990) (Sheet 5)



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Figure 15-2. Communications Control Panel (BuNo 162991 and Subsequent) (Sheet 1 of 6)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|--|--|
| | COMM CONTR | The communications control panel allows manual or computer control of the communications subsystem. |
| 1 | AUTO | Indicates software control of CSCG functions. Not currently implemented in the SH-60B. |
| 2 | UHF-1, UHF-2 (Channel Select-up/down) | Four pushbutton switches, two switches for each UHF/VHF radio. Upper switch increases channel number by one for each actuation; lower switch decreases the channel number by one for each actuation. |
| 3 | CHAN | Channel, two-digit, numeric display indicating UHF, VHF, or OTPI channel being used. Two displays, one for UHF-1 and one for UHF-2. Displays 00 to 20 for normal UHF/VHF; 01 to 31 for OTPI. Channel selection accomplished by operating UHF-1, UHF-2 pushbuttons. If G T/R is selected, CHAN is blanked. |
| 4 | TOP ANT ON (Right) ON (Left) | Top antenna, two-position, left-right toggle switch. UHF-2 assigned to top antenna; UHF-1 to bottom antenna. (Except when in OTPI or ADF modes.) UHF-1 assigned to top antenna; UHF-2 to bottom antenna. (Except when in OTPI, ADF, or BACKUP modes.) |
| 5 | FREQ | Two, six-digit, numeric displays, one for UHF-1 and one for UHF-2. Indicates active frequency corresponding to channel selected, frequency spans of 30.000 to 87.975 MHz FM, 108.000 to 155.975 MHz AM, 156.000 to 173.975 MHz FM, and 225.000 to 399.975 MHz AM/FM in 25 kHz steps. If G T/R ON is selected, the display will indicate the guard frequency of the frequency band in operation. Not affected by OTPI selection. |
| 6 | VALID Black Green Red/White | Two-position, magnetic flag indicator that indicates OTPI strength. Data not valid. Indicates weak OTPI signal. Data valid. Indicates OTPI is receiving signal of sufficient strength to provide reliable pointing. Indicates control indicator switch settings conflict. |
| 7 | SET | Two white-illuminated momentary pushbutton switches, one for each UHF/VHF radio. Used to change the frequency of the selected channel. |
| 8 | VOL INC | Volume, 12-position rotary switch. Increase, clockwise rotation increases audio output (30 db range). Two switches, one for each UHF radio. Inoperative while in secure voice. |
| 9 | Mode selector switch RELAY | Seven-position rotary switch selects UHF-1 and UHF-2 radio modes. For software versions THP-20 and subsequent, OTPI operation is accomplished by rotating the Mode Selector Switch to OTPI and tuning the desired sonobuoy using the TUNE OTPI pushbuttons on the ATO keyset. For this configuration, the OTPI channel displayed in the UHF CHAN display does not correspond to the sonobuoy tuned on the MPD. Receipt/retransmission, reception on one UHF/VHF radio will automatically key and modulate the other radio (Note 1). |

Figure 15-2. Communications Control Panel (BuNo 162991 and Subsequent) (Sheet 2)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|-------------------------|---|
| 10 | ADF | Automatic direction finding mode, in the UHF band, on the selected UHF/VHF radio. |
| | OTPI | On-top position indicator (OTPI) is activated. OTPI channel is displayed in the corresponding UHF CHAN display. |
| 11 | T/R | Both radios in transmit/receive mode (normal position). |
| | AM/FM | Two-position toggle switch. For the UHF-band (225.000 to 399.975 MHz) only. FM mode will be selected in the lower position. AM mode will be selected in the upper position. One toggle switch each is provided for UHF-1 and UHF-2. |
| 12 | G T/R-OFF-G REC | Three position toggle switch. In the lower position, G REC, it will allow monitoring of the main and guard receiver outputs. In the upper position (G T/R), the radio unit will be automatically tuned (main receiver and transmitter) to the guard frequency of the band in operation and the clear voice. It overrides all other modes including secure voice, OTPI, ADF, Relay, and sonobuoy commands. In the center position, OFF, the radio shall be tuned by channel selection for the voice mode and allow monitoring of the main receiver only. One toggle switch each is provided for UHF-1 and UHF-2. |
| 13 | SECURE | Three-position, lever-lock, left-right throw, center-off toggle switch. |
| | ON (left) ON (right) | Secure voice operation of UHF-1 radio. Secure voice operation of UHF-2 radio. |
| 14 | SQL | Squelch, alternate action, pushbutton switch. Enables/disables radio squelch circuits. Two switches, one each for UHF-1 and UHF-2. |
| 15 | TONE | Tone, momentary, non-illuminated pushbutton switch. Commands UHF/VHF radio to transmit 1020 Hz audio tone for the duration of the depression. Two switches, one for each UHF/VHF radio. UHF-1 TONE pushbutton is hardwired to allow operation in case of failure of the ACP and/or the backup radio control. |
| 16 | ZERO CODE | Pushbutton with spring-loaded guard, illuminated when activated. Used to zeroize HF and UHF/VHF speech security equipment. |
| 17 | HF SECURE/ON | Two-position, lever-lock toggle switch. Locked in ON position. All HF transmissions are encrypted; reception can be either plain or secure. These HF secure toggle switches are inoperative on aircraft with ANDVT incorporated. |
| 18 | UHF TD/ON | UHF/VHF Tone Delay, two-position, lever-lock toggle switch (Note 2). Commands KY-58 to insert a time delay prior to transmission or retransmission of UHF/VHF signals. |
| 18 | Magnetic Flag | When data link mode selector switch is in AUTO, indicator is driven by data bus software. Two-position, magnetically actuated flag annunciator, edge light illuminated. |
| | ASW | Data link is in ASW mode. Acoustic data and ESM is downlinked. |
| | ASST | Data link is in ASST mode. RADAR data and ESM is downlinked. |

Figure 15-2. Communications Control Panel (BuNo 162991 and Subsequent) (Sheet 3)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|---------------------------------|---|
| 19 | SYNC LOCK UP DOWN | Synchronization locked, two-position flag annunciator. Red color indicates sync loss. Green indicates sync lock. <p style="text-align: center;">Note</p> Sync Lock does not indicate valid data transfer of proper crypto keying. Data link RF signal from ship to helicopter. Data link RF signal from helicopter to ship. |
| 20 | MODE AUTO ASST ASW | Data link mode selector three-position rotary switch (intended for maintenance/troubleshooting). Enables data bus control of data link ASST/ASW mode. Commands data link operation in ASST mode, link channel 01. Commands data link operation in ASW mode, link channel 01. |
| 21 | Display | Six-digit numeric display. Used for setting UHF/VHF channel frequency and IFF Interrogator code. As number is keyed, it appears in the right display position. Subsequent keyings cause selected digits to shift to the left. |
| 22 | 0,1,2,3,4,5,6,7,8,9 keyboard | Numeric keyboard, 10 momentary pushbuttons. Proper number of digits (leading and trailing 0s) MUST be entered (i.e., 6 digits for UHF, 6 for VHF, and 2 or 4 for IFF. (Note: Leading and trailing 0s are required)). |
| 23 | CLR | Clear momentary pushbutton, clears display of any selected series of digits so that a new series of digits can be selected. |
| 24 | ENTR | Enter momentary pushbutton, enters displayed frequency or code into system, display returns to an all blank state. |
| 25 | M4 ALARM ORIDE | Mode 4 Alarm two-position toggle switch. Override, IFF interrogator computer overrides the Mode 4 (M4) alarm and allows the ATO to force a challenge. Using this feature may compromise the M4 code. |
| 26 | TEST | Momentary, non-illuminated pushbutton switch commands a transponder/interrogator loop test. Transponder must be in NORMAL. Interrogator challenges Mode 3, Code 0000. |
| 27 | DECODE | Six-digit numeric display. The four digits on the left display interrogator code. Two characters on the right display IFF mode (1,2,3,4a, and 4b), set via sequential pushes of the MODE pushbutton. In M4 all digits in the left display area are blanked. |
| 28 | SET | White-illuminated, momentary pushbutton switch, allows changing of code by the keyboard display. |
| 29 | MODE | White-illuminated, momentary pushbutton switch, causes the IFF mode and code to advance. |
| 30 | AUTO GREEN BLACK | Two-position, magnetic status flag annunciator IFF control modes. IFF interrogator is being controlled by software. IFF interrogator is being controlled manually by the CSCG panel. |

Figure 15-2. Communications Control Panel (BuNo 162991 and Subsequent) (Sheet 4)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|---|--|
| 31 | CHAL GREEN BLACK RED | <p>Three-position, magnetic status flag annunciator, indicates interrogator status when CHAL switch is activated.</p> <p>CHAL switch activated signals being transmitted from the interrogator.</p> <p>CHAL switch released.</p> <p>CHAL switch activated, interrogator 'no go' is received by the CSCG ACP, indicating challenge may be unsuccessful. ORIDE activation may change the flag to green. If the annunciator remains red after ORIDE activation, M4 challenges are disabled.</p> |
| 32 | Challenge Switch CHAL STBY CHAL CC | <p>Three-position toggle switch momentary in up-and-down positions. Causes interrogator to transmit an interrogation with the mode of interrogation determined by the mode display setting.</p> <p>Challenge, momentary up position. ACP sends a challenge-enable command to the interrogator to accept a correct mode reply. Correct mode replies will display a single bar. Correct mode and code will display a double bar.</p> <p>Standby, normal inactive position.</p> <p>Challenge correct code momentary down position. ACP sends a challenge command which enables interrogator to accept only a correct code and mode reply. A double bar will be displayed.</p> |
| 33 | INT INC | <p>Intensity, 10 position variable potentiometer.</p> <p>Increase, clockwise rotation increases luminous intensity of all COMM CONTROL numeric displays from minimum intensity upward. Full counterclockwise position is a LAMP test. All '8s will be displayed and all fault lights except ACP.</p> |
| 34 | CI BIT | <p>Control indicator built-in test black and white magnetic flag annunciator. White indicates that the COMM CONTR panel has failed.</p> |
| 35 | CSCG MAN AUTO | <p>Communications system control group ACP two-position, lever-lock, toggle switch.</p> <p>Manual, COMM CONTR panel controls CSCG units.</p> <p>Automatic, COMM CONTR functions are controlled by software, via data bus interface.</p> |
| 36 | TEST | <p>CSCG self-test momentary, non-illuminated pushbutton switch. Pressing of button starts an interruptive self-test only when AUTO/MAN switch is in MAN position and the remote switching controls are not in the CALL mode. TEST is aborted if the TEST button is pressed again. In AUTO, TEST may be initiated through software.</p> |

Figure 15-2. Communications Control Panel (BuNo 162991 and Subsequent) (Sheet 5)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--|---|--|
| 37 | Status Annunciators SR1 SR2 INT UHF 1 UHF 2 RS1 2 RS3 4 ACP | Eight yellow-illuminated annunciators that display non-availability of CSCG and other units. Illuminates when equipment is not available because of failure or power off. Lack of coding of security equipment controlled by CSCG (KY-58 and KYV-5) will cause the ACP annunciator to illuminate. The annunciator legends in left to right sequence are defined as follows: Sonobuoy receiver, NO. 1. Sonobuoy receiver, NO. 2. IFF interrogator. UHF, NO. 1 radio. UHF, NO. 2 radio. Pilot and ATO RADIO panels. SO and observer RADIO panels. Audio converter-processor (light is not tested when Lamp Test is selected but tested when CSCG TEST is initiated). |
| Notes: <ol style="list-style-type: none"> 1. Avoid relay frequency separations of less than 10 MHz, frequency separations of multiples of 29 MHz, UHF relays below 265 MHz, and VHF to VHF relays. 2. A delay will occur regardless of the UHF TD switch position on the COMM CONTR panel if the KY-58 delay is selected on (switch external on KY-58). | | |

Figure 15-2. Communications Control Panel (BuNo 162991 and Subsequent) (Sheet 6)

15.1.3 Radio Control Panels

The four radio control panels ([Figure 15-3](#)) allow crewmembers to control the audio received at and transmitted from their station. Power is supplied by the NO. 1 AC primary and AC essential buses for the pilot and ATO from the center circuit breaker panel, through two circuit breakers marked AUDIO and CONV PROCR AUDIO respectively, and by 115 Vac, 1 phase for the SO and observer through a circuit breaker marked COMM SWG located on the SO console avionics rack circuit breaker panel. These panels are also referred to as RSCs.

Note

The audio channels to be recorded on the FLIR VCR are controlled by the switches on the radio control panels (SO or instructor) to which the VCR audio input is connected.

15.1.4 Hoist Operator and Maintenance IBs

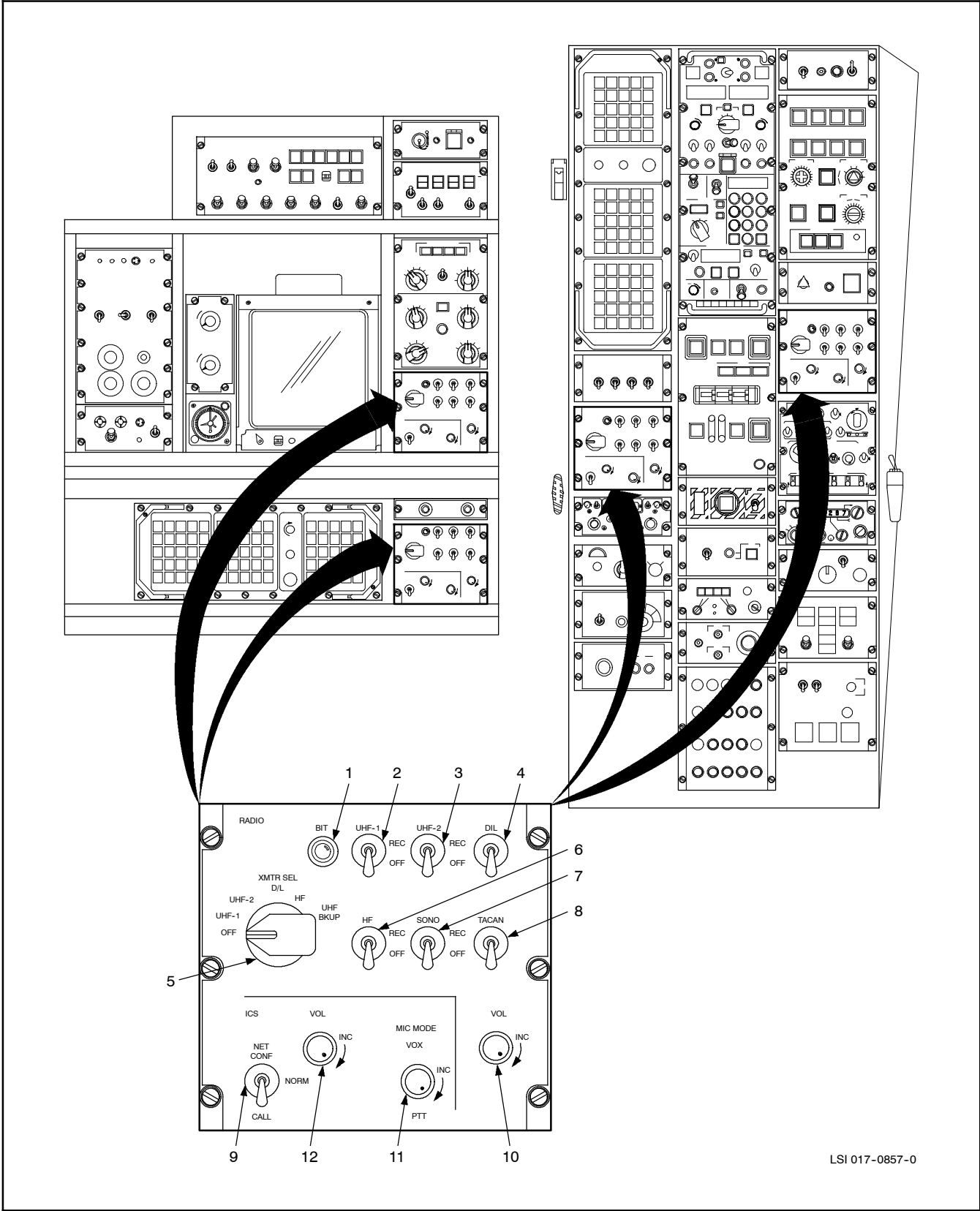
The IBs allow maintenance personnel and hoist operators to patch into the aircraft ICS. The ICS is powered by the CSCG (see [paragraph 15.1.1](#)). The boxes contain volume controls and a push-to-talk switch. The ACP directs audio to and from the IBs. The maintenance IB is located in the external ICS/ARM access cavity above the left mainmount.

15.1.5 Radios

15.1.5.1 UHF Radios, AN/ARC-159

Note

ARC-159 UHF radio sets are installed in aircraft BuNos through 162990. ARC-182 UHF/VHF radio sets (refer to [paragraph 15.1.5.2](#)) are installed in aircraft BuNo 162991 and subsequent.



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Figure 15-3. Radio Control Panel (Sheet 1 of 2)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|----------------|--|
| 1 | RADIO | Allows independent selection of receivers while restricting transmission selection to one. The OFF position disables audio of selected radio. |
| | BIT | Magnetically actuated flag BIT indicator. |
| | BLACK | Go. |
| | WHITE | No go, indicates failure in control box. |
| 2 | UHF-1/REC | UHF-1 radio two-position toggle. Receiver, permits monitoring UHF-1 audio. |
| 3 | UHF-2/REC | UHF-2 radio two-position toggle. Receive, permits monitoring UHF-2 audio. |
| 4 | D/L/REC | Data link (D/L) two-position toggle. Receive, permits monitoring of D/L secure audio. |
| 5 | XMTR SEL | Transmitter select six-position rotary switch selects radio transmission mode. |
| | UHF-1 | UHF-1 radio transmission and reception. |
| | UHF-2 | UHF-2 radio transmission and reception. |
| | D/L | D/L voice transmission and reception. |
| | H/F | High frequency radio transmission and reception. |
| | UHF BKUP | UHF or UHF/VHF radio backup (not available to SO or OBS stations). |
| 6 | HF/REC | High frequency radio two-position toggle. Receive, permits monitoring HF. |
| 7 | SONO/REC | Sonobuoy two-position toggle. Receive, permits monitoring of sonobuoy receiver audio. |
| 8 | TACAN/REC | TACAN two-position toggle. Receive, permits monitoring of TACAN identifier tone. |
| | ICS | Intercommunications System. |
| 9 | NET | Intercommunications system net, three-position toggle switch. Establishes intercom net. |
| | CONF | Conference, connects pilot and ATO positions for cockpit RADIO panels and connects SO and observer positions for cabin RADIO panels. |
| | NORM | Normal, connects originator station to all other stations set to NORM and to the hoist operator and groundcrew ICS boxes. |
| | CALL | Connects originator station to all other crew positions, overrides CONF selection at any RADIO panel. In an emergency (COMM CONTR or ACP power failure), provides backup communications to all stations. |
| 10 | VOL | Volume, 12-position rotary switch. Volume control for radio audio at headset. |
| 11 | MIC MODE | Microphone mode control. |
| | VOX | Voice-operated transmission 12-position rotary switch. |
| | INC | Establishes audio threshold which must be exceeded by the crewmember microphone signal before microphone signal is transmitted to other crewmembers. Clockwise rotation increases threshold. |
| | PTT | Push-to-talk when control is in this position. Switch must be actuated for ICS voice transmission. |
| 12 | VOL | Volume, twelve-position rotary switch. Volume control for intercom audio at headset. |

Figure 15-3. Radio Control Panel (Sheet 2)

The two sets, designated as UHF-1 and UHF-2, can be tuned to any of 7,000 communication frequencies. Each transceiver is provided with a separate guard receiver that will receive voice transmissions on the standard emergency frequency of 243.0 MHz. The UHF transceivers have a line-of-sight range. Line-of-sight range in nautical miles to a spot on the surface of the Earth may be estimated by multiplying 1.23 times the square root of the altitude in feet. Derivation of this formula is left to the reader. Ranges will be greater for any elevation of the other station.

Power for UHF-1 receiver/transmitter is supplied from the DC essential bus through a circuit breaker on the cockpit overhead circuit breaker panel, marked RADIO NO. 1 R/T UHF. Power for UHF-2 receiver/transmitter is supplied from the NO. 2 DC primary bus through a circuit breaker marked RADIO NO. 2 R/T UHF on the SO circuit breaker panel.

In the event of COMM CONTR failure, UHF-1 may be used by the pilot by selecting backup on the RSC and can be controlled from the backup UHF radio control panel. UHF-2 may be used by the ATO for guard communications only by selecting UHF backup on the RSC. If the ACP fails, the pilot will automatically be connected to UHF-1. The ATO will automatically be connected to UHF-2, preset to Guard T/R. Internal communications between all aircrew may be made by selecting CALL on the RSC (foot or cyclic switch) or by using the CALL pushbutton switch on the cyclic for the pilots and the floor switch for the SO. Pilots only can also talk to each other externally over GUARD. If the AC power fails, the pilot will automatically be connected to UHF-1 via the backup UHF radio control panel. In this case, the ATO will have no internal or external communication capability. CSCG/ACP failure modes are covered in [Figure 15-4](#).

Up to 20 channels (1 to 20) can be preset for direct tuning by channel selection on either radio. An additional channel (00) is available for independent frequency selection on either radio. Once channels are preset, the preset frequencies remain stored after power is removed from the unit.

The two UHF radios can be used to relay secure or clear voice UHF communication between two stations. Secure data link cannot be relayed. If secure-voice relay transmissions or monitoring by the flightcrew are required, the SECURE switch on the COMM CONTR panel must be in either ON position. A correctly keyed appropriate wideband speech security set must be installed. Secure voice relay without monitoring or transmitting capability may be conducted without a wideband security set installed. The system will allow simultaneous clear and secure transmissions by the flightcrew. The selected UHF radio may be used by the flightcrew in secure voice while the other radio will be available in clear voice mode.

Note

The KY-58 will not pass guard relay or transmission.

There are two UHF antennas on the helicopter. Using a switch on the panel, the operator may select either UHF-1 or UHF-2 to operate with the top antenna. The other is selected automatically to use the bottom antenna. In the event of communication difficulty using the top antenna, the operator may attempt to correct the problem by switching the communicating unit to the bottom antenna.

The data handling system automatically selects whichever UHF radio is connected to the bottom antenna for command activated sonobuoy command transmission. To provide this capability, the CSCG must be in AUTO and the UHF connected to the bottom antenna must not be in SECURE, G T/R, or UHF BKUP. The data handling system will momentarily cancel the ADF mode, relay mode, or T/R UHF transmissions in order to send its sonobuoy commands.

15.1.5.1.1 UHF Backup

In the event of COMM CONTR panel failure, the UHF-1 radio can be operated directly from the backup UHF radio control panel ([Figure 15-5](#)). Place the XMTR SEL switch on the pilot radio control panel ([Figure 15-3](#)) to the UHF BKUP position.

| OPERATIONAL CAPABILITY | | | | | | | |
|---|--|---|------------|------|-----|-----|--------------|
| MODE | UHF-1 | UHF-2 | ADF | OTPI | DL | IFF | ICS |
| Pilot RSC BKUP selected (Notes 1, 3) | Pilot control via backup control panel, bottom ANT | ATO — Full control SO & OBS-T/R control | UHF-2 only | Yes | Yes | Yes | Yes (Note 9) |
| ATO RSC BKUP selected (Notes 1, 4) | Pilot — Full control SO and OBS-T/R control | ATO — Guard T/R fixed volume TOP ANT | UHF-1 only | Yes | Yes | Yes | Yes |
| Loss of ACP PRI PWR (NO. 1 AC PRI BUS) (Notes 2, 5) | Pilot control via backup control panel, bottom ANT | ATO — Guard T/R fixed volume TOP ANT | No | No | No | No | Call only |
| Loss of ACP/CI DC PWR (NO. 2 DC PRI BUS) (Note 6) | Bottom ANT only | TOP ANT only | No | Yes | Yes | Yes | Yes |
| Loss of UHF R/T PWR (DC ESS BUS) (Note 7) | No | Yes | UHF-2 only | Yes | Yes | Yes | Yes |
| (NO. 2 DC PRI BUS) (Note 8) | Yes | No | UHF-1 only | Yes | Yes | Yes | Yes |
| Notes: | | | | | | | |
| <ol style="list-style-type: none"> 1. Selection of UHF BKUP mode on RSC precludes all other transmit control functions. 2. BKUP mode must be selected on RSC. 3. UHF-1 FREQ and CHAN display blanks, UHF or UHF/VHF backup control energizes. 4. UHF-2 FREQ and CHAN display blanks. 5. CI panel blanks, call function powered via AC ESS BUS. 6. No CI 'Zero Code' function. 7. Zeros on UHF-1 FREQ display for DC ESS BUS. 8. Zeros on UHF-2 FREQ display for DC PRI BUS. 9. If the CSCG ICS function is completely lost, crew intercom can be achieved by using UHF or UHF/VHF radio side tones. All stations must select the same UHF transmit function on RSC and then use radio PTT switch for intercom. | | | | | | | |

Figure 15-4. CSCG Failure Matrix

15.1.5.2 UHF/VHF Radios, AN/ARC-182

The AN/ARC-182 UHF/VHF transceivers operate in the following frequency ranges: from 30.000 through 87.975 MHz FM, 108.000 through 117.975 MHz AM (receive only, VOR), 118.000 through 155.975 MHz AM, 156.000 through 173.975 MHz FM, and 225.000 to 399.975 MHz AM/FM (FM for data transmissions or limited voice). **Figure 15-6** illustrates these operating ranges and guard frequencies.

Note

UHF/VHF transmitter power reduction, down to 2 watts, may occur with high radio temperatures or if the transmitter is keyed continuously for longer than 1 minute.

Note

ARC-182 UHF/VHF radio sets are installed on BuNo 162991 and subsequent aircraft. For aircraft equipped with ARC-159 radio sets, refer to [paragraph 15.1.5.1](#).

In addition, each unit is provided with a separate guard receiver that will receive voice transmissions on the standard emergency frequency corresponding to each frequency band; that is, 40.5 MHz, 121.5 MHz, 156.8 MHz, and 243.0 MHz. If G T/R is on, the ARC-182 radio set will tune the guard frequency of the frequency band in operation. The UHF/VHF transceivers have a line-of-sight range.

A minimum of propagation problems will be experienced if the receiver/transmitter is used as follows: 30 to 87.975 MHz band for close in, air-to-ground communications up to 60 miles distance; 108 to 155.975 MHz band for air traffic control up to 120 miles from the ground station; 155.975 to 173.975 MHz maritime band for communications up to 120 miles from the ground station; and 225 to 399.975 MHz band for communications up to 120 miles from the ground station. Distances up to 300 miles may be achieved in air-to-air communications with frequencies above 117.975 MHz.

External sources of [RF](#) may interfere with ARC-182 operations. In addition, the receiver/transmitter may cause interference with the installed mission equipment.

WARNING

Operations within 5 nm of commercial radio and TV broadcast stations can cause white noise or music interference, which degrades radio reception in the 30.0 to 173.975 MHz frequency bands. Interference from commercial broadcast stations can suddenly render two-way radio communications in the VHF-AM aviation band (108.0 to 155.975 MHz) completely unusable, causing loss of two-way radio communications. During actual IMC approaches, pilots shall use UHF-AM frequencies to the maximum extent practical for primary or backup communications with ground controlling agencies.

Note

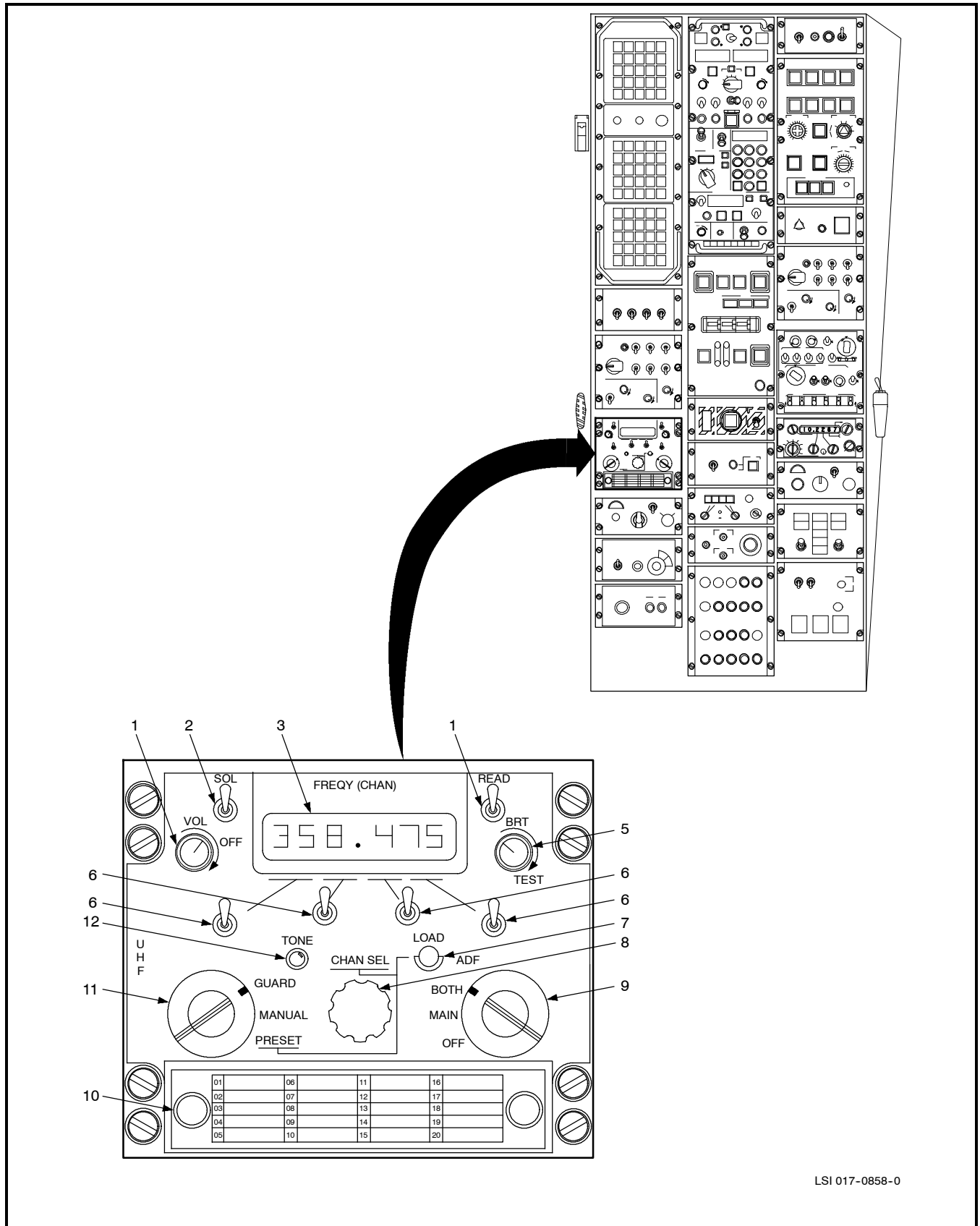
Low VHF band reception can be improved by deselecting guard (G REC — OFF). This helps eliminate undesired signals from the guard receiver being mixed with desired signals from the main receiver.

ADF and OTPI interference will be characterized by false or erroneous bearing indications or needle fluctuations. Active sonobuoy interference will be characterized by display zone noise up to and including complete obliteration of target return. Observe the following frequency separations for optimum performance:

1. ADF — 10 MHz separation.
2. OTPI and active sonobuoy radio frequencies — 5 MHz separation.
 - a. Sonobuoy radio frequencies can be found in the ASW Tactical Pocket Guide (NTTP 3-22.5-ASW).

Note

Upper antenna utilization, for communications, is recommended while using the OTPI.



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Figure 15-5. Backup UHF Radio Control Panel (BuNo through 162990) (Sheet 1 of 2)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|----------------------------------|--|
| | (Backup UHF radio control panel) | Provides controls and displays necessary to operate a UHF radio in the backup mode. |
| 1 | VOL | Continuously variable potentiometer used to adjust the audio volume to compensate for varying levels of cockpit noise. |
| 2 | SQ/OFF | The SQUELCH control is a two-position toggle switch that enables squelch circuitry in the ON position. In effect, it eliminates the background noise level when there are no incoming transmissions being received. |
| 3 | FREQ/(CHAN) | Six-digit frequency readout. Also displays two-digit channel when PRESET knob (NO. 11) is used. |
| 4 | READ | Momentary switch that causes the frequency of the selected preset channel to be displayed at the frequency/channel readout (NO. 3). When toggled, the frequency will be displayed for about 10 seconds. |
| 5 | BRT/TEST | Rotary knob to control display intensity. Full clockwise causes display to read all 8s. |
| 6 | (Frequency Setting) | Four spring-loaded ON-OFF-ON toggles used to enter the six-digit UHF frequency. Observed in the readout (NO. 3) immediately above the switches. |
| 7 | LOAD | Non-illuminated pushbutton used to permanently store frequencies in preset channels. |
| 8 | CHAN SEL | The channel control is used to select any one of 20 preset frequencies when the frequency selector mode switch (NO. 11) is in the PRESET position. The selected channel is displayed by the frequency/channel readout (NO. 3). |
| 9 | (Mode selector) | The mode selector is a four-position rotary switch for selection of the following UHF-1 modes of operation: |
| | ADF | Not functional in the SH-60B. |
| | BOTH | Same as for MAIN with auxiliary guard receiver energized. |
| | MAIN | Transmitter and main receiver are energized and tuned to frequency selected by frequency selector mode control and applicable controls. |
| | OFF | Not functional in the SH-60B. |
| 10 | (Tableau) | Tableau for manually recording frequency of preset channels. |
| 11 | (Frequency mode selector) | The frequency mode selector is a three-position rotary switch used to select the following modes: |
| | GUARD | Tunes main receiver/transmitter to the guard frequency. The guard frequency is displayed at the frequency readout (NO. 3). |
| | MANUAL | Allows selection of any of 7,000 possible operating frequencies using the four frequency selector switches (NO. 6). |
| | PRESET | Allows selection of any one of 20 preset channels. The selected channel number is displayed at the frequency/channel readout (NO. 3). |
| 12 | TONE | The TONE transmit control is a momentary pushbutton switch which commands a 1-KHz tone to be transmitted for the duration of the switch depression. |

Figure 15-5. Backup UHF Radio Control Panel (BuNo through 162990) (Sheet 2)

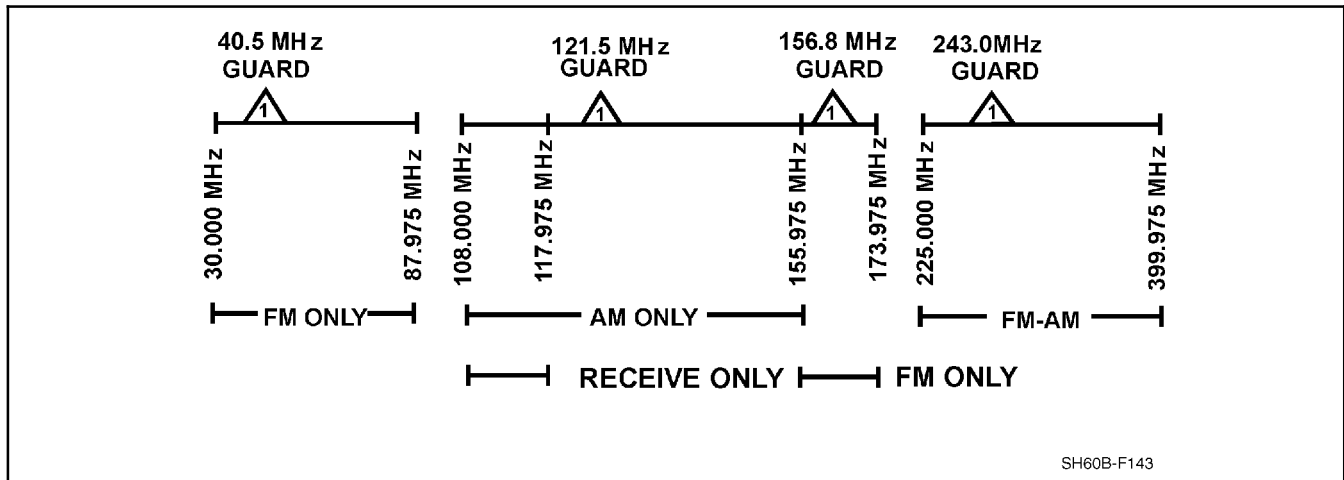


Figure 15-6. ARC-182 Frequency Ranges

Power for UHF-1 receiver/transmitter is supplied from the DC essential bus through a circuit breaker on the cockpit overhead circuit breaker panel marked RADIO NO. 1 R/T UHF. Power for UHF-2 receiver/transmitter is supplied from the NO. 2 DC primary bus through a circuit breaker marked RADIO NO. 2 R/T UHF on the SO circuit breaker panel.

In the event of COMM CONTR failure, the ARC-182 performs the same as the ARC-159. CSCG/ACP failure modes are covered in [Figure 15-4](#). Either UHF/VHF radio may be selected for use with the KY-58 speech security set to provide for enciphered and encoded message reception and transmission. This is done by placing the SECURE switch on the COMM CONTR Panel in the ON position corresponding to the selected radio.

Note

The KY-58 will not pass guard relay or transmission.

The two UHF/VHF radios can be used to relay UHF/VHF communication the same as the ARC-159. For optimum relay operation of the ARC-182, observe the following:

1. Avoid UHF to UHF frequency separations of less than 10 MHz.
2. Avoid frequency separations of multiples of 29 MHz (29, 58, 87, 116, 145 MHz, etc.).
3. Avoid UHF to UHF relays to frequencies below 265 MHz.
4. Avoid VHF to VHF relays where possible.

Note

In the RELAY mode, certain UHF to UHF frequency combinations (and most VHF to VHF frequency combinations) will result in squeals, interference, motorboating or distortion.

The two UHF/VHF antennas on the helicopter operate similarly to the ARC-159 antennas.



Unsecured folded main rotor blades can flap enough in high winds or high sea states to strike the upper UHF antenna. To prevent damage to the rotor blades and antenna, blade crutches shall be applied when the blades are folded and the ambient conditions are conducive to blade flapping.

Note

- In the event of a partial antenna failure, VHF frequencies may be inoperable but degraded operation of UHF communications may still be possible.
- Garbled or distorted side tones during radio transmissions may be experienced for certain VHF frequency combinations (within 10 MHz) when the mixer switch on the alternate radio is selected. The distortion is caused by feedback into the alternate radio receiver and does not affect the quality of the outgoing transmission. Side tone distortion can be eliminated by deselecting the nontransmitting radio receiver mixer switch.
- In the UHF frequency band, FM signals may be received when AM is selected, and vice versa. The received signals will be weak and highly distorted, however, if the proper modulation (AM or FM) is not selected.
- When G REC is selected, the guard frequency monitored will be the guard frequency of the frequency band in operation.

15.1.5.2.1 UHF/VHF Backup

In the event of COMM CONTR panel failure, the UHF/VHF radio can be operated directly from the backup UHF/VHF radio control panel (Figure 15-7). Place XMTR SEL switch on the pilot radio control panel to the UHF BKUP position. In the event of ACP and/or backup radio control failure, the tone pushbutton for UHF-1 is hardwired to the radio to allow operation.

Note

- The backup UHF/VHF radio control panel may display a dot when switching to BKUP position. To activate the display, rotate the CHAN SEL knob one position and back, or toggle a frequency slew switch up and back.
- In BKUP, if 243 is selected and the pilot radio control panel is returned to normal operation, 243.000 will remain in the backup UHF/VHF radio control panel display, but the actual frequency will be selected and displayed by the COMM CONTR control panel. To clear the display, rotate the frequency mode selector to PRESET.

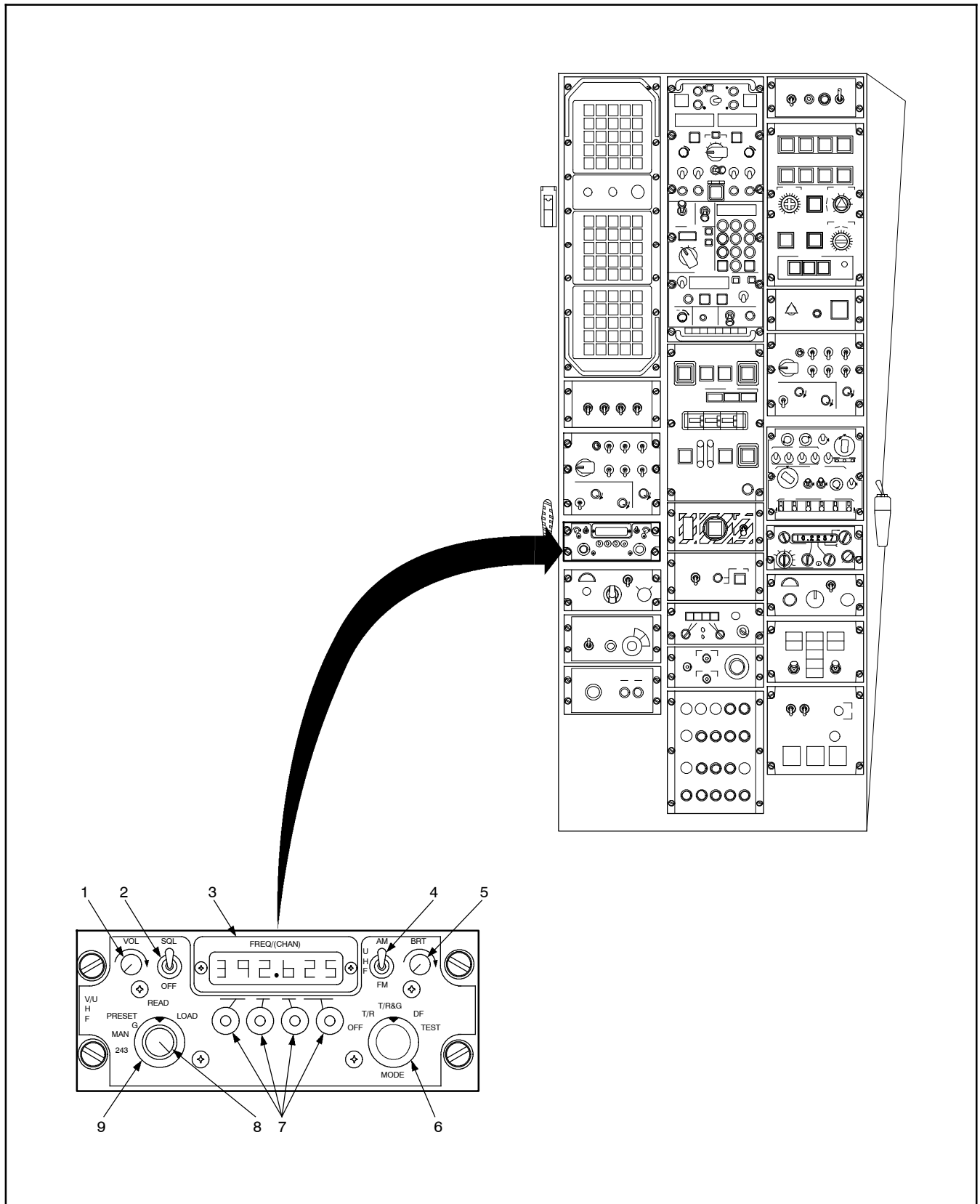


Figure 15-7. Backup UHF/VHF Radio Control Panel (BuNo 162991 and Subsequent) (Sheet 1 of 2)

| ITEM NO. | CONTROL/ INDICATOR | FUNCTION |
|---|-------------------------------|--|
| 1 | VOL | Potentiometer. Adjust audio output level. |
| 2 | SQL/OFF | Toggle switch. Enables main receiver squelch in SQL position. |
| 3 | Frequency/ channel display | Incandescent lamps. Display frequency selected, channel selected, or built-in test (BIT) results. Displays hundreds, tens, and units. Decimal point (is off in PRESET), tenths, hundredths, and thousandths MHz frequency. |
| 4 | UHF AM/FM selector | Toggle switch. Selects either AM or FM operating modes when tuned to a frequency in the UHF band. |
| 5 | BRT | Potentiometer. Varies light intensity of FREQ/(CHAN) display. |
| 6 | Operational mode selector | Rotary switch. |
| | T/R | Enables main receiver/transmitter of radio. |
| | T/R & G | Enables guard receiver in addition to functions described for T/R. Guard receiver is automatically tuned to proper frequency for selected operating band of main receiver. |
| | DF | Not functional in the SH-60B. |
| | TEST | Initiates built-in test sequence of receiver/transmitter. Results of test are displayed on FREQ/(CHAN) display. |
| 7 | Frequency slew switches | Momentary contact on-off-on toggle switches. The first switch increases hundreds and tens MHz frequency in up position and decreases frequency in down position. The second switch increases units MHz frequency in up position and decreases frequency in down position. The third switch increases tenths MHz frequency in up position and decreases frequency in down position, and the fourth switch increases hundredths and thousandths MHz frequency in up position and decreases frequency in down position. |
| 8 | CHAN SEL | Rotary switch. Permits selection of 1 of 30 preset frequencies (channels) when operational mode is set to PRESET. |
| 9 | Frequency mode selector | Rotary switch. |
| | 243 | Turns on radio and causes main receiver/transmitter to tune to 243.000 MHz (UHF AM) guard frequency. All front panel controls except VOL, SQL, and BRT are disabled. |
| | MAN | Permits manual change in operating frequency by using frequency control switches. CHAN SEL control has no effect. Transmitter and receivers are disabled during frequency change. |
| | G (Guard) | Tunes receiver/transmitter to guard frequency to the band to which the radio was last tuned (Note). |
| | PRESET | Permits selection of any 1 of 30 preset operating frequencies. Selected channel number is displayed on front panel tenths MHz readout for channels under 10, and units and tenths MHz readout for channels greater than 10. |
| | READ | Permits display of frequency of preset operating channel instead of channel number. Displayed frequency may be altered by use of frequency control switches, but stored frequency will not change. |
| | LOAD | Loads frequency selected in READ mode into memory to alter preset channel frequency. No change in stored preset frequency unless frequency has been changed while frequency mode selector has been set to READ. |
| <p style="text-align: center;">Note</p> <p>If the frequency mode selector is set to PRESET or READ and then back to G (guard), the guard frequency displayed will be the one appropriate for the frequency band of the preset channel. If the frequency mode selector is then set to MAN and back to G, the guard frequency displayed will be the one appropriate for the frequency band of the manually selected frequency.</p> | | |

Figure 15-7. Backup UHF/VHF Radio Control Panel (BuNo 162991 and Subsequent) (Sheet 2)

15.1.5.2.2 UHF/VHF Test

The backup UHF/VHF radio control panel three test functions are receiver/transmitter monitoring (on-line), control monitoring (continuously), and receiver/transmitter testing (off-line).

1. Receiver/transmitter monitoring BIT (on-line). The backup UHF/VHF radio control sends a transmit command every 1 to 3 seconds that asks for receiver/transmitter BIT results. The receiver/transmitter replies with a receive command followed by BIT results. BIT results contain three constant monitor faults: voltage-to-standing wave ratio (VSWR), forward power (RF output), and loss of lock (synthesizer failure).
2. Control monitoring BIT (on-line). Continuous on-line BIT monitors the control microcomputer. Should the microcomputer fail internally, or because of a faulty power supply, the backup control display will blank except for the decimal point. Receiver/transmitter testing BIT (off-line).
3. Selecting TEST on the backup control panel commands the receiver/transmitter into a BIT algorithm. During test, the backup control display is blank except for the decimal point. Upon completion of test (approximately 5 seconds), the receiver/transmitter sends BIT results which are then displayed by the backup control panel. Sample test readouts are shown in **Figure 15-8**.

| MODE | DISPLAY | FAULT | INTERPRETATION |
|---|-------------|-------------------------------|-----------------------|
| RCV | . | AT LOL OR RMT CONTINUE (NOTE) | SELECT TEST MODE |
| XMT | . | REDUCED PWR HIGH VSWR | SELECT TEST MODE |
| TEST | 8 8 8.8 8 8 | NONE | SELECT TEST MODE |
| TEST | 0 6 1 | VSWR | RT AND ANTENNA SYSTEM |
| TEST | 6 5 1 | FWD POWER | REPLACE RT |
| TEST | 2 2 1 | LOL | REPLACE RT |
| TEST | 1 5 7 | RT | REPLACE RT |
| TEST | 3 3 3 | RT | REPLACE RT |
| TEST | 3 3 2 | RT | REPLACE RT |
| TEST | 3 2 4 | RT | REPLACE RT |
| TEST | 1 5 7 | INTERFACE OR RT | REPLACE RT |
| TEST | . | RMT CONT | REPLACE RMT CONTROL |
| Note LOL designates loss of lock. | | | |

Figure 15-8. AN/ARC-182 BIT Test

15.1.5.3 HF Radio

The AN/ARC-174A(V)2 HF radio operates in the frequency range of 2 to 29.9999 MHz. Provisions exist for narrowband secure-voice USB and LSB. Power is supplied from the NO. 2 DC primary bus through a circuit breaker marked HF RAD R/T MT-AMPL CPLR in the ATO circuit breaker panel.

15.1.5.3.1 HF Radio Operation

Steps for operation of the HF radio refer to the HF radio control panel (**Figure 15-9**). To transmit, position the XMTR SEL switch on the radio control panel to HF (**Figure 15-3**). Key transmitter to tune selected frequency. Once the tune cycle has been completed, the radio is tuned.

WARNING

Do not operate HF transmitter on deck when personnel are within 50 feet of the antennas. Radiation hazard exists.

Note

- Unlike older HF radios, it is not necessary to tune a particular frequency prior to shutting down the radio.
- USN communication personnel generally specify HF radio frequencies as the frequency of the center of the sideband emission rather than the carrier (window) frequency. Most other communications activities such as commercial, USAF, and foreign military specify the window frequency which must be set on the radio control. Therefore, it may be necessary to set a frequency 1.5 to 2.0 KHz (0.0015 to 0.0020 MHz) off of the frequency specified in USN communications plans. Shift down for USB and up for LSB.

15.1.5.3.2 HF Test

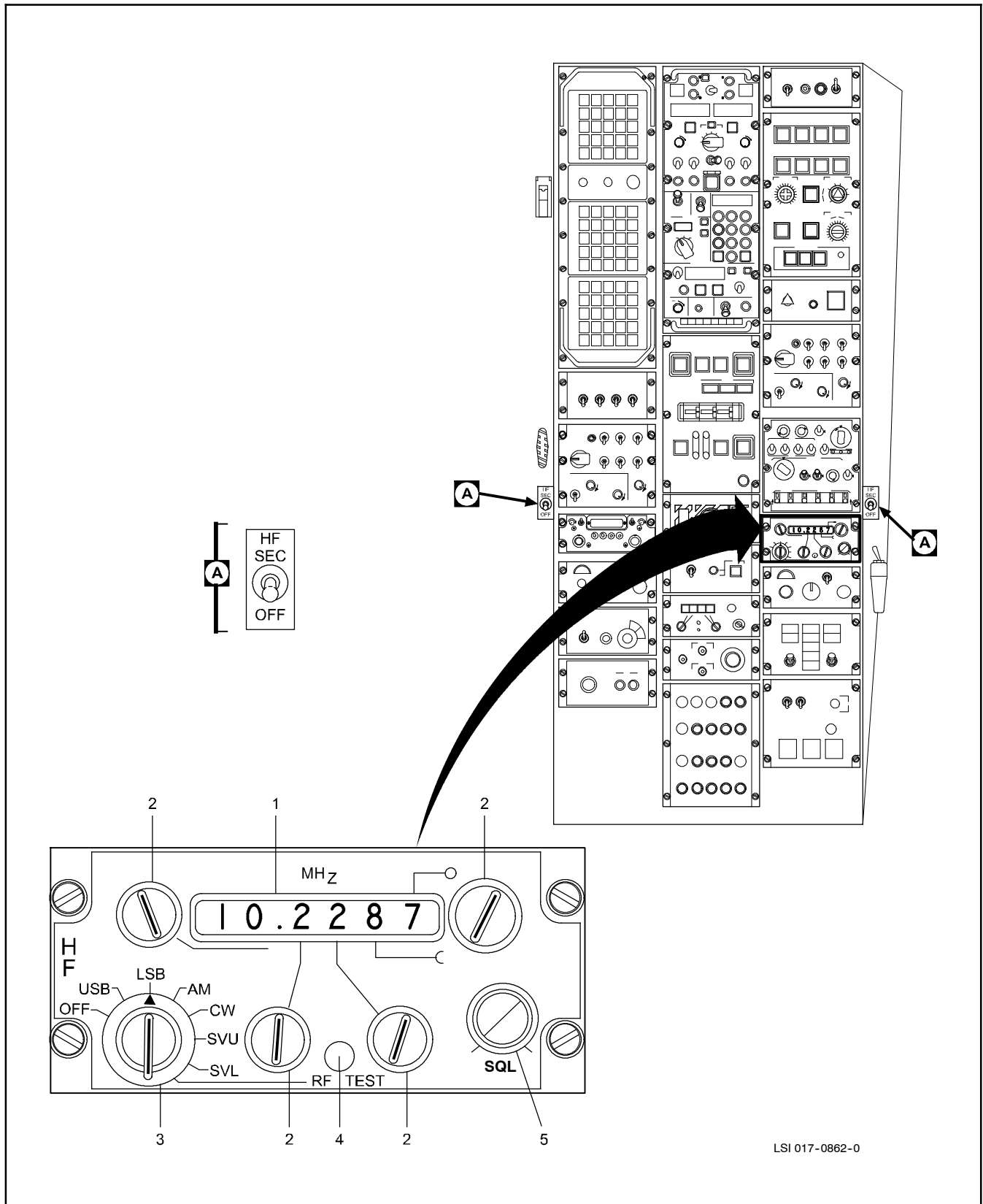
1. Select RF TEST. Lamp may blink for up to one minute but must eventually come on steady.
2. Key the radio momentarily. The tune tone should be audible for 4 to 8 seconds and the RF TEST light should go out. (This step will energize the antenna. For most reliable results, it should be conducted while airborne.)
3. After the tone stops, the RF TEST light may blink for up to one minute but must eventually come on steady.
4. If these indications are not received, the HF radio may not be fully operational and the results of the test should be passed to maintenance personnel.

15.1.6 Intercommunication System

The ICS permits communications between aircrewmembers. Each crewmember RSC panel includes controls for ICS operation ([Figure 15-10](#)). Additional inputs to the ICS network through IBs allow voice communications from the hoist operator station or from outside the helicopter while on the ground.

The pilot, ATO, SO, and instructor stations internal voice microphones may be voice actuated or push-to-talk (PTT). At the pilot and ATO station, the intercommunication PTT switch is the first detent of a trigger switch on the cyclic grip (the second detent actuates a selected radio transmitter). In addition, the pilot, ATO, and SO stations have two footpedal communication switches. The ICS switch for the instructor station is a pushbutton located below the instructor RSC panel. The ICS switches for the rescue hoist station are located on the hover trim control grip and the crewman rescue hoist pendant.

The ICS CALL switch on the cyclic grip or RSC overrides all transmissions or receptions. This allows communication with the other crewmen, regardless of the configuration RSC switches.



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Figure 15-9. HF Radio Control Panel (Sheet 1 of 2)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|-----------------------|---|
| HF | | The HF radio panel contains the switch functions and indications needed to operate the HF radio transmitter/receiver. |
| A | | The HF SECURE ON/OFF lever-lock toggle switch on the COMM CONTR panel is used to transmit secure-voice. |
| 1,2 | MHz (rotary switches) | The frequency readout and frequency selector controls are drum displays and rotary switches used to select one of 280,000 usable HF frequencies in the range from 2.0000 to 29.9999 MHz in increments of 100 Hz. |
| 3 | (Mode select) | The Mode select switch is an eight-position rotary switch. It provides the following mode selections. |
| | USB, LSB, AM | These positions allow the user to select one of three possible clear voice modes of radio transmission and reception — USB, LSB, or AM. USB and LSB can be used to transmit/receive secure voice. |
| | CW | Not implemented in the SH-60B. |
| | SVU, SVL | These modes are for narrowband operation and are only usable when a compatible HF secure-voice encoder, such as the KYV-5, is integrated with the HF radio. SVU and SVL can be used for both transmit and receive (transmit toggle switch on the CSCG must be on). The difference between SVU and SVL, and USB and LSB is a 10 db decrease in volume for SVU and SVL. |
| | RF TEST | Placing the mode selector switch in this position allows the user to isolate an HF radio fault to an individual unit. This is accomplished by selecting an HF frequency and keying the system. The status of the RF TEST lamp (NO. 4) will indicate which unit is faulty. |
| 4 | RF TEST | <p>The yellow RF TEST lamp indicates which unit is faulty when the RF TEST position of the mode selector switch is used. Indications and their meaning are as follows:</p> <p>OFF — Fault is in the receiver/transmitter unit.</p> <p>ILLUMINATED STEADY AFTER BLINKING — Normal operation and no fault.</p> <p>BLINKING — Fault is in amplifier-power supply or antenna coupler. A BLINKING indication can be further interpreted by aural monitoring. After the tune cycle has been completed, the normal tune tone should disappear from the headset. A continuing tone indicates a fault in the Power Amplifier or Power Supply. An interrupted tone (beeping) occurring about 10 seconds after the tune cycle is initiated indicates a fault in the Antenna Coupler.</p> |
| 5 | SQL | The SQUELCH control provides a selection of eight squelch threshold-level settings which reduces the background noise between transmissions. |

Figure 15-9 HF Radio Control Panel (Sheet 2)

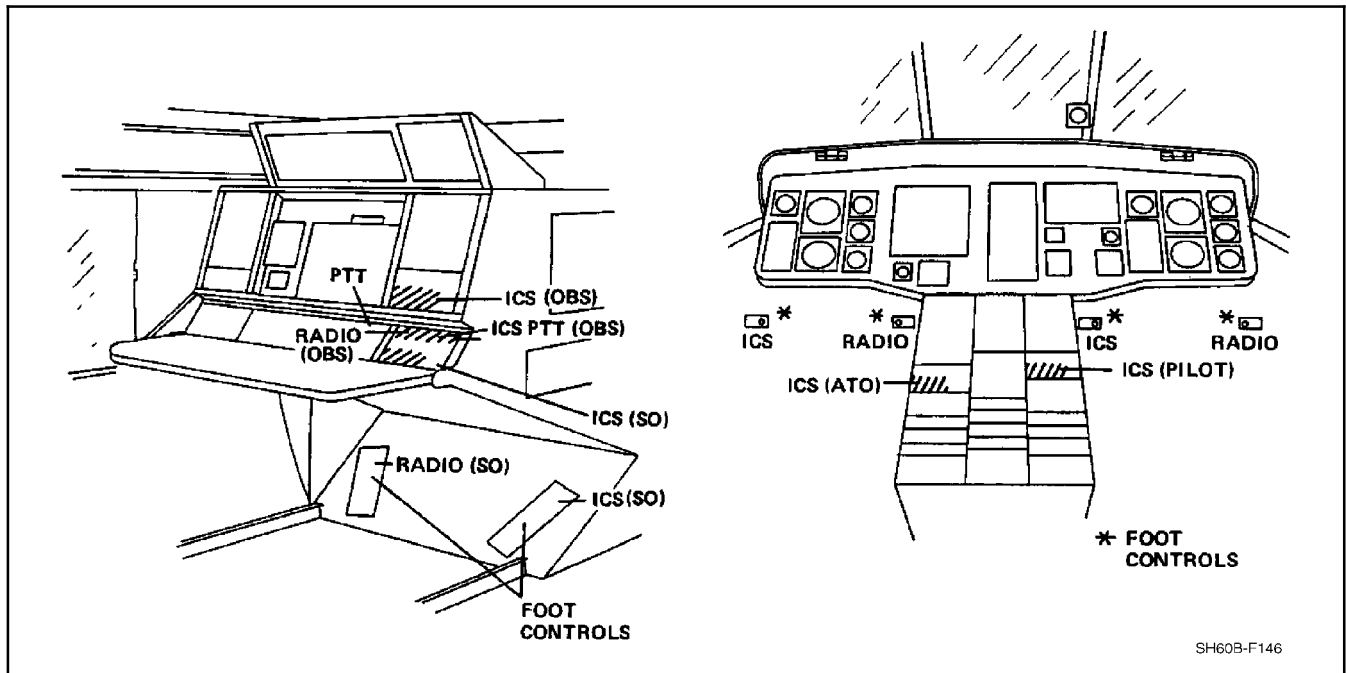


Figure 15-10. Intercommunications System (ICS) Controls

Note

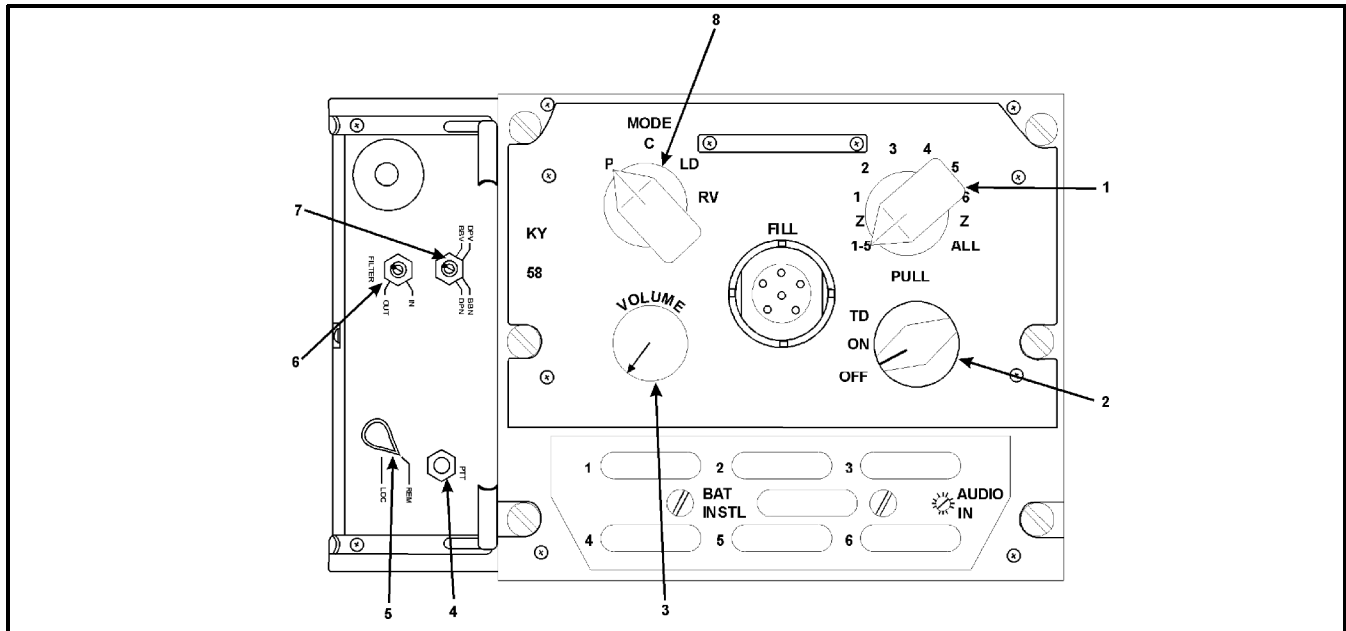
- To avoid the possibility of communications interference, DO NOT utilize ICS while simultaneously transmitting on UHF/VHF or HF.
- To prevent hot mike of other selected transmitters and loss of VOX ICS, ensure the ANDVT (USC-43/KYV-5) HF SECURE toggle switches are OFF when not in use. The toggle switches are mounted on the side of the center console, one on the pilot side and one on the ATO side.
- ICS operation requires AC power. ICS will not be available when the battery is the only source of electrical power.

