TECHNICAL MANUAL

OPERATOR'S MANUAL FOR

UH-60A HELICOPTER

UH-60L HELICOPTER

EH-60A HELICOPTER

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*This manual supersedes TM 1-1520-237-10, dated 17 April 2006, including all changes.

HEADQUARTERS, DEPARTMENT OF THE ARMY

25 SEPTEMBER 2009

WARNING

Personnel performing operations, procedures, and practices which are included or implied in this technical manual shall observe the following warnings. Disregard of these warnings and precautionary information can cause serious injury or loss of life.

BATTERY ELECTROLYTE

Battery electrolyte is harmful to the skin and clothing. If potassium hydroxide is spilled on clothing or other material, wash immediately with clean water. If spilled on personnel, immediately flush the affected area with clean water. Continue washing until medical assistance arrives. Neutralize any spilled electrolyte by thoroughly flushing contacted area with water.

CARBON MONOXIDE

When smoke, suspected carbon monoxide fumes, or symptoms of anoxia exist, the crew should immediately ventilate the cockpit.

ELECTROMAGNETIC INTERFERENCE (EMI)

No electrical/electronic devices of any sort, other than those described in this manual or appropriate airworthiness release and approved by USAAMCOM AMSRD-AMR-AE-U, are to be operated by crewmembers or passengers during operation of this helicopter.

FIRE EXTINGUISHER

Exposure to high concentrations of extinguishing agent or decomposition products should be avoided. The liquid should not be allowed to come into contact with the skin, as it may cause frost bite or low temperature burns.

HANDLING FUEL AND OIL

Turbine fuels and lubricating oils contain additives which are poisonous and readily absorbed through the skin. Do not allow them to remain on skin longer than necessary.

HIGH VOLTAGE

All ground handling personnel shall be informed of high voltage hazards when making external cargo hookups.

NOISE

Sound pressure levels in this helicopter during some operating conditions exceed the Surgeon General's hearing conservation criteria, as defined in DA PAM 40-501. Hearing protection devices, such as the aviator helmet or ear plugs are required to be worn by all personnel in and around the helicopter during its operation. When window guns are firing, when flights exceed 100 minutes during any 24 hour period, or when speeds are above 120 knots, helmet and ear plugs shall be worn by all crewmembers.

WEAPONS AND AMMUNITION

Observe all standard safety precautions governing the handling of weapons and live ammunition. When not in use, point all weapons in a direction offering the least exposure to personnel and property in case of accidental firing. Do not walk in front of weapons. SAFE the machinegun before servicing. To avoid potentially dangerous situations, follow all procedural warnings in text.

ELECTROMAGNETIC RADIATION

Do not stand within six feet of Aircraft Survivability Equipment (ASE), ALQ-156, ALQ-162, and ALQ-144 transmit antennas when the ASE equipment is on. High frequency electromagnetic radiation can cause internal burns without causing any sensation of heat. The HF radio transmits high power electromagnetic radiation. Serious injury or death can occur if you touch the HF antenna while it is transmitting. Do not grasp, or lean against the antenna when power is applied to the helicopter.

ALQ-144

Do not continuously look at the ALQ-144 infrared countermeasure transmitter during operation, or for a period of over 1 minute from a distance of less than 3 feet. Skin exposure to countermeasure radiation for longer than 10 seconds at a distance less than 4 inches shall be avoided.

IR COUNTERMEASURES MUNITIONS

Advanced IR countermeasures munitions (AIRCMM) M-211 and M-212 flares should not be loaded in the M-130 general purpose dispenser as countermeasures against IR missile threat environment. Advanced IR countermeasures munitions (AIRCMM) M-211 and M-212 flares will provide inadequate IR countermeasures capability and will significantly increase aircrew vulnerability.

AIR WARRIOR

If performing a combat mission with an Air Warrior ballistic upgrade plate (BUP), the seat belt buckle must be positioned below the BUP to prevent potential aft cyclic restriction.

When performing a combat mission or overwater mission, aviator worn gear can restrict head and torso movement. Users should conduct ground familiarity drills (blind switch/control identification) and crew coordination exercises before flight since field of regard can be restricted by aviator worn mission equipment. The user must strictly adhere to proper crew coordination procedures during switch identification.

Prior to flight, the user must perform control sweeps to ensure there are no flight control interference problems with aviator worn gear. If a restriction is found, the interfering gear must be adjusted/moved to eliminate the restriction.

LIST OF EFFECTIVE PAGES

Insert latest change pages; dispose of superseded pages in accordance with applicable policies.

NOTE: On a changed page, the portion of the text affected by the latest change is indicated by a vertical line in the outer margin of the page. Changes to illustrations are indicated by a hand pointing to the changed area on the illustration or a MAJOR CHANGE symbol.

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Α	0	3-152 Blank	0	9-1 - 9-28	0
B Blank	0	4-1 - 4-88	0	A-1 - A-2	0
i - v	0	5-1 - 5-24	0	B-1 - B-5	0
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* Zero in this column indicates an original page.

TECHNICAL MANUAL

NO. 1-1520-237-10

HEADQUARTERS DEPARTMENT OF THE ARMY WASHINGTON, D.C. 25 SEPTEMBER 2009

Operator's Manual for UH-60A, UH-60L, EH-60A HELICOPTERS

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can improve this manual. If you find any mistakes, or if you know of a way to improve these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms), located in the back of this manual, directly to: Commander, US Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. A reply will be furnished to you. You may also send in your comments electronically to our E-mail address: 2028@redstone.army.mil or by fax 256-842-6546/DSN 788-6546. For the World Wide Web use: https://amcom2028.redstone.army.mil. Instructions for sending an electronic 2028 may be found at the back of this manual immediately preceding the hard copy 2028.

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CHAPTER 1 INTRODUCTION

1.1 GENERAL.

These instructions are for use by the operator. They apply to UH-60A, UH-60L, and EH-60A helicopters.

1.2 WARNINGS, CAUTIONS, AND NOTES.

Warnings, cautions, and notes are used to emphasize important and critical instructions and are used for the following conditions:



An operating procedure, practice, etc., which, if not correctly followed, could result in personal injury or loss of life.



An operating procedure, practice, etc., which, if not strictly observed, could result in damage to or destruction of equipment.

NOTE

An operating procedure, condition, etc., which is essential to highlight.

1.3 DESCRIPTION.

This manual contains the complete operating instructions and procedures for UH-60A, UH-60L, and EH-60A helicopters. The primary mission of this helicopter is that of tactical transport of troops, medical evacuation, cargo, and reconnaissance within the capabilities of the helicopter. The observance of limitations, performance, and weight and balance data provided is mandatory. The observance of procedures is mandatory except when modification is required because of multiple emergencies, adverse weather, terrain, etc. Your flying experience is recognized and therefore, basic flight principles are not included. IT IS REQUIRED THAT THIS MANUAL BE CARRIED IN THE HELICOPTER AT ALL TIMES.

1.4 APPENDIX A, REFERENCES.

Appendix A is a listing of official publications cited within the manual applicable to and available for flight crews and fault isolation/trouble references.

1.5 APPENDIX B, ABBREVIATIONS AND TERMS.

Abbreviations listed are to be used to clarify the text in this manual only. Do not use them as standard abbreviations.

1.6 INDEX.

The index lists, in alphabetical order, paragraphs, figures, and tables contained in this manual. Chapter 7 and Chapter 7A performance data have additional indexes within the chapters.

1.7 ARMY AVIATION SAFETY PROGRAM.

Reports necessary to comply with the safety program are prescribed in AR 385-10.

1.8 DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE.

For information concerning destruction of Army materiel to prevent enemy use, refer to TM 750-244-1-5.

1.9 FORMS AND RECORDS.

Army aviators flight record and aircraft inspection and maintenance records, which are to be used by crewmembers, are prescribed in PAM 738-751 and TM 55-1500-342-23.

1.10 EXPLANATION OF CHANGE SYMBOLS.

Changes (except as noted below) to the text and tables, including new material on added pages, are indicated by a vertical line in the outer margin extending close to the entire area of the material affected. A miniature pointing hand symbol denotes changes on an illustration. A MAJOR CHANGE symbol on the illustration indicates extensive changes have been made. Change symbols are not used to indicate changes in the following:

a. Introductory material.

b. Indexes and tabular data where the change cannot be identified.

c. Blank space resulting from the deletion of text, an illustration, or a table.

d. Correction of minor inaccuracies, such as spelling, punctuation, relocation of material, etc., unless such correction changes the meaning of instructive information and procedures.

1.11 SERIES AND EFFECTIVITY CODES.

Designator symbols listed below, are used to show limited effectivity of airframe information material in conjunction with text content, paragraph titles, and illustrations. Designators may be used to indicate proper effectivity, unless the material applies to all models and configuration within the manual. Designator symbols precede procedural steps in Chapters 8 and 9. If the material applies to all series and configurations, no designator symbol will be used.

DESIGNATOR SYMBOL	APPLICATION
UH	UH-60A and UH-60L peculiar information.
UH-60A	UH-60A peculiar informa- tion.
H–60A+	UH-60A equipped with T700-GE-701D/CC engines (701D core with 701C hy- dromechanical unit and digital electronic unit) and UH-60L CDU.
UH-60L	UH-60L peculiar informa- tion.

DESIGNATOR SYMBOL

EH	

700

701C 701D/CC	Helicopters equipped with T700-GE-701C engines or T700-GE-701D/CC engines (701D core with 701C hy- dromechanical unit and digital electronic unit).
ERFS	Helicopters with Extended Range Fuel System.
AFMS	Helicopters with Auxiliary Fuel Management System.
CEFS	Helicopters with Crashwor- thy External Fuel System.
AHRS	Helicopters equipped with Attitude Heading Reference Set.
128D	Helicopters equipped with Doppler/GPS Navigation Set (DGNS) AN/ASN-128D.

APPLICATION

tion

EH-60A peculiar informa-

Helicopters equipped with

T700-GE-700 engines.

1.12 HIGH DRAG SYMBOL.

This symbol 🚠 will be used throughout this manual to designate information applicable to the high drag configuration described in Chapters 7 and 7A.

1.13 PLACARDED AIRCRAFT SYMBOL.

This symbol will be used throughout this manual to designate applicability to helicopters which have torque placard limitations.

1.14 USE OF WORDS SHALL, SHOULD, AND MAY.

Within this technical manual the word shall is used to indicate a mandatory requirement. The word should is used to indicate a nonmandatory but preferred method of accomplishment. The word may is used to indicate an acceptable method of accomplishment.

CHAPTER 2 AIRCRAFT AND SYSTEMS DESCRIPTION AND OPERATION

Section I AIRCRAFT

2.1 GENERAL.

This chapter describes the UH-60A, UH-60L, and EH-60A helicopters' systems and flight controls. The functioning of electrical and mechanical components is simplified where more detailed knowledge is not necessary.

2.2 UH-60A.

The UH-60A (BLACK HAWK) (Figure 2-1) is a twinturbine engine, single rotor, semimonocoque fuselage helicopter. Primary mission capability of the helicopter is tactical transport of troops, supplies and equipment. Secondary missions include training, mobilization, development of new and improved concepts, and support of disaster relief. The main rotor system has four blades made of titanium/fiberglass. The drive train consists of a main transmission, intermediate gear box, and tail rotor gear box with interconnecting shafts. The propulsion system has two T700-GE-700 engines operating in parallel. The nonretractable landing gear consists of the main landing gear and a tailwheel. The armament consists of two 7.62 mm machineguns, one on each side of the helicopter in the forward cabin. Kit installations for the helicopter consist of range extension tanks, rescue hoist, medical evacuation, infrared suppression, blade anti-icing/ deicing, blackout devices, snow skis, winterization, and static/rappelling kit. Refer to this chapter and Chapter 4 for kit descriptions.

2.3 UH-60A WITH T700-GE-701D/CC ENGINES.

H-60A+ Some UH-60A helicopters have been modified by replacing the T700-GE-700 with T700-GE-701D/ CC engines. This modification also added upgraded Inlet Anti-Ice valves, cross bleed shutoff valves and couplings that withstand the higher bleed air temperatures of the new engine. An additional Nr sensor mounted on the accessory gearbox and a third potentiometer installed on the mixing unit provide transient droop improvement. Automatic relight is provided by the addition of relays in the cabin overhead. The Central Display Unit (CDU) has been replaced with a UH-60L CDU to provide T700-GE-701D/ CC engine parameters.

2.4 UH-60L.

The UH-60L helicopter is the same as the UH-60A helicopter except engines T700-GE-701C or T700-GE-701D/CC replace T700-GE-700. Also the main transmission has been modified to increase its durability. Differences between the two transmissions are annotated with UH-60A or UH-60L.

2.5 EH-60A.

The EH-60A helicopter is a modified UH-60A (Figure 2-1) with a crew of four. The mission equipment consists of electronic systems with modifications that will ensure that the mission requirements are met. The EH-60A system includes air conditioning, helicopter survivability equipment, and avionics equipment. An electronics compartment within the transition section is used for avionics equipment. The compartment can be entered from the right side of the helicopter. The mission systems employ two operators: The direction finder/electronics surveillance measure (DF ESM) operator controlling the electronics surveillance functions, and the electronics countermeasure (ECM) operator controlling the active countermeasure functions. The EH-60A can operate independently or in conjunction with up to two additional, similarly equipped, helicopter. When operating in the multisystem mode, secured air-to-air communications are provided for automatic tasking between helicopter. Secured air-to-ground communications are also provided for voice reporting purposes.

2.6 DIMENSIONS.

Principle dimensions of the helicopter are based on the cyclic stick and tail rotor pedals being centered and the collective stick being in its lowest position. All dimensions are approximate and they are as shown on Figure 2-2.

2.7 TURNING RADIUS AND GROUND CLEARANCE.

WARNING

Main rotor clearance in Figure 2-3 is shown with cyclic centered and level ground. Cyclic displacement or sloping terrain may cause rotor blade clearance to be significantly less.

For information on turning radius and ground clearance refer to Figure 2-3.

2.8 COMPARTMENT DIAGRAM.

2.8.1 Compartment Diagram. The fuselage is divided into two main compartments, the cockpit and cabin. The cockpit (Figure 2-4) is at the front of the helicopter with the pilots sitting in parallel, each with a set of flight controls and instruments. Operation of electrical controls is shared by both. The cabin compartment contains space for crew chief seating, troop seating, litter installation, and cargo. Restraint of cargo is by tiedown rings installed in the floor. Two stowage compartments (Figure 6-12), at the rear of the cabin over the main fuel tanks, are for flyaway equipment. The equipment storage compartments are reached from inside the cabin. A gust lock control, APU accumulator handpump and pressure gage, and APU ESU (Figure 2-5) are also installed.

2.8.2 Compartment Diagram. If A fixed observer seat is installed to allow observation of either operator position (Figure 2-6). Floor attachments are provided for securing rack mounts and seats. Blackout curtains may be used to eliminate any light intrusion into the cockpit during night operations, or any glare on the operator's console during day operations. Blackout curtains may be used between cockpit and cabin during NVG operations.

2.9 UPPER AND LOWER CONSOLES.

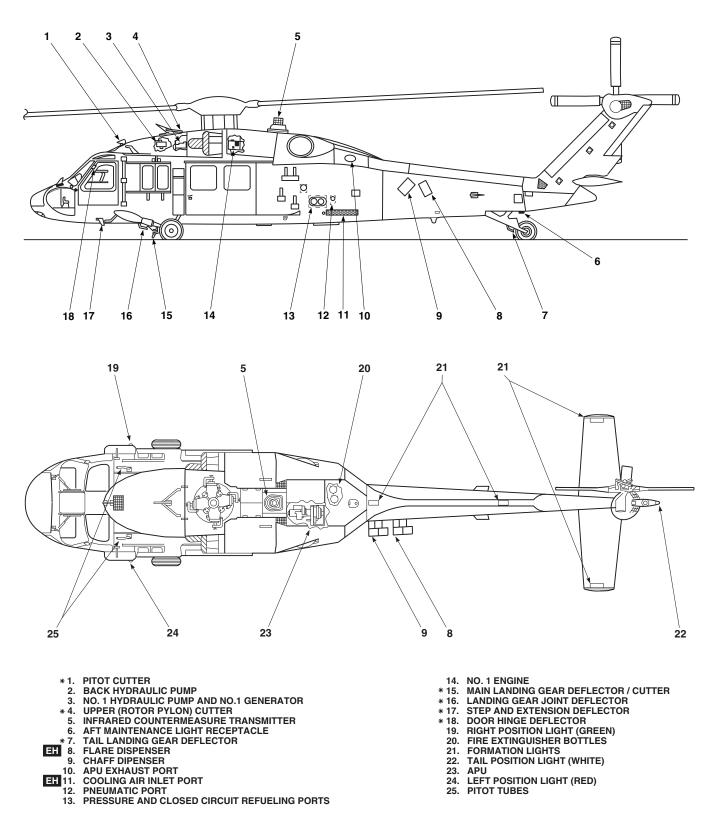
All cockpit electrical controls are on the upper and lower consoles and instrument panel. The upper console (Figure 2-7), overhead between pilot and copilot, contains engine controls, fire emergency controls, heater and windshield wiper controls, internal and external light controls, electrical systems, and miscellaneous helicopter system controls. The rear portion of the upper panel contains the dc essential bus circuit breaker panels. The lower console (Figure 2-8) next to the base of the instrument panel and extending through the cockpit between the pilot and copilot, is easily reached by either pilot. The console is arranged with communication panels, navigational panels, and flight attitude/stability controls. The rear part of the console houses the battery bus and battery utility bus circuit breaker panel and parking brake handle.

2.10 LANDING GEAR SYSTEM.

The helicopter has a nonretractable landing gear consisting of two main gear assemblies and a tailwheel assembly. The landing gear permits helicopter takeoffs and landings on slopes in any direction. The system incorporates a jack and kneel feature that permits manual raising or lowering of the fuselage for air transportability. A landing gear weight-on-wheels (WOW) switch is installed on the left landing gear to control operation of selected systems (Table 2-1). The switch is deactivated when the weight of the helicopter is on the landing gear. On helicopters equipped with ESSS fixed provisions, a WOW switch is also installed on the right landing gear drag beam to provide ac underfrequency cutout and external stores jettison. The left WOW switch provides all other WOW functions as without ESSS provisions and the EMER JETT ALL capabilities. See Table 2-1 for reference.

2.10.1 Main Landing Gear. The main landing gear is mounted on each side of the helicopter forward of center of gravity. Each individual landing gear has a single wheel, a drag beam, and a two-stage oleo shock strut. The lower stage will absorb energy from landings up to 10 feet-per-second (fps). Above 10 fps the upper stage and lower stage combine to absorb loads up to 39 fps (about 11.25 Gs).

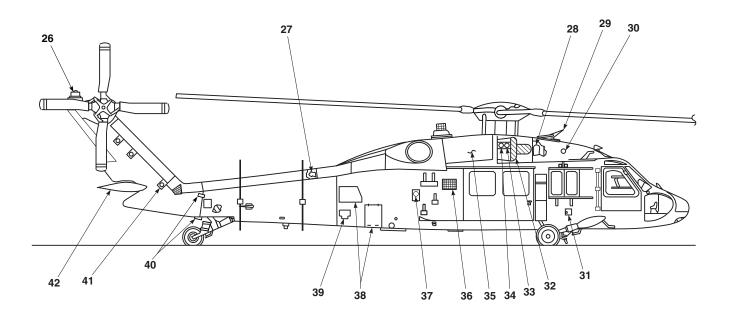
2.10.2 Wheel Brake System. Main landing gear wheels have disc hydraulic brakes. The self-contained, self-adjusting system is operated by the pilot's and copilot's tail rotor pedals. The brakes have a visual brake puck wear indicator. Each wheel brake consists of two steel rotating discs, brake pucks, and a housing that contains the hydraulic pistons. The parking brake handle, marked **PARKING BRAKE**, is on the right side of the lower console. A hand-operated parking brake handle allows brakes to be locked by either pilot or copilot after brake pressure is applied. The parking brakes are applied by pressing the toe brake pedals, pulling the parking brake handle to its fully extended position, and then releasing the toe brakes while holding the handle out. An advisory will appear indicating **PARKING BRAKE ON**. Pressing either pilot or copilot left brake pedal will release the parking brakes, the handle will return to the off position

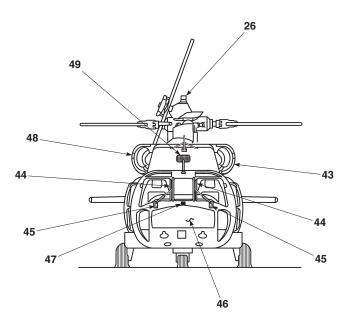


*** ON HELICOPTERS EQUIPPED WITH WIRE STRIKE PROTECTION SYSTEM**

AA0403_1B

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





26. UPPER ANTICOLLISION LIGHT

- 27. TAIL DRIVE SHAFT
- 28. **NO. 2 HYDRAULIC PUMP AND NO. 2 GENERATOR**
- 29. **PYLON CUTTER**
- 30.
- HEATER AIR INTAKE PORT EXTERNAL ELECTRICAL POWER RECEPTACLE NO. 2. ENGINE 31.
- 32. 33. ICE DETECTOR

*

- 34. AMBIENT SENSE PORT
- 35. ENGINE FAIRING / WORK PLATFORM (SAME BOTH SIDES) CONDENSER EXHAUST / STEP
- EH 36. GRAVITY REFUELING PORT (SAME BOTH SIDES) 37.
- 38. 39. AFT AVIONICS COMPARTMENT DOORS
- **IINS BLOWER INLET FILTER**
- 40. TAIL PYLON FOLD HINGES
- 41. TAIL PYLON SERVICE LADDER (SAME BOTH SIDES)
- 42.
- STABILATOR ENGINE BAY AREA COOLING AIR INTAKE (SAME BOTH SIDES) WINDSHIELD POST DEFLECTOR WINDSHIELD WIPER DEFLECTOR 43.
- * 44.
- 45. 46. **AVIONICS COMPARTMENT**
- 47. OAT SENSOR 48. ICE DETECTOR
- PYLON COOLING AIR INTAKE 49.

*** ON HELICOPTERS EQUIPPED WITH WIRE STRIKE PROTECTION SYSTEM**

AA0403_2C

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

EH EH

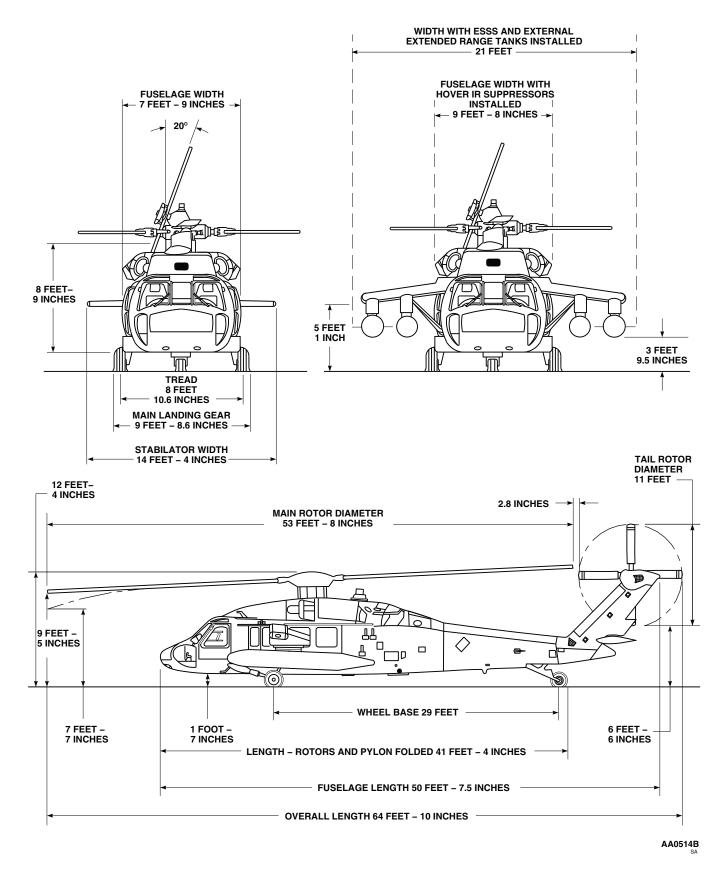


Figure 2-2. Principle Dimensions

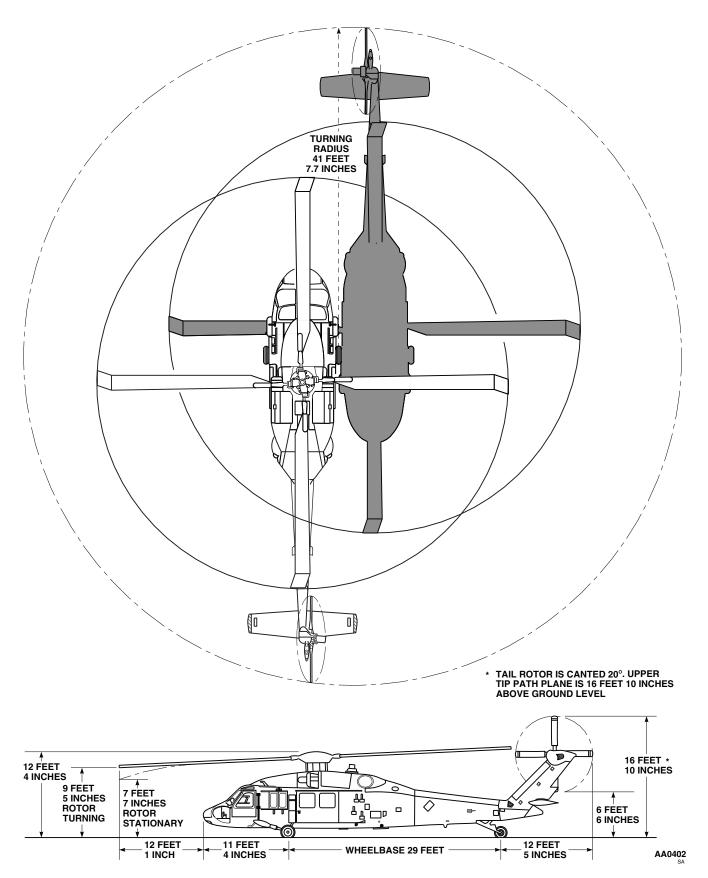


Figure 2-3. Turning Radius and Clearance

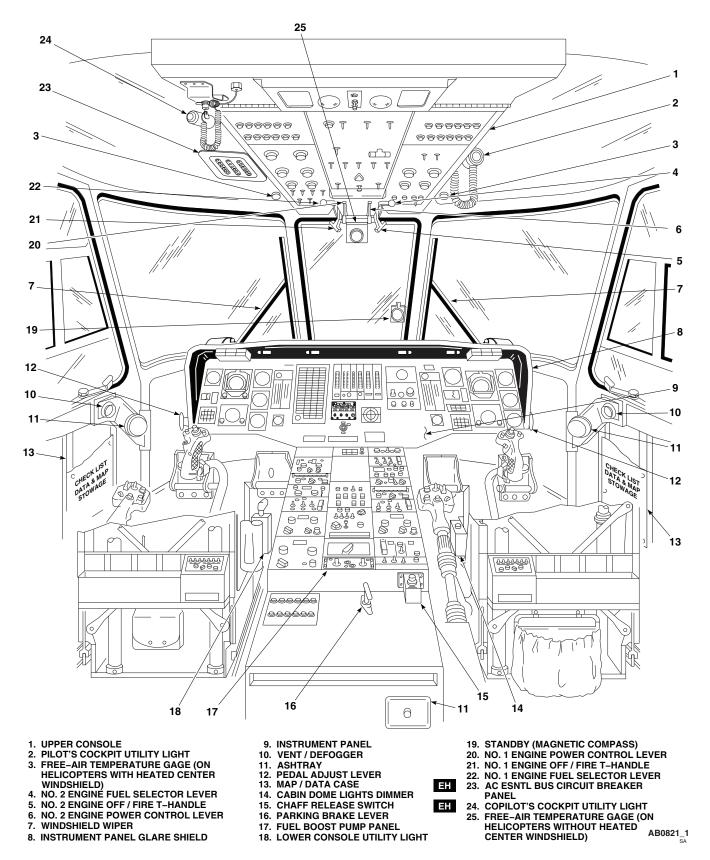


Figure 2-4. Cockpit Diagram (Sheet 1 of 2)

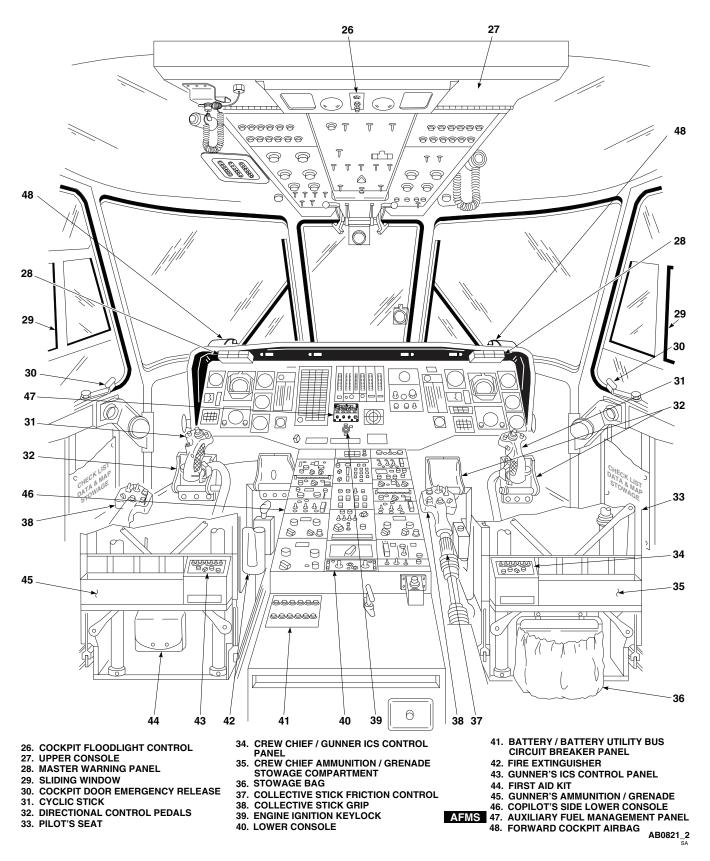


Figure 2-4. Cockpit Diagram (Sheet 2 of 2)

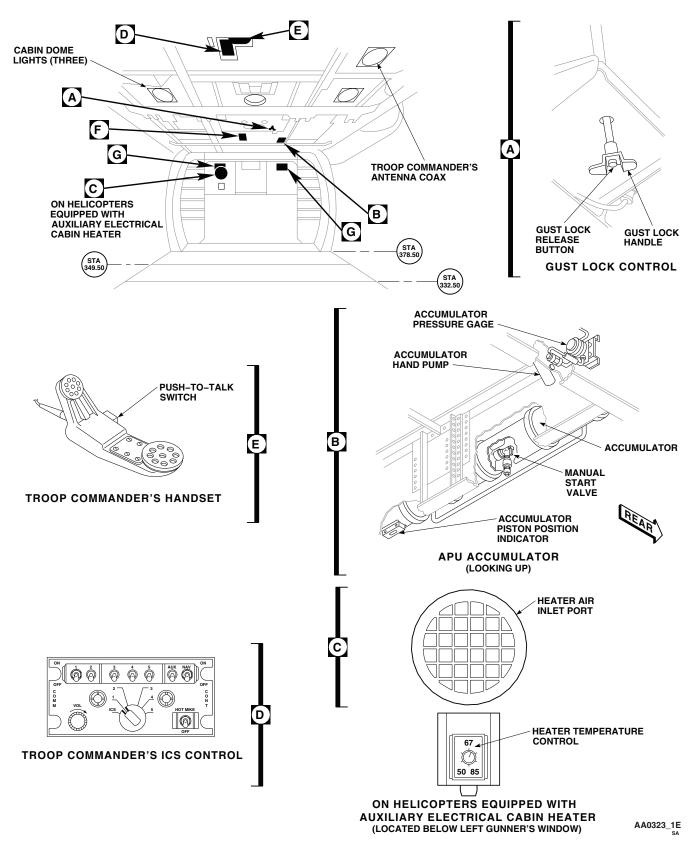
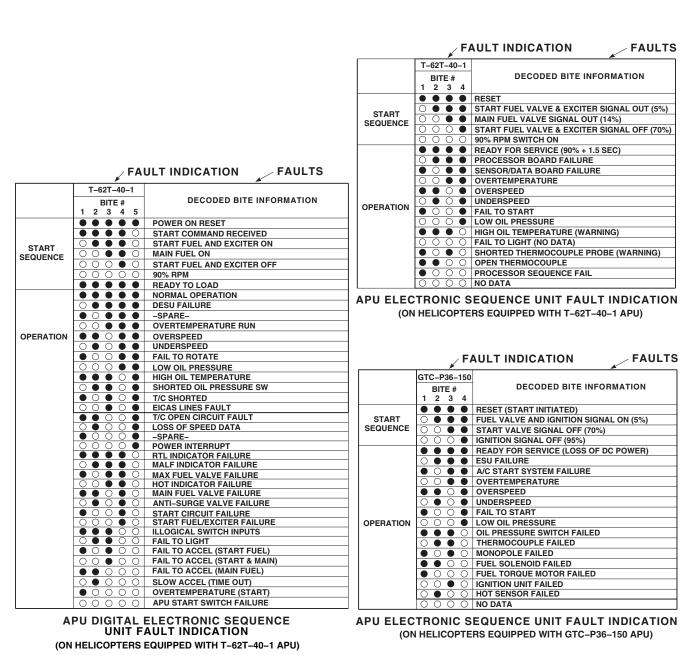


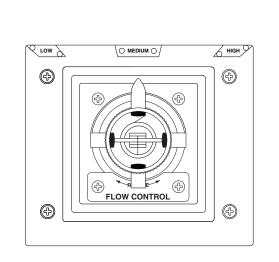
Figure 2-5. Cabin Interior (Sheet 1 of 3)



(F)

AA0323_2D

Figure 2-5. Cabin Interior (Sheet 2 of 3)



(G)

OPTION II CABIN HEATER EJECTOR

AA0323_3

Figure 2-5. Cabin Interior (Sheet 3 of 3)

and the advisory will disappear. Power for the advisory comes from the No. 1 dc primary bus through a circuit breaker marked **LIGHTS ADVSY**.

2.10.3 Tail Landing Gear. The tail landing gear is below the rear section of the tail cone. It has a two-stage oleo shock strut, tailwheel lock system fork assembly, yoke assembly, and a wheel and tire. The fork assembly is the attachment point for the tailwheel and allows the wheel to swivel 360°. The tailwheel can be locked in a trail position by a **TAILWHEEL** switch in the cockpit indicating **LOCK** or **UNLK**. The fork is locked by an electrical actuator through a bellcrank and locking pin. When the pin is retracted, the switch will indicate **LOCK**. When the pin is retracted, the switch will indicate **UNLK**. Power to operate the locking system is by the dc essential bus through a circuit breaker marked **TAIL WHEEL LOCK**.

2.11 INSTRUMENT PANEL.

2.11.1 Instrument Panel. Engine and dual flight instruments are on the one-piece instrument panel (Figure 2-9). The panel is tilted back 30°. The master warning panels are mounted on the upper instrument panel below

the glare shield, to inform the pilot of conditions that require immediate action.

2.11.2 Instrument Panel. If The instrument panel of the EH-60A is as shown on Figure 2-9. Refer to Chapter 3 for description and operation of systems switch panels and Chapter 4 for **BDHI**, **CREW CALL** switch, **FLARE** switch and **ECM ANTENNA** switch and countermeasure set ALQ-156.

2.11.3 Vertical Instrument Display System (VIDS). The VIDS consists of a vertical strip central display unit (CDU), two vertical strip pilot display units (PDU), and two signal data converters (SDC). Those readings are shown by ascending and descending columns of multicolored lights (red, yellow, and green) measured against vertical scales which 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 green-coded segments operate in this manner: when the received signal level is zero or bottom scale, the segments will light in normal progression and will remain on. When the first segment above the red or amber range

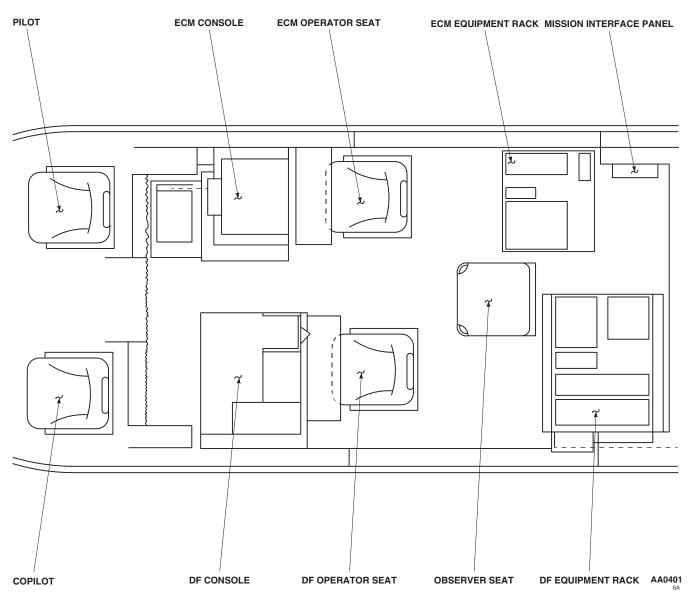


Figure 2-6. Cabin Mission Equipment Arrangement

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 go off in normal progression, depending upon the received signal level. The CDU and PDUs contain photocells that automatically adjust lighting of the indicators with respect to ambient light. If any one of the three photocells should fail, the lights on the vertical scales of the PDUs or CDU may not be at the optimum brightness for the ambient conditions. The **DIM** knob on the CDU contains an override capability which allows the pilot to manually set the display light level. The SDCs receive parameter data from the No. 1 and No. 2 engines, transmission, and fuel system; provides processing and transmits the resulting signal data to the instrument display. The No. 1 engine instruments on the CDU and copilot's PDU, receive signal data from the No. 1 SDC (CHAN 1). The No. 2 engine and main transmission instruments on the CDU and pilot's PDU, receives signal data from the No. 2 SDC (CHAN 2). If either SDC fails, the corresponding CHAN 1 or 2 light will go on, and it is likely the pilot's or copilot's PDU and the corresponding instruments will fail. Failure of a lamp power supply within an SDC will cause every second display light on the CDU to go off. Both SDCs receive % **RPM R**; and % **RPM 1** and **2** and % **TRQ** information from both engines.

WOW SWITCH FUNCTION	ON GROUND	IN FLIGHT
Backup Pump Automatic Operation	Disabled (Except when APU accumulator is low)	Enabled
Hydraulic Leak Test System	Enabled	Disabled
Backup Pump Thermal Switch	Enabled	Disabled
Low % RPM R Audio Warning	Disabled	Enabled
SAS/FPS Computer	Degraded	Enabled
Generator Underfrequency Protection	Enabled	Disabled
IFF Mode 4 Operation	Disabled Automatic Zeroize	Enabled Automatic Zeroize
External Stores Jettison	Disabled	Enabled
ERFS AUX FUEL INCR/DECR Switch	Enabled	Disabled
AFMS 5 minute delay before continuous BIT (CBIT) monitors attitude sensor after AFMP power up	Enabled	Disabled
AFMS AFMP Power up BIT (PBIT) and Initiated BIT (IBIT)	Enabled	Disabled

Table 2-1. Weight-On-Wheels (WOW) Functions

Therefore if one SDC fails only one PDU will provide % **RPM 1** and **2** and % **TRQ** for both engines.

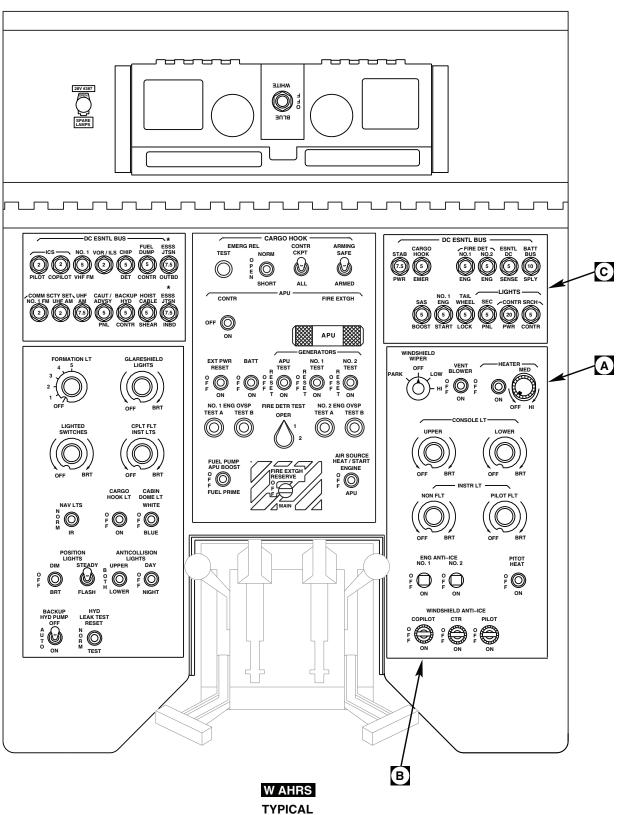
2.11.4 Central Display Unit. The CDU contains instruments that display fuel quantity, transmission oil temperature and pressure, engine oil temperature and pressure, turbine gas temperature (TGT), and gas generator speed (Ng) readings. Those readings are shown by ascending and descending columns of multicolored lights (red, yellow, and green) measured against vertical scales. If the instrument contains low range turnoff (red or yellow lights below green lights) they will go off when the system is operating within the normal range (green). If the instrument contains yellow or red lights above the green range, the green as well as the yellow or red will stay on when operating above the green range. The operating ranges for the different instruments are shown in Figures 5-1 and 5-2. Digital readouts are also installed on the TOTAL FUEL quantity, TGT, and Ng gages.

2.11.4.1 Lamp Test System. The lamp test provides a means of electrically checking all CDU scale lamps, digital readouts, and % **RPM RTR OVERSPEED** lights on the PDUs. When the **PUSH TO TEST** switch on the CDU is pressed, all CDU scale lamps should light, digital readouts should display **888**, and three **RTR OVER-SPEED** lights on the PDUs should be on.

2.11.4.2 Dim Control. The **DIM** control allows the pilot to set a desired display light level of the CDU and PDUs in accordance with the ambient light, or override the auto-dim sensors. If the auto-dim circuitry should fail or malfunction, turn the **DIM** control fully clockwise to regain illumination of the CDU and PDUs.

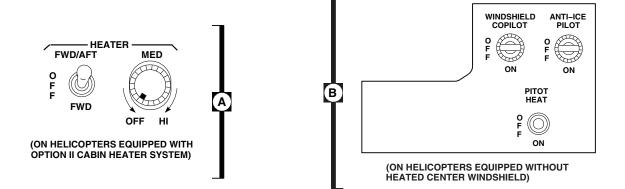
2.11.4.3 CDU and PDU Digital Control. An ON, **OFF DIGITS** control switch is on the CDU to turn on or off the digital readout displays on the CDU and PDUs. If a digital processor fails, all digital displays will go off.

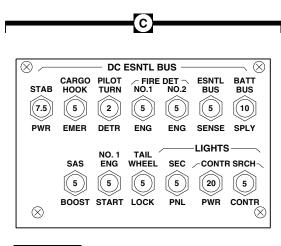
2.11.5 Pilot's Display Unit. The PDU displays to the pilot engine power turbine speed (% **RPM 1** and 2), rotor speed (% **RPM R**), and torque (% **TRQ**). Readings are shown by ascending and descending columns of multicolored lights (red, yellow, and green) measured against vertical scales. A **TEST** switch provides a means of electrically checking all PDU scale lamps and digital readouts. When the **TEST** switch is pressed, all PDU scale lamps should light and digital readouts should display **188**. The % **RPM** indicators contain low range turnoff below the normal operating range. Three overspeed lights at the top will go on from left to right when a corresponding rotor speed of 127%, 137%, and 142% is reached. Once a light is turned on, a latch prevents it from going off until reset by maintenance. Power for the PDUs is from No. 1



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Figure 2-7. Upper Console (Sheet 1 of 3)

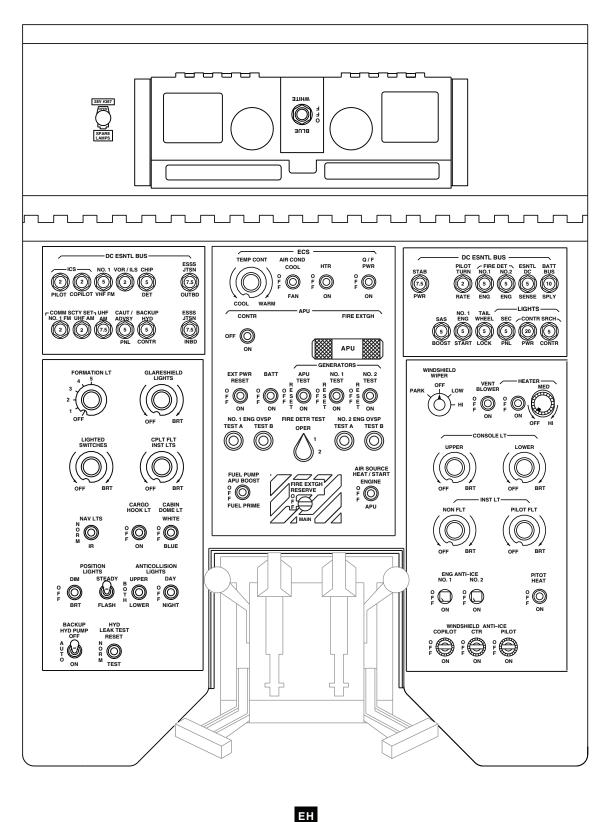




W/O AHRS

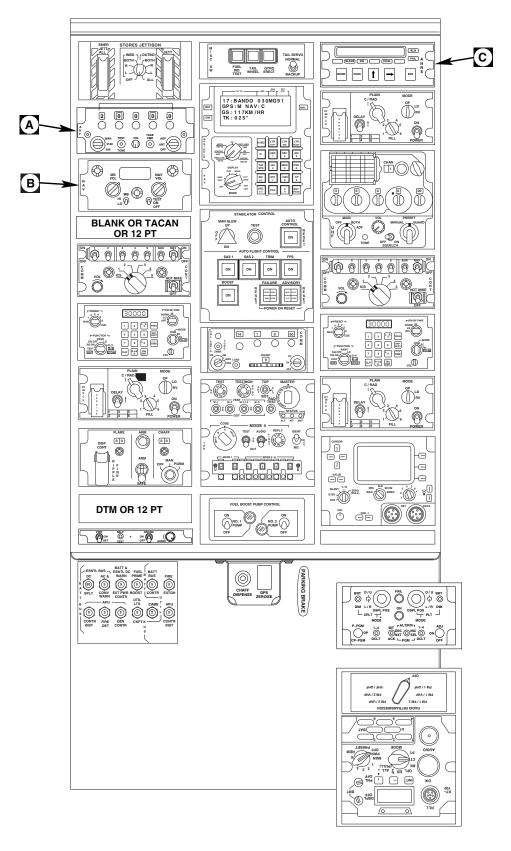
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Figure 2-7. Upper Console (Sheet 2 of 3)



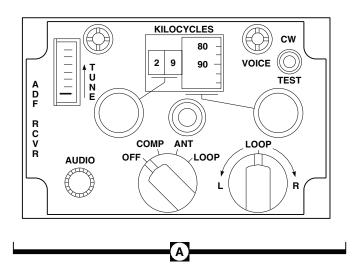
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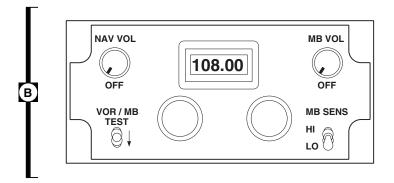
Figure 2-7. Upper Console (Sheet 3 of 3)

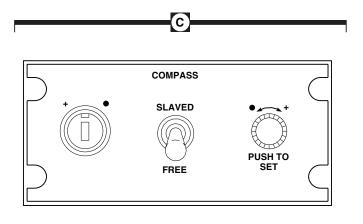


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Figure 2-8. Lower Console (Sheet 1 of 3)







W/O AHRS

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Figure 2-8. Lower Console (Sheet 2 of 3)

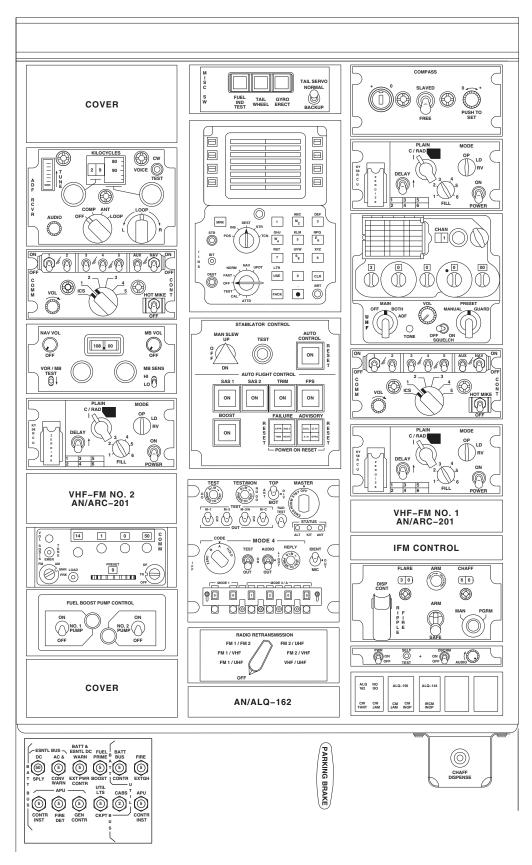


Figure 2-8. Lower Console (Sheet 3 of 3)

and No. 2 ac and dc primary buses through circuit breakers marked NO. 1 AC INST/NO. 1 DC INST and NO. 2 AC INST/NO. 2 DC INST, respectively. Refer to Figures 5-1 and 5-2 for instrument markings.

2.12 DOORS AND WINDOWS.

2.12.1 Cockpit Doors. The crew compartment is reached through two doors, one on each side of the cockpit. The doors swing outward and are hinged on the forward side. Each door has a window for ventilation. Installed on the back of each door is a latch handle to allow unlatching the door from either inside or outside the cockpit. Emergency release handles are on the inside frame of each door (Figure 9-1). They allow the cockpit doors to be jettisoned in case of an emergency. There is an emergency release pull tab on the inside forward portion of each cockpit door window for pilot egress. Data compartments are on each cockpit door.

2.12.2 Troop/Cargo (Cabin) Doors. Aft sliding doors are on each side of the troop/cargo compartment. Single-action door latches allow the doors to be latched in the fully open or fully closed positions. Each of the two doors incorporate two jettisonable windows, for emergency exit (Figure 9-1).

2.12.3 Crew Chief/Gunner Windows. The Crew Chief/Gunner Stations have forward sliding hatch windows, split vertically into two panels. A spring-loaded security latch is installed on each gunner's aft window, to prevent the window opening from the outside. The dead bolt lock requires activation of the security latch lever from inside the helicopter. Another window latch bar is actuated to allow the forward window to be moved to a stowed position. The windows may be opened to move a machine gun into position for firing.

2.12.4 Door Locks. Key door locks are installed on each of the cabin, cockpit and avionics compartment doors. A common key is used to lock and unlock the doors from the outside to secure the helicopter. Each crew chief/gunner sliding window is locked from the inside only.

2.13 CREW SEATS.

2.13.1 Pilots' Seats.



Do not store any items below seats. Seats stroke downward during a crash and any

obstruction will increase the probability and severity of injury.

The pilots' seats provide ballistic protection and can be adjusted for the pilots' leg length and height. The pilot's seat is on the right side, and the copilot's is on the left. Each seat has a one-piece ceramic composite bucket attached to energy absorption tubes. Each seat is positioned on a track with the bucket directly above a recess 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.

2.13.1.1 Seat Height Adjustment.

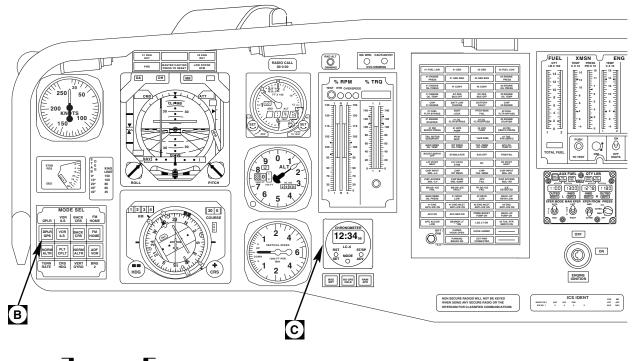


To prevent injury to personnel, do not release either the normal or emergency vertical adjust levers unless someone is sitting in the seat. The extension springs are under load at all times. With seat at lowest position, the vertical preload on the seat could be as high as 150 pounds. If no one is in the seat and vertical adjust lever(s) is released, the seat will be snapped to the highest stop. Anyone leaning over the seat or with hands on guide tubes above linear bearings will be seriously injured.

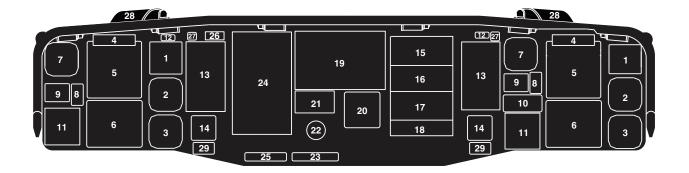
Vertical seat adjustment is controlled by a lever on the right front of the seat bucket. Springs are installed to counterbalance the weight of the seat. The lever returns to the locked position when released.

2.13.1.2 Forward and Rear Adjustment. The seat is adjusted for leg length by a locking lever on the left front of the seat bucket. The lever is spring-loaded and returns to the locked position when released.

2.13.1.3 Emergency Tilt Release Levers. The emergency tilt release levers are on each side of the seat support frame. The seat may be tilted back into the cabin for removal or treatment of a wounded pilot. Seat tilting can be done from the cabin only when the seat is in the full down and aft position. On RA-30525 seats, tilting is achieved by pushing the tilt levers in toward center, and then pulling the seat top rearward. On D3801 and D3802 seats, tilting is achieved by pushing the seat top rearward.







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Figure 2-9. Instrument Panel (Sheet 1 of 4)

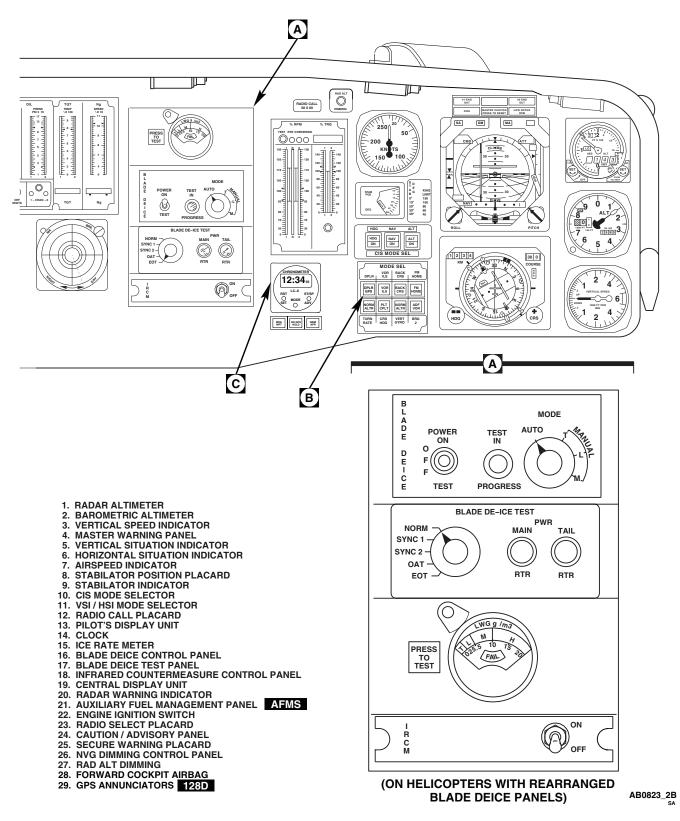
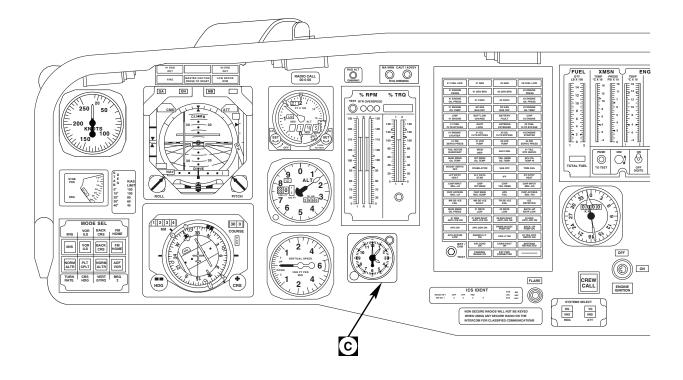
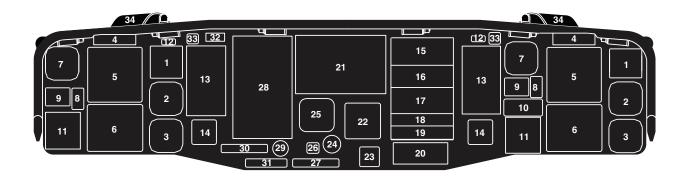


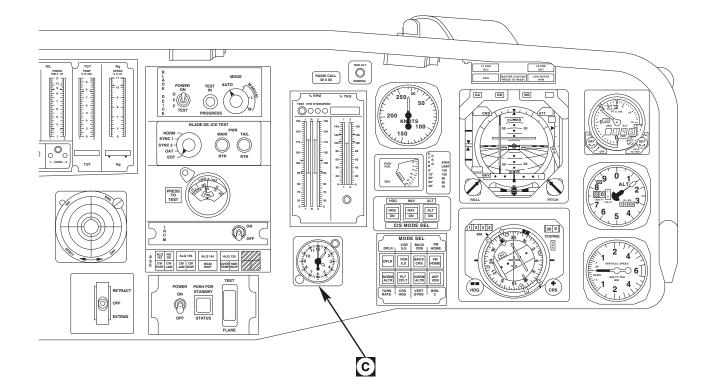
Figure 2-9. Instrument Panel (Sheet 2 of 4)





AA0516_3C

Figure 2-9. Instrument Panel (Sheet 3 of 4)



- **1. RADAR ALTIMETER** 2. BAROMETRIC ALTIMETER 3. VERTICAL SPEED INDICATOR 4. MASTER WARNING PANEL 5. VERTICAL SITUATION INDICATOR 6. HORIZONTAL SITUATION INDICATOR 7. AIRSPEED INDICATOR 8. STABILATOR POSITION PLACARD 9. STABILATOR POSITION INDICATOR 10. CIS MODE SELECTOR 11. VSI / HSI MODE SELECTOR 12. RADIO CALL PLACARD 13. PILOT'S DISPLAY UNIT 14. CLOCK 15. BLADE DEICE CONTROL PANEL 16. BLADE DEICE TEST PANEL

- 17. ICE RATE METER

- 18. ALQ-144 INFRARED COUNTERMEASURE
- CONTROL PANEL
- 19. ASE STATUS PANEL 20. ALQ-156 COUNTERMEASURE PANEL 21. CENTRAL DISPLAY UNIT
- 22. RADAR WARNING INDICATOR
- 23. ECM ANTENNA SWITCH
- 24. ENGINE IGNITION SWITCH 24. ENGINE EQUITION SWITCH 25. BEARING DISTANCE HEADING INDICATOR 26. CREW CALL SWITCH / INDICATOR 27. SYSTEM SELECT PANEL 28. CAUTION / ADVISORY PANEL 29. FLARE DISPENSE SWITCH 29. PLARE DISPENSE SWITCH

- **30. RADIO SELECT PLACARD**
- 30. RADIO SELECT PLACARD 31. SECURE RADIO WARNING PLACARD 32. NVG DIMMING CONTROL PANEL 33. RADAR ALTIMETER DIMMING 34. FORWARD COCKPIT AIRBAG

AA0516_4E

Figure 2-9. Instrument Panel (Sheet 4 of 4)

2.13.1.4 Emergency Vertical Release Lever. The emergency vertical release lever permits the seat to drop to the lowest adjustment point for tilting. The emergency vertical release lever is on the upper center back of RA-30525 seats, and is actuated by pulling right on the lever. The emergency vertical release pedal is on the lower back of the D3801 and D3802 seats, and is actuated by pushing down on the foot operated pedal.

2.13.1.5 Seatbelts. The pilot's and copilot's seats each contain a shoulder harness, seatbelt, and a crotch strap connected to a common buckle assembly. All belts and straps have adjustment fittings. The attachment buckle has a single-point release that will be common in configuration on the pilot's and copilot's seats; they may be of the lift lever or rotary release configuration. When the lanyard is pulled or the release is turned, all belts and straps will release simultaneously.

2.13.2 Protective Armor. Armor protection is provided for the body of the pilot and copilot against 7.62 mm rounds from the side and from the back and below. Armored wings, attached to the cockpit interior, consist of a sliding panel at the outboard side of each seat. A release lever at the front of each panel permits sliding the panel aft to allow rapid entrance and exit, as well as freedom of movement for the seat occupant. The CABS side air bag modules are mounted on the inboard panel.

2.13.3 Crew Chief/Gunner Seats.



Do not store any items below seats. During a crash any obstruction will increase the probability and severity of injury.

Two outward facing seats (Figure 2-10), one on each side of the helicopter at the front of the cabin, are for the crew chief/gunners. Each seat faces a window. Each seat is a cable-supported steel tube assembly with a fire-resistant, high strength fabric seat and backrest containing two lower energy attenuators designed to reduce personal injury in a crash. Each seat has a complete lap belt and dual torsorestraint shoulder harness attached to a dual action rotary release buckle. The shoulder harness is connected to inertia reels on the seat back and bottom. This gives the wearer freedom to move about his station. On helicopters equipped with improved crewchief/gunner's restraint system, the restraint system is equipped with a single action rotary release buckle with a guard. A release plate must be pressed to allow rotation of release, preventing inadvertent handle rotation from contact with equipment, etc. The inertia reel lock control is replaced by a shorter push/pull manual locking control. Push in and the inertia reel is manually locked in place. When the control is pulled out, the reel will lock on sudden pull.

2.14 TROOP PROVISIONS.



Do not store any items below seats. During a crash any obstruction will increase the probability and severity of injury.

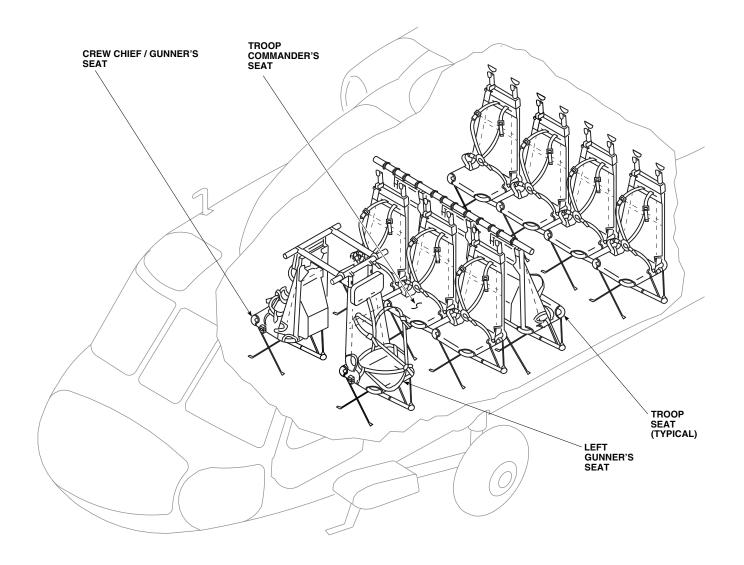
In addition to crew chief and gunner seats, troop seats may be installed for up to 12 persons. Each troop seat has a belt and shoulder harness for body restraint. The backs and seat pans are attached through cables to the cabin ceiling and through cables and rods to seat fittings installed in the floor. The seats may be installed in any quantity from 1 to 12. Each seat contains two lower energy attenuators designed to reduce personnel injury in a crash. In Row 1, do not install a passenger/troop seat in the most forward center position directly behind the cockpit center console. When seats are removed from the cabin and stowed in the stowage compartment, adjustments must be made for weight and balance using data in Figures 6-3 and 6-12.

2.14.1 Troop Seatbelt Operation.

- 1. Extend shoulder strap and attach shoulder strap fittings to buckle.
- 2. Extend lap belt and place across body.
- 3. Place lap belt fitting into buckle and make certain of positive lock.
- 4. Adjust lap belt tension and shoulder straps for a comfortable fit.

2.14.2 DF and ECM Operator's Seats. E The seats are similar to the pilot's and copilot's seats except that armored wing protection is not provided.

2.14.3 Observer's Seat. ED The observer's seat (Figure 2-6) is identical to a troop seat. It is installed behind, and to the right, of the DF operator's seat.



AA0407



Section II EMERGENCY EQUIPMENT

2.15 FIRE PROTECTION SYSTEMS.

Fire detection and fire extinguishing systems are installed so that a fire may be detected and put out at either engine or the APU installation, without affecting the remaining two. The engines and APU are monitored by infrared radiation-type sensing units, and protected by a main and reserve high-rate discharge type fire extinguisher installation.

2.15.1 Fire Detection System. A detection system provides fire warning to the cockpit in case of fire in either main engine compartment or in the APU compartment. The system consists of five radiation-sensing flame detectors, control amplifiers, and a test panel. Two detectors are installed in each main engine compartment and one detector is in the APU compartment. The flame detectors are solid-state photoconductive cells providing continuous volume optical surveillance of the monitored areas. In case of fire, the detectors react to the infrared radiation and send a signal to one of the three control amplifiers which in turn signals the fire warning assembly lighting the proper T-handle. Also, the master FIRE warnings will appear if a fire is detected. The detector system automatically resets itself with warnings disappearing when the infrared radiation source ceases to emit.

2.15.2 Fire Detector Test Panel. A test switch on the FIRE DETR TEST panel on the upper console, when moved to positions 1 or 2, sends a test signal through the system to activate the fire warnings and verify proper system operation to, but not including, the photo cells. The number 1 test position lights #1 and #2 ENG EMER OFF T-handles and APU T-handle and checks all firewall mounted detectors. The number 2 test position lights #1 and #2 ENG EMER OFF T-handle only, and checks all deck mounted detectors. The engines and APU are completely enclosed within their own firewall compartment, thus reducing the possibility of a false fire warning from outside sources. Electrical power to operate the No. 1 and No. 2 detector system is by the dc essential bus through circuit breakers marked FIRE DET, NO. 1 ENG and NO. 2 ENG, respectively. Power to operate the APU detector system is by the battery bus through a circuit breaker marked APU FIRE DET.

2.15.3 Fire Extinguishing Systems. A high-rate discharge extinguishing system provides a two-shot, main and reserve capability to either main engine compartment or APU compartment. Two containers are each filled with liquid and charged with gaseous nitrogen. The containers

are mounted above the upper deck, behind the right engine compartment. Both containers have dual outlets, each with its own firing mechanism. Each extinguishing agent container has a pressure gage, easily viewed for preflight inspection. The system also has a thermal discharge safety port that will cause a visual indicator on the right side of the fuselage to rupture, indicating that one or both containers are empty. Electrical power to operate the No. 1 main and No. 2 reserve outlet valves is by the No. 2 dc primary bus through a circuit breaker, marked **FIRE EX-TGH**. Power to operate the No. 2 main and No. 1 reserve fire extinguisher container outlet port valves and the directional control valve is by the battery utility bus through a circuit breaker on the lower console marked **FIRE EXT-GH**.

2.15.4 Fire Extinguisher Arming Levers (T-Handles). One APU T-handle is on the upper console marked APU, and two engine fire extinguisher T-handles are on the engine control quadrant, marked #1 ENG EM-ER OFF and #2 ENG EMER OFF. The handle marked #1 ENG EMER OFF is for the No. 1 engine compartment; the handle marked #2 ENG EMER OFF is for the No. 2 engine compartment; and the handle marked APU is for the APU compartment. When a handle is pulled, dc power actuates the fire extinguisher logic module to select the compartment to which the fire extinguisher agent is to be directed, and also energizes the circuit to the fire extinguisher switch. The ends of the handles house fire detector warning lights.

2.15.5 Fire Extinguisher Control Panel.



In case of fire when ac electrical power is not applied to the helicopter, the reserve fire extinguisher must be discharged. Fire extinguisher agent cannot be discharged into No. 2 engine compartment if ac electrical power is not applied to helicopter.

The **FIRE EXTGH** switch on the upper console has marked positions **RESERVE-OFF-MAIN**. The switch is operative only after one of the **ENG EMER OFF** or **APU** lever (T-handle) has been pulled. When the switch is placed to **MAIN**, after an **ENG EMER OFF** lever has been pulled, the contents of the main fire extinguisher container are discharged into the corresponding compartment. When the **FIRE EXTGH** switch is placed to **RESERVE** after an **ENG EMER OFF** lever has been pulled, the contents of the opposite fire extinguisher container are discharged into the selected compartment. The contents of the fire extinguisher container discharge into the compartment of the last lever pulled.

2.15.6 Crash-Actuated System. A crash-actuated system is part of the fire extinguisher system. An omnidirectional inertia switch is hard-mounted to the airframe to sense crash forces. Upon impact of a crash of 10 Gs or more, the switch will automatically fire both fire extinguishing containers into both engine compartments. Electrical power is supplied from the battery utility bus through a circuit breaker on the lower console, marked **FIRE EXTGH**.

2.15.7 Hand-Operated Fire Extinguishers.



Exposure to high concentrations of extinguishing agent or decomposition products should be avoided. The liquid should not be allowed to contact the skin; it could cause frostbite or low temperature burns.

a. **UP** One hand-operated fire extinguisher (Figure 9-1) is mounted on the cabin wall left of the gunner's seat. A second fire extinguisher is on the copilot's seat.

b. El Four hand-operated portable fire extinguishers are installed. One mounted on the right gunner window,

one on the left pilot seat, one on the DF operator seat, and one on the ECM operator seat. The extinguishers are held in place by a quick-release spring.

2.16 CRASH AXE.

One axe is installed between the pilots' seats in the cabin.

2.17 FIRST AID KITS.

a. UP Three first aid kits are installed, two on the back of the left pilot seat and one on the back of the right pilot seat.

b. Eff Five first aid kits are installed. One on the back of the right pilot seat, two on the back of the left pilot seat, one on the back of the DF operator seat, and one on the back of the ECM operator seat.

2.18 COCKPIT AIR BAG SYSTEM.

Four Cockpit Air Bag System (CABS) units are installed in the helicopter. Two forward air bag modules are installed on the glare shield. Two lateral air bag modules are installed on the stationary wing panels (one on the right side and one on the left side). An Electronic Crash Sensor Unit (ECSU) is attached to the mounting tray located under the copilot's seat. The CABS provides enhanced supplemental crewmember protection and reduces the likelihood of head strike injuries during survivable crash events. The ECSU detects a crash event and initiates deployment of the air bags. Power to operate the ECSU is provided by the battery bus through a circuit breaker marked **CABS**.

Section III ENGINES AND RELATED SYSTEMS

2.19 ENGINE.

CAUTION

Use of the T700-GE-701D hydromechanical unit and digital electronic control unit are prohibited on the UH-60L. Use of the 701D controls on the UH-60L can cause significant damage to the powertrain.

NOTE

The T700-GE-701D/CC is a drop-in replacement for the T700-GE-701C engine on the UH-60L helicopter. The 701D/CC consists of a T700-GE-701D core controlled by a T700-GE-701C hydromechanical unit and digital electronic control unit. Engine performance is the same between the 701D/CC and the 701C. Therefore, performance charts used with the 701C are also valid with the 701D/CC.

The T700 engine (Figure 2-11), is a front drive, turboshaft engine of modular construction. One is mounted on the airframe at either side of the main transmission. The engine is divided into four modules: cold section, hot section, power turbine section, and accessory section.

2.19.1 Cold Section Module. The cold section module includes the inlet particle separator (IPS), the compressor, the output shaft assembly, and line replaceable units (LRUs). The IPS removes sand, dust, and other foreign material from the engine inlet air. Engine inlet air passes through the swirl vanes, spinning the air and throwing dirt out by inertial action into the collector scroll, after which it is sucked through by the engine-driven blower and discharged overboard around the engine exhaust duct. The compressor has five axial stages and one centrifugal stage. There are variable inlet guide vanes and variable stage 1 and stage 2 vanes. LRUs mounted on the cold section module are the **700** electrical control unit (ECU) or 701C 701D/CC digital electronic control (DEC), antiicing and start bleed valve, **700** history recorder or **701C 701D/CC** history counter, ignition system, and electrical cables.

2.19.2 Hot Section Module. The hot section module consists of three subassemblies; the gas generator turbine, stage 1 nozzle assembly, and combustion liner. LRUs on the hot section module are **701C 701D/CC** ignitors and **700** primer nozzles and ignitors. The gas generator turbine consists of a gas generator stator assembly and a two-stage air cooled turbine rotor assembly which drives the compressor and the accessory gear box. Stage 1 nozzle assembly contains air cooled nozzle segments. The nozzle assemblies direct gas flow to the gas generator turbine. The combustion liner is a ring-type combustor cooled by air flow from the diffuser case.

2.19.3 Power Turbine Section Module. The power turbine section module includes a two-stage power turbine, exhaust frame, and the shaft and C-sump assembly. The LRUs mounted on the power turbine section module are the thermocouple harness, torque and overspeed sensor, and Np (% RPM 1 or 2) sensor.

2.19.4 Accessory Section Module. The accessory section module includes the top mounted accessory gear box and a number of LRUs. The LRUs mounted on the module are the hydromechanical unit (HMU), engine driven boost pump, oil filter, oil cooler, alternator, oil and scavenge pump, IPS blower, fuel filter assembly, chip detector, oil filter bypass sensor, radial drive shaft, fuel pressure sensor, and oil pressure sensor.

2.20 ENGINE FUEL SUPPLY SYSTEM.

The engine fuel supply system consists primarily of the low-pressure engine driven boost pump, fuel filter, fuel filter bypass valve, fuel pressure sensor, hydromechanical unit (HMU), **700** pressurizing and overspeed unit (POU), or **701C 701D/CC** overspeed and drain valve (ODV).

2.20.1 Engine Driven Boost Pump. A low pressure suction engine driven boost pump is installed on the front face of the engine accessory gear box. It assures that the airframe fuel supply system is under negative pressure, lessening the potential of fire in case of fuel system damage. The appearance of the **#1** or **#2 FUEL PRESS** caution at idle speed and above could indicate a leak or failed engine driven boost pump.

2.20.2 Fuel Filter. The fuel filter is a barrier-type full flow filter with integral bypass. An electrical switch

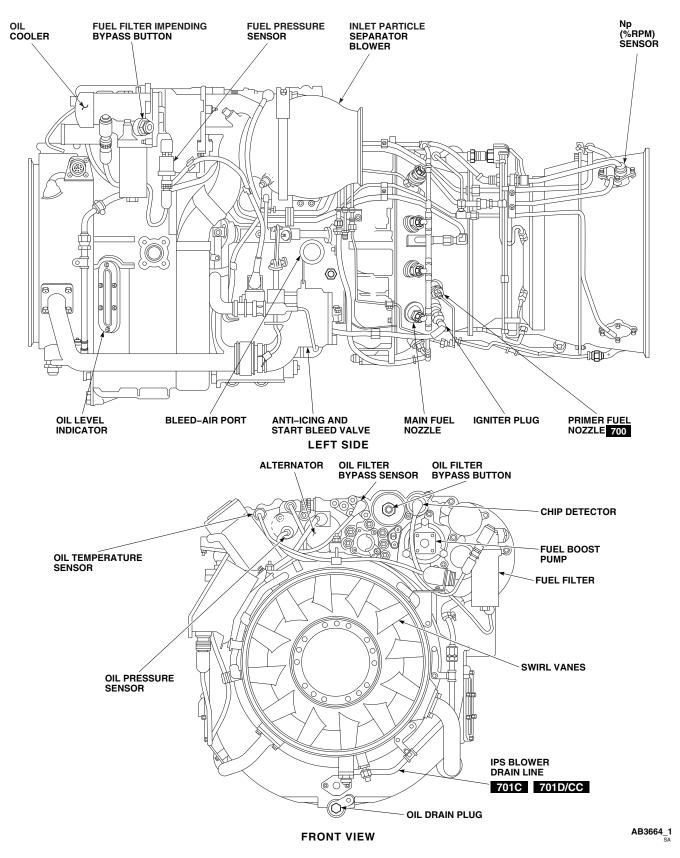
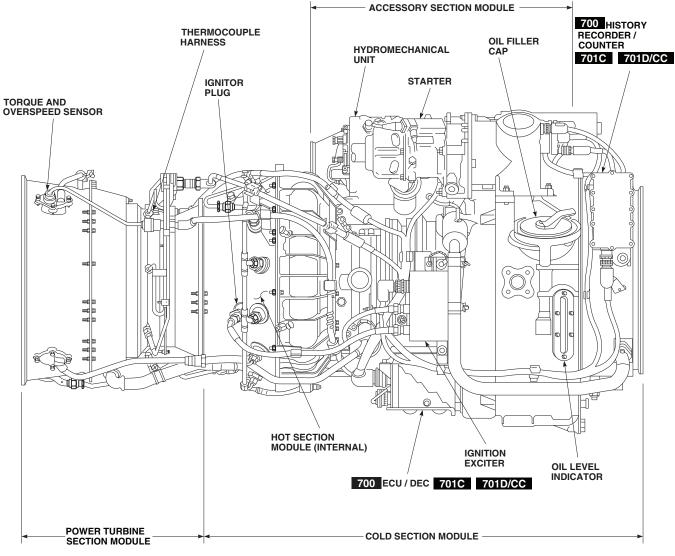


Figure 2-11. Engine T700 (Sheet 1 of 2)



RIGHT SIDE

AB3664_2

Figure 2-11. Engine T700 (Sheet 2 of 2)

activates the **#1 FUEL FLTR BYPASS** or **#2 FUEL FL-TR BYPASS** caution to indicate filter bypass. In addition, a red button on the filter housing pops out when filter element differential pressure indicates impending bypass. Power for the fuel filter bypass cautions is from the No. 1 and No. 2 dc primary buses through circuit breakers marked **NO. 1** and **NO. 2 ENG WARN LTS**, respectively.

2.20.3 Fuel Pressure Warning System. The engine fuel pressure warning system for each engine consists of a pressure switch that activates the FUEL PRESS caution. Fuel pressure cautions #1 FUEL PRESS and #2 FUEL **PRESS** will appear when fuel pressure drops below 9 psi. This caution can appear when fuel pressure drops, due to failure of the low-pressure boost pump or an air leak in the suction fuel system. The effect will vary depending upon the size of the leak. The effect will be more serious at low engine power. A large enough leak may cause a flameout. Power for the No. 1 engine fuel pressure warning system is supplied by the No. 1 dc primary bus through the NO. 1 ENG WARN LTS circuit breaker. Power for the No. 2 engine fuel pressure warning system is supplied by the No. 2 dc primary bus through the NO. 2 ENG WARN LTS circuit breaker.

2.20.4 Engine Fuel System Components. Control of fuel to the combustion system is done by the HMU. The HMU, mounted on the rear center of the accessory gear box, contains a high pressure pump that delivers fuel to the POU/ODV. Various parameters are sensed by the HMU and influence fuel flow, variable geometry position, and engine anti-ice start bleed valve operation. Fuel from the HMU flows to a **700** POU or **701C 701D/CC** ODV.

2.20.4.1 Pressurizing and Overspeed Unit. 700 The POU sends some of the fuel through the fuel start manifold tube to the primer nozzles and allows back flow of high pressure air for purging. The rest of the fuel is sent through the main fuel manifold to the injectors for starting acceleration and engine operation. It purges fuel from the primer nozzles after light off. It purges fuel from the primer nozzle and main fuel manifold on shutdown. It also reduces fuel flow to prevent an engine overspeed when the overspeed system is tripped as sensed by the ECU.

2.20.4.2 Overspeed and Drain Valve. 701C 701D/CC The ODV sends fuel through the main fuel manifold to the injectors for starting acceleration and engine operations. It purges fuel from the main fuel manifold and allows back flow of high pressure air for purging. It shuts off fuel flow to prevent an engine overspeed when the overspeed system is tripped as sensed by the DEC. It also shuts off fuel to prevent hot starts when activated by the hot start preventor (HSP).

2.21 ENGINE ALTERNATOR.

2.21.1 Engine Alternator. 700 The engine alternator supplies ac power to the ignition exciter and ECU. It also supplies a signal to the **Ng SPEED** cockpit indicator. All essential engine electrical functions are powered by the alternator.

a. When the alternator power supply to the ECU is interrupted, a loss of % **RPM 1** or 2 and % **TRQ** indications will occur, with corresponding engine(s) increasing to maximum power (high side).

b. When the alternator Ng signal is interrupted, a loss of Ng cockpit indication will occur with a corresponding **ENG OUT** warning and audio.

c. A complete loss of engine alternator power results in affected engine(s) increasing to maximum power (high side) with a loss of cockpit indications of % **RPM 1** or **2**, % **TRQ**, and **Ng SPEED**; and an **ENG OUT** warning and audio will occur. Overspeed protection is still available.

2.21.2 Engine Alternator. 701C 701D/CC The engine alternator supplies ac power to the ignition exciter and DEC unit. It also supplies a signal to the **Ng SPEED** cockpit indicator. All essential engine electrical functions are powered by the alternator.

a. When the alternator power supply to the DEC is interrupted, 400 Hz 120 vac aircraft power is utilized to prevent engine (high side) failure. There will be a loss of the associated cockpit Ng indication and activation of an **ENG OUT** warning and audio. Overspeed protection is still available.

b. When the alternator Ng signal is interrupted, a loss of the associated engine Ng indication, and an **ENG OUT** warning and audio will occur. Because the DEC can utilize 400 Hz 120 vac aircraft power, there will be no loss of associated % **RPM 1** or **2** and % **TRQ** indications.

2.22 IGNITION SYSTEM.

The engine ignition system is a noncontinuous ac powered, capacitor discharge, low voltage system. It includes a dual exciter, two igniter plugs, ignition leads, and **ENGINE IGNITION** switch.

2.23 HISTORY RECORDER. 700

The engine history recorder is mounted on the right side of the swirl frame. It displays four digital counters which records information for maintenance purposes only. The history recorder will only operate with an ECU.

2.24 HISTORY COUNTER. 701C 701D/CC

The engine history counter is mounted on the right side of the swirl frame. It displays four digital counters which records information for maintenance purposes only. The history counter will only operate with a DEC.

2.25 THERMOCOUPLE HARNESS.

A seven probe harness measures the temperature of the gases at the power turbine inlet. It provides a signal to the **700** ECU, or **701C 701D/CC** DEC, that relays it to the **700** history recorder, or **701C 701D/CC** history counter, through the signal data converter (SDC) to the cockpit temperature gage.

2.26 TORQUE AND OVERSPEED AND % RPM SENSORS.

Two sensors are installed on the exhaust frame of the engine. One sensor provides the power turbine governor and tachometer signal to the **700** ECU, or **701C 701D/CC** DEC. The other sensor feeds the torque computation circuit and overspeed protection system.

2.27 ENGINE BLEED-AIR SYSTEM.

Two bleed-air ports are incorporated on the engine. The outboard port supplies bleed-air to the engine air inlet anti-icing system. The inboard port ties into the pressurized air system. Air from this port is supplied to the cabin heating system and can be supplied to the other engine for crossbleed starts.

2.28 ENGINE ANTI-ICING SYSTEMS.

2.28.1 Engine Anti-Icing.



The engine can incur FOD by improper use of these systems and the other antiice/deice systems. For example, ice shedding off the windshield can cause FOD damage to the engines.

a. The engine is anti-iced by two systems: the first described in subparagraph b. is an engine anti-ice system and a second described in paragraph 2.28.2 is an engine inlet anti-icing system. Both of these systems are turned on by the ENG ANTI-ICE NO. 1 and NO. 2 switches.

b. Engine anti-icing is a combination of bleed-air and heated engine oil. Anti-icing is controlled by a solenoidoperated air valve. The engine anti-ice/start bleed valve opens during starting and will remain open at low power settings until engine reaches 88 to 92% Ng, depending on the outside air temperature, with anti-ice OFF. The engine anti-ice/deice system is designed so that in the event of an electrical failure the valve reverts to the anti-icing mode and activates an advisory indicating #1 ENG ANTI-ICE ON or #2 ENG ANTI-ICE ON. Axial compressor discharge air is bled from stage five of the compressor casing, routed through the anti-icing/bleed valve, and delivered to the front frame through ducting. Within the swirl frame, hot air is ducted around the outer casing to each swirl vane splitter lip and inlet guide vanes. The hot air is directed within each vane by a series of baffles. Hot engine oil passing within the scroll vanes in the main frame prevents ice buildup. Water, snow, and solids are carried out through the IPS discharge system. Switches marked ENG ANTI-ICE NO. 1 or NO. 2 OFF, and ON, control engine and inlet anti-ice. At the ON position, compressor bleed-air is supplied continuously. Power to operate the anti-icing system is by the No. 1 and No. 2 dc primary buses, respectively, through circuit breakers marked NO. 1 ENG ANTI-ICE and ANTI-ICE WARN, NO. 2 ENG ANTI-ICE and ANTI-ICE WARN, respectively.

2.28.2 Engine Inlet Anti-Icing.

a. The engine air inlets are anti-iced by bleed-air from the engines. Four advisories, #1 ENG ANTI-ICE ON, #2 ENG ANTI-ICE ON, #1 ENG INLET ANTI-ICE ON, and #2 ENG INLET ANTI-ICE ON, are provided for the engines. The #1 and #2 ENG ANTI-ICE ON advisories will appear when the ENG ANTI-ICE NO. 1 and ENG ANTI-ICE NO. 2 switches are placed ON. When the anti-ice system is operating and an engine is started, the inlet anti-ice valve for that engine will close. The #1 and **#2 ENG INLET ANTI-ICE ON** advisories operate from temperature sensed at the engine inlet fairing. When the temperature reaches about 93°C (199°F), the temperature switch will activate the appropriate ENG INLET ANTI-ICE ON advisory. If this advisory appears with the switches at ENG ANTI-ICE NO. 1 and NO. 2 OFF, it indicates that heat is being applied to that engine inlet and a malfunction exists. Inlet anti-icing will turn on if dc primary power failure occurs; dc electrical power is applied to keep the valve closed. Functioning of ENG INLET ANTI-ICE is controlled as follows:

(1) Above $13^{\circ}C$ (55°F) - Appearance of the ENG INLET ANTI-ICE ON advisory indicates a system malfunction.

(2) Above $4^{\circ}C$ ($39^{\circ}F$) to $13^{\circ}C$ ($55^{\circ}F$) - The ENG INLET ANTI-ICE ON advisory may appear or may not appear.

(3) At 4° C (39° F) and below - Failure of **ENG INLET ANTI-ICE ON** advisory to appear indicates a system malfunction. Do not fly the aircraft in known icing conditions.

b. At engine power levels of 10% **TRQ** per engine and below, full inlet anti-ice capability cannot be provided due to engine bleed limitations. Power to operate the valves is normally provided from the No. 1 and No. 2 dc primary buses, respectively, through circuit breakers marked **NO. 1** and **NO. 2 ENG ANTI-ICE**, respectively. During engine start, power to operate the No. 1 engine inlet anti-ice valve is provided from the dc essential bus through a circuit breaker marked **NO. 1 ENG START**. The **#1** and **#2 ENG INLET ANTI-ICE ON** advisories receive power from No. 1 and No. 2 dc primary buses, through circuit breakers marked **NO. 1** and **NO. 2 ENG ANTI-ICE WARN**, respectively.

2.29 ENGINE OIL SYSTEM.

Lubrication of each engine is by a self-contained, pressurized, recirculating, dry sump system. Included are oil and scavenge pump, emergency oil system, monitored oil filter, tank, oil cooler, and seal pressurization and venting. The oil tank is a part of the main frame. Each scavenge line has a screen at the scavenge pump to aid fault isolation. A chip detector with a cockpit warning light is in the line downstream of the scavenge pump.

2.29.1 Engine Emergency Oil System. The engine has an emergency oil system in case oil pressure is lost. Oil reservoirs built into the A and B sumps are kept full during normal operation by the oil pump. Oil bleeds slowly out of those reservoirs and is atomized by air jets, providing continuous oil mist lubrication for the bearings. A **#1 ENGINE OIL PRESS** or **#2 ENGINE OIL PRESS** caution will appear when indicated oil pressure drops below **700** 20 psi or **701C 701D/CC** 22 psi. Power for the cautions comes from the No. 1 and No. 2 dc primary buses through circuit breakers marked **NO. 1** and **NO. 2 ENG WARN LTS**, respectively.

2.29.2 Oil Tank. The oil tank is an integral part of the engine. Tank capacity is 7 US quarts. The filler port is on the right. Oil level is indicated by a sight gage on each side of the tank. Servicing of the tank is required if the oil level reaches the **ADD** line. Overservicing is not possible because extra oil will flow out the filler port. The scavenge

pump returns oil from the sumps to the oil tank through six scavenge screens, each one labeled for fault isolation.

2.29.3 Oil Cooler and Filter. The oil cooler cools scavenge oil before it returns to the tank. Oil from the chip detector passes through the oil cooler and is cooled by transferring heat from the oil to fuel. After passing through the oil cooler, oil enters the top of the main frame where it flows through the scroll vanes. This further cools the oil and heats the vanes for full-time anti-icing. The vanes discharge oil into the oil tank. If the oil cooler pressure becomes too high, a relief valve will open to dump scavenge oil directly into the oil tank. Oil discharged from the oil pump is routed to a disposable-element filter. As the pressure differential across the filter increases, the first indicator will be a popped impending bypass button. As the pressure increases further, this indication will be followed by an indication in the cockpit #1 or #2 OIL FLTR BYPASS, after which a filter bypass will occur. Power for the cautions is from the No. 1 and No. 2 dc primary buses, respectively, through circuit breakers marked NO. 1 and NO. 2 ENG WARN LTS. During cold weather starting, or on starting with a partially clogged filter, the highpressure drop across the filter will cause the bypass valve to open and the cautions to appear. The impending bypass indicator has a thermal lockout below 38°C to prevent the button from popping. A cold-start relief valve downstream of the filter protects the system by opening and dumping the extra oil to the gear box case.

2.29.4 Engine Chip Detector. The chip detector is on the forward side of the accessory gear box. It consists of a housing with integral magnet and electrical connector, with a removable screen surrounding the magnet. The detector attracts magnetic particles at a primary chip detecting gap. A common oil discharge from the scavenge pump is routed to a chip detector wired to the CHIP #1 ENGINE or CHIP #2 ENGINE caution. If chips are detected, a signal is sent to activate a CHIP #1 ENGINE or CHIP #2 ENGINE caution. Power to operate the engine chip detector system is from the No. 1 and No. 2 dc primary buses, respectively, through circuit breakers marked WARN LTS, under the general headings NO. 1 ENG and NO. 2 ENG.

2.30 ENGINE START SYSTEM.

The pneumatic start system uses an air turbine engine start motor for engine starting. System components consist of an engine start motor, start control valve, external start connector, check valves, controls, and ducting. Three pneumatic sources may provide air for engine starts: the APU, engine crossbleed, or a ground source. When the start button is pressed, air from the selected source is directed through the start control valve to the engine start motor. The #1 ENGINE STARTER or #2 ENGINE STARTER caution will appear at this time and remains until the starter drops out. As the engine start motor begins to turn, an overrun clutch engages causing the engine to motor. As the engine alternator begins to turn, electrical current is supplied to the ignition exciter. Ignition will continue until either the ENGINE IGNITION switch is moved to OFF or starter dropout occurs. The ENG POWER CONT lever is advanced to IDLE detent for light-off and acceleration. A starter speed switch terminates the start cycle when cutoff speed is reached (52% to 65% Ng SPEED) and causes the starter caution to disappear and engine ignition to turn off. Malfunction of the starter speed switch may be overcome by manually holding the start button pressed until reaching 52% to 65% Ng SPEED. To drop out the starter, manually pull down on the ENG POWER CONT lever. To abort a start, pull down on the ENG POWER CONT lever and move to OFF in one swift movement. Power to operate the No. 1 engine start control valve is from the dc essential bus through a circuit breaker marked NO. 1 ENG START. Power to operate the No. 2 engine start control valve is from the No. 2 dc primary bus through a circuit breaker marked NO. 2 ENG START CONTR. 701C **701D/CC** For the 701C and 701D/CC engine only, fuel flow to the engine will be automatically shut off if TGT **TEMP** exceeds 900°C during the start sequence.

2.30.1 Engine Ignition Keylock. An ENGINE IGNI-TION keylock is installed on the instrument panel to short out and prevent ignition exciter current flow when the switch is OFF and the starter is engaged. The switch is marked ENGINE IGNITION OFF, and ON. When the switch is **ON**, the shorts are removed from both engine alternators, allowing exciter current to flow when the engine alternator begins to turn. The ENGINE IGNI-TION is normally ON during flight and turned OFF at shutdown. One switch serves both engines. If the switch is **OFF**, neither engine can be started, although motoring capability remains. When an engine is to be motored without a start, make certain the ENGINE IGNITION switch is OFF. To prevent a possible hot or torching start never turn the ENGINE IGNITION switch ON after motoring has started. Abort start procedures must be done to remove excess fuel from the engine if a start was attempted with the switch OFF.

2.30.2 APU Source Engine Start. The APU provides an on-board source of air and auxiliary electrical power. The APU bleed-air output is enough to start each engine individually at all required combinations of ambient temperatures and enough to start both engines simultaneously within a reduced range of ambient

temperatures. The **AIR SOURCE HEAT/START** switch must be at **APU**. Refer to Section XII for complete APU description.

2.30.3 Crossbleed Engine Start System. Crossbleed engine starts are used when one engine is operating and it is desired to start the other engine from the bleed-air source of the operating engine. To make a crossbleed start, the operating engine must be at least 90% Ng SPEED. When the AIR SOURCE HEAT/START switch is placed to ENG, both engine crossbleed valves will open. Pressing the start button for the engine not operating will cause the start valve for that engine to open at the same time the crossbleed valve for the starting engine will close, and remain closed until starter dropout occurs. At 52% to 65% Ng SPEED, the starting engine start valve will close, stopping bleed-air flow to the starter. When performing starts at lower power settings (slightly above 90% Ng **SPEED** on the operating engine), it may be necessary to manually disengage the starter if the starter motor does not accelerate enough to trigger the starter speed switch. Power to operate the bleed shutoff valve is from No. 1 dc primary bus through a circuit breaker marked AIR SOURCE HEAT/START.

2.30.4 External Source Engine Start. The external start pneumatic port is on the left side of the fuselage. It is the attachment point for a bleed-air line from an external source for engine starting or helicopter heating on the ground. The assembly contains a check valve to prevent engine or APU bleed-air from being vented. The external air source pressurizes the start system up to the engine start control valves, requiring only that electrical power be applied. If an emergency start is made without ac electrical power, No. 1 engine must be started first because the No. 2 engine start control valve will not operate without dc primary bus power.

2.31 ENGINE CONTROL SYSTEM.

The engine control system consists of the **700** ECU or **701C 701D/CC** DEC, engine quadrant, load demand system, and speed control system.

2.31.1 Electrical Control Unit. 700 The ECU controls the electrical functions of the engine and transmits operational information to the cockpit. It is a solid-state device, mounted below the engine compressor casing. The ECU accepts inputs from the alternator, thermocouple harness, Np (% **RPM 1** and **2**) sensor, torque and overspeed sensors, torque signal from opposite engine for load sharing, feedback signals from the HMU for system stabilization, and a demand speed from the engine speed trim button. The ECU provides signals to the % **RPM 1** and **2**

indicators, % TRQ meter, TGT TEMP indicator, and history recorder.

NOTE

Phantom torque may be observed on the PDU torque display of a non-operating engine while the aircraft's other engine is operating during a ground run. Phantom torque readings of up to 14% have been observed on the PDU of the non-operating engine. During startup of the non-operating engine, its ECU will produce a normal, positive torque signal which displays the correct torque signal on the respective PDU.

a. In case of an ECU malfunction, the pilot may override the ECU by momentarily advancing the ENG **POWER CONT** lever to the LOCKOUT stop, then retarding it to manually control engine power. To remove the ECU from lockout, the ENG POWER CONT lever must be moved to IDLE.

b. The torque matching/load sharing system increases power on the lower-torque engine to keep engine torques approximately equal. The system does not allow an engine to reduce power to match a lower power engine. If an engine fails to the high side, the good engine will only attempt to increase torque upward until its Np is 3% above the reference Np.

c. The temperature limiting system limits fuel flow when the requirement is so great that the turbine temperature reaches the limiting value of approximately 843°C. Fuel flow is reduced to hold a constant TGT. It is normal to see a transient increase above the 850°C TGT TEMP when the pilot demands maximum power (Figure 5-2 transient limits). TGT limiting does not prevent overtemperature during engine starts, compressor stall, or when the engine is operated in LOCKOUT (Paragraph 9.3e).



Delay in release of NO. 1 and NO. 2 ENG OVSP TEST A and TEST B button may result in Ng recycling below idle, resulting in subsequent engine stall and TGT increase. To avoid damage, TGT must be monitored during overspeed check.

d. Overspeed protection protects the power turbine from destructive overspeeds. The system is set to trigger at

 $106\% \pm 1\%$ **RPM 1** or **2** and will result in an initial reduced fuel flow and will cycle until the cause of the overspeed is removed or % RPM is reduced manually. Two momentary switches marked NO. 1 and NO. 2 ENG OVSP TEST A and TEST B on the upper console, are used to check the circuits. Testing individual circuits A and B indicates that those systems are complete and performing correctly. Dual closing of A and B serves to check out the actual overspeed system itself, the overspeed solenoid and the POU. This check must be done only on the ground by designated maintenance personnel. The overspeed protection is not deactivated when in LOCKOUT. Power to operate the overspeed system is from two independent sources: the engine alternators as the primary source and the No. 1 and No. 2 ac primary buses as alternate backup source in case of alternator failure. Circuit protection is through circuit breakers marked NO. 1 ENG OVSP and NO. 2 ENG OVSP.

2.31.2 Digital Electronic Control. 701C 701D/CC The DEC unit controls the electrical function of the engine and transmits operational information to the cockpit. It contains a microcomputer processor in a conductive composite molded case. The DEC can be fully powered by either the engine alternator or by the 400 Hz, 120 vac aircraft power. It incorporates logic that will eliminate the torque spike signal during engine start and shutdown.

a. The DEC accepts inputs from the alternator, thermocouple harness, Np (% **RPM 1** and **2**) sensor, torque and overspeed sensors, RPM R sensor and collective position transducer for improved transient droop response, torque signal from opposite engine for load sharing, feedback signals from the HMU for system stabilization, and the engine speed trim button for Np demand speed reference.



Delay in release of TEST A/B button may result in Ng recycling below idle, resulting in subsequent engine stall and TGT increase. To avoid damage, TGT must be monitored during overspeed check.

b. The DEC provides signals to the % **RPM 1** and **2** indicators, % **TRQ** meter, **TGT TEMP** indicator, and engine history counter. It also provides signal validations or selected input signals within the electrical control system. Signals are continuously validated when the engine is operating at idle and above. If a failure occurred on a selected input signal, the failed component or related

circuit will be identified by a preselected fault code (Figure 2-12) displayed on the engine torque meter. These codes are defined in terms of engine torque. They are displayed for 4 seconds on, 2 seconds off, starting with the lowest code and rotating through all applicable codes, then repeating the cycle. They will only be displayed 30 seconds after both engines are shut down with 400 Hz, 120 vac power applied. They may be recalled by maintenance and the engine restarted. The pilot can suppress the fault code display of an engine by depressing the associated cockpit overspeed test button (**TEST A/B**). The pilot may recall it by again depressing the associated cockpit overspeed test button.

c. In case of a DEC malfunction, the DEC may be recalled by maintenance only, and the engine restarted once action has been performed.

d. The torque matching/load sharing system increases power on the lower-torque engine to keep engine torques approximately equal. The system does not allow an engine to reduce power to match a lower power engine. If an engine fails to the high side, the good engine will only attempt to increase torque upward until its Np is 3% above the reference Np.

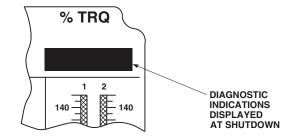
e. The transient compensation system provides significant droop improvement during some maneuvers by monitoring engine torque, collective rate of change, and RPM R speed rate of change.

f. The temperature limiting system limits fuel flow when the **TGT TEMP** reaches the dual engine 10-minute limiting value of approximately 866°C. The automatic contingency power limiting will switch to a higher singleengine 2¹/₂ minute temperature limiting value of approximately 891°C when the opposite % **TRQ** is less than 50%. Fuel flow is regulated to hold a constant TGT. It is normal to see a transient increase above the 903°C **TGT TEMP** limit when the pilot demands maximum power (Figure 5-2 transient limits). TGT limiting does not prevent overtemperature during engine starts, compressor stall, or when the engine is operated in **LOCKOUT**.

g. The HSP is a part of the DEC. It prevents overtemperature during engine starts. The HSP system receives Np, Ng, and TGT signals. When Np and Ng are below their respective hot start reference and **TGT TEMP** exceeds 900°C, an output from the HSP system activates a solenoid in the ODV. This shuts off fuel flow and causes the engine to shut down. The HSP system requires 400 Hz, 120 vac aircraft power be provided to the DEC. The pilot can disable the HSP for emergency starting purposes by pressing and holding the overspeed test button (**TEST A/B**) for the engine being started during the engine start sequence.

h. Overspeed protection protects the power turbine from destructive overspeeds. The system is set to trigger at $120\% \pm 1\%$ **RPM 1** or **2** and will result in a fuel flow shutoff causing the engine to flame out. When % RPM is reduced below the overspeed limit, fuel flow is returned to the engine and engine ignition will come on to provide a relight. This cycle will continue until the overspeed condition is removed. Two momentary switches marked NO. 1 and NO. 2 ENG OVSP TEST A and TEST B on the upper console, are used to check the circuits. Testing individual circuits A and B indicates that those systems are complete and performing correctly. Dual closing of A and B switches serve to check out both the overspeed system, and the ODV. This check must be done only on the ground by designated maintenance personnel. The overspeed protection is not deactivated when in LOCKOUT. Power to operate the overspeed system is from two independent sources: the engine alternators as the primary source, and the No. 1 and No. 2 ac primary buses as alternate backup source in case of alternator failure. Circuit protection is through circuit breakers marked NO. 1 ENG OVSP and NO. 2 ENG OVSP.

2.31.3 Engine Control Quadrant. The engine control quadrant (Figure 2-13) consists of two ENG POWER CONT levers, two ENG FUEL SYS selector levers, and two ENG EMER OFF T-handles. A starter button is on each ENG POWER CONT lever. Each ENG POWER CONT lever has four positions: OFF-IDLE-FLY-LOCKOUT. Movement of the ENG POWER CONT levers moves a cable to mechanically shut off fuel or set available Ng SPEED. The lever is advanced to FLY for flight. This ENG POWER CONT lever setting represents the highest power that could be supplied if demanded. Power turbine speed (% RPM 1 or 2) is not governed until the power lever is advanced from IDLE. The engine quadrant secondary stop, two stop blocks, the quadrant assembly, and a latch on each ENG POWER CONT lever prevent moving the levers below IDLE detent. When shutdown is required, the ENG POWER CONT lever must be pulled out slightly, at the same time the latch release must be pressed, then the ENG POWER CONT lever can be moved below IDLE detent. After being moved momentarily to LOCKOUT, the ENG POWER CONT lever is used to manually control Ng SPEED and % RPM 1 or 2. With the ENG POWER CONT lever at LOCKOUT, the automatic TGT limiting system is



SIGNAL FAILED	DIAGNOSTIC INDICATION ON TORQUE METER (± 3%)
DEC	15%
Np DEMAND CHANNEL	25%
LOAD SHARE CHANNEL	35%
TGT CHANNEL	45%
ALTERNATOR POWER	55%
Ng CHANNEL	65%
Np CHANNEL	75%
TORQUE AND OVERSPEED CHANNEL	85%
HOT START PREVENTION CHANNEL	95%
AIRCRAFT 400 Hz POWER	105%
COLLECTIVE CHANNEL	115%
Nr	125%

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Figure 2-12. Signal Validation - Fault Codes 701C 701D/CC

deactivated and TGT must be manually controlled. The overspeed protection system is not deactivated when at **LOCKOUT**.

2.31.4 Load Demand System. With ENG POWER CONT lever at FLY, the 700 ECU or 701C 701D/CC DEC and HMU respond to collective signals to automatically control engine speed and provide required power. During emergency operations, when the ENG POWER CONT lever is moved to LOCKOUT and then to some intermediate position, the engine will still respond to collective signals. 2.31.5 Engine Speed Control System. An engine RPM control switch on the collective grips controls the speed of both engines simultaneously. There is no individual trim capability. It is used to supply a signal to the **700** ECU, or **701C 701D/CC** DEC for controlling % RPM 1 and 2 as required. The ENG RPM control switch allows adjustment between 96% and 100%. The pilot can override the copilot's control. Power for ENG RPM control system is from the No. 2 dc primary bus through a circuit breaker marked SPEED TRIM.

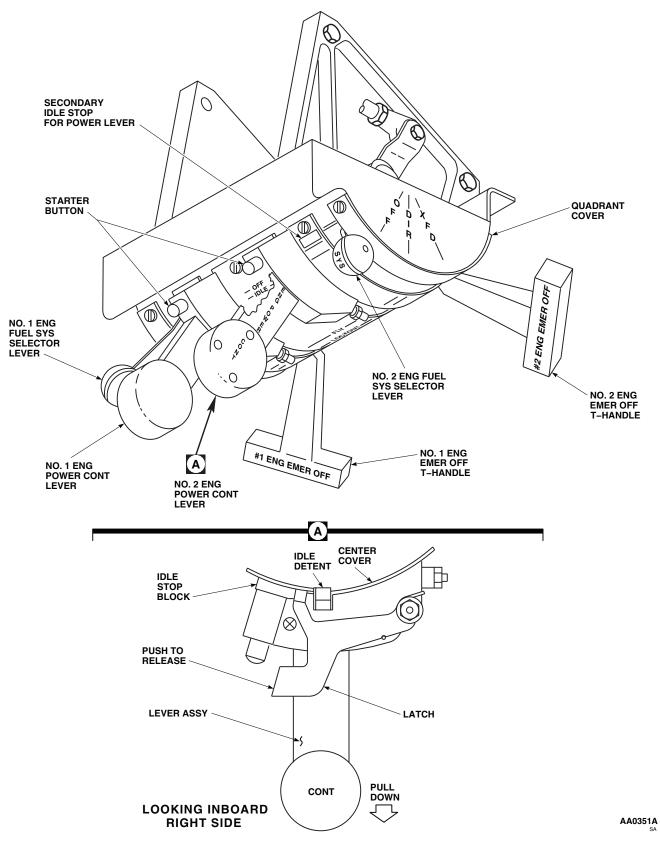


Figure 2-13. Engine Control Quadrant

2.32 HOVER INFRARED SUPPRESSOR SUBSYSTEM (HIRSS).

The hover IR suppressor provides improved helicopter survivability from heat-seeking missiles throughout the flight envelope. The HIRSS kit has no moving parts. It contains a three-stage removable core which reduces metal surface and exhaust gas temperature radiation and prevents line-of-sight viewing of hot engine surfaces. The HIRSS channels hot exhaust gases through the three-stage core and inner baffle to induce the flow of cooling air from the engine bay and the inlet scoops. The three-stage core and inner baffle cold surfaces are coated with low-reflectance material. For further cooling, hot exhaust gas is ducted outboard and downward by the engine, away from the helicopter by the exhaust deflector, where additional cooling air is provided by the main rotor downwash. Installation of each HIRSS module requires removal of the standard engine exhaust module and aft cabin door track fairings. HIRSS modules are installed on the basic airframe equipped with HIRSS fixed provisions by two airframe mounts. The aft fairings are installed using existing mounting points and hardware. While operating in a nonhostile environment, the inner baffle can be removed to enhance helicopter performance.

2.33 ENGINE INSTRUMENTS.

The instrument displays consist of ENG OIL TEMP and PRESS, TGT TEMP, gas generator Ng SPEED, power turbine speed (% RPM 1 or 2), rotor speed % RPM R, engine torque % TRQ, and FUEL QTY to provide the pilots with engine and subsystem monitoring. Continuous indications of those parameters are indicated on vertical scales, digital readouts and cautions. Instruments without low range turn-off feature: % TRQ, TGT TEMP, Ng SPEED, ENG OIL TEMP, and XMSN TEMP will remain on as parameter increases and go out as it decreases. Power for lighting the displays is from the No. 1 and No. 2 ac primary and No. 1 and No. 2 dc primary buses through the SDCs.

2.33.1 Engine Oil Temperature Indicator. Each engine has an oil temperature sensor wired through the SDC to a vertical scale instrument marked **ENG OIL TEMP** on the CDU; and to an **ENGINE OIL TEMP** caution.

2.33.2 Engine Oil Pressure Indicator. Each engine has an engine oil pressure transmitter, downstream of the oil filter, that sends readings to a vertical scale indicator

marked ENG OIL PRESS on the instrument display panel; and to an ENGINE OIL PRESS caution. The lower precautionary and prohibited ranges will go out when reaching the bottom of the normal range. **700** It may be possible that during IDLE operations, the ENGINE OIL PRESS caution will appear. **700** If ENGINE OIL PRESS caution appears at IDLE, verify oil pressure is acceptable by setting Ng SPEED at 90%, check that engine oil pressure is at least 35 psi. As pressure increases above **700** 100 psi, or **701C 701D/CC** 120 psi the respective prohibited scale changes to red.

2.33.3 TGT Temperature Indicator. The TGT indicating system consists of thermocouples transmitting to a **TGT TEMP** indicator. The indicator assembly has two digital readouts that indicate precise temperatures.

2.33.4 Gas Generator Speed (Ng) Indicator. The Ng speed indicating system shows Ng speed for each engine. The system consists of one alternator winding and **Ng SPEED** vertical scale instrument, on the instrument panel, giving percent rpm. Digital readouts for **Ng SPEED** are at the lower section of the instrument faceplate. The three-digit readouts provide a closer indication of **Ng SPEED**.

2.33.5 Engine Power Turbine/Rotor Speed Indica-tor. Power turbine and rotor speed are indicated for each engine on a single instrument marked % **RPM 1 R 2** on the display panel with three vertical scales. Power turbine speed is indicated in % **RPM 1** or **2** and rotor speed % **RPM R**. Rotor speed is sensed by a speed sensor on the right accessory module. Power turbine speed is sensed by a speed sensor on the engine exhaust frame. At the top of the panel are three warning lights that indicate varying degrees of rotor overspeed. These lights remain on, once tripped, and must be manually reset.

2.33.6 Torque Indicator. The torque indicating system shows the amount of power the engine is delivering to the main transmission. A torque sensor mounted on the exhaust case measures the twist of the power turbine shaft, and transmits this signal to the 700 ECU, or 701C 701D/CC DEC and SDC into the torque indicator marked % TRQ on the display panel, displaying readings for both engines. Digital readouts giving torques for each engine are at the top of the indicator. A photocell on the lower center of the display will automatically adjust the lighting of the % RPM and % TRQ indicators with respect to ambient light.

Section IV FUEL SYSTEM

2.34 FUEL SUPPLY SYSTEM.

A separate suction fuel system is provided for each engine. Fuel is stored in two interchangeable, crashworthy, ballistic-resistant tanks. The fuel system consists of lines from the main fuel tanks, firewall-mounted selector valves, prime/boost pump and fuel tanks, and engine-driven suction pumps. The prime/boost pump primes all fuel lines if prime is lost, and also acts as an APU boost for APU starts and operation. A selector valve, driven by cable from the ENG FUEL SYS selector lever on the engine control quadrant permits operation of either engine from either fuel tank. The engines and APU are suction fed, the APU is fed from the left main fuel tank by a separate fuel line. All fuel lines are routed in the most direct manner. The fuel line network includes self-sealing breakaway valves that contain fuel in case of helicopter crash or malfunction. All engine fuel lines are self-sealing with the exception of the APU fuel line.

2.34.1 Fuel Tanks. Both main fuel tanks are crashworthy, self-sealing, and interchangeable. Each tank contains a pressure refuel/defuel valve, fuel quantity and low-level sensors, high-level shutoff valve, low-level shutoff valve, check valve sump drain, and a self-sealing breakaway vent valve. Refer to Table 2-4 for tank capacity. Fuel tank drains are in the sumps to permit removal of sediment and water and provide fuel sampling.

2.34.2 Engine Fuel System Selector Control. Each fuel system has a selector valve which is manually operated through the ENG FUEL SYS selector lever on the overhead engine control quadrant. There is an ENG EM-ER OFF T-handle on each side of the quadrant which is arranged so that pulling the handle engages the ENG FUEL SYS selector lever, bringing it to OFF. The ENG FUEL SYS selectors are connected to the fuel selector valves with low-friction flexible push-pull cables. Each lever can be actuated to three positions: OFF, DIR, and XFD. With the selectors at OFF, the control valves are closed, allowing no fuel flow to the engines. When the selectors are moved forward to **DIR**, the selector valves are opened, providing fuel flow for each engine from its individual fuel tank. If a tank is empty, or the fuel in the tanks needs equalizing, the ENG FUEL SYS selector of the engine that normally feeds from the empty or low-level tank is moved to XFD. This connects that engine to the other tank through the crossfeed system. A check valve in each crossfeed line prevents air from an inoperative engine fuel line crossing to the operating one.

2.35 ENGINE FUEL PRIME SYSTEM.

NOTE

Priming engines using sump mounted fuel boost pumps is described in paragraph 8.39.3.

A toggle switch on the upper console marked FUEL PUMP, FUEL PRIME, OFF, and APU BOOST, when moved to FUEL PRIME, energizes the prime/boost pump and solenoid valves to each main engine fuel supply line and to the solenoid valve for the APU fuel feed system. The **PRIME BOOST PUMP ON** advisory appears during this mode. Prime pump capacity is not enough to prime an engine when the opposite engine is running. Engines should therefore be primed individually with both engines off. The prime/boost pump is actuated and the engine prime valve is opened whenever the engine starter is operating. This provides fuel pressure to aid in a successful engine start. When the engine speed reaches starter dropout speed, engine fuel prime valve will close and the prime/boost pump will also stop operating if the FUEL **PUMP** switch is **OFF**. Power to operate the prime boost system is from the battery bus through a circuit breaker marked FUEL PRIME BOOST.

2.36 FUEL QUANTITY INDICATING SYSTEM.

All internal fuel is continuously gaged with the FUEL QTY gage system. The system consists of two tank unit sensors (probes), one in each tank, a dual channel fuel quantity gage conditioner, and a dual channel low-level warning system. The tank units are connected to the fuel quantity gages marked FUEL QTY 1-2 on the central display panel. A separate total fuel quantity readout numerically displays the total quantity of fuel on board. The system may be checked out by pressing the FUEL IND TEST pushbutton on the miscellaneous switch panel. The vertical scales of the FUEL QTY indicator and the digital readout should show a change, and the #1 and #2 FUEL LOW cautions should flash. When the button is released, the scales and digital readout will return to the original readings. The fuel quantity indicating system is powered by the No. 1 ac primary bus through a circuit breaker, marked NO. 1 AC INST.

2.36.1 Fuel Low Caution. Two low-level sensors, one on each probe, provide signals which activate the **#1 FUEL LOW** or **#2 FUEL LOW** caution. These cautions

flash when the fuel level decreases to approximately 172 pounds in each tank. The appearance of these cautions does not mean a fixed time period remains before fuel exhaustion, but is an indication that a low fuel condition exists. The fuel-low cautions are powered by the No. 1 dc primary bus through a circuit breaker marked **FUEL** LOW WARN.

2.36.2 Fuel Boost Pump. The helicopter fuel system contains an electrically operated submerged fuel boost pump in each fuel tank. When the pumps operate, they provide pressurized fuel to the engine fuel inlet port. Each boost pump is controlled by a switch on the **FUEL BOOST PUMP CONTROL** panel. The two-position switch for each pump, marked **ON-OFF**, activates the pump for continuous operation to maintain a head of fuel pressure at the engine fuel inlet port regardless of engine boost pump discharge pressure. An advisory light near each control switch indicates pump pressure and operation. A check valve in each pump discharge line prevents fuel recirculation during fuel boost operation and prevents loss of engine fuel line prime. Appearance of the **#1** or **#2 FUEL PRESS** caution is also an indicator to turn on boost

pumps. Power to operate the boost pumps is provided from the No. 1 and No. 2 ac primary buses through circuit breakers marked NO. 1 and NO. 2 FUEL BOOST PUMP, respectively.

2.36.3 Refueling/Defueling. A pressure refueling and defueling system provides complete refueling and defueling of both tanks from one point on the left side of the helicopter. Closed circuit refueling uses the pressure refueling system and its components. No electrical power is required for the system during refueling or defueling. The tank full shutoff valve is float-operated. A dual highlevel shutoff system acts as backup for each other. The two high-level float valves close, causing a back pressure to the fueling/defueling valve at the bottom of the tank, closing the refuel valve. The tank empty automatic shutoff system is a function of the low-level float valve opening to allow air to be drawn into the line, closing the defuel valve. A filler neck between the fuselage contour and the fuel cell is a frangible (breakaway) connection. Gravity fueling is done through filler neck on each side of the fuselage for the respective tanks. Gravity defueling capability is provided through the drains.

2.37 FLIGHT CONTROL SYSTEMS.

NOTE

Flight near high power RF emitters such as microwave antennas or shipboard radar may cause uncommanded AFCS and/or stabilator control inputs. Electromagnetic interference (EMI) testing has shown that the master caution may appear before or simultaneously with any uncommanded stabilator trailing edge movement, with 4° or 5° of movement being the maximum.

The primary flight control system consists of the lateral control subsystem, the longitudinal control subsystem, the collective pitch control subsystem, and the directional control subsystem. Control inputs are transferred from the cockpit to the rotor blades by mechanical linkages and hydraulic servos. Pilot control is assisted by stability augmentation system (SAS), flight path stabilization (FPS), boost servos, and pitch, roll, and yaw trim. Dual cockpit controls consist of the cyclic stick, collective stick, and pedals. The pilot and copilot controls are routed separately to a combining linkage for each control axis. Outputs from the cockpit controls are carried by mechanical linkage through the pilot-assist servos to the mixing unit. The mixing unit combines, sums, and couples the cyclic, collective, and yaw inputs. It provides proportional output signals, through mechanical linkages, to the main and tail rotor controls.

2.37.1 Cyclic Stick. Lateral and longitudinal control of the helicopter is by movement of the cyclic sticks through pushrods, bellcranks, and servos to the main rotor. Movement in any direction tilts the plane of the main rotor blades in the same direction, thereby causing the helicopter to go in that direction. Each cyclic stick grip (Figure 2-14) contains a stick trim switch marked STICK TRIM FWD, L, R, and AFT, a go-around switch marked GA, trim release switch marked TRIM REL, a panel light kill switch marked PNL LTS, a cargo release switch marked CARGO REL, and a transmitter ICS switch marked RADIO and ICS.

2.37.2 Collective Pitch Control Stick. The collective sticks change the pitch of the main rotor blades, causing an increase or decrease in lift on the entire main rotor disc. A friction control on the pilot's lever can be turned to adjust the amount of friction and prevent the collective stick from creeping. The copilot's stick telescopes by twisting the grip and pushing the stick aft to improve access to the seat.

Each collective stick has a grip (Figure 2-14) with switches and controls for various helicopter systems. These systems are: landing light control marked LDG LT PUSH ON/OFF, EXT, and RETR, searchlight controls marked SRCH LT ON/OFF, BRT, DIM, EXT, L, R, and RETR, servo shutoff control switch marked SVO OFF 1ST STG and 2ND STG, engine speed trim switch marked ENG RPM INCR and DECR, and cargo hook emergency release switch marked HOOK EMER REL, HUD control switch marked BRT, DIM, MODE, and DCLT. All switches are within easy reach of the left thumb.

2.37.3 Mixing Unit. A mechanical mixing unit provides control mixing functions which minimizes inherent control coupling. The four types of mechanical mixing and their functions are:

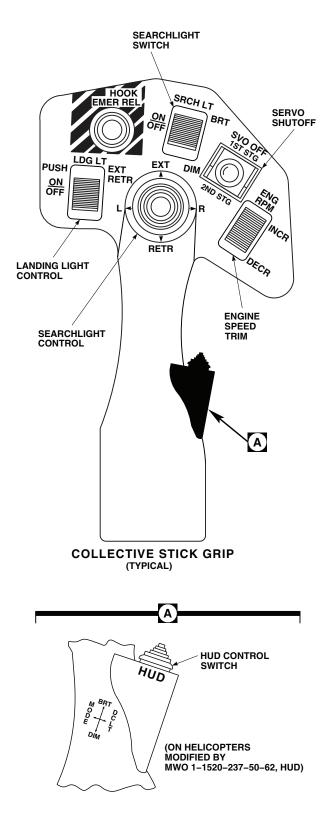
a. Collective to Pitch - Compensates for the effects of changes in rotor downwash on the stabilator caused by collective pitch changes. The mixing unit provides forward input to the main rotor as collective is increased and aft input as collective is decreased.

b. Collective to Yaw - Compensates for changes in torque effect caused by changes in collective position. The mixing unit increases tail rotor pitch as collective is increased and decreases tail rotor pitch as collective is decreased.

c. Collective to Roll - Compensates for the rolling moments and translating tendency caused by changes in tail rotor thrust. The mixing unit provides left lateral input to the main rotor system as collective is increased and right lateral input as collective is decreased.

d. Yaw to Pitch - Compensates for changes in the vertical thrust component of the canted tail rotor as tail rotor pitch is changed. The mixing unit provides aft input to the main rotor system as tail rotor pitch is increased and forward input as tail rotor pitch is decreased.

2.37.4 Collective/Airspeed to Yaw (Electronic Coupling). This mixing is in addition to collective to yaw mechanical mixing. It helps compensate for the torque effect caused by changes in collective position. It has the ability to decrease tail rotor pitch as airspeed increases and the tail rotor and cambered fin become more efficient. As airspeed decreases, the opposite occurs. The SAS/FPS computer commands the yaw trim actuator to change tail rotor pitch as collective position changes. The amount of tail rotor pitch change is proportional to airspeed. Maximum mixing occurs from 0 to 40 knots. As airspeed



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Figure 2-14. Collective and Cyclic Grips (Sheet 1 of 2)

increases above 40 knots, the amount of mixing decreases until 100 knots, after which no mixing occurs.

2.37.5 Tail Rotor Control. The tail rotor control system determines helicopter heading by controlling pitch of the tail rotor blades. Inputs by the pilot or copilot to the control pedals are transmitted through a series of control rods, bellcranks, a mixing unit, control cables, and servos to the pitch change beam that changes blade pitch angle. Hydraulic power to the tail rotor servo is supplied from No. 1 or the backup hydraulic systems.

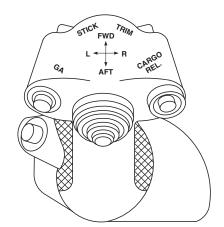
2.37.6 Tail Rotor Pedals. The pedals contain switches that, when pressed, disengage the heading hold feature of FPS below 60 KIAS. Adjustment for pilot leg length is done by pulling a T-handle, on each side of the instrument panel marked **PED ADJ**. The pedals are spring-loaded and will move toward the operator when unlocked. Applying pressure to both pedals simultaneously will move the pedals for desired leg position. The handle is then released to lock the pedal adjusted position.

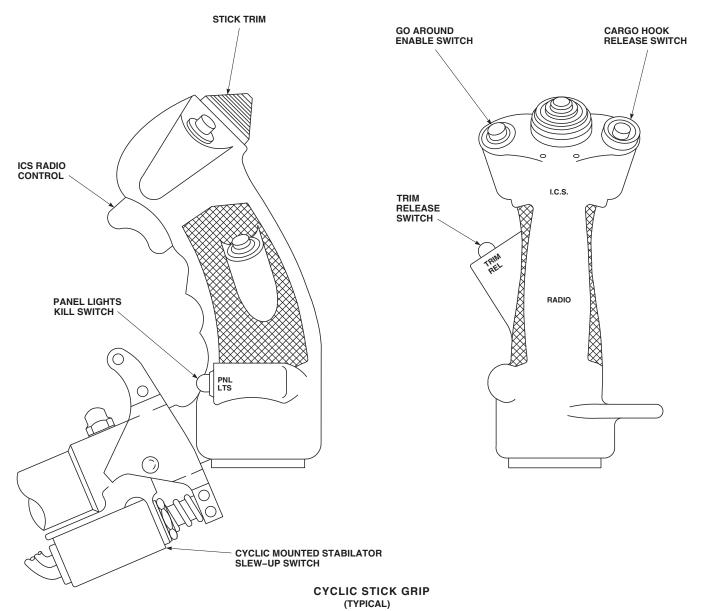
2.38 FLIGHT CONTROL SERVO SYSTEMS.

2.38.1 Primary Servos. Main rotor control loads are reacted by three, two-stage primary servos mounted on the upper deck above the cabin, forward of the main gear box. Each primary servo contains two independent, redundant stages with only the mechanical input linkage in common. If one stage becomes inoperative due to pressure loss, a bypass valve within the depressurized stage will open, preventing hydraulic lock. Electrical interlocks prevent both flight control servos from being turned off simultaneously. If the input pilot valve to the servo becomes jammed, bypass automatically occurs. Automatic bypass is indicated to the pilot by the appearance of the associated **PRI SERVO PRESS** caution.

2.38.2 Tail Rotor Servo. Tail rotor control loads are reacted by a two-stage tail rotor servo mounted on the tail gear box. With the **TAIL SERVO** switch at **NORMAL**, the first stage of this servo is powered by the No. 1 hydraulic system. When the **TAIL SERVO** switch is moved to **BACKUP**, the second stage is powered by the backup system. Should the first stage become inoperative, the backup pump will come on and power the second stage. All aerodynamic loads are then reacted by the second stage.

2.38.3 Flight Control Servo Switch. First and second stage primary servo systems are controlled by the servo switch marked **SVO OFF** on the pilot's and copilot's collective stick grips. The marked switch positions are **1ST STG** and **2ND STG**. The servo systems normally operate





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Figure 2-14. Collective and Cyclic Grips (Sheet 2 of 2)

with the switch in the unmarked center (on) position. To turn off the first stage primary servos, the **SVO OFF** switch is placed to **1ST STG**. To turn off the second stage servo, the switch is placed to **2ND STG**. The systems are interconnected electrically so that regardless of switch position, a system will not shut off unless there is at least 2350 psi in the remaining system. The servo shutoff valve operates on current from the No. 1 and No. 2 dc primary buses through circuit breakers marked **NO. 1** and **NO. 2 SERVO CONTR**, respectively.

2.38.4 Flight Control Servo Low-Pressure Cautions. The first, second and tail rotor stage servo hydraulic low-pressure cautions are marked #1 PRI SERVO PRESS, #2 PRI SERVO PRESS, and #1 TAIL RTR SERVO, and will appear if the pressure is below its respective switch setting or if the servo pilot valve becomes jammed. The servo switches and cautions operate on direct current from the No. 1 and No. 2 dc primary buses through circuit breakers marked NO. 1 SERVO WARN and NO. 2 SERVO WARN, respectively.

2.38.5 Pilot-Assist Servos. Pilot assist servos are normally powered by the No. 2 hydraulic system. If the No. 2 hydraulic pump fails, the pilot assist servos and pitch trim actuator are powered by the backup hydraulic pump. The following units are pilot-assist servos: collective, yaw, and pitch boost servos, which reduce control forces, and three (pitch, roll, yaw) SAS actuators which transfer the output of the SAS controllers into control actuations.

2.38.6 Boost Servo. There are three boost servos: collective, yaw, and pitch, installed between the cockpit controls and mixing unit, which reduce cockpit control forces. The collective, and yaw boost servos are turned on and off by pressing the button marked **BOOST** on the **AUTO FLIGHT CONTROL** panel (Figure 2-15). The pitch boost servo is turned on when **SAS 1** or **SAS 2** is **ON**. The boost shutoff valves receive power from the dc essential bus through a circuit breaker marked **SAS BOOST**.

2.38.7 Pilot-Assist Controls. An AUTO FLIGHT CONTROL panel in the lower console contains the controls for operating the pilot-assist servos and actuators. The panel contains SAS 1, SAS 2, TRIM, FPS, BOOST, and the FAILURE ADVISORY/POWER ON RESET lights/switches. STICK TRIM and TRIM REL switches on the cyclic sticks, are manually operated by either pilot or copilot.

2.39 AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS).

The AFCS enhances the stability and handling qualities of the helicopter. It is comprised of four basic subsystems: stabilator, SAS, trim systems, and FPS. The stabilator system improves flying qualities by positioning the stabilator by means of electromechanical actuators in response to collective, airspeed, pitch rate, and lateral acceleration inputs. The SAS provides short term rate damping in the pitch, roll, and yaw axes. Trim/FPS system provides control positioning and force gradient functions as well as basic autopilot functions with FPS engaged.

2.39.1 Stability Augmentation System (SAS).

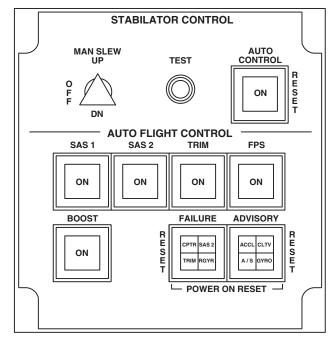
NOTE

As the vertical gyro or inputs from AHRS comes up to speed or when the system is shut down, the derived pitch/roll rate signal which feeds **SAS 1** will cause small oscillations in pitch and roll SAS actuators. This is a temporary situation and can be eliminated by turning **SAS 1** off.

The SAS enhances dynamic stability in the pitch, roll, and yaw axes. In addition, both SAS 1 and SAS 2 enhance turn coordination by deriving commands from lateral accelerometers which together with roll rate signals are sent to their respective yaw channels automatically at airspeeds greater than 60 knots. The SAS 1 amplifier circuitry operates on 28 vdc power from the dc essential bus through a circuit breaker marked SAS BOOST providing excitation for the electronic components within the amplifier. AC power from the ac essential bus through a circuit breaker marked SAS AMPL is also required for normal operation of the SAS. The SAS amplifier uses the vertical gyro or inputs from AHRS roll output to derive roll attitude and rate for the roll SAS commands and an ac-powered yaw rate gyro or inputs from AHRS for the yaw SAS commands. Loss of ac power to the vertical gyro or inputs from AHRS or SAS amplifier causes erratic operation of SAS 1 due to loss of the reference for the ac demodulators. When this condition is encountered, the pilot must manually disengage SAS 1. In case of a malfunction of the SAS 2 function, the input will normally be removed from the actuator and the SAS 2 fail advisory light on the AUTO FLIGHT CONTROL panel will illuminate. If the malfunction is of an intermittent nature the indication can be cleared by simultaneously pressing POWER ON **RESET** switches. If the malfunction is continuous, the

SAS 2 should be turned off. With **SAS 1** or **SAS 2** off, the control authority of the SAS is reduced by one-half (5% control authority). Malfunction of the **SAS 1** system may be detected by the pilot as an erratic motion in the helicopter without a corresponding failure advisory indication. If a malfunction is experienced, **SAS 1** should be turned off. SAS actuator hydraulic pressure is monitored. In case of loss of actuator pressure, or if both **SAS 1** and **SAS 2** are off, the **SAS OFF** caution will appear.

2.39.2 Trim System. When the TRIM is engaged on the AUTO FLIGHT CONTROL panel, the pitch, roll, and yaw trim systems are activated to maintain position of the cyclic and tail rotor controls. Proper operation of the yaw trim requires that the BOOST on the AUTO FLIGHT CONTROL panel be on. The tail rotor and lateral cyclic forces are developed in the electromechanical yaw and roll trim actuators. Both yaw and roll trim actuators incorporate slip clutches to allow pilot and copilot control inputs if either actuator should jam. The forces required to break through the clutch are 80 pounds maximum in yaw and 13 pounds maximum in roll. The longitudinal force is developed by an electrohydromechanical actuator operated in conjunction with the SAS/ FPS computer. When the pilot applies a longitudinal or lateral force to the cyclic stick with trim engaged, a combination detent and gradient force is felt. The pilot may remove the force by pressing the thumb-operated TRIM REL switch on the pilot/copilot cyclic grip. The pedal gradient maintains pedal position whenever the trim is engaged. By placing feet on the pedals, the pedal switches are depressed and the gradient force is removed. The pedals may then be moved to the desired position and released. The pedals will be held at this position by the trim gradient. The pedal trim gradient actuator also includes a pedal damper. The pedal damper is engaged continuously, independent of electric power and the TRIM switch on the AUTO FLIGHT CONTROL panel. Operation of the trim system is continuously monitored by the SAS/FPS computer. If a malfunction occurs, the SAS/ FPS computer will shut off the trim actuator(s) driving the affected axis, and the TRIM FAIL and FLT PATH STAB cautions will appear. If the malfunction is of an intermittent nature, the indication may be cleared by simultaneously pressing both POWER ON RESET switches. In addition to the trim release switch, a four-way trim switch on each cyclic stick establishes a trim position without releasing trim. With trim engaged, the trim position is moved in the direction of switch movement. The cyclic is moved by the trim switch in one direction at a time. When **FPS** is engaged, the **TRIM** switch changes the pitch and roll attitude reference instead of the cyclic stick position reference. The trim system release feature permits the pilot or copilot to fly the helicopter with light stick



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Figure 2-15. Automatic Flight Control System (AFCS) Switch Panel

forces. The push-on/push-off **TRIM** switch on the **AUTO FLIGHT CONTROL** panel or the **TRIM REL** switches on the pilot/copilot cyclic grips may be used to release trim. When the switch is **ON**, the trim system provides gradient and detent holding force for pitch, roll, and yaw. When turned off, the trim system is released and light cyclic control forces are present.

2.39.3 Flight Path Stabilization (FPS).



Pedal trim switches must be pressed while changing the helicopter heading during hover. Do not hold hover heading against yaw trim force. A rapid release of pedal trim force will allow the FPS heading hold feature to immediately correct to the last known engaged heading. This can result in rapid, divergent helicopter heading deviations.

a. Proper FPS operation requires that the **BOOST**, **TRIM**, and **SAS 1** and/or **SAS 2** functions have been

selected on the AUTO FLIGHT CONTROL panel. Although not required for proper operation, the FPS performance will be improved by the proper operation of the stabilator in the automatic mode. To use the FPS features, the pilot first assures that **BOOST**, **SAS**, and **TRIM** are on and operating, and then turns the **FPS** switch **ON**. The desired pitch and roll attitude of the helicopter may be established in one of these ways:

- (1) Pressing the **STICK TRIM** switch to slew the reference attitude to the desired attitude.
- (2) Pressing the **TRIM REL** switch on the pilot/ copilot cyclic grip, manually flying the helicopter to the desired trim condition and releasing the **TRIM REL** switch.
- (3) Overriding the stick trim forces to establish the desired trim condition and then neutralizing stick forces by means of the trim switch.

b. The trim attitude, once established, will be automatically held until changed by the pilot. At airspeeds greater than 60 knots, the pitch axis seeks to maintain the airspeed at which the trim is established, by variation of pitch attitude. When pitch attitude is changed by means of the STICK TRIM switch, there is a delay from the time that the STICK TRIM switch input is removed until the new reference airspeed is acquired. This is to allow time for the helicopter to accelerate or decelerate to the new trim speed. The yaw axis of the FPS provides heading hold at airspeeds less than 60 knots and heading hold or turn coordination at airspeeds greater than 60 knots. For heading hold operation at airspeeds less than 60 knots, the helicopter is maneuvered to the desired heading with feet on pedals. When trimmed at the desired heading, the pilot may remove feet from pedals, at which time the existing heading becomes the reference, which is automatically held. To change heading, the pilot may activate one or both pedal switches, trim up on the desired heading, and remove feet from pedals. At airspeeds greater than 60 knots, heading hold will be automatically disengaged, and coordinated turn engaged under these conditions:

- (1) **STICK TRIM** switch is actuated in the lateral direction.
- (2) **TRIM REL** switch is pressed and roll attitude is greater than prescribed limits.
- (3) About ¹/₂ inch cyclic displacement and a roll attitude of about 1.5°. Heading hold is automatically reengaged and turn coordination disengaged upon recovery from the turn when

the lateral stick force, roll attitude, and yaw rate are within prescribed limits.

c. To make a coordinated turn, the pilot enters a turn in one of these ways:

- (1) Changing reference roll attitude by pressing the **STICK TRIM** switch in the desired lateral direction.
- (2) Pressing **TRIM REL** switch on the cyclic grip and establishing the desired bank angle with feet off pedal switches.
- (3) Exerting a lateral force on the cyclic stick to achieve the desired bank angle, and then neutralizing the force with the **STICK TRIM** switch.
- (4) Keeping a lateral force on the cyclic stick for the duration of the turn.

d. In each of these ways the ball should remain automatically centered during the entry and recovery from the turn. If feet are on the pedals, care must be taken not to apply too much force to the pedals to oppose their motion. If the pilot intentionally miscoordinates the helicopter, the result will be a pedal force roughly proportional to sideslip. The pilot may release the pedal force by pressing the cyclic TRIM REL switch with feet on pedals. During transition through 60 knots airspeed, the pilot may feel a slight pedal motion due to a switching transient which may occur when the commanded coordinated turn pedal position differs slightly from the pilot-commanded position. The FPS monitoring is automatic. If a malfunction is detected, the FLT PATH STAB caution will appear and the FPS will either continue to operate in a degraded mode, such as without heading hold, or without airspeed hold; or may cease to function altogether. The pilot must take over manual flight of the helicopter, and may either turn the FPS off or evaluate performance to determine the degree and type of degradation, and continue flight with the remaining features. To help evaluate the nature of the degradation, eight failure advisory indicators are displayed on two FAILURE ADVISORY switches on the flight control panel. These tell the pilot the type of sensor or actuator which has experienced the failure. If a light goes on, it may be turned off by pressing the lighted switch. All failure advisory lights will be on at initial application of power. The pilot may attempt to clear the indication of temporary malfunction by simultaneously pressing both FAILURE ADVISORY switches. If the FLT PATH **STAB** caution disappears, it may be assumed that normal operation is restored. All FPS functions are provided by automatically moving the cockpit controls.

2.40 STABILATOR SYSTEM.

a. The helicopter has a variable angle of incidence stabilator to enhance handling qualities. The automatic mode of operation positions the stabilator to the best angle of attack for the existing flight conditions. After the pilot engages the automatic mode, no further pilot action is required for stabilator operation. Two stabilator amplifiers receive airspeed, collective stick position, pitch rate, and lateral acceleration information to program the stabilator through the dual electric actuators. The stabilator is programmed to:

(1) Align stabilator and main rotor downwash in lowspeed flight to minimize nose-up attitude resulting from downwash.

(2) Decrease angle of incidence with increased airspeed to improve static stability.

(3) Provide collective coupling to minimize pitch attitude excursions due to collective inputs from the pilot. Collective position sensors detect pilot collective displacement and program the stabilator a corresponding amount to counteract the pitch changes. The coupling of stabilator position to collective displacement is automatically phased in beginning at 30 KIAS.

(4) Provide pitch rate feedback to improve dynamic stability. The rate of pitch attitude change of the helicopter is sensed by a pitch rate gyro in each of the two stabilator amplifiers and used to position the stabilator to help dampen pitch excursions during gusty wind conditions. A sudden pitch up due to gusts would cause the stabilator to be programmed trailing edge down a small amount to induce a nose-down pitch to dampen the initial reaction.

(5) Provide sideslip to pitch coupling to reduce susceptibility to gusts. When the helicopter is out of trim in a slip or skid, pitch excursions are also induced as a result of the main rotor downwash on the stabilator. Lateral accelerometers sense this out of trim condition and signal the stabilator amplifiers to compensate for the pitch attitude change (called sideslip to pitch coupling). Nose left (right slip) results in the trailing edge programming down. Nose right produces the opposite stabilator reaction.

b. The above features are provided via inputs to dual actuators which position the stabilator. Failure of one actuator will restrict total maximum movement of the stabilator to about 35° if failure occurs full down, or about 30° if failure occurs full down, or about 30° if failure occurs full up. The stabilator actuators receive power from the dc essential bus and No. 2 dc primary bus through circuit breakers marked **STAB PWR**. Since the dc

essential bus is powered by the battery, it is possible to manually slew one actuator using battery power only. If the stabilator is slewed up, regain automatic control by manually slewing stabilator full down, then push **AUTO CONTROL RESET** twice. Otherwise, when only one actuator is slewed, it causes a very large mismatch between the two actuator positions. This is detected by the fault monitor and shuts down the automatic mode upon attempted engagement. Automatic control function sensors, airspeed sensors, pitch rate gyros or inputs from AHRS, collective position sensor, and lateral accelerometer receive power from the ac essential bus and No. 2 ac primary bus through circuit breakers marked **STAB CON-TR**.

2.40.1 Stabilator Control Panel. The stabilator control panel on the lower console provides electrical control of the stabilator system. The panel contains a MAN SLEW switch, a TEST button, and AUTO CONTROL RESET switch with a push-to-reset feature. The automatic mode will allow the stabilator to be automatically operated from about 39° trailing edge down to 9° trailing edge up. Manual operation is also restricted to these limits. If a malfunction occurs in the automatic mode, the system will switch to manual, ON will go off in the AUTO CONTROL window, and the STABILATOR caution and MASTER CAUTION will appear and a beeping tone will be heard in the pilot's and copilot's headphones. It may be possible to regain the auto mode by pressing the AUTO CONTROL RESET. If the automatic mode is regained, ON will appear in the AUTO CONTROL switch window and the cautions will disappear. The stabilator automatic mode is held in the energized state within the stabilator control amplifier. On certain occasions during interruption of dc power, such as switching of generators, it is possible to have conditions where the stabilator automatic mode may shut down. If the automatic mode shuts down during flight because of an ac power failure, the helicopter shall be slowed to 80 KIAS before power is restored. In this case the AUTO **CONTROL RESET** switch may be pressed to reengage the auto mode. If the automatic mode is not regained, the MASTER CAUTION must be reset, which turns off the beeping tone, and the stabilator controlled throughout its range with the MAN SLEW switch. When initial power is applied to the stabilator system, it will be in automatic mode. The **TEST** switch is used to check the AUTO mode fault detector feature and is inoperative above 60 KIAS. When pressed, control of the stabilator should go to the manual mode.

2.40.2 Stabilator Position Indicator. Two **STAB POS** indicators are on the instrument panel. They give

pilots a remote indication of stabilator position. The copilot's **STAB POS** indicator may vary from the pilot's indicator as much as 2°. The indicator range is marked from 45° **DN** to 10° up. The stabilator position indicator system is powered from the ac essential bus 26V through a circuit breaker marked **STAB IND**.

2.40.3 Cyclic-Mounted Stabilator Slew Up Switch.

Installed on each cyclic stick below the grip is a pull-type stabilator manual slew up switch. The switch provides the

pilot and copilot with rapid accessibility to stabilator slew up. The cyclic slew switch is wired in parallel with the stabilator panel **MAN SLEW-UP** switch position. When the switch is actuated, the stabilator trailing edge will begin to move up and continue until the up limit stop is reached or the switch is released.

Section VI HYDRAULIC AND PNEUMATIC SYSTEM

2.41 HYDRAULIC SYSTEM.

The three hydraulic systems are designed to provide full flight control pressure. The components of the hydraulic systems are three hydraulic pump modules, two transfer modules, a utility module, three dual primary servos, one dual tail rotor servo, four pilot-assist servos, an APU accumulator, an APU handpump, and a servicing handpump. There are three hydraulic pressure supply systems: number 1, number 2, and backup. All are completely independent and each is fully capable of providing essential flight control pressure for maximum system redundancy. Complete redundancy is accomplished by the backup pump providing hydraulic power to both number 1 and/or number 2 systems if one or both pumps fail. If two systems lose pressure, there will be a slight restriction in the maximum rate of flight control movement due to only one pump supplying both stages with hydraulic power. An automatic turnoff feature is provided. When the SVO OFF switch is moved to 1ST STG or 2ND STG position, that stage of the primary servos is turned off. When the SVO OFF switch is moved to 1ST STG, the first stage of the primary servos is turned off. A malfunction in the second stage will cause first stage (which was turned off) to automatically turn back on in case the backup system does not take over the function of the failed second stage. If the second stage is initially turned off, the sequence is reversed. An additional hydraulic handpump is provided for APU start system.

NOTE

The following listed cautions may momentarily appear when the applicable listed switch is activated; this is considered normal.

CAUTION

SUBSYSTEM	CAUTION
SAS 1 or SAS 2 switch ON	#2 PRI SERVO PRESS #2 HYD PUMP BOOST SERVO OFF
BOOST switch ON	#2 PRI SERVO PRESS #2 HYD PUMP SAS OFF
TAIL SERVO switch BACKUP	#1 PRI SERVO PRESS #1 HYD PUMP

SUDGVOTEM

SUBSYSTEM	CAUTION

HYD LEAK TEST	#1 and #2 PRI SERVO
switch NORM after	PRESS
RESET	#1 and #2 HYD PUMP

2.42 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 with each other. 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. The reservoir part of each pump module has a level indicator window marked REFILL, FULL, and EXPANSION. A pressure relief and bleed valve protects the pump from high pressure in the return system. The pump has two filters: a pressure filter and a return filter. A red indicator button on each filter will pop out when pressure goes up 70 ± 10 psi above normal. The pressure filter has no bypass. The return filter has a bypass valve that opens when return pressure reaches 100 ± 10 psi above normal. Each pump has three check valves: one at the external ground coupling, one at the pressure side, and one at the return side. A fluid quantity switch mounted on top of each pump module senses fluid loss for that system. When the piston in the pump module moves down to the **REFILL** mark, the piston closes the switch activating the RSVR LOW caution. Each hydraulic pump has two temperature sensitive labels mounted on the side. When a temperature level is reached, a circle turns black. There are two types of labels used on the pumps. When the temperature label indicates that a temperature of 132°C (270°F) has been exceeded, an entry shall be made on DA Form 2408-13-1. The helicopter should not be flown until appropriate maintenance action has been taken.

2.42.1 Number 1 Hydraulic System. Number 1 hydraulic 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 **SVO OFF** switch. 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** on the miscellaneous switch panel. If the fluid quantity of the number one pump reservoir becomes low, the fluid quantity switch will complete an electrical circuit to close the first stage tail rotor shut off valve. If fluid continues to be lost and the **#1 HYD PUMP** caution appears, the first stage tail rotor shutoff valve will open, allowing backup pressure to supply first stage tail rotor. The logic modules automatically control the hydraulic system. The tail rotor servo is a two-stage servo but, unlike the primary servos, only one stage is pressurized at a time.

2.42.2 Number 2 Hydraulic System. The number 2 hydraulic system, which also operates with the rotor turning, supplies the second stage primary servo and the pilotassist 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 SVO OFF switch. The pilotassist servos cannot be turned off collectively, but SAS, **TRIM**, and **BOOST** servos can be manually turned off by switches on the AUTO FLIGHT CONTROL panel. If fluid quantity of the number two pump reservoir becomes low, the fluid quantity switch will complete an electrical circuit to close the pilot assist module shut off valve. If fluid continues to be lost and the #2 HYD PUMP caution appears, the pilot assist module shut off valve will open, allowing backup pump pressure to supply pilot assist module pressure.

2.42.3 Backup Hydraulic System.

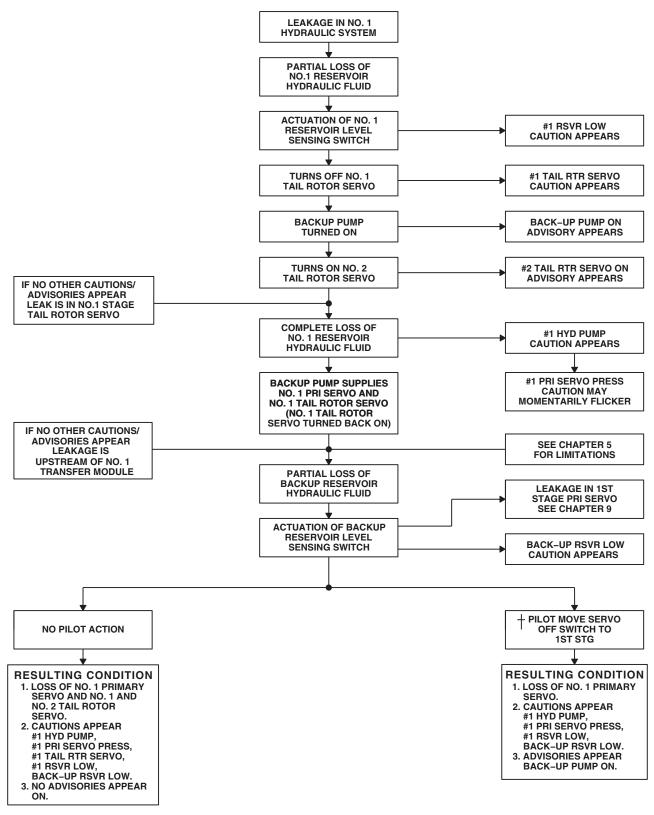


Whenever the No. 1 ac generator is inoperative (failed or not on line) and the BACKUP PUMP PWR circuit breaker is out for any reason, ac electrical power must be shut off before resetting BACKUP PUMP PWR circuit breaker. Otherwise, it is possible to damage the current limiters.

The backup hydraulic pump system supplies emergency pressure to the number 1 and/or number 2 hydraulic systems whenever a pressure loss occurs. It also supplies pressure to the number 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** caution appearance. This system supplies hydraulic pressure to all flight control components during ground checkout. The backup system also provides a hydraulic pressure for automatic recharging of the APU start system accumulator. 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 upon startup of the electric motor. This valve unloads the electric motor by reducing torque requirement at low rpm. After about 0.5 second when main generator is operating, or 4 seconds when operating from APU generator or external power, the valve is closed and 3000 psi pressure is supplied to the hydraulic system. This sequence reduces the current demand during backup system startup. Pressure sensing switches in the number 1 and number 2 transfer modules constantly monitor the pressure output of the number 1 and number 2 pumps. Loss of pressure initiates the backup operation. 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 PUMP switch position, and disables the backup pump ac thermal switch. 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 the first stage tail rotor servo if the number 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 caution appearance. If a leak in a primary servo system depletes the backup system fluid, the backup reservoir level sensing switch will activate the BACK-UP RSVR LOW caution, and the pilot must manually turn off the leaking primary system.

2.43 HYDRAULIC LEAK DETECTION/ISOLATION SYSTEM.

The leak detection/isolation (LDI) system protects the flight control hydraulic system by preventing the further loss of hydraulic fluid in case of a leak. The LDI system uses pressure switches and fluid level sensors for monitoring pump hydraulic fluid level, and pump pressure for primary and tail rotor servos, and pilot-assist servos. When a pump module reservoir fluid level switch detects a fluid loss, the logic module follows the sequence detailed in Figure 2-16 to isolate the leak. To accomplish this, the logic module operates the required shutoff valve(s) to isolate the leak and turns on the backup pump when required. In the cockpit the RSVR LOW caution for that system appears. Backup pump and shutoff valve(s) operation is automatic through the logic module. If, after the isolation sequence, the leak continues, the leakage is in the stage 1 or 2 primary servos and the appropriate SVO OFF



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Figure 2-16. Hydraulic Logic Module Operation Principle (Sheet 1 of 2)

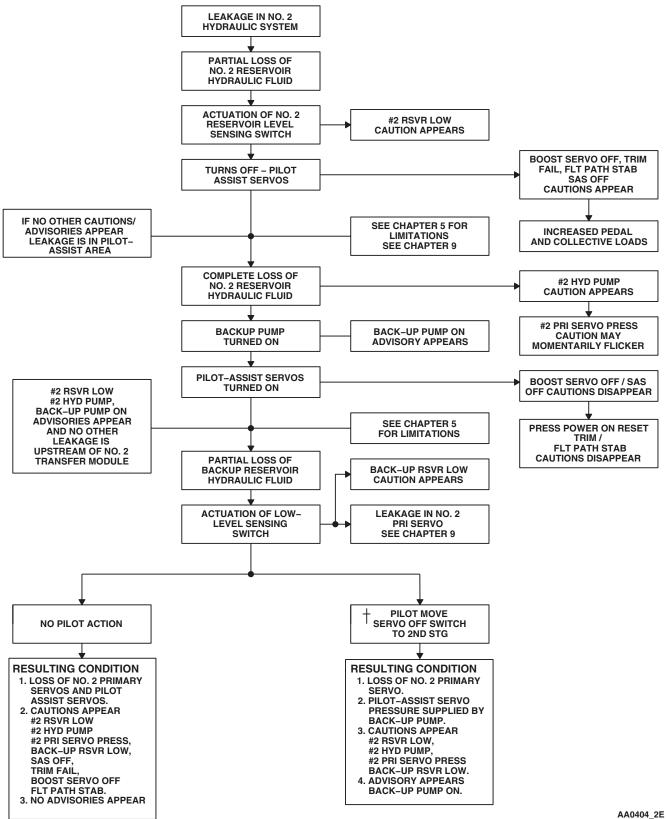


Figure 2-16. Hydraulic Logic Module Operation Principle (Sheet 2 of 2)

switch must be moved to the off position by the pilot. By placing the HYD LEAK TEST switch to TEST, all LDI system components are checked electrically. After a leak test has been made, the HYD LEAK TEST switch must be moved to **RESET** momentarily, to cause cautions and advisories that appeared during the test to disappear. The BACK-UP PUMP ON advisory will appear for about 90 seconds. Refer to Chapter 8 Section II for test procedure. Except for the HYD LEAK TEST switch, the hydraulic leak system consists of components of 1st stage, 2nd stage, 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 marked NO. 2 SERVO CONTR and dc essential bus through a circuit breaker marked BACKUP HYD CONTR.

NOTE

The HYD LEAK TEST should be performed as a ground check only. If the HYD LEAK TEST is inadvertently activated in flight, the **BACK-UP RSVR LOW** caution will appear. Place the **HYD LEAK TEST** switch to **RESET** then **NORM** to make the caution disappear.

2.44 TRANSFER MODULES.

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

2.44.1 No. 1 Transfer Module. This module has a transfer valve, a pressure switch, a 1st stage primary shutoff valve, a 1st stage tail rotor shutoff valve, a restrictor, and check valves. The transfer valve is spring-loaded to the open or normal position. If 1st stage hydraulic pressure is lost, the valve automatically transfers backup pump pressure to the 1st stage system. The 1st stage primary shutoff valve lets the pilot or copilot shut off 1st stage pressure to the primary servos and prevents both stages from being shut off at the same time. The pressure switch activates the **#1 HYD PUMP** caution when pressure drops below 2000 psi and also sends a signal to a logic module that pressure is lost in the 1st stage hydraulic system. The restrictor allows fluid to circulate for cooling under noflow conditions. If a fluid leak develops past the transfer module, the check valves prevent fluid loss on the return side of the transfer module.

2.44.2 No. 2 Transfer Module. The No. 2 transfer module is like the No. 1 module except that it supplies 2nd

stage pressure. The pilot assist shutoff valve turns off pressure to the pilot assist module. The 2nd stage primary servo shutoff valve turns off pressure to the 2nd stage of the primary servos. The pressure switch activates the **#2 HYD PUMP** caution when 2nd stage system pressure is below 2000 psi, and also sends a signal to a logic module that pressure is lost in the 2nd stage system.

2.44.3 Utility Module. The utility module connects hydraulic pressure from the backup pump to the No. 1 and No. 2 transfer modules, the 2nd stage of the tail rotor servo, and the APU accumulator. A pressure switch on the module senses the backup pump operating and activates the **BACK-UP PUMP ON** advisory. If the flow rate through the module to the APU accumulator goes over 1¹/₂ gpm, a velocity fuse shuts off flow.

2.44.4 Logic Modules. Two logic modules, one in the left relay panel and the other in the right relay panel, 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 on the pump modules, and inputs received from control switches in the hydraulic system. The outputs of the logic modules will either activate cautions/advisories notifying the pilot of a failure and/or turn off one or more valves due to a system malfunction. All switching functions of the hydraulic logic modules are automatic, except as shown by a dagger (†) which indicates crewmember action (Figure 2-16).

2.45 RESERVOIR FILL SYSTEM.

A handpump and manual selector valve are on the right side upper deck of the helicopter for system servicing. Refer to Figure 2-28 for servicing. The three hydraulic system reservoir levels can be seen from the fill pump location. The handpump reservoir contains a sight gage above the handpump crank. A 1-quart level mark indicates a requirement for refill. Refer to Section XV this chapter for servicing.

2.46 PNEUMATIC SUBSYSTEM.

A pneumatic subsystem operating from bleed-air furnished by the main engines, the APU, or an external pneumatic power source, is used to drive the main engine starter, for heating system operation and external extended range tank fuel transfer. Bleed-air from the main engines is used for engine inlet anti-icing subsystem operation. The heating subsystem and the extended range fuel tanks use bleed-air supplied by the main engines during flight and on the ground by the main engines, APU, or external source. The subsystem contains check valves at each bleed-air source and a shutoff valve at each main engine.

Section VII POWERTRAIN SYSTEM

2.47 POWERTRAIN.

The powertrain consists of inputs from two engines, a main transmission, intermediate gear box, tail gear box, and connecting drive shafting. Power from the engines is transmitted to the main transmission module through input modules. The main transmission is mounted on top of the cabin between the two engines. It mounts and powers the main rotor head, changes the angle of drive from the engines, reduces rpm from the engines, powers the tail rotor drive shaft, and drives the accessory module. The main transmission consists of five modules: two input modules, the main module, and two accessory modules. The main transmission has a built-in 3° forward tilt.

2.47.1 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 contain an input bevel pinion and gear and a freewheel unit. The freewheel unit allows engine disengagement during autorotation, or in case of a nonoperating engine, the accessory module will continue to be driven by the main rotor. The input module provides the first gear reduction between engine and main module.

2.47.2 Accessory Module. One accessory module is mounted on the forward section of each input module. Each accessory module provides mounting and drive for an electrical generator and a hydraulic pump package. A rotor speed sensor is mounted on the right accessory module and provides signals for the VIDS. On the UH-60L, an additional rotor speed sensor is mounted on the left accessory module which provides input signals to the DEC for improved transient droop response.

2.47.3 Main Module. The main module contains the necessary gearing to drive the main rotor and tail rotor systems. It provides a reduction in speed from the input module to the main module and the tail drive shaft.

2.48 MAIN TRANSMISSION LUBRICATION SYSTEM.



UH-60A EH Prolonged nose-down attitudes of 5° or more may cause high main transmission oil temperature.

The transmission incorporates an integral wet sump lubrication system that provides cooled, filtered oil to all bearing and gears. The ac generators on the accessory modules also receive oil for cooling. Oil under pressure is supplied through internally cored oil lines, except for the pressure and return lines of the oil cooler. Refer to Table 2-4 for oil specification and servicing. The lubrication system includes two lubrication pumps that are combination pressure and scavenge types operating in parallel. The main transmission may run at cruise flight for 30 minutes with loss of all oil. Main transmission oil pressure may fluctuate when the helicopter is known to be in a nose-up attitude (i.e., slope landings or hover with an extreme aft CG). Pressure regulating and bypass valves protect the lube 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 cooler when the oil temperature is below $71^{\circ} \pm 1^{\circ}$ C. Other warning and monitoring systems on the main transmission are: MAIN XMSN OIL TEMP and PRESS cautions and XMSN TEMP and PRESS oil temperature gages. An oil pressure switch on the left accessory module the farthest point from the pumps, activates the MAIN XMSN OIL **PRESS** caution when the pressure drops to 14 ± 2 psi. The transmission oil temperature warning system is triggered by an oil temperature switch at the oil cooler input to the main module near the tail takeoff drive shaft flange. The MAIN XMSN OIL TEMP caution appears when transmission oil temperature reaches 120°C. Temperature for the gage is sensed between the sump and the pump. Pressure readings 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.

2.48.1 Transmission Oil Temperature Indicator. The transmission oil temperature indicator marked **XMSN TEMP** is a part of the CDU. Refer to Chapter 5 for limitations. Power to operate the temperature indicator and **MAIN XMSN OIL TEMP** caution is provided from the No. 1 and No. 2 ac primary buses through the SDCs and the No. 2 dc primary bus through a circuit breaker marked **MAIN XMSN**.

2.48.2 Transmission Oil Pressure Indicator. The transmission oil pressure indicator marked **XMSN PRESS** is a part of the CDU. Refer to Chapter 5 for limitations. Power to operate the pressure indicator and **MAIN XMSN OIL PRESS** caution is provided from the No. 1 and No. 2 ac primary buses through the SDC and No. 2 dc primary bus through a circuit breaker marked **MAIN XMSN**.