15.1.7 Speech Security System

15.1.7.1 Speech Security Equipment, TSEC/KY-58

The half-duplex, wideband KY-58 and interface adapter (Z-AHQ) (Figure 15-11) provide secure operation for the UHF radios. The KY-58 and ZAHQ replaced the older KY-28 speech security equipment. When UHF secure operation is selected on the COMM CONTR panel, the selected UHF Receiver/Transmitter (R/T) operates in conjunction with the KY-58. The other UHF R/T is allowed simultaneous transmissions in the clear. Audio signals from the crewmember headsets are routed to the KY-58 by the CSCG ACP. The KY-58, located in the Mission Avionics Rack (MAR), encrypts the audio signals, which are then sent to the selected UHF R/T via the CSCG ACP. Secure UHF audio received by the UHF R/T is routed to the KY-58 by the CSCG ACP. The KY-58 decrypts the signals using the operational code and sends the clear audio to the CSCG ACP for distribution. Primary mission power is required for secure communications.

The KY-58 incorporates several advantages over the KY-28 it replaced. It allows up to six codes to be electrically loaded at one time into its memory, providing greater tactical communications flexibility. In addition, keying of the KY-58 is done using the same loading devices as the KYV-5 and KG-45.



| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|---|--|
| 1 | FILL Select Z 1-5 1 2 3 4 5 6 Z ALL | Zeroizes memory locations 1 through 5 simultaneously. Addresses memory location 1. Addresses memory location 2. Addresses memory location 3. Addresses memory location 4. Addresses memory location 5. Addresses memory location 6. Zeroizes memory locations 1 through 6 simultaneously. |
| 2 | Power Switch TD ON OFF | Removes power from the KY-58. Clear voice is still available. Selects a time delay for use when transmitting through a COMM relay station. Applies power to the KY-58 (normal mode). Removes power from the KY-58. Clear voice is still available. |
| 3 | VOLUME Control | Adjusts output volume of received signal when in cipher mode. |
| 4 | PTT | Push-to-talk. |
| 5 | LOC/REM | Selects local or remote operation (remote normal operation). |
| 6 | FILTER IN OUT | Baseband premodulation filtering. Selects filtering. Deselects filtering (normal mode). |

Figure 15-11. TSEC/KY-58 and Z-AHQ Interface Adapter Controls and Indicators (Sheet 1 of 2)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|---|---|--|
| 7 | Function switch BBN or BBV DPN or DPV | Selects baseband (FM) mode. (Note) Selects diphase (AM) mode. (Note) |
| 8 | MODE Control Switch P C LD RV | Permits transmission of plain voice. Permits transmission of cipher voice. Permits loading of variables into the KY-58. Permits reception of a remotely keyed variable. |
| <p>Note</p> <p>BBN and BBV are interchangeable. DPN and DPV are interchangeable.</p> | | |

Figure 15-11. TSEC/KY-58 and Z-AHQ Interface Adapter Controls and Indicators (Sheet 2)

These codes are retained by the internal battery or aircraft power until zeroized. Refer to the current operational communication plan for proper mode and code selection. Refer to [Figure 15-12](#) for troubleshooting procedures.

Note

- The ability to receive but not be heard indicates a diphase/baseband mismatch. (Diphase can receive baseband, but baseband cannot receive diphase).
- Inability to hold a key may be the result of a weak or dead battery.
- A good key with the apparent inability to transmit or receive secure voice (noise following the beep) may indicate a code mismatch.
- When in secure voice mode, radio volume is controlled on the KY-58. The CSCG control panel radio volume is disabled.
- Clear guard transmissions do not pass through the KY-58; guard should be monitored on the radio not in secure mode.

The KY-58/Z-AHQ assembly memory can be zeroized by the following methods:

1. Depressing the zeroize button on the CSCG control panel.
2. Selecting Z 1-5 or Z ALL on the KY-58.

15.1.7.1.1 Z-AHQ Adapter

The KY-58 is mechanically mounted to the Z-AHQ adapter as shown in [Figure 15-11](#).

15.1.7.2 Tactical Speech Security Equipment, TSEC/KYV-5

The half-duplex, narrowband KYV-5 ([Figure 15-13](#)) consists of:

1. Processor.
2. Remote Control Unit.

| TONE | OCCURS | INDICATES | PROCEDURE |
|---|--|---|---|
| Continuous beeping (cryptoalarm) with background noise | At turn-on. | | Clear by pushing and releasing push-to-talk (PTT) button. |
| Continuous beeping (cryptoalarm alarm) | At any time other than turn-on. | Equipment or battery failure. | Repeat TURN-ON procedures. If the alarm does not clear, change the prime battery. If it still does not clear, turn the equipment in for maintenance. |
| Continuous tone (parity alarm) | Any time an empty register is addressed and PTT is depressed and held. | 1. An empty storage register. 2. An invalid cryptovvariable is present. 3. Equipment fails to receive a valid cryptovvariable sent by a remote keying operation. 4. Equipment failure. | Follow LOAD procedure to enter a new cryptovvariable. If the alarm does not clear, change the prime battery. If it still does not clear, turn the equipment in for maintenance. |
| A single beep | 1. Each time PTT is initiated with the equipment in cipher and a filled storage register is addressed. 2. When a cryptovvariable has been successfully received. 3. At the beginning of a receive message. | 1. Begin speaking. 2. A valid cryptovvariable. 3. The cryptovvariable has passed the parity check. | |
| A single beep in time delay (TD) | After the preamble is sent. | | Begin speaking. |
| Background noise | At turn-on. | The KY-58 is working properly. | If no background noise is heard at turn-on, turn equipment in for maintenance. (Note) |
| A single beep followed by a burst of noise | At any time in cipher text mode. | Receiving station on a different variable than transmitting station. | 1. Turn fill select switch to the common variable. 2. As a last resort, contact transmitting station in plain and agree to meet on a particular variable. |
| Note | | | |
| This is important because the absence of noise indicates a malfunction which cannot be otherwise detected. It does not affect the communications capability. It does, however, affect the security provided by the KY-58. | | | |

Figure 15-12. KY-58 Aural Tones

A1-H60BB-NFM-000

The KYV-5 provides secure-voice operation capability for the HF radio. When HF secure operation is selected on the COMM CONTR panel, the HF radio operates in conjunction with the KYV-5. Audio signals received by the HF radio are routed to the KYV-5, via the CSCG ACP, for decryption. Clear audio is then returned to the ACP for distribution to crewmember headsets. Audio signals from crewmember headsets are routed to the KYV-5 by the CSCG ACP. The KYV-5 encrypts the audio signals and sends them to the HF radio, via the CSCG ACP, for transmission. Power is supplied from the NO. 2 DC primary bus through a circuit breaker located in the mission avionics circuit breaker panel, marked HF SECURE.

Note

The ARC-182 VHF radio, installed in ESP-modified aircraft as an aftermarket kit, is inoperable with the HF SECURE switch in the ON position.

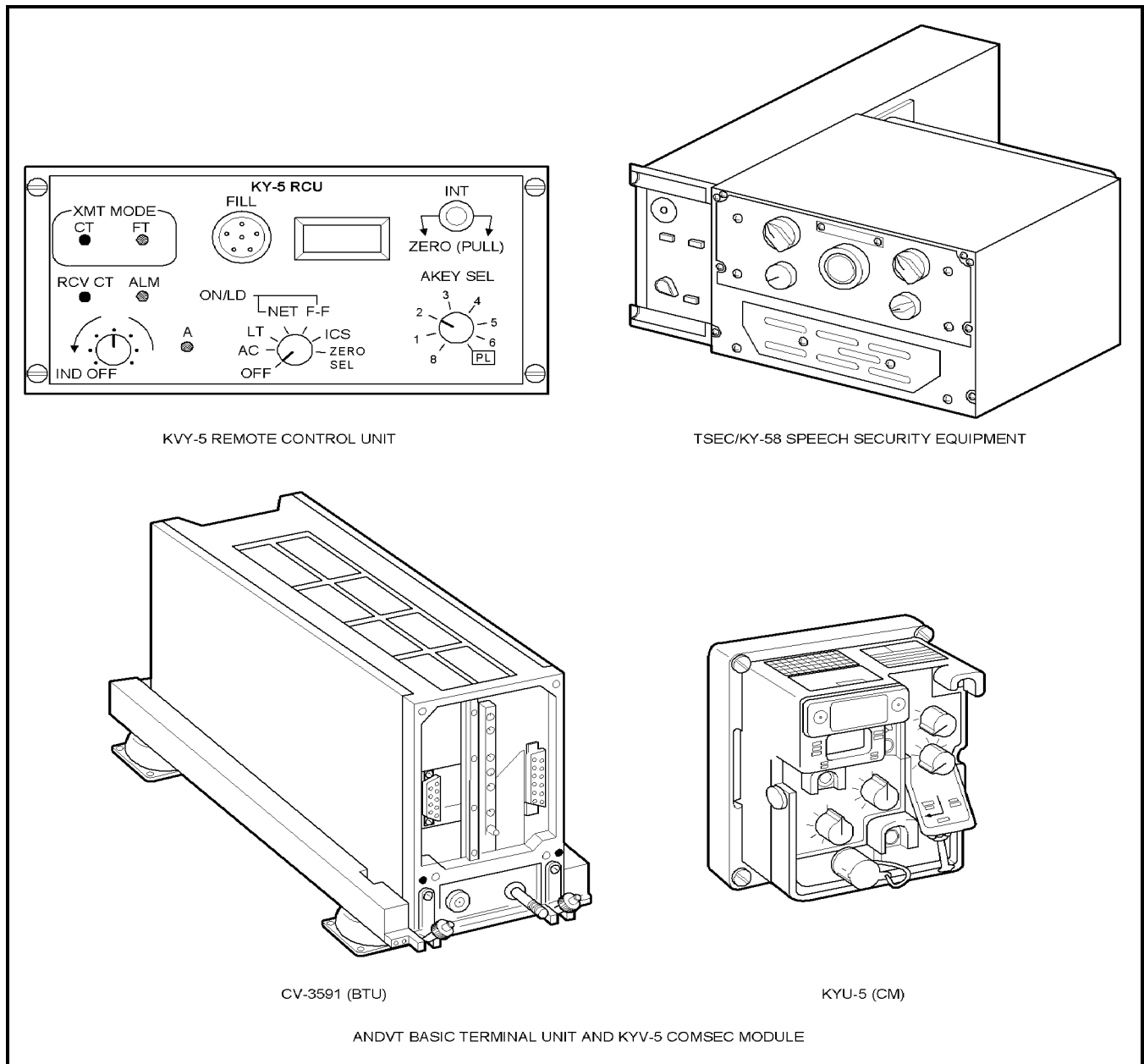


Figure 15-13. Tactical Speech Security Equipment

15.1.7.2.1 Processor

The KYV-5 processor contains the circuits required for encryption/decryption of HF audio signals. The processor contains the electrically inserted operational code. Principles of operation for the KYV-5 processor are contained in classified publications.

15.1.7.2.2 Remote Control Unit

The remote control unit provides an interface for controlling the KYV-5 and is located on the MAR. The operational code is electrically inserted into the remote control unit, which sends it to the KYV-5 processor. The code can be zeroized by activation of the ZERO CODE switch on the COMM CONTR panel. The zeroize signal is sent to the remote control unit, which forwards it to the processor. Electrical reinsertion of the code is required when the code has been zeroized. The code is zeroized in the following two situations:

1. Activation of the zero code switch on the COMM CONTR panel.
2. PWR/FILL dial switch is rotated to OFF/ZEROIZE position.

15.1.7.3 Radio Terminal Set, AN/ARQ-44 (Data Link)

The Radio Terminal Set (Data Link) is a full-duplex, secure RF link between the helicopter and the ship. Operating in the super high frequency (SHF) spectrum, it provides two-way secure data and secure voice communications between the ship and the helicopter. The data link has three modes of operation which are selectable on the CSCG. In ASW mode, the R/T transmits acoustic sensor data on RF channel NO. 1. In ASST mode, it transmits radar/IFF sensor data on RF channel NO. 1. ASW/ASST modes are normally used only for maintenance. In AUTO mode, the Data Link receives antenna pointing, antenna selection, RF channel selection, and mode commands from SAC-1. In HELO CONTROL, all information except ship commands are transmitted and received. The data link consists of the following components: communication security equipment, receiver/transmitter (R/T), multiplexer-demultiplexer (mux-demux), and the data link antennas.

15.1.7.3.1 Communication Security Equipment, TSEC/KG-45

The KG-45 (Figure 15-14) is a high-speed, full-duplex key generator that provides cryptographic security for both uplink and downlink data between the tactical avionics and the ship electronics systems. The KG-45 encrypts and decrypts the data link signal for the radio terminal set. The KG-45 is zeroized by loss of power for approximately two minutes. The data link cannot be operated without a properly keyed KG-45. The KG-45 must be keyed with MSN PWR on. Once keyed, the KG-45 will continue to operate in the voice mode with SAC power secured (e.g., performing engine overspeed checks on hardware). Power is supplied from the NO. 2 DC primary bus through a circuit breaker marked DATA LINK SECURE located on the mission avionics circuit breaker panel.

15.1.7.3.2 Receiver/Transmitter, RT-1275/ARQ-44

The radio R/T provides for continuous wave transmission and reception of mission data between own ship and the helicopter. During uplink, the R/T receives transmission from one of the antennas and sends it to the mux-demux. Data for downlink is received from the mux-demux and routed for transmission. When the data link switch is in RADIATE, RF output is available to either antenna or the hardwire port. In STBY, the transmitter will not radiate. The Weight-On-Wheels switch causes the RF output to shift to the dummy load, while low-level RF power is still present at the hardwire port. Each of the 16 available data link channels contains two discrete SHF frequencies, one for uplink and one for downlink.

15.1.7.3.3 Multiplexer-Demultiplexer, TD-1254/ARQ-44

The mux-demux functions as two basic units, a multiplexer and a demultiplexer. Both units operate simultaneously. The demultiplexer receives uplink data from the R/T and sends it through the KG-45 for decryption. Upon return of the decrypted data, the demultiplexer separates and routes the data to various onboard equipment. The multiplexer gathers downlink data, arranges it into the proper format, sends it through the KG-45 for encryption, and then to the R/T for transmission to the ship.

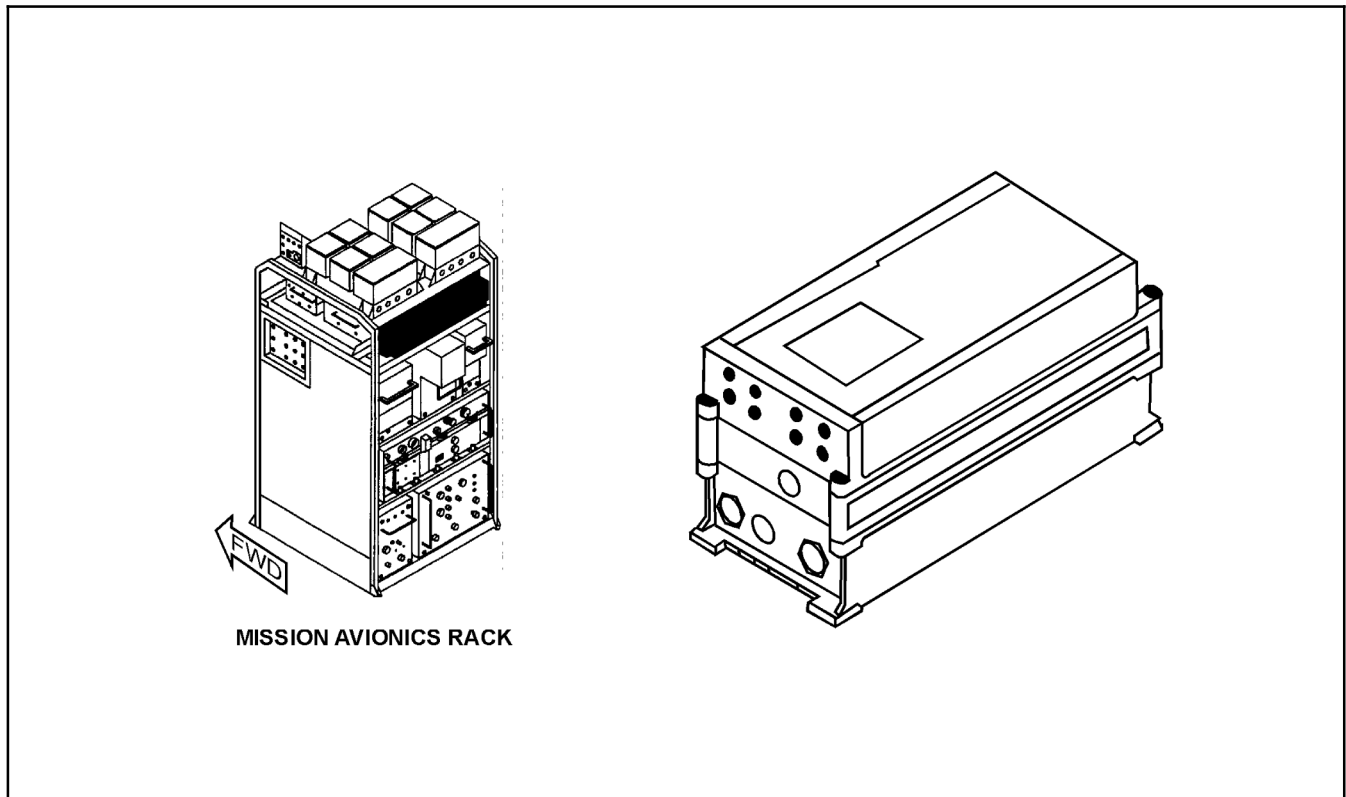


Figure 15-14. Communications Security Equipment TSEC/KG-45

15.1.7.3.4 Data-Link Antennas, AS-3273/ARQ-44

The two data-link antennas are independently steered to continuously point at the ship; however, only one antenna will radiate at any given time. The AOP computes the relative bearing of the ship from the helicopter and sends the antenna select commands to the mux-demux. The mux-demux passes the commands to the R/T to control selection of the RF power to the appropriate antenna. The forward antenna operates from 285° to 075° relative. The aft antenna covers the area from 071° to 289° relative. This gives a 4° overlap to prevent loss of synchronization.

15.1.8 Identification System

The IFF subsystem is comprised of two components: the IFF transponder and associated KIT-1/TSEC series transponder computer, which responds to interrogation from other friendly units; and the IFF interrogator and associated KIT-1/TSEC series interrogator computer, which interrogates other units for identification.

15.1.8.1 IFF Transponder

The transponder is made up of the APX-100 receiver/transmitter and KIT-1/TSEC series transponder computer. It is controlled from the IFF transponder control panel on the lower console ([Figure 15-15](#)). The transponder cannot be controlled by mission computer commands. The IFF subsystem can operate in four modes. Mode 1 provides 32 code combinations, any one of which may be selected in flight. Mode 2 and Mode 3/A each provide 4,096 codes. Mode 4 provides military secure IFF. Mode C provides altitude encoding. Power is supplied by the NO. 1 DC primary bus through a circuit breaker marked APX-100 CONTR XPONDR located in the ATO circuit breaker panel.

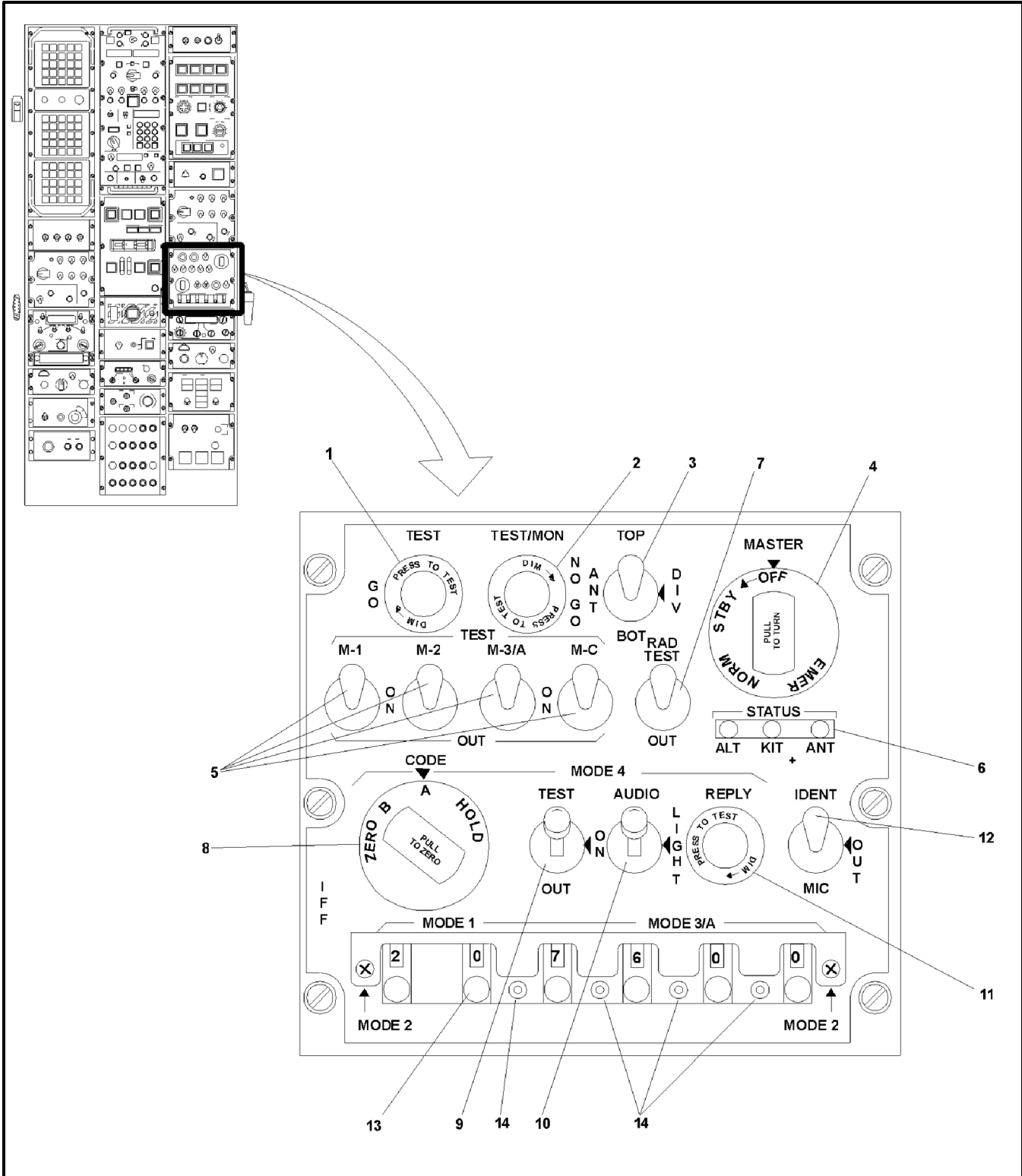


Figure 15-15. IFF Transponder Control Panel (Sheet 1 of 3)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|--------------------|--|
| IFF | | The IFF Transponder Control Panel provides the controls for the IFF Transponder Set. The Transponder cannot be controlled as a result of control commands received from the computer. |
| 1 2 | TEST MON, NO-GO | The green TEST GO and the red TEST/MON NO-GO PRESS TO TEST, turn to dim, annunciators indicate satisfactory operation of the transponder for selftest of Modes 1, 2, 3/A, 4, and C. |
| | | The green GO light indicates a good self-test. The red NO-GO light indicates a bad self-test on the KIT-1/TSEC Series Computer code is connected and Mode 4 is not coded or the Master selector is in STBY. The monitor function of the red light causes the light to illuminate momentarily when the transponder replies to an interrogation with MASTER in NORM. |
| 3 | ANT | The Antenna Control is a three-position toggle switch used to select the IFF antenna. |
| | TOP | Top position selects the upper IFF antenna. |
| | DIV | Diversity position selects automatic switching between the upper and lower IFF antennas. |
| | BOT | Bottom position selects the lower IFF antenna. |
| 4 | MASTER | The MASTER selector is a four-position rotary switch with the following functions: |
| | OFF | OFF turns transponder off. Switch must be pulled outward to rotate to this position. |
| | STBY | Standby places transponder in warmup condition. |
| | NORM | Normal causes the transponder to operate normally. |
| | EMER | Emergency conditions the transponder to transmit emergency reply signals to Mode 1, 2, and 3/A interrogations, regardless of mode-control settings. The switch must be pulled outward to rotate to this position. |
| 5 | ON | When normal mode selected (center position), respective mode is on and will respond to challenges. |
| | M-1 TEST | Mode 1 momentary self-test. |
| | OUT | Out (off) position for Mode 1. |
| | M-2 | Mode 2 momentary self-test. |
| | OUT | Out (off) position for Mode 2. |
| | M-3/A | Mode 3/A momentary self-test. |
| | OUT | Out (off) position for Mode 3/A. |
| | M-C | Mode C (Altitude Encoding) momentary self-test. |
| | OUT | Out (off) position for Mode C. |
| 6 | STATUS | Three red LED annunciators which isolate the fault status of the external units that provide data to the IFF system. |
| | ALT | Fault in altimeter, encoding barometric altimeter at pilot position. |
| | KIT | KIT-1 series Encryption unit fault. |
| | ANT | Fault in selected IFF antenna. |
| 7 | RAD TEST/OUT | The RAD TEST/OUT control is a two-position toggle switch for control of the transponder test circuitry, as follows: |
| | RAD TEST | Causes the transponder to reply to test mode interrogations and to verify BIT #1 for Mode 4. |

Figure 15-15. IFF Transponder Control Panel (Sheet 2)

| INDEX NUMBER | CONTROL LABELS | FUNCTIONAL DESCRIPTION |
|--------------|---|---|
| 8 | OUT MODE 4 CODE Selector CODE ZERO B A HOLD | <p>Monitor — The red TEST/MON light will illuminate when the transponder replies to interrogation.</p> <p>The MODE 4 CODE selector is a four-position rotary switch with the following selections:</p> <p>Causes code in both the KIT-1/TSEC series and the KIR-1/TSEC series computers to be erased. A mechanical latch must be released to turn the switch to zero. There is no guard when going from ZERO to B or A.</p> <p>Selects Mode 4, Code B.</p> <p>Selects Mode 4, Code A.</p> <p>Causes the KIT-1/TSEC series and the KIR-1/TSEC series computers to hold their codes before securing power. The switch is spring loaded out of this position so that it will return to the A position when released by the operator.</p> |
| 9 | MODE 4 TEST/ON/OUT | <p>The MODE 4 TEST/ON/OUT is a three-position toggle switch used to enable or test Mode 4. The up position (TEST) is spring loaded to return to the middle position (ON) when the switch is released. The bottom position (OUT) has a mechanical interlock to prevent inadvertently switching to Mode 4 off.</p> |
| 10 | MODE 4 AUDIO/LIGHT/OUT | <p>The AUDIO/LIGHT/OUT Control is a three-position toggle switch used to select the methods by which invalid Mode 4 interrogations are indicated.</p> <p>AUDIO selects both audio tone and the IFF caution light on the Caution/Advisory Panel.</p> <p>LIGHT, only the IFF caution light on Caution/Advisory Panel.</p> <p>OUT, no indications of invalid Mode 4 interrogation. A mechanical interlock is provided to prevent inadvertent movement of the switch to OUT.</p> |
| 11 | MODE 4 REPLY | <p>The green MODE 4 REPLY PRESS TO TEST, turn-to-dim, annunciator indicates the transmission of valid Mode 4 replies.</p> |
| 12 | IDENT/OUT/MIC | <p>The IDENT/OUT/MIC selector is a three-position toggle switch. The IDENT position is spring loaded. When momentarily selected, it initiates the Identification of Position (I/P) reply for approximately 20 seconds. Selection of OUT prevents triggering of the I/P function. Selection of the MIC position enables the I/P replies to be transmitted when the pilot presses either of his PTT switches.</p> |
| 13 | MODE 1, MODE 3/A (Code Selectors) | <p>The MODE 1 and MODE 3/A code selectors are six unidirectional thumbwheel switches used to select Mode 1 and Mode 3/A reply codes. The first two switches are for Mode 1 codes (octal numbers in range 00 to 73). The last four switches are for Mode 3/A codes (octal numbers in the range 0000 to 7777).</p> |
| 14 | MODE 2 (Code Selectors) | <p>The two cover-retaining screws are loosened and the cover enclosing MODE 1 and MODE 3/A is raised to reveal MODE 2 code settings. The MODE 2 four-digit octal code is inserted via the pushbutton switches and observed on the MODE 2 code display. MODE 2 codes are assigned by operational commanders. After insertion of MODE 2, the cover is lowered and the cover retaining screws tightened.</p> |

Figure 15-15. IFF Transponder Control Panel (Sheet 3)

15.1.8.2 Transponder Computer, KIT-1 TSEC Series

The transponder computer (**Figure 15-16**) processes mode 4 IFF challenges and generates properly coded responses. The transponder computer uses a manually inserted operational code to decode the interrogation and produce the response. The response is then sent back to the IFF transponder for transmission. Power is supplied from the NO. 2 AC primary bus through a circuit breaker marked COMPTR XPONDR located in the corner circuit breaker panel.

The IFF subsystem can operate in four modes. Mode 1 provides 32 code combinations, any one of which may be selected in flight. Mode 2 and mode 3/A provide 4,096 codes each, any one of which may be selected in flight. Mode 4 provides military secure IFF.

Note

The HOLD position should be utilized prior to shutdown if another takeoff is anticipated during the code period.

The IFF subsystem can operate in four modes. Mode 1 provides 32 code combinations, any one of which may be selected in flight. Mode 2 and mode 3/A provide 4,096 codes each, any one of which may be selected in flight. Mode 4 provides military secure IFF.

The transponder computer generates coded replies in response to valid interrogations from an interrogator cryptographic computer. Two Mode 4 codes are set in the transponder computer prior to flight, one for the present code period and one for the succeeding code period. From this time on, whenever the IFF is turned off or electrical power is disconnected for approximately 15 to 20 seconds, the codes will be cleared. This can be prevented by turning the CODE switch to HOLD position at least 15 seconds prior to power interruption. The KIR-1/TSEC functions in the same manner. Power is supplied by the NO. 1 DC primary bus through a circuit breaker, located in the overhead circuit breaker panel, marked APX-100 CONTR XPONDR.

The Mode 4 codes for both the KIT-1/TSEC and KIR-1/TSEC may be cleared manually by turning the CODE switch to ZERO position. This is a guarded position and requires pulling out and turning to reach the ZERO position. Likewise, the HOLD function transfers both KIT and KIR codes to hold.

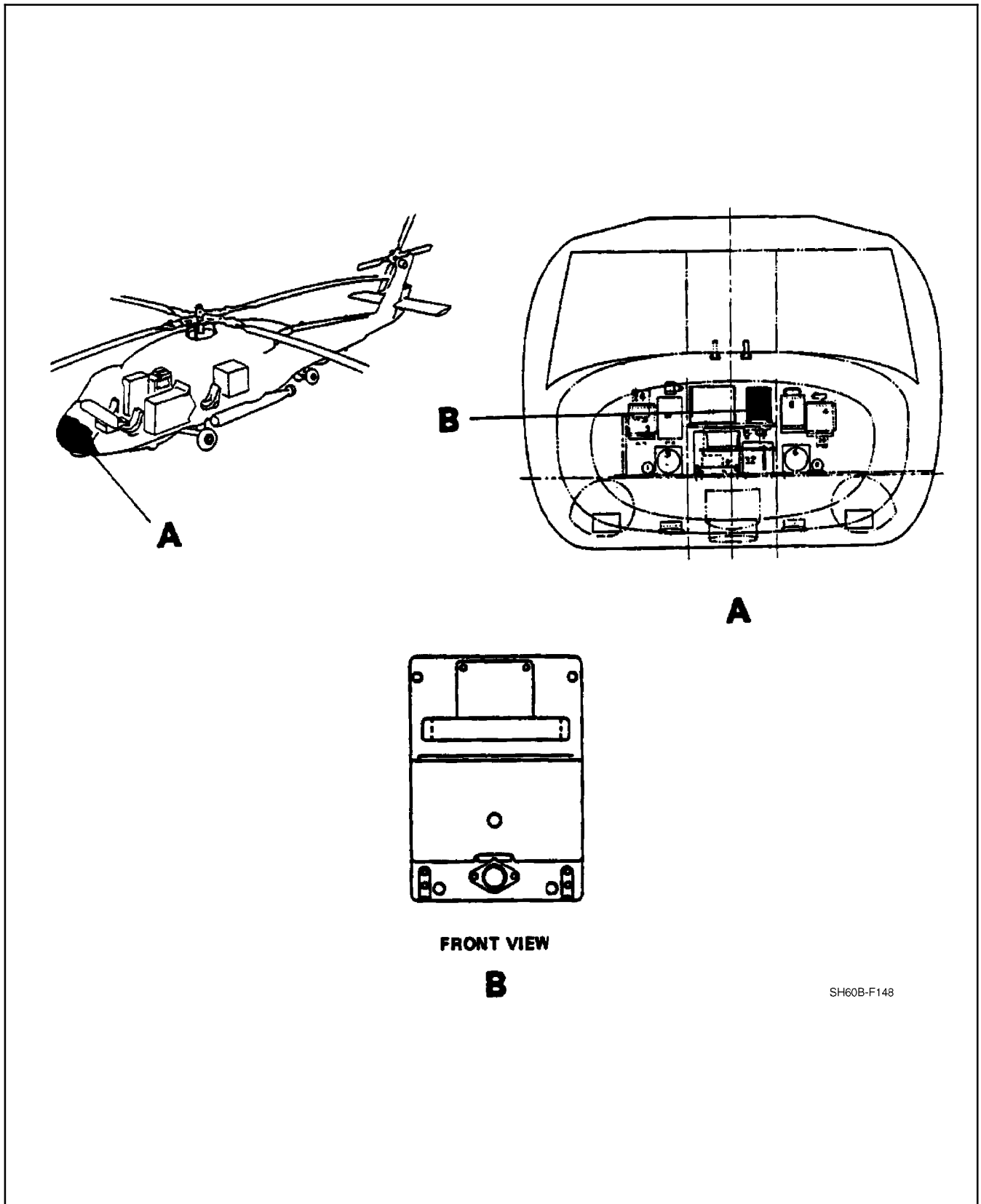
The transponder will give a green reply light to indicate that it has responded to an interrogation. The transponder will also give an audio and/or IFF caution light indication if it is unable to respond to a valid mode 4 interrogation. These may be selected or inhibited using the MODE 4 AUDIO/LIGHT/OUT switch (**Figure 15-15**).

WARNING

All audible and visual indications are inhibited in the OUT position. The IFF caution indicators warn the operator of potential life-threatening conditions relating to the ability to respond to Mode 4 interrogations.

The IFF caution indicator warns of conditions in which Mode 4 interrogations are not being responded to, possibly resulting from the transponder being in standby or having Mode 4 disabled (e. g., Mode 4 select switch in OUT position). The IFF caution indications further serves to warn of a zeroized or malfunctioning IFF crypto computer.

The ANT toggle switch offers three selections: TOP, BOT (Bottom), and DIV (Diversity). When TOP is selected, the transponder will only respond to interrogations from the top antenna. When BOT is selected, responses are only allowed from the bottom antenna. When DIV is selected, the transponder will respond automatically through the antenna receiving the strongest signal. The selection of TOP or BOT will not inhibit the transponder from processing signals from a specific antenna. The transponder attempts to make diversity selection on received signals and attempts to respond through the antenna having the strongest received signal. If the antenna favored by transponder diversity selection process is disabled by the ANT toggle switch, no response will be transmitted.



SH60B-F148

Figure 15-16. Transponder Computer KIT-1/TSEC Series, Mode 4

WARNING

Use of the TOP or BOT vice the DIV selection may cause the transponder not to reply to valid Mode 4 interrogations. Failure to respond to a valid Mode 4 interrogation may identify you as a potential foe. Take immediate corrective action in accordance with local directives.

CAUTION

An IFF antenna fault will be indicated on the ANT status annunciator on the IFF panel (Figure 15-15). This could indicate a failure to transmit. If using an individual antenna, switch to the other one in an effort to correct the problem by using the ANT toggle switch (Figure 15-15) on the IFF panel.

Note

ARC-182 transmissions in the VHF band may cause the test GO (green light) or NO-GO (red light) on the IFF transponder control panel to illuminate momentarily.

15.1.8.3 IFF Interrogator

The interrogator is made up of the AN/APX-76B IFF interrogator, the KIR-1/TSEC series interrogator computer, and the AN/APS-124 Radar Set. In SHIP Control-ASST mode, it can be remotely controlled by the ship via the data link. A challenge may be issued from the COMM CONTR panel at any time, provided the CSCG control switch is placed in the manual position. The mode and code of interrogation are also entered from the COMM CONTR panel. The ATO may then elect to have all responses in the selected mode displayed or only those involving both mode and code. Interrogation then may be made by activating the Challenge (CHAL) button to accept a correct MODE or MODE and CODE reply. Challenge correct code (CHAL CC) may be used to accept only a correct MODE and CODE reply.

WARNING

While operating IFF in auto sweep or single sweep mode and the mode was activated by the SO keyset, the SO will receive no indication when the IFF code is being interrogated, even if AUTO IFF is activated.

Note

Radar power-on causes a resetting of the Interrogator amplifier. At least one manual challenge must be issued from the COMM CONTR panel before an uplinked challenge will be accepted and processed.

15.1.8.4 Interrogator Computer, KIR-1/TSEC

The Interrogator Computer (**Figure 15-17**) generates Mode 4 IFF interrogation pulses. The Mode 4 challenge is activated via the IFF Electrical Synchronizer, which sends a pretrigger to the Interrogator Computer. The Interrogator Computer uses a manually inserted operational code to generate the required pulse train for the Mode 4 interrogation. The interrogation pulses are then returned to the IFF Interrogator for transmission. The Mode 4 reply received from the interrogated station is sent to the Interrogator Computer by the IFF Interrogator. The computer uses the operational code to check the reply for proper coded response. The KIR-1/TSEC code is electrically held in the same manner as the KIT-1/TSEC. Use of the HOLD feature on the Transponder Control Panel will shift the code back to hold. There are three methods of zeroizing the code:

1. Mode 4 code switch on IFF Transponder Control Panel (zeroize position).
2. Loss of electrical power for 15 to 20 seconds.
3. Loading door is opened.

Note

- Override of the M4 ALARM may compromise the Mode 4 code.
- ARC-182 transmissions in the VHF band may cause erroneous IFF contacts. Selection of another COMM frequency may eliminate the problem.

Certain failures of the interrogator computer will disallow interrogations (indicated by a red **CHAL** Flag). If the M4 alarm switch on the COMM CONTR panel is placed to **ORIDE**, it may be possible to force a challenge. If the **ORIDE** is successful, a challenge will be issued. At the present time, there are no aural or visual indications of M4 ALARM activation except for the failure to challenge.

Power is supplied from the NO. 2 DC primary bus through a circuit breaker in the mission avionics circuit breaker panel marked IFF INTERG.

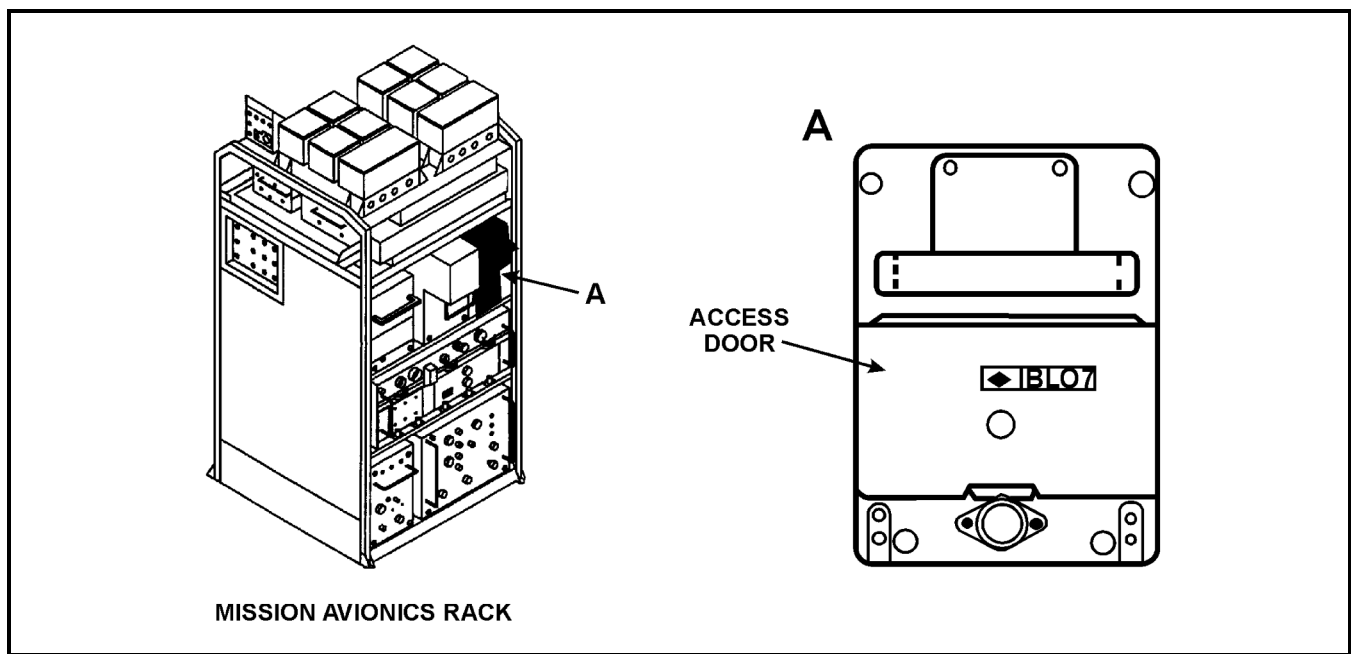


Figure 15-17. Interrogator Computer, KIR-1/TSEC Series

15.1.9 Interference Blanker

The interference blanker prevents interference due to simultaneous transmissions on the following transmitters:

1. IFF interrogator.
2. IFF transponder.
3. TACAN set.

Whenever these units transmit, a suppression input pulse is sent to the interference blanker by the transmitter. The interference blanker then sends suppression pulses to the other two transmitters. The interference blanker also sends suppression pulses to the electronic support measures (ESM) system to prevent spurious inputs to the ESM from the aircraft transmitters. Power is supplied from the NO. 1 AC primary bus through a circuit breaker marked INTRF BLANKER in the center circuit breaker panel. The interference blanker is located in the pilot seatwell.

15.1.10 Radio Terminal Set, AN/ARQ-44 or AN/ARQ-44A

The radio terminal set (data link) provides a directional RF link between the aircraft and the ship. See NTRP 3-22.4-SH60B for system description.

CHAPTER 16

Navigation

16.1 INTRODUCTION

The navigation subsystem determines flight data, such as air and groundspeed, heading, altitude, and attitude of the helicopter. It provides this data for visual display on cockpit indicators and it relays navigational data to the data handling subsystem.

16.2 NAVIGATION OPERATIONS

The navigation function processing requirements are partitioned into five subfunctions:

1. Navigation synchronization, used to synchronize ship and helicopter navigation systems.
2. Position keeping, utilizes Doppler radar navigation.
3. Position correction, used to determine and correct errors which arise due to helicopter navigation drift and sonobuoy drift.
4. Fly-to-point (FTP), provides processing for FTP positions and generated flight path direction commands and display information.
5. Provides navigational inputs for sensor processing and display.

These subfunctions are performed using various combinations of the navigation equipment described in the following sections. **Figure 16-1** shows the functional flow of navigation data in the system.

16.3 COMPONENTS OF THE NAVIGATION SUBSYSTEM

In this subsection, the various components and units that make up the navigation subsystem are described, along with their function, location, and operation. The functional interface of the navigation system is the navigation switching interface unit (NSIU).

16.3.1 Navigation Switching Interface Unit

The NSIU is located in the nose avionics bay and serves as an interface between navigation source equipment and the associated displays and data processors (**Figure 16-2**). The NSIU receives data from navigational sensing devices and distributes this data to navigation displays and subsystem elements. Operator selection of source data is done using the following: mode select control panel located on the pilot/ATO instrument panel, COMP panel, and the TCN panel. In the event of a loss of AC power to the NSIU, or if the NSIU fails, power-off latching relays will establish the following conditions:

1. Pilot AI will be driven from the pilot **AGCA**.
2. ATO AI will be driven from the copilot **AGCA**.
3. Both stations turn-rate needles will be driven from their respective sources.
4. Both BDHIs will only display:
 - a. Magnetic heading.
 - b. NO. 2 needle pointing to the currently selected TACAN station.
5. Both mode select panels will be inoperative.
6. No DME data will be available.

Power is supplied from the AC essential bus through two circuit breakers, located on the center circuit breaker panel, and marked NSIU POWER and NSIU NAV REF, respectively.

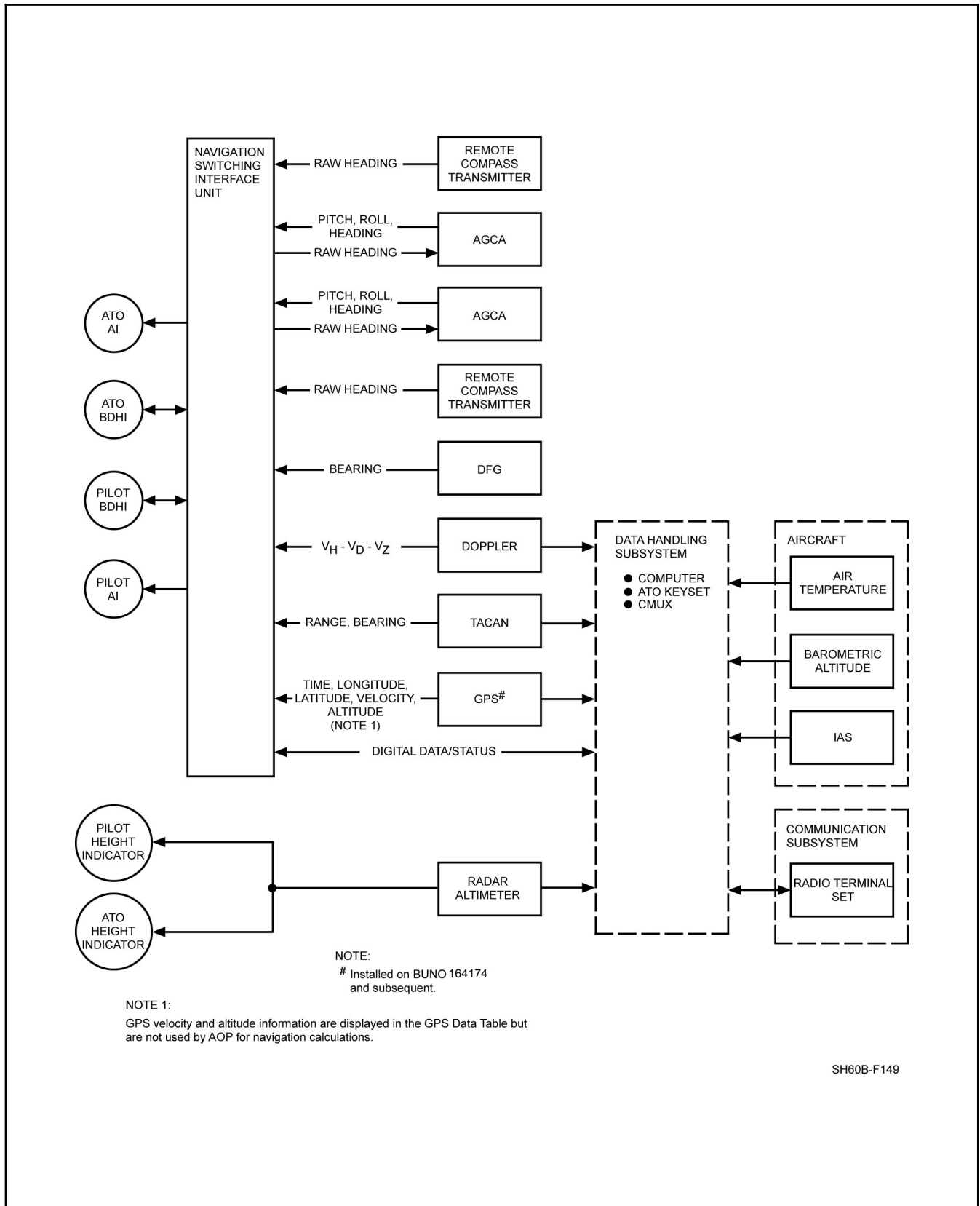


Figure 16-1. Navigation Subsystem Components Block Diagram

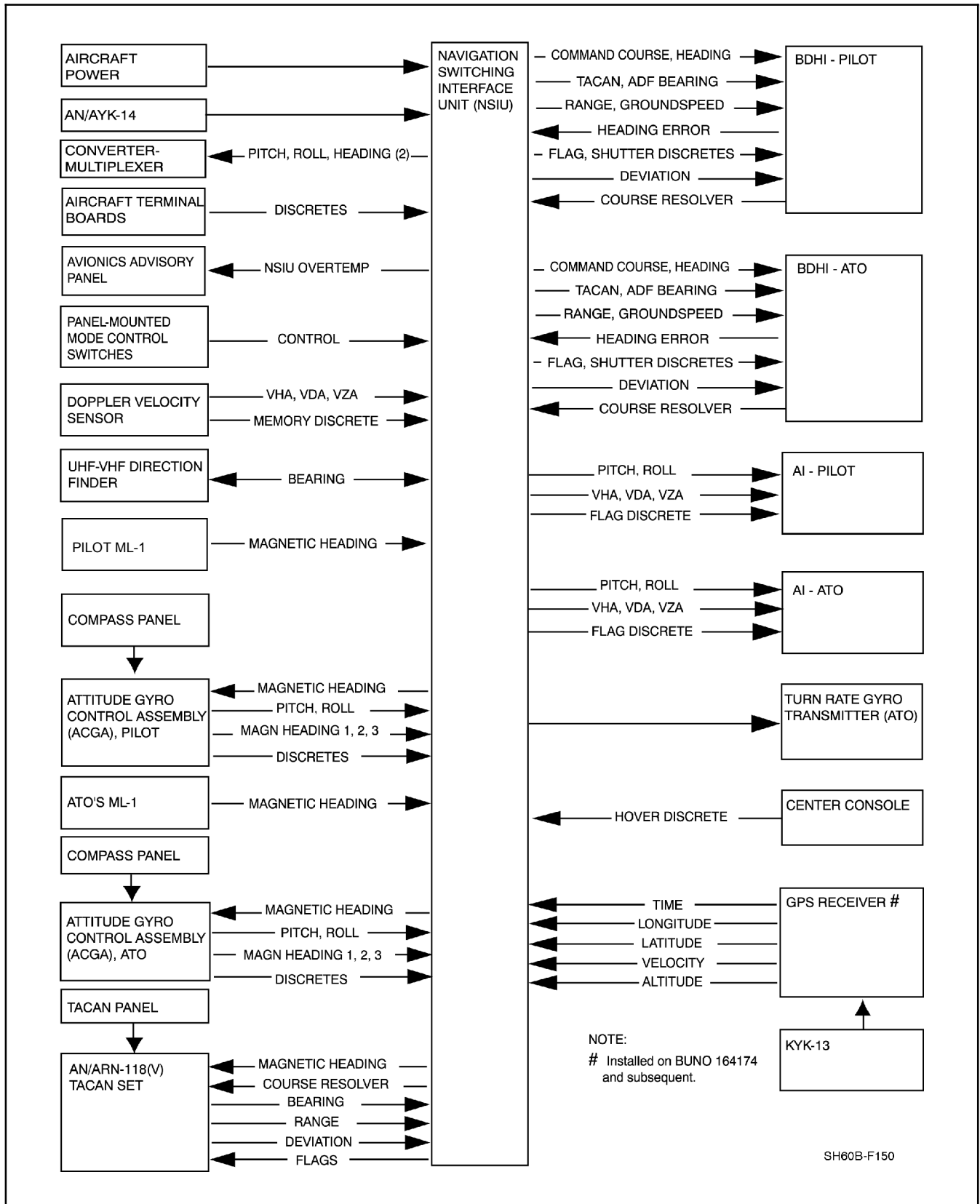


Figure 16-2. Navigation Switching Interface Unit (NSIU) Functional Interface

16.3.2 Compass System

16.3.2.1 Attitude Gyro Control Assembly (AGCA) (Pilot and ATO)

The AGCA consists of a displacement gyroscope, electronic control amplifier, and compass system controllers.

There are two displacement gyroscopes. They supply heading information depending on AGCA mode selected on the COMP panel (Figure 16-2).

When power is applied to the AGCA, the displacement gyroscope (stable platform) must be erected. The information required to align the platform is provided by the compass system controller and the remote compass transmitter (ML-1). A rough alignment phase lasting 2 minutes orients the platform generally in the proper position. At that point a fine alignment phase begins. During this phase the gyro precesses at a normal rate until the platform is precisely aligned.

Each stable platform provides the stable reference from which changes in aircraft pitch, roll, and heading are measured. It consists of a two-gyro, three-gimbal assembly. The gyro heading (directional) gyro is mounted on the innermost gimbal and is erected parallel to the surface of the Earth with its spin axis oriented toward magnetic north in the slaved mode. The pitch (vertical) gyro is mounted on the middle gimbal. For attitude stabilization, this gyro is erected perpendicular to the surface of the Earth, with its spin axis parallel to the local vertical. The displacement gyroscope provides heading, pitch, and roll information via pick-offs from the inner, middle, and outer gimbals, respectively. The information is sent to the electronic control amplifier for processing and distribution.

The electronic control amplifier (ECA) contains an azimuth servo amplifier, slaving amplifier, deviation compensator, turn and acceleration control features, fast synchronization circuitry, malfunction monitoring circuitry, and power supplies. The electronic control amplifiers route heading, pitch, and roll synchro signals to the NSIU and to AFCS for distribution to the various equipments. Power is supplied from the AC essential bus (pilot) and NO. 1 AC primary bus (ATO) through two circuit breakers on the overhead circuit breaker panel, marked PILOT ECA and ATO ECA, respectively.

The electronic control amplifier contains the circuits required to:

1. Erect the stable platform.
2. Process heading information.
3. Correct for anomalies in the ML-1s as they detect the magnetic field of the Earth.
4. Distribute pitch, roll, and heading information.
5. Slave heading gyro to magnetic heading.
6. Suspend erection or remove compass slaving during aircraft acceleration.
7. Perform system monitoring and fault detection.
8. Correct for effects of the rotation of the Earth.

The ECA receives magnetic heading from the remote compass transmitter ML-1 via the NSIU. Mode select information, heading information, and latitude correction information (for Earth rotation) are received from the compass system controller. This information is processed by the electronic control amplifier and signals are generated for the pitch, roll, and heading torques in the stable platform to control erection of the gyros. When acceleration of the aircraft either linearly or rotationally exceeds cutoff points, the electronic control amplifier reduces erection and slaving voltages to prevent loss of the stable platform from overdriving the torques.

Pitch and roll information received from the stable platform drives follow-up servos in the electronic control amplifier. The pitch and roll servos provide three-wire synchro signals to the NSIU and automatic flight control system (AFCS). Heading information received from the stable platform is processed by the electronic control amplifier, and four separate three-wire synchro heading signals are generated. The information represented by these signals depends on the mode of operation selected on the compass system controller.

The electronic control amplifier monitors critical voltages and signals during operation to detect system malfunctions. If a malfunction is detected, an AGCA FAIL signal is transmitted to the NSIU. This alerts the pilot to allow switching navigation displays from one AGCA to the other so that valid information is provided.

The compass system controller (**Figure 16-3**) contains the controls and indicators required to operate the AGCA. Functions of the compass system controller are:

1. Providing synchronization display.
2. Setting local latitude, north or south hemisphere.
3. Setting heading information.
4. Selecting AGCA mode.
5. Generating latitude correction signals.
6. Enabling fast SYNC and fast erect functions.

16.3.2.2 Remote Compass Transmitters (Pilot and ATO), ML-1(MOD)

There are two remote compass transmitters, both located in the tail cone section. One operates with the pilot AGCA and the other operates with the ATO AGCA. The remote compass transmitters, commonly referred to as flux valves, detect the direction of the Earth magnetic field and transmit this information electrically through a slaving circuit to a torque motor in the AGCA Directional Gyroscopes. The AGCA torque motor maintains the directional gyroscope heading reference in a fixed position relative to the Earth magnetic field.

16.3.2.3 Bearing-Distance-Heading Indicators

The BDHIs are primary navigation instruments. The BDHI uses navigation data from various sources to present the pilot with a symbolic display of the horizontal navigation situation. In addition to course settings, bearing information from the TACAN and DFG equipment is presented on the BDHI. **Figure 16-4** shows the BDHI and describes its individual indicators. Power for the pilot BDHI is supplied from the AC essential bus and DC essential bus through two circuit breakers located in the center circuit breaker panel and the overhead circuit breaker panel, both marked PILOT BDHI. Power for the ATO BDHI is supplied from the NO. 1 DC primary bus and NO. 1 AC primary bus through two circuit breakers located in the ATO circuit breaker panel and center circuit breaker panel, respectively.