2.48.3 Transmission Chip Detector System. The transmission chip detector system consists of chip detectors on the left and right input modules, left and right accessory modules, the main gear box module, and cautions marked CHIP INPUT MDL-LH, CHIP INPUT MDL-RH, CHIP ACCESS MDL-LH, CHIP ACCESS MDL-RH, and CHIP MAIN MDL SUMP. These detectors provide warning of chips in any of five areas of the main transmission system. Each chip detector, with the exception of the main gearbox module, incorporates a selfsealing provision so that it can be removed for visual inspection without loss of oil. Refer to the appropriate manual for procedures on removing main gearbox module chip detector. The magnetic plugs on each chip detector attract ferrous particles at any of the detector locations. The fuzz burn-off feature prevents false warnings by burning off small chips and fuzz. The fuzz burn-off feature is deactivated when oil temperature reaches 140°C. Deactivation of the fuzz burn-off feature does not disable detection and appearance of cautions. The main transmission chip detector is also connected to a 30-second time delay relay to allow small chips and fuzz to burn off and/or wash away. Chips that are too large to burn off or wash away trigger the detection system which activates a caution. The pilot or maintenance personnel must check for cautions/advisories before removing power to determine the location of the chip. Power to operate the chip system is provided through the caution/advisory panel from the dc essential bus through a circuit breaker marked CHIP DET.

2.48.4 Built-In Test (BIT) Chip Detectors.

NOTE

The **MASTER CAUTION PRESS TO RESET** caution may or may not disappear after being pressed to reset while the chip detectors BIT is in progress.

BIT chip detectors will automatically test for a continuous circuit from the caution/advisory panel to the individual chip detector when power is first applied. Chip detector cautions appear during test and disappear after successful completion of test. When first placing the BATT switch ON, the CHIP INPUT MDL-LH, CHIP ACCESS MDL-LH, CHIP INT XMSN, CHIP TAIL XMSN, CHIP INPUT MDL-RH, and CHIP ACCESS MDL-RH cautions appear immediately for approximately 45-70 seconds and then disappear. The CHIP MAIN MDL SUMP caution appears after a 30-second delay for approximately 30 seconds and then disappears. A caution that does not appear indicates a failed test on its chip detector circuit.

2.49 TAIL DRIVE SYSTEM.

Six sections of drive shaft connect the main module to the tail rotor gear box. The shafts drive the oil cooler blower and transmit torque to the tail rotor. Each shaft is dynamically balanced tubular aluminum. Multiple disc (flexible) couplings between sections eliminate universal joints. The shafts are ballistically tolerant if hit by a projectile and are suspended at four points in viscousdamped bearings mounted in adjustable plates and bolted to fuselage support brackets.

2.49.1 Intermediate Gear Box. Mounted at the base of the pylon is the oil-lubricated intermediate gear box. It transmits torque and reduces shaft speed from the main gear box to the tail gear box. The intermediate gear box may run at cruise flight for 30 minutes, with loss of all oil. An internal metal fuzz suppression chip/temperature sensor detects metal particles and gear box overtemperature conditions to activate the CHIP INT XMSN and INT XMSN OIL TEMP cautions.

2.49.2 Tail Gear Box. The oil-lubricated tail gear box at the top of the tail pylon transmits torque to the tail rotor head. The gear box mounts the tail rotor, changes angle of drive and gives a gear reduction. It also enables pitch changes of the tail rotor blades through the flight control system. The gear box housing is magnesium. The tail gear box may run at cruise flight for 30 minutes with loss of all oil. An internal fuzz suppression metal chip/temperature sensor detects metal particles and gear box overtemperature conditions to activate the CHIP TAIL XMSN and TAIL XMSN OIL TEMP cautions.

2.49.3 Intermediate and Tail Gear Box Chip/ Temperature Systems. The intermediate and tail gear boxes contain identical chip/temperature sensors that indicate in the cockpit when the gear box temperature is too high, or a chip is present. The chip detectors incorporate a fuzz burn-off feature which eliminates false warning due to fuzz and small particles. When a chip is detected and will not burn off, the CHIP INT XMSN or CHIP TAIL XMSN caution will appear. The oil temperature sensor is a bimetal strip that reacts to temperatures. When the oil temperature reaches 140°C, a switch closes and activates the **INT XMSN OIL TEMP** or **TAIL XMSN OIL TEMP** caution. Power to operate the oil temperature system is from the No. 2 dc primary bus through a circuit breaker marked **MAIN XMSN**.

Section VIII MAIN AND TAIL ROTOR GROUPS

2.50 ROTOR SYSTEMS.

The rotor system consists of a main rotor and tail rotor. Both systems are driven by the engines through the transmission system, with pitch controlled by the flight control system.

2.51 MAIN ROTOR SYSTEM.

The main rotor system consists of four subsystems: main rotor blades, hub, flight controls, and the bifilar vibration absorber. Four titanium-spar main rotor blades attach to spindles which are retained by elastomeric bearings contained in one-piece titanium hub. The elastomeric bearing permits the blade to flap, lead, and lag. Lag motion is controlled by hydraulic dampers and blade pitch is controlled through adjustable control rods which are moved by the swashplate. When the rotor is not turning, the blades and spindles rest on hub-mounted droop stops. Upper restraints called antiflapping stops retain flapping motion caused by the wind. Both stops engage as the rotor slows down during engine shutdown. Blade retaining pins can be pulled from the blade spindle joint and the blades folded along the rear of the fuselage. The bifilar vibration absorber reduces rotor vibration at the rotor. The 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 spindles modules and the hub to restrain hunting (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 on the side of each damper. The reservoir has an indicator that monitors the reserve fluid. When the damper is fully serviced, the indicator will show full gold.

2.51.1 Main Rotor Blades. Four main rotor blades use a titanium spar for their main structural member. The structure aft of the spar consists of fiberglass skin, Nomex honeycomb filler and a graphite/fiberglass trailing edge. The leading edge of each blade has a titanium abrasion strip, the outboard portion of which is protected by a replaceable nickel strip. Electro-thermal blankets are bonded into the blades leading edge for deicing. A Blade Inspection Method (BIM[®]) indicator (Figure 2-17) is installed on each blade at the root end trailing edge to visually indicate when blade spar structural integrity is degraded. If a spar crack occurs, or a seal leaks, nitrogen will escape from the spar. When the pressure drops below minimum, the indicator will show red bands. A manual test lever is installed on each BIM[®] indicator to provide a

maintenance check. The blades are attached to the rotor head by two quick-release expandable pins, that require no tools to either remove or install. To conserve space, all blades can be folded to the rear and downward along the tail cone. When mooring, the blades can be tied down with a fitting on the bottom of each blade.

2.51.2 Main Rotor Gust Lock. The gust lock prevents the blades from rotating when the helicopter is parked. The gust lock is designed to withstand torque from one engine at **IDLE**, and thus allows engine maintenance checks independent of drive train rotation. The locking system consists of a locking handle at the rear of the cabin, a **GUST LOCK** caution and a locking device and teeth on the tail rotor takeoff flange of the main transmission. The lock shall only be applied when the rotor system is stationary; it can only be released when both engines are shut down. Power to operate the caution is provided from the No. 1 dc primary bus through a circuit breaker marked **LIGHTS ADVSY**.

2.52 TAIL ROTOR SYSTEM.

A cross-beam tail rotor blade system provides antitorque action and directional control. The blades are of graphite and fiberglass construction. Blade flap and pitch change motion is provided by deflection of the flexible graphite fiber spar. This feature eliminates all bearings and lubrication. The spar is a continuous member running from the tip of one blade to the tip of the opposite blade. Electro-thermal 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 anti-torque reaction, the tail rotor provides 2.5% of the total lifting force in a hover. A spring-loaded feature of the tail rotor control system will provide a setting of the tail rotor blades for balance flight at cruise power setting in case of complete loss of tail rotor control.

2.53 TAIL ROTOR QUADRANT/WARNING.

The tail rotor quadrant contains microswitches to activate the **TAIL ROTOR QUADRANT** caution if a tail rotor cable becomes severed. Spring tension allows the quadrant to operate in a normal manner. If the helicopter is shut down and/or hydraulic power is removed with one tail rotor cable failure, disconnection 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 boost servo

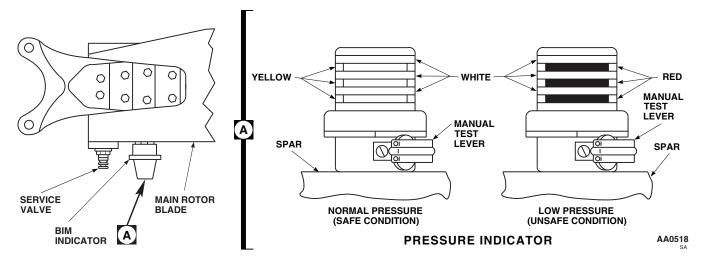


Figure 2-17. Main Rotor Blade and BIM® System

piston enough to unlatch the quadrant cable. Power to operate the warning system is provided from No. 1 dc primary bus through a circuit breaker marked **T RTR SERVO WARN**.

Section IX UTILITY SYSTEMS

2.54 WINDSHIELD WIPERS.

Two electrically operated windshield wipers are installed, one on the pilot's windshield and one on the copilot's windshield. Both wiper arms are driven by a common motor through flexible drives and converters. Power to operate the windshield wiper system is from No. 1 ac primary bus through a circuit breaker marked WSHLD WIPER.

NOTE

The use of rain repellent on the windshields will improve visibility above speeds of 50 KIAS. Rain repellent may be locally purchased.

2.54.1 Windshield Wiper Control.



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

Control of the windshield wipers is through a springloaded rotary switch on the upper console. The switch is labeled **WINDSHIELD WIPER** with marked positions **PARK-OFF-LOW-HI**. When the switch is turned from **OFF** to **LOW** or **HI**, the wipers will operate at the corresponding speed. The wipers will stop at any position when the switch is turned **OFF**. When the switch is turned to **PARK**, the wipers will return to the inboard windshield frame and stop. When the switch is released, it will return to **OFF**.

2.54.2 Windshield Anti-Ice/Defogging System.



- Continued use of a faulty windshield anti-ice system may result in structural damage (delamination and/or cracking) to the windshield.
- Do not allow ice to accumulate on the windshield, as ice shedding can cause engine foreign object damage (FOD).

Pilot's, copilot's and center windshields (on helicopters equipped with center windshield anti-ice system) are electrically anti-iced and defogged. Transparent conductors imbedded between the laminations provide heat when electrical power is applied. The temperature of each panel is controlled to a heat level of about 43°C (109°F). The windshield anti-ice system fault monitoring circuit prevents windshield burnout when the windshield surface heat is above 43°C (109°F). If heat increases, the monitor circuit will turn off the system. Three switches, one for the pilot, one for the copilot and one for the center windshield (when equipped) are on the upper console with markings of WINDSHIELD ANTI-ICE PILOT-OFF-ON and **COPILOT-OFF-ON**,. On helicopters equipped with center windshield anti-ice an additional switch to control the center windshield is marked WINDSHIELD ANTI-**ICECTR-OFF-ON**. Power to operate the anti-icing system is provided by the No. 1 and No. 2 ac primary buses through circuit breakers marked PILOT WSHLD ANTI-ICE and CPLT WSHLD ANTI-ICE. On helicopters equipped with center windshield anti-ice, pilot and center windshield anti-ice circuit breakers are marked WINDSHIELD ANTI-ICE PILOT and CTR. Power to control the anti-ice system is provided by the No. 1 and No. 2 dc primary buses through circuit breakers marked CPLT WSHLD ANTI-ICE and PILOT WSHLD ANTI-ICE, respectively. On helicopters equipped with center windshield anti-ice system, control circuit breakers for pilot's and center windshield are on the No. 2 dc primary bus and are marked WINDSHIELD ANTI-ICE **PILOT** and **CTR**. If the APU generator is the sole source of ac-generated power, the backup pump and the windshield anti-ice cannot be used simultaneously.

2.55 PITOT HEATER.

Pitot tube heat is provided by heating elements within each pitot tube head. Power to operate both heating elements is controlled by a single switch on the upper console marked **PITOT HEAT OFF** and **ON**. When the switch is placed **ON**, current flows to the heating elements. Current sensors in the circuits sense the current flow and prevent the **LFT PITOT HEAT** and **RT PITOT HEAT** cautions from appearing. If a heating element fails, the current sensor will detect no current flow, and activate the caution for that pitot tube. Power to operate the pitot tube heaters is provided from the No. 2 ac primary bus for the right pitot tube through a circuit breaker marked **RT PITOT HEAT**, and from the No. 1 ac primary bus for the left pitot tube through a circuit breaker marked **LEFT PITOT HEAT**. Power to operate the cautions is provided from the No. 1 dc primary bus through a circuit breaker marked **NO. 1 ENG ANTI-ICE**.

2.56 ROTOR BLADE DEICE KIT.

CAUTION

Blade deice operation with erosion strips installed may cause blade damage.

The rotor blade deice kit (Figure 2-18) consists of the following: deice control panel, deice test panel, system controller, power distributor, main and tail sliprings, main and tail blade heating elements, droop stop heaters, cautions, OAT sensor, a modified ambient temperature sense line, and an icing rate meter subsystem. The blade deice system provides improved mission performance in icing conditions by applying controlled electrical power to integral heating elements in the main and tail rotor blades, causing the ice bond layer to melt, allowing symmetrical ice shedding. Droop stop heaters apply heat to the droop stop hinge pins, to prevent icing and permit proper operation. The heaters are electrically powered continuously whenever the blade deice system is operating, either with the power switch **ON**, or the system in the **TEST** mode. The blade deice system, excluding element-on-time (EOT) failure, may be ground checked using the APU generator. To prevent generator overload when only the APU generator is operating, an interlock system is installed to inhibit blade deice test if the backup pump is operating. If the backup pump should go on during the test cycle, the **MR DE-ICE FAIL** caution will appear immediately, alerting the crew to an invalid test attempt. The test cycle must then be initiated again. The OAT sensor, installed below the windshield, provides a signal to the controller for heating EOT of the rotor blades. The lower the OAT, the longer EOT will be. To reduce power requirements, the blades are deiced in cycles. Power to operate the blade deice is provided from the No. 1 and No. 2 ac primary buses and No. 2 dc primary bus through circuit breakers marked ICE-DET, DE-ICE CNTRLR, and DE-ICE PWR TAIL ROTOR, on the mission readiness circuit breaker panel in the cabin. Main blade deice power is routed through current limiters in the deice junction box. When one main generator is inoperative, deice power can be supplied by the APU generator.

2.56.1 Blade Deice System Operation. The ice detector is operational anytime power is applied to the

helicopter. The ice detector senses ice accumulation on a vibrating probe by a change in probe frequency. The frequency change is processed by the ice rate meter. The ice rate meter provides a visual display of icing intensity, T (trace), L (light) blue, M (moderate) yellow, and H (heavy) red. Also, the ice rate meter activates the ICE **DETECTED** caution when the **BLADE DE-ICE POWER** switch is off, informing the pilot of the requirement to turn on the system. When the system has been turned on by placing the **POWER** switch **ON**, the ice detector aspirator heater is turned on, and the ICE **DETECTED** caution disappears. If the **MODE** switch is at AUTO, the rate meter sends an ice rate signal to the controller. The controller processes the ice rate signal to produce heater element-off-time, and the OAT signal to produce the heater EOT. The controller sends command signals through the main rotor sliprings to the system distributor which responds to controller signals by switching power in sequence to the main rotor blade heater zones. Tail rotor blade power is switched directly by the controller and sent through the tail rotor sliprings to the tail rotor blades. A tail blade distributor is not required since the power is applied to the four tail blades simultaneously. The deice control panel contains a rotary switch which allows automatic or manual control of blade heater element-off-time. In AUTO (automatic), the ice rate signal is passed on to the controller, which results in offtime variations proportional to the ice rate. In MANUAL, T, L, or M, fixed signals are transmitted to the controller, resulting in fixed element-off-time. Ice rate subsystem malfunctions are indicated by the appearance of a FAIL flag on the rate meter face, requiring operation of the blade deice system in one of the three manual modes. MANUAL mode should also be used when the rate meter has no indicated malfunction, but any of these three conditions has occurred: pilot has determined that the ice rate system is inaccurate, torque required has increased to an unacceptable level, or helicopter vibration has increased to an unacceptable level. During a single main generator failure, blade deice will be dropped until the APU is started and the APU generator switch is placed ON. Even though the APU generator switch is ON and providing power to the blade deice system, the APU GEN ON advisory will not appear because of one main generator operating.

2.56.2 Blade Deice System Control Panel. All controls for operating the rotor blade deice system are on the **BLADE DEICE** system control panel. Controls are described as follows:

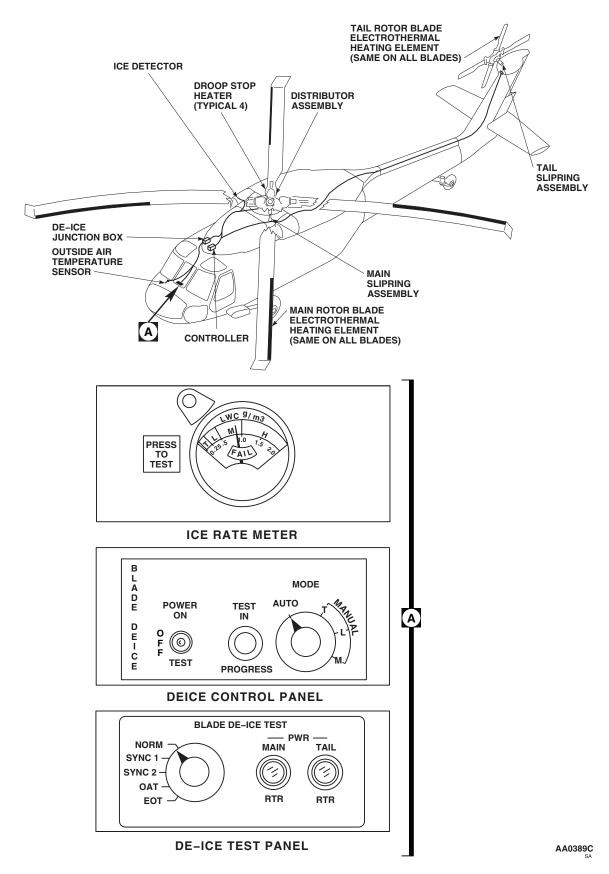


Figure 2-18. Rotor Blade Deice Kit

CONTROL/ INDICATOR	FUNCTION
POWER switch	
TEST	Electrically test main and tail rotor deice system for one test cycle.
ON	Turns on power to blade deice controller and causes the ICE DETECTED cau- tion to disappear.
OFF	Turns off deice system.
TEST IN PROGRESS	Green light goes on during test cycle. At end of test cycle, light should go off.
MODE selector	
Αυτο	System off-time is controlled by ice rate signal.
MANUAL	Gives pilot manual control of system off-time.
Т	Sets a fixed element-off-time for trace icing.
L	Sets a fixed element-off-time for light icing.
Μ	Sets a fixed element-off-time for moderate icing.

2.56.3 Blade Deice Test. The BLADE DE-ICE TEST panel allows the pilot to check the blade deice system for failures that are otherwise dormant during the normal TEST mode, but that can allow abnormal operation during use. The panel accomplishes this by introducing selected failure signals into the system and requiring the deice controller BIT circuitry to function in a specific manner. The blade deice test should be done during the ground checkout before each flight when blade deice use is anticipated. In the NORM position, the test panel allows system test to be done without the introduction of false failure signals. Thus, the system should complete its selfcheckout cycle without caution failure indications. In the SYNC 1 and SYNC 2 positions, the test panel interrupts the distributor sync line and provides the controller with a false sync input. The controller must interpret these false signals as indications of distributor failure and activate the MR DE-ICE FAIL caution for both cases. In the OAT position, the test panel short circuits the OAT sensor input to the controller. Built-in-test equipment (BITE) circuitry within the controller must sense the simulated failure and activate both the MR DE-ICE FAIL and TR DE-ICE FAIL cautions. In the EOT position, the test panel biases BITE circuitry in the controller and the OAT sensor to simulate malfunctioning primary EOT timing circuits. The biased BITE circuit is thus deceived into believing that the primary circuits are in error. The controller must activate both the MR DE-ICE FAIL and TR DE-ICE FAIL cautions when this occurs. The test panel also functions automatically during blade deice system use to sense contradictory signals from the deice power circuits. If electrical power remains applied to either the main or tail rotor heating elements after the controller signals a FAIL condition or when the system is OFF, then the corresponding PWR monitor light on the BLADE DE-ICE TEST panel turns on. The light informs the crew that further action is required to isolate the deice loads indicated. The test panel provides a reliability check of critical deice system functions. The pilot, after doing the indicated tests properly, can be confident that the deice system primary and BITE electronics are functioning within specified tolerances.

2.56.4 Blade Deice Test Panel. The control for selecting test functions of the blade deice system is on the **BLADE DE-ICE TEST** panel. Two **PWR** lights on the panel warn of power malfunctions of the main and tail rotor deice. Control and indicators are as follows:

CONTROL/ INDICATOR	FUNCTION
NORM	Provides a signal path for normal operation.
SYNC 1	Provides a signal to the controller to verify operation of synchronization check circuitry when POWER switch is at TEST .
SYNC 2	Provides an open circuit to the controller to verify opera- tion of synchronization check circuitry when POWER switch is at TEST .

CONTROL/ INDICATOR	FUNCTION
OAT	Short circuits the OAT sen- sor to check BITE circuit sensing a fault when POWER switch is at TEST .
ΕΟΤ	Disables BITE circuits in controller and OAT sensor to simulate a malfunctioning 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.
PWR TAIL RTR light	Indicates a malfunction has occurred in the tail rotor primary power.

2.57 BLACKOUT CURTAINS.

Curtains are provided to cover the cabin windows and the opening between the pilot's compartment and the cabin. Velcro tape is bonded to the cabin structure and the curtains with an adhesive. Loops are attached to the curtains to aid removal.

2.58 WIRE STRIKE PROTECTION SYSTEM.

On helicopters equipped with wire strike protection provisions, the system is a simple, lightweight, positive system with no motorized or pyrotechnic components used to cut, break, or deflect wires that may strike the helicopter in the frontal area between the tires and fuselage, and between the fuselage and main rotor in level flight. The system consists of nine cutters/deflectors located on the fuselage and landing gear/support. They are: upper cutter on the rear of the sliding fairing, the pitot cutter/deflector on the front of the sliding fairing, windshield post and wiper deflectors, door hinge deflector, step extension and step deflector, landing gear joint deflector, main landing gear cutter/deflector, and tail landing gear deflector.

2.59 FLIGHT DATA RECORDER (ON HELICOPTERS EQUIPPED WITH FLIGHT DATA RECORDER KIT).

The flight data recorder system installed in the aft transition avionics compartment is a crash survivable digital tape recorder providing 25 hours of recorded data on a continuous loop magnetic tape. Flight data input to the recorder is sent from different locations throughout the helicopter. The recorder begins to record data as soon as ac and dc essential power is supplied to the helicopter. Electrical power to operate the data recorder system is provided from the dc essential bus and ac essential bus through circuit breakers marked **FLT REC** on the mission readiness circuit breaker panel. There are no controls provided to the pilot or copilot for control of the recorder.

Section X HEATING, VENTILATING, COOLING, AND ENVIRONMENTAL CONTROL UNIT

2.60 HEATING SYSTEM.

The subsystem consists of a heated air source, cold air source, mixing unit, temperature sensing unit, overtemperature sensor, controls, ducting and registers. The heating system uses bleed-air as its heat source. Bleed-air is supplied in flight by the main engines and on the ground by either the main engines or the APU. An external connector allows connection of an external ground source into the pneumatic system, that can provide heat when connected. Power to operate electrical components of the heating system is by the No. 1 dc primary bus through a circuit breaker marked **AIR SOURCE HEAT/START**.

2.60.1 Winterized Heater. The heater consists of a high bleed-air flow mixing valve and a modulation valve. The mixing valve is of enough capacity to keep the interior temperature of the helicopter at 4°C (39°F), to ambient temperatures down to -54°C (-65°F). The mixture sensor controls air mixing to allow control of temperature used for cabin heat. Bleed-air is mixed with ambient air to get the desired temperature selected by the variable temperature HEATER controls on the upper console. Bleed-air is regulated with the modulation valve for downstream mixing with ambient air when the HEATER control switch is **ON**. Overtemperature is prevented by two overtemperature sensors that de-energize solenoid valves when bleed-air temperature reaches about 90° to 96°C (194° to 205°F) at the inlet to the mixing valve or in the mixing chamber. The temperature sensors control current flow to the on-off solenoid and the winterization solenoid to hold them energized, allowing bleed-air to flow to the mixing chamber. When the ENG ANTI-ICE switch is placed ON or a dc power failure occurs, the winterization solenoid will de-energize. An interlock system between engine anti-ice system and the heater winterization solenoid valve prevents engine overbleed by reducing bleed-air flow to the heater when an ENG ANTI-ICE switch is **ON**. Operation of the winterization heating system is the same as in paragraph 2.60.3.

2.60.2 Heat and Ventilation Controls. A variable control air mixing valve assembly is used to control the temperature of air for cabin heating in the helicopter. Bleed-air from the engine, APU, or external source is mixed with ambient air to obtain the desired temperature determined by the setting of the sensor in the downstream air flow. Regulation of the diaphragm position is by a solenoid. Should the **HEATER** control switch be turned **OFF** or dc power fail, bleed-air will shut off. The valve also has a thermal protective switch that de-energizes the

solenoid if mixed air temperature is over 90° to 96°C (194° to 205°F). The mixture temperature sensor downstream of the mixing valve regulates flow output temperature. The sensor is regulated from the cockpit through a control linkage at the overhead console. The temperature control is marked **HEATER OFF**, **MED**, and **HI**. Ventilation is controlled through a panel on the upper console marked **VENT BLOWER**. When the switch is placed **ON**, dc power to the solenoid allows bleed-air to mix with outside air.

2.60.3 Normal Operation.

- 1. APU or engine Start (refer to paragraph 8.19 or 8.20).
- 2. AIR SOURCE HEAT/START switch As required. ENG if engine is operating; OFF for heat from external air source.
- 3. HEATER ON-OFF switch ON.
- 4. **VENT BLOWER** switch **OFF** for maximum heat.
- 5. HEATER control As desired.

2.61 OPTION II CABIN HEATER SYSTEM.

The Option II cabin heater system is installed in conjunction with the standard cockpit/gunner heater. The cabin heater uses bleed-air supplied in flight by the main engines, and on the ground by the main engines or the APU. An external connector allows connection of an external ground source into the pneumatic system that can provide heat when connected. A solenoid valve controls bleed air circulation through insulated tubing which heats the cabin area. Ejectors at the end of the tubes mix the bleed air with ambient cabin air and eject the mixed air. Air flow in the cabin is regulated by control knobs on the ejectors. When the engine anti-ice system is turned on, power is removed from the cabin heater. Placing both ENG ANTI-ICE switches to OFF restores power to the cabin heater. Power to operate electrical components of the heater is supplied by the No. 1 dc primary bus through a circuit breaker marked AIR SOURCE HEAT/START.

2.61.1 Controls and Functions. Controls for the cabin heater are switches on the upper console (Figure 2-7) and on the cabin ejectors (Figure 2-5). Functions of controls are as follows:

CONTROL	FUNCTION
HEATER switch (upper console)	
FWD	Turns on standard cockpit/ gunner heater only.
OFF	Removes power from standard cockpit/gunner heater and Op- tion II cabin heater system.
FWD/AFT	Turns on both the standard cockpit/gunner heater and the Option II cabin heater system.
ROTATE FLOW CONTROL (on rear cabin ejec- tors)	Turn ejector nozzle pointer to desired level LOW , MEDIUM HIGH . Change direction of ejected air by pushing nozzle axially.

2.61.2 Normal Operation.

WARNING

Personnel shall be cautioned about potential high air temperatures coming from heat ejectors.

NOTE

- When APU is the bleed air source, avoid using the heater for extended periods of time due to high APU bleed air temperatures.
- High speed descents (> 1900 fpm) with cockpit/gunner heater or Option II cabin heater system are not recommended.
- Double hearing protection is required when operating heater.
 - 1. APU or engine Start (Refer to paragraph 8.19 or 8.20).
 - 2. AIR SOURCE HEAT/START switch As required. ENG if engine is operating; APU if APU is operating; OFF for heat from external air source.

- HEATER switch FWD for cockpit/gunner heater or FWD/AFT for cockpit/gunner heater and Option II cabin heater system.
- 4. **ROTATE FLOW CONTROL** knobs As desired for cabin heat.

2.61.3 Shutdown.

HEATER switch - **FWD** (power for standard cockpit/gunner heater only) or **OFF**.

2.62 VENTILATION SYSTEM.

2.62.1 Ventilation System. The helicopter is ventilated by an electrically operated blower system controlled through the **VENT BLOWER** control panel on the upper console. The **VENT BLOWER** switch is marked **OFF** and **ON**. When **ON**, the blower forces ambient air into the cabin ducts. The No. 2 ac primary bus powers the blower through a circuit breaker marked **HEAT & VENT**. It is also controlled by dc power from the No. 2 dc primary bus through the **VENT BLOWER** switch protected by a circuit breaker marked **HEAT VENT**. Ram air vents for cooling the cockpit area are on each side of the upper console and at the front of the lower console and are controlled by turning the nozzle to control the opening.

2.62.2 Ventilation System. In addition to the standard ventilation system, the EH-60A has a ventilation system which operates in conjunction with the environmental control system. The system is controlled from the ECS control panel on the upper console. When the AIR COND switch is placed in the FAN position, fresh air is drawn from outside the helicopter into the plenum chamber, mixed with inside air and circulated through the helicopter.

2.62.3 Normal Operation.

- 1. APU, rotor or external power Operating.
- 2. VENT BLOWER switch ON.

2.63 ENVIRONMENTAL CONTROL SYSTEM.

The vapor-cycle system (air conditioner) cools the cabin and cockpit areas. It consists of a heli-rotor compressor, evaporator, condenser, associated valves, protective pressure and temperature switches, a filter, service valves, a liquid indicator, and an electrical control system. A sight glass in the liquid line gives an indication of refrigerant liquid servicing level, when the system is operating. The temperature controller assembly, in the aft cabin, processes the input signals from the temperature selection rheostat in the cockpit and the cabin temperature sensor, and provides the power to the hot gas bypass valve solenoid. The electrical control box, in the transition section, contains the relays, time delays, elapsed time meter, and fault indicators for the vapor-cycle system. The control box routes the power to the electrical components. Inputs from the remote control and temperature controller are channeled to their respective electrical interface in the control box. Across the front of the enclosure are four fault indicators HI and LO PRESS, and HI and LO TEMP, which are tripped to indicate red when a fault is received. These indicators provide visual signals of a fault occurring, even if it is only temporary, and they can be manually reset for reuse by pressing in the fault indicator. The environmental control system is protected to prevent evaporator freezing. The system may be operated at any ambient temperature without causing damage, shown in Table 2-2. Power to operate the environmental control system is provided from the No. 2 ac primary bus and controlled from the No. 1 dc primary bus through a breaker marked ECS CONTR. Control of the environmental control system is through the ECS controls on the upper console. The panel contains a temperature

control rheostat with an increasing arrow indicator to COOL, two mode selection switches marked COOL-OFF-FAN and HTR-OFF-ON. The temperature control rheostat is used with the COOL switch to set the desired cabin temperature. Placing switch to COOL will cause AIR COND ON advisory to appear. Selection of the COOL mode with the cockpit AIR COND controls starts a phased sequence of events leading to full operation of the environmental control system. To prevent a sudden surge in 115 vac power, the major electrical components are started at spaced intervals.

2.64 AUXILIARY HEATER SYSTEM.

Incorporated in the air conditioner plenum chamber is an auxiliary heating system to supplement the bleed air heater. The electrically operated heater is controlled by a switch on the upper console **ECS** control panel marked **HTR ON & OFF**. The heater element will operate continuously as long as the switch is **ON**. With the **HTR** switch **ON** and the **AIR COND** switch placed in the **FAN** position the **CABIN HEAT ON** advisory will appear. An overtemperature protection is provided at 205°F if there is a heater malfunction.

POWER SOURCE	ENVIRONMENTAL CONTROL SYSTEM OPERATION
APU Generator (Helicopter on Ground)	 Air Conditioning Interrupted if: (1) Backup Pump is On. or (2) Windshield Anti-Ice is On. Windshield Anti-Ice Interrupted when Backup Pump is On.
APU Generator (Helicopter in Flight)	Air Conditioning Interrupted while Helicopter in Air.Windshield Anti-Ice Interrupted when Backup Pump is On.
Dual Main Generator (No. 1 and No. 2) (Helicopter in Flight or on Ground)	•Air Conditioning, Backup Pump, and Windshield Anti-Ice can Operate Simultaneously.
Single Generator or External AC Power (Weight on or off Wheels)	•Air Conditioning Interrupted If: (1) Backup Pump is On.

Table 2-2. Environmental Control System Power Source Priority

Section XI ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEMS

2.65 ELECTRICAL POWER SYSTEMS.

Alternating current (ac) is the primary source of power. The primary electrical system (Figure 2-19) consists of two independent systems, each capable of supplying the total helicopter power requirements. The prime source of each system is a 115/200 vac generator. A subsystem feeds two independent ac primary buses and an ac essential bus. A portion of each ac primary bus load is converted to 28 volts direct current (vdc) by two 200 ampere ac/dc converters. The 28 vdc is distributed by two independent dc primary buses and a dc essential bus. Emergency power is provided by a generator driven by the APU. The APU generator is capable of supplying all flight-essential ac and dc bus loads. In addition, the APU generator can supply power to the blade deice system (when installed) if one main generator should fail. Should a second generator fail, the blade deice load will be dropped and the APU generator will power the remaining ac bus loads. An electric power priority feature allows either the No. 1 or No. 2 main generator to automatically supersede the APU generator, which, in turn, automatically supersedes external power. A 24-volt battery provides backup dc power.

2.66 DC POWER SUPPLY SYSTEM.

Primary dc power is obtained from two converters (transformer-rectifiers) with a battery as the secondary power source. There is no external dc power connector.

2.66.1 Converters. Two 200-ampere converters, each powered by the No. 1 and No. 2 ac primary buses respectively, turn ac power into dc power and reduce it to 28 volts. The converter output is applied to the No. 1 and No. 2 dc primary buses whenever ac power is applied to the ac primary buses. If one converter's output is lost, the converter load will be transferred to the operating system and the **#1 CONV** or **#2 CONV** caution will appear. Power for the caution is provided by the battery bus through a circuit breaker marked AC & CONV WARN.

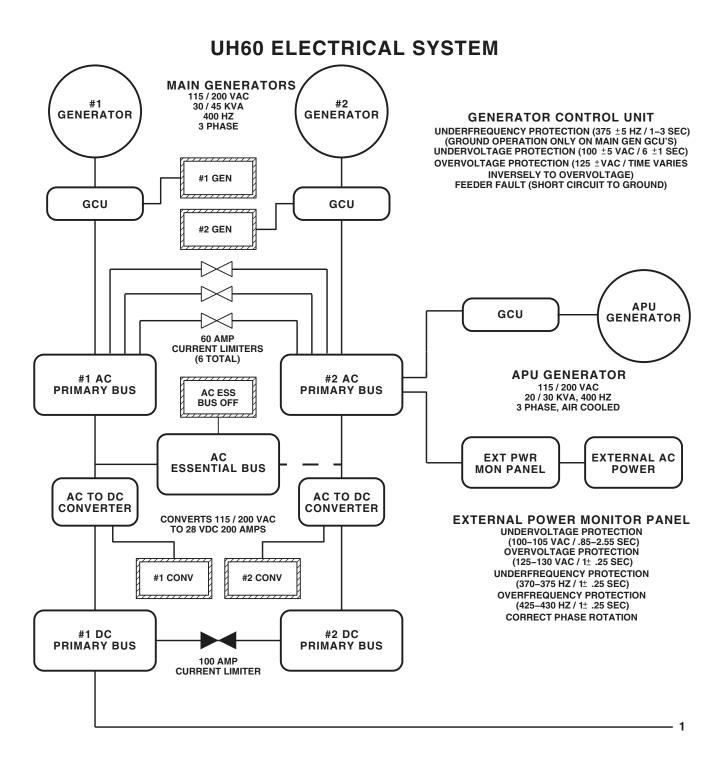
2.66.2 Battery.

2.66.2.1 Nickel Cadmium (Nicad) Battery. A 24 vdc 5.5 ampere hour 20-cell nicad battery provides secondary or emergency dc power. The battery is in the cabin section behind the copilot. It supplies dc power to the battery and battery utility buses for operating dc essential equipment during primary dc malfunction. Power to the battery bus is controlled by the **BATT** switch on the upper console. It

has marked positions OFF and ON. The battery utility bus is connected directly to the battery. During No. 1 and No. 2 dc primary source malfunction, the dc essential bus is powered by the battery bus as long as the battery is at least 35% charged and the BATT switch is ON. When only battery power is available, the battery life is about 22 minutes day and 14 minutes night for a battery 80% charged. The BATT switch should be ON when either external power, APU generator, or main generator power is applied to the helicopter. This will recharge the battery. When the battery is the sole source of dc power, the BATT switch should be turned OFF immediately upon appearance of the BATT LOW CHARGE caution. A malfunction of both dc primary sources will activate the #1 and #2 CONV cautions. If the BATT switch is left ON, the battery will be completely discharged in less than 3.5 hours. If the maintenance light and both cockpit utility lights are left on, the battery will be completely discharged in less than 7 hours. Power for the caution is from the battery bus through a circuit breaker marked BATT & ESNTL DC WARN EXT PWR CONTR.

2.66.2.2 Sealed Lead Acid Battery (SLAB). A 24 vdc 9.5 ampere hour SLAB provides secondary or emergency dc power. The battery is in the cabin section behind the copilot. It supplies dc power to the battery bus, battery utility bus and dc essential bus for operating dc essential equipment during primary dc malfunction. Power to the battery bus is controlled by the **BATT** switch on the upper console. It has marked positions OFF and ON. The battery utility bus is connected directly to the battery. The dc essential bus is powered by the battery bus as long as the BATT switch is ON. When only battery power is available, the battery life is about 38 minutes day and 24 minutes night for a battery 80% charged. The BATT switch should be **ON** when either external power, APU generator or main generator power is applied to the helicopter. This will recharge the battery. When the battery is the sole source of dc power, the **BATT** switch should be turned **OFF** immediately upon appearance of the **BATT** LOW CHARGE caution. This is done so that battery power can be conserved for an APU start. A malfunction of both dc primary sources will activate the #1 and #2 CONV cautions. If the BATT switch is left ON, the battery will be completely discharged in less than 6 hours. Power for the BATT LOW CHARGE caution is from the battery bus through a circuit breaker marked BATT & ESNTL DC WARN EXT PWR CONTR.

2.66.3 DC Monitor Bus. EII The dc monitor bus is normally energized by the No. 1 and No. 2 converters



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Figure 2-19. Electrical System (Sheet 1 of 2)

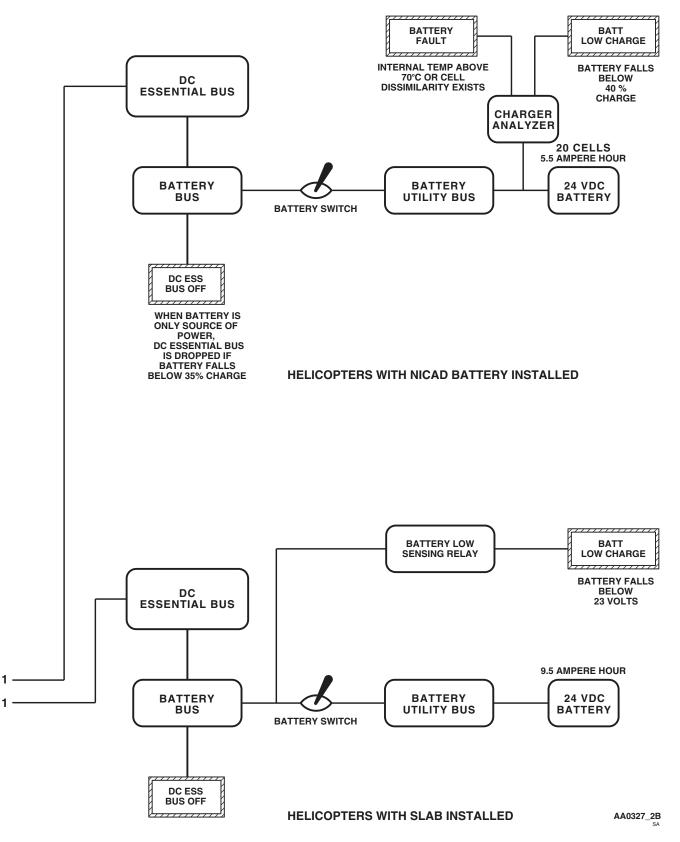


Figure 2-19. Electrical System (Sheet 2 of 2)

when the generators are operating and is powered by the No. 2 converter when operating from external power (Figure 2-19). If either converter should fail, the bus will be automatically dropped from the system.

2.66.4 Quick Fix Power. I Mission equipment dc power is provided from the No. 1 dc primary bus, and is controlled by **Q/F PWR** switch on the upper console.

2.66.5 Battery Charger/Analyzer. A charger/analyzer system restores the battery charge and determines the condition of the battery. The system charges the battery through a converter whenever ac power is available on the helicopter and the BATT switch is ON. The analyzer system monitors battery charge and activates the BATT LOW CHARGE caution when the charge lowers to 35% to 45% of battery capacity. If battery charge continues to lower, at 30% to 40% of battery capacity, the dc essential bus will be disconnected from the battery. At 35% capacity the battery can provide two APU starts. Another analyzer circuit monitors battery temperature. When the internal temperature reaches 70°C (158°F) or if a battery cell dissimilarity condition exists, a **BATTERY FAULT** (only on helicopters equipped with nickel-cadmium batteries) caution will appear. Then the charger/analyzer should automatically disconnect the battery from the charging circuit. As a backup, placing the BATT switch OFF removes input power to the charger/analyzer. By placing **BATT** switch **OFF**, the increasing temperature may be checked.

2.66.6 Battery Low Sensing Relay. On helicopters equipped with the sealed lead acid battery the system charges the battery through the battery charging relay with one or both converters on. The **BATT LOW CHARGE** caution appears when voltage on the battery utility bus drops below 23 vdc.

2.66.7 DC and AC Circuit Breaker Panels. The circuit breaker panels (Figure 2-20) protect the power systems. One is above and to the rear of each pilot, one is on the lower console, and two are on the upper console. The circuit breakers provide both ac and dc protection. Popping of a circuit breaker indicates too much current is being drawn by a component in the circuit that is powered through the circuit breaker. Unnecessary recycling of circuit breakers, or using circuit breakers as a switch should not be done.

2.67 AC POWER SUPPLY SYSTEM.

A primary ac power system delivers regulated three phase, 115/200 vac, 400 Hz. Each system contains a 30/45 kilovolt-ampere generator mounted on and driven by the transmission accessory gear box module, a current transformer, a generator control unit, and current limiter, all of which are interchangeable. System outputs are applied to the No. 1 and No. 2 ac primary buses. The #1 GEN or #2 GEN caution will appear whenever generator output is interrupted. The AC ESS BUS OFF caution appears when there is no power to the ac essential bus. Individual generator controls are provided on the upper console with marked positions of TEST, OFF/RESET, and ON. A generator main bearing caution system is installed on each main generator to activate the #1 GEN BRG or #2 GEN BRG caution to indicate a worn or failed bearing. The caution will appear until power is removed. The auxiliary bearing will allow 10 additional hours of operation after the caution appears. Therefore, it should not be a cause for mission abort. Power to operate the caution system is provided from the No. 1 and No. 2 dc primary buses through circuit breakers marked NO. 1 GEN WARN and NO. 2 GEN WARN, respectively.

NOTE

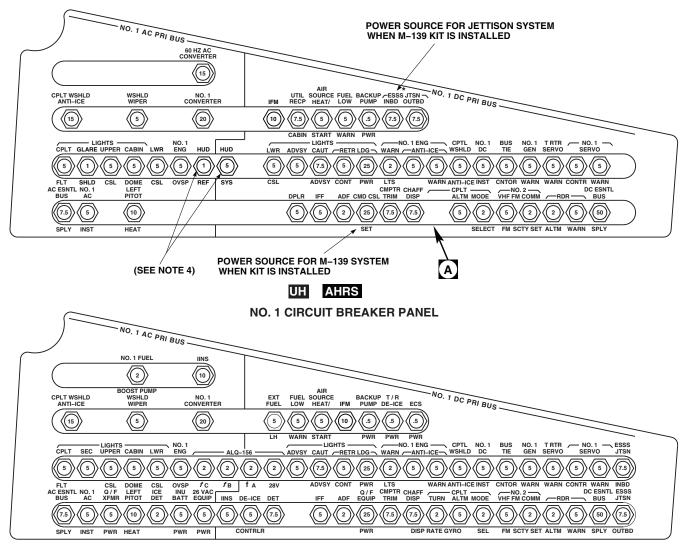
When the **GEN BRG** caution appears for more than 1 minute, make an entry on the DA Form 2408-13-1.

2.67.1 Generator Control Units (GCU). The GCUs monitor voltage from the No. 1, No. 2, and APU generators and take the generator(s) off-line where malfunctions occur. Underfrequency protection is disabled in flight by the WOW switch.

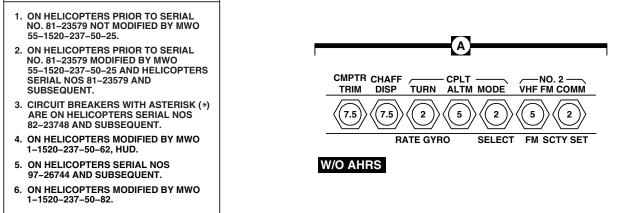
2.67.2 AC Secondary Bus. ED The ac secondary bus is powered by the No. 1 and No. 2 generators when they are operating and their outputs are acceptable. Current limiters protect the system from excessive current draw. If the No. 1 and No. 2 generators are off, the APU generator will supply the ac secondary bus if the output is acceptable, the backup hydraulic pump is off, the blade deice is off, and the weight of the helicopter is on the wheels. The ac secondary bus can also receive power from external power when the weight of the helicopter is on the wheels, and the No. 1, No. 2, and APU generators are off, and the backup hydraulic pump is not operating.

2.68 AUXILIARY AC POWER SYSTEM.

An auxiliary ac power system is a backup ac power source that provides electrical power for ground checkouts. The system consists of a 115 vac three-phase, 400 Hz 20/ 30 kVA, air-cooled generator mounted on and driven by the APU, a current transformer, and a generator control unit. If the primary ac generators are not operating, the auxiliary ac power output will be applied through contac-



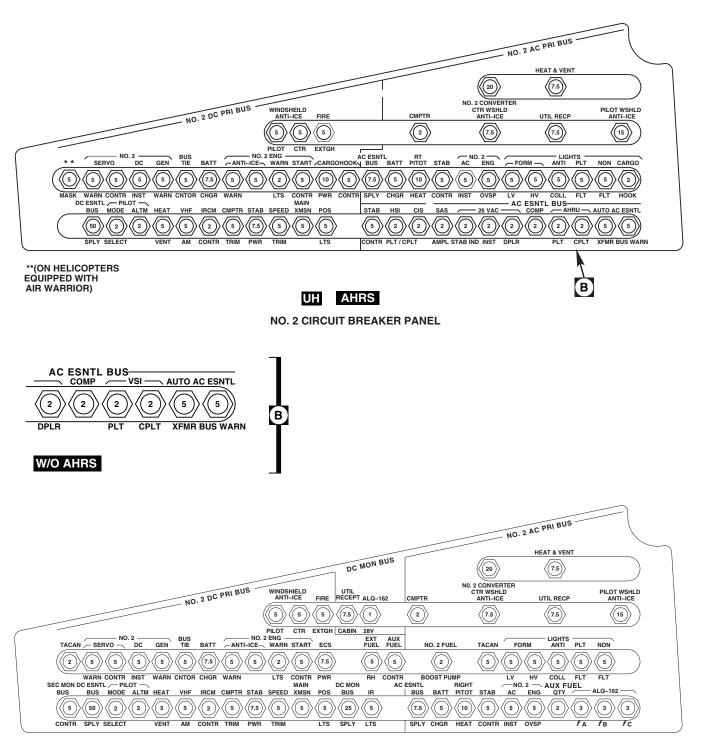
NO. 1 CIRCUIT BREAKER PANEL



NOTES

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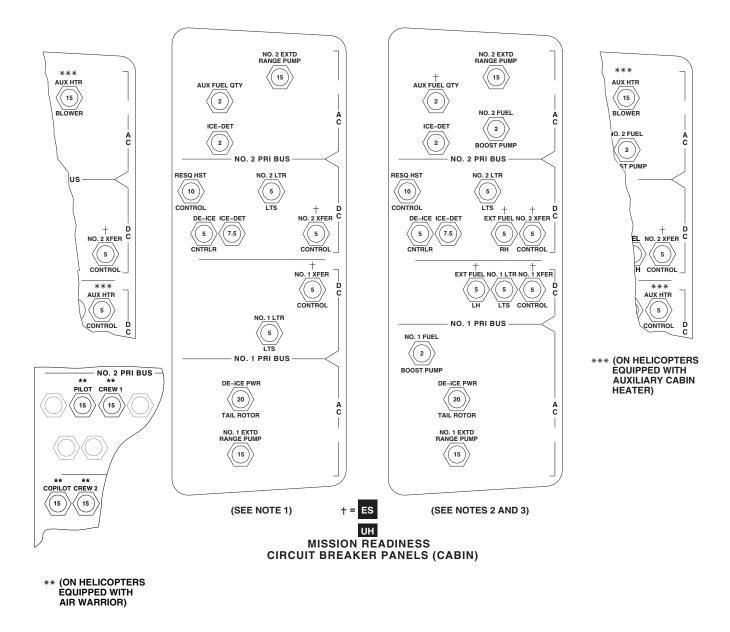
Figure 2-20. DC and AC Circuit Breaker Panels (Typical) (Sheet 1 of 4)





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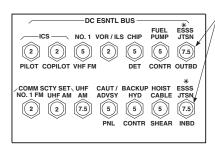
Figure 2-20. DC and AC Circuit Breaker Panels (Typical) (Sheet 2 of 4)

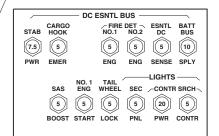


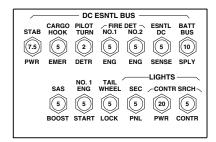
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Figure 2-20. DC and AC Circuit Breaker Panels (Typical) (Sheet 3 of 4)

POWER SOURCE FOR EMERGENCY JETTISON SYSTEM WHEN M-139 KIT IS INSTALLED

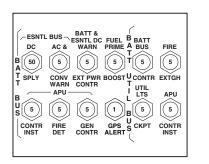






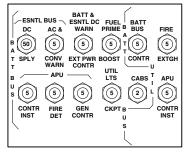
AHRS





ESNTL BUS SENTL DC FUEL B BATT DC AC & WARN PRIME A BUS FIRE 5 **1**5 (5) 5 50) (5) A SPLY CONV EXT PWR BOOST U CONTR EXTGH WARN CONTR UTIL - APU UTIL LTS Ĺ 5 (5) 5 (5) 5) в CKPT S CONTR INST FIRE GÊN CONTR CONTR

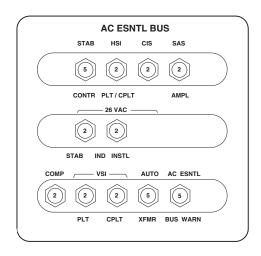
UPPER CONSOLE CIRCUIT BREAKER PANEL



(SEE NOTE 5)

(SEE NOTE 6)

BATTERY AND BATTERY UTILITY BUS CIRCUIT BREAKER PANEL



AC ESSENTIAL BUS

AA0353_4F

Figure 2-20. DC and AC Circuit Breaker Panels (Typical) (Sheet 4 of 4)

tors to the No. 2 ac primary bus and through contactors and current limiters to the No. 1 ac primary bus. An **APU GEN ON** advisory will appear when the APU generator is operating and the APU generator switch is **ON**. The **APU GEN ON** advisory will appear only when supplying power to the system, it will not appear when either the No. 1 generator or the No. 2 generator is supplying power. The generator control switch on the upper console has marked positions of **TEST**, **OFF/RESET** and **ON**.

NOTE

If the APU generator is the sole source of ac generated power, all equipment may be operated, except that when the backup pump is on, the windshield anti-ice and Eff air conditioner are prevented from being used.

2.68.1 Generator Control Switches. Generators are controlled by a three-position generator switch on the upper console. The switch **ON** position energizes the generator and permits connection of generator ac output to the ac loads. **TEST** position permits the testing of the generator

ac output without connecting to the generator loads. **OFF**/**RESET** de-energizes the generator and permits generator recycling if the generator is disabled and disconnected from its loads. The control switch is manually placed to **RESET** and then back to **ON**.

2.68.2 External AC Power System.



Do not connect a source of dc power to the external ac connector.

An external ac power connector on the right side of the helicopter accepts ground source of 115 vac, three-phase, 400 Hz power. The system is controlled by a switch on the upper console marked **EXT PWR-RESET-OFF** and **ON**. External power will be introduced into the system if acceptable external power is connected, the **EXT PWR** switch is **ON**, and no other generating source is operating. An **EXT PWR CONNECTED** advisory will appear whenever external power is connected to the helicopter.

Section XII AUXILIARY POWER UNIT

2.69 AUXILIARY POWER UNIT (APU) SYSTEM.

The APU system (Figure 2-21) consists of an APU, accessories, controls, a monitoring system and a starting system. The APU system provides pneumatic power for main engine starting and cabin heating, and electrical power for ground and emergency in-flight electrical operations.

NOTE

The APU is not qualified for normal inflight use.

APU system accessories include a prime/boost pump, hydraulic accumulator, hydraulic handpump, hydraulic start motor, and ac generator. The hydraulic accumulators and handpump in the aft midsection cabin ceiling provide the hydraulic pressure for driving the APU starter. If the APU does not start, the hydraulic accumulator can be recharged by pumping the hydraulic handpump. The hydraulic utility module and backup pump, on the left forward deck within the main rotor pylon, will automatically recharge the depleted hydraulic accumulator for the next APU start. The APU controls are in the cockpit on the upper console. Cautions and advisories provide cockpit monitoring of the APU. An indicator panel in the cabin will indicate reason for APU shutdown on BITE indicators. The BITE indicators are incorporated in the APU electronic sequence unit (ESU), and will indicate reasons for APU shutdown. Those indicators can be monitored during APU operation without interrupting normal operating systems. During a start, the ESU compares input signals from speed, time, and temperature sensors on the APU to specified values stowed in the ESU memory, and performs functional steps as a result of the comparison. The system also provides for APU protective shutdown in case of turbine overspeed, underspeed, high exhaust temperature, low oil pressure, or loss of electrical power or sequence failure. Each major sequence step will have a visual indication of go/no-go. The ESU samples predetermined parameters of exhaust temperature, turbine speed and oil pressure. If any one of the predetermined values are exceeded, the APU will shut down, and appropriate BITE indication is made. On helicopters modified with improved ESU, if a momentary malfunction occurs (i.e., a power interruption other than switching of the APU CONTR switch) the APU will shut down and the APU CONTR switch must be placed at OFF and then back ON, to restart the APU. There is also an output signal to activate the APU ON advisory indicating the APU is

operating. Power to operate the APU and ESU is provided from the battery bus through a circuit breaker marked **APU CONTR INST**.

2.70 APU.

The APU consists of a gas turbine shaft power section, a reduction gear drive, and appropriate controls and accessories. The accessory gear box provides an axial pad with a 12,000 rpm output drive for the APU ac generator, rpm pad for mounting the APU start motor, rpm drive pad for the APU fuel assembly. A magnetic pickup mounted on the accessory gear box senses engine speed. The APU is lubricated by a self-contained oil system. Refer to Figure 2-28 for servicing.

2.70.1 APU Controls. The APU control on the upper console consists of a CONTR switch and an APU fire extinguisher T-handle. The APU CONTR switch with marked positions OFF and ON controls the operation of the APU. Placing the switch ON starts the APU and allows it to operate. The APU is off when the switch is OFF. The APU FAIL caution will appear any time the APU automatically shuts down. The APU OIL TEMP HI caution appears when APU oil temperature is above normal range. During ground operation at high ambient temperatures the APU OIL TEMP HI caution may appear. If this occurs, the APU should be shut down immediately to prevent damage. After a 30-minute cooling period, the oil level should be checked. If okay, the APU may be restarted. The control system receives electrical power from the battery bus through a circuit breaker marked APU CONTR INST on the lower console. When illuminated, the APU T-handle warns the pilot/copilot of a fire in the APU compartment. When the T-handle is pulled, it turns off fuel to the APU, sends a stop signal to the ESU, arms the fire extinguisher system, and sets the extinguisher direction control valve to the APU. During APU starts using battery power, if the fire extinguisher is required, FIRE EXTGH RESERVE must be used. The T-handle microswitch receives electrical power from the battery utility bus through a circuit breaker marked FIRE **EXTGH** on the lower console circuit breaker panel.

2.70.2 APU Fuel Control System (Helicopters equipped with T-62T-40-1 APU). This system consists of a fuel pump and a control assembly. The fuel pump is protected by a filter. Fuel pump output flow passes through another filter before entering the control assembly. A governor and flow metering valve controls fuel flow to the engine during ignition, permitting automatic starting under all ambient conditions, and controls the turbine at a

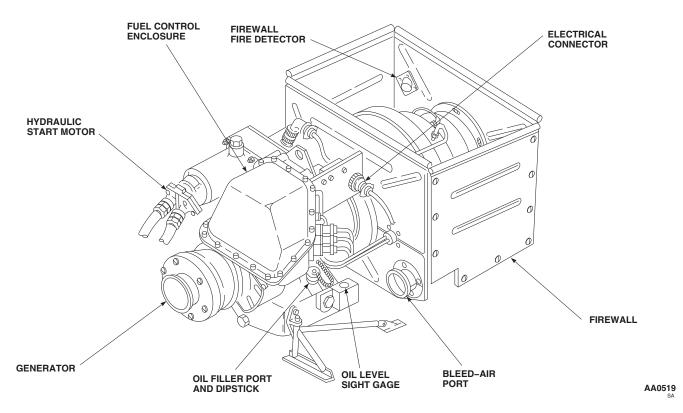


Figure 2-21. Auxiliary Power Unit (APU) (Typical)

constant speed once it has accelerated to operating speed. An electronic speed sensing device provides automatic fuel flow, ignition, and operation of the APU.



Emergency override should only be used under actual emergency conditions. APU Faults must be corrected as soon as possible after discovery.

The Hamilton Sundstrand APU (T-62T-40 Series) utilizes two different types of controllers. The older style Electronic Sequence Units (ESU), and a newer Digital Electronic Sequence Unit (DESU), P/N 4504587. The DESU contains an internal software function to provide emergency override start after a momentary malfunction, or un-commanded APU fail shutdown. Emergency override is obtained by cycling the APU start switch at least 5 times within 5 seconds. The APU should start and **APU OIL TEMP HI** caution will flash to indicate emergency mode is active. The DESU will remain in emergency mode for a maximum of 2 minutes, after which time the APU will revert to normal mode. If the original fault still exists, the APU will shutdown. During emergency start override

mode, all fault conditions are masked, except for overspeed, underspeed, short during start, start fuel, main fuel or max fuel outputs.

2.70.3 APU Fuel Control System (Helicopters equipped with GTC-P36-150 APU). The fuel control system includes a fuel pump and metering section. The fuel pump is protected by an integral inlet filter. Fuel pump output flow passes through a filter screen before entering the metering assembly. Fuel pump discharge pressure is limited by an ultimate relief valve which, when activated, bypasses fuel flow back to the pump inlet. Fuel metering is accomplished by the torque motor metering valve as a function of an electrical signal from the ESU. For accurate fuel metering, a constant, pressure drop across the metering valve is maintained by the differential pressure regulating valve. The fuel solenoid valve is energized by the ESU following the initiation of APU start. This allows fuel to flow to the engine. The fuel control assembly subsequently provides fuel according to a pre-programmed schedule to affect efficient acceleration. The fuel solenoid valve will close completely without visible leakage from the minimum operating fuel pressure to 110% of the maximum operating fuel pressure.

2.70.4 APU Fuel Supply System. APU fuel is supplied to the APU from the left main fuel tank. The **FUEL**

PUMP switch must be at **APU BOOST** for all APU operation, except engine priming. The APU prime/boost shutoff valve is a two-position, open-closed unit mounted on the APU compartment firewall where it also functions as a firewall shutoff valve. The valve is pilot-operated from the upper console **FUEL PUMP** switch as well as by the **APU FIRE EXTGH** T-handle. If the APU does not start and the **APU ACCUM LOW** advisory does not appear, the manual override lever on the accumulator manifold should be pulled to attempt another start, and held until the APU has reached self-sustaining speed.

2.71 ACCUMULATOR RECHARGE.

The accumulator recharge cycle starts when the APU has reached operational speed and the APU-driven generator comes on the line. The pressure switch for the accumulator causes the **APU ACCUM LOW** advisory to appear and the backup system pump to develop pressure. The APU accumulator pressure should be at least 2800 psi before attempting an APU start. The accumulator is recharged from the backup pump which runs for 90 seconds after the accumulator low-pressure switch is actuated. When the winterization kit is installed, an additional identical accumulator. Discharge and recharge of the added accumulator is the same, except a 180-second recharge cycle for the two accumulators will take place when the

accumulator pressure switch senses low accumulator pressure. Both accumulators are charged or discharged simultaneously. If the accumulators do not fully charge during the first 180 seconds of the backup pump operating cycle, the pump will continue to operate in 180-second segments, or until the BACKUP PUMP PWR circuit breaker is pulled, or 115 vac power is removed. The backup system pump shuts down after recharge, unless required for other purposes. Should the accumulator pressure drop, the backup system pump restarts to replenish the accumulator charge. The rate of accumulator charge is limited to protect the backup system from possible depletion due to ballistic damage to the APU start system. Should the APU not start, the accumulator may be recharged by these methods, after the APU CONTR switch is **OFF**. An electric ground cart powering the backup hydraulic pump or a hydraulic ground cart connected to the backup hydraulic system through the ground test quick-disconnects or by using the handpump in the aft upper cabin. The APU CONTR switch should not be turned ON again or the BATT switch turned OFF until after the ESU BITE indicators have been checked. The handpump may also be used to top off the accumulator charge if the charge has dropped due to a low temperature condition. A pressure gage mounted in the aft cabin indicates the charge. Check valves prevent draining of the accumulator charge through the system.

Section XIII LIGHTING

2.72 INTERIOR LIGHTING.

The interior lighting system consists of cockpit dome lights, utility lights, and cabin dome lights. NVG bluegreen lighting can be selected for the cockpit dome, instrument panel glare shield, utility lights, and cabin dome lights.

2.72.1 NVG Lighting System. The NVG lighting system consists of interior NVG blue-green lighting. Exterior lighting consists of cargo hook well area electroluminescent lighting, infrared formation and position lights, and attachable/detachable controllable searchlight filter. A dimming feature is incorporated in the searchlight system to provide dimming through the collective **SRCH LT ON - OFF**, **BRT**, **DIM** switch. The position and formation lights have IR emitters installed within close proximity to the regular installed lights to enhance outside viewing with NVGs.

2.72.2 Cockpit Floodlights. Two blue-green and two white cockpit floodlights are on the upper console cockpit floodlight panel marked **BLUE**, **OFF**, and **WHITE**. Power is supplied from the dc essential bus through a circuit breaker marked **LIGHTS SEC PNL**. Six lights installed in the instrument panel glare shield provide secondary lighting for the instrument panel. The lights are mechanically dimmed by a control on the upper console labeled **GLARESHIELD LIGHTS** with marked positions **OFF** and **BRT**. Power to operate the glare shield lights is provided from the No. 1 ac primary bus through a circuit breaker marked **LIGHTS GLARE SHLD**.

2.72.3 Flight Instrument Lights. Instrument lights are grouped into flight instrument and nonflight instruments. The flight instrument lights are divided into pilot's and copilot's. Lights are controlled by individual rotary intensity controls marked INSTR LT PILOT FLT, OFF, and BRT, and CPLT FLT INST LTS, OFF, and BRT. The nonflight instrument lights operate in the same manner as the flight instrument lights. The nonflight lights intensity is controlled by a rotary control marked INSTR LT NON FLT, OFF and BRT. Instrument lighting is provided by instrument bezels with NVG lights. The radar altimeters lighting incorporates dimming controls on the instrument panel marked RAD ALT DIMMING for the radar altimeters. The vertical instrument display system has NVG information panel lighting to make those instruments compatible with the NVG system. Power to operate the instrument lights is provided by the No. 2 ac primary bus through circuit breakers marked LIGHTS PLT FLT

and **LIGHTS NON FLT**, and No. 1 ac primary bus, through a circuit breaker marked **LIGHTS CPLT FLT**.

2.72.4 Lighted Switches Dimmer. A dimmer control labeled LIGHTED SWITCHES is provided on the upper console to reduce illumination level of the following panel lighted switches: Pilot and copilot MODE SEL, TAIL-WHEEL LOCK, CIS MODE SEL, AUTO FLIGHT CONTROL, and NO. 1 and NO. 2 FUEL BOOST PUMP on lights. The caution/advisory panel must be in DIM mode.

2.72.5 Upper and Lower Console Lights. NVG lights for the upper console, cockpit flood secondary lights, engine control quadrant, flight control panel, miscellaneous switch panel, boost pump control panel, ESSS panels, fuel management panel, retransmission control and rescue hoist panels, and compass or AHRS control panel are illuminated from the No. 1 ac primary bus through dimmer controls marked **CONSOLE LT UPPER** and **LOWER**. Circuits are protected by circuit breakers marked **LIGHTS UPPER CSL** and **LIGHTS LWR CSL**. All other lower console panels are illuminated by the lower console auxiliary utility light next to the copilot's seat.

2.72.6 Utility Lights. All utility lights are dual (blue/ green-white). Two portable cockpit utility lights with coiled cords are attached to the upper console by removable brackets, one on each side of the console. The lights may be adjusted on their mountings to direct the light beams or they may be removed and used portably. All utility lights are controlled by a rheostat or a pushbutton on the end of each casting. The lens casting of the lights may be turned to change from white to blue/green and/or spot to flood. An auxiliary utility light, located at the right rear of the copilot's seat, is used to illuminate some panels on the lower console for night flight. En On helicopters equipped with a transition equipment bay, a utility light is installed on the bay shelf to provide bay lighting. The utility lights operate in the same manner as above. Make certain cockpit utility lights are OFF when not in use. The utility lights operate from the battery utility bus through a circuit breaker marked UTIL LTS CKPT. On helicopters 97-26744 and subsequent, utility lights operate from the battery bus through a circuit breaker marked UTIL LTS CKPT.

2.72.7 Cabin Dome Lights. Three dome lights are provided for cabin lighting. Control of cabin lights is from the upper console by a control marked **CABIN DOME**

LT with intensity control and a light color selector switch. The intensity control has marked positions OFF and BRT, and the light level control may be adjusted to any position between the two extremes. The light color selector switch has marked positions WHITE, OFF and BLUE. To place the switch from OFF to WHITE, the switch must first be pulled out to clear a detent. This prevents accidentally placing the switch to WHITE. Dimming control for the cabin dome lights is from a control on the left side of the pilots seat marked CABIN DOME LT with marked positions OFF and BRT. Power to operate the cabin dome light system is provided from the No. 1 ac primary bus through a circuit breaker marked LIGHTS CABIN DOME.

2.72.8 Maintenance Light. A portable 20-watt floodlight, in the cabin at the crewchief station is used by the crew for maintenance work. The light has a 20-foot cord, allowing its use within the cabin and around the main transmission. A switch on the rear end of the light with marked positions, **DIM**, **OFF**, and **BRIGHT**, controls the light intensity. Another maintenance light receptacle in the aft tail cone allows the light to be used around the tail section. The maintenance light is stowed in a bag at the back of the pilot's seat. Power to operate the maintenance light is provided from the battery utility bus through a circuit breaker marked **UTIL LTS CKPT**. Make sure the maintenance and cockpit utility lights are **OFF** when not in use.

2.73 EXTERIOR LIGHTS.

2.73.1 Searchlight.



Landing and searchlight have less than one-foot ground clearance when extended. Use caution when ground taxiing over rough terrain with landing light and/or searchlight extended.

The searchlight is mounted on the right bottom of the nose section, and is controlled from either collective pitch stick. The 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**, **BRT**, and **DIM**. Directional control of the light is provided through the four-position searchlight control switch, labeled **EXT** (extend), **RETR** (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 about 12° per second. If the switch is placed to OFF the light will extinguish. To retract the searchlight, place the switch to **RETR**. Refer to Chapter 5 for extend/retract limitations. An infrared filter can be installed on the controllable searchlight to enhance viewing objects outside the helicopter when wearing the NVGs. With the IR filter installed, maximum wattage lamp to be used is 250 watt. An OUTPUT switch on the searchlight dimmer under the pilot's seat, is placed at NORM when dimming feature on searchlight is desired. When in **BYPASS** position, the searchlight cannot be dimmed. The IR filter shall not be used with a 450-watt lamp installed. The dimming feature of the controllable searchlight provides a variable light level from 250 to 0 watts to the pilot and copilot through a switch on each collective grip marked SRCH LT ON - OFF. Push ON - OFF BRT DIM to control power to the light and the DIM/BRT mode selector. When the light is on, the BRT DIM switch may be moved to select the desired light level. When the desired level is reached, the switch is released to the center position. Power to light and control the searchlight is provided from the dc essential bus through circuit breakers marked LIGHTS, CONTR PWR and SRCH CONTR. The IR filter may be removed for unaided night flight.

2.73.2 Landing Light. One 600-watt landing light is mounted on the left side beneath the nose section and is controlled from both collective pitch stick grips. The light can be extended 107° from the stowed position. A dualfunction switch is used to operate the light. The LDG LT PUSH ON-OFF switch controls lighting and EXT, RETR controls light position. When the light is ON (LDG LT ON advisory should appear) and the switch is at EXT detent, the light can be positioned at any point between stowed and fully extended, or it will continue to extend until reaching its limit and power is removed. When the switch is held at **RETR** the light retracts to the stowed position. When the light reaches its stowed position, power is automatically removed from the motor. The LDG LT PUSH ON-OFF switch must be pushed OFF (LDG LT ON advisory should disappear). Refer to Chapter 5 for extend/retract limitations. During extension, the travel speed is about 12° per second, and during retract, about 30° per second. Power to light and control the landing light is supplied from the No. 1 dc primary bus through circuit breakers marked LIGHTS, RETR LDG, CONT, and PWR.

2.73.3 Anticollision Lights. This light system contains four strobes in two separate units, one beneath the aft fuselage and one on top of the aft pylon section. The lights are controlled by two switches on the upper console

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, the upper lamp within a red lens for night operation and the lower within a clear lens for day operation. Proper operation is selected by placing the switch to **DAY** or **NIGHT**. The desired strobe(s) is selected by placing the switch to UPPER, LOWER, or BOTH. If at **BOTH**, the lower fuselage and the aft pylon lights will alternately flash. If the selector switch is placed to UPPER or LOWER, only that light will flash. 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.

2.73.4 Position Lights. Position lights are outboard of the left and right landing gear support and top tail pylon. The lights are red on the left, green on the right, and white on the tail. Control of the position lights is through the upper console panel containing two switches marked **POSITION LIGHTS, DIM, OFF, BRT**, and **STEADY, FLASH**. When the intensity switch is placed to **DIM** or **BRT**, all three lights go on at once. If the **STEADY-FLASH** switch is placed to **FLASH**, the three lights will flash. 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 **POS LTS**. Infrared position lights are installed within close proximity of the standard position lights. NVG operation is selected through a toggle switch on the upper console marked **NAV LTS**, with switch positions **NORM** and **IR**. Position lights are to be selected through a switch marked **POSITION LIGHTS**, **DIM**, **OFF**, or **BRT**, and mode of operation through a switch marked **STEADY** or **FLASH**. Power for control of the IR lights is from the No. 2 dc primary bus through a circuit breaker marked **IR LTS**.

2.73.5 Formation Lights. These lights are on top of the main pylon cowling, tail drive shaft cover, and horizontal stabilator. The system consists of four green electroluminescent lights. The lights are controlled by a single rotary selector switch marked FORMATION LT with marked positions OFF and 1 through 5. Position 5 is the brightest. When NVG operations are required, IR lights may be used to enhance viewing outside the helicopter. IR lights are selected through a toggle switch on the upper console marked NAV LTS, NORM, and IR. This switch shares operation with the IR position lights when operating in an NVG environment. Dimming of the IR lights is done with the FORMATION LT control, as used with the electroluminescent formation lights. Selection of position 1 through 4 causes the IR formation lights to illuminate at the same intensity. Position 5 causes the lights to illuminate brighter. Power to operate the formation lights is provided from the No. 2 ac primary bus through two circuit breakers marked LIGHTS, FORM LV, and HV.

Section XIV FLIGHT INSTRUMENTS

2.74 PITOT-STATIC SYSTEM.

Two electrically heated pitot tubes with static ports are aft and above the pilot's and copilot's cockpit doors. The right pitot tube is connected to the pilot's instruments and the left pitot tube is connected to the copilot's instruments. Tubing connects the pitot tube static pressure ports to the airspeed indicators and the altimeters. In addition to standard instrumentation, airspeed data is sensed for operation of stabilator, FPS and command instrument system. Refer to Section IX for pitot tube heater system.

2.75 ATTITUDE INDICATING SYSTEM.

Helicopter pitch and roll attitudes are sensed by the pilot's and copilot's vertical displacement gyroscopes or inputs from AHRS, that apply attitude signals to the vertical situation indicators (VSI) for visual display. Signals are applied through the VERT GYRO select switches to the remote indicator on the VSIs. Helicopter pitch and roll attitudes are shown on the pilot's and copilot's VSIs. The indicator face contains a fixed bar, representing the helicopter, a movable sphere with a white horizon line dividing the two colors, white above and black below, a fixed bank angle scale and a bank index on the moving sphere. Relative position of the fixed bar (helicopter) and the horizon line indicates the helicopter's attitude referenced to the earth's horizon. A ROLL trim knob on the lower left of the VSI permits adjustment of the roll index about $14^{\circ}\pm6^{\circ}$ right and left from zero. A **PITCH** trim knob on the lower right of the VSI permits adjustment of the indicator sphere $14^{\circ}\pm6^{\circ}$ for dive and $7^{\circ}\pm3^{\circ}$ for climb from zero index. If a power failure or unbalance occurs in the pilot's or copilot's vertical displacement gyroscope or inputs from AHRS, a gyroscope power failure flag will appear, indicating ATT, warning the pilot or copilot that pitch and roll attitude signals are not being sent to the onside indicator. To restore attitude information to the indicator, the pilot or copilot should press the onside VERT GYRO select switch on the onside MODE SEL panel so that ALTR appears in the switch window. This causes the ATT flag on the indicator to disappear, and pitch and roll signals are supplied from the operating gyro or inputs from AHRS, restoring attitude information display.

2.76 TURN RATE INDICATING SYSTEM.

A 4-minute turn rate (turn and slip) indicator is at the bottom center of each VSI. The pilot's and copilot's indicators operate independently of each other through **TURN RATE** switches on the **MODE SEL** panels. Each system consists of a rate gyro or inputs from AHRS, a turn slip indicator, and a select switch. The VSI contains a moving turn rate needle and a fixed turn rate scale for indicating rate and direction of turn. During straight flight the needle is positioned at the center of the scale. When the helicopter turns, the rate-of-turn signal from the rate gyroscope or inputs from AHRS deflects the needle in the proper direction to indicate the turn. Amount of deflection is proportional to the rate-of-turn. A one-needle width deflection represents a turn of 1.5° per second. The VSI also contains a slip indicator that shows uncoordinated turns. If a power failure or unbalance occurs in the pilot's or copilot's rate gyroscope, the associated VSI signal will be lost. To restore rate-of-turn information to the indicator, the pilot or copilot will press the TURN RATE switch on the MODE SEL panel so that ALTR appears in the switch window. This applies alternate signals from the operating gyroscope/AHRS to the indicator. On helicopters not equipped with AHRS, the power to operate the pilot's turn rate system is provided from the dc essential bus through a circuit breaker marked PILOT TURN DETR. The copilot's system is powered from the No. 1 dc primary bus through a circuit breaker marked CPLT TURN RATE GYRO. On helicopters equipped with AHRS, the turn rate gyros and associated circuit breakers have been removed.

2.77 AIRSPEED INDICATOR.

Two airspeed indicators are installed on the instrument panel, one each for the pilot and copilot. The indicators are differential pressure instruments, measuring the difference between impact pressure and static pressure. Instrument range markings and limitations are contained in Chapter 5, Section II, System Limits.

2.78 ALTIMETER ENCODER AAU-32A.

Two altimeters (Figure 2-22) are installed on the instrument panel. The altimeter encoder functions as a barometric altimeter for the pilot and a barometric altitude sensor for the AN/APX-100 transponder in mode C. The copilot's functions only as a barometric altimeter. The system is equipped with a continuously operating vibrator to improve altitude measuring accuracy. The altimeter's operating range is from -1000 feet to 50,000 feet. The face of the instrument has a marked scale from zero to nine in 50-foot units. The operating indicators and controls are a 100-foot pointer, 100-foot drum, 1,000-foot drum, 10,000-foot drum, barometric pressure set knob, barometric pressure scale window, and warning flag. The warning flag is

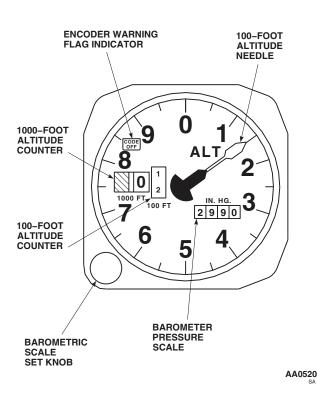


Figure 2-22. Altimeter Encoder AAU-32A

only used in conjunction with the encoder. A counter window next to the sweep hand contains the three digital drums that rotate to indicate the altitude of the helicopter. Another window in the upper left section of the instrument face indicates the normal code operation. When the system fails to transmit signals to the transponder, a flag marked **CODE OFF** will appear in the window. A window on the lower right section of the instrument face indicates barometric pressure setting. The barometric pressure set knob is on the lower left corner of the indicator bezel. Power to operate the encoder system is provided by the No. 2 dc primary bus through a circuit breaker marked **PILOT ALTM**.

2.79 VERTICAL SPEED INDICATOR.

Two VSIs are installed, one each in front of the pilot and copilot to indicate rate of climb or descent.

2.80 ELECTRONIC NAVIGATION INSTRUMENT DISPLAY SYSTEM.

The instrument display system provides displays for navigation and command signals on a vertical situation indicator (VSI) and a horizontal situation indicator (HSI) for pilot visual reference. The system consists of the two VSIs and two HSIs on the instrument panel. The system has a common command instrument system processor (CISP), two HSI/VSI mode select panels and one CIS mode select panel.

2.80.1 Vertical Situation Indicator. The VSI (Figure 2-23) provides a cockpit display of the helicopter's pitch, roll attitude, turn rate, slip or skid, and certain navigational information. It accepts command instrument system processor signals and displays the flight command information needed to arrive at a predetermined point. The system also monitors and displays warnings when selected navigation instrument readings lack reliability. The VSI is composed of a miniature airplane; four warning indicator flags ATT, GS, NAV and CMD; two trim knobs ROLL and PITCH; a bank angle scale; a bank angle index on the spheroid; a turn rate indicator and inclinometer; pitch and roll command bars; collective position pointer; a course deviation pointer; and a glide slope deviation pointer. The gyro erect switch supplies a fast erect signal to the pilot and copilot displacement gyros or inputs from AHRS thereby considerably reducing the time required for the gyros to reach full operating RPM or AHRS to initialize. The pilot and copilot displacement gyros or inputs from AHRS supply pitch and roll attitude signals to the vertical situation indicators, automatic flight control system, and the Doppler navigation system. On helicopters not equipped with AHRS, the power to operate the VSI is provided from the No. 2 ac essential bus through circuit breakers marked VSI PLT, CPLT. AHRS Power to operate the VSI is provided from the No. 2 ac essential bus through a circuit breaker marked AHRU PLT, CPLT **4**.

2.80.1.1 Steering Command Bars and Pointer. The roll and pitch command bars and the collective position pointer operate in conjunction with the command instrument system processor (CISP) and the command instrument system/mode selector (CIS MODE SEL). Selection of HDG on the CIS MODE SEL panel provides a display of a roll signal by the roll command bar. The pitch command bar and the collective position pointer are out of view, and the CMD flag is held from view. Selecting the CIS MODE SEL switch NAV and the MODE SEL switch **VOR ILS**, the roll command bar will display roll commands from the CISP. If an ILS (LOC) frequency is tuned in, the pitch command bar and the collective command pointer will also display CISP signals. If a VOR frequency is tuned-in, the pitch command bar and collective position pointer will be held from view. The CMD warning flag will be held from view indicating that the CISP functional integrity is being monitored. Refer to Figure 2-25 for VSI indications in other switch positions.

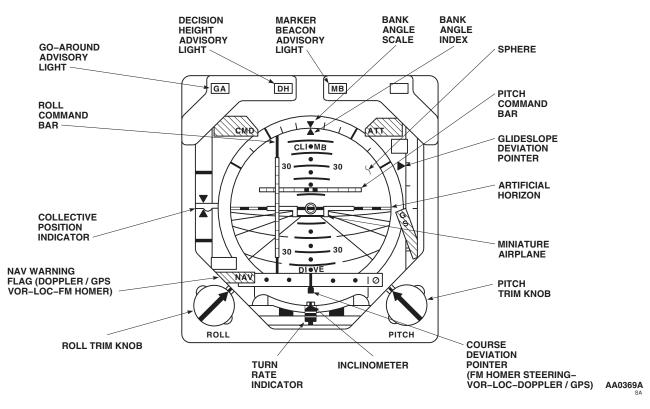


Figure 2-23. Vertical Situation Indicator

2.80.1.2 Command Warning Flag. The command warning flag marked **CMD** is at the top left of the VSI face. It is held from view when initial power is applied to the CIS processor. When any CIS mode selector switch is on and that navigation system is operating properly, the **CMD** flag is not in view. During operation, if the navigation signal becomes unreliable, or is lost, the **CMD** flag will become visible. On helicopters equipped with digital CIS processor the **CMD** flag will not come into view when the navigation signal becomes unreliable or lost. The **NAV** flag will come into view when the navigation signal becomes unreliable or lost. The **NAV** flag will come into view when the navigation signal becomes unreliable even with the digital CIS.

2.80.1.3 Glide Slope Warning Flag. A glide slope warning flag marked **GS** is on the right face of the indicator. The letters **GS** are black on a red/white stripe background. The warning flag will move out of view when the ILS receivers are operating and reliable signals are received.

2.80.1.4 Navigation Warning Flag. A navigation flag marked **NAV** is installed on both the VSIs and the HSIs to indicate when navigation systems are operating and reli-

able signals are being received. The VSI NAV flag is marked NAV with a white background and red strips and is on the lower left side of the indicator. The HSI NAV flag is within the compass card ring. Both instrument flags will retract from view whenever a navigation receiver is on and a reliable signal is being received.

2.80.1.5 Course Deviation Pointer. The course deviation pointer is on the VSI instrument. The pointer works with the course bar on the HSI to provide the pilot with an indication of the helicopter's position with respect to the course selected on the HSI. The scales represent right or left off course, each dot from center (on course) is 1.25° for ILS, 5° VOR and FM. The pilot must fly into the needle to regain on-course track.

2.80.1.6 Glide Slope Deviation Pointer. The glide slope pointer, on the right side of the VSI, is used with ILS. The pointer represents the glide slope position with respect to the helicopter. Each side of the on-glide slope (center) mark are dots, each dot representing .25° above or below the glide slope.

FUNCTION

2.80.1.7 Controls and Indicators. Indicators of the VSI are on the face of the instrument. The function of each indicator is as follows:

CONTROL/ INDICATOR	FUNCTION
Miniature airplane/ horizon line	Provides reference to artificial horizon.
Bank angle scale	Right and left 0°, 10°, 20°, 30°, 45°, 60°, and 90° of bank.
Artificial horizon	Reference of helicopter's attitude to horizon.
Turn rate indicator	4-minute turn (one-needle width either side of center) 2-minute turn (two-needle width each side of center).
Pitch and roll command bars	Display control inputs required to arrive at a predetermined course or glide slope.
Collective position indicator	Displays to the pilot the position of the collective relative to where it should be to arrive at a predetermined altitude.
GA	Go-around (GA) light will go on whenever the GA switch on the pilot's or copilot's cyclic stick is pressed. The light will go off whenever the go-around mode is ended by engaging another mode on the CIS mode selector panel.
DH	Decision height (DH) light will go on whenever the radar altimeter is operating and the altitude indicator is at or below the radar altitude L (low bug) setting.
МВ	Marker beacon (MB) light will go on and the associated marker beacon tone will be heard depend- ing upon volume control setting when the helicopter is over the marker beacon transmitter.

CONTROL/ INDICATOR

Glide slope pointer	Displays to the pilot the position of the ILS glide slope relative to the helicopter. Pointer above center indicates helicopter is below glide path.
Course deviation pointer	Displays to the pilot the position of the course reference (VOR, LOC, DPLR/GPS, FM HOME) relative to the helicopter.
ATT warning flag	Indicates loss of vertical gyro power or inputs from AHRS or VSI malfunction.
NAV warning flag	Indicates loss or unreliable signal indication.
GS warning flag	Indicates loss or unreliable signal indicator.
PITCH trim knob	Adjust artificial horizon up (climb) from at least 4° , no more than 10° or down (dive) from at least 8° , no more than 20° .
ROLL trim knob	Adjust artificial horizon right or left from at least 8° to no more than 20°.

2.80.2 Horizontal Situation Indicator. Two HSIs (Figure 2-24) are installed on the instrument panel, one in front of each pilot. The HSI consists of a compass card, two bearing-to-station pointers with back-course markers, a course bar, a **KM** indicator, heading set (**HDG**) knob and marker, a course set (**CRS**) knob, a **COURSE** digital readout, a to-from arrow, a **NAV** flag, and a compass **HDG** flag. The HSIs operating power is taken from the ac essential bus through a circuit breaker marked **HSI PLT/CPLT**.

2.80.3 Controls and Indicators. Controls of the horizontal situation indicators are as follows:

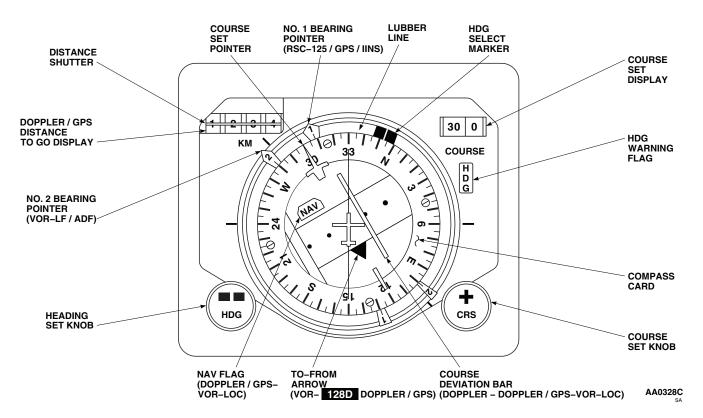


Figure 2-24. Horizontal Situation Indicator

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
Compass card	The compass card is a 360° scale that turns to display heading data obtained from the compass control. The helicopter headings are read at the upper lubber line.	Bearing pointer No. 2	The pointer operates in conjunction with selected VOR or ADF receiver. The pointer is read against the compass card and indicates the magnetic bearing to the VOR or ADF station.
COURSE set	Displays course to nearest degree.		the vort of fibr station.
display	Indicates same as course set	Course deviation	This bar indicates lateral deviation
	pointer.	bar	from a selected course. When the
Bearing pointer No. 1	The pointer operates in conjunction with Doppler/GPS or IINS. Indicates magnetic bearing to Doppler/GPS or IINS destination set on DI FLY-TO-DEST or EI CDU.		helicopter is flying the selected course, the course bar will be aligned with the course set pointer and will be centered on the fixed aircraft symbol.

CONTROL/ INDICATOR	FUNCTION
CRS knob	Course set (CRS) knob and the course set counter operate in conjunction with the course pointer and allow the pilot to select any of 360 courses. Once set, the course pointer will turn with the compass card and will be centered on the upper lubber line when the helicopter is flying the selected course.
KM indicator	Digital distance display in kilometers (KM) to destination set on Doppler FLY TO DEST .
HDG knob	Heading set (HDG) knob operates in conjunction with the heading select marker and allows the pilot to select any one of 360 headings. Seven full turns of the knob produces a 360° turn of the marker.
HDG warning flag	Visible when a failure occurs in the magnetic compass system.
To-From arrow	To-from arrow indicates that the helicopter is flying to or away from a selected VOR or 128D GPS destination 4 .
NAV flag	The NAV flag at the top of the to indicator turns with the compass card. The flag will retract from view when a reliable navigation signal is being applied to the instrument.

2.80.4 VSI/HSI and CIS Mode Selector Panels. The mode select panels are integrally lighted instrument panel mounted controls for the VSI, HSI, and CIS. The panels provide a means for selecting and displaying various navigation functions. Power to operate the pilot's **MODE SEL** is taken from the No. 2 dc primary bus through a circuit breaker marked **PILOT MODE SELECT**. The copilot's **MODE SEL** takes power from the No. 1 dc primary bus through a circuit breaker marked **CPLT MODE SELECT**.

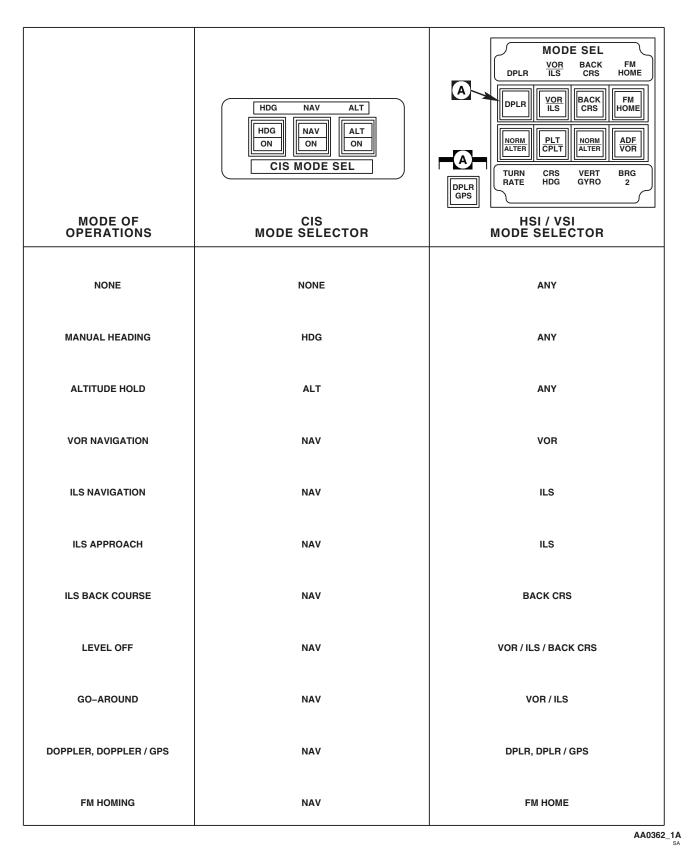
NOTE

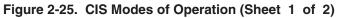
The switches on the VSI/HSI and CIS mode select panels may change state when the caution/advisory panel **BRT/DIM-TEST**

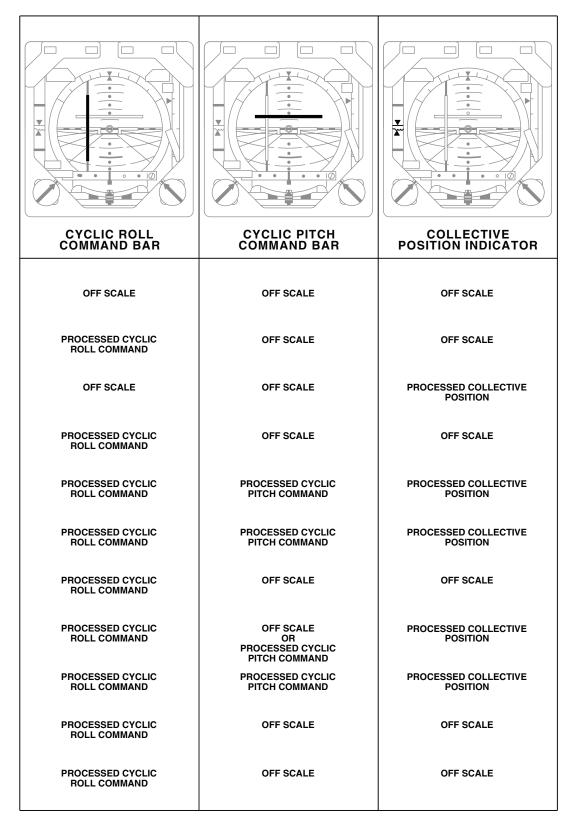
switch is set to **TEST**. The original indications may be restored by pressing the applicable switches.

2.80.4.1 Controls and Functions. Controls of the mode selector panel are as follows:

CONTROL	FUNCTION
DPLR, DPLR/ GPS	GPS lateral deviation and NAV flag signals to VSIs and HSIs.
VOR ILS	Directs VOR or ILS signals to VSIs, and HSIs. Provides a signal to NAV flag.
BACK CRS	Reverse polarity of back course signal to provide directional dis- play for VSIs and HSIs. Provides a signal to NAV flag.
FM HOME	Directs FM homing deviation and flag signals to VSIs.
TURN RATE NORM	Provides pilot and copilot with turn rate gyro or inputs from AHRS information displayed on the on- side VSI.
ALTR	Allows copilot's gyro/inputs from copilot's AHRS to be displayed on pilot's VSI; or pilot's gyro/inputs from pilot's AHRS to be displayed on copilot's VSI.
CRS HDG PLT	Provides for pilot's omni-bearing selector to be connected to naviga- tion receiver, 128D or DGNS SDC ◀, and concurrent connec- tion of pilot's HSI course datum and heading datum output to com- mand instrument system processor.
CPLT	Provides for copilot's omni- bearing selector to be connected to navigation receiver, 128D or DGNS SDC ◀, and concurrent connection of copilot's HSI course datum and heading datum output to command instrument system processor.
VERT GYRO NORM	Provides pilot and copilot with vertical gyro or inputs from AHRS information displayed on the on- side VSI.







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Figure 2-25. CIS Modes of Operation (Sheet 2 of 2)

CONTROL	FUNCTION
ALTR	Allows copilot's gyro/inputs from copilot's AHRS to be displayed on pilot's VSI; or pilot's gyro/inputs from pilot's AHRS to be displayed on copilot's VSI.
BRG 2 ADF	Allows pilot or copilot to select ADF on the onside No. 2 bearing pointer, each independent of the other.
VOR	Allows pilot or copilot to select VOR on the onside No. 2 bearing pointer, each independent of the other.
CIS mode selector	Selects one of three modes of operation to direct navigational signals to the CISP for Command Signal display.
HDG ON	Direct heading and roll signals to CIS processor for steering com- mands that will allow pilot to maintain a selected heading.
NAV ON	Gives heading commands to acquire and track a selected VOR, ILS, DPLR, DPLR/GPS or FM intercept, or to acquire and track glide slope beam.
ALT ON	Directs barometric pressure signals and collective stick position signals to CIS processor.

2.80.4.2 Off Mode. The command instrument system off mode (no switch legends lit) causes the cyclic roll, cyclic pitch and collective command pointers on both vertical situation indicators to be stowed out of view and the command warning flag on both VSIs to be biased out of view. The CISP is in the off mode upon initial application of electrical power before the pilot selects either HDG, NAV or ALT mode on the CIS mode selector. When NAV mode is selected, the CISP remains in the off mode unless the DPLR, DPLR/GPS, VOR ILS or FM **HOME** navigation data has been selected on the pilot's VSI/HSI mode selector. The CISP will return to the off mode whenever the HDG, NAV, and ALT hold modes are disengaged, as indicated by the respective ON legends going off, or by turning off the associated navigation receiver. Separate modes are manually disengaged by pressing the mode switch when ON is lit.

2.80.4.3 Heading Mode. The heading mode processes the heading error and roll attitude signals to supply a limited cyclic roll command which, when followed, causes the helicopter to acquire and track the heading manually selected on either pilot's HSI. The processed signal causes the VSI cyclic roll command bar to deflect in the direction of the required control response; i.e., bar deflection to the right indicates a coordinated right turn is required. When properly followed, the command results in not more than one overshoot in acquiring the selected heading and a tracking error of not more than 2°. The processor gain provides 1° of roll command for each degree of heading error up to a roll command limit of approximately 20°. The CISP heading mode is engaged by momentarily pressing the HDG switch on the pilot's CIS mode selector, or as described in paragraph 2.80.4.6.

2.80.4.4 Altitude Hold Mode. The altitude hold mode processes barometric pressure signals from the air data transducer in addition to the collective stick position signal. When the ALT switch on the pilot's CIS mode selector is pressed, the CISP provides collective command signals, which, when properly followed, cause the helicopter to maintain altitude to within ± 50 feet. The altitude hold mode synchronizes on the engagement altitude for vertical rates up to 200 feet per minute and provides performance for altitude inputs between -1000 and +10,000 feet at airspeeds from 70 to 150 KIAS. It is possible to engage the altitude hold mode regardless of whether the heading mode or navigation mode is engaged except that the CISP logic prevents manual selection of the altitude hold mode whenever the NAV mode is engaged and an ILS frequency is selected. This prevents the operator from selecting altitude hold mode during an instrument approach. The altitude hold mode is manually engaged by pressing the **ALT** hold switch (subject to above restriction) or automatically engaged as described in paragraph 2.80.4.7. The altitude hold mode may be manually disengaged by pressing the ALT hold switch when the ON legend is lit. Altitude hold may be disengaged also by selecting any other mode which takes priority (e.g., Go Around).

NOTE

ALT hold mode should be manually disabled during localizer, localizer back-course, VOR, and ADF approaches.

2.80.4.5 Navigation Mode. The CISP navigation mode is engaged by pressing the NAV switch on the CIS Mode Selector. This navigation mode causes the CISP to enter the VOR NAV, ILS NAV, DPLR NAV, or FM HOME mode as selected on the pilot's VSI/HSI mode selector.

The CISP provides steering commands based on the course selected on either the pilot's or copilot's HSI dependent on the mode select **CRS HDG** selection of **PLT** or **CPLT**.

2.80.4.6 VOR NAV Mode. The VOR NAV mode is established by selecting the VOR/ILS switch on the VSI/ HSI mode selector and pressing the NAV switch on the CIS mode selector. The CISP processes the heading and course signals derived from either the pilot's or the copilot's HSI in addition to the lateral deviation and lateral flag signals applied to the pilot's VSI. The CISP provides a limited cyclic roll command which, when followed, shall cause the helicopter to acquire and track the course setting manually selected on the HSI. Engagement of the VOR **NAV** when the helicopter position is in excess of 10° to 20° from the selected radial will cause the initial course intersection to be made in the heading mode as described in paragraph 2.80.4.3. The CISP logic will light the CIS mode selector HDG switch ON legend during the initial course intersection. When the helicopter is within 10° to 20° of the selected course, the CISP beam sensor will capture the VOR lateral beam. The processor logic will turn off the HDG switch ON legend and the final course interception, about 45°, acquisition and tracking will be based on the VOR lateral deviation signals. The processor causes the roll command pointer to deflect in the direction of the required control response. When properly followed, the command will result in not more than one overshoot at a range of 10 NM at a cruise speed of 100 \pm 10 knots and not more than two overshoots at ranges between 5 and 40 NM at speeds from 70 to 140 knots. When passing over the VOR station, the CISP reverts to a station passage submode and remains in this submode for 30 seconds. Cyclic roll commands during the station passage submode will be obtained from the HSI course datum signal. Outbound course changes may be implemented by the HSI CRS SET knob during the station passage submode. Course changes to a new radial or identification of VOR intersections may be made before station passage by setting the HSI HDG control to the present heading and actuating the HDG switch. This will disengage the NAV mode and allow the pilot to continue on the original radial in the heading mode. A VOR intersection fix or selection of a new radial course may be made without affecting the CIS steering commands. Actuating the NAV switch reengages the VOR NAV mode to either continue on the original VOR radial or to initiate an intercept to the new selected radial.

2.80.4.7 ILS NAV Mode. The instrument landing system NAV mode is established by selecting the VOR/ILS switch on the VSI/HSI mode selector, tuning a localizer frequency on the navigation receiver and selecting the NAV switch on the pilot's CIS MODE SEL panel. Dur-

ing the ILS NAV mode, the CISP processes the following signals in addition to those processed during the VOR NAV mode: 1. The vertical deviation and vertical flag signals, 2. The indicated airspeed (IAS) and barometric altitude signals, and 3. The collective stick position sensor and helicopter pitch attitude signals. The indicated airspeed and pitch attitude signals are processed to provide a limited cyclic pitch command which, when properly followed, will result in maintaining an airspeed that should not deviate more than 5 knots from the IAS existing at the time the ILS NAV mode is engaged. The pitch command bar will deflect in the direction of the required helicopter response, i.e., an upward deflection of the pitch bar indicates a pitch up is required. The BAR ALT and collective stick position signals are processed to provide a limited collective position indication which, when properly followed, will cause the helicopter to maintain the altitude existing at the time the ILS NAV mode is engaged. The collective position indicator will deflect in the opposite direction of the required control response, i.e., an upward deflection of the collective position indicator indicates a descent is required. The CISP will cause the ALT hold switch **ON** legend to light whenever the altitude hold mode is engaged. Actuating the ALT hold ON switch will disengage the altitude hold mode. Desired approach runway course must be set on the CRS window of the HSI selected by the PLT/CPLT indication of the CRS HDG switch. The initial course interception and the localizer course interception, about 45°, acquisition, and tracking will be done as described for the VOR NAV mode except that not more than one overshoot at a range of 10 NM at 100 \pm 10 KIAS and not more than two overshoots at ranges between 5 and 20 NM should occur for airspeeds between 70 and 130 KIAS.

2.80.4.8 Approach Mode. The approach mode, a submode of the ILS NAV mode, will be automatically engaged when the helicopter captures the glide slope. During the approach mode, the CISP processes the vertical deviation, GS flag, and collective stick position signals to provide a limited collective position indicator which, when properly followed, shall cause the helicopter to acquire and track the glide slope path during an approach to landing. When the glide slope is intercepted, the CISP logic disengages the altitude hold mode and causes the ON legend of the ALT hold switch to go off. The CISP will provide a down movement of the collective position indicator to advise the pilot of the transition from altitude hold to glide slope tracking and to assist in acquiring the glide slope path. The cyclic roll commands are limited to $\pm 15^{\circ}$ during the approach submode. When properly followed, the roll commands will result in the helicopter tracking the localizer to an approach. The collective position indicator when properly followed, will result in not more than one overshoot in acquiring the glidepath and have a glidepath tracking free of oscillations. The cyclic roll and collective steering performance is applicable for approach airspeed from 130 KIAS down to 50 KIAS.

2.80.4.9 BACK CRS Mode. The back course mode is a submode of the **ILS NAV** mode and is engaged by concurrent **ILS ON** and **BACK CRS ON** signal from the pilot's HSI/VSI mode selector. The CISP monitors the localizer lateral deviation signals to provide cyclic roll commands which, when properly followed, will allow the pilots to complete back course localizer approach in the same manner as the front course ILS. The desired final approach course should be set on the selected HSI **CRS** window.

2.80.4.10 Level-Off Mode. The level-off mode will be activated when either the VOR NAV or ILS NAV modes are engaged and will be deactivated by selection of another mode or when a radar altitude valid signal is not present. The level-off mode is not a function of a VOR or ILS CIS approach. During ILS or VOR approaches, the barometric altimeter must be used to determine arrival at the minimum altitude. Radar altimeter setting shall not be used for level off commands in the VOR NAV/ILS NAV modes because variations in terrain cause erroneous altitude indications. The level-off mode provides the pilots with a selectable low altitude command. This mode is automatically engaged when the radar altitude goes below either the pilot's or copilot's radar altimeter low altitude warning bug setting, whichever is at the higher setting. A DH legend on the VSI and a LO light display on the radar altimeter indicator goes on whenever the radar altitude is less than the LO bug setting. The CISP monitors the radar altimeter and the collective stick position sensor to provide a collective pointer command which, when properly followed, will cause the helicopter to maintain an altitude within 10 feet of the low altitude setting for settings below 250 feet and 20 feet for settings above 250 feet. The CISP causes the ALT switch ON legend to light and the altitude hold mode to be engaged.

2.80.4.11 Go-Around Mode. The go-around mode processes roll and pitch attitude, altitude rate, collective stick position, and airspeed inputs in addition to internally generated airspeed and vertical speed command signals to provide cyclic roll, cyclic pitch and collective position indication. The go-around mode will engage when either pilot presses the **GA** (Go Around) switch on the cyclic control grip. When the go-around mode is engaged, the CISP immediately provides a collective position indication, which, when followed, will result in a 500 \pm 50 fpm rate-of-climb at zero bank angle. Five seconds after the **GA** switch is pressed, the CISP will provide cyclic pitch

bar commands, which, when followed, will result in an 80-KIAS for the climbout. The go-around mode is disengaged by changing to any other mode on the pilot's CIS mode selector.

2.80.4.12 Doppler, Doppler/GPS Mode. The Doppler, Doppler/GPS navigation mode is engaged by selecting the DPLR, DPLR/GPS switch on the VSI/HSI mode selector and the NAV switch on the CIS mode selector. Doppler and GPS combined navigation is the default setting on the AN/ASN-128B **128D** and the AN/128D **4**, but Doppler only or GPS only navigation can be selected from the DLPR/GPS CDU. During the Doppler, Doppler/ GPS navigation mode, the CISP processes Doppler, Doppler/GPS track angle error and the Doppler, Doppler/ GPS NAV flag signals in addition to the roll angle input from the attitude gyro/AHRU. The CISP provides cyclic roll bar commands which, when followed, result in a straight line, wind-corrected flight over distances greater than 0.2 kilometer from the destination. The course deviation bar and course deviation pointer provide a visual display of where the initial course lies in relationship to the helicopter's position. The initial course is the course the Doppler, Doppler/GPS computes from the helicopter's position to the destination at the time the fly to destination thumbwheel is rotated (or entered from the keyboard). The VSI and HSI course sensitivity is ± 1000 meters when farther than 12 km from the fly-to destination. Course sensitivity gradually scales down from ± 1000 meters at 12 km to ± 200 meters at 2 km and less from the fly-to destination. To achieve a pictorially correct view of the course, rotate the course knob to the head of the No. 1 needle when the fly to destination thumbwheel is rotated (or entered from the keyboard). The DPLR, DPLR/GPS NAV logic detects the condition of station passover and automatically switches to heading mode. The switch to heading mode will be indicated by the HDG switch ON legend being turned on and the NAV switch ON legend being turned off. The Doppler, Doppler/GPS navigation mode will not automatically re-engage, but will require manual re-engagement of the NAV switch on the CIS mode selector.

2.80.4.13 FM HOME Mode. The FM homing is engaged by selecting the **FM HOME** switch on the pilot's VSI/HSI mode selector and the **NAV** switch on the pilot's CIS mode selector. Selecting FM homing on the VSI/HSI mode selector directs FM homing signals only to the VSI. Other **NAV** modes will be retained on the HSI if previously selected. During the **FM HOME** mode, the CISP processes the lateral deviation and flag signals displayed on the pilot's VSI in addition to the roll angle input from the attitude gyro. The CISP filters and dampens the FM homing deviation signals and provides cyclic roll com-

mands to aid the pilot in homing on a radio station selected on the No. 1 VHF-FM communications receiver. When properly followed, the roll commands result in not more than two overshoot heading changes before maintaining a tracking error not to go over 3°. The CISP will revert to the heading mode whenever the lateral deviation rate is over 1.5°/ sec for a period of over 1 second. The CISP will cause the CIS mode selector **HDG** switch **ON** legend to light and remain in the heading mode until the **FM** mode or some other mode is manually selected. Concurrent VOR and FM or concurrent DPLR and FM mode inputs will be considered an **FM** mode input to the CISP.

2.80.4.14 TURN RATE Select. The turn rate gyro selection provides each pilot the option of having the onside VSI display onside turn rate gyro or inputs from AHRS signal (NORM operation) or of having the other pilot's turn rate gyro or inputs from AHRS signal displayed (ALTR operation). The turn rate gyro selection is independent of the navigation modes selected by the top row of switches and is independent of which turn rate gyro or inputs from AHRS the other pilot has selected. The NORM selection connects each pilot's VSI to the onside turn rate gyro or inputs from AHRS. The selection of NORM or ALTR operation is indicated by lighting the respective legend on the TURN RATE selector switch. The lamp power to the indicator legends is controlled through a relay so that the NORM legend is lit in case the mode selector logic or lamp drivers fail. Sequential operation of the TURN RATE switch alternates the rate gyro or inputs from AHRS connected to the VSI.

2.80.4.15 CRS HDG Select. The **CRS HDG** switch on the mode selector provides for either the pilot's or the copilot's course selector (**CRS**) to be connected to the navigation receiver and for concurrent connection of the same pilot's HSI course and heading information to the command instrument system processor. The CRS resolver is normally connected to the pilot's HSI until selected by the copilot on the copilot mode selector. CRS HDG control is transferred by pressing the **CRS HDG** switch. The pilot having the CRS HDG control is indicated by lighting of either the **PLT** or the **CPLT** legend on each mode selector. When power is first applied to the mode selector, the pilot's position is automatically selected. The **CRS HDG** selection is independent of the navigation modes selected by the top row of switches.

2.80.4.16 VERT GYRO Select. The vertical gyro selection provides each pilot the option of having the onside VSI display onside vertical gyro or inputs from AHRS attitude (**NORM** operation) or of having the other pilot's (offside) vertical gyro or inputs from AHRS attitude displayed (**ALTR** operation). The vertical gyro selection is

independent of the navigation modes selected by the top row of switches and is independent of which vertical gyro the other pilot has selected. Each pilot's VSI is normally connected to the onside vertical gyro or inputs from AHRS. The selection of **NORM** or **ALTR** operation is indicated by lighting the respective legend on the **VERT GYRO** selector switch. The lamp power to the indicator legends is controlled through a relay so that the **NORM** legend is lit in case the mode selector logic or lamp drivers fail. Sequential operation of the **VERT GYRO** switch alternates the vertical gyro or inputs from AHRS connected to the VSI.

2.80.4.17 No. 2 Bearing Select. The HSI number 2 bearing pointer selection allows the option of either the LF/ADF bearing or the VOR bearing to a selected station. The **ADF/VOR** selection is independent of the navigation modes selected by the top row of switches and either pilot selects **ADF** or **VOR**, independent of the other pilot's selection. The number 2 bearing pointer is normally connected to the LF/ADF bearing output. The selection of either ADF or VOR bearing is indicated by lighting of the respective legend on the selector switch. The lamp power to the indicator legends is controlled through a relay so that the **ADF** legend is lit in case the mode selector logic or lamp drivers fail. Sequential operation of the **ADF/VOR** switch alternates the bearing source connected to the No. 2 bearing pointer between ADF or VOR.

2.80.5 Operation.

2.80.5.1 Heading Hold.

- 1. CIS MODE SEL switch HDG.
- 2. HDG set knob on HSI Set as desired.
- 3. Selected heading is achieved by banking helicopter to center roll command bar.

2.80.5.2 VOR Course Intercept.

- 1. Frequency Set.
- 2. HSI CRS set knob Set to desired course.
- 3. CIS MODE SEL switch NAV.
- 4. Follow roll command bar to initially follow intercept heading and then follow command bar to intercept VOR course.

2.80.5.3 ILS Approach.

1. Frequency - Set.

- 2. HSI CRS set knob Set to desired course.
- 3. CIS MODE SEL switch NAV.
- 4. At two dots localizer deviation on HSI, follow roll command bar to intercept localizer.
- 5. As glide slope deviation pointer centers, follow collective position indications for glide slope tracking.
- 6. At decision height, press **GA** switch for goaround mode if breakout has not occurred.

2.80.5.4 Back Course Localizer Approach.

- 1. Frequency Set.
- 2. LO altitude bug SET to missed approach point HAT.
- 3. HSI **CRS** set knob Set to inbound back course.
- 4. CIS MODE SEL switch NAV.
- 5. MODE SEL switch BACK CRS.
- 6. Fly same as ILS approach (paragraph 2.80.5.3). Turn off **MODE SEL ALT** legend to stow collective position indicator before making manual descent on back course approach.

2.81 STANDBY MAGNETIC COMPASS.

A magnetic compass is installed above the instrument panel on the right center windshield frame. The compass is used as a standby instrument for heading references. A compass correction card with deviation errors is installed on the right side of the upper console.

2.82 FREE-AIR TEMPERATURE (FAT) INDICATOR.

The FAT indicator is a direct reading instrument marked **FREE AIR** and displays in degrees Celsius. One FAT indicator is installed through the center windshield on helicopters without center windshield anti-ice system. On helicopters with center windshield anti-ice system, two indicators are installed through the overhead windows.

2.83 CLOCK.

2.83.1 Mechanical Clock. Two clocks are installed on the instrument panel. 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.

2.83.2 Digital Clock. Two digital clocks may be installed on the instrument panel. The clock incorporates a six-digit liquid crystal display, 24-hour numerals, and sweep second indication. A battery allows continuous operation for a minimum of one year when helicopter 28 vdc power is not applied. The clock has two modes of operation, clock mode (C) and the elapsed time mode (ET). Power to operate the clock is provided by the No. 1 dc and No. 2 dc primary buses through circuit breakers marked **CPLT ALTM** and **PILOT ALTM**, respectively.

2.83.3 Digital Clock Upgrade. On helicopters modified with the LC-6 digital clock, two digital clocks will be installed on the instrument panel. The clock incorporates a six-digit liquid crystal display with 12-hour numerals. An internal AAA battery allows continuous operation for a minimum of two years when helicopter 28 vdc power is not applied. The clock has the following five modes of operation: local time (LT), Universal Coordinated Time (UTC), trip or flight timer (flight) - not functional, stop watch (SW), and down counter (DC). Power to operate the clock is provided by the No. 1 dc and No. 2 dc primary buses through circuit breakers marked **CPLT ALTM** and **PILOT ALTM** respectively.

2.84 MASTER WARNING SYSTEM.

Two master cautions, one each side for the pilot and copilot and marked MASTER CAUTION PRESS TO **RESET**, are on the master warning panel (Figure 2-26). They appear whenever a caution appears. They alert the pilots and direct attention to the caution/advisory area. The master cautions should be reset at once to provide a similar indication if a second condition or malfunction occurs while the first is still present. A master caution can be reset from either pilot position. Four warnings, also on the master warning panel, require immediate action if they appear. They are #1 ENG OUT, #2 ENG OUT, FIRE, and LOW ROTOR RPM. The LOW ROTOR RPM warning will flash at a rate of three to five flashes per second if rotor rpm drops below 96% RPM R. In addition, if % RPM **R** drops below 96% or Ng drops below 55%, a low steady tone is provided. The low rotor rpm tone is inhibited on



AA0406

Figure 2-26. Master Warning Panel

the ground through the left landing gear WOW switch. The engine Ng steady tone is not inhibited. The **ENG OUT** warnings will appear and tone will be heard at 55% **Ng SPEED** and below. Refer to paragraph 2.15.1 for description of the **FIRE** warnings. Power for the master cautions is provided from the No. 1 dc primary bus through a circuit breaker marked **LIGHTS CAUT/ADVSY**.

2.84.1 Caution/Advisory System. The caution/ advisory panel (Figure 2-27) is on the left of center of the instrument panel. The caution section (upper two-thirds) of the panel indicates certain malfunctions or unsafe conditions which appear in amber. The advisory section (lower one-third) of the panel shows certain noncritical conditions which appear in green. Each has its own operating circuit and will appear as long as the condition that caused it to appear exists. The cautions and advisories are powered by the No. 1 dc primary bus through a circuit breaker marked **LIGHTS CAUT/ADVSY**. Refer to Table 2-3 for a brief description of each fault.

NOTE

The caution/advisory panel (LED) does not use any power from the dc primary bus. All power is from the dc essential bus.

Table 2-3. Caution/Advisory and Warning Parameters

PARAMETER OR FAULT

CAUTIONS

#1 FUEL LOW

Flashes when left fuel tank level is about 172 pounds.

2.84.2 Caution/Advisory BRT/DIM - TEST Switch. Testing of the cautions and advisories is done through a momentary spring-loaded to center switch marked BRT/ **DIM** and **TEST** on the lower left of the caution/advisory panel. Placing the switch to TEST simultaneously checks all cautions, advisories and master warnings and #1 and #2 FUEL LOW cautions and LOW ROTOR RPM warnings will flash. When the pilot's PILOT FLT rotary intensity control is moved from the OFF position, placing the BRT/DIM-TEST switch to BRT/DIM causes the cautions, advisories and master warnings to change intensity. When they are dim and power is removed, the intensity will return to bright when power is reapplied. The TEST switch position receives power from the No. 1 dc primary bus through a circuit breaker marked LIGHTS CAUT ADVSY. The BRT/DIM switch position receives power from the dc essential bus through a circuit breaker marked CAUT/ADVSY PNL on the No. 1 circuit breaker panel. Dimming of the cockpit indicator lights operates with the CAUTION panel dimming system.

C A U T I O N

A

* ADVISORY

#1 FUEL LOW	#1 GEN	#2 GEN	#2 FUEL LO
#1 FUEL PRESS	#1 GEN BRG	#2 GEN BRG	#2 FUEL PRESS
#1 ENGINE OIL PRESS	#1 CONV	#2 CONV	#2 ENGINE OIL PRESS
#1 ENGINE	AC ESS	DC ESS	#2 ENGINE
OIL TEMP	BUS OFF	BUS OFF	OIL TEMP
CHIP	BATT LOW	BATTERY	CHIP
#1 ENGINE	CHARGE	FAULT	#2 ENGINE
#1 FUEL	GUST	PITCH BIAS	#2 FUEL
FLTR BYPASS	LOCK	FAIL	FLTR BYPAS
#1 ENGINE	#1 OIL	#2 OIL	#2 ENGINE
STARTER	FLTR BYPASS	FLTR BYPASS	STARTER
#1 PRI	#1 HYD	#2 HYD	#2 PRI
SERVO PRESS	PUMP	PUMP	SERVO PRES
TAIL ROTOR	IRCM	AUX FUEL	#1 TAIL RT
QUADRANT	INOP		SERVO
MAIN XMSN	INT XMSN	TAIL XMSN	APU OIL
OIL TEMP	OIL TEMP	OIL TEMP	TEMP HI
BOOST SERVO OFF	STABILATOR	SAS OFF	TRIM FAIL
LFT PITOT	FLT PATH	IFF	RT PITOT
HEAT	STAB		HEAT
CHIP INPUT	CHIP	CHIP	CHIP INPUT
MDL – LH	INT XMSN	TAIL XMSN	MDL – RH
CHIP ACCESS	CHIP MAIN	APU	CHIP ACCES
MDL – LH	MDL SUMP	FAIL	MDL – RH
MR DE-ICE	MR DE-ICE	TR DE-ICE	ICE
FAIL	FAULT	FAIL	DETECTED
MAIN XMSN	#1 RSVR	#2 RSVR	BACK-UP
OIL PRESS	LOW	LOW	RSVR LOW
#1 ENG	#1 ENG INLET	#2 ENG INLET	#2 ENG
ANTI-ICE ON	ANTI-ICE ON	ANTI-ICE ON	ANTI-ICE O
APU ON	APU GEN ON	PRIME BOOST PUMP ON	BACK-UP PUMP ON
APU ACCUM	SEARCH LT	LDG LT ON	#2 TAIL RTF
LOW	ON		SERVO ON
BRT /	CARGO	HOOK ARMED	GPS POS
DIM	HOOK OPEN		ALERT
(\bigcirc)	PARKING BRAKE ON	EXT PWR CONNECTED	

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Figure 2-27. Caution/Advisory Panel (Sheet 1 of 2)

#1 FUEL LOW	#1 GEN	#2 GEN	#2 FUEL LOV
#1 FUEL PRESS	#1 GEN BRG	#2 GEN BRG	#2 FUEL PRESS
#1 ENGINE OIL PRESS	#1 CONV	#2 CONV	#2 ENGINE OIL PRESS
#1 ENGINE	AC ESS	DC ESS	#2 ENGINE
OIL TEMP	BUS OFF	BUS OFF	OIL TEMP
CHIP	BATT LOW	BATTERY	CHIP
#1 ENGINE	CHARGE	FAULT	#2 ENGINE
#1 FUEL	GUST	ANTENNA	#2 FUEL
FLTR BYPASS	LOCK	EXTENDED	FLTR BYPAS
#1 ENGINE	#1 OIL	#2 OIL	#2 ENGINE
STARTER	FLTR BYPASS	FLTR BYPASS	STARTER
#1 PRI	#1 HYD	#2 HYD	#2 PRI
SERVO PRESS	PUMP	PUMP	SERVO PRES
TAIL ROTOR QUADRANT	ASE	AUX FUEL	#1 TAIL RTI SERVO
MAIN XMSN	INT XMSN	TAIL XMSN	APU OIL
OIL TEMP	OIL TEMP	OIL TEMP	TEMP HI
BOOST SERVO OFF	STABILATOR	SAS OFF	TRIM FAIL
LFT PITOT	FLT PATH	IFF	RT PITOT
HEAT	STAB		HEAT
CHIP INPUT	CHIP	CHIP	CHIP INPUT
MDL – LH	INT XMSN	TAIL XMSN	MDL – RH
CHIP ACCESS	CHIP MAIN	APU	CHIP ACCES
MDL – LH	MDL SUMP	FAIL	MDL – RH
MR DE-ICE	MR DE-ICE	TR DE-ICE	ICE
FAIL	FAULT	FAIL	DETECTED
MAIN XMSN	#1 RSVR	#2 RSVR	BACK-UP
OIL PRESS	LOW	LOW	RSVR LOW
#1 ENG	#1 ENG INLET	#2 ENG INLET	#2 ENG
ANTI-ICE ON	ANTI-ICE ON	ANTI-ICE ON	ANTI-ICE OI
APU ON	APU GEN ON	PRIME BOOST PUMP ON	BACK-UP PUMP ON
APU ACCUM	SEARCH LT	LDG LT ON	#2 TAIL RTF
LOW	ON		SERVO ON
BRT /	AIR COND	CABIN HEAT	ANTENNA
DIM	ON	ON	RETRACTED
TEST	PARKING BRAKE ON	EXT PWR CONNECTED	

Figure 2-27. Caution/Advisory Panel (Sheet 2 of 2)

AA0354_2

LEGEND	PARAMETER OR FAULT
#1 FUEL PRESS	Left engine fuel pressure between engine-driven low-pressure fuel pump and high- pressure fuel pump is low.
#1 ENGINE OIL PRESS	Left engine oil pressure is too low for continued operation.
#1 ENGINE OIL TEMP	Left engine oil temperature is above 150°C.
CHIP #1 ENGINE	Left engine chip detector in scavenge oil system has metal chip or particle buildup.
#1 FUEL FLTR BYPASS	Left engine fuel filter has excessive pressure differential across filter.
#1 ENGINE STARTER	Left engine start circuit is actuated.
#1 PRI SERVO PRESS	First stage pressure is shut off, or has dropped below minimum, or servo pilot valve is jammed.
TAIL ROTOR QUADRANT	Appears when a tail rotor cable is broken or disconnected.
MAIN XMSN OIL TEMP	Main transmission oil temperature is above 120°C.
BOOST SERVO OFF	Indicates loss of second stage hydraulic pressure to the boost servo, or a boost servo jam.
LFT PITOT HEAT	Indicates left pitot heater element is not receiving power with PITOT HEAT switch ON .
CHIP INPUT MDL-LH	Indicates a metal particle has been detected by the chip detector.
CHIP ACCESS MDL-LH	Indicates a metal particle has been detected by the chip detector.
MR DE-ICE FAIL	Indicates a short or open in the main rotor deice system, which will disable the system.
MAIN XMSN OIL PRESS	Main transmission oil pressure is below about 14 psi.
#1 GEN	Left generator is not supplying power to the buses.
#1 GEN BRG	Generator main bearing is worn or has failed.
#1 CONV	#1 converter (ac to dc current) has no output.
AC ESS BUS OFF	Indicates that no power (115 vac, phase B) is being supplied to the ac essential bus.
BATT LOW CHARGE	SLAB - Indicates that the voltage on the battery utility bus is at or below 23 vdc. NICAD - Indicates that the battery charge state is at or below about 40% of full charge state.
GUST LOCK	Indicates the gust lock is not fully disengaged
#1 OIL FLTR BYPASS	Left engine oil filter pressure differential is excessive.
#1 HYD PUMP	Left hydraulic pump output pressure below minimum.
IRCM INOP	Indicates a malfunction has been detected by the infrared countermeasure system or infrared countermeasure system is in a cooldown cycle
EH ASE	Indicates the ALQ-156 system is being jammed or the ALQ-136, ALQ-144, ALQ-156, or ALQ-162 system is degraded.
INT XMSN OIL TEMP	Intermediate gear box oil temperature is excessive.
STABILATOR	Stabilator system is turned on but is in the manual mode.

Table 2-3. Caution/Advisory and Warning Parameters (Cont)

LEGEND	PARAMETER OR FAULT
FLT PATH STAB	Indicates that FPS is inoperative in one or more axis.
CHIP INT XMSN	Indicates a metal particle has been detected by the chip detector.
CHIP MAIN MDL SUMP	Indicates a metal particle has been detected by the chip detector.
MR DE-ICE FAULT	Indicates partial failure of the blade deice system. Uneven shedding of ice can be expected.
#1 RSVR LOW	Hydraulic fluid level has dropped below about 60% of full capacity.
#2 GEN	Right generator is not supplying power to the buses.
#2 GEN BRG	Generator main bearing is worn or has failed.
#2 CONV	#2 converter (ac to dc current) has no output.
DC ESS BUS OFF	Indicates that no power is being supplied to the dc essential bus.
BATTERY FAULT	Indicates that the battery has exceeded safe operating temperature (overtemperature), or a battery cell dissimilarity exists (on helicopters prior to serial number 97-26744).
PITCH BIAS FAIL	Not used.
EH ANTENNA EXTENDED	ECM antenna not fully retracted and at least one of these conditions exist: Helicopter is below radar altimeter LO bug setting, or power is lost, or AN/APN-209 is turned off or is removed.
#2 OIL FLTR BYPASS	Right engine oil filter pressure differential is excessive.
#2 HYD PUMP	Right hydraulic pump output pressure below minimum.
ERFS AUX FUEL	Indicates one or more auxiliary fuel tanks are empty and/or a degraded mode of system operation.
TAIL XMSN OIL TEMP	Tail gear box oil temperature is excessive.
SAS OFF	Hydraulic pressure supplied to the SAS actuator is below minimum.
IFF	Mode 4 is not capable of responding to interrogation.
CHIP TAIL XMSN	Indicates a metal particle has been detected by the chip detector.
APU FAIL	APU was automatically shut down by the ESU.
TR DE-ICE FAIL	Indicates a short or open in a tail rotor blade deice element.
#2 RSVR LOW	Hydraulic fluid level has dropped below about 60% of full capacity.
#2 FUEL LOW	Flashes when right fuel level is about 172 pounds.
#2 FUEL PRESS	Right engine fuel pressure between engine-driven low-pressure fuel pump and high- pressure fuel pump is low.
#2 ENGINE OIL PRESS	Right engine oil pressure is too low for continued operation.
#2 ENGINE OIL TEMP	Right engine oil temperature is above 150°C.
CHIP #2 ENGINE	Right engine chip detector in scavenge oil system has metal chip or particle buildup.
#2 FUEL FLTR BYPASS	Right engine fuel filter has excessive pressure differential across filter.
#2 ENGINE STARTER	Right engine start circuit is actuated.

Table 2-3. Caution/Advisory and Warning Parameters (Cont)

LEGEND	PARAMETER OR FAULT	
#2 PRI SERVO PRESS	Second stage pressure is shut off, or has dropped below minimum, or servo pilot valve is jammed.	
#1 TAIL RTR SERVO	Pressure to the first stage tail rotor servo is below minimum, or servo pilot valve is jammed.	
APU OIL TEMP HI	APU oil temperature is above the maximum.	
TRIM FAIL	Indicates that yaw, roll, or pitch trim actuators are not responding accurately to computer signals.	
RT PITOT HEAT	Indicates right pitot heat element is not receiving power with PITOT HEAT switch ON .	
CHIP INPUT MDL-RH	Indicates a metal particle has been detected by the chip detector.	
CHIP ACCESS MDL-RH	Indicates a metal particle has been detected by the chip detector.	
ICE DETECTED	Indicates that ice has been detected and the blade de-ice system is not operating.	
BACK-UP RSVR LOW	Hydraulic fluid level has dropped below about 60% of full capacity.	
	ADVISORIES	
#1 ENG ANTI-ICE ON	Indicates that No. 1 engine anti-ice/start bleed valve is open.	
APU ON	APU is operating.	
APU ACCUM LOW	APU accumulator pressure is low.	
#1 ENG INLET ANTI-ICE ON	Indicates that No. 1 engine inlet anti-icing air temperature is 93°C or above.	
APU GEN ON	APU generator output is accepted and being supplied to the helicopter.	
SEARCH LT ON	Either pilot or copilot has selected SRCH LT switch on.	
CARGO HOOK OPEN	Indicates that cargo hook load beam is not latched.	
EH AIR COND ON	Power is applied to air conditioner compressor.	
PARKING BRAKE ON	Indicates that PARKING BRAKE handle is pulled.	
#2 ENG INLET ANTI-ICE ON	Indicates that No. 2 engine inlet anti-icing air temperature is 93°C or above.	
PRIME BOOST PUMP ON	Prime boost pump switch is at PRIME or BOOST .	
LDG LT ON	Either pilot or copilot has selected LDG LT ON.	
HOOK ARMED	The cargo hook release system is armed.	
EH CABIN HEAT ON	Aux heater system is operating.	
EXT PWR CONNECTED	Indicates that external power plug is connected to helicopter's EXT POWER connector.	
#2 ENG ANTI-ICE ON	Indicates that No. 2 engine inlet anti-ice/start bleed valve is open.	
BACKUP PUMP ON	Backup pump pressure is being supplied.	
#2 TAIL RTR SERVO ON	Pressure to 2nd stage tail rotor servo is above minimum.	

LEGEND	PARAMETER OR FAULT
EI ANTENNA RETRACTED	ECM antenna fully retracted.
GPS POS ALERT	Indicates that GPS signals are not reliable.
MASTER WARNING PANEL	
#1 ENG OUT	No. 1 engine Ng SPEED is below 55%.
FIRE	Indicates a fire detector has actuated a fire warning circuit.
MASTER CAUTION PRESS TO RESET	Indicates a caution on the caution panel has been actuated by failed system.
#2 ENG OUT	No. 2 engine Ng SPEED is below 55%.
LOW ROTOR RPM	Rotor speed is below about 96% RPM R.

Table 2-3. Caution/Advisory and Warning Parameters (Cont)

Section XV SERVICING, PARKING, AND MOORING

2.85 SERVICING.

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 2-28. Fuel and lubricant specifications and capacities are in Table 2-4. Table 2-5 contains a listing of acceptable commercial fuel.

2.86 SERVICE PLATFORMS AND FAIRINGS.

Service platforms are a part of the engine cowlings, providing access to the engines. Each service platform is about 46 inches long and 18 inches wide. It is capable of supporting a static weight of 400 pounds on any area without yielding. The platform is made of composite metal and fiberglass with a honeycomb core. The engine cowling is opened by releasing a latch on the side and pulling outward on a locking handle. The cowling is opened outward and down, providing a standing area at the lower section. When closed, the cowling lock prevents opening in flight.

2.87 FUEL SYSTEM SERVICING.



To avoid personnel injury or equipment damage, ensure AN/ARC-220 does not transmit during refueling operations by placing the radio in OFF, STBY, or SILENT mode.

a. Both tanks may be serviced simultaneously through pressure refueling or closed circuit refueling. They may be serviced individually by gravity refueling through refueling ports on the left and right sides of the helicopter.

b. The external extended range tanks can only be serviced by gravity refueling through refueling ports on the forward top of each tank.

2.87.1 Fuel Types. Fuels are classified in Table 2-5.

2.87.2 Use of Fuels. When changing from one type of authorized fuel to another, for example JP-4 to JP-5, it is not necessary to drain the helicopter fuel system before adding the new fuel. Fuels having the same NATO code number are interchangeable. Jet fuels conforming to ASTM D-1655 specification may be used when MIL-T-

5624 fuels are not available. This usually occurs during cross-country flights where helicopters using NATO F-44 (JP-5) are refueled with NATO F-40 (JP-4) or Commercial ASTM Type B fuels. Whenever this condition occurs, 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 Jet A-1 fuels.

2.87.3 Gravity Refueling.

- 1. Ground helicopter to fuel truck or other suitable ground.
- 2. Plug hose nozzle ground into the helicopter grounding jack marked **GROUND HERE**, above refueling ports.
- 3. Remove fuel filler caps and refuel. Refer to Table 2-4 for fuel quantities.

2.87.4 Pressure Refueling.

- 1. Ground helicopter to fuel truck or other suitable ground.
- 2. Ground fuel dispenser nozzle to the helicopter grounding point marked **GROUND HERE**, above refueling ports.



Damage to the fuel system could result if refueling hose pressure exceeds 55 psi during pressure refueling or 15 psi during closed circuit refueling.

3. Connect fuel dispenser nozzle to pressure refueling adapter.

NOTE

The system is designed to restrict fuel flow to 300 gpm during pressure refueling at a nozzle pressure of 55 psi and 110 gpm at a nozzle pressure of 15 psi during closed circuit refueling.

4. Start fuel flow from fuel dispenser and refuel helicopter.

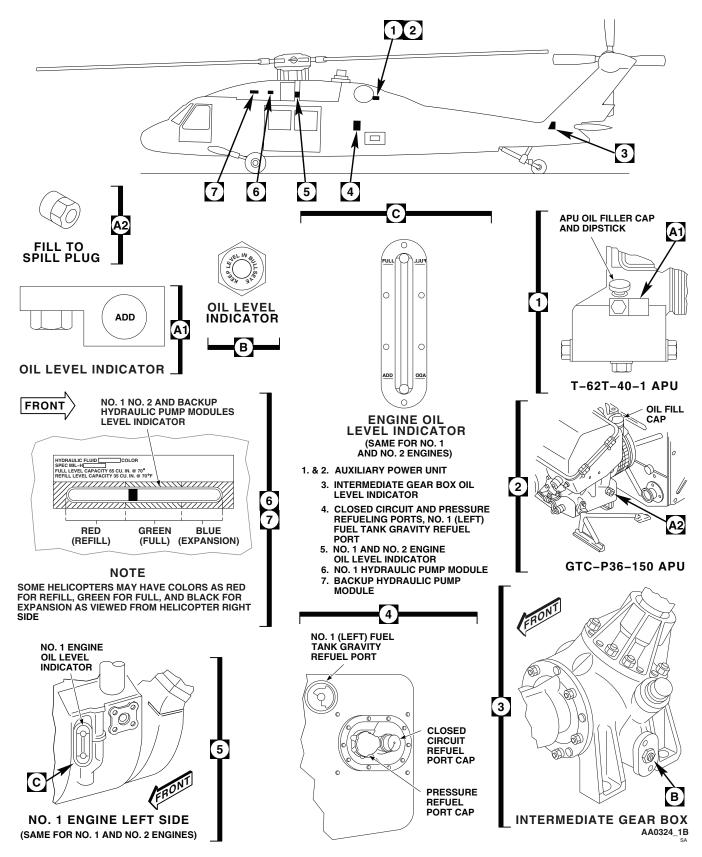


Figure 2-28. Servicing Diagram (Sheet 1 of 3)

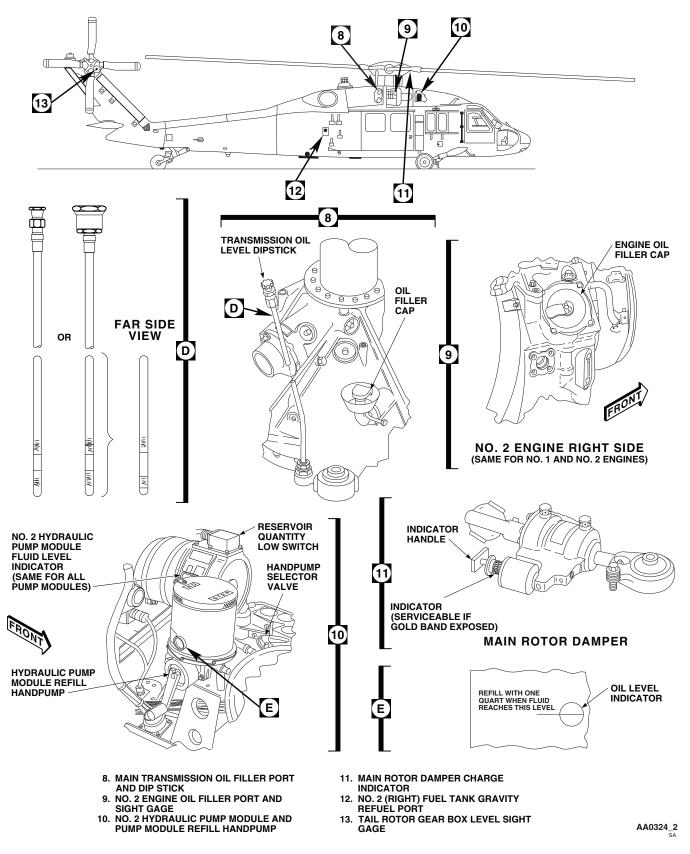


Figure 2-28. Servicing Diagram (Sheet 2 of 3)

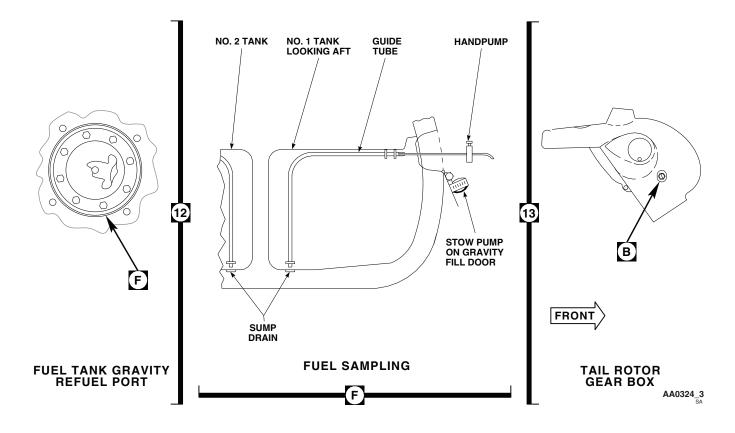


Figure 2-28. Servicing Diagram (Sheet 3 of 3)



If fuel is observed flowing from vent, discontinue refueling and make an entry on DA Form 2408-13-1.

5. Once fuel has reached the desired level, remove the fuel dispenser nozzle from the refueling adapter and cap pressure fueling adapter.

2.87.5 CEFS External Tanks Pressure Refueling.

NOTE

- This procedure applies to CEFS tanks only. For AFMS-modified tanks, refer to paragraph 2.87.3.
- If the helicopter is to be refueled without engines operating, external electrical power

can be applied to the helicopter to activate the AFMP **XFR MODE** and **PRESS** switches. Alternately, the procedure can be done using the APU.

• Prior to engine shutdown, set pressure switch to **INBD**, **OUTBD** or **ALL** based on external tank configuration.

To begin pressure refueling with helicopter electrical power applied, the **XFR MODE** switch must be in the **OFF** position and the **PRESS** switch on the AFMP must be in the **INBD**, **OUTBD** or **ALL** position depending on the number and location of the external CEFS tanks. By selecting the **INBD**, **OUTBD** or **ALL** position, the refueling valve in the pump package and the associated wing gate shutoff valves located in each ESSS wing HSS pylon open. With these valves open, fuel from the helicopter pressure fuel servicing manifold enters the pump package manifold, then into the fuel hoses that connect the pump package to the tanks.

1. Ground helicopter to fuel truck or other suitable ground.

2. Ground fuel dispenser nozzle to the helicopter grounding point marked **GROUND HERE** above refueling ports.



Damage to the fuel system could result if refueling hose pressure exceeds 55 psi during pressure refueling or 15 psi during closed circuit refueling.

3. Connect fuel dispenser nozzle to pressure refueling adapter.

NOTE

The system is designed to restrict fuel flow to 300 gpm during pressure refueling at a nozzle pressure of 55 psi and 110 gpm at a nozzle pressure of 15 psi during closed circuit refueling.

4. Start fuel flow from fuel dispenser and refuel helicopter.



If fuel is observed flowing from vent, discontinue refueling and make an entry on DA Form 2408-13-1.

5. Once fuel has reached desired level, remove fuel dispenser nozzle from the refueling adapter and cap pressure refueling adapter.

2.87.6 CEFS External Tanks Manual Refueling.

1. Ground refueling hose to grounding point jack located on the nose of the CEFS tank.

- 2. Open refueling port cap located on the CEFS tank forward end.
- 3. Insert refueling hose nozzle into tank port and begin fueling.
- 4. Once desired amount of fuel is reached as indicated by the quantity gauge on the refueling dispenser, stop refueling and remove nozzle from tank port.
- 5. Install tank refueling port cap.
- 6. Disconnect refueling hose grounding plug from tank grounding point.



LH and RH tank pairs should be serviced with equal amounts of fuel to prevent an imbalanced helicopter condition.

7. Repeat steps 1. through 6. for remaining tanks to be refueled.

2.87.7 Fuel Sampling System. Fuel sampling is done with a thumb-operated handpump containing 5 feet of plastic tubing. The tubing is placed in a guide tube inside the fuel tank and is directed to the bottom of the tank. The handpump is stroked and fuel is drawn from the tank, with contaminants at the bottom. When sampling is completed, the tubing is emptied, rolled, and stowed with the pump on the gravity refueling door.Fuel sampling of the external extended range fuel system is done by taking the sample with a fuel sampler tube from the sump drain located at the bottom aft of each tank.

2.88 EXTERNAL AIR SOURCE/ELECTRICAL REQUIREMENTS.

Refer to Chapter 5 for limitations.

2.89 ENGINE OIL SYSTEM SERVICING.

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 higher oil level than actual, and the upslope engine will read lower.
- To avoid damage to packings and seals in the engine oil system, MIL-PRF-23699 HTS (High Thermal Stability) oil shall not be used in the engine oil tank.

NOTE

Do not service the engines with DOD-PRF-85734 oil. If DOD-PRF-85734 oil is inadvertently added to the engines, drain the oil and add MIL-PRF-7808 or MIL-PRF-23699 oil. Flushing the system before refilling is not required.

The engine oil tank is within the main frame. When the oil level reaches the **ADD** mark, oil should be added to bring the level to the full mark on the sight gage. Wait at least 20 minutes after engine shutdown before checking engine oil level. Before adding oil, determine whether system contains MIL-PRF-7808 oil or MIL-PRF-23699 oil. If flights of over 6 hours are made, engine oil level must be at the full line of sight glass before flight.

Table 2-4. Fuel and Lubricants, Specifications, and Capacities

SYSTEM	SPECIFICATION	CAPACITY
Fuel	Primary: Grade JP-8 (NATO Code F-34) (Notes 1 and 5) Alternate: Grade JP-5 (NATO Code F-44) (Notes 1 and 5) JP-4 (NATO Code F-40) (Note 5)	Main Tanks usable U.S. Gallons of fuel are: 360 gravity, 359 pressure, and 356 closed circuit. External Tank Gravity Refueling: 230 U.S. Gallons each tank.
	Lubricating oils MIL-PRF-23699, DOD- PRF-85734, and MIL-PRF-7808 contain materials hazardous to health. They produce paralysis if swallowed. Prolonged contact may irritate the skin. Wash hands thoroughly after handling. Oils may burn if exposed to heat or flames. Use only with proper ventilation.	
Engine oil	MIL-PRF-23699 (NATO Code 0-156) MIL-PRF-7808 (NATO Code 0-148) (Notes 2, 3, 7, 8 and 9)	7 U.S. Quarts
APU	MIL-PRF-23699 (NATO Code 0-156) MIL-PRF-7808 (NATO Code 0-148) (Notes 2, 3, and 7)	3 U.S. Quarts (T-62T-40-1) 2 U.S. Quarts (GTC-P36-150)
Transmission oil	MIL-PRF-23699 (NATO Code 0-156) MIL-PRF-7808 (NATO Code 0-148) DOD-PRF-85734 (Notes 2, 3, 6, and 8)	7 U.S. Gallons

SYSTEM	SPECIFICATION	CAPACITY
Intermediate gear box oil	MIL-PRF-23699 (NATO Code 0-156) MIL-PRF-7808 (NATO Code 0-148) DOD-PRF-85734 (Notes 2, 3, 6, and 8)	2.75 U.S. Pints
Tail gear box oil	MIL-PRF-23699 (NATO Code 0-156) MIL-PRF-7808 (NATO Code 0-148) DOD-PRF-85734 (Notes 2, 3, 6, and 8)	2.75 U.S. Pints
First stage hydraulic reservoir	MIL-H-83282 MIL-H-5606 (NATO Code H-515) (Note 4)	1 U.S. Quart
Second stage hydraulic reservoir	MIL-H-83282 MIL-H-5606 (NATO Code H-515) (Note 4)	1 U.S. Quart
Backup hydraulic reservoir	MIL-H-83282 MIL-H-5606 (NATO Code H-515) (Note 4)	1 U.S. Quart
Rescue Hoist	Refer to TM 1-1680-320-13&P for servic- ing.	11.5 U.S. Fluid Ounces

Table 2-4. Fuel and Lubricants, Specifications, and Capacities (Cont)

COMMERCIAL	OILS FOR MA	AIN TRANSMISSION
AND GEAR BOXES		

SOURCE

PRIMARY OIL

ALTERNATE OIL

NOTE

Commercial oils listed	below are approved alternates for
main transmission and	gear boxes except as indicated.

main transmission and gear boxes except as indicated.				
U.S. Military Oil NATO Code No.	DOD-PRF-85734 (Note 7)	MIL-PRF-23699 (Note 8) 0-156	MIL-PRF-7808 (Note 8) 0-148	
COMMERCIAL OIL		TYPE II	TYPE I	
Castrol Inc.		Castrol 5050 Castrol 5000 Aerojet 5	Castrol 399	
Exxon Co.	Turbo Oil 25	Turbo Oil 2380	Turbo Oil 2389 Turbo Oil 2391	
Hatco Corp.		HATCO 3211 HATCO 3611 HATCO 1639 HATCO 1680	HATCO 1278 HATCO 1280	
Mobil Corp.		Mobil Jet Oil II		

COMMERCIAL OILS FOR MAIN TRANSMISSION AND GEAR BOXES				
SOURCE	PRIMARY OIL	ALTERNATE OIL		
Royal Lubricants	Royco 555	Royco 500 Royco 560 Royco 899 Royco 899HC	Royco 808	
Shell Oil Company	Aeroshell 555	Aeroshell 500 Aeroshell 560	Aeroshell 308	
	COMMERCIAL O	ILS FOR ENGINES		
SOURCE	PRIMARY OIL	ALTERNATE OIL		
	N	ОТЕ		
	Commercial oils listed below engines except as indicated.	are approved alternates f	for	
U.S. Military Oil NATO Code No.	MIL-PRF-23699 (Note 9) 0-156	MIL-PRF-7808 (Note 0-148	9)	
COMMERCIAL OIL	TYPE II	TYPE I		
Castrol Inc.	Castrol 5050 Castrol 5000	Castrol 399		
Hatco Corp.	HATCO 3211 HATCO 3611	HATCO 1278 HATCO 1280		
Mobil Corp.	Mobil Jet Oil II			
Shell Oil Company	Aeroshell 500	Aeroshell 308		
Notes:				
1.	When starting in ambient tempera JP-5 or JP-8.	atures below -34°C (-29°F	F), do not use	
2.	When starting in ambient tempera ing oil MIL-PRF-7808 must be u 23699 or DOD-PRF-85734 oil wi	sed. It is not advisable to		
3.	If the type oil being used is not a be added. When one type oil is m drain the system and refill with ou temperature operation. For transn oil is mixed with another, it is no with one type oil.	ixed with another, it is not ne type oil. No mixing is hissions and gear boxes, w	ot necessary to allowed for cold when one type of	
4.	For operation below -34°C (-29°F shall be used. Mixing MIL-H-560 resistant qualities of MIL-H-8328	6 with MIL-H-83282 deg		

Table 2-4. Fuel and Lubricants, Specifications, and Capacities (Cont)

Notes:		
	5.	Fuel settling time for jet (JP) fuel is 1 hour per foot depth of fuel. Allow the fuel to settle for the prescribed period before any samples are taken (about 4 hours for proper settling).
	6.	DOD-PRF-85734 oil is the preferred oil for use in the main transmission, intermediate gear box, and tail gear box, except for cold temperature operation.
	7.	DOD-PRF-85734 oil shall not be used in the engines or the APU. If DOD-PRF-85734 oil is inadvertently added to the engines or APU, the system shall be drained and the correct oil added. There is no need to flush the system.
	8.	When changing from MIL-PRF-7808 or MIL-PRF-23699 oil to DOD- PRF-85734 (and vice versa), drain the oil from the system and refill with desired oil. There is no need to flush the system before refilling.
	9.	To avoid damage to packings and seals in the engine oil system, MIL- PRF-23699 HTS (High Thermal Stability) oil shall not be used in the engine oil tank.

Table 2-4. Fuel and Lubricants, Specifications, and Capacities (Cont)

SOURCE	PRIMARY/STANDARD FUEL	ALTERNATE FUELS	
U.S. Military Fuel	JP-8	JP-5	JP-4
NATO Code No.	F-34	F-44	F-40
Commercial Fuel (ASTM-D-1655)	JET A-1	JET A	JET B

Table 2-5. Approved Fuels

NOTE

Commercial fuels are commonly made to conform to American Society for Testing and Materials (ASTM) Specification D 1655. The ASTM fuel specification does not contain anti-icing additives unless specified. Icing inhibitor conforming to MIL-I-85470 or MIL-I-27686 (Commercial name PRIST) shall be added to commercial and NATO fuels, not containing an icing inhibitor, during refueling operations, regardless of ambient temperatures. Icing inhibitor conforming to MIL-I-85470 is replacing the MIL-I-27686 version. The use of MIL-I-27686 icing inhibitor is acceptable until all supplies are depleted. Adding PRIST during refueling operation shall be done using accepted commercial mixing procedures. The additive provides anti-icing protection and also functions as a biocide to kill microbial growths in helicopter fuel systems.

American Oil Co.		American Type A	American JP-4
Atlantic Richfield	Arcojet A-1	Arcojet A	Arcojet B
Richfield Div.	Richfield A-1	Richfield A	
B.P. Trading	B.P.A.T.K.		B.P.A.T.G.
Caltex Petroleum Corp.	Caltex Jet A-1		Caltex Jet B
City Service Co.		CITCO A	
Continental Oil Co.	Conoco Jet-60	Conoco Jet-50	Conoco JP-4
Exxon Co. U.S.A.	Exxon A-1	Exxon A	Exxon Turbo Fuel B
Gulf Oil	Gulf Jet A-1	Gulf Jet A	Gulf Jet B
Mobil Oil	Mobil Jet A-1	Mobil Jet A	Mobil Jet B
Phillips Petroleum		Philjet A-50	Philjet JP-4
Shell Oil	Aeroshell 650	Aeroshell 640	Aeroshell JP-4
Sinclair	Superjet A-1	Superjet A	
Standard Oil Co.	Jet A-1 Kerosene	Jet A Kerosene	
Chevron	Chevron A-1	Chevron A-50	Chevron B
Texaco	Avjet A-1	Avjet A	Texaco Avjet B

COLIDOR

SOURCE	PRIMARY/STANDARD FUEL	ALTERNATE FUELS	
Union Oil		76 Turbine Fuel	Union JP-4
International Fuel	NATO F-34	NATO F-44	NATO F-40
Belgium			BA-PF-2B
Canada		3-6P-24C	3GP-22F
Denmark			JP-4 MIL-T-5624
France			Air 3407A
Germany		UTL-9130-007 UTL-9130-010	VTL-9130-006
Greece			JP-4 MIL-T-5624
Italy		AMC-143	AA-M-C-1421
Netherlands		D. Eng RD 2493	JP-4 MIL-T-5624
Norway			JP-4 MIL-T-5624
Portugal			JP-4 MIL-T-5624
Turkey			JP-4 MIL-T-5624
United Kingdom (Britain)		D. Eng RD 2498	D. Eng RD 2454

Table 2-5. Approved Fuels (Cont)

2.90 APU OIL SYSTEM SERVICING.

NOTE

Do not service the APU with DOD-PRF-85734 oil. If DOD-PRF-85734 oil is inadvertently added to the APU, drain the oil and add MIL-PRF-7808 or MIL-PRF-23699 oil. Flushing the system before refilling is not required.

a. The APU oil supply is in the APU gear box assembly. The sump filler/oil dipstick port (T-62T-40-1) or cap and fill to spill plug (GTC-P36-150) are on the left side of the gear box housing.

b. When the APU is cool to the touch, the **COLD** side of the dipstick may be used. If the APU is hot to the touch, the **HOT** side of the dipstick may be used.

2.91 HANDPUMP RESERVOIR SERVICING.

{ CAUTION }
Lunn

Do not allow reservoir level to fall below refill line.

Servicing of the refill handpump is done when fluid level decreases to the refill line on the fluid level sight gage, on the side of the pump tank. When fluid level decreases to the refill line, 1 quart of hydraulic fluid can be poured into the reservoir after removing the refill cap. Handpump reservoir level should be replenished only in 1 quart units.

2.92 HYDRAULIC SYSTEMS SERVICING.

Reservoirs for the hydraulic systems are on the hydraulic pump modules. Fluid level sight gages are visible on the side of each pump. All hydraulic pump reservoir capacities are 1 U.S. quart to the blue (black on some pumps) mark. When the indicator reaches the red area (refill) point, $\frac{2}{3}$ of a pint is required to return the indicator to the green mark. The fluid level indication is the $\frac{1}{8}$ inch wide gold band at the outboard edge of the level piston. To refill the reservoirs, the fluid is supplied from the manual handpump. After flight, fluid in hydraulic systems will be hot. Piston movement of up to $\frac{3}{8}$ inch into the blue (black on some pumps) (overfill) zone is acceptable. When piston is beyond this limit, bleed off enough fluid to bring piston back to $\frac{3}{8}$ inch above fill limit. To replenish the pump reservoir fluid, do the following:

- 1. Unscrew handpump lid and pour in clean hydraulic fluid, MIL-H-83282, until pump is full. Make sure you can always see oil in pump reservoir window while servicing, so not to pump air into pump module's reservoir.
- 2. Make sure pump cover is clean, then screw lid on tight.
- 3. Turn selector valve to desired reservoir to be filled. **OUT 1** is left pump module, **OUT 2** is right pump module, and **OUT 3** is backup pump module.
- 4. While holding selector valve handle down, crank pump handle on handpump clockwise and fill desired hydraulic pump module until forward end of piston in reservoir window is at forward end of green decal on reservoir housing.
- 5. Check that reservoirs stay full (forward end of piston at forward end of green decal), with fluid at ambient temperature 1 hour after flight.
- 6. Make sure area remains clean during procedure.
- 7. Stow selector valve handle in **OUT 4** (capped off) position.
- 8. Turn on electrical power.
- Check #1 RSVR LOW, #2 RSVR LOW and BACK-UP RSVR LOW cautions do not appear.

2.93 RESCUE HOIST LUBRICATION SYSTEM SERVICING.

Servicing of the rescue hoist lubrication system consists of replacing automatic transmission fluid in the boom head and the gear box (Figure 4-25) until oil level sight gages indicate full.

2.94 MAIN TRANSMISSION OIL SYSTEM SERVICING.

The transmission oil supply is in the sump case with the filler port and dipstick gage on the right rear of the main module. When filling is required, oil is poured through the filler tube on the main module case, and oil level is checked by a dipstick marked **FULL** and **ADD**, or **FULL**

COLD and **ADD** on one side of the dipstick and **FULL HOT** and **ADD** on the other side. Check oil level as follows:

NOTE

Remove the dipstick; clean and reinsert to obtain correct reading.

a. Single scale dipstick is for checking cold oil levels. Wait at least 2 hours after shutdown to check oil. If oil level must be checked when hot (immediately to $\frac{1}{2}$ hour after shutdown), oil level will read about $\frac{1}{2}$ inch low (halfway between full and add mark or $\frac{1}{2}$ inch below add mark).

b. Dual scale dipstick is for checking cold or hot oil levels. Use appropriate scale when checking oil level. Read hot side of dipstick when checking hot oil (immediately to $\frac{1}{2}$ hour after shutdown), or cold side of dipstick when checking cold oil (at least 2 hours after shutdown).

2.95 TAIL AND INTERMEDIATE GEAR BOX SERVICING.

The intermediate gear box oil level sight gage is on the left side of the gear box. The tail gear box oil level sight gage is on the right side.

2.96 PARKING.

The methods used to secure the helicopter for temporary periods of time will vary with the local commands. The minimum requirements for parking are: gust lock engaged and wheel brakes set, tailwheel locked, and wheels properly chocked. For extended periods of time, engine inlet covers, exhaust covers, and pitot covers should be installed, and stabilator slewed to 0° . When required, the ignition system and the doors and window should be locked.

2.97 PROTECTIVE COVERS AND PLUGS.

The covers and plugs protect vital areas from grit, snow, and water. The protected areas are avionics compartment air inlet, engine air inlet/accessory bay, engine and APU exhausts, pitot tubes, IRCM transmitter and APU air inlet and main transmission oil cooler exhaust. Covers and plugs should be installed whenever the helicopter is to be on the ground for an extended period of time. Each cover may be installed independently of the others.

2.98 MOORING.

Mooring fittings (Figure 2-29) are installed at four points on the helicopter. Two fittings are at the front of the fuselage, one above each main landing gear strut, and two at the rear, one attached to each side of the aft transition section. These fittings are used to tie down the helicopter when parked, and wind conditions require it.

2.98.1 Mooring Instructions. Refer to TM 1-1500-250-23 for mooring instructions.

2.98.2 Main Rotor Tiedown. Tiedown of the main rotor should be done when the helicopter will be parked for a period of time or when actual or projected wind conditions are 45 knots and above. To tie down main rotor blades:

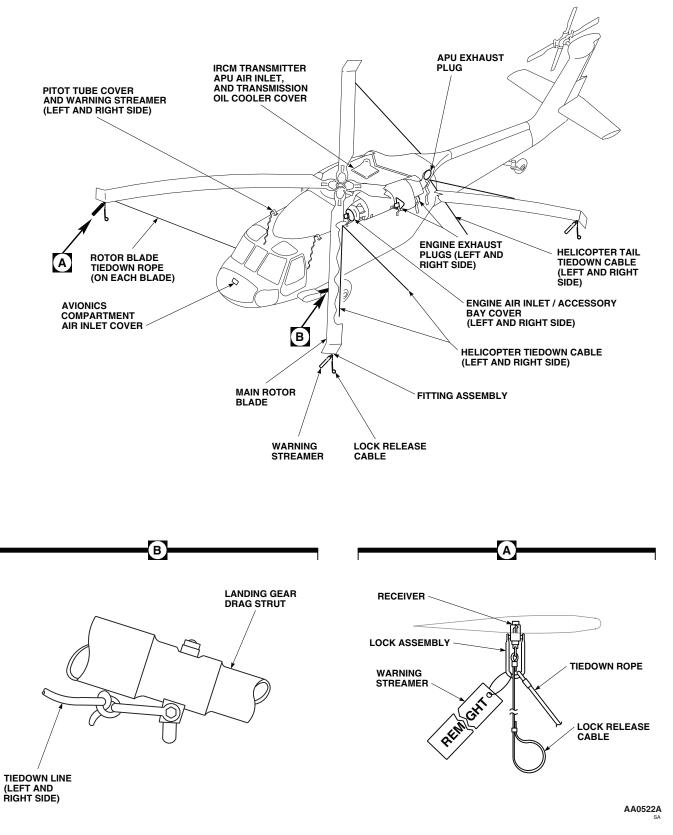
1. Turn rotor head and position a blade over centerline of helicopter. Install tiedown fitting into receiver while pulling down on lock release cable. Release cable when fitting is installed in blade receiver.

- 2. Uncoil tiedown rope.
- 3. Repeat steps 1. and 2. for each remaining blade.
- 4. Turn blade to about 45° angle to centerline of helicopter and engage gust lock.