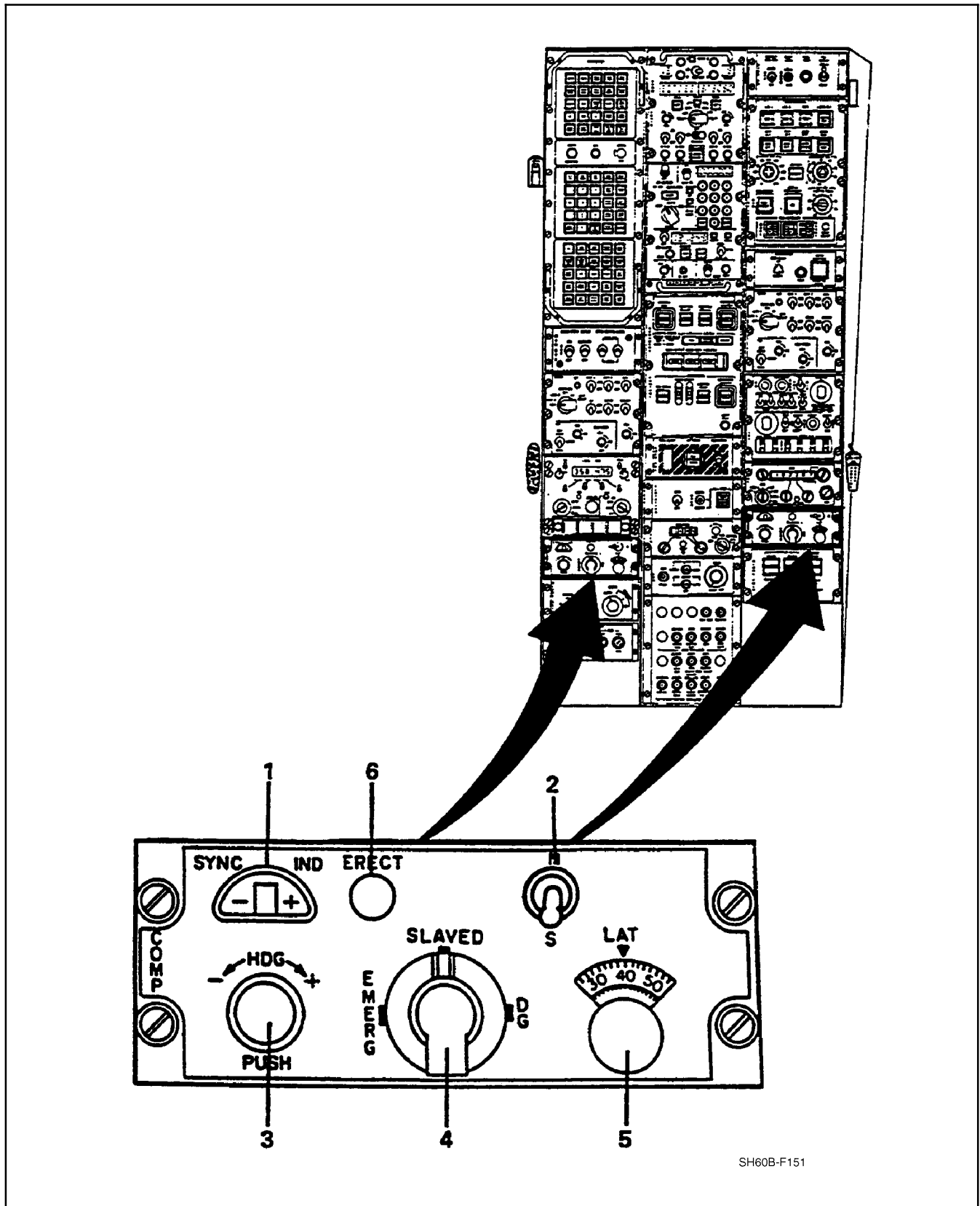
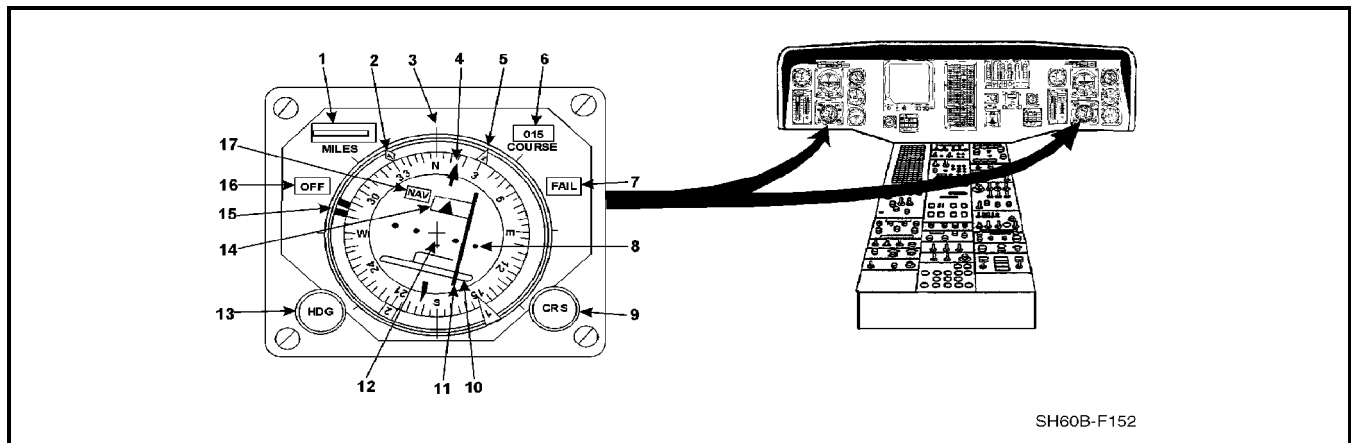


Figure 16-3. Compass System Controller (Sheet 1 of 2)

| INDEX NUMBER | CONTROL | FUNCTIONAL DESCRIPTION |
|--------------|--|---|
| 1 | SYNC IND | The Synchronization Indicator indicates the synchronization between the directional gyro output and the remote compass when the SLAVED mode is selected with the mode selector switch. If they are not synchronized, the indicator shows in which direction a correction must be made to avoid ambiguity. |
| 2 | N/S | The two-position (N/S) hemisphere selector toggle switch permits the selection of either North or South latitude for use by the system. |
| 3 | HDG +/- PUSH | The PUSH to SYNC is a push-and-turn switch (spring return to center) that provides heading set. When the HDG button is pressed, the heading set control markings indicate the direction to turn the control to provide a decreasing (-) or increasing (+) heading change. When synchronized, the synchronization indicator is centered. |
| 4 | Mode selector SLAVED EMERG DG | The mode selector is a three-position rotary switch used to select one of the following modes of operation: The SLAVED mode is the primary mode of operation (gyro stabilized magnetic compass). The SLAVED mode synchronizes the directional gyro output to the remote compass heading. When selected, fast synchronization occurs in the same manner as when the system is first turned on. The compass mode is for emergency use only, when the directional gyro is disabled. Only remote compass information is used for heading (unstabilized magnetic heading). The directional gyro mode is normally selected when local magnetic conditions or operations in high latitudes make the magnetic compass information unreliable. Because no magnetic correction is applied to the directional gyro, manual insertion of latitude information is essential to compensate for precession caused by the rotation of the Earth. |
| 5 | LAT | The latitude selector knob and readout window are used to set the latitude to that of the helicopter during operations in the DG or SLAVED mode. The readout window displays latitudes 0° to 90°, graduated in two-degree intervals with major divisions and numerals every ten degrees. |
| 6 | ERECT | Pushbutton that provides fast compass synchronization and AI fast erect. |

Figure 16-3. Compass System Controller (Sheet 2)



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| INDEX NUMBER | CONTROL | FUNCTIONAL DESCRIPTION |
|--------------|-------------------------------------|--|
| 1 | Range counter | Displays digital range information in hundreds, tens, units, and tenths of a mile (Doppler groundspeed in knots when BDHI is in Doppler mode). Range is slant range to a TACAN station or horizontal range to an FTP. |
| 2 | Bearing needle NO. 1 | Indicates relative bearing to signal source being tracked by DFG. |
| 3 | Lubber line | Reference line indicating center line of aircraft. |
| 4 | Course arrow | Indicates selected course on compass case. |
| 5 | Bearing needle NO. 2 | Indicates relative bearing to selected TACAN station. |
| 6 | COURSE counter | Displays course to the nearest degree. Indicates same value as course arrow. |
| 7 | Fail flag | Unit Fault Indicator indicates failure of one or more internal status monitoring tests. |
| 8 | Course dots | Scale for deviation bar. 1 dot = 5° deviation. |
| 9 | CRS | The course select knob is used for manual course selection. |
| 10 | Deviation bar slot | Slot for control arm of deviation bar. |
| 11 | Deviation bar | Fly-to bar that indicates deviation from selected course. |
| 12 | Aircraft symbol | Miniature aircraft for orientation reference. |
| 13 | HDG | The heading select knob is used to manually set heading. Positions heading select marker. |
| 14 | To/From indicator | When pointing to the head of the course pointer, arrow indicates aircraft flying TO a TACAN station or FTP, when pointing to tail, it indicates flying FROM a TACAN station or FTP. |
| 15 | Heading select marker (heading bug) | Indicates heading necessary to maintain selected or computer generated course. |
| 16 | OFF flag | Indicates absence of internal power or external ground. |
| 17 | NAV flag | When computer is in TACAN mode, indicates TACAN data is unreliable. When computer is in CPTR mode, indicates the absence of a fly-to-point. When computer is in DPLR mode, indicates Doppler groundspeed is below 8 knots. |

Note

Selection of ALTR mode may bypass power failure.

Figure 16-4. Bearing-Distance-Heading Indicator

Both AC and DC power are required for proper BDHI operation. The AC power supply provides operating voltages to rotating components. The DC power is used for various latching solenoids in the BDHI. The latching solenoids provide for computer control of the HDG and CRS knobs, thus if DC power is lost or the DC circuit breaker is out, FTP steering and Doppler steering will be lost.

Three modes are available: TCN (TACAN), CPTR (computer), and DPLR (Doppler) (Figure 16-5). Operating modes of the two BDHIs can be independently selected by their respective mode-select panels (Figure 16-6).

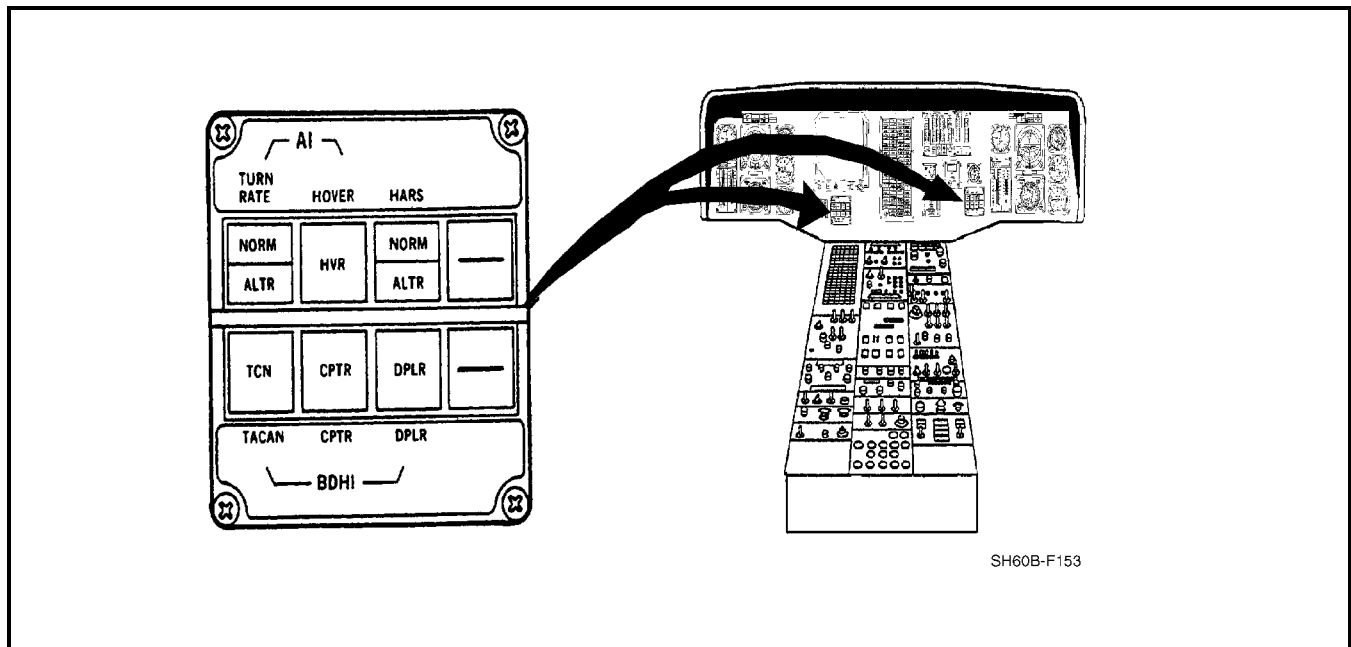
| MODES | | | |
|-------------------|----------------------|------------------------|--|
| DISPLAY INDICATOR | TACAN | COMPUTER | DOPPLER |
| Needle 1 | ADF/OTPI | ADF/OTPI | ADF/OTPI |
| Needle 2 | TACAN radial | TACAN radial | TACAN radial |
| Compass card | Magnetic heading | True heading | Magnetic heading |
| Heading marker | Set by knob (manual) | Command heading to FTP | Command heading to fly selected course |
| Course Arrow | Set by knob (manual) | Course to FTP | Set by knob (manual) |
| Deviation bar | Course error | Course error | Command heading error |
| Course window | Selected course | Course to FTP | Selected course |
| Range window | TACAN DME | Range to FTP | Doppler groundspeed |

Figure 16-5. BDHI Displayed Data as a Function of Selected Mode

16.3.3 Radar Navigation Set, AN/APN-217

The radar navigation set (RNS) is the Doppler groundspeed sensor, designed to operate reliably even in low sea state conditions and over land. The SEA mode is the default mode whereas the LAND mode is selected through the AOP and MPD controls. The RNS provides groundspeed information to the automatic flight control system (AFCS) for coupled hover operations. This information is also displayed on the Attitude Indicators (AI) by the heading velocity (VH) and drift velocity (VD) bars and by the vertical velocity (VZ) pointer. It provides three axis velocities that are used to compute the groundspeed that may be displayed on the BDHI. The RNS transmits four narrow beams to the surface of the Earth and measures the Doppler shift of the return signal due to aircraft motion. From these measurements, the heading, drift, and vertical aircraft velocities are calculated. This data is sent to the NSIU in analog form and then to the pilot and ATO AIs. When the BDHI mode is selected to Doppler, the NSIU displays Doppler groundspeed and heading to fly which it calculates from the heading and drift velocities and the course selected. Digital vector components are sent to the data handling subsystem, where they are used for Doppler navigation. The Doppler radar will maintain a reliable track over sea state one at steady bank angles up to and beyond 45°. However, Doppler tracking is severely degraded by vertical acceleration, roll acceleration, and pitch and roll rate, especially in combination. Loss of Doppler track is indicated by short periods of Doppler in memory. In situations where this could affect navigation (i.e., bias development), avoid abrupt maneuvers or turns combined with climbs or descents.

Power is applied to the RNS whenever AC and DC power are available and the DPLR switch on the MSN SYS panel is ON. The DPLR button on the mode select panel (Figure 16-6) causes the Doppler groundspeed to be displayed in the range readout window of the BDHI (Figure 16-4).



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| INDEX | FUNCTION |
|-------------------|--|
| Mode select panel | This panel permits the pilots to select the source of heading and attitude reference and the gyro to be used for heading and turn-rate displays. |
| AI | |
| TURN RATE | Alternate-action pushbutton with two displays. |
| NORM | The turn-rate gyro normally associated with each AI is being used as the source of turn rate (i.e., the pilot turn-rate gyro is feeding the pilot AI turn-rate needle and the ATO turn-rate gyro feeds the ATO AI turn-rate needle). |
| ALTR | Selection of ALTR on the pilot turn-rate button switches the source of the pilot turn-rate indication to the ATO turn-rate gyro. The ATO ALTR turn-rate selection switches his turn-rate source to the pilot turn-rate gyro. |
| HARS | The heading attitude reference system pushbutton, alternate action with light display for each condition. |
| NORM | The HARS normally associated with each AI and BDHI is being used as the source of attitude and heading. The pilot HARS provides pitch and roll to the pilot AI and heading to the pilot BDHI; the ATO HARS provides pitch and roll to the ATO AI and heading to the ATO BDHI. |
| ALTR | Selection of Alternate (ALTR) on the pilot HARS switches the source of the pilot attitude and heading indications on the pilot AI and BDHI to the ATO HARS. The ATO ALTR selection similarly switches the attitude and heading indication source to the pilot HARS. Only one HARS switch can be in ALTR. Pilot selection of ALTR will override the ATO selection and return the ATO to NORM. |
| HVR | The hover pushbutton is an alternate-action pushbutton switch/display. When illuminated (green), VH, VD, and VZ signals from the Doppler are displayed on crossed bars and a pointer on both AIs for use by the pilot and ATO during hovering flight. |

Figure 16-6. Mode Select Control Panel (Sheet 1 of 2)

| INDEX | FUNCTION |
|-------|--|
| BDHI | |
| TCN | The TACAN pushbutton, when pressed, illuminates green and causes the RANGE readout window on the applicable BDHI to display TACAN range. In addition, the course select and heading set knobs on the applicable BDHI are enabled. |
| CPTR | The computer pushbutton, when pressed, illuminates green and causes range to a computer derived FTP to be displayed in the RANGE readout window. Bearing to the FTP is displayed on the course pointer. In this mode, the course set and heading set knobs are disabled and the heading bug is driven by the computer as command information to the pilot or ATO, as applicable. |
| DPLR | The Doppler pushbutton, when pressed, illuminates green and causes groundspeed to be displayed in the RANGE readout window of the BDHI. During this mode, the course set knob is enabled, but the heading set knob is disabled, and the heading bug is driven by an NSIU as command information to the pilot or ATO, as applicable. |

Figure 16-6. Mode Select Control Panel (Sheet 2)

The NAV flag will appear on the BDHI in the DPLR mode whenever Doppler groundspeed is below 8 knots. If the RNS shifts to the memory mode, the NAV window will remain blank and the VH, VD, and VZ pointers will freeze. Power is supplied from the NO. 2 DC primary bus and the NO. 1 AC primary bus through two circuit breakers located on the ATO and the center circuit breaker panels, both marked NAC RDR SET.

16.3.4 TACAN Navigation Set, AN/ARN-118(V)

The TACAN navigation set consists of a receiver/transmitter (R/T) and control and is a polar-coordinate navigation system, with the aircraft at the origin. The TACAN Set receives a UHF signal from a TACAN surface station (ground or shipboard) or aircraft and calculates the magnetic bearing and slant range to that station. Station identification codes are conveyed by audio modulation of the returning signal. The range of the TACAN is limited to line-of-sight and increases with aircraft altitude up to 123 nm at 10,000 feet. The TACAN set operates on a channel selected from 252 available channels, 126 "x" (FAA) and 126 "y" (tactical). Range information is determined by measurement of the time for round-trip travel of the radio signal between the helicopter and TACAN station. Aircraft radial is determined by phase measurements which are converted to azimuth indications. The TACAN range and bearing are displayed on the pilot and ATO BDHI. The TACAN Set also provides high resolution digital outputs of range and bearing to the CMUX for use in updating the helicopter position.

16.3.4.1 Receiver/Transmitter

The R/T contains all transmitting, receiving, and decoding circuits. The R/T decodes the control and switches to the proper mode. The receiver and transmitter sections (in T/R or A/A T/R modes) are tuned to the frequencies that correspond to the channel specified in the control word. Transmit and receive frequencies are always 63 MHz apart. Power is supplied from the NO. 1 AC primary bus through a circuit breaker, marked TACAN R/T, located on the center circuit breaker panel.

The R/T switches between the upper and lower antennas signal every 5 seconds until a usable beacon signal is received on one of the antennas. The antenna with the usable signal is used as the receiver antenna. The bearing is determined with an accuracy of $\pm 1^\circ$.

Note

NAVAIDS listed in the FLIP publications correspond to the X channels unless otherwise noted.

16.3.4.2 TACAN Control

The TACAN control contains all controls and indicators required for operation of the TACAN set (Figure 16-7). The control relays the TACAN audio station identification signal to the audio converter-processor. Figure 16-4 is a list of the controls and indicators on the BDHI. Refer to Figure 16-8 for a list of the BDHI indications for each operating mode as selected on the TACAN control. Power is supplied from the NO. 1 DC primary bus through the circuit breaker marked TACAN CONTR, located on the ATO circuit breaker panel, and the NO. 1 AC primary bus through the circuit breaker marked TACAN R/T, located on the center circuit breaker panel.

16.3.4.3 TACAN Operation

For TACAN operation in all modes, use the following procedures:

1. Set TACAN mode switch as desired (REC, T/R, A/A REC, A/A T/R).
2. Set TACAN control CHANNEL selector controls to desired channel.
3. Wait approximately 5 seconds for signal acquisition and lock-on. If bearing signal lock-on does not occur, the TACAN remains in the search mode with the NAV flag in view.
4. Check that TACAN control TEST indicator is not lit.
5. Check that correct station audio identification signal is received.
6. Read BDHI bearing pointer NO. 2 needle for relative bearing of the beacon. Read MILES window for distance to the beacon in T/R mode.

If the surface beacon bearing signal is temporarily lost, the TACAN switches to bearing memory and retains the last valid bearing information for 3 seconds. If the signal is reacquired within the 3 seconds, the TACAN locks on the signal to provide continuous valid bearing information.

When the bearing signal is lost or becomes unreliable and after the memory time of 3 seconds elapses, the TACAN switches to an automatic self-test to determine if TACAN operation is correct. During the automatic self-test the only possible indication on the BDHI is a momentary NAV flag in view. If there is a detected malfunction in the TACAN system, the TEST indicator on the TACAN control lights at the end of the test cycle and all BDHI bearing, course deviation, and TO/FROM information may be erroneous. If the TEST indicator does not light at the end of the test cycle but the TACAN has still not reacquired the bearing signal, the NAV flag remains in view, indicating that the TACAN is in bearing search.

When a new TACAN channel is selected, the NO. 2 needle may slew to a bearing 90° greater than the relative bearing of the TACAN station for a nominal 2 seconds, with NAV flag in view, before the NO. 2 needle slews to the correct bearing and the flag is lifted.

16.3.4.4 Air-to-Air Receive Mode (A/A REC)

In the A/A REC mode, the TACAN calculates the relative bearing to an aircraft equipped with a bearing transmitter and rotating antenna. The ARN-118(V) TACAN is not capable of transmitting TACAN bearing and few aircraft are suitably equipped. Any number of aircraft can receive bearing information from one suitably equipped aircraft.

Note

In all TACAN systems there is the possibility of interference from IFF, transponder, and DME signals when operating in the air-to-air modes. In order to minimize the possibility of interference, it is recommended that Y-channels be used and that channels 1 through 11, 50 through 74, and 121 through 126 be avoided.

Use either preassigned channel pairings or establish channel pairing with a 63 channel separation.

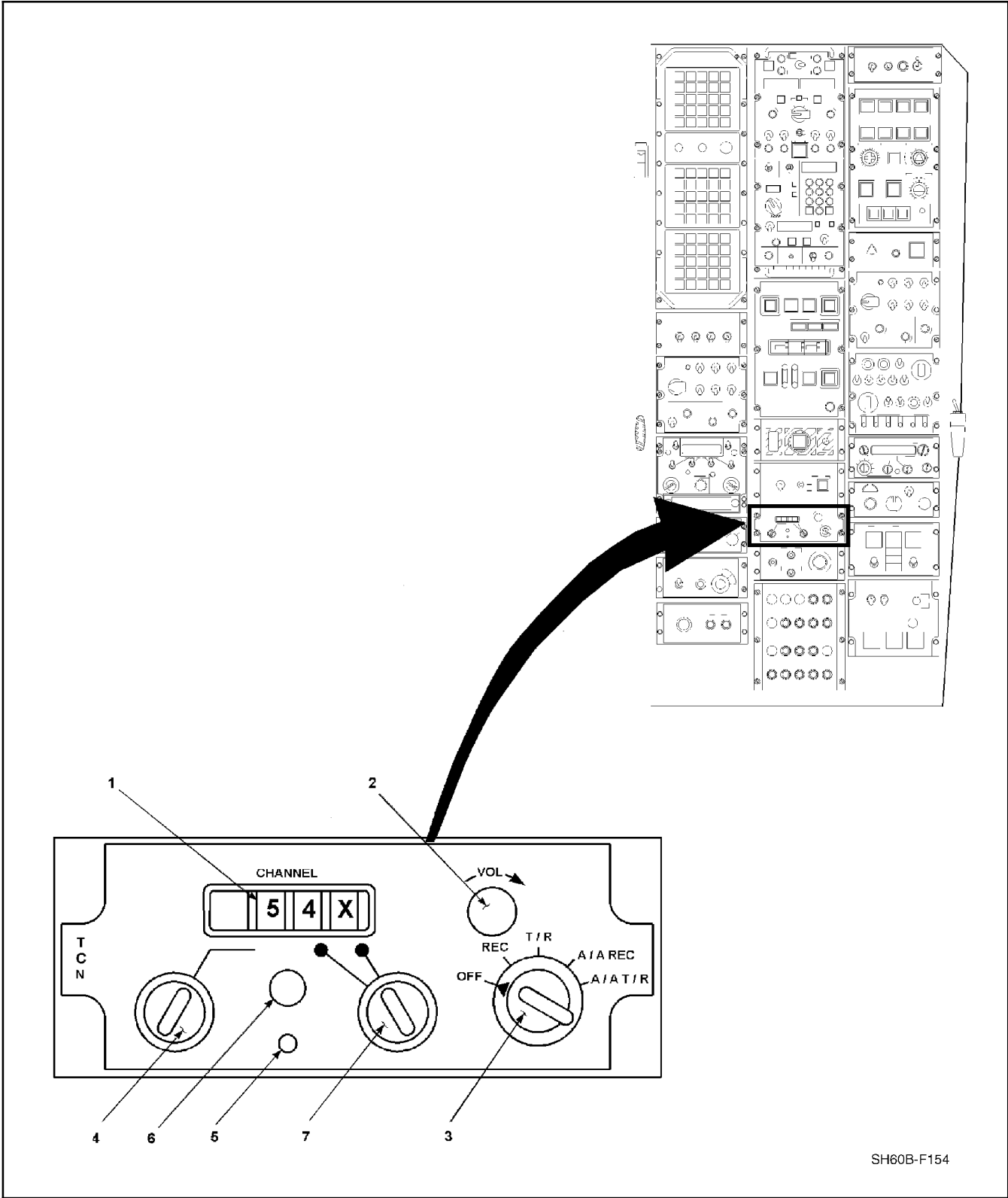


Figure 16-7. TACAN Control Panel (TCN) (Sheet 1 of 2)

| INDEX NUMBER | CONTROL | FUNCTIONAL DESCRIPTION |
|--------------|----------------------|---|
| 1 | CHANNEL | Displays selected TACAN channel. |
| 2 | VOL | Varies level of audio identification signal. |
| 3 | Mode selector switch | OFF switch for TACAN system. |
| | OFF | Receive mode. TACAN system receives and measures surface beacon fundamental bearing and calculates the relative bearing. No distance information calculated. |
| | REC | Transmit/receive mode. TACAN system interrogates a surface beacon and receives both bearing and distance information, which is used to calculate slant-range distance and relative bearing to the surface beacon. |
| | T/R | Air-to-air receive mode. TACAN system receives bearing information from a suitably equipped, cooperating aircraft and calculates the relative bearing to the cooperating aircraft. No distance information available. |
| | A/A REC | Air-to-air transmit/receive mode. TACAN system interrogates a suitably equipped, cooperating aircraft and receives and calculates the slant-range distance and relative bearing to the suitably equipped cooperating aircraft. On cooperating aircraft (not equipped with bearing producing equipment) only slant-range distance is calculated. In this mode, the TACAN system provides distance replies to other aircraft when interrogated. |
| | A/A T/R | Selects desired TACAN, which is displayed in the CHANNEL digital display. |
| 4, 7 | CHANNEL | Initiates system self-test or confidence test. |
| 5 | TEST (switch) | Lights when malfunction occurs during manual or automatic system self-test. Flashes at start of self-test cycle to check indicator lamp. |
| 6 | TEST (indicator) | |

Figure 16-7. TACAN Control Panel (TCN) (Sheet 2)

| TACAN MODE | | | | |
|--------------------------|--|--|--|--|
| BDHI INDICATION | REC | T/R | A/A REC | A/A T/R |
| COURSE WINDOW | Selected TACAN radial to surface beacon. | Selected TACAN radial to surface beacon. | Selected TACAN radial to suitably equipped, cooperating aircraft. | Selected TACAN radial to suitably equipped, cooperating aircraft. |
| COURSE POINTER | Selected TACAN radial to surface beacon on compass card. | Selected TACAN radial to surface beacon on compass card. | Selected TACAN radial to suitably equipped, cooperating aircraft on compass card. | Selected TACAN radial to suitably equipped, cooperating aircraft on compass card. |
| COURSE DEVIATION BAR | Aircraft deviation left or right of selected TACAN radial. | Aircraft deviation left or right of selected TACAN radial. | Aircraft deviation left or right of selected TACAN radial. If cooperating aircraft is not suitably equipped, no indications and NAV flag is in view. | Aircraft deviation left or right of selected TACAN radial. If cooperating aircraft is not suitably equipped, course deviation information is invalid and NAV flag is in view. |
| TO-FROM ARROW (NOTE 1) | Whether course is TO or FROM surface beacon. | Whether course is TO or FROM surface beacon. | Whether course is TO or FROM suitably equipped, cooperating aircraft. If cooperating aircraft is not suitably equipped, indication is invalid and NAV flag is in view. | Whether course is TO or FROM suitably equipped, cooperating aircraft. If cooperating aircraft is not suitably equipped, TO-FROM information is unreliable and NAV flag is in view. |
| BEARING POINTER (NOTE 2) | Relative bearing of surface beacon with respect to aircraft heading. Magnetic bearing indicated on compass card. | Relative bearing of surface beacon with respect to aircraft heading. Magnetic bearing indicated on compass card. | Relative bearing of suitably equipped, cooperating aircraft with respect to aircraft heading. Magnetic bearing indicated on compass card. | Relative bearing of suitably equipped, cooperating aircraft with respect to aircraft heading. Magnetic bearing indicated on compass card. If cooperating aircraft is not suitably equipped, NAV flag is in view. |
| MILES WINDOW | Shuttered (distance not calculated in REC). | Slant-range distance to surface beacon (NOTE 3). | Shuttered (distance not calculated in A/A REC mode). | Slant-range distance to cooperating aircraft (NOTE 3). |

Notes:

1. TO/FROM arrow indicates whether flight on heading displayed in course window would fly aircraft to or from selected TACAN beacon.
2. NAV flag is in view when bearing information is unreliable.
3. Distance shutter in view when distance is unreliable.

Figure 16-8. TACAN Operating Modes and BDHI Indications

16.3.4.5 Air-to-Air Transmit/Receive Mode (A/A T/R)

In the A/A T/R mode, the ARN-118(V) interrogates a suitably equipped, cooperating aircraft (bearing and distance information) or a cooperating aircraft (distance only information). The suitably equipped, cooperating aircraft supplies the interrogating aircraft with both bearing and distance information. The cooperating aircraft supplies the interrogating aircraft with only distance information. At least five aircraft can receive distance information from an interrogated aircraft. In this mode, the ARN-118(V) TACAN also supplies distance information to the other aircraft when interrogated. When the ARN-118(V) is interrogated and supplying distance information to more than one aircraft, the ratio of the distance between the ARN-118(V) and the furthest aircraft and the distance between the ARN-118(V) and the nearest aircraft must be no greater than 4:1.

Note

With interrogating aircraft flying in close proximity of each other, it is possible that a negative distance may be displayed due to the calibration of the TACAN system in either aircraft. Since the BDHI cannot display negative distances, a TACAN output of negative .1 nm is displayed as 399.9 nm and an output of negative 0.5 nm is displayed as 399.5 nm.

16.3.4.6 In-Flight Confidence Test

The in-flight confidence test is initiated when the TEST switch on the TACAN control is momentarily pressed. A manual self-test is activated and the system is checked providing a greater than 85 percent confidence level. The test can be terminated at any point by switching either the CHANNEL selector controls or mode selector on the TACAN control. Perform in-flight confidence test using the same procedures as in the Mission/Weapon System Checklist, [Chapter 7](#).

Note

It is not necessary to select an unused channel to perform the TACAN test.

16.3.5 Direction Finder Group (DFG), AN/ARA-50

The DFG, when in automatic direction finder (ADF) mode, provides relative bearing to another station transmitting on a selected UHF frequency and, when in the OTPI mode, to a deployed sonobuoy transmitting on a selected sonobuoy VHF channel. Selection of ADF or OTPI mode and frequency/channel is made on the COMM CONTR panel. The ADF or OTPI bearing is displayed on the BDHI via the NSIU by the NO. 1 needle. The AN/ARA-50 is used for the following:

1. Location of deployed sonobuoys (OTPI mode).
2. Backup navigation (UHF ADF mode).

Note

ADF is unavailable in secure voice mode. Power is supplied from the AC essential bus and DC essential bus through circuit breakers located on the center circuit breaker panel and the overhead circuit breaker panel. They are labeled DF GP PWR and DIR FINDER GROUP, respectively.

16.3.6 On-Top Position Indicator Receiver

The on-top position indicator (OTPI) receiver, R-1651/ARA, is used in conjunction with the direction finder group (DFG) to provide bearing information to a VHF signal from a sonobuoy. Effective on BuNo 164174 and subsequent, the OTPI receiver R-1651/ARA is replaced by OTPI receiver R-2330/ARN-146 to provide for the 99-channel sonobuoy tuning capability. In the OTPI mode of operation used with sonobuoys, the receiver recovers the AM audio signal from the RF carrier. This provides a means for fixing the position of sonobuoys. Power is supplied from the AC essential bus and DC essential bus through circuit breakers in the center circuit breaker panel, marked DF GP PWR and DIR FINDER GROUP respectively.

Note

- RAST main probe must be in the up position in order to receive accurate OTPI information.
- HF radio transmissions in the range of 5.83 to 28.85 MHz may result in incorrect OTPI bearing information.

The tuning or channel selection of the OTPI Receiver is accomplished by the pressing of channel selection buttons on the COMM CONTR panel. A threshold signal-strength indicator on the COMM CONTR panel, fed by the OTPI Receiver, tells the operator whether or not the received signal is strong enough to track. The signal-strength indicator will be green when the received signal is valid (Figure 15-1).

16.4 GLOBAL POSITIONING SYSTEM

GPS is a radio positioning navigation and time transfer system consisting of NAVSTAR satellites, ground based control facilities, and receiving equipment capable of receiving the GPS satellite signals. The GPS system provides worldwide, accurate, three-dimensional position and velocity information. The helicopter installed GPS system components consist of:

1. GPS Receiver, AN/ARN-151, R-2332/AR.
2. GPS Control Indicator, AN/ARN-151, C-12100.
3. GPS Antenna, AS-3822/URN.
4. GPS Antenna Electronics Unit, AM-7324/URN.
5. Data Bus Coupler (2), AN/ARN-151, CV-2453.

GPS receives satellite data via a fixed reception pattern antenna and the Antenna Electronics Unit. The receiver decodes the data and utilizes it to compute the helicopter position. Position is computed by comparing time-of-arrival measurements from the satellite signals. Velocity is computed by comparing Doppler measurements of the carrier frequency of the satellite signal.

GPS receivers are capable of operating in seven states. Each receiver channel operates in only one state at a time. Five of the seven states are displayed by the LAMPS MK III GPS system on the GPS data table (Figure 16-9). These five states are: State 1, Searching C/A Code; State 2, Direct P-code Acquisition; State 3, Code Tracking/No Carrier Lock; State 5, Carrier Lock Achieved/Data Demodulation (also called Normal Acquisition); State 7, Reacquisition In Process.

The GPS interface allows the GPS capability to come online when the helicopter mission systems are powered up. Power is supplied to the GPS receiver from the NO. 1 AC primary bus on the SO circuit breaker panel.

16.4.1 Navigation Modes

The ATO may select the GPS as the primary navigation mode by depressing the GPS OPTN pushbutton switch on the ATO keyset, then selecting GPS NAV, then On-top-Nav. Navigation modes are automatically selected by the AOP in the following sequence. GPS will be used if available and turned ON. If GPS is not available or turned OFF, or if the GPS Estimated Horizontal Error (EHE) exceeds 500 yards, navigation will revert to Doppler navigation mode. Air Mass navigation mode will be used last if neither GPS nor Doppler is available. When using GPS as the navigation mode, the Bearing-Distance-Heading Indicator (BDHI) displays are driven by navigation data sent from the GPS Receiver to the SAC-1 via the 1553B Data Bus.

The GPS can first be used for navigation when AOP determines that the GPS position has met the initial availability criteria. The initial availability criteria have been met when the receiver has no faults, holds four satellites in state 5, and the EHE is less than 150 yards. If the EHE grows larger than 500 yards while the receiver is tracking four satellites in state 5, then Doppler navigation mode will become the active navigation mode and the last GPS position will be used to initialize the Doppler equations. If Doppler navigation mode is not available, air mass mode equations will be initialized with the last GPS position. The GPS navigation mode will be maintained as long as the EHE remains less than 500 yards and the receiver holds four satellites in state 5. If the number of satellites in state 5 drops below four, AOP will start a 3-minute time; if GPS does not hold four satellites in state 5 after 3 minutes, the navigation mode will switch to Doppler or air mass. This helps prevent frequent navigation mode switching while maneuvering and during satellite constellation changes.

Note

AOP may maintain GPS navigation mode for up to 3 minutes when less than 4 satellites held in state 5. This can cause an increase in EHE of up to 005 (450 to 550 yards) before AOP reverts to Doppler navigation mode. If acceptable GPS EHE cannot be maintained during critical mission phases, consideration should be given to turning GPS off via GPS OPTIONS pushbutton switch on ATO keyset.

The GPS is capable of providing two different levels of navigational accuracy. The Standard Positioning System (SPS) provides a positional accuracy from 150 to 500 yards. The Precise Positioning System (PPS) is capable of providing a positional accuracy of 16 yards. A precision code (P- or Y-code) is transmitted over both the L1 and L2 frequencies sent by each satellite. The L1 frequency also carries a coarse acquisition code (C/A code). When Selective-Availability (SA) is on, the PPS will be degraded for all users tracking the P- or C/A-codes. If Antispoofing (A/S) is enabled (Y-code vice P-code), the P-code is denied to users who do not have special cryptographic keys. The C/A-code will remain available to all users. The cryptographic keys are loaded into the GPS receiver via the GPS Control-Indicator (Figure 16-10). After entering the cryptographic code, the KEY STATUS line of the GPS DATA page via TABLE pushbutton switch must be checked to verify the proper key was entered (Figure 16-11). The AS key may be erased by depressing the guarded ZEROIZE pushbutton switch on the Control Indicator or by selecting ZEROIZE from the SEL GPS OPTN cue by depressing the GPS OPTN pushbutton switch on the ATO keyset.

GPS operation or availability is displayed to the ATO and SO via the Navigation mode field on the MPD. When GPS is in use, the Navigation mode will be displayed as G XXX. The G indicates GPS, XXX indicates the GPS EHE in hundreds of yards, rounded to the nearest hundred. GPS data is polled and updated at a 200 ms rate and transferred to the navigation subsystem via the 1553B Data Bus. The EHE is continuously displayed and updated on the MPD. If the EHE exceeds 500 yards, indicated by the XXX going to 005, the navigation mode will automatically be set to Doppler. This will be indicated by a D followed by the GPS reported EHE in the NAV MODE area of the display.

GPS is considered for reselection as the navigation sensor by AOP when GPS data becomes valid and the EHE is less than 333 yards. GPS will be selected automatically as the navigation mode if the difference between the AOP calculated position and the GPS reported position is less than 100 yards. If the difference between the AOP calculated position and the GPS reported position is greater than 100 yards, the SEL GPS NAV cue will be displayed with the OFF option preselected. A GPS Correct Symbol appears on the display, representing the difference between the GPS reported position and the AOP calculated position from the Doppler or Air Mass navigation modes. This gives the ATO the option to use GPS as the active navigation mode by selecting GPS, or to continue using Doppler or Air Mass navigation mode by selecting the OFF default option.

| 1 of 3 | | | | | |
|------------------|--|--|------------|--|------------|
| GPS DATA | | | | | |
| CPCI VERSION | | | | | |
| XXXX | | | | | |
| OP ENTER | | | GPS | | |
| 1 GET GPS PRESET | | | HH MM SS | | |
| ALTITUDE | | | XXXX | | XXXXXX |
| 2 TIME | | | HH MM SS | | HH MM SS |
| 3 DATE (Y/M/D) | | | YY/MM/DD | | |
| 4 LATITUDE | | | XX XX.X N | | XX XX.X N |
| 5 LONGITUDE | | | XXX XX.X W | | XXX XX.X W |
| 6 CRS/SPD | | | XXX/XXX | | XXX/XXX |
| 7 SEND INIT DATA | | | HH MM SS | | |
| ENT LINE NO | | | | | |
| XX | | | | | |

| 2 of 3 | | | | | |
|-------------|-----|--|--------------|--|------|
| GPS OPTIONS | | | EHE | | XXXX |
| NAV MODE | XXX | | EVE | | XXXX |
| MAG VAR | XXX | | KEY STATUS | | HHHH |
| BIAS CALC | OFF | | ALMANAC REQ | | XXX |
| | | | CONSTELLCHNG | | XXX |
| | | | RCVR MODE | | XXXX |

| 3 of 3 | | | | | |
|-------------------|----|-------|------|-----|--|
| SATELLITE SUMMARY | | | | | |
| CHAN | SV | STATE | C/NO | J/S | |
| 1 | XX | X | XXX | XXX | |
| 2 | XX | X | XXX | XXX | |
| 3 | XX | X | XXX | XXX | |
| 4 | XX | X | XXX | XXX | |
| 5 | XX | X | XXX | XXX | |

Figure 16-9. GPS Data Table

The GPS Correct Symbol (G TTTT) (G indicating GPS and TTTT as the most recent time of the last GPS data update) displays at the point to which the helicopter position will be corrected if the GPS data is accepted by selection of the ACCEPT option. If the GPS positional data is accepted by the depression of the ENT NO CHNG pushbutton switch, the helicopter and all Doppler and air mass referenced sonobuoy positions, fixes, LAMPS Tracks, GPS Correct Symbol, ATTs, and MAD Marks that are not designated as geographic points or are not currently updated to the position, will have the GPS position correction applied. All radar targets are corrected by an amount corresponding to their true radar range on the next full radar sweep.

If the AOP GPS navigation mode is OFF but the receiver is providing data which passes the availability criteria, the MPD shows the current navigation mode with a slash through it. If the operator selects GPS via the GPS OPTN pushbutton switch and the position difference between GPS and AOP is less than 100 yards, the navigation mode changes to GPS and updates the helicopter position and helicopter entered tactical symbols. If the difference between GPS and AOP position is greater than 100 yards, selection of GPS via the GPS OPTN pushbutton switch displays the GPS CORRECT cue, with the difference in the GPS position and the active mode position shown in yards. The ACCEPT option will be preselected and the GPS Correct Symbol will be displayed. Accepting the GPS position correction will change the navigation mode to GPS and update the helicopter position and helicopter entered tactical symbols.

GPS OFFSET is the vector difference between the ACFT position held by GPS and the ACFT position held by DAME. Whenever a DAME update is performed, GPS offset is calculated and entered into the NAV Parameters Table. All uplinked/downlinked symbols then have this GPS offset applied. This maintains identical relative tactical plots on the aircraft and the ship but causes a mismatch in symbol latitude/longitudes when verbalized over the data link. ATO/SO should verify offset value each time a DAME update is completed. If the data link is lost after DAME update and cannot be regained using other techniques (or if data link cannot be gained when transitioning to another LAMPS MK III ship), consideration should be given to performing an INIT HELO. This will clear the GPS OFFSET value contained in NAV Parameters Table.

16.4.2 GPS Options

GPS has five selectable options. Depression of the GPS OPTN pushbutton switch on the ATO keyset displays the SEL GPS OPTN cue with the five options. The five options and the functions performed are:

1. ZEROIZE — Erases the GPS key presently held in the GPS receiver memory.
2. GPS NAV — Displays SEL GPS NAV cue. Selection may be made to set the navigation function to GPS or OFF. The BIAS CALC option will always remain OFF. The mode not in use is the default selection.

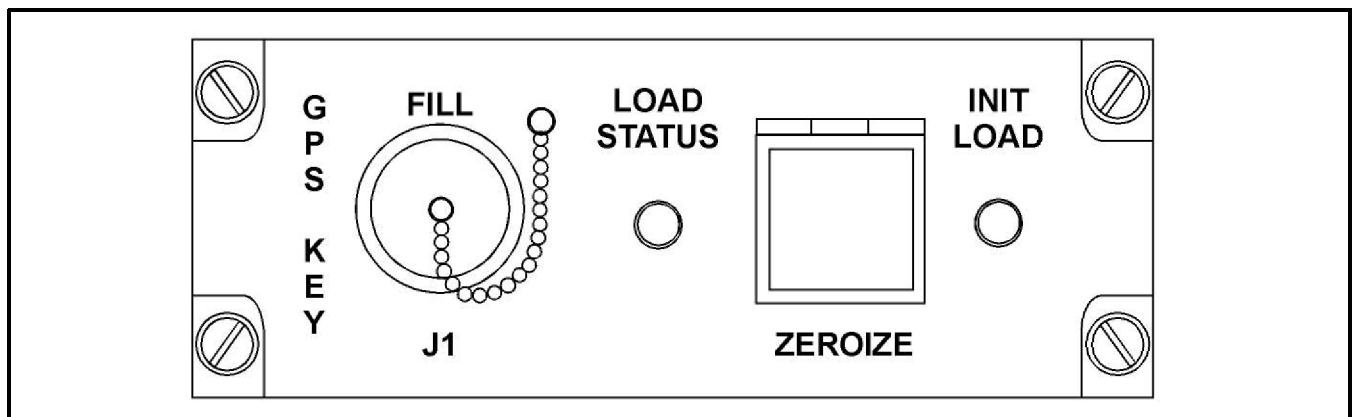


Figure 16-10. GPS Control Indicator

| DISPLAY (H1)(H2)(H3)(H4) (Notes 1,2) | MEANING | NOTES |
|--|--|--------------|
| H1 8 4 2 1 0 | Key entered was accepted and verified by GPS satellite data (can take up to 12 minute to verify). GPS accepted the key but is waiting to verify the code. GPS took the key from the key loader, but the code did not match with satellite data. Key Failed Parity. No key received. | 3 |
| H2 8 4 2 1 0 7 6 5 3 | Group Unique Variable (GUV) code in use. 2 hour alert — 2 hours remain before expiration of last key. Insufficient key for mission duration. Zeroize error — Code not zeroized properly. All keys entered properly, no errors or warnings. Combination of 4, 2, and 1. Combination of 4 and 2. Combination of 4 and 1. Combination of 2 and 1. | 4 |
| H3/H4 | Mission duration — Indicates number of days the GPS can operate without reloading keys (should be something non-zero). | 5 |
| <p>Notes:</p> <ol style="list-style-type: none"> 1. If the GPS control indicator will not load a key, it may be necessary to remove and reinstall the batteries from the GPS unit. This will clear all GPS memory, including almanac data. (GPS will require 1 to 3 hours of tracking time to regain enough almanac data to provide sufficient accuracy for AOP use (<500 yards). The time requirement can be lessened by entering current lat/long and UTC time.) 2. All hexadecimal characters should display zero if crypto key is properly zeroized. 3. Upon initial load, H1 should indicate 4, and will indicate 8 once verified by a GPS satellite. If the key is no longer valid after having been verified, a 2 will be displayed. 4. This digit will display an 8 when the GUV is loaded. 5. This was designed to be used primarily with Crypto Variable (CV) keymat. The GPS can accept up to 12 different monthly and weekly CV keys, but will keep only enough keys for 84 days. | | |

Figure 16-11. Key Status Display Format

3. MAG VAR — Displays SEL MAG VAR cue. Selection may be made to set MAG VAR to GPS or OFF. The mode not in use is the default selection.

Note

Coefficients for magnetic variation (MAG VAR) provided by present software in GPS receiver units may not be accurate. If GPS provided MAG VAR differs from actual local value (or value utilized by ship), GPS MAG VAR input to AOP should be turned off via GPS OPTIONS pushbutton switch and MAG VAR should be manually entered into NAV Parameters Table.

4. GEO DES — Displays the SEL GEO DES cue. Selection of the DESIG or UNDESIG option allows the ATO to designate or undesignate any symbol that can be hook verified and downlinked as a geographic point, with the exception of an ATT. The mode not in use is the default selection.
5. GPS CORR — Displays the GPS CORRECT cue with the number of yards the helicopter position will be corrected if the ACCEPT option is selected. Selection of ACCEPT will result in the helicopter and all Doppler or air mass referenced sonobuoy positions, fixes, LAMPS Tracks, ATTs, and MAD Marks that are not designated as geographic points being corrected to the GPS reported position. Selection of the REJECT option will terminate GPS processing and remove the GPS Correct Symbol from the display.

Note

GPS option 5 (GPS CORRECT) will be accepted by AOP even if the current GPS solution is invalid (including loss of power to GPS receiver). Performing GPS correct with invalid solution will cause significant errors in the navigation plot. ATO/SO should utilize GPS data table to verify GPS solution validity and GPS position prior to utilizing this function.

16.4.3 GPS Data Table

The GPS data table (Figure 16-12) is displayed by depressing the TABLE pushbutton switch and then selecting GPS DATA. When the GPS is initialized it will attempt to acquire satellite signals to localize the position of the helicopter. The GPS requires only one satellite to initiate the search. The satellite search and acquisition status is displayed on the GPS data table in the Satellite Summary field. When one satellite signal is located and being processed in state 5, the GPS should be able to acquire additional satellite signals on its own.

The GPS receiver has a battery to maintain the volatile memory of the last available helicopter position and the AS key in use at the time of system shutdown. It uses that data to commence the initial satellite search upon system initialization. If the helicopter has been inactive for an extended period of time and its position significantly altered since system shutdown, if the GPS antenna is shielded from signal reception, or if the battery is depleted, GPS may not be able to localize the helicopter position without operator assistance. The GPS data will be displayed on the MPD in the column under GPS. The TIME field will display the last time stored at system shutdown and will be updated when the GPS acquires the first satellite signal. The operator may assist the localization by entering the current Zulu time, date, latitude, longitude, and helicopter course and speed. After this data is entered, select SEND INIT DATA to update the GPS. When the GPS data becomes valid, the GPS reported data will be moved to the OP ENTER fields of the display.

A power interrupt (of greater than 7 seconds duration) to the GPS receiver causes the receiver to go into and remain in the INIT mode as indicated on the GPS data table. To regain GPS NAV, ATO or SO must go to the Equipment Status Table and select and initialize GPS. Attempts to utilize options from the GPS OPTIONS cue or GPS data table will not cause the receiver to return to the NAV mode.

| SUMMARY FIELD | MEANING |
|---------------|---|
| CHAN | Indicates the GPS receiver channel number. |
| SV | Indicates the Satellite Vehicle (SV) number. Each GPS satellite has a system assigned ID number. This number is passed to the GPS receiver when the satellite signal is acquired. |
| STATE | Indicates the GPS receiver channel tracking status. 1 — Searching C/A Code 2 — Direct P-code Acquisition 3 — Code Tracking/No Carrier 4 — Not Used 5 — Carrier Lock Achieved/Data Demodulation 6 — Not Used 7 — Reacquisition in Process |
| C/NO | Indicates carrier-to-noise ratio. |
| J/S | Indicates jamming-to-signal ratio. |

Figure 16-12. GPS Data Display Satellite Summary Field Definitions

When the GPS receiver is in the NAV mode and the AOP is using GPS data, use of GET GPS PRESET function (line 1) on the GPS data table will cause erroneous automatic repositioning of the helicopter symbol. An erroneous position is a wraparound of 0.0N/0.0E relative to GRP and can be anywhere within a 512 X 512 nautical mile tactical grid. Once valid the GPS NAV MODE solution is eventually achieved and helicopter symbol will again automatically reposition to remove the error. If this function is used, ATO/SO should note aircraft latitude/longitude prior to initiating GET GPS PRESET function so that, should GPS become unavailable, the aircraft symbol can be repositioned to the proper latitude/longitude. Use of this function should be avoided, especially in flight.

Other fields on the display are GPS OPTIONS, ALMANAC REQ, and CONSTELL CHNG. The GPS OPTIONS field will reflect the status of the NAV MODE and MAG VAR as either GPS or OFF, as selected by the operator from the SEL GPS OPTN cue. The ALMANAC REQ and CONSTELL CHNG status will be reported as either ON or OFF. BIAS CALC will be reported as OFF.

16.4.4 GPS Accuracy Considerations

The AN/ARN-151(V) R-2332/AR GPS may develop a navigation position runoff error as great as 20 to 40 nm with an EHE indication of less than 150 yards. This runoff error is caused by a receiver software defect which occurs when the crypto keys are loaded. Runoff error may occur shortly after the receiver is keyed or later in the flight during satellite swap. AOP will use the invalid data to display the helicopter position inaccurately on the tactical display and the Navigation Parameters Table.

16.4.4.1 Runoff Error Avoidance

To reduce the potential for invalid GPS data, adhere to the following procedures:

1. On deck:
 - a. After keying the GPS receiver and loading AOP, ensure the navigation mode field on the MPD indicates GPS is available.
 - b. When GPS is available, perform an INIT/TEST of GPS via the Equipment Status Table from either the ATO or SO keyset.

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2. When switching from Doppler or Air Mass to GPS as the primary navigation mode during flight:
 - a. Select GPS NAV via the ATO keyset.
 - b. Ensure the navigation mode field on the MPD indicates GPS is available.
 - c. When GPS is available, perform an INIT/TEST of GPS via the Equipment Status Table from either the ATO or SO keyset.

Note

Performing an INIT/TEST of GPS requires up to two minutes to complete.

PART VIII

Mission Systems

[Chapter 17](#) — Armament Systems

[Chapter 18](#) — Aircraft Mission Avionics



CHAPTER 17

Armament Systems

Refer to NTRP 3-22.4-SH60B for applicable armament systems information.



CHAPTER 18

Aircraft Mission Avionics

Refer to NTRP 3-22.4-SH60B for applicable avionics systems information.



PART IX

Crew Resource Management

Chapter 19 — Crew Resource Management



CHAPTER 19

Crew Resource Management

19.1 INTRODUCTION

The goal of Crew Resource Management (CRM) is to improve mission effectiveness, minimize crew-preventable errors, maximize crew coordination, and optimize risk management. CRM principles are integrated into every aspect of flight operations. They begin with mission planning and continue through the flight brief, mission execution, and debrief. Proper CRM requires that all crewmembers actively participate in each phase of the flight.

Successful crews display good CRM by the effective use and integration of all available knowledge, skills, and resources (people, equipment, weapon systems, and facilities) in the safe and efficient accomplishment of an assigned mission.

19.1.1 Minimizing Errors

One of the key benefits of CRM is the increase in aircrew effectiveness by minimizing or reducing crew-preventable errors. Error is an inevitable result of the natural limitation of human performance and the function of complex systems. Some errors will occur despite the best intentions of the aircrew. Human error is a normal by-product of human behavior. Experience alone cannot eliminate errors; however, research indicates that the effective transfer of experience from senior crewmembers to less experienced crewmembers can have a positive effect in preventing knowledge-based errors. Since errors cannot be completely prevented, it is important for aircrews to detect them as early as possible and to minimize or manage their impact. CRM can be viewed as a method of error management. Well-managed errors are an indicator of effective crew performance. CRM is not and never will be the only mechanism to eliminate error and assure safety in a high-risk endeavor such as naval aviation. CRM is one of an array of tools that aircrews can use to minimize or manage error.

19.2 CRM PROGRAM ADMINISTRATION

CRM academic and flight currency requirements shall be completed and documented in accordance with OPNAVINST 1542.7 (series). All Assistant NATOPS Instructors shall be designated CRM Facilitators.

19.3 CRM SKILLS AND BEHAVIORS

Integrated CRM incorporates the use of specifically defined behavioral skills into all Navy/Marine Corps aviation operations. Aircrew that use the following skills and behaviors will improve mission effectiveness and reduce the potential for mishaps.

1. Situational Awareness (SA): The ability to maintain awareness of what is happening in the aircraft and in the mission.
2. Assertiveness (AS): The willingness to actively participate and the ability to state and maintain one's position.
3. Decision Making (DM): The ability to use logic and sound judgement based on the information available.
4. Communication (CM): The ability to clearly and accurately send and acknowledge information, instructions, or commands, and provide useful feedback.
5. Leadership (LD): The ability to direct and coordinate the activities of other crewmembers or wingmen and to encourage the crew to work together as a team.
6. Adaptability/Flexibility (AF): The ability to alter a course of action to meet situational demands.
7. Mission Analysis (MA): The ability to coordinate, allocate, and monitor crew and aircraft resources.

19.3.1 Situational Awareness (SA)

Effective situational awareness refers to the ability to identify the source and nature of problems, extract and interpret essential information, maintain an accurate perception of the external environment, and detect a situation requiring action.

Situational awareness requires that the aircrew know who is responsible for specific activities, what is happening, when events are supposed to occur, and where the aircraft is in three-dimensional space. Situational awareness is the single most important factor in improving mission effectiveness and safety for aircrews. The lack of situational awareness among crewmembers can lead to disastrous consequences.

■ To maintain and/or recover situational awareness, conduct a comprehensive brief, acknowledge potential problems, communicate, use all information sources, and ensure all crewmembers are updated on any changes to the briefed mission and sequence of events. Factors that reduce situational awareness are insufficient communication, fatigue/stress, task overload/underload, group mindset, press on regardless philosophy, and degraded operating conditions.

Combat the loss of situational awareness by actively questioning and evaluating mission progress, using assertive behaviors when necessary, analyzing the situation, and updating and revising the image of the mission. Situational awareness is a critical factor in the ability to respond effectively to a situation. Maintaining a high level of situational awareness will better prepare crews to respond to unexpected situations.

19.3.2 Assertiveness (AS)

Assertiveness refers to the ability, willingness, and readiness to take action, including making decisions, demonstrating initiative and the courage to act, and stating and maintaining your position until convinced otherwise by the facts.

Assertive behaviors include providing relevant information without being asked, making suggestions, asking questions as necessary, confronting ambiguities, maintaining a position when challenged, stating opinions on decisions or procedures, and refusing an unreasonable request. Assertive statements typically use active verbs or recommend an action. To create an assertive statement, get the attention of the receiver, state your concern, offer a solution, and ask for feedback. Aircrew members must be willing to act assertively if they are going to fulfill their responsibility toward mission success.

19.3.3 Decision Making (DM)

Effective decision making refers to the ability to use logic and sound judgment to make decisions based on available information. The decision-making process involves assessing the problem, verifying information, identifying solutions, anticipating consequences of decisions, informing others of decision and rationale, and evaluating decisions.

Factors that promote good decision making include teamwork, time, alert crewmembers, decision strategies, and experience. Barriers to good decision making include lack of time, inaccurate or ambiguous information, pressure to perform, and rank difference. To overcome these barriers, use NATOPS/SOP to select the best decision, cross-check information, evaluate the rationale for making the decision, and use assertive behaviors. Once a hazard has been detected, evaluate it to determine its potential effect on the planned flight by considering its impact on the aircraft, environment, situation, operations, and personnel. The analysis should consider the crew's relative ability to cope with the changes. Allowing other crewmembers to participate in the decision-making process is encouraged; however, this does not mean that all decisions have to be made by committee.

19.3.4 Communication (CM)

■ Effective communication refers to the ability to clearly and accurately send and acknowledge timely information, instructions, or commands, and provide useful feedback. It is important to make sure everyone involved fully understands what is being communicated in order to conduct effective missions, avoid mishaps, pass information from one person to another, and maintain group situational awareness.

Active communication between the sender and receiver is accomplished by the following:

1. Sender should provide information as required, provide information when asked, convey information concisely, convey useful information, convey accurate information, verbalize plans, and use nonverbal communication appropriately.
2. Receiver should acknowledge communication, repeat information, reply with questions or comments, ask for clarification, and provide useful feedback.

Barriers to communication are events or situations that distort or interfere with communication. Examples of communication barriers are radio/ICS malfunctions, differences in rank/experience, task overload, gender, attitudes, and culture. Overcoming barriers can be accomplished by using active listening techniques, feedback, appropriate mode of communication and decibel level, and standard terminology. Effective communication is vital at all times, both inside and outside the aircraft. The crew must be aware of any barriers to communication; the greatest enemy of effective communication is the illusion of it.

19.3.5 Leadership (LD)

Leadership is the ability to direct and coordinate the activities of all crewmembers and to ensure the crew works together as a team. Leadership is not solely the responsibility of the PIC; each crewmember has specialized duties and qualifications.

Two types of leadership exist — designated leadership and functional leadership.

1. Designated leadership is leadership by authority, crew position, rank, or title. Designated leadership is the normal mode of leadership.
2. Functional leadership is leadership by knowledge or expertise. Functional leadership is temporary and allows the most qualified individual to take charge of the situation.

The leader is in control of the situation and has certain responsibilities. The leader must be able to direct and coordinate the crew's activities, delegate tasks, and ensure that the crew understands what is expected of them. Leaders focus attention on the crucial aspects of the situation, keep crewmembers informed of mission-relevant information, provide feedback to the crew on their performance, and create and maintain a professional atmosphere. It is more effective to influence individuals than to dictate. This can be accomplished by making suggestions, making the crew want to perform activities, and leading by inspiration. Feedback should be given to the crew on both good and bad performance.

19.3.6 Adaptability/Flexibility (AF)

Adaptability and/or flexibility refer to the ability to alter one's course of action contingent on, or as a function of, another's action and/or as the situation demands. Adaptable/flexible crewmembers should be able to alter their behavior to meet situational demands, be open and receptive to others' ideas, help others when necessary, maintain constructive behavior under pressure, and adapt to internal and external environmental changes.

Unbriefed situations requiring adaptability include an emergency, transitions, an incapacitated crewmember, and when crew interactions are strained. When faced with a critical decision, the crew should stop, analyze the situation, recognize and acknowledge any change or abnormality, ask for assistance, and interact constructively with others. The crew should then conduct an operational evaluation, determine if an SOP is appropriate, propose a course of action, and gain support for the actions chosen. Once a decision has been made, it is not irrevocable. The crew should keep an open mind and evaluate the decision against new data. A mission's success depends on the crew's ability to alter behavior and dynamically manage resources to meet changing situational demands. To effectively respond to situations, crews must remain flexible in their decision making and actions.

19.3.7 Mission Analysis (MA)

Mission analysis refers to the ability to coordinate, allocate, and monitor crew and aircraft resources. Mission analysis is a crew effort.

The three stages of mission analysis are permission organizing and planning, in-flight monitoring and updating, and postmission review. Each stage of mission analysis has an impact on the mission. Permission analysis establishes mission requirements and constraints, organizes resources, specifies both long-term and short-term plans, and advises the crew what to expect during the mission. A good preflight brief establishes crew expectations, is interactive, comprehensive, and valued by all crewmembers. In-flight analysis involves monitoring the current situation, critiquing previous decisions, and informing the crew of changes to flight concept. Postmission review covers the entire mission, provides feedback, and determines areas for future improvement. A good debrief is interactive, focused, timely, and valuable to all crewmembers. Failure to develop a good plan, or to revise a plan when the situation changes, can result in a failed mission or a mishap.

19.3.8 Factors Affecting CRM

There are numerous factors external and internal to the aircraft that can affect good CRM. The aircrew must be vigilant in recognizing these factors and develop plans to minimize their impact.

Factors internal to the aircraft that might impact CRM include time available, fatigue, distractions, stress, lack of attention, or poor attitude. High crew workloads can impact crew coordination. Low workload situations may result in complacency. The breakdown of CRM may be caused by the fixation on one task, confusion, violation of NATOPS/SOP, no one in charge, no lookout doctrine, failure to meet mission objectives, and/or absence of communication.

19.3.9 CRM Attitude

Aircrew performance can be improved through training, thereby increasing the aggregate level of knowledge, skills, and attitudes required for the mission. Improving CRM skills will often require crewmembers to change their attitude toward crew interaction. Improved application of CRM skills will increase mission effectiveness, reduce or minimize the impact of aircrew errors, and increase safety by reducing poor crew-coordination mishaps.

19.4 OPERATIONAL RISK MANAGEMENT (ORM)

- The operating environment and multimission capability of the H-60 places every crew in a situation where risks may have to be taken. The ability to properly assess risk depends on input from each crewmember as to the requirements of the mission. If every crewmember is not aware of all the risks, a bad decision can result. Accident investigations show that almost all pilot-error accidents are the result of a chain of bad decisions. One bad decision reduces the alternatives for continued safe flight. Usually a crewmember needs only to bring attention to a bad decision to stop the chain of events that could lead to an accident or dire situation.
- ORM fits into the overall planning and implementation of CRM. The two share many of the same aspects with regard to mission analysis, decision making, communication, leadership, adaptability/flexibility, and situational awareness. ORM is a closed-loop process that identifies and controls hazards.