Do not deflect main rotor blade tips more than 6 inches below normal droop position when attaching tiedowns. Do not tie down below normal droop position.

5. Attach tiedown ropes to helicopter as shown in Figure 2-29. To release tiedown fitting, pull down on lock release cable and remove fitting from blade.





CHAPTER 3 AVIONICS

Section I GENERAL

3.1 DESCRIPTION.

The avionics subsystem consists of the communications equipment providing VHF-AM, VHF-FM, and UHF-AM communications. The navigation equipment includes LF-ADF, VOR, ILS, marker beacon, DD Doppler, DD Doppler/GPS, and D Integrated Inertial Navigation System VHF-FM homing is provided through the No. 1 VHF-FM communication radio. Transponder equipment consists of a receiver-transmitter with inputs from barometric altimeter for altitude fixing. Absolute height is provided by a radar altimeter. Each antenna will be described with its major end item and locations as shown in Figure 3-1.

Primary power to operate the avionics systems is provided from the No. 1 and No. 2 dc primary buses, the dc essential bus and No. 1 and No. 2 ac primary buses. The No. 1 VHF-FM and UHF radios as well as the associated KY-58 voice security systems may be operated on helicopter battery power. When operating all other avionics equipment, helicopter generator output must be available or external ac power connected. Function selector switches should be at **OFF** before applying helicopter power.

3.3 AVIONICS POWER SUPPLY.

3.2 AVIONICS EQUIPMENT CONFIGURATION.

Equipment configuration is as shown in Table 3-1.

FACILITY	NOMENCLATURE	USE	RANGE	CONTROL LOCATION
Intercommunication	Interphone control C-6533A/ARC	Intercommunication between crewmembers and control of navigation and communication radio.	Stations within helicopter	Lower console, crewchief/ gunner's sta- tions and troop com- mander's sta- tion at center of cabin overhead with handset

FACILITY	NOMENCLATURE	USE	RANGE	CONTROL LOCATION
VHF AM and FM communications (If installed)	Radio Set AN/ARC-186(V) VHF-AM/FM	Two-way voice communications in the frequency range 30.0 through 87.975 MHz and 116.0 through 151.975 MHz range. 108.0 through 115.975 MHz receive only. VHF-FM No. 2 Provisional.	*Line of sight	Un Lower console, En ECM operator's sta- tion
FM communications	Radio Set AN/ARC- 201 VHF-FM	Two-way voice communica- tions, homing, frequency hop- ping in 30.0 - 87.975 MHz range. VHF-FM No. 1/2 and MEP VHF-FM.	*Line of sight	Lower console
Improved Frequency Modulation Amplifier	IFM Amplifier AM- 7189A/ARC	Variable RF power amplifier; increases output from FM 1 (2.5, 10 or 40 watts out.) ET Amplifier control C-11188A used only when ARC-186 is installed.		FM 1 ARC- 201 control box
UHF communications	Radio-Transmitter Radio, RT-1518C/ ARC-164(V) UHF-AM	Two-way voice communications in the frequency range of 225.000 to 399.975 MHz with HaveQuick I and II ECCM.	*Line of sight	UH Lower console, EH DF operator's station
EH Tunable diplexer	TD-1336/A	Allows narrow band use of guard channel.		Beneath seat of copilot
High frequency communications	Radio Set AN/ARC-220	Two way voice communications in the frequency range of 2 to 29.9999 MHz.	*Over the horizon	UH Lower console
Voice security	TSEC/KY-58	Secure communications. Can be used with FM1, FM2 and UHF-AM.	Not applicable	Lower console
Voice security	TSEC/KY-100	Secure communications. Used with HF AN/ARC-220.	Not applicable	Lower console
Navigation	Direction Finder Set AN/ARN-89 (if in- stalled) AN/ARN- 149(V) (if installed).	Radio range and broadcast reception; automatic direction finding and homing in the fre- quency range of 100 to 3000 kHz. AN/ARN-149(V) tunable, 100 to 2199.5 kHz.	*50 to 100 miles range signals	Lower console

FACILITY	NOMENCLATURE	USE	RANGE	CONTROL LOCATION
Navigation	Radio Receiving Set AN/ARN-123(V) (if installed) AN/ARN- 147(V) (if installed)	VOR/LOC/GS/MB navigational aid, VHF audio reception in the frequency range of 108 to 117.95 MHz and marker beacon receiver operating at 75 MHz. AN/ARN-147(V) tunable, 108 to 126.95 kHz.	*Line of sight	Lower console
Un Navigation	Doppler Navigation Set AN/ASN-128	Provides present position or destination navigation informa- tion in latitude and longitude (degrees and minutes) or Universal Transverse Mercator (UTM) coordinates.		Lower console
■ Navigation	Doppler/GPS Navigation Set AN/ASN-128B	Provides present position or destination navigation informa- tion in latitude and longitude (degrees and minutes) or Military Grid Reference System (MGRS) coordinates. Combined Mode is prime (default) mode of operation where the GPS updates Doppler present posi- tion. When Doppler is in memory (if not available), the system switches to GPS only mode. If GPS is jammed and/or becomes unavailable, the system automatically switches to the Doppler only mode. These modes of operation may also be selected manually. Dop- pler ONLY or GPS ONLY navigation is selectable from CDU.		Lower console

FACILITY	NOMENCLATURE	USE	RANGE	CONTROL LOCATION
■ Navigation	Doppler/GPS Navigation Set AN/ASN-128D	Provides present position or destination navigation informa- tion in latitude and longitude (degrees and minutes) or Military Grid Reference System (MGRS) coordinates. Combined Mode is prime (default) mode of operation where the GPS updates Doppler present posi- tion. Doppler ONLY or GPS ONLY navigation is selectable from CDU. These modes of operation may also be selected manually. This system also provides Position, Velocity, Time (PVT) and steering data to the Pilot and Copilot's Horizon- tal Situation Indicator (VSI), during Instrument Flight Rules (IFR), Visual Flight Rules (VFR) or Instrument Meteorological Conditions (IMC). During en route, terminal flight or non-precision approaches. External connector on the SDC allows for GPS HOT-START from a Precision Lightweight GPS Receiver (PLGR).		Lower console
E Integrated Inertial Navigation System (IINS)	AN/ASN-132(V)	Navigational Aid.		Lower console
Navigation	Gyro Magnetic Compass AN/ASN-43	Slaved gyrocompass.		Lower console
Navigation	Attitude Heading Reference Set AHRS	Provides vehicle pitch, roll, magnetic heading, and turn rate information.		Lower console
Fransponder	Transponder Set AN/APX-100(V)	Transmits a specially coded reply to a ground-based IFF radar Interrogator system.	*Line of sight	Lower console

FACILITY	NOMENCLATURE	USE	RANGE	CONTROL LOCATION
Altimeter	Radar Altimeter AN/APN-209	Measures absolute altitude.	0 to 1500 feet	Instrument panel
		NOTE		
	•	on or reception depends upon main me of day, operating frequency, j licopter.	•	

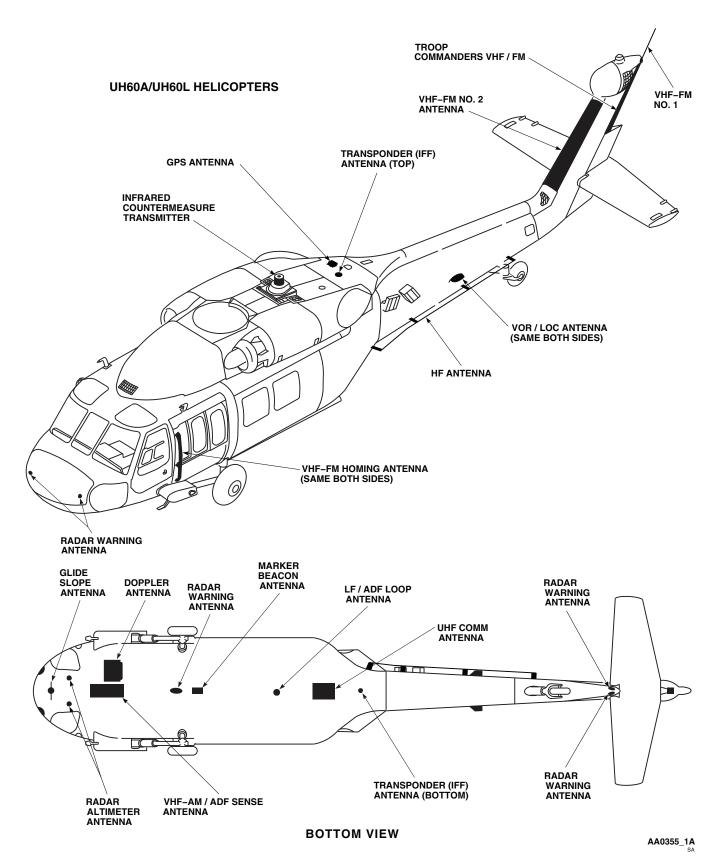


Figure 3-1. Antenna Arrangement (Sheet 1 of 2)

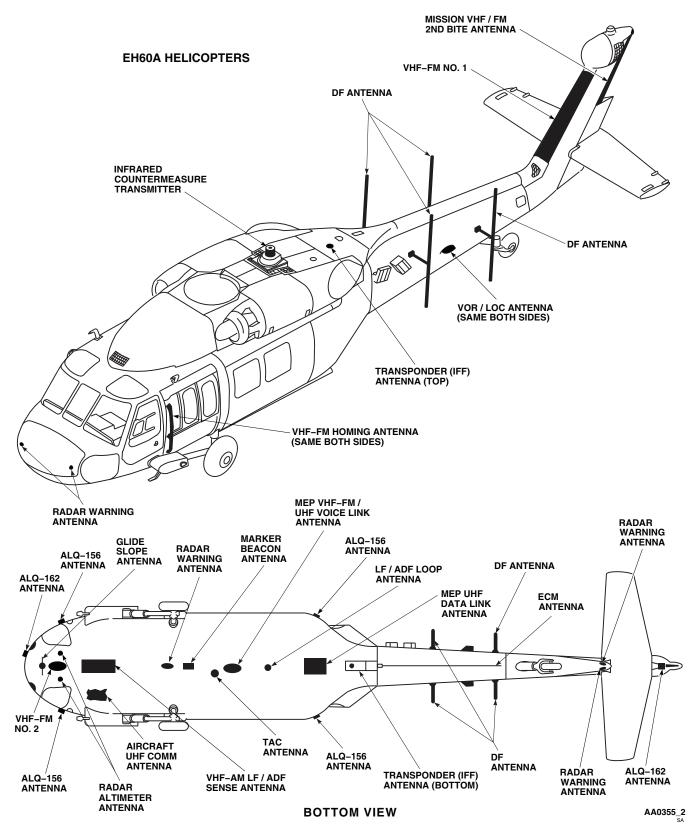


Figure 3-1. Antenna Arrangement (Sheet 2 of 2)

3.4 INTERCOMMUNICATION SYSTEM C-6533A /ARC.

Five intercommunication system (ICS) controls provide interior intercommunication capability between crewmembers and with the troop commander's position. They also provide a means by which the pilot and copilot may select and control associated radio equipment for voice transmission and reception. Additional audio circuits may also be selected for constant monitoring. When the communication control is operated in conjunction with equipment listed in Table 3-1, it is used to select associated radio equipment for voice operations. The operator may select any one of five transmitters and/or any or all of five receivers to monitor. Four direct-wired audio circuits allow continuous monitoring. Hands-free intercommunication is provided by a hot mike feature. An exterior jack is to the front and below each gunner's window. When the walkaround cord is connected to it, the crew chief can communicate with the interior of the helicopter or with the other exterior jack through the crew chief/gunner's control panels. A placard installed on the instrument panel and above each troopcargo compartment ICS station control panel indicates which receiver is selected when a selector switch is placed **ON**. Power for the intercommunication system is provided from the dc essential bus through circuit breakers marked ICS PILOT and ICS COPILOT.

3.4.1 Controls and Functions. Controls for the intercom/radios are on the front panel of the unit (Figure 3-2). The function of each control is as follows:

CONTROL/ INDICATOR Receiver selector switches (ON)	FUNCTION
1	Connects FM 1 receiver to the headphone.
2	Connects UHF receiver to the headphone.
3	Connects VHF receiver to the headphone.
4	Connects FM 2 receiver to the headphone.
5	Connects HF receiver to the headphone.
AUX	Connects VOR/LOC audio to the headphone.
NAV	Connects ADF/Marker Beacon audio to the headphone.

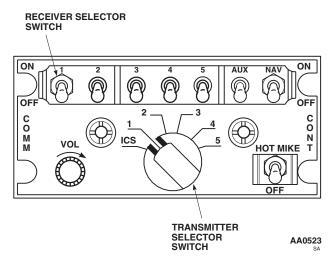


Figure 3-2. Intercommunication Control Panel C-6533A/ARC

CONTROL/ INDICATOR

FUNCTION

VOL control Transmitter selector switch

Adjusts headphone volume level.

ICS	Enables intercom operation when
	keyed.
1	Enables FM 1 transmission when
	keyed.
2	Enables UHF transmission when
	keyed.
3	Enables VHF transmission when
	keyed.
4	Enables FM 2 transmission when
	keyed (provisions).
5	Enables HF transmission when
	keyed.
HOT MIKE	Enables intercom transmission
switch	without manual key.

3.4.1.1 Intercommunication Keying Controls.

Keying of the ICS system is done by these controls:

a. Pilot or copilot station. An **ICS** or **RADIO** switch on the top of each cyclic stick or by a switch on the floor at the pilot's left and the copilot's right foot.

b. Crew chief/Gunner and Left Gunner. A pushbutton at the end of the ICS cord or the exterior walkaround cord,

and foot switches on each side of the helicopter at the crew chief/gunner's and left gunner's station.

c. Troop commander. A push switch on the handset at the troop commander's station.

3.4.2 Normal Operation.

3.4.2.1 Primary Operation Check. There are several methods of intercommunication operation. In all cases, no operator action is required to receive intercom signals other than adjusting the **VOL** control for a comfortable level at the headset.

3.4.2.2 Intercommunication (All Stations).

- 1. Transmitter selector switch **ICS** for pilot and copilot when using foot switch; any position when using cyclic switch; **ICS** for crew chief/ gunner, gunner, and troop commander.
- 2. Key switch **ICS** switch on pilot's or copilot's cyclic or foot switch at pilot's, copilot's or crew chief/gunner, gunner positions, or push-to-talk button on crew chief/gunner's ICS cord, push-to-talk switch on troop commander handset Press speak into microphone and listen for sidetone, release to listen.

3.4.2.3 External Radio Communication. All stations of the helicopter are capable of external radio communications.

3.4.2.3.1 Pilot and Copilot.

- 1. Transmitter selector Desired position: 1 through 5.
- 2. **RADIO** push-to-talk switch on cyclic stick or foot-operated push-to-talk switch Press speak into microphone while holding switch; release to listen.

3.4.2.3.2 Crew Chief/Gunner.

- 1. Transmitter selector Desired position: 1 through 5.
- 2. Push-to-talk switch on headset-microphone cord or foot-operated push-to-talk switch -

Press - speak into microphone while holding switch release to listen.

3.4.2.3.3 Troop Commander.

- 1. Transmitter selector Desired position: 1 through 5.
- 2. Transmitter key switch on handset Press speak into microphone while holding switch; release to listen.

3.4.2.4 Receiver Selection.

- 1. Receiver selector switch(es) ON as desired.
- 2. Adjust volume to a comfortable listening level.

3.5 RADIO SET AN/ARC-186(V).

Radio Set AN/ARC-186(V) (Figure 3-3) is a lightweight multichannel airborne radio communications set, which provides transmission, reception, and retransmission of amplitude modulated (AM), frequency modulated (FM) radio communications, and FM directional finding (homing) with installation of other associated equipment. AM reception only is provided on frequencies between 108.000 and 115.975 MHz. The transceiver has a tunable main receiver and transmitter which operates on any one of 1,469 AM discrete channels, each spaced 25 kHz apart within the frequency range of 116.000 through 151.975 MHz, or 30.000 through 87.975 MHz FM, providing 2,319 channels. FM homing operations within the 30 through 87.975 MHz band. The fixed guard channels are between 116.000 and 151.975 MHz AM (usually 121.500 MHz) and between 30.000 and 87.975 MHz FM (usually 40.500 MHz). The guard frequencies are preset and only require selection by the frequency/emergency select switch. Frequencies can be preset for 20 channels. VHF-AM installations cannot be used to transmit VHF-FM signals. If an AM frequency is selected on an FM only installation, an audible tone would be heard, warning the pilot of an out-of-band frequency selection. The same is true in the case of selection of an FM frequency on an AM installation. Keying the microphone for voice transmission when in FM homing mode will disable the homing function while the mic is keyed. In FM homing mode, audio reception is distorted. When using secured speech and EMER FM or AM is selected, secure speech function will be disabled to enable normal voice communications. Power to operate the AN/ARC-186(V) radio is provided from the No. 2 dc primary bus through a circuit breaker marked **VHF-AM** for the AM radio, and from the No. 1 and No. 2 dc primary buses, respectively, through circuit breakers marked **NO. 1 VHF-FM** and **NO. 2 VHF-FM** for the No. 1 and No. 2 VHF-FM radios.

3.5.1 Antennas.

a. The VHF-AM antenna is under the nose section. The antenna operation is shared with ADF SENSE. The No. 2 VHF-FM communications antenna is within the leading edge fairing of the tail pylon drive shaft cover. The two FM homing antennas used with the No. 1 VHF-FM radio are on each side of the helicopter fuselage, just behind the cockpit doors.

b. The VHF-AM antenna is under the nose section. The antenna operation is shared with ADF sense. No. 1 VHF-FM communications antenna is within the leading edge fairing of the tail pylon drive shaft cover. No. 2 VHF-FM communications antenna is under the nose, forward of VHF-AM antenna. The two FM homing antennas used with the No. 1 VHF-FM radio are on each side of the helicopter fuselage, just behind the cockpit doors.

3.5.2 Controls and Functions. Controls for the AN/ ARC-186(V) are on the control panels for the radio and the IFM amplifer control panel.

3.5.2.1 AN/ARC-186 Control Panel. The function of each control on the AN/ARC-186 control panel is as follows:

CONTROL FUNCTION

0.025 MHz selector	Rotary switch. Selects rt frequency in 0.025 MHz steps. Clockwise ro- tation increases frequency.
0.1 MHz selector	Rotary switch. Selects rt frequency in 0.1 MHz steps. Clockwise rota- tion increases frequency.

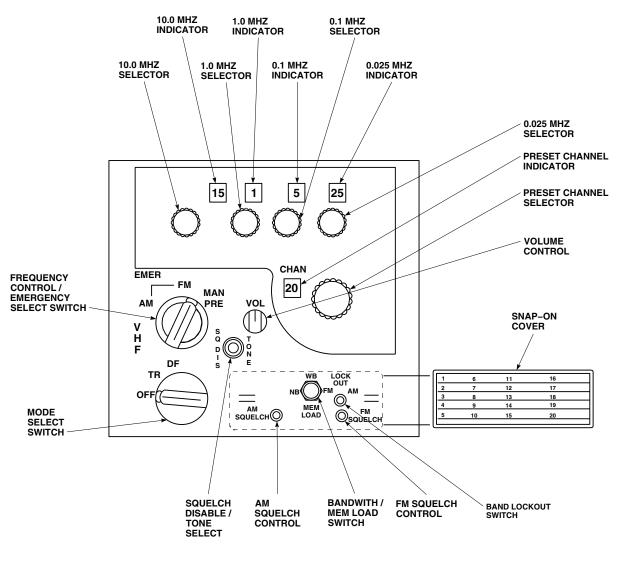
CONTROL	FUNCTION
1.0 MHz selector	Rotary switch. Selects rt frequency in 1.0 MHz steps. Clockwise rota- tion increases frequency.
10 MHz selector	Rotary switch. Selects rt frequency in 10 MHz steps from 30 to 150 MHz. Clockwise rotation increases frequency.
PRESET channel selector	Selects preset channel from 1 to 20. Clockwise rotation increases channel number selected.
VOL control	Potentiometer. Clockwise rotation increases volume.
SQDIS/TONE select	Three-position switch. Center posi- tion enables squelch, SQDIS posi- tion disables squelch, momentary TONE position transmits tone of approximately 1000 Hz.
Frequency control/ Emergency select switch	Four-position rotary switch. PRE position enables preset channel selection, MAN position enables manual frequency selection, EM- ER AM or FM selects a prestored guard channel (FM not used in helicopters with panel-mounted transceiver).
	NOTE
	Selecting EMER AM or FM automatically disables the secure

automatically disables the secure speech function and enables normal voice communication.

Mode selector

switch

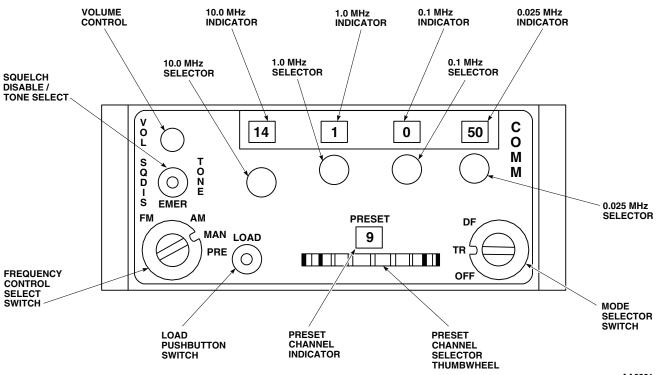
Three-position rotary switch. **OFF** position disables receiver/ transmitter, **TR** position enables transmit/ receive modes. **DF** position enables FM homing.



(PANEL-MOUNTED TRANSCEIVER)

AA0361_1

Figure 3-3. VHF Control AN/ARC-186(V) (Sheet 1 of 2)



AA0361_2A

Figure 3-3. VHF Control AN/ARC-186(V) (Sheet 2 of 2)

CONTROL

FUNCTION

Three-position switch NB (NAR-

enables wideband selectivity in the

LOAD position allows manually

selected preset channel memory.

ROW) position enables narrow-

band selectivity WB (WIDE)

FM band, momentary MEM

selected frequency to go into

CONTROL

FM SQUELCH control (On helicopters with panel-mounted transceiver). (Use of control is a maintenance function).

Band LOCKOUT switch (On helicopters with panel-mounted transceiver). (Use of control is a maintenance function).

Screwdriver adjustable potentiometer. Squelch overridden at maximum counterclockwise position, clockwise rotation increases input signal required to open the squelch.

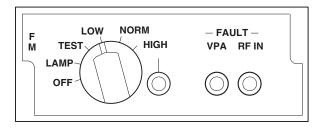
FUNCTION

Screwdriver settable three-position switch. Center position enables both AM and FM bands, **AM** position locks out AM band, **FM** position locks out FM band. (Band lockout is indicated by a warning tone.)

Bandwidth/ **MEM LOAD** (On helicopters with panelmounted transceiver).On helicopters with half-size remote control panel, the memory switch is labeled **LOAD**. Bandwidth switch is inaccessible.

AM SQUELCH control (On

helicopters with panel-mounted transceiver)(Use of control is a maintenance function). Screwdriver adjustable potentiometer. Squelch overridden at maximum counterclockwise position, clockwise rotation increases input signal required to open the squelch.



AA9242

Figure 3-4. IFM Amplifier Control

3.5.2.2 IFM Amplifier Control.

NOTE

IFM amplifier control installed in EH-60A helicopters with ARC-186 as VHF-FM No. 1 (Figure 3-4).

The function of each control on the IFM amplifier control panel is as follows:

CONTROL	FUNCTION
OFF	(Bypass amplifier) - 10 watts.
LAMP	Tests indicator lights.
TEST	Checks IFM amplifier.
LOW	(Low power) - 2.5 watts.
NORM	(Normal power) - 10 watts.
HIGH	(High power) - 40 watts.

3.5.3 Modes of Operation. Depending on the settings of the operation controls, the radio set can be used for these modes of operation:

a. Two-way voice, normal (TR).

b. When voice security system is installed, refer to paragraph 3.8.

c. Constant monitoring of guard channel 121.5 MHz only.

d. Guard receive and transmit only (EMER).

3.5.3.1 Starting Procedure. Before starting radio set, check settings of controls that pertain to communication equipment. With dc power applied, radio set is turned on with mode selector in any position other than **OFF** or **EMER**.

3.5.3.2 Operational Check. Select mode and communicate with or direction to the ground station on selected frequencies in low, middle, and high range of applicable frequency band. Check the action of the volume control and note that the selected frequencies are heard loud and clear. Check that adequate sidetone is audible during all transmissions.

3.5.3.2.1 Communications Mode Check.

- 1. Mode select switch TR.
- 2. Select out-of-band frequency to check warning. (On helicopters with panel-mounted transceivers.)
- 3. Select frequency of station to be used for check, **MAN** or **PRE** as desired.
- 4. Communicate with check station.

NOTE

- Transmitting with the AN/ARC-186 FM#2 radio may cause the LF-ADF (AN/ARN-89) bearing pointer to deflect and lose audio when tuned to a station 400 kHz or below. Releasing the transmitter key allows the LF-ADF receiver to return to the normal audio and bearing indication.
- Transmitting with the AN/ARC-186 VHF/ AM radio on frequencies from 120 MHz and above may cause the LF-ADF (AN/ ARN-89) bearing pointer to deflect and lose audio when tuned to a station below 1500 kHz. Releasing the transmitter key allows the LF-ADF receiver to return to the normal audio and bearing indication.

3.5.3.2.2 FM Homing Mode Check.

- 1. Select frequency of station to be used for homing.
- 2. Mode select switch DF.
- 3. Frequency control select switch MAN or **PRE** as desired.

4. Check for homing indication.

3.5.3.2.3 Squelch Disable/Tone Check.

- 1. Select SQ DIS Check for noise.
- 2. Select momentary **TONE**, check for tone of about 1000 Hz.

3.5.3.2.4 Preset Channel Load.

- 1. Mode select switch TR.
- 2. Frequency control select switch MAN.
- 3. Set MHz frequency for desired channel and rotate **PRESET** channel to number to be used with that frequency using channel selector thumbwheel.
- 4. **LOAD** button Press and release.
- 5. Repeat steps 3. and 4. for other preset channels.

3.5.4 Normal Operation.

3.5.4.1 TR Mode AM or FM as Applicable.

- 1. Set **OFF-TR-DF** switch to **TR**.
- 2. Set frequency control select switch to MAN or **PRE**.
- 3. Rotate four MHz selectors to desired frequency or set **PRESET** channel number as desired.

3.5.4.2 Emergency Mode AM or FM as Applicable.

- 1. Mode select switch **TR** or **DF**.
- 2. Frequency mode selector switch **EMER AM** or **FM** as applicable.

3.5.4.3 FM Homing Mode.

- 1. Mode select switch DF.
- 2. Frequency control select switch MAN or **PRE**.

3.5.4.4 Retransmission Mode. Perform a retransmission check as follows:

NOTE

Do not disable squelch when retransmit switches are in retransmit position. Squelch level is used to key transmitter for retransmission.

- 1. Establish two base stations at unrelated frequencies.
- 2. Set appropriate receiver-transmitter to desired retransmit frequency.
- 3. Place **RADIO TRANSMISSION** selector switch to radios to be used.
- 4. Establish communication between base stations through helicopter radios.
- 5. Note that selected frequencies are heard loud and clear and that received audio is present and clear at each crew station.

3.5.5 Stopping Procedure.

Mode Selector - OFF.

3.6 RADIO SET AN/ARC-201 (VHF-FM) (IF INSTALLED).

Radio set AN/ARC-201 (Figure 3-5) is an airborne VHF-FM radio receiving-transmitting set compatible with the Single Channel Ground Airborne Radio Sets (SING-CARS) Electronic Counter Countermeasures (ECCM) mode of operation. The set provides communications of voice and data, secure or plain text, and homing over the frequency range of 30 to 87.975 MHz channelized in 25 kHz steps. A frequency offset tuning capability of -10 kHz, -5 kHz, +5 kHz and +10 kHz is provided in both transmit and receive mode; this capability is not used in ECCM mode. The set, when used in conjunction with the TSEC/ KY-58 equipment, is used for receiving and transmitting clear-voice or X-mode communications. An additional capability for retransmission of clear-voice communications allows use of the set as a relay link. During retransmission, when one radio receives a signal, it sends a keying signal to the second radio and the first radio's received audio modulates the second radio's transmitter. Use of the homing capability of the No. 1 FM radio set provides a steering output to the VSI course deviation pointer for steering indications. No. 1 VHF-FM receives power from the dc essential bus through a circuit breaker marked NO. 1 VHF-FM. No. 2 VHF-FM receives power from the No. 1 dc primary bus through a circuit breaker marked NO. 2 VHF-FM.

TM 1-1520-237-10

3.6.1 Antennas.		CONTROL	FUNCTION
on top of the tail rotor is within the leading shaft cover. The FM h the fuselage, are used commander's antenna	/HF-FM communications antenna is pylon. The No. 2 VHF-FM antenna edge fairing of the tail pylon drive oming antennas, one on each side of with FM No. 1 radio set. The troop is on the upper trailing edge of the hapter 4, Section I for use of troop	MODE HOM	Homing antennas selected; com- munication antenna disconnected. Provides pilot with steering, station approach and signal strength
b. EI The No. 1 V	/HF-FM communications antenna is e fairing of the tail pylon drive shaft	SC	indicators. Single Channel. Operating frequen- cy is selected by PRESET switch or keyboard entry.
tion. The FM homing fuselage, are used w	R-FM antenna is under the nose sec- antennas, one on each side of the ith FM No. 1 radio set. the troop in on the upper trailing edge of the	FH	Frequency Hopping. PRESET switch positions 1-6 select frequen- cy parameters.
	hapter 4, Section I for use of troop	FH-M	Frequency hopping-master selects control station as the time standard for communicating equipment.
ARC-201 are on the	d Functions. Controls for the front panel. The function of each	PRESET	
control is as follows: CONTROL	FUNCTION	MAN	Used in single channel mode to select any operating frequency in 25 kHz increments.
OFF TEST	Primary power off; Memory battery power ON. RT and ECCM modules are tested,	Positions 1-6	In SC mode, preset frequencies are selected or loaded. In FH or FH-M mode, frequency hopping nets are
SQ ON	Results: GOOD or FAIL . RT on with squelch.	CUE	selected. Used by a non-ECCM radio to signal ECCM radio.
SQ OFF	RT on with squelch disabled.	IFM RF PWR (VHF	F-FM No. 1 only)
RXMT	RT is receiving. Used as a radio relay link.		NOTE
LD	Keyboard loading of preset fre- quencies.		This switch is inactive for VHF- FM No. 2, leave switch in OFF position.
LD-V	TRANSEC variable loading is enabled.	OFF	(Bypass amplifier) - 10 watts.
Z-A	Pull and turn switch. (Not an	LO	(Low power) - 2.5 watts.
	operational position). Used to clear the TRANSEC variable.	NORM	(Normal power) - 10 watts.
STOW	Pull and turn switch. All power	HI	(High power) - 40 watts.
~~~~	removed. Used during extended storage.	VOL control	Adjust receiver volume to comfort- able level.

CONTROL

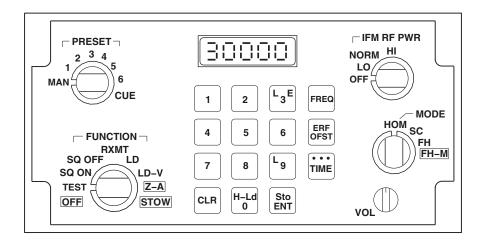


Figure 3-5. FM Control AN/ARC-201

CONTROL	FUNCTION	KY-58 is installed. Refer to p
KEYBOARD Switches 1-9	To key in any frequency, load time information or offsets.	<ol> <li>Two-way voice, frequency FH-M). Secure voice can be time if desired.</li> </ol>
FREQ	Display current operating frequen- cy during single channel (manual or preset) operation.	<ol> <li>Homing (HOM).</li> <li>Retransmission (Function - F</li> </ol>
ERF/OFST	Modify single channel operating frequency, manually selected or preset, to include offsets of $\pm 5$ kHz or $\pm 10$ kHz.	<ul><li><b>3.6.4 Normal Operation.</b></li><li><b>3.6.4.1 Starting Procedure.</b> The roperating in any of the modes indicated</li></ul>
TIME	Used to display or change the time setting maintained within each RT.	selector switch and retransmission on switch.
Sto ENT	Store or enter any frequency into RT; store a received HOPSET or LOCKOUT set held in holding memory.	3.6.4.2 Single Channel (SC) Mode. 1. FUNCTION switch - SQ O
H-Ld 0	Enter zeros; initiate transfer of EC-CM parameters.	2. MODE switch - SC.
CLR	Zeroize the display; clear errone- ous entries.	3. <b>PRESET</b> switch - <b>MAN</b> .

**FUNCTION** 

3.6.3 Modes of Operation. Depending on the setting of the operating controls, the radio set can be used for these modes of operations:

1. Two-way voice, normal (SC).

2. Two-way voice, secure voice, when TSEC/ paragraph 3.8.

AA9243

- y hopping (FH or be used at the same
- RXMT).

radio is capable of ated by the **MODE** n the FUNCTION

- ON or SQ OFF.
- 4. Push **FREQ** then **CLR** button. The display will show all bottom dashes.
- 5. Enter frequency 5 digits.
- 6. Push Sto button. The display will flash once to acknowledge correctly entered frequency.

- 7. ICS transmitter selector Position 1 (FM No. 1), or position 4 (FM No. 2).
- 8. Radio push-to-talk switch Press to talk; release to listen.

#### 3.6.4.3 Enter Frequency into PRESET.

- 1. FUNCTION switch LD.
- 2. **PRESET** switch Desired number 1 to 6.
- 3. MODE switch SC.
- 4. Push **FREQ** then **CLR** button. The display will show all bottom dashes.
- 5. Enter frequency 5 digits.
- 6. Push Sto. The display will flash once.
- 7. Repeat steps 1. through 6. for each desired preset channel.

#### 3.6.4.4 Frequency Hopping (FH or FH-M) Mode.

- 1. MODE switch FH or FH-M.
- 2. PRESET switch Select net (1-6).
- 3. FUNCTIONswitch SQ ON or SQ OFF.

#### 3.6.4.5 Homing (HOM) Mode (FM No. 1 Only).

- 1. Enter or select frequency MAN or PRESET.
- 2. MODE switch HOM.
- 3. MODE SEL panel FM HOME.
- 4. CIS MODE SEL NAV.
- 5. Observe homing indicators on vertical situation indicator (VSI). These are:
  - a. FM navigation (NAV) flag will move from view, and will come into view if the received signal is too weak.
  - b. A steering (course indicator) pointer moves either left or right about  $5^{\circ}$  to indicate any deviation from the course to the transmitting station.

c. Station passage will be indicated by course deviation change and CIS MODE SEL NAV switch light going out and HDG switch light going on.

**3.6.4.6 Retransmission (RXMT).** Retransmission (Figure 3-9) permits helicopter to be used as an airborne relay.

- 1. FUNCTION switch RXMT.
- 2. Frequency(s) Select.
- 3. **RADIO RETRANSMISSION** selector switch Set to radios used.
- 4. Establish communications between each relay in helicopter and its counterpart radio at the terminal station by using appropriate ICS TRANS selector. If audio monitoring is desired, adjust **VOL** control for suitable output.

## **3.6.5 Stopping Procedure.** FUNCTION switch - OFF.

#### 3.7 RECEIVER-TRANSMITTER RADIO, RT-1518C/ ARC-164(V).

Radio Receiver-Transmitter, RT-1518C/ARC-164(V) (Figure 3-6), is an airborne, ultra-high frequency (UHF), amplitude-modulated (AM), radio transmitting-receiving (transceiver) set with Have Quick II (provides Have Quick I and Have Quick II capabilities). Have Quick provides electronic counter countermeasures (ECCM) which use a frequency hopping scheme to change channels multiple times per second. The RT-1518C/ARC-164(V) contains a multichannel, electronically tunable main transmitter and receiver and a fixed-tuned guard receiver. The main transceiver operates on any one of 7,000 channels, spaced in 0.025 MHz units in the 225.000 to 399.975 MHz UHF military band. The guard receiver is always tuned to 243.000 MHz. The radio is primarily used for voice communications. An additional capability for retransmission allows use of the radio as a relay link. The radio interfaces with the Doppler/GPS Navigation Set (DGNS) AN/ASN-128B to obtain time of day. Power to operate the ARC-164(V) radio is from the dc essential bus through a circuit breaker marked UHF AM.

**3.7.1 Antenna.** The UHF antenna is under the fuselage transition section or **ED** under the fuselage below the copilot's seat. The antenna provides a path for both the transmitted and received UHF communication signals. The

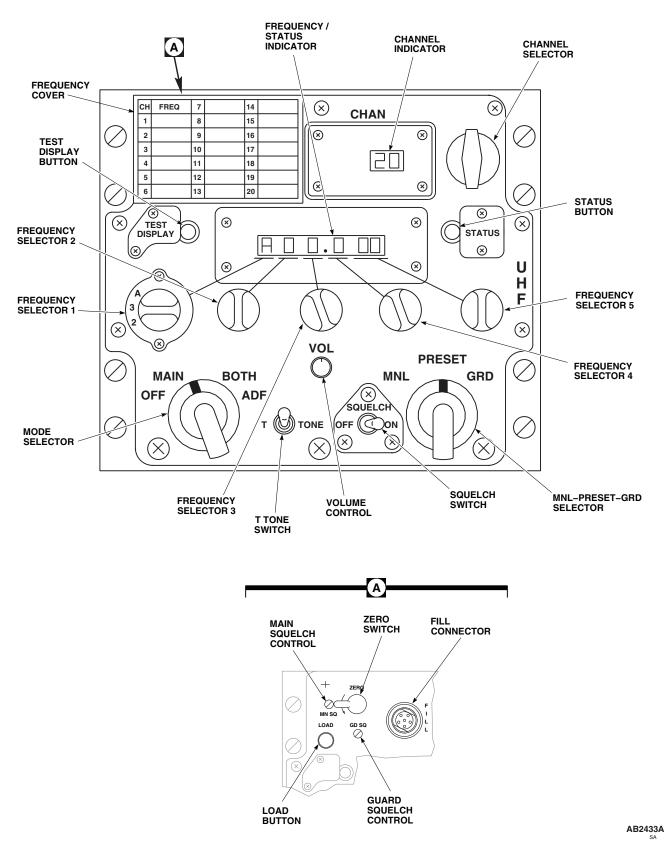


Figure 3-6. UHF Control, AN/ARC-164(V)

**FUNCTION** 

Indicates radio is in normal operat-

Indicates radio is in MWOD load

Indicates radio is in MWOD erase

Indicates radio is in Frequency

Management Training Change

Indicates a keyfill device is con-

nected to the front panel FILL

ing mode.

mode.

mode.

mode.

connector.

EH-60 AN/ALQ-151(V) mission package has two UHF radios that utilize the existing fuselage transition section conformal antenna for the voice link. The mission package also includes the data link antenna under the fuselage where the cargo hook would normally be installed.

**3.7.2 Tunable Diplexer.** If The tunable diplexer (TD-1336/A) is connected between the antenna and the output of the ARC-164(V). When properly tuned, the diplexer acts as a bridge network isolating signals of similar frequency which share the same antenna. The diplexer allows the guard channel in the ARC-164(V) guard receiver to be monitored while other frequencies in the main transmitter-receiver are being used.

**3.7.3 Controls and Functions.** Controls for the ARC-164(V) are on the front panel of the unit. The function of each control is as follows:

CONTROL	FUNCTION	WOD OK	Indicates a valid WOD was suc- cessfully received from the keyfill device.
CHAN indicator	Displays selected channel when MNL-PRESET-GRD selector is set to PRESET, or displays selected memory location when	BAD	Indicates no WOD or a bad parity WOD was received from the key- fill device.
	radio is in the MWOD load mode or FMT change mode.	STATUS button	Initiates an alternate display on the frequency/status and CHAN
Preset channel selector TEST DISPLAY button	Selects one of 20 preset channels. Also selects the desired memory location when radio is in the MWOD load mode (20-14), manual TOD entry mode (1), or FMT change mode (20-5). Lights all segments of the frequency/status and <b>CHAN</b> indicators. Also used with <b>T</b> <b>TONE</b> switch for manual clock start.	Frequency selector 1 ( <b>A</b> , <b>3</b> , <b>2</b> HQ only) <b>A</b> <b>3</b>	<ul> <li>indicators for five seconds.</li> <li>Selects 100s digit of frequency (either 2 or 3) in MHz in the single frequency mode. Selects the desired WOD elements or net number in AJ (Have Quick) mode.</li> <li>Selects AJ mode.</li> <li>Allows manual selection of fre- quencies in the 300 MHz range (3XX.XX).</li> </ul>
Frequency/status indicator	Displays the individual frequency selector settings or any of the fol- lowing operator prompts:	2	Allows manual selection of fre- quencies in the 200 MHz range (2XX.XX).
REMOTE	Not used.		

CONTROL

VER/OP

M-LOAD

ERASE

**FMTCNG** 

FILL

CONTROL	FUNCTION	CONTROL	FUNCTION
Frequency	Selects 10s digit of frequency (0	VOL control	Adjusts volume.
selector 2	through 9) in MHz. Selects the desired WOD elements or net number in AJ (Have Quick) mode.	SQUELCH switch	Disables and enables squelch of main receiver.
Frequency selector 3	Selects units digit of frequency (0 through 9) in MHz. Selects the	MNL-PRESET- GRD selector	Selects method of frequency selection:
	desired WOD elements or net number in AJ (Have Quick) mode.	MNL	Allows manual selection of fre- quency using the five frequency
Frequency selector 4	Selects tenths digit of frequency (0 through 9) in MHz. Selects the desired WOD elements or net number in AJ (Have Quick) mode.	PRESET	selectors. Allows selection of frequency from preset channels (1-20) using the channel selector. Along with
Frequency selector 5	Selects hundredths and thousandths digits of frequency (.00, .25, .50, or .75) in MHz. Selects the desired		<b>LOAD</b> button, also used when programming the 20 preset channels.
	WOD elements or net number in AJ (Have Quick) mode.	GRD	Automatically tunes the radio main receiver and transmitter to the guard frequency (243.000 MHz), and disables the guard receiver.
Mode selector <b>OFF</b>	Selects operating mode function: Turns power off.	MN SQ control	Adjusts level of squelch for main receiver.
MAIN	Enables main receiver and	<b>ZERO</b> switch	Erases all MWOD elements.
WIAIIN	transmitter.		
вотн	Enables main receiver, transmitter, and guard receiver.	<b>LOAD</b> button	Loads frequency data displayed on the frequency/status indicator into preset channels 1-19 as selected by
ADF	Not used.		channel selector. Preset channel 20 is reserved for loading MWOD
T TONE switch	Three position toggle switch:		operating mode data (220.0XX).
	middle position is off, and <b>T</b> and <b>TONE</b> are spring loaded. When placed in the <b>TONE</b> position,	GD SQ control	Adjusts level of squelch for guard receiver.
	transmits a 1,020 Hz DF tone on the selected frequency and stops when switch is released. If radio	Fill connector	Connects a keyfill device to radio for automatic loading of MWOD.
	TOD clock is started, the <b>TONE</b> position transmits the TOD mes- sage data followed by the DF tone. When placed in the <b>T</b> position, enables reception of TOD message	ent methods of free position of the <b>MN</b>	<b>Dperation.</b> The radio has three differ- quency selection as determined by the <b>L-PRESET-GRD</b> selector. The radio <b>N</b> , <b>BOTH</b> , or <b>ADF</b> .
	for one minute. The <b>T TONE</b>	07/1 Normal	<b>Jode</b> The name lands allows true

switch also initiates manual TOD

clock start, loads and erases MWOD elements, and loads FMT-

operating mode.

net operating frequencies when

radio is in the respective MWOD

**3.7.4.1 Normal Mode.** The normal mode allows two-way voice communications.

**3.7.4.2 Secure Speech (x-mode) Mode.** The secure speech mode allows secure two-way voice communications. Operation is identical to the normal mode.

**3.7.4.3 ADF Mode.** This mode is not normally used. Transmission from the radio is normally not possible with the mode selector in the **ADF** position.

**3.7.4.4 1,020 Hz Tone Signal Mode.** This mode allows transmission of a 1,020 Hz tone.

**3.7.4.5 Guard Channel Mode.** The **BOTH** position allows use of the main receiver while monitoring the guard receiver. The guard receiver is always tuned to 243.000 MHz.

**3.7.4.6 Retransmit Mode.** Retransmission permits the helicopter to be used as an airborne relay link. Two RTs (Figure 3-9) are required for operation as a relay unit. Operation in the retransmit mode is identical to the normal mode.

**3.7.4.7 Have Quick/Anti-Jam Mode.** The Have Quick II system provides jam resistant (antijamming) capability through frequency hopping. Frequency hopping is when the frequency being used for a given channel is automatically changed at a rate common to the transmitter and receiver. The jam resistance of the system is due to the automatic frequency changing and the pseudorandom pattern of frequencies used. Certain criteria are necessary for successful system operations. These are:

- 1. Common frequencies.
- 2. Time synchronization.
- 3. Common hopping pattern and rate.
- 4. Common net number.

The common frequencies are programmed into all Have Quick radios. Time synchronization is provided via UHF radio and/or hardware by an external time distribution system. A time-of-day (TOD) signal must be received from the time distribution system each time the radio is turned on. The hopping pattern and hopping rate are determined by the operator inserted word-of-day (WOD). In the AJ mode, a communications channel is defined by a net number. In addition to these Have Quick I capabilities, Have Quick II provides two new frequency tables; multiple word-of-day (MWOD); MWOD erase capability; Frequency Management Training net (FMT net) in addition to existing Training net (T net); and operational date information as part of TOD for proper WOD initialization.

**3.7.4.7.1 Word-Of-Day (WOD).** WOD is entered by using one or more of the six preset channels (15-20).

**3.7.4.7.2 Multiple Word-Of-Day (MWOD).** MWOD allows loading of up to six WODs either manually or automatically (maintenance can load the radio using a keyfill device). Each WOD contains a unique date code that is entered in memory location (channel) 14. The four MWOD operating modes: VER/OP, M-LOAD, ERASE, and FMTCNG are used to initiate various programming functions.

#### 3.7.4.7.3 Time-Of-Day (TOD).

#### NOTE

Automatic TOD is provided from the Doppler/GPS Navigation Set AN/ASN-128B.

TOD allows radios to operate together in the AJ mode. Transmission and reception are possible in both single frequency and AJ modes. Slightly garbled but otherwise acceptable communications indicate the radios have drifted out of synchronization. A time update/resynchronization corrects this. If single WOD is used, an operational date is not necessary.

**3.7.4.7.4 TOD Clock Manual Start.** When TOD from a Universal Coordinated Time (UTC) source is not available, the TOD clock can be manually started and used in the AJ mode. The manually started TOD clock is set to a time completely independent of UTC. Other radios may also communicate using this uncoordinated time once the time has been transmitted to all radios in the net.

**3.7.4.7.5 Net Number.** The net number programs the entry point in the AJ frequency hopping pattern, allowing multiple radio net operations using a common WOD and TOD without interfering with each other. Selecting **A** with frequency selector 1 places the radio in AJ mode and programs the radio to use the net number selected by frequency selectors 2, 3, and 4. The net number begins with **A** and is followed by three digits (000 to 999).

Operational Net Numbers. The last two digits designate the frequency table being used. Net numbers ending in 00 select the original A-net and B-net frequency table. Net numbers ending in 25 select the new NATO/Europe frequency table. Net numbers ending in 50 select the new non-NATO/ Europe frequency table. Net numbers ending in 75 are reserved for future use and will generate an invalid net alarm (pulsating warning tone).

Training/FMT Net Numbers. T-net and FMT-net training numbers are available for training purposes.

In the T-net training mode, the radio hops among five frequencies loaded in with the WOD. In the FMT-net training mode, the radio hops among sixteen frequencies.

**3.7.4.7.6 Conference Capability.** In the AJ mode, the radio is able to receive and process two simultaneous transmissions on the same net. In a conference net, the second transmitting radio automatically shifts its transmission frequency 25 kHz when it monitors a transmission on the primary net frequency. The wide band receiver reads both transmissions without the interference normally associated with two radios transmitting simultaneously on the same frequency. Conference capability is enabled or disabled by the last two digits of the WOD element loaded in memory location (channel) 19. If the WOD element ends with 00 or 50, conferencing is enabled. If the WOD element ends with 25 or 75, conferencing is disabled. When operating in secure speech mode, conferencing is automatically disabled. If operating in AJ mode on a single element WOD (memory location (channel) 20 only), conferencing is enabled by default. For training mode operation, conferencing is always enabled.

#### 3.7.5 Operation.

#### 3.7.5.1 Normal Mode.

- 1. Mode selector MAIN.
- 2. MNL-PRESET-GRD selector As desired.
- 3. Frequency selector/channel selector As desired.
- 4. ICS transmitter selector switch Position 2.
- 5. Establish communication by keying transmitter and speaking into microphone. Release to listen and adjust volume for a comfortable level.

#### 3.7.5.2 Secure Speech Mode.

- 1. Refer to paragraph 3.8 for voice security system procedures.
- 2. Refer to 3.7.5.1 for normal mode procedures.

#### 3.7.5.3 1,020 Hz Tone Signal Mode.

- 1. Mode selector MAIN.
- 2. MNL-PRESET-GRD selector As desired.

- 3. Frequency selector/channel selector As desired.
- 4. **T TONE** switch Press to **TONE** to transmit the 1,020 Hz signal.

#### 3.7.5.4 Guard (Emergency) Channel Mode.

Guard frequency only:

- 1. Mode selector **BOTH**.
- 2. MNL-PRESET-GRD selector GRD (main receiver and transmitter are both tuned to 243.000 MHz).

Guard frequency and main receiver/transmitter frequency:

- 1. Mode selector BOTH.
- 2. MNL-PRESET-GRD selector MNL or PRESET.
- 3. Frequency selector/channel selector As desired for main receiver/transmitter.
- 4. ICS transmitter selector switch Position 2.
- 5. Establish communication by keying transmitter and speaking into microphone. Release to listen and adjust volume for a comfortable level.

#### 3.7.5.5 Retransmit Mode.

- 1. **RADIO TRANSMISSION** selector Set to desired radios.
- 2. Mode selector MAIN.
- 3. MNL-PRESET-GRD selector As desired.
- 4. Frequency selector/channel selector As desired.
- 5. ICS transmitter selector switch Position 2.
- 6. Establish communication between each relay radio in helicopter and its counterpart radio link terminal station.

#### 3.7.5.6 Have Quick/AJ Mode.

1. Mode selector - MAIN or BOTH.

- 2. WOD or MWOD Load per paragraph 3.7.5.6.1 or 3.7.5.6.2.
- 3. TOD Synchronize per paragraph 3.7.5.6.4.
- 4. Verify/operate mode (MWOD only) Select per paragraph 3.7.5.6.3.
- 5. MNL-PRESET-GRD selector MNL.

#### NOTE

- A steady warning tone is heard when the AJ mode is selected and a TOD or a valid WOD has not been entered.
- The **A** cannot be stored in preset channel memory. If loading a net number into a preset channel is attempted, the **A** is accepted as a 3.
  - 6. Frequency selector 1 A.
  - 7. Frequency selectors 2, 3, 4 Enter net number. A pulsating warning tone is heard if an invalid operating net is selected.
  - 8. Establish communication by keying transmitter and speaking into microphone. Release to listen and adjust volume for a comfortable level.

#### 3.7.5.6.1 Manual WOD Loading.

#### NOTE

- If power is lost, or if channel 20 is selected when the **MNL-PRESET-GRD** selector is in the **PRESET** position, reinitialization of all WOD elements is necessary.
- Use of all channels may not be necessary. Any unused channels can be used to store selected preset frequencies.
  - 1. Mode selector MAIN.
  - 2. MNL-PRESET-GRD selector PRESET.
  - 3. Channel selector Channel 20.
  - 4. Frequency selectors Set desired WOD element.
  - 5. LOAD button (under frequency cover) Press.

- 6. If needed, repeat steps 3. through 5. for channels 19 15.
- 7. Initialization: a single beep is heard on each channel with a WOD element with the exception of the final WOD element which has a double beep. This indicates the end of WOD elements and initialization is complete.
- 8. MNL-PRESET-GRD selector MNL.

#### 3.7.5.6.2 Manual MWOD Loading.

#### NOTE

- If the frequency selectors are not used within five seconds, the frequency/status indicator reverts to the M-LOAD display. Pressing the STATUS button allows reviewing of the frequency settings.
- When the current operational date is updated in the radio at midnight (Greenwich Mean Time), the radio automatically reinitializes with the WOD having the same date code.
  - 1. Mode selector MAIN.
  - 2. MNL-PRESET-GRD selector PRESET.
  - 3. Channel selector Channel 20.
  - 4. Frequency selectors Set 220.025 MHz to select MWOD load mode.
  - 5. LOAD button (under frequency cover) Press.
  - 6. MNL-PRESET-GRD selector MNL.
  - 7. Frequency selectors Set WOD element.
  - 8. **T TONE** switch Press to **TONE**, then release and note a single beep to ensure WOD element is entered.
  - 9. Channel selector Select next lower memory location.
  - Repeat steps 7. through 9. for loading remaining WOD elements in memory locations (channels 19 - 15).
  - 11. Channel selector Channel 14 (date tag).

- Frequency selectors Set to applicable date code: XAB.XXX (AB represents the day-ofmonth (01 to 31); Xs do not need a data entry). If two or more WODs have the same date code, the radio recognizes the last one entered.
- 13. **T TONE** switch Press to **TONE**, then release (note a double beep). One complete WOD with date code has been successfully entered.
- 14. Reselect channel 20 and repeat steps 7. through 13. to load more WODs. If power is removed from the radio, MWOD data is not lost. All data remains in memory unless erased. Refer to the operational date load or change procedures in paragraph 3.7.5.6.4 for MWOD data recall.

MWOD Date Code Verify:

- 1. Select MWOD verify/operate mode per paragraph 3.7.5.6.3.
- 2. MNL-PRESET-GRD selector MNL.
- 3. Frequency selectors Select date code to be verified: XAB.XXX (AB represents the day-of-month (01 to 31); Xs do not need a data entry).
- 4. Channel selector Memory location (channel) 20, then 19, and then 20. Single beep verifies an MWOD with a matching date code is stored in memory. If a single beep is not heard, the selected date code is not stored in memory.
- 5. Proceed to paragraph 3.7.5.6.4 for TOD.

#### 3.7.5.6.3 MWOD Operating Mode Selection.

- 1. Channel selector Channel 20.
- 2. MNL-PRESET-GRD selector PRESET.
- Frequency selectors As desired (220.000 MHz for verify/operate mode; 220.025 MHz for MWOD load mode; 220.050 MHz for MWOD erase mode; or 220.075 MHz for frequency management training change mode).
- 4. LOAD button (under frequency cover) Press to enable selected mode. The appropriate operating mode (M-LOAD, ERASE, or

**FMTCNG**) is displayed on the frequency/ status indicator (the **STATUS** button must be pressed to display the **VER/OP** mode).

#### 5. MNL-PRESET-GRD selector - MNL.

MWOD erase:

- 1. Perform steps 1. through 5. to select MWOD erase mode.
- 2. **T TONE** switch Press to **TONE**. All MWODs are now cleared (WOD data and net number information is not cleared).
- 3. MNL-PRESET-GRD selector PRESET.
- 4. Frequency selectors Set 220.000 MHz for verify/operate mode.
- 5. LOAD button (under frequency cover) Press to enable VER/OP mode (the STATUS button must be pressed to display the VER/OP on the frequency/status indicator for five seconds).
- 6. MNL-PRESET-GRD selector MNL.

Alternate method for MWOD erase:

1. **ZERO** switch (under frequency cover) - Press, then release. **ERASE** is displayed (all MWODs are now erased). The **ZERO** switch only erases the MWOD data. WOD data and net number information are not erased.

FMT change:

- 1. Perform steps 1. through 5. to select MWOD FMT change mode.
- 2. Channel selector Set desired memory location (channels 20-5).

#### NOTE

If the frequency selectors are not used within five seconds, the frequency/status indicator reverts to the current operating mode display (**FMTCNG**).

- 3. Frequency selectors Select frequency change.
- 4. **T TONE** switch Press to **TONE**, then release (note an audible tone).

- 5. Repeat steps 2. through 4. until all frequency changes are loaded.
- 6. Channel selector Channel 20.

#### 7. MNL-PRESET-GRD selector - PRESET.

- 8. Frequency selectors Set 220.000 MHz for verify/operate mode.
- LOAD button (under frequency cover) Press to enable VER/OP mode (the STATUS button must be pressed to display the VER/OP on the frequency/status indicator for five seconds).

#### 3.7.5.6.4 Time of Day (TOD).

Request/Receive TOD:

#### NOTE

When the radio is turned on, the first TOD received is accepted. Subsequent messages are ignored.

- 1. MNL-PRESET-GRD selector As desired.
- 2. Frequency selectors/channel selector Select predesignated frequency for TOD transmission.

#### NOTE

The first TOD received within one minute of the TOD request is accepted.

- 3. T TONE switch Press to T then release.
- 4. If time is not being automatically beaconed, request TOD from another station on the operating network. Beacons typically transmit TOD every ten seconds.
- 5. TOD may be received on the main or guard receiver in single frequency or AJ mode. Two momentary tones (1,667 Hz-high tone and 1,020 Hz-low tone) are heard when the TOD synchronization signal is received.

Transmit TOD:

- 1. MNL-PRESET-GRD selector As desired.
- 2. Frequency selector/channel selector As desired.

#### NOTE

The radio will not transmit while the **T TONE** switch is in the **T** position.

3. **T TONE** switch - Press to **TONE** then release. Two momentary tones (1,667 Hz-high tone and 1,020 Hz-low tone) are heard when the TOD synchronization signal is transmitted.

TOD Resynchronization:

- 1. T TONE switch Press to T then release.
- Frequency selectors Select any normal frequency and request a TOD. The first TOD signal is heard within one minute of selecting T is accepted. A momentary 1,667 Hz tone is heard when the TOD signal is received. TOD resynchronization should be performed using the single frequency mode.

TOD Clock Manual Start:

#### NOTE

- The new TOD is arbitrary and is not synchronized to UTC or to any other radio.
- A manual TOD start clears out a previously loaded TOD.
  - 1. **T TONE** switch Press to **T** and hold, while simultaneously pressing the **TEST DISPLAY** button.
  - 2. **T TONE** switch Release prior to releasing the **TEST DISPLAY** button to prevent inadvertent Have Quick time loading.

Operational Date Load or Change:

- 1. Mode selector MAIN.
- 2. MNL-PRESET-GRD selector PRESET.
- 3. Channel selector Channel 20.
- 4. Frequency selectors Set 220.025 MHz to select MWOD load mode.
- 5. LOAD button (under frequency cover) Press.
- 6. MNL-PRESET-GRD selector MNL.

- 7. Channel selector Channel 1.
- 8. Frequency selectors Set to applicable date code: XAB.XXX (AB represents the day-of-month (01 to 31); Xs do not need a data entry).
- 9. **T TONE** switch Press to **TONE**, then release and note a tone (the date code has been successfully entered).
- 10. Frequency selectors Set to 220.000 MHz to select verify/operate mode.
- 11. **LOAD** button (under frequency cover) Press, then release. Radio is now in verify/operate mode.
- 12. **STATUS** button Press, **VER/OP** is displayed on the frequency/status indicator for five seconds.

#### 3.7.5.7 Preset Channel Loading.

#### NOTE

- Channels 14 through 20 can be reserved for loading single WOD and MWOD data. Any channel not used for WOD or MWOD can be used as a preset channel.
- The **A** cannot be stored in preset channel memory. If loading of a net number (AXX.XXX) into a preset channel is attempted, the **A** is accepted as a 3.

Set 20 preset channel numbers to desired frequencies as follows:

- 1. Mode selector MAIN or BOTH.
- 2. MNL-PRESET-GRD selector PRESET.
- 3. Frequency selectors As desired.
- 4. Channel selector As desired.
- 5. LOAD button Press, then release.
- 6. Using a pencil, record frequency selected for channel on the card located on the front panel.

7. Repeat steps 3. through 6. to load additional preset channels.

#### 3.7.6 Stopping Procedure.

Mode selector - OFF.

#### 3.8 TSEC/KY-58.

A complete description of the TSEC/KY-58 can be found in TM 11-5810-262-10. This voice security equipment is used with the FM radio to provide secure two-way communication.

**3.8.1 Controls and Functions.** The equipment is controlled by the Remote Control Unit (RCU) (Z-AHP) (Figure 3-7) mounted in the lower console. The **POWER** switch must be in the **ON** position regardless of the mode of operation, whenever the equipment is installed.

#### CONTROL FUNCTION

<b>ZEROIZE</b> switch	Zeroizes the KY-58. Clears all encoding in the system.
<b>DELAY</b> switch	Up when the signal is to be retransmitted.
PLAIN C/RAD switch	
PLAIN	Permits normal (unciphered) com- munications on the associated FM radio set.
C/RAD	Permits ciphered communications on the associated FM radio set.
C/RAD 2 switch stop	Location stop for <b>C/RAD 2</b> on front panel.
FILL switch	Permits the pilot to select one of 6 storage registers for filling.
MODE switch	
OP	Enables normal operation.
LD	Used to fill the KY-58.
RV	Receive-variable allows the KY-58 to be filled from another external source.

#### CONTROL FUNCTION

**POWER** switch Connects power to the associated KY-58 cipher equipment in the forward position. Disconnects power from the equipment in the off position. Turns on power to KY-58.

#### 3.8.2 Normal Operation.

#### 3.8.2.1 Secure Voice Procedures.

#### NOTE

To talk in secure voice, the KY-58 must be "loaded" with any number of desired variables.

- 1. MODE switch OP.
- 2. **FILL** switch Set to the storage register which contains the desired Crypto-Net Variable (CNV).
- 3. POWER switch ON.
- 4. PLAIN, C/RAD switch C/RAD1.
- 5. **DELAY** switch Down unless the signal is to be retransmitted.

#### NOTE

At this time a crypto alarm and background noise in the helicopter audio intercom system should be heard.

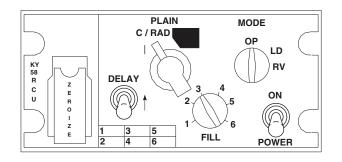
6. Push-To-Transmit (PTT) switch - Press and release to clear the alarm.

#### NOTE

When operating in either secure or clear (plain) voice operations, the volume must be adjusted on the helicopter radio and intercom equipment to a comfortable operating level.

#### 3.8.2.2 Clear Voice Procedures.

1. **POWER** switch - **ON**.



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#### Figure 3-7. Voice Security Equipment

2. PLAIN, C/RAD switch - PLAIN.

#### 3.8.2.3 Zeroizing Procedures.

1. POWER switch - ON.

#### NOTE

Instructions should originate from the Net Controller or Commander as to when to zeroize the equipment.

Spring-loaded ZEROIZE switch - Activate and release. This will zeroize all positions (1-6). The equipment is now zeroized and secure voice communications are no longer possible.

#### 3.8.2.4 Automatic Remote Keying Procedures.

#### NOTE

Automatic remote keying (AK) causes an "old" CNV to be replaced by a "new" CNV. Net controller simply transmits the "new" CNV to the KY-58.

- 1. The net controller will use a secure voice channel with directions to stand by for an AK transmission. Calls should not be made during this standby action.
- 2. Several beeps should now be heard in your headset. This means that the "old" CNV is being replaced by a "new" CNV.
- 3. Using this "new" CNV, the net controller will ask you for a "radio check."

4. After the "radio check" is completed, the net controller instructions will be to resume normal communications. No action should be taken until the net controller requests a "radio check."

**3.8.2.5 Manual Remote Keying Procedures.** The net controller will make contact on a secure voice channel with instructions to stand by for a new CNV by a Manual Remote Keying (MK) action. Upon instructions from the net controller:

- 1. Set the Z-AHP **FILL** switch to position 6. Notify the net controller by radio and stand by.
- 2. When notified by the net controller, set the Z-AHP **MODE** switch to Receive Variable (RV). Notify the net controller and stand by.
- 3. When notified by the net controller, set the Z-AHP **FILL** switch to any storage position selected to receive the new CNV (may be unused or may contain the variable being replaced). Notify the net controller and stand by.

#### NOTE

When performing Step 3, the storage position (1 through 6) selected to receive the new CNV may be unused or it may contain the variable which is being replaced.

- 4. Upon instructions from the net controller:
  - a. Listen for a beep in the headset.
  - b. Wait two seconds.
  - c. Set the RCU MODE switch to OP.
  - d. Confirm.
- 5. If the MK operation was successful, the net controller will now communicate via the new CNV.
- 6. If the MK operation was not successful, the net controller will communicate via clear voice (plain) transmission with instructions to set the Z-AHP FILL selector switch to position 6 and stand by while the MK operation is repeated.

**3.8.2.6 KY-58 Audio Tones.** It is important to be familiar with certain KY-58 audio tones. Some tones

indicate normal operation while others indicate equipment malfunction. These tones are:

- 1. Continuous beeping with background noise is crypto alarm. This occurs when power is first applied to the KY-58 or when the KY-58 is zeroized. This beeping is part of normal KY-58 operation. To clear this tone, press and release the PTT button on the Z-AHQ (after the Z-AHQ LOCAL switch has been pressed). The PTT can also be pressed in the cockpit.
- 2. Background noise indicates that the KY-58 is working properly. This noise should occur at TURN ON of the KY-58 and also when the KY-58 is generating a cryptovariable. If the background noise is not heard at TURN ON, the equipment must be checked out by maintenance personnel.
- 3. Continuous tone could indicate a "parity alarm." This will occur whenever an empty storage register is selected while holding the PTT button in. This tone can mean any of three conditions:
  - a. Selection of any empty storage register.
  - b. A "bad" cryptovariable is present.
  - c. Equipment failure has occurred. To clear this tone, follow the "Loading Procedures" in TM 11-5810-262-10. If this tone continues, have the equipment checked out by maintenance personnel.
- 4. Continuous tone could also indicate a cryptoalarm. If this tone occurs at any time other than in step c. above, equipment failure may have occurred. To clear this tone, repeat the "Loading Procedures" in TM 11-5810-262-10. If this tone continues, have the equipment checked out by maintenance personnel.
- 5. Single beep when RCU is not in TD (Time Delay) can indicate any of the three normal conditions:
  - a. Each time the PTT button is pressed when the KY-58 is in C (cipher) and a filled storage register is selected, this tone will be heard. Normal use (speaking) of the KY-58 is possible.
  - b. When the KY-58 has successfully received a cryptovariable, this tone

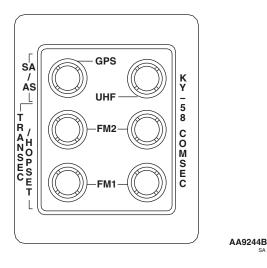


Figure 3-8. Remote Fill Panel

indicates that a "good" cryptovariable is present in the selected register.

- c. When you begin to receive a ciphered message, this tone indicates that the cryp-tovariable has passed the "parity" check and that it is a good variable.
- 6. A single beep when the RCU is in TD (Time Delay) occurring after the "preamble" is sent indicates that transmission may begin.
- 7. A single beep followed by a burst of noise after which exists a seemingly "dead" condition indicates that your receiver is on a different variable than the distant transmitter. If this tone occurs when in cipher text mode, turn RCU **FILL** switch to the CNV and contact the transmitter in PLAIN text and agree to meet on a particular variable.

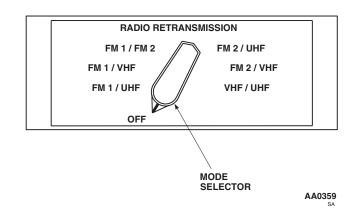


Figure 3-9. Retransmission Control Panel

**3.8.2.7 KY-58 Remote Fill.** A remote fill panel (Figure 3-8) allows a single crew member to load COMSEC variables into each of the three KY-58s from the pilot's side lower center console; FM-1 and FM-2 AN/ARC-201 TRANSSEC and HOPSET codes can be loaded from the same panel.

#### 3.9 RADIO RETRANSMISSION CONTROL.

Control of retransmission is through a switch panel (Figure 3-9) on the lower console. The position of the switch determines which radio set pairs will be used when the corresponding FM and VHF radio function and **VOL** switches (not required for UHF) are placed to **RETRAN**. Operation of the retransmission control is included with the operating procedures of each radio set where applicable. The retransmission control is only a means of directing the audio output of a receiver to the audio input of a transmitter through switching.

#### 3.10 HF RADIO SET AN/ARC-220.

## WARNING

- Make sure that no personnel are within 5 feet of the HF antenna when transmitting, performing radio checks or when in ALE mode. Do not touch the RF output terminal on the antenna coupler, the insulated feed through, or the antenna itself while the microphone is keyed (after the tuning cycle is complete) or while the system is in transmit self-test. Serious RF burns can result from direct contact with the above criteria.
- Do not edit data messages under flight conditions requiring maximum crew coordination such as NOE flight, NVG flight, or flight in the protective mask, except during emergency conditions.

#### NOTE

- Usage of the AN/ARC-220 HF radio with the TSEC/KY-100 on the 9.9380 MHz, 12.0785 MHz, 21.4250 MHz, 27.8485 MHz should be avoided to prevent interference with the AN/ARC-201 radio with IFM using the TSEC/KY-58.
- The AN/ARC-220 radio may cause additional background noise on the communication channel between the AN/ARS-6 PLS and the AN/PRC-112. Operation of the AN/ARC-220 should be avoided during Search and Rescue missions.
- The AN/ARC-220 shall not transmit when the AN/ARN-149 ADF is required for helicopter navigation.
- The AN/ARC-220 radio may cause false alarms on the AN/APR-39 RWR.

a. The AN/ARC-220 HF transceiver provides long range communications. The HF radio receives and transmits on any one of 280,000 frequencies spaced at 100 Hz steps on the high frequency (HF) band. The HF radio

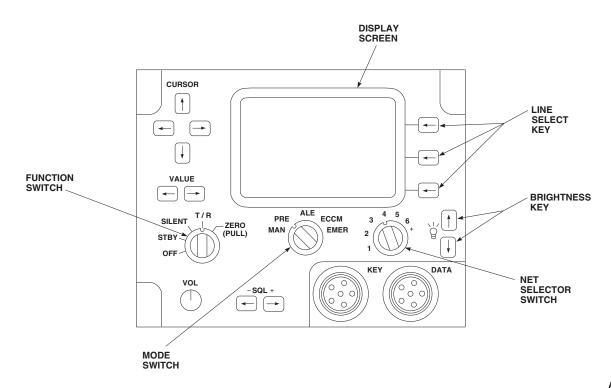
has a frequency range of 2.0000 - 29.9999 MHz. Preset nets can be manually programmed by the pilot, or loaded with a data transfer device (DTD). Emission modes available are upper side band (USB) voice, lower side band (LSB) voice, amplitude modulation equivalent (AME), or continuous wave (CW), with a selection of 10, 50, or 175 watts of transmitting power. Transmit tune time is normally less than 1 second. The radio also has automatic link establishment (ALE) and electronic counter countermeasures (ECCM) frequency hopping mode. Data messages may be composed and stored in the receiver/ transmitter's memory. These messages may be transmitted and received using any operational mode of the radio set.

b. Power for the radio is provided from the No. 1 dc primary bus through a circuit breaker marked **HF**.

**3.10.1 Antenna.** The tubular antenna element extends from the left side of the transition area to a point just forward of the hinged tailcone section, and is supported by four masts. RF energy is supplied to the antenna through the forward mast.

**3.10.2 Controls and Functions.** The radio is controlled by a control display unit (CDU) (Figure 3-10) located in the lower console. The function of each control and display is as follows:

CONTROL/ DISPLAY	FUNCTION
CURSOR keys	Position the cursor in the direction of the arrow on the key.
Display screen	Used to display system informa- tion, and enter data or commands in radio.
Line select keys	Function depends on adjacent display.
Brightness keys	Changes display screen brightness.
Net selector switch	Selects programmed operating net. The + position allows additional nets to be selected using the VALUE keys.
DATA connector	Fills radio with preprogrammed data, required for all modes except <b>MAN</b> .
KEY connector	Used to load <b>ALE</b> and <b>ECCM</b> presets.



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#### Figure 3-10. Control Display Unit AN/ARC-220

CONTROL/ DISPLAY	FUNCTION	CONTROL/ DISPLAY	FUNCTION
Mode switch MAN	Operating frequency and emission mode is selected manually. Once selected, the information is stored in memory, and can be recalled us- ing the net selector switch.	-SQL+ keys	<ul> <li>Selects level of squelch from TONE through 5.</li> <li>TONE provides no muting or squelch.</li> <li>0 gives muting, but no squelch.</li> <li>1 through 5 gives levels of muting and squelch.</li> </ul>
PRE ALE	Selects a preprogrammed frequen- cy and emission mode. Selects Automatic link establish- ment (ALE) mode.		Muting turns off the scanning receiver audio and gives the pilot a tone when an ALE link is established.
ECCM	Selects electronic counter countermeasure (ECCM) mode.		

**EMER** Selects emergency mode.

CONTROL/ DISPLAY	FUNCTION
VOL switch	Changes receive audio output level. <b>VOL</b> settings are displayed for 5 seconds when radio is first powered up, or when the <b>VOL</b> set- ting is changed.
Function switch	
OFF	Turns the radio off.
STBY	Turns the radio on, performs bit and enables fill operations.
SILENT	Prevents the radio from automati- cally responding to incoming calls in ALE or ECCM mode. Used dur- ing refueling, ordinance loading and EMCON conditions.
T/R	Allows the radio to transmit and receive in selected operating mode.
ZERO	Erases all loaded data, to include datafill and keyfill information.
VALUE keys	Increases or decreases a field value or single character value that is marked by the cursor.
Screen displays	Each line can display up to 20 alphanumeric characters. The 5 characters closest to the line select keys are used for control selection. See Table 3-2 for advisory mes- sages and their function.

#### 3.10.3 Modes of Operation.

**3.10.3.1 Manual (MAN) Mode.** Use manual mode to change transmit and receive frequencies, sidebands and transmit power, and operate the radio manually.

#### 3.10.3.1.1 To Change Radio Settings:

- 1. Mode switch MAN.
- 2. Function switch T/R.
- 3. Select the desired net (1 through 20), net selector switch 1 through +. Use VALUE keys to select 7 through 20.
- 4. **EDIT** line select key Press.

#### NOTE

Changing the receive frequency and mode will also change the transmission frequency and mode to the same values. Changing the transmission frequency and mode will not change the receive frequency and mode.

- 5. Edit frequency, emission mode, and transmit power by placing the cursor under field to be edited with **CURSOR** key, and change field value with **VALUE** keys.
- 6. To end edit and store changed data, **RTN** line select key Press.

#### 3.10.3.1.2 To Operate in Manual Mode:

- 1. Function switch T/R.
- 2. Mode switch MAN.
- 3. -SQL+ switch Set squelch to 0.
- 4. **VOL** switch Adjust for comfortable listening level.

#### NOTE

If the radio breaks in and out of squelch, increase setting as required.

- 5. -SQL+ switch Set squelch to 1.
- 6. Select the desired net (1 through 20), net selector switch 1 through +. Use VALUE keys to select 7 through 20.
- 7. ICS Transmitter selector Position 5.
- 8. Radio push-to-talk switch Press to talk; release to listen.

**3.10.3.2 Preset (PRE) Mode.** Preset mode stores preprogrammed frequencies and emission modes that cannot be changed by the operator. To use the radio in preset mode, do the following:

- 1. Function switch T/R.
- 2. Mode switch PRE.
- 3. -SQL+ switch Set squelch to 0.

4. **VOL** switch - Adjust for comfortable listening level.

#### NOTE

If the radio breaks in and out of squelch, increase setting as required.

- 5. -SQL+ switch Set squelch to 1.
- Select the desired net (1 through 20), net selector switch 1 through +. Use VALUE keys to select 7 through 20.
- 7. ICS Transmitter selector Position 5.

#### NOTE

If tune tone is heard, wait until it stops before talking.When radio push-to-talk switch is pressed, **XMT** frequency is displayed. Display returns to preset display when switch is released.

8. Radio push-to-talk switch - Press to talk; release to listen.

## 3.10.3.3 Automatic Link Establishment (ALE) Mode.



When in ALE mode, the radio transmits interrogating signals (sounds) and replies to ALE calls automatically without operator action. To avoid personnel injury, ensure the function switch is set to SILENT, STBY, or OFF when personnel are working near the helicopter during refueling or loading ordinance.

#### NOTE

Self address must be selected before using ALE.

ALE mode may be used for communications, either normal or link protected, or position reporting.

## 3.10.3.3.1 To Set Up the Radio for ALE Communications:

1. Function switch - **T/R**.

- 2. Mode switch ALE.
- Select the desired net (1 through 20), net selector switch 1 through +. Use VALUE keys to select 7 through 20.
- 4. -SQL+ switch Set squelch to TONE.
- 5. **VOL** switch Adjust for comfortable listening level.

#### NOTE

Earphone audio is muted until a link is established. If the link is noisy, set squelch to **1**. Higher squelch settings are not recommended in this mode.

- 6. -SQL+ switch Set squelch to 0.
- 7. To synchronize time in a link protected channel, **EDIT** and **SYNC** soft keys - Press.
- 8. To broadcast AN/ARC-220 system time as net control, **EDIT**, then **TXTIM** soft keys Press. Time will be transmitted, and radio will return to scan mode.

#### 3.10.3.3.2 To Receive an ALE Call:

- 1. **INCOMING CALL** is displayed, followed by the caller's ALE address. A short tone sounds, and **LINKED** is displayed.
- 2. ICS Transmitter selector Position 5.

#### NOTE

Wait for the calling station to make the first transmission.

3. Radio push-to-talk switch - Press to talk; release to listen.

#### 3.10.3.3.3 To Place an ALE Call:

- 1. Select ALE address:
  - a. Select the desired net (1 through 20), net selector switch 1 through +. To select 7 through 20, set the selector switch to the + position and use the value keys to scroll to the desired selection. Net name and address will be displayed.

- b. VALUE switch Press, to scroll through address list.
- c. If placing an ALE call to an address not in the list, edit the address as follows: EDIT soft key - Press. Enter address one character at a time with CURSOR and VALUE switches. To accept the edit and return to ALE screen, RTN soft key -Press.
- 2. ICS Transmitter selector Position 5.

#### NOTE

Press **ABORT** to stop the calling process.

3. Radio push-to-talk switch - Press (and release). **CALLING**, then **LINKED** is displayed with a short gong tone in headphone.

#### NOTE

ALE will cancel the link, and return to scan mode if there is no activity on a link for a predetermined time as set by the data fill (60 seconds is a typical value). To maintain a link, press **HOLD** soft key. When communications are complete, or to return to scan mode, press **SCAN** soft key.

- 4. Radio push-to-talk switch Press to talk; release to listen.
- 5. When communication is complete, to return to scanning mode, **HOLD**, then **SCAN** soft key Press.

#### 3.10.3.4 Electronic Counter Countermeasures

**(ECCM) Mode.** The radio changes frequency in a sequence determined by the ECCM key. Datafill and keyfill must be loaded prior to using ECCM mode, and system time must be synchronized between stations. Frequencies used in hop sets are pretuned in the radio, as ECCM requires frequencies to be changed many times per second. Frequency hopping is performed in the ECCM mode of operation. To use this mode, do the following:

#### 3.10.3.4.1 Initialize the Net:

- 1. Function switch T/R.
- 2. Mode switch **ECCM**.

- 3. Select the desired net (1 through 12), net selector switch 1 through +. Use VALUE keys to select 7 through 12.
- 4. To change values on screen, **EDIT** soft key -Press. Use **CURSOR** to position cursor under area to change, and **VALUE** to change the field to desired value.
- 5. To save changes and return to top level screen, **RTN** soft key Press.
- 6. Push-to-talk switch Press, to tune and time synchronize the radio.

#### 3.10.3.4.2 To Communicate in ECCM Only Mode:

- 1. -SQL+ switch Set squelch to TONE.
- 2. **VOL** switch Adjust for comfortable listening level.

#### NOTE

If the frequency is noisy, set squelch to **1**. Higher squelch settings are not recommended in this mode.

- 3. -SQL+ switch Set squelch to 0.
- Press and hold the push-to-talk switch until XMT READY is displayed. Wait for preamble tones to stop.
- 5. Talk. Release switch to listen.

**3.10.3.5 Message Mode.** The radio can store up to 10 transmit data and 10 received data messages. Each message may be 500 characters long. Messages are numbered from 1 to 10. Message 10 is the oldest, and will be deleted if a new message is received. Messages may be composed using the AN/ARC-220 CDU dictionary or with a custom dictionary listing locally generated words, which may be loaded with datafill.

#### 3.10.3.5.1 To View a Received Message:

- 1. MSG soft key Press.
- 2. Use **CURSOR** keys to scroll left or right, or up and down in a message.
- 3. Use VALUE keys to page up and down in a message.

- To view additional messages, position cursor under message number with CURSOR keys. Use VALUE keys to scroll to the next message number.
- 5. To retain received messages, **RTN** soft key Press.
- 6. To delete received messages, position the cursor under the message number and **DEL** soft key - Press, until messages are deleted. To return to top screen, **RTN** soft key - Press.

#### 3.10.3.5.2 To Edit or Compose a Message:

- 1. MSG soft key Press.
- 2. From MESSAGE screen, PGRM soft key Press.
- 3. Select message to be edited by placing cursor under the message number with **CURSOR** keys, and change number with **VALUE** keys.
- 4. Edit message by placing cursor under area to be changed. Use **VALUE** keys to change one character at a time. Press **DEL** to delete one character at a time.
- 5. To insert a word from the dictionary in a message do the following:
  - a. Position cursor where the word is to be inserted
  - b. **WORD** soft key Press.
  - c. Select the word with VALUE keys.
  - d. To insert word with blank in message, **SELECT** soft key - Press. If desired, return to message without inserting a word by pressing **CANCL**.
- 6. To load edited message in R/T memory and return to top level screen, **RTN** soft key Press.

#### 3.10.3.5.3 To Send a Message:

- 1. Access **PRGM MSG** screen by pressing **MSG**, then **PRGM** soft keys.
- 2. Select message to send as desired by placing cursor under message number, and pressing

VALUE keys until desired message is displayed.

#### NOTE

Message will be sent to currently selected address (ALE modes) or transmitted on the currently selected frequency and mode (MAN, PRE, or ECCM).

3. SEND soft key - Press.

#### 3.10.4 Operation.

#### 3.10.4.1 Starting Procedure.

- Function switch STBY. SYSTEM TEST-ING is displayed while power up built in test (PBIT) is in process. SYSTEM - GO will be displayed upon successful completion of PBIT.
- 2. FILL line select key Press. Status of PRE, ALE, ECCM, and EMER modes will be displayed.

**3.10.4.2 Load Presets.** Datafill contains preset frequencies, scan lists, addresses, data messages, and non secure information needed for ALE/ECCM operation. If the DTD is configured to receive data, it may be copied from the radio to the DTD by pressing **COPY** line select key on the **DATA FILL** page.

- 1. Initialize the DTD. Connect the DTD to the **DATA** connector.
- 2. With the **FILL** page selected, **DATA** line select key Press.

#### NOTE

Pressing **RTN** line select key on **DATA FILL** page stops the fill process.

- 3. On the **DATA FILL** page, **FILL** line select key Press. **FILL ENABLED** screen will appear.
- 4. Start data fill on DTD. Monitor DTD to see when data transfer is complete.

**3.10.4.3 Load Secure Keys.** Key fill contains secure information needed for ALE link protection and ECCM operation.

- 1. Initialize the DTD. Connect the DTD to the **KEY** connector.
- 2. With the **FILL** page selected, **KEY** line select key Press.

#### NOTE

Pressing **RTN** line select key on **KEY FILL** page stops the fill process.

- 3. On the **KEY FILL** page, **LOAD** line select key Press. **FILL ENABLED** message will appear.
- 4. Start keyfill on DTD. Monitor DTD to see when data transfer is complete.

#### 3.10.4.4 Zero Secure Keys.

- 1. Access **KEY FILL** page. From **FILL** screen, **KEY** fixed function key Press.
- 2. ZERO line select key Press.
- 3. Select key to zero with **VALUE** keys. Default is all keys.

#### NOTE

If you do not want to zero the key, press **NO**. The **FILL** screen will then appear.

 Confirm zero by pressing YES line select key. ZEROIZE advisory message will appear, followed by the FILL screen.

**3.10.4.5 Emergency (EMER) Operation.** The mode, frequency, and net to be used in the **EMER** position is determined by the datafill. To use the emergency mode, do the following:

- 1. Function switch T/R.
- 2. Mode switch EMER.
- 3. ICS Transmitter selector Position 5.
- 4. Radio push-to-talk switch Press to talk; release to listen.

#### 3.10.5 Shutdown.

- 1. Function switch OFF.
- 2. To erase all preprogrammed information, Function switch - Pull and turn to **ZERO** (**PULL**).

**3.10.6 Messages.** Table 3-2 lists display advisory messages that may appear during operation of the radio:

ADVISORY	MEANING	ACTION
ALE - NO DATA	ALE mission data not loaded.	Load mission data.
ALE - NO KEYS	ALE link protection keys not loaded.	Load keys.
CALL FAIL	Radio failed to complete an outgoing call.	
CALLING	Radio is placing an ALE call to another address.	
CDU FAIL	Radio set control is inoperative.	
CHANNEL BUSY	ALE or ECCM net is in use.	Wait or try another net.
CHANNEL INOP	ALE or ECCM keys are not loaded, or not correct.	
CHECK MSG	A data message has been received.	

#### Table 3-2. AN/ARC-220 Messages

ADVISORY	MEANING	ACTION
COMPLETE	Indicated power-up BIT is complete.	
COPY COMPLETE	Copying process finished successfully.	
COPY FAIL	Copying process was unsuccessful.	
COPYING DATA	The radio is copying datafill contents from DTS.	
ECCM - NO DATA	ECCM data not installed.	Load mission data.
ECCM - NO KEYS	ECCM keys not installed.	Load keys.
EMER	Mode or net selected for emergency communica- tion is inoperative.	
EMERG - NO KEYS	No keys available for net selected for emergency communication.	Load keys.
EOM	End of message.	
EXT FAIL	Radio failed due to external device, such as antenna.	
GO DATA	Link quality analysis values too low for reliable voice communication; data transmissions recommended.	
GPS FAIL	Position report could not be issued.	
GPS TIME FAIL	Current time could not be established via GPS receiver.	
HELD	ALE call being held in specific frequency by operator.	
INCOMING CALL	Another radio is establishing an ALE link.	
INOP MODES EXIST	Warning to expect inoperative modes.	
LINKED	An ALE link is established.	
LOAD COMPLETE	Keys and data successfully loaded into radio.	
LOAD FAIL	Keys and data not successfully loaded into radio.	
LOADING DATA	Radio currently loading data.	
LOADING KEYS	Radio currently loading keys.	

### Table 3-2. AN/ARC-220 Messages (Cont)

	MEANING	ACTION
ASG ABORT	Radio discontinuing sending of current message.	
NET INOP	Selected net contains no data, corrupted data, or hardware cannot support the selected mode of operation.	
NO AUTO XMT	Radio has been instructed not to make any automatic transmissions.	
NO DATA	Database is not filled with necessary data to perform requested operations.	
NO KEYS LOADED	Keys are not loaded for current selected mode or net.	
NO RCVD MSGS	No messages have been received.	
PAC FAIL	Failure of radio in PA coupler.	
PLGR	Precision lightweight GPS receiver.	
POSN RPT FAIL	Current GPS position report not loaded.	
PRE - NO DATA	Preset data not loaded.	
PTT FOR XMIT BIT	Instruction to press microphone PTT switch to enable transmission BIT.	
RCV BIT - GO	Receiver BIT functions completed without failure.	
RCV READY	Ready to receive ECCM transmissions.	
RCVG PREAMBLE	ECCM preamble being received.	
RCVG DATA	Radio currently receiving data.	
RT-CDU COMM FAIL	Receiver-transmitter is failing to communicate with the radio set control.	
RT FAIL	Receiver Transmitter inoperative.	
RX-TX DEGRADED	Receive and transmit capabilities are degraded.	
RX-TX FAIL	Radio cannot receive or transmit.	
SENDING DATA	Radio currently sending data.	

### Table 3-2. AN/ARC-220 Messages (Cont)

ADVISORY	MEANING	ACTION
SOUND	Radio sending an ALE sound.	
SYNCING	Time synchronization being performed.	
TESTING	BIT in progress.	
TIME SYNC FAIL	Radio failed in attempt to synchronize.	
TRANSEC FAIL	BIT detected a failure that will not allow ECCM operation.	
TUNE XX%	Indicates percentage of ECCM frequencies tuned for current net.	
TUNING	Radio is currently tuning itself.	
TX DEGRADED	BIT detected a failure that is causing transmission capability to be degraded.	
TX FAIL	Radio cannot transmit.	
UNSYNC	ECCM is not synchronized.	
UNTUNED	An ECCM hop set is not tuned.	
XMT READY	Radio is ready to transmit in ECCM mode.	
ZEROIZED	All mission datafill and keys have been erased.	

#### Table 3-2. AN/ARC-220 Messages (Cont)

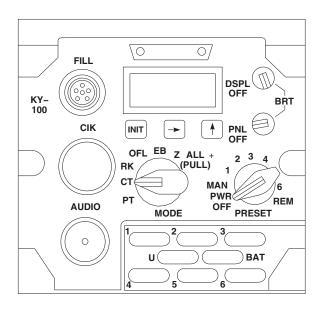
## 3.11 TSEC/KY-100 SECURE COMMUNICATION SYSTEM.

The TSEC/KY-100 provides secure, half duplex voice, digital data, analog data and remote keying capabilities for transmission over the AN/ARC-220 HF radio. It has six operational modes, and can store often used settings on presets. Power is supplied from the No. 1 dc primary bus through a circuit breaker marked **HF SCTY SET**.

**3.11.1 Controls and Functions.** The KY-100 is controlled by a control display unit (CDU) (Figure 3-11) located behind the lower console. The KY-100 must be powered on, regardless of the mode of operation,

whenever the equipment is installed. The function of each control and display is as follows:

CONTROL	FUNCTION
AUDIO	Speaker for audio tones.
СІК	Cryptographic Ignition Key. Not used in this installation.
FILL connector	Used to connect external fill device to KY-100.
INIT, 🛊 and 📥	Function keys used to access and navigate in software menus.



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#### Figure 3-11. KY-100 Secure Communication Control Panel

CONTROL	FUNCTION
DSPL OFF	Varies light intensity of display. Display turned off in <b>OFF</b> posi- tion.
PNL OFF	Varies light intensity of backlit dis- play panel. Display turned off in <b>OFF</b> position.
PRESET switch	Controls power to set, and which key is active.
PWR OFF	Removes power from set.
MAN	Manual rekeying enabled.
1,2,3,4,5,6	Selects preset settings for use.
REM	Allows control of KY-100 from a remote control unit.
MODE switch	
РТ	Sets KY-100 to plaintext mode.

CONTROL	
---------	--

**FUNCTION** 

CT RK	Sets KY-100 to ciphertext mode. Allows cooperative terminal rekey- ing in receive mode.
OFL	Sets KY-100 to off line mode. Disables communications and ac- cesses screens to select mode set- tings, test, and fill screens.
EB	Selects emergency back up key.
Z ALL (PULL)	Erases all cryptographic data (keys) except the emergency back up key.

#### 3.11.2 Modes of Operation.

**3.11.2.1 Plaintext (PT) Mode.** The ICS voice signal is routed through the KY-100 to and from the HF radio, with no processing. Radio transmits and receives unencrypted information.

**3.11.2.2 Cyphertext (CT) Mode.** The ICS voice signal is routed to the KY-100, where it is processed, encrypted and sent to the HF radio for transmission. Received audio signals from the HF radio are processed, decoded, and sent to ICS. Unencrypted information is routed through the KY-100 if CT ONLY is not selected in configuration settings. Non cooperative rekey receive is possible only in this mode.

**3.11.2.3 Rekey Mode.** Use this mode to fill crypto information. The data transfer device must be connected to **FILL** to load keys.

**3.11.2.4 Off-line (OFL) Mode.** For maintenance use to configure and test the system. Communications are not possible in this mode.

**3.11.2.5 Emergency Backup (EB) Mode.** Enables a zeroized terminal to be used for voice privacy operation, only. Key is not erased when terminal is zeroized. This mode is not to be used to transmit classified information.

**3.11.2.6 Zeroize (Z ALL) Mode.** Erases all keys in the KY-100 except the emergency back up key.

#### 3.11.3 Operation.

**3.11.3.1 Keyfill Operation.** When there are no TEKs in the KY-100 at start up, the display will read **CLd STRT**. If there are TEKs in the terminal, skip steps 3 and 6, and load or update keys as required.

- 1. MODE switch OFFLINE.
- 2. PRESET switch MAN.
- 3. Wait until **CLd STRT** is displayed, then **INIT** key Press.
- 4. Connect a fill device to **FILL** connector.
- 5. Turn on device and select key to be loaded.
- 6. **INIT** key Press. At the end of the fill sequence, a tone should be heard in the headset, and **KEY 1 01**, **CIK OK**, and **PASS** will appear. The key that was loaded is stored in fill position 1.
- 8. **INIT** key Push twice. **LOAD KEY**, then **LOAD X** will be displayed with the flashing **X** being the number of currently selected key location.
- 10. **INIT** key Press. The entire **LOAD X** display will flash.
- 11. Turn on device and select key to be loaded.
- 12. **INIT** key Press. At the end of the fill sequence, a tone should be heard in the headset, and **KEY X** will appear. The display will then change to **LOAD X** with the flashing **X** being the number of currently selected key location.
- 13. Repeat steps 9. through 11. until all required locations are filled.
- 14. When all keys are transferred, turn off the fill device, and disconnect it from **FILL** connector.

15. To exit key load, place **MODE** switch out of **OFFLINE**.

#### 3.11.3.2 Normal Operation.

- 1. MODE switch PT or CT.
- 2. PRESET switch MAN, 1, 2, or 3.

#### 3.11.3.3 Emergency Operation.

#### NOTE

Emergency key is not secure. Do not transmit classified information in this mode.

- 1. MODE switch EB.
- 2. PRESET switch MAN, 1, 2, or 3.

#### 3.11.3.4 Zeroize All Keys.

#### NOTE

- Power does not have to be applied to unit to zero all keys.
- Emergency backup key is not zeroized in this procedure.
  - 1. **MODE** switch Pull and rotate to **Z ALL +** (**PULL**).

#### 3.11.3.5 Zeroize Specific Keys.

- 1. MODE switch OFFLINE.
- 2. UP ARROW, or RIGHT ARROW soft key Press, until KEY OPS is displayed.
- 3. **INIT** key Press. **LOAD KEY** will be displayed.
- 4. UP ARROW, or **RIGHT ARROW** key Press, until **ZERO** is displayed.
- 5. **INIT KEY** soft key Press. **ZERO X**, with a flashing number (X) appears. The flashing number indicates the currently selected key to be zeroized.

#### NOTE

Number of keys is 1 through 6 TEKs, U (used to update internal keys) and Eb (emergency backup key).

- 6. **UP ARROW**, or **RIGHT ARROW** key Press, until key number to zeroize is displayed.
- 7. **INIT** key Press. The entire **ZERO X** will now flash.
- 8. **INIT** key Press. The screen will blank while zeroizing process takes place. When zeroizing

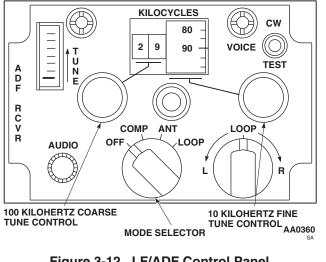
is complete, a tone will be heard in the headset, the display will briefly change to **ZEROED X**, and then revert to **ZERO X**.

- 9. Repeat steps 6. through 8. to zero other key positions, as desired.
- 10. When all desired key positions are zeroized, **MODE** switch Move to any other position.

#### 3.11.4 Shutdown.

PRESET switch - PWR OFF.

#### Section III NAVIGATION





## 3.12 DIRECTION FINDER SET AN/ARN-89. (LF/ ADF).

Direction Finder set AN/ARN-89 is an airborne, low frequency (LF), automatic direction finder (ADF) radio, that provides an automatic or manual compass bearing on any radio signal within the frequency range of 100 to 3,000 kHz. The ADF can identify keyed or CW stations. The ADF displays the bearing of the helicopter relative to a selected radio transmission on the HSI No. 2 bearing pointer. When ADF is selected on the **MODE SEL** panel, three modes of operation permit the system to function: as a CW automatic direction finder, as a CW manual direction finder or as an AM broadcast receiver. Power to operate the Direction Finder AN/ARN-89 is provided by No. 1 dc primary bus through a circuit breaker marked **ADF**, and the ac essential bus through a circuit breaker marked **26 VAC INST**.

**3.12.1 Antennas.** The ADF sense antenna is a part of the VHF/FM No. 2, VHF/AM, antenna under the nose section of the helicopter. The ADF loop antenna is flushmounted, under the center fuselage section.

**3.12.2 Controls and Functions.** Controls for the LF/ ADF receiver are on the front panel (Figure 3-12) of the unit. The function of each control is as follows:

CONTROL	FUNCTION
Mode selector switch	
OFF	Turns power off.
COMP	Provides operation as an ADF.
ANT	Provides for operation as an AM receiver using sense antenna.
LOOP	Provides for receiver operation as a manual direction finder using loop only.
LOOP L-R control switch	Provides manual left and right control of loop when operating mode selector in <b>LOOP</b> position. It is spring loaded to return to center.
AUDIO	Adjusts volume.
100 Kilohertz coarse-tune control knob	Tunes receiver in 100-kHz steps as indicated by first two digits of <b>KILOCYCLES</b> indicator.
10 Kilohertz fine -tune control knob	Tunes receiver in 10-kHz steps as indicated by last two digits of <b>KILOCYCLES</b> indicator.
<b>CW</b> , <b>VOICE</b> , <b>TEST</b> switch	
CW (COMP mode)	Enables tone oscillator to provide audible tone for tuning to CW sta- tion, when mode function switch is at <b>COMP</b> .
CW (ANT or LOOP mode)	Enables beat frequency oscillator to permit tuning to CW station, when mode function switch is at <b>ANT</b> or <b>LOOP</b> .
VOICE	Permits low frequency receiver to operate as a receiver with mode switch in any position.

CONTROL	FUNCTION
TEST (COMP mode)	Provides slewing of loop through 180° to check operation of receiver in <b>COMP</b> mode. (Switch position is inoperative in <b>LOOP</b> and <b>ANT</b> mode.)
TUNE meter	Indicates relative signal strength while tuning receiver to a specific radio signal.
KILOCYCLES indicator	Indicates operating frequency to which receiver is tuned.

#### 3.12.3 Operation.

#### 3.12.3.1 Starting Procedure.

- 1. ICS NAV receiver selector ON.
- 2. Mode selector COMP, ANT, or LOOP.
- 3. Frequency Select.
- 4. **CW**, **VOICE**, **TEST** switch **CW** or **VOICE** as appropriate.
- 5. ICS NAV switch ON.
- 6. Fine tune control Adjust for maximum upward indication on **TUNE** meter.
- 7. AUDIO control Adjust as desired.

#### 3.12.3.2 ANT Mode Operation.

- 1. Mode selector ANT.
- 2. ICS NAV switch ON.
- 3. Monitor receiver by listening.

#### 3.12.3.3 COMP Mode Operation.

- 1. Mode selector COMP.
- 2. MODE SEL BRG 2 HSI/VSI switch ADF.
- 3. The horizontal situation indicator No. 2 bearing pointer displays the magnetic bearing to the ground station from the helicopter, as read against the compass card, when **ADF** is selected on the **MODE SEL BRG 2** switch.

- 4. ICS NAV switch ON.
- 5. To test the ADF, when required:
  - a. **CW**, **VOICE**, **TEST** switch **TEST**. Check to see that No. 2 bearing pointer changes about 180°.
  - b. CW, VOICE, TEST switch Release.

**3.12.3.4 LOOP Mode Operation.** Manual direction finding uses the **LOOP** mode.

- 1. Mode selector switch LOOP.
- 2. ICS NAV switch ON.
- 3. Turn LOOP L-R switch to L (left) or R (right) to obtain an audio null and a TUNE indicator null. Watch HSI No. 2 bearing pointer for a display of magnetic bearing to or from ground station as read against the compass card. In this mode of operation, two null positions 180° apart are possible.

#### 3.12.4 Stopping Procedure. Mode selector - OFF.

#### 3.13 DIRECTION FINDER SET AN/ARN-149 (LF/ ADF) (IF INSTALLED).

The AN/ARN-149 is an LF ADF radio providing compass bearing capability within the frequency range of 100 to 2199.5 kHz. The ADF has two functional modes of operation: **ANT** and **ADF**. The antenna (**ANT**) mode functions as an aural receiver providing only an aural output of the received signal. The **ADF** mode functions as an automatic direction finder providing a relative bearingto-station signal to the horizontal situation indicator No. 2 bearing pointer and an aural output. A **TONE** submode of operation can be selected in either **ANT** or **ADF** mode, providing a 1000-Hz aural output to identify keyed CW signals. Power is provided to the LF/ADF system by the No. 1 dc primary bus through a circuit breaker labeled **ADF** and the ac essential bus through a circuit breaker labeled **26 VAC INST**.

**3.13.1 Antennas.** The antenna system is a single combination antenna containing both loop and sense elements. The RF signal from one loop element is modulated with a reference sine signal while the other loop element is modulated with a reference cosine signal. The two modulated signals are combined, phase shifted 90°, and amplified. The resulting loop signal is summed with the sense antenna signal and sent to the ADF radio for visual

and aural execution. The antenna configuration is flush mounted under the bottom cabin fuselage.

**3.13.2 Controls and Functions.** Controls and frequency digit displays are on the front of the ADF control panel (Figure 3-13). The function of each control is as follows:

frequency when MAN/2182/500

switch is in MAN.

# CONTROL FUNCTION Frequency controls Controls and indicates the selected

#### MAN/2182/500

and indicators

select

MAN	Enables the frequency controls and indicators.
2182	Selects 2182 kHz as the operating frequency.
500	Selects 500 kHz as the operating frequency.
TEST/(off center position)/TONE select	<b>TEST</b> position (up) is a momentary position that enables a self-test. Center position is off. <b>TONE</b> position (down) enables the tone generator for CW operation.
VOL adjust	A 12-position switch controlling volume in 12 discrete steps.
TAKE CMD select	Used in a dual ADF control panel installation allowing each to take control of the receiver away from the other. Not used in this installa- tion.
ADF/ANT/OFF select	
ADF	Applies power to system and turns on ADF and aural capability.
ANT	Applies power to system and turns on antenna or aural function only.

**OFF** Removes power from system.

#### 3.13.3 Operation.

#### 3.13.3.1 ANT (Aural Only) Operation.

1. ICS NAV receiver selector switch - ON.

2. ADF/ANT/OFF switch - ANT.

3. MAN/2182/500 switch - As desired.

If MAN is selected in step 3:

- 4. Frequency switches Select.
- 5. VOL control Adjust as desired.
- 6. **TEST**/off/**TONE** switch **TONE**.

#### 3.13.3.2 ADF Operation.

- 1. ICS NAV receiver selector switch ON.
- 2. HSI/VSI MODE SEL BRG 2 switch ADF.
- 3. ADF/ANT/OFF switch ADF.
- 4. MAN/2182/500 switch As desired.

#### If MAN is selected in step 4:

- 5. Frequency switches Select.
- 6. VOL control Adjust as desired.

#### If CW operation is desired:

- 7. TEST/off/TONE switch TONE.
- 8. Verify HSI No. 2 bearing pointer displays appropriate relative bearing-to-the-station.

#### If self-test is required:

- 9. **TEST**/off/**TONE** switch **TEST** (position up and hold).
- 10. No. 2 bearing pointer deflects 90° away from original reading.
- 11. TEST/off/TONE switch Release to off.
- 12. Verify No. 2 bearing pointer returns to original reading.

#### 3.13.4 Stopping Procedure.

#### ADF/ANT/OFF switch - OFF.

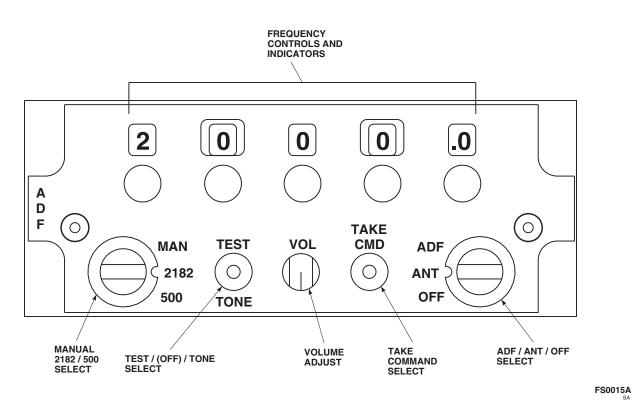


Figure 3-13. LF/ADF Control Panel AN/ARN-149

## 3.14 RADIO RECEIVING SET AN/ARN-123(V) (VOR/ILS/MB).

Radio set AN/ARN-123(V) is a very high-frequency receiver that operates from 108.00 to 117.95 MHz. Course information is presented by the VSI course deviation pointer and the selectable No. 2 bearing pointer on the horizontal situation indicator. The combination of the glide slope capability and the localizer capability makes up the instrument landing system (ILS). Marker beacon passage is visually indicated with the VSI MB light, and aurally indicated through the headphones. The receiving set may be used as a VOR receiver, or ILS receiver. The desired type of operation is selected by tuning the receiving set to the frequency corresponding to that operation. ILS operation is selected by tuning to the odd tenth MHz frequencies between 108.0 and 112.0 MHz. VOR operation is selected by tuning in .050 MHz units to the frequencies between 108.0 and 117.95 MHz, except the odd tenth MHz between 108.0 and 112.0 MHz, which are reserved for ILS operation. The three receiver sections do the intended functions independent of each other. Performance degradation within any one of the major sections will not affect the performance of the others. Power for the AN/ ARN-123 is provided from the dc essential bus through a circuit breaker marked VOR/ILS.

#### NOTE

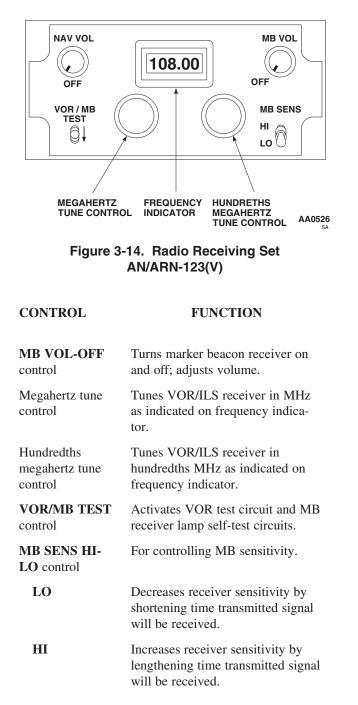
Tuning to a localizer frequency will automatically tune to a glide slope frequency, when available.

**3.14.1 Antenna.** The VOR/LOC antenna system consists of two blade type collector elements, one on each side of the fuselage tail cone. The glide slope antenna is mounted under the avionics compartment in the nose. The antenna provides the glide slope receiver with a matched forward-looking receiving antenna. The marker beacon antenna is flush-mounted under the center section of the fuselage.

**3.14.2 Controls and Functions.** The controls for the VOR/ILS/MB receivers are on the front panel (Figure 3-14) of the unit. The function of each control is as follows:

CONTROL FUNCTION

NAV VOL-OFF Turns VOR/ILS receiver on and off, adjusts volume.



#### 3.14.3 Operation.

#### 3.14.3.1 Starting Procedure.

- 1. ICS AUX selector ON.
- 2. NAV VOL OFF control On.
- 3. Frequency Select.

4. MODE SEL BRG 2 switch - VOR.

5. MODE SEL VOR/ILS switch - VOR.

#### 3.14.3.2 VOR/Marker Beacon Test.

#### NOTE

If acceptable signal is not received, test will not be valid.

- 1. HSI **CRS** set 315° on **COURSE** set display, pilot and copilot.
- 2. **VOR/MB TEST** switch Down and hold. The **MB** light on the VSI should go on.
- 3. HSI VOR/LOC course bar and VSI course deviation pointer Centered ±1 dot.
- 4. No. 2 bearing pointer should go to the  $310^{\circ}$  to  $320^{\circ}$  position.
- 5. To-from arrow should indicate TO.
- 6. VOR/MB TEST switch Release.

#### 3.14.3.3 VOR Operation.

Course - Set.

**3.14.3.4 ILS (LOC/GS) Operation.** ILS operation frequency - Set.

#### 3.14.3.5 Marker Beacon (MB) Operation.

1. MB VOL OFF switch - On.

2. MB SENS switch - As desired.

## 3.14.3.6 VOR Communications Receiving Operation.

Frequency - Set.

#### 3.14.4 Stopping Procedure.

NAV VOL OFF switch - OFF.

## 3.15 RADIO RECEIVING SET AN/ARN-147(V) (VOR/ILS/MB) (IF INSTALLED).

Radio set AN/ARN-147 (V) (Figure 3-15) is a VHF receiver, capable of operating from 108.0 to 126.95 MHz. Course information is presented by the VSI deviation

pointer and the selectable No. 2 bearing pointer on the HSI. The combination of the glide slope and localizer capabilities makes up the instrument landing system (ILS). The marker beacon portion of the receiver visually indicates on the VSI MB, and aurally signals over the headphones helicopter passage over a transmitting marker beacon. The radio set may be used as a VOR or ILS receiver. The desired type of operation is selected by tuning the receiving set to the frequency corresponding to that operation. ILS operation is selected by tuning to the odd tenth MHz frequencies from 108.0 to 111.95 MHz. VOR operation is selected by tuning from 108.0 to 126.95 MHz, except the odd tenth MHz from 108.0 to 111.95 MHz reserved for ILS operation. The three receiver sections do the intended functions independent of each other. Performance degradation within any one of the major sections will not affect performance of the others. Power for the AN/ARN-147 is provided from the dc essential bus through a circuit breaker, labeled VOR/ILS.

#### NOTE

Tuning to a localizer frequency will automatically tune to a glide slope frequency when available.

**3.15.1 Antennas.** The VOR/LOC antenna system consists of two blade-type collector elements, one on each side of the fuselage tail cone. The glide slope antenna is mounted under the avionics compartment in the nose. The antenna provides the glide slope receiver with a matched forward looking receiving antenna. The marker beacon antenna is flush-mounted under the center section of the fuselage.

**3.15.2 Controls and Functions.** The controls for the VOR/ILS/MB receivers are on the front of the control panel. The function of each control is as follows:

#### CONTROL **FUNCTION** Digit window Indicates selected operating frequency. NAV VOL control Varies navigation (VOR/LOC) audio gain of associated receiver. kHz digits select Changes frequency in 50-kHz steps over the range of control (last two digits). TEST/(power) ON/ Controls application of power to **OFF** switch the associated receiver. Controls VOR/marker beacon test.

CONTROL	FUNCTION
MB HI/LO switch	Varies marker beacon (MB) sensitivity (high or low).
MHz digits select	Changes frequency in 1-MHz steps over the range of control (first three digits).
MB VOL control	Varies marker beacon (MB) audio gain of the associated receiver.

#### 3.15.3 Operation.

#### 3.15.3.1 Starting Procedure.

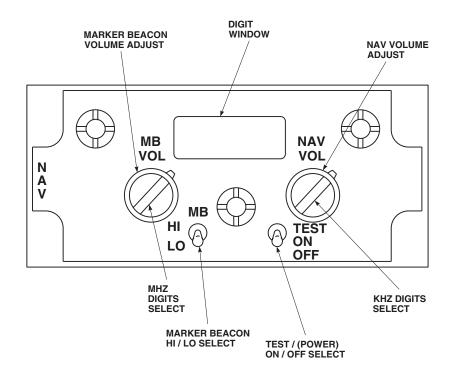
- 1. ICS AUX receiver selector switch ON.
- 2. **TEST**/(power) **ON/OFF** switch **ON** (center position).
- 3. MHz (first three digits) control Select.
- 4. KHz (last two digits) control Select.
- 5. NAV VOL control Adjust.
- 6. MODE SEL BRG 2 switch VOR.
- 7. MODE SEL VOR/ILS switch VOR.
- 8. CIS MODE SEL NAV/ON switch As desired.

#### 3.15.3.2 VOR/Marker Beacon Test.

#### NOTE

If acceptable signal is not received, test will not be valid.

- 1. HSI CRS set 315° on COURSE set display, pilot and copilot.
- TEST/(power) ON/OFF switch TEST (position up and hold). The MB light on the VSI should go on.
- 3. HSI VOR/LOC course bar and VSI course deviator pointer Centered (±1 dot).
- 4. No. 2 bearing pointer should go to the  $310^{\circ}$  to  $320^{\circ}$  position.



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Figure 3-15. VOR/ILS/MB Control Panel AN/ARN-147(V)

- 5. To-from arrow indicates TO.
- 6. TEST/(power) ON/OFF switch Release.

#### 3.15.3.3 VOR Operation.

- 1. HSI CRS control Course select.
- 2. Remote Instrument Controller COURSE 2 control Course select.

#### 3.15.3.4 ILS (LOC/GS) Operation.

- 1. ILS operation frequency/volume Set.
- 2. HSI CRS control Course select.
- 3. CIS MODE SEL NAV/ON switch As desired.

#### 3.15.3.5 Marker Beacon (MB) Operation.

- 1. ICS NAV receiver selector switch ON.
- 2. MB HI/LO switch As desired.
- 3. MB VOL control Adjust as desired.

3.15.3.6 VOR Communications Receiving Operation.

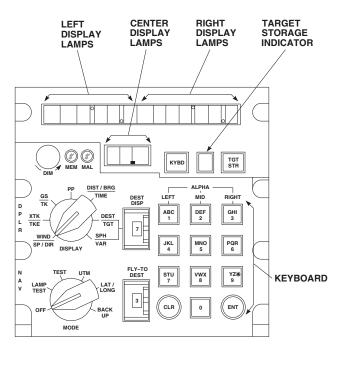
Frequency/Volume - Set.

#### 3.15.4 Stopping Procedure.

TEST/(power) ON/OFF switch - OFF.

# 3.16 DOPPLER NAVIGATION SET AN/ASN-128.

The Doppler navigation set, AN/ASN-128, in conjunction with the helicopter's heading and vertical reference systems, provides helicopter velocity, position, and steering information from ground level to 10,000 feet. To achieve best results with the set, pitch and roll angles should be limited to 30° pitch and 45° roll, and moderate maneuver rates should be employed. The Doppler navigation system is a completely self-contained navigation system and does not require any ground-based aids. The system provides world-wide navigation, with position readout available in both Universal Transverse Mercator (UTM) and Latitude and Longitude (LAT/LONG) (Figure 3-18). Navigation and steering is done using LAT/LONG coordinates, and a bilateral UTM-LAT/LONG conversion routine is provided for UTM operation. Up to ten destina-



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Figure 3-16. Doppler Navigation Set AN/ASN-128

tions may be entered in either format and not necessarily the same format. Present position data entry format is also optional and independent of destination format. Power to operate the AN/ASN-128 is provided from No. 1 dc primary bus through a circuit breaker marked **DPLR**, and from the ac essential bus through a circuit breaker marked **26 VAC DPLR**, refer to TM 11-5841-281-12.

**3.16.1 Antenna.** The Doppler antenna consists of a combined antenna/radome and a receiver-transmitter housing below copilot's seat. The combination antenna/radome uses a printed-grid antenna.

**3.16.2 Controls, Displays, and Function.** The control and displays for the Doppler are on the front panel (Figure 3-16). The function of each control is as follows:

CONTROL/ INDICATOR	FUNCTION
MODE selector	Selects Doppler Navigation Mode of operation.
OFF	Turns navigation set off.

CONTROL/	FUNCTION
INDICATOR	
LAMP TEST	Checks operation of all lamps.
TEST	Initiates built-in-test exercise for navigation set.
UTM	Selects Universal Transverse Mer- cator navigational mode of opera- tion.
LAT/LONG	Select latitude/longitude navigational mode of operation.
BACKUP	Places navigation set in estimated mode of operation or estimated velocity mode of operation.
<b>DISPLAY</b> selector	Selects navigation data for display.
WIND SP/ DIR	Not applicable.
<b>XTK/TKE</b> (Left Display)	Distance crosstrack ( <b>XTK</b> ) of initial course to destination in km and tenths of a km.
(Right Display)	Track angle error ( <b>TKE</b> ) in de- grees displayed as right or left of bearing to destination.
<b>GS-TK</b> (Left Display)	Ground speed (GS) in km/hr.
(Right Display)	Track angle ( <b>TK</b> ) in degrees TRUE.
<b>PP</b> with switch set to <b>UTM</b> (Center Display)	Present position UTM zone.
(Left Display)	Present position UTM area square designator and easting in km to nearest ten meters.
(Right Display)	Present position UTM area north- ing in km to nearest ten meters.
PP with MODE switch set to LAT/LONG (Left Display)	Present position latitude in degrees, minutes, and tenths of minutes.

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
(Right Display)	Present position longitude in de- grees, minutes, and tenths of	<b>DIM</b> control	Controls light intensity of display characters.
<b>DIST/BRG-</b> <b>TIME</b> (Center Display)	minutes. Time to destination selected by <b>FLY TO DEST</b> (in minutes and tenths of minutes).	Left, Right, and Center display lamps	Lights to provide data in alphanumeric and numeric characters, as determined by set- ting of <b>DISPLAY</b> switch, <b>MODE</b> switch, and operation of keyboard.
(Left Display)	Distance to destination selected by <b>FLY TO DEST</b> (in km and tenths of a km).	Target storage indicator	Displays destination number (memory location in which present position will be stored when <b>TGT</b> <b>STR</b> pushbutton is pressed.
(Right Display)	Bearing to destination selected by <b>FLY TO DEST</b> (in degrees MAGNETIC).	TGT STR pushbutton	Stores present position data when pressed.
<b>DEST-TGT</b> (Mode switch set to <b>UTM</b> ) (Center Display)	UTM zone of destination selected by <b>DEST DISP</b> thumbwheel.	<b>KYBD</b> pushbut- ton	Used in conjunction with the keyboard to allow data to be displayed and subsequently entered into the computer when the <b>ENT</b> key is pressed.
(Left Display)	UTM area and easting of destina- tion set on <b>DEST DISP</b> thumb- wheel.	<b>DEST DISP</b> thumbwheel switch	Destination display thumbwheel switch is used along with <b>DEST-</b> <b>TGT</b> and <b>SPH-VAR</b> position of
(Right Display)	Northing of destination set on <b>DEST DISP</b> thumbwheel.		<b>DISPLAY</b> switch to select destina- tion whose coordinates or magnetic variation are to be displayed, or to
<b>DEST-TGT</b> (Mode switch set to <b>LAT/LONG</b> (Left Display)	Latitude (N 84° or S 80° max.) of destination set on <b>DEST DISP</b> thumbwheel.		be entered. Destinations are 0 through 9, P (Present Position) and H (Home).
(Right Display)	Longitude of destination set on <b>DEST DISP</b> thumbwheel.		
<b>SPH-VAR</b> (Left Display)	Spheroid code of destination set on <b>DEST DISP</b> thumbwheel.		
(Right Display)	Magnetic variation (in degrees and tenths of degrees) of destination set on <b>DEST DISP</b> thumbwheel.		
<b>MEM</b> indicator lamp	Lights when radar portion of navigation set is in nontrack condi- tion.		
MAL indicator lamp	Lights when navigation set malfunction is detected by built in self-test		

self-test.

CONTROL/ INDICATOR	FUNCTION	for the k any failu
Keyboard	Used to set up data for entry into memory. When the <b>DISPLAY</b> switch is turned to the position in which new data is required and the <b>KYBD</b> pushbutton is pressed, data may be displayed on the appropri- ate left, right, and center display. To display a number, press the cor- responding key or keys (1 through 0). To display a letter, first depress the key corresponding to the desired letter. Then depress a key in the left, middle or right column, corresponding to the position of the letter on the key. Example: To enter an L, first depress L, then 3, 6, or 9 in the right column.	lamp of converte turning compone turn-on failed un the com signal d provideo tor lamp smooth 10 minu tion in ti <b>MODE</b> malfunc the alpha
FLY-TO-DEST thumbwheel switch	Selects the destination for which <b>XTK/TKE</b> and <b>DIST/BRG/TIME</b> are displayed when the <b>DISPLAY</b> switch is turned to either of these positions which steering informa- tion is desired. Destinations are 0 through 9, and H (Home).	or LAT/ applied to and fund are comp instantan tion and displaye time, dis
ENT key	Enters data set up on keyboard into memory when pressed.	preset de by the <b>F</b>
CLR key	Clears last entered character when pressed once. When pressed twice, clears entire display panel under keyboard control.	<b>3.16.3.</b> velocity insert gr the displ

**3.16.3 Modes of Operation.** The three basic modes of operation are: Navigate, test, and backup.

**3.16.3.1 Test Mode.** The TEST mode contains two functions: **LAMP TEST** mode, in which all display segments are lit, and **TEST** mode, in which system operation is verified. In the **LAMP TEST** mode, system operation is identical to that of the navigate mode except that all lamp segments and the **MEM** and **MAL** indicator lamps (Figure 3-17) are lighted to verify their operation. In TEST mode, the system antenna no longer transmits or receives electromagnetic energy; instead, self-generated test signals are inserted into the electronics to verify operation. System operation automatically reverts into the backup mode during test mode. Self-test of the Doppler set is done using built-in-test equipment (BITE), and all units connected and energized for normal operation. Self-test isolates failures to one of the three units. The computer-display unit (except

keyboard and display) is on a continuous basis, and lure is displayed by turn-on of the MAL indicator on the computer-display unit. The signal data er and receiver-transmitter-antenna are tested by the MODE switch to TEST. Failure of those ients is displayed on the computer-display unit by of the MAL indicator lamp. Identification of the nit is indicated by a code on the display panel of nputer-display unit. Continuous monitoring of the data converter and receiver-transmitter-antenna is ed by the **MEM** indicator lamp. The **MEM** indicap will light in normal operation when flying over water. However, if the lamp remains on for over utes, over land or rough water, there is a malfuncthe Doppler set. Then the operator should turn the switch to TEST, to determine the nature of the ction. Keyboard operation is verified by observing anumeric readout as the keyboard is used.

**3.16.3.2 Navigate Mode.** In the navigate mode (UTM or LAT/LONG position of the MODE selector), power is applied to all system components, and all required outputs and functions are provided. Changes in present position are computed and added to initial position to determine the instantaneous latitude/longitude of the helicopter. Destination and present position coordinates can be entered and displayed in UTM and latitude/longitude. At the same time, distance, bearing and time-to-go to any one of ten preset destinations are computed and displayed as selected by the FLY-TO DEST thumbwheel.

**3.16.3.3 Backup Mode.** In this mode, remembered velocity data are used for navigation. The operator can insert ground speed and track angle with the keyboard and the display in **GS-TK** position. This remembered velocity data can be manually updated through use of the keyboard and CDU **DISPLAY** switch in the **GS-TK** position. When GS-TK values are inserted under these conditions, navigation continues using only these values.

# 3.16.4 Operation.

# 3.16.4.1 Window Display and Keyboard Opera-

tion. In all data displays except UTM coordinates, the two fields are the left and right display windows. In UTM coordinates displays, the first field of control is the center window and the second field is the combination of the left and right displays. When pressing the **KYBD** pushbutton, one or other of the fields described above is under control. If it is not desired to change the display in the panel section under control, the pilot can advance to the next field of the display panel by pressing the **KYBD** pushbutton again. The last character entered may be cleared by pressing the **CLR** key. That character may be a symbol or an

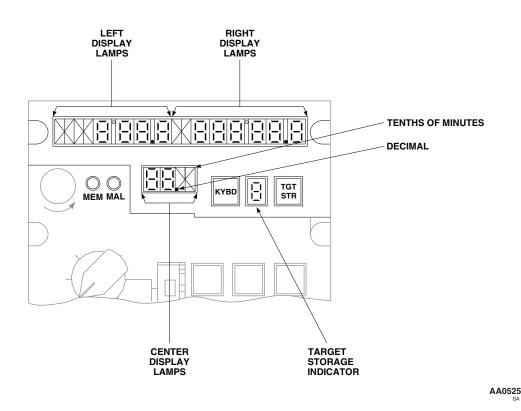


Figure 3-17. Doppler Lamp Test Mode Display

alphanumeric character. However, if the **CLR** key is pressed twice in succession, all characters in the field under control will be cleared and that field will still remain under control.

#### 3.16.4.2 Data Entry.

- To enter a number, press the corresponding key. To enter a letter, first press the key corresponding to the desired letter. Then press a key in the left, middle, or right column corresponding to the position of the letter on the pushbutton.
- 2. Example: To enter an L, first press L, then either 3, 6, or 9 in the right column. The computer program is designed to reject unacceptable data (for example, a UTM area of WI does not exist, and will be rejected). If the operator attempts to insert unacceptable data, the display will be blank after **ENT** is pressed.

#### 3.16.4.3 Starting Procedure.

1. **MODE** selector - **LAMP TEST**. All lights should be lit.

- a. Left, right, center and target storage indicator - Illuminated. All other lights should be on.
- b. Turn **DIM** control fully clockwise, then fully counterclockwise, and return to full clockwise; all segments of the display should alternately glow brightly, go off, and then glow brightly.
- 2. **MODE** selector TEST. After about 15 seconds left display should display GO. Ignore the random display of alpha and numeric characters which occurs during the first 15 seconds. Also ignore test velocity and angle data displayed after the display has frozen. After about 15 seconds, one of the following five displays will be observed in the first two character positions in the left display:

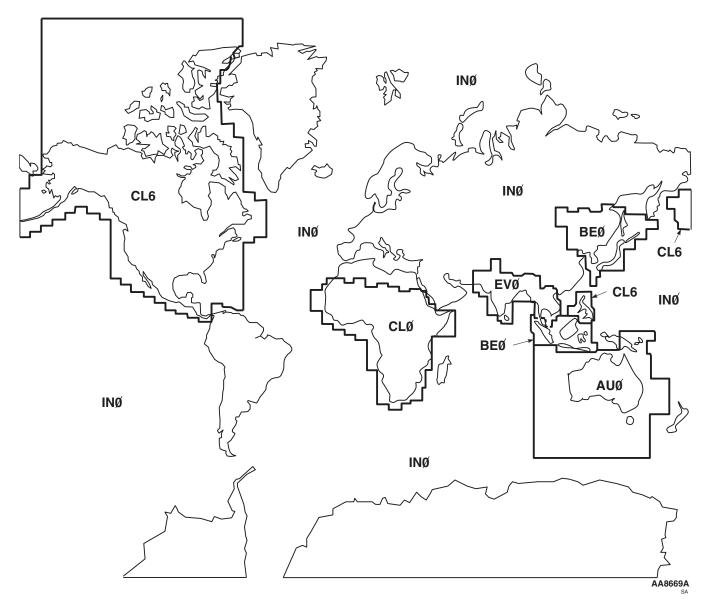


Figure 3-18. Doppler World UTM Spheroids (AN/ASN-128)

# NOTE

If the MAL lamp lights during any mode of operation except LAMP TEST, the computer-display unit MODE switch

should be turned first to **OFF**, and then to **TEST**, to verify the failure. If the **MAL** lamp remains on after recycling to **TEST**, notify organizational maintenance personnel of the navigation set malfunction.

D	SPLAY	REMARKS	DI	SPLAY	REMARKS
LEFT	RIGHT		LEFT	RIGHT	
GO	No display. Display blanks (normal).	If right display is blank, system is operating satisfactorily.	MN	C, R, S, or H followed by a numeric code	A failure has occurred and the <b>BACKUP</b> mode, used for manual navigation (MN), is the only means of valid
GO	Р	If right display is P, then pitch or roll data is missing, or pitch exceeds 90°. In this case, pitch and roll in the computer are both set to zero and navigation continues in a degraded operation. Problem may be in the vertical gyroscope/AHRU or helicopter cabling.			navigation. The operator may use the computer as a dead reckoning device by entering ground speed and track data. The operator should update present position as soon as possible, because it is pos- sible significant navigation errors may have ac- cumulated.
		NOTE	MN	HO10000	No heading information to signal data converter.
	MODE switch	node display is MN or NG, the n should be recycled through		SO5000	No 26 vac to signal data converter.
	momentary on MN, the data UTM or LAT	that the failure is not a ne. If the <b>TEST</b> mode display is entry may be made in the <b>/LONG</b> mode, but any naviga- arried on with the system in	NG	C, R, S, or H followed by a numeric code	A failure has occurred in the system and the operator should not use the system.
BU	the <b>BACKUP</b> C, R, S, or H followed	mode. A failure has occurred and the system has automatically	EN		The 9V battery has failed. All stored data must be reentered after battery replacement.
	by a numeric code	switched to a <b>BACKUP</b> mode of operation as follows: 1. The operator has the option of turning the	Blank	C with random numbers	Computer display unit failure.
		<b>MODE</b> switch to <b>BACKUP</b> and entering the best estimate of ground speed and track angle. 2. The operator	Blank	R with random numbers	Receiver-transmitter-antenna failure.
		has the option of turning the <b>MODE</b> switch to <b>BACKUP</b> and entering his best estimate of wind speed and direction	Blank	S with random numbers	Signal data converter failure.
		and entering his best estimate of ground speed and track	Random display	Random dis- play	Signal data converter failure.
		angle. The operator should update present position as soon as possible, because it is possible that significant navigation errors may have		efore navigating	<b>M Data.</b> This initial data is g with the Doppler. Refer to

accumulated.

a. Spheroid of operation, when using UTM coordinates.

b. UTM coordinates of present position - zone, area, easting (four significant digits) and northing (four significant digits; latitude/longitude coordinates may be used.

c. Variation of present position to the nearest one-tenth of a degree.

d. Coordinate of desired destination - 0 through 5 and H; (6 through 9 are normally used for target store locations; but may also be used for destinations). It is not necessary to enter all destinations in the same coordinate system.

#### NOTE

It is not necessary to enter destinations unless steering information is required, unless it is desired to update present position by overflying a destination, or unless a present position variation computation is desired (paragraph 3.16.3.3). If a present position variation running update is desired, destination variation must be entered. The operator may enter one or more destination variations to affect the variation update; it is not necessary for all destinations to have associated variations entered.

#### 3.16.4.5 Entering Spheroid and/or Variation.

- 1. MODE selector UTM, LAT/LONG or BACKUP.
- 2. DISPLAY selector SPH-VAR.
- 3. **DEST DISP** thumbwheel P, numeral, or H as desired.
- KYBD pushbutton Press. Observe display freezes and TGT STR indicator blanks. Press KYBD pushbutton again and observe left display blinks. If no spheroid data is to be entered, KYBD pushbutton - Press again, goto step 7.
- Spheroid data Entry. (Example: INØ). Press keys 3 (left window blanks), 3, 5, 5, and 0. Left display should indicate INØ. Refer to Figure 3-18 for codes.
- 6. **ENT** pushbutton Press if no variation data is to be entered.

- 7. **KYBD** pushbutton Press, if variation data is to be entered, and note right display blanks. (If no variation data is to be entered, **ENT** key -Press.)
- Variation data Enter. (Example: E001.2, press keyboard keys 2 (right window blanks), 2, 0, 0, 1 and 2. Press ENT key, the entire display will blank and TGT STR number will reappear, display should indicate INø E 001.2.)

# 3.16.4.6 Entering Present Position or Destination In UTM.

- 1. MODE selector UTM.
- 2. DISPLAY selector DEST-TGT.
- 3. **DEST DISP** thumbwheel P, numerical, or H as desired.
- 4. Present position and destination Enter. (Example: Entry of zone 31T, area CF, easting 0958 and northing 3849.)
  - a. **KYBD** pushbutton Press. Observe that display freeze and **TGT STR** indicator blanks.
  - b. **KYBD** button Press. Observe that center display blanks.
  - c. Key 3, 1, 7, and 8 Press.
  - d. **KYBD** button Press. Observe left and right displays blank.
  - e. Key 1, 3, 2, 3, 0, 9, 5, 8, 3, 8, 4, 9 Press.
  - f. ENT pushbutton Press. Left, right, and center displays will momentarily blank and TGT STR number will appear. Displays should indicate 31T CF 09583849.

**3.16.4.7 Entering Present Position or Destination Variation In LAT/LONG.** The variation of a destination must be entered after the associated destination coordinates are entered (since each time a destination is entered its associated variation is deleted). The order of entry for present position is irrelevant.

#### NOTE

If operation is to occur in a region with relatively constant variation, the operator enters variation only for present position, and the computer will use this value throughout the flight.

- 1. MODE selector LAT/LONG.
- 2. **DISPLAY** selector **DEST-TGT**.
- 3. **DEST DISP** thumbwheel P, numerical or H as desired.
- 4. Present position or destination Enter. (Example: Entry of N41° 10.1 minutes and E035° 50.2 minutes.) Press KYBD pushbutton. Observe that display freezes and TGT STR indicator blanks. Press KYBD pushbutton again and observe left display blanks. Press keys 5, 5, 4, 1, 1, 0 and 1. Press KYBD pushbutton (right display should clear) and keys 2, 2, 0, 3, 5, 5, 0, and 2.
- ENT pushbutton Press. Entire display will blank and TGT STR number will reappear. Display should indicate N 41° 10.1 E0 35° 50.2.

#### 3.16.4.8 Ground Speed and Track.

- 1. MODE selector BACK UP.
- 2. DISPLAY selector GS-TK.
- 3. Ground speed and track Enter. (Example: Enter 131 km/h and 024°. Press KYBD pushbutton, observe that left display freezes and TGT STR indicator blanks. Press KYBD pushbutton and observe that left display blanks. Press keys 1, 3, and 1. Left display indicates 131. Press KYBD pushbutton, control shifts to right display, and right display blanks. Press keys 0, 2 and 4.
- 4. **ENT** pushbutton Press. The entire display will blank, and **TGT STR** number will reappear. Display should indicate 131 024°.

**3.16.4.9 Initial Data Entry.** Initial data entry of variation in coordinates is normally done prior to takeoff. To make the initial data entry, do the following:

- 1. Present positon variation Enter (paragraph 3.16.4.5).
- 2. DISPLAY selector DEST-TGT.
- 3. **DEST DISP** thumbwheel P. Do not press **ENT** key now.
- 4. **ENT** pushbutton Press as helicopter is sitting over or overflies initial fix position.
- 5. **FLY-TO DEST** thumbwheel Desired destination location.

**3.16.4.10 Update of Present Position From Stored Destination.** The helicopter is flying to a destination set by the **FLY-TO DEST** thumbwheel. When the helicopter is over the destination, the computer updates the present position when the **KYBD** pushbutton is pressed, by using stored destination coordinates for the destination number shown in **FLY-TO DEST** window, and adding to them the distance traveled between the time the **KYBD** pushbutton was pressed and the **ENT** key was pressed.

- 1. **DISPLAY** selector **DIST/BRG-TIME**.
- 2. **KYBD** pushbutton Press, when helicopter is over the destination. Display freezes.

#### NOTE

If a present position update is not desired, as indicated by an appropriately small value of distance to go on overflying the destination, set the **DISPLAY** selector to some other position, this aborts the update mode.

3. ENT key - Press.

#### 3.16.4.11 Update of Present Position From

**Landmark.** There are two methods for updating present position from a landmark. Method 1 is useful if the landmark comes up unexpectedly and the operator needs time to determine the coordinates. Method 2 is used when a landmark update is anticipated.

#### 3.16.4.11.1 Method 1.

- 1. DISPLAY selector PP.
- 2. **KYBD** pushbutton Press as landmark is overflown. Present position display will freeze.
- 3. Compare landmark coordinates with those on display.

- 4. Landmark coordinates Enter. If difference warrants an update.
- 5. ENT key Press if update is required.
- 6. **DISPLAY** selector Set to some other position to abort update.

### 3.16.4.11.2 Method 2.

- 1. **DISPLAY** selector **DEST/TGT**.
- 2. **DEST DISP** thumbwheel P. Present postion coordinate should be displayed.
- 3. **KYBD** pushbutton Press, observe that display freezes.
- 4. Landmark coordinates Manually enter via keyboard.
- 5. ENT key Press when overflying landmark.
- 6. **DISPLAY** selector Set to some other position to abort update.

**3.16.4.12 Left-Right Steering Signals.** Flying shortest distance to destination from present position.

- 1. DISPLAY selector XTK-TKE.
- 2. MODE SEL DPLR.
- 3. Fly helicopter in direction of lateral deviation pointer on vertical situation indicator to center the pointer, or course deviation bar on HSI.

**3.16.4.13 Target Store (TGT STR) Operation.** Two methods may be used for target store operation. Method 1 is normally used when time is not available for preplanning a target store operation. Method 2 is used when time is available and it is desired to store a target in a specific **DEST DISP** position.

# 3.16.4.13.1 Method 1.

- 1. **TGT STR** pushbutton Press when flying over target.
- 2. Present position is automatically stored and the destination location is that which was displayed in the target store indicator (position 6, 7, 8, or 9) immediately before pressing the **TGT STR** pushbutton.

#### 3.16.4.13.2 Method 2.

- 1. **MODE** selector **UTM** or **LAT/LONG**, depending on coordinate format desired.
- 2. **DISPLAY** selector **DEST-TGT**.
- 3. **DEST DISP** thumbwheel P.
- 4. **KYBD** pushbutton Press when over flying potential target. Display should freeze.

### NOTE

Do not press **ENT** key while **DEST DISP** thumbwheel is at P.

- 5. If it is desired to store the target, turn **DEST DISP** thumbwheel to destination location desired and press **ENT** key.
- 6. If it is not desired to store the target, place **DISPLAY** selector momentarily to another position.

# 3.16.4.14 Transferring Stored Target Coordinates

**From One Location to Another.** The following procedure allows the operator to transfer stored target coordinates from one thumbwheel location to another. For example, it is assumed that the pilot wants to put the coordinates of stored target 7 into location of destination 2.

#### NOTE

Throughout this procedure, range, time-togo, bearing and left/right steering data are computed and displayed for the destination selected via the **FLY-TO DEST** thumbwheel.

- 1. **DISPLAY** selector **DEST-TGT**.
- 2. **DEST DISP** thumbwheel 7.
- 3. **KYBD** pushbutton Press.
- 4. **DEST DISP** thumbwheel 2.
- 5. ENT key Press.

# 3.16.4.15 Transferring Variation From One Loca-

**tion to Another.** The procedure to transfer variation data to the same location where the associated stored target coordinates has been transferred is the same as in

paragraph 3.16.4.14, Transferring Stored Target Coordinates From One Location To Another, except that the **DISPLAY** selector is placed at **SPH-VAR**.

**3.16.4.16 Dead Reckoning Navigation.** As an alternate **BACKUP** mode, dead reckoning navigation can be done using ground speed and track angle estimates provided by the operator.

- 1. MODE selector BACKUP.
- 2. DISPLAY selector GS-TK.
- 3. Best estimate of ground speed and track angle Enter via keyboard.
- 4. Set **MODE** selector to any other position to abort procedure.

3.16.4.17 Operation During and After Power Interruption. During a dc power interruption inflight, or when all helicopter power is removed, the random access memory (RAM) (stored destination and present position) data is retained by power from an 8.4 volt dc dry cell battery. This makes it unnecessary to reenter any navigational data when power returns or before each flight. If the battery does not retain the stored destination data during power interruption, the display will indicate on EN when power returns. This indicates to the pilot that previously stored data has been lost, and that present position, spheroid/variation, and destinations must be entered. The computer, upon return of power, resets present position variation to E000.0°, destination and associated variations to a non-entered state, remembers wind to zero and spheroid to CL6. The following data must be entered following battery failure:

- 1. Enter spheroid.
- 2. Enter present position variation.
- 3. Enter present position.
- 4. Enter each destination and its associated variation.

#### 3.16.5 Stopping Procedure. MODE selector - OFF.

# 3.17 DOPPLER/GPS NAVIGATION SET (DGNS) AN/ASN-128B.

The AN/ASN-128B DGNS is an AN/ASN-128 LDNS with an embedded GPS receiver. The AN/ASN-128B in conjunction with the helicopter's heading, vertical refer-

ences, and position and velocity updates from its internal GPS, provides accurate helicopter velocity, position and steering information from ground level to 10,000 feet. The system provides worldwide navigation, with position readout available in both Military Grid Reference System (MGRS) and Latitude and Longitude (LAT/LONG) coordinates. Navigation and steering is performed using LAT/LONG coordinates and a bilateral MGRS-LAT/LONG conversion routine is provided for MGRS operation. Up to 100 destinations may be entered in either format and not necessarily the same format.

**3.17.1 Antenna.** The GPS antenna is located on the top aft section of the helicopter. The Doppler antenna is located below the copilot's seat.

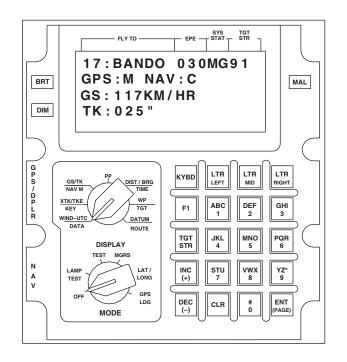
**3.17.2 Controls, Displays, and Function.** The control and displays for the AN/ASN-128B (Figure 3-19) are on the front panel. The function of each control is as follows:

CONTROL/ INDICATOR

#### FUNCTION

#### NOTE

	The <b>MODE</b> switch is locked in the <b>OFF</b> position and must be pulled out and turned to get into or out of the <b>OFF</b> position.
MODE selector	Selects mode of operation.
OFF	In this position the navigation set is inoperable: non-volatile RAM retains stored waypoint data.
LAMP TEST	Checks operation of all lamps.
TEST	Initiates built-in-self test exercise for the Doppler and GPS functions of the navigation set.
MGRS	Selects <b>MGRS</b> navigational mode of operation.
LAT/LONG	Selects latitude/longitude navigational mode of operation.
GPS LDG	Places navigation set in GPS land- ing mode of operation. This mode provides real time, tactical preci- sion landing guidance information to the HSI and VSI indicators.
<b>DISPLAY</b> selector	Selects navigation data for display.



AA9998B

### Figure 3-19. Doppler/GPS Navigation Set AN/ASN-128B/D

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
WIND-UTC DATA "Doppler only"	Used for wind speed and direction (with TAS sensor installed), UTC time, sea current, surface wind, GPS status and data load functions.	DIST BRG TIME	Displays distance, bearing, and time information to the destination or course selected. Selection of fly to destination can be accomplished
XTK/TKE KEY	Displays steering (cross track distance and track angle error)		by direct entry of two digit destina- tion number.
	information and GPS variable key status. Selection of fly to destina- tion by direct entry of two digit destination number.	WP TGT	Accesses waypoint or target data (landing data, variation, motion). Selection of destination for display/entry by direct entry of two
GS/TK NAV M	Displays ground speed, track angle and selection of <b>GPS</b> and naviga- tion mode.	DATUM ROUTE	digit destination number. Accesses datum and steering/route functions.
PP	Displays present position, altitude, and magnetic variation.		

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
MAL indicator lamp	Lights when a malfunction is detected by the built-in-test circuitry. In the event of an intermittent malfunction, the system may operate correctly but must be cycled to the <b>OFF</b> posi- tion then to on, to extinguish the <b>MAL</b> light.	<b>INC</b> and <b>DEC</b> keys	Used to increment or decrement the displayed waypoint/target number when the <b>DISPLAY</b> selec- tor is set to <b>WP/TGT</b> . To access <b>P</b> , press the <b>LTR LEFT</b> key fol- lowed by key 6; display waypoint 99 then press the <b>INC</b> key; or dis- play waypoint 00 then press the
BRT and DIM keys	Used to brighten or dim the light intensity of the LCD display.		<b>DEC</b> key. Also used to increment or decrement the fly-to destination number when the <b>DISPLAY</b> selec-
Four line alphanumeric	Displays alphanumeric characters, as determined by the setting of the DISPLAN selector, the MODE		tor is set to <b>DIST/BRG/TIME</b> or <b>XTK/TKE/KEY</b> .
display	<b>DISPLAY</b> selector, the <b>MODE</b> selector and operation keyboard. The keys activate function upon pressing the key.	ENT key (PAGE)	Enters data into memory (as set up on keyboard and displayed). This key is also used for paging of displays. The bottom right corner
TGT STR key	Stores present position data in the indicated target store/memory loca- tion (90-99) when pressed.		of the display indicates "more" when additional pages are avail- able, and "end" when no additional pages are available. Pressing this
KYBD key	Used in conjunction with the keyboard to allow data display and entry into the computer.		key when "end" is displayed will return the display to the first page.
Keyboard and <b>LTR</b> keys	Used to set up data for entry into memory. When <b>DISPLAY</b> selector is set to a position in which new data is required and <b>KYBD</b> key is	CLR key	Clears last entered character when pressed once. When pressed twice, clears entire input field of display keyboard control.
	pressed, data may be displayed on the appropriate input field of dis-	F1 key	Reserved for future growth.
	play. To display a number, press the corresponding key or keys (0- 9). To display a letter, first press the <b>LTR</b> key corresponding to the position of the desired letter on a key. Then press the key which contains the desired letter. Example: To enter an <b>L</b> , first press	GPS, including sele and readout of data Unit (CDU) front p of operation: <b>OFF</b> , navigate mode thre or automatically.	<b>Operation.</b> Control of the Doppler/ ection of modes and displays, and entry is performed via the Computer Display panel. The system has four basic modes navigate, <b>TEST</b> and <b>GPS LDG</b> . In the submodes may be selected manually These are combined mode (default or peration) GPS only mode, or Doppler

only mode.

the LTR RIGHT key, then press

key 4.

primary mode of operation), GPS only mode, or Doppler

**3.17.3.1 OFF Mode.** In the **OFF** mode the system is inoperable. However, the edge lighting is lighted by an external helicopter power source and is independent of the Doppler/GPS **MODE** selector setting. Edge lighting may not be available if the helicopter is modified with the night vision MWO.

**3.17.3.2 Navigate Mode.** In the navigate mode (MGRS or LAT/LONG) position of the CDU MODE selector) power is applied to all system components, and all required outputs and functions are provided. The Doppler radar velocity sensor (DRVS) measures helicopter velocity, and converts analog heading, pitch and roll into digital form. This data and embedded GPS receiver (EGR) velocity and position data are then sent to the CDU for processing. Barometric altitude is used for aiding the GPS when only three satellites are available. Four satellites are required if the barometric altitude sensor is not available. Present position is computed by using one of three navigation submodes which can be selected manually or automatically. These submodes are as follows:

# 3.17.3.2.1 Combined Mode (Default or Primary

**Mode of Operation).** Doppler and GPS position and velocity data are combined to provide navigation. This mode is used when a minimum of three (with barometric sensor) or four satellites are available, GPS Estimated Position Error (EPE) is less than approximately 150 meters, and the Doppler is not in memory. If GPS becomes invalid (e.g. due to increased EPE), the system will automatically switch to Doppler mode until a valid GPS status is received. The **GPS POS ALERT** advisory will appear when this happens. If the Doppler becomes invalid (e.g. flight over glassy smooth water), the system will automatically switch to GPS mode if GPS is valid or an alternate Doppler mode if the GPS is not valid.

**3.17.3.2.2 GPS Mode.** GPS positions and velocities are used for navigation by the Doppler navigation processor in the CDU. If GPS mode is selected and the GPS becomes invalid (paragraph 3.17.3.2.1), the system will not navigate. The **GPS POS ALERT** advisory indicates that GPS signals are not reliable.

**3.17.3.2.3 Doppler Mode.** Doppler position and velocity data are used for navigation. If Doppler mode is selected and the Doppler becomes invalid (paragraph 3.17.3.2.1), the system will automatically switch to True Air Speed (TAS) mode (using remembered wind) if a TAS sensor is available, or remembered velocity if a TAS sensor is not available. If Doppler mode is manually selected at the start of the flight an initial present position must be obtained and entered prior to flight. Navigation is performed in latitude/longitude for computational

convenience only. At the same time, distance, bearing and time-to-go to any one of 100 preset destinations are computed (as selected by **FLY-TO-DEST**).

3.17.3.3 Test Mode. The TEST mode contains two functions: LAMP TEST mode, in which all display segments are lit, and TEST mode, in which system operation is verified. In the LAMP TEST mode, system operation is identical to that of the navigate mode except that all lamp segments and the MEM and MAL indicator lamps are lighted to verify their operation. In TEST, the RTA no longer transmits or receives electromagnetic energy; instead, self-generated test signals are inserted into the electronics to verify operation of the DRVS. At this time a self test is performed by the GPS and navigation computations continue using remembered velocity. In the TEST mode, Doppler test results are displayed on the CDU front panel for the first 15 seconds (approximate). At the end of this period either GO is displayed if there is no malfunction in the navigation set, or a failure code is displayed if a malfunction has occurred. A rotating bar on the display indicates that the GPS has not completed self test. If the navigation set is maintained in the **TEST** mode, no navigation data can be displayed on the CDU front panel. If a Doppler malfunction is detected, the MAL indicator lamp lights and **DF** is displayed. At the completion of GPS self test (up to two minutes), the rotating bar is replaced with a complete test result code. The failed unit and the failed circuit card are also indicated by a code on the CDU display. The CDU is continuously monitored for failures, using its own computer as built-in-test-equipment (BITE). Any BITE malfunction causes the MAL indicator lamp on the CDU to light. If the MODE selector on the CDU is set to TEST, identification of the failed LRU is indicated by a code on the display panel. Helicopter heading, pitch and roll are also displayed in the mode by pressing the ENT key after Doppler test is completed. GPS test status is displayed if the ENT key is pressed a second time. Malfunction codes are automatically latched and can only be cleared by recycling the CDU power via the CDU mode switch (OFF-ON).

**3.17.3.4 GPS Landing Mode.** In the GPS LDG mode, the Doppler navigation system provides information to the HSI and VSI indicators for real time landing guidance to a touch down point previously entered in any of the 100 fly-to destinations. The landing approach is determined by present position and the entered touch down altitude, glideslope and inbound approach course.

**3.17.4 CDU Operation.** Various required operating data, such as initial present position (if GPS is not valid or Doppler mode is selected), destination coordinates with or without GPS landing data, and magnetic variation can at

any time be entered into the CDU via its keyboard, or the remote fill panel (Figure 3-8) via the preprogrammed data loader cartridge. In most cases, these data will be entered before the helicopter takes off. The GPS provides present position to the Doppler/GPS. If GPS is not available or Doppler is selected present position can be initialized as follows:

- 1. The MODE selector should be set to MGRS or LAT/LONG, the WP/TGT display position of the DISPLAY selector is selected, the destination number is set to P (default waypoint) and KYBD key is pressed. The coordinates of the initial position is overflown, the ENT key is pressed. The computer then determines changes from the initial position continuously, and the coordinates of the current present position can be read either by remaining in this configuration or by setting the DISPLAY selector to PP (present position) and the MODE selector to MGRS or LAT/ LONG.
- 2. To update present position over a stored destination, KYBD key is pressed when the helicopter overflies this destination. If an update is desired, the ENT key is pressed and the update is completed. The DISPLAY selector is in the DIST/BRG/TIME position and the FLY-TO-DEST is set to this destination during this process. The distance-to-go, displayed while over the stored destination, is the position error of the system at that moment.
- 3. To update present position over a fixed point not previously stored in the computer, the **DISPLAY** selector is placed to **PP** and **KYBD** key is pressed as the fix point is overflown. This freezes the display while allowing computation of changes in present position to continue within the computer. If an update is required the coordinates of the fix point are entered via the keyboard, and **ENT** key is pressed. The position change which occurred since over-flying the fix point is automatically added to the fix point coordinates to complete the position update.
- 4. Magnetic variation can be entered for each destination, and the system will compute present position magnetic variation. If operation is to occur in a region with relatively constant magnetic variation, the operator enters

magnetic variation only for present position and the computer will use this value throughout the flight. If **MGRS** data are to be entered or displayed, the **MGRS** datum of operation is also entered.

**3.17.5 Target-of-Opportunity.** Target-of-opportunity data can be stored by pressing **TGT STR** (target store) key when the target is overflown. This operation stores the coordinates of the target in one of ten destination locations in the computer; locations 90-99 sequentially incrementing each time the **TGT STR** key is pressed. The location is displayed in the appropriate display field. The computer can keep track of individual target positions which may include speeds and directions input by the operator.

**3.17.6 Self Test.** Self test of the AN/ASN-128B is accomplished using BITE with the **RTA**, **SDC**, and **CDU** units connected and energized for normal operation. Self test enables the unit to isolate failures to one of the four main functions (**RTA**, **SDC**, **CDU** or **EGR**) or to one of the circuit cards in the **SDC** or **CDU**. Self test is accomplished as follows:

- 1. The CDU (except for the keyboard and display) is checked on a continuous basis, and any failure is displayed by the illumination of the MAL indicator lamp on the CDU. If the MODE selector on the CDU is set to the TEST position, identification of the failed circuit card in the CDU is indicated by a code on the display panel.
- The DRVS and EGR are tested by setting the MODE selector on the CDU to the TEST position. Failure of the DRVS or EGR are displayed on the CDU by illumination of the MAL indicator lamp, and identification of the failed unit or circuit card is indicated by a code on the display panel of the CDU.
- 3. Continuous monitoring of the signal data converter and receiver transmitter antenna is provided by the system status indication. The system will not use Doppler velocities in normal operation when flying over glassy smooth water. However, if the system continues to not use Doppler (e.g. using GPS only when combined has been selected) for excessive periods of time (e.g. more than 10 minutes) over land or rough water, then a malfunction may exist in the navigation set and the operator should set the **MODE** selector to **TEST** to determine the nature of the failure.

- 4. The display portion of the CDU is tested by illuminating all the lamp segments in each alphanumeric character in the LAMP TEST mode.
- 5. Keyboard operation is verified by observing the alphanumeric characters as the keyboard is exercised.

**3.17.7 Route Sequencing Modes.** The system has the ability to fly a preprogrammed sequence of waypoints. This sequence can be either consecutively numbered in which case a start and end waypoint are entered or random numbered, in which case all waypoints are put in a list and the start and end waypoints are entered. Both sequence modes can be flown in the order they are in the list or in the reverse order. Directions will be displayed to the waypoint next on the list until approximately 10 seconds before overflying the waypoint at which time the display will advance to the next waypoint and the new waypoint number will blink for ten seconds. One consecutive and one random sequence may be stored in the system.

**3.17.8 To-To Route Mode.** The system has the ability to provide steering information onto a course defined by the start and end waypoints. Only the second waypoint will be overflown. The distance displayed is the distance to the course when outside two nautical miles of the course and the distance to the second waypoint when inside two nautical miles of the course.

#### 3.17.9 General Operating Procedures for Entering

Data. The panel display consists of four line LED readout. The top line of the display is reserved for the display of Fly-To destination number and destination name/ International Civil Aeronautic Organization (ICAO) identifier, EPE in meters, mode of GPS and mode of AN/ ASN-128B operation and target store number. The remaining lines will display data in accordance with the **DISPLAY** and **MODE** selectors. When pressing the **KYBD** key for the first time in an entry procedure, the display freezes, kybd is displayed in the bottom right corner indicating the display is in the keyboard mode and the input field under keyboard control blinks. If it is not desired to change the display field under control, the pilot can advance to the next field of the display by pressing the KYBD key again. Pressing the ENT key (whether or not new data has been entered) causes the display to blank momentarily and return with the latest computed data. To abort a keyboard operation, move the MODE or DIS-PLAY selector to another position.

**3.17.9.1 Data Entry.** To display a letter, first press the **LTR** key corresponding to the position of the desired letter

on a key. Then press the key which contains the desired letter. For example, to enter an L, first press the LTR **RIGHT** key, then press key **4**.

**3.17.9.2 Keyboard Correction Capability.** The last character entered may be cleared by pressing the **CLR** key. If the **CLR** key is pressed twice in succession, the field is cleared but remains under control (indicated by blinking) and the last valid data entered is displayed.

**3.17.9.3 Destination Variation Constraint.** The magnetic variation associated with a destination must be entered after the coordinates for that destination are entered. The order of entry for present position is irrelevant.

#### 3.17.9.4 Impossibility of Entering Unacceptable

**Data.** In most cases the computer program will reject unacceptable data (for example, a **MGRS** area of **W1** does not exist and will be rejected). If the operator attempts to insert unacceptable data, the unacceptable data will be displayed on the panel and then the selected field will blink after **ENT** key is pressed displaying the last valid data.

# 3.17.9.5 Displaying Wind Speed and Direction (TAS Sensor Required).

### NOTE

The computer cannot prevent insertion of erroneous data resulting, for example, from human or map errors.

In **MGRS** mode, wind speed is displayed in km/hr; in **LAT/LONG** mode, wind speed is displayed in knots. Wind direction is defined as the direction from which the wind originates.

- 1. Set **MODE** selector to **LAT/LONG** (**MGRS** may also be used).
- 2. Set **DISPLAY** selector to **WIND-UTC** (coordinated universal time)/DATA and observe display.