19.4.1 Five-Step Sequence

The use of ORM assessment is normally done during the preflight mission analysis stage. It follows a five-step sequence:

1. Identify hazards (e.g., route study, weather brief).
2. Assess hazards (e.g., LZ obstacles, loss of wind effect).
3. Make risk decisions (e.g., navigation around areas of known icing, selecting an altitude to avoid terrain).
4. Implement controls (e.g., SOP, briefs, and rehearsals).
- 5. Supervise and watch for change (CRM principle of leadership and the need to enforce standards).

19.4.2 Three Levels of Application

The three application levels of ORM utilize the CRM skills of adaptability/flexibility, situational awareness, and mission analysis.

1. When applying time-critical ORM, very little time is available for assessment. Situational awareness and adaptability/flexibility are required to perform the five-step sequence.
2. When applying deliberate ORM, time is not an issue. Normal planning time is available to perform mission analysis.
3. When applying in-depth ORM, the integration of mission analysis is easily accomplished due to the advanced planning time allocated.

19.4.3 Four Principles of Application

The four principles of applying ORM share a commonality with decision making, mission analysis, and situational awareness.

1. Accept risk when benefits outweigh the cost.
2. Accept no unnecessary risk.
3. Anticipate and manage risk by planning.
4. Make risk decisions at the right level.

During every mission, the decision must be made to either accept or decline the risks. If the returns on the risks are not worthwhile, they must provide a justifiable return for the effort. During the mission analysis (planning) phase of the flight, risks are addressed using control measures and proper briefing techniques. The aircrew, using good situational awareness, must identify those risks and deal with in-flight challenges as they occur appropriately.

19.5 COCKPIT INTERRUPTIONS AND DISTRACTIONS

The skills of CRM are utilized and accepted by aircrew's worldwide. Due to the fact that error is universal and in most cases unavoidable, CRM has been defined as the management of human error.

Human factor errors have been attributed to a majority of all Navy/Marine aircraft mishaps. One of the largest components of human factor errors is cockpit interruptions and distractions. Activities such as routine conversations sometimes interfere with monitoring and controlling the aircraft. Research indicates that people are able to perform two tasks concurrently only in limited circumstances, even if they are skillful in performing each task separately. Humans have two cognitive systems that enable them to perform tasks: one involves conscious control, the other is an automatic system that operates separately from conscious control. The conscious system is slow and effortful; it performs one operation at a time, in sequence. Automated cognitive processes develop as we acquire skill; these processes are specific to each task, operate rapidly and fluidly, and require little effort or attention.

Many real-world tasks require a mixture of automatic and conscious processing. A skilled pilot in a familiar aircraft performing a familiar mission can perform the flight largely on the automatic system, leaving enough conscious capacity to carry on a conversation. However, if the automatic (cognitive) system is allowed to operate without conscious supervision, the pilot is vulnerable to a type of error called habit capture. For example, if the pilot intends (and briefs) to take a different route than usual and is distracted by conversation, the pilot will be more prone to revert to an automatic response and take the usual or often-used route of flight.

19.5.1 Reducing Human Factor Errors

The reduction of human factor errors will increase mission effectiveness and safety. There are several strategies for reducing the vulnerability of aircrew to human factor errors caused by interruptions and distractions:

1. Recognize that conversation is a powerful distraction.
2. Recognize that head-down tasks greatly reduce one's ability to monitor other crewmembers and the status of the aircraft.
3. Schedule/reschedule activities to minimize conflicts, especially during critical in-flight operations.
4. When two tasks must be performed at the same time, set up a scan and avoid letting attention linger too long on either task.
5. Treat interruptions as red flags.
6. Explicitly assign PAC, PNAC, and aircrewman responsibilities, especially in abnormal situations.

19.6 AIRCREW DEFINITIONS

The following definitions apply to CRM discussions:

1. Formation Leader — Pilot responsible for safe and effective execution of formation flight.
2. Helicopter Aircraft Commander (HAC)/Pilot In Command (PIC) — The cockpit crewmember designated as pilot in command of the aircraft. The HAC/PIC may occupy either cockpit seat.
3. Copilot (CP) — The cockpit crewmember not designated as the PIC.
4. Pilot at the Controls (PAC) — The cockpit crewmember exercising physical control of the aircraft regardless of seat or position.
5. Pilot not at the Controls (PNAC) — The cockpit crewmember not exercising physical control of the aircraft, regardless of seat or position.
6. Aircrewmembers (AC) — All enlisted members of the aircrew.
7. Sensor Operator (SO) — The enlisted aircrewman operating mission and acoustic systems in the SO seat.
8. Aircrew — All personnel (pilots and aircrewmembers) assigned to the crew.

19.7 CREW GENERAL RESPONSIBILITIES

The following general descriptions of responsibilities apply to CRM discussions:

1. Formation Leader — Ultimately responsible for the planning, organization, and integration of actions by the flight. If a disagreement in the formation exists, the Formation Leader should take the most conservative action until more information is available. During situations with high workloads (e.g., multiple malfunctions, severe weather, communication difficulties in airport traffic area), the Formation Leader should consider delegating tasks to other elements in the formation.
2. PIC — Ultimately responsible for the planning, organization, and integration of actions by the crew. If a disagreement in the aircraft exists, the PIC should take the most conservative action until more information is available. During situations with high workloads (e.g., multiple malfunctions, severe weather, communication difficulties in airport traffic area), the PIC should consider delegating the flying to the CP in order to apply maximum attention to the situation at hand.
3. CP — Assisting the PIC in the execution of the mission.
4. PAC.
 - a. Flying within established parameters, monitoring of flight instruments, and safely maneuvering the helicopter.
 - b. Complying with all instructions from the controlling agency.
 - c. Directing the PNAC to read appropriate checklists and provide backup during high workload maneuvers.

Note

- Cockpit duties that may interfere with the PAC's ability to maintain flight within established operational parameters may be transferred to the PNAC.
 - The PAC should not operate any mission system.
- d. Verbalizing plans and ensuring the information is understood and acknowledged.
 - e. Notifying the PNAC if experiencing vertigo.
 - f. Announcing all altitude changes while below 500 ft AGL to include intended level-off altitude.
 - g. Acknowledge RADALT tones except when operating in a traffic pattern.

5. PNAC.

- a. Assisting the PAC as required (e.g., changing radio frequencies, copying controller instructions).
- b. Reading and completing checklists.
- c. Monitoring engine performance instruments, nonflight instruments, fuel usage, and navigation as necessary.
- d. Backing up the PAC on altitudes, airspeeds, and AOB.
- e. Informing the PAC verbally of deviations from established limits.
- f. The PNAC should intervene to prevent a hazardous situation if it appears the PAC has lost situational awareness. In extreme situations, the PNAC should take the controls if the PAC:
 - (1) Does not respond to two challenges.
 - (2) Exceeds NATOPS operating limits.
 - (3) As required for safety of flight.
- g. Acknowledge RADALT tones except when operating in a traffic pattern.

6. Sensor Operator/Aircrewmen.

- a. Routinely inspecting the cabin for abnormalities.
- b. Ensuring that mission-required equipment is properly tested prior to arriving on station.
- c. Informing the HAC of any mission system degradations in a timely manner.
- d. Operating mission systems to extract, analyze, interpret, and classify data obtained by sensors and provide that information for general and tactical use.

7. Aircrew.

- a. Monitoring the aircraft and communicating abnormal indications/conditions.
- b. Maintaining a proper lookout and reporting obstacles, air traffic, hazards, or dangerous situations using clock position, high/low altitude calls, or distance as appropriate.
- c. Calling out hold/waveoff/evasive maneuver when appropriate to ensure safety of flight.
- d. Communicating that their personal comfort level is being approached or exceeded.
- e. Questioning and obtaining clarification on parts of the brief or in-flight directions that are not clear or are incomplete.
- f. Having a thorough knowledge of the equipment at their station, its operation, and tactical employment.
- g. Knowing their individual duties and responsibilities and maintaining awareness of the duties and responsibilities of the other crewmembers, including their strengths and weaknesses.
- h. Monitoring other crewmembers for signs of stress, fatigue, overload, spatial disorientation, vertigo, or tunnel vision and being assertive in voicing concerns when they see a situation that might affect safety of flight.

19.7.1 Dual-Concurrence Items

In flight, the following items require concurrence from two members of the aircrew that the correct control is selected before the control is moved.

- 1. PCLs.
- 2. Engine T-handles.
- 3. Fuel selectors.
- 4. Generators.
- 5. Fuel Dump.

19.8 CREW BRIEF AND PREFLIGHT

The PIC shall ensure a proper NATOPS brief is conducted with all crewmembers. The brief shall be conducted in accordance with [Chapter 6](#). The PIC should ensure that the crew reviews the ADB and is familiar with all performance parameters required for the mission. The PIC shall ensure that each crewmember and each passenger is equipped with all necessary survival gear. The PIC shall also ensure each crewmember understands their individual area of responsibility during preflight. PIC shall ensure all passengers are properly briefed. All other crewmembers shall assist the PIC as directed.

19.9 CHECKLIST METHODS

The crew should use the challenge-reply-reply checklist method or the challenge-reply checklist method as appropriate. When using the challenge-reply-reply checklist method, one crewmember reads the challenge and the reply. The crewmember performing the action will respond with the reply indicating that the task is complete. When using the challenge-reply checklist method, the crewmember will read the checklist aloud; challenge and reply to each item in sequence, then report the checklist complete.

1. The challenge-reply-reply checklist method should be used for the following checklists: Prestart, Systems Check, Starting Engines, Rescue Hoist Operational Check, and Cargo Hook Operational Check.
2. During the Rotor Engagement Checklist, the challenge-reply-reply method will be used until the beginning of the Post Engagement Checklist. From the Post Engagement Checklist on the challenge-reply method should be used with the PNAC affecting switches and the PAC monitoring all flight controls. This will allow the PAC to monitor the rotor disc and the plane captain/LSE while the aircraft is in the chocks with the rotors turning.
3. For all other checklists, the challenge-reply method should be used.

19.10 AIRCRAFT CONTROL CHANGES

Aircraft control changes will be three-way positive. This will ensure that one pilot maintains aircraft control at all times. The following sequence should be used:

1. The PAC should initiate the change with the words, "YOU HAVE THE CONTROLS".
2. The pilot assuming the controls takes physical control of the aircraft and will respond, "I HAVE THE CONTROLS".
3. The pilot who just relinquished the controls then responds, "YOU HAVE THE CONTROLS".

19.11 SIMULATED EMERGENCIES

The PIC shall ensure that each simulated emergency that involves a descent has associated with it a waveoff altitude and an absolute minimum altitude or hard deck. The term hard deck is defined as an absolute altitude that the aircraft shall not descend below in a simulated emergency during approach or descent to the surface, airfield, or water. Waveoff altitude or soft deck is defined as the minimum altitude at which appropriate control inputs shall be made to arrest the rate of descent to ensure that the hard deck is not violated. The PAC shall initiate waveoff control inputs at the waveoff altitude to achieve single-engine level-flight parameters above or at the established hard deck. The cockpit configuration shall be normalized by the PNAC once the aircraft is either re-established at a safe altitude or safely on deck.

The one exception to the soft deck/hard deck procedure is for simulated emergencies where the intent is to continue the approach to a landing. An example of this exception includes a simulated single-engine failure over a landing pad where the intent is to perform a practice landing on the pad.

PART X

NATOPS Evaluation

Chapter 20 — NATOPS Evaluation



CHAPTER 20**NATOPS Evaluation****20.1 CONCEPT**

The standard operating procedures prescribed in this manual represent the optimum method of operating this aircraft. The NATOPS evaluation program is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for compatibility with the various operational commitments and missions of Navy units. The prime objective of the NATOPS evaluation program is to assist the commanding officer in improving unit readiness and safety. Maximum benefit from the NATOPS evaluation program is achieved only through the vigorous support of the program by commanding officers as well as flightcrewmembers.

20.1.1 Applicability

The NATOPS evaluation will be administered to all aircrew maintaining a current flight status in the H-60 helicopter within the time limitations prescribed in the current NATOPS General Flight and Operating Instructions (OPNAVINST 3710.7 [series]).

20.2 IMPLEMENTATION

The NATOPS evaluation program shall be carried out in every unit operating naval aircraft. Aircrew desiring to attain/retain qualification in the aircraft shall be evaluated initially in accordance with OPNAVINST 3710.7 (series). The NATOPS evaluators and instructors shall administer the program as outlined in OPNAVINST 3710.7 (series). Those 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 day the initial ground evaluation was commenced and the date the flight evaluation is satisfactorily completed. The NATOPS evaluator and NATOPS instructor will administer the program through discharge of the following responsibilities.

20.2.1 NATOPS Evaluator

1. Assists the NATOPS instructor in all phases of the program. On request, the evaluator will be available to assist the unit in any phase of the training cycle.
2. Administers NATOPS evaluations in accordance with OPNAVINST 3710.7 (series). They will fly training or operational flights with a cross-section of the unit to observe adherence to standard operating procedures. The missions observed will be those scheduled for that phase of the unit's training cycle.

20.2.2 NATOPS Instructor

1. Implements and coordinates an aggressive and continuing NATOPS education and evaluation program pertaining to all aspects of standard operating procedures.
2. Enhances the educational benefits of the NATOPS program by flying with all squadron pilots/crewmembers as often as possible.
3. Administers the NATOPS evaluation to each squadron pilot/crewmember at least once each year.

20.3 DEFINITIONS

The following terms, which are used throughout this section, are defined as to their specific meaning within the NATOPS program:

1. NATOPS Evaluation. An annual evaluation of a crewmember's standardization. The NATOPS evaluation consists of an open- and closed-book examination, an Operational Flight Trainer/Weapons System Trainer

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(OFT/WST) evaluation (if available), and a flight evaluation. Annual NATOPS currency may be maintained by satisfactory completion of these examinations in conjunction with a flight evaluation or (at the unit commanding officer's discretion) an OFT/WST evaluation. An OFT/WST cannot be used in lieu of a flight evaluation for initial qualification or requalification after lapse of currency.

2. NATOPS reevaluation. A partial NATOPS evaluation administered to a flightcrewmember who has been placed in an unqualified status by receiving an UNQUALIFIED grade for any of the ground examinations or the evaluation flight. Only those areas in which an unsatisfactory level was noted need to be observed during a reevaluation.
3. QUALIFIED. The degree of standardization demonstrated by a very reliable flightcrewmember who has a good knowledge of standard operating procedures and a thorough understanding of aircraft capabilities and limitations.
4. CONDITIONALLY QUALIFIED. That degree of standardization demonstrated by a flightcrewmember who meets the minimum acceptable standards. He is considered safe enough to fly as a PIC or to perform normal duties without supervision, but more practice is needed to become QUALIFIED.
5. UNQUALIFIED. That degree of standardization demonstrated by a flightcrewmember who fails to meet minimum acceptable criteria. They should receive supervised instruction until A GRADE OF QUALIFIED or CONDITIONALLY QUALIFIED is achieved.
6. Area. A routine of preflight, flight, or postflight.
7. Subarea. A performance subdivision within an area that is observed and evaluated during an evaluation flight.
8. Critical Area. Any area or subarea that covers items of significant importance to the overall mission requirements, the marginal performance that would jeopardize safe conduct of the flight.
9. Emergency. An aircraft component, system failure, or condition that requires instantaneous recognition, analysis, and proper action.
10. Malfunction. An aircraft component, system failure, or condition that requires recognition and analysis, but permits more deliberate action than is required for an emergency.

20.4 MULTI-SERIES QUALIFIED AIRCREW

1. Conduct an open book examination for each qualified series NFM.
2. Conduct a closed book examination for each qualified series NFM.
3. Conduct an oral brief to include differences in series.
4. Simulator should be completed if available.
5. Flight evaluation conducted in H-60 model aircraft.

20.5 GROUND EVALUATION

Before commencing the flight evaluation, an evaluatee must achieve a minimum grade of QUALIFIED on the open-book and closed-book examinations and OFT/WST evaluation (if available). The oral examination is also part of the ground evaluation, but may be conducted as part of the flight evaluation.

20.5.1 Open-Book Examination

Questions in this category may be based on tables, graphs, charts, figures, and other information not conducive to memorization. The number of questions on the examination shall be between 40 and 80. The purpose of the open-book portion of the written examination is to evaluate the knowledge of appropriate publications and the aircraft. The maximum time for this examination shall not exceed 5 working days.

20.5.2 Closed-Book Examination

The number of questions shall be between 40 and 80. The purpose of the closed-book portion of the written examination is to evaluate the individual's knowledge of the aircraft systems and procedures that would normally be required to commit to memory to safely operate the aircraft. The maximum time limit for this examination shall not exceed 3 hours.

20.5.3 Oral Evaluation

This examination is designed to evaluate the examinee's overall knowledge of the aircraft systems and ability to recognize malfunctions. Such questions should be direct and positive and shall not be opinionated.

20.5.4 OFT/WST Procedures Evaluation

The **OFT/WST** (if available) can be used to evaluate the crewmembers' efficiency in the execution of normal procedures and their reaction to simulated emergencies and malfunctions.

20.5.5 Grading Instructions

Examination grades shall be compared on a 4.0 scale and converted to an adjective grade of QUALIFIED or UNQUALIFIED.

20.5.5.1 Open-Book Examination

To obtain a grade of QUALIFIED, an evaluatee must obtain a minimum score of 3.5.

20.5.5.2 Closed-Book Examination

To obtain a grade of QUALIFIED, an evaluatee must obtain a minimum score of 3.3. On retake examinations, an evaluatee must obtain a minimum score of 3.5 to obtain a grade of QUALIFIED.

20.5.5.3 Oral Examination and OFT/WST Procedures Evaluation (if conducted)

To obtain a grade of QUALIFIED an evaluatee must obtain a 3.0.

20.6 FLIGHT EVALUATION

The NATOPS flight evaluation is intended to measure pilot and crewmember performance with regard to knowledge of and adherence to prescribed procedures. The number of flights required to complete the flight evaluation should be kept to a minimum, normally one. It may be conducted on any operational or training flight and only those areas observed will be graded. The grade for the flight evaluation and overall NATOPS evaluation shall be determined as outlined in this section. Areas and subareas to be evaluated are outlined here with the critical areas/subareas marked by an asterisk.

20.6.1 Conduct of the Evaluation

An evaluation of emergency procedures should be conducted in an OFT/WST, if available, in addition to the actual flight evaluation. This will allow for a more realistic training/evaluation scenario than can be accomplished in the actual aircraft.

20.6.2 Safety Considerations During Evaluation Flights

Due to the broad significance of safety, it is impractical to list all contingencies that may fall under the general category of safety grading criteria. Generally, mission success is subject to compromise when there are any safety infractions, omissions, or deviations, beginning with mission planning and ending with the postflight debriefing. The following provide additional guidance in these areas:

1. Violations of pertinent directives or procedures that have a direct bearing on the safe completion of the mission, or negligence in following any procedure or directive that jeopardizes the safety of the crew or aircraft, will constitute an overall grade of UNQUALIFIED. The degree of jeopardy involved, in the absence of specific directives, must be determined by the instructor/evaluator based on good judgment and experience.
2. The latitude given the examiner in grading safety items must be exercised with care. The examiner must observe a discrepancy that directly contributes to an unsafe condition to justify an overall grade of UNQUALIFIED for safety reasons.
3. When an in-flight safety discrepancy is imminent, and the pilot/crewman appears unaware of the condition or has not taken the appropriate action, the examiner will correct the situation by directing that action be taken. Safety of flight cannot and shall not be compromised due to the reluctance on the part of the examiner to correct any discrepancy.
4. If a grade of UNQUALIFIED is given for safety reasons, the examiner will include a written statement describing the deficiency on the NATOPS Evaluation Report. The statement shall be clearly entitled SAFETY DISCREPANCY.

20.6.3 Flight Evaluation Grading Criteria

The grading criteria establish the standard for grading flightcrew performance, but do not relieve the evaluator/instructor from using good judgment based on experience. In those items where a flightcrewmember fails to meet the minimums set forth in the grading criteria, but the examiner (through past experience and judgment) knows that the discrepancy could have been caused by other factors such as weather, turbulence, or partial malfunction of aircraft or weapons systems, the examiner may assign a grade of QUALIFIED. A note to this effect will be included on the NATOPS Evaluation Report. Critical areas/subareas are denoted with an asterisk (*). Only those subareas observed or required will be graded. The grades assigned for the subareas shall be determined by comparing the degree of adherence to standard procedures with ratings as listed. Momentary deviations from standard procedures should not be considered as unqualified, provided such deviations do not jeopardize flight safety or mission performance and the evaluatee applies prompt corrective action.

QUALIFIED. An individual shall be considered QUALIFIED in each subarea if standard procedures were executed in accordance with the provisions of this manual and its subsets (i.e., checklists).

CONDITIONALLY QUALIFIED. An individual shall be considered CONDITIONALLY QUALIFIED in each subarea if minimal omissions, errors, or deviations are made, none of which would affect successful completion of mission or safety of flight/crew.

UNQUALIFIED. An individual shall be considered UNQUALIFIED for a subarea where any omissions, errors, or deviations are made, which would affect the successful completion of the mission or safety of the flight/crew. Failure to utilize checklists or complete required systems checks shall result in a grade of UNQUALIFIED for the applicable subarea.

20.7 PILOT GRADING CRITERIA

20.7.1 Oral Examination and OFT/WST Procedures Evaluation Grading Criteria

The NATOPS Pilot Evaluation Worksheet (**Figure 20-1**) is to be used to enter the status assigned as a result of the oral examination and the OFT/WST procedures evaluation. Final examination grades are to be determined by the evaluator/instructor.

20.7.1.1 Oral Examination

1. HELICOPTER SYSTEMS.

QUALIFIED. Exhibits a thorough knowledge of helicopter systems and their operations. Answers all questions on the systems satisfactorily.

CONDITIONALLY QUALIFIED. Shows a slight lack of familiarity with helicopter systems and their operation. Could have applied corrective action in case of emergency or malfunction of any system.

UNQUALIFIED. Shows a definite lack of familiarity with helicopter systems and their operation. Could not have applied proper corrective action in case of emergency or malfunction of a system due to this lack of knowledge.

20.7.1.2 OFT/WST Evaluation

1. EMERGENCIES/MALFUNCTION ANALYSIS.

QUALIFIED. Exhibits thorough knowledge of, and familiarity with, all cockpit switches and controls in the application of corrective action necessary in combating system malfunctions. Demonstrated thorough knowledge of emergency procedures with no deviations.

CONDITIONALLY QUALIFIED. Exhibits satisfactory knowledge of, and familiarity with, all cockpit switches and controls in the application of corrective action necessary in combating system malfunctions. Identification of emergency procedures was slower than normal, but still considered safe. Demonstrated satisfactory knowledge of emergency procedures with minor deviations.

UNQUALIFIED. Shows lack of familiarity with cockpit switches and controls. Unable to apply corrective action necessary to cope with helicopter system malfunctions. Slow and hesitant in the recognition of malfunctions. Misses one or more emergency procedures or sequential steps in corrective action that compounded the situation.

2. PROCEDURES.

QUALIFIED. NATOPS procedures and checklists followed without deviation, omission, or errors. Displayed complete knowledge and familiarity with the cockpit. Properly utilized copilot. Complied with all safety precautions.

CONDITIONALLY QUALIFIED. NATOPS procedures and checklists followed with minor deviation, omission, or errors. Displayed satisfactory knowledge and familiarity with the cockpit. Did not fully utilize copilot. Safety of flight was not jeopardized by discrepancies in checklists.

UNQUALIFIED. Did not utilize checklists. Demonstrated a complete lack of familiarity with cockpit. Did not utilize copilot. Disregarded safety precautions.

20.7.2 Flight Evaluation

The NATOPS Evaluation Worksheet ([Figure 20-1](#)) shall be used to enter the status assigned as a result of the flight evaluation.

*1. AREA 1 — BRIEF.

a. PILOT EQUIPMENT.

QUALIFIED. Possessed all personal flight gear in accordance with applicable directives. All gear subject to periodic inspections was up to date and current. Knew location of all equipment.

CONDITIONALLY QUALIFIED. Unsure of location of some equipment.

UNQUALIFIED. Nonstandard, missing, or out-of-date equipment noted. Did not know the location of most equipment.

b. NAVIGATION PUBLICATIONS.

QUALIFIED. Ensured all navigation publications necessary for flight were present and up to date.

CONDITIONALLY QUALIFIED. Ensured all publications necessary for flight were present. Minor omissions related to currency of publications not affecting safety of flight.

UNQUALIFIED. Publications not carried in aircraft or out of date.

***c. WEATHER.**

QUALIFIED. Obtained and interpreted all the available weather and sea information affecting the flight and the planned mission. Obtained a forecast for all intended operating and landing areas.

CONDITIONALLY QUALIFIED. Obtained and interpreted weather and sea information with only minor errors. The errors did not adversely affect the safety of the flight or violate civilian or military flight rules.

UNQUALIFIED. Unable to properly interpret weather sequences, weather forecast information, or sea environment to safely and effectively complete the mission.

***d. NATOPS FLIGHT MANUAL/POCKET CHECKLIST(S)/SOP.**

QUALIFIED. Both publications current with respect to incorporated changes.

CONDITIONALLY QUALIFIED. Publications current with respect to incorporated changes.

UNQUALIFIED. Current changes not incorporated in either publication.

***e. BRIEF/DEBRIEF.**

QUALIFIED. The briefing was conducted in an orderly, well-organized manner in accordance with the NATOPS briefing guide. Debriefing was conducted in a professional manner and contained constructive criticism of the entire flight.

CONDITIONALLY QUALIFIED. The briefing was conducted in an orderly manner with errors and/or omissions not affecting the safe and orderly completion of the mission. The debriefing was not complete.

UNQUALIFIED. Did not brief for the mission in accordance with this manual. No debriefing guide was used and/or the debriefing was omitted.

f. PERFORMANCE CALCULATIONS

QUALIFIED. Ensured all applicable performance calculations were compiled before flight, with no errors or omissions.

CONDITIONALLY QUALIFIED. Completed applicable performance calculations before flight with minor deviation.

UNQUALIFIED. Did not complete performance calculations in accordance with this manual. Calculations incomplete or incorrect.

g. MISSION PLANNING SYSTEM (MPS)

QUALIFIED. Properly utilized MPS. Successfully entered all data needed for flight operations and compared results to performance calculations. The downloaded MPS files would have greatly enhanced aircrew situational awareness and reduced aircrew workload.

CONDITIONALLY QUALIFIED. Completed MPS process, but unable to enter all data required without guidance. Flight could be safely conducted with cards completed, but numerous areas such as communications, navigation, and performance calculations were not utilized. MPS cards used would slightly enhance situational awareness and provide a minor reduction in aircrew workload.

UNQUALIFIED. Could not successfully complete the MPS process. Data was consistently entered incorrectly or neglected entirely. Use of downloaded MPS cards could create confusion in the aircraft and result in increased aircrew workload and decreased situational awareness.

*2. AREA 2-GROUND OPERATIONS.

*a. LOGS AND RECORDS.

QUALIFIED. Consulted the Aircraft Discrepancy Book (ADB) for completeness, accuracy, and the status of the helicopter. Reviewed the Maintenance Action Forms (MAFs) from the previous ten flights for discrepancies and corrective action. Filled out the applicable sections of the NAVFLIRS without errors or omissions. Reviewed weight and balance for currency and within limits.

CONDITIONALLY QUALIFIED. Consulted the ADB for status of the helicopter, but failed to properly avail themselves of all the information contained therein, and/or neglected to review the previous ten flights.

UNQUALIFIED. Failed to ascertain that all grounding discrepancies had been corrected. Accepted a helicopter that was not ready for flight. Failed to review weight and balance limitations.

*b. PREFLIGHT CHECK.

QUALIFIED. Accomplished the preflight inspection as outlined in this manual. Ensured proper servicing of the helicopter in accordance with the planned mission.

CONDITIONALLY QUALIFIED. Accomplished the preflight inspection as outlined in this manual with minor omissions or errors, none of which could affect safety of flight.

UNQUALIFIED. Performed the required preflight inspection with errors and/or omissions that could affect safety of flight. Failed to verify that the helicopter was serviced and ready for flight.

c. PRESTART CHECKS.

QUALIFIED. NATOPS procedures and checklist followed without deviation, omission, or errors. Displayed complete knowledge and familiarity with the cockpit. Properly utilized copilot. Complied with all visual signals and safety precautions.

CONDITIONALLY QUALIFIED. Deviations and omissions of the prescribed procedures caused undue delay. Hesitation in the manipulation of cockpit switches and circuit breakers. Marginal use of the copilot.

UNQUALIFIED. Did not utilize checklist. Demonstrated a complete lack of familiarity with cockpit. Did not utilize copilot. Disregarded visual signals and/or safety precautions.

*d. SYSTEMS CHECKS.

QUALIFIED. Performed all checks in accordance with this manual. Ensured proper operation of all equipment.

CONDITIONALLY QUALIFIED. Minor deviations and/or omissions in the use of checklists not involving safety of flight. Incomplete systems checks.

UNQUALIFIED. Failed to follow checklist. Did not perform required checks in accordance with this manual.

*e. ENGINE START.

QUALIFIED. NATOPS procedures and checklist followed without deviation, omission, or errors. Displayed complete knowledge and familiarity with the cockpit. Properly utilized copilot.

CONDITIONALLY QUALIFIED. Deviations and omissions of the prescribed procedures caused delayed and erratic starting. Poor timing in the manipulation of the controls. Demonstrated lack of knowledge of starting procedures. Marginally effective use of copilot.

UNQUALIFIED. Could not start the engine and/or demonstrated a complete lack of proper procedure or limitations.

*f. ROTOR ENGAGEMENT AND ENGINE RUNUP.

QUALIFIED. NATOPS procedures followed without error and/or omission. Proper procedures used to effect smooth, safe operation. Desired directional control maintained without abrupt changes.

CONDITIONALLY QUALIFIED. Improper or incomplete use of checklist resulting in nonstandard procedures. Rough or erratic engagement. Misinterpretation of visual signals. No errors that affected mission capability or flight safety.

UNQUALIFIED. Did not utilize checklists. Disregarded visual signals. Significant errors that could affect safety of aircrew and/or ground personnel.

g. TAXI.

QUALIFIED. NATOPS procedures followed without error and/or omission. Proper procedures used to effect smooth safe operation. Desired directional control maintained without abrupt changes.

CONDITIONALLY QUALIFIED. Minor deviations from standard procedures, none of which jeopardized safe operation. Directional control slightly erratic.

UNQUALIFIED. NATOPS procedures were not followed. Errors or omissions that jeopardized or could jeopardize safe operation.

h. SHUTDOWN/POSTFLIGHT.

QUALIFIED. The securing of rotors, engines, and all equipment was done in accordance with this manual. Ensured that a complete postflight inspection was performed. Completed NAVFLIRS and VIDS/MAFS forms completely and correctly.

CONDITIONALLY QUALIFIED. The securing of the rotors, engines, and all equipment was performed, but not in the order prescribed in this manual. Minor deviations or omissions are allowed unless deviations or omissions are injurious to the equipment or personnel. Minor omissions on postflight and/or flight documentation.

UNQUALIFIED. Did not shut down the rotors, engines, or equipment in accordance with standard procedures. Deviations or omissions in the procedures that if allowed to continue would be injurious to equipment or personnel. Did not ensure a postflight was conducted. Did not fill out NAVFLIRS and/or VIDS/MAFS.

*i. CREW COORDINATION.

QUALIFIED. Demonstrated effective crew utilization throughout all areas. Crew never placed in jeopardy.

CONDITIONALLY QUALIFIED. Did not fully or properly utilize crew.

UNQUALIFIED. Failed to utilize crew, resulting in safety implications.

*3. AREA 3-NORMAL FLIGHT OPERATIONS.

*a. PROCEDURES.

QUALIFIED. NATOPS procedures followed with no deviation. Checklists used. Site selected for landing was adequate. Pattern for selected site showed proper planning. Demonstrated complete knowledge and utilization of AFCS functions.

CONDITIONALLY QUALIFIED. Minor deviations from NATOPS procedures that did not jeopardize safety of flight.

UNQUALIFIED. NATOPS procedures not followed. Failed to use checklists.

b. VERTICAL TAKEOFF/HOVER.

QUALIFIED. NATOPS procedures followed without error or deviation. Power was applied smoothly and positively. Heading remained constant.

CONDITIONALLY QUALIFIED. Minor deviations in procedures not affecting safety of flight. Aircraft and/or power not handled smoothly, but still effectively.

UNQUALIFIED. NATOPS procedures not followed. Power control was not smooth or applied in accordance with standard procedure.

c. NORMAL TAKEOFF/TRANSITION.

QUALIFIED. Transition to climb airspeed made with a smooth addition of collective pitch to prevent settling. All control applications smooth.

CONDITIONALLY QUALIFIED. Transition to climb airspeed was made, but with slight settling. Power control applied abruptly. Heading control somewhat erratic.

UNQUALIFIED. Allowed aircraft to settle. Heading and power control abrupt.

d. MAXIMUM GROSS WEIGHT TAKEOFF.

QUALIFIED. NATOPS procedures followed without error or deviation. Hover check completed. Power was applied smoothly and positively. Heading remained constant.

CONDITIONALLY QUALIFIED. Minor deviations in procedures not affecting safety of flight. Aircraft and/or power not handled smoothly, but still effectively.

UNQUALIFIED. NATOPS procedures not followed. Power control was not smooth or applied in accordance with standard procedure. Hover check not performed. Touched surface after takeoff.

e. OBSTACLE CLEARANCE TAKEOFF.

QUALIFIED. NATOPS procedures followed without error or deviation. Power was applied smoothly and positively. Heading remained constant.

CONDITIONALLY QUALIFIED. Minor deviations in procedures not affecting safety of flight. Aircraft and/or power not handled smoothly, but still effectively.

UNQUALIFIED. NATOPS procedures not followed. Power control was not smooth or applied in accordance with standard procedure. Did not clear obstacle.

f. NORMAL APPROACH/VERTICAL LANDING.

QUALIFIED. NATOPS procedures followed to place helicopter in a position for a proper approach. Power was handled in a smooth manner so as to effect proper approach speed, altitude, and descent rate. Aircraft controlled so as to arrive at normal hover with zero groundspeed, proper attitude, and power. Smooth descent and no drift on touchdown.

CONDITIONALLY QUALIFIED. Aircraft altitude and power control rough. Slight over- or undershoot. Slight drift on touchdown.

UNQUALIFIED. Power applications erratic and rough. Erratic altitude and heading control. Excessive descent rate and/or drift on touchdown.

g. STEEP APPROACH/NO HOVER LANDING.

QUALIFIED. NATOPS procedures followed to place helicopter in a position for a proper approach. Power was handled in a smooth manner so as to effect proper approach speed and descent rate. Aircraft controlled so as to arrive at touchdown point with little or no forward roll.

CONDITIONALLY QUALIFIED. Aircraft attitude and power control rough. Slight groundspeed on touchdown.

UNQUALIFIED. Excessive sink rate. Power applications erratic and rough. Erratic attitude and heading control. Missed intended point of touchdown. Excessive groundspeed on touchdown.

h. RUNNING LANDING.

QUALIFIED. NATOPS procedures followed to place aircraft on proper approach path with proper airspeed, descent rate, and attitude. Transition from approach to landing smooth with no abrupt power or heading changes.

CONDITIONALLY QUALIFIED. Minor deviations in procedures which did not jeopardize safety of flight. Aircraft attitude, airspeed, power, and heading control rough.

UNQUALIFIED. Proper procedures not followed. Touchdown in skid. Over-rotated just prior to touchdown. Landing speed exceeded helicopter limitations. Poor heading control on rollout.

i. RUNNING TAKEOFF.

QUALIFIED. NATOPS procedures followed without error or deviation. Power was applied smoothly and positively. Heading remained constant.

CONDITIONALLY QUALIFIED. Minor deviations in procedures not affecting safety of flight. Aircraft and/or power not handled smoothly, but still effectively.

UNQUALIFIED. NATOPS procedures not followed. Power control was not smooth or applied in accordance with standard procedure. Poor heading control on ground roll. Over-rotated helicopter just after lift-off.

*j. COMM/NAV/KEYSETS.

Note

The COMM/NAV/KEYSETS evaluation shall be limited to the areas listed. The pilot NATOPS evaluation is not intended to be an evaluation of NATIP publication (NTRP 3-22.2-SH60B) related material, although Mission Systems related emergencies may be evaluated. Tactics shall not be evaluated.

QUALIFIED. Demonstrates a thorough ability to recall system operations, functions, and capabilities. Able to accomplish operation of communication, navigation and keyset systems without hesitation or error. Able to accurately navigate aircraft using system navigation tools and symbols without hesitation or error. Able to operate keys and display functions without hesitation or error.

CONDITIONALLY QUALIFIED. Demonstrates the ability to recall system operational functions, and capabilities sufficient to operate the communication, navigation, and keysets with minor procedural errors or omissions not affecting the continuation of the mission.

UNQUALIFIED. Lacks the ability to recall system operations, functions, and capabilities and/or makes procedural errors affecting mission accomplishment.

***k. CREW COORDINATION.**

QUALIFIED. Demonstrated effective crew utilization throughout all areas. Crew never placed in jeopardy.

CONDITIONALLY QUALIFIED. Did not fully or properly utilize crew.

UNQUALIFIED. Failed to utilize crew, resulting in safety implications.

***4. AREA 4-EMERGENCY PROCEDURES.**

***a. AUTOROTATIONS.**

QUALIFIED. All procedures carried out in accordance with this manual. Minor non-recurring discrepancies not affecting flight safety.

CONDITIONALLY QUALIFIED. Airspeed, N_r , and heading control erratic. Slight drift at recovery.

UNQUALIFIED. Airspeed, N_r , and heading control beyond safe limits. Implemented techniques that would have jeopardized the successful completion and recovery of the autorotation.

***b. ENGINE MALFUNCTIONS.**

QUALIFIED. Properly analyzed the emergency situation and took appropriate action. Utilized PNAC and crew as needed.

CONDITIONALLY QUALIFIED. Properly analyzed the emergency situation and accomplished the required action, but with minor errors or omissions that did not preclude the successful completion of the appropriate action.

UNQUALIFIED. Made errors or omissions that if allowed to continue would jeopardize safety of flight.

***c. SINGLE ENGINE TO A SPOT/RUNWAY.**

QUALIFIED. All procedures carried out in accordance with NATOPS. Power was handled in a smooth manner so as to effect proper approach speed and descent rate. Aircraft controlled so as to arrive at touchdown with proper attitude and power.

CONDITIONALLY QUALIFIED. Followed procedures with only minor deviations that did not affect safety of flight. Did not prebrief approach to PNAC.

UNQUALIFIED. Did not follow proper procedures. Handling of aircraft jeopardized safety of flight. Touched down with excessive descent rate or unsafe groundspeed.

***d. SINGLE ENGINE FAILURE HIGE/HOGE.**

QUALIFIED. All procedures carried out in accordance with NATOPS. Power was handled in a smooth manner so as to effect a safe recovery. Descent rate, Nr, and nose attitude were controlled. Landed with no drift. Minor Nr droop is allowable.

CONDITIONALLY QUALIFIED. Followed procedures with only minor deviations that did not affect safety of flight. Landed with slight drift. Moderate Nr droop.

UNQUALIFIED. Did not follow proper procedures. Handling of aircraft jeopardized safety of flight. Touched down with excessive sink rate, Nr control was erratic. Landed with excessive drift or severe Nr droop.

***e. AFCS/SAS OFF.**

QUALIFIED. Aircraft control smooth and positive. Heading, altitude, and attitude properly maintained.

CONDITIONALLY QUALIFIED. Aircraft control occasionally rough but without jeopardizing safety of flight.

UNQUALIFIED. Aircraft control rough and abrupt. Jeopardized safety of flight.

***f. BOOST OFF.**

QUALIFIED. Aircraft control smooth and positive. Heading, altitude, and attitude properly maintained.

CONDITIONALLY QUALIFIED. Aircraft control occasionally rough but without jeopardizing safety of flight.

UNQUALIFIED. Aircraft control rough and abrupt. Jeopardized safety of flight.

***g. STABILATOR MALFUNCTION.**

QUALIFIED. All procedures carried out in accordance with this manual.

CONDITIONALLY QUALIFIED. Slight deviations from procedures. Did not jeopardize safety of flight.

UNQUALIFIED. Did not follow procedures. Jeopardized safety of flight.

***h. FIRE.**

QUALIFIED. All procedures carried out in accordance with this manual.

CONDITIONALLY QUALIFIED. Slight deviations from procedures. Did not jeopardize safety of flight.

UNQUALIFIED. Did not follow procedures. Jeopardized safety of flight.

***i. COUPLER EMERGENCIES.**

QUALIFIED. All procedures carried out in accordance with this manual.

CONDITIONALLY QUALIFIED. Slight deviations from procedures. Did not jeopardize safety of flight. Delay in analysis of malfunction.

UNQUALIFIED. Did not follow procedures. Jeopardized safety of flight. Failure to analyze malfunction.

***j. DITCHING/EGRESS.**

QUALIFIED. All procedures carried out in accordance with this manual.

CONDITIONALLY QUALIFIED. Slight deviations from procedures. Did not jeopardize safety of flight. Delay in analysis of malfunction.

UNQUALIFIED. Did not follow procedures. Jeopardized safety of flight. Failure to analyze malfunction.

*k. CREW COORDINATION.

QUALIFIED. Demonstrated effective crew utilization throughout all areas. Crew never placed in jeopardy.

CONDITIONALLY QUALIFIED. Did not fully or properly utilize crew.

UNQUALIFIED. Failed to utilize crew, resulting in safety implications.

*5. AREA 5 — SPECIAL PROCEDURES.

*a. RESCUE PROCEDURES.

(1) AUTOMATIC APPROACH CHECKLIST.

QUALIFIED. NATOPS procedures and checklist followed without deviation, omissions, or errors. Displayed complete understanding and familiarity with the cockpit switches and procedures.

CONDITIONALLY QUALIFIED. Deviations and omissions of the prescribed procedures caused undue delay. Hesitation in the manipulation of cockpit switches. Marginally effective use of copilot.

UNQUALIFIED. Did not utilize checklist. Demonstrated a complete lack of familiarity with cockpit. Did not utilize copilot.

(2) ICS PROCEDURES.

QUALIFIED. Utilized standard ICS terminology in accordance with NATOPS.

CONDITIONALLY QUALIFIED. Used nonstandard or slight deviations from standard ICS terminology. Did not jeopardize safety of flight.

UNQUALIFIED. Did not follow procedures. Jeopardized safety of flight or safety of swimmer or survivor.

(3) VERBAL CONTROL PROCEDURES.

QUALIFIED. NATOPS procedures and terminology utilized in order to expeditiously fly aircraft to proper location.

CONDITIONALLY QUALIFIED. Deviations and omissions of the prescribed procedures caused undue delay. Did not jeopardize safety of flight.

UNQUALIFIED. Did not follow procedures. Positioned aircraft improperly for rescue completion. Safety of flight jeopardized.

(4) CREW HOVER PROCEDURES.

QUALIFIED. NATOPS ICS, flight, crew hover, and control transfer procedures followed without deviation, omissions, or errors. Procedures briefed were followed during conduct of flight.

CONDITIONALLY QUALIFIED. Deviations or omissions of the prescribed procedures caused undue delay. Did not jeopardize safety of flight.

UNQUALIFIED. Did not follow procedures. Significant deviations from crew NATOPS brief. Jeopardized safety of flight.

(5) DAY VMC PROCEDURES.

QUALIFIED. NATOPS day, VMC rescue, and manual approach procedures followed without deviation, omissions, or errors. Safely manipulated aircraft into appropriate swimmer deployment regime.

CONDITIONALLY QUALIFIED. Deviations from, or omissions of, the prescribed ICS communications and NATOPS procedures caused undue delay. Did not jeopardize safety of flight.

UNQUALIFIED. Did not follow procedures. Jeopardized safety of flight.

(6) NIGHT/IMC PROCEDURES.

QUALIFIED. NATOPS Night/IMC rescue procedures followed without deviation, omissions, or errors. Demonstrated effective use and understanding of windline rescue pattern.

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CONDITIONALLY QUALIFIED. Deviations and/or omissions of the prescribed procedures caused undue delay. Misunderstanding of windline rescue pattern and automatic approach procedures. Did not jeopardize safety of flight.

UNQUALIFIED. Did not follow procedures. Jeopardized safety of flight.

(7) CREW COORDINATION.

QUALIFIED. Demonstrated effective copilot and aircrew utilization throughout rescue procedures. Included entire crew in decision-making processes during conduct of rescue.

CONDITIONALLY QUALIFIED. Did not fully or properly utilize aircrew or copilot for mission accomplishment. Slow to respond to aircrew recommendations regarding positioning or conduct of rescue. No impact overall on safety of flight.

UNQUALIFIED. Failed to utilize copilot and/or aircrew, caused alienation of crew during flight, actions resulted in jeopardizing safety of flight.

b. SONAR PROCEDURES (F/R).

QUALIFIED. Demonstrated thorough knowledge of NATOPS procedures in manipulation of the controls to set the equipment into full operation.

CONDITIONALLY QUALIFIED. Demonstrated a fair knowledge of the equipment but deviated from the NATOPS procedures. Was able to complete assigned mission.

UNQUALIFIED. Demonstrated lack of knowledge of the equipment and did not use NATOPS procedures. Made major deviations or omissions that prolonged the mission or caused the mission to fail.

20.8 AIRCREW GRADING CRITERIA

20.8.1 Oral Examination Grading Criteria

The NATOPS Aircrew Evaluation Worksheet ([Figure 20-2](#)) is to be used to enter the status assigned as a result of oral examinations.

QUALIFIED. Demonstrated a thorough knowledge of location, operation and/or procedures of discussed item. Answers all questions satisfactorily.

CONDITIONALLY QUALIFIED. Shows a slight lack of familiarity with or knowledge/understanding of the procedures and operation of discussed item. Answered all questions with minor deviations not detrimental to aircrew duties.

UNQUALIFIED. Definite lack of knowledge and/or understanding of discussed item. Unable to answer questions considered essential for safe and proper execution of aircrew duties.

20.8.2 Flight Evaluation Grading Criteria

The NATOPS Aircrew Evaluation Worksheet ([Figure 20-2](#)) should be used to enter the status assigned as a result of the flight evaluation. General crewmen (Aerial Door Gunners, SAR Medical Technicians, Special Mission Crewmen, and Lookout Non-Aircrewmen) require ORAL, GROUND, and GENERAL areas only.

1. GROUND OPERATIONS.

*a. NATOPS FLIGHT MANUAL/POCKET CHECKLIST/SOP.

QUALIFIED. Publications current with respect to all incorporated changes.

CONDITIONALLY QUALIFIED. Publications are current with minor deviations.

UNQUALIFIED. Current changes not incorporated in either publication.

***b. FLIGHT EQUIPMENT.**

QUALIFIED. Demonstrated thorough knowledge of location, operation and proper wearing of all safety and survival equipment.

CONDITIONALLY QUALIFIED. Demonstrated satisfactory knowledge of location, operation and proper wearing of all safety and survival equipment with minor deviations.

UNQUALIFIED. Non standard, missing on or properly worn. Did not know the location of all safety and survival equipment.

c. AIRCRAFT DISCREPANCY BOOK.

QUALIFIED. Reviewed the ADB for completeness, accuracy, and the status of the aircraft.

CONDITIONALLY QUALIFIED. Consulted the ADB for status of the aircraft, but failed to properly avail them self of all the information contained therein.

UNQUALIFIED. Failed to review the ADB for completeness, accuracy, and the status of the aircraft.

d. BRIEF/DEBRIEF/MISSION PLANNING.

QUALIFIED. Arrived to the brief having obtained/given all information pertinent to the successful completion of the mission.

CONDITIONALLY QUALIFIED. Met the criteria for **QUALIFIED** except for minor omissions, not affecting the successful completion of the mission.

UNQUALIFIED. Major omissions which could affect the successful completion of the mission or failed to attend.

***e. PREFLIGHT.**

QUALIFIED. Accomplished the preflight inspection as outlined in this manual.

CONDITIONALLY QUALIFIED. Accomplished the preflight inspection as outlined in this manual with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Performed required preflight inspection with deviations/omissions which affected safety of flight

***f. AIRCRAFT SERVICING/HANDLING.**

QUALIFIED. Ensured proper servicing and handling procedures as outlined in this manual.

CONDITIONALLY QUALIFIED. Completed servicing and handling procedures as outlined in this manual with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Performed servicing and handling with deviations/omissions which affected safety of flight.

***g. SAFETY.**

QUALIFIED. Observed all safety precautions and displayed no conduct that could jeopardize safety of flight.

CONDITIONALLY QUALIFIED. Observed safety precautions with minor deviations not affecting safety of flight.

UNQUALIFIED. Flagrant disregard of safety precautions which affected safety of flight.

2. GENERAL OPERATIONS.

*a. CHECKLIST UTILIZATION.

QUALIFIED. Procedures completed in the proper sequence as outlined in this manual.

CONDITIONALLY QUALIFIED. Procedures completed with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major omissions/deviations which affected safety of flight.

*b. EMERGENCY PROCEDURES.

QUALIFIED. Recognized emergencies and followed procedures stated in this manual.

CONDITIONALLY QUALIFIED. Recognized emergencies with minor deviations not affecting safety of flight.

UNQUALIFIED. Failed to recognize emergencies and/or follow procedures stated in this manual which affected safety of flight.

c. LOOKOUT PROCEDURES.

QUALIFIED. Observed all safety precautions and displayed sound judgment.

CONDITIONALLY QUALIFIED. Observed safety precautions and displayed sound judgment with minor errors not affecting safety of flight.

UNQUALIFIED. Flagrant disregard of safety precautions which affected safety of flight.

d. OPERATIONAL CHECKS.

QUALIFIED. Procedures completed in the proper sequence as outlined in this manual.

CONDITIONALLY QUALIFIED. Procedures completed with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major omissions/deviations which affected safety of flight.

*e. AIRCRAFT LIMITATIONS.

QUALIFIED. Familiar with all aircraft limitations. Operated within the limitations outlined in this manual.

CONDITIONALLY QUALIFIED. Familiar with aircraft limitations. Operated within limitations with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Unfamiliar with aircraft limitations. Operated outside of limitations which affected safety of flight.

f. RADIO PROCEDURES.

QUALIFIED. Provided a constant status, using standard terminology that was clear and concise.

CONDITIONALLY QUALIFIED. Provided a constant status with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

***g. SAFETY.**

QUALIFIED. Observed all safety precautions and displayed no conduct that could jeopardize safety of flight.

CONDITIONALLY QUALIFIED. Observed safety precautions with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Flagrant disregard of safety precautions which affect safety of flight.

3. SAR OPERATIONS.

***a. CHECKLIST UTILIZATION.**

QUALIFIED. Procedures completed in the proper sequence as outlined in this manual.

CONDITIONALLY QUALIFIED. Procedures completed with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

***b. HOIST OPERATIONS/LIMITATIONS.**

QUALIFIED. Followed approved procedures and limitations outlined in this manual.

CONDITIONALLY QUALIFIED. Followed approved procedures and limitations with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

c. ICS PROCEDURES.

QUALIFIED. Provided a constant status, using standard terminology that was clear and concise.

CONDITIONALLY QUALIFIED. Provided a constant status with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

d. SAR EQUIPMENT OPERATIONS.

QUALIFIED. Demonstrated thorough knowledge and operation of equipment.

CONDITIONALLY QUALIFIED. Demonstrated adequate knowledge and operation of equipment with minor deviations/omissions not affecting the safe completion of the mission.

UNQUALIFIED. Demonstrated a lack of knowledge and operation of equipment.

***e. HOIST EMERGENCIES.**

QUALIFIED. Recognized emergencies and followed procedures stated in this manual.

CONDITIONALLY QUALIFIED. Recognized emergencies with minor deviations not affecting safety of flight.

UNQUALIFIED. Failed to recognize emergencies and/or follow procedures stated in this manual which affect safety of flight.

f. DAY/NIGHT SAR OPERATIONS.

QUALIFIED. Followed procedures outlined in this manual.

CONDITIONALLY QUALIFIED. Followed procedures with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

*g. SAFETY.

QUALIFIED. Observed all safety precautions and displayed no conduct that could jeopardize safety of flight.

CONDITIONALLY QUALIFIED. Observed safety precautions with minor deviations not affecting safety of flight.

UNQUALIFIED. Flagrant disregard of safety precautions which affected safety of flight.

4. UTILITY OPERATIONS.

*a. CHECKLIST UTILIZATION.

QUALIFIED. Procedures completed in the proper sequence as outlined in this manual.

CONDITIONALLY QUALIFIED. Procedures completed with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major omissions/deviations which affected safety of flight.

b. CARGO/VERTREP OPERATIONS.

QUALIFIED. Followed procedures outlined in this manual.

CONDITIONALLY QUALIFIED. Followed procedures with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

c. HIFR OPERATIONS.

QUALIFIED. Followed procedures outlined in this manual.

CONDITIONALLY QUALIFIED. Followed procedures with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

d. SHIPBOARD OPERATIONS.

QUALIFIED. Followed procedures outlined in this manual.

CONDITIONALLY QUALIFIED. Followed procedures with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

e. ICS PROCEDURES.

QUALIFIED. Provided a constant status, using standard terminology that was clear and concise.

CONDITIONALLY QUALIFIED. Provided a constant status with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

*f. LIMITATIONS.

QUALIFIED. Within limitations outlined in this manual.

CONDITIONALLY QUALIFIED. Within limitations with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Outside of limitations which affected safety of flight.

*g. SAFETY.

QUALIFIED. Observed all safety precautions and displayed no conduct that could jeopardize safety of flight.

CONDITIONALLY QUALIFIED. Observed safety precautions with minor deviations not affecting safety of flight.

UNQUALIFIED. Flagrant disregard of safety precautions which affected safety of flight.

5. NON-ACOUSTIC OPERATIONS.

a. RADAR/IFF.

QUALIFIED. Demonstrated a thorough knowledge of equipment, control functions, troubleshooting and procedures.

CONDITIONALLY QUALIFIED. Demonstrated a fair knowledge of equipment, control functions, troubleshooting and procedures with minor errors not affecting the mission.

UNQUALIFIED. Demonstrated a complete lack of knowledge with errors that affected the mission.

b. ELECTRONIC SUPPORT MEASURES.

QUALIFIED. Demonstrated a thorough knowledge of equipment, control functions, troubleshooting and procedures.

CONDITIONALLY QUALIFIED. Demonstrated a fair knowledge of equipment, control functions, troubleshooting and procedures with minor errors not affecting the mission.

UNQUALIFIED. Demonstrated a complete lack of knowledge with errors that affected the mission.

c. ISD/ASE.

QUALIFIED. Demonstrated a thorough knowledge of equipment, control functions, troubleshooting and procedures.

CONDITIONALLY QUALIFIED. Demonstrated a fair knowledge of equipment, control functions, troubleshooting and procedures with minor errors not affecting the mission.

UNQUALIFIED. Demonstrated a complete lack of knowledge with errors that affected the mission.

d. NAVIGATION.

QUALIFIED. Demonstrated a thorough knowledge of equipment, control functions, troubleshooting and procedures.

CONDITIONALLY QUALIFIED. Demonstrated a fair knowledge of equipment, control functions, troubleshooting and procedures with minor errors not affecting the mission.

UNQUALIFIED. Demonstrated a complete lack of knowledge with errors that affected the mission.

e. COMMUNICATION.

QUALIFIED. Demonstrated a thorough knowledge of equipment, control functions, troubleshooting and procedures.

CONDITIONALLY QUALIFIED. Demonstrated a fair knowledge of equipment, control functions, troubleshooting and procedures with minor errors not affecting the mission.

UNQUALIFIED. Demonstrated a complete lack of knowledge with errors that affected the mission.

f. FLIR.

QUALIFIED. Demonstrated a thorough knowledge of equipment, control functions, troubleshooting and procedures.

CONDITIONALLY QUALIFIED. Demonstrated a fair knowledge of equipment, control functions, troubleshooting and procedures with minor errors not affecting the mission.

UNQUALIFIED. Demonstrated a complete lack of knowledge with errors that affected the mission.

*g. SAFETY.

QUALIFIED. Observed all safety precautions and displayed no conduct that could jeopardize safety of flight.

CONDITIONALLY QUALIFIED. Observed safety precautions with minor deviations not affecting safety of flight.

UNQUALIFIED. Flagrant disregard of safety precautions which affected safety of flight.

6. ACOUSTIC OPERATIONS.

a. DIPPING/MAD OPERATIONS.

QUALIFIED. Demonstrated a thorough knowledge of equipment, control functions and procedures.

CONDITIONALLY QUALIFIED. Demonstrated a fair knowledge of equipment, control functions and procedures with minor errors not affecting the mission.

UNQUALIFIED. Demonstrated a complete lack of knowledge with errors that affected the mission.

*b. EMERGENCY PROCEDURES.

QUALIFIED. Recognized emergencies and followed procedures stated in this manual.

CONDITIONALLY QUALIFIED. Recognized emergencies with minor deviations not affecting safety of flight.

UNQUALIFIED. Failed to recognize emergencies and/or follow procedures stated in this manual which affected safety of flight.

c. ICS PROCEDURES.

QUALIFIED. Provided a constant status, using standard terminology that was clear and concise.

CONDITIONALLY QUALIFIED. Provided a constant status with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Major deviations/omissions which affected safety of flight.

d. TROUBLESHOOTING.

QUALIFIED. Followed approved troubleshooting procedures outlined in this manual.

CONDITIONALLY QUALIFIED. Followed approved troubleshooting procedures with minor errors not affecting the mission.

UNQUALIFIED. Major errors which affected safety of flight.

e. SONOBUOY OPERATIONS.

QUALIFIED. Demonstrated a thorough knowledge of equipment, control functions and procedures.

CONDITIONALLY QUALIFIED. Demonstrated a fair knowledge of equipment, control functions and procedures with minor errors not affecting the mission.

UNQUALIFIED. Demonstrated a complete lack of knowledge with errors that affected the mission.

*f. LIMITATIONS.

QUALIFIED. Within limitations outlined in this manual.

CONDITIONALLY QUALIFIED. Within limitations with minor deviations/omissions not affecting safety of flight.

UNQUALIFIED. Outside of limitations which affected safety of flight.

*g. SAFETY.

QUALIFIED. Observed all safety precautions and displayed no conduct that could jeopardize safety of flight.

CONDITIONALLY QUALIFIED. Observed safety precautions with minor deviations not affecting safety of flight.

UNQUALIFIED. Flagrant disregard of safety precautions which affected safety of flight.

20.9 FLIGHT EVALUATION GRADE DETERMINATION

The following procedures shall be used in determining the oral, OFT/WST, and flight evaluation grade. A grade of UNQUALIFIED in any critical area or critical 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:

| | |
|-------------------------|-----|
| UNQUALIFIED | 0.0 |
| CONDITIONALLY QUALIFIED | 2.0 |
| QUALIFIED | 4.0 |

Note

Only the numerals 0, 2, or 4 will be assigned in subareas. No interpolation is allowed. To determine the numerical grade for each area and the overall grade for the flight, add all the points assigned to the subareas and divide this sum by the number of subareas graded. The adjective grade shall then be determined on the basis of the following scale:

| |
|--------------------------------------|
| FLIGHT: 0.0 to 2.19 UNQUALIFIED. |
| 2.2 to 2.99 CONDITIONALLY QUALIFIED. |
| 3.0 to 4.00 QUALIFIED. |

| |
|--|
| ORAL or OFT/WST: 0.0 to 2.99 UNQUALIFIED. |
| 3.0 to 4.00 QUALIFIED. |

EXAMPLE: (Add subarea numerical equivalents)
 $(4 + 2 + 4 + 2 + 4)/5 = 16/5 = 3.20$ QUALIFIED.

20.10 FINAL GRADE DETERMINATION

The final NATOPS evaluation grade shall be based on the results of the oral, OFT/WST, and flight evaluation. An evaluatee who receives an UNQUALIFIED on any ground examination or the flight evaluation shall be placed in an UNQUALIFIED status until achieving a grade of CONDITIONALLY QUALIFIED or QUALIFIED on a reevaluation.

20.11 RECORDS AND REPORTS

A NATOPS Evaluation Report (OPNAV Form 3710/7) shall be completed for each evaluation and forwarded to the evaluatee’s commanding officer. This report shall be filed in the individual’s flight training record and retained therein in accordance with OPNAVINST 3710.7 (series). In addition, an entry shall be made in the Flight Log Book (OPNAV 3760/10) under QUALIFICATION AND ACHIEVEMENTS.

| QUALIFICATION | DATE | SIGNATURE | |
|--|--------|----------------------------|------------------------------------|
| NATOPS EVAL. H-60 (Series) PILOT/AIRCREWMAN | (DATE) | (Authenticating Signature) | (Unit Administering Qualification) |

20.12 NATOPS EVALUATION FORMS

In addition to the NATOPS Evaluation Report, the Evaluator/Instructor provides a NATOPS flight evaluation worksheet (Figure 20-1 and 20-2) for use during the flight. All of the flight areas and subareas are listed on the worksheet with space.

CRM FLIGHT EVALUATION WORKSHEET

DATE: _____

EVALUEE: _____

FACILITATOR: _____

| OVERALL GRADE | |
|----------------|----------|
| OUTSTANDING | 3.5-4.0 |
| EXCELLENT | 2.8-3.49 |
| SATISFACTORY | 2.0-2.79 |
| UNSATISFACTORY | 0.0-1.99 |

| | Q | CO | UQ |
|-----------------------------|-----------|----------|--------------|
| 1. SITUATIONAL AWARENESS | 4 | 2 | 0 |
| 2. ASSERTIVENESS | 4 | 2 | 0 |
| 3. DECISION MAKING | 4 | 2 | 0 |
| 4. COMMUNICATION | 4 | 2 | 0 |
| 5. LEADERSHIP | 4 | 2 | 0 |
| 6. ADAPTABILITY/FLEXIBILITY | 4 | 2 | 0 |
| 7. MISSION ANALYSIS | 4 | 2 | 0 |
| TOTAL | 17 | = | _____ |

COMMENTS: _____

FACILITATOR SIGNATURE: _____

CRM FLIGHT EVALUATION DETERMINATION
 A GRADE OF UNSATISFACTORY IN ANY CRM SKILL WILL
 RESULT IN AN OVERALL GRADE OF UNSATISFACTORY.

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H-60 PILOT EVALUATION WORKSHEET

NAME (Last, First, MI): _____

RANK: _____ SSN: XXX-XX-_____

SQD/UNIT _____ A/C: H-60 Position: Pilot

TOTAL FLT TIME: _____

TIME IN MODEL: _____ LAST EVAL: _____

OPEN BOOK DATE _____ GRADE _____

CLOSED BOOK DATE _____ GRADE _____

ORAL EXAM DATE _____ GRADE _____

OFT/WST EVAL DATE _____ GRADE _____

EGRESS DRILL DATE _____ GRADE _____

FLIGHT EVAL DATE _____ GRADE _____

OVERALL GRADE _____

ACFT BUNO: _____ FLIGHT DURATION: _____

EVALUATOR: _____ RATE: _____

EXPIRATION DATE: _____

FLIGHT EVALUATION GRADE DETERMINATION

1. GRADE OF UNQUALIFIED IN ANY CRITICAL AREA/SUBAREA (*) WILL RESULT IN AN OVERALL GRADE OF UNQUALIFIED FOR THE FLIGHT.
2. ONLY THE NUMBERS 0, 2, 4 WILL BE ASSIGNED TO SUBAREAS.

| | |
|-------------------------|-----|
| QUALIFIED | 4.0 |
| CONDITIONALLY QUALIFIED | 2.0 |
| UNQUALIFIED | 0.0 |

PAGE 1

Figure 20-1. Pilot Evaluation Worksheet (Sheet 1 of 4)

| FLIGHT EVALUATION SUMMARY | |
|----------------------------------|-------|
| 1. BRIEF | _____ |
| 2. GROUND OPERATIONS | _____ |
| 3. NORMAL FLIGHT OPERATIONS | _____ |
| 4. EMERGENCY PROCEDURES | _____ |
| 5. SPECIAL PROCEDURES | _____ |
| | _____ |
| | _____ |
| FLIGHT EVALUATION GRADE | _____ |
| COMMENTS: | |

| ORAL EXAMINATION | |
|---|-------|
| 1. HELICOPTER SYSTEMS | _____ |
| a. HYDRAULIC SYSTEM | _____ |
| b. ELECTRICAL SYSTEM | _____ |
| c. FLIGHT CONTROL SYSTEM | _____ |
| d. ENGINE/APU | _____ |
| e. AFCS/STAB | _____ |
| f. TRANSMISSION | _____ |
| g. FUEL SYSTEM | _____ |
| h. NAVIGATION SYSTEMS | _____ |
| i. COMMUNICATION SYSTEMS | _____ |
| j. H-60 SERIES DIFFERENCES (AS SPPLICABLE) | _____ |
| COMMENTS: | |

Figure 20-1. Pilot Evaluation Worksheet (Sheet 2)

*** 5. SPECIAL PROCEDURES**

a. RESCUE PROCEDURES

(1) AUTOMATIC APPROACH CHECKLIST _____

(2) ICS PROCEDURES _____

(3) VERBAL CONTROL PROCEDURES _____

(4) CREW HOVER PROCEDURES _____

(5) DAY VMC PROCEDURES _____

(6) NIGHT/IMC PROCEDURES _____

* (7) CREW COORDINATION _____

b. SONAR (F/R)

COMMENTS:

PAGE 6

OFT/WST EVALUATION

1. EMERGENCY/MALFUNCTION ANALYSIS

a. HYDRAULICS _____

b. ELECTRICAL _____

c. FLIGHT CONTROL _____

d. ENGINES _____

e. APU _____

f. AFCS / STAB _____

*g. TRANSMISSION _____

*h. FIRES _____

*i. DITCH/EGRESS _____

*j. DOME MALFUNCTIONS (F/R) _____

k. CREW COORDINATION _____

TOTAL: _____

COMMENTS:

2. PROCEDURES

a. PRESTART _____

b. SYSTEM CHECK _____

c. ENGINE START _____

d. ENGAGEMENT _____

e. TAXI _____

f. SHUTDOWN _____

g. SAR _____

h. SONAR (F/R) _____

I. CREW COORDINATION _____

TOTAL: _____

COMMENTS:

PAGE 3

Figure 20-1. Pilot Evaluation Worksheet (Sheet 3)

*** 3. NORMAL FLIGHT OPERATIONS**

*a. PROCEDURES _____

b. VERTICAL TAKEOFF/HOVER _____

c. NORMAL TAKEOFF/TRANSITION _____

d. MAXIMUM GROSS WEIGHT TAKEOFF _____

e. OBSTACLE CLEARANCE TAKEOFF _____

f. NORMAL APPROACH/VERTICAL LANDING _____

g. STEEP APPROACHING NO HOVER LANDING _____

h. RUNNING LANDING _____

i. RUNNING TAKEOFF _____

* j. COMM/NAV/KEYSETS _____

* k. CREW COORDINATION _____

COMMENTS: _____

TOTAL: _____

*** 4. EMERGENCY PROCEDURES**

*a. AUTOROTATIONS _____

*b. ENGINE MALFUNCTIONS _____

*c. SINGLE-ENGINE SPOT/RUNWAY _____

*d. SINGLE-ENGINE FAILURE HIGE/HOGE _____

*e. AFCS/SAS OFF _____

*f. BOOST OFF _____

*g. STABILATOR MALFUNCTION _____

*h. FIRE _____

*i. COUPLER EMERGENCIES _____

* j. DITCHING/EGRESS _____

* k. CREW COORDINATION _____

COMMENTS: _____

TOTAL: _____

PAGE 5

PILOT FLIGHT EVALUATION

*1. BRIEF _____

a. PILOT EQUIPMENT _____

b. NAVIGATION PUBLICATIONS _____

*c. WEATHER _____

*d. NATOPS PUBLICATIONS/SOP _____

*e. BRIEF/DEBRIEF _____

f. PERFORMANCE CALCULATIONS _____

g. MISSION PLANNING SYSTEM (MPS)(R/S) _____

COMMENTS: _____

TOTAL: _____

*2. GROUND OPERATIONS _____

*a. LOGS AND RECORDS _____

*b. PREFLIGHT CHECK _____

c. PRESTART CHECKS _____

*d. SYSTEM CHECKS _____

*e. ENGINE START _____

*f. ROTOR ENGAGEMENT AND ENGINE RUN-UP _____

g. TAXI _____

h. SHUTDOWN/POSTFLIGHT _____

*i. CREW COORDINATION _____

COMMENTS: _____

TOTAL: _____

PAGE 4

Figure 20-1. Pilot Evaluation Worksheet (Sheet 4)

CRM FLIGHT EVALUATION WORKSHEET

DATE: _____

EVALUÉE: _____

FACILITATOR: _____

| OVERALL GRADE | |
|----------------|----------|
| OUTSTANDING | 3.5-4.0 |
| EXCELLENT | 2.8-3.49 |
| SATISFACTORY | 2.0-2.79 |
| UNSATISFACTORY | 0.0-1.99 |

| C | CQ | UQ |
|-------|----|-------------|
| 4 | 2 | 0 |
| 4 | 2 | 0 |
| 4 | 2 | 0 |
| 4 | 2 | 0 |
| 4 | 2 | 0 |
| 4 | 2 | 0 |
| 4 | 2 | 0 |
| 4 | 2 | 0 |
| TOTAL | | / 7 = _____ |

1. SITUATIONAL AWARENESS

2. ASSERTIVENESS

3. DECISION MAKING

4. COMMUNICATION

5. LEADERSHIP

6. ADAPTABILITY/FLEXIBILITY

7. MISSION ANALYSIS

COMMENTS: _____

FACILITATOR SIGNATURE: _____

CRM FLIGHT EVALUATION DETERMINATION
A GRADE OF UNSATISFACTORY IN ANY CRM SKILL
WILL RESULT IN AN OVERALL GRADE OF UNSATISFACTORY.

PAGE 6

AIRCREW EVALUATION WORKSHEET

NAME (Last, First, Mi): _____

RANK: _____ SSN: _____ SQD/UNIT: _____

TOTAL FLT TIME: _____ TYP/MDL: _____

TIME IN MODEL: _____ LAST EVAL: _____

OPEN BOOK DATE _____ GRADE _____

CLOSED BOOK DATE _____ GRADE _____

ORAL DATE _____ GRADE _____

EVALUATION FLIGHT DATE _____ GRADE _____

CRM ACADEMIC DATE _____ GRADE _____

CRM FLIGHT EVAL DATE _____ GRADE _____

EGRESS DATE _____ GRADE _____

OVERALL GRADE _____

ACFT BUNO: _____ FLIGHT DURATION: _____

EVALUATOR: _____ RATE: _____

FLIGHT EVALUATION GRADE DETERMINATION

- GRADE OF UNQUALIFIED IN ANY CRITICAL AREA/SUBAREA (*) WILL RESULT IN AN OVERALL GRADE OF UNQUALIFIED FOR THE FLIGHT.
- ONLY THE NUMBERS 0, 2, 4 WILL BE ASSIGNED TO SUBAREAS.
- GENERAL CREWMEN REQUIRE ORAL, GROUND, AND GENERAL AREAS ONLY.

| GRADING CRITERIA | AREA/SUBAREA | OVERALL FLIGHT |
|-------------------------|--------------|----------------|
| QUALIFIED | 4 | 3.0 - 4.0 |
| CONDITIONALLY QUALIFIED | 2 | 2.2 - 2.99 |
| UNQUALIFIED | 0 | 0.0 - 2.19 |

PAGE 1

Figure 20-2. Aircrewman Evaluation Worksheet (Sheet 1 of 3)

6. ACOUSTIC/USW OPERATIONS (B/H/R/F ONLY)

a. DIPPING/MAD OPERATIONS (B/R/F) _____

*b. EMERGENCY PROCEDURES _____

c. ICS PROCEDURES _____

d. TROUBLESHOOTING _____

e. SONOBUOYS OPERATIONS (B/R/F) _____

*f. LIMITATIONS _____

*g. SAFETY _____

TOTAL _____ / 7 = _____

COMMENTS:

FLIGHT EVALUATION SUMMARY

1. GROUND OPERATIONS _____

2. GENERAL OPERATIONS _____

3. SAR OPERATIONS _____

4. UTILITY OPERATIONS _____

5. NON-ACOUSTIC SYSTEMS _____

6. ACOUSTIC SYSTEMS _____

FLIGHT EVALUATION TOTAL _____ / 6 = _____

OVERALL COMMENTS: _____

PAGE 5

ORAL

1. ENGINE/DRIVE SYSTEM _____

2. HYDRAULIC/FLIGHT CONTROLS _____

3. ELECTRICAL _____

4. AFCS _____

5. MISSION EQUIP / CONFIGURATION _____

6. WEAPONS/STORES _____

7. WEATHER _____

TOTAL _____ / 7 = _____

COMMENTS:

1. GROUND OPERATIONS _____

*a. NATOPS MANUAL/PCL _____

*b. FLIGHT EQUIPMENT _____

c. AIRCRAFT DISCREPANCY BOOK _____

d. BRIEF/DEBRIEF/MSN PLANNING _____

*e. PRE-FLIGHT _____

*f. AIRCRAFT SERVICING/HANDLING _____

*g. SAFETY _____

TOTAL _____ / 7 = _____

COMMENTS:

PAGE 2

Figure 20-2 Aircrewman Evaluation Worksheet (Sheet 2)

4. UTILITY OPERATIONS

*a. CHECKLIST UTILIZATION _____

b. CARGO/VERTREP OPERATIONS _____

c. HIFR OPERATIONS _____

d. SHIPBOARD OPERATIONS _____

e. ICS PROCEDURES _____

*f. LIMITATIONS _____

*g. SAFETY _____

TOTAL _____ / 7 = _____

COMMENTS:

5. NON-ACOUSTIC OPERATIONS (B/H/R/F ONLY)

a. RADAR/IFF (B/R) _____

b. ESM (B/R/F) _____

c. ISD / ASE (B/H/R) _____

d. NAVIGATION _____

e. COMMUNICATIONS _____

f. FLIR (B/H/R) _____

*g. SAFETY _____

TOTAL _____ / 7 = _____

COMMENTS:

PAGE 4

2. GENERAL OPERATIONS

*a. CHECKLIST UTILIZATION _____

*b. EMERGENCY PROCEDURES _____

c. LOOKOUT PROCEDURES _____

d. OPERATIONAL CHECKS _____

*e. AIRCRAFT LIMITATIONS _____

f. RADIO PROCEDURES _____

*g. SAFETY _____

TOTAL _____ / 7 = _____

COMMENTS:

3. SAR OPERATIONS

*a. CHECKLIST UTILIZATION _____

*b. HOIST OPERATIONS/LIMITATIONS _____

c. ICS PROCEDURES _____

d. SAR EQUIPMENT OPERATIONS _____

*e. HOIST EMERGENCIES _____

f. DAY / NIGHT SAR OPERATIONS _____

*g. SAFETY _____

TOTAL _____ / 7 = _____

COMMENTS:

PAGE 3

Figure 20-2 Aircrewman Evaluation Worksheet (Sheet 3)

PART XI

Performance Data

[Chapter 21](#) — Performance Data Introduction

[Chapter 22](#) — Standard Data

[Chapter 23](#) — Takeoff

[Chapter 24](#) — Climb

[Chapter 25](#) — Range

[Chapter 26](#) — Hover Endurance

[Chapter 27](#) — Emergency Operation

[Chapter 28](#) — Level Flight Performance Charts

CHAPTER 21

Performance Data Introduction

21.1 INTRODUCTION

The performance data covered in Chapters 22, 23, 24, 25, 26, 27, and 28 is arranged by type of chart, with each type of chart discussed in a separate chapter. Each chapter, and the charts contained within, is arranged in the order that reflects the sequence of operational use. Each chapter incorporates a page containing explanatory text which describes the functions indicated for each chart, conditions assumed in chart preparation, and guidelines to permit adjustment of the solution attained.

The sample problem, typical of the normal mission of the helicopter, includes the sample problem data shown on each chart contained within that chapter. If conditions are less than the lowest value shown on a chart, use the lowest value shown. Limitations that should not be exceeded are identified on appropriate charts.

Subsequent chapters contain the following: [Chapter 22](#) contains information that is needed to enter charts found in subsequent chapters; [Chapter 23](#) provides the necessary information concerning takeoff performance; [Chapter 24](#) provides the necessary climb performance; [Chapter 25](#) presents range data; [Chapter 26](#) presents hover endurance data; [Chapter 27](#) provides performance data associated with emergency or nonstandard conditions; and [Chapter 28](#) provides information to select and determine level flight performance data at various conditions.

21.1.1 Sample Problem

A sample problem, typical of a normal mission, is included with each type chart in applicable chapters. For consistency and continuity, the chart values shown on the charts are actual chart values used in the sample problem explanatory text. The explanatory text for each type chart used in computing the sample problem contains a graphic illustration explaining how that chart is used.

21.2 FACTORS AFFECTING RANGE AND ENDURANCE

As weight decreases, the power required to maintain constant airspeed decreases. Heavily loaded helicopters must fly at a greater power setting than lightly loaded helicopters flying at the same speed. Altitude has a marked effect on the performance of all gas turbine engines. Air density and temperature decrease as altitude increases. As the density of the air decreases, the mass flow of air through the engine decreases and efficiency decreases. The gas turbine operates more efficiently at lower temperatures encountered at high altitudes because the thrust delivered per pound of air consumed is higher at high altitudes. Since power output decreases and efficiency increases, specific fuel consumption decreases with increased altitude. A definite advantage is gained when operating at high altitudes since higher true airspeed will result from a given power output. The helicopter is limited in using the gas turbines for fullest efficiency at altitude. This is not due to the engines, but to the decreased lift capability of the rotor system at high altitudes. For flight planning purposes, consult the appropriate charts in [Part XI](#).

21.3 PLANNING FOR AND TRANSPORT OF CARGO

Detailed procedures for planning, loading, securing, and delivery of cargo loads are contained in the Cargo Loading Manual, Navy Model H-46 Helicopters (NAVAIR 01-250-HDA-9), and Packaging and Handling of Dangerous Materials for Transportation by Military Aircraft (NAVSUPPUB 505).

CHAPTER 22

Standard Data

22.1 TEMPERATURE CONVERSION CHART

The Temperature Conversion Chart (Figure 22-1) provides a conversion of temperature scale that will permit conversion between Fahrenheit and Celsius temperatures.

22.1.1 Sample Problem for Use of Temperature Conversion Chart

Enter the left side of chart at 68 °F. Then, trace right to the Celsius scale and read 20 °C.

22.2 DENSITY ALTITUDE CHART

The Density Altitude Chart (Figure 22-2) provides a density altitude when ambient temperature is applied to pressure altitude. The chart also contains an airspeed conversion factor that, when used to multiply a calibrated airspeed, provides a true airspeed.

22.2.1 Sample Problem for Use of Density Altitude Chart

1. Enter bottom of chart at OAT (+20 °C) and trace up to pressure altitude line (4,000 ft).
2. Trace left to the density altitude scale and read density altitude (5,500 ft) or trace right to the airspeed conversion scale and read conversion factor (1.085).

22.3 BLADE STALL CHART

The Airspeed for Onset of Blade Stall Chart (Figure 22-3) represents speeds at which stall begins to occur on the retreating blade tip. At these speeds, reasonable maneuvers or mild turbulence can be tolerated. Increased airspeed, severe turbulence, or abrupt control maneuvers at or near these speeds will increase the severity of the stall, and the helicopter will become more difficult to control. If blade stall is allowed to fully develop, a complete loss of control will be experienced and the helicopter will pitch up and to the left. The use of forward cyclic to correct this pitch up may aggravate the stall as it increases the angle of attack of the retreating blade.

22.3.1 Sample Problem for Use of Blade Stall Chart

Given:

1. Gross weight: 22,000 pounds.
2. Angle of bank: 20°.
3. Pressure altitude: 5,000 feet.
4. OAT: 20°.
5. Rotor speed: 100 percent N_r .

Determine:

Maximum recommended speed.

Solution:

1. Enter chart at left at 5,000 foot pressure altitude.
2. Move horizontally to 20 °C OAT line.
3. Move down to known or estimated gross weight, 22,000 pounds.
4. Move left to 20° angle of bank influence line.
5. Move down to read the indicated airspeed (KTS).
6. The indicated airspeed for the above conditions would be 120 KIAS.

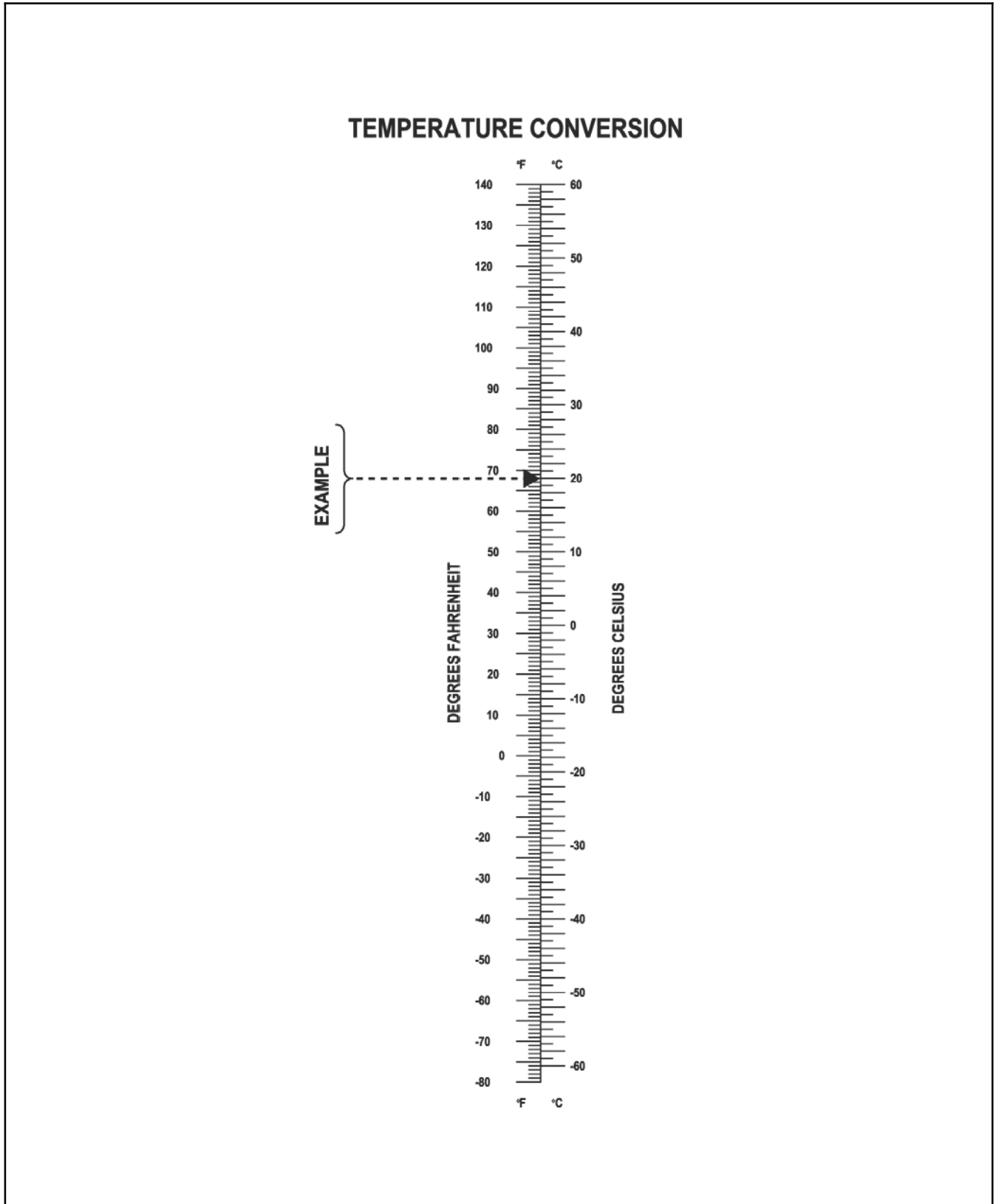


Figure 22-1. Temperature Conversion Chart

DENSITY ALTITUDE CHART

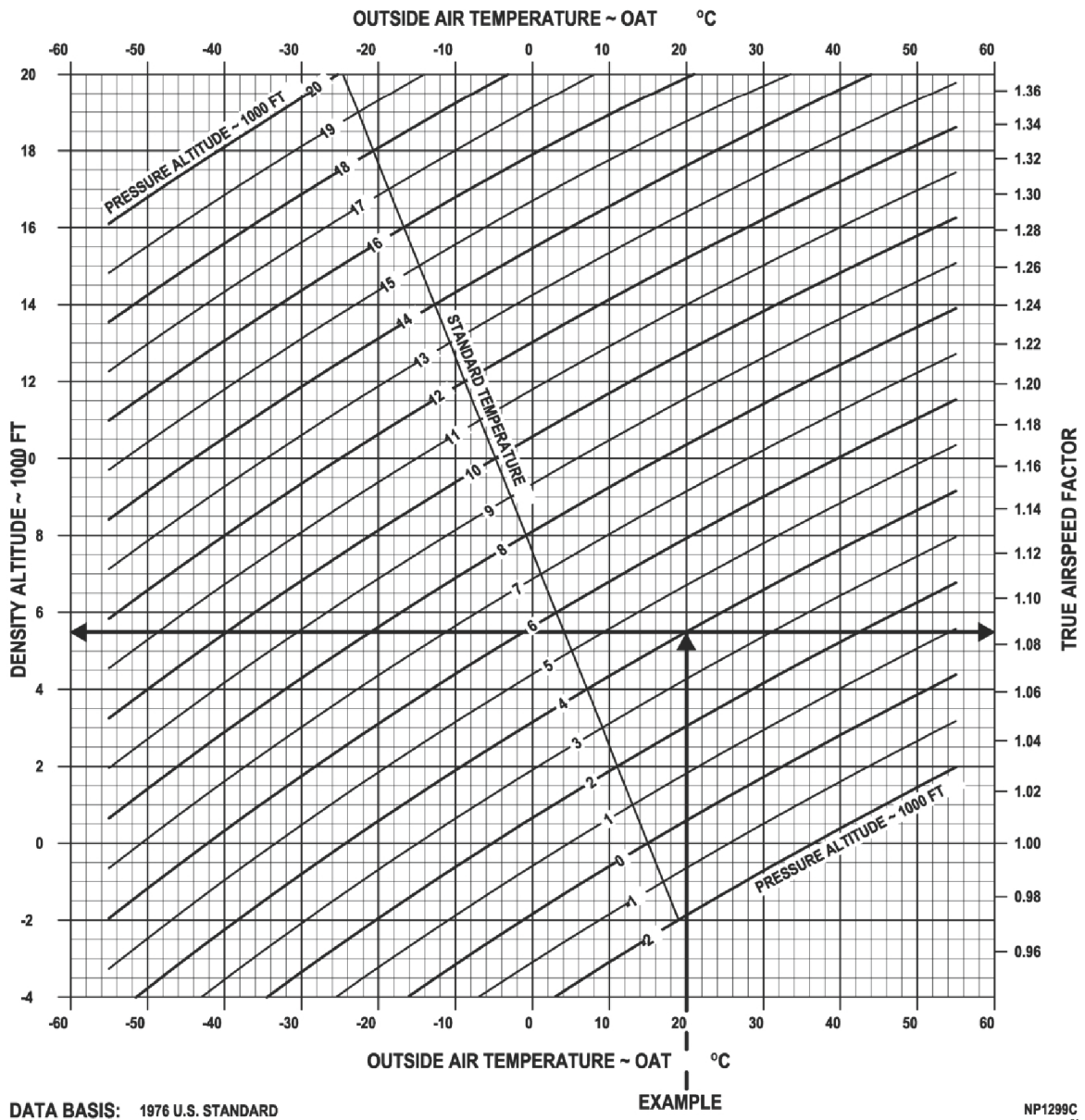
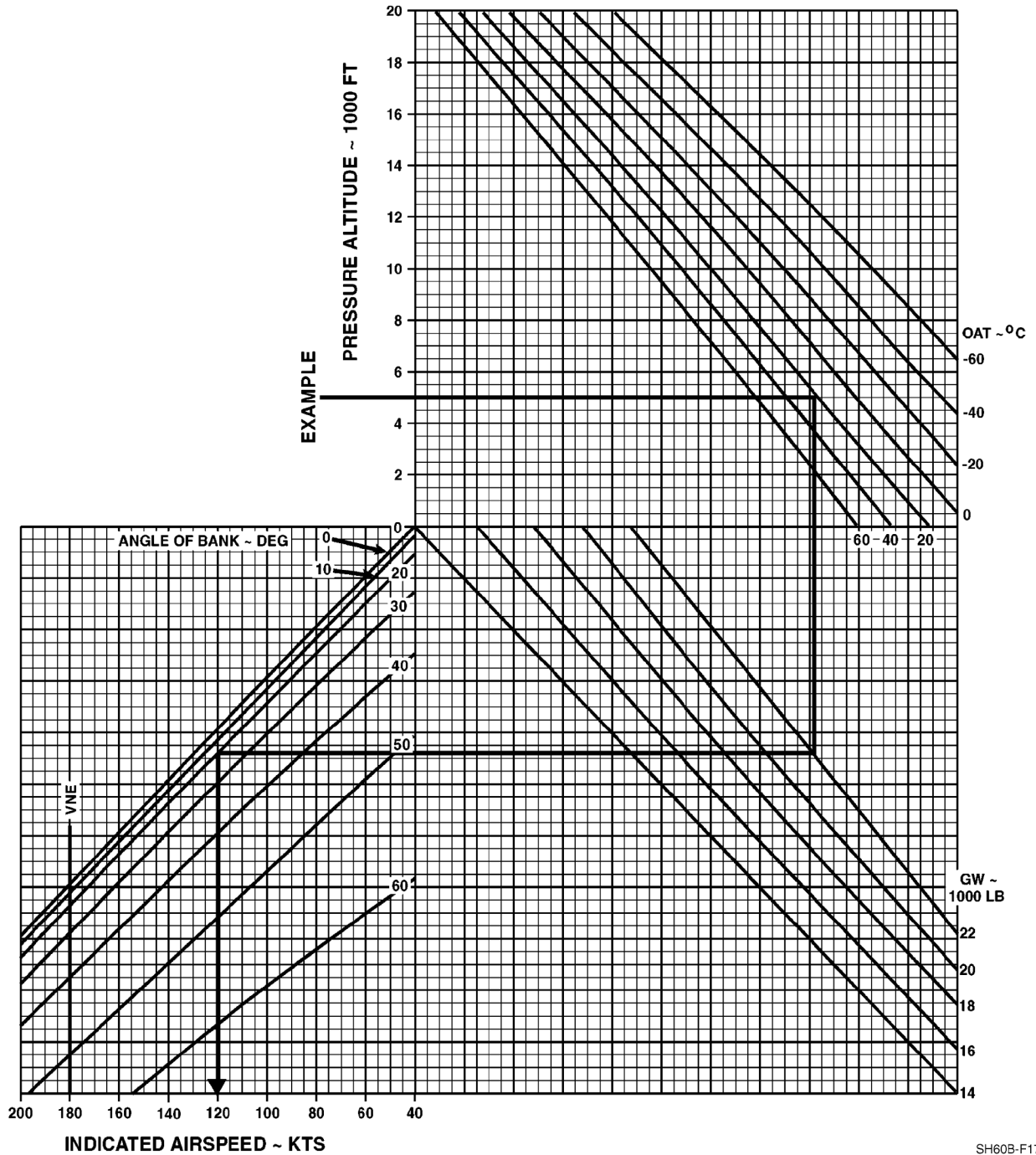


Figure 22-2. Density Altitude Chart

AIRSPEED FOR ONSET OF BLADE STALL LEVEL FLIGHT 100% Nr

MODEL: SH-60
DATE: DECEMBER 1994
DATA BASIS: FLIGHT TEST

ENGINE: (2) T700-GE-401C
FUEL GRADE: JP4, JP5, JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F171

Figure 22-3. Airspeed for Onset of Blade Stall Chart

22.4 ENGINE PERFORMANCE

Performance planning is used to determine if the installed engines have enough power (torque) to accomplish the assigned mission. Planning should also be used to determine single engine capability. The actual torque available to the pilot under mission conditions is what is critical, and it is important to determine this prior to the mission. When mission planning, use Aircraft Torque Factor (ATF), and for single engine capability, use the Engine Torque Factor (ETF) for the weakest engine (lowest ETF). In all calculations in this section, ATF can be substituted for ETF.

22.4.1 Engine Performance Charts

The Engine Performance Charts (Figures 22-4, 22-5, and 22-6) provide torque available at contingency, intermediate, and maximum continuous power when ambient temperature factors are applied to pressure altitude.

22.4.1.1 Engine Performance, Contingency (2.5 Minute) Power Chart

The Engine Performance Contingency (2.5 Minute) Power Chart (Figure 22-4) provides a torque value at 903 °C TGT when ambient temperature is applied to pressure altitude.

22.4.1.2 Engine Performance, Intermediate (30 Minute) Power Chart

The Engine Performance, Intermediate (30 Minute) Power Chart (Figure 22-5) uses like factors in the same manner as Figure 22-4 to provide a torque at 851 °C TGT.

22.4.1.3 Engine Performance, Maximum Continuous Power Chart

The Engine Performance, Maximum Continuous Power Chart (Figure 22-6) uses like factors in the same manner as Figure 22-4 to provide a torque at 810 °C TGT.

22.4.1.4 Sample Problem for Use of Engine Performance, Contingency (2.5 Minute) Power, Intermediate (30 Minute) Power and Maximum Continuous Power Charts

Enter bottom of chart at Ambient Temperature 20 °C. Trace up to 8,000 feet Pressure Altitude line, then trace left to the Specification Torque (Available) scale and read percent Torque.

22.4.1.5 Torque Factor Terms

1. Torque Ratio (TR): The ratio of torque available to specification torque at the desired ambient temperature.
2. Engine Torque Factor (ETF): The ratio of an individual-engine torque available to specification torque at a reference temperature of 35 °C.
3. Aircraft Torque Factor (ATF): The ratio of an individual aircraft power available to specification power at a reference temperature of 35 °C. The ATF is the average of the ETFs of both engines.

22.4.2 Engine Performance Procedures

22.4.2.1 Torque Factor Method

The torque factor method provides an accurate indication of actual torque available for a specific engine by incorporating ambient temperature effects on degraded engine performance. To calculate actual torque available, multiply the specification torque available (obtained from the Engine Performance Power Charts) by the TR for the specific engine. To obtain the TR, use the Torque Power Chart (Figure 22-7) and enter the ETF and ambient temperature. For ambient temperatures below -5 °C, TR always equals 1.0. For ambient temperatures above 35 °C, TR equals ETF. The aircraft HIT log forms for each engine provide the ETF obtained from the maximum power check torque factor method.

22.4.2.2 Maximum Power Check

The Maximum Power Chart (Figure 22-8) is used during engine power checks to determine target torque value (TTV).

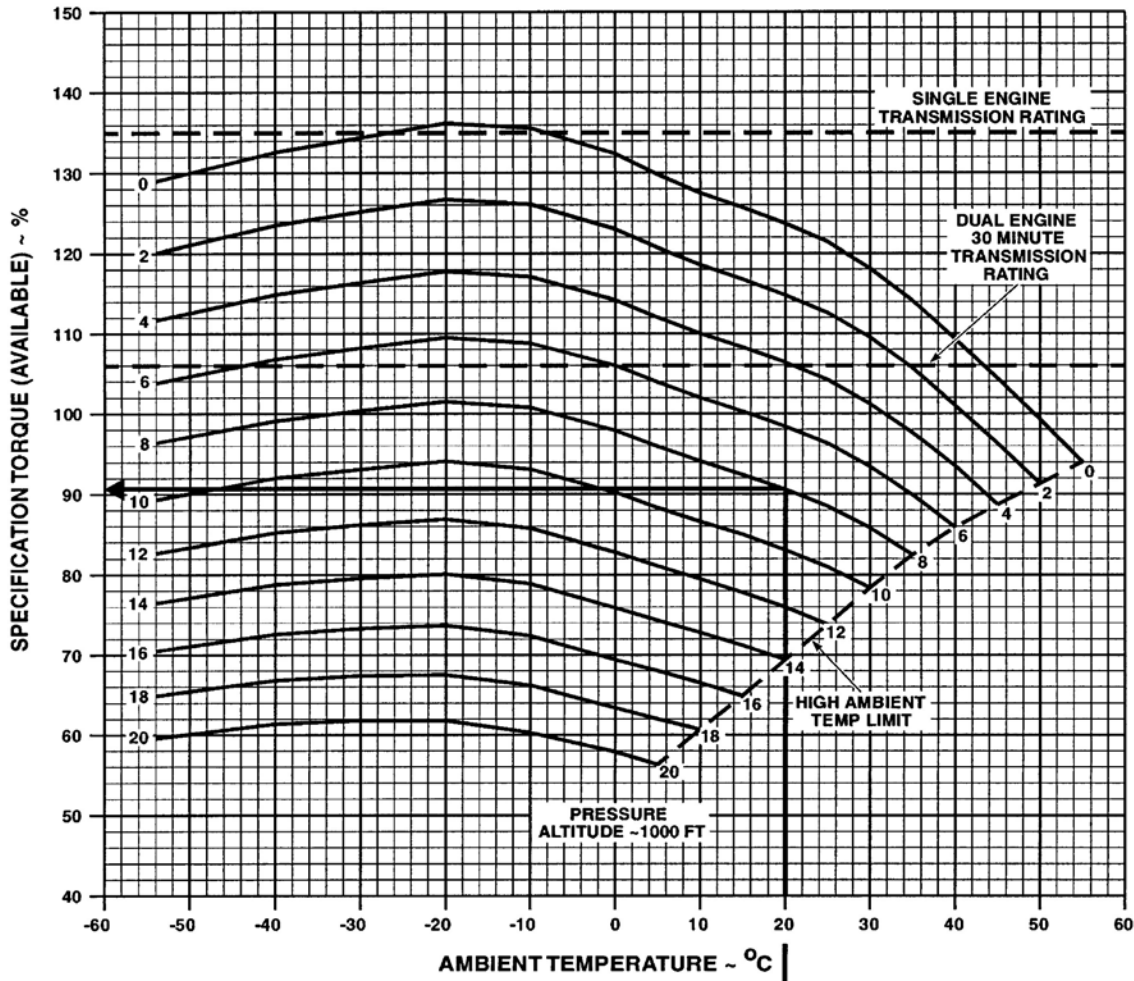
ENGINE PERFORMANCE

INTERMEDIATE (30 MINUTE) POWER
851°C LIMIT TGT ZERO AIRSPEED
100% Np ECS - OFF

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: ENG. MFR. SPEC

ENGINE: T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

| NOTE | REDUCE TRQ AVAILABLE |
|-------------------------|----------------------|
| FOR BLEED ON: | |
| ECS ON HOT | 5% |
| ECS ON COLD (LOW FLOW) | 4% |
| ECS ON COLD (HIGH FLOW) | 7% |
| ANTI-ICE ON | 18% |



NOTE
 THIS CHART DEPICTS PERFORMANCE BASED ON A SPECIFICATION ENGINE. MULTIPLY SPECIFICATION TORQUE AVAILABLE BY TORQUE RATIO TO OBTAIN THE ACTUAL TORQUE AVAILABLE FOR A SPECIFIC ENGINE.

EXAMPLE

SH60B-F175

Figure 22-5. Engine Performance, Intermediate (30-Minute) Power Chart

ENGINE PERFORMANCE

MAXIMUM CONTINUOUS POWER 810°C LIMIT TGT ZERO AIRSPEED ECS - ON

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: ENG. MFR. SPEC

100% Np

ENGINE: T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

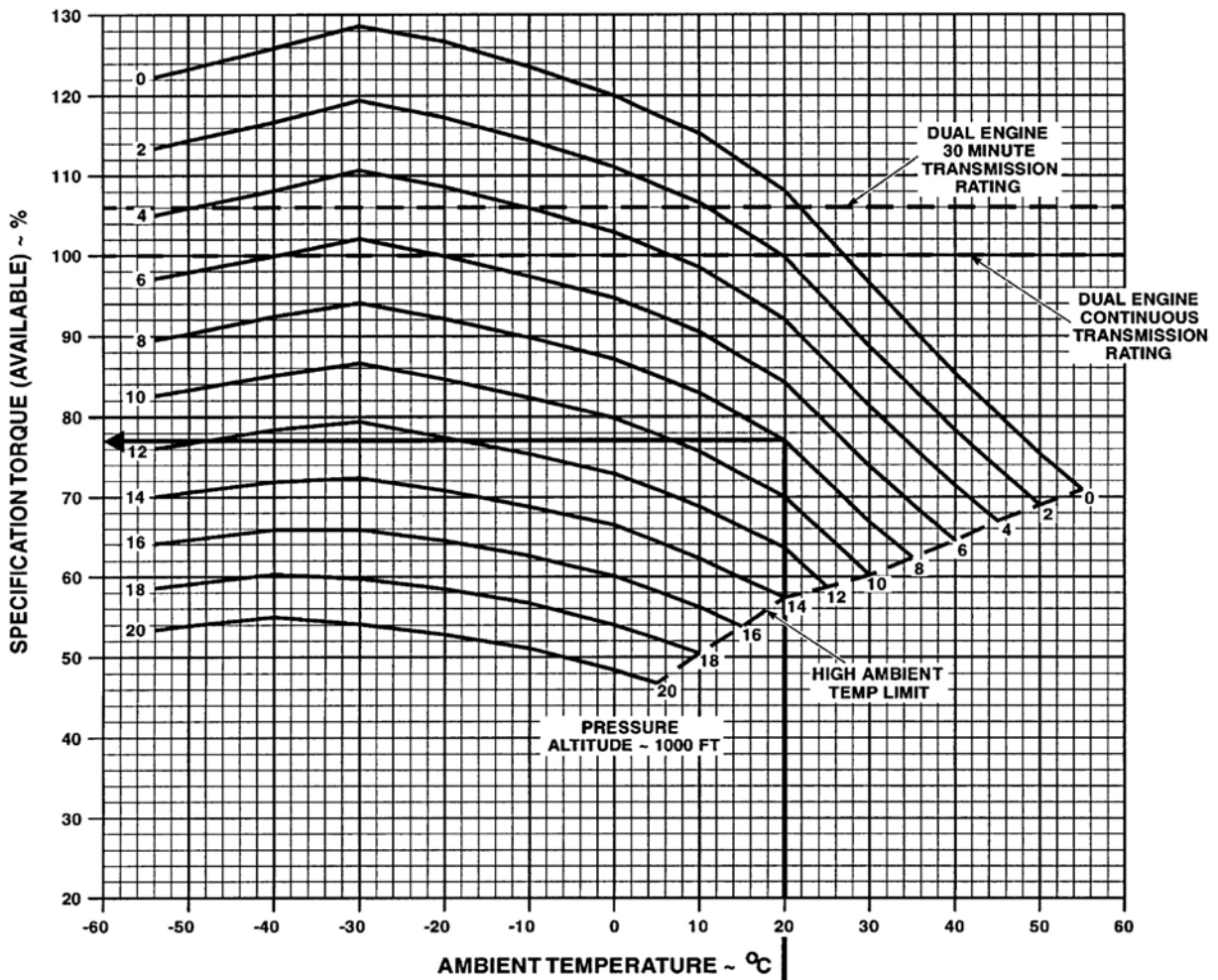
NOTE
FOR BLEED OFF:

INCREASE TORQUE AVAILABLE

ECS (HOT) BELOW 15°C OAT 5%
ECS (COLD/NORM FLOW) <30°C OAT 4%
ECS (COLD/HIGH FLOW) >30°C OAT 7%

FOR ANTI-ICE ON

DECREASE TORQUE AVAILABLE 18%



NOTE

THIS CHART DEPICTS PERFORMANCE BASED ON A SPECIFICATION ENGINE. MULTIPLY SPECIFICATION TORQUE AVAILABLE BY TORQUE RATIO TO OBTAIN THE ACTUAL TORQUE AVAILABLE FOR A SPECIFIC ENGINE.

EXAMPLE

SH60B-F0176

Figure 22-6. Engine Performance, Maximum Continuous Power Chart

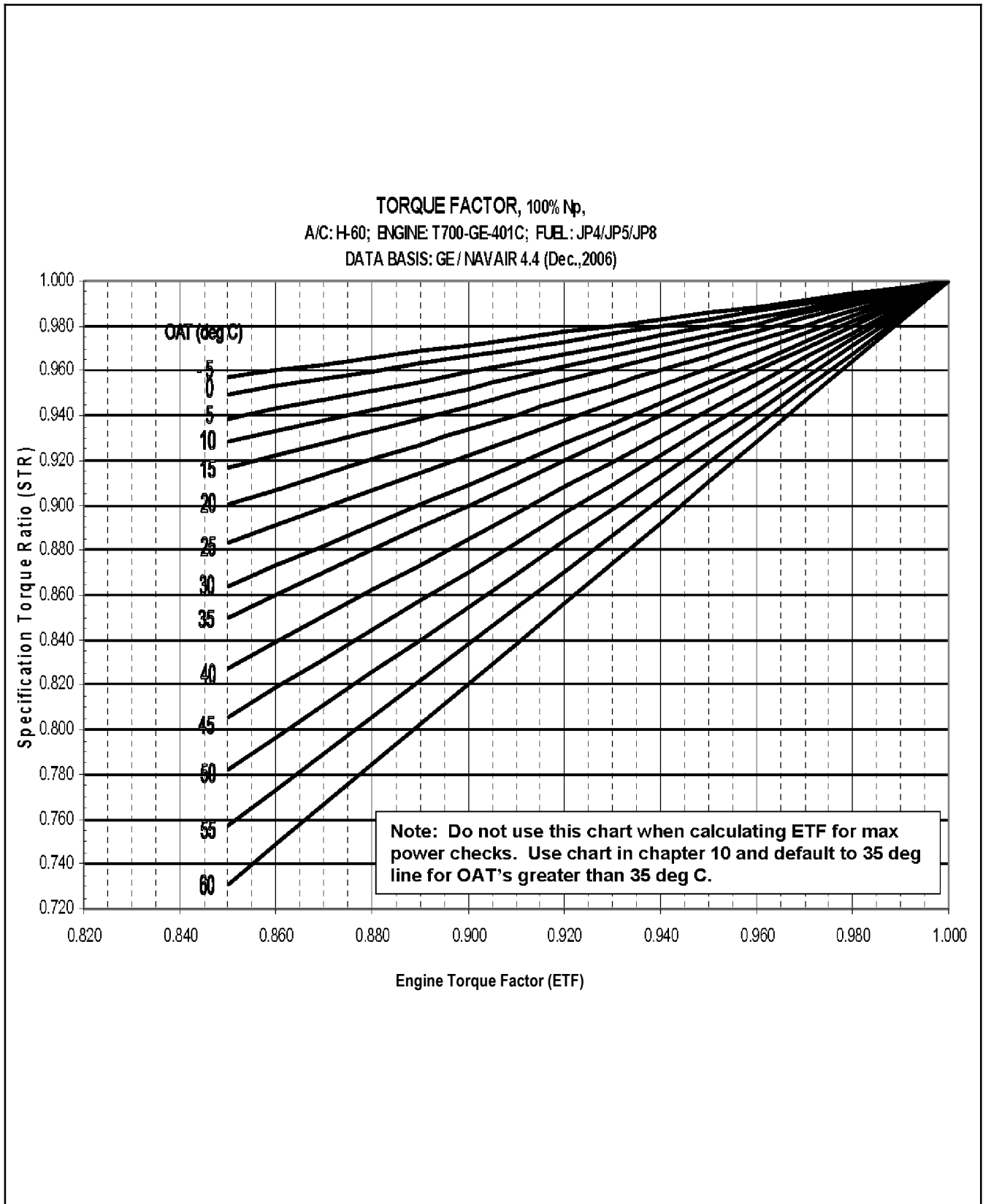
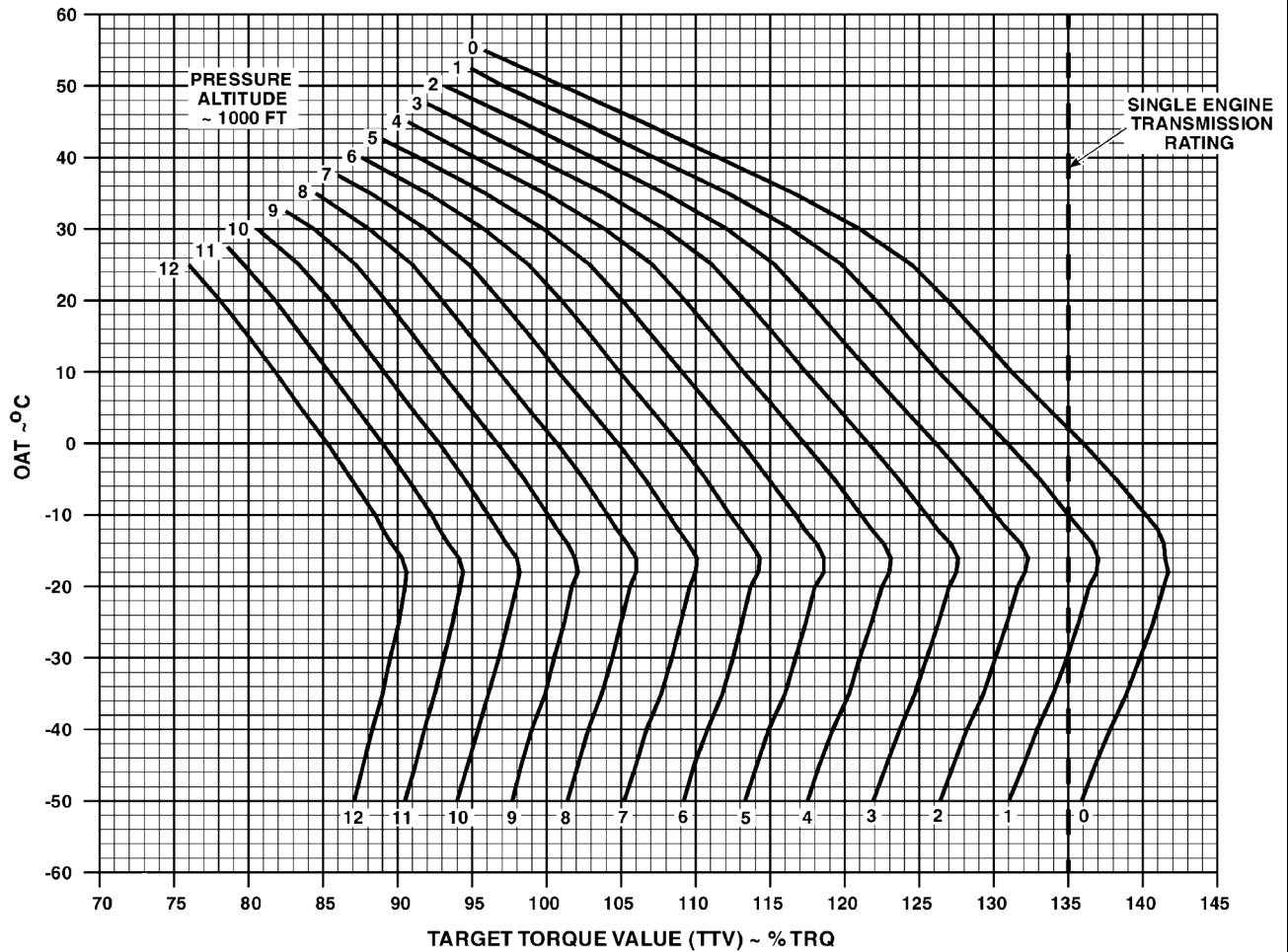


Figure 22-7. Torque Factor Chart

MAXIMUM POWER CHECK
INTERMEDIATE (30 MINUTE) POWER
839°C LIMITER TGT 120 KIAS
100% Np ECS & ANTI-ICE OFF

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: ENG. MFR. SPEC

ENGINE:(1) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F178

Figure 22-8. Maximum Power Check Chart

22.4.2.3 Engine Bleed Air

With engine bleed air turned ON, the actual torque available is reduced as follows:

1. Engine Anti-Ice ON: Reduce torque determined from engine performance intermediate power chart by a constant 18 percent TRQ (Example: 90 percent TRQ - 18 percent TRQ = 72 percent TRQ).
2. ECS on HOT: Reduce torque available by 5 percent.
3. ECS on COLD (Low Flow): Reduce torque available by 4 percent.
4. ECS on COLD (High Flow): Reduce torque available by 7 percent.

22.4.3 Torque Factor Sample Problem

Ambient Temperature: 20 °C.

Pressure Altitude: 8,000 feet.

ETF #1 Engine: .96.

ETF #2 Engine: 1.0.

ECS and Anti-Ice OFF.

ATF (.98) is the average of ETF #1 (.96) and ETF #2 (1.0). For intermediate power available enter the Engine Performance Intermediate (30-Minute) Power Chart (Figure 22-5) with OAT (20 °C) and pressure altitude of 8,000 feet to obtain a specification torque available of 90.5.

For Mission Planning:

Enter the Torque Power Chart (Figure 22-7) with ATF (.98) and OAT (20 °C) to obtain a TR of .987. Multiply the specification torque available (90.5) by the TR (.987) to obtain the actual intermediate dual-engine torque available of 89 percent.

For Single Engine Capability:

#1 Engine is the weakest engine (lowest ETF). For Engine #1, enter Figure 22-7 with ETF (.96) and OAT (20 °C) to obtain a TR of .973. Multiply the specification torque available (90.5) by the TR (.973) to obtain the actual intermediate single engine torque available of 88 percent for Engine #1.

CHAPTER 23

Takeoff

23.1 HOVER CHARTS

The Indicated Torque Required to Hover Charts (Figures 23-1 and 23-2) provide the indicated torque required to hover at a 10 foot wheel height and out-of-ground effect when density altitude is applied to gross weight and headwind factors.

Note

Although (Figures 23-1 and 23-2) are for standard temperature, the use of density altitude results in only minor variations of hover performance from that indicated by the charts.

23.1.1 Indicated Torque Required to Hover Out of Ground Effect

The Indicated Torque Required to Hover Out of Ground Effect Chart (Figure 23-1) provides the indicated torque required to hover when density altitude is applied to gross weight and headwind factors. Hovering in crosswind conditions may require up to 4 percent additional torque.

23.1.1.1 Sample Problem for Use of Indicated Torque Required to Hover Out of Ground Effect

1. Enter the left side of chart at 4,000 foot density altitude, then trace right to the 20,000 pound gross-weight line.
2. Trace down to the headwind baseline.
3. Follow the headwind influence line to the 10 knot headwind line, then trace to the torque scale and read 94 percent indicated torque per engine.

23.1.2 Indicated Torque Required to Hover 10 Feet In Ground Effect

The Indicated Torque Required To Hover 10 Feet In Ground Effect Chart (Figure 23-2) uses like factors in the same manner as Figures 23-1 to provide the indicated torque required to hover in ground effect.

1. Enter the left side of chart at 4,000 foot density altitude, then trace right to the 20,000 pound gross-weight line.
2. Trace down the headwind baseline.
3. Follow the headwind influence line to the 25 knot headwind line, then trace to the torque scale and read 77 percent indicated torque per engine.

23.1.3 Maximum Gross Weight to Hover, Headwind or Ground Effect Influence

The ability to hover at various gross weights with headwinds or ground effect factors is provided in the Maximum Gross Weight to Hover, with Headwind or Ground Effect Influence Chart (Figure 23-3).

23.1.3.1 Sample Problem for Use of Maximum Gross Weight to Hover, Headwind or Ground Effect Influence

1. Enter bottom of chart at 20,000 pounds gross weight, zero wind, then trace up to headwind 10 knots. Trace left to read gross weight of 20,600 pounds.
2. Enter bottom of chart at 20,000 pounds gross weight, then trace up to wheel height 40 feet. Trace left to read 20,400 pounds gross weight.
3. If both ground effect and headwinds are present, use the heavier gross weight.

23.1.4 Maximum Gross Weight to Hover Out of Ground Effect

The ability to hover out of ground effect at 30 minute power or at torque placard limit at various pressure altitudes and temperatures is provided in the Maximum Gross Weight to Hover, Dual Engine, Out-of-Ground Effect Chart (Figure 23-4).

23.1.4.1 Sample Problem for Use of Maximum Gross Weight to Hover, Out of Ground Effect

1. Enter left side at 4,000-foot pressure altitude, trace right to 20 °C OAT, then trace down to read 20,100 pounds.

INDICATED TORQUE REQUIRED TO HOVER

OUT OF GROUND EFFECT

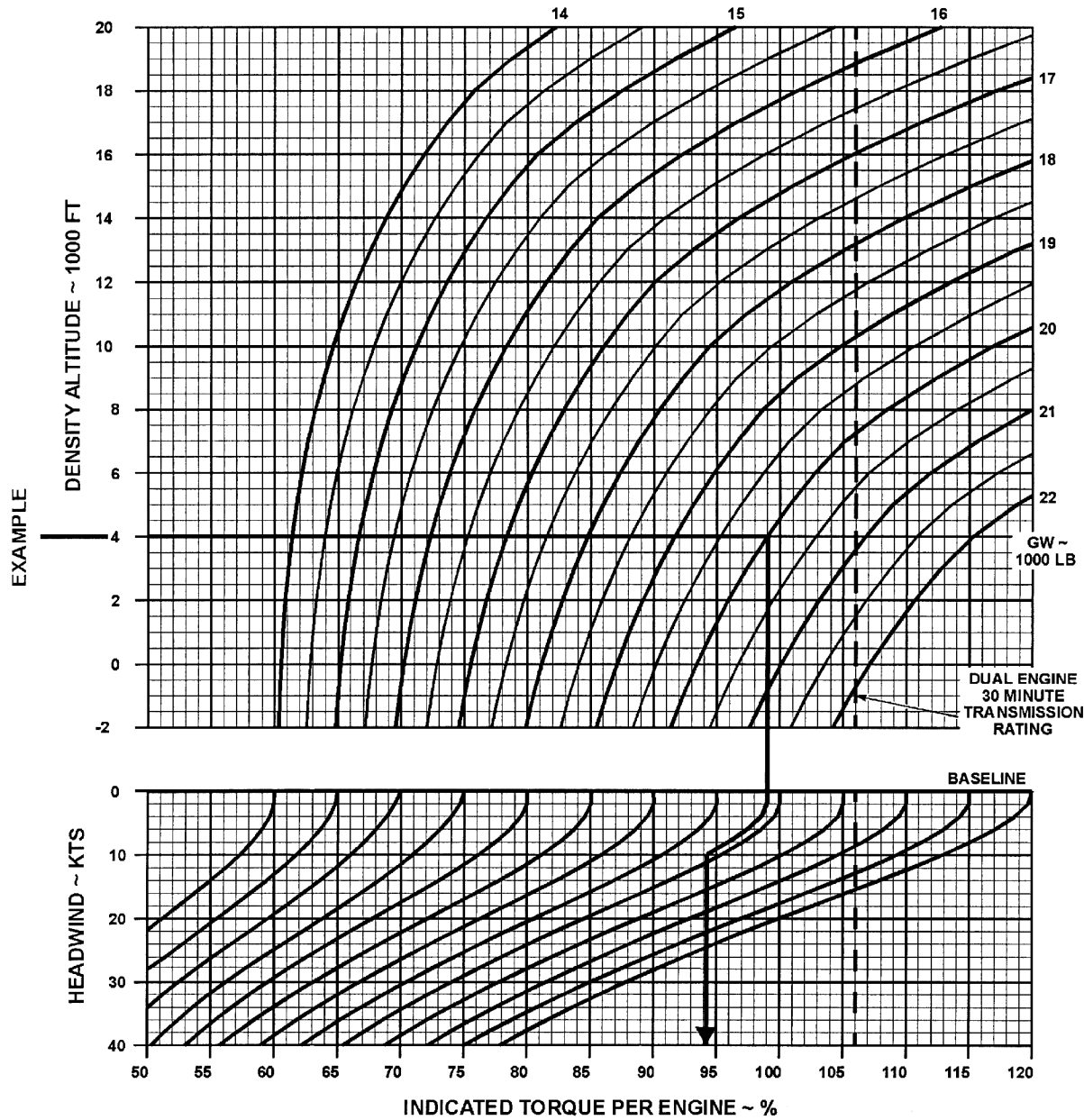
100% Nr

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

ENGINE:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

NOTE

HOVERING IN CROSSWIND CONDITIONS MAY REQUIRE UP TO 4% ADDITIONAL TORQUE.