- 3. The display indicates:

#### SP:XXXKn

#### DIR:XXX°

# 3.17.9.6 Displaying/Entering UTC and Displaying GPS Status.

- 1. Set **MODE** selector to **LAT/LONG** (**MGRS** may also be used).
- 2. Set **DISPLAY** selector to **WIND-UTC/DATA** and observe the wind speed/direction display.
- Press ENT key. Observe that the CDU display indicates year ** (default year is 93), day 317 and indicates hours, minutes, and seconds of UTC time: 09 Hours, 25 Minutes, 10 Seconds.
- 4. To enter year, day and time press the **KYBD** key to select the field for input shown as a blinking field, enter the desired data and press the **ENT** key.
- 5. To display GPS status press the **ENT** key to display selection menu.
  - 1 > SEA CURRENT
  - 2 > SURFACE WIND
  - 3 > **GPS STATUS**
  - 4 > DATA LOAD end
- 6. To select the GPS STATUS page press key 3.
- 7. Observe the CDU display. The display indicated the GPS test mode status as of one of the following:

### **GPS TEST: IN PROCESS**

#### GPS TEST: NOT RUN

#### GPS TEST: PASSED

### **GPS TEST: FAILED**

# 3.17.9.7 Displaying GPS Key and GPS Satellite Status.

- 1. Set the **DISPLAY** selector to **XTK/TKE/ KEY**.
- 2. Set the MODE selector to LAT/LONG (MGRS may also be used).

3. The display indicates GPS daily key status, time remaining on the currently entered keys and how many satellites are currently being used by the GPS.

KEY	STATUS	TIME	REMARKS
DK	OK	Days or hours still available on key	GPS daily key in use and verified
DK	NO	*	No GPS daily key available
DK	IN	*	GPS daily key available but not verified

#### 3.17.10 Preflight Procedures.

#### 3.17.10.1 Data Required Prior to DGNS Turn-On.

- 1. The following initial data must be entered by the pilot after system turn-on and initialization, unless previously entered data is satisfactory:
- 2. Datums of operation, when using **MGRS** coordinates. This data may be part of the data load if preprogrammed.
- 3. In combined or GPS mode the GPS provides preset position. If the Doppler only mode is selected **MGRS** coordinates of present position - zone area, easting and northing; latitude/ longitude coordinates may also be used to input present position. This data may be part of the data load if preprogrammed. Variation of present position to the nearest one-tenth of a degree.
- 4. Coordinates of desired destinations 00-99. It is not necessary to enter all destinations in the same coordinate system. This data may be part of the data load if preprogrammed. Destination locations of 70 through 89 are only programmable through the data loader.
- 5. Variation of destinations to the nearest one-tenth of a degree.
- 6. Crypto-key variables necessary to enable the GPS receiver to operate in **Y** code are entered

via remote fill data only and not via the CDU keyboard.

#### NOTE

Destinations are entered manually when steering information is required to a destination that was not in the set of data loaded via the data loader, or it is desired to update present position by overflying a destination, or a present position variation computation is desired. (See CDU operation). If a present position variation update is desired, destination variation must be entered. The operator may enter one or more destination variations; it is not necessary for all destinations to have associated variations entered and also not necessary to enter all destinations in any case, but variations must be entered after destination coordinates are entered.

7. The Doppler outputs true heading and accepts magnetic heading from gyromagnetic/AHRU heading reference. If accurate magnetic variations are not applied, then navigation accuracy will be affected.

# 3.17.10.2 System Initialization.

1. Enter GPS mode "M".

#### NOTE

Select GPS mode "**M**" during initialization. If "**Y**" mode is selected before crypto-key variables are loaded the system will lockup. System must be turned off, then back on.

- 2. Perform self test.
- 3. Perform download of data loader cartridge if necessary, or manually enter datum, destinations, magnetic variations, and present position.
- 4. Load crypto-key variables (unless previously loaded and still valid) necessary for operation of the GPS in **Y** mode.

#### NOTE

It is necessary to wait at least 12 minutes for key validation when new keys have been entered, or collection of almanac data when set has no previous almanac data. During this time the GPS operation mode must be **M** and uninterrupted. After this time the GPS operating mode may be switched to **Y**. Observe the GPS key status and number of satellite vehicles (SVs) tracked after switching to **Y** mode. If the SV number goes to zero, repeat this procedure. The key status shall switch from **DK IN** to **DK OK** sometime during the 12 minutes.

- 5. Check datum of operation, if **MGRS** is being used.
- 6. Check destinations in MGRS or LAT/LONG coordinates as desired.
- 7. Check associated destination variations as desired. Remove all incorrect variations by setting **DISPLAY** selector to **WP/TGT**, setting the destination number to appropriate destination, and pressing the **KYBD** key and **ENT** key in that order. Variations of at least two destinations must be entered for automatic variation update computation to be performed. For accurate navigation it is advised to enter variations after each destination unless the variations are the same.
- 8. Select DGNS operating mode.

#### NOTE

The set will automatically select combined mode (default or primary operating mode) as this allows the system to select the best possible navigation method available.

9. Set the FLY-TO-DEST to the desired destination location.

# 3.17.10.3 Downloading Data from Dataloader Cartridge.

- 1. Set the CDU MODE selector to OFF.
- 2. Insert the preprogrammed data loader cartridge.
- 3. Set the CDU MODE selector to MGRS (LAT/LONG may be used). Enter desired GPS code (M or Y) mode of operation.

- 4. Set the **DISPLAY** selector to **WIND-UTC**/**DATA**.
- 5. To display the select menu press the **ENT** key twice.
  - 1 > SEA CURRENT
  - 2 > SURFACE WIND
  - 3 > GPS STATUS
  - 4 > DATA LOAD end
- 6. To select the **DATA LOADER** page press key **4**.

#### DATA LOADER

#### ENTER DATA: N - Y

- 7. To begin the download press the **KYBD** and enter **Y** (yes).
- 8. Observe the CDU display. The CDU shall display **DOWNLOAD WAYPTS IN PROCESS.** If a transmission error occurs the CDU display shall change to **ERROR-RETRYING.**
- 9. When the transmission is complete the CDU shall display **DOWNLOAD WAYPTS COMPLETE**. If this display is not obtained within one minute of beginning the download, check the data programming and connections.

10. Set the CDU **MODE** selector to **OFF**, remove the data loader cartridge if desired, and then set the CDU **MODE** selector to the desired setting.

#### 3.17.10.4 Self Test.

- 1. Set the MODE selector to LAMP TEST. Enter GPS mode "M" or "Y". Verify the following:
  - a. All edge lighting is illuminated.
  - b. The MAL lamp is illuminated.
  - c. All keyboard keys are lit.
- 2. Set the **MODE** selector to **TEST**. After Doppler and/or GPS self tests have completed (approximately 15 seconds for Doppler, up to 2 minutes for GPS), one of the following displays will be observed in the left and right displays:

#### NOTE

In the event the **TEST** mode display is not **GO ALL** the system should be recycled through **OFF** to verify the failure is to a momentary one.

3. Press the **BRT** pushbutton at least 10 times, then press the **DIM** pushbutton at least 10 times, then press the **BRT** pushbutton at least 10 times. LED display shall alternately glow bright, extinguish, and glow bright.

LEFT DISPLAY	RIGHT DISPLAY	REMARKS
GO		Doppler has completed BIT and is operating satisfactorily, GPS is still performing BIT (GPS has a two minute BIT cycle maximum). Note that a rotating bar in the display indicates that the GPS is still performing self test.
GO	ALL	The entire system has completed BIT and is operating satisfactorily.
GO	Р	Pitch or Roll data is missing or exceeds 90°. In this case, pitch and roll in the computer are both set to zero and navigation in the Doppler mode continues with degraded operation. Problem may be in the vertical gyro/AHRU or helicopter cabling.

		(Cont)
LEFT DISPLAY	RIGHT DISPLAY	REMARKS
NG	C, R, S, or H fol- lowed by a numeric code	A failure has occurred in the computer display unit or the signal data converter power supply. The operator should not use the system.
DN	GPS failure code	GPS has failed but operator can use Doppler to perform all navigation.
DF	Doppler failure code	Doppler has failed. GPS is still performing self test.
GN	Doppler failure code	Doppler has failed but operator can use GPS to perform all navigation.
EN	Doppler failure code	SDC battery is discharged. Items stored in memory have been deleted.

(Cont)

3.17.10.5 Display GPS Operating Modes,

**Groundspeed, and Track.** Use this procedure to display or select **GPS M** or **Y** operating mode, Doppler, GPS or combined operation, and displaying groundspeed and track.

- Set MODE selector to MGRS position (LAT/ LONG or GPS LDG position may also be used).
- 2. Set DISPLAY selector to GS/TK/NAV M.
- 3. The display indicates the current GPS and navigation mode on the top line:
  - a. Selected fly to waypoint.
  - b. EPE (GPS estimated position error in meters). An asterisk (*) in the character position of the EPE display indicates an EPE of greater than 999 or data unavailable.
  - c. GPS mode of operation:

M for mixed C/A and P/Y code GPS reception.

- Y for only Y code GPS reception.
  - d. DGNS mode of operation:
- C for combined Doppler and GPS.
- **D** for Doppler only.
- G for GPS only.
- **R** for remembered velocities.
- * for no navigation.

e. Target destination where the present position will be stored next time **TGT/STR** is pressed.

### NOTE

- In MGRS mode, ground speed is displayed in km/hr; in LAT/LONG mode, ground speed is displayed in knots.
- Only mode **C**, **G**, and **D** may be selected as the primary navigation mode. Modes **R** and * are automatic fall back modes used when both the Doppler and GPS are unavailable
  - 4. Selection of GPS mode of operation: As an example, consider selection of Y- only mode. Press KYBD key two times. Observe that the GPS mode blinks. To enter Y (for Y mode) press key LTR LEFT followed by key 9, or press key 9 only. A Y will be displayed. Press ENT key. The entire display will blank out for less than one second and the center display will now indicate: Y.
  - 5. Selection of DGNS mode of operation. As an example, consider selection of GPS only mode of operation. Press KYBD key. Observe that the DGNS mode blinks. To enter G (for GPS mode) press key LTR LEFT followed by key 3, or press key 3 only. A G will be displayed. Press ENT key. The entire display will blank out for less than one second and the DGNS mode will now indicate: G (or * if GPS is not available).
  - 6. Ground speed and ground track angle are displayed on lines 3 and 4.

# 3.17.10.6 Entering/Displaying Present Position or

**Destination in MGRS.** Use this procedure to enter and display present position or a destination in **MGRS**. The DGNS has the capability to display 100 destinations (numbered 00-99).

#### 100 destinations

-00 to 69	Standard waypoints.
-----------	---------------------

- -70 to 89 Data load only waypoints, observable but not changeable via CDU keyboard. Used for national airspace data such as VORs, NDBs, and intersections.
- -90 to 99 Target store waypoints (usable as standard waypoints, but not as route sequencing waypoints).

As an example, consider display of destination number **25**.

- 1. Enter datum as described in paragraph 3.17.10.10.
- 2. Set MODE selector to MGRS.
- 3. Set **DISPLAY** selector to **WP/TGT**.
- 4. Notice the current destination number displayed. To display destination number 25 press the INC or DEC key, or press key 2 then
  5. This is a direct key entry action.
- 5. Observe that the current destination **MGRS** zone, area, and easting/northing coordinates are now displayed. The destination number 25 and location name/ICAO identifier also appears in the display.
- 6. Entry for destination coordinates and location name/ICAO identifier: As an example, consider entry of zone **18T**, area **WN**, easting 5000, northing 6000, and ICAO identifier **BANDO**.
- To enter key board mode press the KYBD key. Observe "kybd" displayed in the bottom right corner of the display. (Destination number blinks.) Press KYBD again. (Zone field blinks.) To enter 18T press keys 1, 8, LTR MID, 7.
- 8. Press **KYBD**. (Area and northing/easting blinks.) To enter **WN5000 6000** press keys

LTR MID, 8, LTR MID, 5, KYBD, 5, 0, 0, 0, 6, 0, 0, 0.

- Press KYBD. (Location name/ICAO identifier blinks.) To enter BANDO press keys LTR MID, 1, LTR LEFT, 1, LTR MID, 5, LTR LEFT, 2, LTR RIGHT, 5.
- 10. To store the displayed information into the selected destination display position press the **ENT** key.

#### NOTE

- To access **P**, press the **LTR LEFT** key followed by key **6**. Another way to access **P** is to display waypoint **99** then press the **INC** key or display waypoint **00** then press the **DEC** key.
- Waypoints cannot be recalled by location name/ICAO identifier.

**3.17.10.7 Entering/Displaying Present Position or Destination in LAT/LONG.** Use this procedure to enter and display present position or a destination in LAT/ LONG. The DGNS set has the capability to display 100 destinations (number 00-99).

100 destinations

-00 to 69	Standard waypoints
-70 to 89	Data load only waypoints, observ- able but not changeable via CDU keyboard. Used for National Airspace Data such as VORs, NDBs, and intersections.
-90 to 99	Target store waypoints (Usable as standard waypoints, but not as route sequencing waypoints).

As an example, consider display of destination number **25**.

- 1. Enter the datum as described in paragraph 3.17.10.10.
- 2. Set MODE selector to LAT/LONG.
- 3. Set **DISPLAY** selector to **WP/TGT**.
- 4. Notice that the current destination number is displayed. To display destination number **25**

press the **INC** or **DEC** key, or press key **2** then **5**. This is a direct key entry action.

- 5. Observe that the current latitude and longitude coordinates are now displayed. The destination number **25** and location name/ICAO identifier appears in the display.
- 6. Entry of destination coordinates and location name/ICAO identifier: As an example, consider entry of Latitude N41° 10.13 minutes and longitude E035° 50.27 minutes and ICAO identifier BANDO.
- To enter keyboard mode press KYBD key. Observe "kybd" display in the bottom right corner of the display. (Destination number blinks.) Press KYBD again. (Latitude field blinks.) To enter N41° 10.13 press keys N, 4, 1, 1, 0, 1, 3.
- Press **KYBD**. (Longitude field blinks.) To enter E035° 50.27 press keys **E**, **0**, **3**, **5**, **5**, **0**, **2**, **7**.
- Press KYBD. (Location name/ICAO identifier blinks.) To enter BANDO press keys LTR MID, 1, LTR LEFT, 1, LTR MID, 5, LTR LEFT, 2, LTR RIGHT, 5.
- 10. To store the displayed information into the selected destination display position press the ENT key. Display indicates: N41° 10.13 E035° 50.27.

# NOTE

- To access **P**, press the **LTR LEFT** key followed by key **6**. Another way to access **P** is to display waypoint **99** then press the **INC** key or display waypoint **00** then press the **DEC** key.
- Waypoints cannot be recalled by location name/ICAO identifier.

# 3.17.10.8 Entering Variation and Landing Mode Data.

 Set MODE selector to MGRS positionaltitude entered/displayed in meters (LAT/ LONG may also be used-altitude entered/ displayed in feet).

- 2. Set **DISPLAY** selector to **WP/TGT** position.
- 3. Select the waypoint number desired by directly entering the two digit target number or pressing the **INC/DEC** keys. Observe the waypoint number entered and position data.
- 4. Press the **ENT** key and observe the waypoint number, variation and/or landing data if entered.
- 5. To enter a magnetic variation and/or landing mode data press the **KYBD** key to select the field for entry and enter the desired data as shown in steps 6 through 10 below. To end the entry operation press the **ENT** key.
- 6. Entry of variation: as an example, consider entry of a variation of E001.2. Press keys E, 0, 0, 1 and 2. The decimal point is inserted automatically. If no landing mode data is to be entered, press ENT to complete the operation. Display indicates: E001.2°.

#### NOTE

An asterisk appearing in the variation field indicates the variation is not entered. Variations may not be entered for waypoints containing target motion.

- 7. The bottom two lines indicate the MSL altitude, desired glideslope, and the desired inbound approach course (IAC) to the indicated destination. As an example, consider entry of a glideslope of 8° an IAC of 270°, and an altitude of 230 meters, for destination number **25**.
- 8. Press the **KYBD** key to blink the glide slope field. Enter glideslope. The maximum allowable glideslope is 9°. In the example enter 8 for an eight degree glideslope.
- Press the **KYBD** key to blink the inbound approach course field. Enter a three digit inbound approach course angle. In the example enter 2, 7, 0 to enter a 270 degree inbound approach course. Press the **ENT** key to complete the operation.
- Press the **KYBD** key to blink the altitude field.
   Press the **INC/+** key to enter a positive altitude, press keys 2, 3, 0 (the leading zeros

may be omitted) for the altitude of 230 meters in the example.

# **3.17.10.9 Entering Target Motion and Direction.** In **MGRS** mode, target speed is entered in km/hr; in **LAT/LONG** mode, target speed is entered in knots.

- 1. Set the MODE selector to LAT/LONG (MGRS may be used).
- Set the **DISPLAY** selector to **WP/TGT** and select the target number desired (00-69 or 90-99) by directly entering the two digit target number or **INC/DEC** keys. Observe the way-point number entered and position data.
- 3. Press the **ENT** key and observe the waypoint number, variation and/or landing data if entered.
- 4. Press the **ENT** key and observe the target speed and direction page.
- 5. To select target speed press the **KYBD** key twice and enter the target speed. The maximum target speed that may be entered is 50 knots.
- 6. To select the target direction press the **KYBD** key and enter the target direction.
- 7. To end the entry operation press the **ENT** key. In the example target 93 has a speed of 18 knots and a bearing of 128°. At the time the **ENT** key is pressed and released, the target position will begin to be updated as a function of time based on the speed and direction entered.

#### NOTE

To abort/cancel and entry of target motion, enter a target speed of 000 using the above procedure.

# 3.17.10.10 Entering/Displaying Datum (Table 3-3) or Clearing Waypoints.

- 1. Set the **MODE** selector to **MGRS** position (LAT/LONG may also be used).
- 2. Set the **DISPLAY** selector to **DATUM/ ROUTE**.
- 3. To select the datum field press the **KYBD** key.

 Entry of ellipsoid: as an example consider entry of 47, the code of the WGS 84 datum. Press keys 4 and 7. Press the ENT key, the display shall show DATUM: 47.

### NOTE

Entering a new datum number to a particular waypoint applies that datum to all waypoints and converts their coordinates accordingly. For example, assume that the datum for waypoint 22 is datum 47 and the datum for waypoint 23 is datum 25. The datum number must be changed from 47 to 25 prior to entering data for waypoint 23. This will change the displayed coordinates for waypoint 22 because they have been converted from datum 47 to datum 25. The actual ground position of waypoint 22 has not changed. Extreme care must be taken not to confuse these newly converted coordinates with those originally entered.

5. To clear all waypoints, variations, landing data, and target motions, enter **RDW** for the datum.

# 3.17.10.11 Entering Sea Current Speed and Direction for Water Motion Correction.

### NOTE

Not required or necessary when in combined or **GPS** mode. In **MGRS** mode, surface wind speed is entered in km/hr; in **LAT/LONG** mode, surface wind speed is entered in knots. Leading zeros must be entered. Wind direction is defined as the direction from which the wind originates.

- 1. Set **MODE** selector to **LAT/LONG** (**MGRS** may be used).
- 2. Set **DISPLAY** selector to **WIND-UTC/DATA** and observe the standard wind speed and direction display.
- 3. Press the **ENT** key twice to display the selection menu.
  - 1 > SEA CURRENT
  - 2 > SURFACE WIND
  - 3 > GPS STATUS

1520-237-10		
4 > DATA LOAD end		
4. Press the <b>1</b> key to selec The display indicates:	t SEA CURRENT.	ID
SEA CURRENT		03
SP:XXXKn		04
		05
DIR:XXX°		06
5. Entry of sea current speed		07
example, consider the e 135°. Press <b>KYBD</b> key. C		08
field blinks.		09
6. To enter speed, press ke		10
speed indicates <b>004Kn</b> . The maximum sea current speed that may be entered is 50 knots.		
		12
7. Press <b>KYBD</b> key. The dir	ection display blinks.	13
8. To enter direction, pres Direction indicates 135°.	ss keys 1, 3, and 5.	14
	1 / 1	15
9. Press <b>ENT</b> key. The di blinks and then reappears.	splay momentarily	16
NOTE		17
NOTE		18
To abort entry of sea curren		
current speed of 000 usin procedure.	g the above	19
Proceeding		20
Table 3-3. Datums (AN/A	ASN-128B)	21
		22
NAME	ELLIPSOID	23
	ID	24

# NOTE

	Only use map datums WGS- 84 and NAD-27. Other map datums were not verified us- ing the Aviation Mission Planning System (AMPS), and should not be used.	
01	Adindan	CD
02	ARC 1950	CD

# Table 3-3. Datums (AN/ASN-128B) (Cont)

NAME	ELLIPSOID
	ID

03	Australian Goodetic 1966	AN
04	Bukit Rimpah	BR
05	Camp Area Astro	IN
06	Djakarta	BR
07	European 1950	IN
08	Geodetic Datum 1949	IN
09	Ghana	WE
10	Guam 1963	CC
11	G. Segara	BR
12	G. Serindung	WE
13	Herat North	IN
14	Hjorsey 1955	IN
15	Hu-tzu-shan	IN
16	Indian	EA
17	Ireland 1965	AM
18	Kertau (Malayan Revised Triangulation)	EE
19	Liberia 1964	CD
20	USER ENTERED	
21	Luzon	CC
22	Merchich	CD
23	Montjong Lowe	WE
24	Nigeria (Minna)	CD
25	North American 1927 (CO- NUS)	CC
26	North American (Alaska and Canada)	CC
27	Old Hawiian, Maui	IN
28	Old Hawiian, Oahu	IN
29	Old Hawiian, Kauai	IN
30	Ordnance Survey of Great Britain 1936	AA

ID

Table 3-3. Datums (AN/ASN-128B) (Cont)

ID	NAME	ELLIPSOID ID
31	Qornoq	IN
32	Sierra Leone 1960	WE
33	South American (Provisional 1956)	IN
34	South American (Corrego Alegre)	IN
35	South American (Campo In- chauspe)	IN
36	South American (Chua As- tro)	IN
37	South American (Yacare)	IN
38	Tananarive Observatory 1925	IN
39	Timbalai	EA
40	Tokyo	BR
41	Voirol	WE
42	Special Datum, Indian Special	EA
43	Special Datum, Luzon Special	CC
44	Special Datum, Tokyo Special	BR
45	Special Datum, WGS 84 Special	WE
46	WGS72	WD
47	WGS84	WE

# **3.17.10.12** Entering Surface Wind Speed and Direction for Water Motion Correction.

- 1. Set MODE selector to LAT/LONG (MGRS may also be used).
- 2. Set **DISPLAY** selector to **WIND-UTC/DATA** and observe the wind speed/direction display.

Display will not appear if TAS sensor is not installed.

- 3. Press the ENT key twice to display the selection menu.
  - 1 > SEA CURRENT
  - 2 > SURFACE WIND
  - 3 > GPS STATUS
  - 4 > **DATA LOAD end**
- 4. Press key 2 to select **SURFACE WIND**. The display indicates:

#### SURFACE WIND

#### SP:XXXKn

#### DIR:XXX°

- 5. Entry of wind speed and direction: as an example, consider the entry of 20 knots and 150°. Press **KYBD** key. Observe that the wind speed field blinks.
- 6. To enter the speed, press keys **0**, **2**, and **0**. The wind speed indicates 020. The maximum surface wind speed is 50 knots.
- 7. Press **KYBD** key. The direction display blinks.
- To enter direction, press keys 1, 5, and 0. Wind direction indicates 150°.
- 9. Press **ENT** key. The display momentarily blinks and then reappears.

#### NOTE

To abort entry of surface wind speed and direction, enter a surface wind speed of 000 using the above procedure.

**3.17.11 Flight Procedures.** These procedures are applicable to the Doppler only mode. Present position is automatically updated when DGNS is in combined mode.

# 3.17.11.1 Updating Present Position from a Stored Destination.

### NOTE

The preface is: The helicopter is flying to a destination. Destination is set to the number of the desired destination.

- 1. Set **DISPLAY** selector to **DIST/BRG/TIME** position. Distance, bearing, and time-to-go to the fly-to destination are displayed.
- 2. When the helicopter is over the destination, press **KYBD** key. Observe that the display freezes.
- 3. Position update can be affected by pressing the **ENT** key. The computer updated the present position at the time the **KYBD** key was pressed by using the stored destination coordinates, and adding to them the distance traveled between the time the **KYBD** key was pressed and the **ENT** key was pressed. In addition, if an associated variation for the stored destination exists, the present position variation is also updated.
- If a present position update is unnecessary (as indicated by an appropriately small value of **DISTANCE** to go on overflying the destination), set the **DISPLAY** selector to some other position - this action aborts the update mode.

# 3.17.11.2 Updating Present Position from a

**Landmark.** There are two methods for updating present position from a landmark. Method 1 is particularly useful if the landmark comes up unexpectedly and the operator needs time to determine the coordinates. Method 2 is useful when a landmark update is anticipated.

# 3.17.11.2.1 Method 1 (Unexpected Update).

- 1. Set **DISPLAY** selector to **PP** position.
- 2. Overfly landmark and press **KYBD** key. The present position display shall freeze.
- 3. Compare landmark coordinates with those on display.
- 4. If the difference warrants an update, enter the landmark coordinates by pressing the **KYBD** key to blink the field to be changed, enter

coordinates, then press the **ENT** key. The computer updates the present position (from the time the **KYBD** key was pressed) to the landmark coordinates, and adds to the updated present position the distance traveled between the time the **KYBD** key was pressed and the **ENT** key was pressed.

5. If an update is not desired, set the **DISPLAY** selector to some other position. This action aborts the update mode.

# 3.17.11.2.2 Method 2 (Anticipated Update).

- 1. Set **DISPLAY** selector to **WP/TGT** position.
- Access P by pressing the LTR LEFT key followed by key 6, entering destination 00 then pressing the DEC key, or entering destination 99 then pressing the INC key.
- 3. Press **KYBD** key. Observe that the display freezes.
- 4. Manually enter the landmark coordinates by pressing the **KYBD** key to blink the field to be changed and enter the coordinates.
- 5. When overflying landmark, press ENT key.
- 6. If an update is not desired, set the **DISPLAY** selector to some other position. This action aborts the update mode.

**3.17.12 Fly-To Destination Operation.** Initialization of Desired Course. When a fly-to destination is selected such as at the start of a leg, the present position at the time is stored in the computer. A course is then computed between the selected point and the destination. If the helicopter deviates from this desired course, the lateral offset or crosstrack distance error is computed. Distance and bearing to destination, actual track angle, and track angle error correction are computed from resent position to destination. Refer to Figure 3-20 for a graphic definition of these terms.

# 3.17.12.1 Selecting Fly-To Destinations (Direct/

**Default Mode).** The DGNS has the capability of selecting a fly-to destination from 100 destinations (number 00-99). As an example, consider selecting Fly-To destination number 43.

1. Set **MODE** selector to **MGRS** (LAT/LONG or **GPS** LDG may also be used).

- 2. Set **DISPLAY** selector to **XTK/TKE**. Observe standard crosstrack (**XTK**) and track angle error (**TKE**) display. (**DIST/BRG/TIME** may also be used).
- 3. To display Fly-To destination 43 press the **INC** or **DEC** key, or press key 4 then 3. This is a direct key entry action.

**3.17.12.2 Left-Right Steering Signals.** There are two methods the pilot may use to fly-to destination, using left-right steering signals displayed on the CDU. As an aid to maintaining course, set **DISPLAY** selector to **XTK/TKE** position and steer vehicle to keep track angle error (TKE) nominally zero. Left-right steering signals may be used when flying the shortest distance to destination from present position (Method 1) or when flying a ground track from start of leg to destination (Method 2).

**3.17.12.2.1 Method 1.** When flying shortest distance to destination from present position, set **DISPLAY** selector to **DIST/BRG/TIME** position and steer vehicle to bearing displayed. If the display indicates an L (left) **TKE**, the helicopter must be flown to the left to zero the error and fly directly to the destination.

**3.17.12.22 Method 2.** When flying a ground track, set **DISPLAY** selector to **XTK/TKE** position. Steer vehicle to obtain zero for crosstrack error (**XTK**). If **XTK** is left (**L**), helicopter is to right of the desired course and must be flown to the left to regain the initial course. Select the course deviation bar by pressing, then releasing the **DPLR GPS** lens on the HSI **MODE SEL** panel.

#### 3.17.12.3 Enter Route-Sequence To-To Mode.

The DGNS has the capability to navigate a course set up between two destinations. As an example, consider navigating onto a course starting from destination number 62 and ending at destination number 45.

- 1. Set **MODE** selector to **MGRS** (LAT/LONG may also be used).
- 2. Set **DISPLAY** selector to **DATUM/ROUTE**.
- 3. Press the **ENT** key. Observe that a menu of special steering functions appears.
  - 1 > **TO-TO**
  - 2 > **RANDOM**

3 > CONSEC END

- 4. To select the route-sequence to-to display press key 1. Observe that **TO-TO** and selection mode appears in the display. The display provides entry of starting and ending destination numbers.
- 5. To enter keyboard mode press the **KYBD** key. (**START** field blinks.) To enter starting destination 62 press keys **6**, **2**.
- 6. Press **KYBD** key. (**END** field blinks.) To enter ending destination 45 press keys **4**, **5**.
- 7. Press **KYBD** key. (**SELECT** field blinks.) Enter **Y** (yes) for mode selection. **N** (Default mode) may be entered to arm the system with the start and end destinations but without entering the route-sequence to-to mode, or to exit the Route-sequence to-to mode if the system is currently in that mode. Then press the **ENT** key.

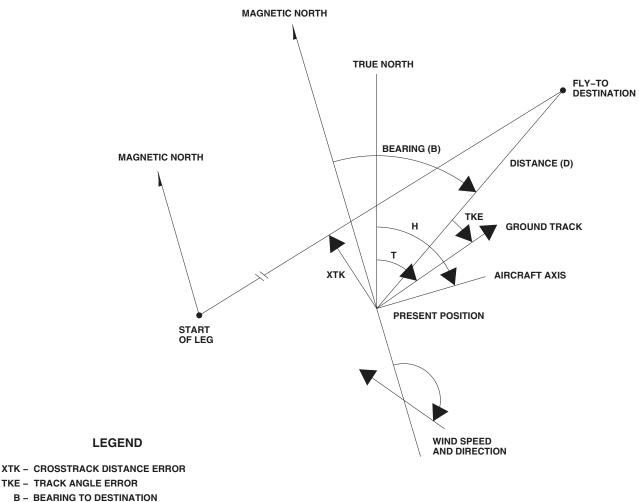
# NOTE

- There must be valid waypoint data to select a waypoint as a starting or ending waypoint. If not, upon pressing the **ENT** key, the invalid waypoint number will blink.
- If an entry is changed after **Y** is entered for selection, an **N** must be entered for the selection then it may be changed to **Y**. The sequences must be flown from the beginning waypoint. The route cannot be flown in reverse (R).
- No target destination or destination with target motion may be included as to-to waypoints.
- If the MODE switch is placed to the GPS LDG position when TO-TO, RANDOM, or RT SEQ CONSEC is selected, it will turn off the route sequencing mode and change it back to direct-to.

# 3.17.12.4 Enter Route-Sequence Random Mode.

The DGNS has the capability to navigate through a sequence of random number destinations. As an example, consider navigating through destination numbers 32, 25, 74, 01, 48, 83, 35.

1. Set **MODE** selector to **MGRS** (**LAT/LONG** may also be used).



- T ACTUAL TRACK ANGLE (TRUE TRACK)
- D DISTANCE FROM PRESENT POSITION TO FLY-TO-DESTINATION
- H TRUE HEADING

AA9999

Figure 3-20. Definition of Course Terms

- 2. Set DISPLAY selector to DATUM/ROUTE.
- 3. Press the **ENT** key. Observe that a menu of special steering functions appears.
  - 1 > **TO-TO**
  - 2 > RANDOM
  - 3 > CONSEC END
- 4. To select the route-sequence random display press key 2. Observe that **RT SEQ RANDOM** now appears in the display followed by the se-

quence of destination numbers and a continuation prompt.

- 5. Enter the sequence of destination numbers by pressing the **KYBD** key to enter keyboard mode. (First destination field blinks.) To enter destination 32 press keys **3**, **2**.
- 6. Press **KYBD** key. (Next destination field blinks.) Press keys **2**, **5** to enter second destination 25.
- 7. Repeat step 6 until a maximum of ten destinations are entered; if less than ten need to be

entered, leave asterisks for the remaining destinations.

- 8. To complete the entry of the random sequence of waypoints press **ENT** key.
- 9. To select the start field and enter the starting destination press **KYBD** key.
- 10. To select the ending field and enter the ending destination press **KYBD** key.
- 11. Press KYBD key. (SELECT field blinks.) Enter Y (yes) for mode selection. N (default) may be entered to arm the system but without entering the route-sequence random mode, or to exit the Route-Sequence Random mode if the system is currently in that mode. An entry Y and R indicates a choice of Y- flying in forward order, or R- flying in reverse order. To clear the random sequence, enter a C for selection. Then press the ENT key.

#### NOTE

- The sequence must be flown from the beginning waypoint.
- No target destinations or destinations with target motion may be included as route sequence random waypoints.
- If the MODE switch is placed to the GPS LDG position when TO-TO, RANDOM, or RT SEQ CONSEC is selected, it will turn off the route sequencing mode and change it back to direct-to.

#### 3.17.12.5 Enter Route-Sequence-Consecutive

**Mode.** The DGNS has the capability to navigate through a sequence of consecutively numbered destinations. As an example, consider navigating through destination numbers 32 through 35.

- 1. Set **MODE** selector to **MGRS** (LAT/LONG may also be used).
- 2. Set **DISPLAY** selector to **DATUM/ROUTE**.
- 3. Press the **ENT** key. Observe that a menu of special steering functions appears.
  - 1 > **TO-TO**
  - 2 > **RANDOM**

#### 3 > CONSEC END

- To select the route-sequence-consecutive display press key 3. Observe that RT SEQ CONSEC now appears in the display, followed by the starting and ending destination numbers and mode selection.
- 5. To enter keyboard mode, press the **KYBD** key. (**START** field blinks.) To enter destination 32 press keys **3**, **2**.
- 6. Press **KYBD** key. (**END** field blinks.) Press keys **3**, **5** to enter ending destination 35.
- 7. Press KYBD key. (SELECT field blinks.) Enter Y (yes) for mode selection. N (default mode) may be entered to arm the system but without entering the route-sequenceconsecutive mode, or to exit the routesequence-consecutive mode if the system is currently in that mode. An entry of Y and R indicates a choice of Y- flying in the forward order, or R- flying in reverse order.

#### NOTE

- The sequence must be flown from the beginning waypoint.
- No target destinations or destinations with target motion may be included as route sequence consecutive waypoints.
- If the MODE switch is placed to the GPS LDG position when TO-TO, RANDOM, or RT SEQ CONSEC is selected, it will turn off the route sequencing mode and change it back to direct-to.

# 3.17.12.6 Displaying Distance/Bearing/Time Information.

- 1. Set **MODE** selector to **MGRS** (LAT/LONG or **GPS** LDG may also be used).
- 2. Set **DISPLAY** selector to **DIST/BRG/TIME**.
- 3. Observe that the distance-to-go in kilometers (to the fly-to destination), bearing, and timeto-go appears on the bottom two lines of the display. (Distance is in nautical miles when **MODE** selector position is **LAT/LONG**.)

Bearing-to-destination is displayed in degrees, and the time-to-go is displayed in hours, minutes, and tenths of a minute.

- 4. The display of the second line depends on the current steering mode as follows:
  - a. Direct-To steering (default): Fly-to destination number and ICAO identifier are displayed. Example: **58:BANDO**.
  - b. To-To Steering: **TO-TO-:XX TO YY** where **XX** is the "To-To" start-of-leg destination number, and **YY** is the "To-To" fly-to destination number.
  - c. Route-sequence steering (both consecutive and random): **RT-RANDOM:XX TO YY** where **XX** is the current route-sequence fly-to destination number, and **YY** is the next destination number in the sequence. Approximately 10 seconds before overflying the fly-to destination, the system automatically 'pickles' to the next destination, and the new fly-to destination number blinks for 10 seconds then stops blinking.

# 3.17.12.7 Displaying Present Position and GPS Altitude.

- 1. Set the MODE selector to MGRS (LAT/ LONG or GPS LDG may also be used). Set the DISPLAY selector to PP and observe present position display.
- 2. To display present position variation and GPS altitude press the ENT key. Present position variation may be entered by pressing the **KYBD** key to select the variation field. A variation is entered and the ENT key is pressed.

**3.17.12.8 Target Store (TGT STR) Operation.** Two methods may be used for target store operation. Method 1 is normally used when time is not available to preplan a target store operation. Method 2 is used when time is available and it is desired to store a target in a specific location.

# 3.17.12.8.1 Method 1 (Uses Location 90-99).

1. Press the **TGT STR** key while flying over target.

2. Present position and variation are automatically stored in the target destination location which was displayed in the target store field immediately prior to pressing the **TGT STR** key.

# 3.17.12.8.2 Method 2 (Uses Locations 00-69 and 90-99).

- 1. Set **MODE** selector to **MGRS** or **LAT/LONG** position, depending on coordinate from desired.
- 2. Set **DISPLAY** selector to **WP/TGT** position.
- 3. To access **P**, press the **LTR LEFT** key followed by key **6**. Another way to access **P**, is to display waypoint 99 then press the **INC** key or display waypoint 00 then press the **DEC** key.
- 4. Press **KYBD** key when overflying potential target. Observe that display freezes and **kybd** is displayed in the bottom right corner of the display indicating keyboard mode. The destination number is now under keyboard control indicated by a blinking field.

### NOTE

Do not press **ENT** key while destination is set to P.

- 5. If it is desired to store the target, enter the two digit destination number and press the **ENT** key.
- 6. If it is not desired to store the target, set the **DISPLAY** selector momentarily or permanently to another position.

# 3.17.12.9 Entering Landing Mode.

- Set the fly-to destination by setting the DIS-PLAY selector to either XTK/TKE/KEY or DIST/BRG/TIME. Directly enter the two digit destination number or use the INC or DEC keys.
- 2. Set **MODE** selector to **GPS LDG**.
- 3. The **DISPLAY** selector continues to function as before. To switch between metric and English units, press the **ENT** key.

#### NOTE

In this mode, the DGNS provides real-time landing guidance information to the HSI and VSIs. To display course deviation information on VSI and HSI, press then release the **DPLR GPS** button on the HSI/ VSI **MODE SEL** panel.

#### 3.17.12.10 Transferring Stored Destination/Target

**Data.** The following procedure allows the operator to transfer (copy) stored destination/target data from one destination/target location to another destination location. The transferred data consists of destination name/ICAO identifier, location, variation, and landing information. For illustrative purposes only, it is assumed that the operator wants to put the coordinates of stored target 97 into the location for destination 12.

- 1. Set **DISPLAY** selector to **WP/TGT** position.
- 2. Press key 9 then 7.
- 3. Press **KYBD** key, press key 1 then 2.

#### NOTE

Location name/ICAO identifier, variation, and landing data may be deleted by first displaying the waypoint, pressing the **KYBD** key, then the **ENT** key.

4. Press ENT key.

#### 3.17.12.11 Operation During and After a Power

Interruption. During a power interruption, the stored destination and target data and present position are retained by non-volatile RAM inside the CDU. This makes it unnecessary to re-enter any navigation data when power returns. GPS satellite data are also retained by a battery inside the SDC. This makes it unnecessary to reload the crypto-key or wait for the collection of any almanac. Navigation will be interrupted during the absence of power; however the present position will be updated when the GPS data becomes valid provided the DGNS mode has not been selected as Doppler only. The pilot will have to re-enter the GPS operating mode (M or Y) using a single key (5 or 9). In the event the CDU is initialized, the display will indicate only EN when the CDU is operated. This is an indication to the operator that previously stored data has been lost and that spheroid/variation, destinations, and calibration data must be entered. Present position needs to be entered only if Doppler only mode has been selected. The **KYBD** key must be pressed to clear the **EN**.

The pilot will have to re-enter the GPS operating mode (**M** only) using single key (**5**). The computer initializes to the following: operating mode to combined, present position variation to E000.0, destinations and associated variations to a nonentered state, wind speed (water motion) and sea current speed to 000, spheroid to WGS 84 (WG-4), present position to N45° 00.00'E000°00.00' (until updated by GPS), target store location to 90, along track calibration correction to 00.0 percent, and magnetic compass deviation corrections to 000.0°. The following data must be entered:

- 1. Press KYBD key.
- 2. Set MODE selector to OFF momentarily, to LAMP TEST for approximately one second, and then to MGRS or LAT/LONG.
- 3. Select GPS M or Y mode.
- 4. Select **DGNS** operating mode if other than combined.
- 5. Enter datum.
- 6. Enter present position if Doppler only has been selected.
- 7. Enter each destination and its associated variation.

# 3.17.12.12 Displaying Helicopter Heading, Pitch, and Roll (Maintenance Function).

- 1. Set the CDU mode switch to **TEST** and observe the CDU test mode display.
- 2. After the Doppler test is completed, press the **ENT** key.
- 3. Observe the CDU display. The top three display lines indicate, in degrees and tenths of a degree, helicopter system heading, pitch, and roll.

#### 3.18 DOPPLER/GPS NAVIGATION SET (DGNS) AN/ASN-128D. III 128D

The AN/ASN-128D DGNS provides world wide navigation and integrates the Horizontal Situation Indicator (HSI), Vertical Speed Indicator (VSI), and Variable Omni Range (VOR) systems for GPS Approach capabilities. External connector on the Signal Data Converter (SDC) allows for GPS HOT START from a Precision Lightweight GPS Receiver (PLGR). This system displays locations in longitude and latitude coordinates for all three GPS codes; or Military Grid Reference System (MGRS) when GPS code M or Y is selected. During an Instrument Approach Procedure, navigational data is displayed in latitude and longitude coordinates only, the Computer Display Unit (CDU) must be configured to operate in the **S** mode. The AN/ASN-128D maintains a Digital Aeronautical Flight Information File (DAFIF) database. The DAFIF is maintained within a Personal Computer Memory Card International Association (PCMCIA) card which is inserted into the PCMCIA Data Transfer Device (PDTD) (Figure 3-21). The PCMCIA card can store either the User Defined waypoints or the DAFIF, or both the DAFIF and user defined waypoints as one file.

**3.18.1 Antenna.** The GPS antenna is located on the top aft section of the helicopter. The Doppler antenna is located below the copilot's seat.

3.18.2 Global Positioning System Annunciator

**Panel.** The GPS Annunciator Panel is located on the pilot's and copilot's instrument panel below the clock (Figure 3-21). The function of each indicator is as follows:

CONTROL/ INDICATOR	FUNCTION
MSG (Message)	When illuminated indicates DGNS has issued a message to the opera- tor, viewable via the F1 key. MSG indicator will illuminate for 10 seconds.
<b>WPT</b> (Waypoint)	Illuminates when aircraft is 10 seconds from waypoint, based on aircraft's ground speed.
NO GPS	When illuminated GPS data is not available due to poor reception or equipment failure.
HOLD	When illuminated, indicates flight plan has been suspended.
<b>RAIM</b> (Receiver Autonomous Integrity Monitoring)	When illuminated indicates lack of satellite coverage for non-precision approaches, or RAIM failure.
<b>APR</b> (Approach)	When illuminated indicates a change in course deviation indica-

tor (CDI) sensitivity.

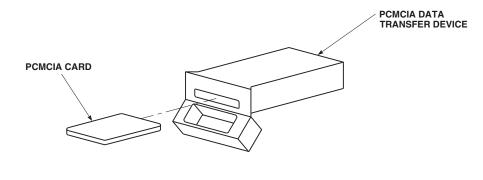
**3.18.3 Signal Data Converter.** The Signal Data Converter (SDC) is located in the avionics compartment and houses the embedded 12 channel GPS receiver with all in view Receiver Autonomous Integrity Monitoring (RAIM) and satellite lock out capabilities. This unit is responsible for integrating GPS and HSI/VSI systems, and maintaining the DAFIF database. PCMCIA, PLGR or RS232 port data transfers are also controlled by the SDC.

**3.18.4 Controls, Displays, and Function.** The control and displays for the AN/ASN-128D are on the front panel, which is identical with AN/ASN-128B (Figure 3-19). The function of each control is as follows:

# CONTROL/ FUNCTION INDICATOR

### NOTE

	The <b>MODE</b> switch is locked in the <b>OFF</b> position and must be pulled out and turned to get into or out of the <b>OFF</b> position.
MODE selector	Selects mode of operation.
OFF	In this position the navigation set is inoperable: non-volatile RAM retains stored waypoint data.
LAMP TEST	Checks operation of all lamps dis- play segment and GPS annunciator panel lights.
TEST	Initiates built-in-self test exercise for the Doppler and GPS systems. This mode also permits the view- ing of DAFIF database status, RS- 232 connection; OBS test results and aircraft's heading, pitch, roll and true airspeed (TAS).
MGRS	Selects <b>MGRS</b> navigational mode of operation.
LAT/LONG	Selects latitude/longitude navigational mode of operation.
GPS LDG	Not supported under AN/ASN- 128D operating system.
<b>DISPLAY</b> selector	Selects navigation data for display.





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# Figure 3-21. PCMCIA Data Transfer Device and GPS Annunciator Panel

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION	
WIND-UTC DATA	Used for wind speed and direction, UTC date and time, data load func- tions, system status and configura- tion.	DIST BRG TIME	Displays distance, bearing, and time information to the destination or course selected. Also displays Fault Detection and Exclusion (FDE), predictive Reciever Autonomous Integrity Monitoring (RAIM) status and current phase of flight.	
XTK/TKE KEY	Displays steering (cross track distance and track angle error) information and GPS variable key status and Selective Availability /			
	Anti-Spoofing Module (SAASM) WP TGT codes.	Accesses waypoint or target designation. Also displays magnetic variation and GPS		
GS/TK NAV M	Displays ground speed, track angle and selection of <b>GPS</b> and naviga-		altitude.	
	tion mode. DATUM	DATUM ROUTE	Accesses flight plan options, way- point and IAP lookup, RT consecu-	
PP	Displays present position, altitude, and magnetic variation.	ROUIL	tive and datum selection.	

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
MAL indicator lamp	Lights when a malfunction is detected by the built-in-test circuitry. In the event of an intermittent malfunction, the system may operate correctly but must be cycled to the <b>OFF</b> posi- tion then to on, to extinguish the <b>MAL</b> light.	INC and DEC keys	Used to increment or decrement the displayed waypoint or flight plans when the <b>DISPLAY</b> selector is set to <b>WP/TGT</b> . To access <b>P</b> , press the <b>LTR LEFT</b> key followed by key 6; display waypoint 99 then press the <b>INC</b> key; or display way- point 00 then press the <b>DEC</b> key. Also used to increment or decre- ment the fly-to destination number when the <b>DISPLAY</b> selector is set
<b>BRT</b> and <b>DIM</b> keys	Used to brighten or dim the light intensity of the LCD display.		
Four line alphanumeric	Displays alphanumeric characters, as determined by the setting of the		to <b>DIST/BRG/TIME</b> or <b>XTK/</b> <b>TKE/KEY</b> .
display	<b>DISPLAY</b> selector, the <b>MODE</b> selector and operation keyboard. The keys activate function upon pressing the key.	ENT key (PAGE)	Enters data into memory (as set up on keyboard and displayed). This key is also used for paging of displays. The bottom right corner
TGT STR key	Stores present position data in the indicated target store/memory loca- tion (90-99) when pressed.		of the display indicates <b>more</b> when additional pages are available, and <b>end</b> when no additional pages are available. Pressing this key when
KYBD key	Used in conjunction with the keyboard to allow data display and entry into the computer		end is displayed will return the display to the first page.
Keyboard and LTR keys		CLR key	Clears last entered character when pressed once. When pressed twice, clears entire input field of display keyboard control.
pressed, data may be displayed on the appropriate input field of dis- play. To display a number, press the corresponding key or keys (0- 9). To display a letter, first press the <b>LTR</b> key corresponding to the position of the desired letter on a	F1 key	Selects Omni Bearing Selection, Direct-To and Message retrieval. When pressed twice, Vector To Final menu will appear if within 30 nautical miles from the destination airport.	
	key. Then press the key which contains the desired letter. Example: To enter an L, first press the LTR RIGHT key, then press key 4.	<b>3.18.5 AN/ASN-128D Configurations Page.</b> The AN/ASN-128D Configurations page (Figure 3-22) is momentarily displayed after power up on the Computer Display Unit (CDU).	

**3.18.5.1 BRAVO Build.** The AN/ASN-128D is backwards compatible with the AN/ASN-128B system. All features of the legacy AN/ASN-128B system are retained when Bravo build is selected.

**3.18.5.2 DELTA Build.** Allows pilots to build a flight plan utilizing user defined waypoints and fly an IFR approach utilizing the loaded DAFIF.

### NOTE

When switching from either BRAVO to DELTA or DELTA to BRAVO build, all user defined waypoints will be erased. The DAFIF in the DELTA build will remain intact.

**3.18.6 Modes of Operation.** Control of the Doppler/ GPS, including selection of modes and displays, and entry and readout of data is performed via the Computer Display Unit (CDU) front panel. The system has three basic modes of operation: **OFF**, navigate, **TEST**. In the navigate mode, four submodes may be selected manually or automatically. These are Combined mode (default or primary mode of operation), GPS only mode, Doppler only mode, and Remembered Velocities mode. GPS Landing mode is not available when operating in the AN/ASN-128D DELTA Build.

**3.18.6.1 OFF Mode.** In the **OFF** mode the system is inoperable. However, the edge lighting is lighted by an external helicopter power source and is independent of the Doppler/GPS **MODE** selector setting. Edge lighting may not be available if the helicopter is modified with the night vision MWO.

3.18.6.2 Navigate Mode. In the navigate mode (MGRS or LAT/LONG) position of the CDU MODE selector) power is applied to all system components, and all required outputs and functions are provided. The Doppler radar velocity sensor (DRVS), consisting of the Signal Data Converter (SDC) and Receiver Transmitter Antenna (RTA), will measure the helicopter velocity, and converts analog heading, pitch and roll into digital form. This data and embedded GPS receiver (EGR) velocity and position data are then sent to the CDU for processing. Barometric altitude is used for aiding the GPS when only three satellites are available. Four satellites are required if the barometric altitude sensor is not available. Present position is computed by using one of four navigation submodes which can be selected manually or automatically. These submodes are as follows:

### 3.18.6.2.1 Combined Mode (Default or Primary

**Mode of Operation).** Doppler and GPS position and velocity data are combined to provide navigation. This mode is used when a minimum of three (with barometric sensor) or four satellites are available, GPS Estimated Position Error (EPE) is less than approximately 150 meters, and the Doppler is not in memory. If GPS becomes invalid (e.g. due to increased EPE), the system will automatically switch to Doppler mode until a valid GPS status is received. The **GPS POS ALERT** advisory will appear when this happens. If the Doppler becomes invalid (e.g. flight over glassy smooth water), the system will automatically switch to GPS mode. Whenever both GPS and Doppler becomes invalid the system will automatically switch to Remembered Velocities mode.

**3.18.6.2.2 GPS Mode.** GPS positions and velocities are used for navigation by the Doppler navigation processor in the CDU. If GPS mode is selected and the GPS becomes invalid (paragraph 3.18.6.2.1), the system will not navigate. The **GPS POS ALERT** advisory and the **NO GPS** light on the pilots and copilot's GPS annunciator panel will illuminate indicating that GPS signals are not reliable.

**3.18.6.2.3 Doppler Mode.** Doppler position and velocity data are used for navigation. If Doppler mode is selected and the Doppler becomes invalid (paragraph 3.17.3.2.1), the system will automatically switch to True Air Speed (TAS) mode (using remembered wind) if a TAS sensor is available, or remembered velocity if a TAS sensor is not available. If Doppler mode is manually selected at the start of the flight an initial present position must be obtained and entered prior to flight. Navigation is performed in latitude/longitude for computational convenience only.

**3.18.6.2.4 Remembered Velocities Mode.** The system will automatically used data, from the last valid remembered ground speed and track velocities.

**3.18.6.3 Test Mode.** The **TEST** mode contains two functions: **LAMP TEST** mode, in which all display segments are lit, and **TEST** mode, in which system operation is identical to that of the navigate mode except that all lamp segments and the **MAL** indicator and GPS annunciator panel are lighted to verify their operation. In **TEST**, the RTA no longer transmits or receives electromagnetic energy; instead, self-generated test signals are inserted into the electronics to verify operation of the DRVS. At this time a self test is performed by the GPS and navigation

computations continue using remembered velocity to test the GPS receiver, AN/ASN-128D system, and IFR function. During test each GPS annunciator panel lens will illuminate sequentially and the TO-FROM indicator, on the HSI will toggle between the TO and FROM positions throughout the test. In the **TEST** mode, Doppler test results are displayed on the CDU front panel for the first 15 seconds (approximate). At the end of this period either GO is displayed if there is no malfunction in the navigation set, or a failure code is displayed if a malfunction has occurred. A rotating bar on the display indicates that the GPS has not completed self test. If the navigation set is maintained in the TEST mode, no navigation data can be displayed on the CDU front panel. If a Doppler malfunction is detected, the MAL indicator lamp lights and DF is displayed. At the completion of GPS self test (up to two minutes), the rotating bar is replaced with a complete test result code. The failed unit and the failed circuit card are also indicated by a code on the CDU display. The CDU is continuously monitored for failures, using its own computer as built-in-test-equipment (BITE). Any BITE malfunction causes the MAL indicator lamp on the CDU to light. If the **MODE** selector on the CDU is set to TEST, identification of the failed LRU is indicated by a code on the display panel. Helicopter heading, pitch and roll are also displayed in the mode by pressing the ENT key after Doppler test is completed. GPS test status is displayed if the ENT key is pressed a second time. Malfunction codes are automatically latched and can only be cleared by recycling the CDU power via the CDU mode switch (OFF-ON).

**3.18.6.4 GPS Landing Mode.** GPS Landing Mode is supported only when operating under the BRAVO Build.

**3.18.7 CDU Operation.** Various required operating data, such as initial present position (if GPS is not valid or Doppler mode is selected), destination coordinates and magnetic variation can at any time be entered into the CDU via its keyboard, or the remote fill panel (Figure 3-8) via the preprogrammed data loader cartridge. In most cases, this data will be entered before the helicopter takes off. The GPS provides present position to the Doppler/GPS. If GPS is not available or Doppler is selected present position can be initialized as follows:

 The MODE selector should be set to MGRS or LAT/LONG, the WP/TGT display position of the DISPLAY selector is selected, the destination number is set to P (default waypoint) and KYBD key is pressed. The coordinates of the initial position is overflown, the ENT key is pressed. The computer then determines changes from the initial position continuously, and the coordinates of the current present position can be read either by remaining in this configuration or by setting the DISPLAY selector to PP (present position) and the MODE selector to MGRS or LAT/ LONG.

- 2. To update present position over a stored destination, **KYBD** key is pressed when the helicopter overflies this destination. If an update is desired, the **ENT** key is pressed and the update is completed. The **DISPLAY** selector is in the **DIST/BRG/TIME** position and the **FLY-TO-DEST** is set to this destination during this process. The distance-to-go, displayed while over the stored destination, is the position error of the system at that moment.
- 3. To update present position over a fixed point not previously stored in the computer, the **DISPLAY** selector is placed to **PP** and **KYBD** key is pressed as the fix point is overflown. This freezes the display while allowing computation of changes in present position to continue within the computer. If an update is required the coordinates of the fix point are entered via the keyboard, and **ENT** key is pressed. The position change which occurred since over-flying the fix point is automatically added to the fix point coordinates to complete the position update.
- 4. Magnetic variation can be entered for each destination, and the system will compute present position magnetic variation. If operation is to occur in a region with relatively constant magnetic variation, the operator enters magnetic variation only for present position and the computer will use this value throughout the flight. If **MGRS** data are to be entered or displayed, the **MGRS** datum of operation is also entered.

**3.18.8 Target-of-Opportunity.** Target-of-opportunity data can be stored by pressing **TGT STR** (target store) key when the target is overflown. This operation stores the coordinates of the target in one of ten destination locations in the computer; locations 90-99 sequentially incrementing each time the **TGT STR** key is pressed. The location is

displayed in the appropriate display field. The computer can keep track of individual target positions which may include speeds and directions input by the operator.

**3.18.9 Self Test.** Self test of the AN/ASN-128D is accomplished using BITE with the **RTA**, **SDC**, and **CDU** units connected and energized for normal operation. Self test enables the unit to isolate failures to one of the four main functions (**RTA**, **SDC**, **CDU** or **EGR**) or to one of the circuit cards in the **SDC** or **CDU**. Self test is accomplished as follows:

- The CDU (except for the keyboard and display) is checked on a continuous basis, and any failure is displayed by the illumination of the MAL indicator lamp on the CDU. If the MODE selector on the CDU is set to the TEST position, identification of the failed circuit card in the CDU is indicated by a code on the display panel.
- 2. The **DRVS** and **EGR** are tested by setting the **MODE** selector on the CDU to the **TEST** position. Failure of the **DRVS** or **EGR** are displayed on the CDU by illumination of the **MAL** indicator lamp, and identification of the failed unit or circuit card is indicated by a code on the display panel of the CDU.
- 3. Continuous monitoring of the signal data converter and receiver transmitter antenna is provided by the system status indication. The system will not use Doppler velocities in normal operation when flying over glassy smooth water. However, if the system continues to not use Doppler (e.g. using GPS only when combined has been selected) for excessive periods of time (e.g. more than 10 minutes) over land or rough water, then a malfunction may exist in the navigation set and the operator should set the **MODE** selector to **TEST** to determine the nature of the failure.
- 4. The display portion of the CDU is tested by illuminating all the lamp segments in each alphanumeric character in the LAMP TEST mode.
- 5. Keyboard operation is verified by observing the alphanumeric characters as the keyboard is exercised.

**3.18.10 Route Sequencing Modes.** The system has the ability to fly a preprogrammed sequence of waypoints.

This sequence can be either consecutively numbered in which case a start and end waypoint are entered or random numbered, in which case all waypoints are put in a list and the start and end waypoints are entered. Both sequence modes can be flown in the order they are in the list or in the reverse order. Directions will be displayed to the waypoint next on the list until approximately 10 seconds before overflying the waypoint at which time the display will advance to the next waypoint and the new waypoint number will blink for ten seconds. One consecutive and one random sequence may be stored in the system.

**3.18.11 To-To Route Mode.** The system has the ability to provide steering information onto a course defined by the start and end waypoints. Only the second waypoint will be overflown. The distance displayed is the distance to the course when outside two nautical miles of the course and the distance to the second waypoint when inside two nautical miles of the course.

3.18.12 General Operating Procedures for Entering Data. The panel display consists of four line LED readout. The top line of the display is reserved for the display of Fly-To destination number and destination name/ International Civil Aeronautic Organization (ICAO) identifier, EPE in meters, mode of GPS and mode of AN/ ASN-128D operation and target store number. The remaining lines will display data in accordance with the DISPLAY and MODE selectors. When pressing the **KYBD** key for the first time in an entry procedure, the display freezes, kybd is displayed in the bottom right corner indicating the display is in the keyboard mode and the input field under keyboard control blinks. If it is not desired to change the display field under control, the pilot can advance to the next field of the display by pressing the KYBD key again. Pressing the ENT key (whether or not new data has been entered) causes the display to blank momentarily and return with the latest computed data. To abort a keyboard operation, move the MODE or DIS-PLAY selector to another position.

**3.18.12.1 Data Entry.** To display a letter, first press the LTR key corresponding to the position of the desired letter on a key. Then press the key which contains the desired letter. For example, to enter an L, first press the LTR RIGHT key, then press key 4.

**3.18.12.2 Keyboard Correction Capability.** The last character entered may be cleared by pressing the **CLR** key. If the **CLR** key is pressed twice in succession, the field is cleared but remains under control (indicated by blinking) and the last valid data entered is displayed.

**3.18.12.3 Destination Variation Constraint.** The magnetic variation associated with a destination must be entered after the coordinates for that destination are entered. The order of entry for present position is irrelevant.

## 3.18.12.4 Impossibility of Entering Unacceptable

**Data.** In most cases the computer program will reject unacceptable data (for example, a **MGRS** area of **W1** does not exist and will be rejected). If the operator attempts to insert unacceptable data, the unacceptable data will be displayed on the panel and then the selected field will blink after **ENT** key is pressed displaying the last valid data.

### NOTE

The computer cannot prevent insertion of erroneous data resulting, for example, from human or map errors.

**3.18.12.5 GPS Tracking Codes.** The AN/ASN-128D GPS receiver has two tracking code options, one for keyed and one for non-keyed operations. The **S** selection is not a tracking code, but forces the AN/ASN-128D in the Standard Positioning Service (SPS) mode in order to facilitate IFR approaches. When **S** is selected the navigation solution is exclusively determined by the GPS receiver and changes the Navigation mode to GPS only. Listed below are the modes and available coordinate presentation.

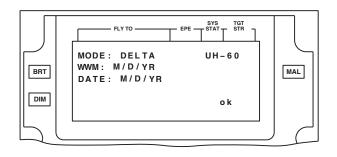
Mode	Code	Coordinates
М	Mixed C/A and P/Y code	LAT/LONG MGRS
Y	Y code	LAT/LONG MGRS
S	Standard Positioning Service	LAT/LONG

## 3.18.12.6 AN/ASN-128D CDU Menu Presentations.

Listed below are the various menu selections for the AN/ ASN-128D when operating in the Delta configuration.

## 3.18.12.7 AN/ASN-128D CDU Power Up Menu.

When power is first applied the CDU will display Figure 3-22.



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## Figure 3-22. AN/ASN-128D Power Up Menu

DISPLAY	FUNCTION	
MODE:	Displays mode and type aircraft. <b>DELTA</b> for AN/ASN-128D <b>BRAVO</b> for AN/ASN-128B	
WMM:	Displays date of World Magnetic Model (WMM).	
DATE:	Displays current date stored in system.	

This screen will only be displayed momentarily. If the WMM has expired, the operator will need to press the **ENT** key to acknowledge the screen and notify a maintenance technician to update the WMM. The WMM expires every five years.

### 3.18.12.8 AN/ASN-128D CDU Power Up DAFIF

**Menu.** Figure 3-23 will appear immediately after the Power Up Menu.

user to view wind information, enter date and time, and view GPS status, system configuration and selection one of the two data loading options. There are a total of six menu selections; additional menus are selected by pressing the **ENT** key when **more** is visible on the lower right hand corner of the CDU.

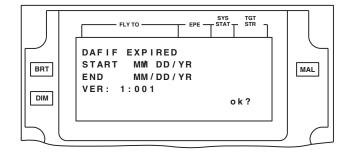
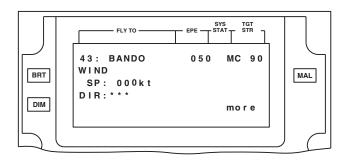


Figure 3-23. AN/ASN-128D Power Up DAFIF Menu

DISPLAY



AA9998_4

### Figure 3-24. WIND-UTC/DATA Main Menu

DAFIF EXPIRED:	Displays current DAFIF status.
START:	Displays the start of valid date.
END:	Displays the end of valid date.
VER:	Displays the software version number.

**FUNCTION** 

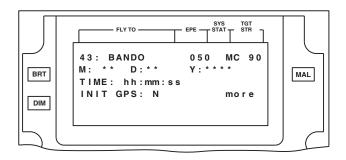
AA9998_3

The Digital Aeronautical Flight Information File (DAFIF) menu will appear every time power is applied. If the DAFIF has expired, the operator must acknowledge that the DAFIF loaded is expired. User must press the **ENT** key to continue.

**3.18.12.9 WIND-UTC/DATA Main Menu.** The WIND-UTC/DATA main menu (Figure 3-24) allows the

DISPLAY	FUNCTION	
WIND	Displays the title of menu.	
SP:	Displays wind speed in knots for LAT/ LONG or kilometers per hour for MGRS.	
DIR:	Wind Direction.	
more	Press <b>ENT</b> key to select additional menus.	

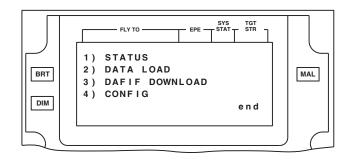
**3.18.12.9.1 WIND-UTC/DATA Menu 2.** The WIND-UTC/DATA Menu 2 (Figure 3-25) allows the user to update system date and time. This option is used to reduce system acquisition time.



#### Figure 3-25. WIND-UTC/DATA Menu 2

DISPLAY **FUNCTION** M: Displays the current month current date stored in system. D: Displays the current date stored in system. Y: Displays the current year stored in system. TIME: Displays the current time (hours: minutes:seconds) stored in system. **INIT GPS** Allows user to initiation a GPS Synchronization using the following two keys: N: - Does not update system time (default). Y: - Updates system time with new GPS information. Press ENT key to select additional more menus.

**3.18.12.9.2 WIND-UTC/DATA Menu 3.** The WIND-UTC/DATA Menu 3 (Figure 3-26) provides the user with system status, data load options and configuration selection.

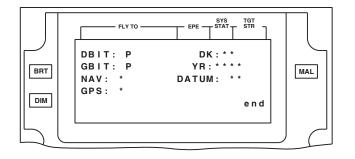


AA9998_6

### Figure 3-26. WIND-UTC/DATA Menu 3

DISPLAY	FUNCTION
1) STATUS	Displays the <b>GPS STATUS</b> menu option. Press the <b>1</b> key to select this option.
2) DATA LOAD	Displays the <b>DATA LOAD</b> menu option. Press the <b>2</b> key to select this option.
3) DAFIF DOWNLOAD	Displays the <b>DAFIF</b> <b>DOWNLOAD</b> menu option. Press the <b>3</b> key to select this option.
4) CONFIG	Displays the <b>CONFIG</b> menu option. Press the <b>4</b> key to select this option.

**3.18.12.9.3 WIND-UTC/GPS STATUS Menu.** The WIND-UTC/GPS STATUS Menu (Figure 3-27) displays all the critical navigational information.



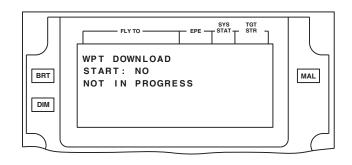
DISPLAY **FUNCTION** NAV: Displays one of the following navigation reception modes: G - GPS only mode. C - Combined GPS and Doppler mode. **D** - Doppler only mode. DATUM: Displays current Datum code. GPS: Displays one of the following tracking modes:  $\mathbf{Y}$  - P/Y code. **M** - Mixed P/Y and C/A code. S - Standard Positioning Service.

AA9998_7

# Figure 3-27. WIND-UTC/GPS STATUS Menu

DISPLAY	FUNCTION
DBIT	Displays Doppler BIT status P - Pass. F - Fails.
DK:	<ul> <li>Displays one of the following Load status: DK or GK</li> <li>DK: ** - No key loaded.</li> <li>DK: NO - Daily key in use is incorrect.</li> <li>DK: IN - Daily key loaded but not verified.</li> <li>DK: OK - Daily key loaded and verified.</li> <li>GK: NO - GUV user keys in use is incorrect.</li> <li>GK: IN - GUV user keys loaded but not verified.</li> <li>GK: OK - GUV user keys loaded and verified.</li> </ul>
GBIT:	Displays the GPS BIT status: P - Pass. F - Fails.
YR:	Displays current year.

**3.18.12.9.4 WIND-UTC/DOWNLOAD Menu.** The WIND-UTC/DOWNLOAD Menu (Figure 3-28) allows the user to download waypoints via the dataloader.



AA9998_8

## Figure 3-28. WIND-UTC/DOWNLOAD Menu

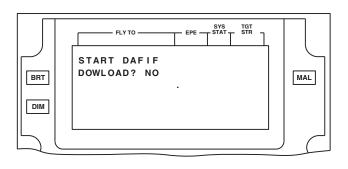
DISPLAY

FUNCTION

WPT DOWNLOAD Displays the title of menu.

DISPLAY	FUNCTION
START: NO	Displays the one of the following Download options: <b>NO</b> - Default setting. <b>YES</b> - Starts the downloading procedure.
NOT IN PROGRESS	Displays the current Download status.

3.18.12.9.5 WIND-UTC/DAFIF Menu. The WIND-UTC/DAFIF Menu (Figure 3-29) allows the user to down DAFIF database via a PCMCIA CARD.



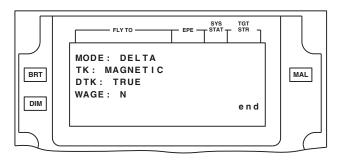
AA9998_55

### Figure 3-29. WIND-UTC/DAFIF Menu

DISPLAY **FUNCTION** 

- **START DAFIF** Displays the title of menu.
- **DOWNLOAD?** Displays the one of the following NO DAFIF Download options: NO - Default setting. YES - Starts the DAFIF downloading procedure.

3.18.12.9.6 WIND-UTC/CONFIG Menu. The WIND-UTC/CONFIG Menu (Figure 3-30) allows the user to verify the configuration of the AN/ASN-128D.



AA9998_9

## Figure 3-30. WIND-UTC/CONFIG Menu

DISPLAY	FUNCTION
MODE:	Displays current configuration mode. <b>DELTA</b> - for AN/ASN-128D configuration. <b>BRAVO</b> - for AN/ASN-128B configuration.
TK:	Displays the one of the following options: MAGNETIC reference. TRUE reference.
DTK:	Displays the one of the following options: MAGNETIC reference. TRUE reference.
WAGE:	<b>N</b> (This feature is Not Used in the AN/ASN-128D Configuration).

3.18.12.10 XTK/TKE/KEY Main Menu. The XTK/ TKE/KEY Main Menu (Figure 3-31) provides the user with track information, Crypto load status, space vehicle monitoring, and SAASM options. XTK/TKE/KEY consists of seven menus. Line two of the CDU displays a numerical value as well as a graphic icon indicating TO/FROM condition and LEFT or RIGHT course correction.

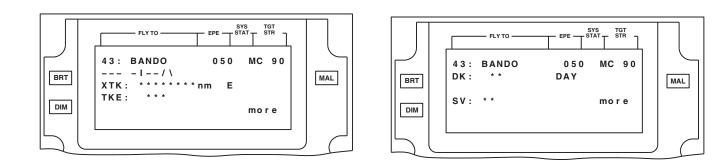


Figure 3-31. XTK/TKE/KEY Main Menu

AA9998_11

# Figure 3-32. XTK/TKE/KEY Menu 2

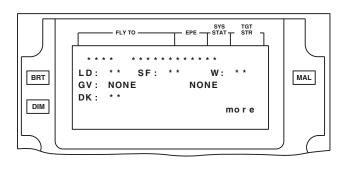
DISPLAY	FUNCTION	DISPLAY	FUNCTION
I	Displays course correction required.	DK:	Displays one of the following Load status: <b>DK</b> or <b>GK</b>
/[]	Displays the one of the following options: /[] - TO indication. []/ - ROM indication.		<ul> <li>DK: ** - No key loaded.</li> <li>DK: NO - Daily key in use is incorrect.</li> <li>DK: IN - Daily key loaded but not verified.</li> </ul>
XTK:	Cross Track Correction.		<b>DK: OK</b> - Daily key loaded and verified.
TKE:	Track Correction Error.		<b>GK: NO</b> - GUV user keys in use
more	Press <b>ENT</b> key to select additional menus.		is incorrect. GK: IN - GUV user keys loaded but not verified. GK: OK - GUV user keys loaded
3.18.12.10.1	XTK/TKE/KEY Menu 2. The XTK/TKE/		and verified.

**3.18.12.10.1 XTK/TKE/KEY Menu 2.** The XTK/TKE/KEY Menu 2 (Figure 3-32) displays the status of the Crypto keys.

3-91

DISPLAY	FUNCTION
SV:	Displays the current amount of Space Vehicles being tracked by the AN/ASN-128D system.
more	Press <b>ENT</b> key to select additional menus.

**3.18.12.10.2 XTK/TKE/KEY Menu 3.** The XTK/TKE/KEY Menu 3 (Figure 3-33) displays the load status of GUV keys and daily keys.



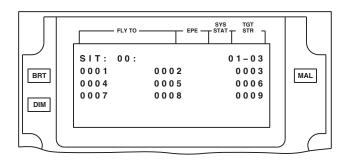
AA9998_12

# Figure 3-33. XTK/TKE/KEY Menu 3

# DISPLAY **FUNCTION** LD: Displays the one of the following options: **NO** - if Crypto is not loaded. YES - if Crypto is loaded. SF: Displays the one of the following options: **NO** - if sub word is not loaded. YES - if sub word is loaded. **W**: Displays the one of the following options: NO - if word is not loaded. **YES** - if word is loaded.

DISPLAY	FUNCTION
GV:	Displays the one of the following options: <b>NONE</b> - if GV keys word is not loaded. <b>YES</b> - if GV keys are loaded.
DK:	Displays either the <b>DK</b> or <b>GK</b> with one of the following options: <b>NO</b> - if DK or GV is not loaded. <b>YES</b> - if DK or GV is loaded.

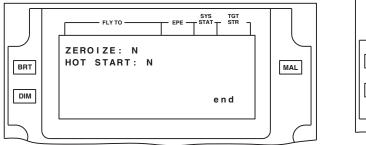
**3.18.12.10.3 XTK/TKE/KEY Menus 4-6.** The XTK/ TKE/KEY Menu 4 (Figure 3-34) displays the SAASM codes.



AA9998_14

# Figure 3-34. XTK/TKE/KEY Menu 4

**3.18.12.10.4 XTK/TKE/KEY Menu 7.** The XTK/TKE/ KEY Menu 7 (Figure 3-35) displays the zeroize and Hot Start features.



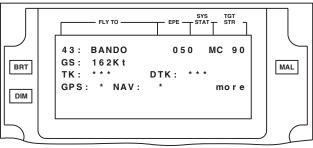


Figure 3-35. XTK/TKE/KEY Menu 7

AA9998_18 SA

## Figure 3-36. GS/TK/NAV M Main Menu

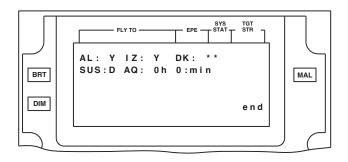
S - Standard Positioning Service.

DISPLAY	FUNCTION	DISPLAY	FUNCTION
ZEROIZE:	Displays the one of the following options: N - Default setting. Y - Zeroize the almanac from GPS receiver.	GS	Displays ground speed in the fol- lowing options: Listed in knots for LAT/LONG. Listed in kilometers per hour for MGRS.
HOT START:	Displays the one of the following options:	ТК	Displays the Track Angle listed in degrees.
	<b>NO</b> - Default setting. <b>YES</b> - Starts the Hot Start procedure.	DTK:	Displays desired Track Angle listed in degrees.
end:	Last menu page.	GPS:	Displays one of the following tracking modes: <b>Y</b> - P/Y code.
3.18.12.11 GS/TK/NAV M Main Menu. The GS/TK/			<b>M</b> - Mixed P/Y and C/A code.

**3.18.12.11 GS/TK/NAV M Main Menu.** The GS/TK/ NAV M Main Menu (Figure 3-36) displays the ground speed, track angle, desired track, GPS tracking and navigation mode.

DISPLAY	FUNCTION	DISPLAY
more	Press <b>ENT</b> key to select additional menus.	DK:
NAV:	<ul> <li>Displays one of the following navigation reception modes:</li> <li>G - GPS only mode.</li> <li>C - Combined GPS and Doppler mode.</li> <li>D - Doppler only mode.</li> </ul>	
		SUS

**3.18.12.11.1 GS/TK/NAV M Menu 2.** The GS/TK/ NAV M Menu 2 (Figure 3-37) displays GPS initialization status and key load status.



AA9998_19

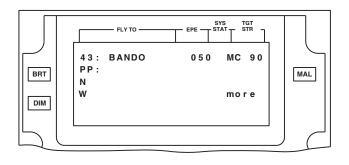
# Figure 3-37. GS/TK/NAV M Menu 2

DISPLAYFUNCTIONAL:Displays the almanac status with<br/>one of the following options:<br/>N - if almanac is not loaded.<br/>Y - if almanac is loaded.IZ:Displays the initialization status<br/>with one of the following options:<br/>N - Default setting.<br/>Y - Starts the initialization<br/>procedure.

DISPLAY	FUNCTION
DK:	<ul> <li>Displays either the DK or GK with one of the following options:</li> <li>** - No keys loaded.</li> <li>NO - Daily keys in use is incorrect.</li> <li>IN - Daily keys loaded but not verified.</li> <li>OK - Daily keys loaded and verified.</li> </ul>
SUS:	Displays the Start Up Sequence (SUS) with the following option: <b>D</b> - Default setting.
AQ:	Displays the Acquisition time.
end:	Last menu page.

## 3.18.12.12 Presentation Position (PP) Main Menu.

The (PP) Presentation Position Main Menu (Figure 3-38) displays present position when the **MODE** selector is in **LAT/LONG** or **MGRS**. User defined waypoints as well as other waypoints can be viewed in this menu by pressing **INC** or **DEC** keys on CDU keyboard.



AA9998_20



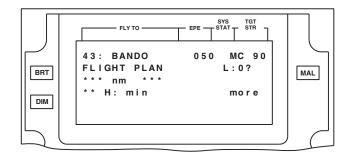
DISPLAY	FUNCTION
PP:	Displays the title of menu.
Ν	Displays the current latitude or MRGS coordinates.
W	Displays the current longitude or MRGS coordinates.
more	Press <b>ENT</b> key to select additional menus.

## 3.18.12.12.1 Presentation Position (PP) Menu 2.

The Presentation Position (PP) Menu 2 displays the GPS altitude, magnetic variation and allows the user to select automatic or manual variation selection.

DISPLAY	FUNCTION
PP:	Displays the title of menu.
V:	Displays the current magnetic variation used on the current PP.
GPS ALT:	Displays the current GPS altitude in feet (with <b>MODE</b> selector in <b>LAT/LONG</b> ) or meters (with <b>MODE</b> selector in <b>MGRS</b> ).
AUTO/MAN:	Displays the selection of magnetic variation mode with one of the fol- lowing options: A - Automatic Mode. M - Manual Selection.
end:	Last menu page.

**3.18.12.13 DIST/BRG/TIME Main Menu.** The DIST/ BRG/TIME Main Menu (Figure 3-39) displays current leg of flight distance to leg and estimated time to leg.



AA9998_21

## Figure 3-39. DIST/BRG/TIME Main Menu

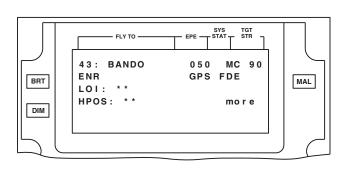
**FUNCTION** 

DISPLAY

DISILAI	FUNCTION
FLIGHT PLAN:	Displays the current navigation mode with one of the following option: FLIGHT PLAN VTF (Vector To Final) DIRECT-TO OBS (Omni Bearing Search)
L:	Displays the current leg number of flight plan.
nm	Displays the current flight distance left to fly on current leg in nautical miles.
***	Displays the current bearing to on current leg in degrees.
H:	Displays the current hours left to fly on current leg.

DISPLAY	FUNCTION	DISPLAY	FUNCTION
min more	Displays the current minutes left to fly on current leg. Press <b>ENT</b> key to select additional menus.	HPOS:	Displays the Horizontal Position with one of the following options: <b>P</b> - Pass (IFR Flight is possible with this advisory). <b>F</b> - Fail (IFR Flight is no longer
3.18.12.13.1	DIST/BRG/TIME Menu 2. The DIST/	more	possible with this advisory). Press <b>ENT</b> key to select additional

BRG/TIME Menu 2 (Figure 3-40) displays the phase of flight and GPS reliability.



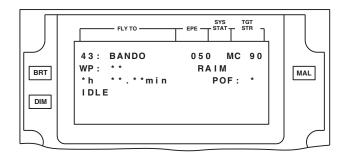
AA9998_22

# Figure 3-40. DIST/BRG/TIME Menu 2

**FUNCTION** 

ENR:	Displays the current phase of flight with one of the following options: <b>ENR</b> - Enroute. <b>TER</b> - Terminal. <b>APP</b> - Approach.
GPS FDE:	Displays the GPS Fail Detection Error (FDE) title.
LOI:	Displays the Loss Of Integrity with one of the following options: <b>NO</b> - IFR Flight is possible with this advisory. <b>YES</b> - IFR Flight is no longer pos- sible with this advisory.

**3.18.12.13.2 DIST/BRG/TIME Menu 3.** The DIST/ BRG/TIME Menu 3 (Figure 3-41) displays the GPS availability at the destination thru the current selected waypoint (WP) number.



AA9998_23

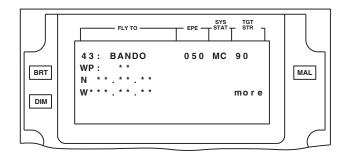
## Figure 3-41. DIST/BRG/TIME Menu 3

DISPLAY	FUNCTION
WP:	Displays the current selected way- point (WP) number.
h:	Displays the hours remaining for Satellite Availability.
min:	Displays the minutes remaining for Satellite Availability.

DISPLAY

DISPLAY	FUNCTION	DISPLAY	FUNCTION
POF:	<ul> <li>Displays the phase of flight with one of the following options:</li> <li>E - Enroute.</li> <li>T - Terminal.</li> <li>A - Approach.</li> </ul>	N:	Displays the waypoint information in either of the following options: Latitude presentation (LAT/LONG format) MGRS format.
IDLE	Displays the phase of flight with one of the following options: IDLE AVAILABLE.	W	Displays the waypoint information in either of the following options: Longitude presentation (LAT/ LONG format) MGRS format.

3.18.12.14 WP/TGT Main Menu. The WP/TGT Main Menu (Figure 3-42) displays waypoint location in either LAT/LONG or MGRS format. Waypoint information will not displayed under the S GPS Tracking Mode. Locations 00 to 69 are Standard waypoints and locations 70 to 89 are reserved for Data Loaded waypoints (which can only be observed and not changed). Locations 90 to 99 are Target Store waypoints (usable as standard waypoints, but not as route sequencing waypoints). The current destination number will be displayed. To display desired destination number, press the INC or DEC key, or enter destination number using the CDU keyboard.



AA9998_24

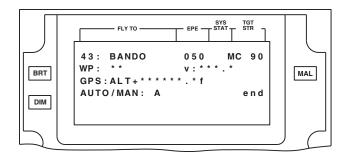
#### Figure 3-42. WP/TGT Main Menu

DISPLAY **FUNCTION** 

WP: Displays the current destination number waypoint.

IN.	in either of the following options: Latitude presentation (LAT/LONG format) MGRS format.
W	Displays the waypoint information in either of the following options: Longitude presentation (LAT/ LONG format) MGRS format.
more	Press <b>ENT</b> key to select additional menus.
	<b>WP/TGT Menu 2.</b> The WP/TGT Menu 2 llows the user to enter magnetic variation

and select either automatic manual magnetic variation mode per waypoint.



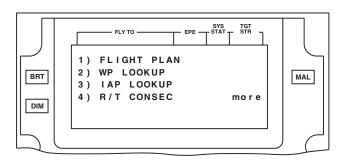
AA9998_25

#### Figure 3-43. WP/TGT Menu 2

DISPLAY	FUNCTION
WP:	Displays the current destination number waypoint.
V:	Displays the current magnetic variation used on the current WP.

DISPLAY	FUNCTION
GPS ALT:	Displays the current GPS altitude in feet (with <b>MODE</b> selector in <b>LAT/LONG</b> ) or meters (with <b>MODE</b> selector in <b>MGRS</b> ).
AUTO/MAN:	Displays the selection of magnetic variation mode with one of the fol- lowing options: <b>A</b> - Automatic Mode. <b>M</b> - Manual Selection.
end:	Last menu page.

**3.18.12.15 DATUM ROUTE Main Menu.** The DATUM ROUTE Main Menu (Figure 3-44) allows the user to build and activate a flight plan, review WP, review instrument approach procedures (IAP) information, or enable route consecutive.



AA9998_26

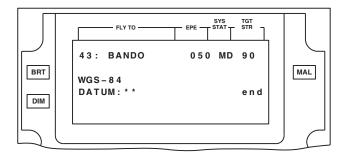
DISPLAY

## Figure 3-44. DATUM ROUTE Main Menu

DISPLAY	FUNCTION
1) FLIGHT PLAN	Displays the <b>FLIGHT PLAN</b> menu option. Press the <b>1</b> key to select this option.
2) WP LOOKUP	Displays the <b>WP LOOKUP</b> menu option. Press the <b>2</b> key to select this option.
3) IAP LOOKUP	Displays the <b>IAP LOOKUP</b> menu option. Press the <b>3</b> key to select this option.

DISPLAY	FUNCTION
4) R/T CON- SEC	Displays the <b>R/T CONSEC</b> menu option. Press the <b>4</b> key to select this option.
more	Press <b>ENT</b> key to select additional menus.

**3.18.12.15.1 DATUM ROUTE Menu 2.** The DATUM ROUTE Menu 2 (Figure 3-45) displays current datum and allows the user to enter a new datum code.



AA9998_27

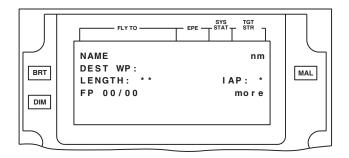
### Figure 3-45. DATUM ROUTE Menu 2

**FUNCTION** 

WGS84	Displays the current datum.
DATUM:	Allows user to enter a new datum code from Table 3-4.
end:	Last menu page.

## 3.18.12.15.2 DATUM ROUTE FLIGHT PLAN (FP)

**Main Menu.** The DATUM ROUTE FLIGHT PLAN (FP) Main Menu (Figure 3-46) allows the user to scroll through the various flight plans or build a flight plan. The system can store up to 3 separate flight plans. When the system has three flight plans stored, a saved flight plan must be deleted in order to create a new flight plan.



### Figure 3-46. DATUM ROUTE FP Main Menu

**FUNCTION** 

DISPLAY

DEST WP:

LENGTH:

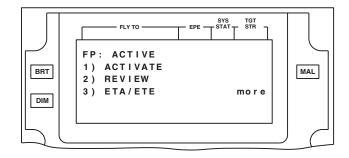
IAP:

FP:

more

NAME

current active flight plan, allows the user to review the active a flight plan, and displays the completion time of the flight plan.



AA9998_29

### Figure 3-47. DATUM ROUTE FP Menu 2

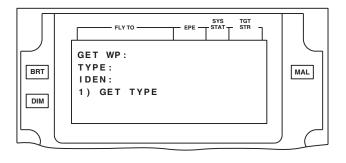
Displays the current flight plan name.	DISPLAY	FUNCTION
Displays the next concurrent way- point within the current flight plan.	FP:	Displays the current active or non-
Displays the total number of way- points within the current flight plan.	1) ACTIVATE	active flight plan. Allows user the option to activate the flight plan listed on line 1 of
<ul><li>Displays the IAP loaded status</li><li>with one of the following options:</li><li>Y - IAP is loaded in the current</li><li>flight plan.</li><li>N- IAP is not loaded in the current</li><li>flight plan.</li></ul>	2) REVIEW	<ul><li>the CDU display. Press the 1 key to select this option.</li><li>Allows user the option to review the flight plan listed on line 1 of the CDU display. Press the 2 key to select this option.</li></ul>
Displays the current viewed and total number of flight plans (Max of 3 stored flight plans).	3) ETA/ETE	Displays the ETA and ETE to completion of the flight plan. Press the <b>3</b> key to select this option.
Press <b>ENT</b> key to select additional menus.	more	Press <b>ENT</b> key to select additional menus.

3.18.12.15.2.1 DATUM ROUTE FP Menu 2. The DATUM ROUTE FP Menu 2 (Figure 3-47) displays the

3.18.12.15.2.2 DATUM ROUTE FP Menu 3. The DATUM ROUTE FP Menu 3 (Figure 3-48) allows the

user to delete a flight plan, review IAP information, and to remove an IAP from a flight plan.





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## Figure 3-49. DATUM ROUTE WP Menu

**FUNCTION** 

DISPLAY	FUNCTION	GET WP	Displays the title of menu.
FP:	Displays the current active or non- active flight plan.	TYPE:	Allow user to view waypoints as the following options: <b>ARPT</b> (Airport)
4) DELETE FLIGHT PLAN	Allows user the option to delete the flight plan listed on line 1 of the CDU display. Press the <b>4</b> key to select this option.		HELIPORT INTERSECTION USER DEFINE VOR NDB
5) IAP INFO	Allows user the option to review any loaded DAFIF the flight plan listed on line 1 of the CDU dis- play. Press the <b>5</b> key to select this option.	IDEN:	<b>DME</b> Allow user to enter the name of ICAO (a 4-letter station identifier) or waypoint desired.
	ΝΟΤΕ	1) GET TYPE	Allows user the option to initiate a search for the requested waypoint listed on line 3 of the CDU dis-
	If an IAP is not loaded into a flight plan, option five will read <b>5</b> ) <b>Set</b> <b>Approach</b> and option six will not be available.		play. Press the 1 key to select this option.
6) REMOVE	Allows user the option to remove		ATUM ROUTE IAP Menu. Th

AA9998_30

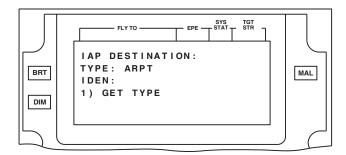
DISPLAY

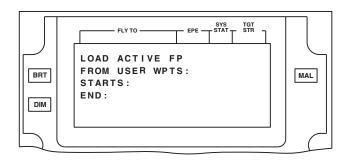
**3.18.12.15.4 DATUM ROUTE IAP Menu.** The DATUM ROUTE IAP Menu (Figure 3-50) allows the user to review and search for any stored IAP information from the DAFIF. Only GPS approved and GPS overlay approaches will be listed on the DAFIF.

# Figure 3-48. DATUM ROUTE FP Menu 3

6) REMOVEAllows user the option to removeIAPIAP from the flight plan listed on<br/>line 1 of the CDU display. Press<br/>the 6 key to select this option.

**3.18.12.15.3 DATUM ROUTE WP Menu.** The DATUM ROUTE WP Menu (Figure 3-49) allows the user to review and search for any stored waypoint information.





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## Figure 3-50. DATUM ROUTE IAP Menu

DISPLAY	FUNCTION
IAP DESTINA- TION	Displays the title of menu.
TYPE:	Allow user to view waypoints as the following options: <b>ARPT</b> (Airport) <b>HELIPORT</b>
IDEN:	Allow user to enter the name of ICAO (a 4-letter station identifier) or waypoint desired.
1) GET TYPE	Allows user the option to initiate a search for the requested waypoint listed on line 3 of the CDU display. Press the <b>1</b> key to select this option.

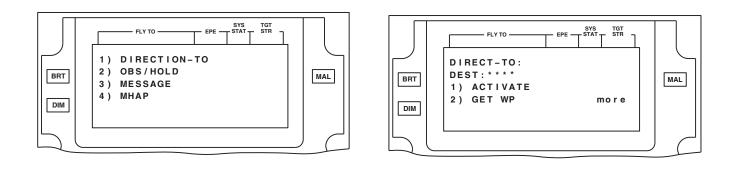
**3.18.12.15.5 DATUM ROUTE R/T CONSEC Menu.** The DATUM ROUTE R/T CONSEC Menu (Figure 3-51)

allows the user to enter up to 25 consecutive waypoints into a active flight plan.

## Figure 3-51. DATUM ROUTE R/T CONSEC Menu

DISPLAY	FUNCTION
LOAD ACTIVE FP	Displays the title of menu.
FROM USER WPTS:	Displays the sub-title of menu.
START:	Allow user to enter starting way- point number.
END:	Allow user to enter ending way- point number.

**3.18.12.16 F1 SELECTION Main Menu.** The F1 SELECTION Main Menu (Figure 3-52) allows the user to activate the IFR menu at any time. The F1 SELECTION main menu is access by pressing F1 key on the CDU keyboard.



## Figure 3-52. F1 SELECTION Main Menu

DISPLAY	FUNCTION
1) DIRECT-TO	Displays the <b>DIRECT-TO</b> menu option. Press the <b>1</b> key to select this option.
2) OBS/HOLD	Displays the <b>OBS/HOLD</b> menu option. Press the <b>2</b> key to select this option.
3) MESSAGE	Displays the <b>MESSAGE</b> menu op- tion. Press the <b>3</b> key to select this option.
4) MHAP	Displays the <b>MHAP</b> menu option. Press the <b>4</b> key to select this op- tion.

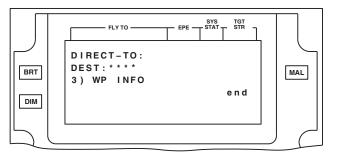
**3.18.12.16.1 F1 DIRECT-TO Menu 1.** The F1 DIRECT-TO Menu 1 (Figure 3-53) provides the user with a direct course to a previously stored user defined waypoint or a waypoint from the DAFIF. Direct-To mode can be accessed at any time. If DIRECT-TO is selected while viewing a flight plan leg or waypoint, that location will be selected as the destination.

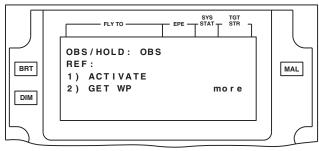
Figure 3-53. F1 DIRECT-TO Menu 1

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DISPLAY	FUNCTION
DIRECT-TO:	Displays the flight plan mode or waypoint name.
DEST:	Displays the next waypoint.
1) ACTIVATE	Allows user the option to initiate a direct course to the destination listed on line 2 of the CDU display. Press the <b>1</b> key to select this option.
2) GET TYPE	Allows user the option to initiate a search for the requested waypoint listed on line 2 of the CDU display. Press the <b>2</b> key to select this option.
more	Press ENT key to select additional menus.

**3.18.12.16.1.1 F1 DIRECT-TO Menu 2.** The F1 SELECTION Menu 2 (Figure 3-54) allows the user to use the waypoint retrieval option.





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## Figure 3-54. F1 DIRECT-TO Menu 2

DISPLAY	FUNCTION
DIRECT-TO:	Displays the title of menu.
DEST:	Displays the reference waypoint.
3) WP INFO	Allows user to initiate the way- point information retrieval option. Press the <b>3</b> key to select this op- tion.
end:	Last menu page.

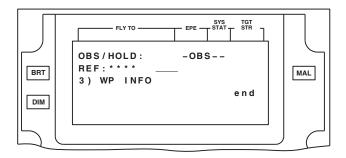
**3.18.12.16.2 F1 OBS/HOLD Menu 1.** The F1 OBS/ HOLD Menu 1 (Figure 3-55) allows user to provide the OBS digital steering data to the number one bearing pointer and TO/FROM flag on the HSI. OBS mode can be selected when IFR flight plan mode is enabled. OBS/ HOLD is automatically enabled when the flight plan has been suspended or when missed approach is sequenced as the next waypoint. Figure 3-55. F1 OBS/HOLD Menu 1

DISPLAY	FUNCTION
OBS/HOLD:	Displays the OBS mode with one of the following options: <b>FROM</b> - OBS is enabled <b>FROM</b> arrow in view. <b>TO</b> - OBS is enabled <b>TO</b> arrow in view. <b>HOLD</b> - Flight plan has been suspended.
REF:	Displays the name of waypoint and bearing to course.
1) ACTIVATE	Allows user the option to initiate a direct to course to the destination listed on line 2 of the CDU display. Press the <b>1</b> key to select this option.

DISPLAY	FUNCTION
2) GET TYPE	Allows user the option to initiate a search for the requested waypoint listed on line 2 of the CDU display. Press the <b>2</b> key to select this option.
more	Press ENT key to select additional

menus.

**3.18.12.16.2.1 F1 OBS/HOLD Menu 2.** The F1 OBS/ HOLD Menu 2 (Figure 3-56) allows the user to use the waypoint retrieval option.



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## Figure 3-56. F1 OBS/HOLD Menu 2

DISPLAYFUNCTIONOBS/HOLD:Displays the title of menu.REF:Displays the reference waypoint.3) WP INFOAllows user to initiate the waypoint information retrieval option.<br/>Press the 3 key to select this option.<br/>Press the 3 key to select this option.end:Last menu page.

**3.18.12.16.3 F1 MESSAGE OPTION Menu.** The F1 MESSAGE OPTION Menu allows the user to view system status and navigational information. Messages can only be viewed by selecting this option. All messages will remain active until user acknowledges each messages. Messages can be viewed when the **MSG** light on the pilot's and

copilot's annunciator panel illuminates. Messages are generated during the following conditions:

WARNING: APPROACH MODE NOT ACTIVE APPROACH MODE IS ACTIVE APPROACH MODE WAS ENABLED AUTOMATICALLY CDI SENSITIVITY CHANGE TO OCCUR CDI SENSITIVITY HAS CHANGED TO ENROUTE TERMINAL APPROACH ALL FLIGHT PLANS DELETED FLIGHT PLAN IS INVALID PROCEDURE TURN **OUTBOUND: INBOUND: HOLDING PATTERN ALT:** LOSS OF RAIM **BIT FAILURE GPS MALFUNCTION 30 NMI FROM DESTINATION 3 NMI FROM DESTINATION** MISSED APPROACH **NEW COURSE SELECTED** 

**3.18.12.16.4 F1 MAHP OPTION Menu.** The F1 MAHP OPTION menu allows the user to execute a missed approach procedure any point within 30 nm of the MAP. If a missed approach is activated prior to the MAP the system will automatically go into terminal mode and provide DIRECT-TO guidance to the last waypoint of the loaded approach. Missed approach option is only available if an IAP has already been loaded for that flight plan.

## 3.18.12.16.5 F1 VECTOR TO FINAL Menu.



# ATC must release the aircraft prior to activating the Vector To Final Option.

The F1 VECTOR TO FINAL (VTF) Menu allows the user to activate the VTF option. The F1 VTF menu is accessed by pressing the F1 key twice on the CDU keyboard. VTF option allows the user to retrieve a saved IAP or enable an new VTF, by providing bearing information to initial IAP point. VTF has the following two menu option displays.

**3.18.12.16.5.1 F1 VECTOR TO FINAL Menu 1.** The F1 VECTOR TO FINAL Menu 1 (Figure 3-57) displays

when the aircraft presentation position is within 30 nautical miles from destination airport. displayed. Once the aircaft is within 30 nautical miles of selected destination airport, the VTF Menu 2 display will automatically switch to VTF Menu 1 display.

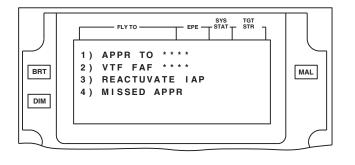


Figure 3-57. F1 VECTOR TO FINAL Menu 1

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BRT DIM

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#### Figure 3-58. F1 VECTOR TO FINAL Menu 2

DISPLAY	FUNCTION
1) APPR TO:	Displays the approach to ICAO information. Press the <b>1</b> key to select this option.
2) VTF FAF:	Displays the vectors to final approach fix information. Press the <b>2</b> key to select this option.
3) REACTIVATE IAP	Allows user the option to reactivate the stored IAP. Press the <b>3</b> key to select this option.
4) MISSED AP- PR	Allows user the option to initiate the Missed Approach Procedure. Press the <b>4</b> key to select this op- tion.

**3.18.12.16.5.2 F1 VECTOR TO FINAL Menu 2.** The F1 VECTOR TO FINAL Menu 2 (Figure 3-58) displays when the aircraft presentation position is outside of 30 nautical miles from destination airport. Also allows the user the option to enter an destination airport, initiating bearing to information and airport information to be

DISPLAY

FUNCTION

1) GETDisplays the get approach option.APPROACH:Press the 1 key to select this option.

3.18.12.17 Flight Steering Modes. AN/ASN-128D has TO-FROM and FLIGHT PLAN steering modes. TO-FROM mode steers a specified course angle to a FLY-TO destination displaying TO or FROM indication on the CDU and on the HSI when Doppler has been selected on the Mode SEL panel. FLIGHT PLAN steering is designed to steer through a specified sequence of waypoints, optionally ending with an IFR non-precision approach to the destination. Both steering modes can access the user defined waypoints or DAFIF database waypoints. The AN/ASN-128D will compute a course from the aircraft's current position to its destination. If the aircraft deviates from the desired course, the lateral off set or cross track distance error is computed. Distance and bearing to destination, actual track angle, and track angle error correction are computed from resent position to destination. Reference Figure 3-20 for a graphic definition of these terms.

# 3.18.13 Preflight Procedures.

# 3.18.13.1 Data Required Prior to DGNS Turn-On.

- 1. The following initial data must be entered by the pilot after system turn-on and initialization, unless previously entered data is satisfactory:
- 2. Datums of operation, when using **MGRS** coordinates. This data may be part of the data load if preprogrammed.
- 3. In combined or GPS mode, the GPS provides preset position. If the Doppler only mode is selected **MGRS** coordinates of present position - zone area, easting and northing; latitude/ longitude coordinates may also be used to input present position. This data may be part of the data load if preprogrammed. Variation of present position to the nearest one-tenth of a degree.
- 4. Coordinates of desired destinations 00-99. It is not necessary to enter all destinations in the same coordinate system. This data may be part of the data load if preprogrammed. Destination locations of 70 through 89 are only programmable through the data loader.
- 5. Variation of destinations to the nearest onetenth of a degree.
- 6. Crypto-key variables necessary to enable the GPS receiver to operate in **Y** code are entered via remote fill data only and not via the CDU keyboard.

# NOTE

Destinations are entered manually when steering information is required to a destination that was not in the set of data loaded via the data loader, or it is desired to update present position by overflying a destination, or a present position variation computation is desired. (See CDU operation). If a present position variation update is desired, destination variation must be entered. The operator may enter one or more destination variations; it is not necessary for all destinations to have associated variations entered and also not necessary to enter all destinations in any case, but variations must be entered after destination coordinates are entered.

7. The Doppler outputs true heading and accepts magnetic heading from gyromagnetic/AHRU heading reference. If accurate magnetic variations are not applied, then navigation accuracy will be affected.

# 3.18.13.2 System Initialization.

1. Enter GPS mode M.

# NOTE

Select GPS mode **M** during initialization. If **Y** mode is selected before crypto-key variables are loaded the system will lock-up. System must be turned off, then back on.

- 2. Perform self test.
- 3. Perform download of data loader cartridge if necessary, or manually enter datum, destinations, magnetic variations, and present position.
- 4. Load crypto-key variables (unless previously loaded and still valid) necessary for operation of the GPS in **Y** mode.

# NOTE

It is necessary to wait at least 12 minutes for key validation when new keys have been entered, or collection of almanac data when set has no previous almanac data. During this time the GPS operation mode must be **M** and uninterrupted. After this time the GPS operating mode may be switched to **Y**. Observe the GPS key status and number of satellite vehicles (SVs) tracked after switching to **Y** mode. If the SV number goes to zero, repeat this procedure. The key status shall switch from **DK IN** to **DK OK** sometime during the 12 minutes.

- 5. Check datum of operation, if **MGRS** is being used.
- 6. Check destinations in MGRS or LAT/LONG coordinates as desired.

- 7. Check associated destination variations as desired. Remove all incorrect variations by setting **DISPLAY** selector to **WP/TGT**, setting the destination number to appropriate destination, and pressing the **KYBD** key and **ENT** key in that order. Variations of at least two destinations must be entered for automatic variation update computation to be performed. For accurate navigation it is advised to enter variations after each destination unless the variations are the same.
- 8. Select DGNS operating mode.

## NOTE

The set will automatically select combined mode (default or primary operating mode) as this allows the system to select the best possible navigation method available.

9. Set the FLY-TO-DEST to the desired destination location.

#### 3.18.13.3 Changing Mode of Operation.

#### NOTE

All previously entered USER waypoints and stored flight plans will be deleted when changing modes of operation.

Delta or Bravo are the two modes of operation. The Delta mode allows IFR approaches on approved GPS and GPS overlay approaches and RNAVS. Bravo mode allows the updated system to operate as the legacy AN/ASN-128B system. The CDU will power up in the last mode selected during power down.

- Set the CDU MODE selector to LAT/LONG. Enter desired GPS code (M or Y) mode of operation.
- 2. Set the **DISPLAY** selector to **WIND-UTC**/**DATA**.
- 3. To display the configuration menu press the **ENT** key twice.
- To select the CONFIG option page press key
   4.
- 5. Press the **KYBD** once to advance to **MODE** selection field.

- Press the desired mode of operation, key 1 for Bravo mode or key 2 for Delta mode. Then press the ENT key.
- 7. Press the Y key (yes) to confirm switching modes on the confirmation display menu.
- 8. Press the **ENT** key to exit the confirmation display menu.
- 9. Recycle CDU power and confirm the current mode of operation is correct within the initial Power Up Sequence display menu.

**3.18.13.4 Data Loading Procedures.** The AN/ASN-128D is capable of downloading waypoint information, datum of operation, present position and magnetic variation via the Data Transfer Module (DTM), as well as down loading the DAFIF, via the PCMCIA card.

- 1. Set the CDU MODE selector to OFF.
- 2. Insert the preprogrammed data loader module.
- 3. Set the CDU MODE selector to (LAT/ LONGMGRS may be used). Enter desired GPS code (M or Y) mode of operation.
- 4. Set the **DISPLAY** selector to **WIND-UTC**/**DATA**.
- 5. To display the select menu press the **ENT** key twice.
- 6. To select the **DATA LOAD** page press key 2.
- 7. To begin the download press the **KYBD** and enter **Y** (yes).
- 8. Observe the CDU display. The CDU shall display **DOWNLOAD WAYPTS IN PROCESS**. If a transmission error occurs the CDU display shall change to **ERROR-RETRYING**.
- 9. When the transmission is complete the CDU shall display **DOWNLOAD COMPLETE**. If this display is not obtained within one minute of beginning the download, check the data programming and connections.
- 10. Set the CDU **MODE** selector to **OFF**, remove the data loader module.

## NOTE

Ensure DTM is removed prior to flight.

## 3.18.13.5 Manual Loading Procedures (DTM Not

**Available).** The Data Transfer Module contains all the required information to being navigating with the AN/ ASN-128D system. In the event that a Data Transfer Module is not available the following steps must be performed to ensure the system operates correctly.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **DATUM/ ROUTE**.
- 3. To display the DATUM menu press the **ENT** key once.
- 4. Select the DATUM field press the **KYBD** and enter DATUM code, if required, press the **ENT** key to store new entry.
- 5. Set the CDU MODE selector to LAT/LONG.
- 6. Set the **DISPLAY** selector to **PP**.
- 7. Select the AUTO/MAN field press the **KYBD** key twice and enter desired magnetic variation mode of operation (**A** (automatic) or **M** (manual)), if required.
- 8. Press the **ENT** key to advance to store new entry.
- 9. Press the **ENT** key to advance to the next menu.
- 10. Select the MAG VAR field press the **KYBD** key once and enter new magnetic variation, if required.
- 11. Press the **ENT** key to store new entry.
- 12. Press the **ENT** key to return to PP main menu display.
- 13. Enter present position by setting the **DIS-PLAY** selector to **PP**.

- 14. Press the **KYBD** key twice to select present position field.
- 15. Enter latitude and press the **KYBD** key to advance to the longitude field and press the **ENT** key.
- 16. Enter waypoint by placing the CDU **MODE** selector to **LAT/LONG**.
- 17. Set the **DISPLAY** selector to **WP/TGT**.
- 18. Press the **KYBD** to select WP number field and enter WP number. Press the **ENT** key to accept.
- 19. Press the **KYBD** to select WP number field and enter WP number. Press the **ENT** key to accept.
- 20. Press the **KYBD** to select latitude field and enter latitude of the WP. Press the **ENT** key to accept.
- 21. Press the **KYBD** to select longitude field and enter longitude of the WP. Press the **ENT** key to accept.

## 3.18.13.6 Digital Aeronautical Flight Information

**File (DAFIF) Loading Procedures.** This procedure loads the DAFIF with all the approved navaids, airports, intersection, and GPS overlay approaches to be used during an IFR approach.

- 1. Set the CDU **MODE** selector to **OFF**. Insert the pre-programmed PDTD into data loader receptacle.
- 2. Set the CDU MODE selector to LAT/LONG.
- 3. Set the DISPLAY selector to GS/TK/NAV M.
- Press the **KYBD** key to advance to GPS mode field, enter the **M** key, follow by pressing the **ENT** key.
- 5. Set the CDU MODE selector to LAT/LONG.
- 6. Set the **DISPLAY** selector to **WIND-UTC**/ **DATA**, follow by pressing the **ENT** key twice.

- 7. Select the **DAFIF DOWNLOAD** option press the **3** key.
- 8. Press the **KYBD** key and press the **Y** key. The DAFIF loading can be canceled at any time by pressing the **KYBD** key and press the **N** key.
- 9. Press the **ENT** key once the DAFIF download is complete (DAFIF download time can take up to 15 minutes).
- 10. Set the CDU **MODE** selector to **OFF**, remove the PDTD from loader.

## 3.18.13.7 Self Test.

- Set the MODE selector to LAMP TEST. Enter GPS mode M or Y. Verify the following:
  - a. All edge lighting is illuminated.
  - b. The MAL lamp is illuminated.
  - c. All keyboard keys are lit.
  - d. Pilot's and copilot's GPS annunciator panels are illuminated.
- 2. MODE SEL switches DPLR/GPS and CRS HDG PLT or CPLT (as appropriate).
- 3. Set the **MODE** selector to **TEST**. After Doppler and/or GPS self tests have completed (approximately 15 seconds for Doppler, up to 2 minutes for GPS), the following display will be observed in CDU display:

### NOTE

In the event the **TEST** mode display is not **GO ALL** the system should be recycled through **OFF** to verify the failure is to a momentary one. Refer to the following table for fault code descriptions, if fault is displayed a second time.

- 4. Press the **BRT** pushbutton at least 10 times, then press the **DIM** pushbutton at least 10 times, then press the **BRT** pushbutton at least 10 times. LED display shall alternately glow bright, extinguish, and glow bright.
- 5. Press ENT key to view current aircraft HEADING, PITCH, ROLL, and TAS information.
- 6. Press ENT key again to view OBS test results. OBS should indicate PASS and the bearing displayed on the CDU will match the course shown on the HSI of the pilot in command of the CIS.

### NOTE

If DB, RS-232 or OBS fails, IFR operations and approach functions of the AN/ASN-128D is not possible.

7. Press the ENT key to view GPS panel lighting sequence and TO/FROM arrow sequence on the CDU. Lighting sequence and TO/FROM indicator on CDU display will match both the pilot's and copilot's GPS annunciator panels and HSI, when DPLR/GPS is selected on MODE SEL panel.

LEFT DISPLAY	RIGHT DISPLAY	REMARKS	
GO		Doppler has completed BIT and is operating satisfactorily, GPS is still performing BIT (GPS has a two minute BIT cycle maximum). Note that a rotating bar in the display indicates that the GPS is still performing self test.	
GO	ALL	The entire system has completed BIT and is operating satisfactorily.	
GO	Р	Pitch or roll data is missing or exceeds 90°. In this case, pitch and roll in the computer are both set to zero and navigation in the Doppler mode continues with degraded operation. Problem may be in the vertical gyro/AHRU or helicopter cabling.	

LEFT DISPLAY	RIGHT DISPLAY	REMARKS		
NG	C, R, S, or H fol- lowed by a numeric code	A failure has occurred in the computer display unit or the signal data converter power supply. The operator should not use the system.		
DN	GPS failure code	GPS has failed but operator can use Doppler to perform all navigation.		
DF	Doppler failure code	Doppler has failed. GPS is still performing self test.		
GN	Doppler failure code	Doppler has failed but operator can use GPS to perform all navigation.		
EN	Doppler failure code	SDC battery is discharged. Items stored in memory have been deleted.		
DB	P or F	<ul><li>P: Indicates the database is operating satisfactory.</li><li>F: Indicates an error with the DAFIF database. IFR procedures will not be available. Database error code will be displayed under DB.</li></ul>		
RS-232	P or F	P: Indicates the SDC and CDU interface is operating satisfactory. F: Indicates an error between the SDC and CDU interface. If this error oc- curs IFR operation and access to WP database is not possible.		
OBS	PASS or FAIL	A pass code indicates the SDC and HSI are operating satisfactory. A fail code indicates a failure between the SDC and HSI. If this error occurs IFR operation is not possible.		

(Cont)

**3.18.13.8 Building a Flight Plan.** This procedure allows the user to review, edit and build a flight plan. Up to three flight plans can be created and stored and activated at anytime throughout the flight. Each flight can consist of up to 25 waypoints. A flight plan can be created, with or without an instrument approach procedure (IAP). The IAP can be loaded into the flight plan once it is created. Only RNAV, GPS and GPS overlay approaches can be used. IFR approaches are not possible if at anytime GPS is unavailable, or a fault is detected within the AN/ASN-128D system.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **DATUM ROUTE**.
- 4. Press the key 1 to select the Flight Plan option menu.
- 5. To build or review available flight plans press the **INC** key.

## NOTE

If the **BUILD NEW FLIGHT PLAN** does not appear, then one of the three already stored flight plans, must be deleted prior to creating a new flight plan.

- 6. Press the **ENT** key to enter the new flight option menu.
- 7. Press the **KYBD** key to select and enter a flight plan name.
- 8. Press the **ENT** key once the flight plan name has been entered.
- 9. Press the **ENT** key to confirm the new flight plan name and flight plan number.
- 10. Press the **1** key to enter the **INSERT WP** menu option.
- 11. Press the **KYBD** key to advance through the available fields.
- 12. Select a WP TYPE. There are two different methods to enter a WP TYPE into a flight plan. The first method using the HOTKEYS option or the second method using **GET TYPE** option.
  - a. To use HOTKEYS method press the letter on the CDU that corresponds with the first letter of the type of WP. If two WP share a key press the letter twice to select the

- other WP. HOTKEYS: H - HELIPORT A - AIRPORT D - DME I - INTERSECTION N - NDB T - TACAN
- U User Define
- b. To use **GET TYPE** method press **1** key. Then select the appropriate option by corresponding key number or press **ENT** key to advance to display the remaining selection options.
- 13. Once the WP TYPE has been selected the CDU will advance to the **IDEN** menu, at this time enter the ICAO code or waypoint name and press the **ENT** key.
- 14. Press the **ENT** key to retrieve the entered information from the database.
- 15. Once the first waypoint has been accepted, now enter the next fly to waypoint, repeating the same procedures as stated above. A total of 25 waypoints can be entered in a single flight plan. Once all waypoints have been entered press the **ENT** key.
  - a. If the system does not locate the waypoint in the database, a **SEARCH FAILED** screen will display. Press the **ENT** key and enter new or correct information.
- 16. The DATUM ROUTE FP main menu will be displayed after the last the waypoint of the flight plan is entered. Press the ENT key to advance to the next menu, the DATUM ROUTE FP menu 2 page. Press the number to select options or press the ENT key to list remaining menus.
- 17. To load an instrument approach procedure, press the **5** key to select **SET APPROACH** option.
- 18. System will search for and display all available GPS overlay approaches for the ICAO entered. Press the number to select desired approach options or press the ENT key to list remaining menus.

- 19. The AN/ASN-128D can only use GPS approaches or GPS overlay approaches. Once then desired approach is selected, the display will list all the available procedures for the selected approach. Press the number to select desired procedures options or press the **ENT** key to list remaining menus.
- 20. The flight plan is now stored and available to be used or activated at any time by the pilots. The AN/ASN-128D cannot provide navigational information for a flight plan until it has be activated.

**3.18.13.9 Activating a Flight Plan.** This procedure activates any one of the three flight plans at anytime during a flight.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **DATUM ROUTE**.
- 3. Press the 1 key to enter the flight plan main menu.
- 4. Press the **INC** or **DEC** keys to scroll through the saved flight plans.
- 5. Once the flight plan has been located, press the **ENT** key to select and view available options.
- 6. Press the **1** key to **ACTIVATE** the selected flight plan. Press the **ENT** key once to view the information for the activated flight plan.
  - a. Once activated, the system will provide the pilots with bearing, heading, To/From indication on the CDU and HSI as well as distance and time to go information.

#### 3.18.13.10 Procedures For Checking Destination.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **WP/TGT**.
- 3. Notice that the current waypoint number is displayed. To display desired waypoint numbers enter numeric designator or press the **INC** or **DEC** keys.
- 4. Enter waypoint coordinates if not previously entered.

- a. Press the **KYBD** key twice to enter the WP latitude information.
- b. Press the **KYBD** key once to enter the WP longitude information.
- c. Press the **KYBD** key once to enter the name of WP.
- 5. Once the new WP information has been entered, press the **ENT** key to store into memory.

## 3.18.13.11 Procedures For Displaying Or Updating Month, Day, Year, Time and GPS Initialization.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **WIND-UTC-DATA**.
- 3. Press the **ENT** key to view current GPS status information.
- 4. To update the current GPS information, press the **KYBD** key and enter the new information.
  - a. Press the **ENT** to store the updated information.
- 5. Once the new information has been entered, press the **Y** key to intialization the GPS.

# 3.18.13.12 Procedures For Viewing Key Status, Days Remaining On Key and SV Tracked.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **XTK/TKE/ KEY**.
- 3. Press the **ENT** key to view current status information.

# 3.18.13.13 Procedures For Viewing GUV Key Status and SAASM Tables.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **XTK/TKE/KEY**.
- 3. Press the **ENT** key twice to view current GUV key status information.

4. Press the **ENT** key once more to view current SAASM tables information.

## 3.18.13.14 Procedures For Viewing Ground Speed and Track Error or changing GPS Tracking and NAV Mode.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **GS/TK/NAV** M.
- 3. To change the current GPS track or NAV mode, press the **KYBD** key and enter the new information.
  - a. Press the **ENT** to store the updated information.

# 3.18.13.15 Procedures For Viewing Almanac Status and Acquisition Time.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **GS/TK/NAV** M.
- 3. Press the **ENT** key to view current status information.

# 3.18.13.16 Procedures For Displaying GPS Altitude, Updating Variation and Auto/Man.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **PP**.
- 3. Press the **ENT** key to view current information.
- 4. To change the current GPS altitude or update variation, press the **KYBD** key and enter the new information.
  - a. Press the **ENT** to store the updated information.

## 3.18.13.17 Before and After Power Interrupt

**Procedures.** During a power interruption the stored destination, GPS satellite data along with target data and present position are retained by non-volatile RAM inside the CDU. This makes it unnecessary to re-enter any navigational data or re-key the crypto when power returns. GPS operating code (Y or M) will have to be re-entered, along with Present Position if Doppler Only mode was selected. In the event that the data is lost or corrupted **EN** will be displayed on the CDU.

- 1. Press the **KYBD** key to acknowledge the fault.
- 2. Set the CDU MODE selector to OFF, and then to LAT/LONG.
- 3. Set the **DISPLAY** selector to **WIND-UTC-DATA**.
- 4. Press the **KYBD** key and enter navigation mode if other than Combined mode is to be used.

# 3.18.13.18 Entering/Displaying Datum (Table 3-4) or Clearing Waypoints.

- 1. Set the **MODE** selector to **MGRS** position (LAT/LONG may also be used).
- 2. Set the **DISPLAY** selector to **DATUM/ ROUTE**.
- 3. To select the datum field press the **KYBD** key.
- 4. Entry of ellipsoid: as an example consider entry of **47**, the code of the **WGS 84** datum. Press keys **4** and **7**. Press the **ENT** key, the display shall show **DATUM: 47**.

#### NOTE

Entering a new datum number to a particular waypoint applies that datum to all waypoints and converts their coordinates accordingly. For example, assume that the datum for waypoint 22 is datum 47 and the datum for waypoint 23 is datum 25. The datum number must be changed from 47 to 25 prior to entering data for waypoint 23. This will change the displayed coordinates for waypoint 22 because they have been converted from datum 47 to datum 25. The actual ground position of waypoint 22 has not changed. Extreme care must be taken not to confuse these newly converted coordinates with those originally entered.

5. To clear all waypoints, variations, landing data, and target motions, enter **RDW** for the datum.

ID

01

02

03

04

05

06

07

08

09

10

11

12

13

14

15

16

17

18

19

20

21

NAME

#### ELLIPSOID ID

# NOTE

Only use map datums WGS-84 and NAD-27. Other map datums were not verified using the Aviation Mission Planning System (AMPS), and should not be used. Adindan CD ARC 1950 CD Australian Goodetic 1966 AN **Bukit Rimpah** BR Camp Area Astro IN Djakarta BR European 1950 IN Geodetic Datum 1949 IN Ghana WE Guam 1963 CC BR G. Segara G. Serindung WE Herat North IN Hjorsey 1955 IN Hu-tzu-shan IN Indian EA Ireland 1965 AM Kertau (Malayan Revised EE Triangulation) CD Liberia 1964 USER ENTERED --CC Luzon

### Table 3-4. Datums (AN/ASN-128D) (Cont)

ID	NAME	ELLIPSOID ID
22	Merchich	CD
23	Montjong Lowe	WE
24	Nigeria (Minna)	CD
25	North American 1927 (CO- NUS)	CC
26	North American (Alaska and Canada)	CC
27	Old Hawiian, Maui	IN
28	Old Hawiian, Oahu	IN
29	Old Hawiian, Kauai	IN
30	Ordnance Survey of Great Britain 1936	AA
31	Qornoq	IN
32	Sierra Leone 1960	WE
33	South American (Provisional 1956)	IN
34	South American (Corrego Alegre)	IN
35	South American (Campo In- chauspe)	IN
36	South American (Chua As- tro)	IN
37	South American (Yacare)	IN
38	Tananarive Observatory 1925	IN
39	Timbalai	EA
40	Tokyo	BR
41	Voirol	WE
42	Special Datum, Indian Special	EA
43	Special Datum, Luzon Special	CC
44	Special Datum, Tokyo Special	BR

#### Table 3-4. Datums (AN/ASN-128D) (Cont)

ID	NAME	ELLIPSOID ID
45	Special Datum, WGS 84 Special	WE
46	WGS72	WD
47	WGS84	WE

3.18.14 Flight Procedures. The following procedures will describe the available option on the CDU while in flight. Press F1 key at any time to access IFR menu. F1 key options provide the pilot with instant access to DIRECT-TO function, OBS/HOLD selection, MISSED APPRCH option and MESSAGE retrieval option.

## 3.18.14.1 Procedure for DIRECT-TO Steering.

- 1. Set the **DISPLAY** selector to **LAT/LONG** position and press the F1 key.
- 2. Press the 1 key to activate the **DIRECT-TO** mode using the current active waypoint. To select a user defined waypoint, select the 2 key.
- 2. The system will provide you with direct steering information to destination; rotate the DIS-**PLAY** selector to view desired navigational information.

## 3.18.14.2 OBS Steering Mode Procedures.

- 1. Set the **DISPLAY** selector to **LAT/LONG** position and press the F1 key.
- 2. Press the 2 key to activate the OBS/HOLD mode.
- 3. Press the 1 key to ACTIVATE the WP listed in the **REF** field. Information displayed is flyto bearing.
- 4. To select a WP from the database, press the 2 key to activate the GET WP option.
  - a. Press the KYBD key and enter the TYPE WP.

- b. Press the KYBD key again and enter the WP IDEN.
- c. Press the 1 key to activate the REF WP option. The OBS menu will display the reference waypoint name and the OBS bearing angle.

**3.18.14.3 OBS Hold Procedures.** Hold mode is automatically activated and the flight plan suspended when a Missed Approach Point (MAP) has occurred and sequenced as the next waypoint.

1. To resume the flight plan select **1** key.

**3.18.14.4 F1 Message Option.** Messages can only be viewed by selecting the **MSG** option. All messages will remain active until user acknowledges each **MSG**.

- 1. Press the **F1** key on CDU to enter IFR menu, when the **MSG** lamp on the pilot's and copilot's GPS annunciator panel is illuminated, for 10 seconds.
- 2. Press the **3** key to view and acknowledge messages.

**3.18.14.5 Missed Approach Procedures.** A missed approach can be executed at any point within 30nm of the Missed Approach Point (MAP), as long as the approach has a published Missed Approach Holding Point (MAHP). If the missed approach is activated, before the MAP is sequenced as the fly-to waypoint, the system will transition to terminal mode, and provide DIRECT-TO guidance to the MAHP from its present position. If the missed approach is activated after the MAP is sequenced as the fly-to waypoint, the flight plan will resume navigation at the leg beginning with the MAP. The Missed Approached option will only be available if an Instrument Approach Procedure has been loaded into the flight plan.

- 1. Set the **DISPLAY** selector to **LAT/LONG** position and press the **F1** key.
- Press the 4 key to activate the MISSED AP-PRCH mode, this will change to DIRECT-TO, with the MAHP listed as the destination.

# 3.18.14.6 Fault Detection and Exclusion (FDE) and Receiver Autonomous Integrity Monitoring

**(RAIM).** FDE and RAIM are determined by the Embedded GPS Receiver, within the SDC. The CDU displays FDE and Predicative RAIM status. Predicative RAIM was designed to forecast the integrity of the GPS signal from

space vehicles at the destination in order to support IFR approaches. FDE capabilities allow the receiver to discard unreliable satellite signals.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **DIST/BRG/TIME**.
- 3. Press the **ENT** key to view the current FDE and RAIM status information.

# 3.18.14.7 Procedures For Displaying GPS Predictive RAIM.

## NOTE

IFR approaches and GPS navigation is only possible when RAIM status is AVAIL-ABLE.

- 1. Set the CDU MODE selector to LAT/LONG.
- 2. Set the **DISPLAY** selector to **DIST/BRG/ TIME**.
- 3. Press the **ENT** key twice to view the current NAV RAIM status information.

## 3.18.14.8 Instrument Approach Look Up

**Procedures (IAP).** The IAP menu allows the pilot to view and enter IAPs to a destination.

- 1. Set the **DISPLAY** selector to **DATUM/ ROUTE**.
- 2. Set the CDU MODE selector to LAT/LONG.
- 3. Press the **3** key to select **IAP LOOKUP** option.
- 4. Press the **KYBD** key and enter **IAP TYPE** or press the **1** key to select from a list.
- 5. Press the **KYBD** key and enter the **IAP IDEN** and press the **ENT** key to store the entered information.
- 6. To retrieve an IAP, press the **ENT** key. Once the desired IAP has been found select the corresponding number.
- 7. When approach information is displayed, press the **ENT** key to view WP legs. Use the **INC** or

**DEC** keys to scroll through each WP. Press **1** key to accept and load IAP.

# 3.18.14.9 Procedures For Displaying Or Updating Present Position, When GPS Is Not Available.

- 1. Set the **DISPLAY** selector to **PP**.
- 2. Set the CDU MODE selector to LAT/LONG.
- 3. Press the **KYBD** key to enter latitude and press **ENT** key to store entered information.
- 4. Press the **KYBD** key to enter longitude and press **ENT** key to store entered information.

**3.18.14.10 Vectors to Final (VTF) Procedures.** This option allows the pilot to select a vector to final at anytime when within 30 nautical miles of an airport with a missed approach procedure.

- 1. The following procedures are for selecting a VTF when within 30 nautical miles of the desired airport.
  - a. Set the **DISPLAY** selector to **DIST/BRG/TIME**.
  - b. Press the **F1** key twice on CDU to enter VTF menu and observe the CDU display.
- 2. The following VTF procedures are performed when the desired airport is more than 30 nautical miles away.
  - a. Set the **DISPLAY** selector to **DIST**/**BRG/TIME**.
  - b. Press the **F1** key twice on CDU to enter VTF menu and observe the CDU display.
  - c. Press the **KYBD** key to advance the cursor to the **TYPE** and **IDEN** fields. Enter appropriate **TYPE** and **IDEN** and press the **ENT** key twice.
  - d. Select the desired approach. The CDU will display airport and approach information.
  - e. Press the ENT key to view WP information. Use the INC or DEC keys to scroll through each WP.