SH60B-F179

Figure 23-1. Indicated Torque Required to Hover Out of Ground Effect Chart

INDICATED TORQUE REQUIRED TO HOVER

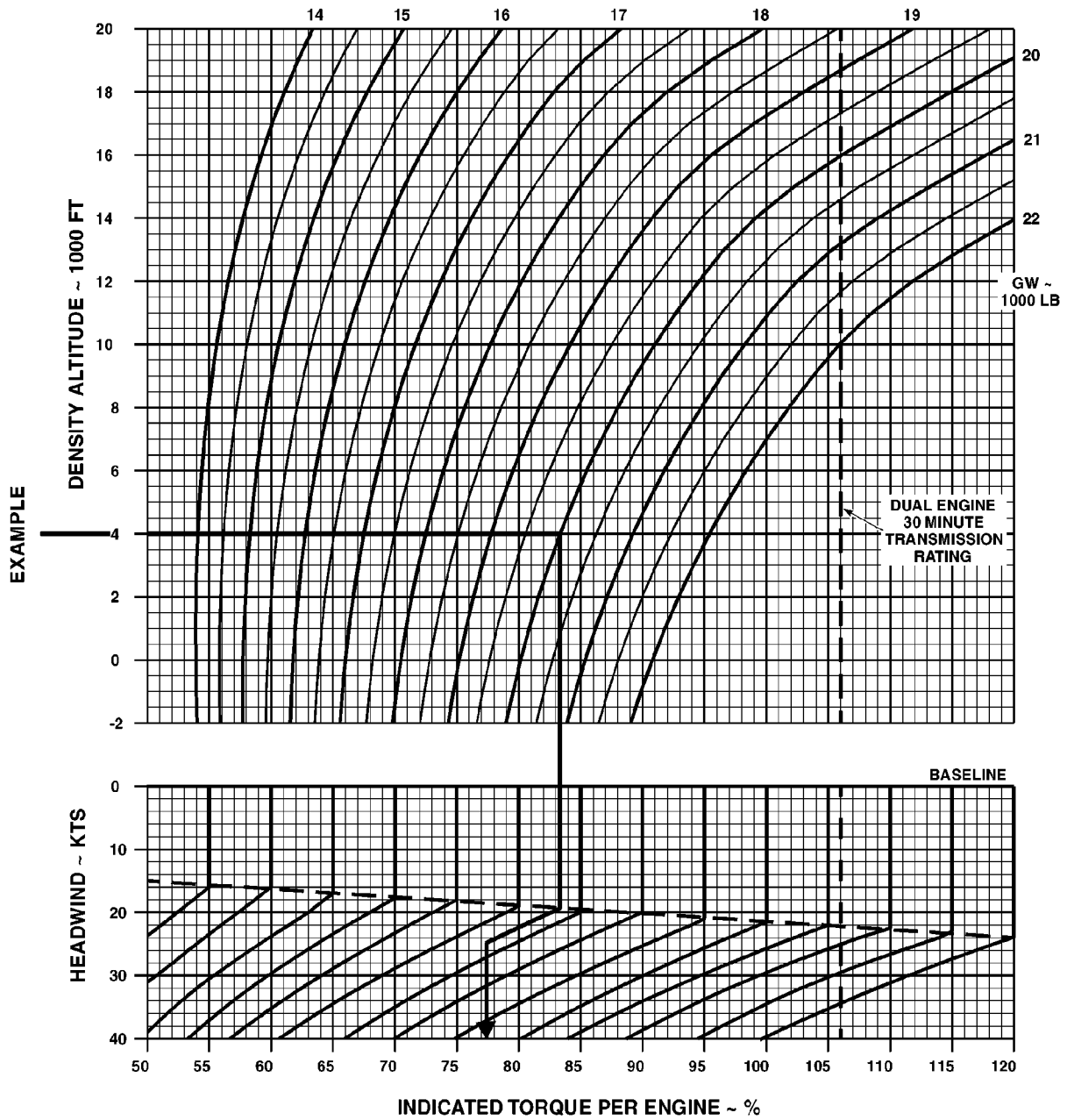
IN GROUND EFFECT

10 FT WHEEL HEIGHT

100% Nr

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

ENGINE:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F180

Figure 23-2. Indicated Torque Required to Hover 10 Feet In Ground Effect Chart

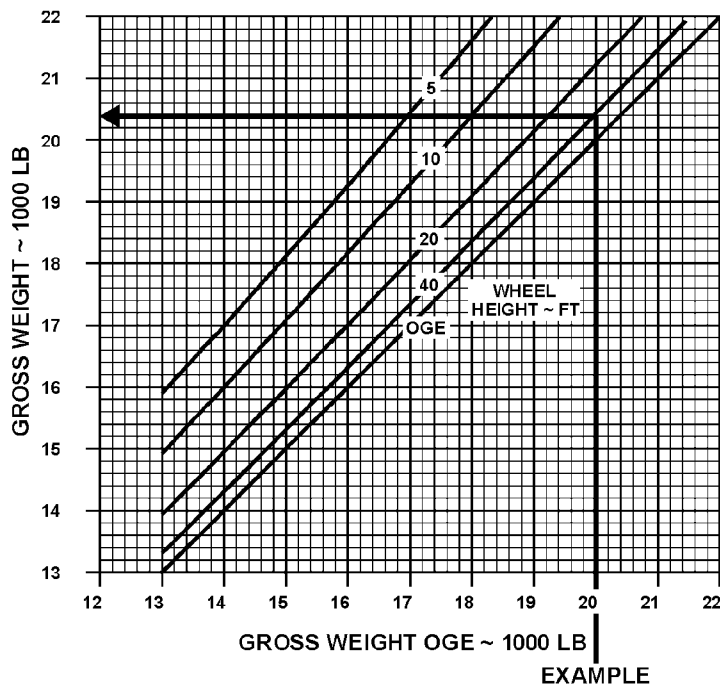
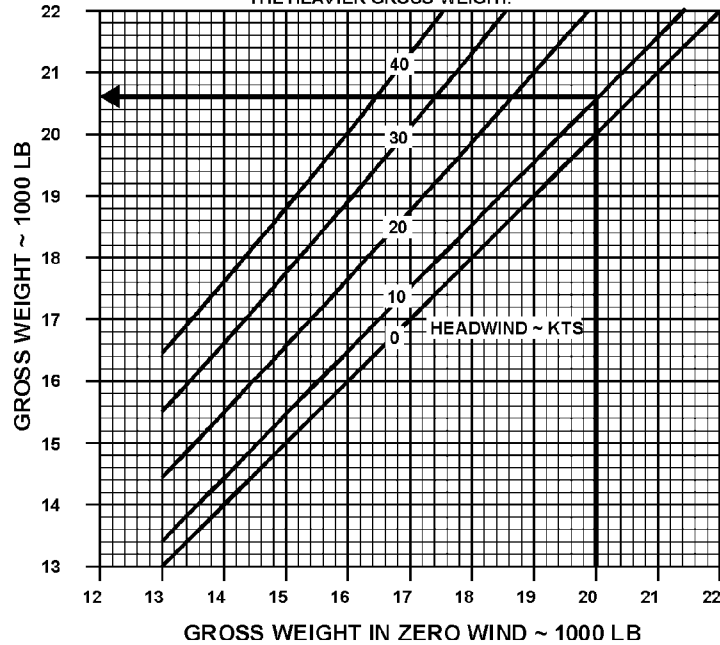
MAXIMUM GROSS WEIGHT TO HOVER WITH HEADWIND OR GROUND EFFECT INFLUENCE DUAL ENGINE

100% Nr INTERMEDIATE (30 MINUTE) POWER

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

NOTE
IF BOTH GROUND EFFECT AND
HEADWINDS ARE PRESENT USE
THE HEAVIER GROSS WEIGHT.

ENGINE:(2) T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F181

Figure 23-3. Maximum Gross Weight to Hover, with Headwind or Ground Effect Influence Chart

MAXIMUM GROSS WEIGHT TO HOVER

OUT-OF-GROUND EFFECT
DUAL ENGINE

851°C LIMIT TGT

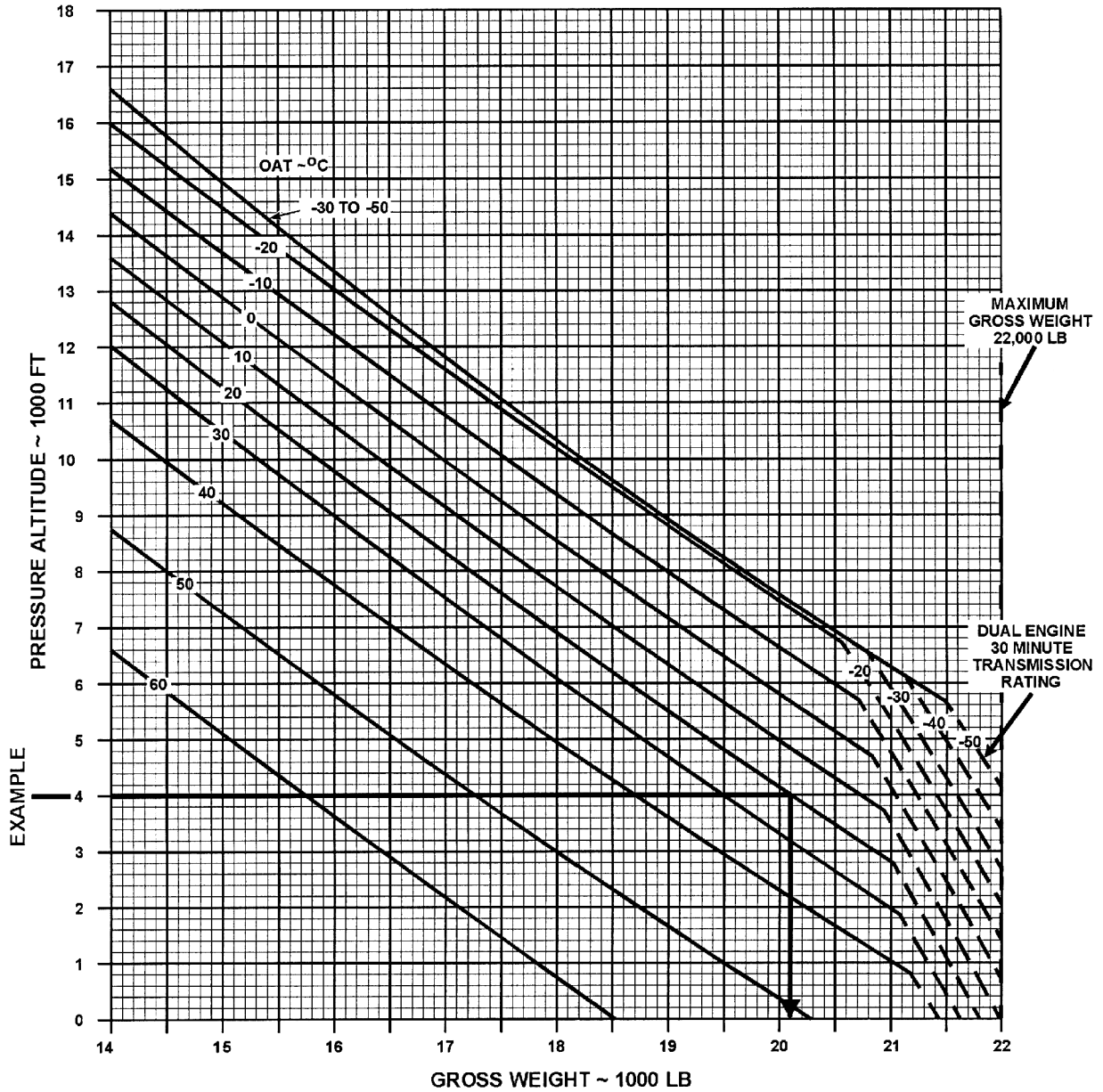
30 MINUTE POWER OR TORQUE PLACARD LIMIT

100% Nr

ZERO WIND

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE: (2) T700-GE-401C
FUEL GRADE: JP4, JP5, JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



NOTE
THIS CHART DEPICTS PERFORMANCE BASED ON A SPECIFICATION ENGINE. FOR DEGRADED ENGINES, IT MAY BE NECESSARY TO USE CONTINGENCY (2.5 MINUTE) POWER TO ACHIEVE THE DEPICTED GROSS WEIGHT.

SH60B-F182

Figure 23-4. Maximum Gross Weight to Hover, Dual Engine, Out of Ground Effect Chart

CHAPTER 24**Climb****24.1 CLIMB PERFORMANCE, DUAL-ENGINE, 30 MINUTE POWER, ZERO WIND**

The Climb Performance Chart (Figure 24-1) provides a means of determining time to climb, fuel used, and horizontal distance traveled at various gross weights at other than standard day conditions.

24.1.1 Sample Problem for Use of Climb Performance Chart, Dual-Engine, 30 Minute Power, Zero Wind

Enter left side of chart at 18,000 pounds gross weight, trace right to 6,000 feet pressure altitude line, trace down through approximate standard day temperature of -3°C , continue down to standard day deviation line of $+10^{\circ}\text{C}$, then trace left to read 2.9 minutes, 68 pounds fuel, and 4 nm distance.

CLIMB PERFORMANCE

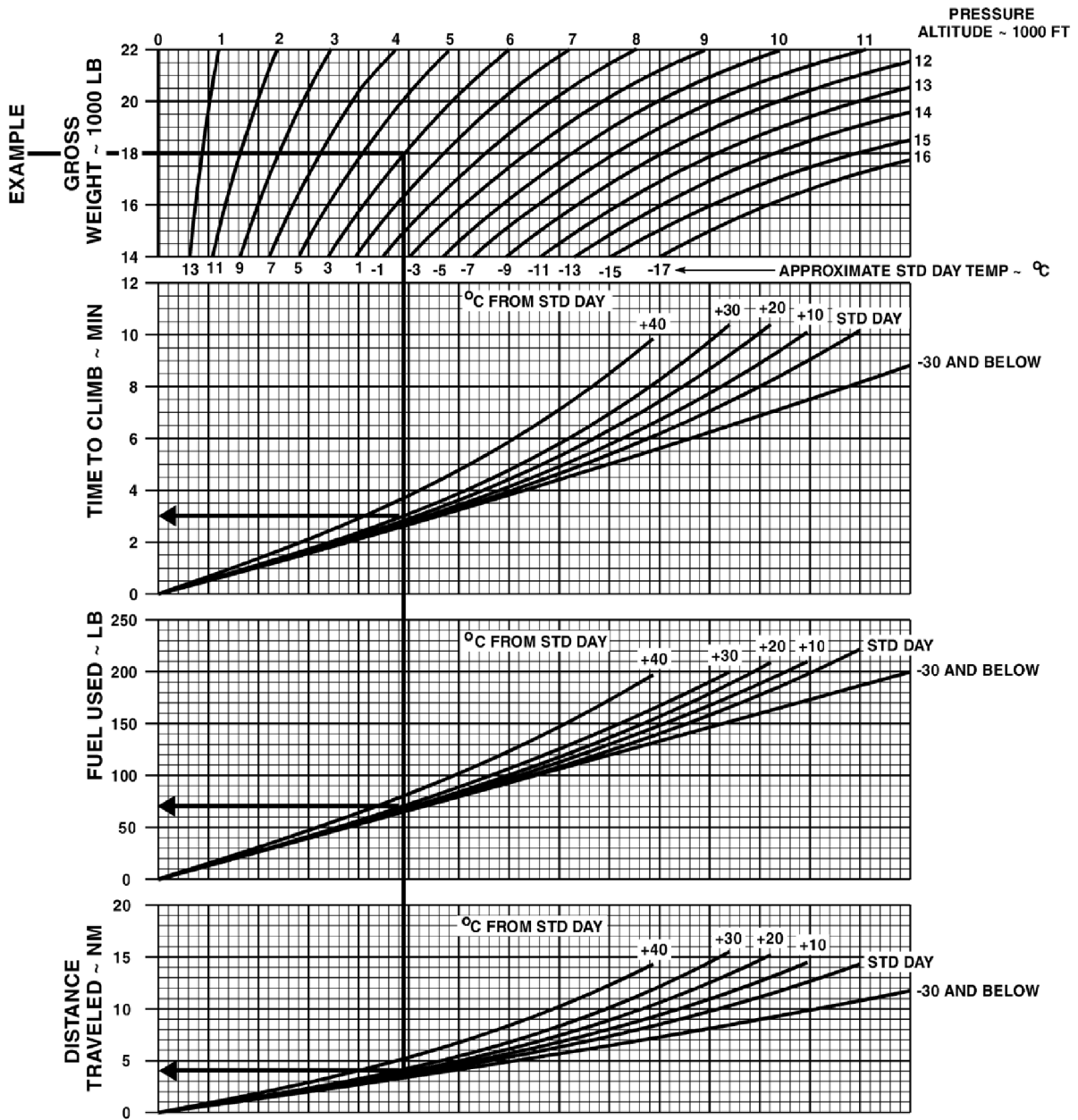
DUAL ENGINE

30 MINUTE POWER
100% Nr

ZERO WIND
70 KIAS

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE:(2) T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



NOTE

THIS CHART DEPICTS PERFORMANCE BASED ON A SPECIFICATION ENGINE. FOR DEGRADED ENGINES, IT MAY BE NECESSARY TO USE CONTINGENCY (2.5 MINUTE) POWER TO ACHIEVE THE DEPICTED CLIMB PERFORMANCE.

Figure 24-1. Climb Performance, Dual-Engine, 30 Minute Power, Zero Wind Chart

CHAPTER 25

Range

25.1 RANGE CHARTS

25.1.1 Maximum Range, Standard Day Chart

The Maximum Range, Standard Day, Dual Engine Chart (Figure 25-1) provides the unit range, indicated airspeed, and approximate torque when gross weight is applied to pressure altitude to produce maximum range for the helicopter.

25.1.1.1 Sample Problem for Use of Maximum Range, Standard Day Chart

1. Enter the bottom of the chart at 18,000 pounds gross weight. Trace up to the 10,000 foot pressure altitude line, then trace left to the unit range scale of approximate nautical miles per pound of fuel and read 0.127 nautical miles per pound of fuel.
2. From the gross weight/pressure altitude intersection, continue to trace up to the next pressure altitude intersection, 10,000 feet, then trace left to the airspeed scale and read 100 KIAS.
3. Return to the gross weight/pressure altitude intersection, continue to trace up to the next pressure altitude intersection, 10,000 feet, then trace left and read approximate torque of 64 percent.

25.1.2 Bingo Profile, Maximum Range with Dual Engine

The Bingo Profile Maximum Range with Dual Engine Chart (Figure 25-2) contains the Bingo Profile for maximum range with both engines operating.

25.1.3 Nautical Miles per Pound of Fuel Conversion Chart

The Nautical Miles Per Pound of Fuel Conversion Chart (Figure 25-3) provides the factors necessary to determine nautical miles per pound of fuel from the combination of total fuel flow pound per hour (pph) and true airspeed.

25.1.3.1 Sample Problem for Nautical Miles per Pound of Fuel Conversion Chart

Enter bottom of chart at 1,000 pounds per hour fuel flow, trace up to the 120 true airspeed knots line, then trace left and read 0.12 nautical miles per pound of fuel.

25.1.4 Single/Dual-Engine Fuel Flow

Engine fuel flow is presented in the Single/Dual Engine Fuel Flow Chart (Figure 25-4) for various torque and pressure altitudes at a baseline OAT of 0 °C. When operating at other than 0 °C OAT, engine fuel flow is increased 1 percent for each 20 °C above the baseline temperature and decreased 1 percent for each 20 °C below the baseline temperature, dual-engine fuel flow may be obtained from Figure 25-4 when each engine is indicating approximately the same torque by averaging the indicated torques and reading fuel flow from the dual-engine fuel flow scale. To determine single engine fuel flow during level flight, enter the fuel flow chart at double the torque required for dual-engine level flight as determined from the level flight performance charts, and obtain fuel flow from the single engine scale. The single engine torque may not exceed the transmission limit shown on the chart. With bleed air on, dual-engine fuel flow increases as follows:

1. Anti-ice ON: +84 pounds per hour (single-engine: +42 pph).
2. Heater ON: +10 pounds per hour.

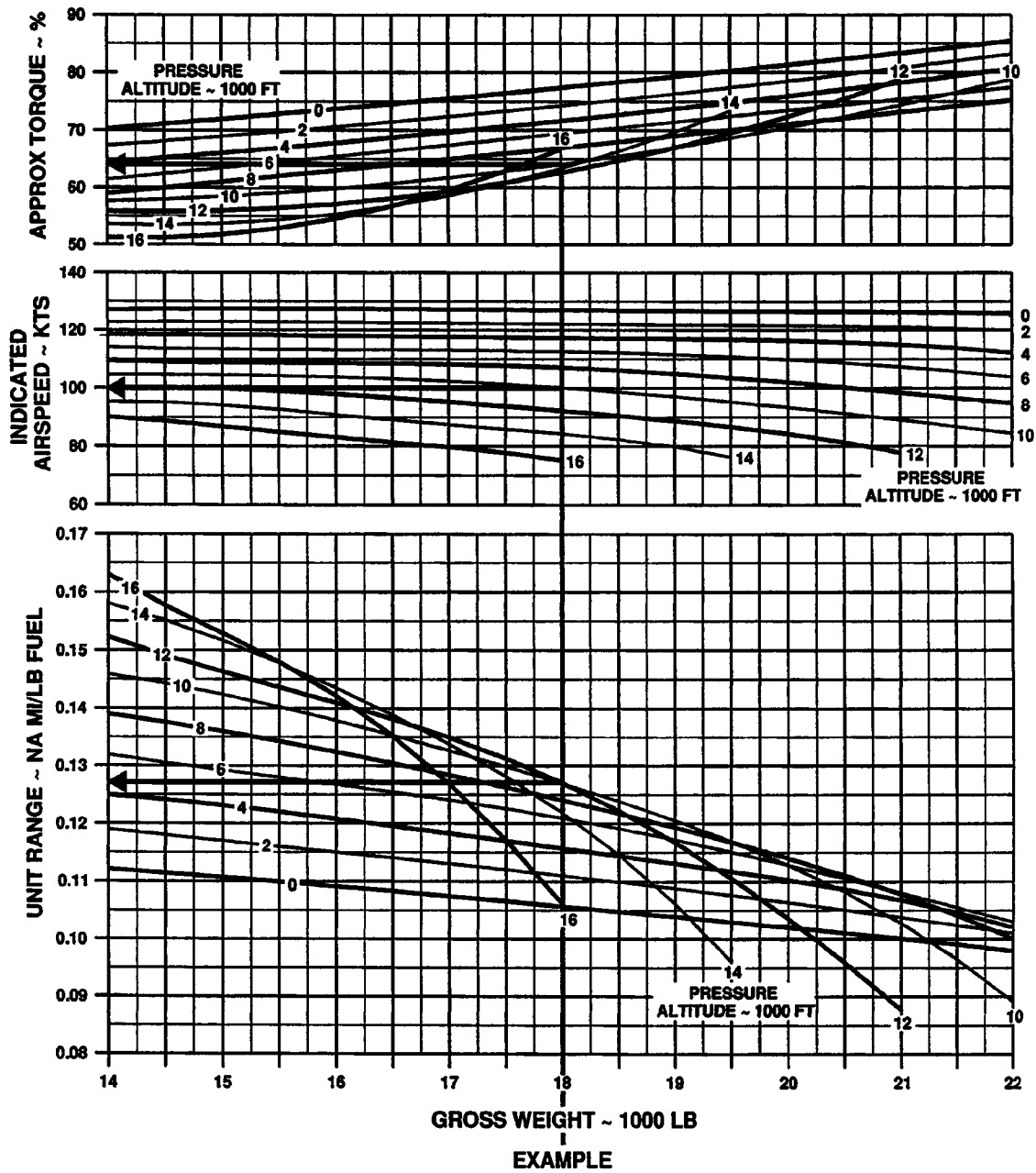
MAXIMUM RANGE

STANDARD DAY
100% Nr ECS - ON

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE: (2) T700-GE-401C
FUEL GRADE: JP4, JP5, JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

WITH ENGINE ANTI-ICE ON, UNIT RANGE IS REDUCED BY APPROXIMATELY 0.014 NA. MI/LB OF FUEL WHILE MAINTAINING CRUISE SPEED SHOWN ON THE CHART



SH60B-F184

Figure 25-1. Maximum Range, Standard Day, Dual Engine Chart

BINGO PROFILE MAXIMUM RANGE - DUAL ENGINE

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE: (2) T700-GE-401C
FUEL GRADE: JP4, JP5, JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

| AIRCRAFT | | | | | AIR RANGE (NM) | | | | | | | | | |
|---------------------|--------------------|-----------------------|-----------|-----|----------------|------|------|------|------|------|------|-----|-----|-----|
| GW LBS x 1000 | PA FT x 1000 | FUEL FLOW LB/HR | MAX RANGE | | LBS OF FUEL | | | | | | | | | |
| | | | KIAS | TRQ | 4000 | 3500 | 3000 | 2500 | 2000 | 1500 | 1000 | 800 | 600 | 400 |
| 22 | 10 | 1134 | 84 | 81 | 356 | 312 | 267 | 223 | 178 | 134 | 89 | 71 | 53 | 36 |
| | 8 | 1181 | 95 | 76 | 400 | 350 | 300 | 250 | 200 | 150 | 100 | 80 | 60 | 40 |
| | 6 | 1106 | 104 | 77 | 412 | 361 | 309 | 258 | 206 | 155 | 103 | 82 | 62 | 41 |
| | 4 | 1162 | 112 | 80 | 410 | 358 | 307 | 256 | 205 | 154 | 102 | 82 | 61 | 41 |
| | 2 | 1219 | 120 | 83 | 404 | 353 | 303 | 252 | 202 | 151 | 101 | 81 | 61 | 40 |
| | 0 | 1273 | 126 | 86 | 390 | 341 | 292 | 244 | 195 | 146 | 97 | 78 | 58 | 39 |
| 20 | 10 | 996 | 93 | 68 | 451 | 394 | 338 | 282 | 225 | 169 | 113 | 90 | 68 | 45 |
| | 8 | 1015 | 102 | 71 | 457 | 400 | 343 | 286 | 229 | 171 | 114 | 91 | 69 | 46 |
| | 6 | 1068 | 110 | 74 | 449 | 393 | 337 | 281 | 225 | 169 | 112 | 90 | 67 | 45 |
| | 4 | 1117 | 116 | 76 | 440 | 385 | 330 | 275 | 220 | 165 | 110 | 88 | 66 | 44 |
| | 2 | 1168 | 122 | 78 | 425 | 372 | 318 | 265 | 212 | 159 | 106 | 85 | 64 | 42 |
| | 0 | 1228 | 127 | 81 | 407 | 356 | 305 | 254 | 204 | 153 | 102 | 81 | 61 | 41 |
| 18 | 10 | 930 | 100 | 65 | 508 | 444 | 381 | 317 | 254 | 190 | 127 | 102 | 76 | 51 |
| | 8 | 975 | 107 | 67 | 496 | 434 | 372 | 310 | 248 | 186 | 124 | 99 | 74 | 50 |
| | 6 | 1019 | 113 | 69 | 483 | 422 | 362 | 302 | 241 | 181 | 121 | 97 | 72 | 48 |
| | 4 | 1068 | 117 | 72 | 464 | 406 | 348 | 290 | 232 | 174 | 116 | 93 | 70 | 46 |
| | 2 | 1127 | 122 | 74 | 444 | 388 | 333 | 277 | 222 | 166 | 111 | 89 | 67 | 44 |
| | 0 | 1191 | 127 | 77 | 423 | 370 | 317 | 264 | 212 | 159 | 106 | 85 | 63 | 42 |
| 16 | 10 | 882 | 104 | 61 | 549 | 480 | 412 | 343 | 274 | 206 | 137 | 110 | 82 | 55 |
| | 8 | 926 | 109 | 63 | 531 | 465 | 398 | 332 | 266 | 199 | 133 | 106 | 80 | 53 |
| | 6 | 976 | 113 | 65 | 508 | 445 | 381 | 318 | 254 | 191 | 127 | 102 | 76 | 51 |
| | 4 | 1032 | 118 | 68 | 481 | 421 | 360 | 300 | 240 | 180 | 120 | 96 | 72 | 48 |
| | 2 | 1093 | 123 | 71 | 457 | 400 | 343 | 286 | 229 | 172 | 114 | 91 | 69 | 46 |
| | 0 | 1156 | 127 | 74 | 436 | 381 | 327 | 272 | 218 | 163 | 109 | 87 | 65 | 44 |
| 14 | 10 | 840 | 105 | 57 | 581 | 508 | 436 | 363 | 290 | 218 | 145 | 116 | 87 | 58 |
| | 8 | 890 | 109 | 59 | 557 | 488 | 418 | 348 | 279 | 209 | 139 | 111 | 84 | 56 |
| | 6 | 942 | 114 | 62 | 527 | 461 | 395 | 329 | 263 | 197 | 132 | 105 | 79 | 53 |
| | 4 | 998 | 119 | 64 | 501 | 438 | 376 | 313 | 251 | 188 | 125 | 100 | 75 | 50 |
| | 2 | 1056 | 123 | 67 | 473 | 414 | 355 | 296 | 237 | 178 | 118 | 95 | 71 | 47 |
| | 0 | 1119 | 127 | 70 | 450 | 394 | 338 | 282 | 225 | 169 | 113 | 90 | 68 | 45 |

NOTES

1. STANDARD DAY, ZERO WIND, 100% Nr
2. (2) 401C ENGINES, ECS-ON, ANTI-ICE OFF
3. NO RESERVE FUEL
4. FOR ANTI-ICE ON: MULTIPLY TABULATED AIR RANGE BY 0.93

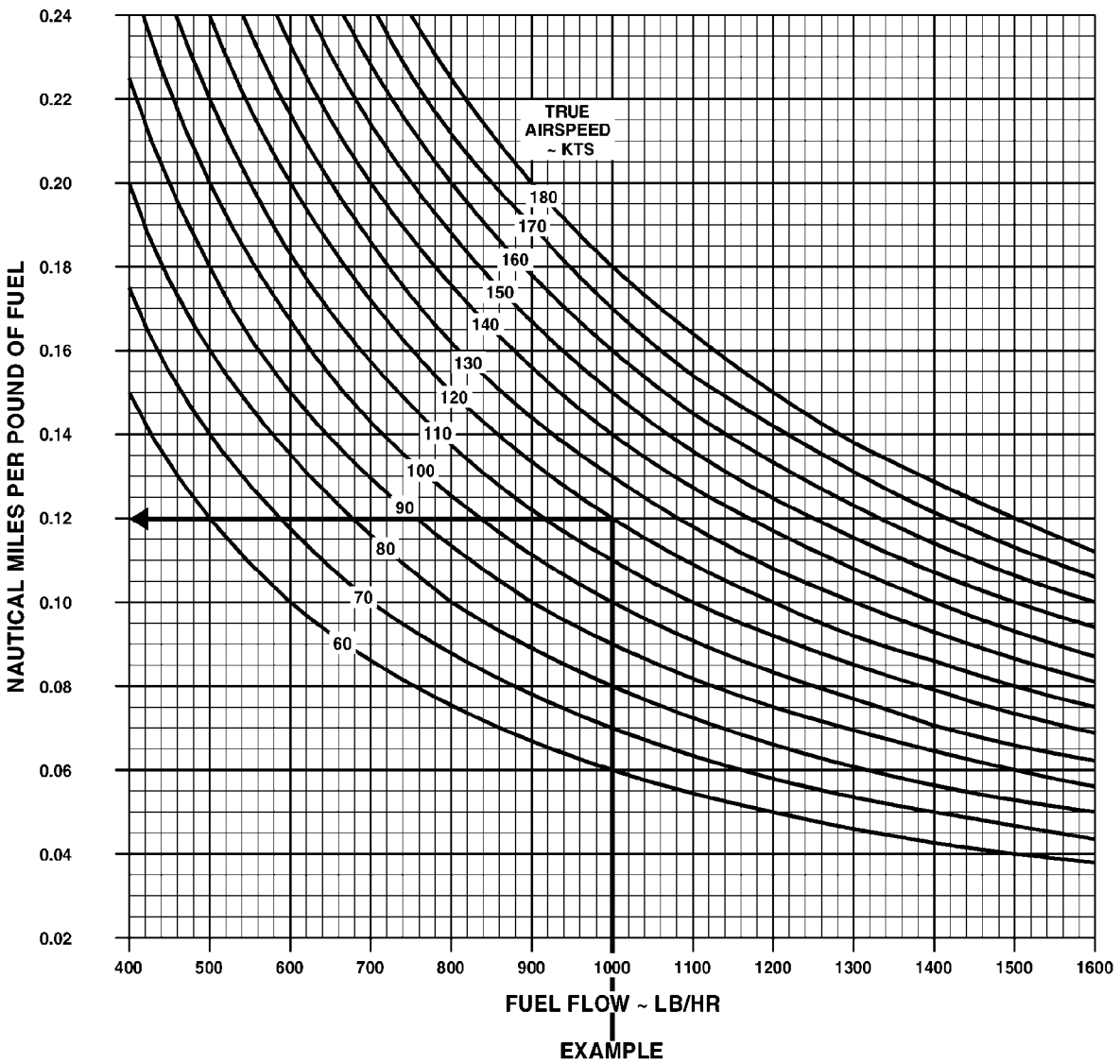
SH60-F185

Figure 25-2. Bingo Profile, Maximum Range Dual Engine Chart

NAUTICAL MILES PER POUND OF FUEL CONVERSION CHART ZERO WIND

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: CALCULATED

ENGINE: T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F186

Figure 25-3. Nautical Miles per Pound of Fuel Conversion Chart

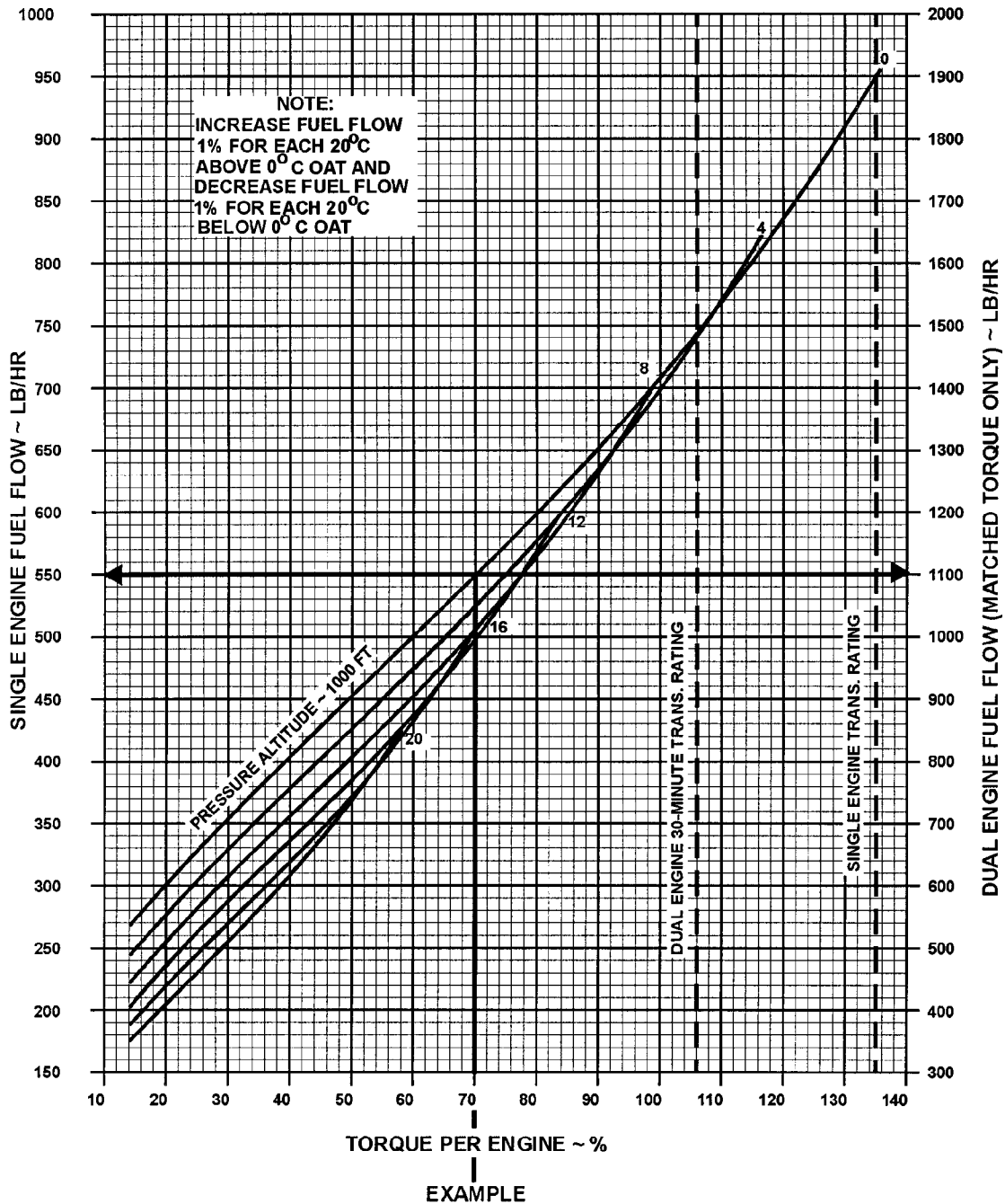
SINGLE/DUAL ENGINE FUEL FLOW

ZERO AIRSPEED
OAT=0 °C

100% Np
ECS - ON

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: ENG. MFR. SPEC

ENGINE: T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F187

Figure 25-4. Single/Dual-Engine Fuel Flow Chart

CHAPTER 26

Hover Endurance

26.1 HOVER ENDURANCE, OUT OF GROUND EFFECT

The Hover Endurance, Out of Ground Effect Chart ([Figure 26-1](#)) provides fuel flow required to hover at various gross weights, pressure altitudes, and ambient temperatures.

26.1.1 Sample Problem for Hover Endurance, Out of Ground Effect

Enter left side of chart with known gross weight (18,400 pounds). Trace right to pressure altitude influence line (8,000 feet), trace down to ambient temperature baseline, trace along influence line to ambient temperature +20 °C, then trace down to read fuel flow 13.6. Multiply by 100 pounds per hour = 1,360 pounds per hour. Fuel flow will increase approximately 42 pounds per hour per engine with anti-ice on. ■

HOVER ENDURANCE OUT-OF-GROUND EFFECT

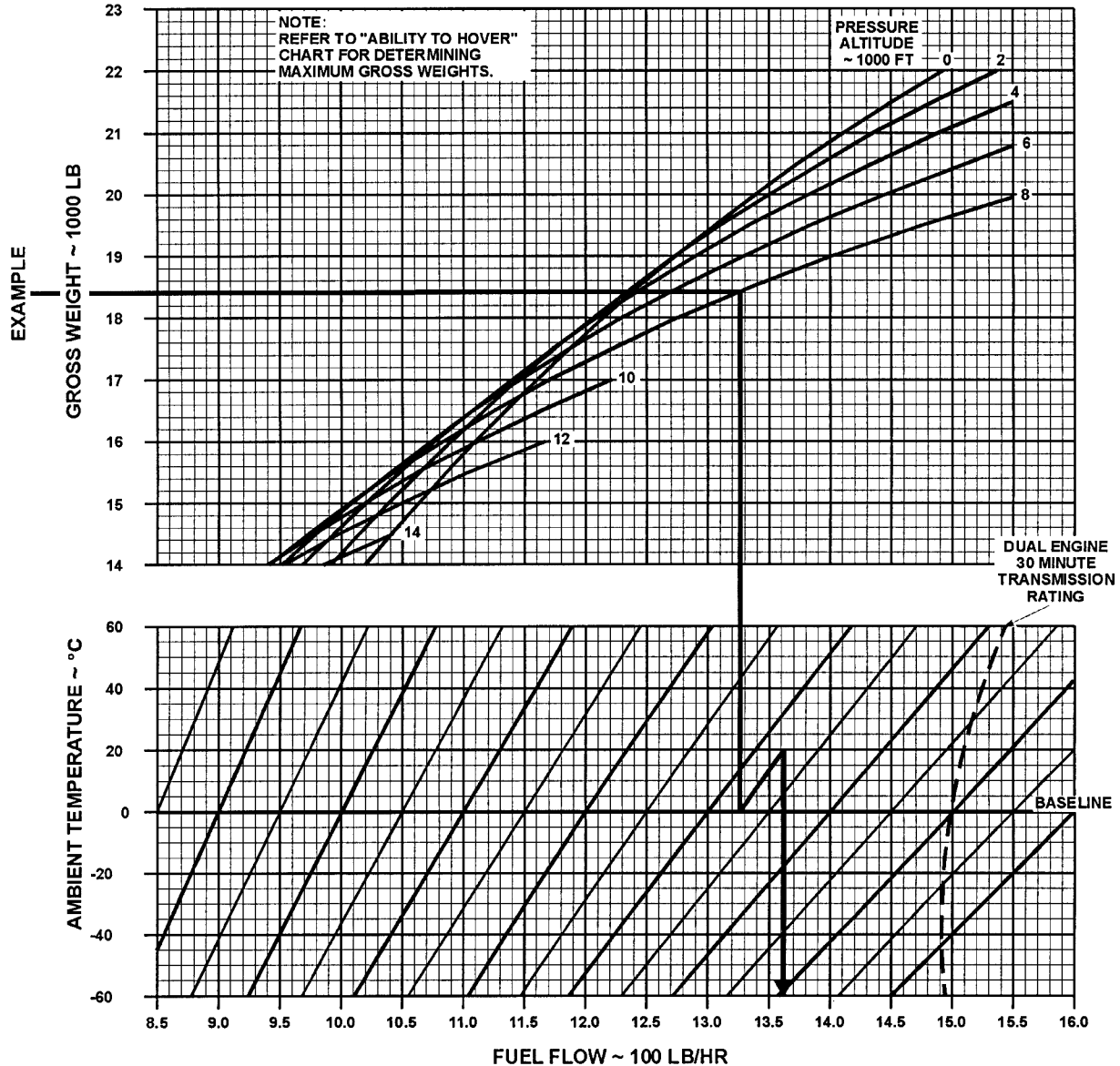
MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

100% Nr ECS - ON

ENGINE: (2) T700-GE-401C
FUEL GRADE: JP4, JP5, JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

NOTE

WITH ENGINE ANTI-ICE ON, FUEL CONSUMPTION
INCREASES BY APPROXIMATELY 84 LBS/HR.



SH60B-F188

Figure 26-1. Hover Endurance, Out of Ground Effect Chart

CHAPTER 27

Emergency Operation

27.1 ABILITY TO MAINTAIN LEVEL FLIGHT, SINGLE ENGINE CHART

The Ability To Maintain Level Flight, Single Engine Chart (Figure 27-1) provides the speed range wherein single engine level flight may be maintained at various density altitudes and gross weights at a torque value the engine is producing.

27.1.1 Sample Problem for Use of Ability to Maintain Level Flight, Single Engine Chart

1. Enter the upper chart on the left side at a 2,000 foot pressure altitude and trace right to 18,500 pounds gross weight.
2. Trace down to OAT baseline, then follow influence line up to -10°C .
3. Trace down to the indicated airspeed baseline.
4. Follow the influence line down to where it intersects the torque available line, 127 percent OEI torque available. (Torque available is provided by Engine Performance, Military Power Charts, Chapter 22.)
5. At bottom of chart at 127 percent OEI torque available, trace left to read the V_{\min} at 22 KIAS.
6. Return to the indicated airspeed baseline, follow the influence lineup to where it intersects 127 percent torque available, then trace left to read V_{\max} 118 KIAS.

27.2 CLIMB PERFORMANCE, SINGLE ENGINE, 30 MINUTE POWER

The Climb Performance, Single Engine, 30 Minute Power Chart (Figure 27-2) provides single engine climb data (30 minute power) at various gross weights, pressure altitudes, and ambient temperatures.

27.2.1 Sample Problem for Climb Performance, Single Engine, 30 Minute Power Chart

Enter chart at left at known gross weight (18,000 pounds). Trace right to pressure altitude influence line (5,000 feet). Trace down through approximate standard day temperature (-2°C), trace down to $^{\circ}\text{C}$ from standard day influence line, then trace left to read: time to climb (11 minutes), fuel used (140 pounds), and distance traveled (14 nm).

27.3 RANGE CHART

The Maximum Range Single Engine, Standard Day Chart (Figure 27-3) is based on the power to provide maximum range for the helicopter during a one-engine operation. The chart uses like factors in the same manner as the range charts in Chapter 25; therefore, explanatory text and sample problem data are not included. The maximum range single engine Bingo Profile is contained in the Bingo Profile, Maximum Range Single Engine Chart Figure 27-4.

27.4 MAXIMUM GROSS WEIGHT TO HOVER IN GROUND EFFECT, SINGLE ENGINE

The Maximum Gross Weight To Hover In Ground Effect Chart is depicted in Figure 27-5. This chart assumes a 5 foot wheel height at 100 percent N_p , one engine inoperative (OEI) 2.5 minute power, and zero wind conditions.

27.4.1 Sample Problem for Maximum Gross Weight to Hover In Ground Effect, Single Engine

Enter chart at left at known pressure altitude (4,000 feet). Trace right to OAT °C (+20 and -40), then trace down to read gross weight (15,700 pounds).

27.5 SERVICE CEILING, SINGLE ENGINE, INTERMEDIATE (30 MINUTE) POWER

This Service Ceiling, Single Engine, Intermediate (30 Minute) Power Chart (Figure 27-6) depicts the service ceiling attainable at various gross weights and ambient temperatures. Intermediate (30 minute) (851 °C TGT limit) power, 70 KIAS at 100 percent N_r is assumed.

27.5.1 Sample Problem for Service Ceiling, Single Engine, Intermediate (30 Minute) Power

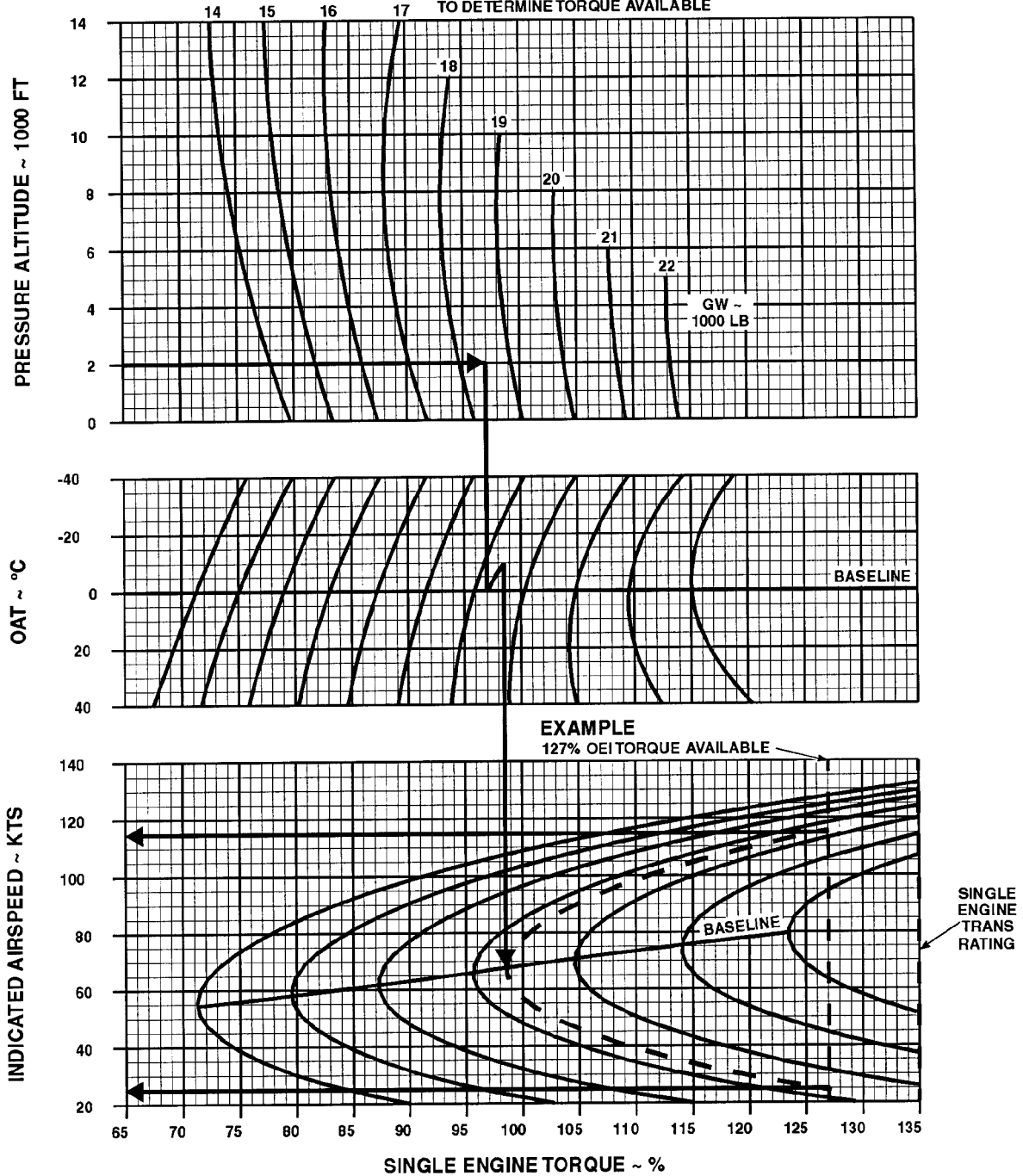
Enter bottom of chart at known gross weight (17,000 pounds), trace up to outside air temperature (OAT) influence line (+10 and -50 °C), then trace left to read pressure altitude (8,350 feet).

ABILITY TO MAINTAIN LEVEL FLIGHT SINGLE ENGINE 100% Nr

MODEL: SH-60
DATE: DECEMBER 1994
DATA BASIS: FLIGHT TEST

ENGINE: (1) T700-GE-401C
FUEL GRADE: JP4, JP5, JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

NOTE
REFER TO ENGINE PERFORMANCE CHART
TO DETERMINE TORQUE AVAILABLE



SH60B-F189

Figure 27-1. Ability to Maintain Level Flight, Single Engine Chart

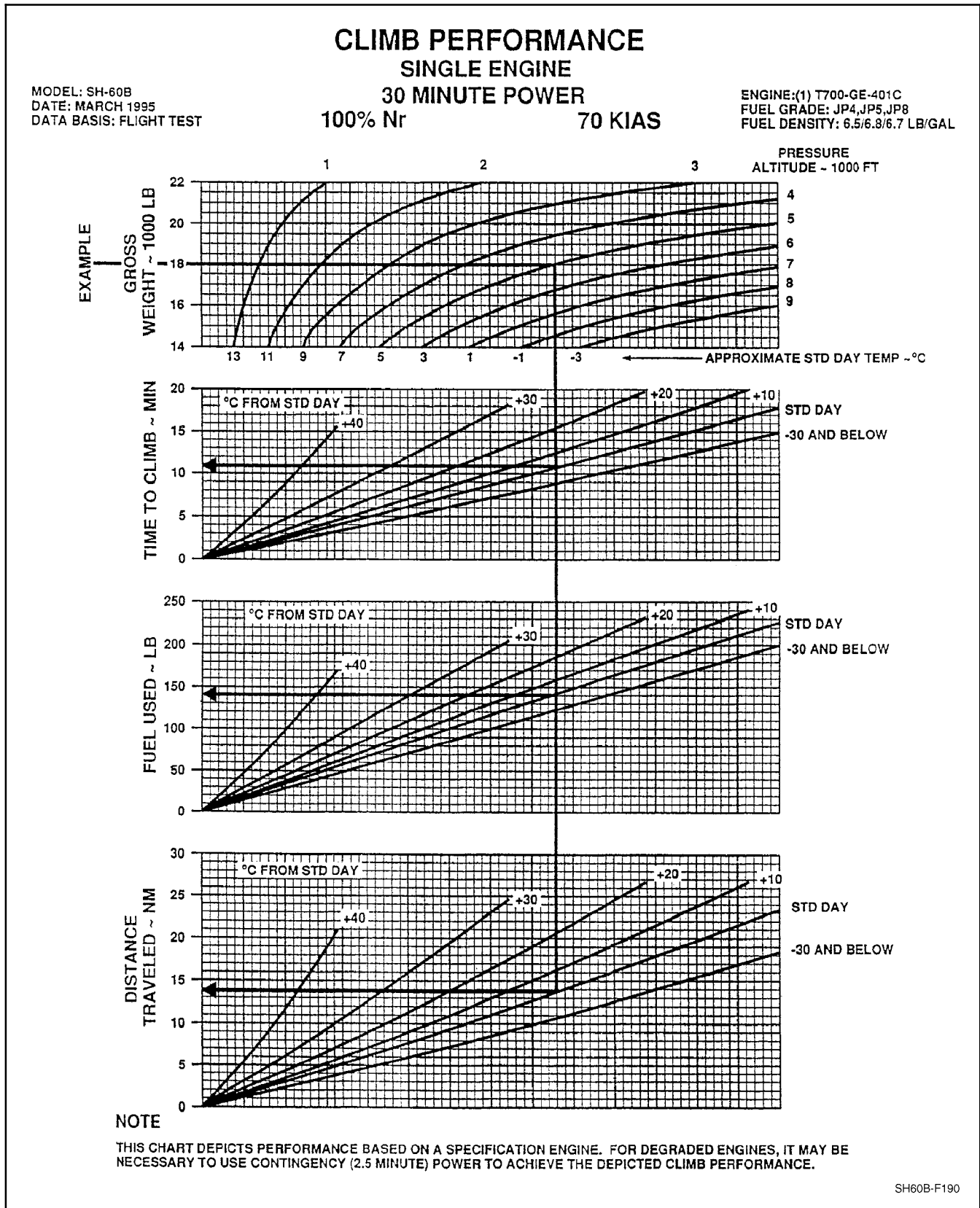
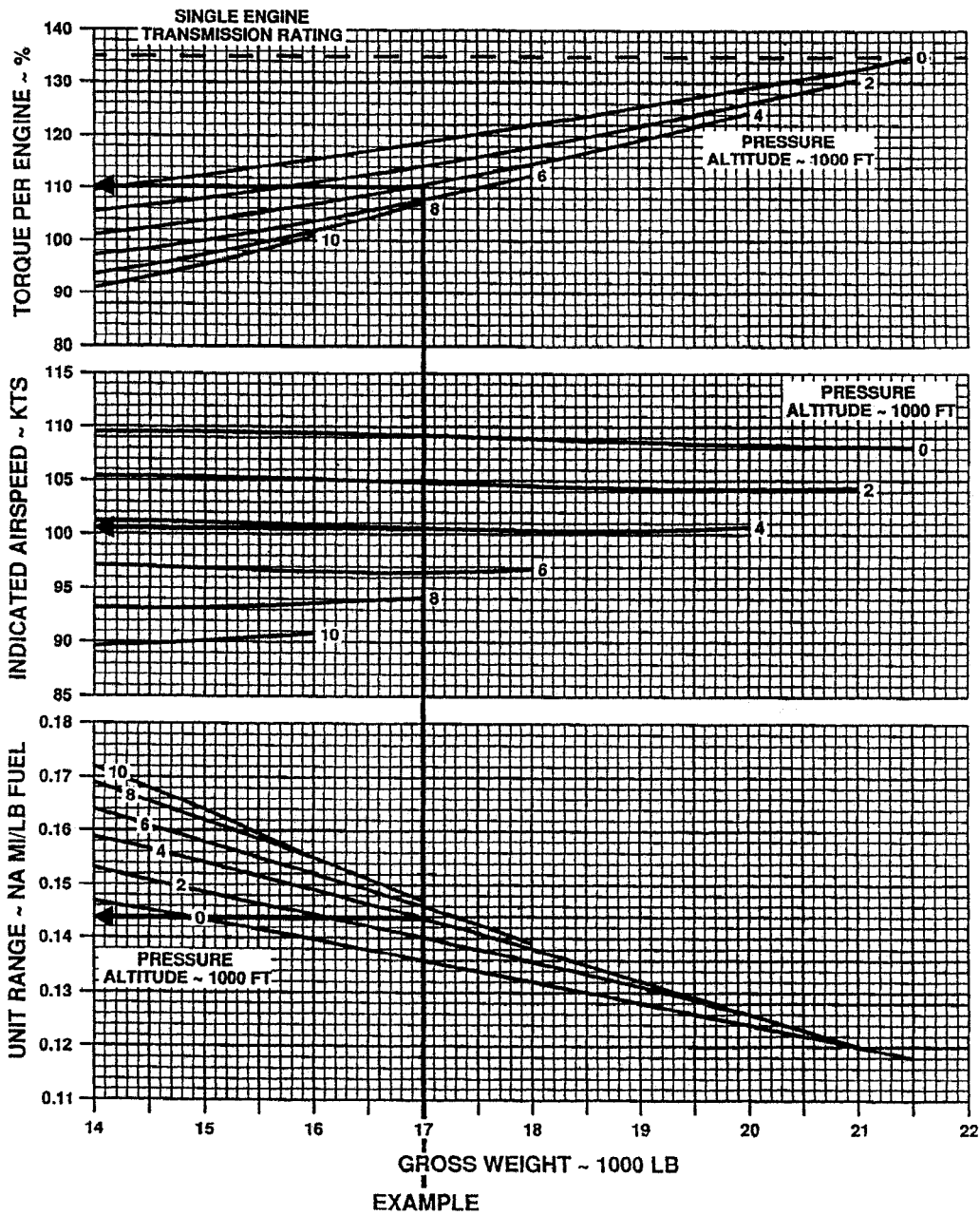


Figure 27-2. Climb Performance, Single Engine, 30 Minute Power Chart

MAXIMUM RANGE - SINGLE ENGINE STANDARD DAY 100% Nr ECS - OFF

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE: (1) T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F191

Figure 27-3. Maximum Range, Single Engine, Standard Day Chart

BINGO PROFILE MAXIMUM RANGE – SINGLE ENGINE

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE:(2) T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL

| AIRCRAFT | | | | | AIR RANGE (NM) | | | | | | | | | | MIN A / S KIAS |
|---------------------|--------------------|-----------------------|-----------|-----|----------------|------|------|------|------|------|------|-----|-----|-----|----------------------|
| GW LBS x 1000 | PA FT x 1000 | FUEL FLOW LB/HR | MAX RANGE | | LBS OF FUEL | | | | | | | | | | |
| | | | KIAS | TRQ | 4000 | 3500 | 3000 | 2500 | 2000 | 1500 | 1000 | 800 | 600 | 400 | |
| 22 | * 2 | 817 | 89 | 120 | 455 | 398 | 341 | 285 | 228 | 171 | 114 | 91 | 68 | 46 | 56 |
| | * 0 | 872 | 101 | 128 | 468 | 409 | 351 | 292 | 234 | 175 | 117 | 94 | 70 | 47 | 45 |
| 20 | * 6 | 728 | 76 | 106 | 478 | 418 | 359 | 299 | 239 | 179 | 120 | 96 | 72 | 48 | 60 |
| | * 4 | 774 | 91 | 114 | 506 | 443 | 380 | 317 | 253 | 190 | 127 | 101 | 76 | 51 | 47 |
| | * 2 | 819 | 100 | 121 | 508 | 444 | 381 | 317 | 254 | 190 | 127 | 102 | 76 | 51 | 39 |
| | 0 | 872 | 108 | 129 | 500 | 438 | 375 | 313 | 250 | 188 | 125 | 110 | 75 | 50 | 31 |
| 18 | * 8 | 684 | 82 | 100 | 556 | 486 | 417 | 347 | 278 | 208 | 139 | 111 | 83 | 56 | 48 |
| | * 6 | 730 | 92 | 107 | 564 | 494 | 423 | 353 | 282 | 212 | 141 | 113 | 85 | 56 | 39 |
| | 4 | 777 | 100 | 114 | 551 | 482 | 413 | 344 | 275 | 207 | 138 | 110 | 83 | 55 | 31 |
| | 2 | 797 | 105 | 118 | 542 | 474 | 407 | 339 | 271 | 203 | 136 | 108 | 81 | 54 | 25 |
| | 0 | 826 | 109 | 122 | 528 | 462 | 396 | 330 | 264 | 198 | 132 | 106 | 79 | 53 | 20 |
| 16 | * 10 | 641 | 84 | 94 | 630 | 551 | 473 | 394 | 315 | 236 | 158 | 126 | 95 | 63 | 38 |
| | * 8 | 686 | 92 | 101 | 618 | 541 | 464 | 386 | 309 | 232 | 155 | 124 | 93 | 62 | 30 |
| | 6 | 702 | 97 | 104 | 610 | 533 | 457 | 381 | 305 | 229 | 152 | 122 | 91 | 61 | 24 |
| | 4 | 727 | 101 | 107 | 594 | 520 | 446 | 371 | 297 | 223 | 149 | 119 | 89 | 59 | 19 |
| | 2 | 753 | 105 | 111 | 579 | 507 | 434 | 362 | 290 | 217 | 145 | 116 | 87 | 58 | 15 |
| | 0 | 784 | 109 | 116 | 561 | 491 | 421 | 351 | 281 | 210 | 140 | 112 | 84 | 56 | 11 |
| 14 | 10 | 618 | 90 | 91 | 686 | 600 | 515 | 429 | 343 | 257 | 172 | 137 | 103 | 69 | 22 |
| | 8 | 634 | 93 | 94 | 675 | 591 | 506 | 422 | 338 | 253 | 169 | 135 | 101 | 68 | 18 |
| | 6 | 656 | 97 | 97 | 659 | 576 | 494 | 412 | 329 | 247 | 165 | 132 | 99 | 66 | 14 |
| | 4 | 682 | 101 | 101 | 633 | 554 | 475 | 396 | 317 | 238 | 158 | 127 | 95 | 63 | 10 |
| | 2 | 713 | 105 | 105 | 612 | 535 | 459 | 382 | 306 | 229 | 153 | 122 | 92 | 61 | 5 |
| | 0 | 745 | 110 | 109 | 591 | 517 | 443 | 369 | 295 | 221 | 148 | 118 | 89 | 59 | 0 |

NOTES

1. STANDARD DAY, ZERO WIND, 100% Nr
2. (1) 401C ENGINE, ECS-OFF, ANTI-ICE OFF
3. (*) 30 MINUTE POWER LIMITED
4. NO RESERVE FUEL
5. FOR ANTI-ICE ON: MULTIPLY TABULATED AIR RANGE BY 0.93

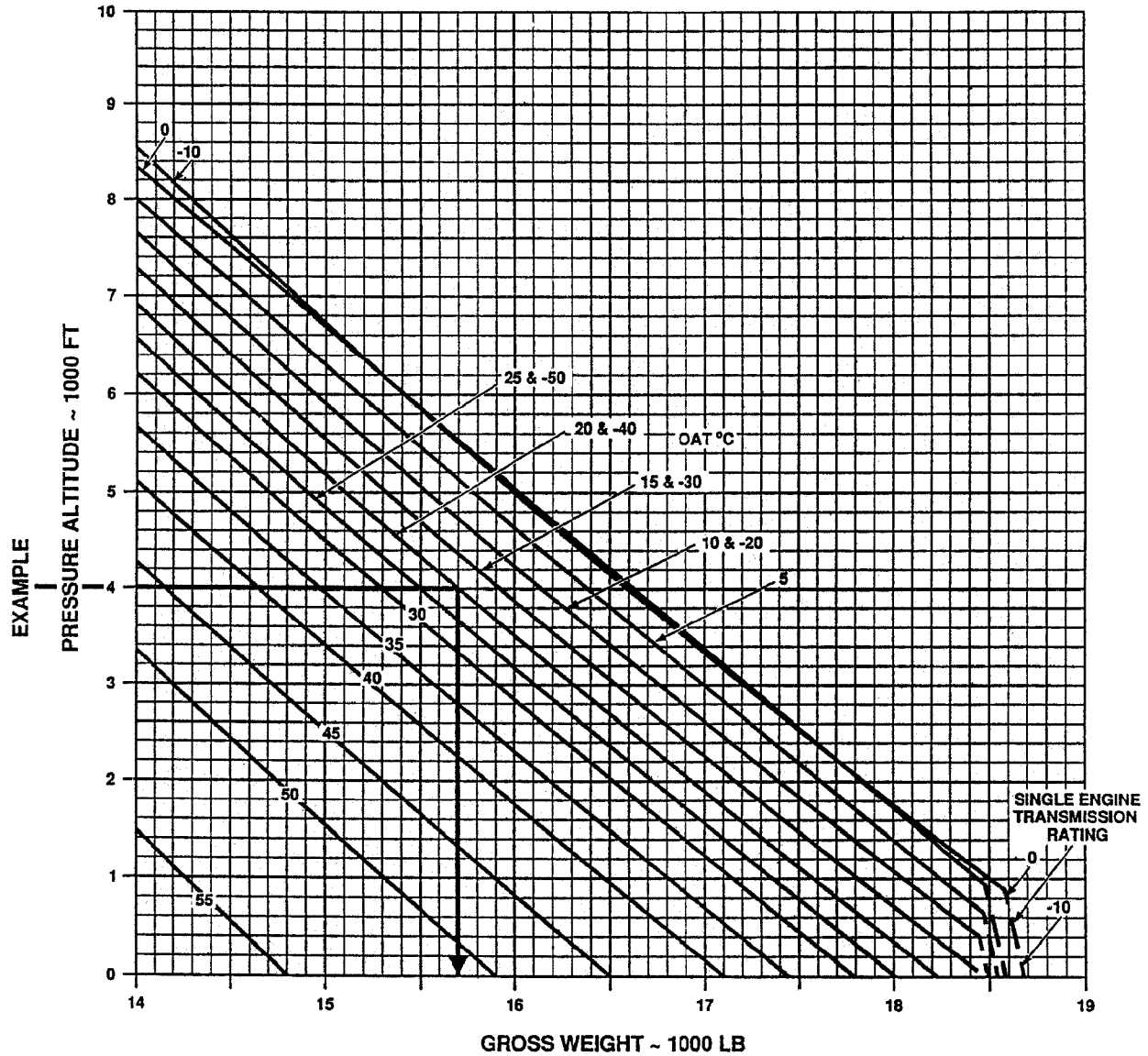
SH60B-F192

Figure 27-4. Bingo Profile, Maximum Range Single Engine Chart

**MAXIMUM GROSS WEIGHT TO HOVER
IN GROUND EFFECT 5 FT WHEEL HEIGHT
SINGLE ENGINE
903°C LIMIT TGT OEI (2.5 MINUTE) POWER
100% Nr ZERO WIND**

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE:(1) T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



NOTE
THIS CHART DEPICTS PERFORMANCE BASED ON A SPECIFICATION ENGINE. FOR DEGRADED ENGINES, GROSS WEIGHT CAPABILITY WILL BE REDUCED FOR ANY OAT ABOVE -15 °C.

SH60B-F193

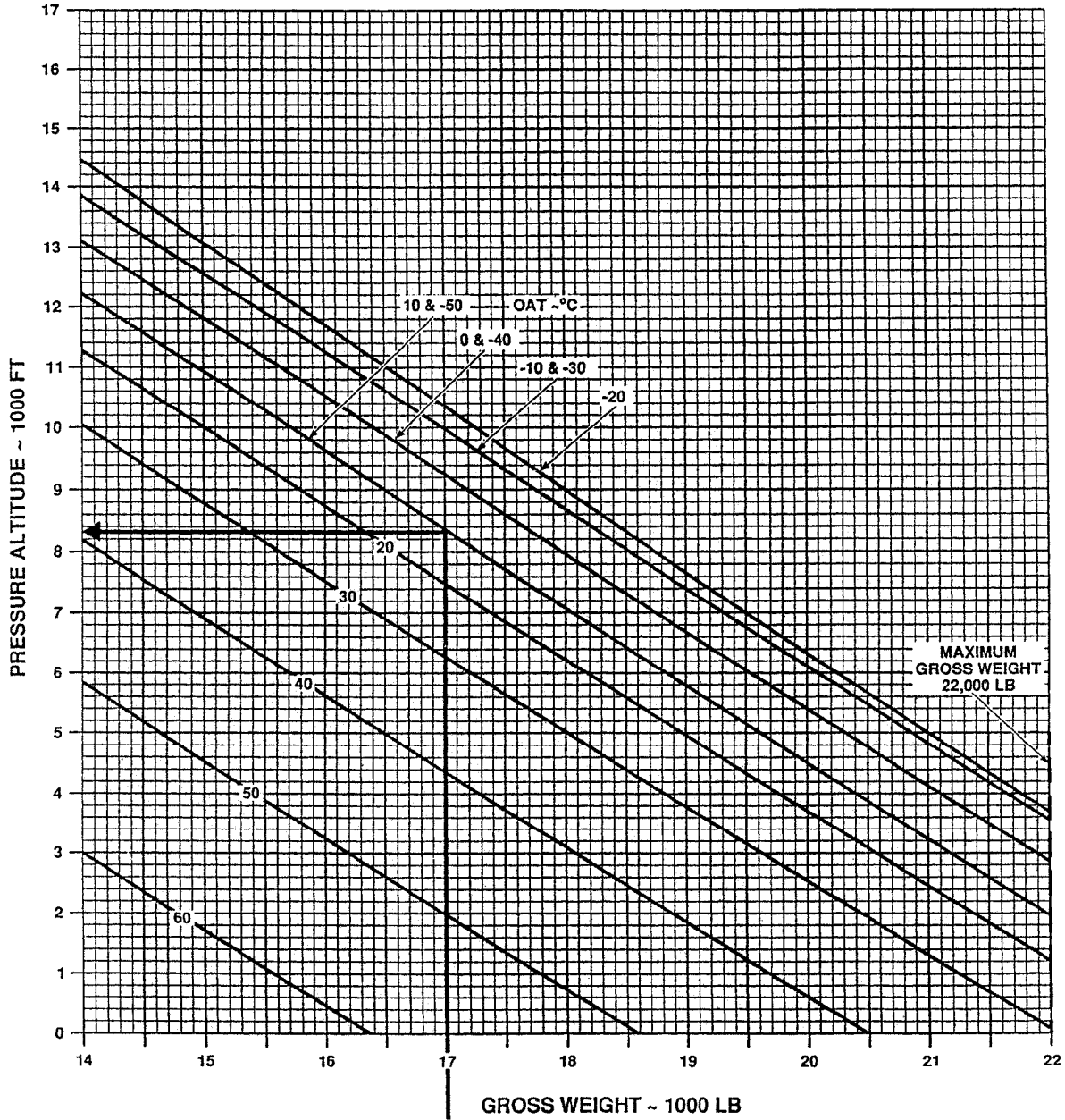
Figure 27-5. Maximum Gross Weight to Hover, in Ground Effect, Single Engine Chart

SERVICE CEILING SINGLE ENGINE

INTERMEDIATE (30 MINUTE) POWER
100% Nr 851°C LIMIT TGT 70 KIAS

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE:(1) T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



NOTE

THIS CHART DEPICTS PERFORMANCE BASED ON A SPECIFICATION ENGINE. FOR DEGRADED ENGINES, IT MAY BE NECESSARY TO USE CONTINGENCY (2.5 MINUTE) POWER TO ACHIEVE THE DEPICTED SERVICE CEILING.

SH60B-F194

Figure 27-6. Service Ceiling, Single Engine, Intermediate (30 Minute) Power Chart

CHAPTER 28

Level Flight Performance Charts

28.1 SERVICE CEILING, DUAL-ENGINE, INTERMEDIATE (30 MINUTE) POWER OR TORQUE PLACARD LIMIT

The Service Ceiling, Dual-Engine, Intermediate (30 Minute) Power Or Torque Placard Limit Chart (Figure 28-1) depicts the service ceiling attainable at various gross weights and ambient temperatures. Intermediate (30 minute, 851 °C TGT limit) power or torque placard limit and 70 KIAS at 100 percent N_T is assumed.

28.1.1 Sample Problem for Service Ceiling, Dual-Engine, Intermediate (30 Minute) Power or Torque Placard Limit

1. Enter bottom of chart at known gross weight (20,700 pounds), trace up to outside air temperature (OAT) influence line (0 °C), then trace left to read pressure altitude (12,000 feet).

28.2 CRUISE CAPABILITY, TIME, AND RANGE

The Cruise Capability, Time, and Range Chart (Figure 28-2) provides time and range solutions to variable fuel flow, true airspeed, and fuel quantity conditions in zero wind with no fuel reserve.

28.2.1 Sample Problem for Cruise Capability, Time, and Range Chart

1. Enter chart at left at known fuel quantity in pounds (1,500 pounds). Trace right to fuel flow 100 pounds per hour line (1,100 pounds), trace down to true airspeed ~ KTS (100), then trace down and read 1.36 hours or trace left from true airspeed ~ KTS (100) line and read 136 nm.

28.3 AIRSPEED SYSTEM CORRECTION FROM LEVEL FLIGHT CHARTS

All indicated airspeeds shown on the cruise charts are based on level flight. The Airspeed System Correction From Level Flight Chart (Figure 28-3) provides the airspeed correction to be added to the level flight performance IAS value to determine the related airspeed indicator reading for other than level flight mode. There are relatively large variations in airspeed system errors associated with climbs and descents. These errors are significant and the Airspeed System Correction From Level Flight Chart (Figure 28-3) is provided primarily to show the general magnitude and direction of the errors associated with the various flight modes. If desired this figure may be used in the manner shown to calculate specific airspeed corrections.

The following anomalies in the airspeed indicating system may be observed on the pilot and copilot airspeed indicators:

1. During takeoffs, in the speed range of 40 to 80 KIAS, 5 to 10 KIAS airspeed fluctuation may be observed on the pilot and copilot airspeed indicators.
2. Power changes in high power, low airspeed climbs may cause as much as 30 knot airspeed changes in indicated airspeed. Increase in power causes an increase in indicated airspeed, and a decrease in power causes a decrease in indicated airspeed.
3. The pilot and copilot airspeed indicators may be unreliable during high power climbs at low airspeeds (less than 50 KIAS) with the copilot system reading as much as 30 knots lower than the pilot system.

28.3.1 Sample Problem for Airspeed System Correction from Level Flight Charts

Enter bottom of chart at indicated airspeed from level flight performance chart (70 knots), trace up to climb influence line, trace left to airspeed correction knots and read (7 knots).

28.4 OPTIMUM ALTITUDE FOR MAXIMUM RANGE

The Optimum Altitude For Maximum Range Chart ([Figure 28-4](#)) provides the pressure altitude at which to cruise to obtain the maximum possible range for any gross weight and OAT conditions. The altitude determined for optimum range may also be used for optimum endurance. Use this chart at current or anticipated takeoff conditions and move along the temperature guide lines to the estimated gross weight for cruise and obtain the optimum pressure altitude. Turn to the level flight performance chart closest to the altitude/temperature combination predicted by the optimum range chart for specific cruise information. This method optimizes cruise performance for long range missions when the altitudes flown are not restricted by operational requirements.

28.4.1 Sample Problem for Optimum Altitude for Maximum Range

1. Enter left at ambient temperature of +22 °C and read right to takeoff pressure altitude of 2,000 feet, move right along temperature trend lines to known or estimated gross weight (16,800 pounds), move down to read optimum pressure altitude (12,000 feet), move left to read OAT at optimum altitude (+3 °C).
2. To select the appropriate level flight performance chart, use the temperature/altitude combination predicted by the optimum altitude for maximum range chart and apply these predicted values to the level flight performance chart nearest these conditions. Use of the level flight performance chart for 12,000 feet and 0 °C would be correct in determining cruise conditions for this example, but observe altitude limits in [Chapter 4](#) and OPNAV 3710.7 (series).

28.5 LEVEL FLIGHT PERFORMANCE CHARTS

28.5.1 Description

The Level Flight Performance Charts ([Figures 28-5, 28-6, 28-7, 28-8, 28-9, 28-10, 28-11, 28-12, 28-13, 28-14, 28-15, 28-16, 28-17, 28-18, 28-19, 28-20, 28-21, and 28-22](#)) present torque required and total fuel flow as a function of airspeed, altitude, temperature, and gross weight at 100 percent N_r . Scales for both true airspeed and indicated airspeed are presented. Maximum level flight airspeed (V_h) is obtained at the intersection of the gross weight arc and torque available 30 minutes or the transmission torque limit, whichever is lower. Airspeeds that will produce maximum range, maximum endurance, and maximum rate of climb are also shown. Level flight performance charts are provided from sea level to 10,000 feet pressure altitude in units of 2,000 feet. The charts provide level flight data for free air temperatures from -20 °C to +40 °C in units of 10 or 20.

28.5.2 Use of Charts

To use the charts, it is usually necessary to know the planned pressure altitude, estimated outside air temperature, planned cruise speed, [TAS](#), and gross weight. First, select the proper chart on the basis of planned cruise pressure altitude and temperature, or by using the optimum altitude for maximum range chart. Enter the chart at the cruise airspeed, IAS, move up and read TAS, move up to the gross weight arc, move left and read torque required, and then move right and read associated fuel flow. Maximum performance conditions are determined by entering the chart where the maximum (LONG RANGE) range line or the maximum endurance and rate of climb (MAX END AND R/C) intersects the gross weight line; then read airspeed, fuel flow and torque required. Normally, sufficient accuracy can be obtained by selecting the chart nearest the planned cruising altitude and OAT or, more conservatively, by selecting the chart with the next higher altitude and OAT. If greater accuracy is required, interpolation between altitudes and/or temperatures is permissible. To be conservative, use the gross weight at the beginning of the cruise flight. For greater accuracy on long flights, it is preferable to determine cruise information for several flight segments to allow for the decreasing gross weight.

1. Airspeed. True and indicated airspeeds are presented at opposite sides of each chart. On any chart, indicated airspeed can be directly converted to true airspeed by reading directly across the chart without regard to other chart information.
2. Torque. Since pressure altitude and temperature are fixed for each chart, torque required varies according to gross weight and airspeed. The torque and torque limits shown on these charts are for dual- and single-engine operation. The maximum torque available is presented on each chart as either the transmission torque limit, torque available 30 minutes, or torque available continuously. The dual-engine torque limit placard is

presented above the TAS scale of each chart where applicable. Single-engine torque, OEI continuous, and OEI 2.5 minute limits are also represented.

3. Fuel Flow. Fuel flow scales are provided opposite the torque scales. On any chart, torque may be converted directly to fuel flow without regard to other chart information. Data shown is for two-engine operation. For single-engine fuel flow, refer to the Single/Dual-Engine Fuel Flow Chart [Figure 25-4](#).
4. Long Range. The long range lines (LONG RANGE) indicate the combinations of gross weight and airspeed that will produce the greatest flight range per pound of fuel under zero wind conditions. When maximum range airspeed is above maximum torque available, the resulting maximum airspeed should be used for maximum range.
5. Maximum Endurance and Rate of Climb. The maximum endurance and rate of climb lines (MAX END and R/C) indicate the combinations of gross weight and airspeed that will produce the maximum endurance and the maximum rate of climb. The torque required for level flight at this condition is a minimum, providing a minimum fuel flow (maximum endurance) and a maximum torque change available for climb (maximum rate of climb).
6. Single Engine. The minimum and maximum single-engine speeds can be determined by using a combination of torque available ([Chapter 22](#)) and level flight performance charts. To calculate single-engine speeds, first determine the torque available at the TGT limit desired and then divide by 2 (for example: 90 percent TQ/2 = 45 percent TQ). Select the appropriate level flight performance chart for the desired flight condition and enter the torque scale with the torque value derived above. Move to the intersection of torque available and mission gross weight arc and read down to determine minimum single-engine speed. Move further across to the second intersection of torque and weight and read maximum single-engine speed. If no intersections occur, there are no single-engine level flight capabilities for the conditions.
7. Additional Uses. The low speed end of the level flight performance charts (below 40 knots) is shown primarily to familiarize the pilot with the low speed power requirements of the helicopter. It shows the power margin available for climb or acceleration during maneuvers, such as Nape of the Earth flight. At zero airspeed, the torque represents the torque required to hover out of ground effect. In general, mission planning for low-speed flight should be based on hover performance out of ground effect. Refer to [Chapter 23](#).

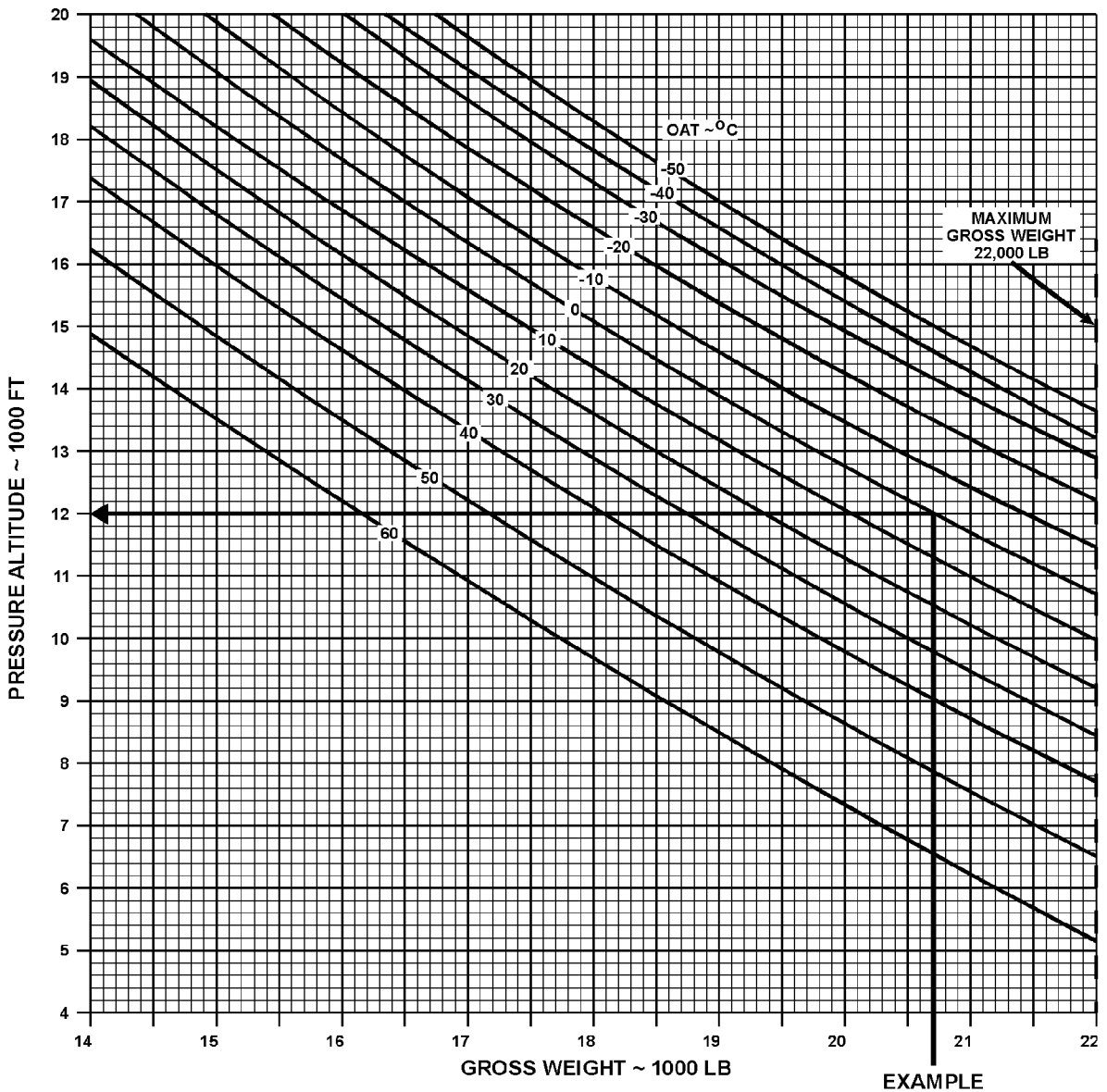
SERVICE CEILING DUAL ENGINE

INTERMEDIATE (30 MINUTE) POWER OR TORQUE PLACARD LIMIT

100% Nr 851°C TGT LIMIT 70 KIAS

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE:(2) T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



NOTE

THIS CHART DEPICTS PERFORMANCE BASED ON A SPECIFICATION ENGINE. FOR DEGRADED ENGINES, IT MAY BE NECESSARY TO USE CONTINGENCY (2.5 MINUTE) POWER TO ACHIEVE THE DEPICTED SERVICE CEILING.

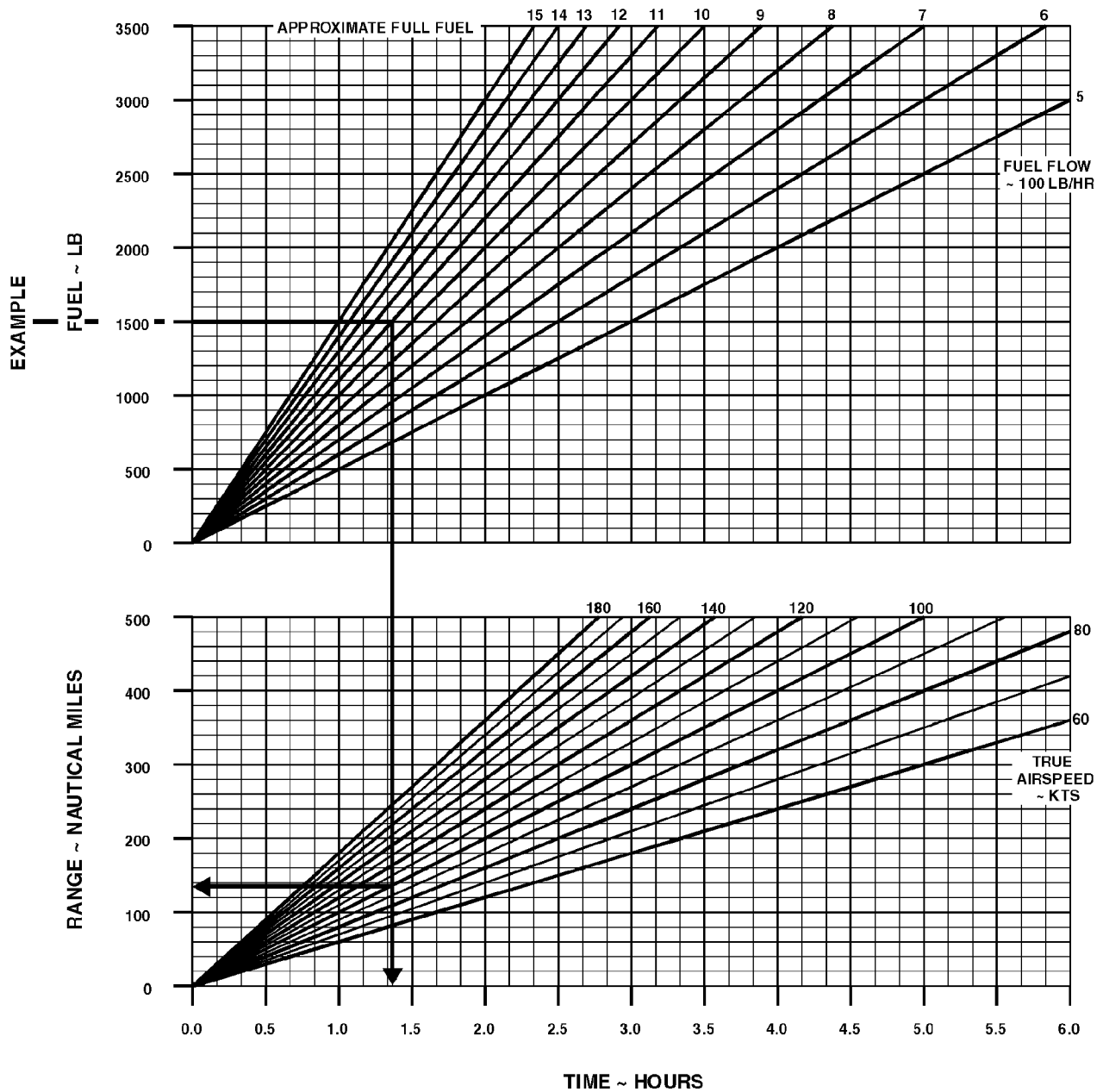
SH60B-F195

Figure 28-1. Service Ceiling, Dual-Engine, Intermediate (30 Minute) Power or Torque Placard Limit Chart

CRUISE CAPABILITY TIME AND RANGE ZERO WIND NO RESERVES

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: CALCULATED

ENGINE: T700-GE-401C
FUEL GRADE: JP4, JP5, JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F196

Figure 28-2. Cruise Capability, Time, and Range Chart

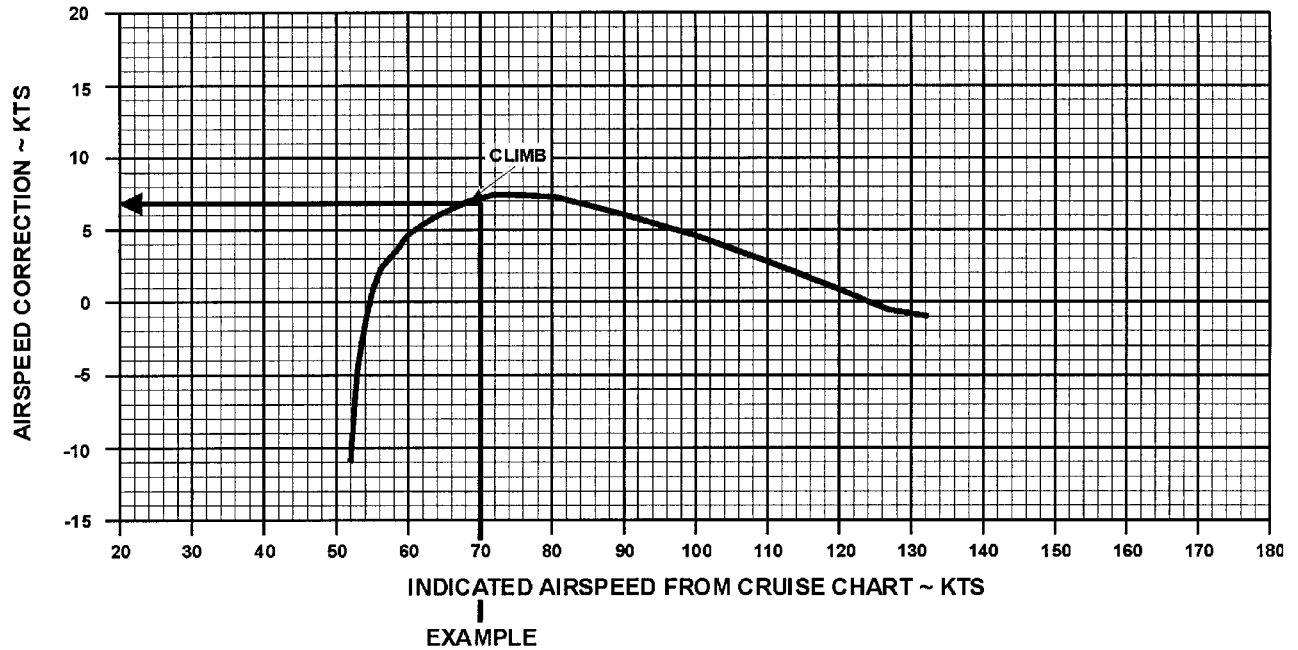
AIRSPEED SYSTEM CORRECTION FROM LEVEL FLIGHT

PILOT'S AIRSPEED SYSTEM

100% Nr

MODEL: SH-60B
DATE: MARCH 1995
DATA BASIS: FLIGHT TEST

ENGINE: T700-GE-401C
FUEL GRADE: JP4,JP5,JP8
FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F197

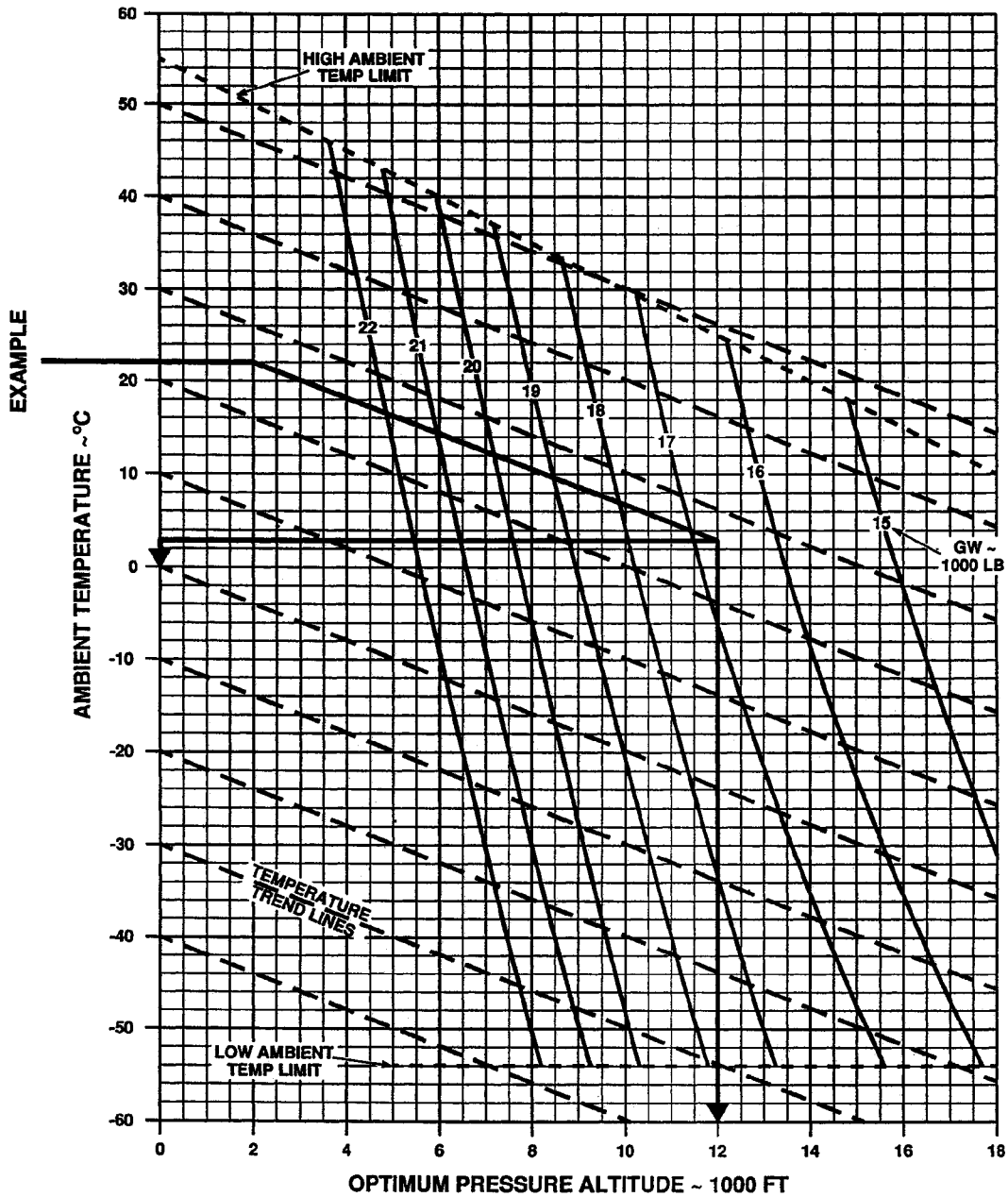
Figure 28-3. Airspeed System Correction from Level Flight Chart

OPTIMUM ALTITUDE FOR MAXIMUM RANGE

100% Nr ECS - ON

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

ENGINE: (2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F198

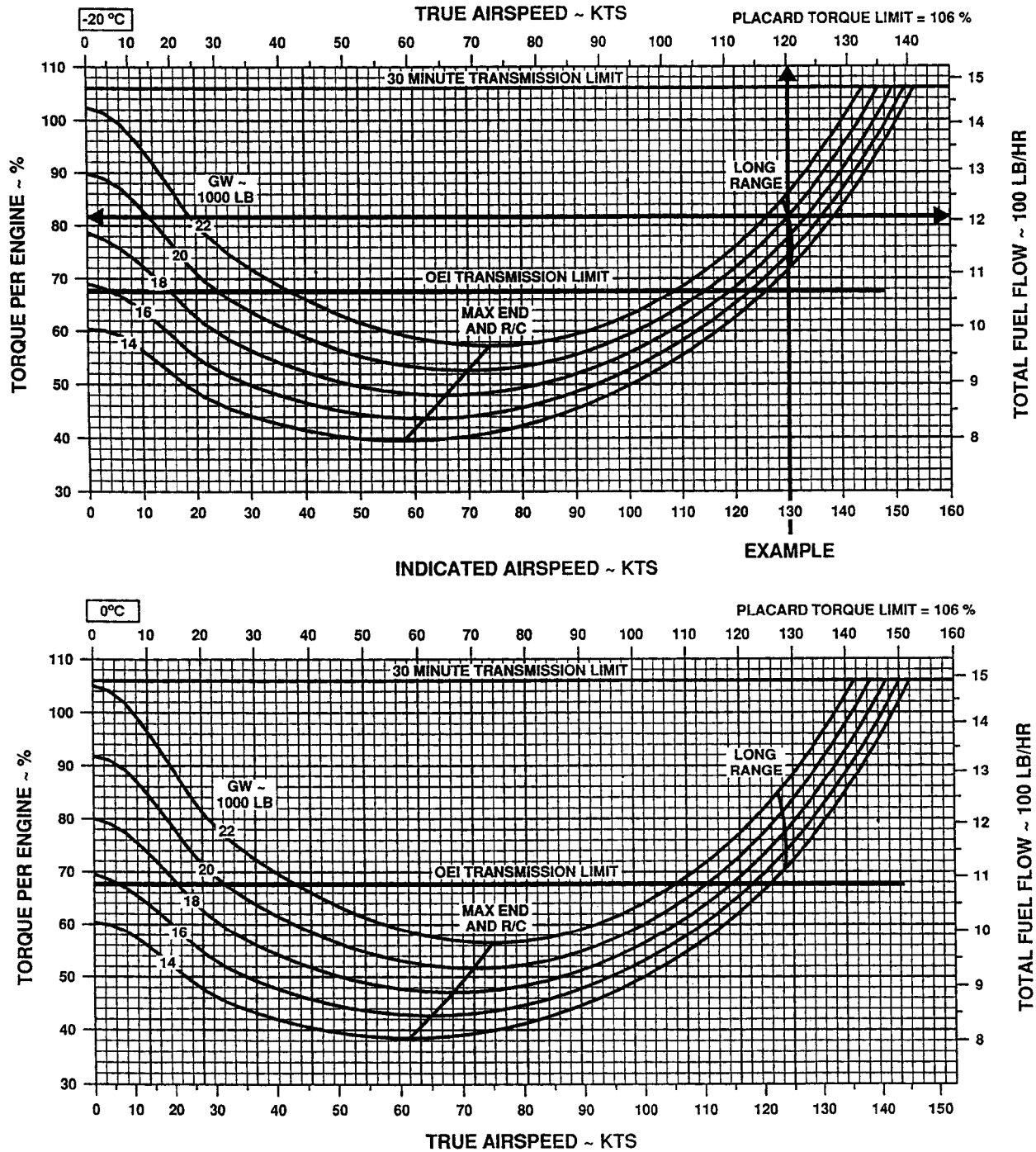
Figure 28-4. Optimum Altitude for Maximum Range Chart

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 0 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F199

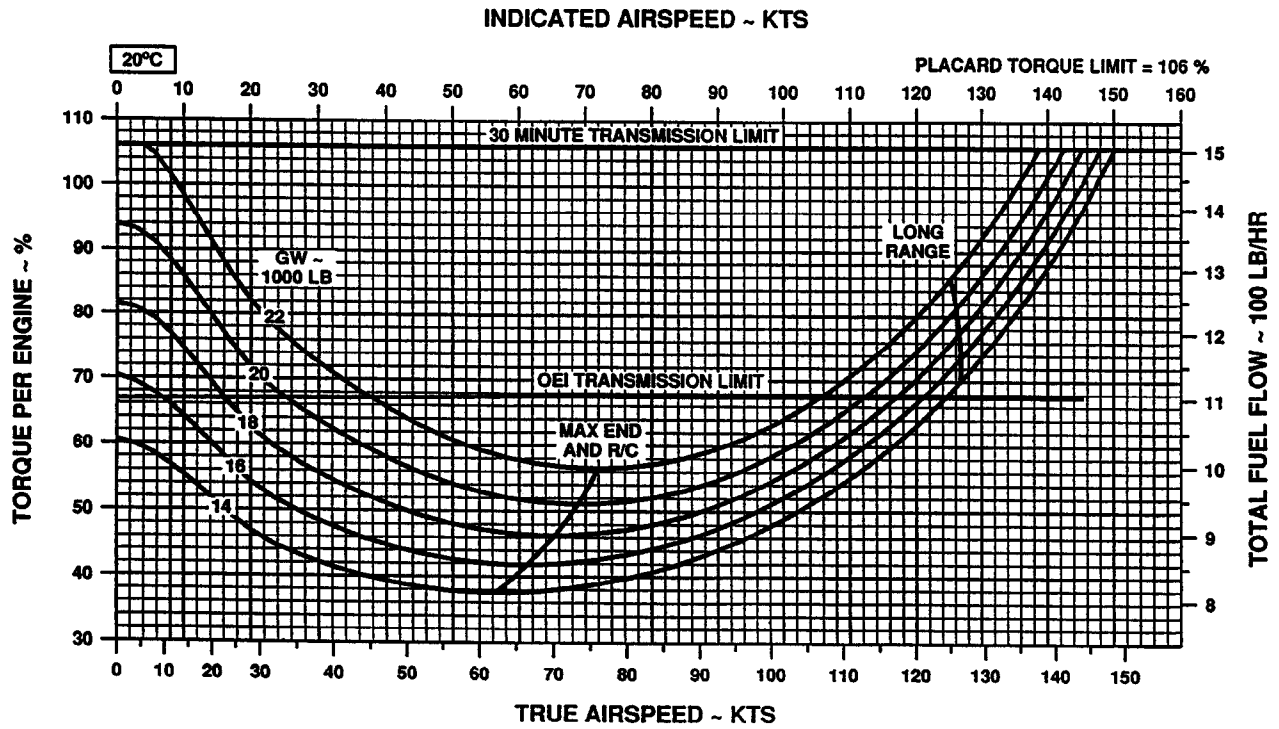
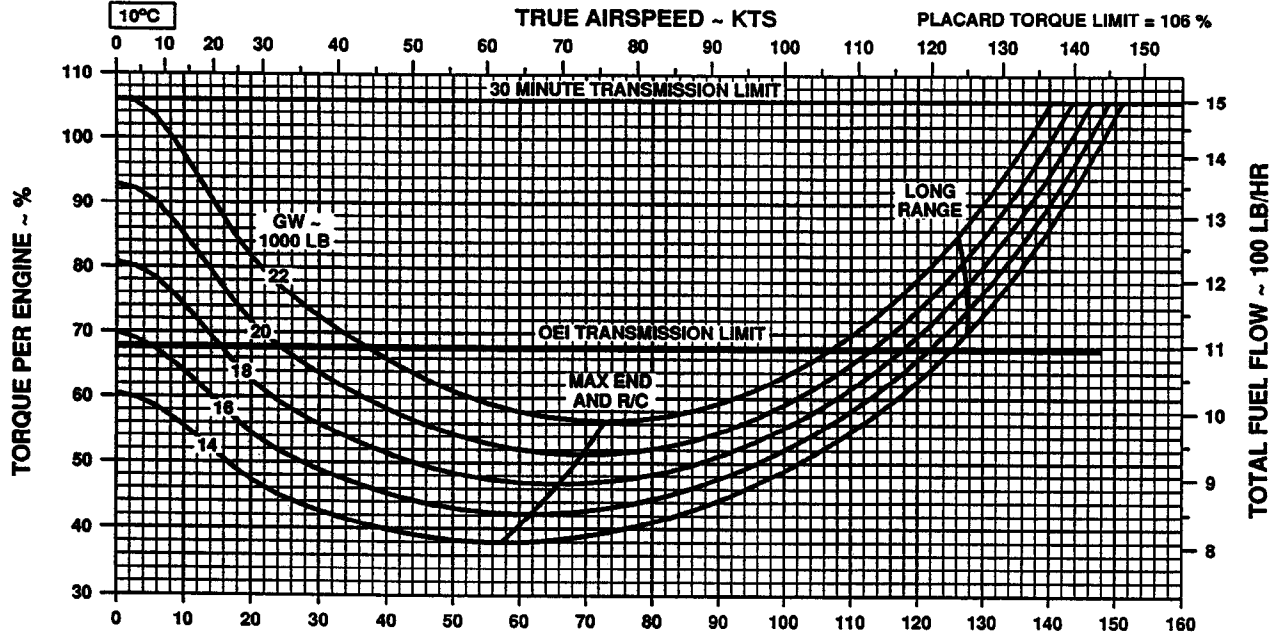
Figure 28-5. Level Flight Performance (0 Feet, -20, 0 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 0 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F200

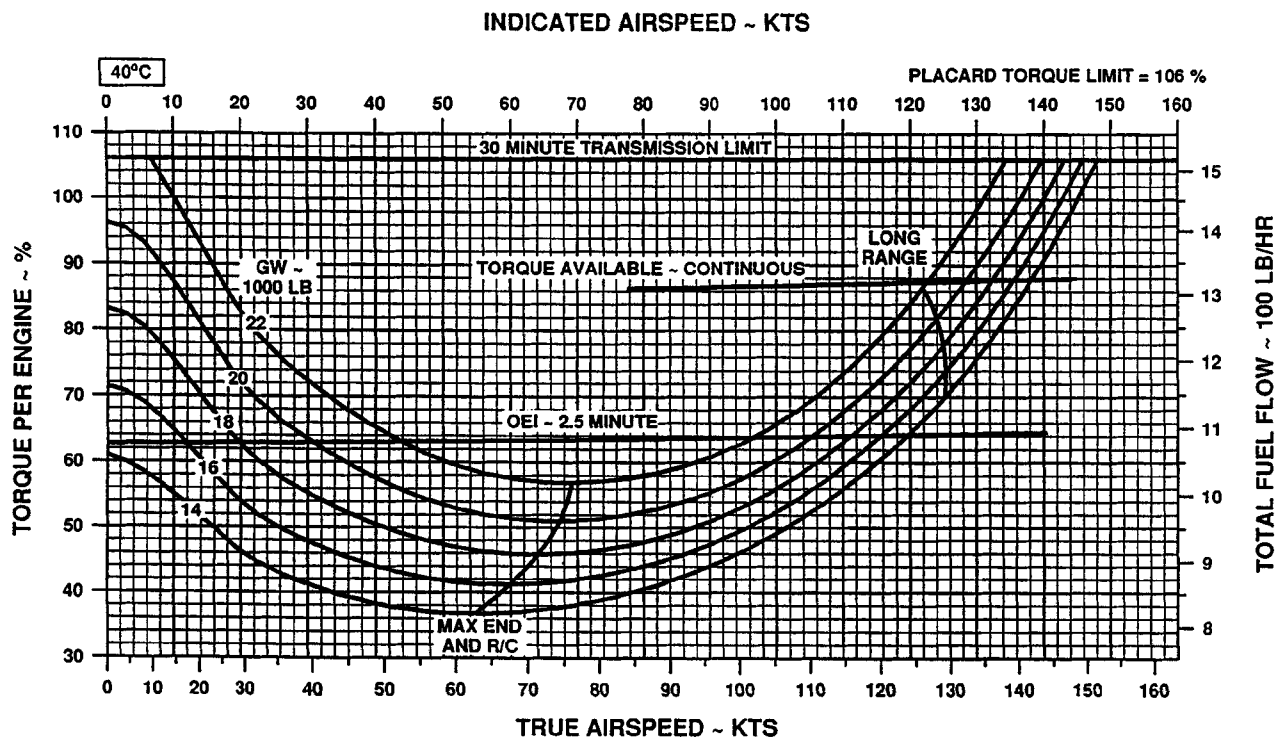
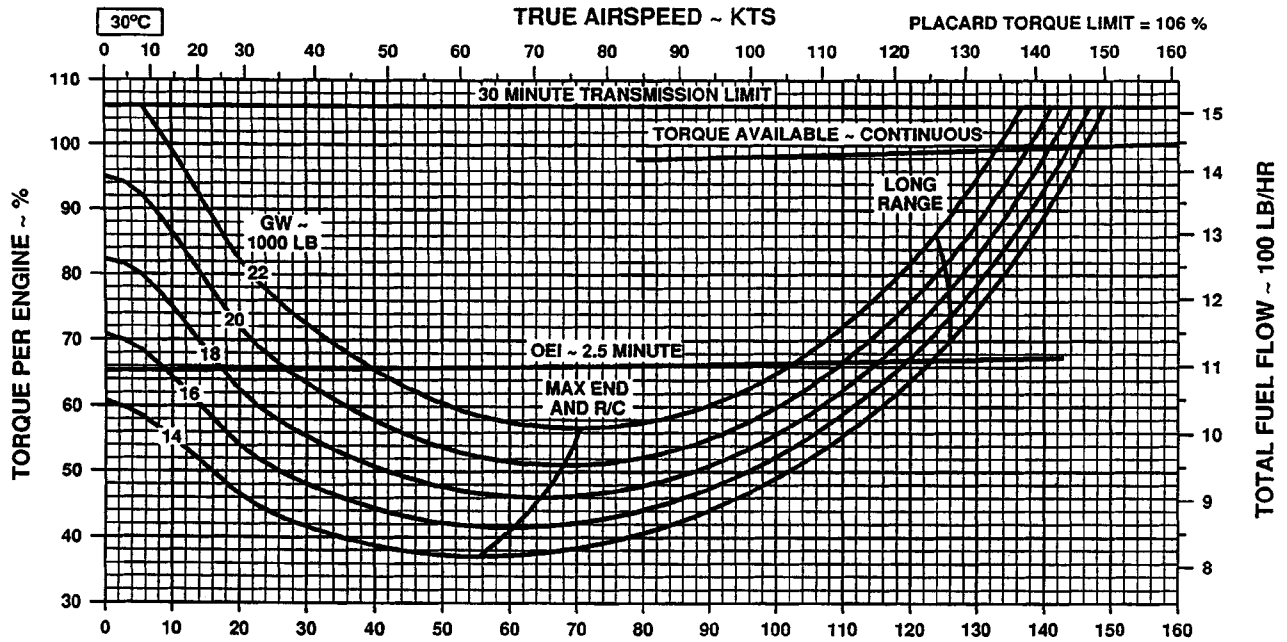
Figure 28-6. Level Flight Performance (0 Feet, 10, 20 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 0 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F201

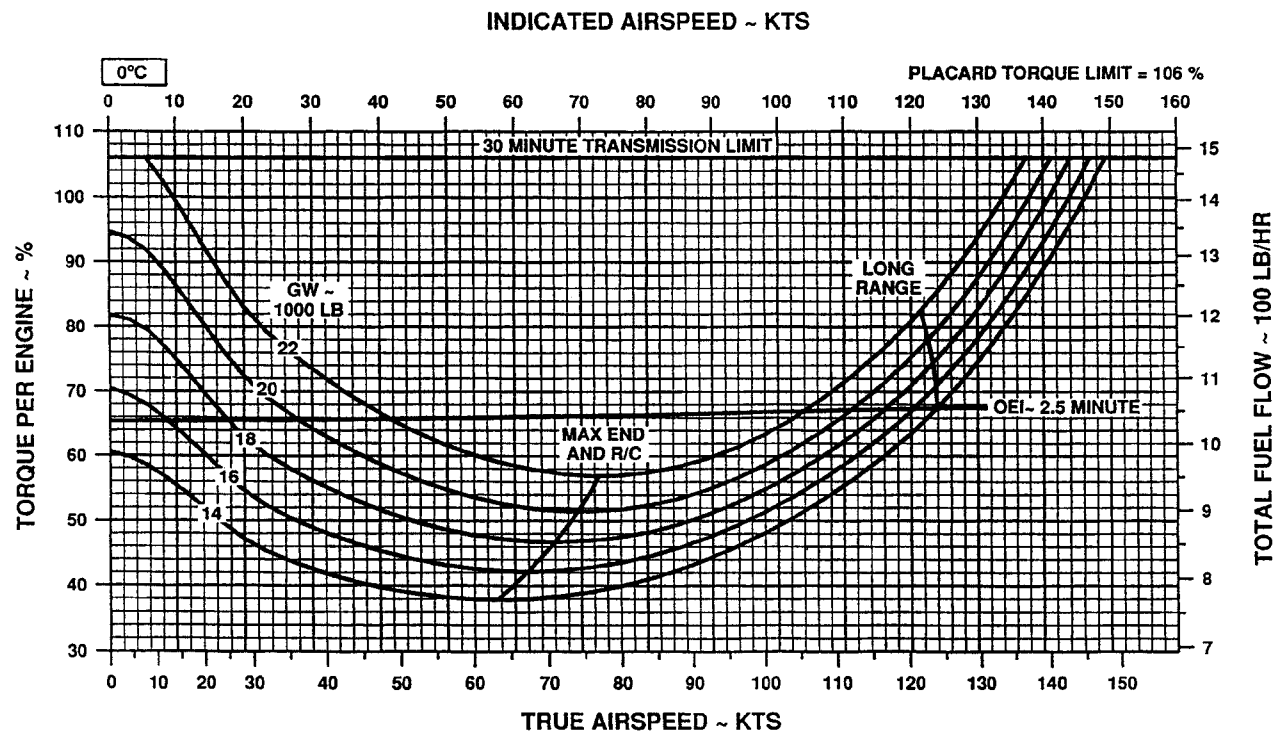
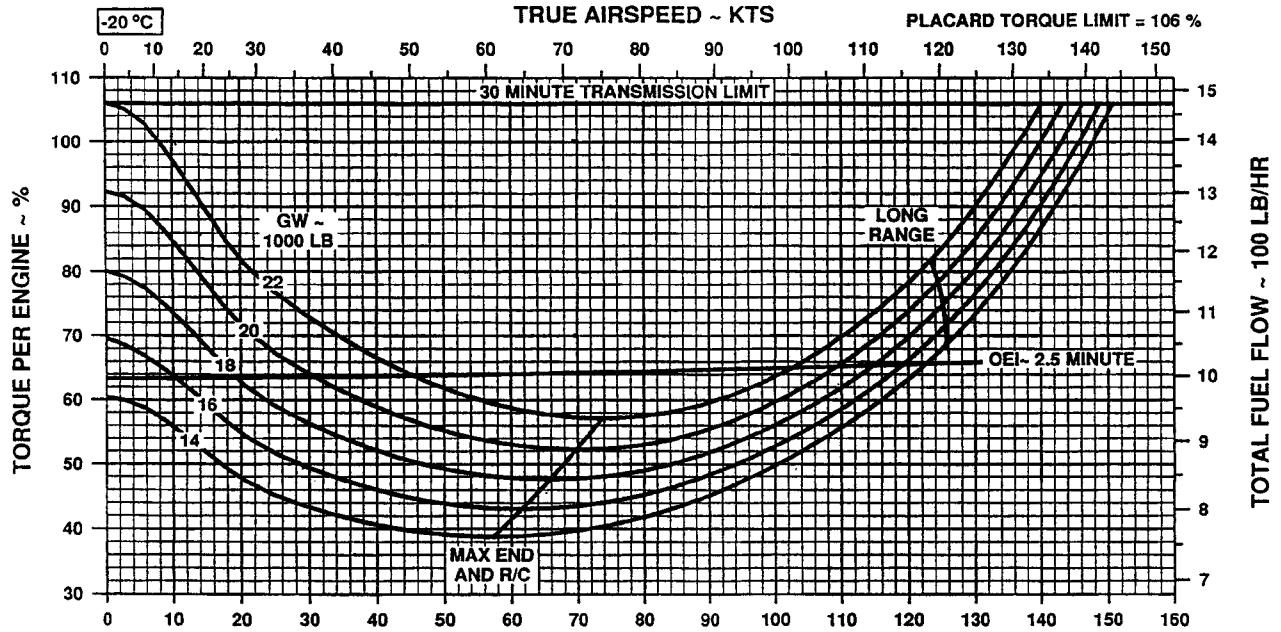
Figure 28-7. Level Flight Performance (0 Feet, 30, 40 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 2000 FT

ENGINES: (2) T700-GE-401C
 FUEL GRADE: JP4, JP5, JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F202

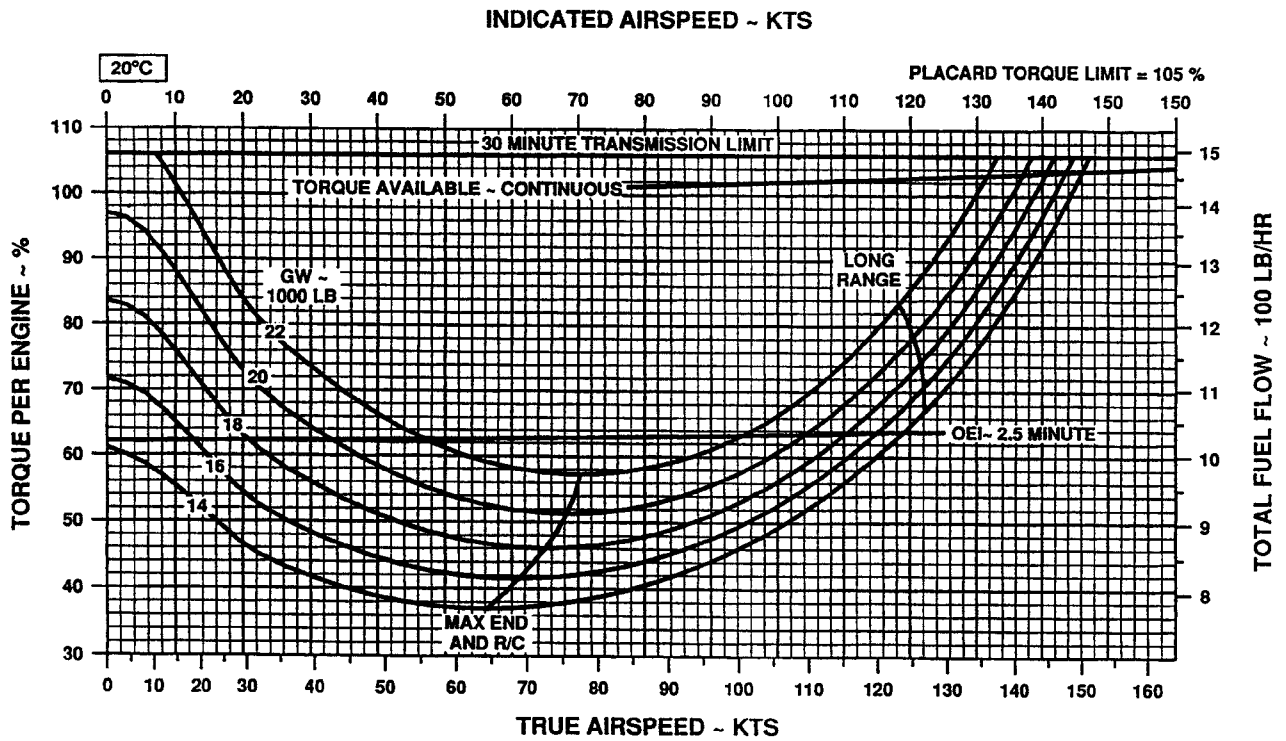
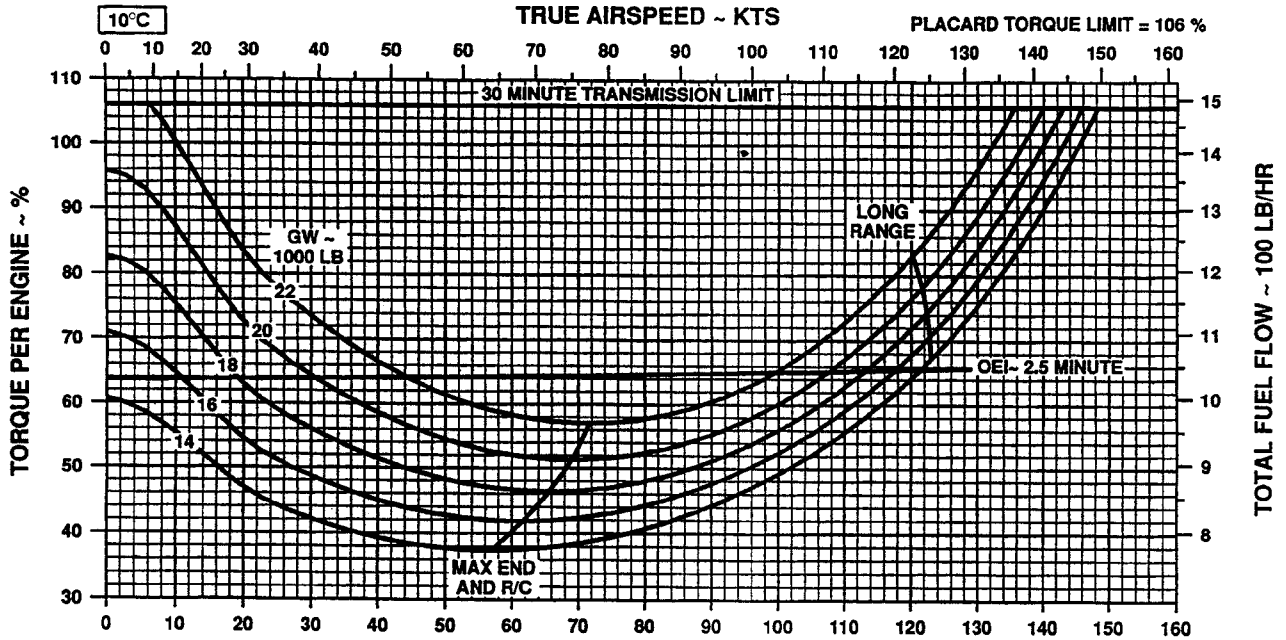
Figure 28-8. Level Flight Performance (2,000 Feet, -20, 0 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 2000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F203

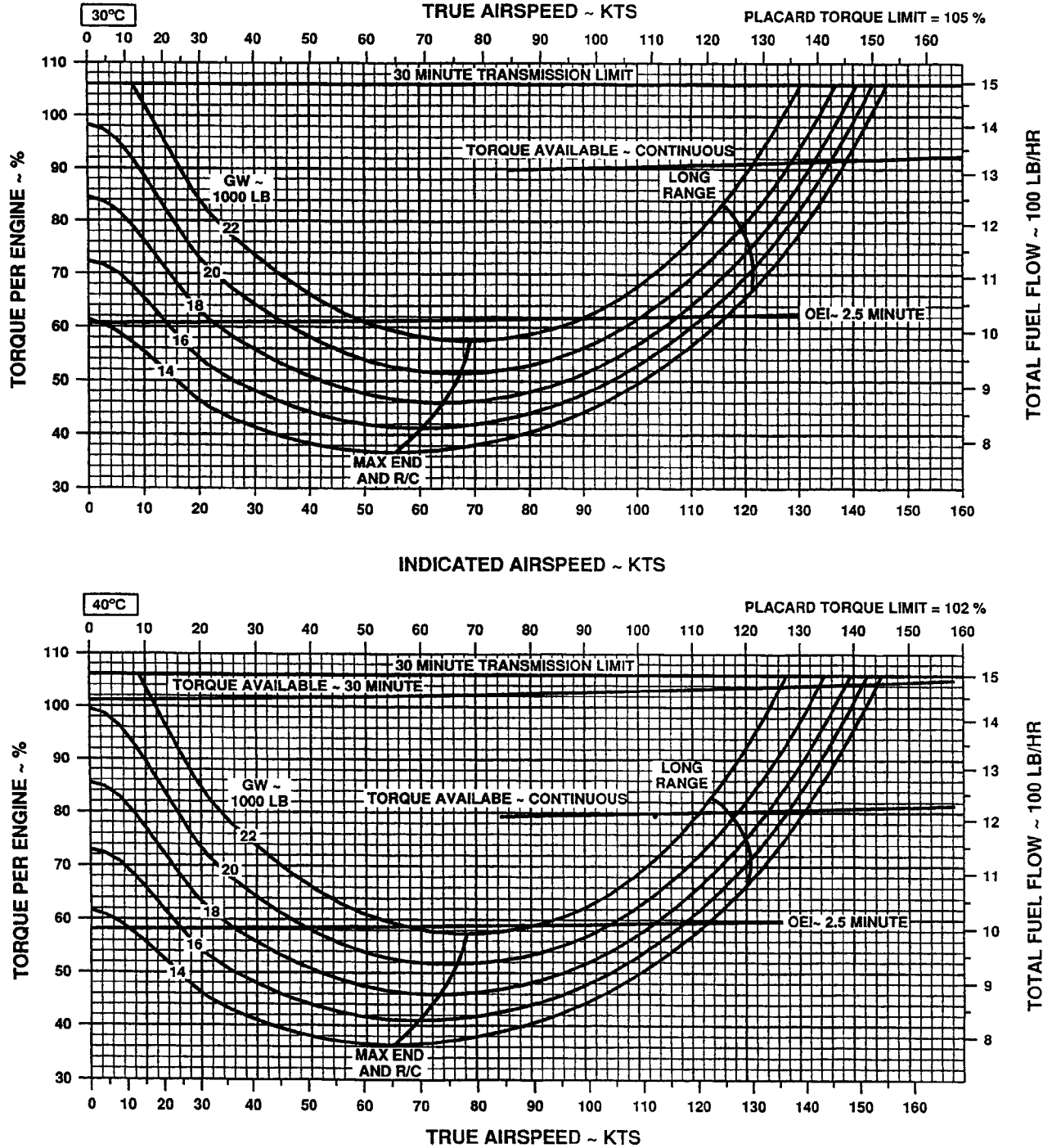
Figure 28-9. Level Flight Performance (2,000 Feet, 10, 20 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 2000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F204