  - f. Set the **DISPLAY** selector to **DIST**/ **BRG/TIME** and press the **1** key to load the IAP.

**3.18.14.11 Consecutive Waypoints.** This option allows the pilots to enter a starting waypoint number and ending waypoint number, which the system will fly consecutively. Waypoints enter can be in either ascending or descending order.

- 1. Set the **DISPLAY** selector to **DATUM/ ROUTE**.
- 2. Set the CDU MODE selector to LAT/LONG.
- 3. Press the 4 key to select the consecutive menu.
- 4. Press the **KYBD** key to enter two digital starting waypoint number.
- 5. Press the **KYBD** key to enter two digital ending waypoint number and press the **ENT** key to store the entered information.
- 6. Press the **ENT** key to confirm selection.

# 3.19 INTEGRATED INERTIAL NAVIGATION SYSTEM (IINS) AN/ASN-132(V). ☐

a. The IINS is a self-contained integrated navigation system capable of short and/or long-range missions which can be updated whenever TACAN navigational facilities exist or manually without TACAN data, and displays location of the helicopter on the control display unit (CDU). The IINS consists of the following equipment:

TYPE DESIGNATION	NAME	COMMON NAME
C-11097/ ASN-132	Control Indicator	Control Display Unit
CV-3739/ASN- 132	Converter, Signal Set	Signal Converter Unit (SDC)
AN/UYK-64(V)2	Data Processing Set	Navigation Processor Unit (NPU)
RT-1159/A	Receiver- Transmitter, Radio	TACAN RT
AN/ASN-141	Inertial Naviga- tion Set	Inertial Naviga- tion Unit (INU)
MT-4915/A	Mounting Base, Elect Equip	TACAN/SCU Mount

b. Auxiliary components of the IINS includes the SYSTEMS SELECT panel, INU blower assembly, INU battery assembly, and data bus couplers. The IINS provides accurate indications of the helicopter navigation parameters including present position, velocity, altitude and heading information. The system employs a serial data bus for data interchange within the IINS and with external mission system computers. The IINS also interfaces with the helicopter flight instruments and altimeter encoder. The multiplex data bus system consisting of two buses (A and B), with only one bus active at any given time. The other bus is in a standby mode for redundancy purposes to provide a path for data flow between the Standard Inertial Navigation System (STD INS), Signal Converter Unit, Navigation Processor Unit, Control Display Unit, and the external mission systems. Data to and from the TACAN receiver-transmitter is first processed by the SCU before it is applied to the multiplex data bus.

c. The Signal Converter Unit (SCU), CV-3739/ASN-132, performs data processing to convert the TACAN RT Aeronautical Radio Incorporated (ARINC) inputs and outputs to corresponding serial data formats for transmission over the multiplex data buses to the NPU and CDU. The SCU can communicate via one of the two multiplex data buses. Although the SCU communicates over only one multiplex data bus at a time, it can monitor both buses continuously to determine over which bus valid data communications are taking place. Redundant portions of the SCU circuitry are isolated to ensure that a failure of one bus does not degrade performance of the remaining bus.

d. TACAN Navigational Set Receiver-Transmitter, RT-1159/A. The position error of an inertial navigation

system increases with time, therefore, a position reference sensor is used to update the inertial data, and thereby bound the time-growing position error. The **IINS** derives position updates from the TACAN RT range and bearing measurements. The TACAN RT determines the relative bearing and range of the helicopter from a selected TACAN ground station. The TACAN RT operates within 390 nautical miles of a TACAN ground station. Since the TACAN system operating limit is line of sight, the actual operating range is dependent on helicopter altitude. The TACAN system operates on a selected channel from 252 available channels. The 252 channels are equally divided into 126 x-channels and 126 y-channels with both x- and y-channels spaced at 1 MHz intervals. Upon being interrogated by the TACAN RT, the ground station beacon transmits a signal. From the return signal, the TACAN RT computes bearing and distance values for updating the inertial system information. The TACAN RT outputs are processed by the SCU for compatibility with the multiplex data buses. The TACAN RT also produces and transmits distance information when interrogated in the air-to-air operation another TACAN equipped helicopter, however, this air-to-air mode precludes using the TACAN information to update the **IINS**.

### 3.19.1 Controls, Displays, and Function.

**3.19.1.1 IINS Controls and Displays.** The IINS controls and displays (Figure 3-59) are contained on the CDU. The function of each control is as follows:

KEY	CONTROL OR INDICATOR	FUNCTION
1	Data display	Displays multiple flight parameters to the operator on seven data lines and a scratchpad line on the face of the cathode ray tube (CRT).
2	Line select keys	On both sides of data display lines 1, 3, 5, and 7 are pushbuttons (line select keys) which perform functions as defined by the legend adjacent to the key on the data display. If a line select key is active on a particular page, an arrow will appear in the character space closest to the key. Arrows will be oriented toward the legend, up, or toward the key (away from the legend). These orientations (with examples) are defined as follows:
		1. $\blacklozenge$ legend $\blacklozenge$ (TH 358.3 $\blacklozenge$ ). If the arrow points toward the legend a numeric entry (entered into the scratchpad on line 8) is allowed by pressing the adjacent line select key.

KEY	CONTROL OR INDICATOR	FUNCTION	
		2. $(MAG)$ . If the arrow points away from the legend, pressing the adjacent line select key will initiate the function described by the legend. For example, pressing the line select key adjacent to "MAG "," will change the display to MAG Heading (MH) and MAG VAR (MV).	
		3. • legend • (• T/R). If the arrow points up, the legend indicates current mode status and pressing the adjacent line select key will change the mode. If no arrow appears next to a legend, the adjacent line select key performs no operation.	
		4. Up or down pointing arrows on the sixth line of the data display allows operator to slew display one page up or down by pressing page slew toggle switch up or down.	
3	Alphanumeric keys	Alphanumeric entries are made, by pressing one of the ten character keys on the keyboard and will appear first in the scratchpad (line 8). Each actuation of a key will cause a character to be displayed from left to right in the scratchpad. When using multiple letter keys (e.g., <b>KLM/5</b> ), letters K, L, or M can be entered into the scratchpad by successive actuations of the KLM/5 key. The 0-9 and. keys shall enter the respective number of decimal points unless the keyboard is in the letter mode. When the <b>LTR/USE</b> key is pressed, <b>LTR</b> is annunciated to the right of the scratchpad, and the next keystroke will enter an alpha character. When the desired data appears in the scratchpad, it will be entered by pressing the line select key adjacent to the data being updated. When the line select key is pressed, the scratchpad contents will be checked for proper range and format. If the entry is valid, it will be transferred to the <b>IINS</b> , read back, and displayed adjacent to the line select key. Completion of this cycle will clear the scratchpad.	
4	CLR key	Used for erasing scratchpad parameters before entry. First actuation clears the last number or letter entered, second actuation clears the entire entry.	
5	BRT control	Controls brightness of the data display from full on to full off.	
6	0 key	Used to enter number 0 into the scratchpad.	
7	-/● key	Used to enter a minus symbol or decimal into the scratchpad. When pressed, $\bigcirc$ will be entered into the scratchpad. When <b>LTR/USE</b> key is pressed, then -/ $\bigcirc$ key is pressed, - will be entered into the scratchpad. To use the - in the scratchpad, the <b>LTR/USE</b> key must be pressed again.	
8	LTR/USE key	When pressed, allows letters to be entered into the scratchpad. When pressed a second time, signals the CDU to use the character that was just entered, and deletes <b>LTR</b> entry mode.	
9	FACK key	When pressed, signals the system that an annunciated failure has been recognized by the operator, and causes the flashing annunciation to go to a steady annuncia- tion.	
10	Page select switch	Selects the type of information to be displayed. The following five categories of display pages can be selected:	
		NOTE	
		All CDU distance and speed displays in L/L mode are in nautical miles (NM). All	

All CDU distance and speed displays in L/L mode are in nautical miles (NM). All distance and speed displays in **UTM** mode are in kilometers.

KEY	CONTROL OR INDICATOR	FUNCTION		
		1. <b>POS</b> . Provides present position; universal transverse mercator (UTM) or latitude/longitude (L/L) selection; magnetic heading selection; magnetic variation; true or magnetic heading; ground track; and ground speed.		
		2. <b>INS</b> . Provides inertial alignment status; barometric pressure; altitude; data zeroize; and access to system data and unit tests.		
		3. <b>DEST</b> . Provides selected course entry; destination coordinates; UTM or L/L selection; range, bearing, and time to destination; cardinal heading/distance.		
		4. <b>STR</b> . Provides selected course; range, bearing and time to steerpoint; present position; UTM or L/L selection; cardinal heading/distance.		
		5. <b>TCN</b> . Provides both TACAN control and station data. The TACAN control page provides power control; mode selection; slant range and bearing to station; update enable; and access to station pages. The TACAN station pages provide station magnetic variation; coordinates, channel; slant range/bearing; and elevation.		
11	Mode select switch	Selects eight different modes of operation for the IINS. The mode select switch selects the following IINS modes of operation:		
	Mode select switch 1. <b>OFF</b> . Turns off the IINS (removes power from TACAN CDU).			
		2. <b>FAST</b> . In this position the STD INS either performs a stored heading alignment or best available true heading (BATH) alignment. If a BATH alignment is per- formed, true or magnetic heading information must be entered not later than 1 minute after selecting the <b>FAST</b> mode. If magnetic heading information is not entered, system will assume a stored heading. After heading information is entered, present position may be entered if desired. <b>FAST</b> alignment is a degraded mode of operation and should not be used under normal conditions.		
		3. <b>NORM</b> . In this position the STD INS performs a gyrocompass alignment. Present coordinates must be entered not later than 2 minutes after selecting the <b>NORM</b> mode.		
		4. <b>NAV</b> . This is the STD INS primary flight mode of operation. <b>NAV</b> is entered after satisfactory alignment conditions have been met.		
		5. <b>UPDT</b> . In this position the NPU freezes present position data for a later manual position update by overflying a known position designated by a mark.		
		6. <b>ATTD</b> . In this position the STD INS initiates an attitude reference mode of operation. Although navigation processing is discontinued, the STD INS continues to provide a stable reference frame for generation of roll, pitch, and inertial heading angles.		
		7. <b>CAL</b> . In this position the STD INS performs an automatic calibration of the gyro biases.		
		8. <b>TEST</b> . In this position the STD INS performs functional performance tests, fault detection, and fault localization checks.		
12	<b>DEST</b> switch	Three-position toggle switch used to increment/decrement selected destination. The number of the selected destination appears on line 1 of the data display. Up increases and down decreases the selected destination.		

KEY	CONTROL OR INDICATOR	FUNCTION		
13	<b>BIT</b> indicator	Used to indicate the results of all internal CDU tests. White indicates a failure and black indicates test passed.		
14	STR switch	Three-position toggle switch used to increment/decrement selected steer point. The number of the selected steerpoint appears on line 1 of the data display. Up increases and down decreases the steerpoint number.		
15	MRK key	Used to signal the STD INS to note the current position and use it for one of two of the following purposes:		
	MRK key	1. Store as a markpoint (destination A thru F) when the mode select switch is in the <b>NAV</b> position.		
		2. Store present position relative to selected destination for possible updating when mode select switch is in the <b>UPDT</b> position.		
16	Page slew switch	Three-position toggle switch used to slew data display one page up or down by pressing page slew switch up or down.		
3.19.1.2 SYSTEMS SELECT Panel. The SYSTEMS SELECT panel (Figure 3-60) consists of two switch light indicators, located on the center lower edge of the instru- ment panel. It provides a switching capability for utiliza- tion of IINS through a relay assembly. The SYSTEMS				
SELECT panel CONTROL/ INDICATOR HDG	operates as follows: FUNC	TION	IINS:	INU output is displayed on the VSIs and is used by the SAS/FPS computer depending on the VSI/ HSI <b>MODE SEL VERT GYRO</b> setting.
DG:	ASN-43 directional gyro output is displayed on the HSIs. ASN-43 interface with the VSI/HSI Mode Select System, the SAS/FPS flight computer, the civil navigation system, and the Command Instru- ment System (CIS).			<b>NOTE</b> If the <b>IINS</b> is to be turned <b>OFF</b> during flight, the <b>IINS</b> should be deselected on the <b>SYSTEMS</b> <b>SELECT</b> panel prior to <b>IINS</b> turn <b>OFF</b> .
IINS:	IINS heading outp on the HSIs. IINS the above system, ASN-43.	S interface with modified for <b>HNS</b> , operates the same as the UH-60A. Th		HSI MODE SEL Panel (Figure 3-61) operates the same as the UH-60A. The
ATT			IINS	
VG:	CN-1314 Pilot or displacement gyro displayed on respe used by the SAS/I determined by the <b>MODE SEL VER</b>	o output is ective VSIs and FPS computer as VSI/HSI	range, steerpo display	on of <b>IINS</b> will display IINS calculated bearing, and course deviation to the bint on the associated HSI. Range is ed as distance (KM), bearing by the #1 , and deviation by the course deviation

ting.

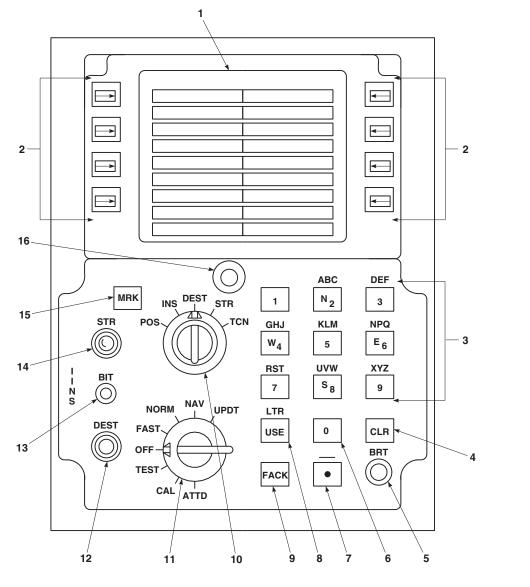


Figure 3-59. CDU Controls and Indicators

Selection of **IINS** disconnects the VOR (ARN-123) TO/FROM output to the HSIs and connects the SCU TO/FROM output to the HSIs.

To select **IINS** on the **MODE SEL** panels, **IINS** must be selected on the **SYSTEMS SELECT** panel. Also the CDU must be on and in the **NAV** mode.

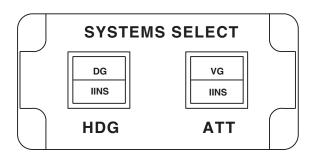
**3.19.2 Valid Entry Procedures.** The following paragraphs describe valid entry formats for data which may be entered on each of five main pages. An inward

pointing arrow indicates that data can be entered on that line by pressing the adjacent line select key.

**3.19.2.1 POS (Position) Page.** The position page (Figure 3-62) provides for entry of mag/true heading (BATH alignment), present position (**FAST/NORM** alignment) and magnetic variation.

 Magnetic True Heading Entry. Magnetic heading and magnetic variation or true heading may be entered during the first 60 seconds of a FAST alignment. Scratchpad entries may be up to four numeric digits including an optional

AA0391



AA0392

#### Figure 3-60. SYSTEMS SELECT Panel

decimal point. If no decimal point is entered, whole degrees are assumed. Leading zeros are optional.

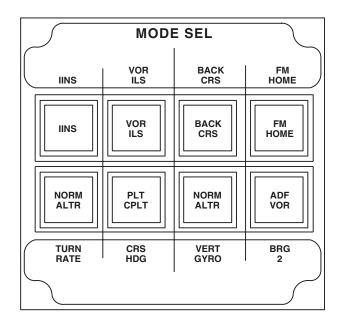
2. Latitude Entry. Key in N or S and then the numeric digits. The first two digits are degrees, third and fourth are minutes and fifth and sixth are seconds. A leading zero must be entered for any latitude less than 10°. Entry examples:

PREVIOUS VALUE	SCRATCH PAD CONTENTS	ENTERED VALUE					
S 6° 15 34	N263415	N 26° 34 15					
N 33° 25 15	2634	N 26° 34 00					
S 46° 13 00	S26	S 26° 00 00					
S 46° 13 00	26	S 26° 00 00					

_ . _ _

3. Longitude Entry. Key in E or W and then the numeric digits. A leading zero must be entered for a longitude less than 100° and two leading zeros for a longitude less than 10°.

PREVIOUS VALUE	SCRATCH PAD CONTENTS	ENTERED VALUE
E 176° 16 00	W1263415	W 126° 34 15
E 176° 16 00	12634	E 126° 34 00



AA0393

# Figure 3-61. VSI/HSI MODE SEL Panel

PREVIOUS VALUE	SCRATCH PAD CONTENTS	ENTERED VALUE				
W 135° 42 32	E126	E 126° 00 00				
E 120° 16 24	126	E 126° 00 00				

4. Spheroid or Grid Zone Entry. Either spheroid or grid zone may be entered. Spheroid entries consist of numbers 0 through 10 and are an alpha display as listed in Table 3-5. Grid zone entries consist of two numbers and alpha character. Entry examples:

PREVIOUS VALUE	SCRATCH PAD CONTENTS	ENTERED VALUE
16T INT	1	16T CL6
16T INT	18T	18T INT

PREVIOUS VALUE	SCRATCH PAD CONTENTS	ENTERED VALUE
16T INT	18T1	18T CL6

5. Area/Eastings/Northings Entry. Scratchpad entries may be made for area, eastings and northings, just area, or just eastings and northings. Entries for area must consist of two alpha characters. Entries for eastings/northings must be 2, 4, 6, 8, or 10 digits. Digits will be evenly split between eastings and northings with trailing zeros inserted. Although entries may be made and sent to the INU to a resolution of 1 meter, the display will round to the nearest 10 meters. The following illustrates several examples:

# Table 3-5. Spheroid Data Codes 🖽

CODE	MODEL	ABBR
0	International	INT
1	Clark 1866	CL6
2	Clark 1880	CL0
3	Everest	EVR
4	Bessel	BSL
5	Australian National	AUS
6	Airy	ARY
7	Hough	HGH
8	South American	SAM
9	Modified Everest	MEV
10	WGS.72	WGS

#### NOTE

When mission equipment operator selects WGS 1984, CDU is code 10.

PREVIOUS VALUE	SCRATCH PAD CONTENTS	ENTERED VALUE
AU 1234 5678	UV23456789	UV 2345 6789
AU 1234 5678	23456789	AU 2345 6789
AU 1234 5678	2345678	AU 2340 6780
AU 1234 5678	2367	AU 2300 6700
AU 1234 5678	26	AU 2000 6000
AU 1234 5678	UV	UV 1234 5678

6. Magnetic Variation Entry. Scratchpad entries consist of an E/W and up to four numeric digits including decimal point. If no decimal point is entered, while degrees are assumed. The range of entries is 0.0° to E/W 180.0°. For entries greater than or equal to 100°, only whole degrees are displayed. The following gives some entry examples:

SCRATCH PAD CONTENTS	ENTERED VALUE
E2	E20
W10.9	W10.9
E.7	E0.7

**3.19.2.2 INS (Inertial) Page.** The INS page (Figure 3-63) provides miscellaneous control/display functions such as entry of altitude and barometric pressure and provides access to INU and NPU memory.

 Manually Entered Altitude (MALT). Field altitude must be entered to the nearest 100 ft. MSL during alignment; however, MALT may be entered any time during the mission to override barometric altimeter. The range of valid entries is from -1000 to +65,520 feet in increments of 100 feet. Entries shall delete MALT by causing an output of -65,520 feet over the barometric pressure.

SCRATCH PAD CONTENTS	ENTERED VALUE
2	2.0
10	10.0
10.5	10.5

2. Barometric Pressure (BARO). Barometric pressure must be entered (0.01 in Hg) during alignment. The information is used by the NPU to initialize the scale factor of encoding altimeter data during alignment.

# 3.19.2.3 DATA Page.

- 1. Press the line select key adjacent to line 5 right (DATA).
- 2. Line 7 of the DATA page provides the capability to enter and read the contents of various INU registers. Although the CDU will accept entered memory addresses with a range of 0 to 65,535 (decimal), the INU will not accept all of these as valid. If an illegal address is entered, the illegal address and the message "ENTRY REJECTED" will alternately appear in the scratchpad. Pressing the CLR key will clear the scratchpad. Register contents that are entered may be any six alphanumeric characters plus sign. Many of the INU registers are "read only". That is, their contents can be read but not altered. If an attempt is made to change the contents of one of these registers, "ENTRY REJECTED" will appear as described above.

**3.19.2.4 DEST (Destination) Page.** Two types of data may be entered on the destination page, destination coordinates, and course to destination.

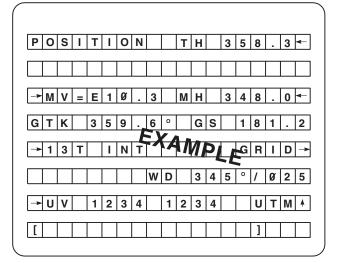
- Destination Coordinates Entry. Destination coordinates may be entered during any phase of the mission. Either LAT/LONG or MGRS (UTM) coordinates may be entered. Coordinate selection is provided on line 7 (display right).
  - a. Latitude entry described in paragraph 3.19.2.1.
  - b. Longitude entry described in paragraph 3.19.2.1.

- c. Spheroid and zone entry described in paragraph 3.19.2.1.
- d. Area/Eastings/Northings entries described in paragraph 3.19.2.1.
- 2. Course to Destination Entry. The desired true course to destination may be entered for each destination during any phase of the mission.
  - a. Enter the true course in the scratchpad. Entries may be up to four numeric digits with an optional decimal point. If no decimal point is entered, whole degrees are assumed. Leading zeros are optional.
  - b. Press line 1 right line select key. The true course to destination will be displayed on line 1 right.
  - c. System will utilize any previous course data. If no data has been entered, the system will assume a true course of 000.0°.

**3.19.2.5 STR (Steer) Page.** This page contains no enterable parameter.

**3.19.2.6 TCN (TACAN) Pages.** The TACAN pages (Figure 3-64) consist of the TACAN control page and TACAN station pages.

- TACAN Control Page Data Entry. The only data entry on this page is channel number. Paragraph 3.19.3. step 8. describes the channel number entry.
- 2. TACAN Station Page Entries. Parameter entries are station location magnetic variation channel and elevation.
  - a. Latitude entry described in paragraph 3.19.2.1.
  - b. Longitude entry decribed in paragraph 3.19.2.1.
  - c. Spheroid and zone entry described in paragraph 3.19.2.1.
  - d. Area/Eastings/Northings entries described in paragraph 3.19.2.1.
  - e. Station Magnetics Variation entry described in paragraph 3.19.2.1.



TO SELECT THIS PAGE, SET CDU PAGE SELECT SWITCH TO POS AND PRESS LINE 5 AND / OR LINE 7 RIGHT LINE SELECT KEYS AS REQUIRED.

#### AA0396

# Figure 3-62. Position Page

3. Station Channel Entry. The TACAN Station Pages provide the capability to enter station channel for each of the 16 stations. A total of 252 channels are possible (126 "X" channels and 126 "Y" channels). Unless "Y" is entered, an "X" channel is assumed.

# 3.19.3 Starting Procedure (IINS NORMAL ALIGN-MENT).

- 1. Ensure that the circuit breakers are in.
  - a. NO. 1 AC PRI BUS circuit breaker panel
    - (1) **INS**
    - (2) XFMR PWR
    - (3) INU BATT PWR
    - (4) 26 VAC EQUIP PWR
  - b. NO. 1 DC PRI BUS circuit breaker panel
    - (1) CPLT ALTM
    - (2) **IINS**

- c. NO. 2 AC PRI BUS circuit breaker panel
  - (1) TACAN
- d. NO. 2 DC PRI BUS circuit breaker panel
  - (1) TACAN

# NOTE

- Present position must be entered during the first two minutes of **NORM** alignment. If present position is displayed, it must be reentered. A steady NAVRDY indicates INU attitude data and degraded NAV performance are available. After turn-on, flashing **NAVRDY** will be displayed on line 6 indicating full alignment.
- CDU display will remain blank for 30 seconds after turn-on. If the CDU does not light after 30 seconds, rotate the brightness control on the CDU clockwise to provide a comfortable intensity level.
  - 2. IINS mode select switch NORM.
    - a. Check for annunciations on line 2 of the display. If any annunciation is flashing, return mode select switch to **OFF**.



Wait two minutes before returning mode select switch to NORM. Failure to do so will damage the INU.

- b. If mode select switch was turned off, rotate mode select switch to NORM. If an annunciation is still flashing, make an entry on DA Form 2408-13-1. Refer to paragraph 3.19.6 for an explanation of annunciations.
- 3. Page selector switch POS.

# NOTE

If UTM coordinates are selected, the COM-PLETE UTM coordinates must be entered for present position: GRID ZONE, SPHEROID, AREA, EASTINGS, and NORTHINGS.

- 4. Verify line 7 on right side display indicates desired COORDINATE SYSTEM (UTM or L/L). If not press the line select key once to switch to the desired coordinate system.
  - a. Enter GRID ZONE/SPHEROID or LATITUDE in scratchpad.
  - b. Press line select key 5 left.
  - c. Enter AREA, EASTINGS, NORTHINGS, or LONGITUDE in scratchpad.
  - d. Press line select key 7 left.

If INU computed MV is changed, updated MV will have to be manually entered as MV lines are crossed. If INU computed MV is utilized, automatic MV updating will be performed by the INU.

- 5. Verify line 3 on left side display indicates correct magnetic variation, MV.
  - a. If incorrect, enter MV in scratchpad.
  - b. Verify scratchpad entry is correct.
  - c. Press line select key 3 left.
  - d. Verify line 3 left displays: -> MV = XNN.N. (The "=" sign indicates that a manual MV was entered and automatic MV updating will not occur.)
- 6. Page select switch INS.
  - a. Enter barometric pressure of present position in scratchpad.
  - b. Press line select key 5 left.
  - c. Enter altitude of present position in scratchpad (e.g., 156 ft is entered as 0.156 and displayed as 0.2).
  - d. Press line select key 3 left.
- 7. Page select switch DEST.
  - a. Press **DEST** toggle switch to select **DEST** desired page.

- b. Press line select key 7 right to display desired coordinate system (UTM or L/L).
- c. Enter grid zone and spheroid or latitude in scratchpad.
- d. Press line select key 5 left.
- e. Enter Area/Eastings/Northings or longitude in scratchpad.
- f. Press line select key 7 left.
- g. Press **DEST** toggle switch to increment to the next page.
- 8. Page select switch TCN.



Potential radiation hazard exists at the TACAN antenna when the TACAN is turned on. Make sure that no person is within 3 feet of antenna. When TACAN is first turned on and line 3 left of CDU displays anything other than REC, immediately press line select key 3 left until the display shows REC.

- a. Turn ON TACAN by pressing line select key 1 left.
- b. Press line 3 left until REC is displayed on the CRT.
- c. Press page slew toggle switch to display TACAN station zero page.
- d. Enter magnetic variation in scratchpad.
- e. Press line select key 3 left.
- f. Enter latitude in scratchpad.
- g. Press line select key 5 left.
- h. Enter longitude in scratchpad.
- i. Press line select key 7 left.
- j. Press line select key 1 right to display ACT.

N	S		D										_				
			U	2		S	3			Ζ	Ε	R	0	Ι	Ζ	Ε	->
Ι	A	L	Т		2	7		5				Т	Ε	S	Т	S	->
						E	X	Λ									
								~ 4	И	P							
B	Α	R	0		2	9	•	Ø	1				D	Α	Т	Α	->
								L	Α	S	Т		Μ	R	Κ		С
1	9		9	М	Ι	Ν			S	Т	Α	Т	=	Α	+	Н	
														1			
	I B 1					B A R O 2	B A R O 2 9	BARO 29.	BARO 29.0	B A R O 2 9 . Ø 1	BARO 29.01 LAS	BARO 29.Ø1 LAST	BARO 29.Ø1	BARO 29.Ø1 FD		BARO 29.Ø1 FDAT	

TO SELECT THIS PAGE, SET CDU PAGE SELECT SWITCH TO INS.

#### AA0394

#### Figure 3-63. INS Page 🖽

- k. Enter channel number in scratchpad.
- 1. Press line select key 3 right.
- m. Enter elevation of TACAN station on scratchpad.
- n. Press line select key 5 right.
- o. Press page slew toggle switch to display next TACAN page.
- Enter data as described in steps d. through o.

#### NOTE

- In order for HSI steering command to be correct, a valid destination and steer point must be entered prior to switching the **MODE** selector to **NAV**.
- Example: If DX is homebase (alignment point), the SX STEER point is invalid as an initial Destination/Steer Point.
  - 9. Select an appropriate destination number and toggle the **STR** toggle switch to indicate the

number, i.e., S1. (It is not necessary that the DX and SX numbers agree, only that SX is the desired destination.)

- 10. Mode select switch **NAV**. (Pull switch up; then rotate.)
- 11. Page select switch TCN.
  - a. Press line select key 3 left to display T/R.
  - b. Press line select key 5 left to display UP-DT.
- 12. On VSI/HSI **MODE SEL** panel, press **IINS** switch. Note that bearing to destination (No. 1 needle), range to destination, course deviation and **TO/FROM** flag are displayed on the HSI.
- 13. On **SYSTEMS SELECT** panel, set switches and observe indications as follows:
  - a. Press **HDG** switch, **IINS** illuminates and inertial derived heading is displayed on the HSI.
  - b. Press **ATT** switch, **IINS** illuminates and inertial derived pitch and roll is displayed on the VSI.

# 3.19.4 Starting Procedure (FAST Alignment).

Switching to **FAST** mode commands the INU to perform either a stored heading alignment or best available time heading (BATH) alignment.

#### 3.19.4.1 Stored Alignment.

# NOTE

CDU display will remain blank for 30 seconds after turn on. Barometric pressure must be entered during alignment. Alignment will be complete when data display line 6 NAVRDY indicator begins to flash if a normal alignment was performed and the mode select switch was not set to NAV. Alignment will be complete when data display line 6 NAVRDY indicator lights if a normal alignment was performed and the mode select switch was set to NAV.

1. Ensure system preoperational checks have been performed and that helicopter power is on.

- 2. Set mode select switch to FAST.
- 3. Set page select switch to **POS**.
- 4. Observe that data display line 7 right indicates desired coordinate system (**UTM** or **L/L**). If it does not, press line select key 7 right until the desired coordinate system is deployed.
- 5. If data display line 8 right indicates LTR, press LTR/USE key to place the keyboard in the numeric mode.
- 6. Observe that data display line 5 left and line 7 left indicate present position latitude and longitude or grid zone, spheroid area, eastings and northings, respectively. If not, normal or BATH alignment must be performed:
- 7. Set page select switch to **INS**. Observe that data display line 3 left indicates present position altitude. If not, a change must be made within the first 60 seconds of this alignment.

- The following steps are an example of entering barometric pressure. Substitute your own barometric pressure when performing these steps. Enter local barometric pressure to the nearest 0.01 inches Hg.
- When making keyboard entries, if an incorrect key is pressed, press **CLR** key as required and begin again.
  - Enter local barometric pressure on data display line 8 by pressing in sequence ABC/N2, XYZ/ 9, -/●, 0, and 1 keys. Observe that data display line 8 indicates 29.01.
  - 9. Press data display line 5 left line select key. Observe that data display line 5 left indicates -> BARO 29.01.
  - 10. Observe that data display line 7 indicates alignment and status.

# NOTE

Data display line 6 left indicates a flashing NAVRDY if a normal alignment was performed and the mode select switch was not set to NAV.

11. When data display line 6 left NAVRDY indicator lights, set mode select switch to NAV.

# 3.19.4.2 BATH Alignment.

# NOTE

- CDU display will remain blank for 30 seconds after turn on. True or magnetic heading must be entered during the first 60 seconds of turn on. Present position must be entered within 2 minutes of turn on. Barometric pressure and altitude must be entered during alignment.
- Alignment will be complete when data display line 6 NAVRDY indicator lights.
  - 1. Ensure system preoperational checks have been performed and that helicopter power is on.
  - 2. Set mode select switch to FAST.
  - 3. Set page select switch to **POS**.
  - 4. Observe that data display line 7 right indicates desired coordinate system (**UTM** or **L/L**). If it does not, press line select key 7 right until desired coordinate system is displayed.
  - 5. If data display line 8 right indicates LTR, press LTR/USE key to place the keyboard in the numeric mode.

# NOTE

The following steps are examples of entering present position data. Substitute your own present position and heading when performing these steps. Either true heading or magnetic heading can be entered. Magnetic heading is entered by pressing line select key. The following example uses true heading. When making keyboard entries, if an incorrect key is pressed, press **CLR** key as required and begin again.

6. Enter true heading on data display line 8 by pressing in sequence DEF/3, KLM/5, UVW/ S8, -/ and DEF/3 keys. Observe that data display line 8 indicates 358.3.

- Press data display line 1 right line select key. Observe that data display line 1 right indicates TH 358.3 <-.</li>
- If required, enter present position latitude (or UTM, GRID ZONE and SPHEROID) on data display line 8 by pressing in sequence LTR/ USE, ABC/ N2, LTR/USE, DEF/3, GHJ/W4, 1, 0, DEF/3, and 0 keys. Observe that data display line 8 indicates N341030.
- 9. Press data display 5 left line select key. Observe that data display line 5 left indicates -> N34° 10 30.
- If required, enter present position longitude (or UTM area, EASTING and NORTHING) on data display line 8 by pressing in sequence LTR/USE, GHJ/W4, LTR/USE, 1, 1, UVW/ S8, DEF/3, and 0 keys. Observe that data display line 8 indicates W1183530.
- Press data display line 7 left line select key. Observe that data display 7 left indicates - > W118° 35 30.
- 12. Set page select switch to **INS**.

When entering present position altitude, altitude must be entered to the nearest 100 feet (mean sea level). The range of valid entries from -1000 to 65,520 feet in increments of 100 feet. Entries are made in thousands of feet.

- 13. If required, enter present position altitude on data display line 8 by pressing in sequence UVW/S8, -/●, and NPQ/E6 keys. Observe that data display indicates 8.6. This represents an altitude of 8,600 feet.
- 14. Press data display line 3 left line select key. Observe that data display line 3 left indicates -> AALT 8.6.

# NOTE

Enter local barometric pressure to the nearest 0.01 inches Hg.

15. Enter local barometric pressure on data display line 8 by pressing in sequence ABC/N2, XYZ/

ŧ	Т	Α	С	A	Ν		0	Ν				S	Т	Α			3	
<b></b>	Т	/	R		3	K	A	M	r		C	Η		1	2	5	X	
S	R	Ν	G			4	2		5		в	R	G		1	2	2	0
	U	Р	D	т			6		0	F		1	ø					
												-						
							S		A	Ť								
3	S	Ι	G	=		1												
[															]			

NOTE

TO SELECT THIS PAGE, SET CDU PAGE SELECT SWITCH TO TCN.

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# Figure 3-64. TACAN Control Page

9, -/, 0, and 1 keys. Observe that data display line 8 indicates 29.01.

- 16. Press data display line 5 left line select key. Observe that data display line 5 left indicates -> BARO 29.01.
- 17. Observe that data display line 7 indicates alignment time and status.
- When data display line 6 left NAVRDY indicator lights, set mode select switch to NAV.

# 3.19.5 In-Flight Procedures.

**3.19.5.1 MARK Operation.** Current helicopter position may be stored in one of the markpoint locations (destinations A-F) by pressing the **MRK** key when in **NAV** mode. The location where present position was stored is displayed in the CDU scratchpad regardless of currently selected page. Figure 3-63 illustrates "MARK C" in the scratchpad with the **STR** page selected.

1. The MARK locations are used in sequence (-A, B, C, D, E, F, A, B,...). The MARK display will remain in the scratchpad unless it is cleared with the **CLR** key or the scratchpad is used to enter some other data.

2. Pressing the **MRK** pushbutton will freeze, for 30 seconds, the display of present position on the Steering and Position pages; and the display of cardinal headings/distance on both the destination and Steering Page. After 30 seconds or after the **CLR** key is pressed, the current position will return.

# 3.19.5.2 Manual Updating (Overfly Position Updat-

**ing).** An overfly update represents a manual position update technique in which the pilot overflies his selected destination and signals the INU by pressing the **MRK** key. To initiate a manual update, proceed as follows.

# NOTE

If IAS is greater than 5 knots, the manual update will not remove 100% of the positional error or zero out the cardinal headings, time to go (TTG) or distance to destination. The percentage of actual update is a dynamic function of the computer software.

# 3.19.5.2.1 Indicated Airspeed Greater Than 5 Knots.

- 1. Ensure that the displayed Destination and Steerpoint indicators (Dx, Sx) are both set to the destination that the update will be performed on.
- 2. Rotate the mode select switch to the **UPDT** position. The page shown in Figure 3-65 will be displayed.
- 3. When the helicopter is directly over the destination point, depress the **MRK** key. The page shown in Figure 3-66 will be displayed.
- 4. If the pilot decides to accept the update (AC-CEPT here means to tell the INU that the positional update will be accepted) depress line select key 7 left to accept the update (REJECT here means to tell the INU that the positional update will not be accepted), depress line select key 7 right to reject the update. In either case, the page shown in Figure 3-66 will be redisplayed.

# NOTE

The following display changes are not immediate. It will take approximately 5 seconds for the data to change.

- 5. Rotate the mode select switch to NAV.
- 6. Observe that the cardinal heading, TTG, and range decrease towards 0.0, and that present position changes to more closely reflect the coordinates stored in the selected destination.
- 7. If the mission will continue, select a new steerpoint and proceed.

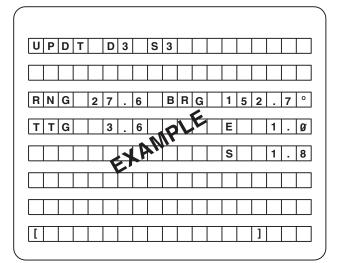
# 3.19.5.2.2 IAS Is 5 Knots or Less.

- 1. Perform steps 1. through 6. above.
- 2. If the cardinal headings, TTG and range do not decrease to 0.0, verify that both the destination and steerpoint indicators (Dx, Sx) are set to the destination that the update is being performed on. Repeat steps 1. through 6.
- 3. To proceed with the mission, select a new steerpoint.
- 4. Selection of the "**UPDT**" mode on the mode select switch deletes automatic TACAN updating during the period of the manual update.

# 3.19.6 Annunciations.

**3.19.6.1 System Status Messages.** System status messages (Figure 3-67) appear on line 2 and the left side of line 6 regardless of selected page. The following is a summary of messages that are presented and the failures/ conditions they represent.

MES- SAGE	CONDITION	LINE
MSC	Mission Computer has failed.	2
NPU	Navigation Processor has failed.	2
INU	INU navigation processing has failed Attitude may be valid.	2
ADC	Copilot's Altimeter-Encoder has failed.	2



TO SELECT THIS PAGE, SET CDU MODE SELECT SWITCH TO UPDT. WHEN THIS PAGE IS SELECTED, TACAN UPDATING IS DELETED.

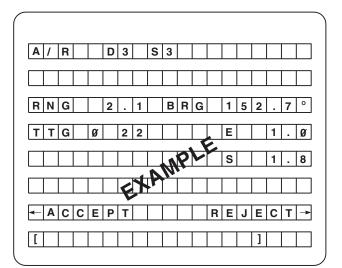


Figure 3-65. Update Page

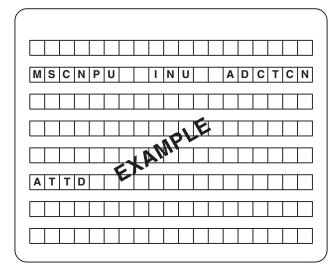
#### NOTE

TO SELECT THIS PAGE, SET CDU MODE SELECT SWITCH TO UPDT AND PRESS MRK KEY.

#### AA0398

AA0397

Figure 3-66. Accept/Reject Page



#### NOTE

SYSTEM STATUS MESSAGES APPEAR ON LINE 2 (2) AND THE LEFT SIDE OF LINE 6 (6) REGARDLESS OF SELECTED PAGE (EXCEPT NPU DATA PAGE). DATA APPEARING ON LINES 1 (1), 3 (3), 4 (4), 5 (5), 7 (7) AND 8 (8) WILL BE WHATEVER IS APPLICABLE TO THE PAGE SELECTED. THE FOLLOWING IS A SUMMARY OF MESSAGES THAT ARE PRESENTED AND THE FAILURES / CONDITIONS THEY REPRESENT:

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# Figure 3-67. System Annuciators 🖽

MES- SAGE	CONDITION	LINE
TCN	TACAN has failed or is off.	2
PFM	Post Flight maintenance is required.	2
TTG	Helicopter is within two minutes of selected steer- point (flashing).	2
FROM	Distance to steerpoint is increasing.	2
ТО	Distance to steerpoint is decreasing.	2
SCU	Signal Converter Unit or ARINC BUS has failed. (See TEST page.)	2
NAVRDY (steady)	During alignment. INU at- titude data and degraded nav performance are available.	6
NAVRDY (flashing)	During alignment. Full INU nav performance is available.	6

MES- SAGE	CONDITION	LINE
ATTD	The INU is in attitude mode due to: 1. operator selection. 2. INU failure or 3. data bus failure. Attitude data is valid.	6
DEGRD	The INU is in navigate mode and a degraded performance alignment, not a full performance alignment was performed.	
	1	6
UPDT	The INU is being automati- cally updated by the TACAN.	6
DEGUPD	Degraded mode update by TACAN.	6

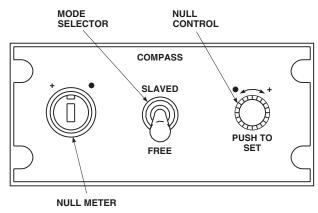
**3.19.6.2 Placement of Annunciations.** Placement of annunciations on their respective lines is shown in Para. 3.19.6.1. NPU and PFM annunciators occupy the same location. When a failure occurs, the annunciation will flash to attract the pilot's attention. Pressing the "FACK" key causes the annunciation to go from flashing to steady. If an LRU recovers from the failure, its annunciator will clear.

# 3.20 GYRO MAGNETIC COMPASS SET AN/ASN-43.

Gyro Magnetic Compass Set AN/ASN-43 provides heading information by reference to a free directional gyro when operating in the **FREE** mode, or by being slaved to the earth's magnetic field when operating in the **SLAVED** mode. It provides heading information to the HSI. Power to operate the AN/ASN-43 is provided from the ac essential bus through circuit breakers marked **COMP** and **AUTO XFMR** under the general heading **AC ESNTL BUS**.

**3.20.1 Compass Control C-8021/ASN-75.** Compass Control C-8021/ASN-75 is required to synchronize (electrically and mechanically align) the AN/ASN-43 to the correct magnetic heading when used in the **SLAVED** mode of operation. The synchronizing knob on the control panel may be used as a set heading knob for operation in the **FREE** mode.

**3.20.2 Controls and Functions.** Controls for the magnetic compass set are on the front panel (Figure 3-68) of the unit. The function of each control is as follows:



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# Figure 3-68. Compass Control Panel C-8021/ ASN-75

CONTROL	FUNCTION
Null Meter	Moves left (+) or right (•) of center to indicate misalignment (synchronization) of the AN/ASN- 43.
Mode Selector (SLAVED- FREE)	Selects either magnetically <b>SLAVED</b> or <b>FREE</b> gyro operation of the AN/ASN-43.
Null Control PUSH TO SET	Is manually pressed and turned to null the annunciator, thereby synchronizing (electrically and mechanically aligning) the AN/ ASN-43. Turns compass card of HSI for alignment.

# 3.20.3 Operation.

# 3.20.4 Starting Procedure.

- 1. Mode selector As desired.
- 2. Null control Push and turn in direction indicated by null meter (+ or •) until annunciator is centered. In **SLAVED** mode, during normal operation, the annunciator will oscillate slightly about the center position; however, during certain helicopter maneuvers, the annunciator will move off center.

**FUNCTION** 

3. HSI - Check to see that HSI heading agrees with a known magnetic heading.

# 3.21 ATTITUDE HEADING REFERENCE SET (AHRS).

The Attitude Heading Reference Set (AHRS) is a selfcontained strap-down Fiber Optics Gyro (FOGs) system that provides vehicle pitch, roll, magnetic heading, and turn rate for integration within an avionics subsystem. The set consists of a CN-1716/A Attitude Heading Reference Unit (AHRU), a C-12712/A Control Unit, and a Flux Valve. Power to operate the AHRS is provided from the No. 2 ac essential bus through the circuit breakers marked AHRU PLT, CPLT. The AHRS is designed as a retrofit of the mechanical gimbaled gyros type CN-1314/A (Vertical Gyro - VG), CN-998/ASN-43 (Directional Gyro - DG), and TRU-2NA (Rate Gyro - RG). It can be installed both in DUAL and SINGLE configuration. The system obtains a magnetic heading reference from the FLUX VALVE (MDU) and supplies heading, pitch and roll inputs to the DOPPLER, HSI, roll and pitch to the VSI and roll to the AFCS. In the SINGLE AHRU installation, only the pilot's side Vertical Gyro, Rate Gyro and Directional Gyro are replaced, and no heading input redundancy is available. For the DUAL AHRU installation full redundancy is provided for heading input to the instruments, and heading, pitch and roll input to the Doppler Receiver and is managed automatically by the Control Unit (CU).

**3.21.1 Control Unit C-12712/A.** The Control Unit C-12712/A provides controls and indicators to allow commands to be sent to the CN-1716/A AHRU and to provide system status information to the crew. The Control Unit replaces the Compass Controller Unit (CCU) in the helicopter cockpit in both the single and dual AHRS installation. Normal operation is in the SLAVED mode, but free mode or DG and compass calibration CCAL can be selected.

**3.21.2 Controls and Functions.** Controls for the AHRS are on the front panel (Figure 3-69) of the unit. The function of each control is as follows:

CONTROL/ INDICATOR	FUNCTION
Mode Selector	Used to select <b>SLAVE</b> , <b>DG</b> , or <b>CCAL</b> modes of operation.
Function Selector	Used to select specific function within each mode of operation.
Display Cursor Movement	Moves display cursor up or down, left or right.

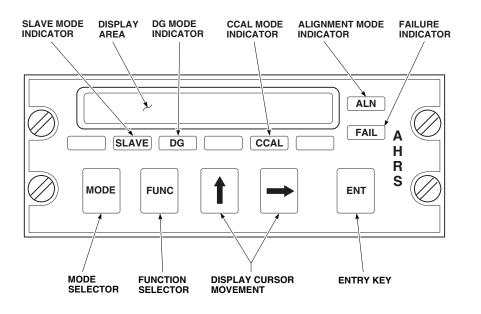
#### CONTROL/ INDICATOR

INDICATOR	
Enter Key	Manually pressed to select Mode or function desired.
Display Area	Displays AHRU and mode information.
SLAVED Mode Indicator	AHRU is in slave mode.
DG Mode Indica- tor	AHRU is in DG mode.
CCAL Mode Indicator	AHRU indicates performing magnetic detector unit calibration.
Alignment Mode Indicator	During the alignment sequence the ALN lamp on the Control Unit panel will be illuminated.
Failure Indicator	If a failure condition is detected, the FAIL lamp on the Control Unit will illuminate, and the Control Unit display will show a message indicating which AHRU has failed.

# 3.21.3 AHRS Modes Of Operation.

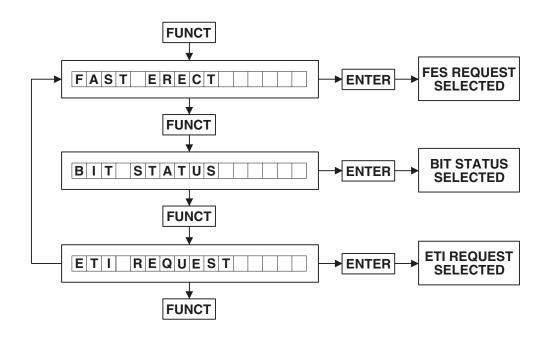
**3.21.3.1 Slave Mode.** When SLAVE mode is selected, the Magnetic Heading output becomes a gyro stabilized Magnetic Detector Unit (MDU). While in SLAVE mode the AHRS displays the current magnetic heading error, computed as the difference between MDU heading and AHRU heading output. It is indicated in the form of a vertical bar (Delta Heading Bar- DHDG Bar) shown on the Control Unit display, moving between a minus (-) and a plus (+) sign. The distance between the bar position and the center of the scale, indicated by small ticks, represents the error in the range of  $\pm 5^{\circ}$ . In SLAVE mode three functions are enabled: BIT STATUS, FAST ERECT SYNC (during flight only), and ETI REQUEST (elapsed time indicator).

**3.21.3.2 DG Mode.** In Free Gyro or DG mode, the AH-RU outputs free gyro heading and stabilized attitude data, corrected for earth and aircraft rate. During DG mode the delta heading bar is fixed at the center of scale. During alignment time (45 sec) the system provides invalid attitude signal, indicated by VSI flags in view, and the ALN lamp on the Control Unit panel is illuminated. In DG mode the system automatically detects the transition from



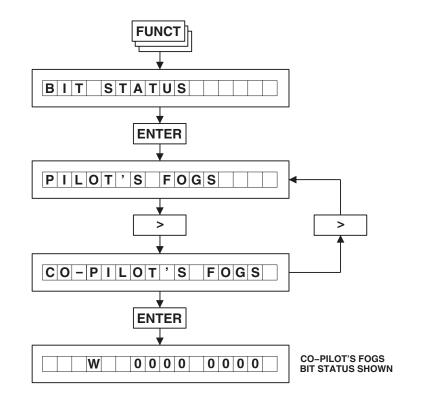
AB4216





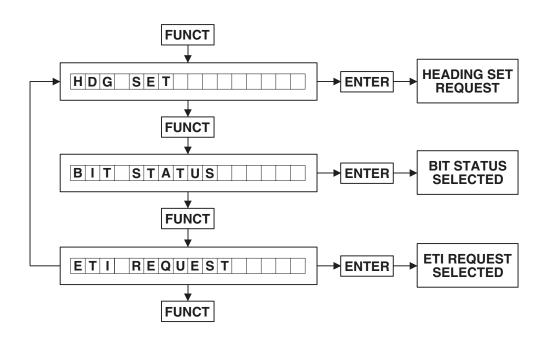
AB4217

Figure 3-70. AHRS Control Unit Slave Mode Function Select Flow Chart



AB4218

Figure 3-71. AHRS BIT Status Function Sample Flow Chart



AB4219

Figure 3-72. AHRS Control Unit DG Mode Function Select Flow Chart

ground-to-air at the first take off. In Free mode the Delta Heading (DHDG) graduated bar on the Control Unit display is stuck in the null position. In DG (Free) mode three functions are enabled: BIT STATUS, HEADING SLEW and ETI REQUEST.

**3.21.3.3 CCAL Mode.** The purpose of the CCAL mode is to perform the Magnetic Detector Unit (MDU) calibration. CCAL mode can be selected only on ground, and the method of CCAL selection is fail-safe and it is not possible to inadvertently select this mode in flight. The AHRU is capable of compensating the host vehicle magnetic heading as represented by the Flux Valve, minimizing the one- and two-cycle errors detected during the CCAL procedure. The AHRU CCAL method enables the pilot or qualified crewmembers to perform the CCAL procedure by self contained means without the need for external specialized calibration equipment or assistance, within a time period of less than 10 minutes, excluding aircraft motion. In CCAL Mode the functions enabled are COMPASS CAL START (for compass calibration procedure start), COMPASS CAL STORE (for compass calibration coefficients store in case of an unsuccessful

compass calibration execution), COMPASS CAL COEF-FICIENTS READ (for reading and storing in the Control Unit internal Non Volatile Memory (NVM) the computed compass calibration coefficients), COMPASS CAL COEFFICIENTS WRITE (for copying compass calibration coefficients stored in the Control Unit Non Volatile Memory (NVM) in AHRU Non Volatile Memory), BIT STATUS request (for detailed BIT information), BIT HISTORY request (for AHRU BIT history records detailed reading), INDEX Set request and ETI REQUEST.

# NOTE

To retune system to normal operation after compass calibration, cycle aircraft power or reset AHRU circuit breakers.

# 3.21.3.4 Starting Procedure.

- 1. Mode selector As desired.
- 2. HSI Check to see that HSI heading agrees with a known magnetic heading.

#### 3.22 TRANSPONDER AN/APX-100(V)1 (IFF).

The transponder set provides automatic radar identification of the helicopter to all suitably equipped challenging aircraft and surface or ground facilities within the operating range of the system. AN/APX-100(V) receives, decodes, and responds to the characteristic interrogations of operational modes 1, 2, 3/A, C, and 4. Specially coded identification of position (IP) and emergency signals may be transmitted to interrogating stations when conditions warrant. The transceiver can be operated in any one of four master modes, each of which may be selected by the operator at the control panel. Five independent coding modes are available to the operator. The first three modes may be used independently or in combination. Mode 1 provides 32 possible code combinations, any one of which may be selected in flight. Mode 2 provides 4096 possible code combinations, but only one is available and is normally preset before takeoff. Mode 3/A provides 4096 possible codes, any one of which may be selected in flight. Mode C will indicate pressure altitude of the helicopter when interrogated. Mode C is only available if both mode 3/A and mode C switches are placed to the **ON** position. Mode 4 is the secure mode of cooperative combat identification, IFF operational codes are installed, the current period's code and either the previous or the next period's code. Power to operate the IFF system is provided from the No. 1 dc primary bus through a circuit breaker marked IFF. Refer to TM 11-5895-1199-12 and TM 11-5895-1037-12&P.

#### 3.22.1 Antenna.



The transponder will ignore (and not respond to) interrogations received from the ground if the ANT switch is in the TOP position and will ignore interrogations received from above if the ANT switch is in the BOT position.

Flush-mounted antennas are installed on the top fairing between engine exhaust ports, and under the transition section behind the UHF-AM antenna. They receive signals of interrogating stations and transmit reply signals. The AN/APX-100(V) is a diversity transponder, functioning to receive the rf interrogation from two antennas and transmit the reply via the antenna from which the stronger interrogation signal was received. If the **ANT** switch is in the

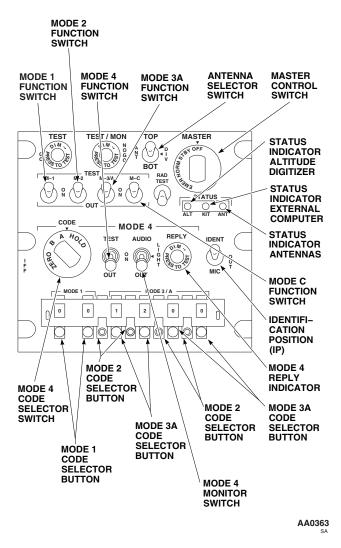


Figure 3-73. Control Panel RT-1296/APX-100(V)

**TOP** position and the stronger signal was received from the bottom antenna, no rf reply will be transmitted. If the **ANT** switch is in the **BOT** position and the stronger signal was received from the top antenna, no rf reply will be transmitted. Therefore the **ANT** switch must be in the **DIV** position to ensure the IFF will reply to all valid interrogations.

**3.22.2 Controls and Functions.** All operating and mode code select switches for transceiver operation are on Control Panel RT-1296/APX-100(V) (Figure 3-73). The function of each control is as follows:

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
TEST GO	Indicates successful BIT.	M-1, M-2,	The four three-position switches on
TEST/MON NO GO	Indicates unit malfunction.	M-3/A, M-C switches	the IFF control panel will enable or disable the system for modes 1, 2, 3/A, or C operation. Mode 1, mode
ANT-DIV switch	Allows the pilot to select the <b>TOP</b> (upper antenna), <b>BOT</b> (bottom antenna), or <b>DIV</b> (diversity, both antennas) of the helicopter.		2, mode 3/A, or mode C replies are possible only when their respective switches are placed in the ON positions. Mode C is available only if both mode 3/A and mode C are
	NOTE		placed in the <b>ON</b> position. Mode 1
	The <b>ANT-DIV</b> switch shall be placed in the <b>DIV</b> position at all times.		switches permit selection of a desired code from 00 through 73. Mode <b>2</b> and mode <b>3/A</b> switches permit selection of a desired code
MASTER/OFF	Selects operating condition.		from 0000 through 7777. The
/STBY/NORM/ EMER	NOTE		<b>OUT</b> position if each switch prevents a reply to the respective
EMER	Emergency reply provisions. This mode of operation is possible when the <b>MASTER</b> switch on the IFF		mode interrogations. The <b>TEST</b> position of each switch tests the respective mode operation.
	control panel is placed in the <b>EM</b> - <b>ER</b> position and the system is interrogated. Emergency operation results in four short dashes on the	RAD TEST/ OUT	The <b>RAD</b> switch is used to allow the RT to reply to external test interrogation when held in the <b>RAD</b> position.
	interrogating radar indicator, which indicates an aircraft in distress, and singles out the aircraft in	RAD TEST	Allows receiver transmitter to reply to external test interrogations.
	emergency condition within the group of aircraft. (The <b>MASTER</b> switch must be in <b>NORM</b> , then	OUT	Disables the <b>RAD TEST</b> features of the transponder.
	lifted and turned to <b>EMER</b> , therefore preventing the switch	STATUS ALT	Indicates that BIT or <b>MON</b> failure is due to altitude digitizer.
	from accidentally being in <b>EM</b> -	STATUS KIT	Indicates that BIT or MON failure

**ER**). The emergency reply consists

of a code 7700 in mode 3/A.

**STATUS KIT** Indicates that BIT or **MON** failure is due to external computer.

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
STATUS ANT	Indicates that BIT or <b>MON</b> failure is due to cables or antenna.	AUDIO	Enables aural and <b>REPLY</b> light monitoring of valid mode 4 inter-
MODE 4 CODE selector	When the IFF mode 4 computer is installed, mode 4 interrogations bypass the decoder in the RT and	LIGHT	rogations and replies. (Preferred position). Enables only <b>REPLY</b> light
	go directly to the crypto computer. In the crypto computer, the mode 4 interrogation signal is decoded and applied to the mode 4 recognition circuit. When a mode 4 complete concurrence exists, the mode 4		monitoring of valid mode 4 inter- rogations and replies.
	recognition circuit generates a signal to the mode 4 computer which, in turn, generates a mode 4 reply. The <b>REPLY</b> light on the IFF control unit comes on to indicate a mode 4 reply is being transmitted.		Placing the switch in the OUT position will disable mode 4 REPLY monitoring and IFF cau- tion on the caution/advisory panel.
ZERO	Zeroize code setting in computer.	OUT	Disables aural, <b>REPLY</b> light and caution monitoring of valid mode 4
Α	Selects mode 4 code setting for previous, present, or next period, depending on which crypto period		interrogations and replies.
	applies.	MODE 4 REPLY	Indicates that a mode 4 reply is transmitted.
В	Selects mode 4 code setting for previous, present, or next period, depending on which crypto period applies.	IDENT/ OUT/MIC	The <b>IDENT/OUT/MIC</b> switch is spring loaded to the <b>OUT</b> position. If <b>IDENT</b> operation is desired, the switch must be moved to the
HOLD	Retains mode 4 code setting when power is removed from transponder.		<b>IDENT</b> position momentarily. The <b>IDENT</b> pulse trains will be transmitted for approximately 30
MODE 4 TEST/ ON/OUT			seconds. The <b>MIC</b> position is not connected in this installation.
ON	Allows system to reply to mode 4 interrogations.	MODE 1 selector buttons	Selects mode 1 reply code to be transmitted.
OUT	Prevents reply to mode 4 interroga- tions.	MODE 2 selector buttons	Selects four-digit mode 2 reply code to be transmitted. (Located on the control panel or on the remote
TEST	Provides self-test for mode 4.		RT).
MODE 4 AUDIO/LIGHT /OUT		MODE 3/A selector buttons	Selects four-digit mode 3/A reply code to be transmitted.

3.22.3 Operation.

3.22.3.1 Starting Procedure.



When flying in a combat situation near friendly radar sites or in the vicinity of friendly fighter aircraft, the MODE 4 monitor switch must be in either the AUDIO or LIGHT position. This will enable the pilot to observe that the IFF is periodically responding to expected MODE 4 interrogations.

If the MODE 2 code has not been set previously, loosen two screws which hold MODE 2 numeral cover, and slide this cover upward to expose numerals of MODE 2 code switches. Set these switches to code assigned to helicopter. Slide numeral cover down and tighten screws.

- 1. MASTER switch STBY. NO-GO light should be on.
- 2. Allow 2 minutes for warmup.
- 3. MODES **1** and **3/A** CODE selector buttons -Press and release until desired code shows.
- 4. TEST, TEST/MON, and REPLY indicators -PRESS TO TEST. If MODE 1 is to be used, check as follows:
- 5. ANT switch DIV.
- 6. MASTER switch NORM.
- 7. M-1 switch Hold at TEST, observe that only TEST GO indicator is on.
- 8. M-1 switch Return to ON. If modes 2, 3/A, or M-C are to be used, check as follows:
- 9. M-2, M-3/A, and M-C switches Repeat steps 7. and 8.

#### NOTE

• Do not make any checks near a radar site or with **MASTER** control switch in **EMER**, nor with **M-3/A** codes 7500, 7600, or 7700 without first obtaining authorization from the interrogating station(s) within range of the transponder.

- The following steps can be done only with KIT/1A computer transponder installed.
  - 10. MODE 4 CODE switch A.
    - a. Set assigned test code in the KIT/1A computer transponder.
    - b. AUDIO-ON-OUT switch OUT.
    - c. **MODE 4 TEST-ON-OUT** switch Place to **TEST** and hold, then release.
    - d. TEST GO light ON, MODE 4 REPLY light off, KIT STATUS light off.
  - 11. When possible, request cooperation from interrogating station to activate radar **TEST** mode.
    - a. Verify from interrogating station that **MODE TEST** reply was received.
    - b. **RAD TEST** switch **RAD TEST** and hold.
    - c. Verify from interrogating station that **TEST MODE** reply was received.

**3.22.3.2 Normal Procedures.** Completion of the starting procedure leaves the AN/APX-100(V) in operation. The following steps may be required depending upon mission.

- 1. MODE 4 CODE selector switch A or B as required.
  - a. If code retention is desired, momentarily place the **MODE 4 CODE** selector switch to **HOLD** prior to turning the **MASTER** switch **OFF**.
  - b. If code retention in external computer is not desired during transponder off mode, place **MODE 4 CODE** selector switch to **ZERO** to dump external computer code setting.
- 2. ModeM-1, M-2, M-3/A, M-C, or MODE 4 switches Select desired mode.
- 3. I/P switch **IDENT** when required to transmit identification of position pulses.

#### 3.22.3.3 Emergency Operation.

#### NOTE

# **MASTER** control switch must be lifted before it can be switched to **NORM** or **EMER**.

During a helicopter emergency or distress condition, the AN/APX-100(V) may be used to transmit specially coded emergency signals on mode 1, 2, 3/A, and 4 to all interrogating stations. Those emergency signals will be transmitted as long as the **MASTER** control switch on the control panel remains in **EMER** and the helicopter is interrogated. **MASTER** control switch - **EMER**.

#### 3.22.4 Stopping Procedure.

#### MASTER switch - OFF.

#### 3.23 TRANSPONDER AN/APX-118 (IFF).

The CXP transponder set provides automatic radar identification, altitude, and surveillance reporting of the helicopter to all suitably equipped challenging aircraft, surface ships, and ground facilities within the operational, Line-of-Sight (LOS), range of the system. AN/APX-118 (V) receives RF interrogations through either or both of the helicopter's two transponder antennas. The reply to the interrogation is transmitted from the antenna that receives the strongest interrogation signal. The transponder provides all of the Mark XII IFF capabilities of Modes 1, 2, 3/A, C, and 4 with the capability to support future Mode 5 Level I and II operation. In addition, the transponder incorporates Mode S Level 2 capability. The CXP transponder receives, decodes, encodes, and transmits pulse radio signals that carry the identification of position (I/P) and IFF information to and from the aircraft. The transponder receives encoded altitude data from the helicopter's Air Traffic Control Radar Beacon System (ATCRBS) IFF Mark XII System (AIMS) barometric altimeter. The CXP transponder is also electrically interfaced (via existing wiring interconnection junction boxes) with the caution advisory panel system, the ICS, and the helicopter's landing gear by means of a WOW switch. The CXP IFF transponder has embedded cryptographic capability for secure IFF operation. The IFF operates by decrypting and authenticating encrypted interrogations and generating appropriate encrypted replies when the interrogations are judged valid. This internal capability resides on a Single Board Computer (SBC) card. Transponder operation is continuously monitored by BIT circuits. The transponder operates in any of the seven modes. The test feature activates the transponder self-test to verify operation by internally generating and sampling RF interrogation signals. Mode 1 provides a maximum of 32 possible combinations of discrete code replies, any one of which may be selected in flight by the pilot. The Mode 2 code is a preset four-digit number with a maximum code size of 12 bits for a total range of 4,096 possible combinations of discrete code replies, but only one is available and is normally present before operation. For this reason it is referred to as a 4096 code. Mode 3/A combines military identification Mode 3 with civilian Secondary Surveillance Radar (SSR) Mode A. Modes 3 and A are identical and used for Air Traffic Control (ATC) identification. There are 4,096 discrete reply codes, any of which may be selected in flight. Each code consists of 4 octal (0 through 7) digits. This number is entered manually by the flight crew at the direction of an ATC operator when flying under IFR and is typically set to 1200 when flying under VFR unless otherwise directed by ATC. Mode C provides encoded barometric pressure altitude information, generated from the AIMS altimeter to ground controllers when interrogated. Mode C is only available when Mode 3/A is operational. Mode 4 provides the secure mode of cooperative combat IFF. For Mode 4 operation, the IFF operational codes are loaded for two periods: A and B. The A or the B code positions hold the current time period's code while the other code position holds either the previous or the next time period's code. Received Mode 4 interrogation signals go directly to the embedded cryptographic computer and are decoded and applied to the Mode 4 recognition circuit. When a complete Mode 4 concurrence exists, the Mode 4 recognition circuit generates a signal to provide an encoded response to IFF codes A or B interrogations. When a Mode 4 reply is transmitted, a visual indication is provided on the remote control unit (RCU). The pilot can use the RCU to select an audio signal when a Mode 4 reply can not be made. This audio signal is supplied to the pilot through the ICS when a code A interrogation is received and the Mode 4 B position is selected and vise versa. An IFF caution on the caution advisory panel appears when there is an error, mode 4 codes are not loaded, malfunction in the Mode 4 reply operation, and the Mode 4 computer is not capable of responding to interrogation. A landing gear WOW switch is installed on the left main landing gear and is used in both the code hold function of the Mode 4 computer and also disables the Mode 4 reply transmissions when the helicopter is on the ground. The WOW switch is deactivated when the weight of the helicopter is on the landing gear. The Mode 4 codes are held in the transponder until the first time the helicopter becomes airborne. Thereafter, the Mode 4 codes automatically zeroize anytime power to the transponder is interrupted, unless the pilot activates the transponder HOLD function from the RCU. The Mode 4 codes can be manually zeroized by placing the code switch to **ZERO**. Mode S provides additional capabilities through a reply process that contains Differential Phase-Shift Keying (DPSK) modulated data fields in the interrogation messages and Pulse Position Modulation (PPM) data fields in the reply. The reply messages contain a digital 24-bit aircraft address identity and pressure altitude reported resolutions down to 25-foot increments (if the altimeter has this resolution). The helicopter is equipped with the AAU-32/A altimeter and thus can only report in minimum of 100-foot increments. Mode S uses a unique address for selective interrogations which provide surveillance benefits, improving aircraft identification, suppression of synchronous garbling, and relief from over-interrogation. The Mode S interrogator code (IC) uniquely identifies Mode S interrogators to lock out All-Calls once an interrogator acquires the transponder. With a mix of Modes S, 3/A, and C crowding the signal environment, the ground sensors must detect the aircraft irrespective of whether it is Mode S equipped or a Mode 3/A and C only aircraft. This is achieved by transmitting All-Call interrogations. Mode 3/A and C only aircraft reply with Mode 3/A and C, but Mode S aircraft reply with a Mode S message giving its 24-bit address and status information. Once the address has been determined by the interrogating station, the Mode S aircraft are individually interrogated from then on in Mode S only reducing RF clutter. The Mode S also provides unsolicited transmissions in the form of a "squitter." A squitter transmission is sent on a Mode S downlink (1090MHz) message, on average, once a second. The format is similar to that of an All-Call reply, consisting of 56 bits containing control, Mode S address and parity fields. The transmission rate is actually randomly distributed over the range 0.8 to 1.2 seconds. Extended squitter transmissions use the long Mode S 112-bit format used in the Mode S datalink via the Ground Initiate Comm B (GICB) protocol. It still contains the information in the conventional squitter but it also contains a 56 bit field for Automatic Dependent Surveillance Broadcasts (ADS-B) data. The basic data set transmitted from this transponder are: Modes 1, 2, 3/A, C and 4, Mode S address, on/off ground indicator and maximum cruising true airspeed data link capability report. There is also an emergency transponder reply provision. This mode of operation is activated by placing the MASTER switch to EMER **PULL**; the system is then interrogated. The emergency operation results in four short dashes on the interrogating radar indicator, which indicates an aircraft in distress and singles out the aircraft in an emergency condition within a group of aircraft. The emergency reply consists of a Mode 3/A code of 7700. The HOLD position retains the Mode 4 code settings when power is removed from the transponder. The identification of position or IDENT

feature permits the operator to transmit position identifying signals to all interrogating stations in Modes 1, 2, 3/A, C, and S. These signals are special pulses added to the standard reply codes. The modified codes are transmitted for a duration of 15 to 30 seconds each time the operator initiates the IDENT feature. Power for the transponder system (APX-118) is provided from the number 2 dc primary bus through a circuit breaker marked **IFF**.

# 3.23.1 Antenna.

CAUTION

When selecting upper or lower antenna on the transponder, the selection is only active for 10 seconds and then returns to diversity.

Flush-mounted antennas are installed on the top fairing between engine exhaust ports (Figure 3-1) and under the transition section behind the UHF-AM antenna. They receive signals of interrogating stations and transmit reply signals. The AN/APX-118 (V) is an IFF space diversity transponder, functioning to receive the RF interrogation from two antennas, and then transmit the reply via the antenna that received the stronger interrogation signal.

**3.23.2 Controls and Functions.** All operating and mode code select switches for transceiver operation are on the RCU AN/APX-118 (V) (Figure 3-74).

CONTROL/ INDICATOR

# **FUNCTION**

KEYPAD

Used to accomplish both directly implemented and menu-driven functions. Directly-implemented functions allow the operator to enable replies to the various modes of interrogation, initiate transponder IBIT and RCU BIT, enable verification bit #1 tests, and enable or disable the microphone key initiation of the I/P response (this function is disabled). Menudriven functions allow the operator to locate, select, modify, and store the settings and/or observe the status of menu items presented on the alphanumeric display.

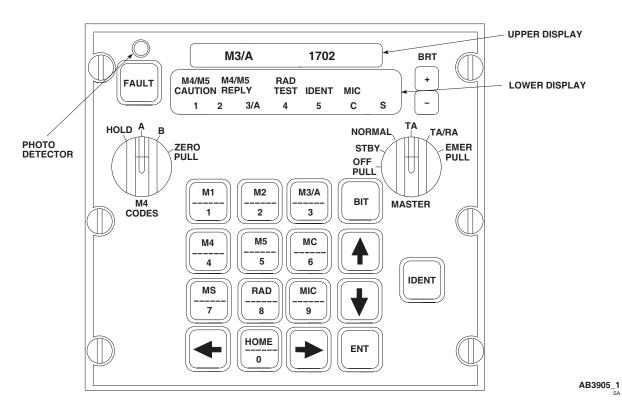
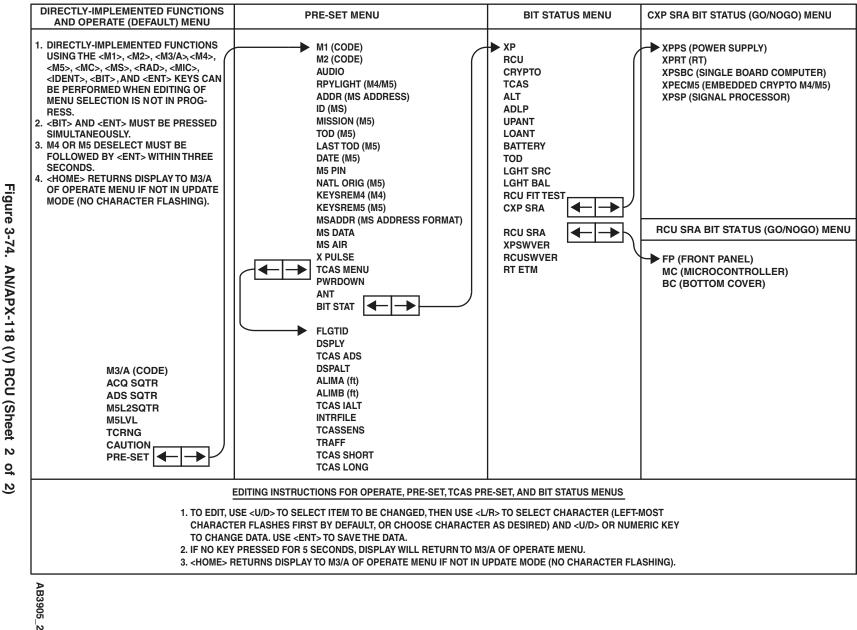


Figure 3-74. AN/APX-118 (V) RCU (Sheet 1 of 2)

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
MASTER switch	Controls the primary operating	ТА	Not connected.
	mode of the transponder equipment:	TA/RA	Not connected.
OFF PULL	Disables the transponder and RCU power supplies and transponder switched power output. The switch must be pulled out from the panel to allow movement from <b>STBY</b> to <b>OFF PULL</b> .	EMER PULL	The transponder is in the normal operating state with emergency operation in modes 1, 2, 3/A, and S enabled. The switch must be pulled out from the panel to allow movement to <b>EMER PULL</b> .
STBY	Power is applied to the transponder and is available at the switched power output. The transponder is in the standby operating state, and power-up initialization and PUBIT are performed.		
NORMAL	Transponder is in the normal operating state, with normal transponder functions enabled in the selected modes.		



AN/APX-118 (V) RCU l (Sheet

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
FAULT switch	Illuminates to indicate a system fault or when mode 4 codes are not loaded. Upon illumination of the	1, 2, 3/A, 4, 5, M/C, S	Illumination indicates that the generation of replies in that mode has been enabled.
	indicator, the NO-GO status of the failed equipment or mode is displayed. If more than one fault occurs, the display alternates between each fault, with each displayed for approximately three seconds. The <b>FAULT</b> switch is pressed to remove the currently displayed fault, and remains il- luminated until all faults are removed.	Upper display	The 12-character upper display normally displays the currently selected Menu Selection Identifier and where applicable, the cor- responding data in the entry field. The default selection identifier is the Mode 3/A selection of the operate menu. If transponder and RCU BIT or menu-invoked tests are not running, an inactivity time- out (no RCU operator input for 5
Photo detector	Detects ambient light conditions, precluding inadvertent dimming of warning and advisory indicators and alphanumeric display during daylight conditions. The sensor's three-second response prevents excessive display brightness changes that could otherwise occur in a dynamic lighting environment.		seconds) will return the display to this default display. If a parameter update is not in progress, pressing the <b>HOME</b> key will have the same effect. When transponder and RCU BIT is invoked during power-up or thereafter by the operator, "8888888888888" is displayed for three seconds, followed by the
Lower display	Provides mode select, advisory and warning indications when lit:		NOGO status of the equipment or modes (if any) that failed the tests. When the RCU functional interface
M4/M5 CAU- TION	Yellow warning indications when ht. Yellow warning indication of an absence of Mode 4/5 keys (code zeroized) with Mode 4/5 enabled, or a transponder failure to reply to valid Mode 4/5 interrogations under the following conditions:		test (FIT) is initiated, RCU-FIT- TEST is displayed, followed by a series of prompts directing the operator in the performance of the test. After the test is over, the results are displayed.
	Mode 4/5 is disabled; the transponder is in standby operation state; transponder Mode 4/5 computer, Mode 4/5 output video circuitry, or transmitter is defec- tive.	<b>BRT</b> switch	Used to increase or decrease the il- lumination level of the 12- character alphanumeric display, advisory and mode indicators. There are eight levels of adjust- ment from dimmest to brightest.
M4/M5 REPLY	Green advisory indicates that the rate of Mode 4 or Mode 5 inter- rogations has exceeded the		The current brightness level is retained when the RCU is powered down.
RAD TEST	threshold. Green advisory indicates that the Verification bit #1 has been selected.	M4 CODES switch	Allows management of stored cryptographic codes:
IDENT	Green advisory indicates that the I/P response interval is in progress.		

MIC Not connected.

CONTROL/ INDICATOR	FUNCTION
ZERO PULL	Activates the code zeroize func- tion. The switch will not move from <b>B</b> to <b>ZERO</b> unless it is first pulled out from the panel. When released, momentary action returns it to <b>B</b> .
В	Transponder uses Code B for the Mode 4 function.
Α	Transponder uses Code A for the Mode 4 function.
HOLD	Places transponder into a code hold mode for Mode 4 codes. This switch has a momentary action and returns to <b>A</b> when released.
<b>IDENT</b> switch	Activates the I/P function when pressed and released. MIC mode is disabled on the system.

# 3.23.3 Operation.

# 3.23.3.1 Starting Procedure.

### NOTE

- Do not use RCU keypad during 30 second warm-up cycle.
- During self-test portion of power up sequence, the transponder checks for presence of valid Mode 4 codes. If codes are not detected, **CRYPTO NOGO** and **CXP NOGO** fault will appear on the RCU upper display. The **IFF** caution will also illuminate. **WRA GO** on the R/T (Figure 3-75) will display a flashing pattern of 3 flashes on and off. Press the **FAULT** switch to clear the message. Press M4 button and then press the RCU **ENT** key to deselect M4. This will turn off the **IFF** caution and the **M4/M5 CAUTION**.

**MASTER** switch - **STBY**. RCU initiates power up self-test routine. After 30-second warm-up is complete, **WRA GO** on the R/T illuminates; **NO LINK** on the RCU extinguishes; no faults indicated with the **FAULT** switch.

# 3.23.3.2 Normal Operation.

- 1. M4 CODES selector switch As required.
- 2. Keypad (upper legend) Select desired mode: M1, M2, M3/A, MC, MS, or M4 as required.

# NOTE

Selection of the upper or lower antenna will persist for approximately 10 seconds and then automatically return to diversity (DIV) mode.

> a. If upper or lower antenna is desired: Enter Preset Menu on RCU by pressing and releasing  $\uparrow$  key, then  $\rightarrow$  key; then use the  $\uparrow$  and  $\downarrow$  keys to scroll to ANT. Select **UPANT** for the upper antenna or **LOANT** for the lower antenna. Press and release **ENT** on the RCU keypad to accept selection.

# NOTE

If Mode S is enabled, Mode 3/A and Mode C will not be enabled.

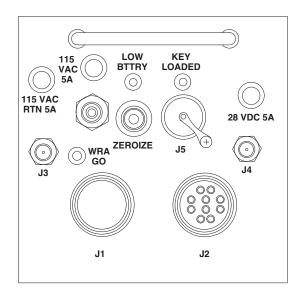
b. RCU **BIT** and **ENT** keys - Simultaneously press and release. RCU display indicators illuminate and **888888888888** is displayed for 1 second. No RCU **FAULT** or pop-up messages should indicate on upper display.

To enter M1 codes:

- a.  $\uparrow$  key Press; then  $\rightarrow$  key Press for M1.
- b. → key Press and release again to allow entering the M1 code. Enter code using the numeric keys on the keypad. This changes the selected value. The cursor automatically advances to the next digit to be updated once an entry has been made.
- c. **ENT** key Press and release to accept selection.

To enter M2 codes:

- a.  $\uparrow$  key Press; then  $\rightarrow$  key Press for M1.  $\downarrow$  key - Press and release for M2.
- b. → key Press to allow entering the M2 code. Enter code using the numeric keys



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# Figure 3-75. AN/APX-118 (V) R/T

on the keypad. This changes the selected value. The cursor automatically advances to the next digit to be updated once an entry has been made.

c. **ENT** key - Press and release to accept selection.

To enter M3/A codes:

- a. → key Press. This changes the selected value. The cursor automatically advances to the next digit to be updated once an entry has been made.
- b. **ENT** key Press and release to accept selection.

#### To select or deselect AUDIO:

- a.  $\uparrow$  key Press; then  $\rightarrow$  key Press for M1.  $\downarrow$  key - Press and release twice.
- b. Select AUDIO ON or OFF using the  $\rightarrow$  or  $\leftarrow$  keys.
- c. **ENT** key Press and release to accept selection.

To select or deselect RPLYLIGHT:

- a.  $\uparrow$  key Press; then  $\rightarrow$  key Press for M1.  $\downarrow$  key - Press and release three times.
- b. Select **RPLYLIGHT ON** or **OFF** using the  $\rightarrow$  or  $\leftarrow$  keys.
- c. **ENT** key Press and release to accept selection.
- 3. **MASTER** switch **NORMAL**. RCU initiates full cycle power up BIT. **WRA GO** on the R/T illuminates within 5 minutes. The **FAULT** switch on the RCU front panel should remain off.

# 3.23.3.3 Fault Codes.

POP-UP FAULT	DESCRIPTION
XP NOGO	Fault detected in R/T.
RCU NOGO	Fault detected in RCU.
CRYPTO NOGO	Mode 4 codes not detected.

POP-UP FAULT	DESCRIPTION
UPANT NOGO	Fault detected in upper antenna portion of system.
LOANT NOGO	Fault detected in lower antenna portion of system.
NO LINK	Communications fault detected between RCU and R/T.
BATTERY	CRYPTO internal low battery condition exists.

Do not make any checks near a radar site, or with **MASTER** switch in **EMER PULL**, or with M3/A codes 7500, 7600 or 7700, without first obtaining authorization from the interrogation station(s) within range of the transponder.

# 3.23.3.4 Emergency Operation.

# NOTE

The **MASTER** switch must be pulled out from the panel to allow movement to **EM-ER PULL**.

During a helicopter emergency or distress condition the AN/APX-118 (V) may be used to transmit specially coded emergency signals on mode 1, 2, 3/A and S to all interrogation stations. Those emergency signals will be transmitted as long as the **MASTER** switch remains in the **EMER PULL** position and the helicopter is interrogated. EMERGENCY code (7700) is displayed on the upper display anytime the transponder is operating in the Emergency mode.

# 3.23.4 Stopping Procedure.

If code retention is desired:

- 1. **M4 CODES** selector switch Pull and turn to **HOLD** then release (3-5 seconds).
- 2. M4 CODES selector switch A or B as required.
- 3. MASTER switch Pull and turn OFF.

If code retention is not desired:

- 1. M4 CODES selector switch Pull and turn to ZERO.
- 2. M4 CODES selector switch A or B as required.
- 3. MASTER switch Pull and turn OFF.

# 3.24 TRANSPONDER MODE 4 CRYPTO.

The AN/APX-118 transponder is equipped with a cryptographic circuit card that operates in conjunction with Mode 4. An **IFF** caution appears when a malfunction occurs in mode 4, mode 4 codes are not loaded or a crypto card that will prevent a reply when interrogated. The cryptographic circuit card operation is classified.

# 3.25 AN/APX-118 CRYPTOGRAPHIC LOAD.

# NOTE

- The KYK-13 Transfer Device must be in the off position before connecting or disconnecting. If this is not observed it is possible to corrupt or erase the crypto load.
- Crypto fill device must be pre-loaded with both A and B fills and the RCU switch must be in **STBY**.

Load mode 4 variables with KYK-13 as follows:

- 1. If previous mode 4 codes are loaded: zeroize the codes by pressing the **ZEROIZE** button on the R/T.
- 2. KYK-13 mode switch OFF/CHECK.
- 3. Connect the KYK-13 to the R/T J5 connector using key fill cable.
- 4. KYK-13 select switch Position 1.
- 5. KYK-13 mode switch **ON** and observe the red flash of the **GO** indicator.
- 6. KYK-13 mode switch OFF/CHECK.
- 7. KYK-13 select switch Position 2.
- 8. KYK-13 mode switch **ON** and observe the red flash of the **GO** indicator and the green **KEY LOADED** LED on the R/T. The LED will momentarily flash green, the **M4/M5 CAUTION** and the RCU **FAULT** switch will

extinguish, and the **IFF** caution will extinguish if the keys from both A and B have been loaded correctly.

- 9. KYK-13 mode switch OFF/CHECK.
- 10. Disconnect the KYK-13 and key fill cable from the R/T J5 connector.

# 3.26 TRANSPONDER COMPUTER KIT-1A/TSEC.

The transponder computer in the nose section of the helicopter operates in conjunction with mode 4. An IFF caution will appear on the caution/advisory panel when a malfunction occurs in mode 4 or the computer that will prevent a reply when interrogated. Mode 4 operation is selected by placing the MODE 4 switch ON, provided the MASTER switch is at NORM. Placing the MODE 4 switch to **OUT** disables mode 4. **MODE 4 CODE** switch is placarded ZERO, B, A, and HOLD. The switch must be lifted over a detent to switch to ZERO. It is springloaded to return from HOLD to the A position. Position A selects the mode 4 code for the previous, present, or next period depending on which crypto period applies and position **B** selects the mode 4 code for previous, present, or next period depending on which crypto period applies. Both codes are mechanically inserted by a code-changing key. The codes are mechanically held in the transponder computer, regardless of the position of the MASTER switch or the status of helicopter power, until the first time the helicopter becomes airborne. Thereafter, the mode 4 codes will automatically zeroize any time the MASTER switch or helicopter power is turned off. The code setting can be mechanically retained. With weight on the landing gear, turn the MODE 4 CODE switch to HOLD (only momentary actuation is required) and release. Mode 4 codes can be zeroized any time the helicopter power is on and the MASTER switch is not in OFF, by turning the CODE switch to ZERO. Power to operate the transponder computer is provided automatically when the AN/APX-100(V) is on. The transponder computer KIT-1A/TSEC operation is classified.

# 3.27 CRYPTOGRAPHIC COMPUTER KIT-1C.

The cryptographic computer uses electronic key loading. Key loading is accomplished by use of the KYK-13 Electronic Transfer Device per TM 11-5810-389-13&P. The Cryptographic Computer Kit-1C operation is classified.

#### 3.28 RADAR ALTIMETER SET AN/APN-209(V).

The radar altimeter set (Figure 3-76) provides instantaneous indication of actual terrain clearance height. Altitude, in feet, is displayed on two radar altimeter indicators on the instrument panel in front of the pilot and copilot. The radar altimeter indicators each contain a pointer that indicates altitude on a linear scale from 0 to 200 feet (10 feet per unit) and a second-linear scale from 200 to 1500 feet (100 feet per unit). An on/OFF/LO altitude bug set knob on the lower left corner of each indicator combines functions to serve as a low-level warning bug set control and an on/OFF power switch. The system is turned on by turning the LO control knob marked SET on either indicator clockwise from OFF. Continued clockwise turning of the control knob will permit either pilot to select any desired low-altitude limit as indicated by the LO altitude bug. Whenever the altitude pointer exceeds low-altitude set limit the LO altitude warning light will go on. Pressing the PUSH TO TEST HI SET control provides a testing feature of the system at any time and altitude. When the PUSH TO TEST control knob is pressed a reading between 900 feet and 1100 feet on the indicator and a reading between 900 and 1100 feet on the digital display and the OFF flag removed from view, indicates satisfactory system operation. Releasing the PUSH TO TEST SET control knob restores the system to normal operation. A low-altitude warning light, on the center left of the indicator, will light to show the word LO any time the helicopter is at or below the altitude limit selected by the low altitude bug. Each pilot may individually select a low-altitude limit and only his LO light will go on when the low-altitude is reached or exceeded. Loss of system power will be indicated by the indicator pointer moving behind the dial mask and the **OFF** flag appearing in the center of the instrument. If the system should become unreliable, the flag will appear and the indicator pointer will go behind the dial mask to prevent the pilot from obtaining erroneous readings. Flight operations above 1600 feet do not require that the system be turned off. The pointer will go behind the dial mask but the transmitter will be operating. Power to operate the AN/APN-209 is supplied from the No. 1 dc primary through circuit breakers marked RDR ALTM.

**3.28.1 Antennas.** Two identical flush-mounted radar altimeter antennas are on the cockpit section under the avionics compartment. One is for the transmitter and the other is for the receiver.

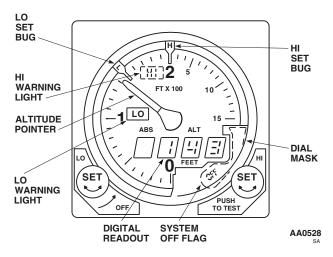


Figure 3-76. Radar Altimeter Set AN/APN-209(V)

**3.28.2 Controls and Functions.** Control of the radar altimeter set is provided by the **LOW SET OFF** knob on the front of the height indicator. The knob marked **HI SET** also controls the **PUSH TO TEST**. The function of each control is as follows:

CONTROL/ INDICATOR	FUNCTION OR INDICATION
LO SET knob	Power control turned counterclockwise to <b>OFF</b> , clockwise to on.
L bug	Sets altitude trip point of <b>LO</b> warning light.
H bug	Sets altitude trip point of <b>HI</b> warn- ing light.
HI SET knob	Pushing knob actuates built-in test system to self-test altimeter.
Altitude pointer	Provides an analog indication of absolute altitude from zero to 1500 feet.
Digital readout	Gives a direct-reading four-digit indication of absolute altitude from zero to 1500 feet.
LO warning light	Lights whenever dial pointer goes below $\mathbf{L}$ altitude bug setting.
HI warning light	Lights whenever dial pointer goes above $\mathbf{H}$ altitude bug setting.
OFF flag	Moves into view whenever altimeter loses track while power is applied.

# 3.28.3 Operation.

- 1. LO SET knob On.
- 2. L bug Set to 80 feet.
- 3. **H** bug Set to 800 feet.
- 4. Indicator pointer Behind mask above 1500 feet.
- 5. Track Operation. After about 2 minutes of warmup, the altimeter will go into track mode with these indications:
  - a. **OFF** flag Not in view.
  - b. Altitude pointer  $0 \pm 5$  feet.
  - c. Digital readout 0 to +3 feet.
  - d. LO warning light Will light.
  - e. HI warning light Will be off.
- 6. **HI SET** knob Press and hold. The altimeter will indicate a track condition as follows:
  - a. **OFF** flag Not in view.
  - b. Altitude pointer  $1000 \pm 100$  feet.
  - c. Digital readout 1000  $\pm$ 100 feet.
  - d. LO warning light Will be off.
  - e. HI warning light Will light.
- 7. **HI SET** knob Release. The altimeter will return to indications in step 5, Track Operation.

# 3.28.4 Stopping Procedure.

LO SET knob - OFF.

3.29 MISSION EQUIPMENT INTERFACE.

# CAUTION

The ECM antenna can be extended with the helicopter on the ground if the radar altimeter is turned off or removed from the installation, or the L (LO set) indicator is set below the radar altimeter indication.

Two signals are provided by the radar altimeter to the AN/ALQ-151(V)2 mission equipment. **RADAR** ALTIMETER ON indicates the altimeter is installed and

has power applied. If this signal is not present, and the ECM antenna is not fully retracted, a signal is generated to activate the ANTENNA EXTENDED caution on the caution/advisory panel. The other signal, RADAR ALTITUDE LOW, is sent to the mission equipment when the helicopter altitude drops below the LO bug setting of the radar altimeter. The signal initiates automatic retraction of the ECM antenna, activates the ANTENNA EXTENDED caution until the antenna is fully retracted, and disables the ECM ANTENNA switch.

# CHAPTER 4 MISSION EQUIPMENT

# Section I MISSION AVIONICS

#### 4.1 TROOP COMMANDER'S ANTENNA.

The troop commander's antenna, on the upper trailing edge of the tail rotor pylon, provides for use of a VHF/FM mobile/man pack radio, such as the AN/PRC-25 or AN/ PRC-77, from the cabin area. The antenna gives the troop commander the capability of liaison, command, and control of ground elements. A coaxial cable, coiled in the cabin ceiling near the left cabin door, is for connecting the antenna to the radio set.

#### 4.2 CREW CALL SWITCH/INDICATOR.

A CREW CALL switch/light (Figure 4-1) is on the instrument panel and in the cabin on the DF and ECM consoles. The switches are used to provide signals between crewmembers to indicate communication is desired and establishing ICS circuits between cockpit and cabin. When the pilot/copilot CREW CALL switch is pressed in, the light is steady. This allows only one-way communication, from pilot/copilot to mission equipment operator(s). All stations desiring to communicate must then place their respective intercom switches to ICS. To establish two- or three-way communications, the flashing switches must be pressed in. The pilot's ICS audio overrides all other mission equipment operator's audio. To establish communication from mission equipment operator(s) to pilot/copilot, the DF and/or ECM operator must press in their respective **CREW CALL** switch. The DF and/or ECM operator(s) CREW CALL switch(es) will light steady. The pilot/ copilot CREW CALL light flashes. When the pilot/copilot CREW CALL switch is pressed in, the switch lights steady, and communications can then be established. In establishing communications, the first CREW CALL switch pressed will light steady, all others will flash until pressed in. To terminate two-way communication, the pilot/copilot and mission equipment operator(s) must press

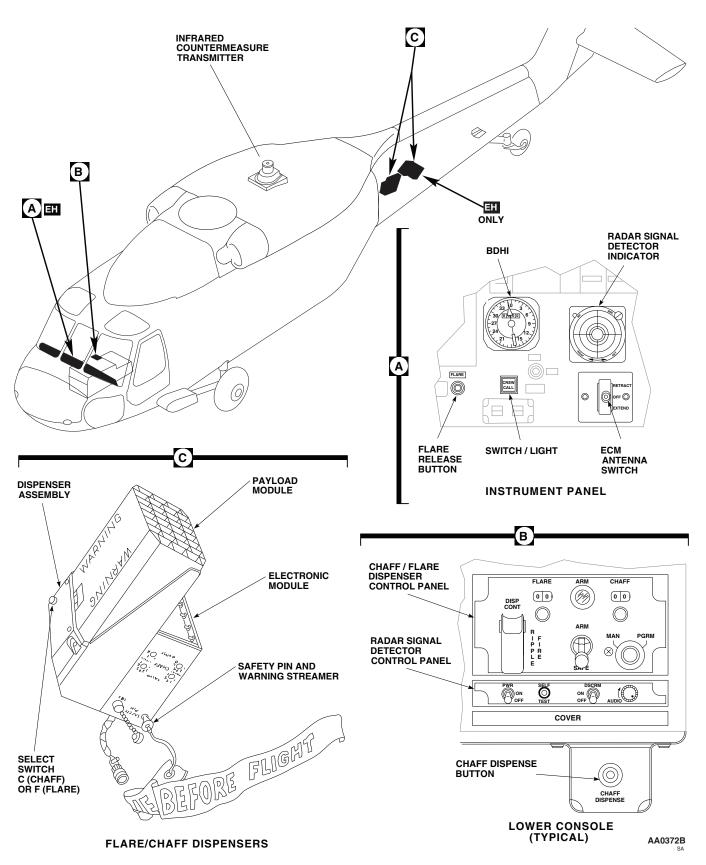
the respective **CREW CALL** switch(es), causing all indicators to go off. In terminating communications, **CREW CALL** switches pressed in must be pressed to release. Power to operate the **CREW CALL** system is provided from the No. 1 dc primary bus through a circuit breaker marked **LIGHTS ADVSY**.

# 4.3 CHAFF AND FLARE DISPENSER M130.

**4.3.1 Chaff Dispenser M130.** The general purpose dispenser M130 (Figure 4-1) consists of a single system (dispenser assembly, payload module assembly, electronics module and dispenser control panels) and a **CHAFF DISPENSE** button (on the lower console) designed to dispense decoy chaff, M-1 (refer to TM 9-1095-206-13&P). The system provides effective survival countermeasures against radar-guided weapon systems threats. The dispenser system, M130, has the capability of dispensing 30 chaff. Power to operate the chaff dispenser system is provided from the No. 1 dc primary bus through a circuit breaker marked **CHAFF DISP**.

**4.3.2 Flare Dispenser M130. E** The general purpose dispenser (Figure 4-1) consists of a single system dispenser assembly, payload module assembly, electronics module, and dispense control button (on the instrument panel), designed to dispense decoy flares M206. The system provides effective survival countermeasure against infrared sensing missile threats. The dispenser system has the capability of dispensing 30 flares. Power to operate the flare dispenser system is provided from the No. 1 dc primary bus through a circuit breaker marked **CHAFF DISP**.

**4.3.3 Controls and Function.** The dispenser control panel contains all necessary controls to operate the





dispenser system from the cockpit. The control panel is on the lower console. The function of each control is as follows:

CONTROL/ INDICATOR	FUNCTION
CHAFF counter	Shows the number of chaff cartridges remaining in payload module.
Chaff counter setting knob	Adjusts counter to correspond to number of chaff cartridges remain- ing in payload module.
PUSH-RESET	When pushed, resets chaff counter to "00".
<b>ARM</b> indicator light	Indicates that arming switch is at <b>ARM</b> , safety flag pin is removed, and payload module is armed.
ARM-SAFE	
switch ARM	Applies electrical power through safety flag switch to <b>CHAFF</b> <b>DISPENSE</b> button, and flare firing switch. Flare firing system is not used in this installation.
SAFE	Removes power from dispenser system.
UH FLARE counter	Not used in this installation.
UH Flare counter setting knob	Not used in this installation.
UH DISP CONT	Not used in this installation.
Mode selector	Selects type of chaff release opera- tion.
MAN	Dispenses one chaff cartridge each time dispense button is pressed.
PGRM	Dispenses chaff according to predetermined burst/salvo and number of salvos automatically.
CHAFF DISPENSE button	Ejects chaff cartridges from payload module.

# 4.3.4 Controls and Function. EI CONTROL/ FUNCTION INDICATOR

FLARE counter	Indicates the number of flare cartridges remaining in payload module.
Flare counter set knob	Adjusts counter to correspond to number of flare cartridges in payload module.
DISP CONT RIPPLE FIRE	Release (jettison) all flares from payload module without pressing <b>FLARE</b> switch for each flare.
FLARE switch (Instrument panel)	Fires one flare from payload module each time switch is pressed.

**4.3.5 Dispenser Assembly.** The dispenser assembly contains the breech assembly, C-F selector switch for either chaff or flares, a reset switch, and a housing containing the sequencer assembly. The sequencer assembly receives power through the firing switches circuit and furnishes pulses to each of the 30 contacts of the breech assembly, in sequential order 1 through 30, thus firing each of the impulse cartridges.

**4.3.6 Payload Module Assembly.** The payload module assembly consists of the payload module and retaining plate assembly. The payload module has 30 chambers which will accept chaff. The chaff cartridges are loaded through the studded end of the module, one per chamber, and are held in place by the retaining assembly. The payload module assembly is assembled to the dispenser assembly.

**4.3.7 Electronic Module Assembly.** The electronic module (EM) contains a programmer and a cable assembly which includes a 28-volt supply receptacle and a safety switch, actuated by inserting the safety pin with streamer assembly. The programmer consists of a programming circuit which allows the setting of chaff burst number, chaff burst interval, chaff salvo number, and chaff salvo interval.

CONTROL

**4.3.8 Electronics Module Controls.** Controls on the EM are used to program the chaff dispenser for predetermined release of chaff cartridges. The function of each control is as follows (refer to TM 9-1095-206-13&P):

**FUNCTION** 

SAFETY PIN	Safety switch to accept the safety pin with streamer, placing the dispenser in a safe condition when the helicopter is on the ground.
SALVO COUNT	Programs the number of salvos: 1, 2, 4, 8, or C (Continuous).
SALVO INTERVAL	Programs the time in seconds between salvos: 1, 2, 3, 4, 5, 8, or R (Random 2, 5, 3, 4, 3).
BURST COUNT	Programs the number of burst: 1, 2, 3, 4, 6, or 8.
BURST INTERVAL	Programs the time in seconds for burst intervals: 0.1, 0.2, 0.3, or 0.4

**4.3.9 Safety Procedures.** The safety pin shall be installed in the safety switch when the helicopter is parked.

# 4.3.10 Operation.

- 1. Counter(s) Set for number of cartridges in payload module(s).
- 2. Mode switch MAN.

# NOTE

Mode switch should always be at **MAN** when the **ARM-SAFE** switch is moved to **ARM** to prevent inadvertent salvo of chaff.

- 3. **ARM-SAFE** switch **ARM**. **ARM** indicator light on.
- 4. Dispense button press or mode switch **PGRM**, as required.

# 4.3.11 Flare Operation.

- 1. **FLARE** counter Set for number of flare cartridges in payload module.
- 2. ARM switch ARM.

3. **FLARE** switch (instrument panel) - Press for each release.

# NOTE

If the flare detector does not detect burning of the first flare fired, another flare is automatically fired within 75 milliseconds; if burning is still not detected, a third and final flare is fired. If all three flares do not fire, automatic ejection of flares will stop until the system is activated again by the **FLARE** switch.

# 4.3.12 Stopping Procedure.

# ARM-SAFE switch - SAFE.

# 4.4 BEARING, DISTANCE, HEADING INDICATOR (BDHI).

The BDHI (Figure 4-1) at the center of the instrument panel consists of three indicators. The position of the indicator allows easy viewing by both pilot and copilot. The functions of the indicators are as follows:

a. Compass Rose - displays the magnetic heading of the helicopter.

b. Bearing Pointer - displays bearing to the signal received from an airborne or ground emitter/transmitter. The DF operator selects signal to be displayed.

c. Distance Readout - displays, in kilometers, the distance to a signal emitter selected by the DF operator.

# 4.5 RADAR SIGNAL DETECTING SET AN/APR-39(V)2. ■

The radar signal detecting set indicates the relative position of search radar stations. Differentiation is also made between various types of search radar and tracking stations. Audio warning signals are applied to the pilot's and copilot's headsets. The radar signal detecting set is fed through the 50-ampere **LH MAIN AVIONICS** and **RH MAIN AVIONICS** circuit breakers on the copilot's circuit breaker panel and protected by the 7.5-ampere APR-39 circuit breaker on the copilot's circuit breaker panel. The associated antennas are shown in Figure 3-1. Refer to TM 11-5841-288-12.

**4.5.1 Controls and Function.** The operating controls of the AN/APR-39(V)2 panel (Figure 4-2) are as follows:

#### CONTROL **FUNCTION** MA indicator Lamp flashes when low band signals associated with missile guidance systems are correlated with high band signals associated with tracking systems. **BRIL** control Varies the brilliance of the alphanumeric symbology. Night-Day filter Varies the intensity of the red polarizing faceplate filter for day or night operation. If the IP-1150A is used in the aircraft, the day-night switch is not used as the IP-1150A is night vision compatible.

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#### Figure 4-2. AN/APR-39(V)2 Control Panel

CONTROL	FUNCTION
PWR ON	Supplies 28 vdc to the Radar Detecting Set. Fully operational after one minute.
PWR OFF	Turns system off.
HI ALT	Selects high altitude mode of operation. Selection is based on aircraft mission profile.
LOW	Selects low altitude mode of opera- tion. Selection is based on aircraft mission profile.
TEST	Initiates system self-test function when momentarily depressed downward. Permits flight line test- ing of Radar Detecting Set when held in the upward position. (Self test does not test antennas, antenna/receiver cabling.)
AUDIO	Controls level of audio output to the aircraft interphone control system. Turn to the right for audio volume increase. Turn to the left for audio volume decrease.
Direction/Display (Scope/IP-1150)	Shows alphanumeric symbology for signals programmed in the processor emitter identification table.

**4.5.2 Processor Unit.** The processor has a theater selection switch on the front of the processor. Selection of one of six theaters is possible depending on mission and geographical location.

#### 4.5.3 Self-Test Procedures.

a. The self-test confidence checks all AN/APR-39(V)2 circuits except antennas, high pass filters, and detectors in the high band receivers, bandpass filter and detector in the low band receiver, high low blanking circuits and antenna/ receiver cabling.

b. The radar detecting set performs a self-test sequence when the **TEST** switch on the control unit is set to **TEST** and then released. This self-test takes seven seconds, during which time four different patterns are displayed. The alphanumeric symbology that is displayed at the 12, 3, 6, and 9-o'clock positions will vary depending upon the selected theater switch on the processor.

c. In the self-test, four patterns will be displayed in sequence (Figure 4-3) on the display **MA**. Pattern number one alphanumerics displayed will depend on the selected theater position on the processor.

d. Observe that the radar signal indicator unit displays patterns 1-3 and finally, either the NO signal pattern or an actual threat pattern. As each of the first three patterns are displayed, a different type audio tone will flash on and off during the display of pattern number 3.

e. An **H** symbol will appear in the center of the NO signal pattern if the control unit **HI ALT/LOW** switch is

in the HI ALT mode. Conversely, an L symbol will appear in place of the H symbol if this switch is in the LOW mode.

f. The AN/APR-39(V)2 software version number is displayed at the 12-o'clock position on the display.

#### 4.6 RADAR SIGNAL DETECTING SET AN/APR-39A(V)1.

Refer to TM 11-5841-294-12.

CONTROL

4.6.1 Controls and Functions. The function of each control (Figure 4-4) is as follows:

**FUNCTION** 

PWR	Controls 28 vdc from the No. 1 dc primary bus.
ON	Locks the switch in the <b>ON</b> posi- tion. System is fully operational after approximately one minute. On power up, the synthetic voice will announce "APR-39 POWER UP". The plus (+) symbol will ap- pear and be centered on the IP 1150A cathode ray tube (CRT) (Figure 4-5) during system opera- tion. Refer to Figure 4-6 for specific software version numbers.
OFF	Turns system off. Switch must be pulled to unlock and turn system off.
TEST	When momentarily depressed initiates self-test confidence check (except for antennas and antenna receiver cabling). Refer to Figure 4-7 for CRT self-test display.
MODE	Selects synthetic voice message format only. <b>MODE 1</b> (up) selects normal voice message format. <b>MODE 2</b> (down) selects test/ abbreviated voice message format.
AUDIO	Controls volume to the interphone system.
Direction/Display (Scope IP 1150A)	Shows alphanumeric symbology on a bearing for each processed emitter signal. Does not indicate any range data.
MA indicator	Not used.

**FUNCTION** 

Not used.

MA switch **BRIL** control

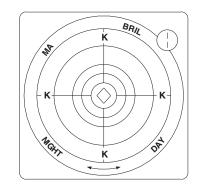
Varies brilliance of CRT.



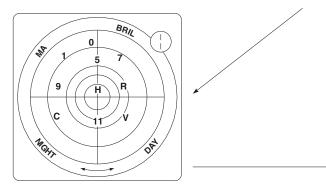
- · To prevent damage to the receiver detector crystals, assure that the AN/APR-39A(V)1 antennas are at least 60 yards from active ground radar antennas or 6 yards from active airborne radar antennas. Allow an extra margin for new, unusual, or high power emitters.
- · Excessive indicator display brightness may damage CRT.

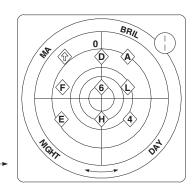
#### 4.6.2 Modes of Operation.

- 1. Self-test mode.
  - a. After power up, the AN/APR-39A(V)1 synthetic voice will announce "APR-39 POWER UP" and the (+) symbol will stabilize in the center of the CRT. Self-test should be initiated after approximately one minute. Self-test can be performed in MODE 1 or MODE 2. In MODE 1 the synthetic voice will announce "SELF-TEST SET VOLUME, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, ". In **MODE 2** the synthetic voice will announce "SELF-TEST SET VOLUME, 5, 4, 3, 2, 1".
  - b. The CRT will display specific software version numbers i.e., operational flight program (OFP) at the 12-o'clock position and the emitter identification data (EID) at the 6-o'clock position.
  - c. After the software version numbers have been displayed the test sequence checks the receivers. A good visual self-test will show two triangles, one at the 6-o'clock position and one at 12-o'clock position on the CRT. This is a normal indication and does not effect system performance.



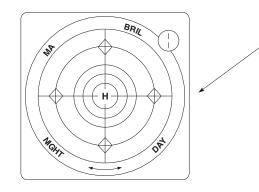






PATTERN NO. 2

PATTERN NO. 3



NO SIGNAL PATTERN

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Figure 4-3. Self-Test Patterns AN/APR-39(V)2



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#### Figure 4-4. AN/APR-39A(V)1 Control Panel

- d. A good self-test (no faults detected) ends with the message "APR-39 OPERATION-AL". A bad self-test (faults detected) ends with the "APR-39 FAILURE".
- MODE 1 operation. Selecting MODE 1 the operator will hear all the normal synthetic voice audio when an emitter has been processed e. g., the AN/APR-39A(V)1 will announce; "SA, SA-6 12-O'CLOCK TRACK-ING". Selection of this mode does not have any effect on emitters received, processed, or displayed; it only affects synthetic voice audio.
- 3. **MODE 2** operation. Selecting **MODE 2** the operator will hear an abbreviated synthetic voice audio e.g., the AN/APR-39A(V)1 will announce; "MISSILE 12-O'CLOCK TRACK-ING".

#### 4.6.3 Function.

a. The radar signal detecting set (RSDS) receives, processes, and displays pulse-type signals operating in the C-D and H-M radio frequency bands. The emitters that it processes and displays are derived from the EID contained in the user data module (UDM) that is inserted in the top of the digital processor. In normal circumstances the processor is classified confidential if a classified UDM is installed.

b. The UDM contains the electronic warfare threat data that makes up the specific library for a specific mission(s) or a geographical location (it is theaterized). When a match of the electronic warfare data occurs the processor

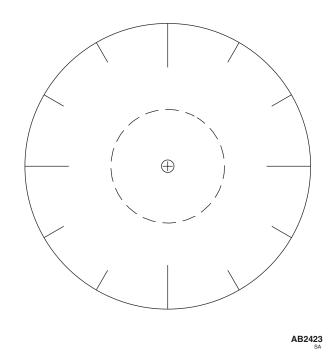
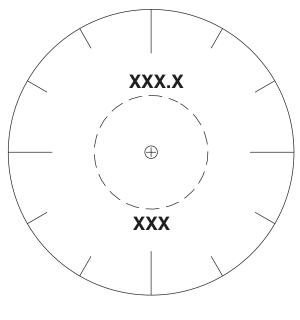


Figure 4-5. CRT Power Up Display

generates the appropriate threat symbology and synthetic audio. It is important therefore that the correct theaterized EID and UDM are installed for the mission or geographic location.

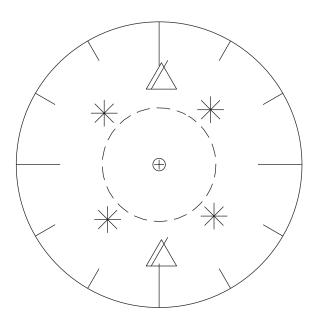
c. Symbol generation and position relative to the center of the CRT shows the threat lethality, it does not show or represent any lethality of range, but of condition/mode of the emitter. Highest priority threats (most lethal) are shown nearest the center. Each symbol defines a generic threat type; symbols are modified to show change in the status of the emitter. The symbols are unclassified, the definitions of what the symbols mean are classified. The complete set of symbols and definitions are contained in TM 11-5841-294-30-2. Each theaterized library EID has a specific classified pilot kneeboard produced with it. The unit electronic warfare officer (EWO) should contact PM-ASE if sufficient cards are not available within the unit for the installed EID.

d. The RSDS on specific helicopters has been interfaced with other helicopter survivability equipment. The equipment includes the AN/AVR-2 laser detection set, AN/APR-44(V) continuous wave receiver, and the AN/ AAR-47 missile warning system.



AB2425

Figure 4-6. CRT Version Number Display



AB2424

Figure 4-7. CRT Self-Test Display

#### 4.7 INFRARED COUNTERMEASURE SET AN/ ALQ-144A(V)1.

### WARNING

- Do not continuously look at the infrared countermeasure (IRCM) transmitter during operation, or for a period of over 1 minute from a distance of less than 3 feet. Skin exposure to countermeasure radiation for longer than 10 seconds at a distance less than 4 inches shall be avoided.
- Ensure the countermeasure set is cooled off before touching the unit.



Observe that the IRCM INOP caution appears when the OCU ON/OFF switch is set to OFF. After 60 seconds, observe that the IRCM INOP caution disappears.

The countermeasure system provides IRCM capability. The system transmits radiation modulated mechanically at high and low frequencies using an electrically heated source. A BIT feature monitors system operation and alerts the pilot should a malfunction occur. The system is made up of a control panel on the instrument panel, and a transmitter on top of the main rotor pylon aft of the main rotor. On helicopters Serial No. 78-22987 and subsequent, the countermeasure system functionally interfaces with the caution/advisory system through the left relay panel. The countermeasure system gets dc electrical power from the No. 2 dc primary circuit breaker panel and the No. 2 junction box. The 28 vdc is routed through the **IRCM PWR** circuit breaker in the No. 2 junction box to the transmitter. The No. 2 dc primary bus also supplies 28 vdc through the **IRCM CONTR** circuit breaker on the No. 2 dc primary circuit breaker panel to the control unit. Panel lighting of the control unit is controlled by the INSTR LTS NON FLT control on the upper console. When the control unit **ON-OFF** switch is placed **ON**, the power distribution and control circuits are activated. The source begins to heat, the servo motor and drive circuits are energized, turning on the high and low speed modulators, and a signal is applied to stabilize system operations before energizing the BIT function. After a warmup period the stabilizing signal is removed, and the system operates normally. Placing the ON-OFF control switch momentarily to OFF causes the power distribution and control circuits to de-energize the source and initiates a cooldown period. During the cooldown period, the servo motor drive circuits remain in operation, applying power to the motors that cause the modulators to continue turning. The **IRCM INOP** caution will appear. After the cooldown period, the power distribution and control circuits de-energize, all system operating voltage is removed and the **IRCM INOP** caution will disappear. If a system malfunction activates the **IRCM INOP** caution, the **IRCM INOP** caution appears until the control panel **ON-OFF** switch is momentarily placed **OFF**. The system can be returned to operating mode by momentarily placing **ON-OFF** switch **OFF**, then **ON**, provided the cause of the malfunction has cleared. For additional information, refer to TM 11-5865-200-12.

#### 4.7.1 Infrared Countermeasure System Control

**Panel.** Control of the countermeasure set is provided by the operator control panel on the helicopter instrument panel. A power **ON-OFF** switch is on the control panel. Power to operate the countermeasure set is supplied from the No. 2 dc primary bus through a circuit breaker marked **IRCM CONTR**.

**4.7.2 Controls and Function.** Controls for the AN/ ALQ-144 are on the front panel (Figure 4-1) of the control unit. The function of each control is as follows:

FUNCTION

CONTROL	
<b>ON-OFF</b> switch	Turns set on and off.
<b>IRCM INOP</b> caution	Indicates a malfunction has oc- curred or the countermeasure system is in cooldown cycle.

#### 4.7.3 Operation.

CONTROL

**ON-OFF** switch - **ON**.

#### NOTE

If the **IRCM INOP** caution appears, place the power switch **OFF**.

#### 4.7.4 Stopping Procedure.

**ON-OFF** switch - **OFF**. The transmitter will continue to operate for about 60 seconds during the cooldown cycle. **IRCM INOP** caution should appear during cooldown cycle.

#### 4.8 ECM ANTENNA SWITCH.

The ECM antenna switch is a three-position switch, on the instrument panel, providing control of ECM antenna deployment and retraction. The switch is spring-loaded to center (**OFF**) with positions marked **EXTEND** and **RETRACT**. Normal operation of the switch is as follows:



The ECM antenna can be extended with the helicopter on the ground if the radar altimeter is turned off or removed from the installation, or the L (LO SET) indicator is set below the radar altimeter indication.

a. Extend. When the helicopter is on the ground with all systems working properly and the radar altimeter L (LO SET) indicator is set above the radar altimeter indication, the antenna cannot be extended because of the interlock system. When the helicopter is in flight, with the copilot's radar altimeter indication above the L (LO SET) indicator, the antenna can be extended until it reaches the fully extended position, by momentarily placing the switch to EXTEND. Once the extension or retraction process has started, it cannot be overridden with another command from the ECM ANTENNA switch. The cycle can be interrupted by turning off the radar altimeter or setting L SET bug above radar altitude indication. When the antenna is fully extended, a light on the ECM operator's console, marked ANTENNA DEPLOYED, will go on. The ANTENNA EXTENDED caution on the caution/advisory panel will not appear when the antenna is extended. It is a condition caution rather than an antenna position caution.

#### NOTE

Automatic ECM antenna retraction is controlled by the copilot's radar altimeter L (LO SET) indicator when the altimeter is turned on.

b. Retract. If the antenna is extended, the pilot may momentarily select **RETRACT** to return the antenna to the retracted position. The antenna will automatically retract if the helicopter descends below the altimeter L indicator setting or a failure occurs in the radar altimeter. When the antenna is fully retracted, the **ANTENNA RETRACTED** advisory on the caution/advisory panel will appear and remain as long as the antenna stays in that position. The ANTENNA DEPLOYED light and ANTENNA EXTENDED caution should be off/disappear with the antenna retracted. An emergency retract switch accessible to the ECM operator may be used to retract the ECM antenna if a failure occurs in the cockpit retract system. A light next to the switch indicates when the antenna is extended.

c. Emergency ECM Antenna Retract Switch. An emergency ECM antenna retract switch on the antenna relay assembly on the ECM equipment rack, provides a backup mode of retraction of the antenna if a failure occurs in the cockpit **ECM ANTENNA** switch. To retract, the switch must be held at up until the antenna is fully retracted and the **ANTENNA RETRACTED** advisory appears.

### 4.9 COUNTERMEASURES SET AN/ALQ-156(V)2.

Countermeasure set AN/ALQ-156(V)2 consists of Receiver Transmitter RT-1220. Control indicator C-10031, and four each circular horn antenna AS-3650. Antenna locations are illustrated on Figure 3-1. The countermeasures set provides aircraft protection against infrared-seeking missiles by detecting valid targets and sending pulses to flare dispenser M130. Decoy flares are then launched away from the aircraft. Power to operate the countermeasures set is taken from the No. 1 dc primary and No. 1 ac primary buses through circuit breakers located on the copilot's circuit breaker panel.

**4.9.1 Basic Principles of Operation.** Incoming and outgoing radio frequency (RF) signals are routed between the circular horn antennas and the receiver transmitter through coaxial cables. The transmit signal is modulated and amplified in the receiver transmitter, and routed alternately to forward and aft antennas. After each pulse transmission, return signals are received by the same antenna used for transmission and routed to the receiver transmitter for processing. When an approaching missile is

detected, the countermeasures set sends a pulse to flare dispenser M130. If armed, the flare dispenser launches a decoy flare to draw the missile away from the aircraft.

#### 4.9.2 Controls, Displays, and Functions.



During takeoff, landing, and ground operations, the ALQ-156 POWER switch must be in the OFF position. Failure to comply may cause inadvertent release of flares resulting in personal injury or damage to equipment.

Control indicator C-10131, located on the instrument panel to the right of the **ECM ANTENNA** switch, contains controls and status indicators for system operation. The control indicator front panel is illuminated by integral lighting. Controls and indicator of C-10131 are described below:

CONTROL/ INDICATOR	FUNCTION
<b>POWER</b> switch	Places countermeasure set in oper- ate ( <b>ON</b> ) mode. The switch is a positive-locking type and cannot be accidentally shut off. The switch must be pulled out and then down to turn off the countermeasure set.
TEST FLARE switch	Tests ALQ-156/M130 systems and enables test flare launch in <b>ON</b> condition. The switch is a momentary depress-release type. It should be used only in conjunction with flare dispenser M130 test procedures.

CONTROL/	
INDICATOR	

PUSH FOR STANDBY STATUS pushbutton

#### FUNCTION

Places countermeasure set in standby or operate mode. When depressed, switch places system in standby mode and upper half of indicator shows STBY. In "out" position, switch places system in operate mode. During initial warmup, lower half of indicator shows WRMUP. After warmup, the indicator is blank to show that the system is on and ready for flare dispense.

**4.9.3 Operation.** The following procedures shall be followed to operate the countermeasure set:

# WARNING

- Do not stand within six feet of Aircraft Survivability Equipment (ASE), ALQ-156 and ALQ-162, transmit antennas when the ASE equipment is on. High frequency electromagnetic radiation can cause internal burns without causing any sensation of heat.
- When ALQ-156 POWER switch is ON, and the M130 Flare system is armed, a flare can be fired.
  - 1. M130 flare system **ARM/SAFE** switch **SAFE**.

#### NOTE

Prior to beginning the turn-on procedure, ensure that the push for standby pushbutton is in the "out" position (not depressed).

2. ALQ-156 **POWER** switch - **ON**. Observe that status indicator shows WRMUP, indicating that receiver transmitter is in warmup mode.

#### NOTE

The actual length of time that the WRMUP lamp remains on depends upon a combination of equipment operating status and environmental temperature. Under normal operating conditions, and with air temperature about 77°F (25°C), WRMUP lamp will go out in approximately 8 to 10 minutes.

- 3. Observe that WRMUP lamp goes out, indicating that the receiver transmitter is now in the on condition.
- 4. **PUSH FOR STANDBY/STATUS** pushbutton - Push once to place the countermeasure set in standby. Subsequent depressions switch the countermeasure set alternately from on to standby.
- 5. M130 flare system ARM/SAFE switch ARM.

**4.9.4 Stopping Procedure.** The following procedure shall be used to turn off the countermeasures set:

ALQ-156 POWER switch - OFF.

#### 4.10 COUNTERMEASURES SET AN/ALQ-162(V)2. ■

Countermeasures set AN/ALQ-162(V)2 consists of Receiver Transmitter RT-1377, Control Unit C-11080, and two each antenna AS-3554. Antenna locations are illustrated on Figure 3-1. The countermeasures set provides warning and protection against surface-to-air (SAM) and airborne interceptor missiles (AIM). Missile radar signals are detected by the system, modulated internally, and retransmitted as false, misleading echoes. Power to operate the countermeasures set is taken from the DC MON and No. 2 ac primary buses through circuit breakers located on the pilot's circuit breaker panel (Figure 2-20), refer to TM 11-5865-229-10.

**4.10.1 Basic Principles of Operation.** Incoming signals received from SAM and AIM missiles using continuous wave (CW) for guidance are validated by the countermeasures set. Depending upon validation results, the system initiates jamming action and/or warns the crew of approaching missiles. Automatic jamming/warning decisions are determined by warning and jamming thresholds pre-programmed in the system. The countermeasures set may be used in stand-alone fashion or in conjunction with AN/APR-39(V)2 Radar Warning Receiver (RWR). The RWR processes and displays threat information. A BIT automatically and continually tests systems operations. Malfunctions cause a no-go lamp to light in the control unit front panel. The countermeasures

set can be structured to counter different threats by programming the program module assembly in the front of the receiver transmitter. The programming is done before flight by the ground crew, as the receiver transmitter is not within operator reach.

**4.10.2 Controls, Displays, and Functions.** Located in the center of the lower console, Control Unit C-11080 contains controls and indicators necessary for countermeasures set operation. The control unit is described below:

#### CONTROL/ INDICATOR

### FUNCTION

**VOLUME** control Controls tone generator volume. A tone is generated in the aircraft headset immediately upon threat detection. **BIT** test switch Initiates automatic and continuous BIT of countermeasures set operations. Lamp test switch Tests lamp functions of WRMUP, NO GO lamps. Function switch Controls countermeasures set operation. **OFF** removes power from the set. STDY provides warmup power but does not enable transmit-receive circuits. RCV turns on the receiver for maintenance testing of antenna, sensing, and processing circuits. **OPR** provides full operational power to both receiver and transmitter. Warmup & No Go Indicates countermeasures set Lamps

status. WRMUP appears when unit is first turned on and goes out after approximately 3 minutes. NO GO will light if BIT operation detects a system failure.

#### 4.10.3 Operation.



When the countermeasures set is operating, electromagnetic radiation is present. DO NOT OPERATE if personnel are within six feet of transmit antennas. High frequency electromagnetic radiation can cause internal burns without causing any sensation of heat.

#### NOTE

A complete operational test consisting of a lamp test, operator-initiated BIT test, and a signal test is incorporated in normal operational procedures. The test shall be performed before flying any mission that requires use of the countermeasures set.

The following procedures shall be used to operate the countermeasure set under usual conditions: OPERATOR-INITIATED BIT TEST

#### NOTE

Before beginning step 1, turn control unit **VOLUME** control fully clockwise.

- 1. Control unit function switch **STBY**. Observe front panel and **WRMUP** lamps light. A tone should be heard briefly in the headset.
- 2. Lamp test switch Press and observe all four lamps light in pushbutton switch.

#### NOTE

If the countermeasures set has been without power for 30 seconds or more, a 3 minute warmup period is required. Do not attempt operation of the unit until warmup is successfully completed.

3. **WRMUP** lamp - Check that lamp goes out after 3 minutes.



The countermeasure set will radiate powerful, high-frequency electromagnetic energy when countermeasures set function switch is set to OPR. Ensure personnel are at least six feet from antennas while countermeasures set is in operate mode.

- 4. Control unit function switch OPR.
- 5. **BIT** switch Depress. A tone should be heard in the headset.

**4.10.4 Stopping Procedure.** The following procedure shall be used to turn off the countermeasures set: Control unit function switch - **OFF**.

#### 4.11 HEADS UP DISPLAY AN/AVS-7.

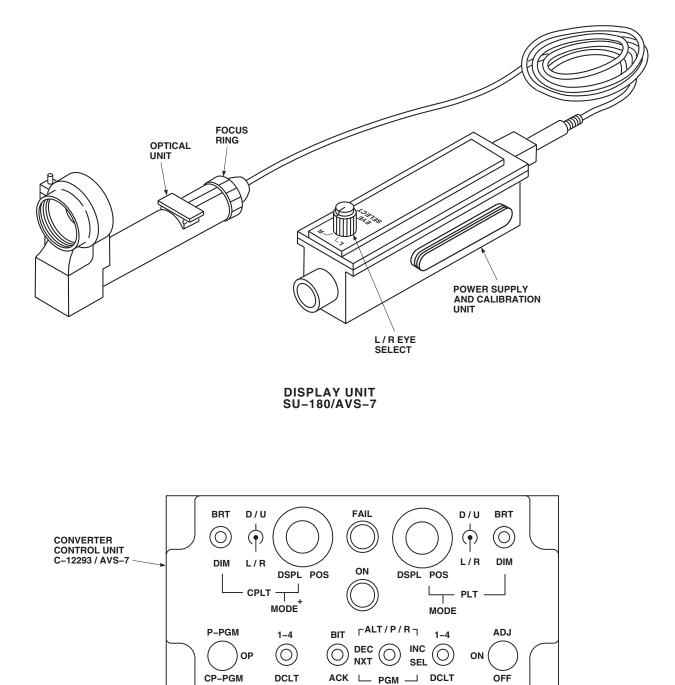
Heads up display (HUD) AN/AVS-7 (Figure 4-8) consists of signal data converter (SDC) CV-4229/AVS-7 located in the avionics compartment, the converter control unit (CCU) C-12293/AVS-7 located on the lower console, and the display unit (DU) SU-180/AVS-7 consisting of the optical unit (OU) and power supply calibration unit (PSCU). Two thermocouple amplifiers are located in the avionics compartment and two HUD control switches are located on the pilot's collective sticks. The HUD system serves as an aid to pilots using the AN/AVS-6 (ANVIS) during night flight operations by providing operational symbology information about the helicopter. There are two programming modes and one operational mode which allow both pilots to independently select the symbology for their respective display modes from a master set of symbols in the signal data converter. Power to operate the HUD system is provided by the 26 vac essential bus and the 28 vdc bus through circuit breakers marked HUD REF and HUD SYS.

4.11.1 Basic Principles of Operation. The pilots can independently select from four normal symbology modes and four declutter modes that are pre-programmed. Declutter mode has four vital symbols that will always be displayed: airspeed, altitude (MSL), attitude (pitch and roll), and engine torque(s). During operation adjust mode is used to adjust barometric altitude, pitch, and roll. If the HUD system loses operating power after adjustments have been made, the brightness, mode, barometric altitude, pitch, and roll must be adjusted as necessary. The system has three BITs. The first BIT occurs when the system is turned on and lasts approximately 4 seconds after which the FAIL light should extinguish. There is also a limited IBIT that is initiated by the operator when the BIT/ACK switch is placed in the **BIT** position for at least 4 seconds. The FAIL light illuminates until a successful test, then the test pattern in Figure 4-10 is displayed (the BIT will terminate with no pilot indications). The continuous BIT runs in the background during normal operations and will display faults as they occur. A failure of the SDC, or the pilot's DU will illuminate the CCU FAIL light and display a FAIL message on the DU. When a FAIL message is

displayed on the DU, the operator should acknowledge the failure and re-run BIT to confirm the fault.

**4.11.2 Controls and Functions.** The CCU, located on the lower console, and the control switches on the pilot's collective stick are controls and indicators necessary for HUD operation. The **EYE SELECT L/R** position is set when display units are connected prior to operation. A focus ring on the OU provides control for focusing the display. The OU is adjusted by the manufacturer and under normal conditions adjustment is not required. The function of each control is as follows:

CONTROL/ INDICATOR	FUNCTION
CPLT	
BRT/DIM	Copilot's control for display brightness.
DSPL POS D/U/ L/R	Copilot's control for display posi- tion down/up (outer knob) and left/ right (inner knob).
MODE 1-4/ DCLT	Copilot's mode select 1-4 and de- clutter switch.
PLT	
BRT/DIM	Pilot's control for display bright- ness.
DSPL POS D/U/ L/R	Pilot's control for display position down/up (outer knob) and left/right (inner knob).
MODE 1-4/ DCLT	Pilot's mode select 1-4 and declut- ter switch.
FAIL	Indicates a system failure.
ON	Indicates system ON.
ADJ/ON/OFF	Selects adjust mode, enabling the <b>INC/DEC</b> switch to adjust altitude, pitch, or roll. Turns power on or off to HUD system.
P-PGM/OP/CP- PGM	Selects pilot program mode, operational mode, or copilot program mode. Used with the <b>PGM NXT/SEL</b> switch.



AA9221B

Figure 4-8. Heads Up Display AN/AVS-7

CONTROL/ INDICATOR	FUNCTION	CONTROL	FUNCTION
BIT/ACK	Three-position toggle switch spring loaded to the center position. Selects IBIT when placed to <b>BIT</b>	MODE/DCLT	Allows pilot's to select respective display modes or declutter modes.
	for more than 4 seconds. Acknowledges displayed faults, completion of adjustment, or completion of the programming se-		o either ANVIS monocular housing. vitch on <b>PSCU</b> to <b>L</b> or <b>R</b> .
	quence when placed to <b>ACK</b> . After the switch is used to acknowledge a fault, a true fault will not appear until BIT is selected or power is cycled off then on.	ming modes and on system selected by th	<b>peration.</b> There are two program- e operational mode for the HUD e programming switch on the CCU. submode under the operational mode.
ALT/P/R DEC/	Active when adjust mode is	1. Pilot progr	ramming switch - Set to <b>P-PGM</b> .
INC	selected to decrease/increase altitude/pitch roll. When adjusting altitude (MSL) a momentary	2. Copilot p PGM.	programming switch - Set to CP-
	movement of the <b>INC/DEC</b> switch will change data in 5 feet incre- ments. When the <b>INC/DEC</b> switch		n (flight mode) switch - Set to <b>OP</b> . <b>ADJ/ON/OFF</b> switch to <b>ADJ</b> ).
	is held for one second data will change 10 foot increments. Pitch and roll change in increments of one degree.	programmable by the located on the lowe	<b>des.</b> Symbology display modes are ne pilots via the converter control er console. Modes are defined by er symbology menu (Figure 4-9 and
PGM NXT/SEL	Active when program mode is selected. Allows operator to pre- program the four normal modes and four declutter modes. Operator can select a flashing symbol for display and/or go to the next symbol. Once complete, operator	four declutter, can by be selected for displa switch on the pilot's c	ght display modes, four normal and y programmed for each user and can ay using the display mode selection collective control or on the CCU. The e has a minimum symbology display
	toggles the ACK switch to save programmed display.	a. Airspeed - No. 2	25.
		b. Altitude (MSL)	- No. 7.
	ntrols are described as follows:	A	
CONTROL	FUNCTION	c. Attitude (pitch a	nd roll) - Nos. 1, 5, 6, 20, 26.
BRT/DIM	Allows pilot's to control brightness of their respective displays.	d. Engine Torque(s	s) - Nos. 22, 23.

### Table 4-1. UH-60A/L Master Mode Symbology Display (HUD)

No.	Symbol	Source	Range/Description
1	Angle of Pitch Scale	HUD System	$\pm 30^{\circ}$ (10° units, tic marks flash when angle of pitch is > $\pm 30^{\circ}$ ).

No.	Symbol	Source	Range/Description	
2	Bearing to Waypoint - Pointer	Doppler	0 - 359° (cursor will invert "V" when helicopter is moving away from waypoint).	
3	Compass Reference Scale	HUD System	0 - 359° (10° units).	
4	Helicopter Heading Fix Index	HUD System	Fixed Reference Mark.	
5	Angle of Roll - Pointer	Copilot's Verti- cal Gyro/AHRU	$\pm 30^{\circ}$ (right turn moves pointer to right, pointer flashes > $\pm 30^{\circ}$ ).	
6	Angle of Roll - Scale	HUD System	$\pm 30^{\circ}$ (10° units).	
7	Barometric Altitude (MSL)	Air Data System	-1000 to 20,000 feet (set during adjustment mode).	
8	Adjust/Program Mode Message	HUD System	ADJ or PROG.	
9	OK/FAIL	HUD System	OK or FAIL.	
10	Velocity Vector	Doppler	0 - 15 knots/15 kilometers, 0 - 359°.	
11	Rate of Climb Pointer	Air Data System	$\pm 2000$ feet-per-minute (used with vertical speed scale, No. 15).	
12	Radar Altitude (AGL) - Numeric	Pilot's Radar Altimeter	0 - 1000 feet (0 - 200 feet, 1 foot units; 200 - 1000 feet, 10 foot units; disappears above 999 feet, and reappears below 950 feet).	
13	Minimum Altitude Warn- ing	Pilot's Radar Altimeter	Blinking square around symbol - No. 12, (set or pilot's low warning bug).	
14	Radar Altitude (AGL) Analog Bar	Pilot's Radar Altimeter	0 - 250 feet (disappears at 250 feet, reappears a 230 feet; digital readout symbol, No. 12).	
15	AGL, Vertical Speed - Scale	HUD System	0 - 200 feet/±2000 feet-per-minute.	
16	HUD Fail Message	HUD System	CPM, SDR, SDA, PS, PDU, CPDU, NAV, PGM; can be cleared from the display by select- ing ACK (see note).	
17	Trim (Slide Ball)	SAS/FPS Computer	$\pm 2$ balls (left/right).	
18	MST, MEM, HOOK Messages	Master Caution Panel	MST, MEM, HOOK cannot be cleared from the display by selecting ACK.	
19	Sensor, Engine, Fire, RPM Warnings	Master Warning Panel	ATT, ENG 1 or 2, FIRE, RPM; ATT can be cleared from the display by selecting ACK (see note). ENG, FIRE, and RPM cannot be cleared.	
20	Horizon Line (pitch, roll)	Copilot's Verti- cal Gyro/AHRU	Pitch: $\pm 30^{\circ}$ Roll: 0 - 359°.	
21	Display Mode Number	HUD System	<b>1N - 4N</b> for normal modes, <b>1D - 4D</b> for declutter modes.	
22	Torque Limits	Torque Transducer	0 - 150% Yellow ( > 100% ), (solid box) Red ( > 110% ) Thresholds (solid box flashes).	

No.	Symbol	Source	Range/Description	
23	Torque - Numerics	Torque Transducer	0 - 150% (flashes when engine torque separation is greater than 5% threshold) Maximum % torque split between cockpit panel and HUD is 3%.	
24	Ground Speed	Doppler	0 - 999 knots/0 - 530 km/h (dependent on Doppler).	
25	Indicated Airspeed	SAS/FPS Computer	30 - 180 knots (no symbol 30 knots and below, reappears at 32 knots).	
26	Attitude Reference Indica- tor	HUD System	Represents helicopter.	
27	Engines Temperature	Thermocouple Amplifers	0 - 999°C (0 - 755°C - 999°C, 1° units) Maxi- mum split between cockpit and HUD is $\pm 15^{\circ}$ .	
28	Distance to Waypoint	Doppler	0 - 999.9 km.	
29	Bearing to Waypoint - Numeric	Doppler	0 - 359°	
	NOTE: After <b>ACK</b> is used fault, the fault will not reap selected or power is cycled	pear until BIT is		
	NOTE: IBIT may be require ASN-128B display informat must be moving with the Al operating during the IBIT pr	tion. The helicopter N/ASN-128B		

#### Table 4-1. UH-60A/L Master Mode Symbology Display (HUD) (Cont)

#### 4.11.5 Operation.

#### 4.11.5.1 Starting Procedure.

- 1. ADJ/ON/OFF switch OFF.
- 2. Optical unit support clamps Installed on AN-VIS. Verify clamps can by rotated.

#### NOTE

Check surface of lens for cleanliness. Clean in accordance with TM 11-5855-300-10.

3. DU lens - Check.



Failure to remove the ANVIS neck cord prior to operation of the HUD may

## prevent egress from the helicopter in an emergency.

- 4. ANVIS neck cord Removed.
- 5. Optical unit Install on ANVIS. Attach optical unit to either monocular housing. Do not tighten OU clamp completely with thumbscrew at this time. The OU (display) may have to be rotated to horizon after the system is operating.

#### NOTE

The helmet may now have to be rebalanced.

6. EYE SELECT switch on PSCU - L or R.



The AN/AVS-7 system should not be used if the quick-release connector is not in working order.



To prevent damage to the AN/AVS-7 system, the CCU ADJ/ON/OFF switch must be OFF before connecting or disconnecting quick-release connector.

7. PSCU - Connect. Connect PSCU to quickrelease connector by rotating the connector engagement ring.



Keep the protective caps on the ANVIS whenever it is not in use. Operate the ANVIS only under darkened conditions.

#### NOTE

Ensure ANVIS operator procedures have been completed.

- 8. P-PGM/OP/CP-PGM switch OP.
- 9. **ADJ/ON/OFF** switch **ON**. System **ON** and **FAIL** lights illuminate and BIT will initiate automatically.
- 10. **FAIL** light Check. Light should go out after ten seconds. BIT is complete.

#### NOTE

- Allow one minute for display warmup. Display intensity is preset to low each time **ADJ/ON/OFF** switch is set from **OFF** to **ON**.
- If a fault is displayed in the DU, acknowledge fault and re-run BIT to confirm fault.

- 11. BRT/DIM switch As desired.
- 12. **DSPL POS** control As required. Center display in field of view.
- 13. Display aligned to horizon Check. Tighten OU clamp.

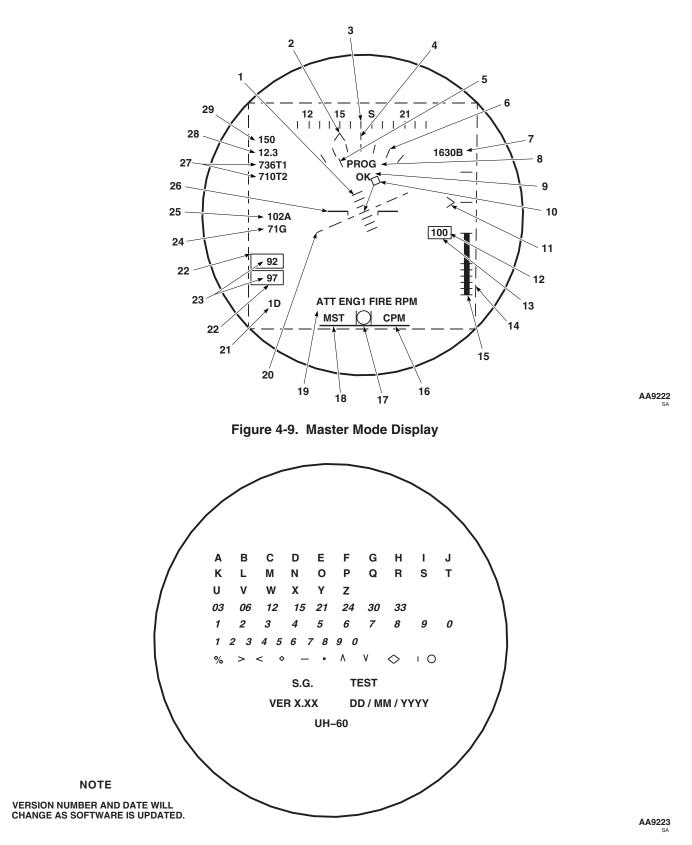
#### 4.11.5.2 Operator Self Test (BIT).

- 1. **BIT/ACK** switch Press to **BIT** and hold for a minimum of 4 seconds. The **ON** and **FAIL** light will illuminate. At end of BIT, **FAIL** indicator will extinguish.
- 2. BIT/ACK switch Release.

4.11.5.3 Displayed System Faults. The system self test is divided into power-up or operator initialized BIT and inflight BIT. The faults result as warnings and messages that blink at a rate of two per second in the display units. Part of the BIT is a periodic test that is performed automatically along with normal system operation. This BIT monitors and/or tests SDC functions and/or signals. A failure of the SDC, NAV signals pilot's DU, will illuminate the converter control FAIL light and display a FAIL message CPM, SDR, SDA, PS, NAV, PDU, or CPDU on the display unit. An attitude (ATT) sensor indication will be displayed when a gyro/AHRU invalid condition exits. ATT, NAV, PDU, CPDU, and all SDC faults can be cleared by setting **BIT/ACK** switch to **ACK**. The following helicopter status messages are also displayed.

- 1. The caption **MST** (first priority) indicates operation of the master caution warning lamp. This message will disappear during the rest of the main warning lamp operation.
- 2. The caption **MEM** (second priority) indicates that the Doppler data is not updated. A previous computed data is available. This message will appear simultaneously with the **MEM** lamp on the Doppler operating panel.
- 3. The caption **HOOK** (third priority) indicates the cargo hook is open. The message will appear simultaneously with the indication lamp in the cockpit.

Setting **BIT/ACK** switch to **ACK** will not clear **MST**, **MEM**, or **HOOK** status messages from the DU. Engine, **FIRE** and **RPM** warnings cannot be cleared from the DU. The faulty unit or warning must be removed from





the helicopter. When both engines fail at the same time, engine priority is: ENG 1 then ENG 2.

#### 4.11.5.4 Programming Procedure.

#### NOTE

The programming procedure for the pilot and copilot is identical except for the location of controls on the CCU.

- 1. Select mode to be programmed (**1N-4N**). The first mode that will appear is 1N (normal mode 1).
- 2. P-PGM/CP-PGM/OP switch P-PGM or CP-PGM.
- 3. **PROG** blinking in display Check. Verify that a complete set of symbology is displayed and attitude reference symbol is blinking. Verify **PGM** is displayed in the **HUD FAIL** message location for the DU not being programmed.
- 4. **BIT/ACK** switch **ACK** to program the full display or go to step 5 and select desired symbols.
- 5. **PGM SEL/NXT** control **SEL** to select symbol. Selected symbol stops blinking. If symbol is not desired, toggle switch to **NXT** and the symbol will disappear.

#### NOTE

All symbols have been programmed when the **PROG** annunciator is the only symbol flashing.

- 6. **BIT/ACK** switch **ACK**. (Hold switch to **ACK** for one second.)
- 7. **OK** displayed Check. (**OK** will be displayed for two seconds.)

#### NOTE

- If programming is not accepted, FAIL will be displayed. If a FAIL message is displayed, attempt to reprogram the same mode; if FAIL reappears notify maintenance.
- Declutter mode is recognized by flashing ground speed indicator in lieu of attitude reference symbology.

 MODE 1-4/DCLT - DCLT (1D-4D). The first DCLT mode that will appear is 1D (declutter mode 1).

#### NOTE

If **MODE 1-4/DCLT** switch is toggled to **DCLT** a second time, the display will cycle back to the **DCLT's** normal mode (**1N-4N**). The **MODE 1-4/DCLT** switch must be set to **MODE 1-4** to advance to another normal mode.

- 9. Repeat steps 4 through 7, for declutter.
- 10. MODE 1-4/DCLT switch As required.
- 11. Repeat steps 4 through 10 until all desired modes are programmed.
- 12. P-PGM/CP-PGM/OP switch OP.

### 4.11.5.5 Adjustment of Barometric Altitude, Pitch, and Roll.

### WARNING

An improperly adjusted barometric altimeter will result in an improperly set HUD barometric altitude display.

#### NOTE

Barometric altimeter should be set to the most current altimeter settings, field elevation.

- 1. Ensure **P-PGM/CP-PGM/OP** switch is in the **OP** position.
- 2. ADJ/ON/OFF switch Pull and set to ADJ.
- 3. ADJ blinking in display Check.

#### NOTE

Changes to barometric altimeter settings require a corresponding change to the HUD barometric altitude. Each .01 inch change in pressure equals 10 feet.

4. INC/DEC switch - As required.

- 5. BIT/ACK switch ACK.
- 6. Repeat steps 3 through 5 for pitch and roll.
- 7. ADJ/ON/OFF switch ON.

#### 4.11.5.6 Inflight Operation.



- Whenever the symbology displayed in the DU is suspected of being incorrect, the pilot's will compare the data with the helicopter instrument indicator and take the appropriate action.
- Excessive brightness of the symbology display may impair vision outside the cockpit.
- Interruption of electrical power, such as changeover from APU generator to NO. 1 and NO. 2 generators and vice versa, will cause DU to default to dim and MODE 1N. Any adjustments made to the barometric altitude, pitch, and roll prior to flight will be lost, thereby decreasing the accuracy of the barometric altitude, pitch, and roll.

#### NOTE

Software problems with version 1.70 may prevent the HUD from displaying information (groundspeed, distance to waypoint, bearing-to-waypoint numeric, bearing-towaypoint pointer, and velocity vector) from the AN/ASN-128B. An IBIT may be required to obtain AN/ASN-128B display information. The helicopter must be moving (ground taxi, hover taxi, etc.) with the AN/ ASN-128B operating during the IBIT process.

1. **BRT/DIM** switch - As desired.

#### NOTE

Whenever the symbology is interfering with the outside visibility, decluttering may be selected to remove symbology.

2. MODE 1-4/DCLT switch - As desired.

#### 4.11.5.7 System Shutdown Procedure.

- 1. ADJ/ON/OFF switch OFF.
- 2. Turn off ANVIS.



- CCU ADJ/ON/OFF switch must be OFF before connecting or disconnecting quick-release connector.
- Do not disconnect DU by pulling on the cable connected to the PSCU. The DU could be damaged or the cable may separate from the PSCU creating an explosive atmosphere hazard.
- Do not attempt to egress from the helicopter without performing disconnect as this may result in neck injury.



## Do not disconnect DU by pulling on the cable. To do so may damage the DU.

- 3. Display unit Disconnect. Disconnect DU by grasping the PSCU and rotating the quick-release connector engagement ring and pull downward. Remove OU and remove from the ANVIS and place into storage case.
- 4. Reattach neck cord to ANVIS.

#### 4.11.5.8 Emergency Egress.

a. The quick-release feature allows quick exit from the helicopter in an emergency without:

- (1) Damaging or turning the unit off.
- (2) Getting tangled in cords.

(3) Being restrained in the cockpit by hardwired connections.

(4) Removing ANVIS.

b. It is up to the operator to determine the desired mode of disconnect based upon his evaluation of the emergency

condition and whether or not the ANVIS goggles will be CONTROL/ **INDICATOR** needed following egress. The available means of discon-**FUNCTION** nect are as follows: AN-ALQ-156 (1) Release the ANVIS goggles from the helmet. CM JAM Lights if the AN/ALQ-156 is being jammed. (2) Disconnect the OU from the ANVIS goggles via the thumbscrew. Lights if the AN/ALQ-156 R/T **CM INOP** fails self-test. (3) Grasp PSCU and pull down. NOTE 4.12 ASE STATUS PANEL. Only a **NO GO** light will activate The ASE status panel (Figure 4-11) is designed to the ASE caution on the caution/ integrate several ASE indicator lights (for various ASE advisory panel and the MASTER systems installed) into one location and also tie those CAUTION. status lights to the MASTER CAUTION and the caution/ AN/ALQ-144 advisory panel. The status panel provides status lights for three ASE systems currently designated to be installed, **IRCM INOP** Lights if the AN/ALQ-144 R/T and two blank slots for expansion. fails self-test. **CONTROL**/ **INDICATOR FUNCTION** NOTE NO GO Lights if the AN/ALQ-162 R/T This condition will activate both fails self-test. the ASE caution on the caution/ advisory panel and the MASTER **CW THRT** Lights if the AN/ALQ-162 detects CAUTION. a CW threat radar. **CW JAM** Lights if the AN/ALQ-162 is being jammed.

#### NOTE

Only a **NO GO** light will activate the **ASE** caution on the caution/ advisory panel and the **MASTER CAUTION**.

ALQ 162	NO GO	ALQ-156	ALQ-144	
CW THRT	CW JAM	CM CM JAM INOP	IRCM INOP	

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### Figure 4-11. ASE Status Panel

#### 4.13 ARMAMENT SUBSYSTEM.

The subsystem is pintle-mounted in each gunner's window at the forward end of the cabin section (Figure 4-12). The two M60D 7.62 millimeter machine guns are free-pointing but limited in traverse, elevation, and depression field of fire. Spent cartridges are collected by an ejection control bag on the right side of the weapon. An ammunition can assembly is on the left side, refer to TM 9-1005-224-10. For information on the gun mount, refer to TM 9-1005-262-13.

#### 4.14 MACHINEGUN 7.62 MILLIMETER M60D.

The machinegun (Figure 4-13), is air-cooled, gasoperated, and automatic. It uses standard 7.62 mm ammunition (Table 4-2). Headspace is fixed to permit quick change of barrels. Designed primarily for operation in the air, the M60D has an aircraft ring-and-post sighting system. The weapon is pintle-mounted and is held by a quick-release pin. The weapon mount is on a rotating arm assembly which allows the weapon to be locked outboard in the firing position, or stowed inside the aircraft when the rotating arms are locked in the inboard position. It is easily removed from the helicopter and can be used for ground defense with the bipod extended. For more detail of the M60D refer to TM 9-1005-224-10.

**4.14.1 Controls.** Controls for the M60D are on the weapon and consist of: barrel lock lever, safety, cocking handle, cover latch, grip and trigger, and magazine release latch.

**4.14.1.1 Barrel Lock Lever.** The lever is at the right front of the receiver. It is attached to the barrel locking shaft and turns to lock or unlock the barrel assembly.

**4.14.1.2 Safety.** The safety (Figure 4-14), at the lower front of the receiver, consists of a cylindrical pin with a sear clearance cut which slides across the receiver to block the sear and prevent firing. The ends of the pin are marked **S** (safe) and **F** (fire). The exposed letter shows the operating state of the weapon.

**4.14.1.3 Cocking Handle.** The handle at the right front of the receiver is used to manually cock the weapon.

**4.14.1.4 Cover Latch.** The latch is at the right rear side of the cover assembly. When the latch is vertical, it locks the cover in the closed position. When moved to the horizontal, it unlocks the cover.

**4.14.1.5 Grip and Trigger Assembly.** The assembly at the rear section of the receiver includes the spade grips. The U-shaped trigger design permits the weapon to be fired by thumb pressure from either hand.

#### Table 4-2. Authorized Ammunition

7.62mm:	NATO M59, Ball
7.62mm:	NATO M61, Armor pierce
7.62mm:	NATO M62, Tracer
7.62mm:	NATO M63, Dummy
7.62mm:	NATO M80, Ball

**4.14.1.6 Magazine Release Latch.** The magazine release latch is on the left side of the receiver. The latch spring automatically locks when the ammunition box is seated on the magazine bracket. Pressing the release latch manually releases the ammunition box.

#### 4.14.2 Installation of Machinegun M60D.



The XM-144 (NSN 5340-01-389-7688) pintle mount stop must be installed in its proper position if the external stores support system (ESSS) is installed. The stop is a three-position stop: stow, wings only, and external tanks. The stow and wings only positions are independent of aircraft side. The external tanks position is particular to the aircraft side. Care must be taken to ensure the correct position and/or side is installed. Use of the M60D machine guns is prohibited when external ERFS tanks are installed on the inboard vertical pylon.

- 1. Install one machine gun M60D on the right side and one on the left side of the helicopter at the crew chief/gunner's stations.
- 2. Attach gun to pintle with quick-release pin and safety by passing a plastic tie or 0.032-in.

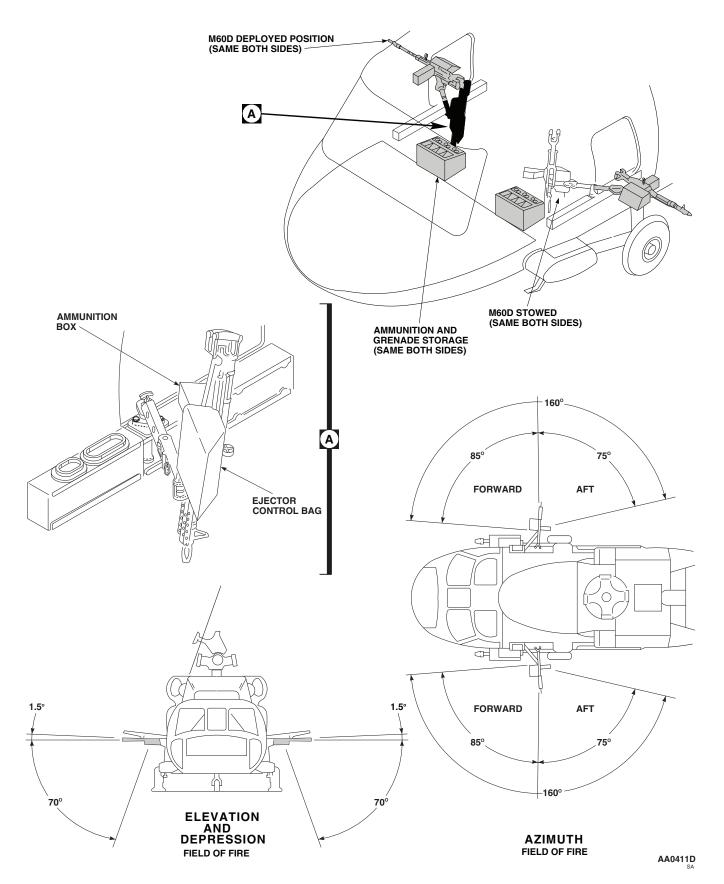


Figure 4-12. Machinegun M60D Installation

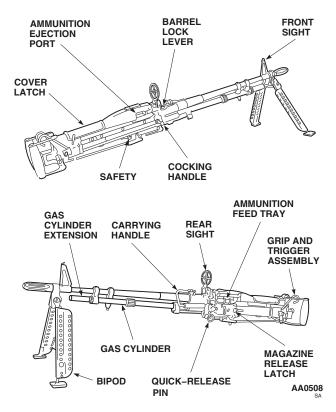


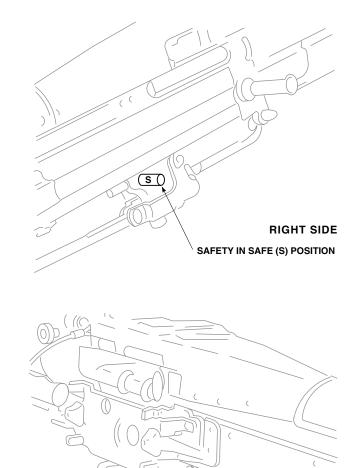
Figure 4-13. Machinegun 7.62 Millimeter M60D

safety wire through quick-release ring and around the pintle (Figure 4-15).

- 3. Check that each gun moves freely in azimuth and can be depressed.
- 4. Removal of gun is reverse of installation.

#### 4.14.3 Installation of Ejection Control Bag.

- 1. Position bag on right side of gun (Figure 4-16).
- 2. Position forward arm bracket of bag in front of matching forward mounting point on gun adapter. At the same time, press down on rear bracket safety latch. Slide bag basket rearward on mounting points and plate.
- 3. Position rear bracket of bag behind mounting plate on bottom of receiver.
- 4. Release latch to lock bag in place.



5. Check bag for positive attachment to gun.

Figure 4-14. Location and Identification of

Safety on Machinegun M60D

LEFT SIDE

SAFETY IS IN FIRING (F) POSITION

6. Removal of ejection control bag is reverse of installation.

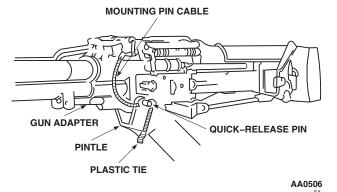
OF

#### 4.14.4 Installation of Ammunition Can Assembly.

1. Open release latch and install ammunition can assembly (Figure 4-17).

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TO INSTALL: POSITION MACHINE GUN MOUNTING BRACKET IN PINTLE AND SECURE WITH MOUNTING PIN





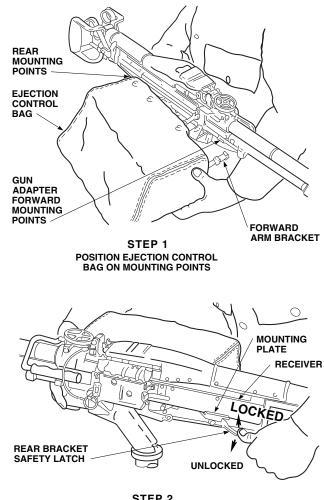
- 2. Check that latch makes positive lock, holding can in place.
- 3. Removal of ammunition can is reverse of installation.

#### 4.14.5 Loading Ammunition.



Observe all safety precautions for uploading ammunition in accordance with TM 9-1005-224-10.

- 1. With ammunition can installed, retract bolt fully.
- 2. Press safety button to (S) position.
- 3. Open latch and raise cover assembly.

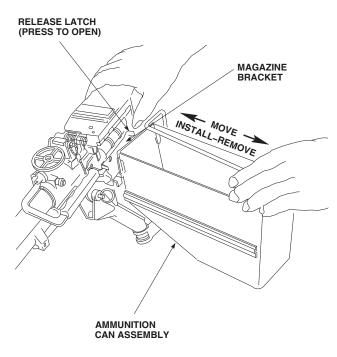


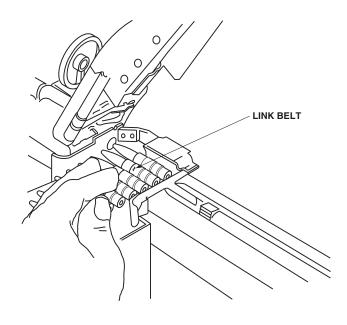


#### Figure 4-16. Installation of Ejection Control Bag on Machinegun M60D

4. Insert link belt with open side of links down on tray assembly (Figure 4-18).

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#### Figure 4-17. Installation and Removal of Ammunition Can on Machinegun M60D

5. Close cover and latch in place.

#### 4.14.6 Cocking Machinegun M60D.

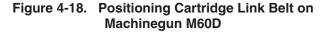


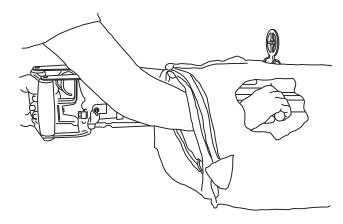
To prevent accidental firing, do not retract bolt and allow it to go forward if belted ammunition is in feed tray, or a live round is in chamber. Move cocking handle forward by hand.

1. Open ejection control bag and pull cocking handle fully to rear (Figure 4-19).



Cocking handle assembly must be returned to full forward (locked) before firing.





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## Figure 4-19. Charging (Cocking) Machinegun M60D

- 2. Move cocking handle full forward to locked position.
- 3. Press safety button to (S) position (Figure 4-14).



Do not fire machine gun unless the ejection control bag is mounted in place.

- 4. With machine gun M60D positioned, loaded and aimed, push safety button to firing (F) position.
- 5. To fire gun automatically, press trigger fully and hold. Refer to Figure 4-12 for field of fire.

#### NOTE

When ammunition is exhausted, the last link will remain in tray assembly. The link assembly can be removed by hand after the cover assembly is opened for loading.

 Low cycle rate of fire of machine gun M60D allows firing of single rounds or short bursts. Trigger must be completely released for each shot.

#### 4.14.7 Firing Malfunctions.



If a stoppage occurs, never retract bolt assembly and allow it to go forward again without inspecting chamber to see if it is clear. Such an action strips another cartridge from belt. If an unfired cartridge remains in the chamber, a second cartridge can fire the first and cause injury to personnel and/or weapon damage.

a. Misfire. This is a complete failure to fire. It must be treated as a hangfire until this possibility is eliminated.

b. Hangfire. This is a delay in functioning of the propelling charge. Time intervals set out in paragraph 4.14.8 must be observed after a failure to fire.

c. Cookoff. This is firing of the chambered cartridge from a hot barrel. A cookoff may occur from 10 seconds to 5 minutes after cartridge has been in contact with barrel.

d. Runaway Gun. If gun continues to fire after trigger has been released, grasp belt, twist and break belt, allow-

ing the gun to run out of ammunition (usually when the belt is broken only 3 to 5 rounds will remain).

#### 4.14.8 Failure to Fire Procedure.

- 1. If a stoppage occurs, wait 5 seconds. Pull handle assembly to rear, making sure operating rod assembly is held back.
- 2. If cartridge ejects, return handle assembly forward, re-aim machine gun and attempt to fire. If machine gun does not fire, it must be cleared.
- 3. If cartridge does not eject, retract bolt assembly. Move safety button to SAFE (S), position. Remove ammunition and links and inspect receiver assembly. Move safety button to FIRING (F) and attempt to fire. If cartridge does not fire and barrel is considered hot enough to cause a cookoff (200 rounds fired within 2 minutes), wait 15 minutes with bolt assembly in forward position. Remove cartridge and reload. If weapon is not hot enough to cause a cookoff, disregard 15-minute wait.

#### 4.14.9 Extracting a Ruptured Cartridge Case.

Position ruptured cartridge case extractor in chamber. Run cleaning rod through barrel assembly from muzzle end. Tap cleaning rod against extractor until extractor and ruptured cartridge case come out of chamber.

**4.14.10 Double Feeding.** When a stoppage occurs with bolt assembly in forward position, assume there is an unfired cartridge in chamber. Treat this as a hangfire (paragraph 4.14.7).

**4.14.11 Unloading.** Raise cover assembly and remove linked cartridges. Inspect chamber.

**4.14.12 Ammunition.** Ammunition for the machine gun is connected to form a link belt; the rounds are used to hold two links together. When a round is fired, the cartridge and link separate and is contained in the ejection bag assembly. Ammunition stowage in the cabin has compartments for six grenades and extra rounds of ammunition.

### 4.15 VOLCANO MULTIPLE MINE DELIVERY SYSTEM.

The volcano system is an automated, scatterable mine delivery system that is capable of launching mines from the helicopter. The system can dispense mines during day/ night and all weather conditions. The system can lay a mine field of up to 960 mines at an average density of 0.9 mines per meter front. For a more detailed description of the volcano system, refer to TM 9-1095-208-13&P.

#### NOTE

The forward two-thirds of the cabin entry/ exit doors are restricted by the volcano system making the loading and unloading of passengers and cargo more difficult. Internal loads should be planned accordingly.

4.15.1 System Components. The volcano system consists of five major components: dispenser control unit (DCU), launcher racks, jettison system, aircraft mounting hardware, interface control panel (ICP) and ammunition mine canisters.

4.15.1.1 DCU. The DCU (Figure 4-20) is the primary electronic component and houses the electronics that control the system and contains a control panel for operating the system. An ICP is provided to connect the applicable controls to the DCU. The DCU controls firing signals to the canisters and conducts BIT of the entire mine dispensing system. The DCU is the main operator interface for the system. On the DCU TOP panel, the operator controls the system with the following controls:

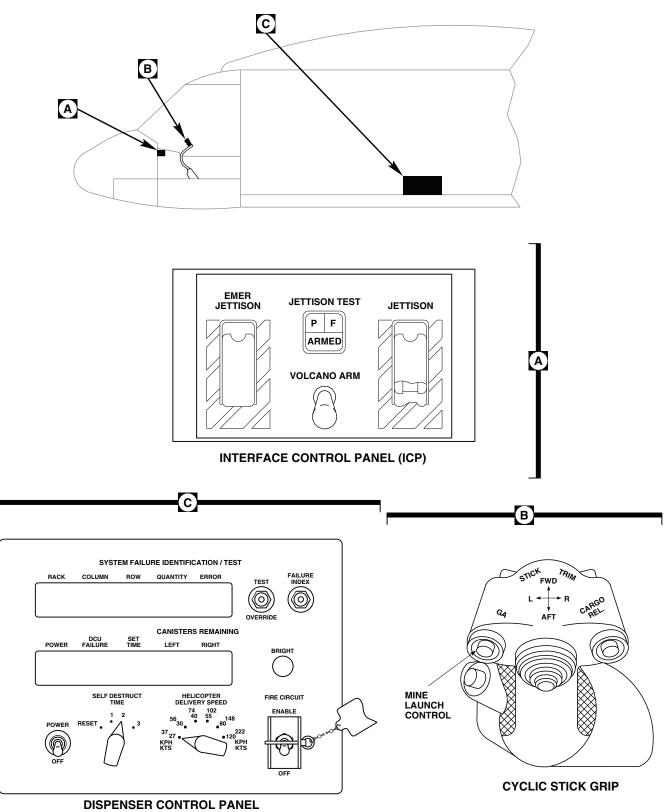
- 1. POWER switch.
- 2. SELF DESTRUCT TIME control.
- 3. HELICOPTER DELIVERY SPEED control.
- 4. FIRE CIRCUIT ENABLE switch.
- 5. **DIM** control.
- 6. FAILURE INDEX switch.
- 7. TEST/OVERRIDE switch.

From the DCU panel the operator also oversees system SYSTEM with the FAILURE status IDENTIFICATION/TEST displays. Power to operate the volcano system is provided from No. 1 dc primary bus through the CMD CSL SET circuit breaker.

4.15.1.2 Launcher Rack Jettison System. The jettison system consists of an interface panel, emergency and primary jettison circuits, and explosive cartridges. Jettison capability is provided for upper and lower launcher racks on each side of the helicopter. The one shot jettison circuits are independent of each other and either may be used to jettison the launcher racks. Upon activation of JETTISON or EMER JETTISON, the lower racks on each side will separate from the helicopter. After a lower racks away signal is received by the upper racks, the upper racks will automatically jettison. The EMER JETTISON is a backup for the JETTISON and provides the same launcher rack jettison function on an independent circuit. When the helicopter is on the ground, the WOW switch disables the jettison circuits to prevent unintentional jettisoning of the racks. Power for the jettison system is provided from the dc essential bus through the ESSS JTSN OUTBD and ESSS JTSN INBD circuit breakers. Power for emergency jettison is supplied by the battery.

4.15.1.3 Interface Control Panel. Controls and indicators for the ICP are on the control panel and are as follows:

CONTROL/ INDICATOR	FUNCTION			
EMER JETTISON/ JETTISON switch	Jettison all launcher racks with canisters.			
VOLCANO ARM switch	Arms system.			
<b>ARMED</b> light	Illuminates when <b>VOLCANO</b> <b>ARM</b> switch is pulled out and moved up if canisters are loaded and system is enabled. Light will go out when switch is pulled out and moved down.			
Flashing <b>ARMED</b> light	Indicates arm enable or launch switch error (GA) or all canisters have been dispensed.			
JETTISON TEST/ ARMED switch indicator	Press to start/stop jettison system self-test.			
Р	Illuminates if jettison system passes test.			
F	Illuminates if jettison cartridges are missing.			
Flashing <b>F</b>	Indicates one of the following malfunctions:			
	-WOW switch.			



(ON HELICOPTERS EQUIPPED WITH M-139 MINE DISPENSER KIT)

AA9411C



#### CONTROL/ INDICATOR

#### **FUNCTION**

#### -EMER JETTISON switch.

#### -JETTISON switch.

-Missing rack sensor(s).

#### NOTE

**VOLCANO ARM** function is independent of **EMER JETTISON** and **JETTISON** function.

#### 4.15.2 Volcano Operational Check.



This operation will be completed only when helicopter is on the ground.

#### NOTE

- If, for any reason prior to a mission, DCU is turned **OFF** or loses power, redo steps 2 through 5.
- DCU must warm up for two minutes prior to mine laying operation.
- DCU will not function if backup hydraulic pump is in operation.
  - 1. Install mine canisters (TM 1-1520-237-23).
  - 2. Toggle DCU **POWER** switch to **POWER**. BIT runs automatically. **POWER** indicator displays **ON**. Other indicators display 8s or 88s except **DCU FAILURE** display, which will flash **F**. All displays, except for **POWER** are then blank (Figure 4-21).
  - 3. Displays automatically go blank followed by 88s being displayed in left and right **CANISTERS REMAINING** displays. If an error code appears in **ERROR** display, refer to TM 9-1095-208-13&P.

#### NOTE

The following assumes a full canister load. Any load other than 80 canisters each side should result in the number of canisters loaded being displayed instead of 80 after overriding the applicable number of error code "9s" for empty canister slots.

4. Toggle **TEST/OVERRIDE** switch to **TEST**. Canister test is initiated. Canister test is complete when 80s are displayed in **CANISTERS REMAINING** readout and no error code appears. If an error code appears in **ERROR** display, refer to TM 9-1095-208-13&P.

#### NOTE

Error codes 5, 8, and 9 may be overridden. Refer to TM 9-1095-208-13&P.

### WARNING

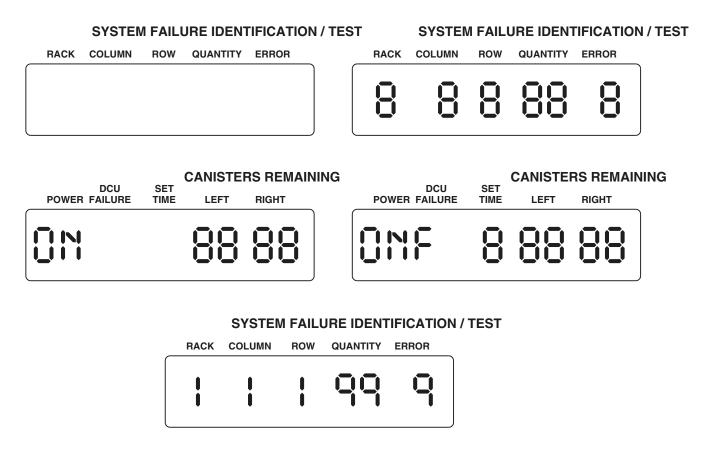
Check SET TIME display to make sure number set with dial is displayed in indicator, otherwise, mines may be launched with a false self-destruct time.

- 5. SELF-DESTRUCT TIME indicator flashes after 15 seconds. Set self-destruct time by turning SELF-DESTRUCT switch to RESET position for minimum of two seconds, and then to the desired 1, 2, or 3 setting. The set time display must agree with SELF-DESTRUCT switch position. If not, repeat procedure. If wrong indication appears again, postpone mission and return to maintenance.
- 6. Repeat step 5. to reset or change the self-destruct times.

#### NOTE

If flashing **1** continues to appear in DCU indicator, repeat setting self-destruct time.

7. Set planned dispensing helicopter ground speed with **HELICOPTER DELIVERY SPEED** knob on DCU.



501	CANISTERS REMAINI			NING
DCU POWER FAILURE	SET TIME	LEFT	RIGHT	
		80	80	

(SEE NOTE)

NOTE

READOUT IF NO CANISTERS ARE INSTALLED.

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Figure 4-21. Volcano System DCU Displays

#### 4.15.3 Arming Canisters.

### WARNING

Do not walk or stand in front of launcher racks when racks are loaded and arming levers are locked in armed position.

#### NOTE

- Green latching levers must be in locked position before red arming levers are moved to armed position.
- Verify red arming levers are fully forward to the arm (lock) position by pushing back levers without depressing plungers.

Mechanically arm one row of canisters at a time as follows:

- 1. Individually seat each canister of the five canisters in a row by pushing canisters in and up into rack keyholes. Canisters should be loaded top to bottom back to front.
- 2. Depress plunger on red arming lever with thumb and pull lever towards personnel. When lever begins to move, release thumb from plunger. When lever reaches locked position (about 45°) plunger will click out. Push inboard to ensure lever has locked (Figure 4-22).
- 3. Repeat steps 1 and 2 for all racks.
- 4. Remove all eight jettison system **REMOVE BEFORE FLIGHT** safety pins from each side panel.

#### NOTE

When operating the helicopter configured with the volcano system at high gross weight and high airspeeds, the pilot may encounter intermittent lateral tail pulse "tail shake". The intensity of the tail shake is further aggravated by left sideslip.

- 5. Lift off and proceed to designated target.
- 6. Prior to reaching target area, remove safety pin and place the DCU **VOLCANO ARM** switch

on the ICP in **ARMED** position. (Pull **VOLCANO ARM** switch out and lift up.)

#### 7. FIRE CIRCUIT switch to ENABLE.

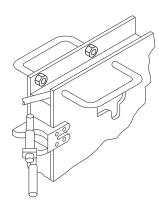
**4.15.4 Mine Launch Control.** Launching of mines is controlled by buttons on the pilot's cyclic control marked **GA**. When the system is in an armed condition, pressing and releasing either **GA** button will start the launch sequence. If mines are being launched, press and release either **GA** button to stop mine launching. In addition to pressing the **GA** button to stop mine launch, the **VOLCANO ARM** switch may be moved to off (down) position or the **DCU FIRE CIRCUIT** switch may be placed **OFF**.

#### NOTE

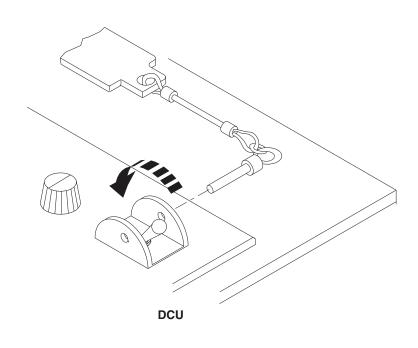
If launching is stopped by pressing a **GA** button before all mines are launched, the launch must be restarted within 60 seconds of stopping to prevent an error code. The **VOLCANO ARM** switch should also be moved to off (down) position within 60 seconds of stopping to prevent an error code.



- Ensure same number of racks are installed on either side of aircraft.
- Ensure same number of canisters are installed on either side of aircraft.
- Partial load of canisters may result due to rack or canister failures (error codes 5, 8, or 9).
- Partial canister loads, if not adjusted or balanced, will degrade mine field pattern.
  - 1. Place **TEST/OVERRIDE** switch to **OVER-RIDE**.
  - 2. After overriding error code 9, remove and discard all failed canisters.
  - 3. One at a time, fill vacant positions left by removal of failed canisters as follows:
    - a. Remove canister from top rack of same side, forward most column, top most position with canister.



LAUNCHER RACK



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#### Figure 4-22. Arming Volcano System Canisters

- b. Place this canister in vacant position.
- c. Repeat steps a. and b. until all positions, other than those removed to fill vacant positions, have canisters.
- 4. Canister load may be balanced out by moving canisters from side with most canisters to side with fewest canisters as follows:
  - a. Remove canister from top rack, forward most column, topmost row of side with canisters.
  - b. Place removed canister in top rack, rear most column, lowest position of side with fewest canisters.
  - c. Repeat steps a. and b. above until load is balanced.

#### 4.15.5 Mine Launch.

#### NOTE

• Mine launching may be started and stopped as many times as required until all mines have been launched.

- If launching is stopped by pressing a **GA** button before all mines are launched, the launch must be restarted within 60 seconds after stopping to prevent an error code. The **VOLCANO ARM** switch may also be moved to off (down) position within 60 seconds after stopping to prevent an error code.
  - 1. DCU **FIRE CIRCUIT** switch safety pin and streamer Remove.
  - 2. DCU FIRE CIRCUIT switch ENABLE.
  - 3. Before reaching target, VOLCANO ARM switch ARM. Verify P/F/ARMED indicates ARMED.
  - 4. Verify that the **HELICOPTER DELIVERY SPEED** settings agree with the helicopter ground speed.

# CAUTION

FIRE CIRCUIT switch must be enabled for at least two minutes prior to mine launching.

5. **GA** button - Press either pilot's to start launching mines. Press either **GA** button a second time to stop mine launching.

#### NOTE

If launching is interrupted for longer than 60 seconds, the **ARMED** light on the ICP will flash and error code 1 will be displayed in the DCU **ERROR** indicator.

- 6. If launch is interrupted longer than 60 seconds, resume launch: **VOLCANO ARM** switch Off for at least sixteen seconds.
- 7. **VOLCANO ARM** switch **ARM**. Verify a steady **ARMED** is displayed on the ICP. Launching can then be resumed.
- 8. During mine launching, if an error code appears on DCU panel that affects mission performance, do the following:
  - a. DCU FIRE CIRCUIT switch OFF.
  - b. Safety pin and streamer assembly Install to **FIRE CIRCUIT** switch.
  - c. DCU POWER switch OFF.
  - d. Return to downloading area and remove canisters, refer to TM 9-1095-208-13&P.

#### 4.15.6 Volcano System Recycle Procedures.

These procedures are to be used in the event of a volcano system lockup during a tactical mission.

#### NOTE

If any error codes occur during this recycle, return to step 1 and repeat all steps.

- 1. Identify error code.
- 2. Return the **VOLCANO ARM** switch on the ICP to the safe position.

- 3. Return the **FIRE CIRCUIT ENABLE** switch on the DCU to the **OFF** position.
- 4. Toggle the **POWER** switch on the DCU to **OFF**, then release. Ensure DCU turns off.
- 5. Leave the DCU turned off at least two minutes prior to system restart.

#### NOTE

During cold temperature operation (less than 0°C (32°F)), the DCU should be turned off at least five minutes prior to system restart.

- 6. After waiting the minimum time, toggle **POWER** switch to on, then release. Ensure that the DCU displays the following sequence:
  - a. Error code F.
  - b. "ON" displayed under POWER.
  - c. All "8s" in the remainder of the displays.
  - d. The DCU is blank, except for the "**ON**" message.
- 7. Wait approximately one minute. At that time, the DCU should display "88 88" under **CANISTERS REMAINING**.
- 8. Toggle the **TEST/OVERRIDE** switch to **TEST**, then release.
- 9. After approximately two minutes, the DCU should display "80 80" or what was displayed upon canister installation under CANISTERS REMAINING.
- 10. After approximately 15 seconds, the number under **SET TIME** should flash. At that time, turn **SELF DESTRUCT TIME** knob to **RESET** for 20 seconds.
- 11. Turn **SELF DESTRUCT** knob to the desired setting. Ensure that this setting is displayed under **SET TIME** without any flashing.
- 12. Move the **FIRE CIRCUIT ENABLE** switch on DCU to **ENABLE**.
- 13. Move the **VOLCANO ARM** switch on the ICP to **ARM**, if the switch was in that position before restarting.

#### 4.15.7 Partial Load Error Codes.

a. Three error codes can be overridden to allow mine laying without a full load of canisters. These are:

(1) Error code 5 - Rack problems. This allows operation with less than 4 racks, if desired, for laying an abbreviated minefield.

(2) Error code 8 - Rack electronics error. This error indicates one complete row of ten canisters is not available. No other errors shall be overridden with the error code 8 override.

(3) Error code 9 - Canister failure. Canister failures are allowed to be overridden. Failed canister should be removed and remaining canisters balanced prior to mission.

b. Troubleshoot all error codes overridden during mission after completion of flight and make an appropriate entry on DA Form 2408-13-1, refer to TM 9-1095-208-13&P.

#### 4.15.8 Volcano Post Mission Procedures.

#### 4.15.8.1 Post Mine Launch Check.

- 1. ICP VOLCANO ARM switch Off (down).
- 2. DCU FIRE CIRCUIT switch OFF.
- 3. Safety pin and streamer assembly Install to **FIRE CIRCUIT** switch.
- 4. DCU POWER switch OFF.

#### 4.15.8.2 After Landing Checks.



Do not stand in front of rack loaded with mine canisters. All personnel will remain clear of the outboard side of the launcher racks until the arming levers are safe and the jettison safety pins are installed, or until the helicopter is shut down and power removed.

- 1. Install jettison safety pins (four on each rack).
- 2. Push in plunger on red arming lever and push lever back until it is in safe position, parallel

with rack and plunger clicks out. Latch all arming levers in safe position.

#### 4.15.8.3 Post Flight Checks.

- 1. Remove canisters.
- 2. Record all error codes overridden during mission on DA Form 2408-13-1.
- 3. Install launcher rack covers.

**4.15.9 Volcano Operation Under Unusual Conditions.** The volcano system is designed to operate during adverse weather and extreme temperature conditions. Operator will be required to perform additional checks when operating during extreme climatic conditions.

#### 4.15.9.1 Operating In Extreme Cold.



- Do not force launcher rack levers or mounting pins to operate.
- Static electricity discharges may damage DCU.

#### NOTE

Operators wearing arctic gloves should have no difficulty installing or operating the volcano system.

- 1. Check movement of launcher rack arming and latching levers to ensure that they do not bind. Use warm air source to loosen if required.
- 2. Install launcher rack cover when dispenser is installed, but canisters have not been loaded.
- 3. Perform complete volcano operational check before any mission (paragraph 4.15.2).
- 4. Assure all expando and/or single acting pins have seated and spring button is out.
- 5. Check to see that launcher rack levers and canister connectors are free of ice, snow, and frost. Use warm air source to clean and dry as necessary.
- 6. Allow 10 minutes of additional warmup time before using system.

7. Prior to turning on power, make sure all DCU switches are free of ice, that **FIRE CIRCUIT** switch and streamer are free of ice, and that rotary switches move freely. Use warm air to heat and dry sticking or stiff switches.

## 4.15.9.2 Operating In Wet, Mud, Salt Water, and Ice Conditions.



Wet and/or icy hardware may be slippery. Use extra precaution when handling dispenser components. Do not force ice covered launcher rack levers.

- 1. During flight in icing conditions shed ice particles may cause foreign object damage (FOD) to the helicopter, especially main rotor and tail rotor blades and engine compressors. Flight tests have shown that this FOD is difficult to detect during flight. Minimizing descent rates after ice has accumulated on the helicopter or external stores should reduce the probability of FOD because the airflow will carry particles aft and down away from the helicopter. Normal instrument procedure descents or approximately 100 feet per minute (fpm) or less are preferable. During shutdown, crewmembers should be alert for unusual engine noise (high pitched whine) that indicates compressor damage. The helicopter should be visually inspected prior to further flight.
- 2. Engine torque increase of up to 20% can be expected during cruise flights in icing conditions with the volcano system installed.
- 3. After flight in icing conditions with the volcano system installed, the jettison safety pins may be difficult to install due to ice in and around the safety pin holes. The forward launcher rack locking levers and arming levers may also be covered with ice making it difficult to move the arming levers to the safe position. Use an external heater to remove ice from these areas. Do not use foreign objects to break ice from these areas as this may cause damage to the system.

- 4. Do not bend ice covered cables until ice has been removed with a warm air source.
- 5. Check launcher rack canister connectors for ice. Use warm air source to melt and dry connectors.
- 6. Check launcher rack arming and latching levers for ice. Use warm air source to remove ice. Test operation of levers to assure they have free movement.
- 7. Check expando and single acting pins to ensure that they are seated and spring button is out.
- 8. After exposure to mud or salt water, clean and wash dispenser components immediately. If dirty, clean, wash and dry components before repackaging them into shipping containers, refer to TM 9-1095-208-13&P.
- 9. When DCU cover is removed, make sure that switches are free of ice. Remove ice using warm air source.
- 10. Check DCU connectors for ice. Remove ice using warm air source.
- 11. Check DCU switch for ice. Remove ice with warm air source.
- 12. Allow 10 minutes of additional warmup time before testing and operating dispenser.
- 13. Perform PMCS, refer to TM 9-1095-208-13&P.
- 14. Perform complete volcano operational check before any mission (paragraph 4.15.2).

#### 4.15.10 Accident Procedures.



After an accident, turn DCU power OFF, evacuate all personnel to a distance of 2000 feet (640 meters) and notify EOD.

#### Section III CARGO HANDLING SYSTEMS

#### 4.16 CARGO HOOK SYSTEM.

The system consists of a hook assembly (Figure 4-23) mounted on the lower fuselage, a control panel on the upper console, a normal release switch on each cyclic stick grip, one emergency release switch on each collective stick grip, and a firing key in the cabin for use by the crew chief. The system incorporates three modes of load release, an electrical circuit actuated from the cockpit, a manual release worked by the crewmember through a covered hatch in the cabin floor, and an emergency release system using an electrically activated explosive charge.

**4.16.1 Cargo Hook Stowage.** The cargo hook shall be maintained in the stowed position during periods of nonuse. The cargo hook can be placed in a stowed position by opening the cargo hook access door in the cabin floor and pulling the hook to the right and up. When the hook is in the stowed position, the load beam rests on a spring-loaded latch assembly and is prevented from vibrating by a Teflon bumper applying downward pressure on the load beam. To release the hook from its stowed position, downward pressure is placed on the latch assembly lever retracting the latch from beneath the cargo load beam allowing the cargo hook to swing into operating position.

4.16.2 Cargo Hook Control Panel. The CARGO HOOK control panel on the upper console consists of an EMERG REL NORM, OPEN, SHORT test switch, a TEST light, CONTR CKPT or ALL station selector switch, and an ARMING, SAFE, ARMED switch. Before the normal release (electrical) can operate, the **ARMING** switch must be at **ARMED** to provide electrical power to the release switches. The pilot and copilot CARGO REL switches, on the cyclics, will release the load when the CONTR switch is at CKPT or ALL. The crewmember's **NORMAL RLSE** switch will release the load when the CONTR switch is at ALL. The EMERG REL switch and TEST light permit checking the emergency release circuit when at SHORT or OPEN. In both cases of testing, if the release circuit is good, the **TEST** light will go on when the HOOK EMER REL switch on the pilot's or copilot's collective or the EMER RLSE switch on the crewmember's pendant is pressed.

**4.16.3 Crewmember's Cargo Hook Control Pendant.** The crewmember's cargo hook control pendant (Figure 4-24), in the aft cabin, provides the crew chief with an electrical release and jettison of an external load when the **CARGO HOOK CONTR** switch is placed to **ALL**. The **NORMAL RLSE** and **EMER RLSE** switches are covered by guards to prevent accidental activation. When the cover is raised, the switch can be pressed. When not in use, the pendant is stowed in the stowage bag at the back of the pilot's seat. Electrical power to operate the pendant is provided from the No. 2 dc primary bus through a circuit breaker marked **CARGO HOOK CONTR**.

4.16.3.1 Normal Release. Normal release of external cargo is done by pressing the CARGO REL switch on either cyclic stick grip or the CARGO HOOK NORMAL **RLSE** on the crewmember's cargo hook pendant, after placing the CARGO HOOK ARMING switch to **ARMED**. The **HOOK ARMED** advisory will appear. This informs the pilot that electrical power is applied to the control circuit; the actuation of any of the release switches will release the load. When the CARGO REL switch is pressed and the release solenoid begins to move, a switch closes and activates the CARGO HOOK OPEN advisory. The load arm will swing open releasing the cargo. When the sling is detached from the load beam, spring tension on the arm will cause it to close and relatch and the CARGO HOOK OPEN advisory disappears. The normal release system is a one-shot cycle; once the solenoid travel begins and the load arm relatches, the release cycle can again be initiated. Power to operate the normal release system is supplied from the No. 2 dc primary bus through circuit breakers marked CARGO HOOK CONTR and PWR.

### 4.16.3.2 Operational Check - Normal Release Mode.

- 1. CARGO HOOK CONTR switch As required. CKPT for pilot and copilot check, or ALL for crewmember check.
- 2. CARGO HOOK ARMING switch ARMED.
- 3. **HOOK ARMED** advisory Check that it appears.
- 4. Place about 20 pounds downward pressure on load beam.
- 5. CARGO REL switch (pilot and copilot); NORMAL RLSE (crewmember) - Press and release.
- 6. Load beam Check open. CARGO HOOK OPEN advisory Appears.

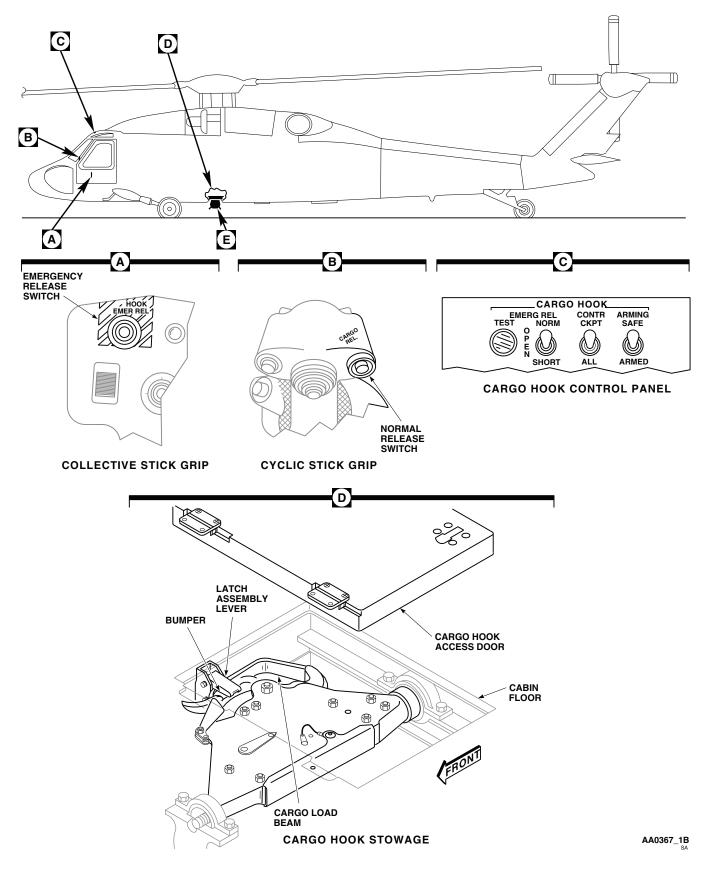
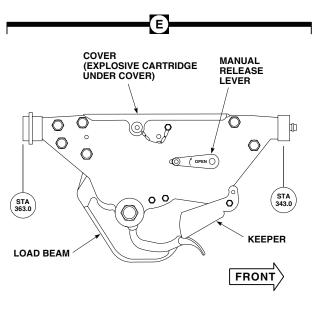


Figure 4-23. Cargo Hook System (Sheet 1 of 2)





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## Figure 4-23. Cargo Hook System (Sheet 2 of 2)

- 7. CARGO HOOK OPEN advisory Check that it disappears when hook closes.
- 8. Repeat steps 4. through 7. for copilot and crewmember positions.

**4.16.3.3 Manual Release.** Manual release of external cargo can be done from the cabin through a covered port in the floor or by ground personnel from outside the helicopter with power on or off. Turning the release control on the right side of the hook clockwise causes the latching mechanism to release the load beam. The load beam will not move unless a downward pressure is exerted to cause opening. With power applied to the helicopter and the **CARGO HOOK ARMING** switch at **ARMED**, the **CARGO HOOK OPEN** advisory will appear at the start of release control turning and will disappear at the end of release control rotation.

# 4.16.3.4 Operational Check - Manual Release Mode.

1. Manual release lever spring - Installed. Check that spring is straight and provides positive pressure on the lever.

- 2. Place about 20 pounds downward pressure on load beam.
- 3. Manual release lever Pull up/turn fully clockwise and release.
- 4. Load beam Check open.
- 5. CARGO HOOK OPEN advisory Appears.
- 6. When downward pressure is released, load beam will close and latch.
- 7. CARGO HOOK OPEN advisory Disappears when hook closes.

**4.16.4 Emergency Release Circuit Tester.** The cargo hook emergency release circuit tester marked **CARGO HOOK EMERG REL** on the upper console, contains a test light and switch. The **TEST** light goes on during circuit testing to indicate the system is functioning properly. The switch, with marked positions **NORM**, **OPEN**, and **SHORT**, is normally at **NORM**. When the switch is placed to **OPEN** or **SHORT** and the cargo **HOOK EMER REL** switch on the pilot's or copilot's collective, or **EMER RLSE** switch on the circuit tester light will go on if the circuit is good.

# 4.16.4.1 Cargo Hook Emergency Release Circuit Check.

### NOTE

To prevent unintentional discharge of the cargo hook explosive cartridge, the pilot shall call off each procedural step of the emergency release circuit test before that step is done. Station being checked shall reply to pilot's command.

- 1. **EMERG REL TEST** light Press. Light should be on.
- 2. Pilot's release Check.
  - a. Short test.
    - (1) CARGO HOOK EMERG REL switch SHORT.
    - (2) Pilot's **HOOK EMER REL** switch Press and hold.
    - (3) CARGO HOOK TEST light On.

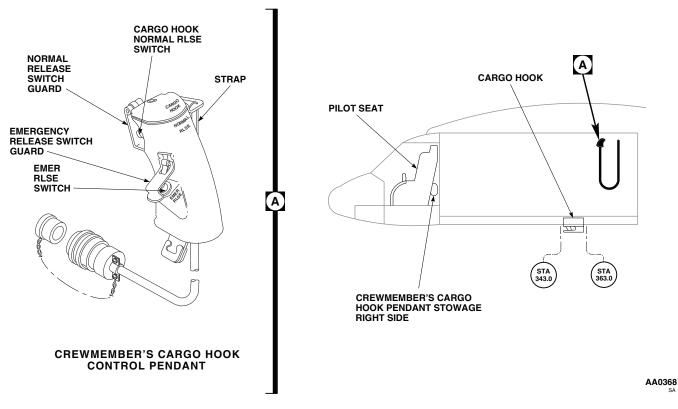


Figure 4-24. Crewmember's Cargo Hook Control Pendant

- (4) **HOOK EMER REL** switch -Release. **TEST** light off.
- (5) Repeat steps (2) through (4) for copilot's HOOK EMER REL switch and crewmember's cargo hook control pendant EMER RLSE switch.
- b. Open test.
  - (1) CARGO HOOK EMERG REL switch OPEN.
  - (2) Pilot's **HOOK EMER REL** switch Press and hold.
  - (3) CARGO HOOK TEST light On.
  - (4) **HOOK EMER REL** switch -Release. **TEST** light off.
  - (5) Repeat steps (2) through (4) for copilot's HOOK EMER REL switch and crewmember's cargo hook control pendant EMER RLSE switch.
- 3. CARGO HOOK EMERG REL switch NORM. If the cargo hook is not to be used

immediately after completing the circuit test check, the **EMERG REL** switch shall remain at **OPEN** until ready for load pickup.

#### 4.16.4.2 Emergency Release.

#### NOTE

When the emergency hook release has been used and a replacement squib (explosive cartridge) is not available, the hook cannot be used until the explosive device is replaced since the hook load beam will not close and lock.

Emergency release of an external cargo load is done by an electrically fired explosive cartridge, initiated from either of the collective stick grip switches marked **HOOK EMER REL**, or the crewman's cargo hook control pendant marked **EMER RLSE**. 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 at **NORM**, power will be applied to the emergency release switch. Pressing the switch applies 28 vdc to the explosive cartridge producing a high gas pressure to drive a piston in the lock assembly, releasing 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 **CARGO HOOK OPEN** advisory will appear until the explosive cartridge device is replaced. When the explosive cartridge device is replaced: the load arm will close, the advisory will disappear and the emergency release mode is returned to operation. Power to operate the emergency release system is from the dc essential bus through a circuit breaker marked **CARGO HOOK EMER**.

**4.16.5 Preflight.** When cargo hook loads are to be carried, checks within this paragraph and the before takeoff, emergency release, inflight, and before landing paragraphs apply.

- 1. Cargo hook Check condition, security, and explosive cartridge installed.
- 2. Emergency release system Check. Refer to paragraph 4.16.4.2.
- 3. Manual release Check. Refer to paragraph 4.16.3.3.

### 4.16.6 Before Takeoff.

- 1. CARGO HOOK EMERG REL switch NORM.
- 2. CARGO HOOK ARMING switch ARMED.

### 4.16.7 Emergency Release Procedure.

Pilot or copilot **HOOK EMER REL** or crewman's control pendant **EMER RLSE** - Press.

### 4.16.8 Inflight Procedures.



Cargo suspended from the cargo hook should not be over a  $30^{\circ}$  cone angle. To prevent damage to the cargo hook keeper, the pilot shall use extreme care to prevent placing load pressure on the keeper.

**CARGO HOOK ARMING** switch - As required. **ARMED** for low altitude/low airspeed. **SAFE** at cruise altitude and airspeed.

### 4.16.9 Before Landing.

CARGO HOOK ARMING switch - ARMED.

## 4.17 MISSION READINESS CIRCUIT BREAKER PANEL.

The mission readiness circuit breaker panel is on the No. 1 electrical junction box in the cabin and contains all required circuit breakers for mission equipment.

### 4.18 RESCUE HOIST SYSTEM KIT.

The high performance, two speed rescue hoist (Figure 4-25) is post-mounted in the cabin on the right side of the helicopter when installed. 42305–1 The hoist system consists of modular components that are electrically driven and electronically controlled to provide lift capacities of 300 pounds at 0 to 250 feet-per-minute and 600 pounds at 0 to 125 feet-per-minute. A speed mode switch at the back of the rescue hoist control panel assembly on the hoist support assembly, provides a selection of either LOW SPEED (0 to 125 feet-per-minute), or HIGH SPEED (0 to 250 feet-per-minute). The hoist motor mounted at the top of the pole provides selectable 125 or 250 feet-perminute reel-in and reel-out drive of a 250-foot hoist cable. **42305–5** The hoist system consists of modular components that are electrically driven and electronically controlled to provide lift capacities of 300 pounds at 0 to 275 feet-per-minute and 600 pounds at 0 to 150 feet-perminute. The cable management system speed mode circuit automatically provides acceleration/deceleration to protect the hoist against excessive G forces and loads in excess of 300 pounds. The hoist motor mounted at the top of the pole provides 150 or 275 feet-per-minute reel-in and reelout drive of a 250-foot hoist cable. • A fail-safe mechanism limits the induced loading to the hoist to 1200 pounds at all times. A continuously running circulating fan cools the hoist motor. The hoist is controlled through a lower console mounted RESCUE HOIST CONTROL panel and/or crewman's control pendant grip in the cabin. A hoist cable cutter system is used to cut the hoist cable in case of emergency, by exploding a squib-actuated cable cutter. The cut cable then drops free of the hoist boom. Power to operate the rescue hoist system is from the No. 2 dc primary bus through a circuit breaker on the mission readiness circuit breaker panel marked RESO HST **CONTROL**. Power for the cable cutter system is from the dc essential bus through a circuit breaker marked HOIST CABLE SHEAR. Refer to Table 2-4 for servicing.

**4.18.1 Controls and Function.** The **RESCUE HOIST CONTROL** panel has all necessary controls for operating the hoist from the cockpit, and contains the system **MASTER** switch, controlling **ON** or **OFF** for both cockpit and cabin. The hoist will respond to the first control signal received.

### NOTE

During hoist operation, over travel of the cable assembly may occur in the extended mode of operation after stopping hoist operation in mid-travel. Cable over travel should not exceed ten feet.

CONTROL/ INDICATOR	FUNCTION
<b>BOOM</b> switch	Swings hoist boom in or out from cockpit.
OFF	Static position, removes electrical power from hoist boom positioning motor.
IN	Provides power to boom motor to position boom inboard from cockpit.
OUT	Provides power to boom motor to position boom outboard from cockpit.
MASTER switch	Selects control point for hoist operation.
OFF	Disconnects all electrical power from hoist operating controls.
ON	Provides power to both cockpit controls and crewman's pendant for hoist operation.
CABLE	Provides cable up or down control from cockpit.
OFF	Static position, removes electrical power from hoist reel motor for cockpit operation.

CONTROL/ INDICATOR	FUNCTION
42305–1 UP	Provides power to hoist reel motor to reel in cable at 125 feet-per- minute or 250 feet-per-minute as determined by the speed mode switch.
42305–5 UP	Provides power to hoist reel motor to reel in cable at 150 feet-per- minute or 275 feet-per-minute as determined by the cable manage- ment system.
42305-1 DOWN	Provides power to hoist reel motor to reel out cable operation from cockpit at 250 feet-per-minute only.
42305–5 DOWN	Provides power to hoist reel motor to reel out cable operation from cockpit at 275 feet-per-minute only.
SQUIB switch	Selects either <b>TEST</b> or <b>NORM</b> operation.
TEST	Checks condition of <b>CABLE</b> <b>SHEAR</b> circuit through squib to indicate circuit is complete.
NORM	Places squib circuit in a ready for fire condition.
IND	Lights when test of <b>CABLE</b> <b>SHEAR</b> circuit through squib is good.
CABLE SHEAR switch	Controls cable cutter firing circuit.
FIRE	Directs electrical power to cable cutter squib for shearing hoist cable.
SAFE	Removes electrical power from cable cutter circuit.

**4.18.2 Boom Assembly Module.** The boom assembly module consists of the boom structure boom head, up-limit switch, cable-cut device, and a cable guide, all installed in the boom. The boom head is allowed to swivel  $65^{\circ}$  above the boom cable and  $30^{\circ}$  from side-to-side and guide the cable to wrap or unwrap from a  $30^{\circ}$  cone angle. The upper limits of cable control include an automatic means for

decelerating the cable to 67 feet-per-minute cable speed. At 8 to 10 feet below the boom head, a light on the crewman's control pendant marked **CAUTION** will go on. The cable will again decrease speed to 12 feet-per-minute at 12 to 18 inches below the boom head.

**4.18.3 Limit Switches.** Four limit switches are actuated by actuation assembly cams. They are: a down all stop that actuates when 250 feet of cable is reeled out; a down-limit switch that actuates at 247 feet to provide deceleration; a 10-foot caution switch that actuates when the hook is within 10 feet of the boom head or within 10 feet of the down limit (240 feet); and an up deceleration switch that actuates when the cable hook is within 12 inches of the boom head.

**4.18.4 Crewman's Controls.** Crewman's controls are found on the hoist control box and the crewman's control pendant grip. The pendant grip is connected to the control box by a cable connector. Controls and indicators on the hoist control box and pendant grip are as follows:

CONTROL/ INDICATOR	FUNCTION
Pendant Grip	A hand-held control for use in the cabin. Enables single handed control of the hoist.
42305–1 HOIST switch	A directional and variable speed switch spring loaded to center with marked positions of <b>UP</b> , and <b>DOWN</b> . As the switch is moved further away from center, the hoist speed increases in the marked direction. When the switch is released, the hoist will stop.
42305–5 REEL switch	A directional and variable speed switch spring loaded to center with marked positions of <b>IN</b> , and <b>OUT</b> . As the switch is moved further away from center, the hoist speed increases in the marked direction. When the switch is released, the hoist will stop.
<b>BOOM</b> switch	3-position switch, sprung loaded to center. When switch is released, boom will stop moving.
OUT	Moves boom out to deployed posi- tion.

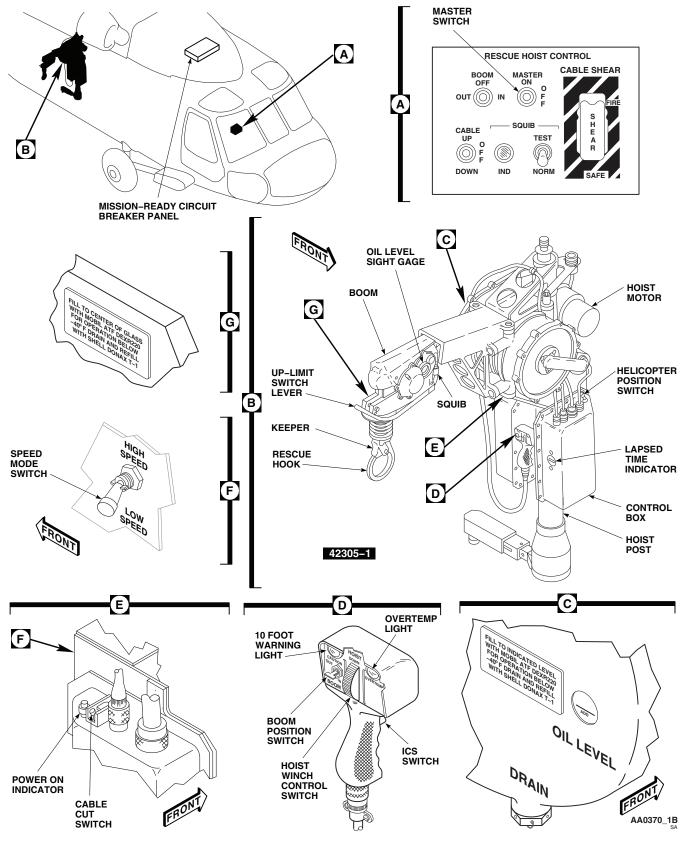


Figure 4-25. Rescue Hoist Kit UH 42305-1 (Sheet 1 of 2)

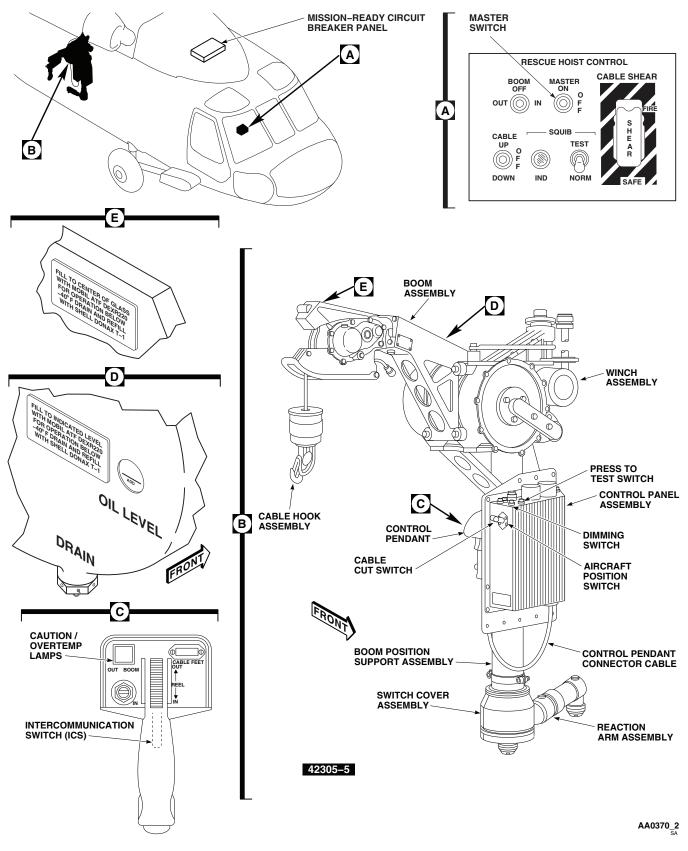


Figure 4-25. Rescue Hoist Kit UH 42305-5 (Sheet 2 of 2)

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
IN	Moves boom in to stowed position in cabin.	LOW SPEED	Maximum hoist speed is 150 ft. per minute.
CAUTION light	Lights when the hoist cable is within 10 feet or less of all stop limits.	AIRCRAFT POSI- TION switch	Selects correct boom direction and stopping position. Set to position 2 – 4 for UH-60 installations.
<b>OVERTEMP</b> light	Lights when either the hoist gearbox or the hoist motor	CABLE CUT guarded switch	Initiates firing of cable cutting cartridges.
	temperature exceeds 280-300°F (138-149°C). The light automati- cally goes out when the temperature drops below 250- 270°F (121-132°C). Whenever the <b>OVERTEMP</b> light is on, the hoist should be allowed to cool down	42305–5 Lamp Press to Test switch	Tests CAUTION and OVER- TEMP lamps and cable cutter circuit. Pressing the switch causes CAUTION and OVERTEMP lights to go on, and CABLE FEET will read 888.
42305–5 CABLE FEET	until the light goes off. 3-digit display showing the amount of cable extended. The optimum	42305–5 Dimming switch	Turn switch to increase or decrease <b>CAUTION</b> and <b>OVERTEMP</b> lamp brightness.
	<b>CABLE FEET</b> readout is $248 \pm 2$ .		
	<b>NOTE</b> Limit switches shall be adjusted if <b>CABLE FEET</b> readout is not optimal; however, the digital readout will not be used to downgrade the hoist.	releases a rescue hois system consists of a so <b>SHEAR</b> switch on the at the hoist assembly, may be fired by the p	<b>ar System.</b> A cable shear feature t load in case of an emergency. The quib-actuated cable cutter, a <b>CABLE</b> e pilot's control panel, a shear switch and a <b>SQUIB</b> test circuit. The cutter ilot or the copilot from the <b>SHEAR</b> panel or by the hoist operator using
Intercom trigger switch	Located on the front of the pendant, acts as an additional push- to-talk switch on the crew chief's ICS panel.	the CABLE-CUT switch on the control box. The SQ test circuit consists of a TEST-NORM switch and a good IND light. When the SQUIB switch is at NO and the SHEAR switch is placed to FIRE, electr	
Control Panel Switches 42305–1 Speed Mode Switch	Manually controls hoist speed range.	cartridge then drives shears it. The resc operational whenever Once fired, a replacer	lual squib for firing. The exploding s a cutter into the hoist cable and ue hoist cable shear feature is power is applied to the helicopter. nent cable cutter kit and cable must
HIGH SPEED	Maximum hoist speed is 250 ft. per		operate the cable shear is provided ous through a circuit breaker marked

minute.

HOIST CABLE SHEAR.

### 4.18.6 Operation.

# WARNING

- It is the hoist operator's responsibility to assure that the hoist cable does not contact any portion of the aircraft. 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, interrupt hoist operations and inspect the cable for damage in accordance with applicable procedures. If any broken wires, unraveling, or kinks are observed, hoisting operations should be discontinued and the cable replaced.
- Reeling a kinked/damaged cable into the hoist may cause a hoist jam condition when reel-out is attempted, rendering hoist inoperative.
- If a load oscillation is not quickly stopped, it may become unmanageable. Reeling in an oscillating load will only aggravate the motion.

The hoist operator is responsible for maintaining stability of the hoisted load by use of hoist controls, ICS calls to pilot, and physical control of cable (hand or foot). For minor oscillation (linear or circular swing), stop reel-in, apply hand motion to cable in direction opposite to oscillation. For significant oscillation, stop reel-in, start reelout, or call for pilot to lower aircraft. All crew should watch for shock loads, jerks, or snaps that impart high loads on cable. If observed, hoisting should be interrupted and cable inspection undertaken to verify integrity (no broken wires, unraveling, or kinks) before resuming operations. Refer to TM 1-1680-320-13&P, high performance rescue hoist assembly.

### 4.18.6.1 Preflight (if use is anticipated).

### NOTE

For preflight PMCS, refer to TM 1-1680-320-13&P.

### 4.18.6.2 Rescue Hoist Squib Circuit Test.

1. **SQUIB** switch - Hold at **TEST**.

- 2. SQUIB IND light Check on.
- 3. SQUIB switch Release to NORM. SQUIB IND light off.

## 4.18.6.3 Boom Position and Hoist Cable Control Operational Check.

To position the rescue hoist inboard or outboard:

- 1. MASTER switch ON.
- 2. Hoist operator Check power on indicator (blue light), check to ensure that the 10-foot **CAUTION** light on the pendant grip is on, and cooling fan operating.

### NOTE

**42305–5** The Lamp Press to Test switch will verify the serviceable condition of the **CAUTION** and **OVERTEMP** indicator lamps and the cable cut assembly system. **42305–5** If the cable length meter does not display the number 888 during the test sequence, the cable cut circuit has a break and may not function when the **CABLE CUT** switch is engaged.

- 3. **42305–5** Press and hold Lamp Press to Test switch, check the **CAUTION** and **OVERTEMP** lights illuminate, and **CABLE FEET** displays the number 888; Release -Lamp Press to Test switch, ensure the **OVER-TEMP** light extinguish, and **CABLE FEET** displays indicate cable length.
- 4. Check ICS switch on pendant.



Hands must be kept off hoist boom during operation to prevent hand entrapment and injury.

- 5. Hoist operator **BOOM** switch **OUT** and then **IN**.
- 6. **RESCUE HOIST CONTROL** panel Rotate boom **OUT**; then **IN**, then **OUT** to test boom operation.

7. 42305-1 Speed mode switch - HIGH SPEED.

# WARNING

- Rescue hoist cable is stiff and abrasive. Broken cable strands are sharp, therefore leather work gloves must be worn whenever handling rescue hoist cables.
- A crewmember must reel cable out from the boom head in line with the boom axis during the following test procedures. Care must be taken not to pull the cable taut around the cable guide/roller, since kinking of the cable might result. Avoid damaging cable on rough surfaces, including the ground.
  - 8. **RESCUE HOIST CONTROL** panel -**CABLE** switch - **DOWN**; lower cable hook and ensure the 10-foot **CAUTION** light on the pendant grip extinguishes after the first ten feet of cable is reeled out.
  - RESCUE HOIST CONTROL panel CABLE switch - UP; reel in cable and observe that cable speed slows when the 10-foot CAU-TION light on the pendant grip goes on (8 to 10 feet of cable out).
  - Boom up limit actuator arm Push up on arm during reeling in to check that hoist stops running when up limit switches are activated. Observe that cable slows when hook is 12 to 18 inches from full up position.
  - 11. Repeat steps 7. through 9., using control pendant assembly. Check that cable speed can be regulated by control pendant from 0 to maximum speed when cable is reeled out beyond 10 feet.
  - 42305-1 Speed mode switch LOW SPEED. Repeat steps 7. through 9., using control pendant assembly. Check that cable speed can be regulated by control pendant from 0 to 125 fpm when cable is reeled out beyond 10 feet.



Make sure hoist cable is completely up, to prevent cable wear between cable and hook assembly.

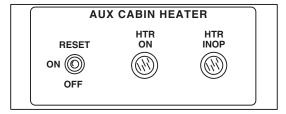
13. **BOOM** switch - Rotate boom into the stowed position.

### 4.18.7 Stopping Procedure.

MASTER switch - As desired.

### 4.19 AUXILIARY ELECTRICAL CABIN HEATER. (ON HELICOPTERS EQUIPPED WITH AUXILIARY CABIN HEATER KIT.)

A 55,000 BTU/hr electrical auxiliary cabin heater is installed in the transition section to provide an increase in cabin temperature in extremely cold environments. The auxiliary heater system consists of a heater control panel on the lower console replacing the retransmission control panel when the heater kit is installed (Figure 4-26), a blower and electrical heater unit in the transition section, a heater inlet port on the cabin aft bulkhead (Figure 2-5), a temperature control located under the left gunner's window, and ducting throughout the cabin. The auxiliary heater system is turned on from the cockpit by a switch marked OFF-ON-RESET on the AUX CABIN HEATER control panel. With both main generators operating and AUX CABIN HEATER switch ON, the HTR ON light on the control panel will go on indicating that power is applied through the heater control relay to the duct temperature sensor and to the blower motor and cabin heater elements. If a heater unit overheats, an element thermostat circuit will automatically open, causing the heater to shut off. When the element cools, the AUX **CABIN HEATER** switch must be momentarily placed at **RESET** to restore the system. A heater outlet duct cycling thermostat is also provided at the air outlet side of the heater. If duct temperature exceeds  $82^\circ \pm 8^\circ C$ , the temperature sensor contacts will open, temporarily interrupting power to the heater elements. On decreasing temperature, the contacts will automatically reset to closed at  $77^{\circ} \pm 8^{\circ}$ C to restore power. A redundant duct overheat sensor/shutoff switch is installed next to the duct cycling thermostat to shut off power to the heater elements if the delivered air flow temperature exceeds  $99^{\circ} \pm 8^{\circ}$ C due to heater cycling sensor failure. Sensor switch contacts reset



(ON HELICOPTERS EQUIPPED WITH AUXILIARY CABIN HEATER)

LOWER CONSOLE

AA0400

### Figure 4-26. Auxiliary Cabin Heater Control Panel

closed on decreasing temperature. However, the cockpit heater panel switch must be momentarily placed at **RESET** to restart system operation. Heated air is carried through the cabin via ducts along each side of the cabin at the ceiling. Power to operate the auxiliary cabin heater elements is provided from the No. 1 ac primary bus through the No. 1 junction box and protected by current limiters. Blower power is provided from the No. 2 ac primary bus and protected by a circuit breaker marked AUX HTR BLOWER. Control of both heater elements and blower is provided by power from the No. 1 dc primary bus through a circuit breaker marked AUX HTR CONTROL. The blower will operate with APU power on and the backup hydraulic pump off. The auxiliary cabin heater will only operate with both generators on and the backup hydraulic pump off.

### 4.20 ROTOR BLADE DEICE KIT.

Refer to Chapter 2 for description and operation of the blade deice kit.

# 4.21 EXTERNAL EXTENDED RANGE FUEL SYSTEM KIT. ERES

The external extended range fuel system (ERFS) is supported by the external stores support system extending horizontally from each side of the fuselage aft of the cockpit doors. The 230-gallon and 450-gallon jettisonable tanks may be suspended from the vertical stores pylons (VSP). Removable fuel lines, bleed-air lines, valves, and electrical connectors are within the horizontal stores support (HSS). A tank pressurizing system, using bleed-air, transfers fuel to the main tanks. Fuel lines carrying fuel to the No. 1 and No. 2 main fuel tanks contain check valves to prevent backflow. The extended range system does not supply fuel directly to the engines but is used to replenish the main tanks. Servicing of the external tanks can be done only through fueling ports on the tanks. Control of the system is provided by a control panel on the lower console. Power to operate the fuel transfer system is provided from the No. 1 dc primary bus through circuit breakers marked **EXT FUEL LH**, and **NO. 1 XFER CONTROL** and from the No. 2 dc primary bus through circuit breakers marked **EXT FUEL RH** and **NO. 2 XFER CONTROL** and from the No. 2 ac primary bus through a circuit breaker marked **AUX FUEL QTY** on the mission readiness circuit breaker panel.

4.21.1 External Extended Range Fuel Transfer **Modes.** Fuel can be transferred from external tanks to main tanks in either of two modes, AUTO MODE or MANUAL. AUTO (primary) transfers fuel automatically after switches are manipulated. Fuel transfer will be managed by the microprocessor as described in paragraph 4.21.6. The pilot need only occasionally monitor the AUXILIARY FUEL MANAGEMENT panel to ensure that during AUTO MODE of fuel transfer, fuel in external tanks is decreasing as it should. The second mode of transfer is the MANUAL XFR (secondary) mode. In the MANUAL mode, the pilot may replenish main tank fuel in any quantity or frequency desired. Transfer must be initiated by the pilot. The pilot must constantly monitor the fuel quantity indicator in order to start and terminate transfer to remain within CG limits. It is possible to transfer fuel from any one tank while in MANUAL mode. Transfer is shut off by the pilot when the external tank low-level sensor signals that the tank is empty. During manual transfer, at the illumination of a tank EMPTY light, immediately switch from **OUTBD** to **INBD** or to manual transfer MODE OFF. Do not wait for the NO FLOW light to illuminate. This will preclude air from entering the fuel line and entering the main tank. At the illumination of the TANK EMPTY capsule, 2.5 to 4.0 gallons of fuel remain in the tank. Sloshing of the fuel will cause frequent illumination of the TANK EMPTY light and NO FLOW light when the tank is in this condition. The AUX FUEL caution can also appear frequently.

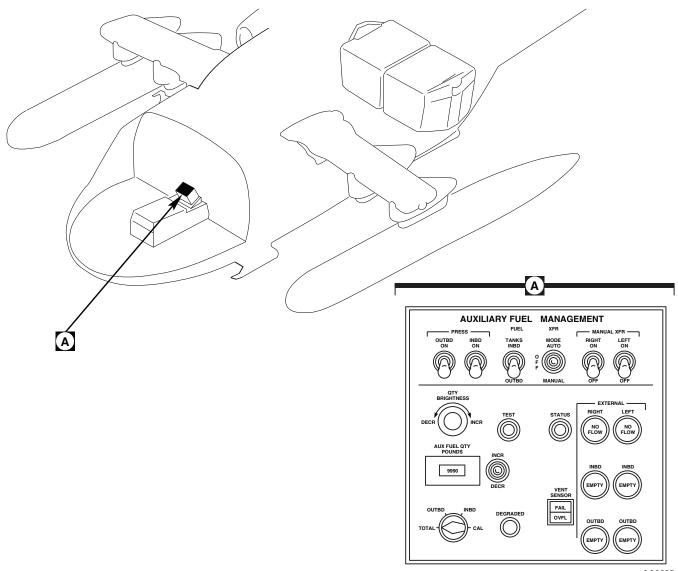
**4.21.2 External Extended Range Fuel System Tanks.** External ERFS contains two or four tanks suspended from supports outboard of the fuselage. The tanks contain baffles to prevent fuel sloshing. Quickdisconnect valves are provided in external fuel and bleedair lines to provide seals when tanks are jettisoned or removed. If tanks are not installed, **cccc** will be displayed in the **AUX FUEL QTY POUNDS** display when **OUTBD** or **INBD** is selected on the rotary fuel quantity selector. The preferred location of the external ERFS auxiliary fuel tank is the outboard pylon. This facilitates ingress and egress of troops, loading of cargo, and the use of the M60D door gun.

**4.21.3 Auxiliary Fuel Management Control Panel.** The **AUXILIARY FUEL MANAGEMENT** control panel (Figure 4-27) contains all controls for operating the external extended range fuel system. Controls description is as follows:

CONTROL/ INDICATOR	FUNCTION	
FUEL XFR	Controls fuel management of	MANUAL X
	external extended range system.	RIGHT O
PRESS		
OUTBD ON	Opens bleed-air valves to outboard tanks for pressurization.	OFF
Off	Closes bleed-air valves to tanks.	LEFT ON
INBD ON	Opens bleed-air valves to inboard tanks for pressurization.	OFF
Off	Closes bleed-air valves to tanks.	AUX FUEL
TANKS INBD	Selects fuel transfer valves from inboard tanks for fuel transfer to main tanks; deselects outboard valves.	POUNDS
TANKS OUTBD	Selects fuel transfer valves from outboard tanks for fuel transfer to main tanks; deselects inboard valves.	
MODE	Selects <b>AUTO-OFF-MANUAL</b> mode of fuel transfer from external fuel tanks.	OUTBD
Αυτο	Automatically transfers fuel to main tanks from selected external tanks, until empty sensor in each tank interrupts transfer. Transfer	INBD
	occurs in levels as shown under fuel transfer sequence. When tanks	TOTAL
	are empty, <b>NO FLOW</b> and <b>EMPTY</b> lights will illuminate, and the <b>AUX FUEL</b> caution will appear.	CAL

CONTROL/ INDICATOR	FUNCTION
OFF	Interrupts automatic or manual transfer mode of operation.
MANUAL	Provides electrical path to MANUAL XFR switch(es), which allows transfer from selected tank(s) until switch is moved to off.
MANUAL XFR	
RIGHT ON	Transfers from right tank used in conjunction with <b>MODE</b> switch in <b>MANUAL</b> position of the pair selected by <b>TANKS</b> select switch.
OFF	Interrupts transfer operation.
LEFT ON	Transfers from left tank of the pair selected by <b>TANKS</b> select switch.
OFF	Interrupts transfer operation.
AUX FUEL QTY POUNDS	Indicates pounds of external fuel remaining in symmetrical pair of tanks total of auxiliary tanks, self- test indication or failure codes. Displays K factors of flow meter.
	NOTE
	Fuel tanks selector and quantity indicators are also used in conjunc- tion with <b>INCR-DECR</b> switch when initializing fuel quantity of tanks.
OUTBD	Total pounds of fuel remaining in outboard pair of tanks.
INBD	Total pounds of fuel remaining in inboard pair of tanks.
TOTAL	Pounds of fuel remaining in all external extended range tanks.
CAL	Adjusts K factor of flow switch on AUXILIARY FUEL MANAGE- MENT panel.

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION	
<b>INCR</b> switch position	Increases setting of digital readout to adjust for fuel remaining in	VENT SENSOR	Detects the presence of fuel on the vent thermistor.	
DECD and tak	tanks selected by fuel tank selector.	*OVFL	Indicates fuel venting overboard.	
<b>DECR</b> switch position	Decreases setting of digital readout to adjust for fuel remaining in tanks selected by fuel tank selector.		NOTE	
STATUS button	Resets AUX FUEL caution and stores condition of NO FLOW and EMPTY indicators.		Illumination of this capsule on the Fuel Management Panel will activate the <b>AUX FUEL</b> caution and the <b>MASTER CAUTION</b> .	
TEST	Checks display and indicator lights. Performs memory check- sum, displays 8 sequentially in each digital display. Verifies that temperature probe is connected;		Pushing the <b>STATUS</b> button will reset the <b>NO FLOW</b> light, <b>AUX</b> <b>FUEL</b> caution, and the <b>MASTER</b> <b>CAUTION</b> , but does not correct the no flow condition.	
	verifies that flow meter is con- nected; performs trial calculation	FAIL	Open in vent sensor line.	
	based on a known temperature and flow meter input, compares it with a known good value, and displays setting of fuel density switch. At completion of test, <b>GOOD</b> or error code will be displayed (Table 4-3).	Indicating System digital readout displa type is preset by sv MANAGEMENT p	<b>4.21.4 External Extended Range Fuel Quantity</b> <b>ndicating System.</b> The AUX FUEL QTY POUNDS ligital readout displays the amount of fuel remaining. Fuel ype is preset by switches in the AUXILIARY FUEL MANAGEMENT panel. Preset can only be done when he halicopter weight is on the wheels. When measuring	
<b>DEGRADED</b> light	Error in critical function has oc- curred. Error code will be displayed as shown under <b>TEST</b> . Only E02 error will allow microprocessor to clear failure code and regain fuel remaining information by doing two self- tests.	the helicopter weight is on the wheels. When measu quantity, the readout is used in conjunction with the re- selector switch to select tank pair subtotal, or <b>TO</b> remaining in all tanks. Fuel used is sensed from a com- flow transmitter within the fuel line to the main tanks. amount is subtracted from the preset fuel quantity i and is displayed on the digital readout as pounds rem- ing. A <b>DEGRADED</b> light will go on when a comp failure has occurred in the microprocessor, or an e		
EXTERNAL		temperature sensor h	by the microprocessor, or when the as failed. Power for the fuel quantity ded from the Ne. 2 as primery bus	
* <b>RIGHT NO</b> FLOW light	Fuel flow does not exit from selected right tank.	subsystem is provided from the No. 2 ac primary through a circuit breaker marked <b>AUX FUEL QTY</b> the mission readiness circuit breaker panel.		
* <b>INBD EMPTY</b> light	Right inboard tank fuel exhausted.	4.21.5 Auxiliary F Test.	Fuel Management Control Panel	
* <b>OUTBD</b> EMPTY light	Right outboard tank fuel exhausted.	1. <b>TEST</b> bu	tton - Press. Digits should display 8s,	
*LEFT NO FLOW light	Fuel flow does not exit from selected left tank.		lights and <b>DEGRADED</b> and <b>VENT R</b> (FAIL and OVFL) lights should il-	
* <b>INBD EMPTY</b> light	Left inboard tank fuel exhausted.		ttton - Release. Digits should display	
* <b>OUTBD</b> EMPTY light	Left outboard tank fuel exhausted.	seconds	uence from left to right three times; 5 later, display GOOD or EO failure econds later, display type fuel density, <b>TOTAL</b> .	



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Figure 4-27. Auxiliary Fuel Management Control Panel ERFS

3. Auxiliary fuel quantity switch - CAL.

### NOTE

**CAL** is the calibration value marked on the fuel flow transmitter. Enter the four digit number, disregarding the numbers to the right of the decimal point.

- 4. **INCR/DECR** switch Set calibration.
- 5. Auxiliary fuel quantity switch INBD.
- 6. **INCR/DECR** switch Set inboard fuel quantity.
- 7. Auxiliary fuel quantity switch **OUTBD**.

- 8. **INCR/DECR** switch Set outboard fuel quantity.
- 9. Auxiliary fuel quantity switch move to **TOTAL** Check.
- 10. **PRESS OUTBD** and **INBD** switches As desired.

### 4.21.6 Fuel Transfer Sequence.



FUEL BOOST PUMP CONTROL switches shall remain on during external range fuel transfer and remain on for 10 minutes after PRESS switches are moved to OFF. Failure to observe this warning may cause engine flameout.



Fuel transfer sequence must be carefully planned and executed in order to maintain CG within limits.

Fuel transfer sequence shall be based on mission requirement and CG limitations. Automatic transfer is started when the proper switches are manipulated and fuel level is as shown below and external range tanks internal pressure is increased enough to force fuel to the main tanks. Transfer will continue until the main tank signal conditioner provides a signal through the microprocessor to stop fuel transfer. This cycle is done as required until interrupted by placing the MODE switch to OFF or MANUAL or placing the PRESS switch OFF. Manual transfer will be started on selection of MANUAL and appropriate switches, and external fuel tanks are bleed-air pressurized to start fuel transfer from external tank(s) to main tanks. Transfer will continue until tanks are full. They will remain full as long as the manual mode remains engaged. Manual transfer requires close monitoring of fuel level to initiate and stop transfer to remain within CG limits. The automatic transfer sequence is as follows:

TOTAL	TRANSFER	TRANSFER
AUXILIARY	START WHEN	STOP WHEN
FUEL REMAIN-	ONE MAIN	EACH MAIN
ING (BASED	FUEL TANK	FUEL TANK
ON JP-4	QUANTITY	QUANTITY
DENSITY)	LESS THAN	MORE THAN
8840-7041 lbs	950 lbs	1000 lbs
7040-5001 lbs	750 lbs	1000 lbs
5000-0 lbs	600 lbs	1000 lbs

# 4.21.7 External Extended Range Fuel Transfer Check.

### NOTE

When ambient temperature is below  $4^{\circ}$ C ( $40^{\circ}$ F), ESSS/ERFS shall not be turned off after transfer check has been completed to avoid potential for freeze-up of the pressure regulator.

- 1. AIR SOURCE HEAT/START switch ENG.
- 2. FUEL BOOST PUMP CONTROL switches Check ON.

WARNING

FUEL BOOST PUMP CONTROL switches shall remain on during external range fuel transfer and remain on for 10 minutes after PRESS switches are moved to OFF. Failure to observe this warning may cause engine flameout.

- 3. **PRESS OUTBD** and **INBD** switches **ON** for tanks installed.
- 4. Fuel quantity switch TOTAL.
- 5. TANKS switch OUTBD.
- 6. MODE switch MANUAL.

- 7. MANUAL XFR RIGHT switch ON.
- 8. UH-60A TOTAL FUEL or UH-60L MAIN FUEL readout - Check for increase of about 20 pounds.
- 9. TANKS switch Repeat steps 7. and 8. for INBD, if installed.
- 10. MANUAL XFR RIGHT switch OFF.
- 11. MANUAL XFR LEFT switch ON.
- 12. Repeat steps 8. and 9. for MANUAL XFR LEFT.
- 13. MANUAL XFR LEFT switch OFF.
- 14. External ERFS Set as desired.

### 4.21.7.1 External Extended Range Fuel Transfer In AUTO Mode.

### NOTE

- If either main fuel quantity is below 1,000 lbs, selecting the automatic mode may initiate a transfer sequence.
- Allow sufficient time for tank pressurization (approximately 10 minutes for a half full 230-gallon tank).
- During transfer, periodically verify that **AUXILIARY FUEL MANAGEMENT** panel quantity is decreasing at a minimum of 40 pounds per minute, per tank pair. Fuel transfer rate of less than 40 pounds per minute may indicate reduced flow from one or both tanks.
  - 1. AIR SOURCE HEAT/START switch ENG.
  - 2. FUEL BOOST PUMP CONTROL switches Check ON.
  - 3. **PRESS OUTBD** and **INBD** switches **ON** for tanks installed.
  - 4. MODE switch AUTO.
  - 5. **TANKS** switch **OUTBD**. Switch to **INBD** after outboard tanks are empty.

### 4.21.7.2 External Extended Range Fuel Transfer In MANUAL Mode.

If **AUTO** mode is inoperative, transfer in **MANUAL** mode as follows:



Monitor fuel transfer to remain within CG limits and avoid asymmetric loading.

- 1. AIR SOURCE HEAT/START switch ENG.
- 2. FUEL BOOST PUMP CONTROL switches Check ON.
- 3. **PRESS OUTBD** and **INBD** switches **ON** for tanks installed.
- 4. MODE switch MANUAL.
- 5. **TANKS** switch **OUTBD**. Switch to **INBD** after outboard tanks are empty.
- 6. MANUAL XFR switches RIGHT and LEFT ON.

#### 4.21.7.3 External Extended Range Fuel Flow

**Verification In Manual Mode.** If extended range without landing is required and the helicopter is not equipped with an ERFS fuel indicating system, verify fuel flow from each tank as follows:

### NOTE

Ensure main fuel tanks are not completely full.

- 1. AIR SOURCE HEAT/START switch ENG.
- 2. FUEL BOOST PUMP CONTROL switches Check ON.
- 3. **PRESS OUTBD** and **INBD** switches **ON** for tanks installed.
- 4. MODE switch MANUAL.
- 5. **TANKS** switch **OUTBD**. Switch to **INBD** after outboard tanks are empty.

- MANUAL XFR RIGHT switch ON. Note the rate of decrease of the AUX FUEL QTY POUNDS indicator. The normal transfer fuel flow rate per tank should be between 20 to 38 pounds per minute.
- 7. MANUAL XFR RIGHT switch OFF.
- 8. Repeat steps 6. and 7. for left tank.

### 4.22 EXTERNAL AUXILIARY FUEL MANAGEMENT SYSTEM. AFMS

The external ERFS is supported by the external stores support system. The 230-gallon and 450-gallon jettisonable tanks may be suspended from the VSP. Removable fuel lines, bleed-air lines, valves, and electrical connectors are within the HSS. A tank pressurizing system, using bleedair, transfers fuel from the external tanks to the main tanks.

SYSTEM FAILURE CODES AND INDICATIONS	DEGRADED LIGHT	AUX FUEL CAUTION	DESCRIPTION OF DEGRADED OPERATION
E01 MICROPROCESSOR ERROR E03 FLOWMETER DISCONNECTED E04 ERROR FUEL FLOW CIRCUITS E05 ERROR FUEL FLOW COMPUTATION E06 MEMORY ERROR	ON	ON	<ol> <li>AUTO XFR CAPABILITIES REMAIN</li> <li>DEFAULTS TO CURRENT XFR SCHEDULE</li> <li>PILOT MUST COMPUTE FUEL USAGE</li> </ol>
E02 TEMPERATURE SENSOR NOT CONNECTED OR OUT OF RANGE	ON	ON	<ol> <li>AUTO XFR CAPABILITIES REMAIN</li> <li>PERFORMING TWO SELF-TESTS WILL:         <ul> <li>CLEAR FAILURE CODE AND REGAIN FUEL REMAINING INFO</li> <li>RESET AUX FUEL LIGHT</li> <li>DEFAULT TO PRESELECTED TEMP VALUE</li> </ul> </li> </ol>
LOSS OF DIGITAL READOUT	ON	ON	<ol> <li>AUTO XFR CAPABILITIES REMAIN</li> <li>NO FLOW AND EMPTY MONITORING INDICATIONS REMAIN</li> <li>PILOT MUST COMPUTE FUEL USAGE</li> </ol>
LOSS OF ONE MAIN TANK LEVEL QUANTITY SENSOR OR LOSS OF ONE SIGNAL CONDITIONER INPUT	OFF	OFF	NO DEGRADATION
FAILED AUX TANK EMPTY SENSOR PROVIDES FALSE EMPTY SIGNAL	OFF	ON-IF FUEL TRANSFER SELECTED	AUX TANK FUEL TRANSFER SHUTOFF VALVE CLOSES. PILOT SELECTING MANUAL MODE REOPENS VALVE.

Table 4-3. Extended Range Fuel System Degraded Operation Chart ERFS

Fuel lines carrying fuel to the No. 1 and No. 2 main fuel tanks contain check valves to prevent backflow. The external tanks are gravity refueled only. Control of the system is provided by an Auxiliary Fuel Management Panel (AFMP) located in the center of the instrument panel. Dimming control for the AFMP lighting is provided by the cockpit **INST LT NON FLT** rheostat on the upper console. Dimming control for all fuel quantity displays and annunciators on the AFMP is provided by the **LIGHTED SWITCHES** rheostat on the upper console only when the caution/advisory panel is in the **DIM** mode. Power for the auxiliary fuel management system is provided from the No. 2 dc primary bus through circuit breakers marked **EXT FUEL RH** and **NO. 2 XFER CONTROL** on the mission readiness circuit breaker panel.

4.22.1 External Auxiliary Fuel Management

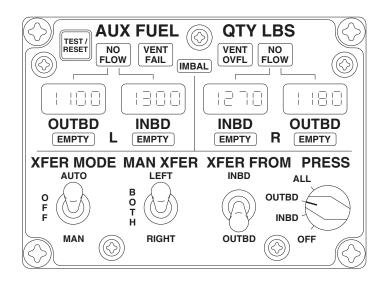
**System.** This system contains two or four tanks suspended from supports outboard of the fuselage. The tanks contain baffles to prevent fuel sloshing. Quickdisconnect valves are provided in external fuel and bleedair lines to provide seals when tanks are jettisoned or removed. If tanks are not installed, the fuel quantity display for the removed tank is blank when the **XFER MODE** is **OFF**. When the **XFER MODE** switch is in any other position, the removed tank display will show **NT**.

#### 4.22.2 Auxiliary Fuel Management Control Panel.

The AFMP (Figure 4-28) contains all controls for operating the external ERFS. Controls description is as follows:

CONTROL/ INDICATOR	FUNCTION
PRESS switch	Provides control of bleed air pres- surization of auxiliary tanks.
ALL	Opens bleed-air valves to all in- stalled tanks for pressurization.
OUTBD	Opens bleed-air valves to outboard tanks for pressurization.
INBD	Opens bleed-air valves to inboard tanks for pressurization.
OFF	Closes bleed-air valves to tanks.

CONTROL/ INDICATOR	FUNCTION	
XFER FROM		
INBD	Selects fuel transfer from inboard tanks.	
OUTBD	Selects fuel transfer from outboard tanks.	
XFER MODE	Selects <b>AUTO-OFF-MAN</b> mode of fuel transfer from external fuel tanks.	
AUTO	Activates automatic fuel transfer.	
OFF	Closes all fuel transfer valves. Interrupts automatic or manual transfer mode of operation. Deactivates <b>NO FLOW</b> indicators.	
MAN	Selects manual transfer mode. Activates <b>MAN XFER</b> switches.	
MAN XFER		
LEFT	Transfers from left inboard or outboard tank.	
вотн	Transfers from both left and right inboard or outboard tanks.	
RIGHT	Transfers from right inboard or outboard tank.	
AUX FUEL QTY LBS		
L OUTBD	Pounds of fuel remaining in the left outboard tank to the nearest 10 lbs.	
L INBD	Pounds of fuel remaining in the left inboard tank to the nearest 10 lbs.	
R OUTBD	Pounds of fuel remaining in the right outboard tank to the nearest 10 lbs.	



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### Figure 4-28. Auxiliary Fuel Management Control Panel AFMS

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION
R INBD	Pounds of fuel remaining in the right inboard tank to the nearest 10 lbs.		<b>NOTE</b> • Illumination of annunciators on
TEST/RESET	On the ground (WOW) - Activates the Initiated Built-in Test (IBIT) and conducts a lamp test of all displays and indicator lights. System malfunctions are displayed from left to right in the fuel quantity displays, using the error codes (Table 4-4). Fuel quantity displays return after the lamp test, if no errors are identified. Acknowledges <b>E04</b> through <b>E07</b>		<ul> <li>the AFMP will activate the AUX</li> <li>FUEL caution and MASTER</li> <li>CAUTION.</li> <li>The NO FLOW condition must exist for 5 seconds before the AUX</li> <li>FUEL caution and MASTER</li> <li>CAUTION are activated.</li> <li>One of these indications will occur if a tank empty sensor fails (for related tank).</li> </ul>
Inflight (weight off	error codes.		A false <b>EMPTY</b> light (tank shows quantity greater than zero).
wheels) - Resets AUX FUEL caution and MASTER CAUTION, but does not correct the condition.			A false <b>NT</b> fuel quantity indication (tank installed, <b>AUTO</b> or <b>MAN</b> mode selected).

### **INDICATOR** A false "blank" fuel quantity indication (tank installed, XFER MODE is OFF). Degraded operation for the above conditions: AUTO mode is disabled, use MAN mode. AUX FUEL OTY LBS ***R NO FLOW** No fuel flowing from right tank(s). light ***R INBD EMPTY** Right inboard tank fuel exhausted. light ***R OUTBD** Right outboard tank fuel **EMPTY** light exhausted. *L NO FLOW No fuel flowing from left tank(s). light *L INBD EMPTY Left inboard tank fuel exhausted. light *L OUTBD Left outboard tank fuel exhausted. **EMPTY** light NOTE • EMPTY light will only activate AUX FUEL caution and **MASTER CAUTION** when its tank is selected for transfer.

**FUNCTION** 

CONTROL/

• If the **EMPTY** light is on for more than 10 seconds and the fuel quantity display is greater than zero, the tank empty sensor has failed.

VENT FAIL lightsVent sensor inoperative.*VENT OVFLIndicates when AFMS detects the<br/>presence of fuel in vent line.* IMBAL lightIndicates a lateral imbalance of at<br/>least 450 pounds between fuel<br/>quantity indications for outboard

tanks.

### 4.22.3 External Auxiliary Fuel Management Quantity Indicating System.

### NOTE

Unmodified 230-gallon and 450-gallon tanks are prohibited from use on helicopters modified for AFMS. Crews should visually inspect each tank identification plate to verify that only AFMS modified tanks are installed on AFMS modified helicopters.

The AUX FUEL QTY LB digital readout indicates the amount of fuel in each of the installed external tanks in ten pound increments. A fuel probe in each of the external tanks sends a signal to the AFMP proportional to the fuel level in the tank. The level of fuel at the probe varies significantly with tank attitude. Aircraft body pitch angle data from the copilot's vertical gyro/AHRU is used by the AFMP so that the fuel quantity displayed includes compensation for angles between 10° nose down and 1° nose up. E07 will result in a drop in AUX fuel quantities for pitch down attitudes. A pitch up attitude may result in a slight increase. The copilot's attitude indicator will not indicate OFF if the E07 error code occurs due to failure of AFMP circuits external to the gyro. The pilot's vertical gyro/AHRU is not connected to the AFMP and therefore not available for attitude compensation. Level flight provides most accurate fuel quantity. A filter is incorporated in the AFMP software to minimize fuel quantity variations due to fuel slosh during maneuvering flight.

### NOTE

- The AFMP may display fuel quantities of up to 150 pounds below the actual fuel quantity per tank due to tank angle when the helicopter is on the ground.
- A lateral imbalance is defined as any difference in fuel quantity readings between tank pairs greater than 400 pounds. The crew should not wait for the illumination of the **IMBAL** light to begin correcting the lateral imbalance condition.

The AFMP has three BIT functions; power up BIT (PBIT), initiated BIT (IBIT), and continuous BIT (CBIT). PBIT and IBIT are disabled in flight by the WOW

interlock. Circuits tested and related error codes are shown in Table 4-4. PBIT is initiated when power is applied or reapplied to the AFMP. IBIT is initiated by pressing the **TEST/RESET** button for one second or more. CBIT is activated at the completion of PBIT or IBIT and runs continuously.

### NOTE

The transition from APU to main generators during engine runup can cause the PBIT to be initiated. The AFMP will display fuel quantities once the PBIT functions are completed.

### 4.22.4 External Auxiliary Fuel Management System Modes of Operation.

4.22.4.1 Automatic Mode Fuel Transfer.

# WARNING

FUEL BOOST PUMP CONTROL switches shall remain on during external range fuel transfer and remain on for 10 minutes after PRESS switch is moved to OFF. Failure to observe this warning may cause engine flameout.



### Monitor fuel transfer to remain within CG limits and avoid asymmetric loading.

The fuel transfer sequence shall be based on mission requirements and CG limitations. Automatic transfer is controlled by the AFMP sensing the No. 1 and 2 main tank fuel quantities to start and stop fuel transfer. When **AUTO** mode is selected, transfer starts when the fuel level in either main tank falls below 1,000 pounds, and the external tanks are pressurized. The **NO FLOW** lights may flicker upon initiation of fuel transfer. The AFMP transfers fuel from both tanks selected with the **XFER FROM** switch regardless of the position of the **MAN XFER** switch. Fuel transfer stops when the **UH=60A TOTAL FUEL** or **UH=60I MAIN FUEL** quantity indicates 2,200 pounds or when the **EMPTY** light on either tank or **VENT OVFL** light illuminates on the AFMP.

4.22.4.2 Manual Mode Fuel Transfer.



FUEL BOOST PUMP CONTROL switches shall remain on during external range fuel transfer and remain on for 10 minutes after PRESS switch is moved to OFF. Failure to observe this warning may cause engine flameout.



- Monitor fuel transfer to remain within CG limits and avoid asymmetric loading.
- If the IMBAL indicator illuminates, the crew should verify selection of the heavy tank and closely monitor the fuel quantity displays on the AFMP. No additional warnings are provided by the AFMP or caution/advisory system if the crew selects the wrong tank with the MAN XFER switch.

Manual transfer requires close monitoring of the main fuel quantity and AFMP fuel quantity displays to remain within CG limits and maintain lateral balance. Manual mode is initiated by the pilot when the XFER MODE switch is placed to MAN and external tanks are pressurized. Fuel transfer will continue as long as MAN is selected. The **NO FLOW** lights will randomly flicker as fuel is transferred until the main fuel quantity reaches approximately 2,300 pounds, unless the XFER MODE switch is placed to OFF or AUTO. The NO FLOW condition results when the tank pressurization can no longer add fuel to the tanks due to activation of the highlevel fuel shutoff valves in the main tanks. Illumination of the EMPTY light alerts the pilot to change tank pairs using the XFER FROM switch, select another tank using the MAN XFER switch, or place the XFER MODE switch to **OFF**. To avoid pumping air into the main tanks, do not wait for the NO FLOW light to illuminate. Sloshing of the fuel will cause frequent illumination of the **EMPTY** light only when the tank is selected for fuel transfer. Sloshing of fuel and activation of the fuel transfer valves using the XFER MODE switch can cause flickering of the NO FLOW light; however the AUX FUEL caution and MASTER CAUTION will only appear if the NO FLOW lights remain illuminated for more than 5 seconds. If lateral imbalance results during fuel transfer, the AFMP senses the imbalance and illuminates the **IM-BAL** light. The lateral imbalance can be resolved by selecting fuel transfer from the heavy tank. The **IMBAL** light illuminates with approximately 685-pound difference between outboard tanks, and will remain illuminated until the lateral imbalance is reduced below approximately 450-pound difference between outboard tanks.

# 4.22.5 Auxiliary Fuel Management Control Panel Test.

- 1. AUX FUEL QTY digital readouts Note current reading.
- TEST/RESET button Press. All annunciators will light and E07 will be displayed, if test is initiated within approximately one minute of applying ac power. If E07 appears, press TEST/RESET again. E07 should not appear until test is finished.
- 3. **BIT** indications Check. Ensure the **AUX FUEL** caution does not appear. Press and release **TEST/RESET** button on AFMP to reset the **AUX FUEL** caution.
- 4. **PRESS** switch As desired for tanks installed.

# 4.22.6 External Auxiliary Fuel Management System Fuel Transfer Check.

### NOTE

When ambient temperature is below 4°C (39°F), the ERFS/AFMS **PRESS** switch shall not be turned **OFF** after transfer check has been completed to avoid potential freeze up of the pressure regulator.

- 1. AIR SOURCE HEAT/START switch ENG.
- 2. FUEL BOOST PUMP CONTROL switches Check ON.

WARNING

FUEL BOOST PUMP CONTROL switches shall remain on during external range fuel transfer and remain on for 10 minutes after PRESS switch is moved to OFF. Failure to observe this warning may cause engine flameout.

- 3. **PRESS** switch As required for tanks installed.
- 4. XFER FROM switch OUTBD.
- 5. MAN XFER switch BOTH.
- 6. XFER MODE switch MAN.
- UH=60A TOTAL FUEL or UH=60L MAIN FUEL readout - Check for increase of approximately 40 pounds and AUX FUEL QTY LBS decrease of 20 pounds per tank.
- 8. XFER FROM switch INBD if installed.
- UH=60A TOTAL FUEL or UH=60L MAIN FUEL readout - Check for increase of approximately 40 pounds and AUX FUEL QTY LBS decrease of 20 pounds per tank.
- 10. XFER MODE switch OFF.
- 11. External ERFS Set as desired.

### 4.22.6.1 Fuel Transfer in AUTO Mode.

### NOTE

- Allow sufficient time for tank pressurization (approximately 10 minutes for a half full 230-gallon tank).
- During transfer, periodically verify the UH=60A TOTAL FUEL or UH=60L MAIN FUEL quantity remains above 2,000 pounds and the selected tank pair remains in balance. A decrease below 2,000 pounds on the UH=60A TOTAL FUEL or UH=60L MAIN FUEL quantity display or the generation of an imbalance in the AUTO mode may indicate reduced flow from one or both of the external tanks selected.
  - 1. AIR SOURCE HEAT/START switch -ENG.
  - 2. FUEL BOOST PUMP CONTROL switches Check ON.
  - 3. **PRESS** switch As required for tanks installed.

Table 4-4. Auxiliary Tuer Management System Taut Messages Armo			
SYSTEM FAILURE CODES AND/ OR INDICATIONS	DESCRIPTION OF DEGRADED OPERATIONS		
<ul><li>E01 - AFMP microprocessor fail</li><li>E02 - AFMP memory fail</li><li>E03 - AFMP display fail</li></ul>	<b>E01-E03</b> error codes displayed continuously if failure occurs during PBIT or IBIT on the ground (WOW only).		
	Only <b>MAN</b> mode for transfer is available.		
E04 - AFMP tank gaging electronics failure E05 - Auxiliary tank probe (OPEN) E06 - Auxiliary tank probe (SHORT)	Error codes display during PBIT or IBIT if failure occurs on the ground (WOW only). Acknowledge failure by pressing <b>TEST/RESET</b> button and error code changes to the CBIT display () or <b>FP</b> .		
	Manual mode only is available for the tank pair selected. Fuel quantity must be calculated for the tank with the failure.		
<ul> <li>( ) AFMP tank gaging electronics failure.</li> <li>FP - Auxiliary tank probe circuit failure (open or short).</li> <li>NF - No tank detected.</li> </ul>	() is the failure indication for error code E04 and FP is the failure indication for E05 and E06 during CBIT on the ground or in flight or during PBIT or IBIT on the ground after the crew acknowledges the error using TEST/RESET.		
	Manual mode only is available for the tank pair with the failure. Fuel quantity must be calculated for the tank with the failure.		
	No tank detected by system, when that tank is selected for transfer.		
E07 - AFMP memory fail	May occur on the ground if IBIT is initiated within approximately 1 minute of applying ac power to the helicopter. Acknowledge <b>E07</b> with the <b>TEST/RESET</b> button.		
	If <b>E07</b> is observed in flight or persists on the ground, AUTO and MAN mode are available but the pitch attitude correction defaults to a level attitude regardless of flight condition.		

### Table 4-4. Auxiliary Fuel Management System Fault Messages AFMS

4. XFER FROM switch - OUTBD, then INBD.

5. XFER MODE switch - AUTO.

4.22.6.2 Fuel Transfer in MANUAL Mode.

## CAUTION

# Monitor fuel transfer to remain within CG limits and avoid asymmetric loading.

If the **AUTO** mode is inoperative or a lateral imbalance greater than 400 pounds between tank pairs is identified, transfer in the **MAN** mode as follows:

- 1. AIR SOURCE HEAT/START switch ENG.
- 2. FUEL BOOST PUMP CONTROL switches Check ON.
- 3. **PRESS** switch As required for tanks installed.
- 4. XFER FROM switch OUTBD, then INBD.
- 5. **MAN XFER** switch **BOTH** or select heavy tank to correct an imbalance.
- 6. XFER MODE switch MAN.

### 4.23 CRASHWORTHY EXTERNAL FUEL SYSTEM. CEFS

The Crashworthy External Fuel Systems (CEFS) is a crashworthy, ballistically self-sealing external fuel system designed to provide a safe and convenient means of increasing the range and endurance of the helicopter. The system features up to four jettisonable 200-gallon external auxiliary fuel tanks installed on either the left and right inboard or left and right outboard horizontal stores support (HSS) pylons on the external stores support system (ESSS) wings. Fuel hoses, connecting hardware, and interface controls are also part of the CEFS. The CEFS consists of four major functional components: 200-gallon CEFS tanks, helicopter and ESSS wing interconnect hoses, pump package, and CEFS modified auxiliary fuel management control panel (AFMP).

### 4.23.1 Crashworthy External Fuel System.



If CEFS tanks are empty and AFMP mode switch is in MAN, the CEFS pump

### will continue to run, which may cause it to over-heat and fail.

The 200-gallon CEFS tanks consist of an outer fiberglass container, an internal crashworthy, ballistically self-sealing bladder, and internal fuel lines and shutoff valves. The bladder contains baffles to reduce fuel sloshing. The CEFS tanks are installed in pairs on the inboard or outboard HSS pylons equipped with BRU-22A launcher racks. Steel braided hoses are used to connect the CEFS tanks to the pump package, in turn, to the No. 2 main fuel tank. The hoses are equipped with self-sealing quickdisconnect breakaway couplings. The pump package is mounted at STA 443, BL 0 above the No. 1 and No. 2 main fuel cells. It contains a suction pump, refuel valve, and fuel manifold. The suction pump transfers fuel from the CEFS tanks to the main fuel system through the number two fuel cell. The refuel valve works in conjunction with the inboard and outboard wing gate shutoff valves to pressure refuel or defuel the CEFS tanks.

### 4.23.2 Auxiliary Fuel Management Panel (AFMP).

The AFMP (Figure 4-29) contains all controls for operating the CEFS. Dimming control for the AFMP lighting is provided by the cockpit **INST LT NON FLT** rheostat on the upper console. Dimming control for all fuel quantity displays and annunciators on the AFMP is provided by the **LIGHTED SWITCHES** rheostat on the upper console only when the caution/advisory panel is in the **DIM** mode. Power for the auxiliary fuel management system is provided from the No. 2 dc primary bus through circuit breakers marked **EXT FUEL RH** and **NO. 2 XFER CONTROL** on the mission readiness circuit breaker panel.

CONTROL/ INDICATOR	FUNCTION
PRESS switch	Selects inboard, outboard, or both sets of CEFS external tanks to be pressure refueled. The <b>PRESS</b> switch is only active when the <b>XFER MODE</b> switch is <b>OFF</b> .
ALL	Opens pump package refuel valve and wing gate valves on all HSS pylons where CEFS external tanks are installed.
OUTBD	Opens pump package refuel valve and wing gate valves on outboard HSS pylons where CEFS external tanks are installed.

CONTROL/ INDICATOR	FUNCTION	CONTROL/ INDICATOR	FUNCTION	
INBD	Opens pump package refuel valve and wing gate valves on inboard HSS pylons where CEFS external	R OUTBD	Pounds of fuel remaining in the right outboard tank to the nearest 10 lbs.	
OFF	tanks are installed. Closes pump package refuel valve and all wing gate valves.	R INBD	Pounds of fuel remaining in the right inboard tank to the nearest 10 lbs.	
XFER FROM		TEST/RESET	On the ground (WOW) - Activates	
INBD	Selects fuel transfer from inboard tanks.		the Initiated Built-in Test (IBIT) and conducts a lamp test of all displays and indicator lights.	
OUTBD	Selects fuel transfer from outboard tanks.		System malfunctions are displayed from left to right in the fuel	
XFER MODE	Selects <b>AUTO-OFF-MAN</b> mode of fuel transfer from external fuel tanks.		quantity displays, using the error codes (Table 4-5). Fuel quantity displays return after the lamp test, if no errors are identified.	
AUTO	Activates automatic fuel transfer.		Acknowledges <b>E04</b> through <b>E07</b> error codes.	
OFF	Closes all fuel transfer valves. Interrupts automatic or manual transfer mode of operation. Allows pressure refueling selections to be made using the <b>PRESS</b> switch.		• Illumination of any of the aster- isked annunciators on the AFMP	
MAN	Selects manual transfer mode. Activates <b>MAN XFER</b> switches.		will activate the <b>AUX FUEL</b> caution and <b>MASTER CAUTION</b> .	
MAN XFER	Activates MAN XFER switches. Selects tanks to transfer from in MAN mode (switch is only active when XFER MODE switch is in MAN). Transfers from left inboard or		• One of these indications will oc- cur if a tank empty sensor fails (for related tank):	
LEFT			A false <b>NT</b> fuel quantity indication (tank installed, <b>AUTO</b> or <b>MAN</b> mode selected).	
	outboard tank.		A false "blank" fuel quantity	
вотн	Transfers from both left and right inboard or outboard tanks.		indication (tank installed, <b>XFER</b> <b>MODE</b> is <b>OFF</b> ).	
RIGHT	Transfers from right inboard or outboard tank.		Degraded operation for the above conditions: <b>AUTO</b> mode is disabled, use <b>MAN</b> mode.	
AUX FUEL QTY LBS		* <b>R INBD EMPTY</b> light	Right inboard tank fuel exhausted.	
L OUTBD Pounds of fuel remaining in the left outboard tank to the nearest 10 lbs.	* <b>R OUTBD</b> EMPTY light	Right outboard tank fuel exhausted.		
L INBD	Pounds of fuel remaining in the left inboard tank to the nearest 10 lbs.	* <b>L INBD EMPTY</b> light	Left inboard tank fuel exhausted.	

#### CONTROL/ INDICATOR

#### **FUNCTION**

*L OUTBD EMPTY light Left outboard tank fuel exhausted.

#### NOTE

• EMPTY light will only activate AUX FUEL caution and MASTER CAUTION when its tank is selected for transfer.

• If the **EMPTY** light is on for more than 10 seconds and the fuel quantity display is greater than zero, the tank empty sensor has failed or a wiring fault exists.

VENT FAIL lights	Vent sensor inoperative.
* <b>VENT OVFL</b> lights	Indicates when AFMS detects the presence of fuel in vent line.
* IMBAL light	Indicates a lateral imbalance of at least 270 pounds for outboard tanks and 375 pounds for inboard tanks.

### 4.23.3 External Auxiliary Fuel Management Quantity Indicating System.

### NOTE

Unmodified 230-gallon and 450-gallon tanks are prohibited from the use on helicopters modified for AFMS. Crews should visually inspect each tank identification plate to verify that only CEFS tanks or AFMS modified tanks with CEFS adaptors are installed on CEFS modified helicopters.

The AUX FUEL QTY LB digital readout indicates the amount of fuel in each of the installed external tanks in ten pound increments. A fuel probe in each of the external tanks sends a signal to the AFMP proportional to the fuel level in the tank. The level of fuel at the probe varies significantly with tank attitude. Helicopter body pitch angle data from the copilot's vertical gyro is used by the AFMP so that the fuel quantity displayed includes compensation for angles between 10 degrees nose down and 1 degree nose up. Error code E07 (Attitude sensor input test failure) will result in a drop in AUX fuel quantities for pitch down attitudes. A pitch up attitude may result in a slight increase. The copilot's attitude indicator will not indicate OFF if the E07 error code occurs due to failure of

AFMP circuits external to the gyro. The pilot's vertical gyro is not connected to the AFMP and therefore not available for attitude compensation. Level flight provides most accurate fuel quantity. A filter is incorporated in the AFMP software to minimize fuel quantity variations due to fuel slosh during maneuvering flight.

### NOTE

- The AFMP may display fuel quantities of up to 150 pounds below the actual fuel quantity per tank due to the tank angle when the helicopter is on the ground.
- A lateral imbalance is defined as any difference in fuel quantity readings between tank pairs greater than 270 pounds in the outboard tanks or 375 pounds in the inboard tanks. The crew should not wait for the illumination of the **IMBAL** light to begin correcting the lateral imbalance condition.

The AFMP has three BIT functions: power up BIT (PBIT), initiated BIT (IBIT), and continuous BIT (CBIT). PBIT and IBIT are disabled in flight by the WOW interlock. Circuits tested and related error codes are shown in Table 4-5. PBIT is initiated when power is applied or reapplied to the AFMP. IBIT is initiated by pressing the **TEST/RESET** button for one second or more. CBIT is activated at the completion on PBIT or IBIT and runs continuously.

### NOTE

The transition from APU to main generators during engine run-up can cause PBIT to be initiated. The AFMP will display fuel quantities once the PBIT functions are completed.

## 4.23.4 CEFS Auxiliary Fuel Management System Modes of Operation.

4.23.4.1 Automatic Mode Fuel Transfer.



Monitor fuel transfer to remain within CG limits and avoid asymmetric loading.

The fuel transfer sequence shall be based on mission requirements and CG limitations. Automatic transfer is controlled by the AFMP sensing the No. 1 and 2 main tank

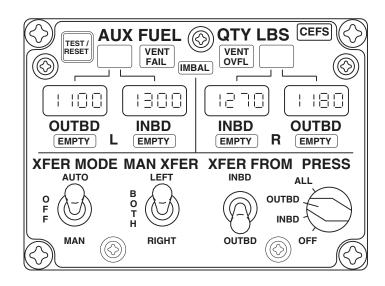


Figure 4-29. Auxiliary Fuel Management Control Panel CEFS

fuel quantities to start and stop fuel transfer. When AUTO mode is selected, transfer starts when the fuel level in either main tank falls below 1,000 pounds. The AFMP transfers fuel from both tanks selected with the XFER FROM switch regardless of the position of the MAN XFER switch (the MAN XFER switch is only active when the MAN XFER switch is in MAN). Fuel transfer stops when the UH=50A TOTAL FUEL or UH=60I MAIN FUEL quantity indicates 2,200 pounds or when the EMPTY light on either tank or VENT OVFL light illuminates on the AFMP.

### 4.23.4.2 Manual Mode Fuel Transfer.



- Monitor fuel transfer to remain within CG limits and avoid asymmetric loading.
- If the IMBAL indicator illuminates, the crew should verify selection of the heavy tank using the MAN XFER switch and closely monitor the fuel quantity displays on the AFMP. No additional warnings are provided by the AFMP or caution/

### advisory system if the crew selects the wrong tank with the MAN XFER switch.

Manual transfer requires close monitoring of the main fuel quantity and AFMP fuel quantity displays to remain within CG limits and maintain lateral balance. Manual mode is initiated by the pilot when the **XFER MODE** switch is placed to MAN. Fuel transfer will continue as long as MAN is selected until the main fuel quantity reaches approximately 2,300 pounds, unless the XFER **MODE** switch is placed to **OFF** or **AUTO**. Illumination of the EMPTY light alerts the pilot to change tank pairs using the XFER FROM switch, select another tank using the MAN XFER switch, or place the XFER MODE switch to OFF. Sloshing of the fuel may cause frequent illumination of the EMPTY light only when the tank is selected for fuel transfer. If lateral imbalance results during fuel transfer, the AFMP senses the imbalance and illuminates the IMBAL light. The lateral imbalance can be resolved by selecting fuel transfer from the heavy tank. The IMBAL light illuminates with approximately 270 pound difference between outboard tanks or a 375 pound difference between the inboard tanks, and will remain illuminated until the lateral imbalance is reduced below approximately a 60 pound difference between outboard tanks or a 85 pound difference in the inboard tanks.

SYSTEM FAILURE CODES AND/ OR INDICATIONS	DESCRIPTION OF DEGRADED OPERATIONS
<ul><li>E01 - Microprocessor fail</li><li>E02 - AFMP memory fail</li><li>E03 - AFMP display fail</li></ul>	<b>E01-E03</b> error codes displayed continuously if failure occurs during PBIT or IBIT on the ground (WOW only).
	Only MAN mode for transfer is available.
<ul> <li>E04 - AFMP tank gaging electronics failure.</li> <li>E05 - Auxiliary tank probe (OPEN).</li> <li>E06 - Auxiliary tank probe (SHORT).</li> </ul>	Error codes display during PBIT or IBIT if failure occurs on the ground (WOW only). Acknowledge failure by pressing <b>TEST/RESET</b> button and error code changes to the CBIT display () or <b>FP</b> .
	Manual mode only is available for the tank pair selected. Fuel quantity must be calculated for the tank with the failure.
<ul> <li>( ) AFMP tank gaging electronics failure.</li> <li>FP - Auxiliary tank probe circuit failure (open or short).</li> <li>NT - No tank detected.</li> </ul>	( ) is the failure indication for error code <b>E04</b> and <b>FP</b> is the failure indication for <b>E05</b> and <b>E06</b> during CBIT on the ground or in flight or during PBIT or IBIT on the ground after the crew acknowledges the error using <b>TEST/RESET</b> .
	<b>AUTO</b> mode unavailable. <b>MAN</b> fuel transfer only. Fuel quantity must be calculated for the tank with the failure.
	No tank detected by system, when that tank is selected for transfer.
E07 - Attitude sensor input test failure.	May occur on the ground if IBIT is initiated within approximately 1 minute of applying ac power to the helicopter. Acknowledge <b>E07</b> with the <b>TEST/RESET</b> button.
	If <b>E07</b> is observed in flight or persists on the ground, <b>AUTO</b> and <b>MAN</b> mode are available but the pitch attitude correction defaults to a level attitude regardless of flight condition.

### Table 4-5. Auxiliary Fuel Management System Fault Messages CEFS

# 4.23.5 Auxiliary Fuel Management Control Panel Test.

- 1. AUX FUEL QTY digital readouts Note current reading.
- 2. **TEST/RESET** button Press. All annunciators will light and **E07** will be displayed, if test is

initiated within approximately one minute of applying ac power. If **E07** appears, press **TEST/RESET** again. **E07** should not appear until test is finished.

3. **BIT** indications - Check. Ensure the **AUX FUEL** caution does not appear. Press and

release **TEST/RESET** button on AFMP to reset the **AUX FUEL** caution.

### 4.23.6 External Auxiliary Fuel Management System Fuel Transfer Check.

- 1. XFER FROM switch OUTBD.
- 2. MAN XFER switch BOTH.
- 3. XFER MODE switch MAN.
- UH=60A TOTAL FUEL or UH=60L MAIN FUEL readout - Check for increase of approximately 40 pounds and AUX FUEL QTY LBS decrease of 20 pounds per tank.
- 5. XFER FROM switch INBD if installed.
- UH=50A TOTAL FUEL or UH=50L MAIN FUEL readout - Check for increase of approximately 40 pounds and AUX FUEL QTY LBS decrease of 20 pounds per tank.
- 7. XFER MODE switch OFF.

4.23.6.1 Fuel Transfer in AUTO Mode.

#### NOTE

During transfer, periodically verify the UH-GOA TOTAL FUEL or UH-GOL MAIN FUEL quantity remains above 2,000 pounds and the selected tank pair remains in balance. A decrease below 2,000 pounds on the UH-GOA TOTAL FUEL or UH-GOL MAIN FUEL quantity display or the generation of an imbalance in the AUTO mode may indicate reduced flow from one or both of the external tanks selected.

- 1. XFER FROM switch OUTBD, then INBD.
- 2. XFER MODE switch AUTO.

#### 4.23.6.2 Fuel Transfer in MANUAL Mode.



Monitor fuel transfer to remain within CG limits and avoid asymmetric loading.

If the **AUTO** mode is inoperative or a lateral imbalance (270 pounds for outboard tanks or 375 pounds for inboard tanks) is identified, transfer in the **MAN** mode as follows:

- 1. XFER FROM switch OUTBD, then INBD.
- 2. **MAN XFER** switch **BOTH** or select heavy tank to correct an imbalance.
- 3. XFER MODE switch MAN.

### 4.24 EXTERNAL STORES SUPPORT SYSTEM.

ESSS provides a means of carrying a variety of external stores, including external extended range fuel tanks. The ESSS consists of fixed and removable provisions.

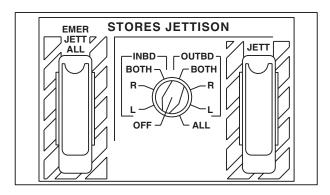
**4.24.1 External Stores Fixed Provisions.** Fixed provisions are: upper fuselage fixed fittings for attaching the HSS subsystem, and lower fuselage strut support fittings for attaching two struts for each HSS. In addition to exterior components, fixed provisions are: interior helicopter provisions, including electrical harnesses, fuel lines, bleed-air lines, and circuit breakers.

### 4.24.2 External Stores Removable Provisions.

The external stores removable subsystem extends horizontally from each side of the helicopter at station 301.5, buttline 42.0. Extending below each HSS are two VSPs and attaching ejector racks. The racks are used to attach fuel tanks or other external stores dispensers.

**4.24.3 ESSS Side Position Lights.** A position light is on each outboard end of HSS. Those lights use the power source provided to operate the standard installed position lights, colors are the same. Upon installation of the HSS, the electrical connectors connected to the jumper plugs, providing power for the standard position lights, are removed and reconnected to the connectors from the HSS position lights. Operation and power source for the ESSS position lights are the same as for the standard installed position lights.

**4.24.4 External Stores Jettison Control Panel.** The stores jettison control panel (Figure 4-30) provides the capability of phase jettison of all external stores or symmetrical jettison of fuel tanks. Interlock circuitry prevents jettison of fuel tanks other than in pairs. Emergency jettison is completely independent of the primary jettison subsystem.



AA0664 Figure 4-30. Stores Jettison Control Panel



The BRU-22A/A and MAU-40/A ejector rack CARTRIDGES are explosive devices and must not be exposed to heat, stray voltage or static electricity. Refer to TM 9-1300-206 for information concerning handling and storage of ammunition.

The stores jettison control panel contains all controls for jettisoning external stores. The function of each control is as follows:

**FUNCTION** 

**CONTROL** 

EMER JETT ALL Applies 28 volts from essential dc bus to all stores stations when the helicopter weight is off the wheels, regardless of the rotary selector switch. A 1-second time delay permits the outboard stations to jettison before the inboard stations.

### CONTROL

Rotary selector switch OFF

INBD

### **FUNCTION**

Determines which station receives primary jettison signal.

Prevents jettison signal from going to any stores station.

### NOTE

*If fuel tanks are connected to the left, right, or both stores stations, the **BOTH** mode of jettison is automatically selected even if the selector switch is at L or R.

L	*Directs jettison signal to inboard left station.
R	*Directs jettison signal to inboard right station.
ВОТН	Directs jettison signal to inboard left and right stores stations.
OUTBD	
L	*Directs jettison signal to outboard left station.
R	*Direct jettison signal to outboard right station.
ВОТН	Directs jettison signal to outboard left and right stores stations.
ALL	Directs primary jettison signal to all stores stations. Outboard stores will jettison and 1 second later inboard stores will jettison.

### CONTROL

**FUNCTION** 

JETT Applies 28 volts from primary dc bus through the rotary selector switch to the selected stores station if the weight is off the wheels and the selector switch is not OFF.

4.24.5 Stores Jettison Control Operation.

# CAUTION

To prevent unintentional jettison of external stores when the helicopter weight is on the wheels, do not actuate any jettison switch.

The jettison system provides two modes of jettisoning external stores, primary and emergency. The primary subsystem uses the rotary selector switch and the JETT toggle switch. The emergency jettison subsystem uses only the EMER JETT ALL toggle switch. Primary jettison is used when selective jettison is desired. The rotary switch is used to select the stores point for release, and the JETT toggle switch is used to actuate the release. Emergency jettison is used to release all external stores through one actuation of the EMER JETT ALL toggle switch, regardless of rotary switch position. During primary (rotary switch ALL selected) and emergency jettison, a 1-second delay is provided after the outboard stores are released, before the inboard stores will be released. When one pair of tanks is jettisoned in a four-tank system, cccc will appear on the AUX FUEL QTY POUNDS digital readout when the corresponding fuel quantity position is selected. The fuel remaining in the tanks jettisoned will be subtracted from the total displayed when TOTAL is selected. Power to operate the primary jettison subsystem is from the No. 1 dc primary bus through circuit breakers marked ESSS JTSN INBD and OUTBD. The emergency jettison subsystem is powered from the dc essential bus through circuit breakers marked ESSS JTSN INBD and OUTBD.