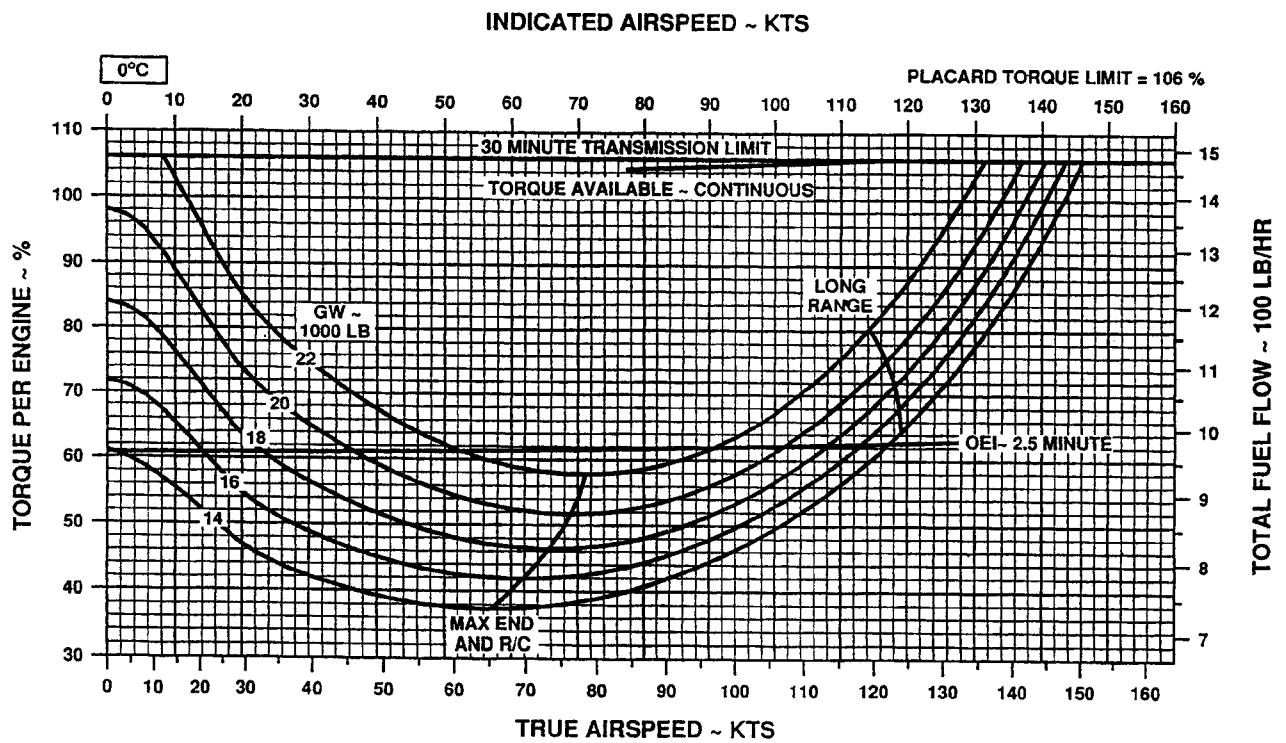
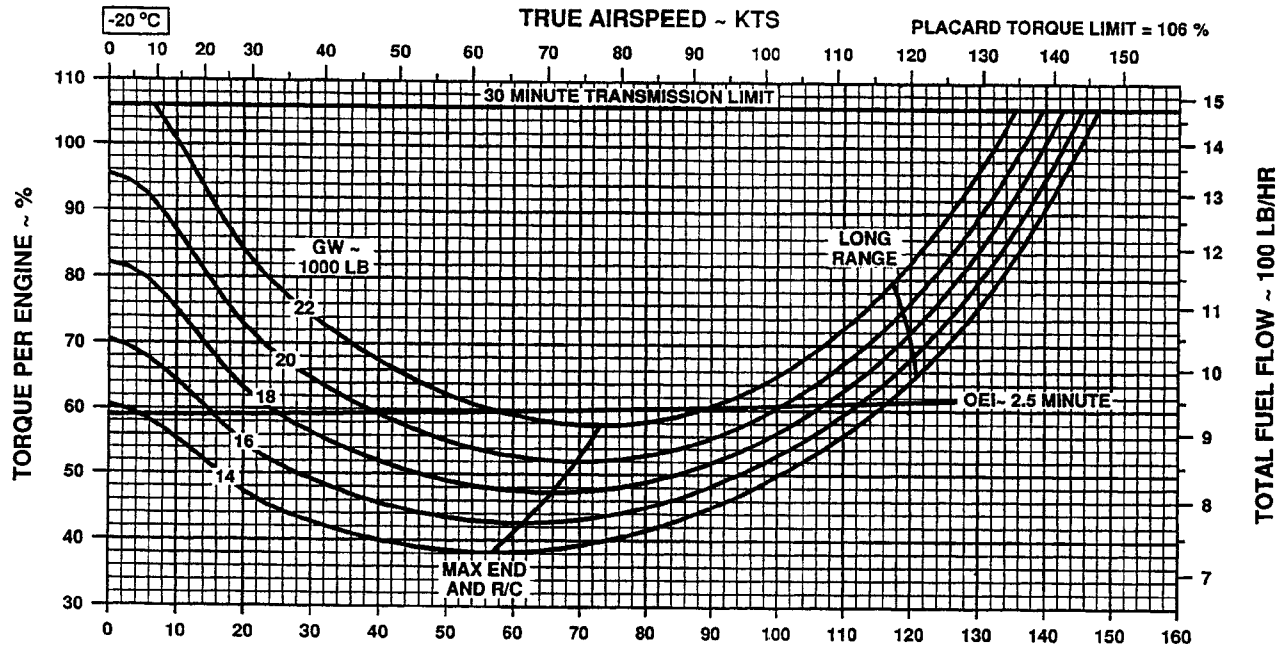
Figure 28-10. Level Flight Performance (2,000 Feet, 30, 40 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 4000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F205

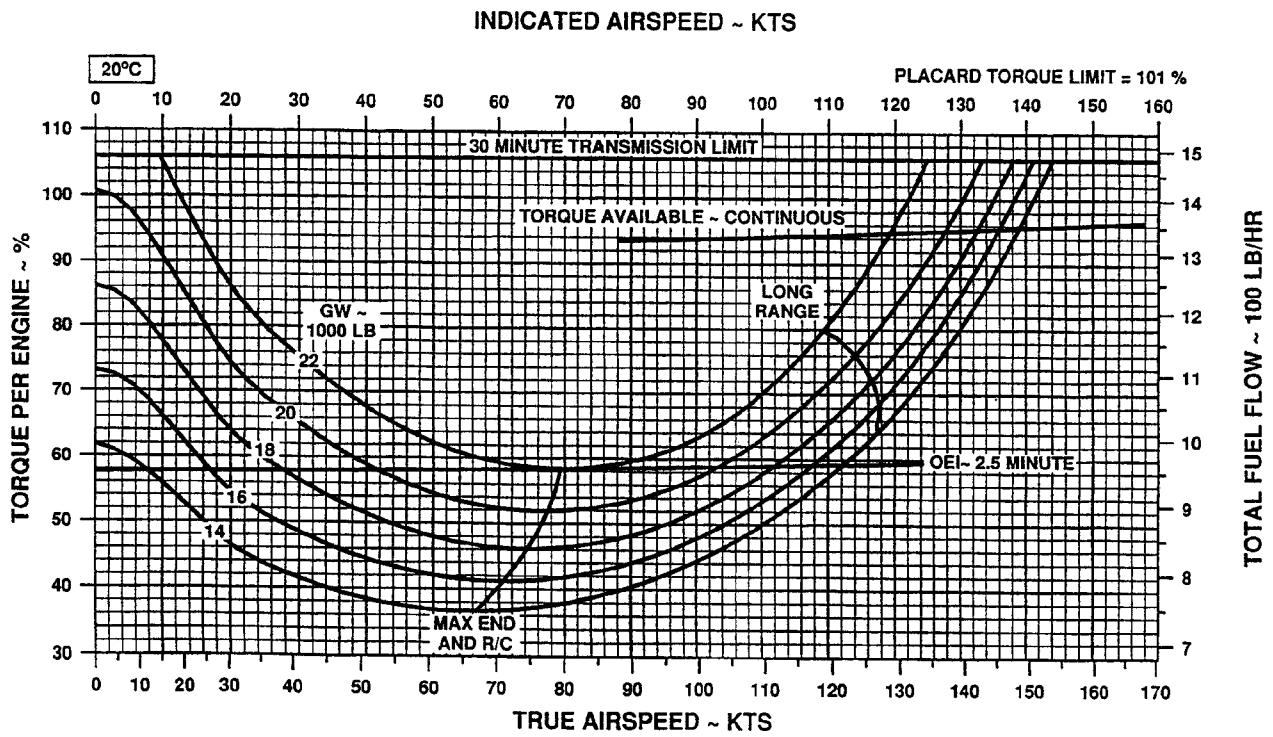
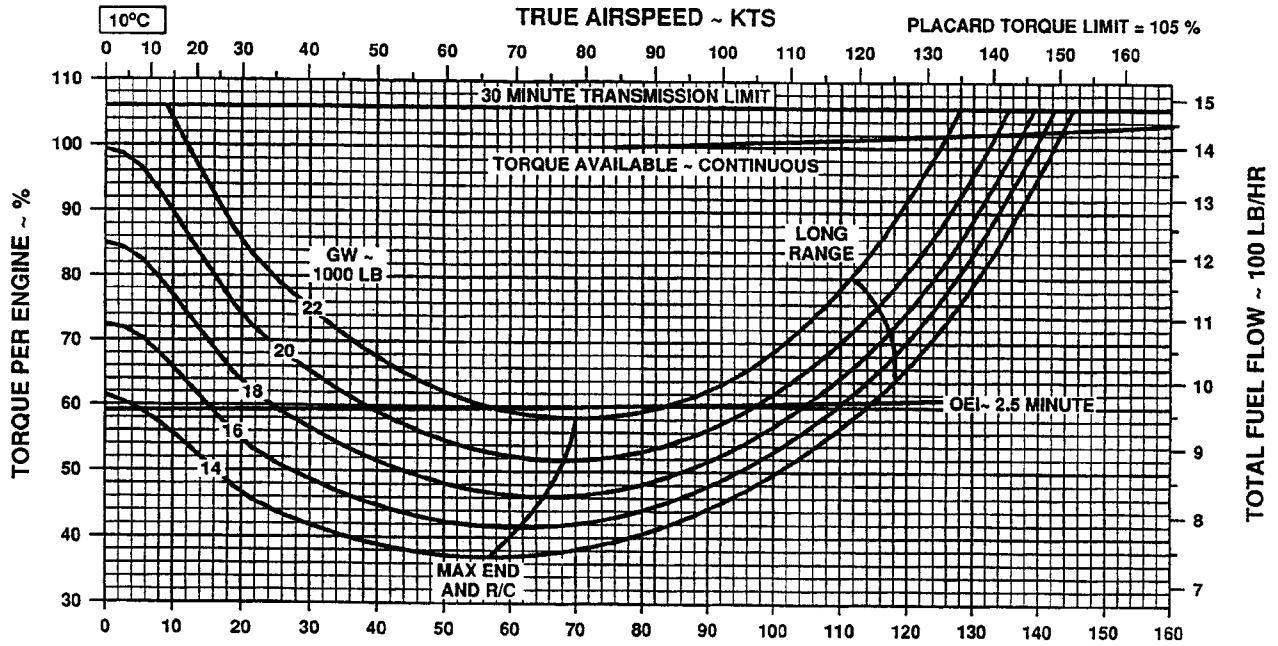
Figure 28-11. Level Flight Performance (4,000 Feet, -20, 0 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 4000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F206

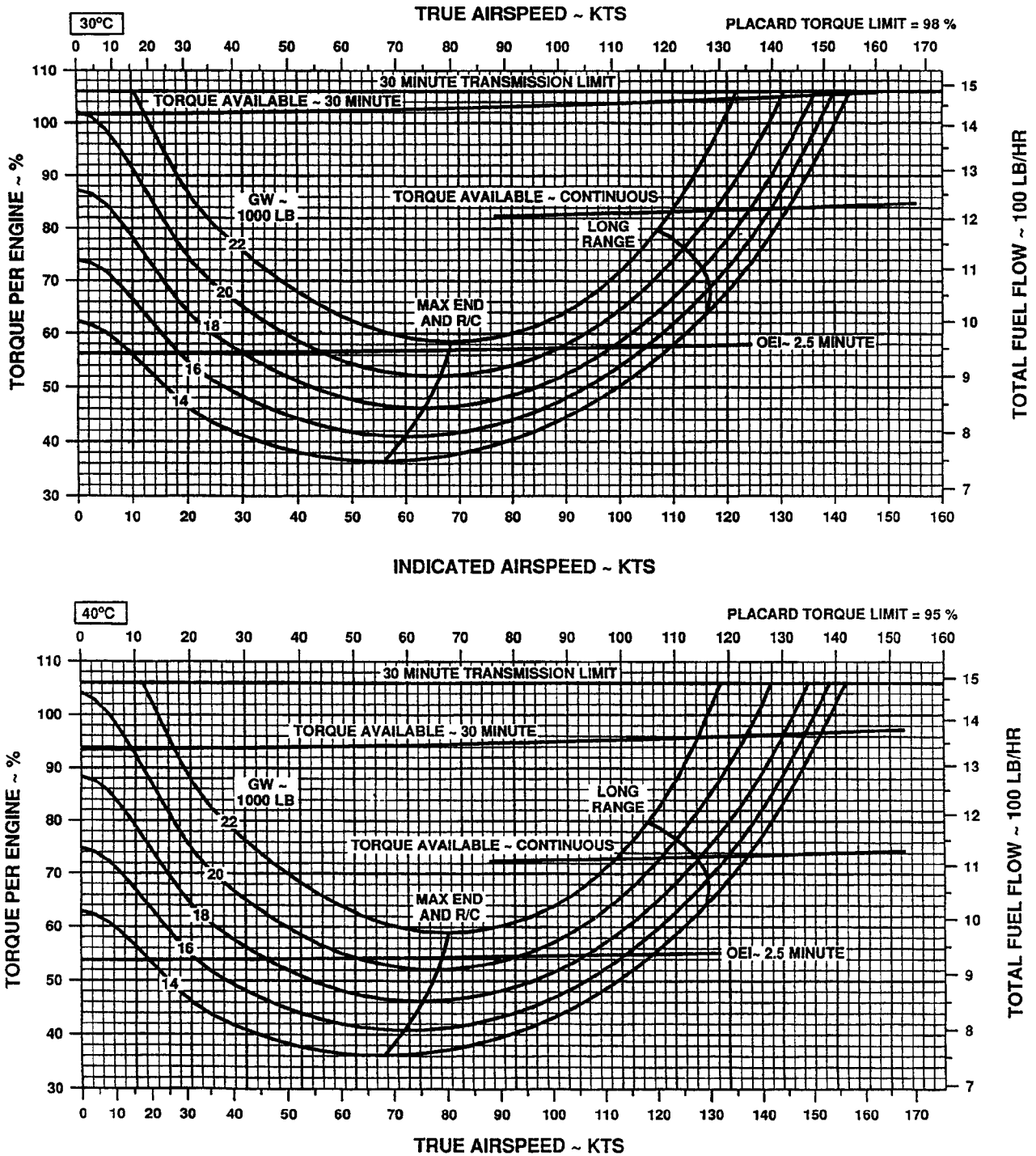
Figure 28-12. Level Flight Performance (4,000 Feet, 10, 20 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 4000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F207

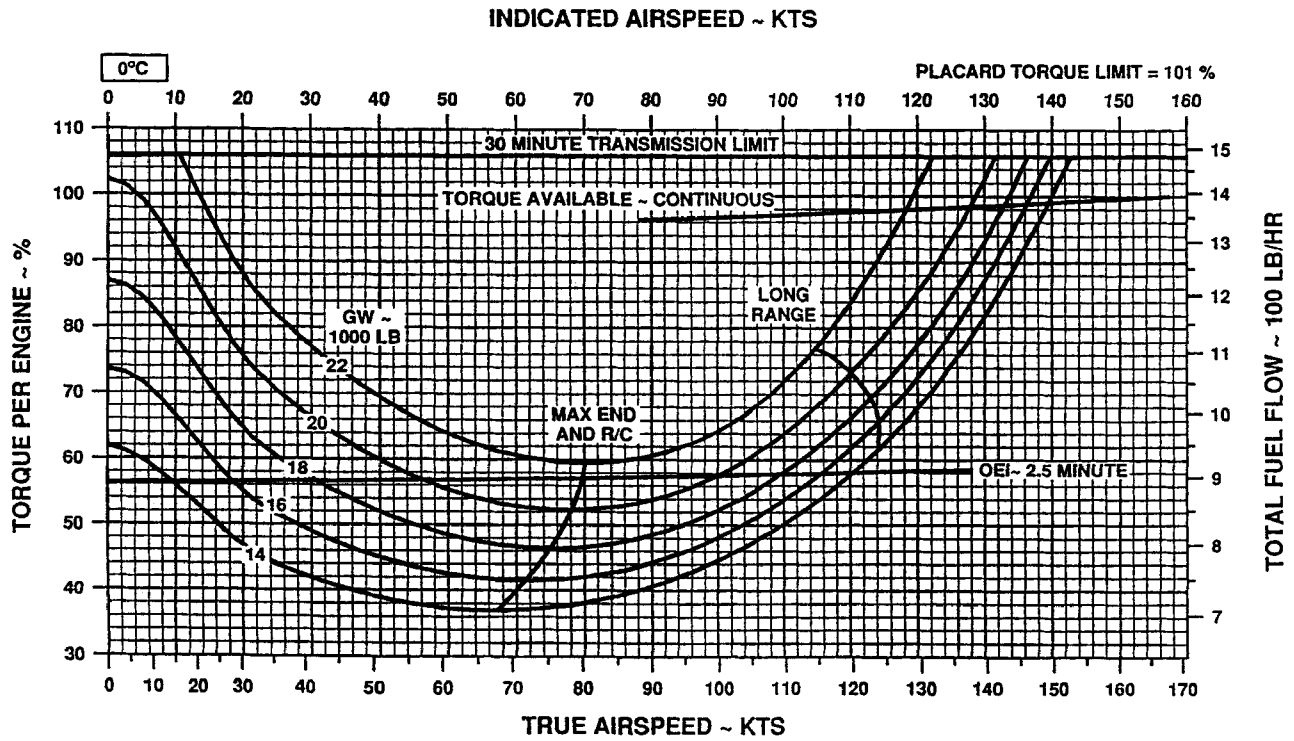
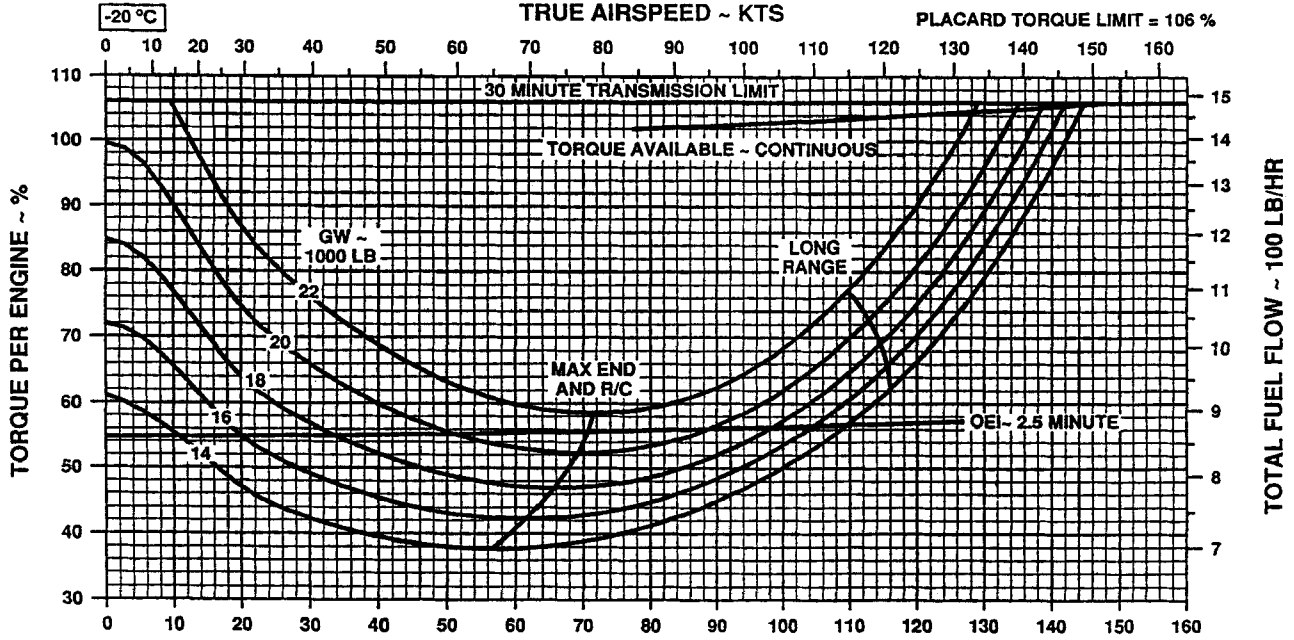
Figure 28-13. Level Flight Performance (4,000 Feet, 30, 40 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 6000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F208

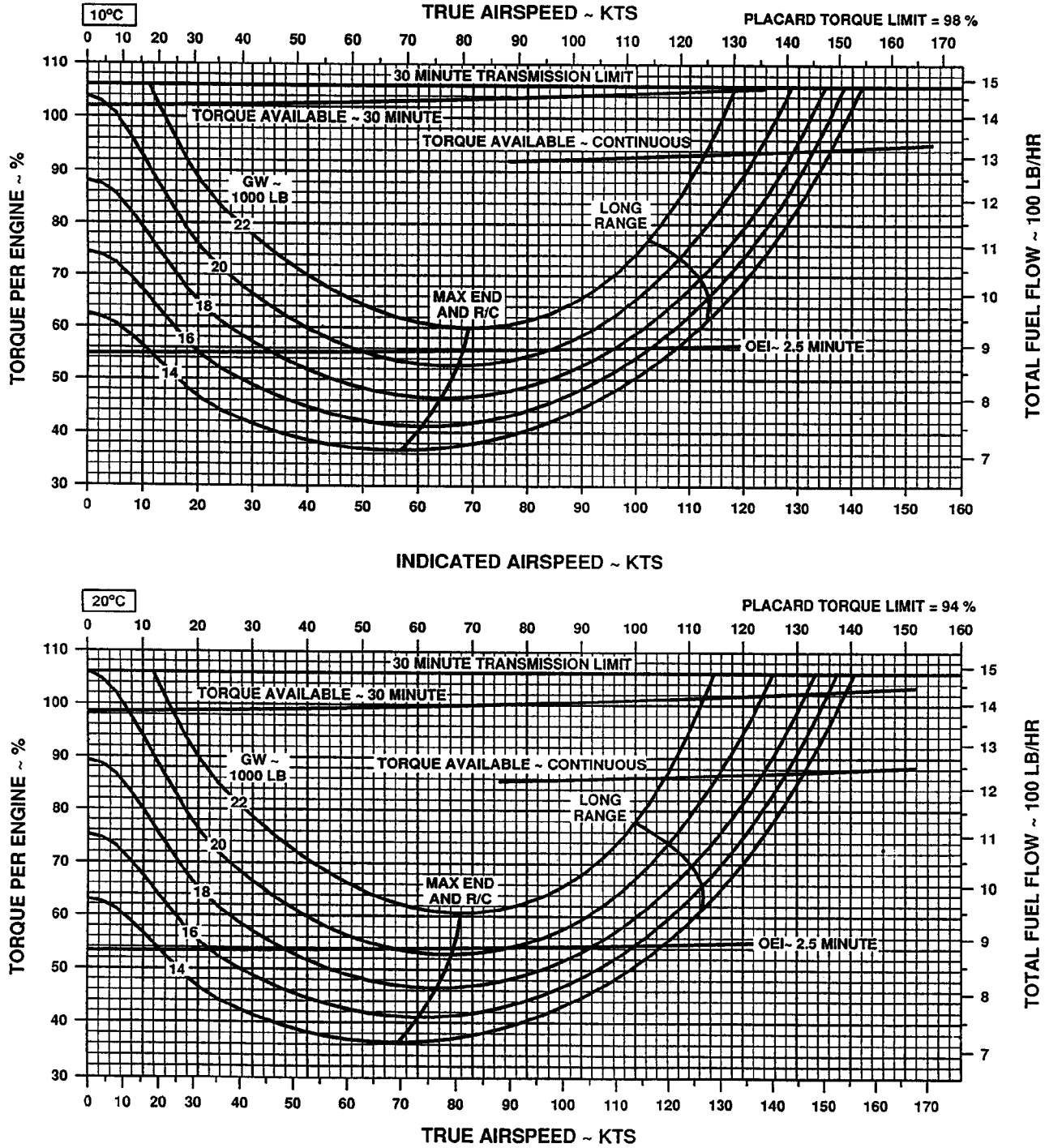
Figure 28-14. Level Flight Performance (6,000 Feet, -20, 0 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 6000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F209

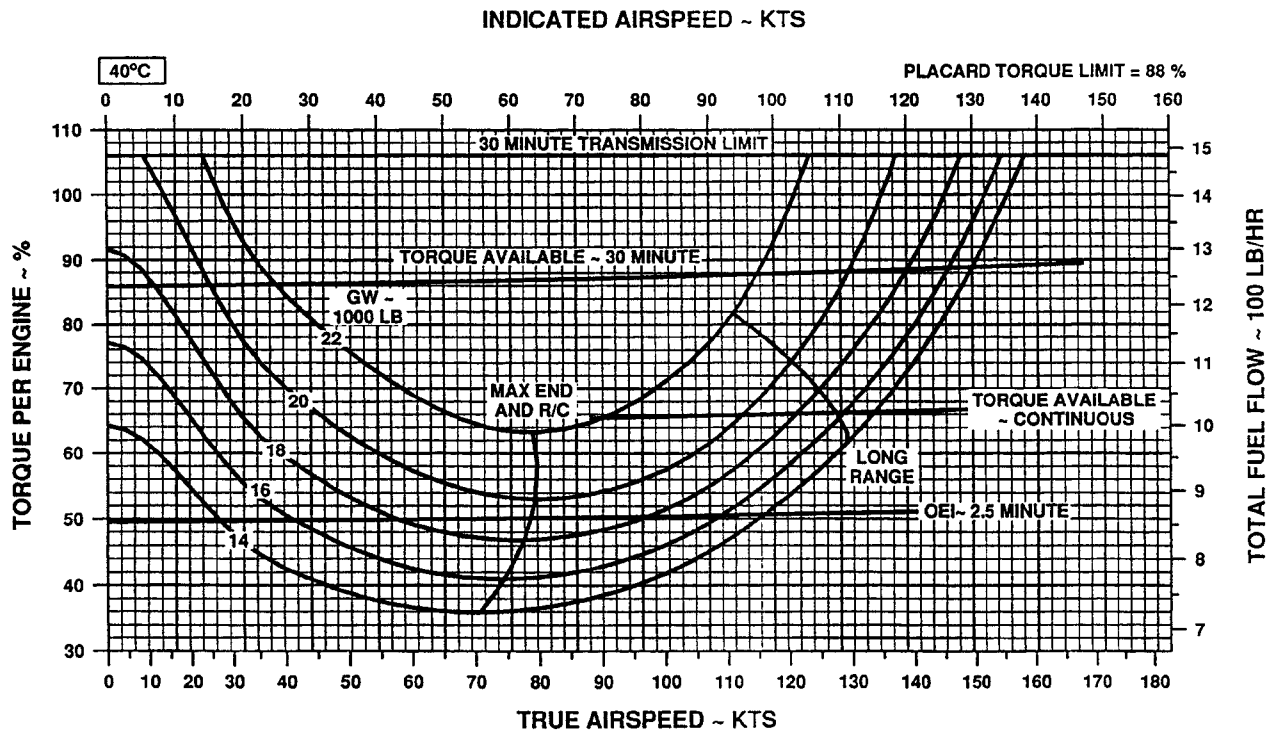
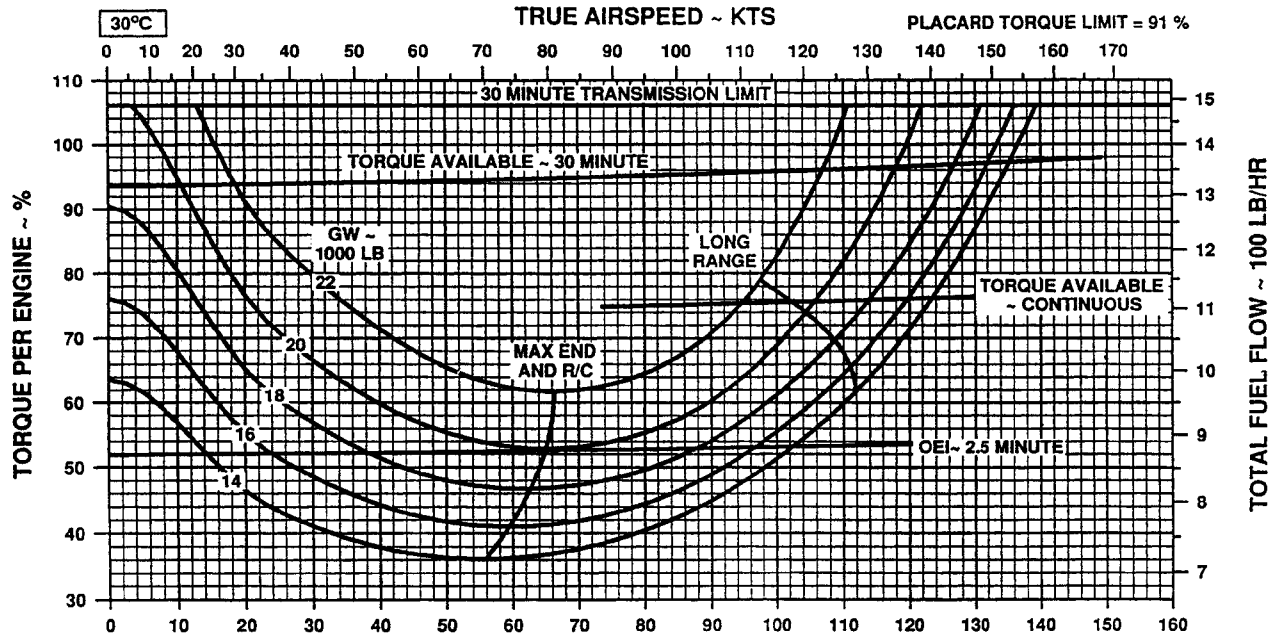
Figure 28-15. Level Flight Performance (6,000 Feet, 10, 20 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 6000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F210

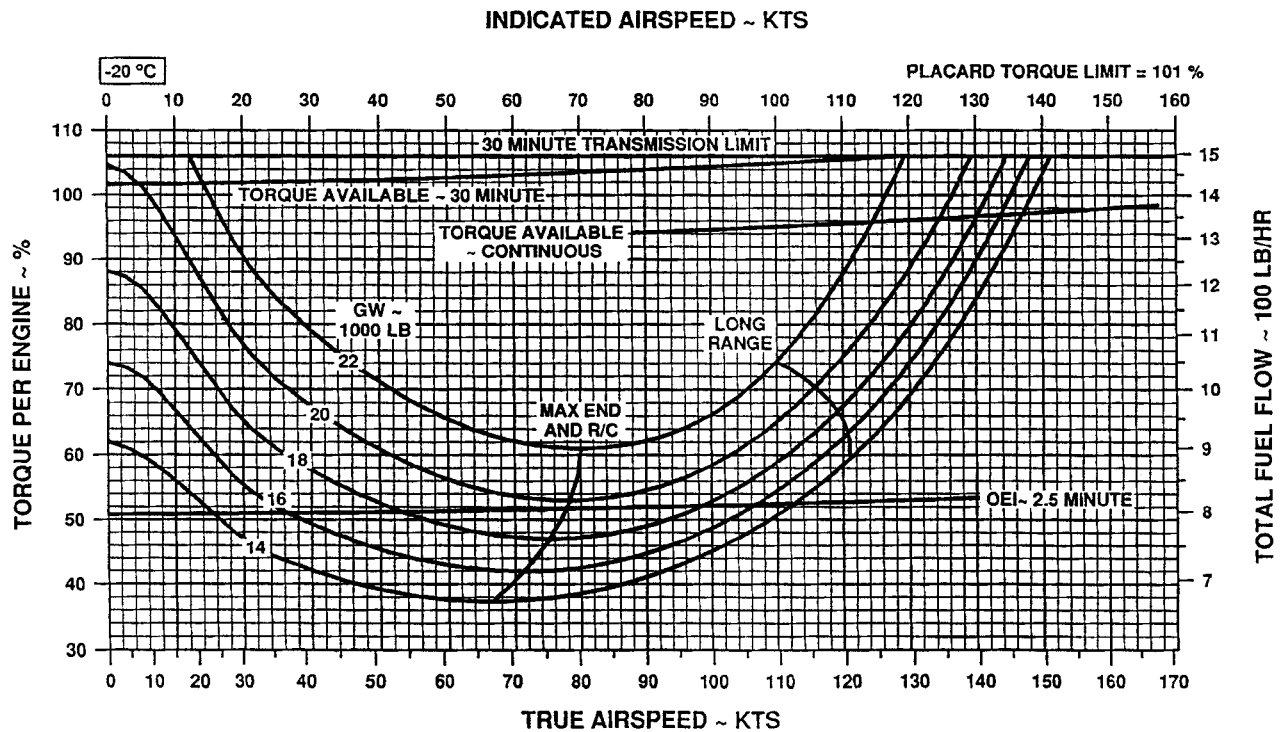
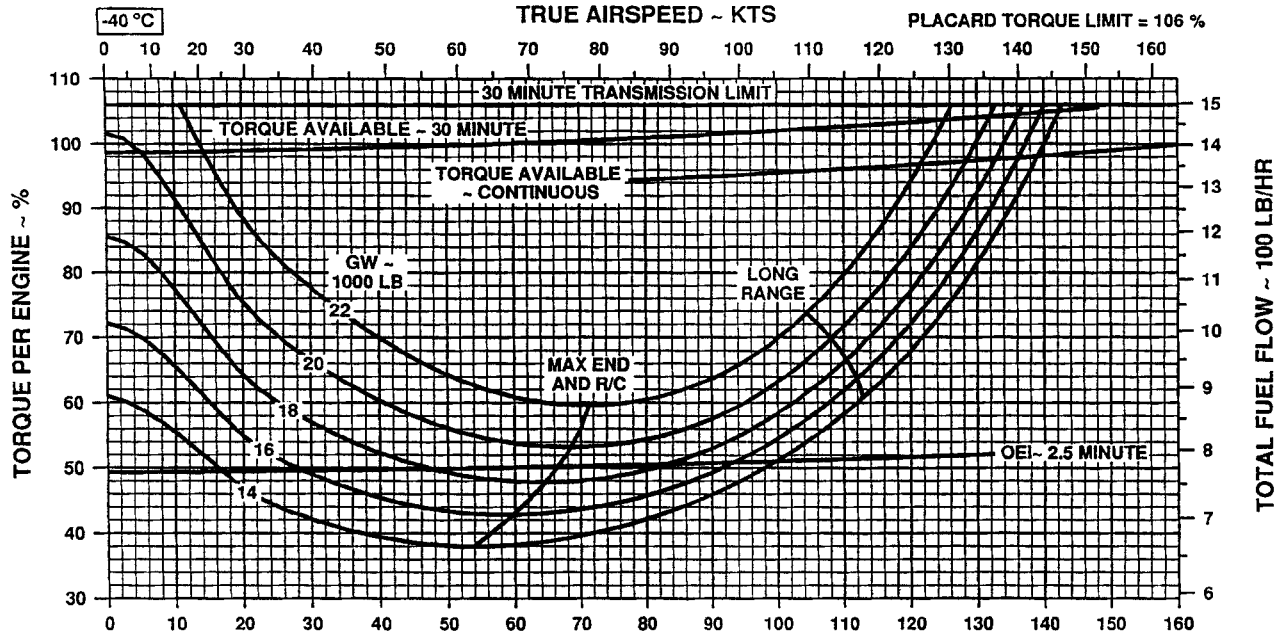
Figure 28-16. Level Flight Performance (6,000 Feet, 30, 40 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 8000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F211

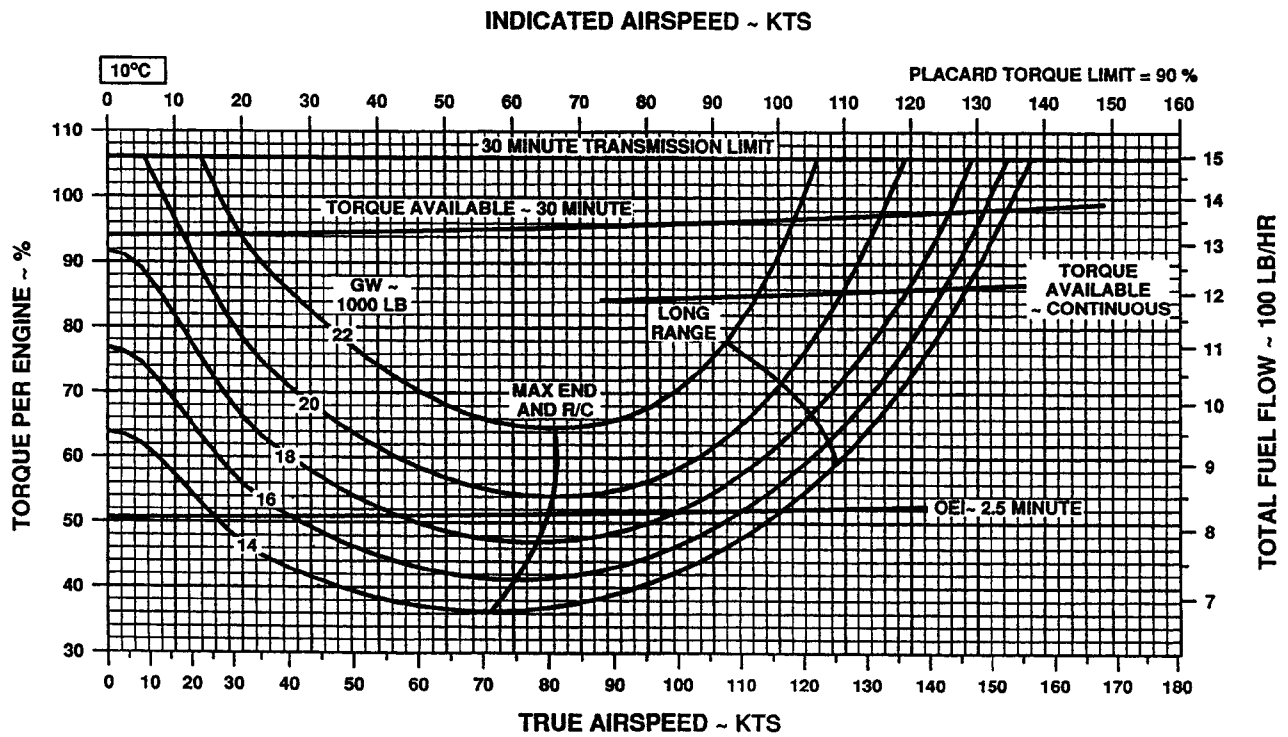
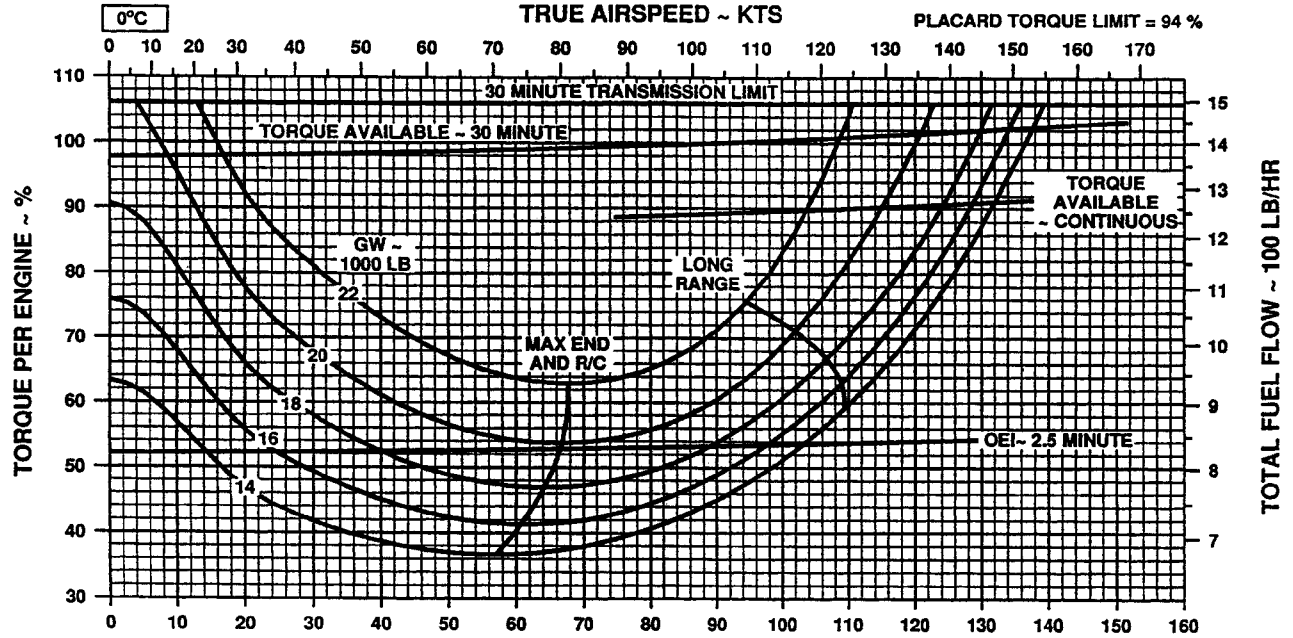
Figure 28-17. Level Flight Performance (8,000 Feet, -40, -20 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 8000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F212

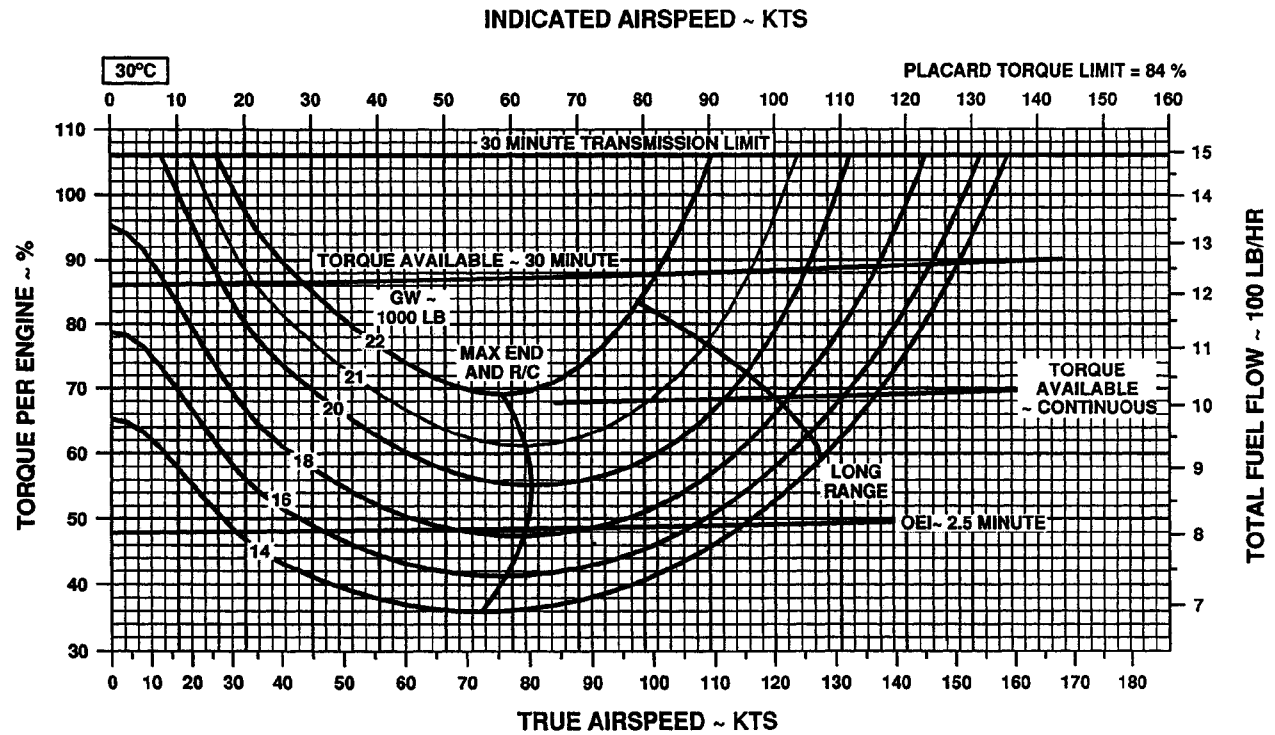
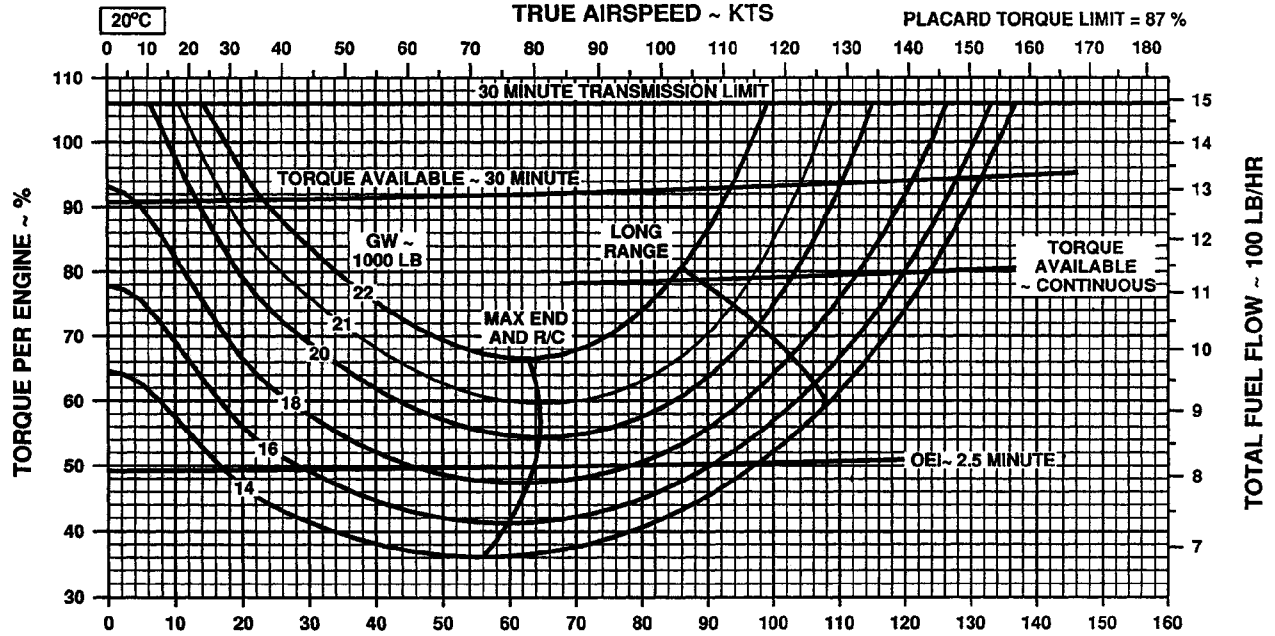
Figure 28-18. Level Flight Performance (8,000 Feet, 0, 10 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 8000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F213

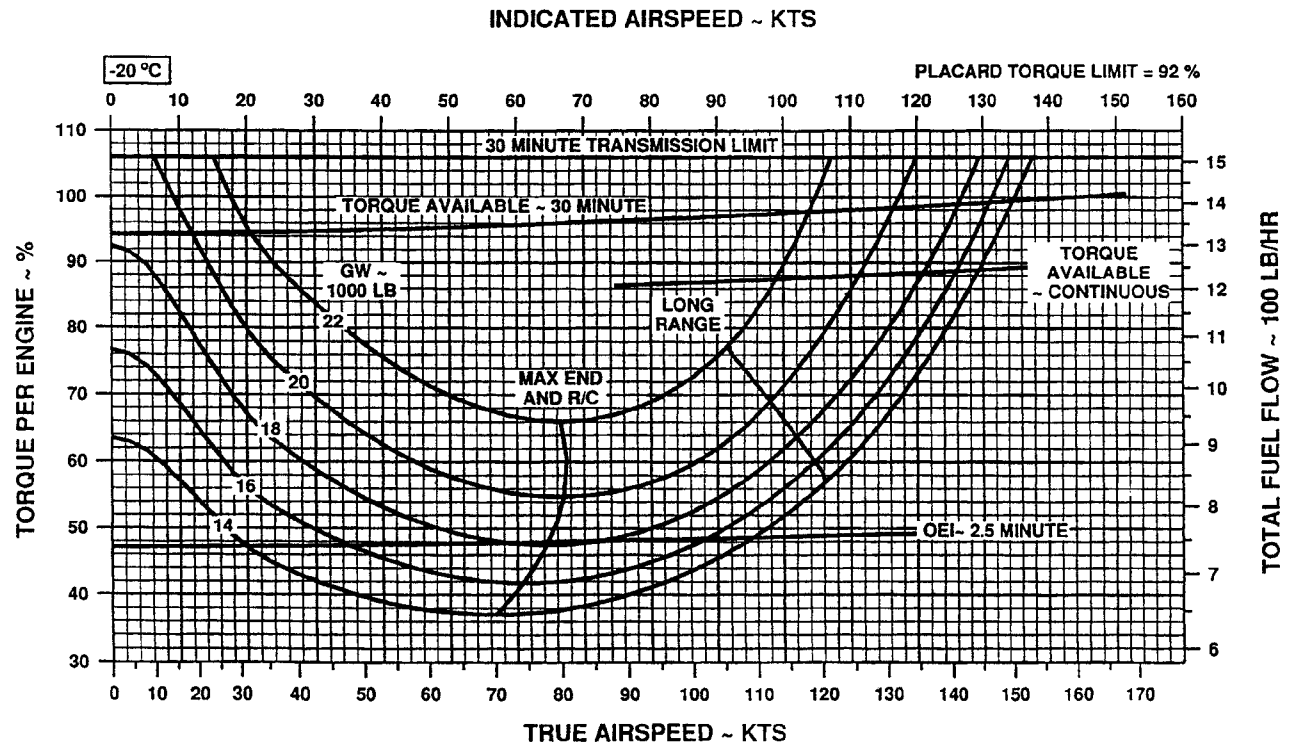
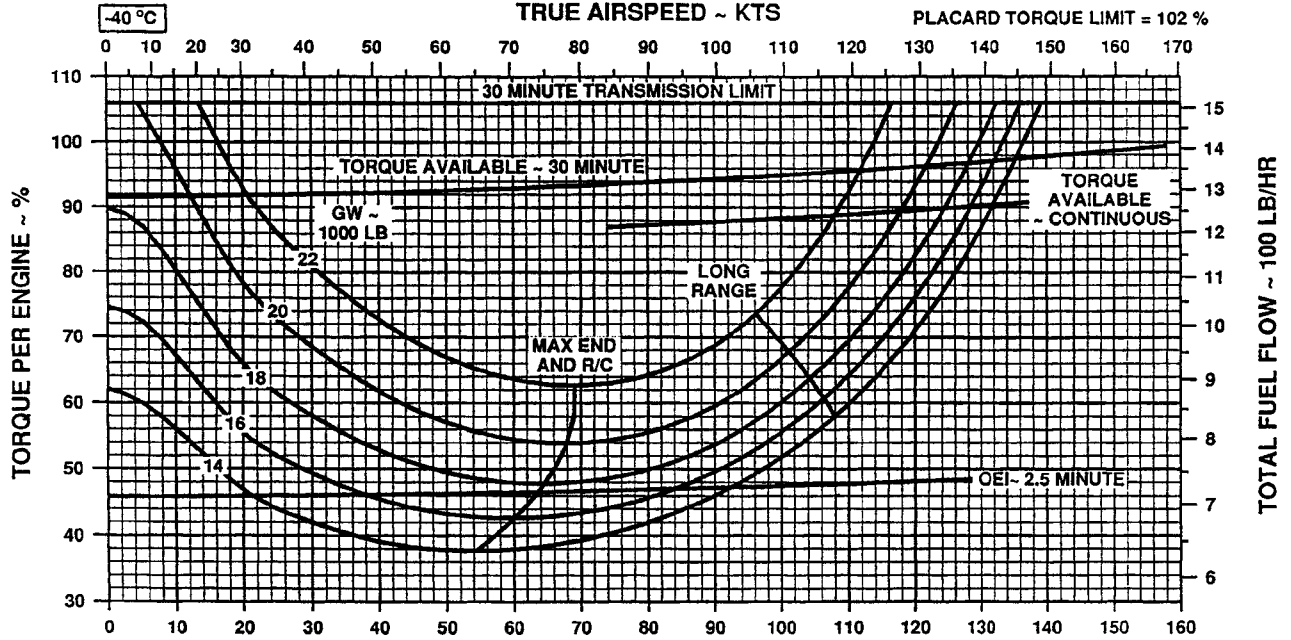
Figure 28-19. Level Flight Performance (8,000 Feet, 20, 30 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 10000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F214

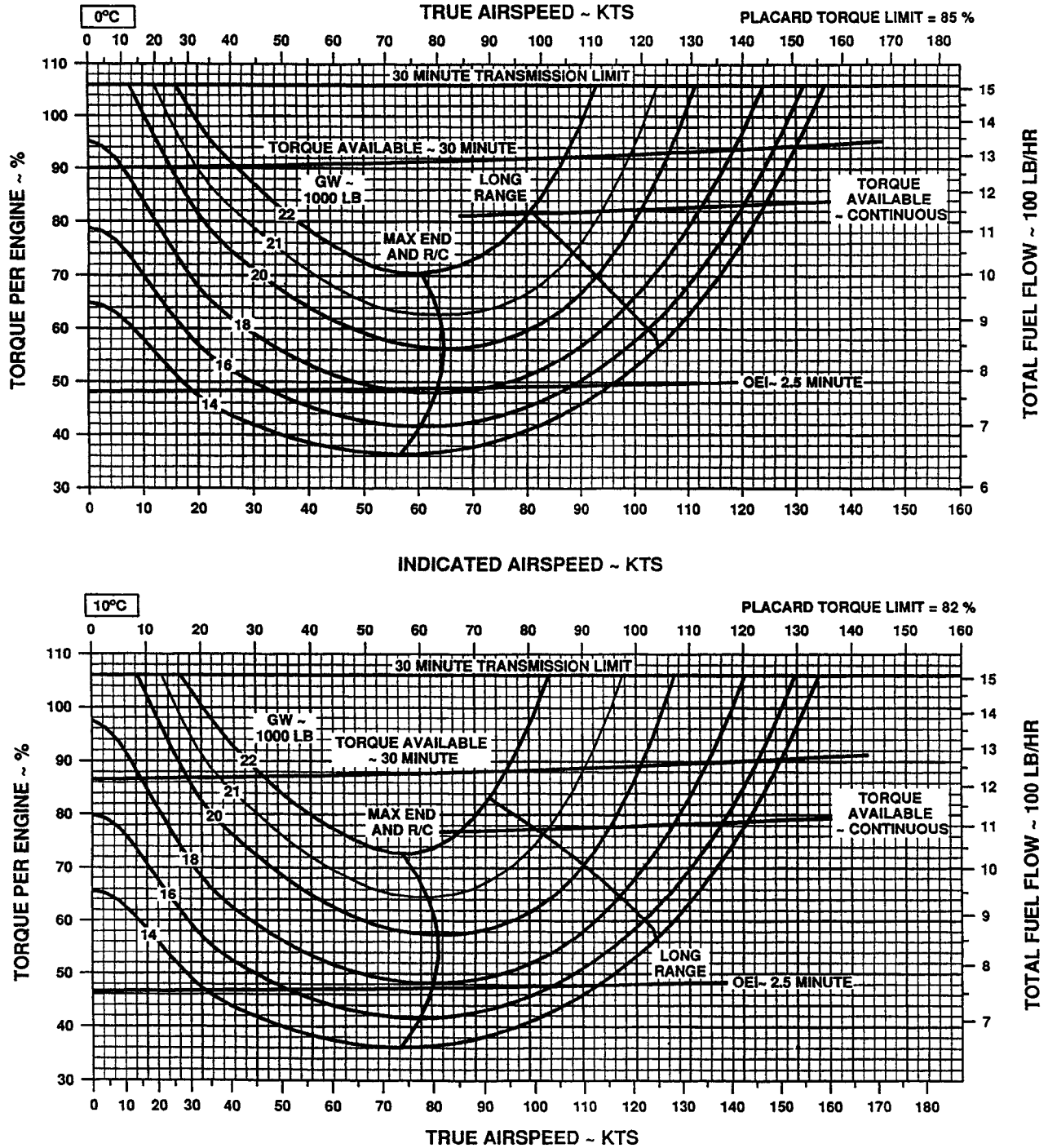
Figure 28-20. Level Flight Performance (10,000 Feet, -40, -20 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 10000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F215

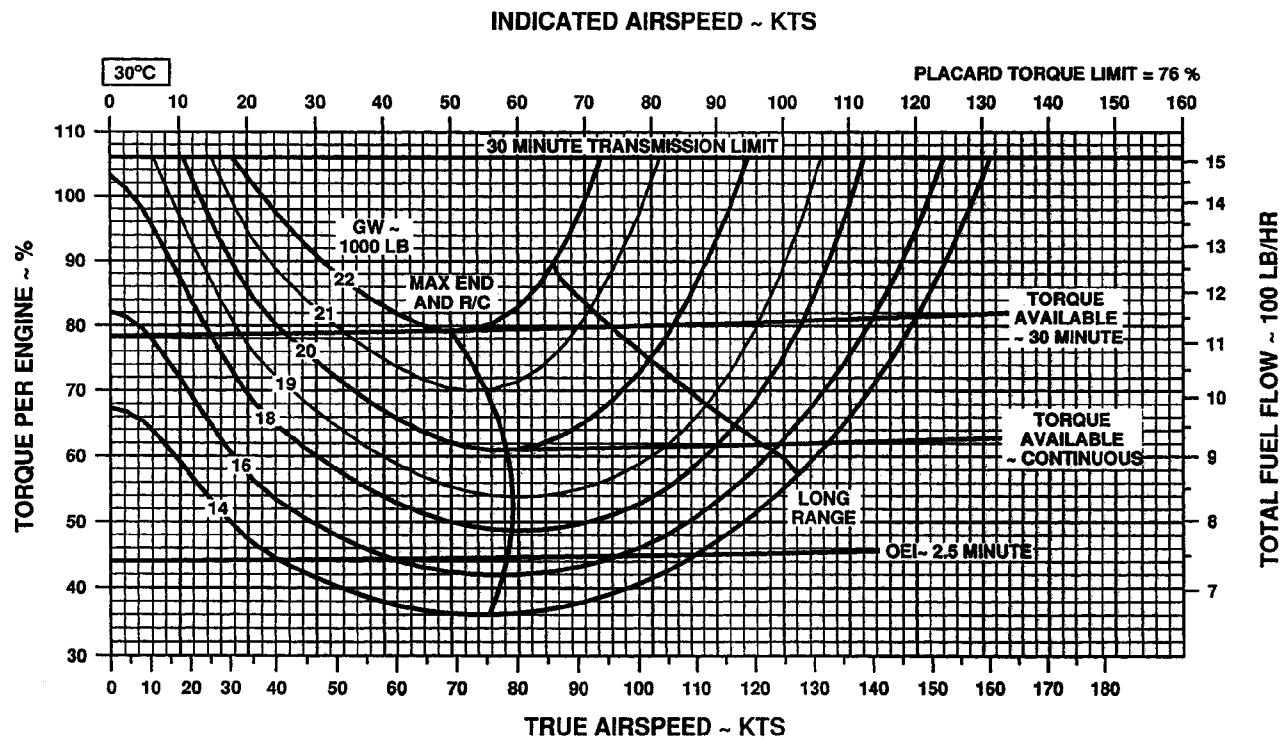
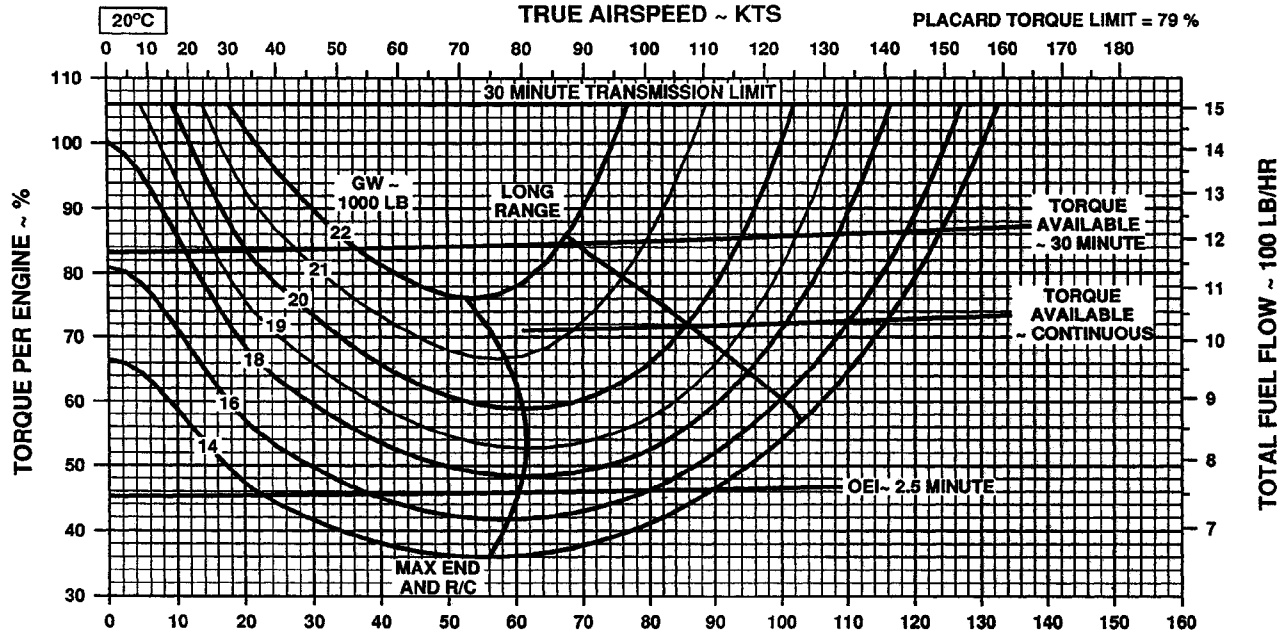
Figure 28-21. Level Flight Performance (10,000 Feet, 0, 10 °C) Charts

LEVEL FLIGHT PERFORMANCE

MODEL: SH-60B
 DATE: MARCH 1995
 DATA BASIS: FLIGHT TEST

100% Nr PRESSURE ALT: 10000 FT

ENGINES:(2) T700-GE-401C
 FUEL GRADE: JP4,JP5,JP8
 FUEL DENSITY: 6.5/6.8/6.7 LB/GAL



SH60B-F216

Figure 28-22. Level Flight Performance (10,000 Feet, 20, 30 °C) Charts

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| Sample problem for use of ability to maintain level flight, single engine chart | 27-1 | Air taxi | 7-89 |
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