### 4.25 RAPPELING ROPE CONNECTORS.

Rappeling rope connectors consist of four cabin ceiling tiedown fittings.

4.26 MEDICAL EVACUATION (MEDEVAC) KIT.

### WARNING

Use of the medevac pedestal ambulatory configuration for transport of personnel other than patients or essential medical personnel is prohibited.

A medevac kit consisting of a pedestal support assembly and provisions for two rear-facing troop seats may be installed in the UH-60 helicopter (Figure 4-31) after removing the existing troop seats. Optional medevac configuration for troop seats: do not remove existing troop seat configuration, crewchief/gunner and optional rear facing troop seat (Figure 6-4). The medevac pedestal assembly, when installed, is directly below the main transmission. The pedestal can be turned about a vertical axis. Litter supports are cantilevered from the pedestal. The litter supports may be positioned to accept four to six litter patients, up to six ambulatory patients or essential medical personnel, or combination thereof. The pedestal should be positioned along the longitudinal axis of the helicopter for flight, to provide maximum crash attenuation. The pedestal contains restraint belts for each litter, restraint lap belts for each ambulatory occupant, eight individually operated lights for the four-man litter configuration, provisions for eight 1000 ml. intravenous fluid bags, and provisions for two size D oxygen bottles. Another feature of the medevac kit is a 115 vac, 60 Hz frequency converter to provide electrical power for use of standard hospital equipment. On missions not requiring electrical power, the power pack may be left out. The two-man rear-facing seat provisions are in the forward portion of the cabin, and accommodate standard troop seats. The four-man litter configuration allows rotation of the pedestal so that the litter patients can be loaded from either side of the helicopter. The six-man litter configuration also allows for side loading: however, the pedestal must be rotated back to the locked position along the longitudinal axis of the helicopter after four litters are loaded. Floor restraints are then installed to the cabin floor tiedown studs on both sides of the pedestal. The last two litters are placed on both sides of the pedestal between the floor restraints and secured. Only the upper supports are capable of being tilted for loading or unloading of the litters. Unloading the patients is the reverse of loading. To convert to the six-man ambulatory patient or essential medical personnel configuration, the upper litter supports are folded down to accommodate three patients or essential medical personnel seated side by side on either side of the pedestal. The medevac pedestal ambulatory configuration provides significantly less crashworthiness capability (energy attenuation and occupant restraint) than the troop seats.

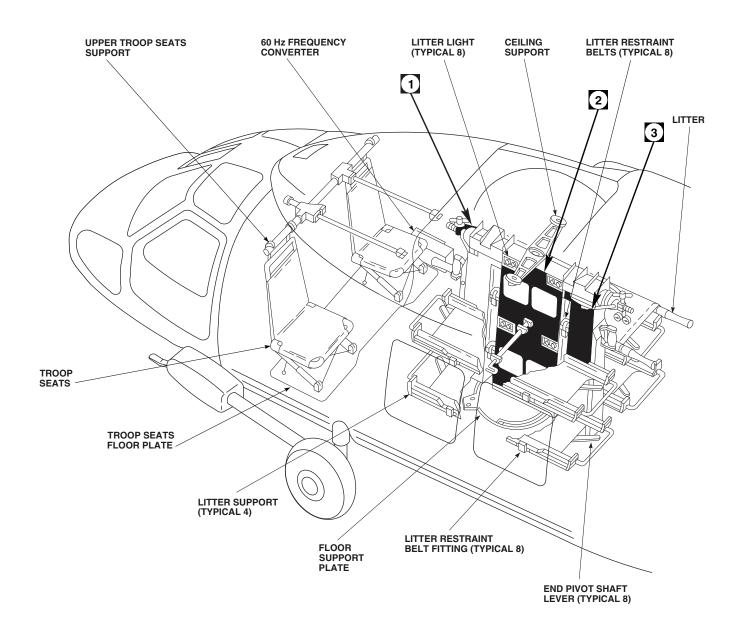
**4.26.1 Litter Support.** Each litter support is attached to the center pedestal by two end pivot shafts and by two T-shaped fittings, which allows removal, interchange, or repositioning of the supports. Crashload absorption works on the deformation principal. There are five pivot shaft support holes on the right and left side of the center console at both ends. Behind the holes are support rollers for the pivot shafts. From top to bottom, the top hole is provisions for the upper litter in the six-litter configuration. The second hole is for the upper litter support of a fourlitter configuration. These end holes line up with a central pivot shaft on the litter support. Only this litter position allows midposition pivoting for loading or unloading. The third hole is for the center litter of the six-litter configuration. The fourth hole is used when installing the litter support in the four-litter configuration. The third, fourth, and fifth positions do not provide a tilt function.

**4.26.2 Litter Lighting.** Two litter lights are installed in the pedestal at each litter. Each light contains a **PUSH-ON**, **PUSH-OFF** switch. The positioning of those lights is adjustable. Power to operate the litter lights is from the No. 1 and No. 2 dc primary buses through circuit breakers on the mission readiness circuit breaker panel marked **NO**. 1 LTR LTS and **NO. 2 LTR LTS**. The lights are operated from a split bus to provide one light at each litter in case of a single dc primary bus failure.

**4.26.3 Litter Support Installation.** The upper litter supports are supported by a center pivot shaft and two end pivot shafts, one at each end of the support. To tilt the upper end of the support only for loading or unloading of litter patients, the center shaft remains locked to the pedestal and the end shafts are disengaged for support pivoting. This system was designed to pivot about the center shaft. Although the supports may be pivoted at either end, more effort is required when the loaded litter is installed. To install the litter supports:

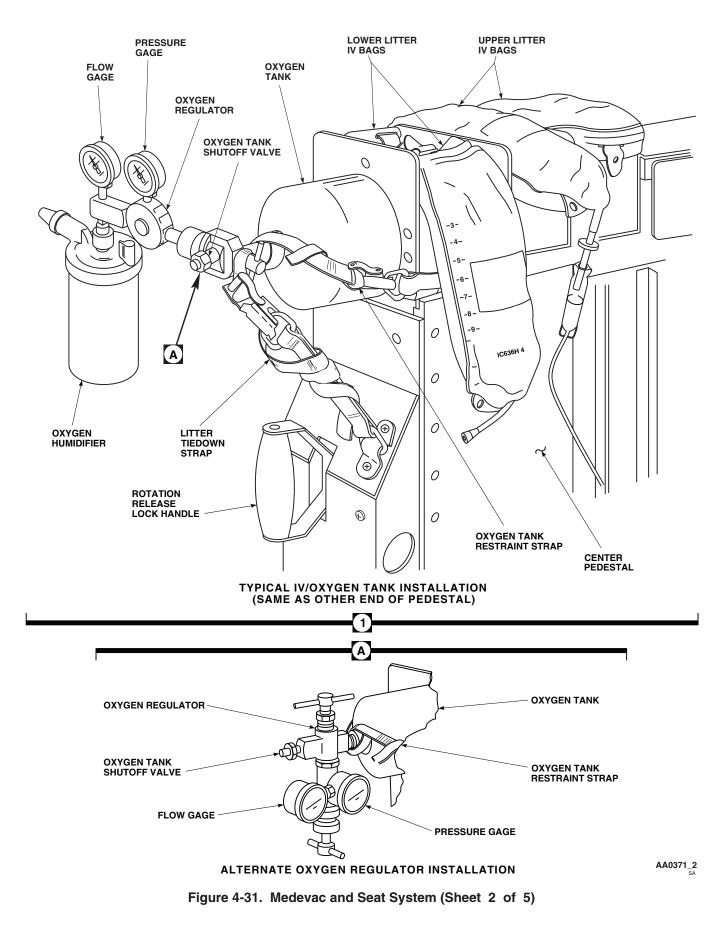
- 1. Install lower litter support:
  - a. Before installation, each center pivot shaft must be retracted and unlocked. The center pivot shaft handle must be secured in the handle retainer. End pivot handles must be in disengaged position.
  - b. Engage T-bars on litter support with split retention fittings at bottom of pedestal.

- c. Line up end pivot shafts with holes. Disengage pivot shaft lever locks and move end pivot shaft lever toward pedestal, until pivot shaft is fully inserted into pivot shaft hole on pedestal and handle lock is engaged.
- d. Repeat step c. for other end of litter support.
- 2. Install upper litter support:
  - a. Prepare support. Before installation, each center pivot pin must be unlocked and retracted, and the handle disengaged from its retainer. End pivot handles must be in disengaged position.
  - b. Tilt outer edge of litter support slightly down and engage T-bars into split retention fittings at second support hole from top of pedestal.
  - c. Raise outer edge of litter support until support is level.
  - d. Insert end pivot shaft into pedestal by pulling on pivot shaft lever lock, and moving lever toward pedestal until end pivot shaft engages partway in end pivot support hole.
  - e. Position center pivot shaft lock handle counterclockwise to horizontal.
  - f. Push center pivot shaft toward pedestal until shaft is fully inserted into center pivot shaft hole. Opposite end of litter support should be raised or lowered to help line up center shaft on support with center hole on pedestal.
  - g. Turn center pivot lock lever clockwise to horizontal.
  - h. Repeat step d. for other end of litter support. Now slide both end pivot shafts in fully by moving pivot lever lock handle to engage position.
- 3. Install litter support for ambulatory patient seating:
  - a. Prepare support as in 2a. above.



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Figure 4-31. Medevac and Seat System (Sheet 1 of 5)



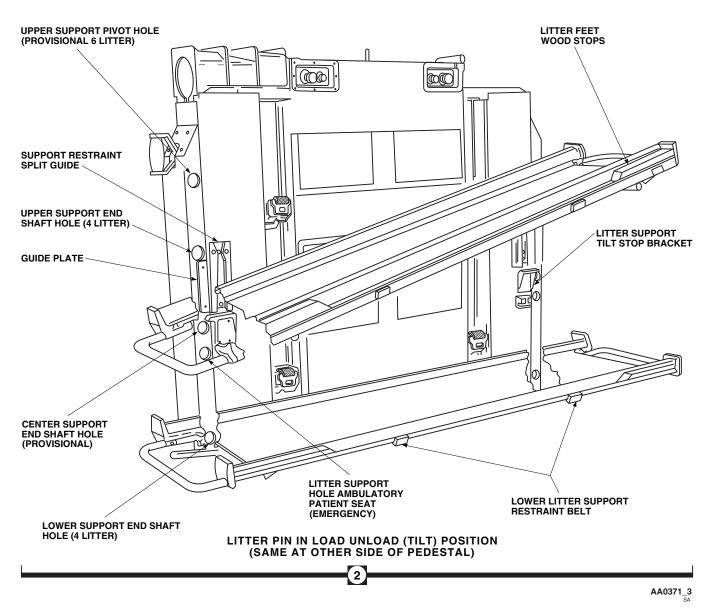


Figure 4-31. Medevac and Seat System (Sheet 3 of 5)

- b. Engage T-bar on litter pan with split retention brackets below support tilt stop brackets.
- c. Position litter support at second from bottom litter support end pivot hole on pedestal.
- d. Line up end pivot shafts with holes. Disengage pivot shaft lever lock and move

pivot shaft lever toward pedestal, until pivot shaft is fully inserted into pivot shaft hole on pedestal and handle lock is engaged.

e. Repeat step c. for other end of litter support.

**4.26.4 Litter Support Removal.** Removal of the litter support is the reverse of installation. Before removal, any

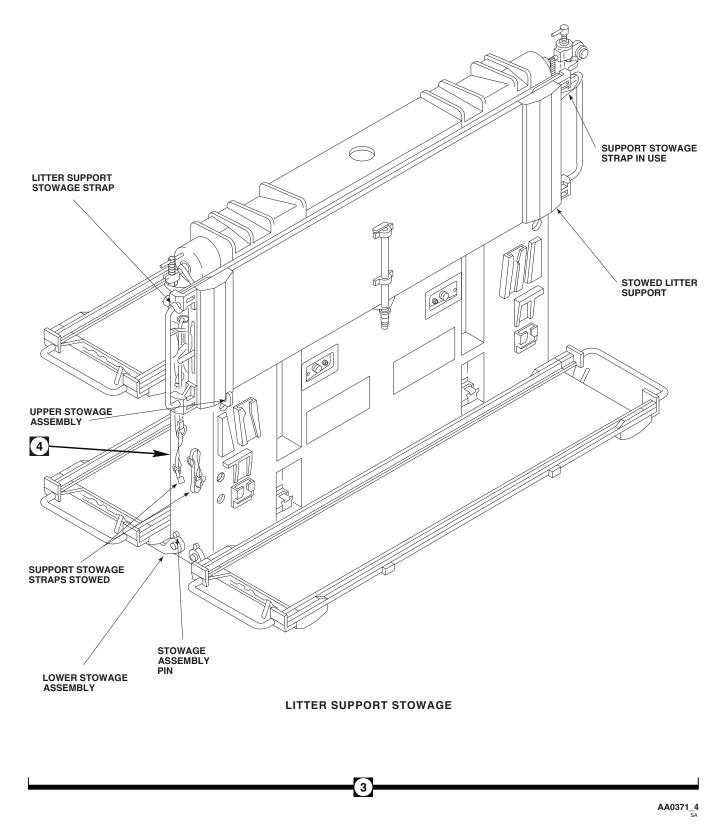


Figure 4-31. Medevac and Seat System (Sheet 4 of 5)

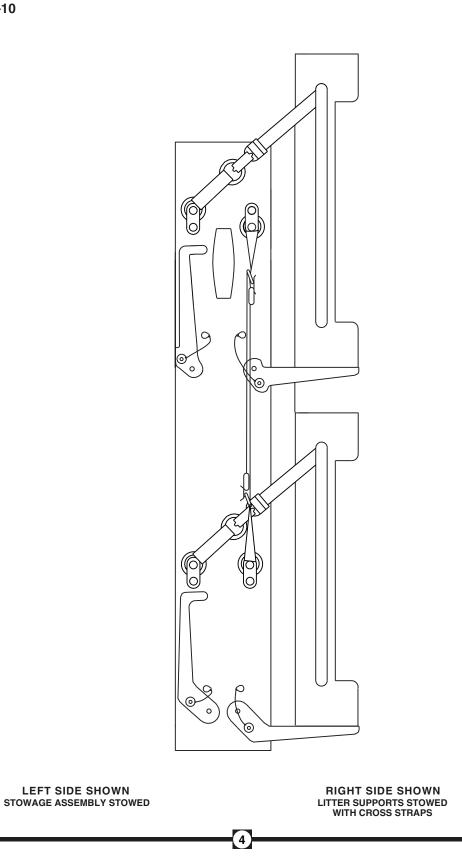


Figure 4-31. Medevac and Seat System (Sheet 5 of 5)

litters on the support should be removed and belts unlocked. If IV or oxygen is installed, make certain hoses are not tangled with supports, then proceed as required.

**4.26.5 Medevac Seats Installation.** The seat installation consists of two of the troop seats that were removed for medevac system installation. Install required number of seats at station 271.0.

4.26.6 Litter Loading and Unloading. Litters can be loaded and unloaded laterally, directly onto the litter supports, from either side of the helicopter. Whenever rescue hoist and medevac kit are installed simultaneously, the upper, right litter support should be removed from the aircraft. The lower, right support may be stowed if not actually in use. The lower right litter support shall be installed in the lowest position and used when transporting more than two litter patients or when conducting hoist operations with a stokes litter. Loading of a stokes litter patient may be facilitated by rotating the litter pedestal approximately 30° from the fly position. When returning the pedestal to the fly position the aft right corner of the litter support must be lifted to prevent interference with the lower hoist mount bracket. To load and unload litter patients, assuming the medevac kit is in the flight position (litters along longitudinal axis), do this:

- 1. Both cabin doors Open.
- Pedestal rotation lock release handle Pull handle and turn pedestal clockwise 90° (viewed from above). On helicopters with extended external range fuel tanks installed, the pedestal will rotate only 60° from center line for loading litter patients.
- 3. Release lock handle while turning pedestal. Pedestal will automatically lock in a lateral position for loading and unloading.
- 4. Release both litter support end pivot shaft on upper litters. Disengage pivot lever locks and move levers away from pedestal. Hold support with opposite hand. Release lever. End pivot shafts should rest on fitting at hole. Litter support is now ready to be loaded from either side. Select side desired. Move end pivot

release lever about 1 inch more to compress the shaft springs, which allows the shaft to clear the end guide and the litter support to be lowered at the end. During the lowering, release pivot shaft lever to allow pivot shaft spring to push shaft onto lower stop fitting.

- 5. Using two persons (one each side or end) -Place litter with patient on end of upper support and push litter into position. Note that litter feet must be trapped between wood stops on litter support. If three or more patients are to be loaded, the upper supports must be loaded first. The reverse applies to unloading.
- 6. To tilt upper litter support end, pull shaft lever lock and move lever away from pedestal at support end which is being raised. Pivot litter support to level position until pivot shaft holes are lined up with pivot shafts. Move levers toward pedestal until shaft is fully inserted into shaft holes and handle locks are engaged.
- 7. Lower litters Using two persons (one each side or end) place litter with patient on end of support and push litter into position. Note that litter feet must be trapped between wood stops on litter support.
- 8. Litter straps Extend straps (on pedestal) and engage in buckle on litter supports. Pull straps out uniformly to engage; partial pulling will require complete retraction of the belt to disengage belt lock.
- 9. Pedestal rotation lock handle Pull and turn pedestal counterclockwise 90° (viewed from above) into flight position (longitudinal axis), and release handle.
- 10. Cabin doors Close.
- 11. Unloading is reverse of loading after litter straps are removed and oxygen and IV tubes are checked to make certain tangling will not occur with litter or support.

4.26.7 IV Bags and Oxygen Tanks Installation.



The pilot must be advised when oxygen is on board, its use must be per the Surgeon General's directives, and must have oxygen regulators attached.

Provisions for IV bags and oxygen tanks are on the top of the pedestal at each end. Four IV bags may be attached to each IV/oxygen assembly. IV bag hooks at the outer end of the assembly are used for the lower litters and the inner hooks are used for the upper litters. Eyelets at the top of the bag are placed on the IV hooks and the bags are hung downward. To prevent damage to IV bags, check clearance between transmission drip pan drain tube clamps and installed IV bags. Flow adjustment and replacement will be done by the medical attendant. Oxygen tanks are inserted into the assembly, bottom first. A restraint strap is provided to prevent the tank from falling out during normal maneuvering during flight. The strap is placed across the regulator in a manner and routed as shown in Figure 4-31, to prevent the restraint strap from slipping. The strap ends are attached and drawn tight to keep the tank secure.

#### 4.26.8 Litter Support Stowage.



Storage of the litter support in the upper level stowed position can be dangerous during a crash sequence due to the release of the litter support from the carousel. Advise storage in this manner be avoided. Maintain this litter support in the installed position or place in the back of the carousel in the ambulatory level if there are no occupants along the aft bulkhead (Row 5).

The litter supports may be stowed along the center pedestal on each side, one above the other. Stowage brackets at each end of the pedestal provide lower support of the supports, and prevent the supports from moving away from the pedestal. Web straps attached to rings are used to hold the upper ends of the supports to the pedestal. Pins are used to hold the stowage brackets in a stowed position against the pedestal end. Two brackets are provided for each litter support. The top support must be stowed first, then the lower support. For reinstallation the sequence is reversed.

> 1. Lower the stowage support arm to the horizontal position and insert the support arm stowage pin through the support arm and into the center pedestal.

### NOTE

Improper positioning of the support arm stowage pin reduces the holding capability of the support arm, which may cause the support arm to shear its pivot bolt during a hard landing or aircraft mishap.

- 2. Place the litter pan in the stowed position, with the top of the litter pan against the center pedestal and the pivot support arm properly stowed.
- 3. Secure the litter pan to the center pedestal by routing the opposite side web strap around the upper portion of the litter pan handle. Secure the metal clasp to the metal ring and tighten the web strap. (Use of the opposite side web strap will reduce excess movement of the litter pan while stowed).
- 4. If only one upper litter pan is to be stowed, as in step 3, additional security may be added by routing the same side web strap around the lower portion of the litter pan handle and fastening the web strap.



# Do not store equipment between the stowed litter pan and the center pedestal.

- 5. The lower litter pan will be stowed in the same manner as in steps 1 through 3. The same side web strap may be used to secure the lower portion of the litter pan as in step 4 if only one lower litter is to be stowed.
- 6. Removal of stowed litter pans is accomplished in the reverse order of steps 1 through 4.

## 4.27 APU INLET PARTICLE SEPARATOR (IPS) KIT (HELICOPTERS WITH IPS KIT INSTALLED).

The APU IPS Kit provides APU inlet air filtration via a centrifugal particle separator unit. The separator is attached to the APU radial inlet housing and provides for collection and overboard exhausting of scavenge particles. The passive separator operation employs APU bleed air to drive an ejector pump used for particle scavenging. The IPS kit is designed to be physically compatible with both HIRSS and non-HIRSS helicopters with the T-62T-40-1 series 200/ 300 APU installations only. The kit consists of three categories of removable components:

a. Air particle separator assembly.

b. APU modification kit - Parts required to modify the APU to accept the separator assembly.

c. Airframe provisions - Parts required to install the separator assembly and provide bleed air supply and scavenge exhaust provisions.

#### 4.28 LANDING GEAR SKI KIT.



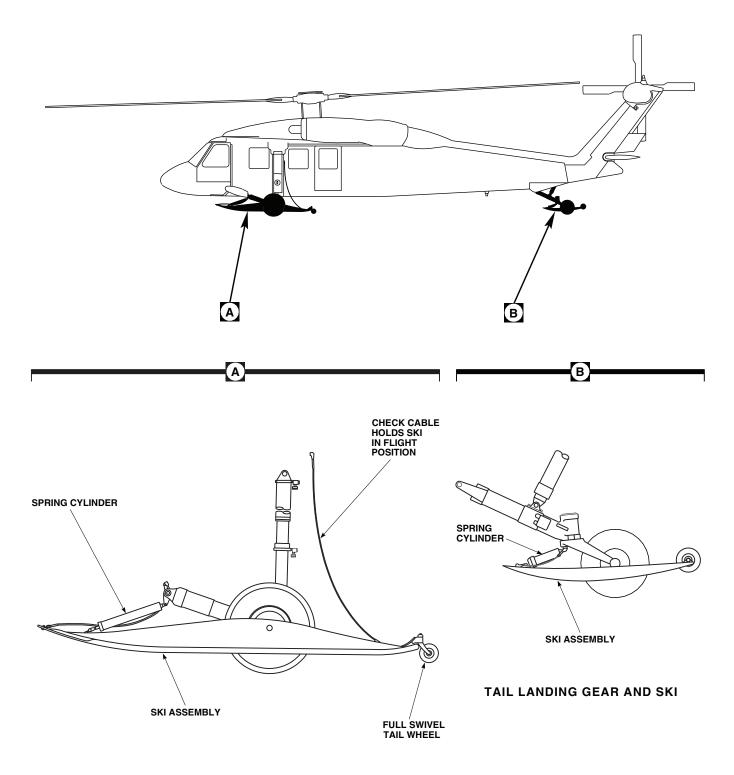
• Installation of skis requires removal of landing gear wire cutters and severely degrades the helicopter wire strike capability. Upon removal of skis, wire strike hardware shall be reinstalled, restoring helicopter to standard configuration prior to next flight.

• Cockpit entry/exit paths are partially restricted by the main skis making cockpit entry/exit slightly more difficult. Additionally, the cabin entry/exit doors are partially restricted making the loading/unloading of cargo slightly more difficult.

#### NOTE

The hinged main gear ski shall only be used on the right landing gear of helicopters equipped with rescue hoists. The hinged ski is equipped with a retraction cable. This cable may be removed if it interferes with the hoist, or other equipment, and alternative retraction methods, such as a gaff, may be used.

The skis are designed to keep the aircraft from becoming immobile when operating on snow and tundra. The ski kit consists of a fixed penetration wheel ski on each main landing gear and the tail wheel (Figure 4-32). The wheels penetrate through the ski for operation on hard surfaces. There is a full swivel spring mounted tailwheel on the aft of each main landing gear ski and a stationary tail wheel on the aft of the tailwheel ski to protect the ski during ground operation. Landing gear skis are attached to the landing gear axle. The skis have spring cylinders and check cables to retain the ski in a 5° nose-up attitude during flight.



MAIN LANDING GEAR AND SKI

FT0273A

Figure 4-32. Landing Gear Ski Configuration

#### 4.29 MICROCLIMATE COOLING SYSTEM (MCS).

The MCS provides the aircrew members a means to help maintain a lower body temperature while conducting missions in Mission Oriented Protective Posture (MOPP) IV or during hot-weather operations.

**4.29.1 MCS Components.** The MCS consists of the Microclimate Cooling Unit (MCU), umbilical cable assembly (hose assemblies and bypass control assembly) with temperature controls, and Microclimate Cooling Garment (MCG). The components (Figure 4-33) connect together to provide a complete system to allow cooled fluid to circulate through the MCG and provide lower body core temperatures for aircrew members.

4.29.1.1 Microclimate Cooling Unit (MCU). The MCU (Figure 4-34) provides chilled liquid which is pumped through assemblies to the aircrew member's MCG where metabolic heat is transferred from the aircrew member's body to the circulating fluid. The warmed fluid is then pumped back to the MCU where heat is rejected to the ambient environment. The MCU is a vapor compression cooling unit using R-134a as a refrigerant. The MCU provides 320 to 330 watts of cooling for each aircrew member. The MCU delivers cooled fluid at approximately 60°F to 72°F depending on the temperature of the external environment. The MCU is approximately 7 inches wide x 11 inches long x 6 inches high and weighs approximately 13 lbs and is secured to a mounting tray located in the cabin of the helicopter. The MCU is powered from +28 VDC source and requires 6-10 amps continuous and 12 amps peak.

**4.29.1.2 Hose Assembly.** The hose (Figure 4-35) used to route the fluid from the MCU to the aircrew member is  $7/_{16}$  inch tygon tubing. There are two (cooled fluid) hose lines connected to the aircrew member, one is for garment supply (S) flow and the other is for garment return (R) (warm fluid). The hose is encased in insulation with fittings on each end to connect the MCU, Liquid-Quick Disconnect (L-QDC), Bypass Control Assembly (BCA), and MCG. The hose assembly with insulation is approximately 2 inches in diameter and weighs approximately 0.3 lbs per foot (excluding liquid). The hose assembly has a jacket on the outside of the insulation to provide protection from the helicopter environment in the hose assembly and routed from the MCU to the BCA.

**4.29.1.3 Bypass Control Assembly (BCA).** The MCS has a bypass control assembly that utilizes an automatic bypass to allow fluid to be circulated and cooled prior to connecting to the MCG. The BCA is approximately 2 inches wide x 3 inches long x 1 inch high and weighs approximately 0.25 lb. The MCU control knob is a rotary knob that is mounted on the BCA to allow the aircrew members to adjust fluid temperature from the MCU. The BCA contains an automatic bypass valve which permits liquid pre-cooling and also provides pressure relief to protect the MCG from over pressurization.

**4.29.1.4 Liquid-Quick Disconnect (L-QDC).** The L-QDC serves as an interface between hoses from the BCA to the MCG. The L-QDC is comprised of two segments: aircraft-retained and aviator-retained. The aviator-retained portion of the L-QDC protrudes approximately 6 inches outside the aviator's outer garment. The aircraft-retained portion of the L-QDC is attached, via hoses, to the BCA. The connection of the L-QDC halves allows the cooling fluid to flow from the MCU to the MCG. The L-QDC serves as a disconnect point for normal egress and hands-free breakaway for emergency egress. The force required for emergency egress does not exceed 25 lbs. The L-QDC (Figure 4-35) is approximately 3 inches long x 2 inches wide x 0.75 inch high and weighs 0.25 lb.

#### 4.29.1.5 Microclimate Cooling Garment (MCG).

The MCG is a vest that is worn by aircrew members to provide cooling to the body. The MCG consists of over 100 feet of ⁵/₃₂ outside diameter (OD) plasticized Polyvinyl Chloride (PVC) tubing laminated between two layers of cotton fabric. The MCG is worn against the skin and has one or more pass-through devices incorporated into the other clothing items to accommodate the supply/return hoses that feed the MCG. Since the MCS is a closed-loop liquid circulating system, the effectiveness of the system depends on efficient transfer of heat between the aircrew member's skin and the fluid circulating through the smalldiameter tubes in the MCG.

**4.29.1.6 Circuit Breakers.** Power for the MCUs is provided from the No. 2 dc primary bus through circuit breakers marked **PILOT**, **CREW 1**, **COPILOT**, and **CREW 2** on the mission readiness circuit breaker panel (Figure 2-20).

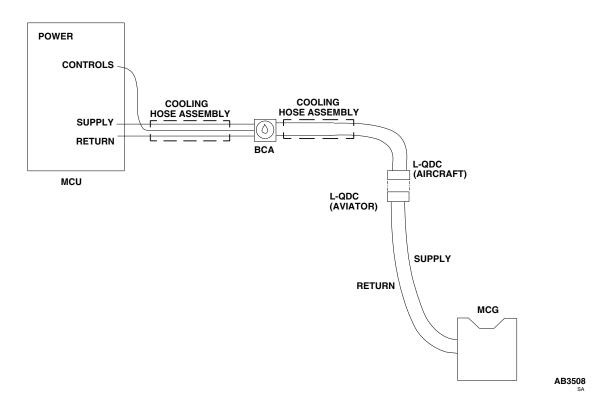


Figure 4-33. MCS Functional Diagram

### 4.29.2 MCS Operation.

### 4.29.2.1 Normal Operation.



Ensure that the mask blowers are disconnected and position the BCA MCU control knobs to OFF prior to switching from main power to APU power.

#### NOTE

- To avoid heat discomfort, turn the MCU on and allow to run for approximately 2-3 minutes before attaching the suit (MCG) side of the L-QDC to the MCU. This will cause circulation of coolant through the bypass to the MCU to reduce coolant temperature prior to coolant circulation within the MCG. Check umbilical hose assemblies for coolant leaks.
- The MCU may cycle off if the helicopter is flown close to radar emitters. The unit can

be reset by cycling the BCA MCU control knob to **OFF** and then back to the desired operating setting.

Upon entering the helicopter, the aircrew member attaches the MCG cooling hose L-QDC to the mating connector on the end of the umbilical cable assembly. After the MCG is connected to the MCU, the temperature may be adjusted for the desired cooling level by turning the BCA MCU control knob. The BCA MCU control knob has incremental detented positions **OFF**, **1-9**, and **FULL**. The higher the number selected, the greater the cooling power delivered to the MCG. Under normal shutdown conditions, turn the BCA MCU control knob to **OFF** and disconnect the suit portion of L-QDC from the umbilical cable before exiting the helicopter.

#### 4.29.2.2 Normal Egress.



Failure to use the manual release on the L-QDC may cause damage to connectors.

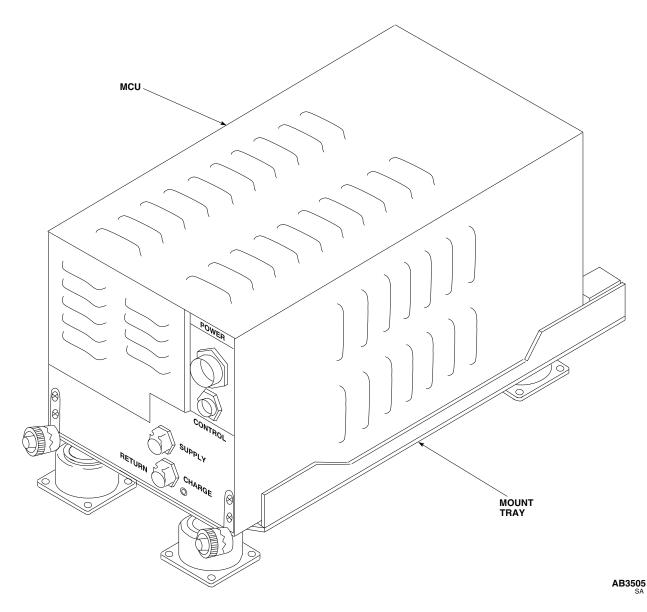


Figure 4-34. Microclimate Cooling Unit

Prior to normal egress from the helicopter, hold the airframe side electrical disconnector firmly in one hand and press the L-QDC button.

**4.29.2.3 Emergency Egress.** In the event of an emergency egress, the following procedure is recommended: Exit the helicopter as quickly as possible.

The umbilical will detach (breakaway) at the L-QDC with a moderate (5-20 lbs) application of force.

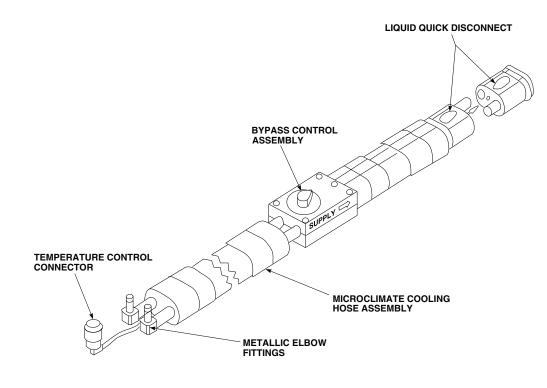


Figure 4-35. Hose Assembly

#### 4.30 MASK BLOWER.

#### NOTE

Failure of the mask blower is not criteria for mission abort.

Mate the blower connector to the blower power wire connector. There is not an on/off switch on the blower, so if helicopter power is active, the blower will operate normally. The blower power wire is normally run concurrent with the ICS cord using plastic wire ties every 8 to 12 inches. If the blower or its power source fails, the mask still provides protection. The blower provides two primary functions to the user, one being to relieve the psychological isolation effects of MOPP IV gear, the other to defog the mask under certain atmospheric conditions, usually common to lower temperatures. Operation and maintenance of the M45 Mask, Chemical and Biological can be found in TM 3-4240-341-10 and TM 3-4240-341-20&P. Use of the M45 mask blower with the M45 mask (Figure 4-36) can be found in Air Warrior TM 1-1680-377-13&P.

**4.30.1 Power Distribution Box (PDB).** The PDB is installed on the bottom of the copilot's stowage box behind the copilot's seat (Figure 4-37). The PDB provides power for the mask blowers through the Quick Disconnect Wiring Assembly (QDWA). Plug in jacks for the pilot, copilot, and crewmembers plug into the mask blowers. The PDB draws power from the No. 2 DC primary bus and is protected by the pilot's and copilot's mask circuit breaker located on the No. 2 circuit breaker panel (Figure 2-20).

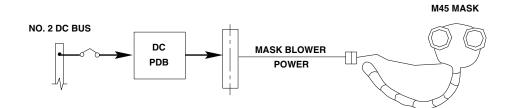


Figure 4-36. Mask Blower System

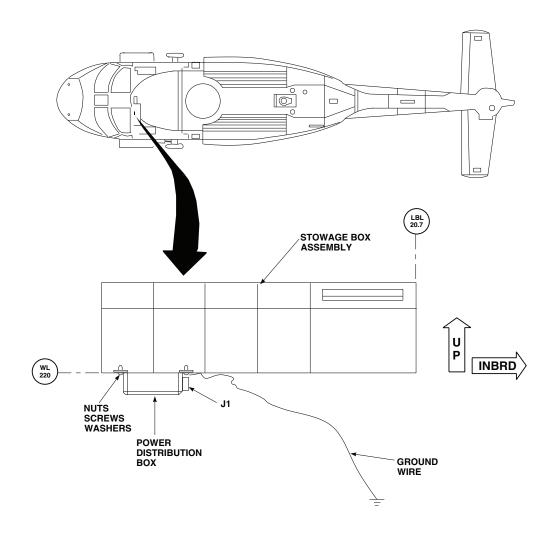


Figure 4-37. Power Distribution Box Location

## CHAPTER 5 OPERATING LIMITS AND RESTRICTIONS

## Section I GENERAL

#### 5.1 PURPOSE.

This chapter identifies or refers to all important operating limits and restrictions that shall be observed during ground and flight operations.

#### 5.2 GENERAL.

The operating limitations set forth in this chapter are the direct results of design analysis, tests, and operating experiences. Compliance with these limits will allow the pilot to safely perform the assigned missions and to derive maximum use from the helicopter.

#### NOTE

- See current Interim Statement of Airworthiness Qualification for operating limits and restrictions for EH-60A helicopters.
- See current Interim Statement of Airworthiness Qualification for operating limits and

restrictions for UH-60L helicopters 96-26723 and 97-26744 and subsequent.

#### 5.3 EXCEEDING OPERATIONAL LIMITS.

Any time an operational limit is exceeded, an appropriate entry shall be made on DA Form 2408-13-1. Entry shall state what limit or limits were exceeded, range, time beyond limits, and any additional data that would aid maintenance personnel in the maintenance action that may be required. The helicopter shall not be flown until corrective action is taken.

### 5.4 MINIMUM CREW REQUIREMENTS.

The minimum crew required to fly the helicopter is two pilots. Additional crewmembers, as required, will be added at the discretion of the commander, in accordance with pertinent Department of the Army regulations.

## Section II SYSTEM LIMITS

#### 5.5 INSTRUMENT MARKING COLOR CODES.

#### NOTE

- Instrument marking color codes may differ from actual limits.
- The appropriate digital readout shall be used as the primary source of indication as individual VIDS approaches a limit.

Operating limitations are shown as side arrows or colored strips on the instrument faceplate of engine, flight and utility system instruments (Figures 5-1 and 5-2). Those readings are shown by ascending and descending columns of multicolor lights (red, yellow, and green) measured against vertical scales. RED markings indicate the limit above or below which continued operation is likely to cause damage or shorten component life. GREEN markings indicate the safe or normal range of operation. YELLOW markings indicate the range when special attention should be given to the operation covered by the instrument.

#### 5.6 ROTOR LIMITATIONS.

It is not abnormal to observe a % **RPM 1** and **2** speed split during autorotational descent when the engines are fully decoupled from the main rotor. A speed increase of one engine from 100% reference to 103% maximum can be expected. During power recovery, it is normal for the engine operating above 100% RPM to lead the other engine. Refer to Figure 5-1 for limitations.

**5.6.1 Rotor Start and Stop Limits.** Maximum wind velocity for rotor start or stop is 45 knots from any direction.

**5.6.2 Rotor Speed Limitations.** Power off (autorotation) rotor speeds up to **120% RPM R** are authorized for use by maintenance test flight pilots during autorotational RPM checks.

## 5.7 MAIN TRANSMISSION MODULE LIMITATIONS.

a. Oil pressure should remain steady during steady state forward flight or in level hover. Momentary fluctuations in oil pressure may occur during transient maneuvers (i.e. hovering in gusty wind conditions), or when flying with pitch attitudes above  $+6^{\circ}$ . These types of oil pressure fluctuations are acceptable, even when oil pressure drops into the yellow range (below 30 psi). Oil pressure should remain steady and should be in the 45 to 55 psi range for the UH-60A/EH-60A, and 45 to 60 psi range for the UH-60L, to ensure that when fluctuations occur, they remain in the acceptable range as defined above. If oil pressure is not steady during steady state forward flight or in a level hover, or if oil pressure is steady but under 45 psi, make an entry on DA Form 2408-13-1. Sudden pressure drop (more than 10 psi) without fluctuation requires an entry on DA Form 2408-13-1.

b. A demand for maximum power from engines with different engine torque factors (ETF) will cause a torque split when the low ETF engine reaches TGT limiting. This torque split is normal. Under these circumstances, the high power engine may exceed the dual engine limit. (Example: #1 TRQ = 96% at TGT limiting, #2 TRQ is allowed to go up to 104%. Total helicopter torque = (96%+104%)/2 = 100%.

c. With transmission oil temperature operation in the precautionary range, an entry should be made on DA Form 2408-13-1 except when hovering in adverse conditions described in Chapter 8 Desert and Hot Weather Operations.

#### MAIN ROTOR OVERSPEED

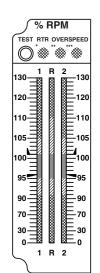
* 🎇 127%

- ** 🎇 137%
- *** 🔆 142%

ENGINE % RPM 1-2

12-SECOND TRANSIENT	105% – 107%
TRANSIENT	101% – 105%
CONTINUOUS	95% – 101%
TRANSIENT	91% – 95%

AVOID OPERATIONS IN 20% – 40% AND 60% – 90% RANGE EXCEPT DURING START AND SHUTDOWN



#### **MAIN ROTOR % RPM R**

POWER ON

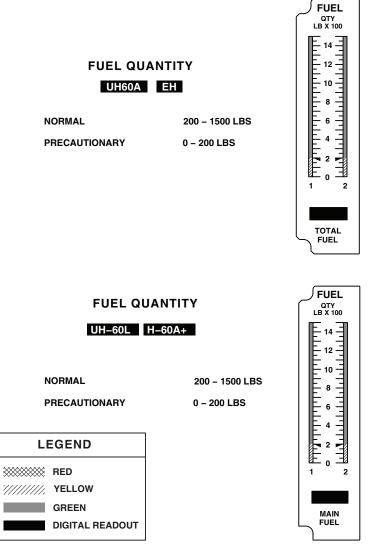
 TRANSIENT
 101% - 107%

 CONTINUOUS
 95% - 101%

 TRANSIENT
 91% - 95%

#### POWER OFF (AUTOROTATION)

MAXIMUM	110%
TRANSIENT	105% – 110%
NORMAL	90% – 105%



AA0034

Figure 5-1. Instrument Markings (Sheet 1 of 2)

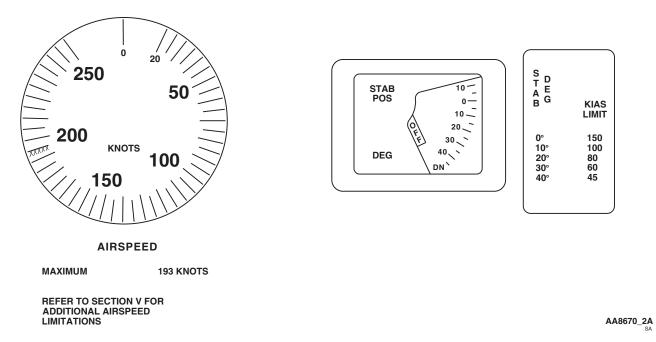
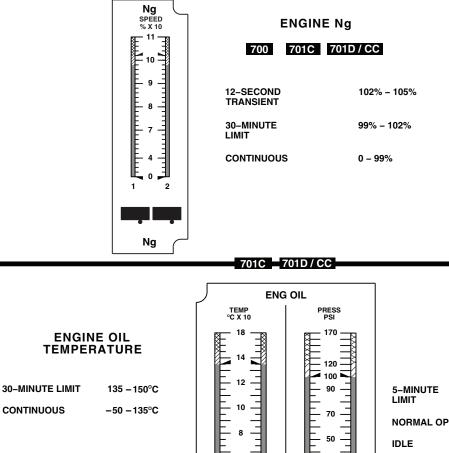


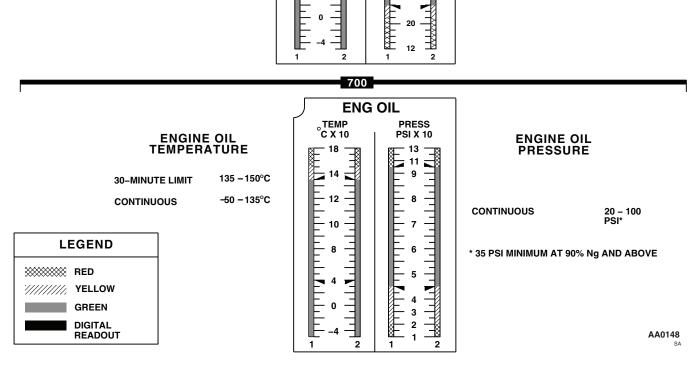
Figure 5-1. Instrument Markings (Sheet 2 of 2)



CONTINUOUS

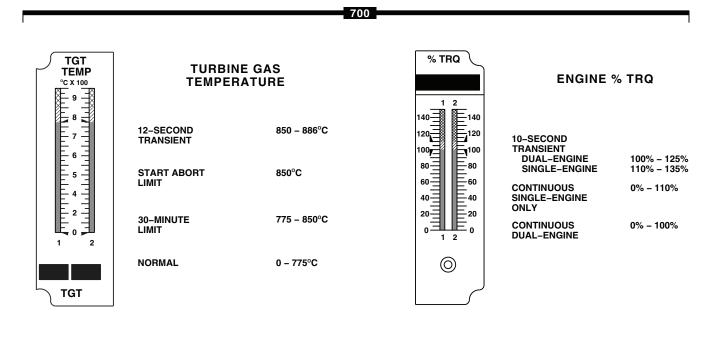




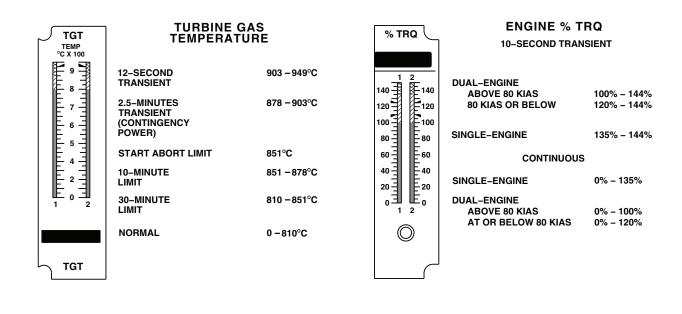


30

Figure 5-2. Instrument Markings (Sheet 1 of 3)



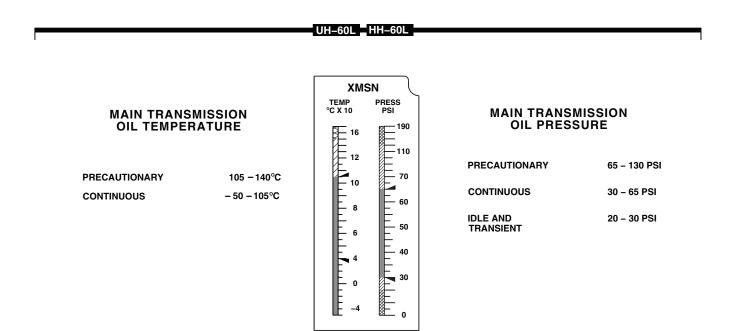
#### 701C 701D / CC



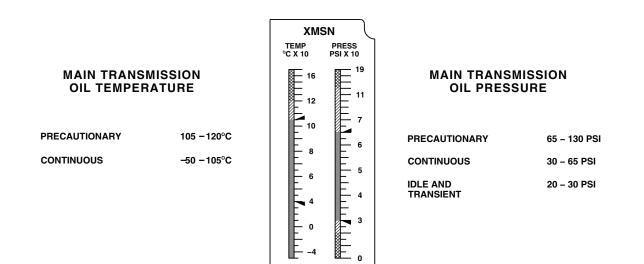
LEGEND	
	NOTE
XXXXXXX RED	HELICOPTERS PRIOR TO S / N 91-26354 THAT
'/////// YELLOW	ARE NOT EQUIPPED WITH IMPROVED MAIN
GREEN	ROTOR FLIGHT CONTROLS ARE FURTHER RESTRICTED ABOVE 80 KIAS TO DUAL– ENGINE CONTINUOUS TORQUE LIMITS
DIGITAL READOUT	AS INDICATED BY A PLACARD ON THE INSTRUMENT PANEL. SEE FIGURE 5-4.

Figure 5-2. Instrument Markings (Sheet 2 of 3)

AA0180A



#### UH-60A EH HH-60A H-60+



## AA0183A

Figure 5-2. Instrument Markings (Sheet 3 of 3)

## Section III POWER LIMITS

#### 5.8 ENGINE LIMITATIONS.

**5.8.1 Engine Power Limitations. 700** The limitations which are presented in Figure 5-2, present absolute limitations, regardless of atmospheric conditions. For variations in power available with temperature and pressure altitude, refer to the TORQUE AVAILABLE charts in Chapter 7.

#### 5.8.2 Engine Power Limitations. 701C 701D/CC

a. The limitations which are presented in Figure 5-2, present absolute limitations regardless of atmospheric conditions. For variations in power available with temperature and pressure altitude, refer to TORQUE AVAILABLE charts in Chapter 7A.

b. Helicopters prior to S/N 91-26354 that are not equipped with improved main rotor flight controls are further restricted above 80 KIAS to dual-engine continuous torque limits as indicated by a placard (Figure 5-3) on the instrument panel.

**5.8.3 Engine % RPM Limitations.** Transient **% RPM 1** or **2** operation in yellow range (101% to 105%) is not recommended as good operating practice. However, no damage to either engine or drive train is incurred by operation within this range. Momentary transients above 107% **RPM 1** or **2** are authorized for use by maintenance test pilots during autorotational rpm checks.

#### 5.8.4 Engine Starter Limits.

a. The pneumatic starter is capable of making the number of consecutive start cycles listed below, when exposed to the environmental conditions specified, with an interval of at least 60 seconds between the completion of one cycle and the beginning of the next cycle. A starting cycle is the interval from start initiation and acceleration of the compressor, from zero rpm, to starter dropout. The 60second delay between start attempts applies when the first attempt is aborted for any reason, and it applies regardless of the duration of the first attempt. If motoring is required for an emergency, the 60-second delay does not apply.

b. At ambient temperatures of  $15^{\circ}$ C ( $59^{\circ}$ F) and below, two consecutive start cycles may be made, followed by a 3-minute rest period, followed by two additional consecutive start cycles. A 30-minute rest period is then required before any additional starts. c. At ambient temperatures above  $15^{\circ}$  up to  $52^{\circ}$ C ( $59^{\circ}$  up to  $126^{\circ}$ F), two consecutive start cycles may be made. A 30-minute rest period is then required before any additional start cycles.

#### 5.9 PNEUMATIC SOURCE INLET LIMITS.

The minimum ground-air source (pneumatic) required to start the helicopter engines is 40 psig and 30 ppm at 149°C (300°F). The maximum ground-air source to be applied to the helicopter is 50 psig at 249°C (480°F), measured at the external air connector on the fuselage.

#### 5.10 ENGINE START LIMITS.



Engine start attempts at or above a pressure altitude of 701C 701D/CC 18,000 feet or 700 20,000 feet could result in a Hot Start.

Crossbleed starts shall not be attempted unless the #1 ENG ANTI-ICE ON or #2 ENG ANTI-ICE ON advisory does not appear, and operating engine must be at 90% Ng SPEED or above and rotor speed at 100% RPM R. When attempting single-engine starts at pressure altitudes above 14,000 feet, press the start switch with the ENG POWER CONT lever OFF, until the maximum motoring speed (about 24%) is reached, before going to IDLE. Engine starts using APU source may be attempted when within the range of FAT and pressure altitude of Figure 5-4.

#### 5.11 ENGINE OVERSPEED CHECK LIMITATIONS.

Engine overspeed check in flight is prohibited. Engine overspeed checks, on the ground, are authorized by designated maintenance personnel only.

#### 5.12 FUEL LIMITATIONS.

a. Fuel boost pumps shall be off except as required by emergency procedures and the following limitations: Boost pumps shall be on when operating with JP-4 or equivalent (as specified in Operator's Manual) at 5000 feet pressure altitude and above; when operating in crossfeed with JP-4 at any altitude; during external ERFS transfer operations

	DUAL-ENGINE TORQUE LIMITS – % TORQUE										
FAT, ° C –20 –10 0 10 20 30						30	40	50	FAT, °	FAT, ° C	
	20	60	58	56	53	51	49	48	46	20	
	18	66	63	61	59	56	54	52	50	18	
F	16	72	69	66	64	61	59	57	55	16	E
1000	14	79	75	73	70	67	65	62	60	14	1000
ALT 1	12	86	82	79	76	73	70	68	66	12	E
	10	93	89	85	83	80	77	74	71	10	ALT
PRESSURE	8		97	93	90	86	83	81	77	8	PRESSURE
<u>ชั</u> 6 97 93				90	87	83	6	SSI			
ш 5 100 97 93					93	90	87	5	ЯË		
4 97						97	94	91	4	ויין	
3 100% TORQUE 2000 FT & BELOW					97	95	3				
FAT, ° C –20 –10 0 10 20 30				30	40	50	FAT, °	с			

HELICOPTERS PRIOR TO S / N 91-26354 NOT EQUIPPED WITH IMPROVED MAIN ROTOR FLIGHT CONTROLS.

AA0245

#### Figure 5-3. Dual-Engine Torque Limitations at Airspeeds Above 80 KIAS 701C 701D/CC

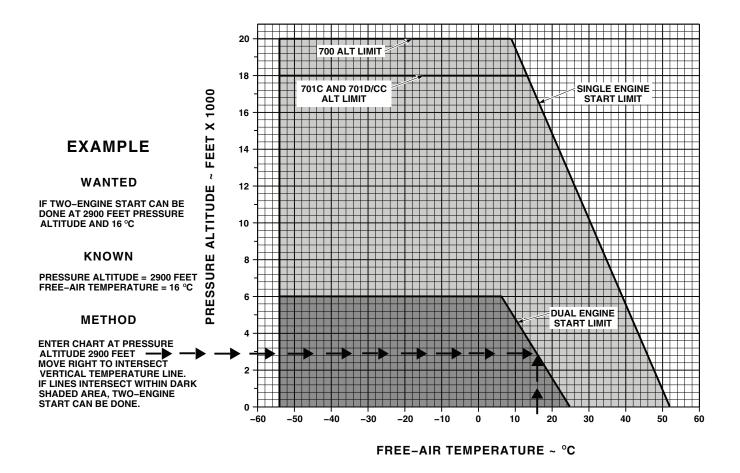
(ERFS utilizing engine bleed air only) regardless of fuel type.



Due to fuel volatility, when converting from JP-4 to JP-5/JP-8, three helicopter refueling operations must be completed before performing operations with fuel boost pumps off.

b. When a helicopter operating with JP-4 is restarted within 2 hours of engine shutdown and the air temperature is above  $21^{\circ}$ C (70°F), a minimum of 2 minutes of dual engine ground operation at 100% **RPM R** is required prior to takeoff to purge possible hot fuel from engine nacelle area.

## **ENGINE START ENVELOPE**



AB3666

Figure 5-4. Engine Start Envelope

### Section IV LOADING LIMITS

#### 5.13 CENTER OF GRAVITY LIMITATIONS.

Center of gravity limits for the helicopter to which this manual applies and instructions for computation of the center of gravity are contained in Chapter 6.

#### 5.14 WEIGHT LIMITATIONS.

HELICOPTER	MAXIMUM WEIGHT
UH-60A	20,250
EH-60A	20,250
UH-60A (paragraph a.)	22,000
EH-60A (paragraph a.)	22,000
UH-60L	22,000
Helicopters with seven- lug wheels (paragraph e.)	20,500
UH-60L external lift mis- sion (paragraph c.)	23,500
ESSS helicopter on ferry mission (paragraph b.)	24,500

a. UH-60A and EH-60A maximum gross weight can be extended from 20,250 pounds to 22,000 pounds only when wedge mounted pitot-static probes and either/or MWO 55-1520-237-50-58 or MWO 1-1520-237-50-73 are installed.

b. Airworthiness release required.

c. External lift missions above 22,000 pounds can only be flown with cargo hook loads above 8,000 pounds and up to 9,000 pounds.

d. Maximum weight is further limited by cargo floor maximum capacity of 300 pounds per square foot. Refer to Chapter 6.

e. Ground operations with seven-lug wheels are limited to gross weights less than 20,500 pounds. Fourteen-lug

wheels shall be utilized during ground operations when operating at or above gross weights of 20,500 pounds.

#### 5.15 STOWAGE PROVISIONS.

Maximum capacity for each storage compartment is 125 pounds.

#### 5.16 CABIN CEILING TIEDOWN FITTINGS.

The four cabin ceiling tiedown fittings have a limited load capability of 4,000 pounds.

#### 5.17 CARGO HOOK WEIGHT LIMITATION.

#### NOTE

UH-60L helicopter will require an entry on DA Form 2408-13-1 requiring inspection following the first mission carrying an external cargo hook load exceeding 8,000 pounds.

The external load limit of the airframe shall not be exceeded when using either cargo hook (P/N 70800-02503-111 or P/N 70800-02503-113).

HELICOPTER/CARGO	MAXIMUM CARGO
HOOK	WEIGHT
UH-60A with either cargo	8,000 lbs

hook	
UH-60L with cargo hook P/N 70800-02503-111	9,000 lbs
UH-60L with cargo hook P/N 70800-02503-113	9,000 lbs

#### 5.18 RESCUE HOIST WEIGHT LIMITATIONS.

The maximum weight that may be suspended from the rescue hoist is 600 pounds.

### Section V AIRSPEED LIMITS

#### 5.19 AIRSPEED OPERATING LIMITS.

The airspeed operating limits charts (Figures 5-5, 5-6, and 5-7) define velocity never exceed (Vne) as a function of altitude, temperature, and gross weight. The dashed lines represent the Mach limited airspeeds due to compressibility effects. Additional airspeed limits not shown on the charts are:

a. Maximum airspeed with external cargo hook loads greater than 8,000 pounds and a corresponding gross weight greater than 22,000 pounds will vary due to the external load physical configuration, but shall not exceed 120 KIAS.

b. Maximum airspeed for one engine inoperative is 130 KIAS.

c. Maximum airspeed for autorotation at a gross weight of 16,825 pounds or less is 150 KIAS.

d. Maximum airspeed for autorotation at a gross weight of greater than 16,825 pounds is 130 KIAS.

e. Sideward/rearward flight limits. Hovering in winds greater than 45 knots (35 knots with external ERFS) from the sides or rear is prohibited. Sideward/rearward flight into the wind, when combined with windspeed, shall not exceed 45 knots (35 knots with external ERFS).

f. SAS inoperative airspeed limits:

(1) One SAS inoperative - 170 KIAS.

(2) Two SAS inoperative - 150 KIAS.

(3) Two SAS inoperative in IMC - 140 KIAS.

g. Hydraulic system inoperative limits:

(1) One hydraulic system inoperative - 170 KIAS.

(2) Two hydraulic systems inoperative - 150 KIAS.

(3) Two hydraulic systems inoperative in IMC - 140 KIAS.

h. Searchlight and landing light airspeed limits.

(1) Landing light. If use is required, the landing light must be extended prior to reaching a maximum forward

airspeed of 130 KIAS. With landing light extended, airspeed is limited to 180 KIAS.

(2) Searchlight. If use is required, the searchlight must be extended prior to reaching a maximum forward airspeed of 100 KIAS. With searchlight extended, airspeed is limited to 180 KIAS.

i. The maximum airspeed for autorotation shall be limited to 100 KIAS with Volcano installed.

j. Maximum airspeed with skis installed is 155 KIAS.

## 5.20 FLIGHT WITH CABIN DOOR(S)/WINDOW(S) OPEN.

The following airspeed limitations are for operating the helicopter in forward flight with the cabin doors/window open:

a. Cabin doors.

(1) Cabin doors may be fully open up to 100 KIAS with soundproofing installed aft of station 379.

(2) Cabin doors may be fully open up to 145 KIAS with soundproofing removed aft of station 379 or with soundproofing secured properly.

(3) The doors will not be intentionally moved from the fully open or closed position in flight. The cabin doors may be opened or closed during hovering flight. The cabin doors must be closed or fully opened and latched before forward flight. Should the door inadvertently open in flight, it may be secured fully open or closed.

b. Gunner's window(s) may be fully open up to 170 KIAS.

c. Cockpit doors sliding windows will not be opened or closed during flight except during hover.

d. Flight with cockpit door(s) removed is prohibited.

e. Flight with cabin door(s) open is not authorized with Volcano installed.

#### 5.21 AIRSPEED LIMITATIONS FOLLOWING FAILURE OF THE AUTOMATIC STABILATOR CONTROL SYSTEM.

a. Manual control available. If the automatic stabilator control system fails in flight and operation cannot be restored:

## **AIRSPEED OPERATING LIMITATIONS**

### EXAMPLE

#### WANTED

MAX IAS FOR VARIOUS TEMPS, PRESSURE ALTITUDE AND GROSS WEIGHTS

#### KNOWN

FAT = - 20 °C PRESSURE ALTITUDE = 4000 FEET. GROSS WEIGHT = 18,000 POUNDS.

#### METHOD

ENTER FAT AT -20 °C. MOVE RIGHT TO PRESSURE ALTITUDE 4000 FEET. MOVE DOWN TO 18.000 POUNDS GROSS WEIGHT **OR MACH LIMIT** FAT WHICHEVER IS ENCOUNTERED FIRST, IN THIS CASE 18,000 POUNDS IS ENCOUNTERED FIRST. MOVE LEFT TO READ 186 KNOTS.

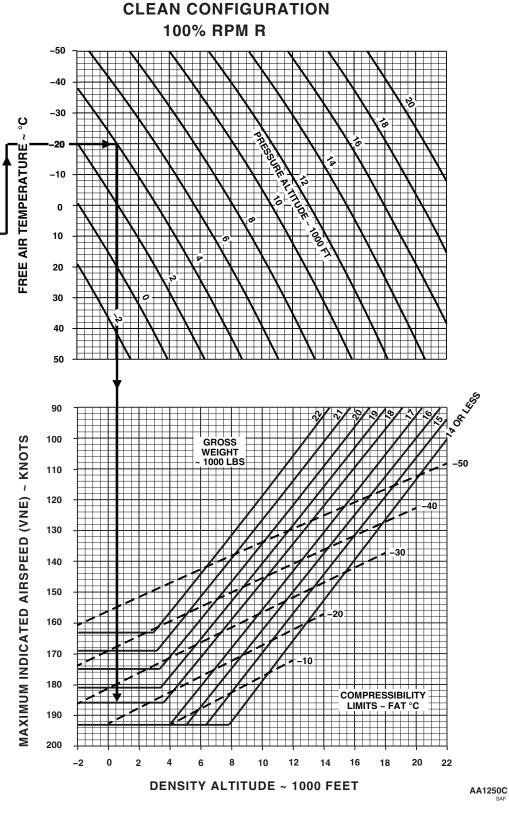
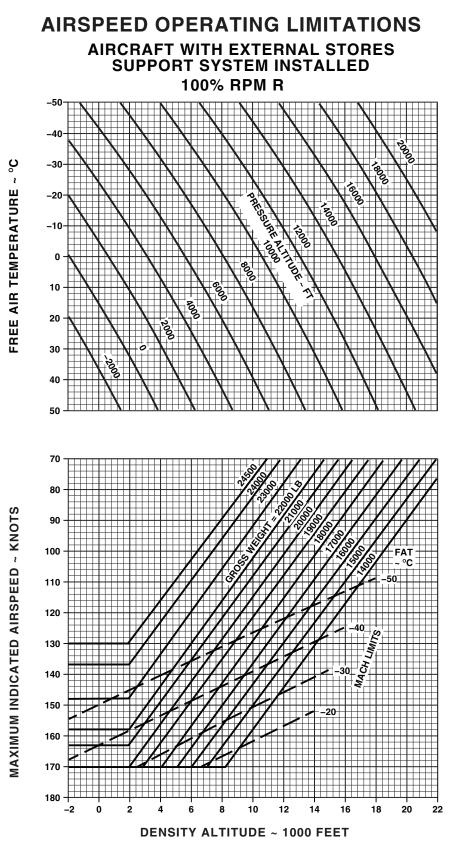
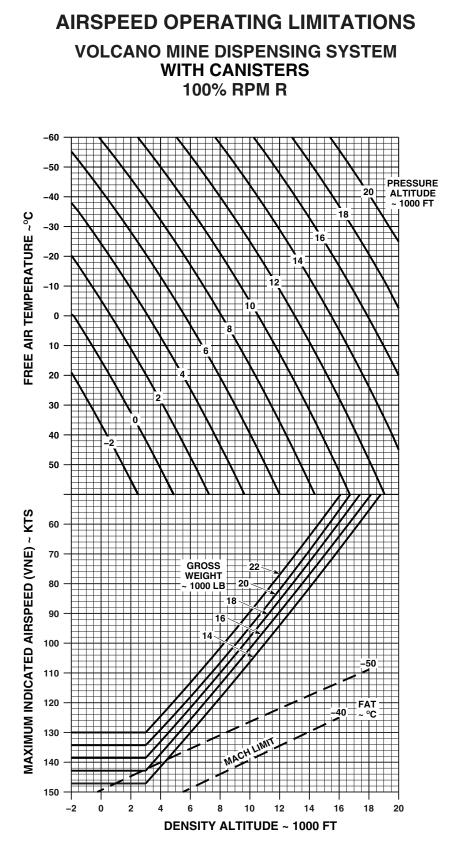


Figure 5-5. Airspeed Operating Limits



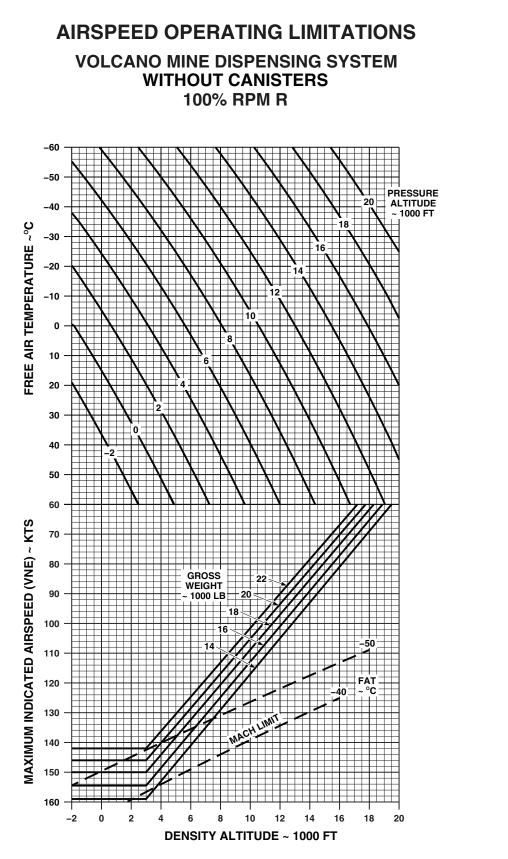
AA1251B

Figure 5-6. Airspeed Operating Limits - ESSS



AA9440A

Figure 5-7. Airspeed Operating Limits - Volcano (Sheet 1 of 2)



AA9441A

Figure 5-7. Airspeed Operating Limits - Volcano (Sheet 2 of 2)

(1) The stabilator shall be set full down at speeds below 40 KIAS.

(2) The stabilator shall be set at  $0^{\circ}$  at speeds above 40 KIAS.

(3) Autorotation airspeed shall be limited to 120 KI-AS at all gross weights.

b. Manual control not available. The placard airspeed limits shall be observed as not-to-exceed speed (powered flight and autorotation), except in no case shall the autorotation limit exceed 120 KIAS.

## Section VI MANEUVERING LIMITS

#### 5.22 PROHIBITED MANEUVERS.

a. Hovering turns greater than  $30^{\circ}$  per second are prohibited. Intentional maneuvers beyond attitudes of  $\pm 30^{\circ}$  in pitch or over  $60^{\circ}$  in roll are prohibited.

b. Simultaneous moving of both ENG POWER CONT levers to IDLE or OFF (throttle chop) in flight is prohibited.

c. Rearward ground taxi is prohibited.

#### 5.23 RESTRICTED MANEUVERS.

**5.23.1 Manual Operation of the Stabilator.** Manual operation of the stabilator in flight is prohibited except as required by formal training and maintenance test flight requirements or as alternate stabilator control in case the **AUTO** mode malfunctions.

**5.23.2 Downwind Hovering.** Prolonged rearward flight and downwind hovering are to be avoided to prevent accumulation of exhaust fumes in the helicopter and heat damage to windows on open cargo doors.

#### 5.23.3 Maneuvering Limitations.

#### NOTE

Maneuvers entered from a low power setting may result in transient droop of 5% **RPM R** or greater.

a. The maneuvering limits of the helicopter other than as limited by other paragraphs within this section are always defined by main rotor blade stall. Stall has not been encountered in one G flight up to the airspeeds shown in chart Figure 5-5 for helicopters without ESSS installed and Figure 5-6 for helicopters with ESSS installed.

b. The blade stall chart (Figure 5-8), while not a helicopter limitation, provides the level flight angle of bank at which blade stall will begin to occur as a function of airspeed, gross weight, pressure altitude, and temperature. When operating near blade stall, any increase in airspeed, load factor (bank angle), turbulence, or abrupt control inputs will increase the severity of the stall. Fully developed stall will be accompanied by heavy four-per-rev vibration, increasing torque, and loss of altitude. Recovery is always accomplished by reducing the severity of the maneuver, that is by reducing collective, reducing airspeed, and/or reducing the angle of bank. Maneuvering flight which results in severe blade stall and significant increase in 4-per-rev vibration is prohibited.

#### 5.23.3.1 High-Speed Yaw Maneuver Limitation.

Above 80 KIAS avoid abrupt, full pedal inputs to prevent excess tail rotor system loading.

#### 5.23.3.2 Limitations for Maneuvering With Sling

**Loads.** Maneuvering limitations with a sling load (Figure 5-9) is limited to a maximum of  $30^{\circ}$  angle of bank in forward flight. Side flight is limited by bank angle and is decreased as airspeed increases. Rearward flight with sling load is limited to 35 knots.

#### 5.23.3.3 Limitations for Maneuvering With Rescue

**Hoist Loads.** Maneuvering limitations with a rescue hoist load (Figure 5-9) is limited to maximum of 30° angle of bank in forward flight. Side flight is limited by bank angle and is decreased as airspeed is increased. Rearward flight with hoist load is limited to 35 knots. Rate of descent is limited to 1,000 feet-per-minute.

**5.23.3.4 Bank Angle Limitation.** Bank angles shall be limited to 30° when a **PRI SERVO PRESS** caution appears.

#### 5.24 LANDING GEAR LIMITATIONS.

Do not exceed a touchdown sink rate of 540 feet-perminute on level terrain and 360 feet-per-minute on slopes with gross weights of up to 16,825 pounds; above 16,825 pounds gross weight 300 feet-per-minute on level terrain and 180 feet-per-minute on slopes.

#### 5.25 LANDING SPEED LIMITATIONS.

Maximum forward touchdown speed is limited to 60 knots ground speed on level terrain.

#### 5.26 SLOPE LANDING LIMITATIONS.

The following slope limitations apply regardless of gross weight or CG, with or without ESSS/ERFS.



When performing slope landings with External Extended Range Fuel System Tanks, ensure tank to ground clearance.

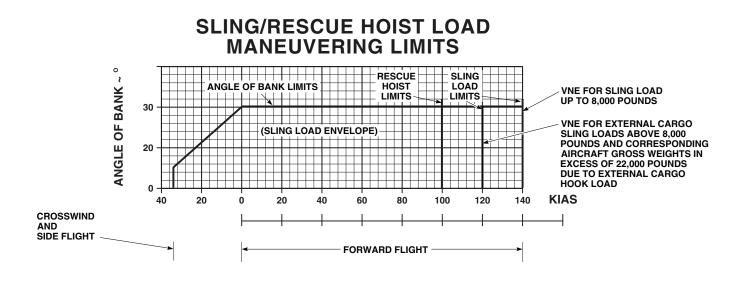
## AIRSPEED FOR ONSET OF BLADE STALL

#### **EXAMPLE**

## LEVEL FLIGHT 100% RPM R

#### WANTED 20 MAX RECOMMENDED AIRSPEED FOR KNOWN ANGLE OF BANK 18 ᇤ KNOWN 16 ALTITUDE ~ 1000 FAT = 20 °C 14 PRESSURE ALTITUDE = 5,000 FEET. GROSS WEIGHT 12 = 20,000 POUNDS ANGLE OF BANK = 20 DEGREES 10 METHOD 8 PRESSURE ENTER PRESSURE ALTITUDE AT 5,000 FEET. MOVE 6 **RIGHT TO 20 DEGREES FAT.** MOVE DOWN TO GROSS WEIGHT 20,000 POUNDS. MOVE л LEFT TO 20 DEGREES ANGLE OF BANK. MOVE VERTICALLY DOWN TO READ INDICATED 2 **AIRSPEED OF 135 KNOTS.** FAT ~ °C n 60 40 20 40 - 20 4 -40 -60 ANGLE OF BANK ~ DEG +++ **∏**0∶ 10 20 VNE 30 NE NE 50 24.5 **GROSS WEIGHT** ~ 1000 LBS ╈ 22 **60**+ ++20 NOTE WITH ESSS INSTALLED, REDUCE AIRSPEED 18 BY 6 KNOTS. 16 40 200 180 160 140 120 100 80 60 AA1306B **INDICATED AIRSPEED ~ KTS**

Figure 5-8. Airspeed for Onset of Blade Stall



AA0668A

Figure 5-9. Sling/Hoist Load Maneuvering Limitations

#### NOTE

Because of the flat profile of the main transmission and forward location of both transmission oil pumps, transmission oil pressure will drop during nose-up slope operations. At slope angle of  $10^{\circ}$ , an indicated oil pressure of 30 to 35 psi is normal; and at a  $15^{\circ}$  slope angle, a pressure in the range of 10 to 15 psi is normal due to pitching of the helicopter.

a.  $15^{\circ}$  nose-up, right wheel up or left wheel upslope. The slope limitations shall be further reduced by  $2^{\circ}$  for every 5 knots of wind.

#### NOTE

The low fuel pressure indicator light(s) may intermittently light when the helicopter returns to a neutral or positive attitude after extended operation at nose down attitudes with fuel boost pumps off. This may also occur during a climb to high altitude followed by a pitch-up maneuver. If the light extinguishes immediately, no action is required by the pilot.

b.  $6^{\circ}$  nose downslope. Landing in downslope conditions with tail winds greater than 15 knots shall not be conducted. A low-frequency oscillation may occur when landing nose-down on a slope with the cyclic near the aft stop.

c. The main gearbox may be operated up to 30 minutes at a time with pressure fluctuations when the helicopter is known to be at a nose-up attitude (i.e., slope landings or hover with extreme aft CG).

d. When attempting a nose upslope landing at gross weights in excess of 16,000 pounds with skis installed, the parking brake may not hold the helicopter in position. The pilot should be prepared to use the toe brakes.

e. Slope landings with skis installed are limited to  $10^{\circ}$  nose-up and right wheel or left wheel upslope. The slope limitation shall be further reduced by  $2^{\circ}$  for every 5 knots of wind above 12 knots.

#### 5.27 FLIGHT IN INSTRUMENT METEOROLOGICAL CONDITIONS (IMC).

This helicopter is qualified for operation in IMC.

#### 5.28 FLIGHT IN ICING CONDITIONS.

a. When the ambient air temperature is  $4^{\circ}C$  (39°F) or below and visible liquid moisture is present, icing may occur. Icing severity is defined by the liquid water content (LWC) of the outside air and measured in grams per cubic meter (g/m3).

(1) Trace:	LWC 0 to 0.25 g/m3
(2) Light:	LWC 0.25 to 0.5 g/m3
(3) Moderate:	LWC 0.5 to 1.0 g/m3
(4) Heavy:	LWC greater than 1.0 g/m3

b. Helicopters with the following equipment installed, operational, and turned on are permitted to fly into trace or light icing conditions. Flight into light icing is not recommended without the blade deice kit. Flight into moderate icing shall comply with paragraph 5.28 c.

- (1) Windshield Anti-ice.
- (2) Pitot Heat.
- (3) Engine Anti-ice.
- (4) Engine Inlet Anti-ice Modulating Valve.
- (5) Insulated Ambient Air Sensing Tube.

c. For flight into moderate icing conditions, all equipment in paragraph 5.28 b. and blade deice kit must be installed, operational, and turned on. Flight into heavy or severe icing is prohibited.

d. Helicopters equipped with blade erosion kit are prohibited from flight into icing conditions.

# 5.29 ENGINE AND ENGINE INLET ANTI-ICE LIMITATIONS.

At engine power levels of 10% **TRQ** 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 (1900 fpm or greater), or ground operation below 100% RPM R, during icing conditions. The cabin heating system should be turned off before initiating a high rate of descent.

## 5.30 BACKUP HYDRAULIC PUMP HOT WEATHER LIMITATIONS.

During prolonged ground operation of the backup pump using MIL-H-83282 or MIL-H-5606 with the rotor system static, the backup pump is limited to the following temperature/time/cooldown limits because of hydraulic fluid overheating.

FAT °C (°F)	Operating Time (Minutes)	Cooldown Time (Pump Off) (Minutes)
-54° - 32° (-65° - 90°)	Unlimited	
33° - 38° (91° - 100°)	24	72
$(91^{\circ} - 100^{\circ})^{\circ}$ $(39^{\circ} - 52^{\circ})^{\circ}$ $(102^{\circ} - 126^{\circ})^{\circ}$	16	48

#### 5.31 APU OPERATING LIMITATIONS.

To prevent APU overheating, APU operation at ambient temperature of  $43^{\circ}$ C (109°F) 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  $51^{\circ}$ C (124°F).

#### 5.32 WINDSHIELD ANTI-ICE LIMITATIONS.

Windshield anti-ice check shall not be done when FAT is over  $27^{\circ}$ C ( $80^{\circ}$ F).

## 5.33 TURBULENCE AND THUNDERSTORM OPERATION.

- a. Intentional flight into severe turbulence is prohibited.
- b. Intentional flight into thunderstorms is prohibited.

c. Intentional flight into turbulence with a sling load attached and an inoperative collective pitch control friction is prohibited.

#### 5.34 AIR WARRIOR.

When flying missions in chemically contaminated environments, overwater flight, and/or extreme cold, the following applies:

a. If performing an overwater mission with the Air Warrior Overwater Gear Carrier, remove the seat back cushion to allow space for the raft. The pan cushion must remain in the seat. Failure to remove the seat back cushion may result in aft cyclic restriction.

b. When performing a mission in chemical-biological protective gear (Mission Oriented Protective Posture (MOPP) IV), the chemical protective mask reduces the field of regard to the user. This impacts the user's ability to properly identify controls and switches by sight and reduces the ability to detect ground motion cues. Users should conduct ground familiarity drills (blind switch/ control identification) and crew coordination exercises before flight. The user must strictly adhere to proper crew coordination procedures during switch identification. Prior to flight, the user should be proficient in the chemical protective mask while wearing combat gear. The pilot not on the flight controls must assist the pilot flying in identifying the visual cues required to properly control and clear the helicopter.

c. While wearing the chemical protective mask, the mask hose should be secured to the vest to eliminate potential snagging of the flight controls without restricting head movement and without crimping the hose.

## Section VIII OTHER LIMITATIONS

## 5.35 EXTERNAL EXTENDED RANGE FUEL SYSTEM KIT CONFIGURATIONS.

#### NOTE

Flight with 450-gallon ERFS tanks is prohibited unless operating under an Airworthiness Release from U.S. Army Aviation and Missile Command.

The ERFS kit shall only be utilized in the following approved configurations:

a. A 230-gallon tank installed on each inboard vertical stores pylon.

b. A 230-gallon tank installed on each outboard vertical stores pylon.

c. Four 230-gallon tanks installed, one on each inboard and each outboard vertical stores pylon.

#### 5.36 JETTISON LIMITS.

a. The jettisoning of fuel tanks in other than an emergency is prohibited.

b. The recommended external fuel tank jettison envelope is shown in Table 5-1.

c. Jettisoning with Volcano installed, if necessary, shall be accomplished at airspeeds not to exceed 110 KIAS and rates of descent not to exceed 500 fpm.

## 5.37 USE OF M60D GUN(S) WITH ERFS KIT INSTALLED.

Use of the M60D gun(s) is prohibited when external ERFS tanks are installed on the outboard vertical stores pylons, unless the external ERFS pintle mount stop is installed. Use of the M60D gun(s) is prohibited when external tanks are installed on the inboard vertical stores pylon.

#### 5.38 GUST LOCK LIMITATIONS.



Before engine operations can be performed with the gust lock engaged, all main rotor tiedowns shall be removed.

a. Dual-engine operation with gust lock engaged is prohibited.

b. Single-engine operation with gust lock engaged will be performed by authorized pilot(s) at **IDLE** only.

		-	-				-
RECOMMENDED EMERGENCY JETTISON ENVELOPE							
AIRSPEED KIAS							
	0 TO 120						120 TO Vh
LEVEL FLIGHT	SLIP INDICATOR DISPLACED NO MORE THAN ONE BALL WIDTH LEFT OR RIGHT					NO SIDESLIP BALL CENTERED	
			AIR				
DESCENT	*JETTISON BELOW 80 KIAS	80	90	100	110	120	*JETTISON ABOVE 120 KIAS
		1000	875	750	625	500	
	NOT RECOMMENDED		MAX R.	NOT RECOMMENDED			
*Not recommended because safe jettison at these conditions has not been verified by tests.							

#### Table 5-1. Recommended Emergency External Fuel Tank Jettison Envelope

c. Gust lock shall not be disengaged with engine running.

### 5.39 MAINTENANCE OPERATIONAL CHECKS.

Maintenance operational checks (MOC) will be accomplished in accordance with TM 1-1500-328-23.

#### 5.40 USE OF AN/ARC-220() HF RADIO.

If installation of the AN/ARC-220() HF radio is not in accordance with MWO 1-1520-237-50-76, an airworthiness release from U.S. Army Aviation and Missile Command is required.

# 5.41 USE OF AN/ASN-128B DOPPLER/GPS RADIO.

a. The AN/ASN-128B shall not be used as the primary source of navigation information for Instrument Flight Rule (IFR) operations in controlled airspace.

b. Use of GPS landing mode of CIS is prohibited under IMC.

### CHAPTER 6 WEIGHT/BALANCE AND LOADING

#### Section I GENERAL

#### 6.1 INTRODUCTION.

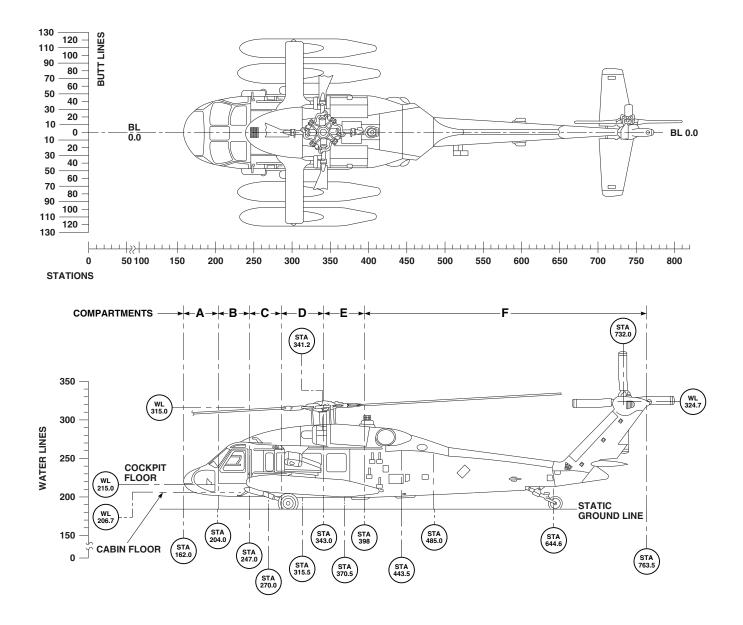
This chapter contains instructions and data to compute any combination of weight and balance for this helicopter, if basic weight and moment are known.

#### 6.2 CLASS.

Army helicopters defined in this manual are in Elass 1 and D Class 2. Additional directives governing weight and balance of Class 1 and Class 2 aircraft forms and records are contained in AR 95 series, TM 55-1500-342-23, and PAM 738-751.

# 6.3 HELICOPTER COMPARTMENT AND STATION DIAGRAM.

Figure 6-1 shows the reference datum line that is 341.2 inches forward of the centroid of the main rotor, the fuselage stations, waterlines, and buttlines. The fuselage is divided into compartments A through F. The equipment in each compartment is listed on DD Form 365-1 (Chart A) in the individual aircraft weight and balance file.



AA0374A

Figure 6-1. Helicopter Compartment and Station Diagram

#### Section II WEIGHT AND BALANCE

#### 6.4 SCOPE.

This section provides appropriate information required for the computation of weight and balance for loading an individual helicopter. The forms currently in use are the DD Form 365 series. The crewmember has available the current basic weight and moment which is obtained from DD Form 365-3 (Chart C) for the individual helicopter. This chapter contains weight and balance definitions; explanation of, and figures showing weights and moments of variable load items.

#### 6.5 WEIGHT DEFINITIONS.

a. Basic Weight. Basic weight of a helicopter is that weight which includes all hydraulic systems and oil systems full, trapped and unusable fuel, and all fixed equipment, to which it is only necessary to add the crew, fuel, cargo, and ammunition (if carried) to determine the gross weight for the helicopter. The basic weight varies with structural modifications and changes of fixed helicopter equipment.

b. Operating Weight. Operating weight includes the basic weight plus aircrew, the aircrew's baggage, and emergency and other equipment that may be required. Operating weight does not include the weight of fuel, ammunition, cargo, passengers, or external auxiliary fuel tanks if such tanks are to be disposed of during flight.

c. Gross Weight. Gross weight is the total weight of the helicopter and its contents.

#### 6.6 BALANCE DEFINITIONS.

**6.6.1 Horizontal Reference Datum.** The horizontal reference datum line is an imaginary vertical plane at or forward of the nose of the helicopter from which all horizontal distances are measured for balance purposes. Diagrams of each helicopter show this reference datum line as balance station zero.

**6.6.2 Arm.** Arm, for balance purposes, is the horizontal distance in inches from the reference datum line to the CG of the item. Arm may be determined from the helicopter diagram in Figure 6-1.

**6.6.3 Moment.** Moment is the weight of an item multiplied by its arm. Moment divided by a constant is generally used to simplify balance calculations by reducing

the number of digits. For this helicopter, moment/1000 has been used.

**6.6.4 Average Arm.** Average arm is the arm obtained by adding the weights and moments of a number of items and dividing the total moment by the total weight.

**6.6.5 Basic Moment.** Basic moment is the sum of the moments for all items making up the basic weight. When using data from an actual weighing of a helicopter, the basic moment is the total of the basic helicopter with respect to the reference datum. Basic moment used for computing DD Form 365-4 is the last entry on DD Form 365-3 for the specific helicopter. Cargo Hook Moments and Rescue Hoist Moments are shown in Figures 6-7 and 6-8, respectively.

**6.6.6 Center of Gravity.** CG is the point about which a helicopter would balance if suspended. Its distance from the reference datum line is found by dividing the total moment by the gross weight of the helicopter.

**6.6.7 CG Limits.** CG limits (Figures 6-13 and 6-14) define the permissible range for CG stations. The CG of the loaded helicopter must be within these limits at takeoff, in the air and on landing.

# 6.7 DD FORM 365-3 (CHART C) WEIGHT AND BALANCE RECORDS.

DD Form 365-3 (Chart C) is a continuous history of the basic weight, moment, and balance, resulting from structural and equipment changes in service. At all times the last weight, moment/constant, is considered the current weight and balance status of the basic helicopter.

#### 6.8 LOADING DATA.

The loading data in this chapter is intended to provide information necessary to work a loading problem for the helicopter. From the figures, weight and moment are obtained for all variable load items and are added arithmetically to the current basic weight and moment from DD Form 365-3 (Chart C) to obtain the gross weight and moment. If the helicopter is loaded within the forward and aft CG limits, the moment figure will fall numerically between the limiting moments. The effect on the CG of the expenditures in flight of such items as fuel and cargo may be checked by subtracting the weights and moment, and checking the new moment, with the CG limits chart. This check should be made to determine whether or not the CG will remain within limits during the entire flight.

#### 6.9 DD FORM 365-4 (FORM F).

There are two versions of DD Form 365-4. Refer to TM 55-1500-342-23 for completing the form.

#### Section III FUEL/OIL

6.10 FUEL MOMENTS.

# CAUTION

- Fuel transfer sequence must be carefully planned and executed in order to maintain CG within limits.
- When operating with a light cabin load or no load, it may be necessary to adjust fuel load to remain within aft CG limits. Fuel loading is likely to be more restricted on those helicopters with the HIRSS installed.

For a given weight of fuel there is only a very small variation in fuel moment with change in fuel specific weight. Fuel moments should be determined from the line on Figure 6-2 which represents the specific weight closest to that of the fuel being used. The full tank usable fuel weight will vary depending upon fuel specific weight. The helicopter fuel gage system was designed for use with JP-4, but does tend to compensate for other fuels and provide acceptable readings. When possible the weight of fuel onboard should be determined by direct reference to the helicopter fuel gages. The following information is provided to show the general range of fuel specific weights to be expected. Specific weight of fuel will vary depending on fuel temperature. Specific weight will decrease as fuel temperature rises and increases as fuel temperature decreases at the rate of approximately 0.1 lb/gal. for each 15°C change. Specific weight may also vary between lots of the same type fuel at the same temperature by as much as 0.5 lb/gal. The following approximate fuel weights at 15°C may be used for most mission planning:

Fuel Type	Specific Weight
JP-4	6.5 lb/gal.
JP-5	6.8 lb/gal.
JP-8	6.7 lb/gal.
Jet A	6.8 lb/gal.
Jet B	6.3 lb/gal.

#### EXAMPLE

WANTED FUEL MOMENT

KNOWN FUEL QUANTITY MAIN 1700 POUNDS

#### FUEL MOMENTS

ITEM	STA	WEIGHT- LB	MOMENT/1000
200 GALLON CEFS AUX TANK (IB OR OB)	320	344	110.1
230 GALLON AUX TANK (IB OR OB)	321	150	48.2
450 GALLON AUX TANK (IB ONLY)	316	234	73.9

METHOD

FOR THE MAIN TANK ENTER AT 1700 POUNDS AND MOVE RIGHT TO MAIN TANK LINE MOVE DOWN READ MOMENT / 1000 = 716

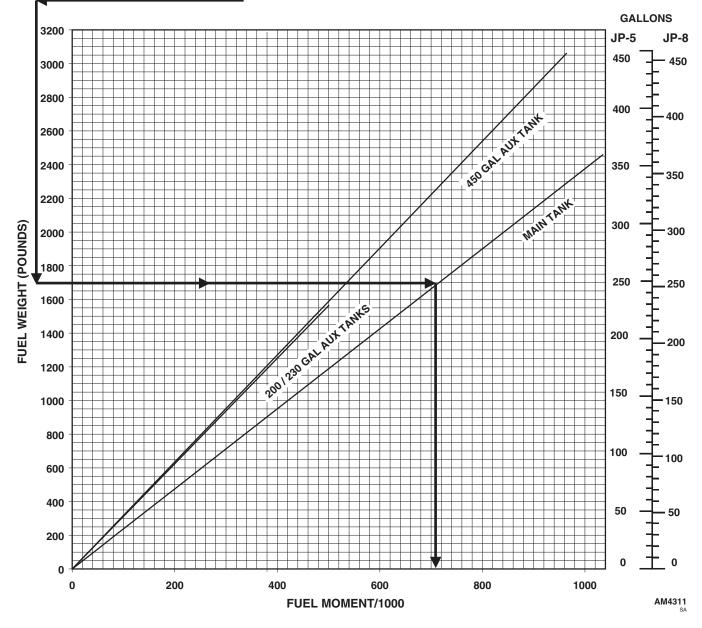


Figure 6-2. Fuel Moments

#### Section IV PERSONNEL

#### 6.11 PERSONNEL MOMENTS.

When helicopters are operated at critical gross weights, the exact weight of each individual occupant plus equipment should be used. Personnel moments data is shown in Figure 6-3. If weighing facilities are not available or if the tactical situation dictates otherwise, loads shall be computed as follows:

a. Combat equipped soldiers: 240 pounds per individual.

b. Combat equipped paratroopers: 260 pounds per individual.

c. Crew and passengers with no equipment: compute weight according to each individual's estimate.

#### 6.12 MEDEVAC KIT PERSONNEL MOMENTS.

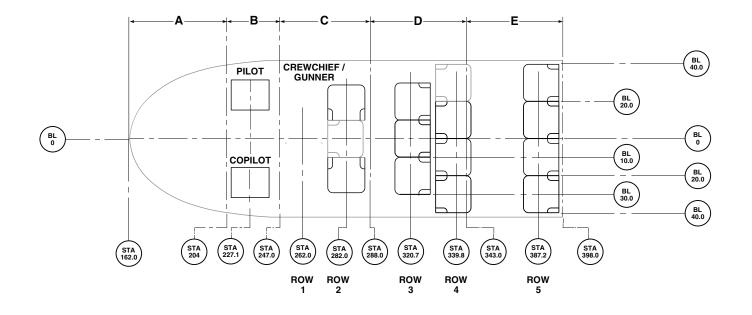
a. Litter moments are in Figure 6-4.

b. Medevac system (excluding litters) weight and moments are included in the helicopter basic weight and moments DD Form 365-3 when installed.

c. Litter weight is estimated to 25 pounds which includes litter, splints, and blankets.

d. Medical attendant's average weight is 200 pounds.

e. Medical equipment and supplies should be stored per unit loading plan and considered in weight and balance computations.



#### **PERSONNEL MOMENTS**

#### SEAT WEIGHT - AND MOMENT TABLE*

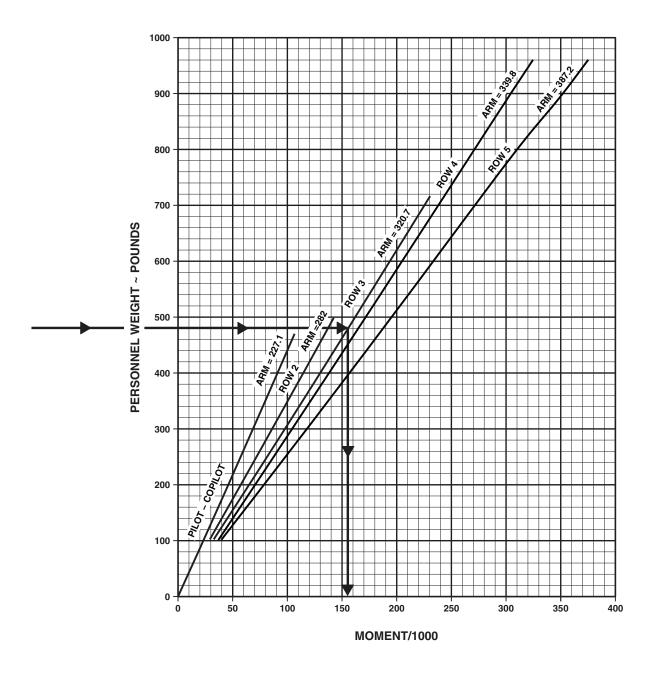
ITEM	ROW	WEIGHT	MOM / 1000
CREWCHIEF / GUNNER (2) TROOPS (3) TROOPS (3) TROOPS (4)	2 3 4 5	43 48 48 63	12 15 16 25
TOTAL-12 SEATS		202	68
ALTERNATE SEAT	NG (BR	OKEN LINES)	
FORWARD TROOP SEAT (NO SEAT AUTHORIZED IN THIS POSITION)	1		
REAR FACING TROOP SEAT (1)	2	16	5
REAR FACING TROOP SEAT (1)	4	16	6
TOTAL-14 SEATS		234	79

*SEAT WEIGHT AND MOMENTS SHOULD BE INCLUDED ON CHART C EXAMPLE WANTED: PESONNEL MOMENTS KNOWN: 2 PERSONNEL IN ROW 3 TOTAL WEIGHT 480 POUNDS METHOD: ENTER WEIGHT AT 480 POUNDS-MOVE RIGHT TO ROW 3. MOVE DOWN. READ MOMENT / 1000=154

AA0669_1B

Figure 6-3. Personnel Moments (Sheet 1 of 3)

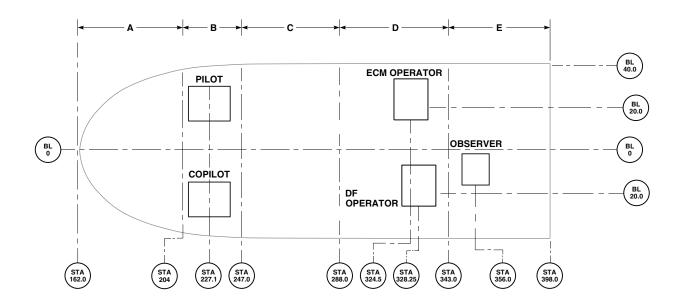
#### PERSONNEL MOMENTS



DATA BASIS: CALCULATED

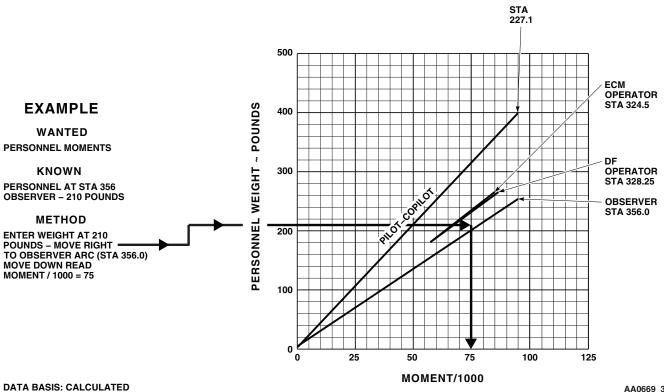
Figure 6-3. Personnel Moments (Sheet 2 of 3)

AA0669_2A



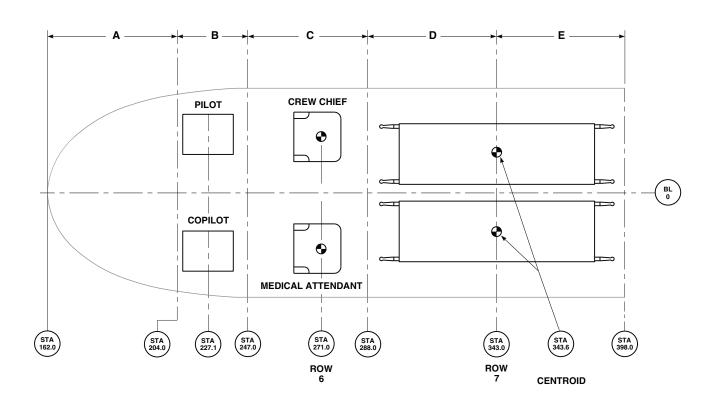
* ITEM	STA	WEIGHT	MOM / 1000
OBSERVER SEAT	356.0	18	6
TOTAL – 1 SEAT	-	18	6

* SEAT WEIGHT AND MOMENTS SHOULD BE INCLUDED ON CHART C.



AA0669_3B

Figure 6-3. Personnel Moments (Sheet 3 of 3)



### LITTER MOMENTS

#### EXAMPLE

WANTED LITTER MOMENTS

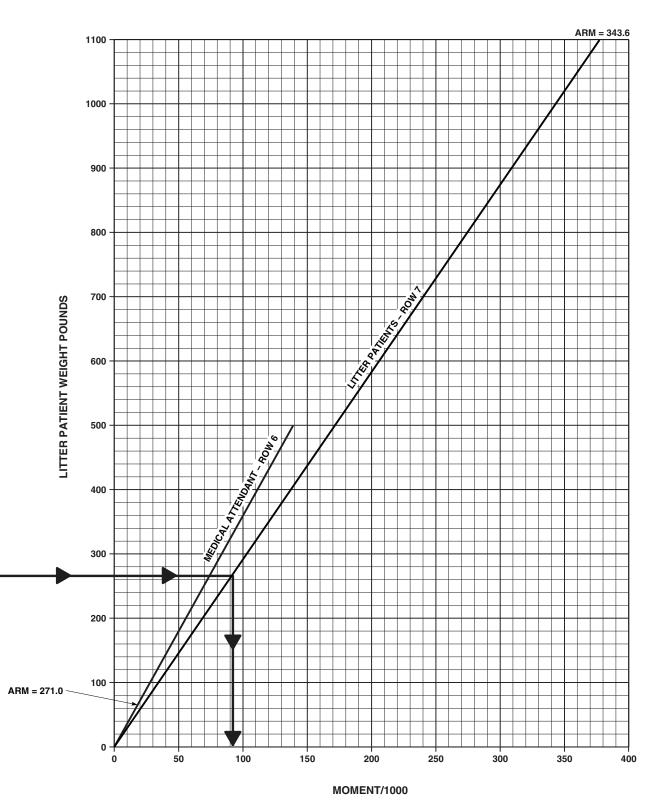
LITTER WEIGHT = 265 POUNDS

METHOD

ENTER WEIGHT AT 265 POUNDS – MOVE – RIGHT TO LITTER ROW 7 MOVE DOWN. READ MOMENT / 1000 = 91

AA0378_1B

Figure 6-4. Litter Moments (Sheet 1 of 2)



LITTER MOMENTS

DATA BASIS:CALCULATED

AA0378_2A

Figure 6-4. Litter Moments (Sheet 2 of 2)

#### Section V MISSION EQUIPMENT

#### 6.13 ARMAMENT LOADING DATA MOMENTS.

Armament consists of two M60D machineguns, ammunition, and grenades. Various loads of ammunition are presented in Figure 6-5. When determining the moments for a given ammo load not shown on the chart, go to the nearest load shown. Volcano mine moments are presented in Figure 6-6.

# 6.14 EH-60A HELICOPTERS WITHOUT MISSION EQUIPMENT.

When operating without EH-60 mission equipment or with a light cabin load or no cabin load, it may be necessary to limit fuel load to remain within aft CG limits.

### ARMAMENT LOADING DATA

#### AMMUNITION TABLE

LIVE ROUNDS	LIVE AMMO (7.62 MM) ARM – 247.0				
	WEIGHT – LB	MOM / 1000			
100	7				
100		2			
200	13	3			
300	20	5			
400	26	6			
500	32	8			
600	39	10			
700	46	11			
800	52	13			
	ARM – 279.8				
100	7	2			
200	13	4			
300	20	5			
400	26	7			

#### CHAFF

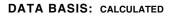
CHAFF CARTRIDGE MI. 30 RDS ARM – 505.0 (SINGLE CHAFF WEIGHT 0.33 LB)						
WEIGHT – LB MOM / 1000						
10 5						

#### FLARE EH

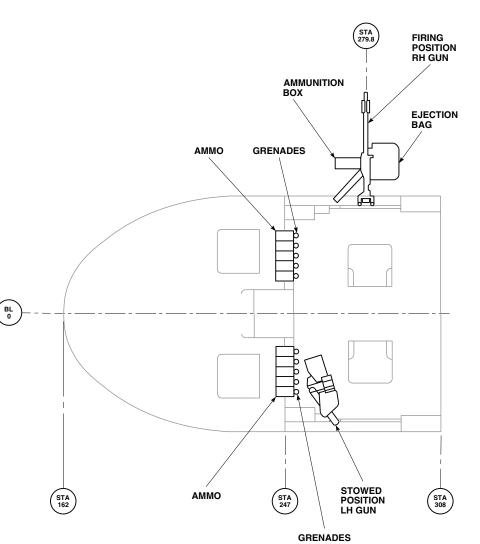
FLARE DISPENSED M130, 30 RDS ARM – 525.0 (SINGLE FLARE WEIGHT 0.43 LB)						
WEIGHT – LB MOM / 1000						
13	13 7					

#### GRENADE TABLE

	STOWED					
QUANTITY	GRENADE AN-M8 ARM - 251.0		GRENADE M18 ARM – 251.0			
	WEIGHT – LB	MOM / 1000	WEIGHT – LB	MOM / 1000		
2	3	1	2	1		
4	6	2	5	1		
6	9	2	7	2		
8	12	3	10	2		
10	15 4		12	3		
12	18	5	14	4		





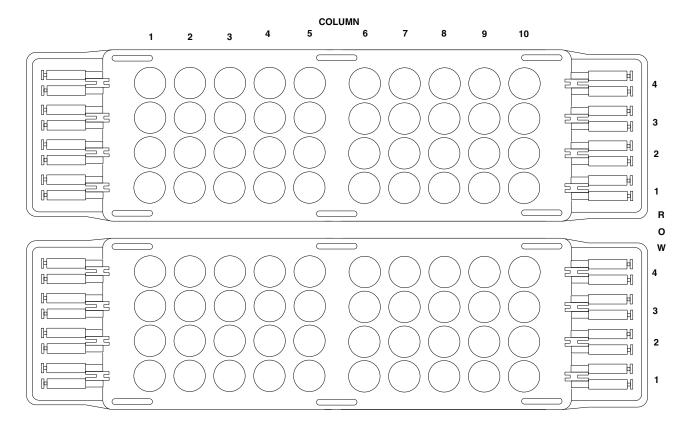


(GUN STOWED AND FIRING POSITIONS ARE SAME EACH SIDE)

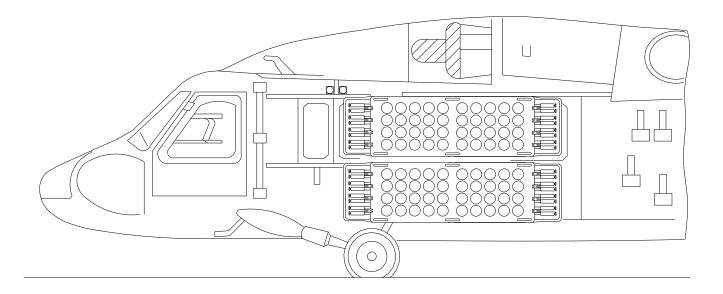
#### M60D TABLE

		МОМ	/ 1000
ITEM	TEM WEIGHT STOWED	FIRING POSITION	
M60D (2)	45.4	12	13
EJECTION BAG (2)	9.0	2	3
AMMO BOX (2)	3.4	1	1
STORAGE BOX (2)	2.6	1	1
SUPPORT (2)	20.2	5	6
BIPOD (2)	4.0	1	1
TOTAL	84.6	22	25
			AA0375

TM 1-1520-237-10



CANISTER COLUMN REFERENCE



#### AA9415

Figure 6-6. Volcano Mine Moments (Sheet 1 of 2)

RACK WEIGHTS (PER RACK)								
NO CANISTERSEMPTY CANISTERS (40)FULL CANISTERS (40)								
Weight (lb)	Arm	Moment/ 1000	Weight (lb)	Arm	Moment/ 1000	Weight (lb)	Arm	Moment/ 1000
226	331.5	74.9	434	331.5	143.9	1450	331.5	480.7

		WEIGHT (LB)	QUANTITY PER SYSTEM	TOTAL WEIGHT (LB)	ARM	MOMENT/1000
Rack Without	Canisters	226	4	904	331.5	299.7
Canisters:						
]	Empty	5.2	160	832	331.5	275.8
	Full	30.6	160	4896	331.5	1623.0
Side Panels		236	2	472	322.8	152.4
DCU with Pa	llet	87	1	87	300	26.1
Cabling/ICP/F /Cable Tubes	Fairing	54	1	54	264.4	14.3
Total System	Full Canisters:			6413	329.7	2114.4
Total System	Empty Canisters			2349	326.7	767.4
Total System	No Canisters			1517	324.1	491.6

UNIT CANISTER LOADING							
COLUMN	EMPTY CANISTER WEIGHT	FULL CANISTER WEIGHT	ARM	EMPTY CANISTER MOMENT/1000	FULL CANISTER MOMENT/1000		
1	5.2	30.6	306.3	1.6	9.4		
2	5.2	30.6	311.8	1.6	9.5		
3	5.2	30.6	317.3	1.6	9.7		
4	5.2	30.6	322.8	1.7	9.9		
5	5.2	30.6	328.3	1.7	10.0		
6	5.2	30.6	333.8	1.7	10.2		
7	5.2	30.6	339.3	1.8	10.4		
8	5.2	30.6	344.8	1.8	10.6		
9	5.2	30.6	350.3	1.8	10.7		
10	5.2	30.6	355.8	1.9	10.9		

Figure 6-6. Volcano Mine Moments (Sheet 2 of 2)

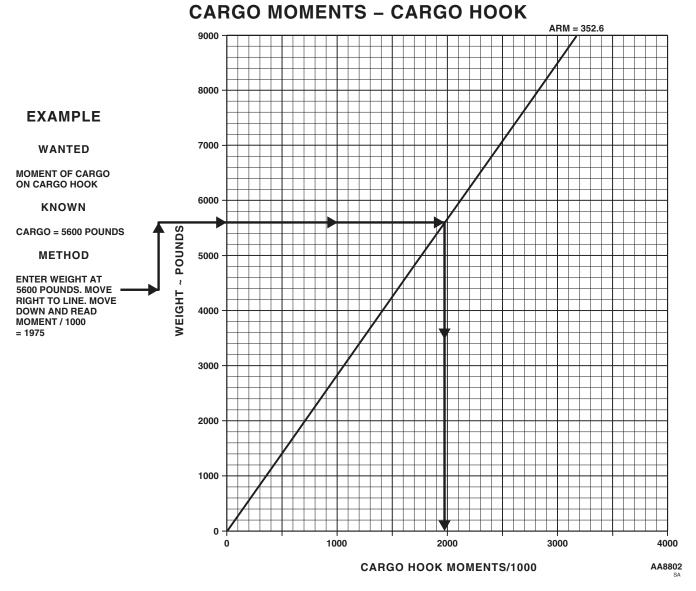


Figure 6-7. Cargo Hook Moments

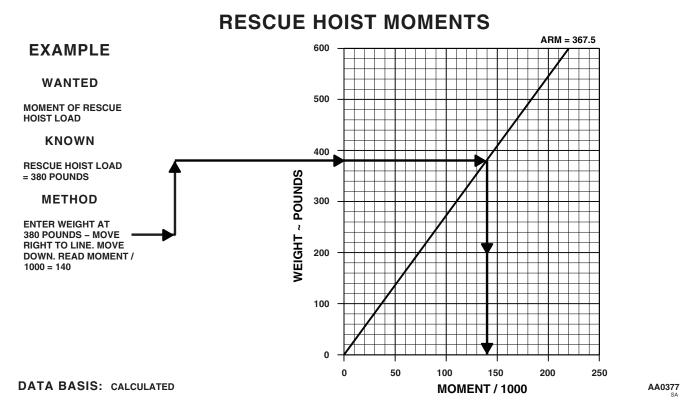


Figure 6-8. Rescue Hoist Moments

#### Section VI CARGO LOADING

#### 6.15 CABIN DIMENSIONS.

Refer to Figure 6-9 for dimensions. For loading and weight and balance purposes, the helicopter fuselage is divided into six compartments, A through F, three of which are in the cabin, C, D, and E. There are 17 tiedown fittings rated at 5,000 pounds each. Cargo carrier restraint rings are at stations 308 and 379, to cover the 71 inches of longitudinal space. Cargo tiedown devices are stored in the equipment stowage space of compartment F.

#### 6.16 CABIN DOORS.

Cabin doors are at the rear of the cargo compartment on each side of the fuselage. The door openings are 54.5 inches high and 69 inches wide; maximum package sizes accommodated by the openings are 54 inches high by 68 inches wide and are shown on Figure 6-10.

# 6.17 MAXIMUM CARGO SIZE DIAGRAM FOR LOADING THROUGH CABIN DOORS.

Figure 6-10 shows the largest size of cargo of various shapes that can be loaded into the cabin through the cabin doors.

# 6.18 TIEDOWN FITTINGS AND RESTRAINT RINGS.

The 17 tiedown fittings (Figure 6-11) installed on the cargo floor can restrain a 5,000-pound load in any direction. All tiedown fittings incorporate studs that are used to install the troop seats. Eight net restraint rings in the cargo compartment prevent cargo from hitting the bulkhead at station 398, or entering the crew area. The upper restraint rings are rated at a 3,500-pound capacity in any direction. Tests have demonstrated failure of the lower restraint rings when individually loaded at limits less than 3,500 pounds. This depends on the restraint ring attachment hardware and surrounding structure condition. Multiple tie-down fittings and restraint rings should be used when securing internal cargo.

#### 6.19 EQUIPMENT STOWAGE COMPARTMENTS.

Equipment stowage compartment moments are shown in Figure 6-12.

#### 6.20 EQUIPMENT LOADING AND UNLOADING.

**6.20.1 Data Prior to Loading.** The following data should be assembled or gathered by the loading crew

before loading (Refer to FM 55-450-2, Army Helicopter Internal Load Operations):

a. Weight of the individual items of cargo.

b. Overall dimensions of each item of cargo (in inches).

c. The helicopter's center of gravity.

- d. Floor loads for each item of cargo.
- e. Any shoring that may be required.

f. When required, the location of the center of gravity of an individual item of cargo.

**6.20.2 Cargo Center of Gravity Planning.** The detail planning procedure consists of four steps, as follows:

a. Determine ALLOWABLE LOAD from LIMITA-TIONS section of DD Form 365-4.

b. Plan the location in the helicopter for the individual items of cargo. Since the CG of the load is determined by the station method, then specific locations must be assigned to each item of cargo.

c. Determine the CG of the cargo load as planned. Regardless of the quantity, type, or size of cargo, use the station method.

d. Determine the CG of the fully loaded helicopter from Figures 6-13 and 6-14, and if the CG of the helicopter falls within allowable limits. If it does, the cargo can be loaded. If not, the planned location of the individual items must be changed until an acceptable loading plan is obtained. When cargo loads consist of more than one item, the heavier items of cargo should be placed so that their CG is about in the center of the cabin, and the lighter items of cargo are forward and rear of them.

**6.20.3 Restraint Criteria.** The amount of restraint that must be used to keep the cargo from moving in any direction is called the "restraint criteria" and is usually expressed in units of the force of gravity (Gs). Following are the units of the force of gravity (Gs) needed to restrain cargo in four directions:

#### TM 1-1520-237-10

	Cargo		Cargo
Forward	12 Gs	Vertical	3 Gs (Up)
Rear	3 Gs		3 Gs (Down)
Lateral	8 Gs		

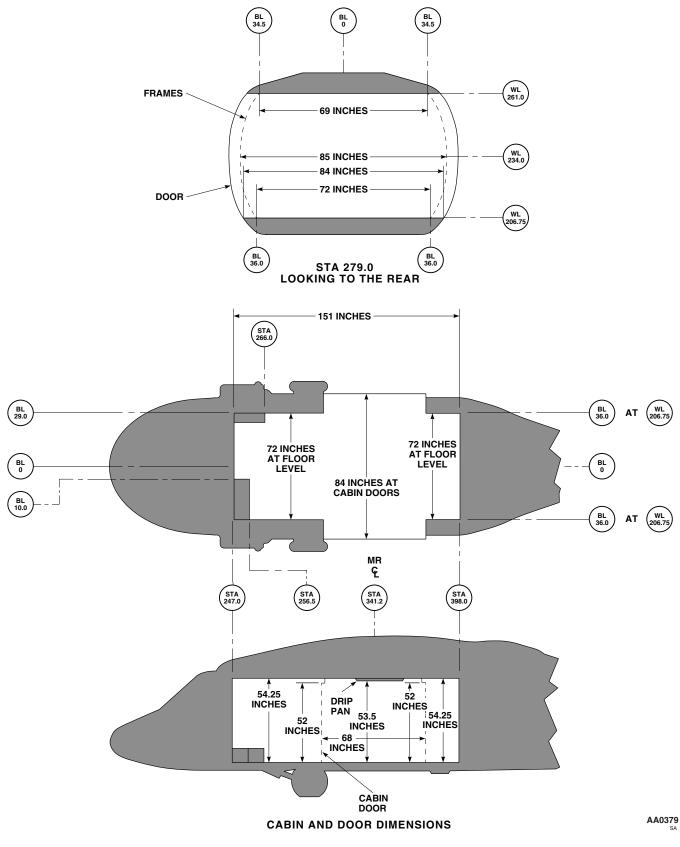
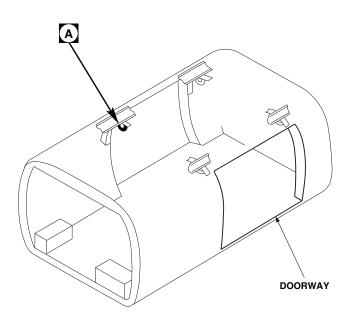
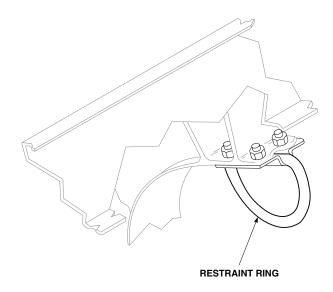


Figure 6-9. Cabin Dimensions



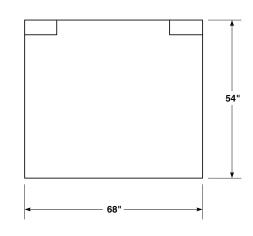


RIGHT SIDE SHOWN (2 PLACES) LEFT SIDE SAME (2 SHOWN)



#### MAXIMUM PACKAGE SIZE TABLE CABIN DOORS

		н	HEIGHT – INCHES		
WIDTH INCHES	50 & UNDER	51	52	53	54
	MAXIMUM LENGTH – INCHES				
46	102	102	102	96	93
48	102	102	102	96	93
50	101	101	101	95	92
52	100	100	100	94	92
54	99	99	99	93	91
56	98	98	98	93	91
58	97	97	97	93	91
60	96	96	96	91	90
62	93	93	93	89	87
64	91	91	91	87	
66	86	86	86	80	
68	80	80	80	77	
1	1	1	1		1

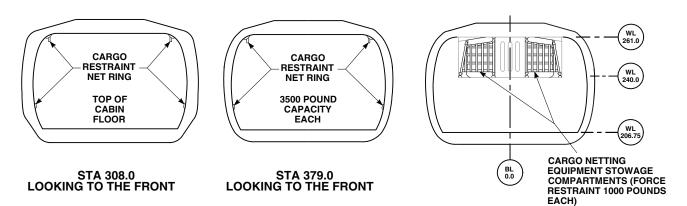


**CABIN DOOR – BOTH SIDES** 

NOTE IF GUNNER'S AREA NOT USED, LENGTHS ARE APPROXIMATELY 90% OF TABLE VALUES.

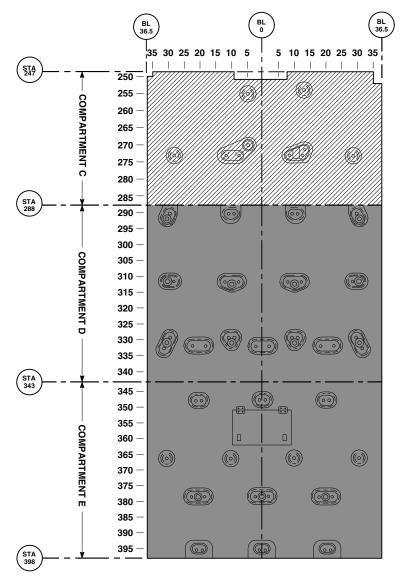
AA0670B





STA 402.19 - LOOKING TO THE REAR

CAUTION FAILURE OF THE LOWER RESTRAINT RINGS MAY OCCUR AT LOADS AS LOW AS 1350–POUNDS. THIS DEPENDS ON RESTRAINT RING ATTACHMENT HARDWARE AND SURROUNDING STRUCTURE CONDITION.



© TIEDOWN FITTING 5000 POUNDS CAPACITY

MAXIMUM COMPARTMENT CAPACITY IN POUNDS	FLOOR CAPACITY POUNDS PER SQUARE FOOT
5460	300
8370	300

AB4481_1 sa

Figure 6-11. Cargo Tiedown Arrangement

### STOWAGE COMPARTMENT MOMENTS

#### STOWED SEAT TABLE

ITEM	ROW	WEIGHT	MOMENT / 1000
CREWCHIEF / GUNNER (2) TROOPS (3) TROOPS (3) TROOPS (4)	2 3 4 5	43 48 48 63	18 20 20 27
TOTAL-12 SEATS		202	85
ALTERNATE (1) ALTERNATE (1)	2 4	16 16	7 7
TOTAL-14 SEATS		234	98

#### EXAMPLE

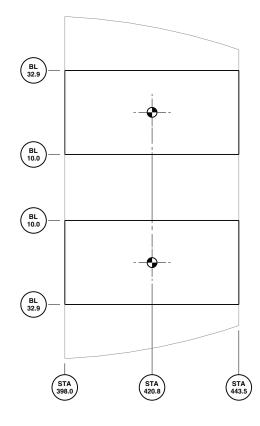


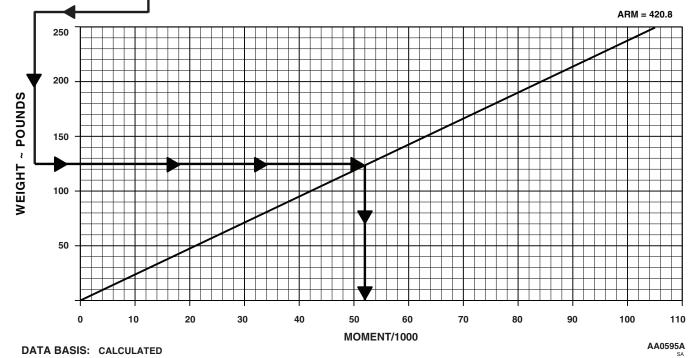
MOMENT OF STOWED EQUIPMENT

KNOWN

EQUIPMENT WEIGHT = 125 POUNDS

METHOD ENTER WEIGHT AT 125 POUNDS – MOVE RIGHT TO LINE MOVE DOWN READ MOMENT / 1000 = 52







### Section VII CENTER OF GRAVITY

#### 6.21 CENTER OF GRAVITY LIMITS CHART.

The CG limit charts (Figures 6-13 and 6-14) allow the CG (inches) to be determined when the total weight and total moment are known.

### **CENTER OF GRAVITY**

#### WITHOUT EXTERNAL STORES SUPPORT SYSTEM OR **VOLCANO MULTIPLE MINE DELIVERY SYSTEM INSTALLED** 11,500 TO 16,500 POUNDS GROSS WEIGHT **CENTER OF GRAVITY LIMITS**

345.8

MAIN ROTOR

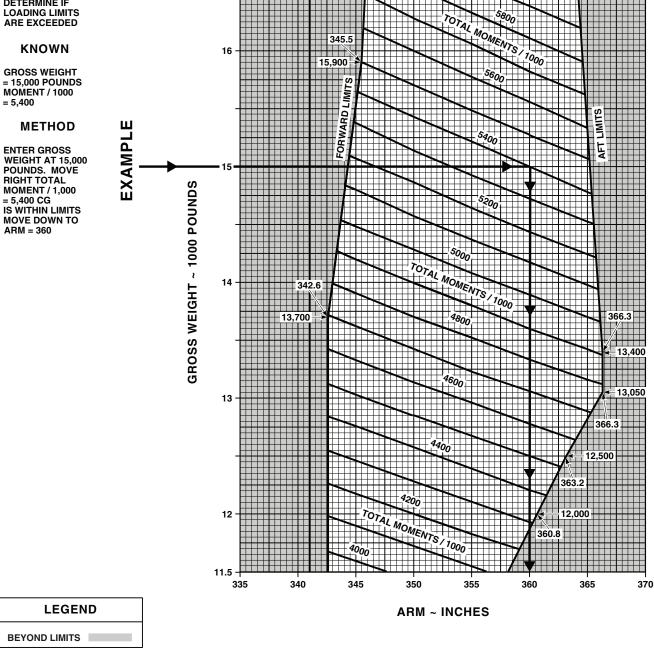
ፍ

16.5

#### **EXAMPLE**

#### WANTED

DETERMINE IF LOADING LIMITS





364.2

Figure 6-13. Center of Gravity Limits Chart (Sheet 1 of 2)

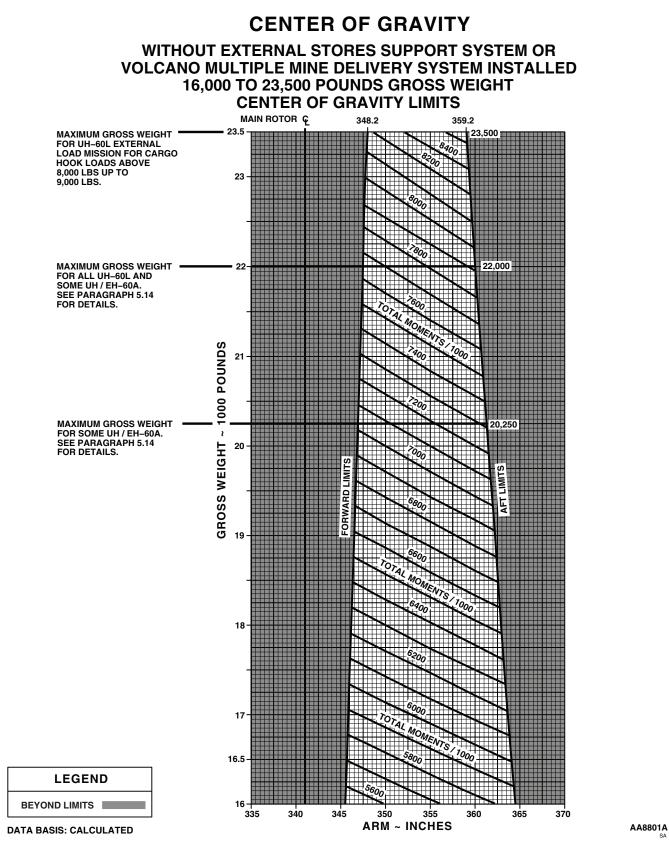
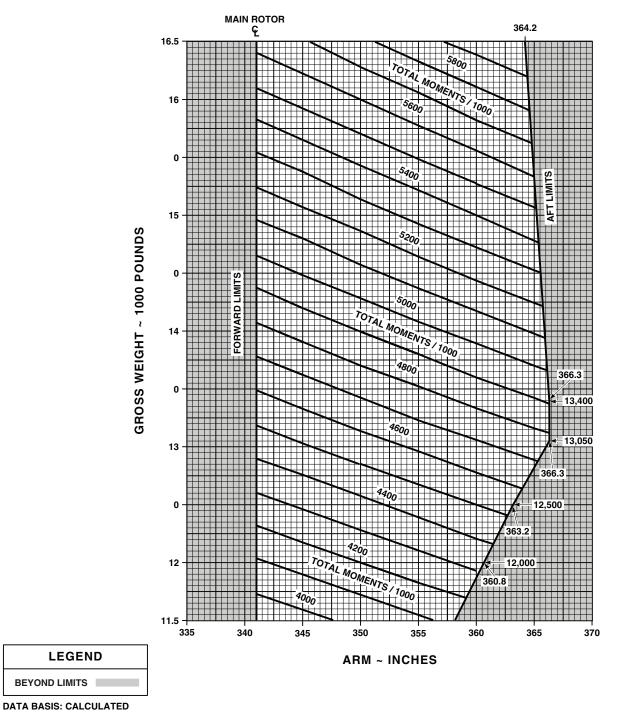


Figure 6-13. Center of Gravity Limits Chart (Sheet 2 of 2)

#### CENTER OF GRAVITY WITH EXTERNAL STORES SUPPORT SYSTEM INSTALLED 11,500 TO 16,500 POUNDS GROSS WEIGHT CENTER OF GRAVITY LIMITS



AA1254_1B

Figure 6-14. Center of Gravity Limits Chart (Sheet 1 of 3)

### **CENTER OF GRAVITY**

#### WITH EXTERNAL STORES SUPPORT SYSTEM OR VOLCANO MULTIPLE MINE DELIVERY SYSTEM INSTALLED 16,000 TO 22,000 POUNDS GROSS WEIGHT CENTER OF GRAVITY LIMITS

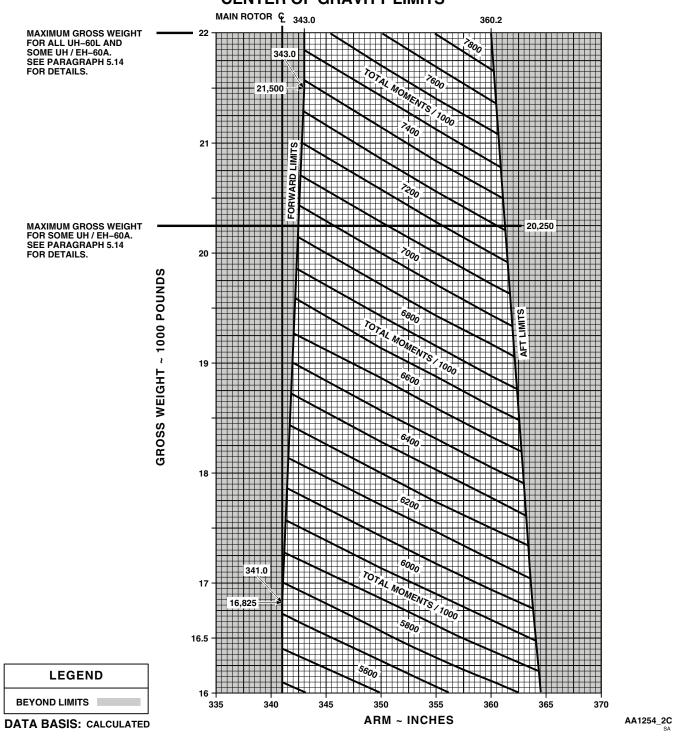
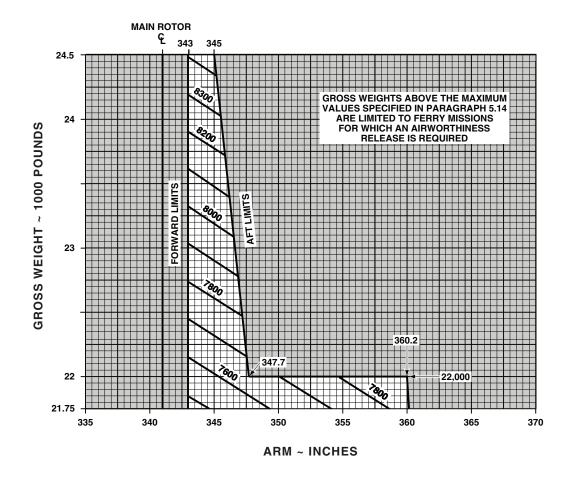
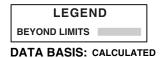


Figure 6-14. Center of Gravity Limits Chart (Sheet 2 of 3)

### **CENTER OF GRAVITY**

#### WITH EXTERNAL STORES SUPPORT SYSTEM OR VOLCANO MULTIPLE MINE DELIVERY SYSTEM INSTALLED 21,750 TO 24,500 POUNDS GROSS WEIGHT CENTER OF GRAVITY LIMITS





AA1254_3B

Figure 6-14. Center of Gravity Limits Chart (Sheet 3 of 3)

# CHAPTER 7 PERFORMANCE DATA 700

#### Section I INTRODUCTION

#### 7.1 PURPOSE.

#### NOTE

- Chapter 7 contains performance data for helicopters equipped with T700-GE-700 engines. Performance data for the T700-GE-701C and T700-GE-701D/CC engines are contained in Chapter 7A. Users are authorized to remove whichever chapter is not applicable to their model helicopter, and are not required to carry both chapters on board.
- Tabular performance data is presented in the checklist (TM 1-1520-237-CL) and may be used in lieu of Figures 7-4 and 7-5 to obtain "Maximum Hover Weight", "Torque Required to Hover" and "Maximum Torque Available".

a. The purpose of this chapter is to provide the best available performance data. Regular use of this information will enable you to receive maximum safe utilization of the helicopter. Although maximum performance is not always required, regular use of this chapter is recommended for these reasons:

(1) Knowledge of your performance margin will allow you to make better decisions when unexpected conditions or alternate missions are encountered.

(2) Situations requiring maximum performance will be more readily recognized.

(3) Familiarity with the data will allow performance to be computed more easily and quickly.

(4) Experience will be gained in accurately estimating the effects of variables for which data are not presented.

b. The information is primarily intended for mission planning and is most useful when planning operations in unfamiliar areas or at extreme conditions. The data may also be used in flight, to establish unit or area standard operating procedures, and to inform ground commanders of performance/risk trade-offs.

#### 7.2 CHAPTER 7 INDEX.

The following index contains a list of the sections, titles, figure numbers, subjects, and page numbers of each performance data chart contained in this chapter.

### Section

and Figure Number	Title	Page
Ι	INTRODUCTION	7-1
7-1	Temperature Conversion Chart	7-4
II	MAXIMUM TORQUE AVAILABLE	7-6
7-2	Aircraft Torque Factor (ATF)	7-7
7-3	Maximum Torque Available - 30-Minute Limit	7-8
III	HOVER	7-9
7-4	Hover - Clean	7-10
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IV	CRUISE	7-13
7-6	Sample Cruise Chart	7-15
7-7	Cruise - Altitude Sea Level	7-16
7-8	Cruise High Drag - Altitude Sea Level	7-26
7-9	Cruise - Altitude 2,000 Feet	7-36

Section and Figure		
Number	Title	Page
7-10	Cruise High Drag - Altitude 2,000 Feet	7-46
7-11	Cruise - Altitude 4,000 Feet	7-40
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7-17	Cruise - Altitude 10,000 Feet	7-90
7-18	Cruise High Drag - Altitude 10,000 Feet	7-95
7-19	Cruise - Altitude 12,000 Feet	7-100
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7-2	

and Figure Number	Title	Page
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#### 7.3 GENERAL.

Section

The data presented covers the maximum range of conditions and performance that can reasonably be expected. In each area of performance, the effects of altitude, temperature, gross weight, and other parameters relating to that phase of flight are presented. In addition to the presented data, your judgment and experience will be necessary to accurately obtain performance under a given set of circumstances. The conditions for the data are listed under the title of each chart. The effects of different conditions are discussed in the text accompanying each phase of performance. Where practical, data are presented at conservative conditions. However, NO GENERAL CONSERVATISM HAS BEEN APPLIED. All performance data presented are within the applicable limits of the helicopter. All flight performance data are based on JP-4 fuel. The change in fuel flow and torque available, when using JP-5 or JP-8 aviation fuel, or any other approved fuels, is insignificant.

#### 7.4 LIMITS.



Exceeding operating limits can cause permanent damage to critical components. Overlimit operation can decrease performance, cause early failure, or failure on a subsequent flight.

Applicable limits are shown on the charts. Performance generally deteriorates rapidly beyond limits. If limits are exceeded, minimize the amount and time. Enter the maximum value and time above limits on DA Form 2408-13-1, so proper maintenance action can be taken.

#### 7.5 USE OF CHARTS.

**7.5.1 Dashed Line Data.** Weights above 22,000 pounds are limited to ferry missions for which an Airworthiness Release is required. On some charts dashed line data are shown for gross weights greater than 22,000 pounds.

**7.5.2 Data Basis.** The type of data used is indicated at the bottom of each performance chart under DATA BASIS. The data provided generally is based on one of three categories:

a. Flight test data. Data obtained by flight test of the helicopter by experienced flight test personnel at precise conditions using sensitive calibrated instruments.

b. Calculated data. Data based on tests, but not on flight test of the complete helicopter.

c. Estimated data. Data based on estimates using aerodynamic theory or other means but not verified by flight test.

**7.5.3 Specific Conditions.** The data presented is accurate only for specific conditions listed under the title of each chart. Variables for which data is not presented, but which may affect that phase of performance, are discussed in the text. Where data is available or reasonable estimates can be made, the amount that each variable affects performance will be given.

#### 7.6 PERFORMANCE DISCREPANCIES.

Regular use of this chapter will allow you to monitor instrument and other helicopter systems for malfunction, by comparing actual performance with planned performance. Knowledge will also be gained concerning the effects of variables for which data is not provided, thereby increasing the accuracy of performance predictions.

#### 7.7 PERFORMANCE DATA BASIS - CLEAN.

The data presented in the performance charts are primarily derived for a clean UH-60A helicopter and are based on U. S. Army test data. The clean configuration assumes all doors and windows are closed and includes the following external configuration:

a. Fixed provisions for the External Stores Support System (ESSS).

b. Main and tail rotor deice system.

c. Mounting brackets for infrared (IR) jammer and chaff dispenser.

d. The Hover Infrared Suppressor System (HIRSS) with baffles installed.

e. Includes wire strike protection system.

#### NOTE

Helicopters which have an external configuration which differs from the clean configuration may be corrected for drag differences on cruise performance as discussed in Section VI DRAG.

#### 7.8 PERFORMANCE DATA BASIS - HIGH DRAG.

The data presented in the high drag performance charts are primarily derived for the UH-60A with the ESSS system installed and the 230-gallon tanks mounted on the outboard pylons, and are based on U.S. Army test data. The high drag configuration assumes all doors and windows are closed and includes the following external configuration:

a. External stores support system installed.

b. Two 230-gallon tanks mounted on the outboard pylons.

c. Inboard vertical pylons empty.

### **TEMPERATURE CONVERSION**

#### EXAMPLE

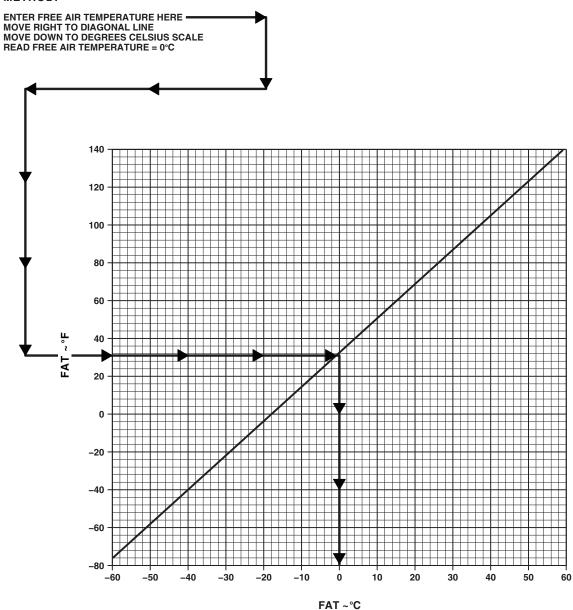
WANTED:

FREE AIR TEMPERATURE IN DEGREES CELSIUS

#### KNOWN:

FREE AIR TEMPERATURE = 32°F

**METHOD:** 



AA0674

Figure 7-1. Temperature Conversion Chart

- d. IR jammer and chaff dispenser installed.
- e. HIRSS with baffles are installed.

f. Main and tail rotor deice and wire strike protection systems are installed.

#### NOTE

Helicopters with an external configuration that differs from the high drag configuration baseline may be corrected for differences in cruise performance as discussed in Section VI DRAG.

g. Use the high drag configuration hover charts to determine hover performance with the volcano system in-

stalled. Use the high drag cruise charts and the volcano drag correction factor to determine cruise performance with volcano installed. The volcano drag correction factor is based on flight test data obtained with the complete volcano system installed, to include all of the canisters and mines. The drag correction factor may be used to provide a conservative estimate of cruise performance for volcano configurations which do not include all of the canisters and mines.

#### 7.9 FREE AIR TEMPERATURES.

A temperature conversion chart (Figure 7-1) is included for the purpose of converting Fahrenheit temperature to Celsius.

#### Section II MAXIMUM TORQUE AVAILABLE

#### 7.10 TORQUE FACTOR METHOD.

The torque factor method provides an accurate indication of available power by incorporating ambient temperature effects on degraded engine performance. This section presents the procedure to determine the maximum dual- or single-engine torque available for the T700-GE-700 engine as installed in each individual aircraft. Specification power is defined for a newly delivered low time engine. The aircraft HIT log forms for each engine, provide the engine and aircraft torque factors which are obtained from the maximum power check and recorded to be used in calculating maximum torque available.

**7.10.1 Torque Factor Terms.** The following terms are used when determining the maximum torque available for an individual aircraft:

a. Torque Ratio (TR). The ratio of torque available to specification torque at the desired ambient temperature.

b. Engine Torque Factor (ETF). The ratio of an individual engine torque available to specification torque at reference temperature of 35°C. The ETF is allowed to range from 0.85 to 1.0.

c. Aircraft Torque Factor (ATF). The ratio of an individual aircraft's power available to specification power at a reference temperature of  $35^{\circ}$ C. The ATF is the average of the ETF's of both engines and its value is allowed to range from 0.9 to 1.0.

**7.10.2 Torque Factor Procedure.** The use of the ATF or ETF to obtain the TR from Figure 7-2 for ambient temperatures between  $-5^{\circ}$ C (23°F)and 35°C (95°F)is shown by the example. The ATF and ETF values for an individual aircraft are found on the engine HIT Log. Use the  $-5^{\circ}$ C (23°F) TR value for temperatures less than  $-5^{\circ}$ C (23°F). The TR equals the ATF or ETF for temperatures of 35°C (95°F) and above. For these cases, and for an ATF or ETF value of 1.0, Figure 7-2 need not be used.

#### 7.11 MAXIMUM TORQUE AVAILABLE CHART.

This chart (Figure 7-3) presents the maximum specification torque available at zero airspeed and 100% RPM R for the operational range of pressure altitude and

FAT. The single- and dual-engine transmission limits for continuous operation are shown and should not be exceeded. The engine torque available data above the single-engine transmission limit is presented as dashed lines and is required for determining torque available when TR values are below 1.0. When the TR equals 1.0, the maximum torque available may be read from the horizon-tal specification torque available per engine scale. When the TR value is less than 1.0, the maximum torque available. The lower portion of Figure 7-3 presents TR correction lines which may be used in place of multiplication to read torque available per engine directly from the vertical scale.

#### 7.12 ENGINE BLEED AIR.

With engine bleed air turned on, the maximum available torque is reduced as follows:

a. Engine anti-ice on: Reduce torque determined from Figure 7-3 by a constant 16% TRQ. Example: (90% TRQ - 16% TRQ) = 74% TRQ.

b. Cockpit/gunner heater on: Reduce torque available by 4% TRQ.

c. Cockpit/gunner heater and Option II cabin heater system on: Reduce torque available by 5.5% TRQ.

#### NOTE

Option II cabin heater system shuts off when anti-ice is turned on. Power to the heater returns when the anti-ice is turned off.

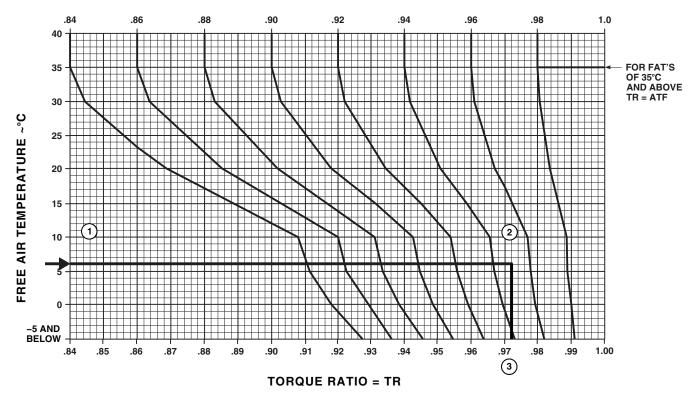
d. Anti-ice and cockpit/gunner heater on: Reduce torque available by 20%TRQ.

#### 7.13 INFRARED SUPPRESSOR SYSTEM.

When the hover IR suppressor system is installed and operating in the benign mode exhaust (baffles removed) the maximum torque available is increased about 1% TRQ. When an IR suppressor system is not installed, maximum torque available is also increased about 1%.

# **TORQUE FACTOR**

#### **TORQUE FACTOR ~ ATF OR ETF**



## **EXAMPLE**

#### WANTED:

TORQUE RATIO AND MAXIMUM TORQUE AVAILABLE

#### **KNOWN:**

ATF = .95 PRESSURE ALTITUDE = 6000 FT FAT = 6°C

### **METHOD:**

TO OBTAIN TORQUE RATIO:

1. ENTER TORQUE FACTOR CHART AT KNOWN FAT 2. MOVE RIGHT TO THE ATF VALUE 3. MOVE DOWN, READ TORQUE RATIO = .972

TO CALCULATE MAXIMUM TORQUE AVAILABLE:

- ENTER MAXIMUM TORQUE AVAILABLE CHART AT KNOWN FAT (FIGURE 7-3)
   MOVE RIGHT TO KNOWN PRESSURE ALTITUDE
   MOVE DOWN, READ SPECIFICATION TORQUE = 97.2%

TO OBTAIN VALUE FROM CHART:

- 7. MOVE DOWN TO TORQUE RATIO OBTAINED FROM FIGURE 7-2
- 8. MOVE LEFT, READ MAXIMUM TORQUE AVAILABLE = 93.0%

DATA BASIS: CALCULATED

AA0675B

Figure 7-2. Aircraft Torque Factor (ATF)

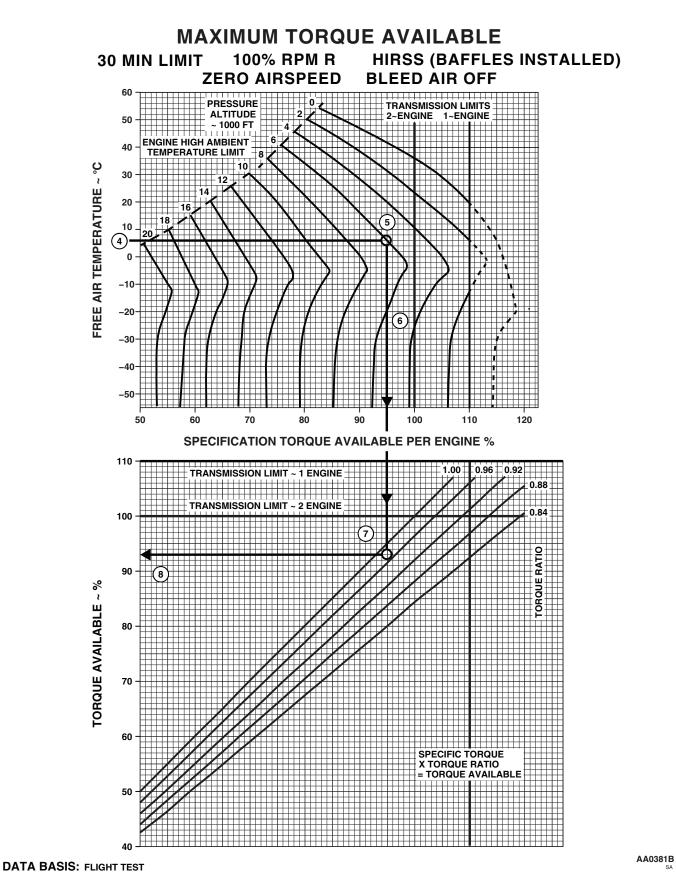


Figure 7-3. Maximum Torque Available - 30-Minute Limit

## Section III HOVER

#### 7.14 HOVER CHART.

### NOTE

For performance calculations with volcano system installed, use the applicable high drag performance charts.

a. The primary use of the charts (Figures 7-4 and 7-5) is illustrated by EXAMPLE A. To determine the torque required to hover, it is necessary to know pressure altitude, FAT, gross weight, and desired wheel height. Enter the upper right grid at the known FAT, move right to the pressure altitude, move down to gross weight. For OGE hover, move left to the torque per engine scale and read torque required. For IGE hover, move left to desired wheel height, deflect down and read torque required for dualengine or single-engine operation. The IGE wheel height lines represent a compromise for all possible gross weights and altitude conditions. A small torque error up to  $\pm 3\%$  torque may occur at extreme temperature and high altitude. This error is more evident at lower wheel heights.

b. In addition to the primary use, the hover chart may be used to predict maximum hover height. To determine maximum hover height, it is necessary to know pressure altitude, FAT, gross weight, and maximum torque available. Enter the known FAT, move right to the pressure altitude, move down to gross weight, move left to intersection with maximum torque available and read wheel height. This wheel height is the maximum hover height.

c. The hover chart may also be used to determine maximum gross weight for hover at a given wheel height, pressure altitude, and temperature as illustrated in EXAMPLE B. Enter at known FAT, move right to the pressure altitude, then move down and establish a vertical line on the lower grid. Now enter lower left grid at maximum torque available. Move up to wheel height, then move right to intersect vertical line from pressure altitude/ FAT intersection. Interpolate from gross weight lines to read maximum gross weight at which the helicopter will hover.

### 7.15 EFFECTS OF BLADE EROSION KIT.

With the blade erosion kit installed, it will be necessary to make the following corrections. Multiply the torque required to hover determined from the charts by 1.02. (Example: If indicated torque is 90%, multiply 90 x 1.02 = 91.8% actual torque required.) Multiply the maximum gross weight to hover obtained from the charts by 0.98. (Example: If gross weight is 22,000 lbs, multiply by 0.98 = 21,560 lbs actual gross weight to hover.) When determining maximum hover wheel height, enter the chart at 1.02 x gross weight. (Example: If gross weight is 20,000 lbs, multiply 20,000 x 1.02 = 20,400 lbs).

## EXAMPLE A

#### WANTED:

## TORQUE REQUIRED TO HOVER OGE AND AT A 10-FOOT WHEEL HEIGHT

### KNOWN:

FAT = 30°C PRESSURE ALTITUDE = 2,000 FEET GROSS WEIGHT = 19,500 POUNDS

### METHOD:

ENTER HOVER CHART AT KNOWN FAT. MOVE RIGHT TO PRESSURE ALTITUDE, MOVE DOWN THROUGH GROSS WEIGHT LINES TO DESIRED GROSS WEIGHT. MOVE LEFT TO INDICATE TORQUE/ENGINE % (OGE) SCALE AND READ OGE HOVER TORQUE (94%). MOVE DOWN FROM INTERSECTION OF 10-FOOT HOVER LINE AND HORIZONTAL LINE TO READ TORQUE REQUIRED TO HOVER 10 FEET (80%).

## **EXAMPLE B**

WANTED:

MAXIMUM GROSS WEIGHT TO HOVER OGE

KNOWN:

ATF = 1.0 FAT =15°C PRESSURE ALTITUDE = 8,000 FEET MAXIMUM TORQUE AVAILABLE =96%

## METHOD:

ENTER INDICATED TORQUE/ENGINE (IGE) SCALE AT MAXIMUM TORQUE AVAILABLE (96%), MOVE UP TO OGE LINE. ENTER CHART AT KNOWN FAT (15°C). MOVE RIGHT TO PRESSURE ALTITUDE LINE (8,000 FT). MOVE DOWN FROM PRESSURE ALTITUDE LINE AND MOVE RIGHT FROM OGE LINE. WHERE LINES INTERSECT, READ MAXIMUM GROSS WEIGHT TO HOVER OGE.

Figure 7-4. Hover - Clean (Sheet 1 of 2)

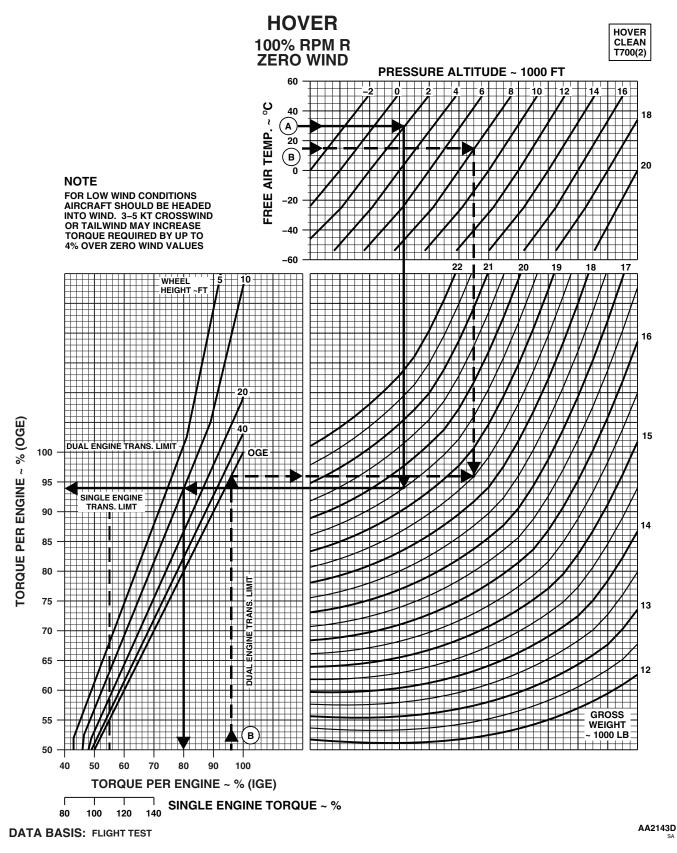


Figure 7-4. Hover - Clean (Sheet 2 of 2)

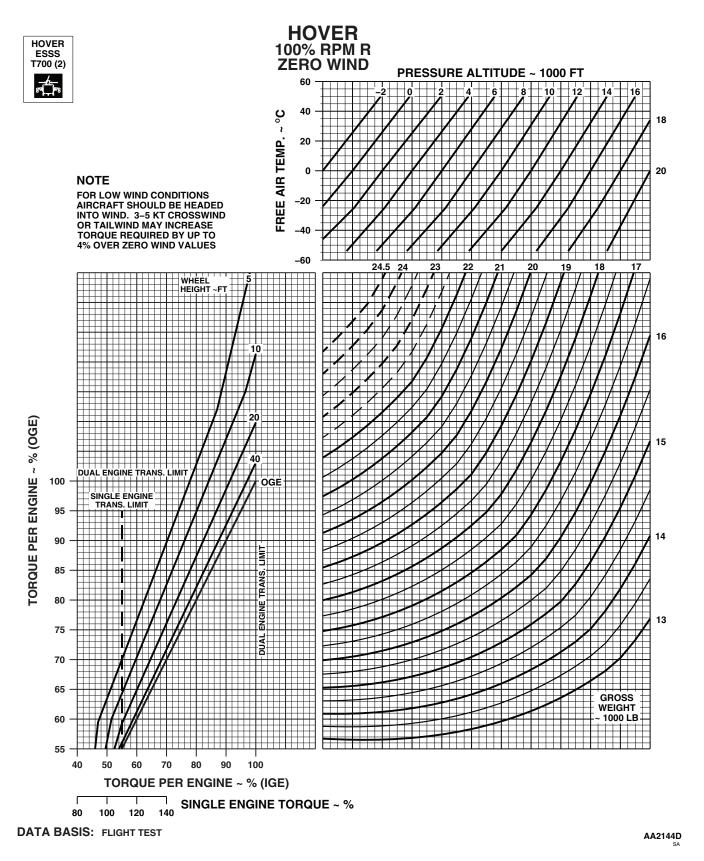


Figure 7-5. Hover - High Drag

## Section IV CRUISE

#### 7.16 DESCRIPTION.

The cruise charts (Figures 7-6 through 7-28)present torque required and total fuel flow as a function of airspeed, altitude, temperature, and gross weight at 100% rotor speed. Scales for both TAS and IAS are presented. The baseline helicopter configuration for these charts was the "clean and high drag" configuration as defined in Section I. Each cruise chart also presents the change in torque (  $\Delta$ TRQ) required for 10 sq. ft. of additional flat plate drag with a dashed line on a separate scale. This line is utilized to correct torque required for external loads as discussed in Section VI DRAG. Maximum level flight airspeed (Vh) is obtained at the intersection of 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. Cruise charts are provided from sea level to 20,000 feet pressure altitude in units of 2,000 feet. Each figure number represents a different altitude. The charts provide cruise data for FATs from -50° to +60°C, in units of 10°. Charts with FATs that exceed the engine ambient temperature limits by more than 10°C are deleted.

## 7.17 USE OF CHARTS.

The primary uses of the charts are illustrated by the examples of Figure 7-6. To use the charts, it is usually necessary to know the planned pressure altitude, estimated FAT, planned cruise speed, TAS, and gross weight. First, select the proper chart on the basis of pressure altitude and FAT. Enter the chart at the cruise airspeed, IAS, move horizontal and read TAS, move horizontal to the gross weight, move down and read torque required, and then move up and read associated fuel flow. Maximum performance conditions are determined by entering the chart where the maximum range line or the maximum endurance and rate of climb line 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 FAT or, more conservatively, by selecting the chart with the next higher altitude and FAT. 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, however, it is preferable to determine cruise information for several flight segments to allow for the decreasing gross weight.

a. Airspeed. TAS and IAS are presented at opposite sides of each chart. On any chart, IAS can be directly

converted to TAS (or vice versa) by reading directly across the chart without regard for the other chart information. The level flight airspeed calibration was used to convert IAS to TAS.

b. Torque. Since pressure altitude and temperature are fixed for each chart, torque available varies with airspeed, and torque required varies with airspeed, gross weight, and drag. The torque and torque limits shown on these charts are for dual-engine operation. The maximum torque available is presented on each chart as either the transmission torque limit or engine torque available - 30-minute. The maximum torque available - 30-minute and maximum continous power (MCP) are presented on each chart for an ATF of 1.0 as a solid line originating from the torque per engine scale and continuing vertically. The maximum torque available - 30-minute and MCP for aircraft with an ATF value of 0.9 may be derived by starting at the ATF =0.9 reference mark at the bottom of the chart, continuing vertically and paralleling the respective torque available line. The maximum torque available for aircraft with an ATF value between 1.0 and 0.9 must be interpolated by entering the chart at the required airspeed and intersecting the point between the 0.9 ATF and the applicable maximum torque available - 30-minute or MCP solid line at the known ATF (Figure 7-6). Higher torque than that represented by these lines may be used if it is available without exceeding the limitations presented in Chapter 5. An increase or decrease in torque required as a result of a drag area change is described in 7.17.F.

c. 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 in this section is for two-engine operation. For one-engine fuel flow, refer to paragraph 7.18 or Section VIII FUEL FLOW.

(1) With bleed-air extracted, fuel flow increases:

(a) Engine anti-ice on - About 60 lbs/hr. Example: (760 lbs/hr + 60 lbs/hr = 820 lbs/hr).

(b) Cockpit/gunner heater on - About 20 lbs/hr.

(c) Cockpit/gunner heater and Option II cabin heater system on - About 28 lbs/hr.

### NOTE

Option II cabin heater system shuts off when anti-ice is turned on. Power to the heater returns when the anti-ice is turned off.

(d) Anti-ice and cockpit/gunner heater on - About 80 lbs/hr.

(2) When the hover IR suppressor system is installed and operating in the benign mode (exhaust baffles removed), the dual-engine fuel flow will decrease about 16 lbs/hr.

d. Maximum Range. The maximum range lines (MAX 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 line is above the maximum torque available, the resulting maximum airspeed should be used for maximum range. A method of estimating maximum range speed in winds is to increase IAS by 2.5 knots per each 10 knots of effective headwind (which reduces flight time and minimizes loss in range) and decrease IAS by 2.5 knots per 10 knots of effective tailwind for economy.

e. 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).

f. Change in Frontal Area. Since the cruise information is given for the "clean configuration," adjustments to torque should be made when operating with external sling loads or helicopter external configuration changes. To determine the change in torque, first obtain the appropriate multiplying factor from the load drag chart (Figure 7-31), then enter the cruise chart at the planned cruise speed TAS, move right to the broken  $\Delta$  TRQ line, and move up and read  $\Delta$  TRQ. Multiply  $\Delta$  TRQ by the multiplying factor to obtain change in torque, then add or subtract change in torque from torque required for the primary mission configuration. Enter the cruise chart at resulting torque required, move up, and read fuel flow. If the resulting torque required exceeds the governing torque limit, the torque required must be reduced to the limit. The resulting reduction in airspeed may be found by subtracting the

change in torque from the limit torque; then enter the cruise chart at the reduced torque, and move up to the gross weight. Move left or right to read TAS or IAS. The engine torque setting for maximum range obtained from the clean configuration cruise chart will generally result in cruise at best range airspeed for the higher drag configuration. To determine the approximate airspeed for maximum range for alternative or external load configurations, reduce the value from the cruise chart by 6 knots for each 10 square foot increase in drag area,  $\Delta F$ . For example, if both cabin doors are open the  $\Delta F$  increases 6 ft² and the maximum range airspeed would be reduced by approximately 4 knots (6 Kts/10 ft²×6 ft² = 3.6 Kts).

g. Additional Uses. The low-speed end of the cruise chart (below 40 knots) is shown primarily to familiarize you with the low-speed power requirements of the helicopter. It shows the power margin available for climb or acceleration during maneuvers, such as nap of earth (NOE) 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 out of ground effect.

## 7.18 SINGLE-ENGINE.

a. The maximum torque available, single-engine, is presented on each chart up to the single engine transmission limit as a SE  $\sim$  30 MIN line at half the actual maximum torque available for an ATF of 1.0 as a solid line originating from the torque per engine scale and continuing vertically. The maximum single-engine torque available for engines with an ETF of 0.85 may be derived by starting at the ETF = 0.85 reference mark at the bottom of the chart, continuing vertically and paralleling the SE  $\sim$ 30 MIN torque available line. The maximum torque available for engines with an ATF value between 1.0 and 0.85 must be interpolated. To read torque available interpolate between the 0.85 reference mark and the SE  $\sim$  30 MIN reference line.

b. Select the cruise chart for the desired condition and enter the torque scale at the appropriate ETF. Move up to the intersection of torque available and the mission gross weight arc, and read across for minimum single-engine airspeed. Move up to the second intersection of torque and the mission gross weight arc, and read across to determine the maximum single-engine airspeed. If no intersections occur, there is no single-engine level flight capability for the conditions. Single-engine fuel flow at the desired 30minute and continuous conditions may be obtained by doubling the torque required from the cruise chart and referring to Figure 7–35.

## CRUISE EXAMPLE 100% RPM R

Z

FAT: 30 °C ALT: 6000 FT TOTAL FUEL FLOW 100 LB/HR

## **EXAMPLE**

#### WANTED

- A. CRUISE CONDITIONS FOR MAXIMUM RANGE
- B. CONDITIONS FOR MAXIMUM ENDURANCE C. MAXIMUM AIRSPEED IN LEVEL FLIGHT
- D. DETERMINE TORQUE AND FUEL FLOW **REQUIRED TO CRUISE WITH CARGO** DOORS OPEN

#### KNOWN

FAT = 30 °C PRESSURE ALTITUDE = 6000 FT GW = 19,000 LBS ATF = 0.95

#### **METHOD**

- A. TURN TO CRUISE CHARTS NEAREST KNOWN FLIGHT CONDITIONS, AT INTERSECTION OF MAX RANGE LINE AND KNOWN VALUE OF GROSS WEIGHT: MOVE LEFT, READ TAS = 130 KTS MOVE RIGHT, READ IAS = 114 KTS MOVE DOWN, READ TORQUE = 66% TRQ MOVE UP, READ TOTAL FUEL FLOW = 945 LBS / HR
- B. AT INTERSECTION OF MAX END AND R / C LINE AND KNOWN VALUE OF GROSS WEIGHT: MOVE LEFT, READ TAS = 85 KTS MOVE RIGHT, READ IAS = 69 KTS MOVE DOWN, READ TORQUE = 47% TRQ MOVE UP, READ TOTAL FUEL FLOW = 760 LBS / HR
- C. ENTER THE TORQUE PER ENGINE SCALE HALF WAY BETWEEN THE 30 MIN TORQUE AVAILABLE LINE AND THE ATF=.9 (30 MIN) TICK MARK. MOVE UP PARALLEL TO THE 30 MIN LINE UP UNTIL INTERSECTING 19,000 LB GW: MOVE LEFT, READ MAXIMUM TAS = 143 KTS MOVE RIGHT, READ MAXIMUM IAS = 126 KTS MOVE DOWN, READ MAXIMUM TORQUE = 82% TRQ MOVE UP, READ TOTAL FUEL FLOW = 1120 LBS / HR
- D. ENTER ATRO% PER 10 SQ FT SCALE AT 130 KTAS HOVE UP READ  $\triangle$  TRQ = 8.0% TURN TO DRAG TABLE IN SECTION VII NOTE CARGO DOORS OPEN = 6.0 SQ FT $\triangle$  F AND HAS A DRAG MULTIPLYING FACTOR VALUE OF 0.60, CALCULATE TOTAL TORQUE REQUIRED USING THE CONDITIONS OF EXAMPLE A: 66% + (0.6 X 8.0%) = 70.8% TOTAL TORQUE READ FUEL FLOW AT TOTAL TORQUE = 1000 LBS / HR

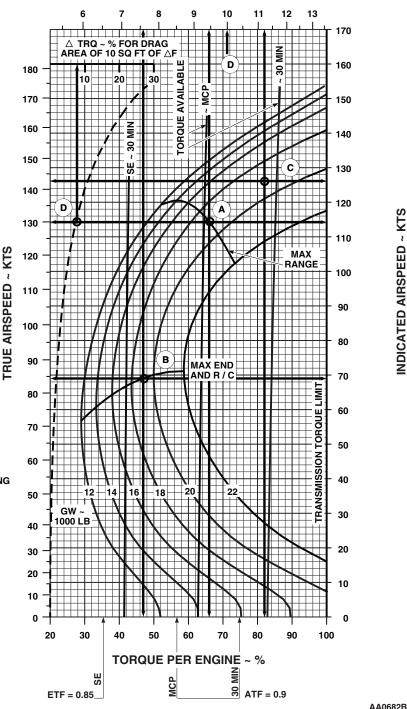


Figure 7-6. Sample Cruise Chart

INDICATED AIRSPEED ~ KTS

# CRUISE CLEAN CONFIGURATION PRESSURE ALT: 0 FT

CRUISE 0 FT T700 (2)

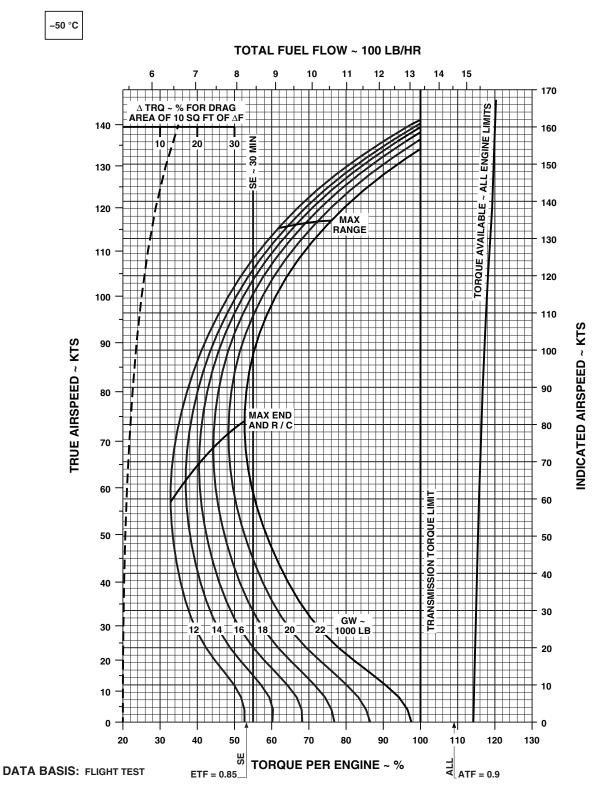


Figure 7-7. Cruise - Altitude Sea Level (Sheet 1 of 10)

## CLEAN CONFIGURATION PRESSURE ALT: 0 FT

-40 °C

CRUISE 0 FT T700 (2)

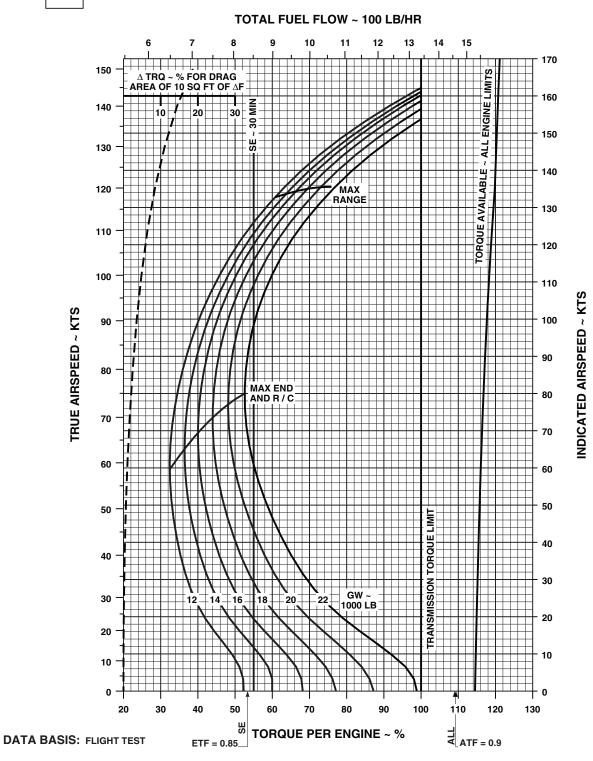


Figure 7-7. Cruise - Altitude Sea Level (Sheet 2 of 10)

## CLEAN CONFIGURATION PRESSURE ALT: 0 FT

CRUISE 0 FT T700 (2)

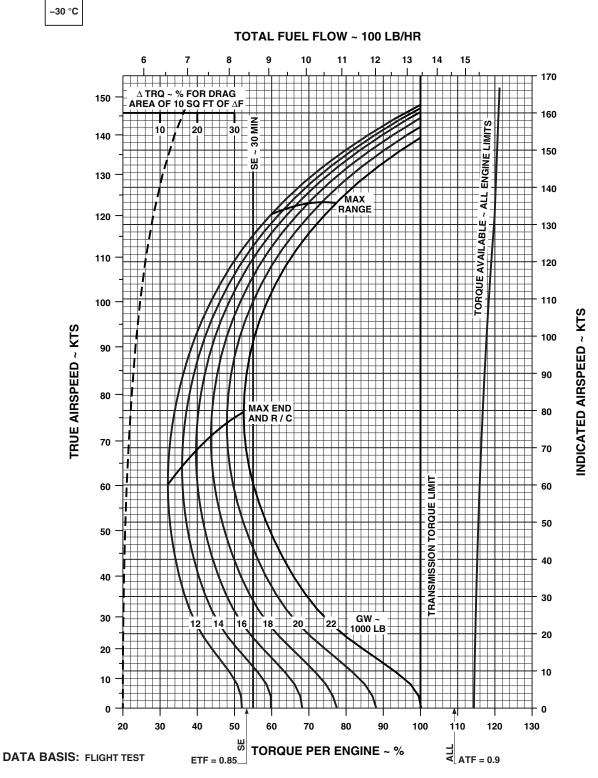


Figure 7-7. Cruise - Altitude Sea Level (Sheet 3 of 10)

# 

## CLEAN CONFIGURATION PRESSURE ALT: 0 FT

–20 °C

CRUISE 0 FT T700 (2)

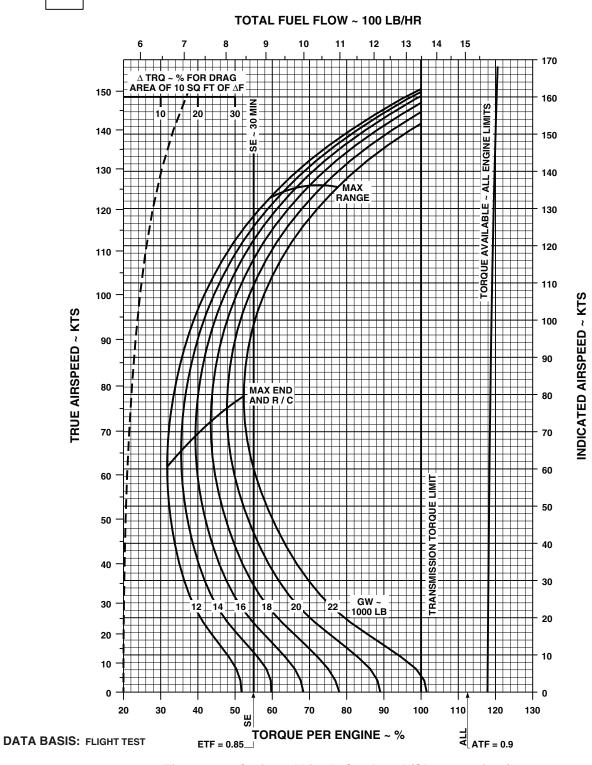
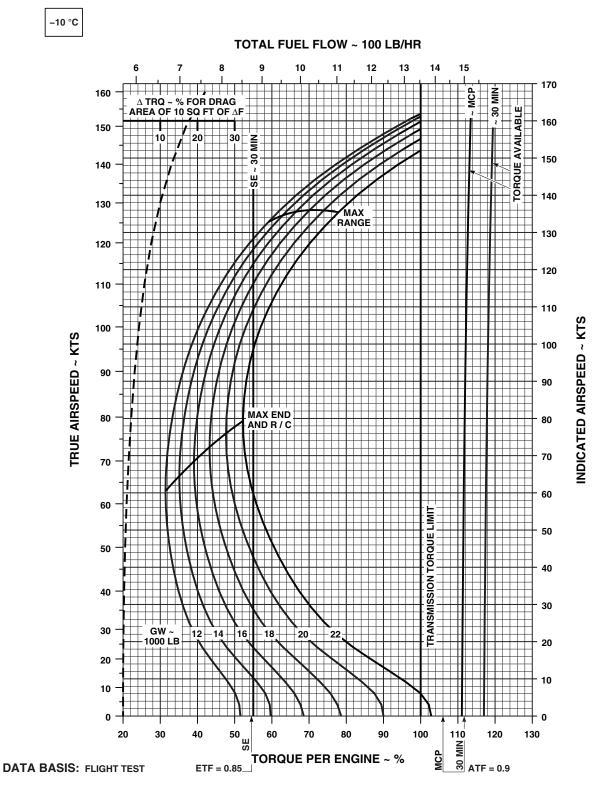


Figure 7-7. Cruise - Altitude Sea Level (Sheet 4 of 10)

7-19

## CLEAN CONFIGURATION PRESSURE ALT: 0 FT

CRUISE 0 FT T700 (2)





## CLEAN CONFIGURATION PRESSURE ALT: 0 FT

CRUISE 0 FT T700 (2)

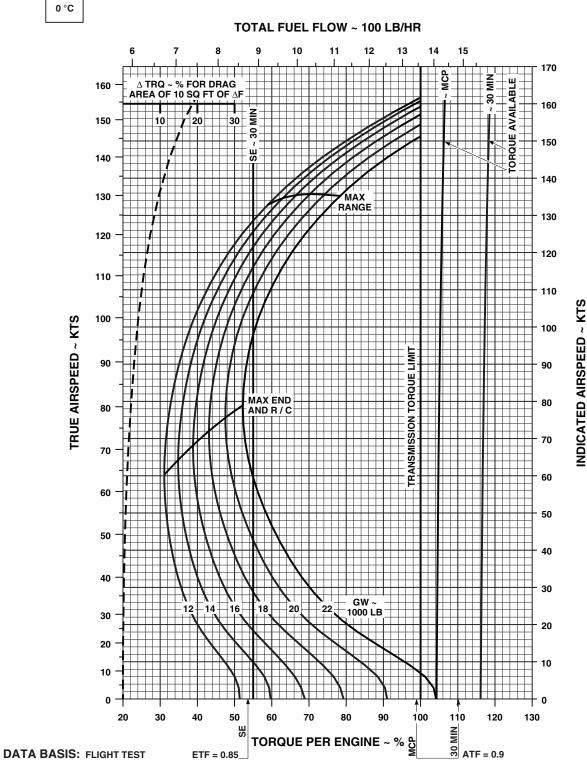


Figure 7-7. Cruise - Altitude Sea Level (Sheet 6 of 10)

10 °C

# **CRUISE**

## **CLEAN CONFIGURATION PRESSURE ALT: 0 FT**

CRUISE 0 FT T700 (2)

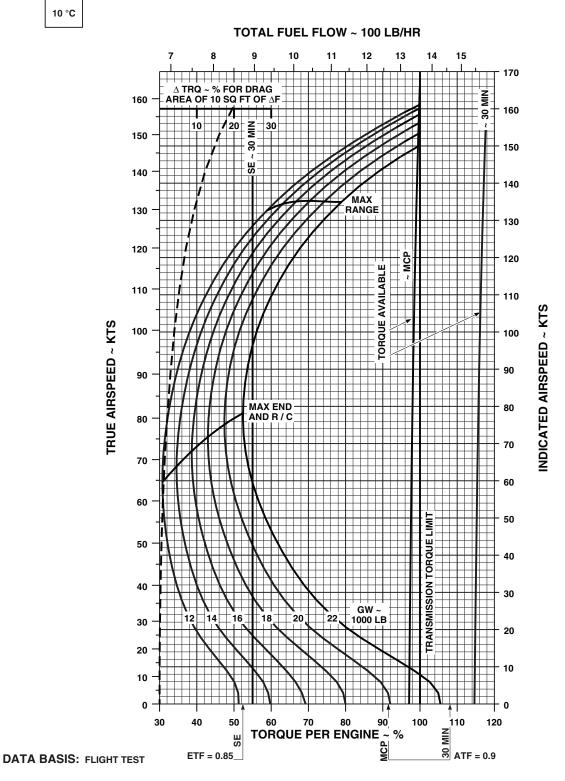
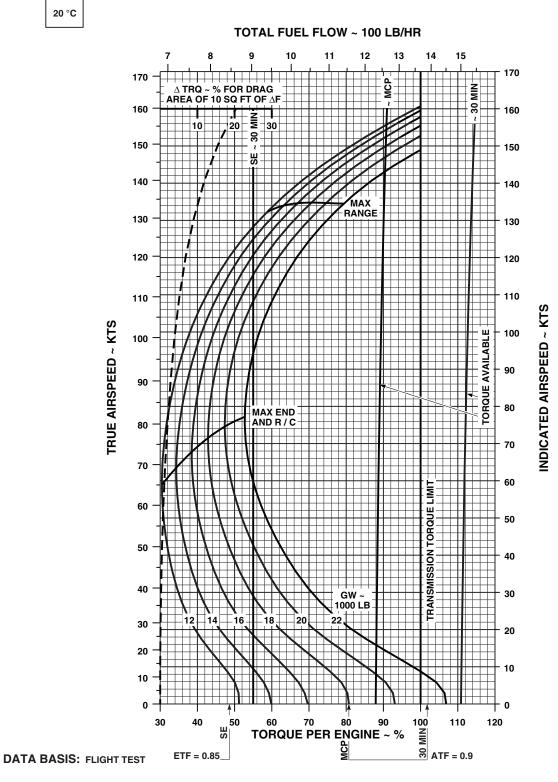


Figure 7-7. Cruise - Altitude Sea Level (Sheet 7 of 10)

## **CLEAN CONFIGURATION** PRESSURE ALT: 0 FT

20 °C

CRUISE 0 FT T700 (2)



## Figure 7-7. Cruise - Altitude Sea Level (Sheet 8 of 10)

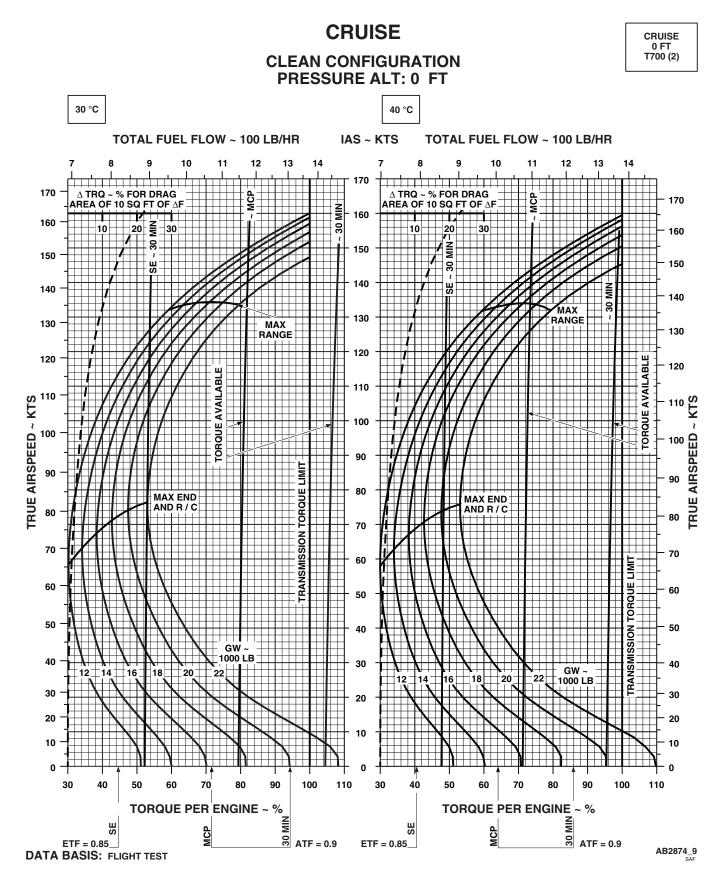


Figure 7-7. Cruise - Altitude Sea Level (Sheet 9 of 10)

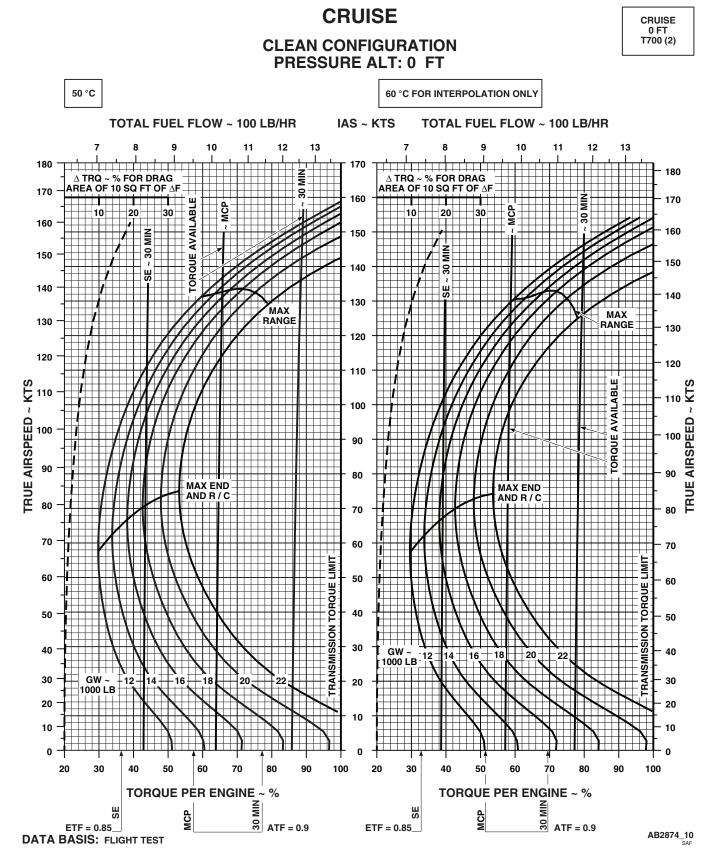
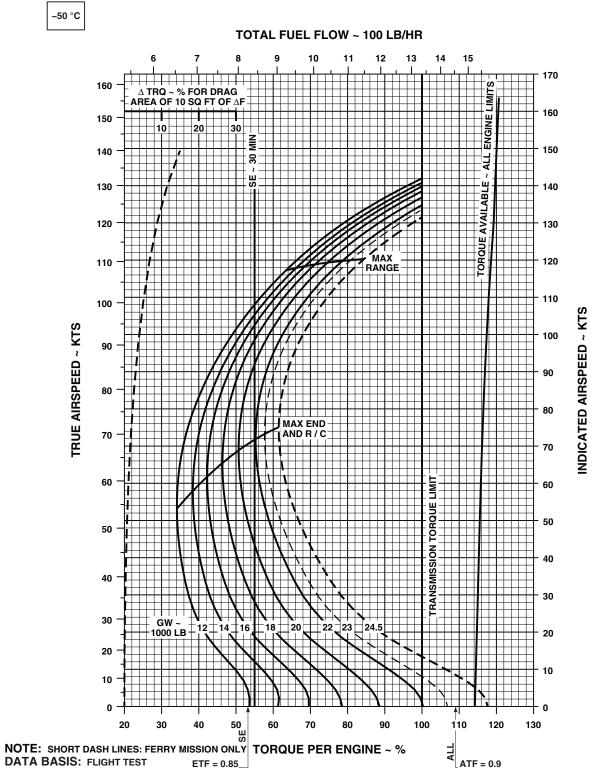


Figure 7-7. Cruise - Altitude Sea Level (Sheet 10 of 10)









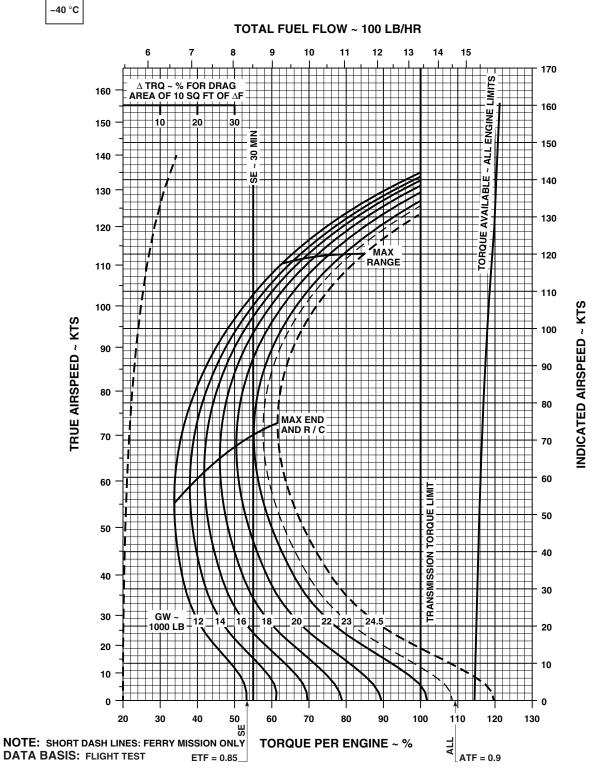
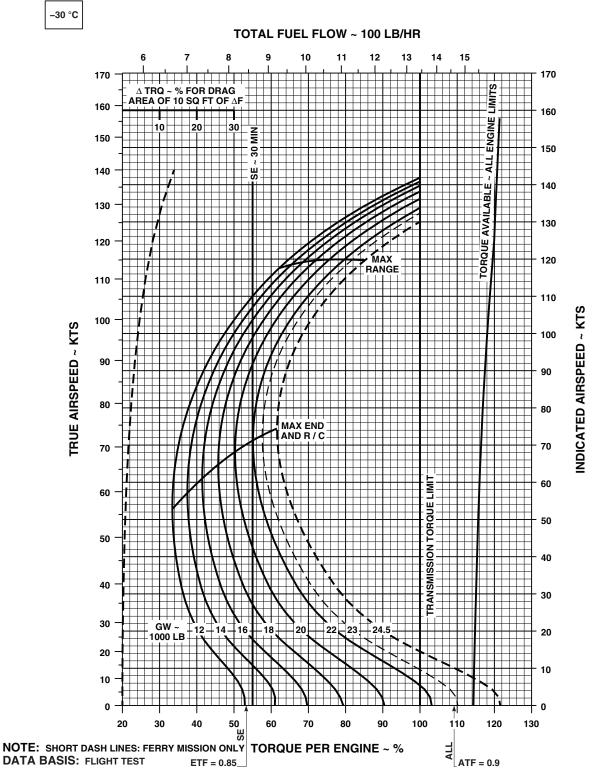


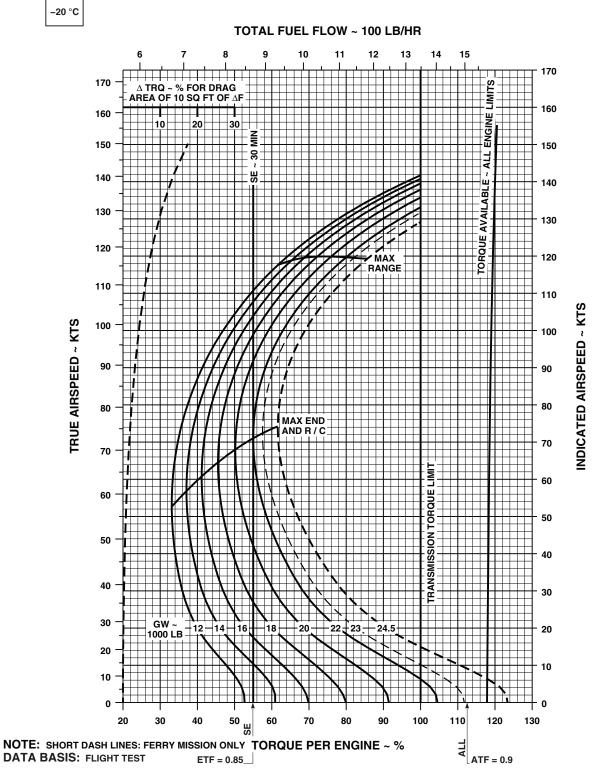
Figure 7-8. Cruise High Drag - Altitude Sea Level (Sheet 2 of 10)













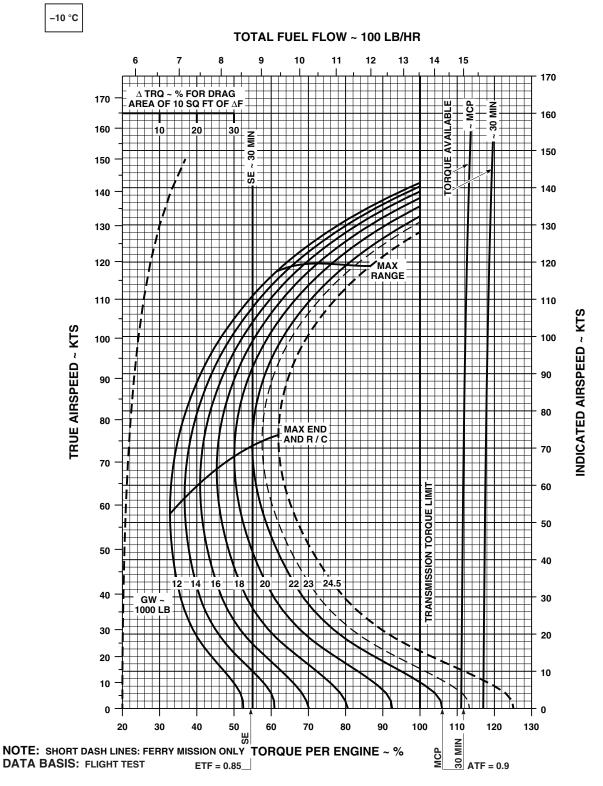




Figure 7-8. Cruise High Drag - Altitude Sea Level (Sheet 5 of 10)



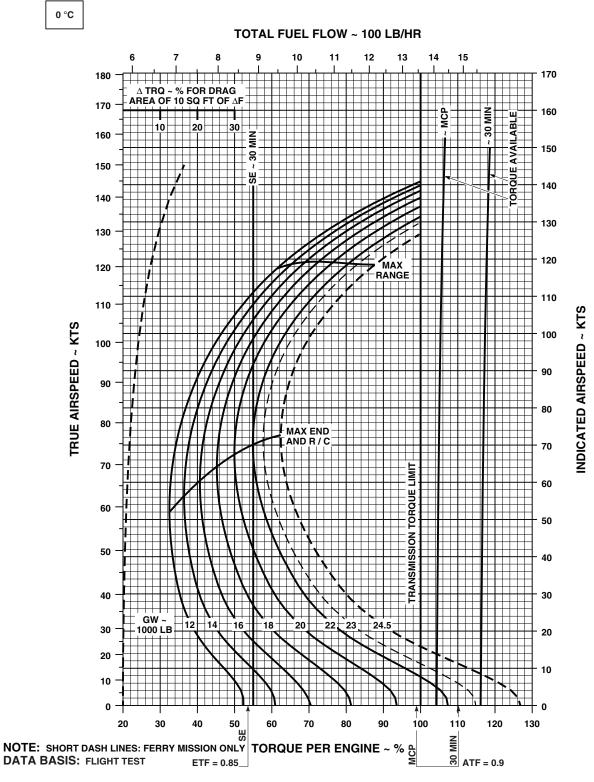


Figure 7-8. Cruise High Drag - Altitude Sea Level (Sheet 6 of 10)



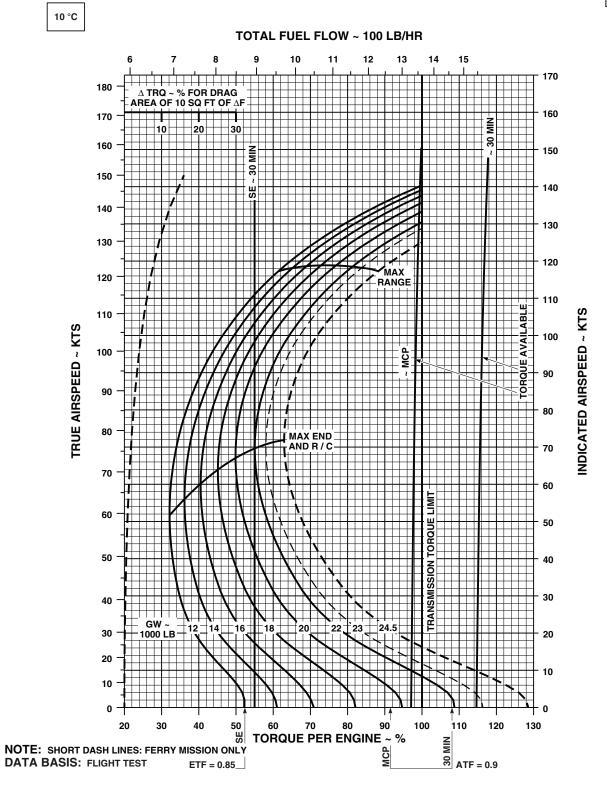
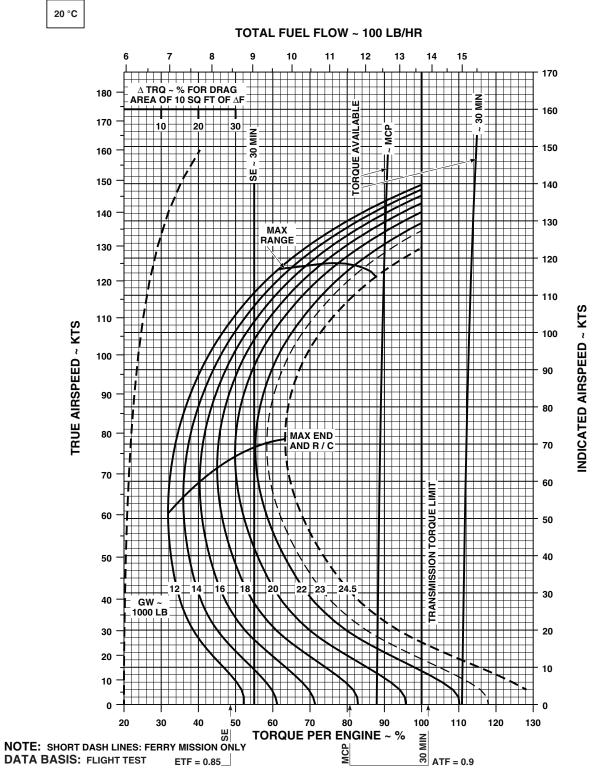




Figure 7-8. Cruise High Drag - Altitude Sea Level (Sheet 7 of 10)







CRUISE 0 FT T700 (2)

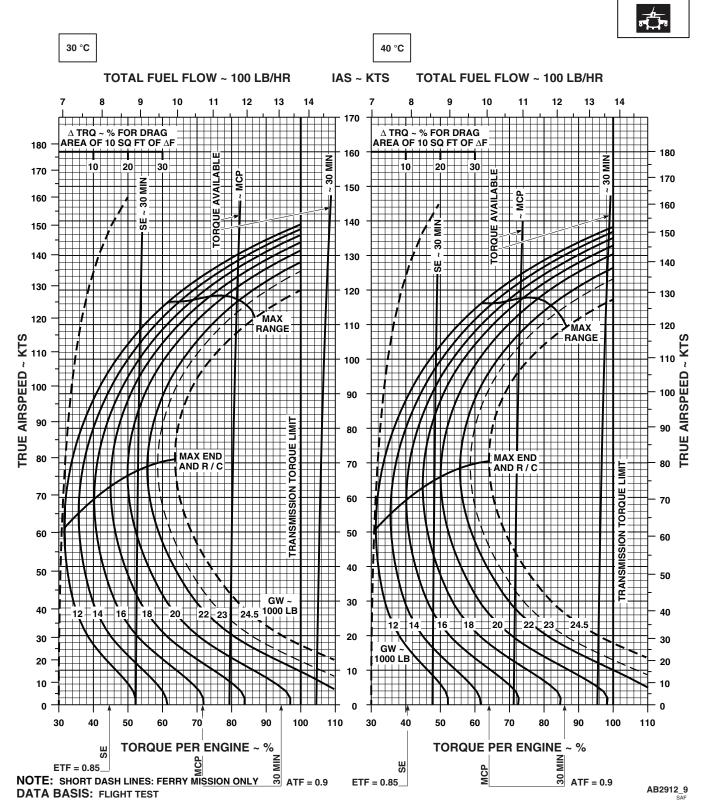


Figure 7-8. Cruise High Drag - Altitude Sea Level (Sheet 9 of 10)

CRUISE 0 FT T700 (2)

# CRUISE PRESSURE ALT: 0 FT

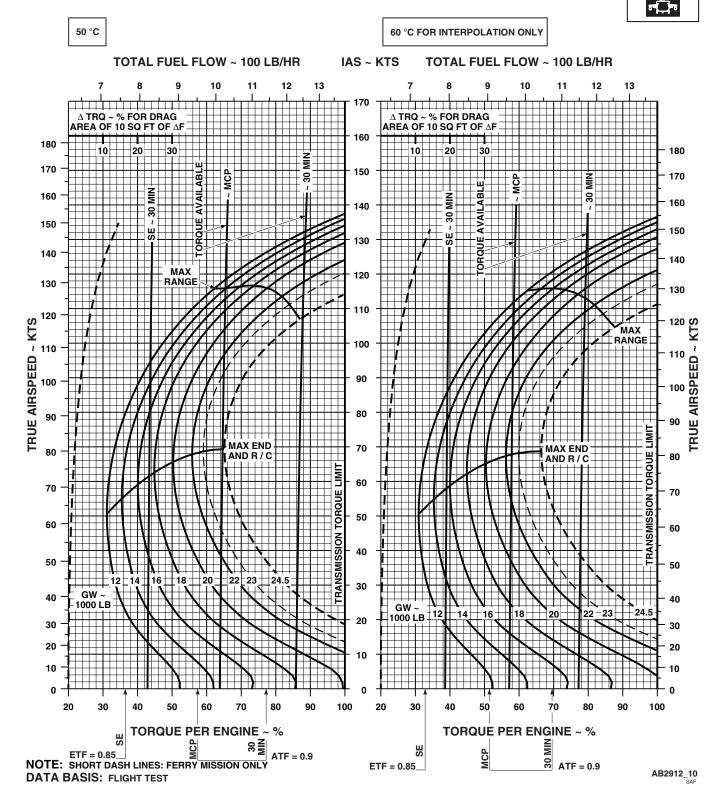


Figure 7-8. Cruise High Drag - Altitude Sea Level (Sheet 10 of 10)

# CLEAN CONFIGURATION PRESSURE ALT: 2000 FT



AB2875_1

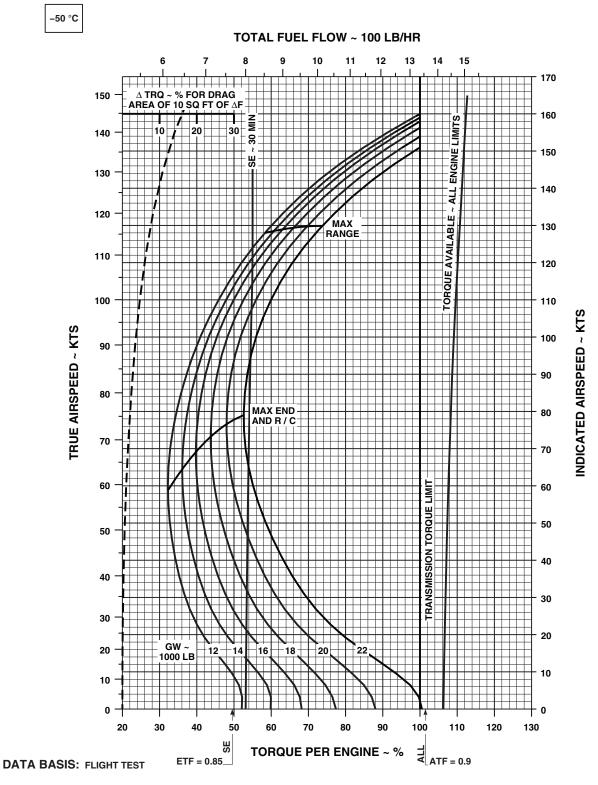


Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 1 of 10)

## CLEAN CONFIGURATION PRESSURE ALT: 2000 FT

CRUISE 2000 FT T700 (2)

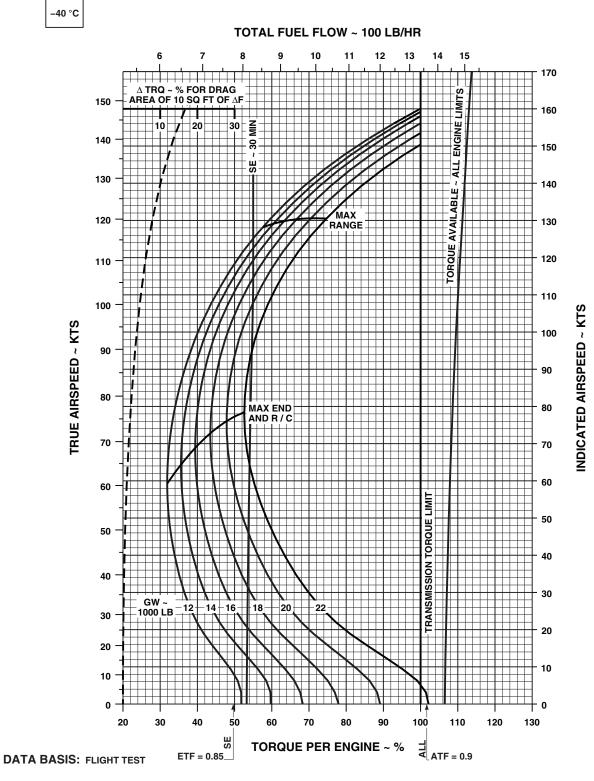


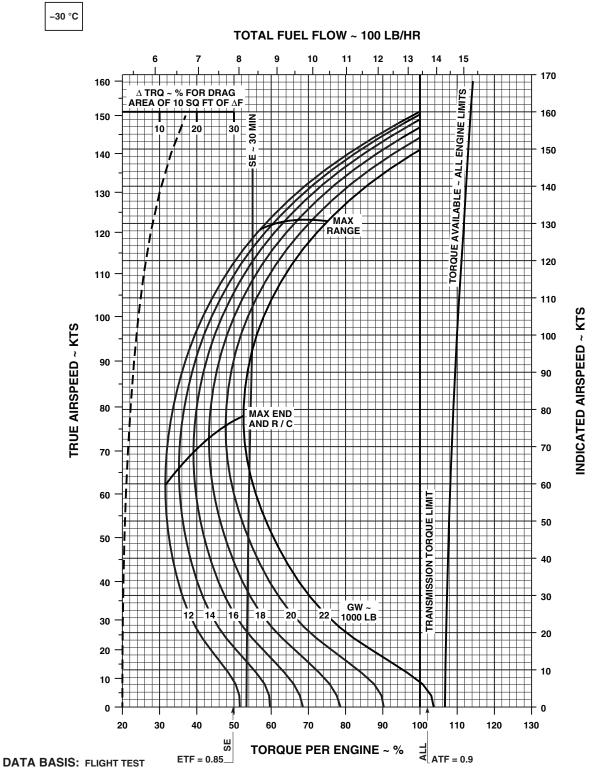
Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 2 of 10)

AB2875_2

# CLEAN CONFIGURATION PRESSURE ALT: 2000 FT



AB2875_3



### Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 3 of 10)

## CLEAN CONFIGURATION PRESSURE ALT: 2000 FT

CRUISE 2000 FT T700 (2)

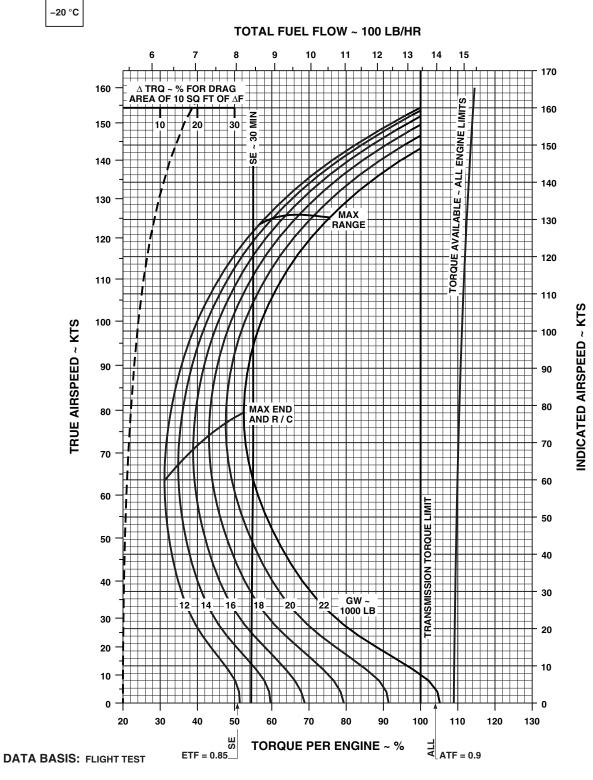


Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 4 of 10)

AB2875_4

# CLEAN CONFIGURATION PRESSURE ALT: 2000 FT



AB2875_5

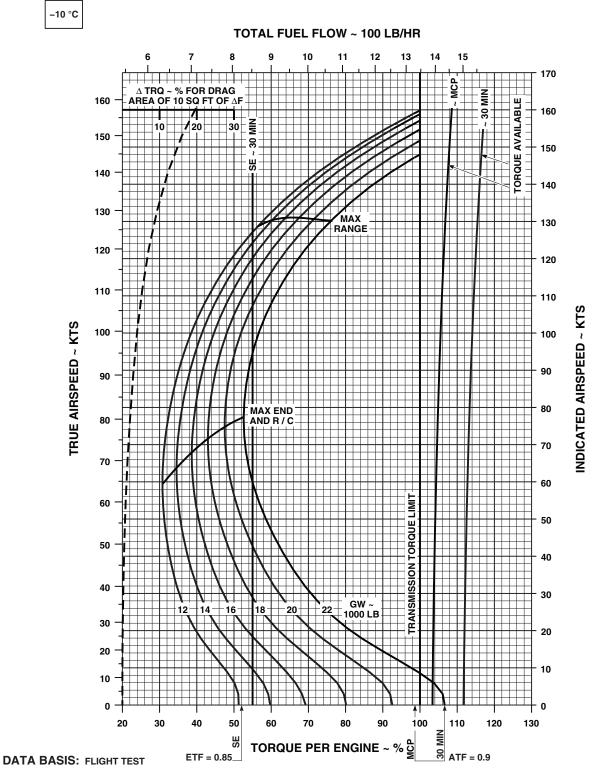


Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 5 of 10)

## CLEAN CONFIGURATION PRESSURE ALT: 2000 FT



0 °C TOTAL FUEL FLOW ~ 100 LB/HR **∆ TRQ ~ % FOR DRAG** MCP AREA OF 10 SQ FT OF AF MIN MIN + - 140 TORQUE AVAILABLE МАХ RANGE INDICATED AIRSPEED ~ KTS TRUE AIRSPEED ~ KTS Т t MAX END AND R / C H LIMIT ш rorqu ISSION GW ~ 1000 LB -16 TRANSM 0 -**TORQUE PER ENGINE** ~ % MIN SЕ MCP ਲ ATF = 0.9 ETF = 0.85_ **DATA BASIS:** FLIGHT TEST

### Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 6 of 10)

AB2875_6

# CLEAN CONFIGURATION PRESSURE ALT: 2000 FT



AB2875_7

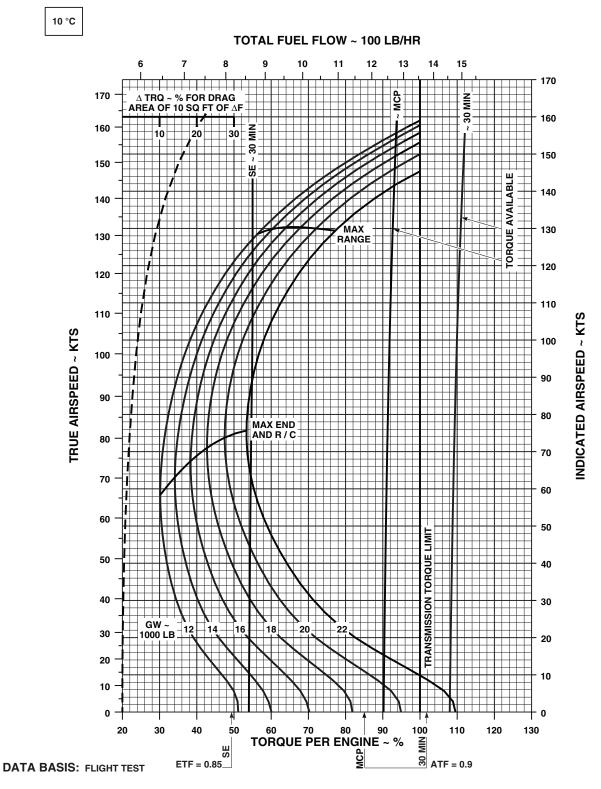


Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 7 of 10)

## **CRUISE**

## CLEAN CONFIGURATION PRESSURE ALT: 2000 FT

CRUISE 2000 FT T700 (2)

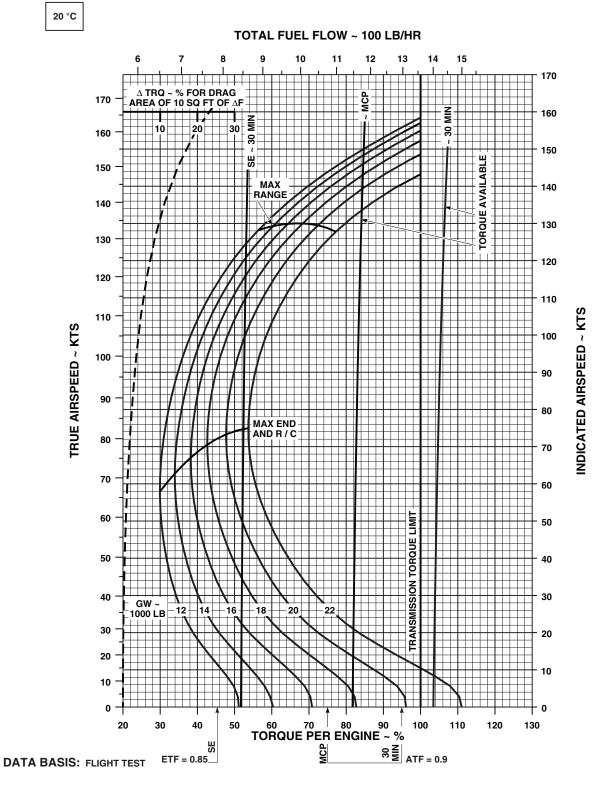


Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 8 of 10)

AB2875_8

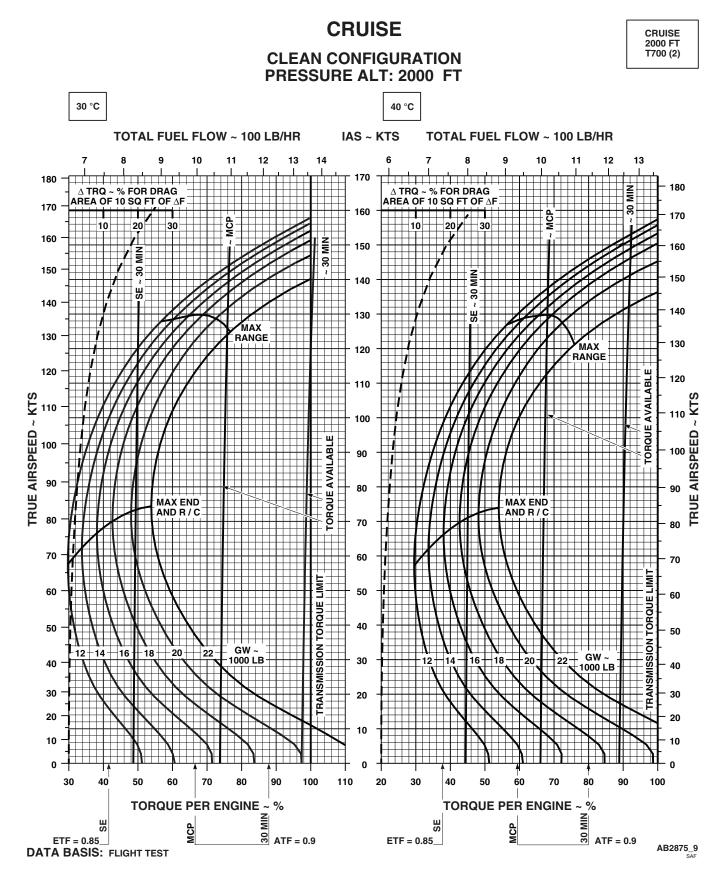
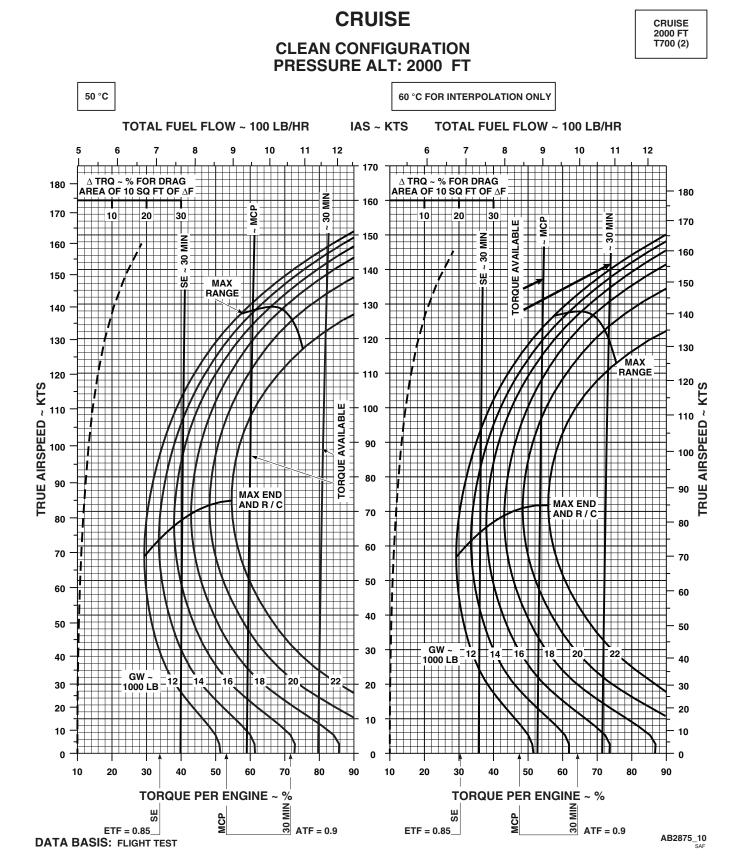


Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 9 of 10)



#### Figure 7-9. Cruise - Altitude 2,000 Feet (Sheet 10 of 10)

7-45



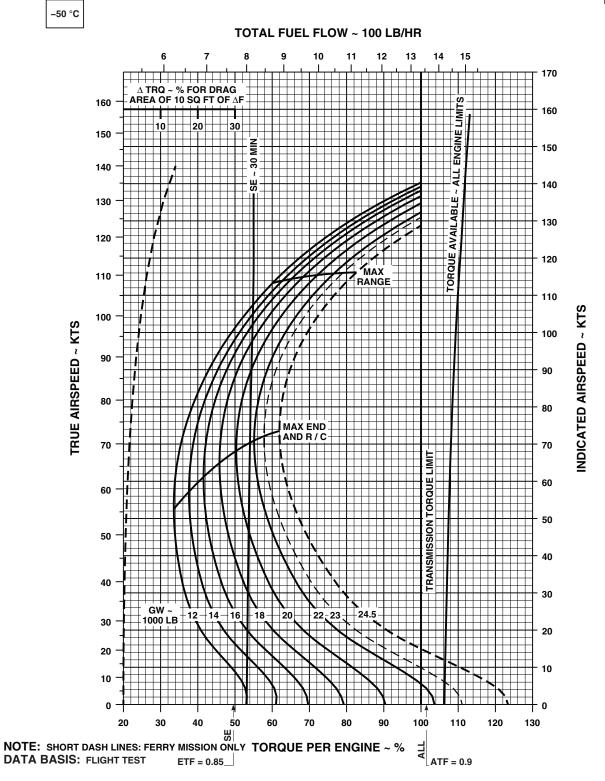
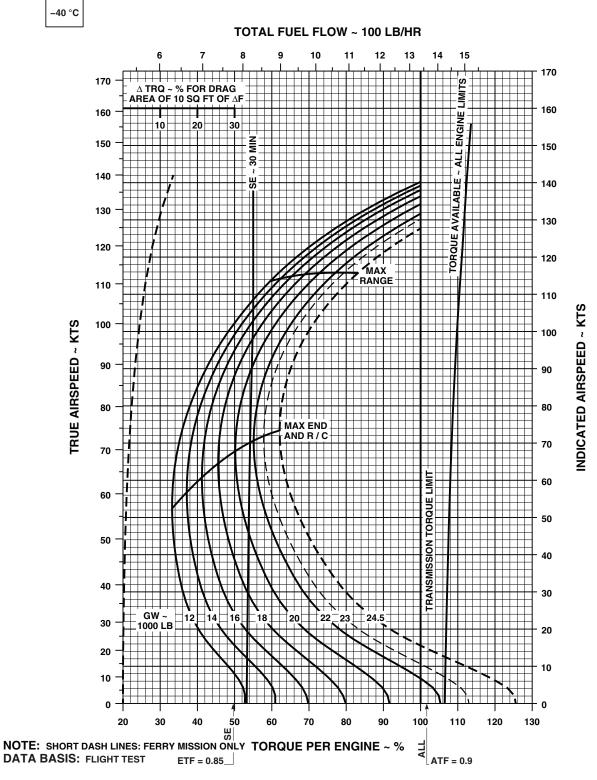




Figure 7-10. Cruise High Drag - Altitude 2,000 Feet (Sheet 1 of 10)



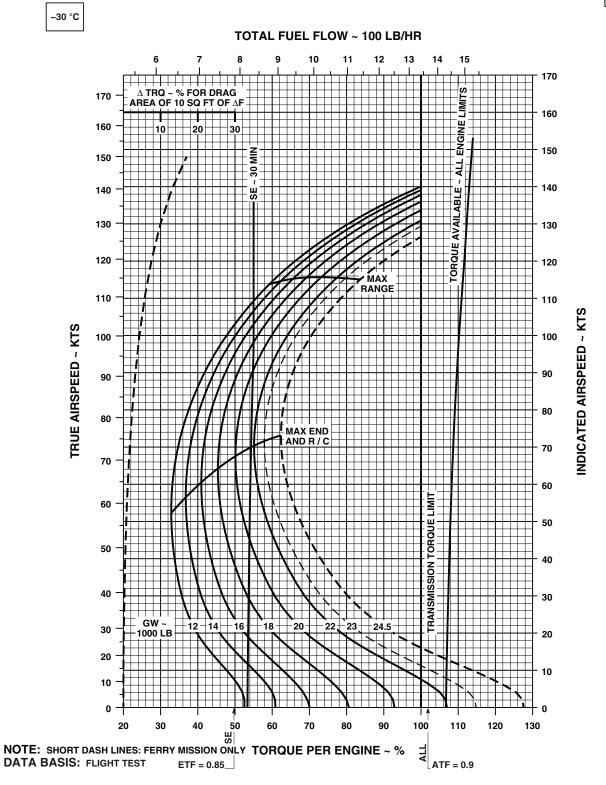


#### Figure 7-10. Cruise High Drag - Altitude 2,000 Feet (Sheet 2 of 10)

7-47

AB2913_2











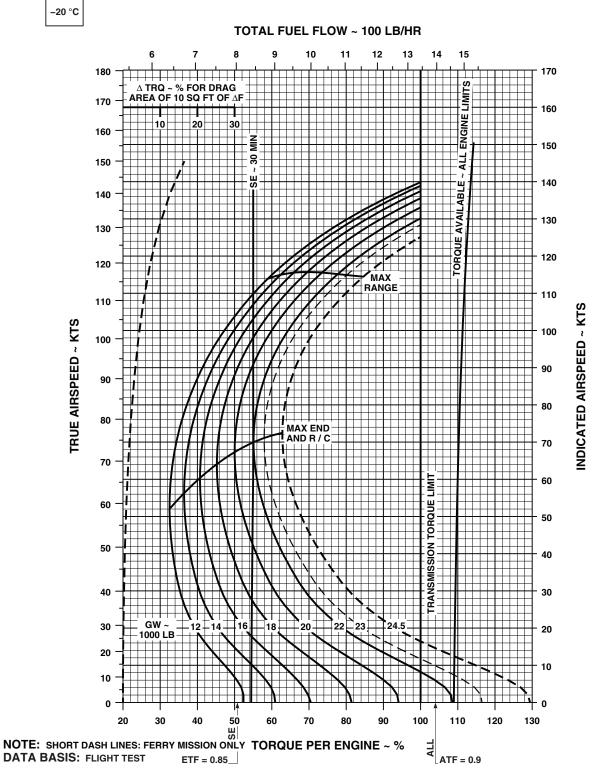


Figure 7-10. Cruise High Drag - Altitude 2,000 Feet (Sheet 4 of 10)

AB2913_4



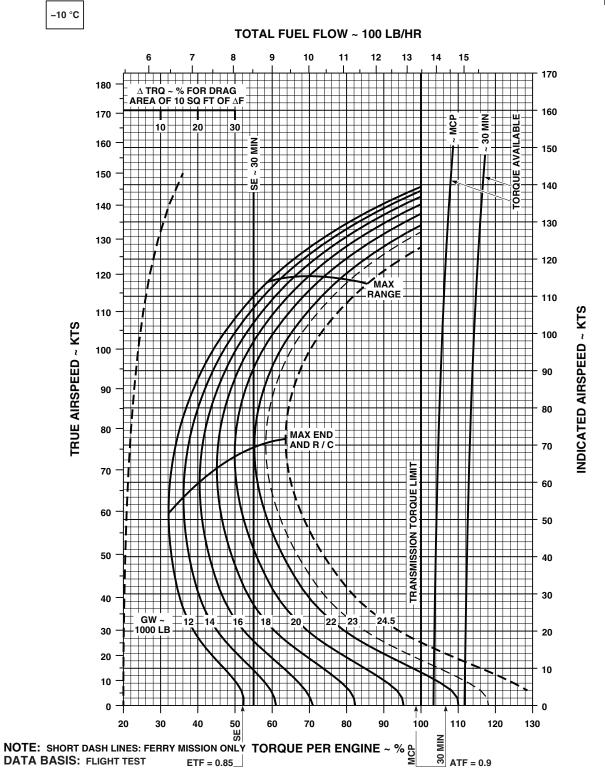
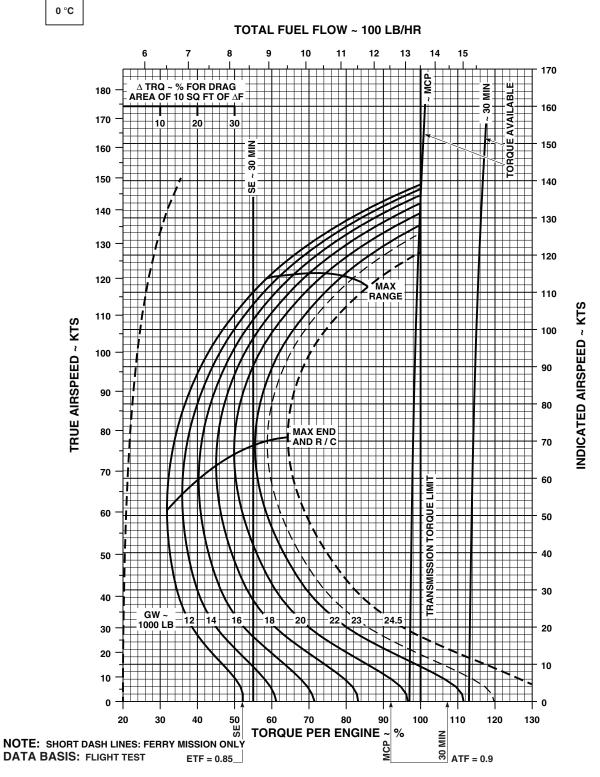




Figure 7-10. Cruise High Drag - Altitude 2,000 Feet (Sheet 5 of 10)



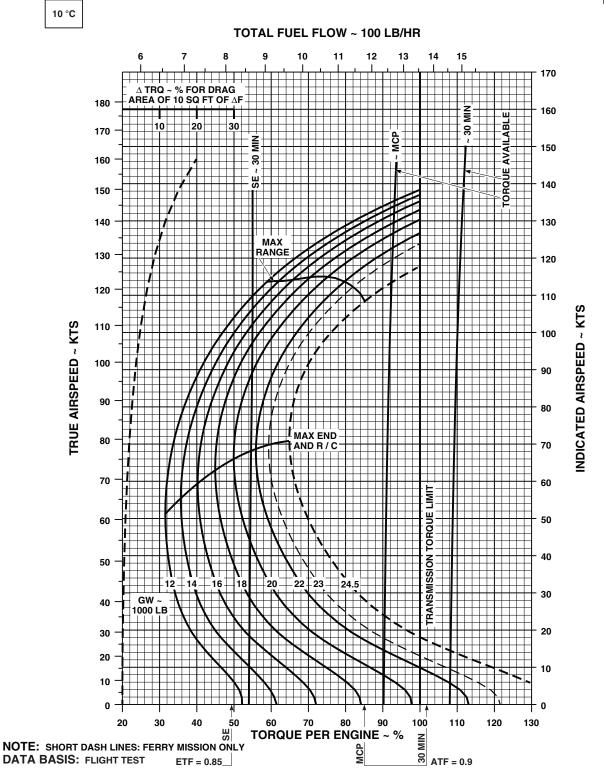


#### Figure 7-10. Cruise High Drag - Altitude 2,000 Feet (Sheet 6 of 10)

AB2913_6



AB2913_7







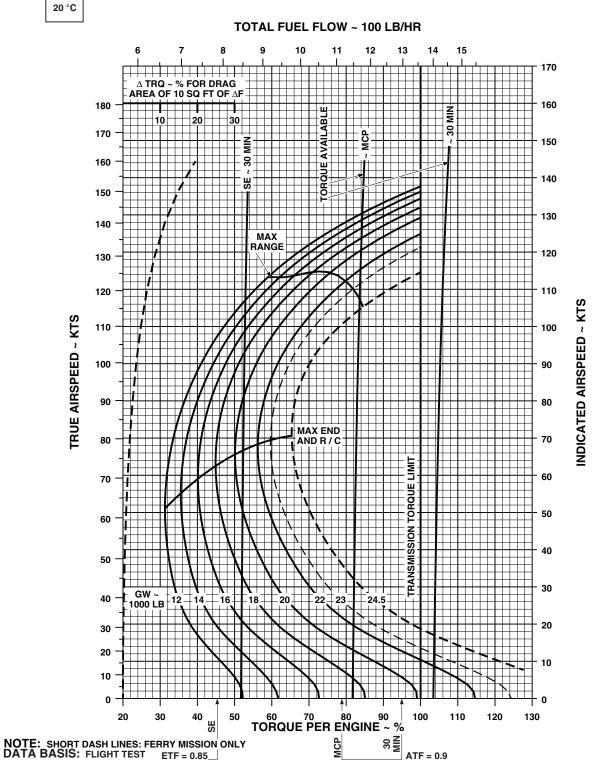


Figure 7-10. Cruise High Drag - Altitude 2,000 Feet (Sheet 8 of 10)

AB2913_8 SAF

CRUISE 2000 FT

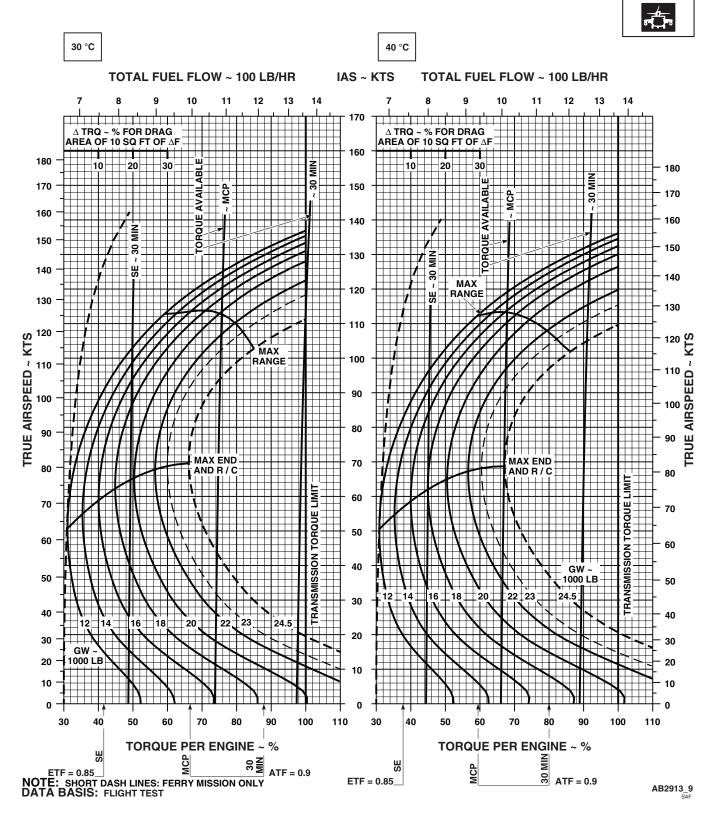


Figure 7-10. Cruise High Drag - Altitude 2,000 Feet (Sheet 9 of 10)

CRUISE 2000 FT

T700 (2)

## CRUISE PRESSURE ALT: 2000 FT

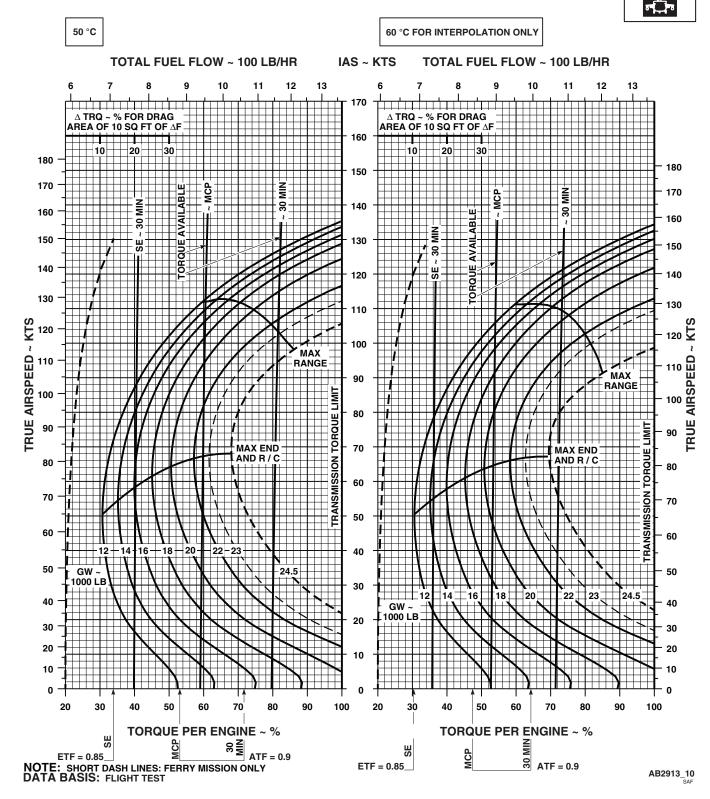


Figure 7-10. Cruise High Drag - Altitude 2,000 Feet (Sheet 10 of 10)

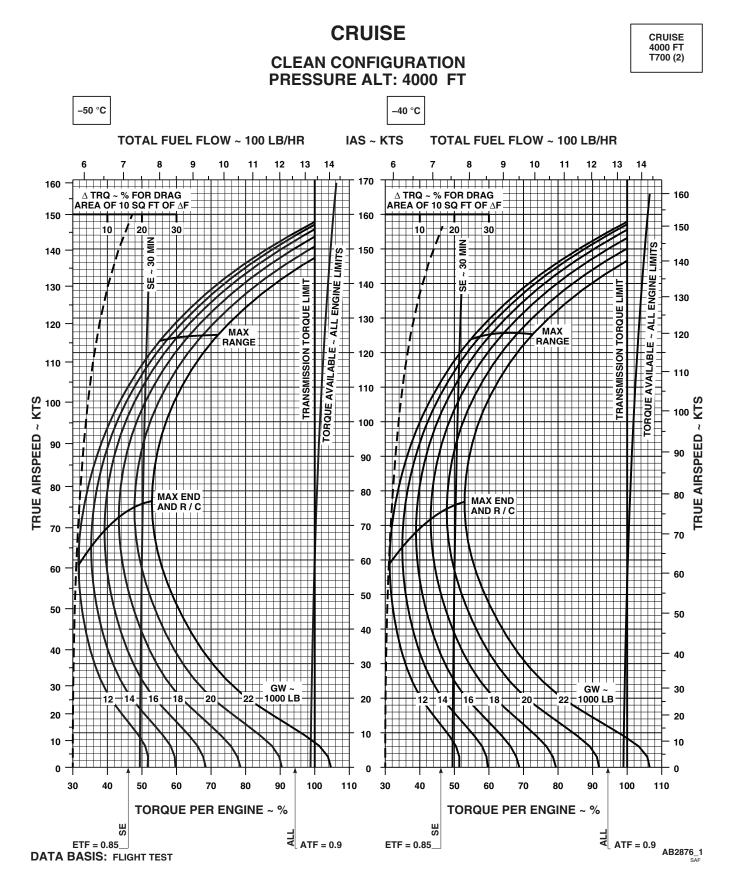


Figure 7-11. Cruise - Altitude 4,000 Feet (Sheet 1 of 6)



## CLEAN CONFIGURATION PRESSURE ALT: 4000 FT



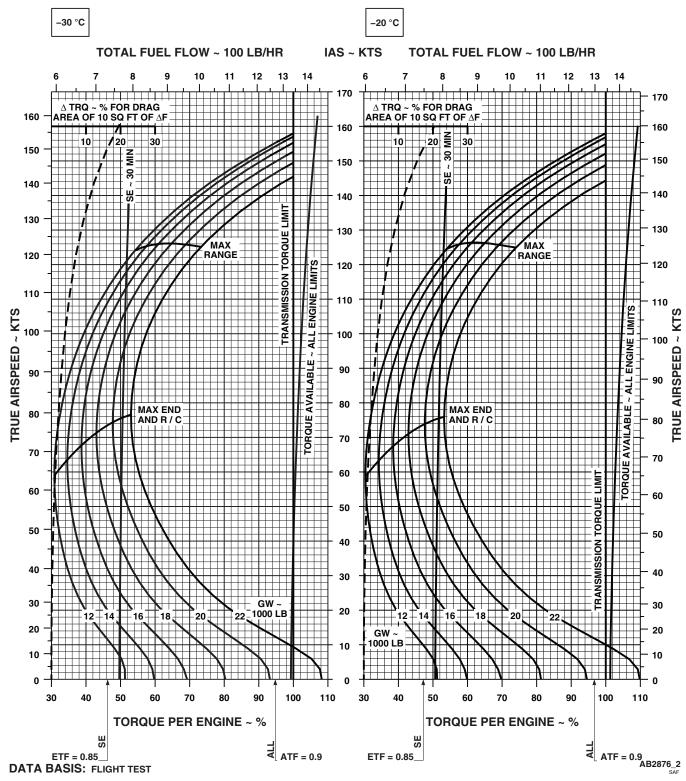


Figure 7-11. Cruise - Altitude 4,000 Feet (Sheet 2 of 6)

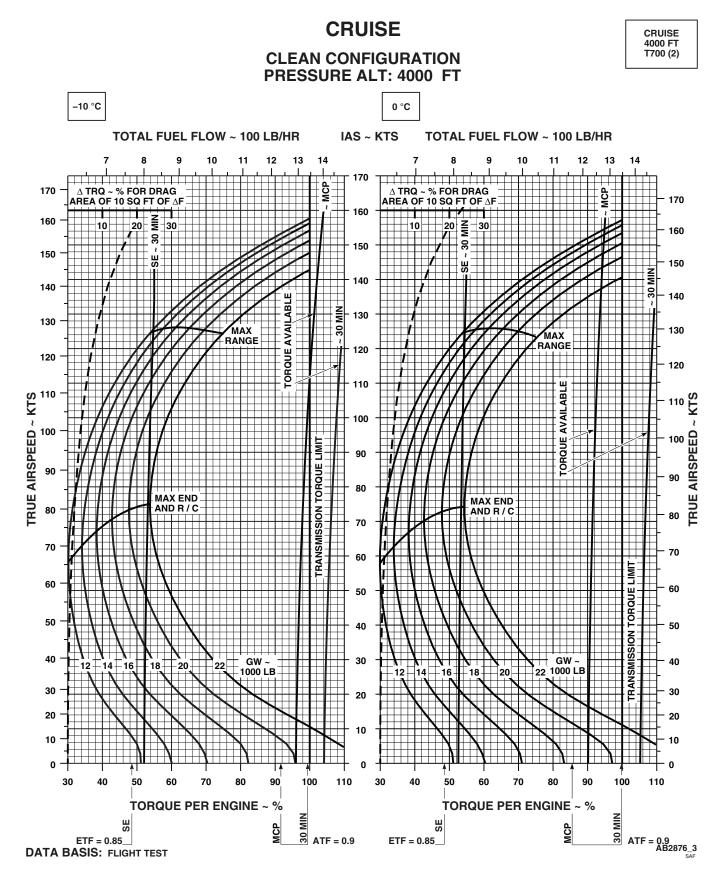


Figure 7-11. Cruise - Altitude 4,000 Feet (Sheet 3 of 6)

## **CRUISE**

### CLEAN CONFIGURATION PRESSURE ALT: 4000 FT



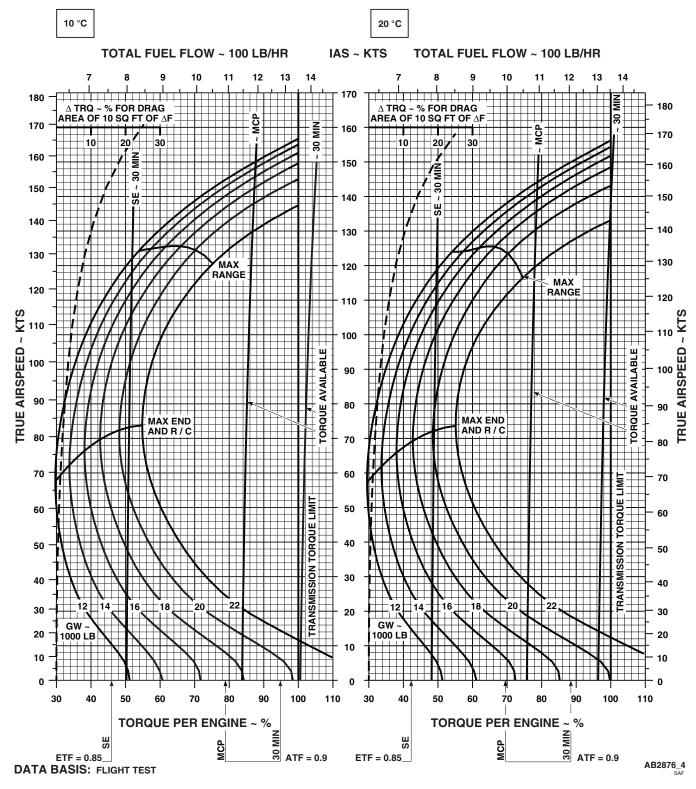


Figure 7-11. Cruise - Altitude 4,000 Feet (Sheet 4 of 6)

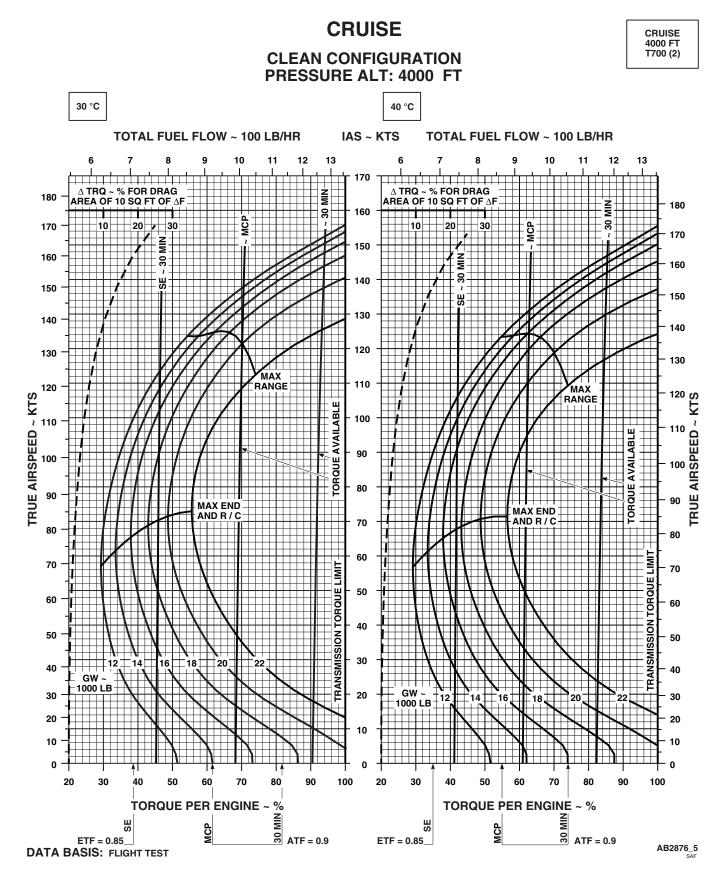


Figure 7-11. Cruise - Altitude 4,000 Feet (Sheet 5 of 6)

## **CRUISE**

## CLEAN CONFIGURATION PRESSURE ALT: 4000 FT

CRUISE 4000 FT T700 (2)

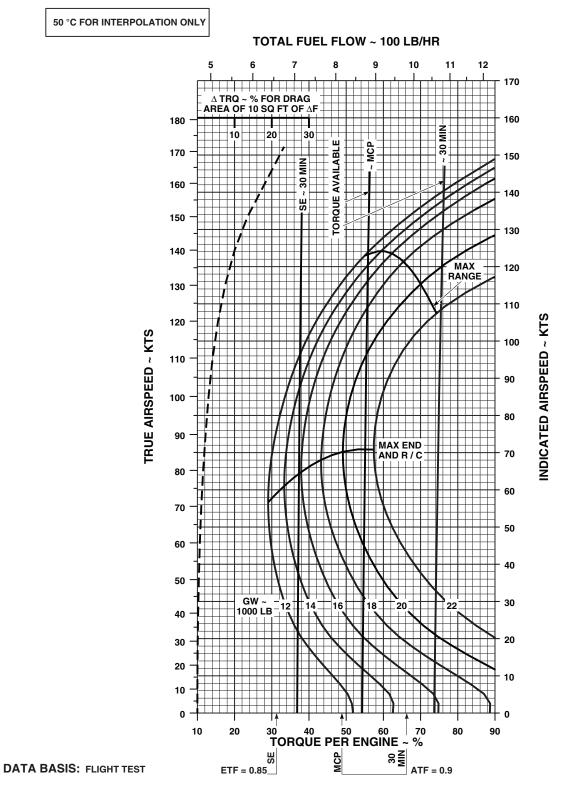


Figure 7-11. Cruise - Altitude 4,000 Feet (Sheet 6 of 6)

AB2876_6

CRUISE 4000 FT

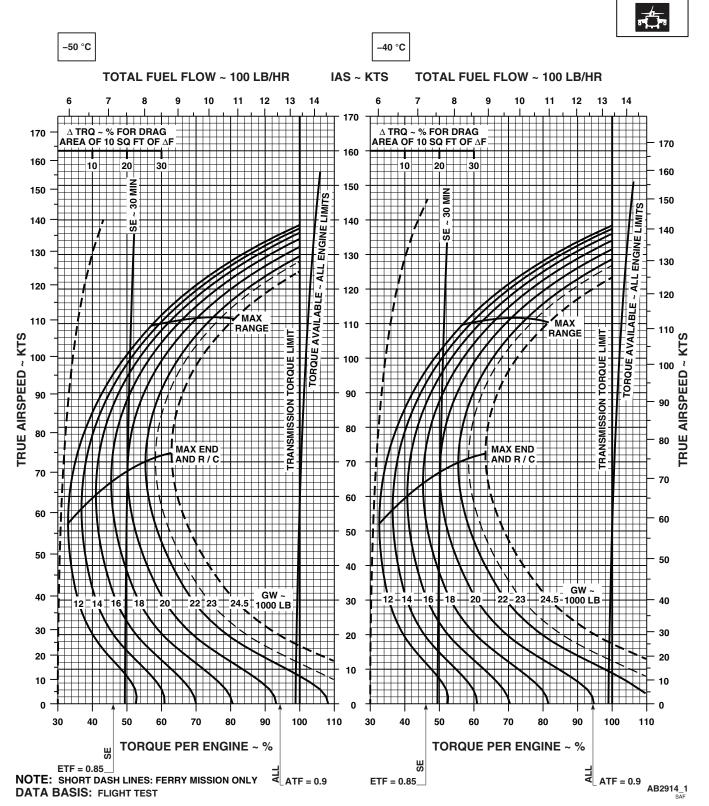


Figure 7-12. Cruise High Drag - Altitude 4,000 Feet (Sheet 1 of 6)

CRUISE 4000 FT

T700 (2)

## CRUISE PRESSURE ALT: 4000 FT

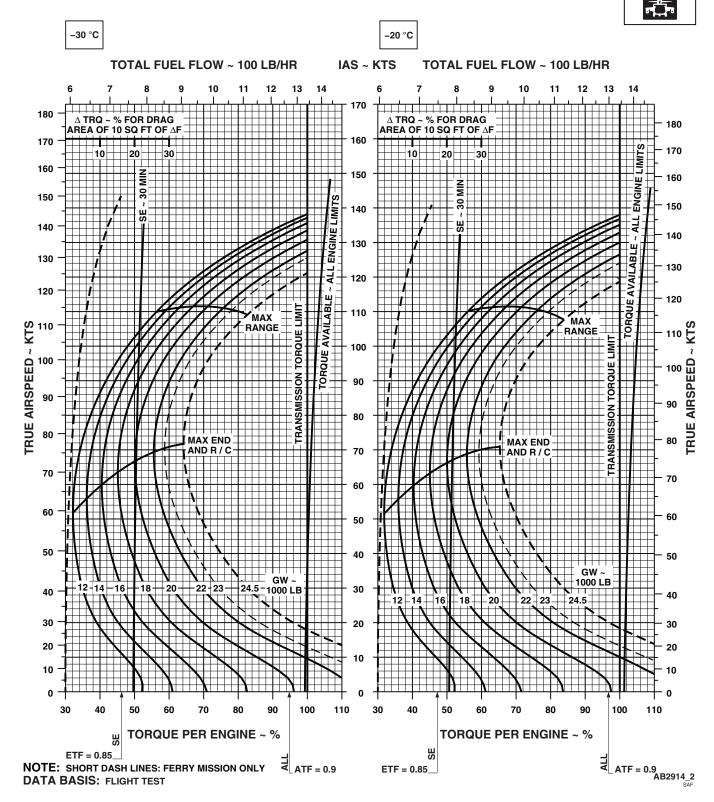


Figure 7-12. Cruise High Drag - Altitude 4,000 Feet (Sheet 2 of 6)

CRUISE 4000 FT

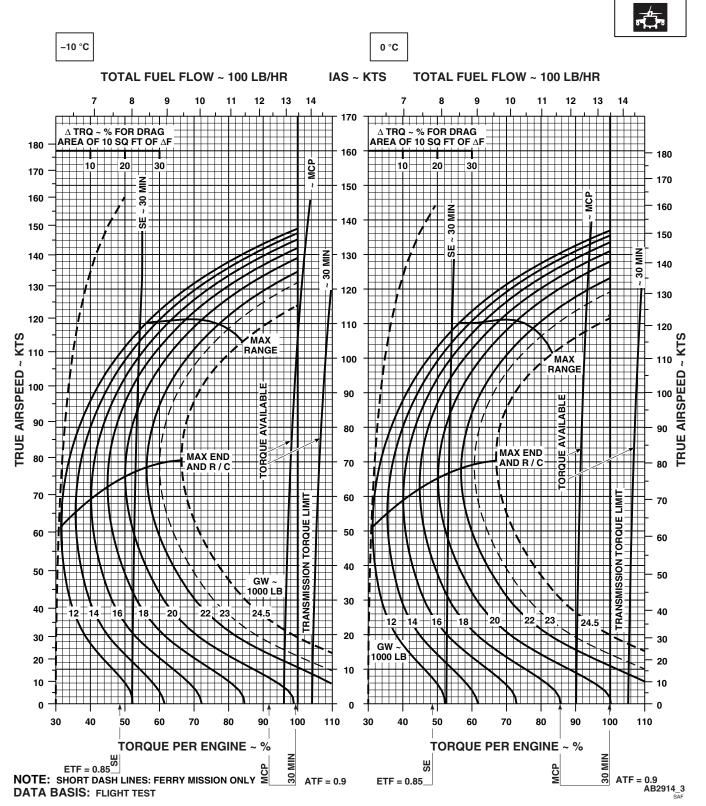


Figure 7-12. Cruise High Drag - Altitude 4,000 Feet (Sheet 3 of 6)

CRUISE 4000 FT

T700 (2)

## CRUISE PRESSURE ALT: 4000 FT

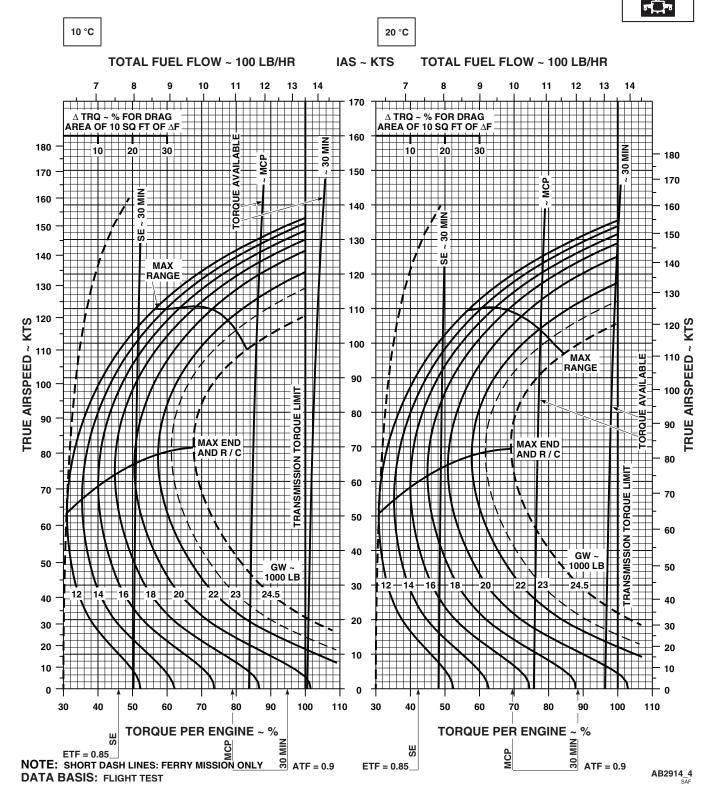


Figure 7-12. Cruise High Drag - Altitude 4,000 Feet (Sheet 4 of 6)

CRUISE 4000 FT

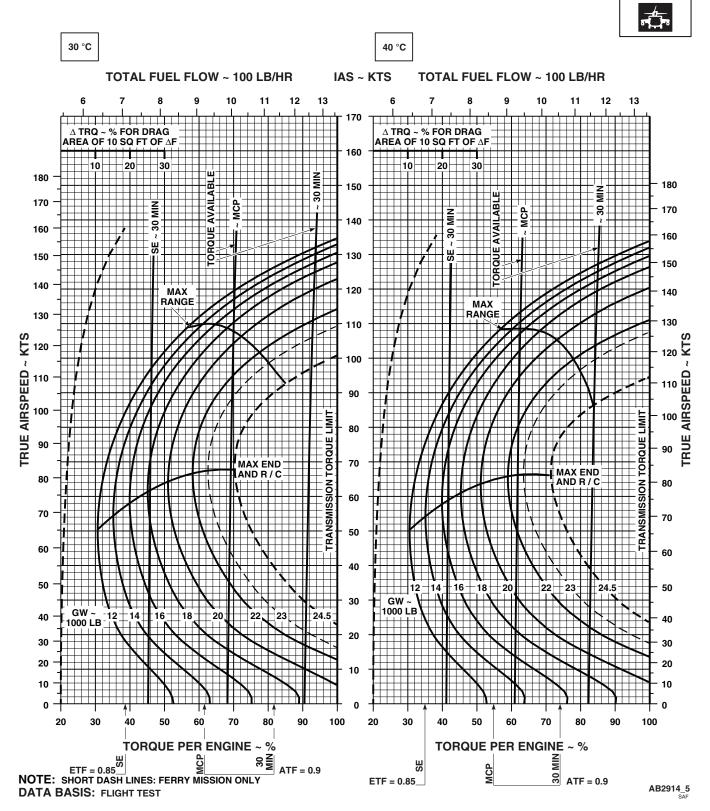


Figure 7-12. Cruise High Drag - Altitude 4,000 Feet (Sheet 5 of 6)



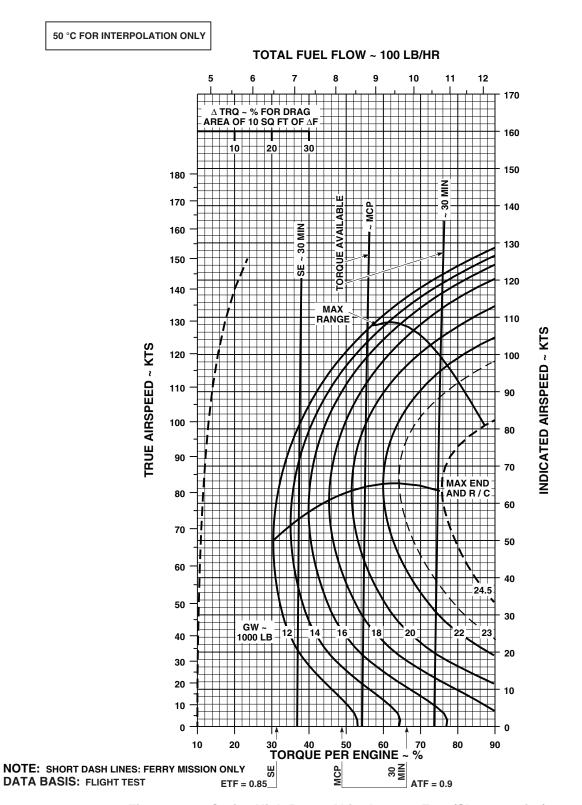




Figure 7-12. Cruise High Drag - Altitude 4,000 Feet (Sheet 6 of 6)

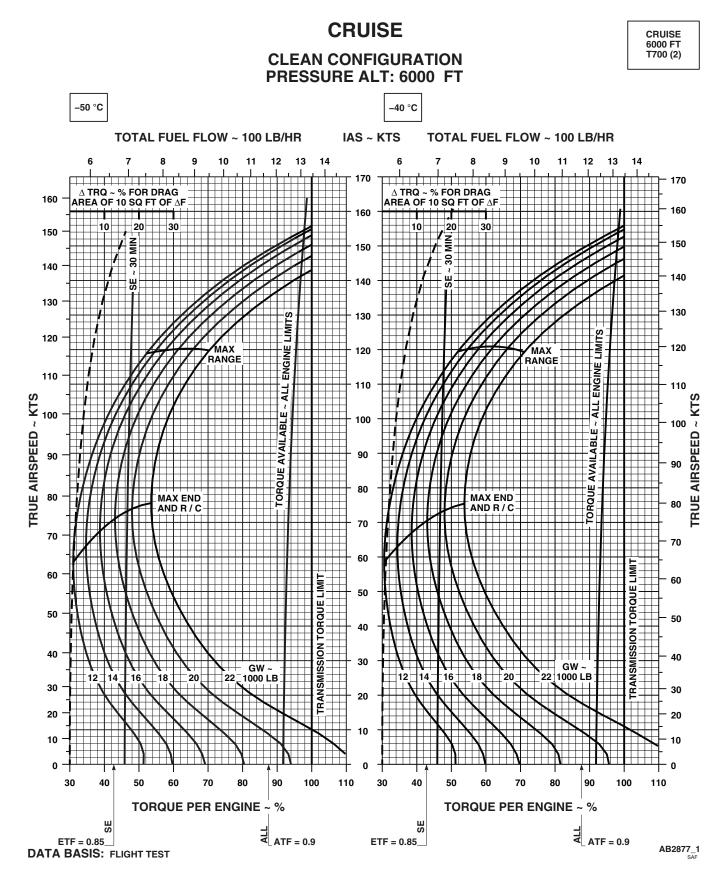


Figure 7-13. Cruise - Altitude 6,000 Feet (Sheet 1 of 6)



# CLEAN CONFIGURATION PRESSURE ALT: 6000 FT

CRUISE 6000 FT T700 (2)

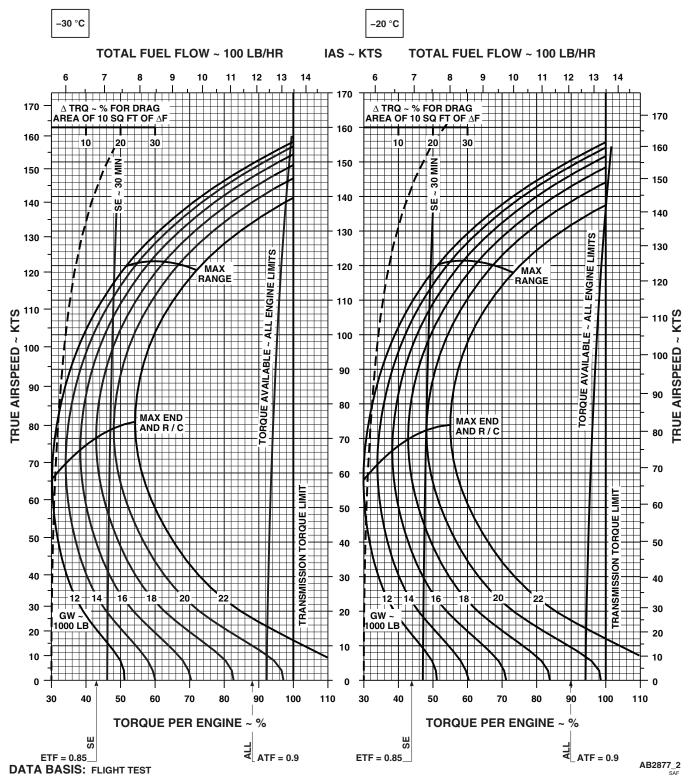


Figure 7-13. Cruise - Altitude 6,000 Feet (Sheet 2 of 6)

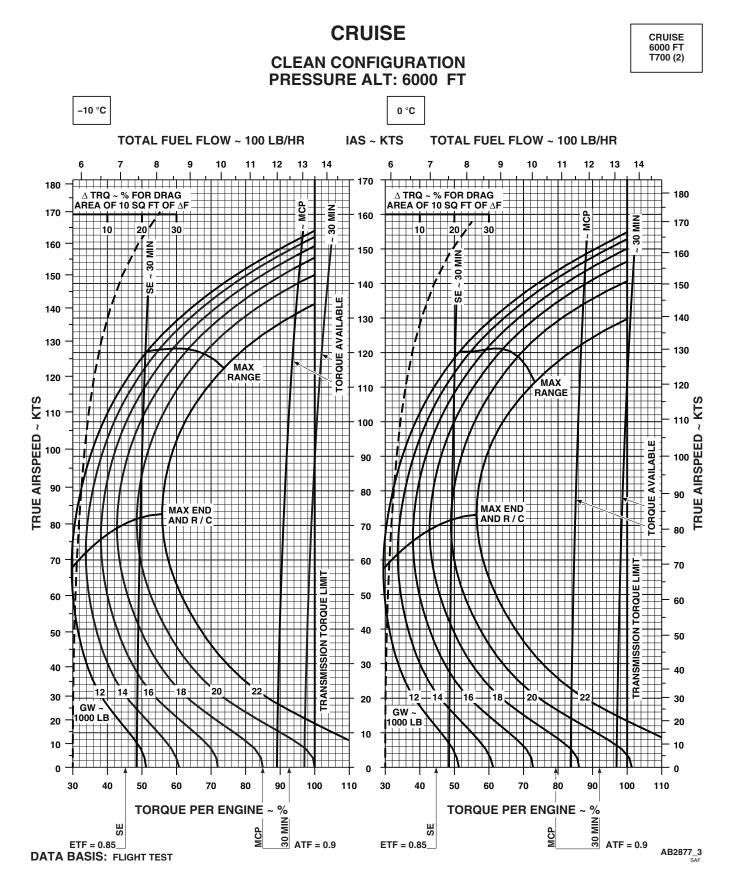


Figure 7-13. Cruise - Altitude 6,000 Feet (Sheet 3 of 6)

## **CRUISE**

### CLEAN CONFIGURATION PRESSURE ALT: 6000 FT

CRUISE 6000 FT T700 (2)

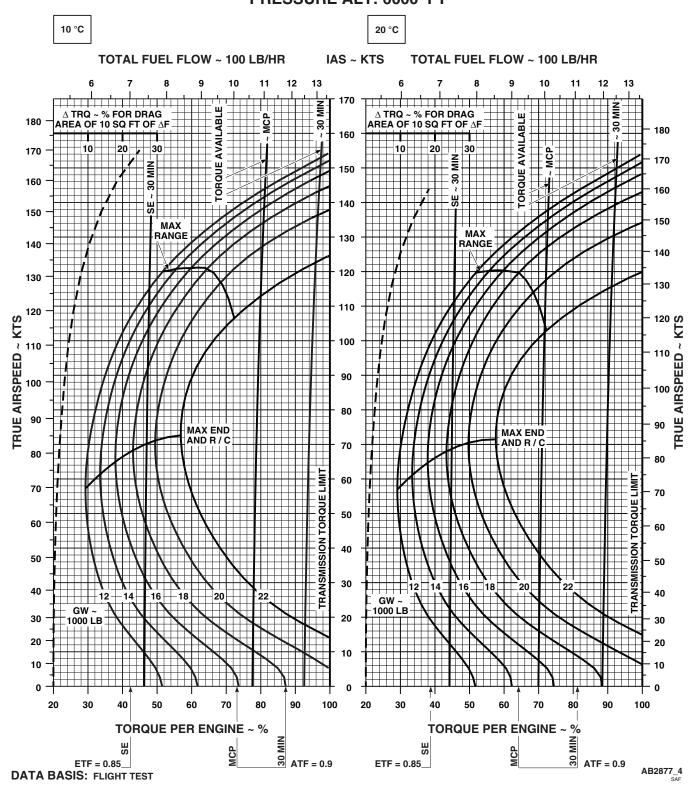


Figure 7-13. Cruise - Altitude 6,000 Feet (Sheet 4 of 6)

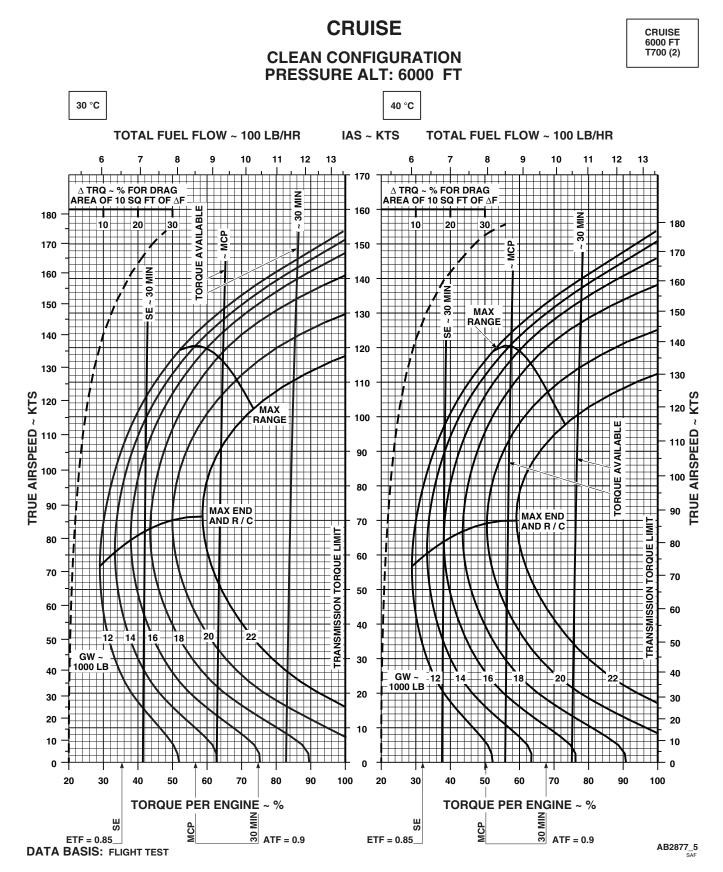
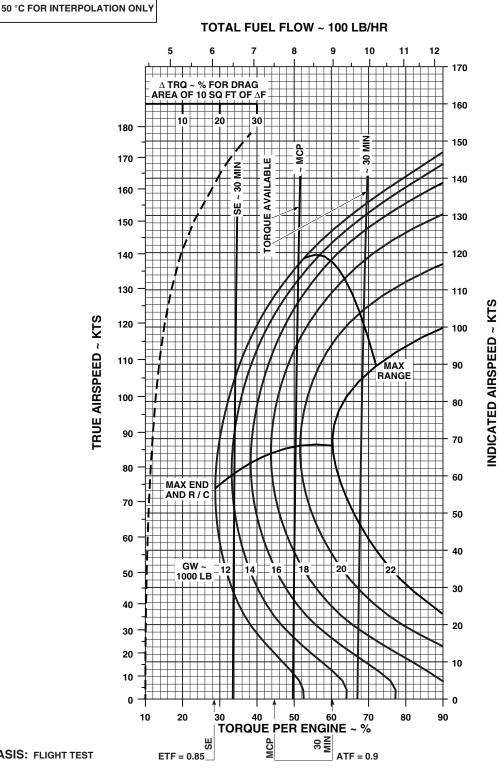


Figure 7-13. Cruise - Altitude 6,000 Feet (Sheet 5 of 6)

## **CRUISE**

## **CLEAN CONFIGURATION** PRESSURE ALT: 6000 FT

CRUISE 6000 FT T700 (2)



DATA BASIS: FLIGHT TEST

Figure 7-13. Cruise - Altitude 6,000 Feet (Sheet 6 of 6)

AB2877_6

CRUISE 6000 FT

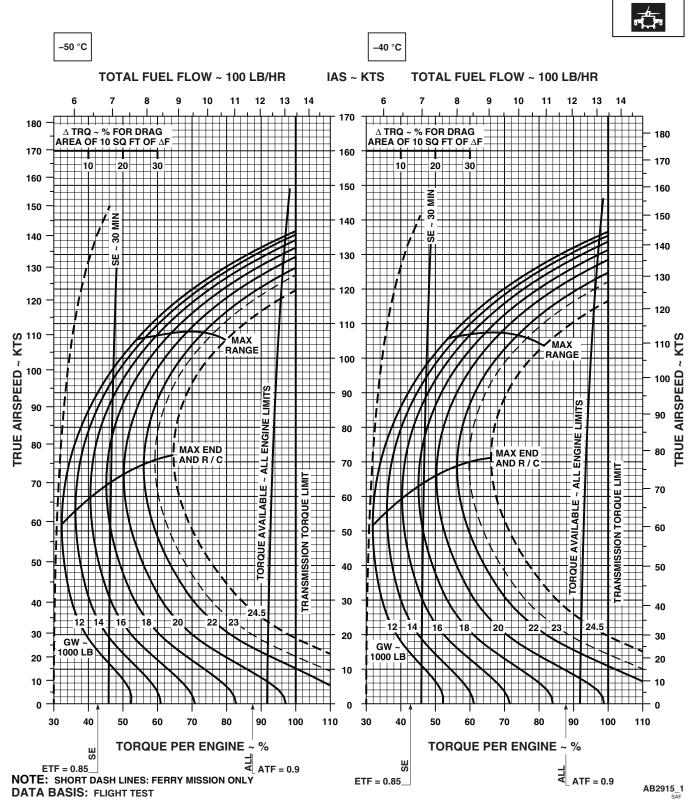


Figure 7-14. Cruise High Drag - Altitude 6,000 Feet (Sheet 1 of 6)

CRUISE 6000 FT

T700 (2)

## CRUISE PRESSURE ALT: 6000 FT

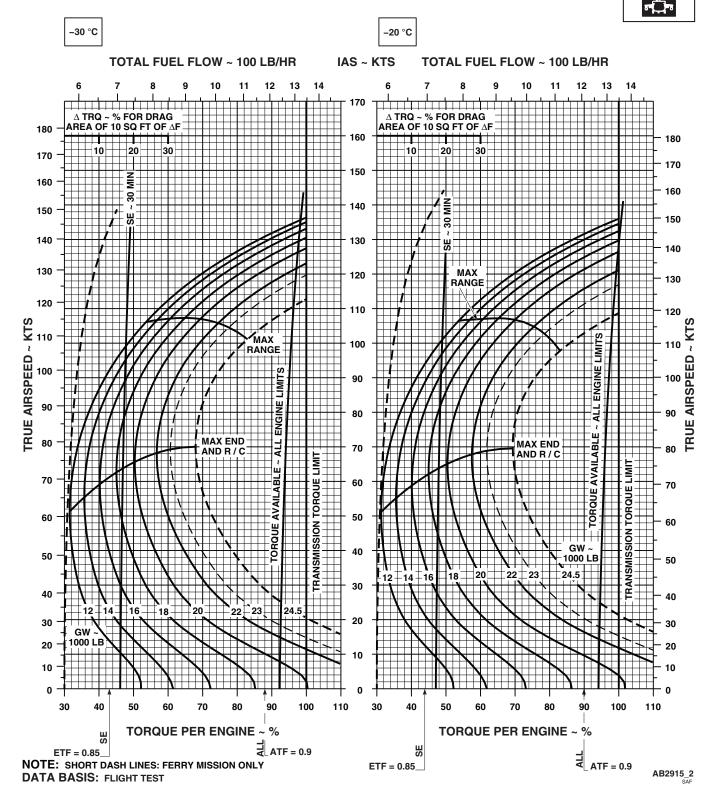


Figure 7-14. Cruise High Drag - Altitude 6,000 Feet (Sheet 2 of 6)

CRUISE 6000 FT

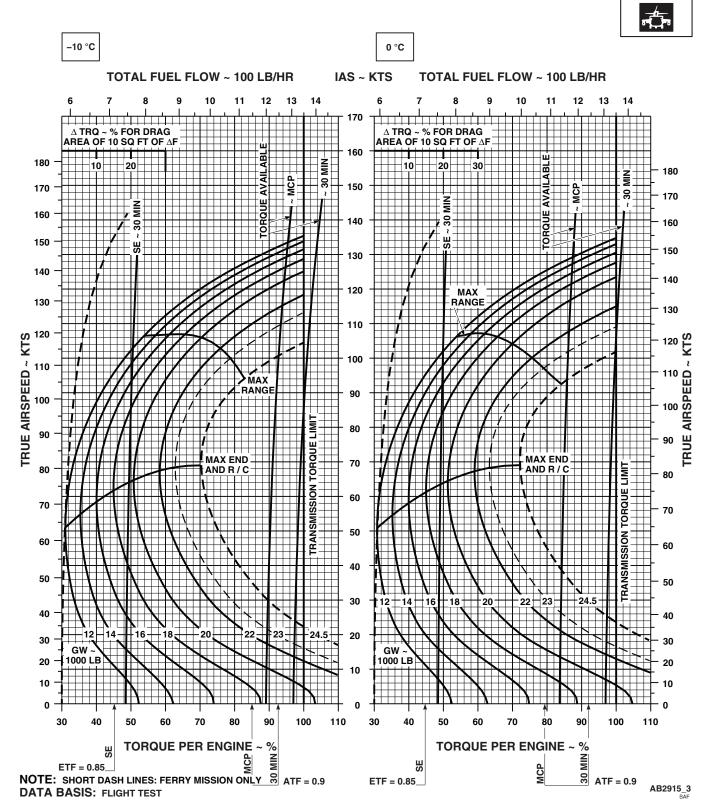


Figure 7-14. Cruise High Drag - Altitude 6,000 Feet (Sheet 3 of 6)

CRUISE 6000 FT

T700 (2)

## CRUISE PRESSURE ALT: 6000 FT

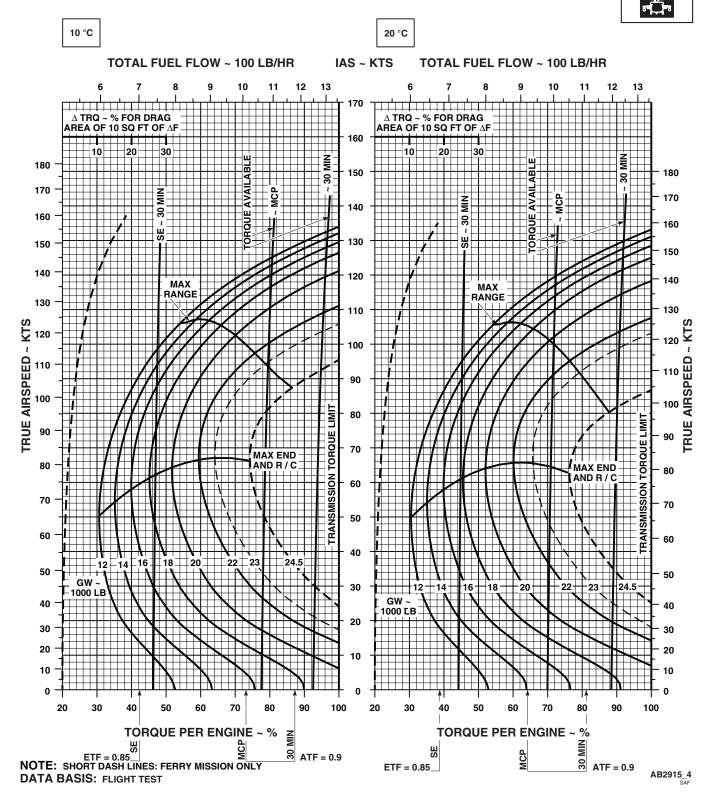


Figure 7-14. Cruise High Drag - Altitude 6,000 Feet (Sheet 4 of 6)

CRUISE 6000 FT

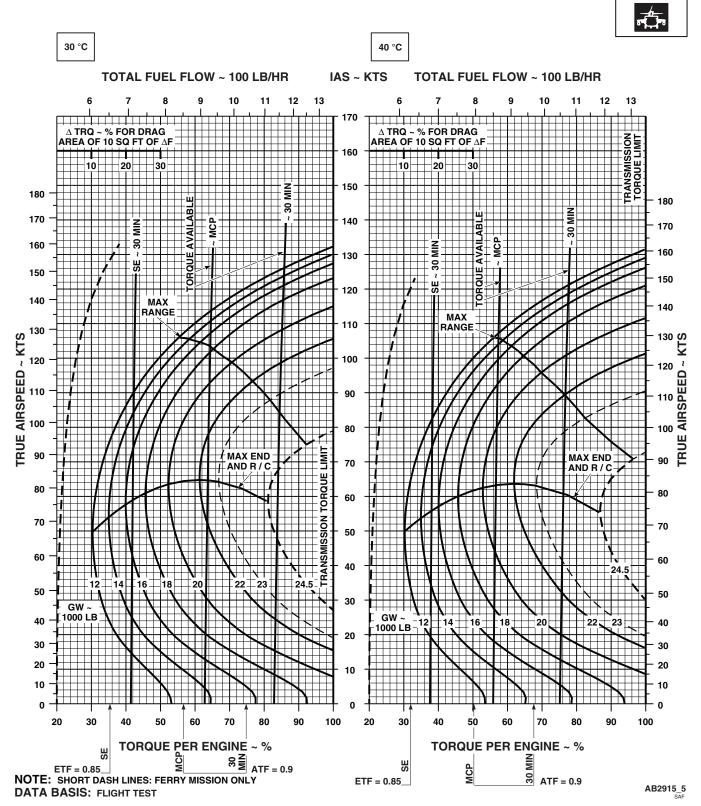
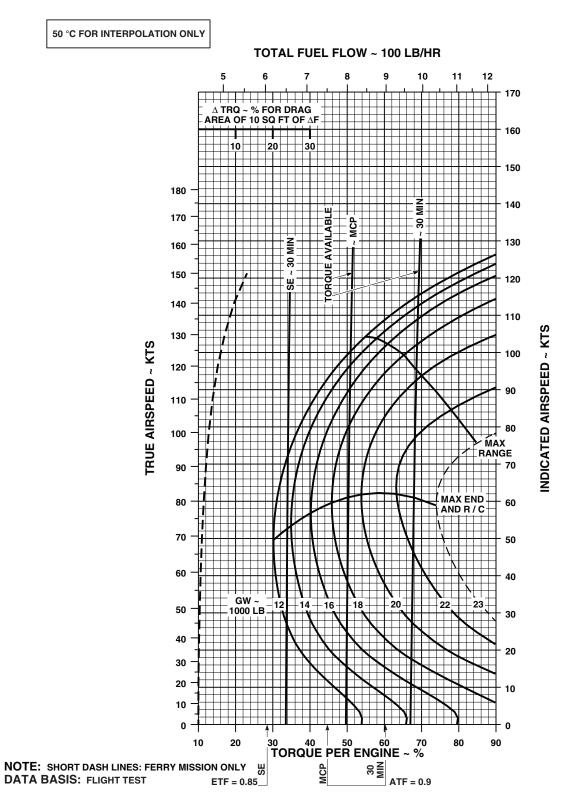


Figure 7-14. Cruise High Drag - Altitude 6,000 Feet (Sheet 5 of 6)

## CRUISE PRESSURE ALT: 6000 FT





AB2915_6

Figure 7-14. Cruise High Drag - Altitude 6,000 Feet (Sheet 6 of 6)

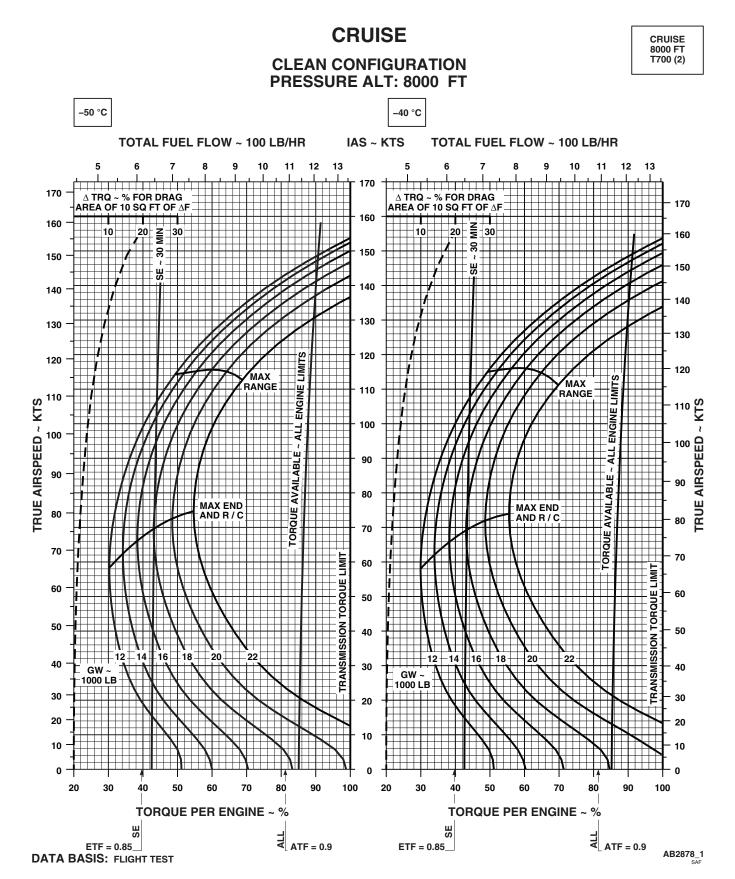


Figure 7-15. Cruise - Altitude 8,000 Feet (Sheet 1 of 5)

## **CRUISE**

# CLEAN CONFIGURATION PRESSURE ALT: 8000 FT

CRUISE 8000 FT T700 (2)

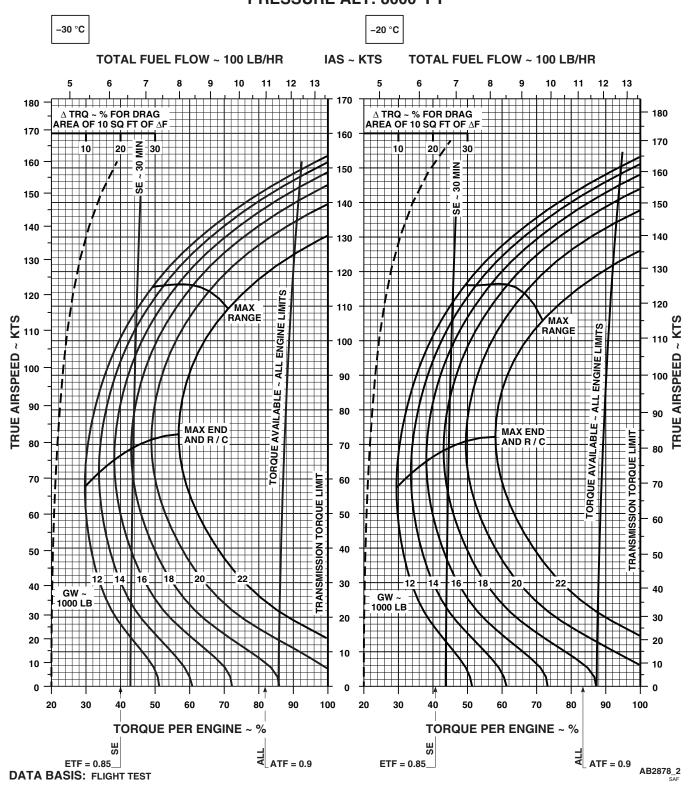


Figure 7-15. Cruise - Altitude 8,000 Feet (Sheet 2 of 5)

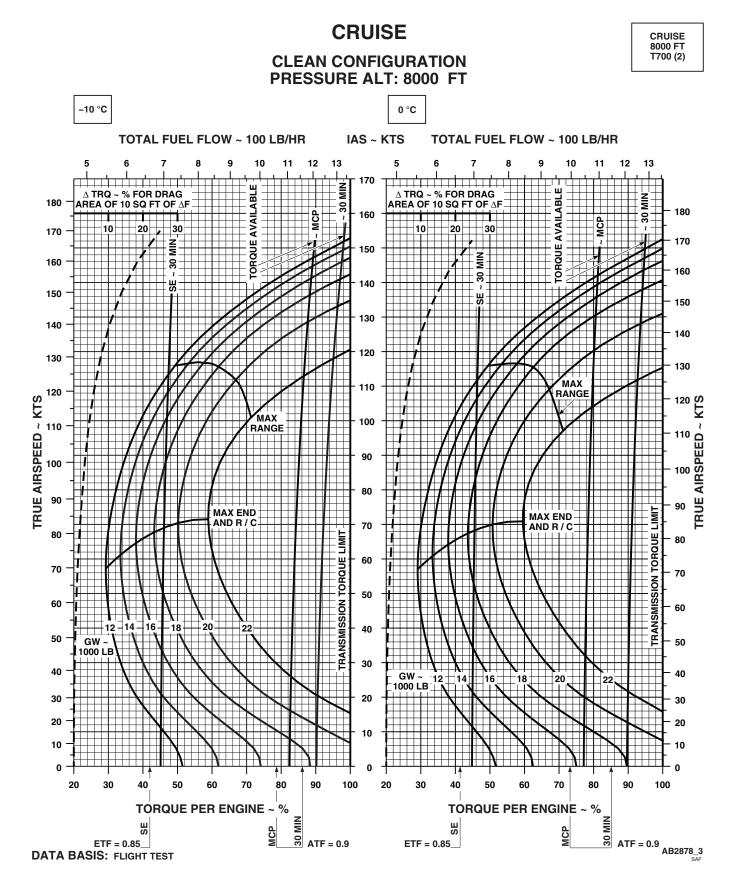


Figure 7-15. Cruise - Altitude 8,000 Feet (Sheet 3 of 5)

## **CRUISE**

# CLEAN CONFIGURATION PRESSURE ALT: 8000 FT

CRUISE 8000 FT T700 (2)

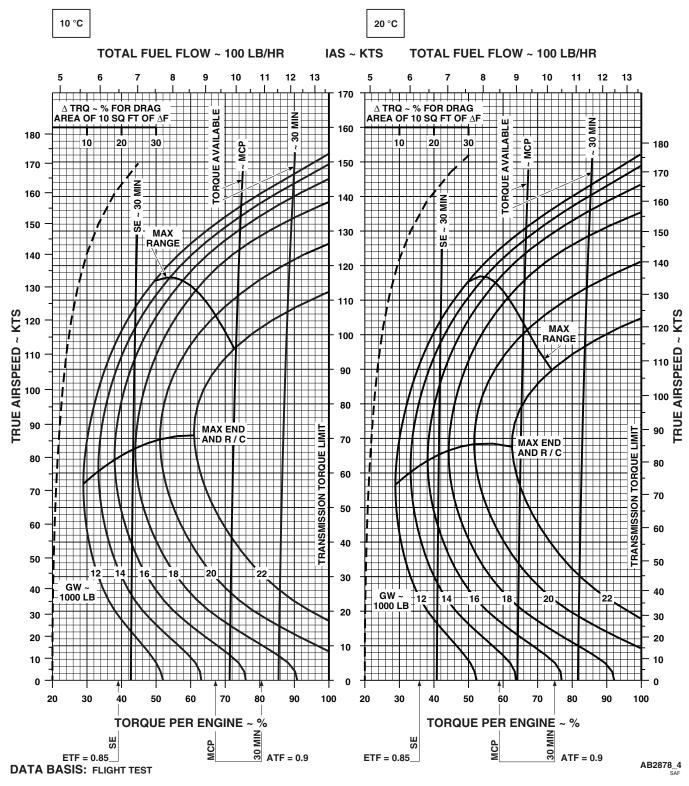


Figure 7-15. Cruise - Altitude 8,000 Feet (Sheet 4 of 5)

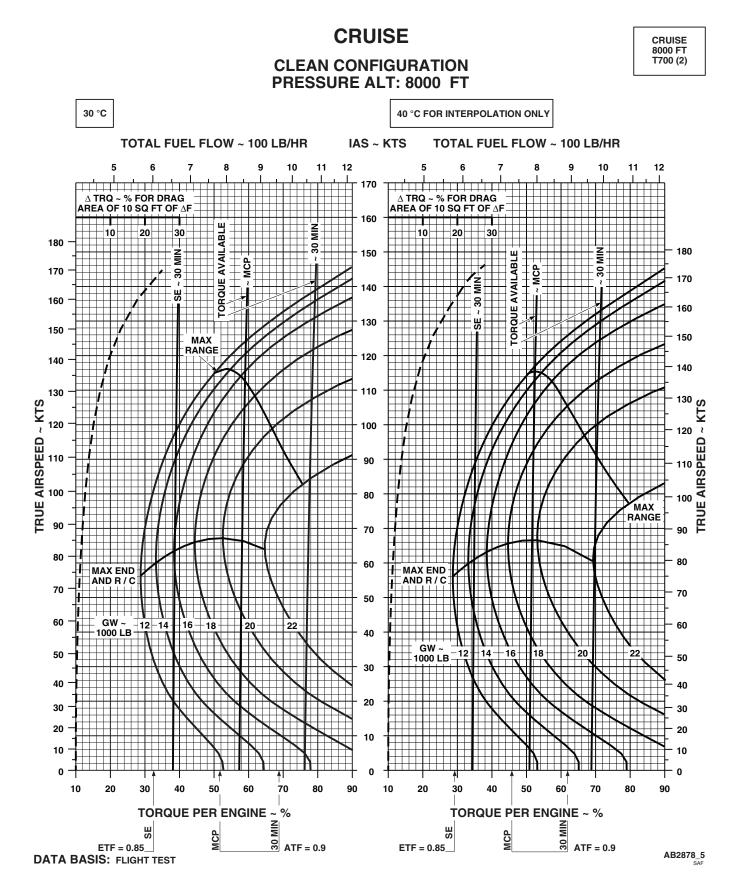


Figure 7-15. Cruise - Altitude 8,000 Feet (Sheet 5 of 5)

CRUISE 8000 FT

T700 (2)

## CRUISE PRESSURE ALT: 8000 FT

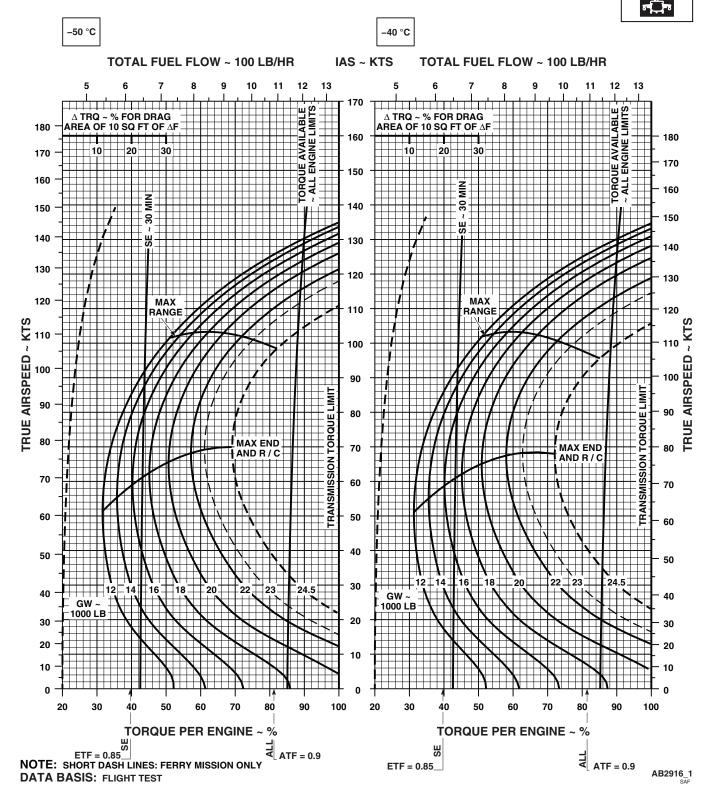
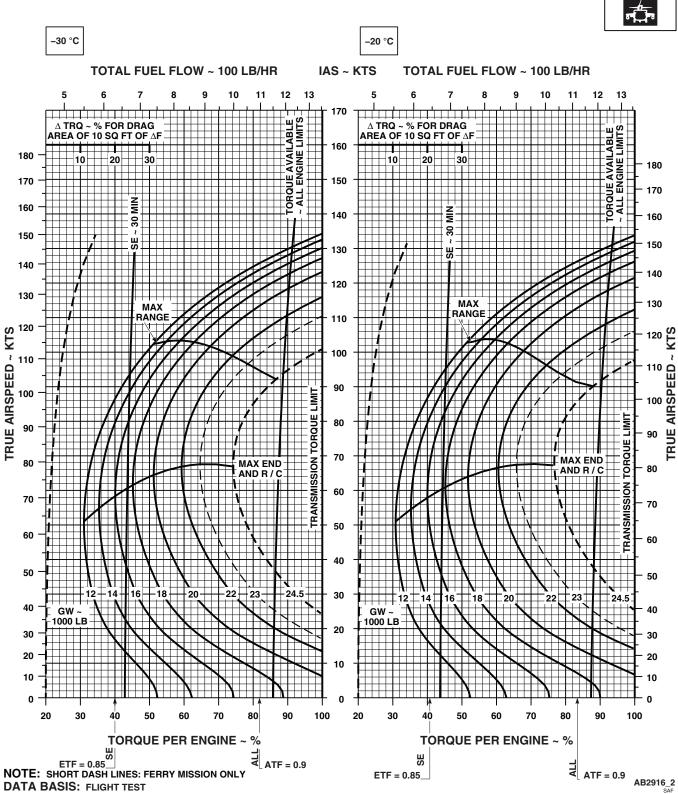


Figure 7-16. Cruise High Drag - Altitude 8,000 Feet (Sheet 1 of 5)

## **CRUISE** PRESSURE ALT: 8000 FT

CRUISE 8000 FT



**DATA BASIS:** FLIGHT TEST

Figure 7-16. Cruise High Drag - Altitude 8,000 Feet (Sheet 2 of 5)

CRUISE 8000 FT

T700 (2)

#### CRUISE PRESSURE ALT: 8000 FT

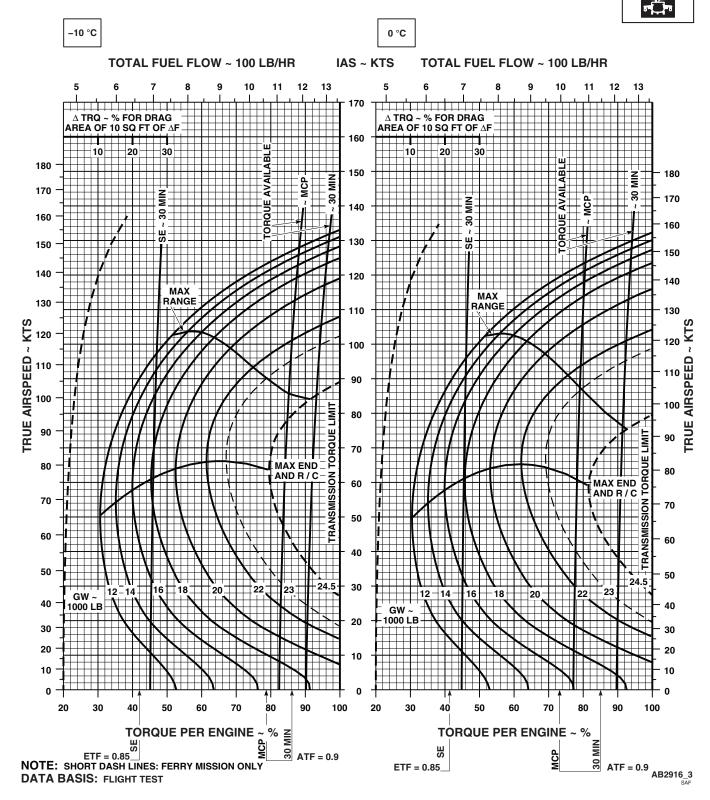


Figure 7-16. Cruise High Drag - Altitude 8,000 Feet (Sheet 3 of 5)

## CRUISE PRESSURE ALT: 8000 FT

CRUISE 8000 FT

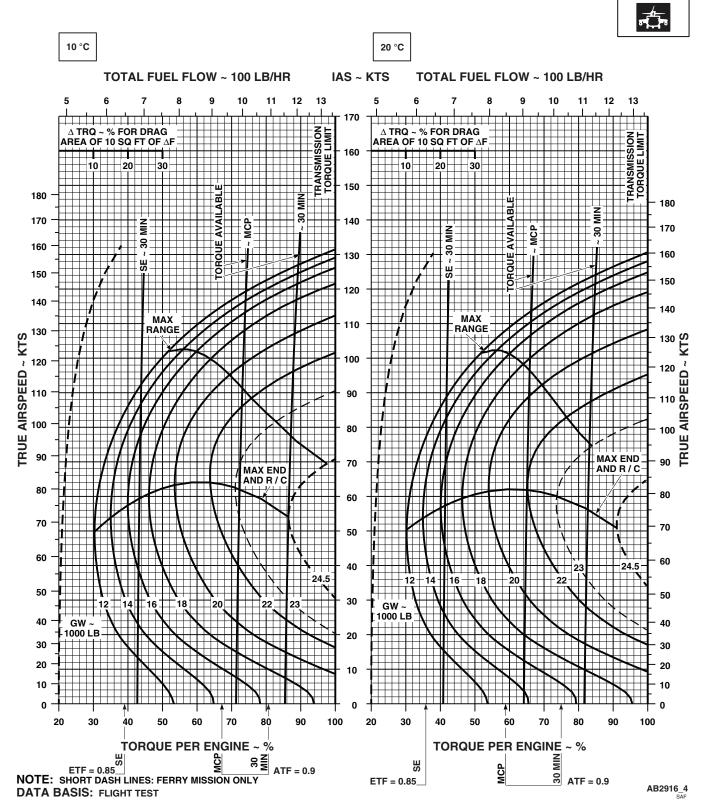


Figure 7-16. Cruise High Drag - Altitude 8,000 Feet (Sheet 4 of 5)

CRUISE 8000 FT

T700 (2)

## CRUISE PRESSURE ALT: 8000 FT

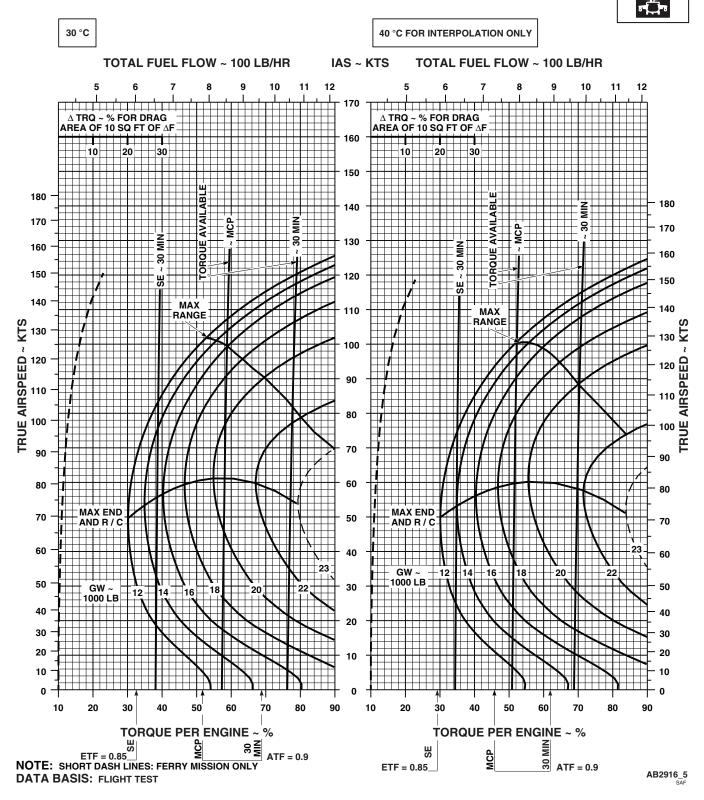


Figure 7-16. Cruise High Drag - Altitude 8,000 Feet (Sheet 5 of 5)

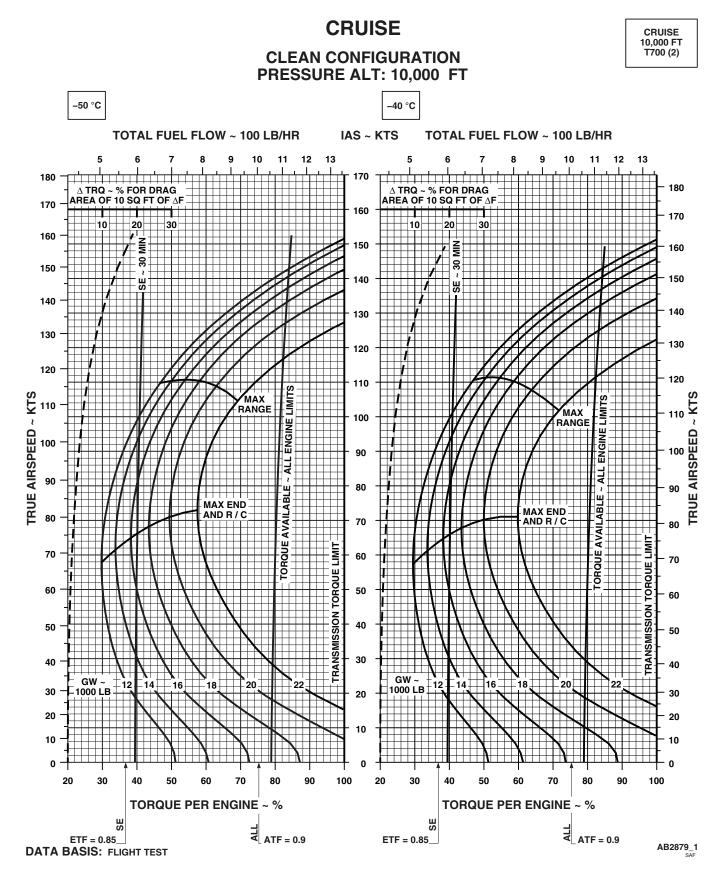


Figure 7-17. Cruise - Altitude 10,000 Feet (Sheet 1 of 5)



#### CLEAN CONFIGURATION PRESSURE ALT: 10,000 FT

CRUISE 10,000 FT T700 (2)

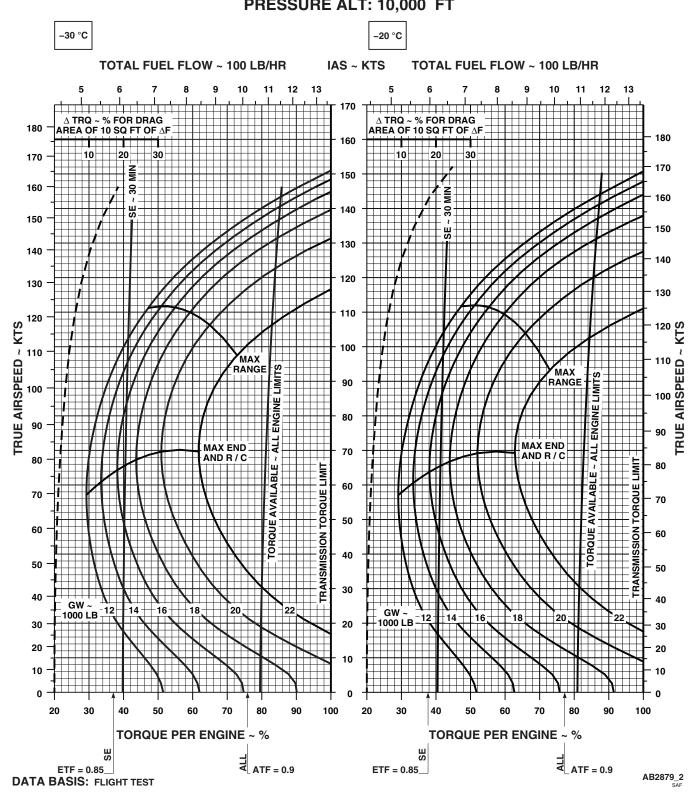


Figure 7-17. Cruise - Altitude 10,000 Feet (Sheet 2 of 5)

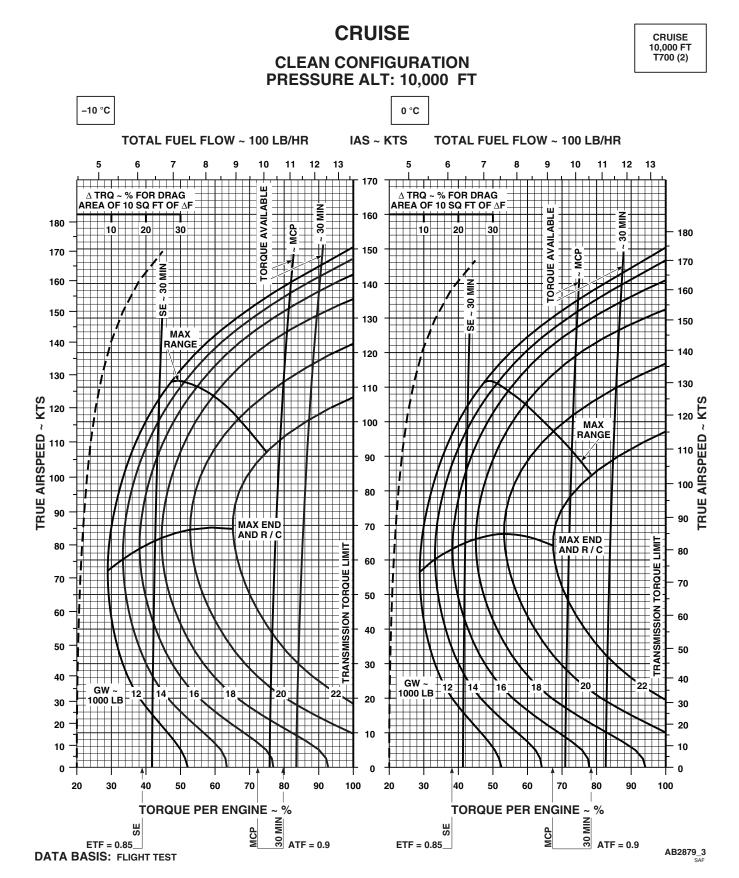


Figure 7-17. Cruise - Altitude 10,000 Feet (Sheet 3 of 5)

## **CRUISE**

#### CLEAN CONFIGURATION PRESSURE ALT: 10,000 FT

CRUISE 10,000 FT T700 (2)

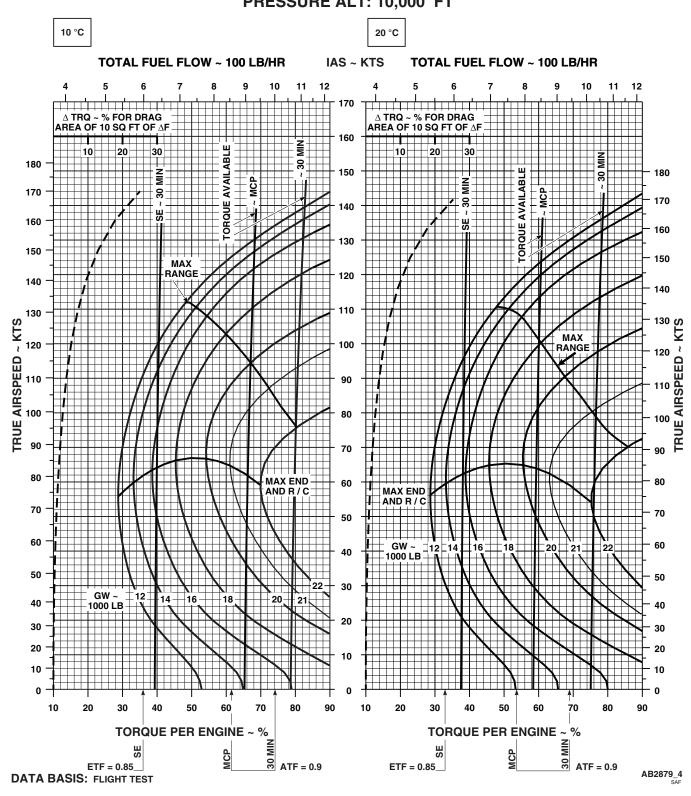


Figure 7-17. Cruise - Altitude 10,000 Feet (Sheet 4 of 5)

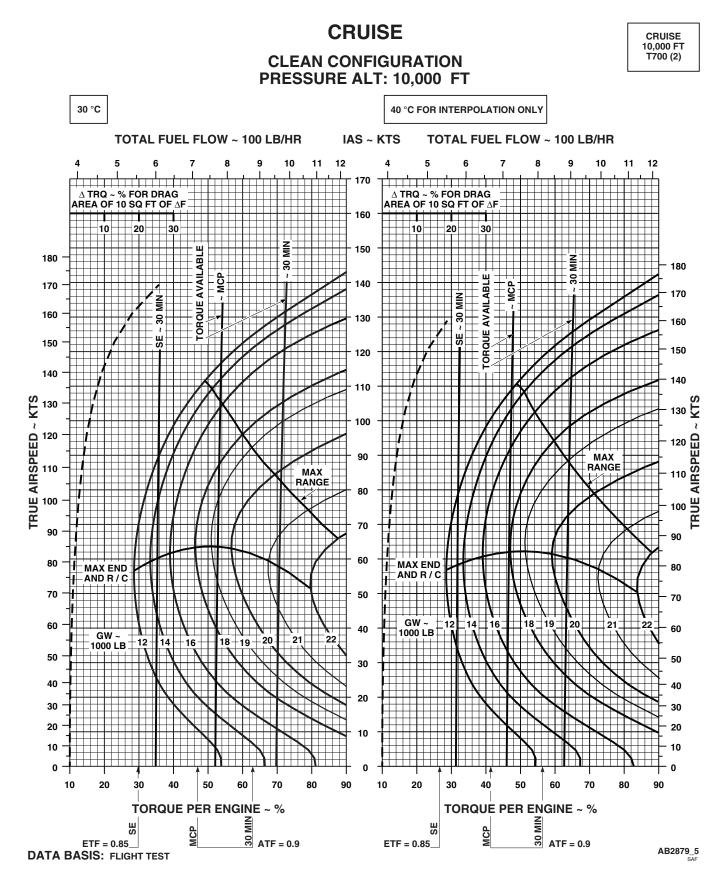


Figure 7-17. Cruise - Altitude 10,000 Feet (Sheet 5 of 5)

T700 (2)

## CRUISE PRESSURE ALT: 10,000 FT

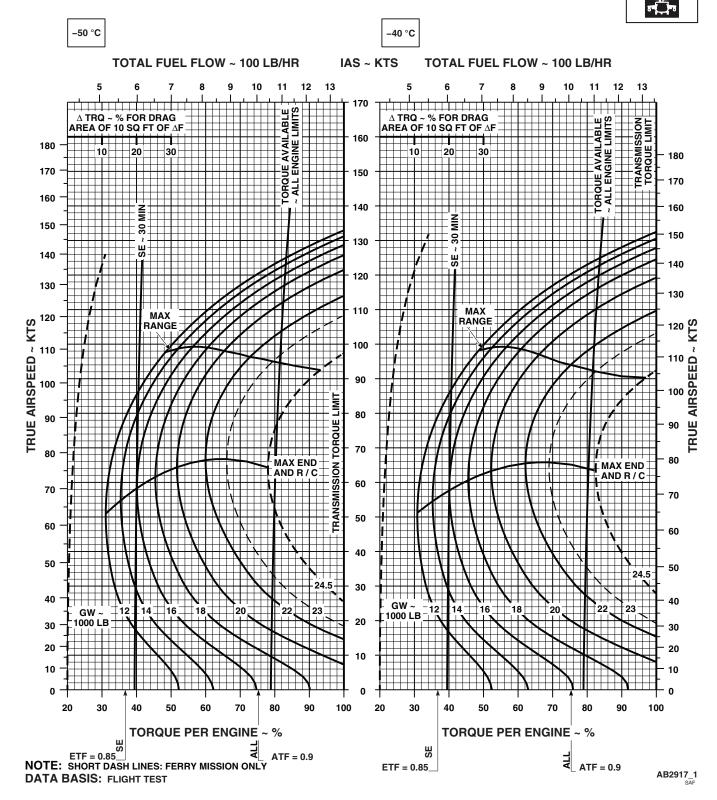


Figure 7-18. Cruise High Drag - Altitude 10,000 Feet (Sheet 1 of 5)



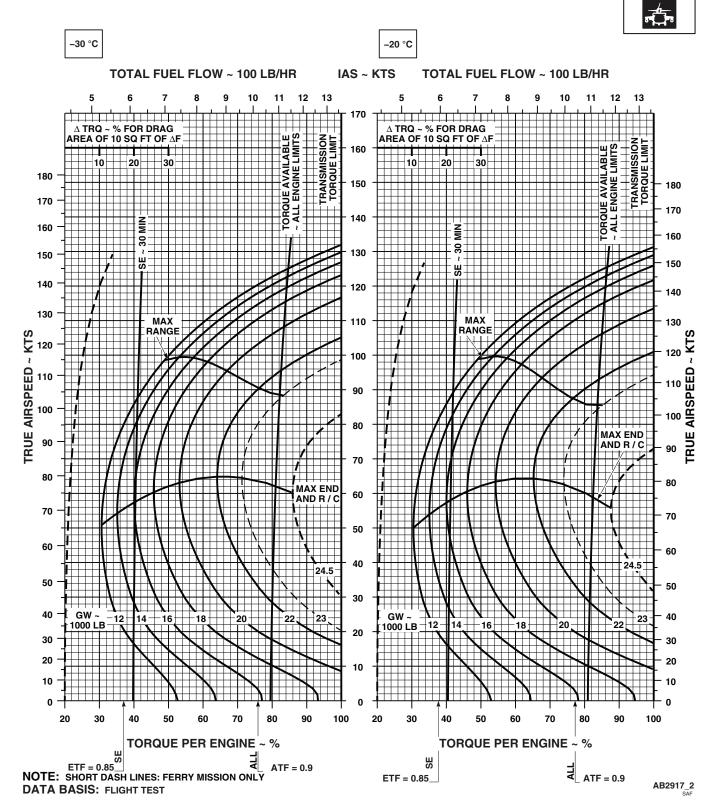


Figure 7-18. Cruise High Drag - Altitude 10,000 Feet (Sheet 2 of 5)

T700 (2)

## CRUISE PRESSURE ALT: 10,000 FT

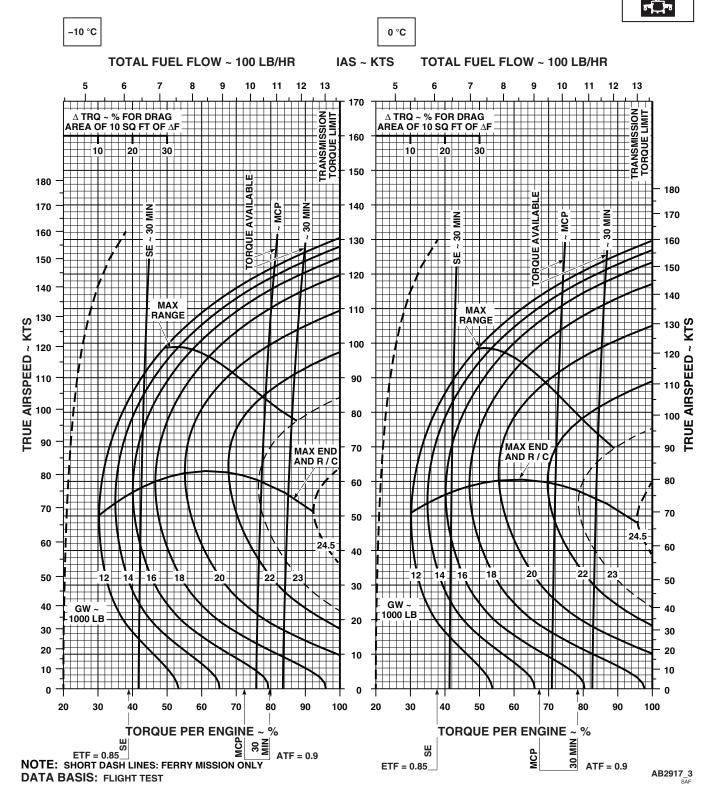


Figure 7-18. Cruise High Drag - Altitude 10,000 Feet (Sheet 3 of 5)



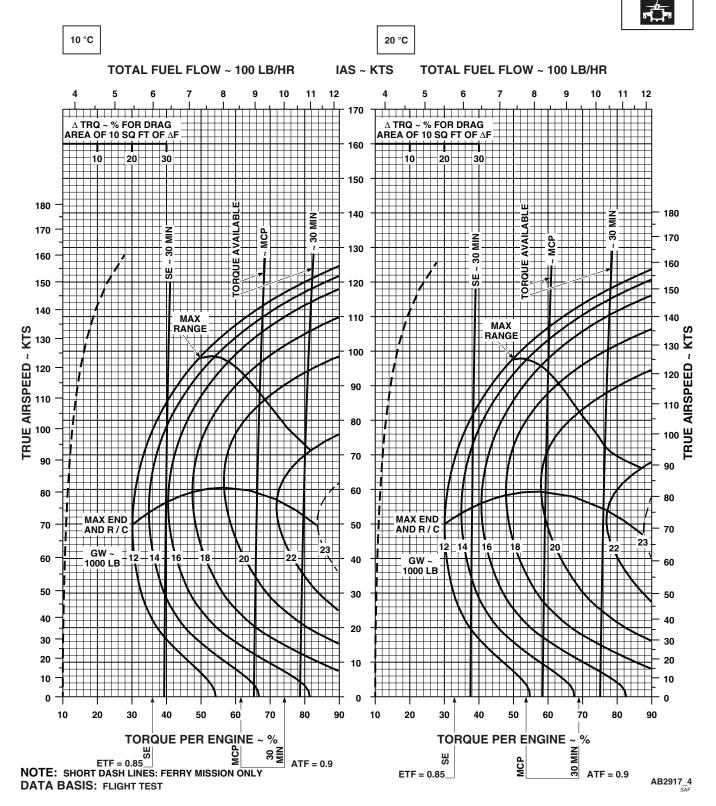


Figure 7-18. Cruise High Drag - Altitude 10,000 Feet (Sheet 4 of 5)

T700 (2)

## CRUISE PRESSURE ALT: 10,000 FT

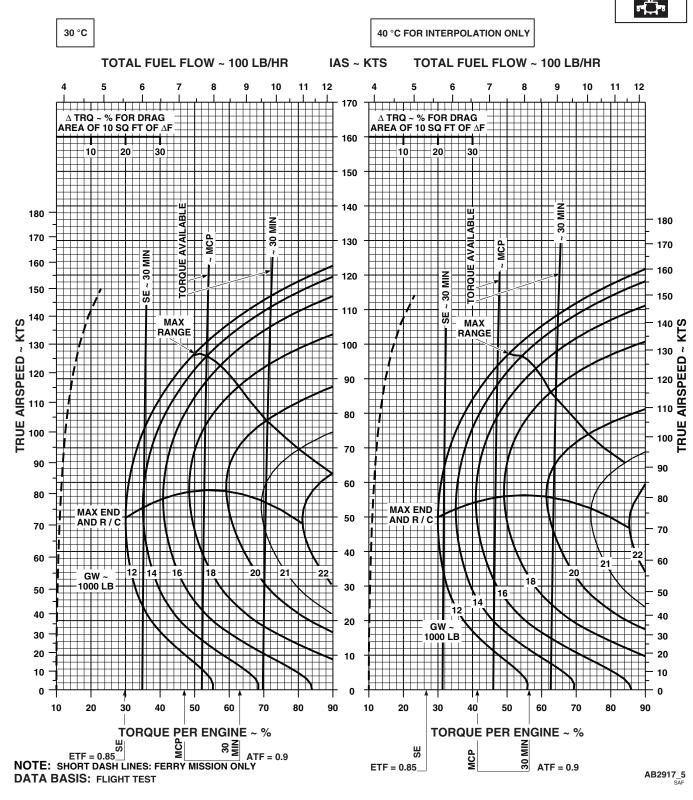


Figure 7-18. Cruise High Drag - Altitude 10,000 Feet (Sheet 5 of 5)

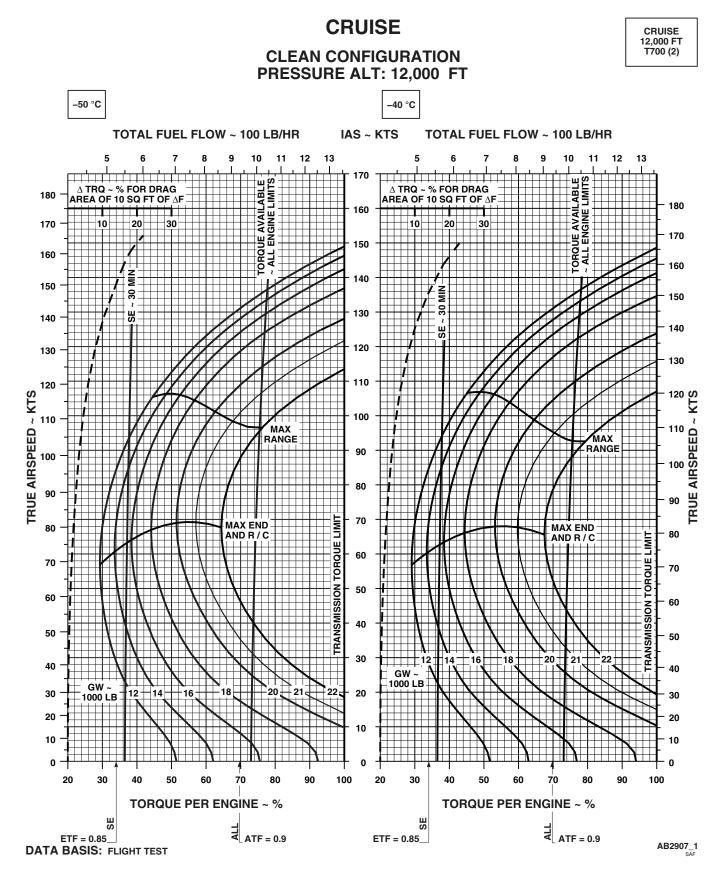


Figure 7-19. Cruise - Altitude 12,000 Feet (Sheet 1 of 5)



#### CLEAN CONFIGURATION PRESSURE ALT: 12,000 FT



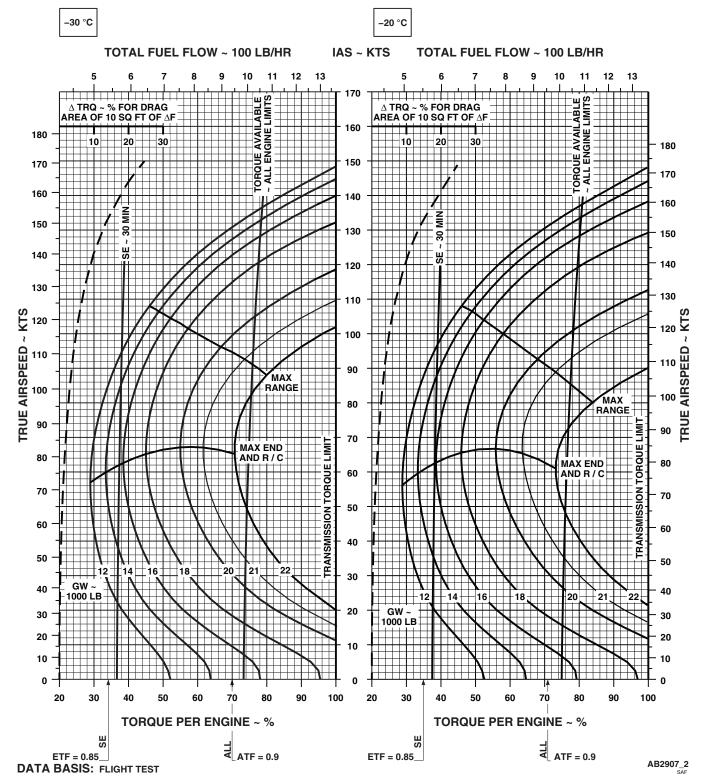


Figure 7-19. Cruise - Altitude 12,000 Feet (Sheet 2 of 5)

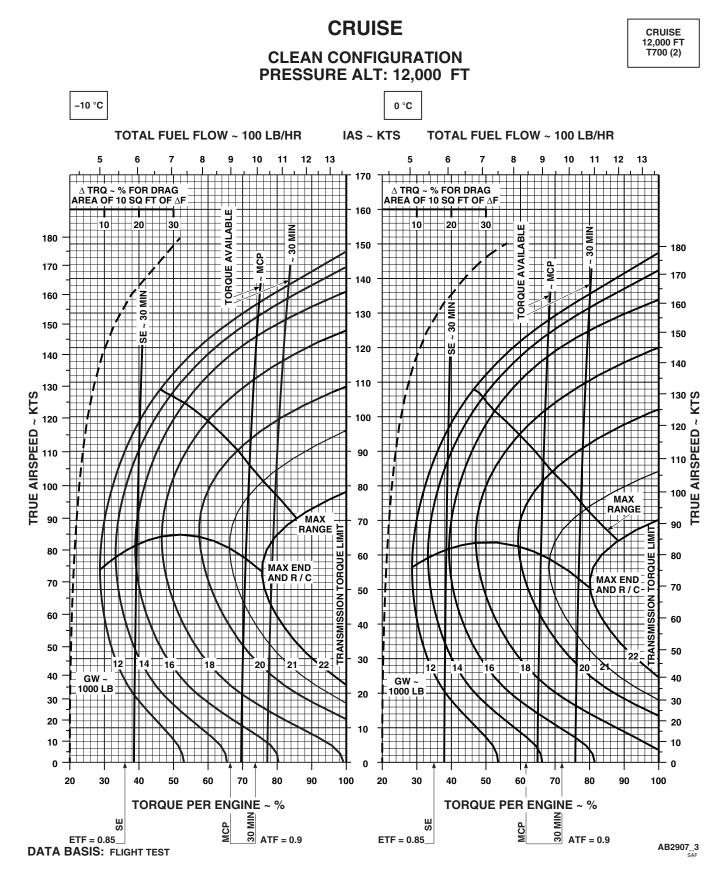


Figure 7-19. Cruise - Altitude 12,000 Feet (Sheet 3 of 5)



#### CLEAN CONFIGURATION PRESSURE ALT: 12,000 FT

CRUISE 12,000 FT T700 (2)

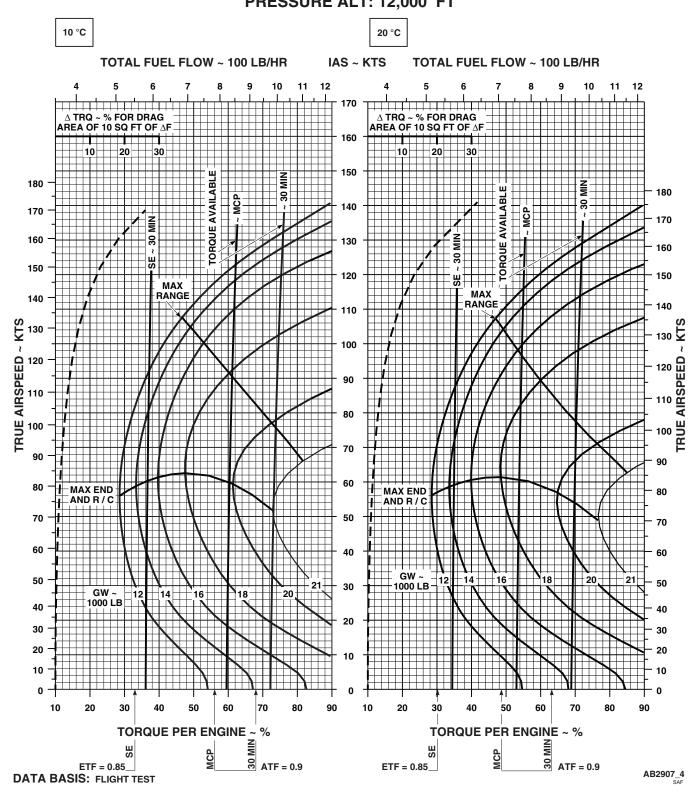
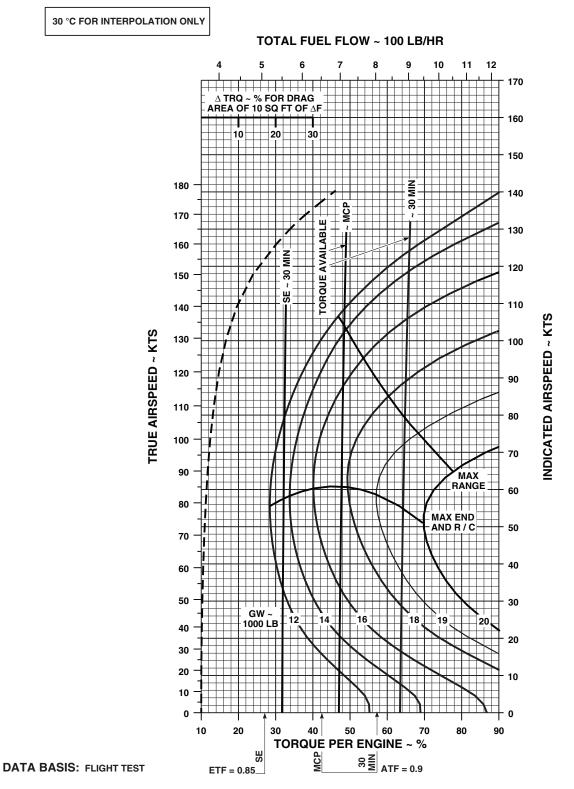


Figure 7-19. Cruise - Altitude 12,000 Feet (Sheet 4 of 5)

# CRUISE

#### CLEAN CONFIGURATION PRESSURE ALT: 12,000 FT

CRUISE 12,000 FT T700 (2)



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Figure 7-19. Cruise - Altitude 12,000 Feet (Sheet 5 of 5)

T700 (2)

## CRUISE PRESSURE ALT: 12,000 FT

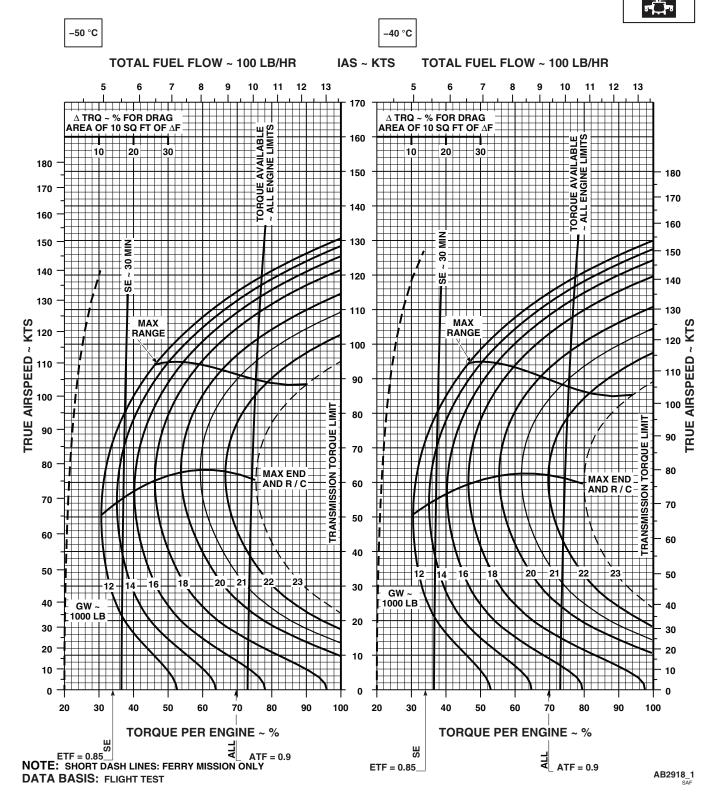


Figure 7-20. Cruise High Drag - Altitude 12,000 Feet (Sheet 1 of 5)

# CRUISE PRESSURE ALT: 12,000 FT

CRUISE 12,000 FT

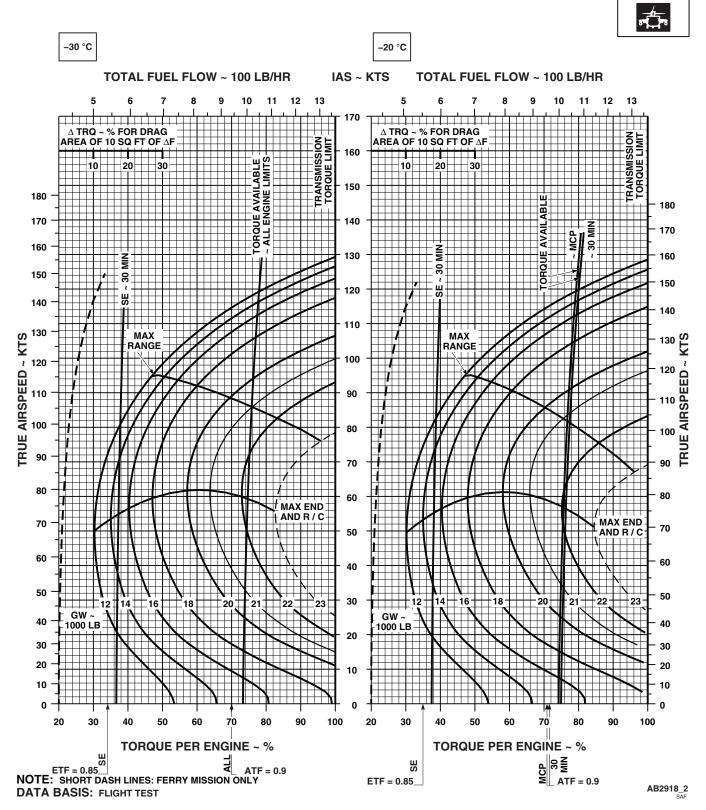


Figure 7-20. Cruise High Drag - Altitude 12,000 Feet (Sheet 2 of 5)

T700 (2)

## CRUISE PRESSURE ALT: 12,000 FT

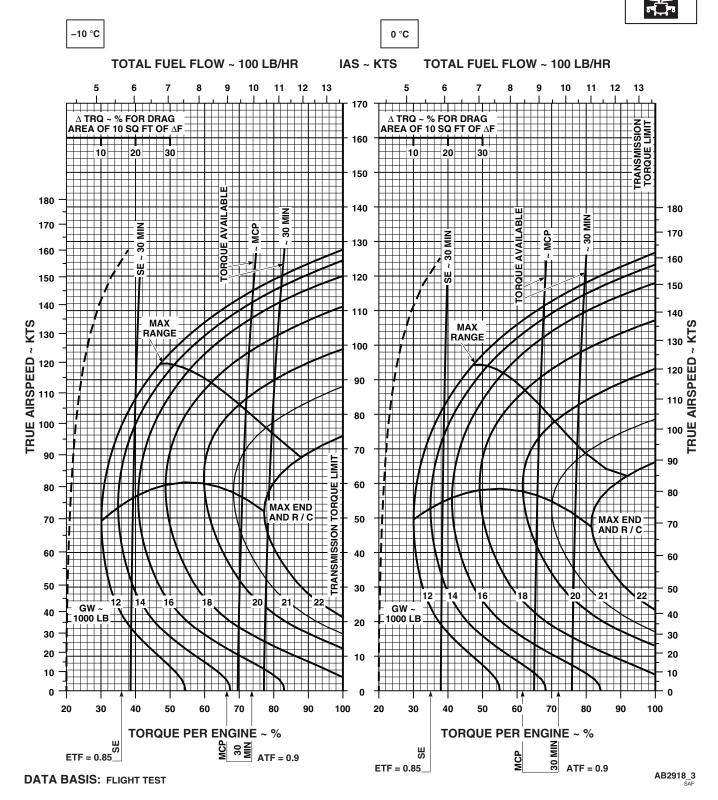
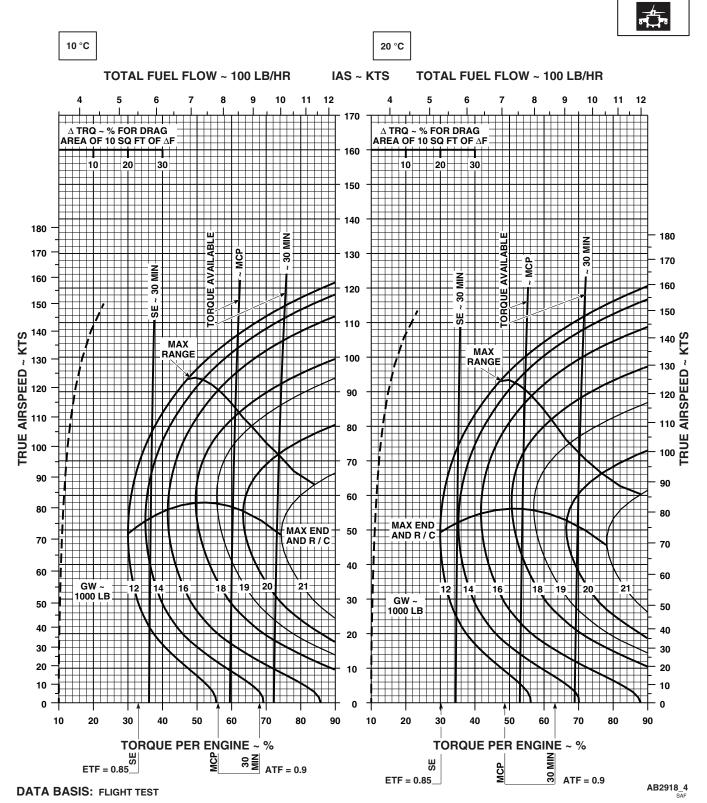


Figure 7-20. Cruise High Drag - Altitude 12,000 Feet (Sheet 3 of 5)

# CRUISE PRESSURE ALT: 12,000 FT

CRUISE 12,000 FT





## CRUISE PRESSURE ALT: 12,000 FT



30 °C FOR INTERPOLATION ONLY TOTAL FUEL FLOW ~ 100 LB/HR q ∆ TRQ ~ % FOR DRAG AREA OF 10 SQ FT OF AF E MCP З **FORG** INDICATED AIRSPEED ~ KTS TRUE AIRSPEED ~ KTS MAX RANGE MAX END AND R / C GW ~ 1000 LB **TORQUE PER ENGINE ~ %** S MIN 8 MCP DATA BASIS: FLIGHT TEST ETF = 0.85____ ATF = 0.9



Figure 7-20. Cruise High Drag - Altitude 12,000 Feet (Sheet 5 of 5)

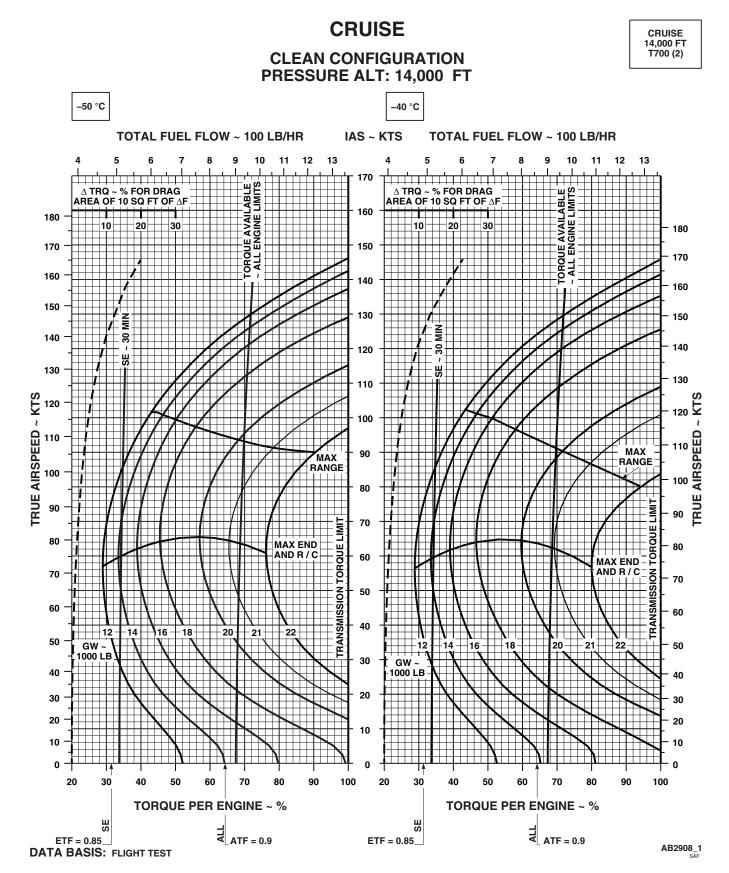


Figure 7-21. Cruise - Altitude 14,000 Feet (Sheet 1 of 5)



#### CLEAN CONFIGURATION PRESSURE ALT: 14,000 FT

CRUISE 14,000 FT T700 (2)

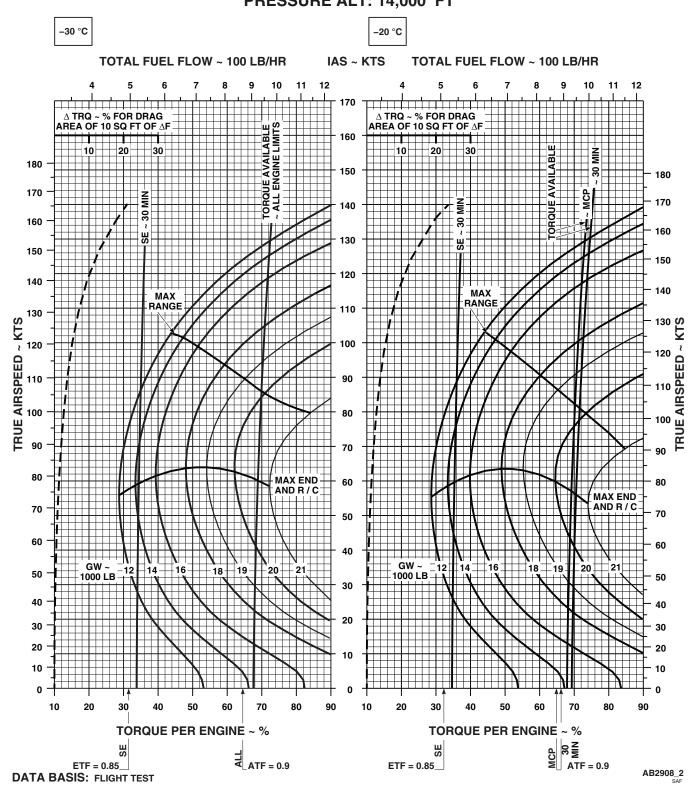


Figure 7-21. Cruise - Altitude 14,000 Feet (Sheet 2 of 5)

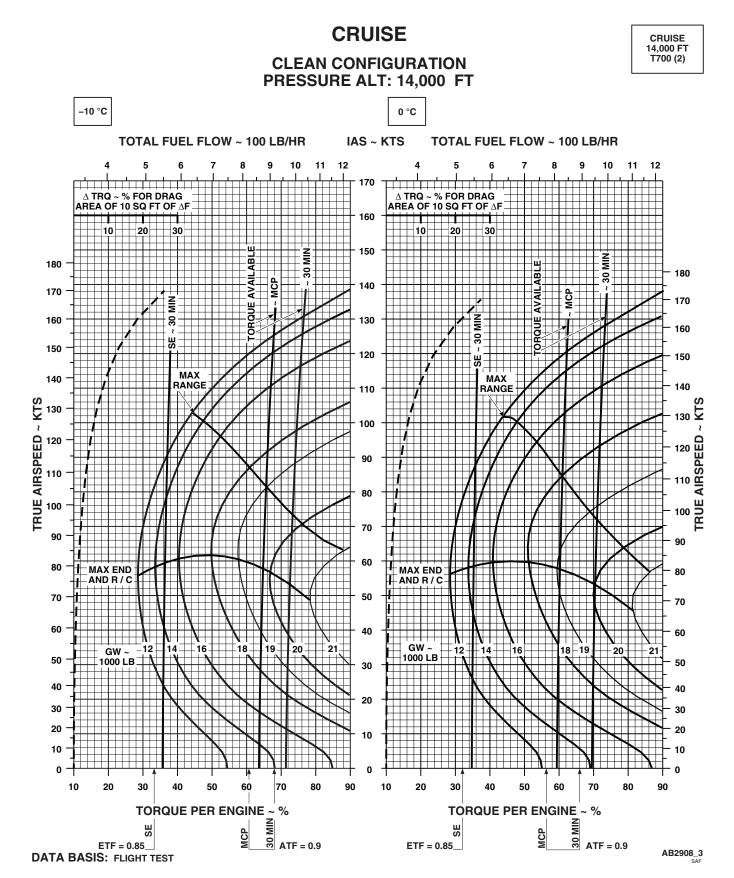


Figure 7-21. Cruise - Altitude 14,000 Feet (Sheet 3 of 5)



#### CLEAN CONFIGURATION PRESSURE ALT: 14,000 FT

CRUISE 14,000 FT T700 (2)

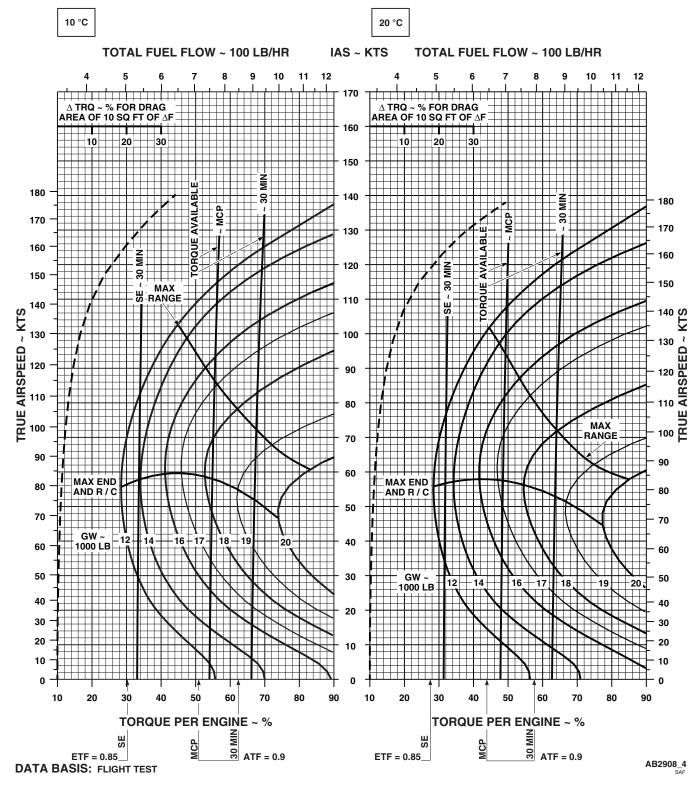
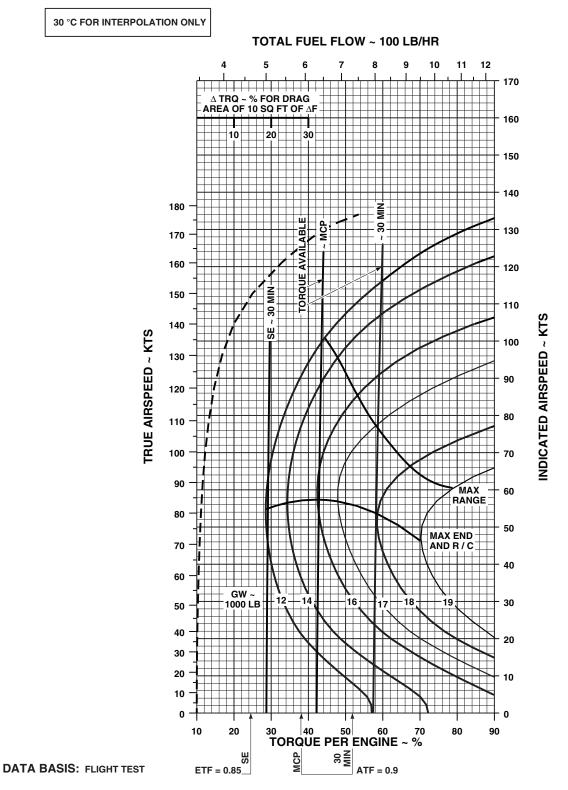


Figure 7-21. Cruise - Altitude 14,000 Feet (Sheet 4 of 5)

## CRUISE

#### CLEAN CONFIGURATION PRESSURE ALT: 14,000 FT

CRUISE 14,000 FT T700 (2)



AB2908_5

Figure 7-21. Cruise - Altitude 14,000 Feet (Sheet 5 of 5)

T700 (2)

## CRUISE PRESSURE ALT: 14,000 FT

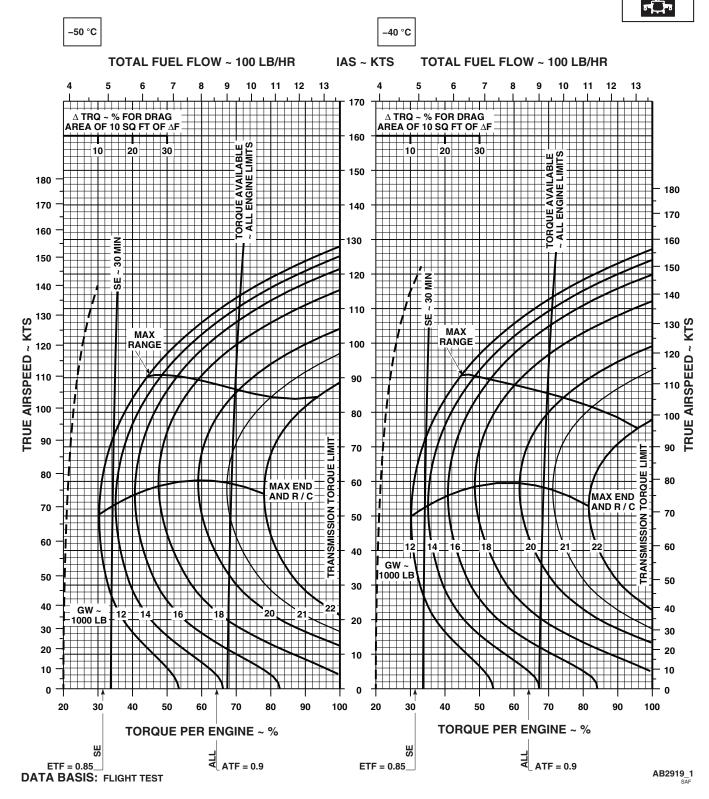


Figure 7-22. Cruise High Drag - Altitude 14,000 Feet (Sheet 1 of 5)



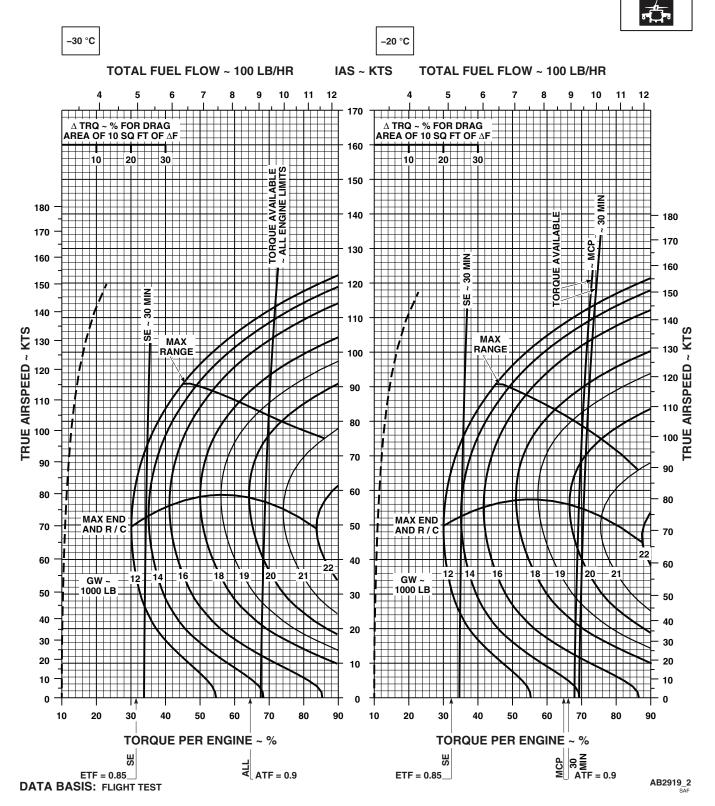


Figure 7-22. Cruise High Drag - Altitude 14,000 Feet (Sheet 2 of 5)

T700 (2)

## CRUISE PRESSURE ALT: 14,000 FT

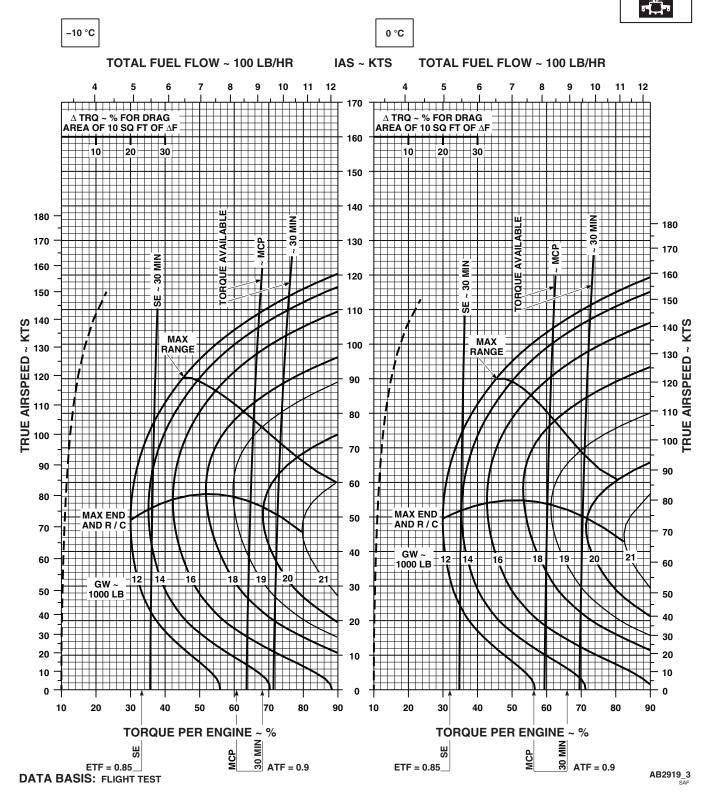


Figure 7-22. Cruise High Drag - Altitude 14,000 Feet (Sheet 3 of 5)



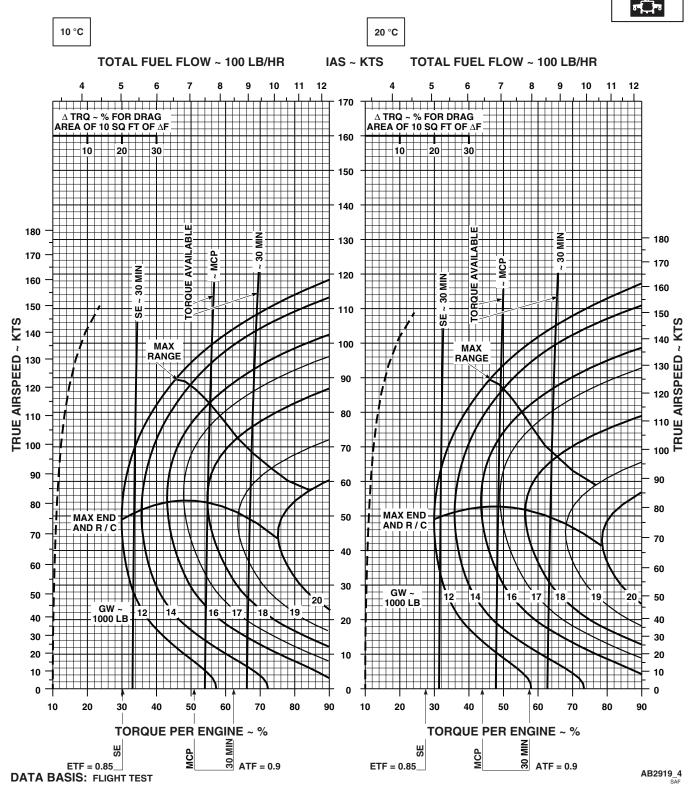


Figure 7-22. Cruise High Drag - Altitude 14,000 Feet (Sheet 4 of 5)

## CRUISE PRESSURE ALT: 14,000 FT



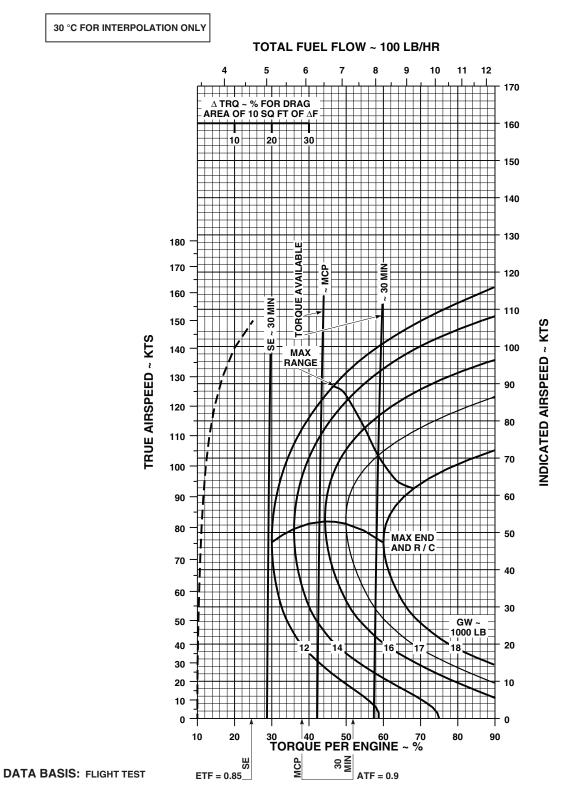


Figure 7-22. Cruise High Drag - Altitude 14,000 Feet (Sheet 5 of 5)



AB2919_5

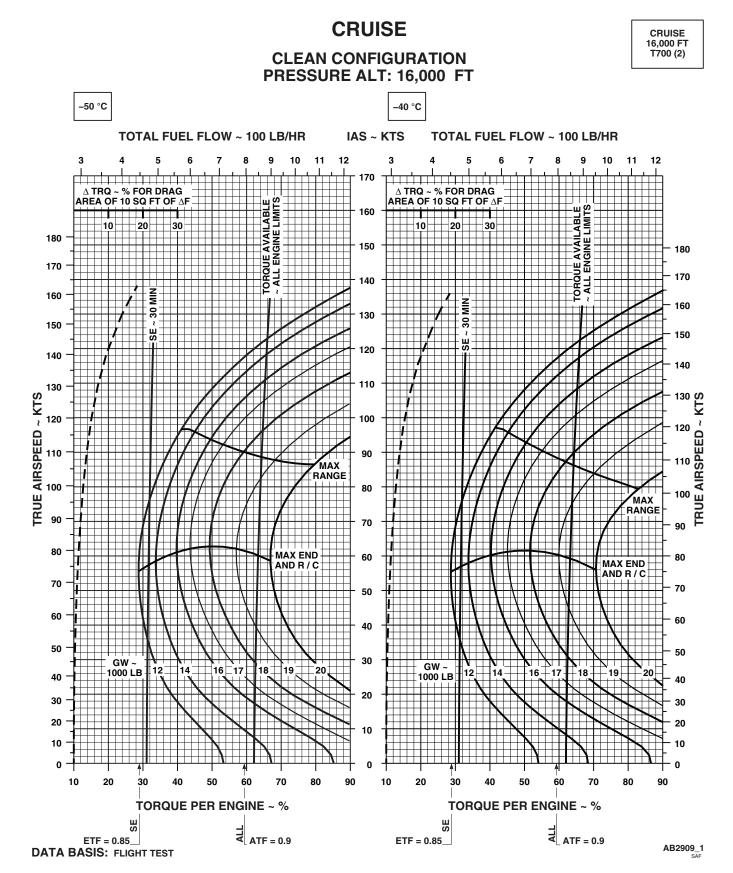


Figure 7-23. Cruise - Altitude 16,000 Feet (Sheet 1 of 4)



#### CLEAN CONFIGURATION PRESSURE ALT: 16,000 FT

CRUISE 16,000 FT T700 (2)

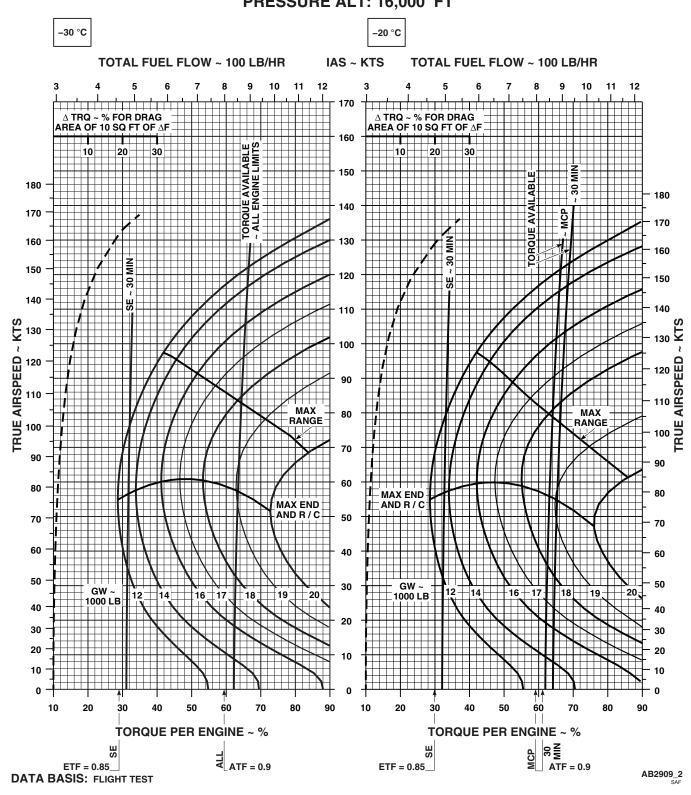


Figure 7-23. Cruise - Altitude 16,000 Feet (Sheet 2 of 4)

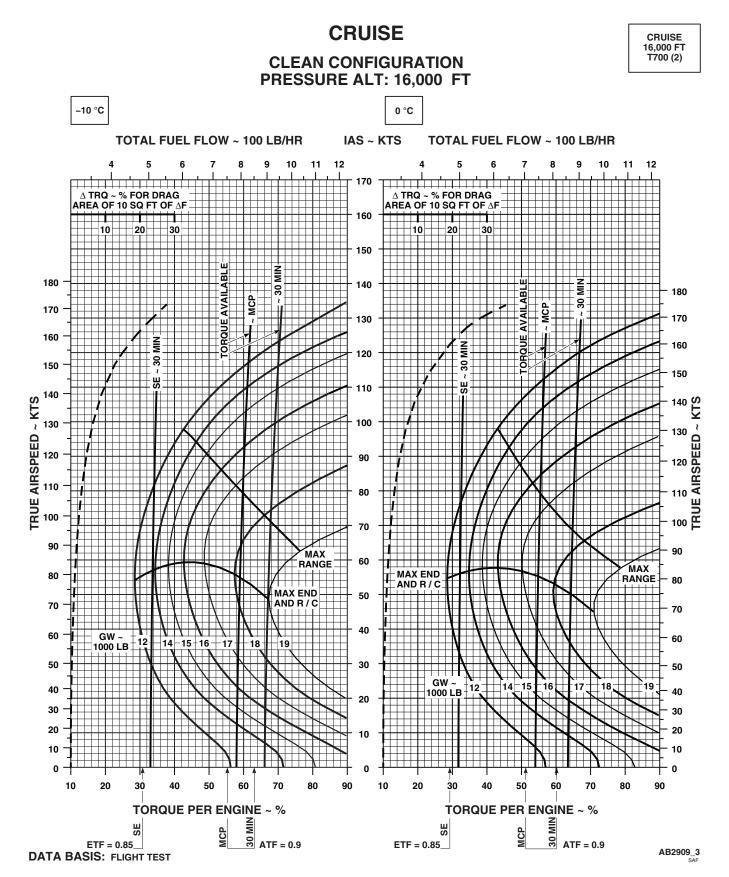


Figure 7-23. Cruise - Altitude 16,000 Feet (Sheet 3 of 4)

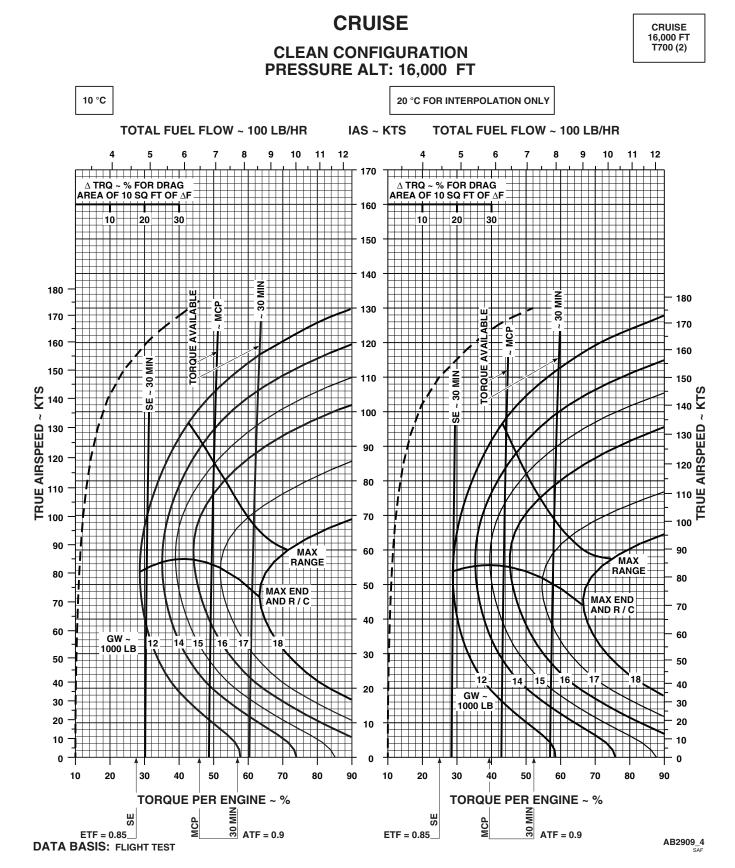


Figure 7-23. Cruise - Altitude 16,000 Feet (Sheet 4 of 4)

## CRUISE PRESSUE ALT: 16,000 FT

CRUISE 16,000 FT

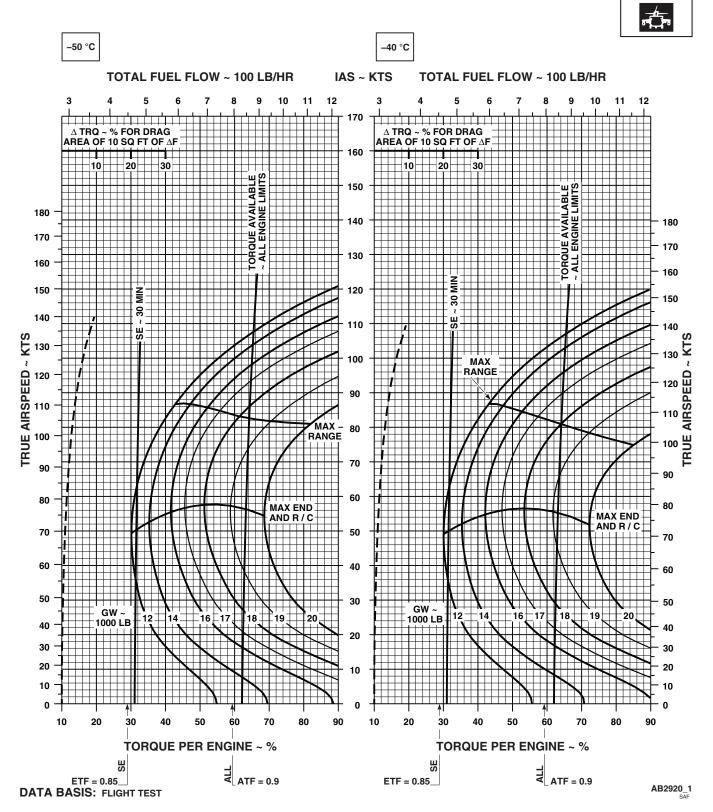


Figure 7-24. Cruise High Drag - Altitude 16,000 Feet (Sheet 1 of 4)

T700 (2)

## CRUISE PRESSURE ALT: 16,000 FT

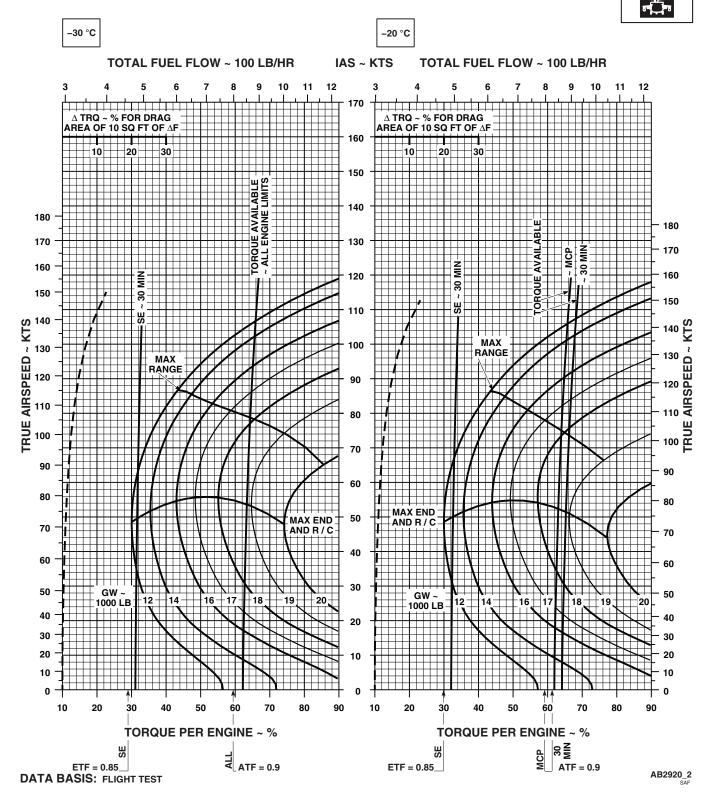


Figure 7-24. Cruise High Drag - Altitude 16,000 Feet (Sheet 2 of 4)

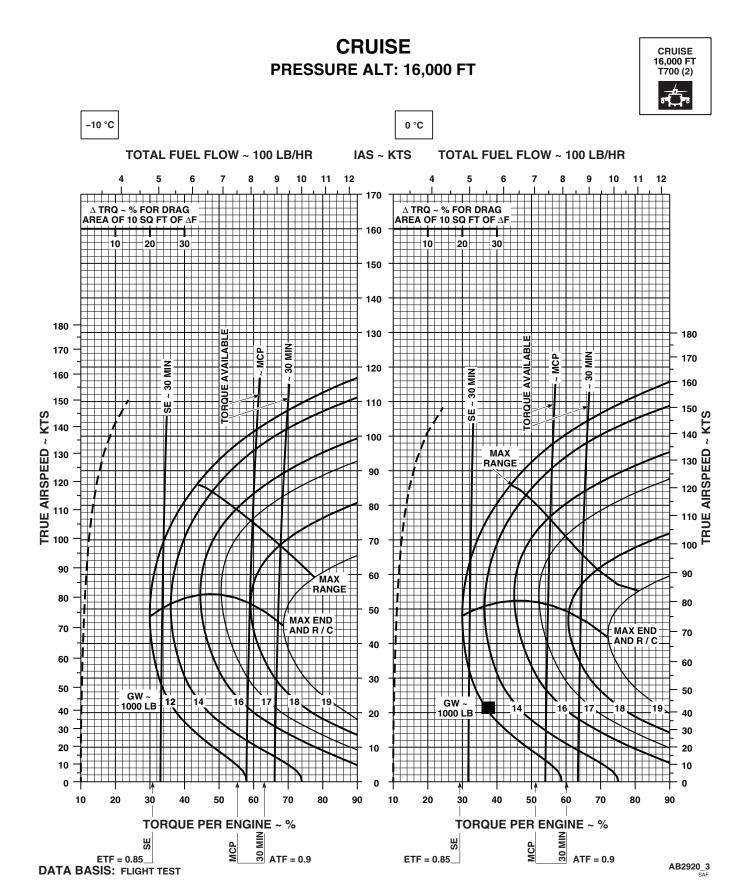


Figure 7-24. Cruise High Drag - Altitude 16,000 Feet (Sheet 3 of 4)

## CRUISE PRESSURE ALT: 16,000 FT



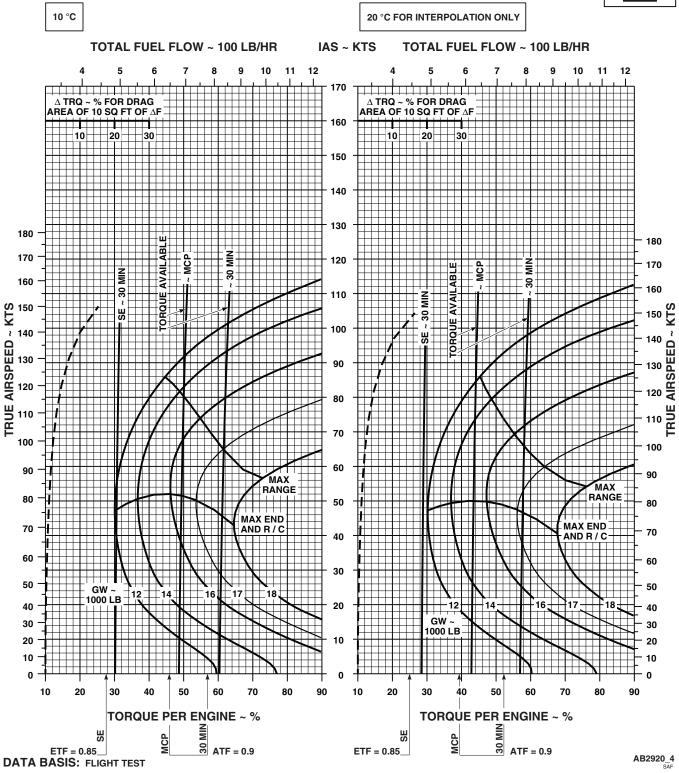


Figure 7-24. Cruise High Drag - Altitude 16,000 Feet (Sheet 4 of 4)

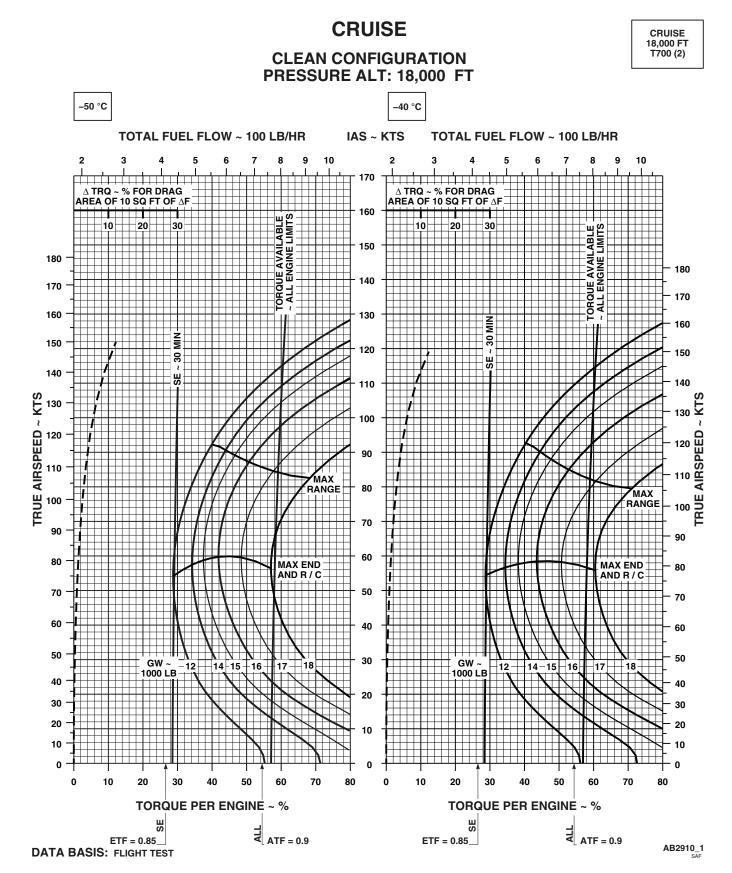


Figure 7-25. Cruise - Altitude 18,000 Feet (Sheet 1 of 4)



#### CLEAN CONFIGURATION PRESSURE ALT: 18,000 FT



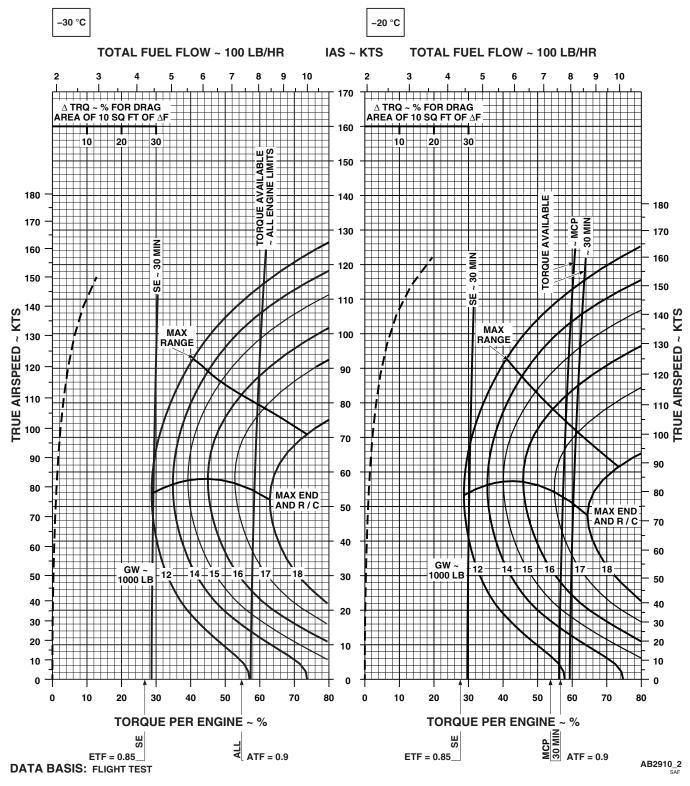


Figure 7-25. Cruise - Altitude 18,000 Feet (Sheet 2 of 4)

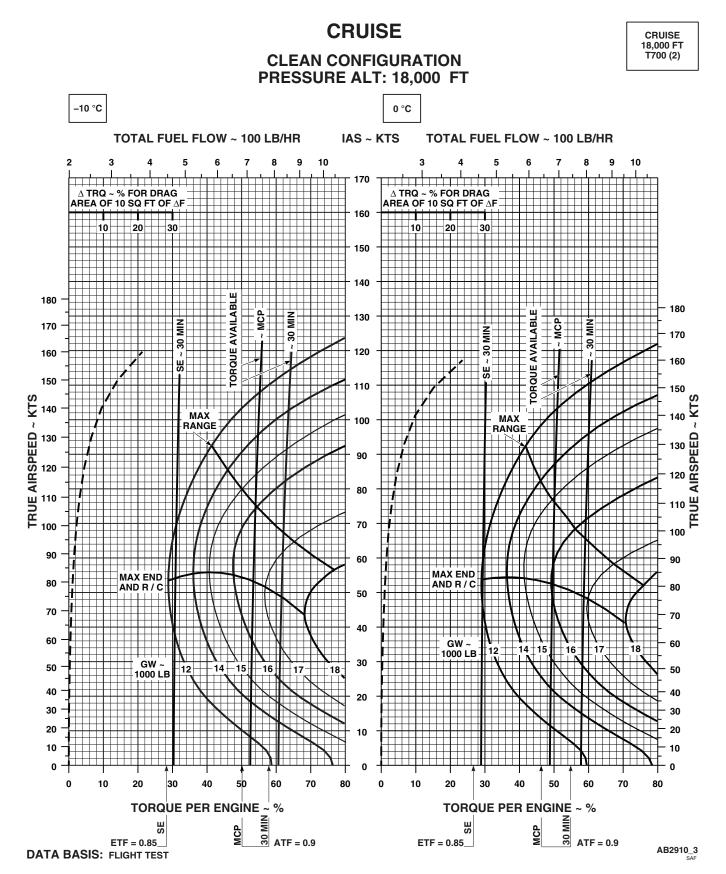


Figure 7-25. Cruise - Altitude 18,000 Feet (Sheet 3 of 4)

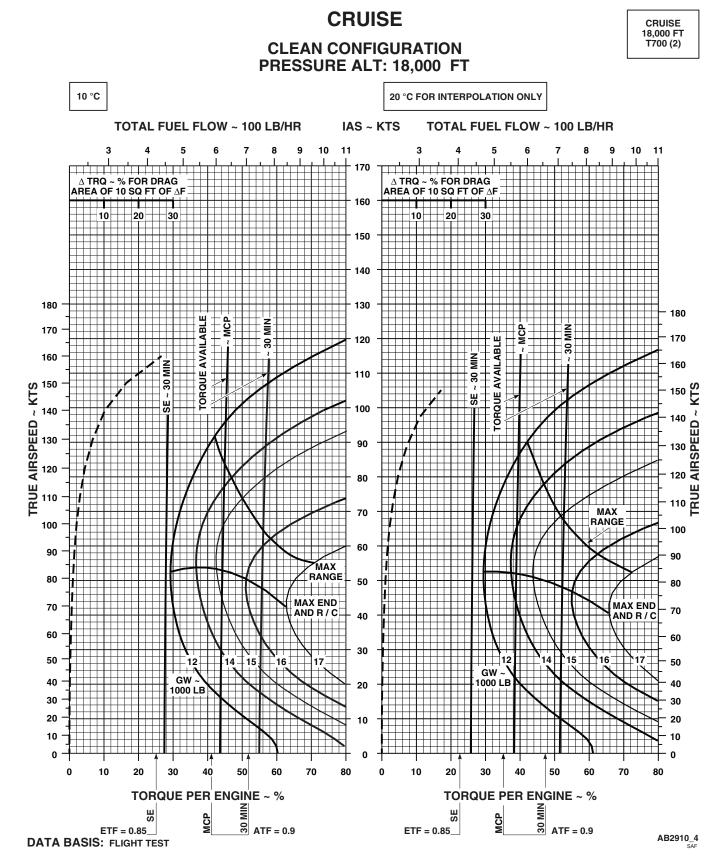


Figure 7-25. Cruise - Altitude 18,000 Feet (Sheet 4 of 4)

## CRUISE PRESSURE ALT: 18,000 FT

CRUISE 18,000 FT

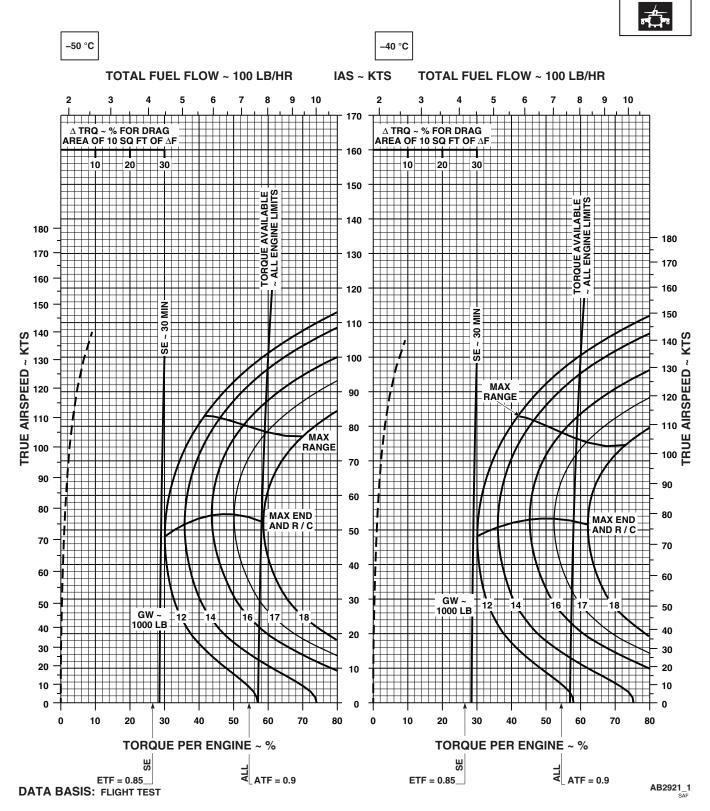


Figure 7-26. Cruise High Drag - Altitude 18,000 Feet (Sheet 1 of 4)

T700 (2)

## CRUISE PRESSURE ALT: 18,000 FT

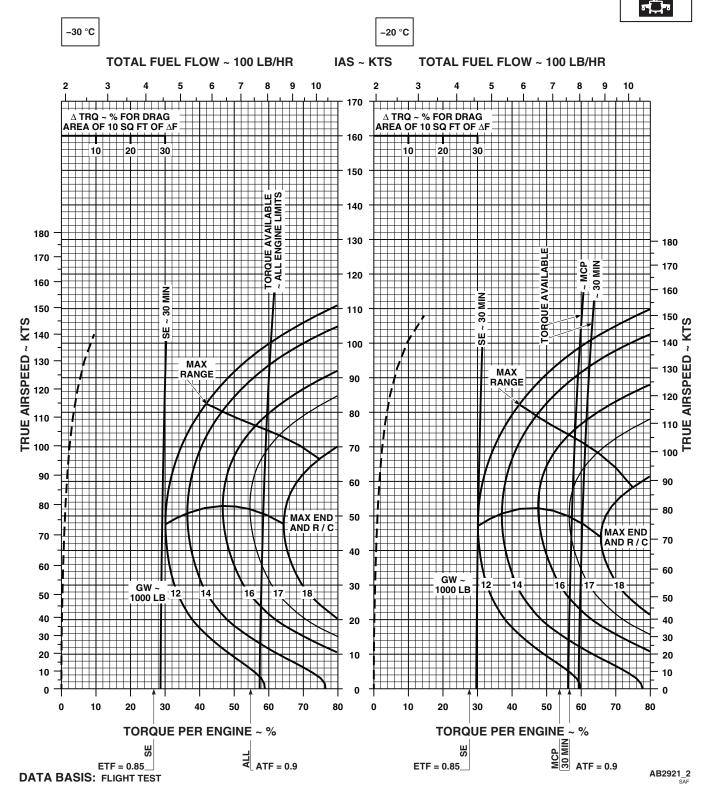
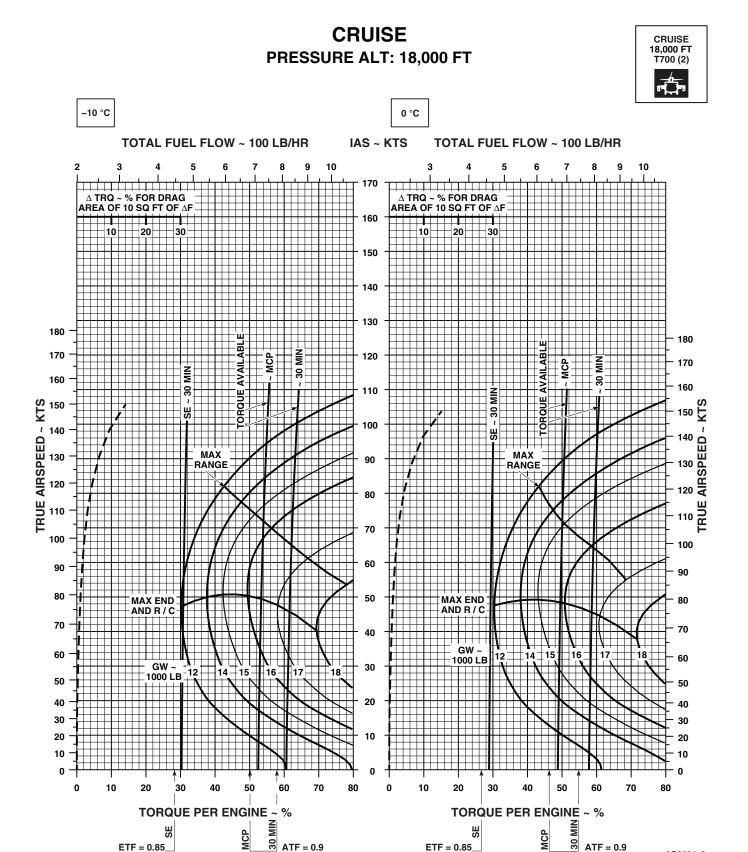


Figure 7-26. Cruise High Drag - Altitude 18,000 Feet (Sheet 2 of 4)



ETF = 0.85_ DATA BASIS: FLIGHT TEST

Figure 7-26. Cruise High Drag - Altitude 18,000 Feet (Sheet 3 of 4)

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## CRUISE PRESSURE ALT: 18,000 FT



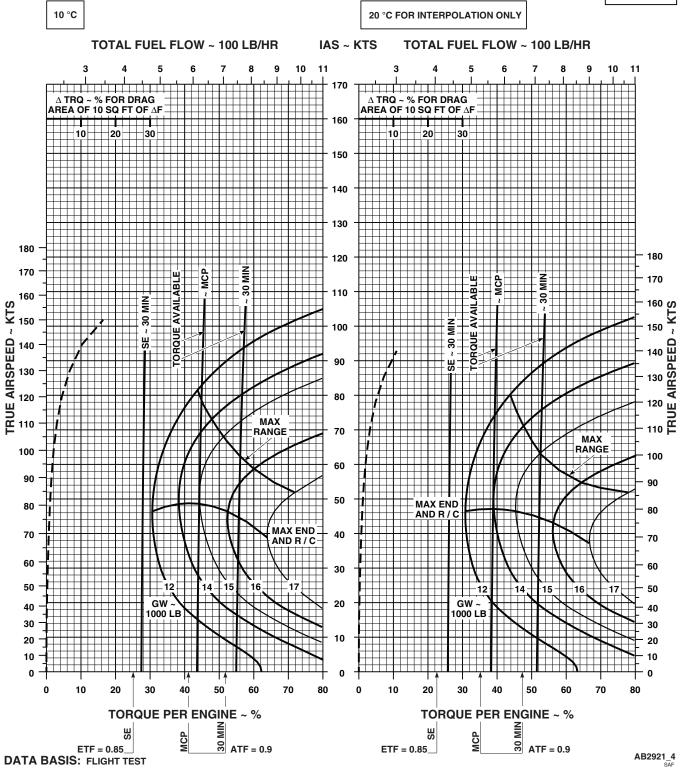


Figure 7-26. Cruise High Drag - Altitude 18,000 Feet (Sheet 4 of 4)

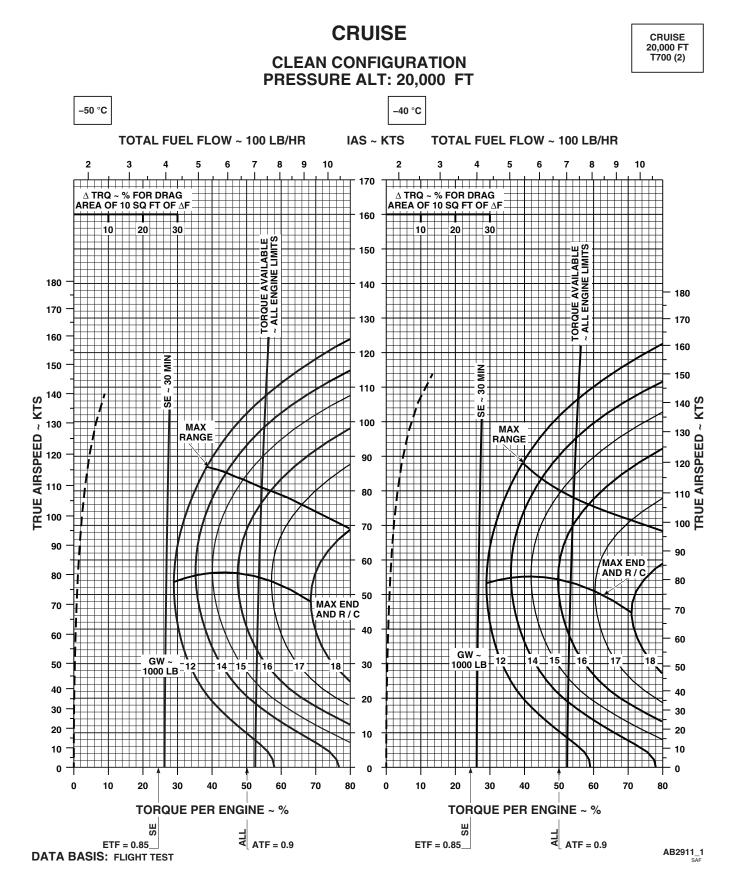


Figure 7-27. Cruise - Altitude 20,000 Feet (Sheet 1 of 4)



#### CLEAN CONFIGURATION PRESSURE ALT: 20,000 FT

CRUISE 20,000 FT T700 (2)

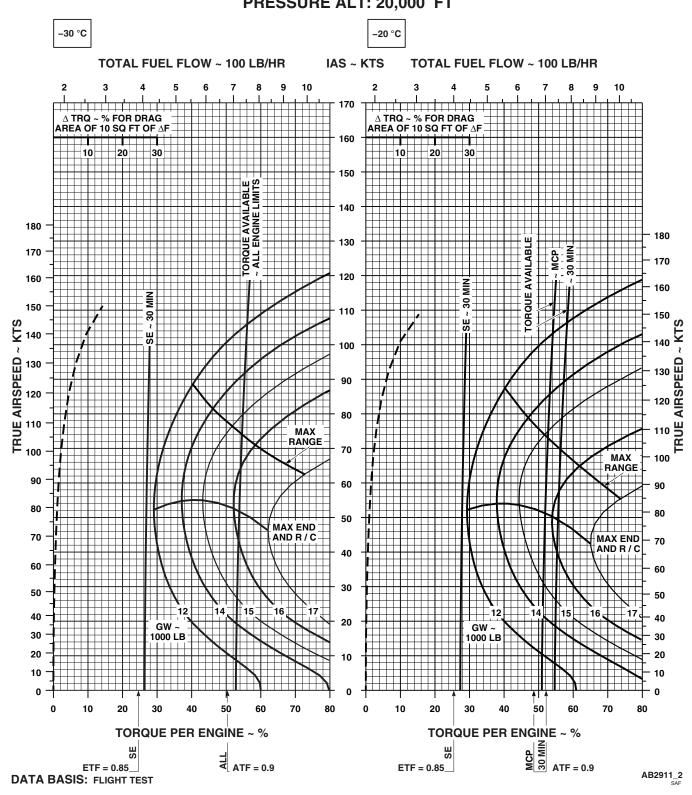


Figure 7-27. Cruise - Altitude 20,000 Feet (Sheet 2 of 4)

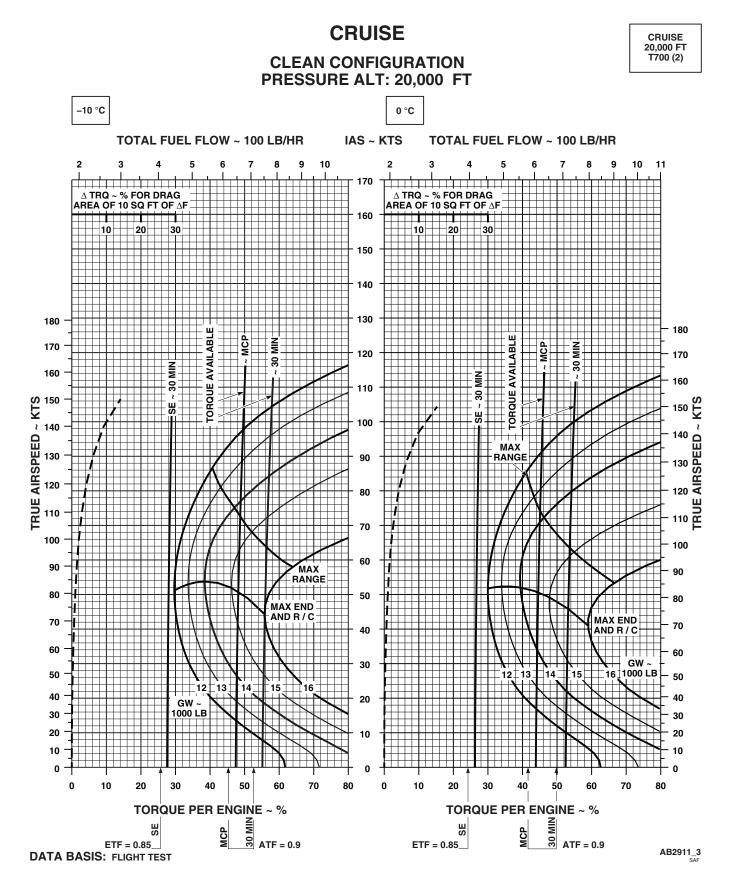
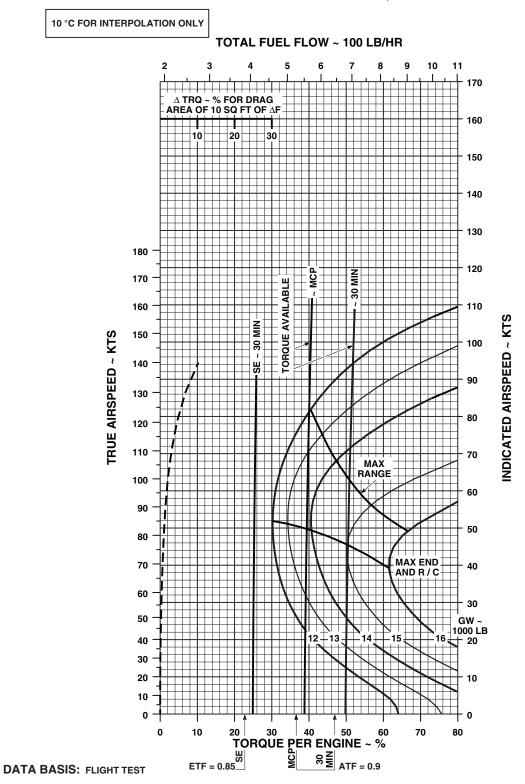


Figure 7-27. Cruise - Altitude 20,000 Feet (Sheet 3 of 4)

## **CRUISE**

#### CLEAN CONFIGURATION PRESSURE ALT: 20,000 FT

CRUISE 20,000 FT T700 (2)



AB2911_4

Figure 7-27. Cruise - Altitude 20,000 Feet (Sheet 4 of 4)

## CRUISE PRESSURE ALT: 20,000 FT

CRUISE 20,000 FT

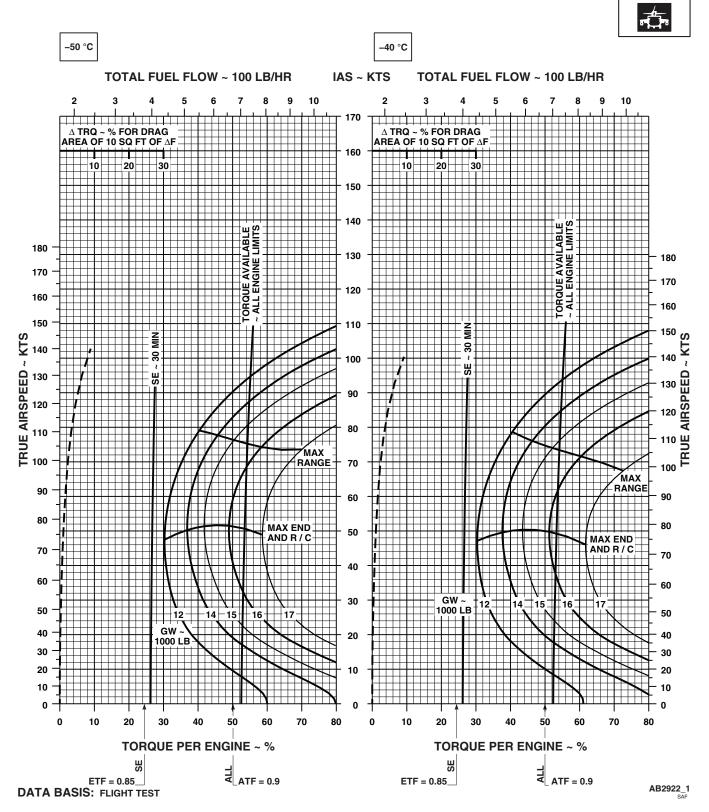


Figure 7-28. Cruise High Drag - Altitude 20,000 Feet (Sheet 1 of 4)

CRUISE 20,000 FT

T700 (2)

## CRUISE PRESSURE ALT: 20,000 FT

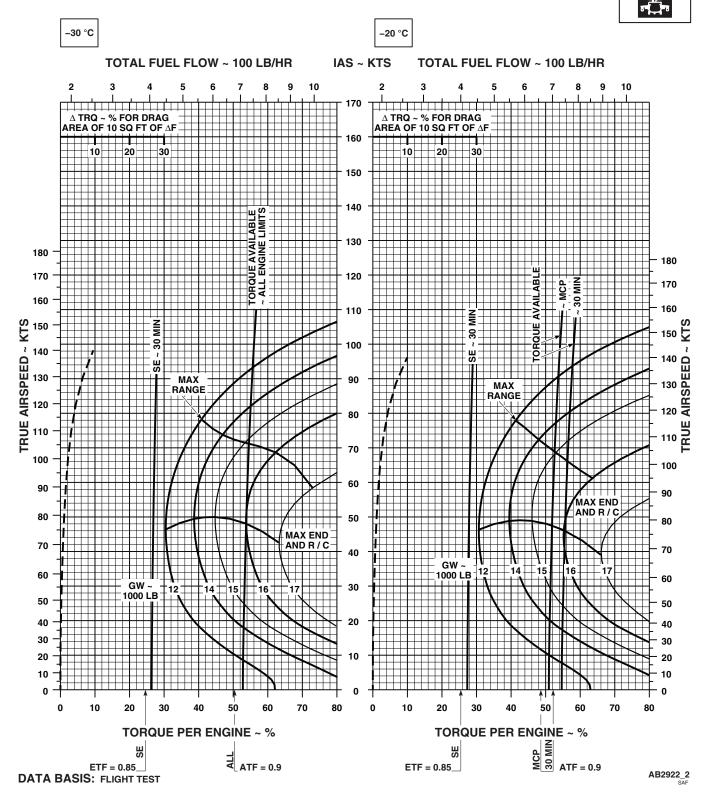


Figure 7-28. Cruise High Drag - Altitude 20,000 Feet (Sheet 2 of 4)

## CRUISE PRESSURE ALT: 20,000 FT

CRUISE 20,000 FT

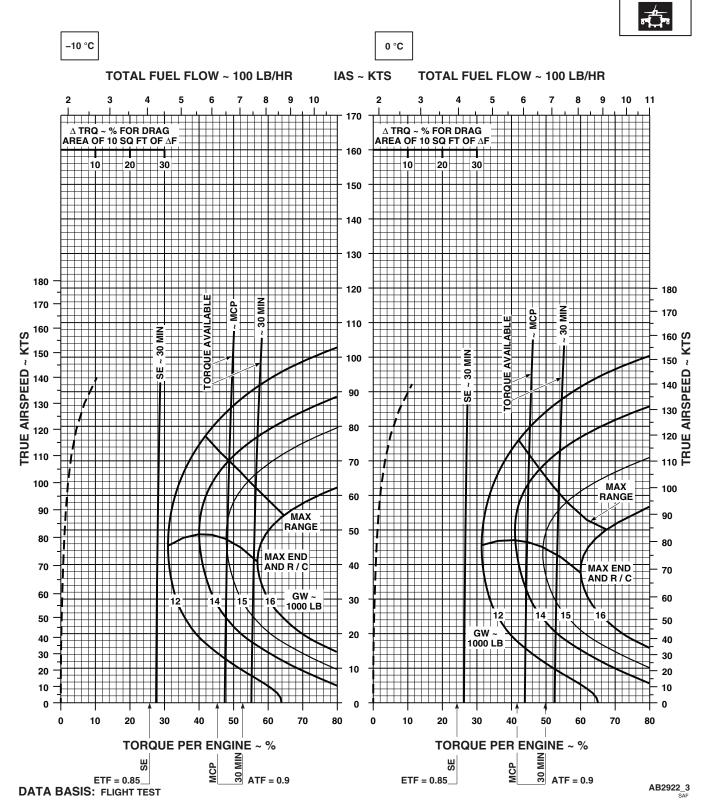


Figure 7-28. Cruise High Drag - Altitude 20,000 Feet (Sheet 3 of 4)

## CRUISE PRESSURE ALT: 20,000 FT



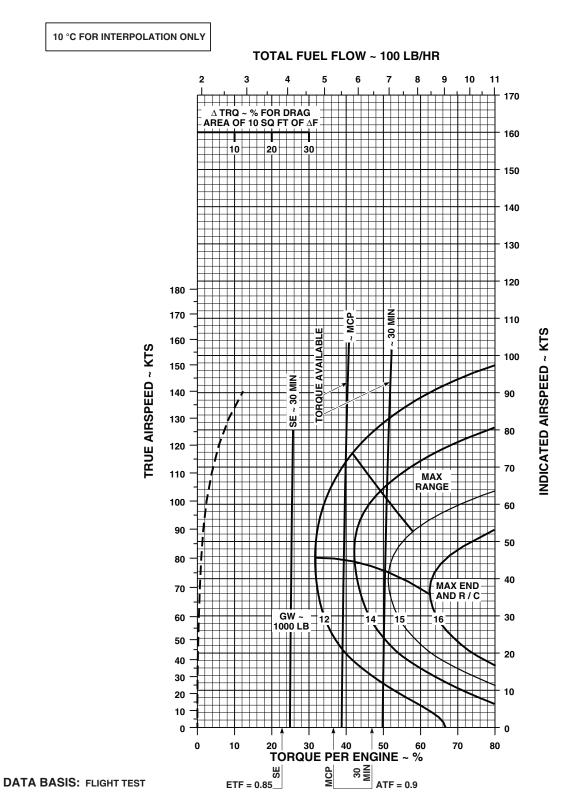




Figure 7-28. Cruise High Drag - Altitude 20,000 Feet (Sheet 4 of 4)

#### Section V OPTIMUM CRUISE

#### 7.19 OPTIMUM RANGE CHARTS.

This section presents a method to optimize cruise performance for long range missions when the altitudes flown are not restricted by other requirements. The optimum altitude for maximum range chart (Figures 7-29 and 7-30)provides the pressure altitude at which to cruise to obtain the maximum possible range for any gross weight and FAT conditions. The altitude determined for optimum range may also be used for optimum endurance. Enter the chart at a current cruise or takeoff temperature condition and move along the temperature guidelines to the anticipated gross weight for cruise and obtain the optimum pressure altitude. Turn to the cruise chart closest to the altitude and temperature predicted by the optimum range chart for specific cruise information. The use of this chart is shown by the example.

### OPTIMUM RANGE CLEAN CONFIGURATION 100% RPM R HIRSS (BAFFLES INSTALLED)

#### EXAMPLE

WANTED:

CRUISE ALTITUDE FOR OPTIMUM RANGE AND CORRESPONDING CRUISE CHART FOR FLIGHT CONDITIONS

KNOWN:

REFERENCE CONDITIONS OF: PRESSURE ALTITUDE = 1,500 FT FAT = 24 °C GROSS WEIGHT = 16,500 LB **METHOD:** 

ENTER CHART AT FAT (24 °C), MOVE RIGHT TO REFERENCE / OPTIMUM PRESSURE ALTITUDE = (1,500 FT). MOVE PARALLEL WITH THE TEMPERATURE TREND LINES TO AIRCRAFT GROSS WEIGHT (16,500 LB). MOVE LEFT OR RIGHT PARALLELING THE TEMPERATURE TREND LINE TO NEAREST EVEN THOUSAND REFERENCE / OPTIMUM PRESSURE ALTITUDE LINE (12,000). MOVE LEFT TO FREE AIR TEMPERATURE LINE (2.5 °C), MOVE UP OR DOWN TO NEAREST TEN VALUE ON THE FREE AIR TEMPERATURE SCALE (0 °C).

SELECT CRUISE CHART WITH ALTITUDE AND TEMPERATURE DATA AT THE NEAREST REFERENCE / OPTIMUM PRESSURE ALTITUDE (12,000 FT) AND THE NEAREST TEN DEGREE FREE AIR TEMPERATURE (0 °C).

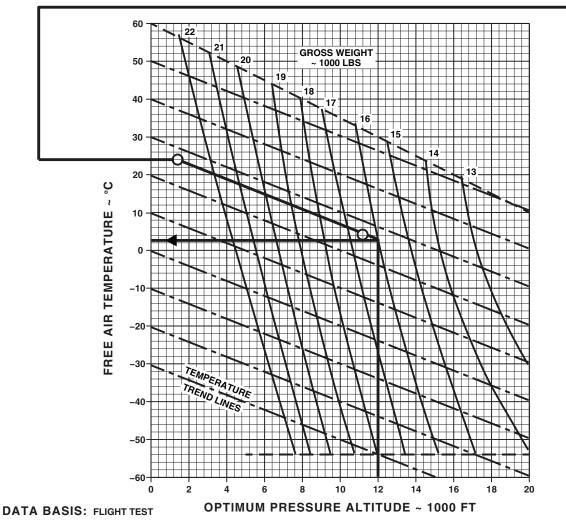
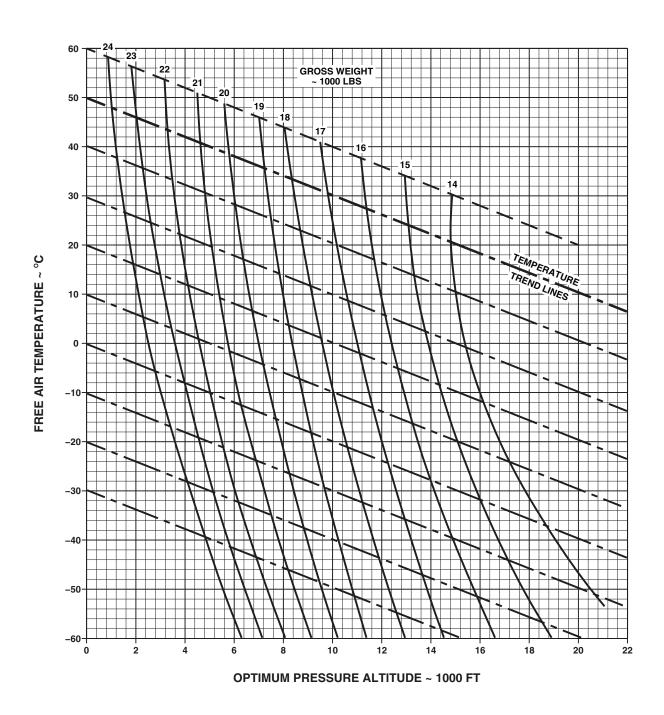




Figure 7-29. Optimum Altitude For Maximum Range

# OPTIMUM RANGE HIGH DRAG CONFIGURATION 100% RPM R HIRSS (BAFFLES INSTALLED)



DATA BASIS: FLIGHT TEST

AA0683_2C

<u>_</u>

Figure 7-30. Optimum Altitude For Maximum Range - High Drag

#### Section VI DRAG

#### 7.20 EXTERNAL LOAD DRAG CHART.

The general shapes of typical external loads are shown on Figure 7-31 as a function of the load frontal area. The frontal area is combined with the typical drag coefficient of the general shapes to obtain a drag multiplying factor for use with the 10 sq. ft. drag scale on each cruise chart. The  $\Delta$  TRQ ~% value obtained from the cruise chart is multiplied by the drag multiplying factor and added to indicated torque to obtain total torque required at any airspeed.

#### 7.21 AIRCRAFT CONFIGURATION DRAG CHANGES FOR USE WITH CLEAN CRUISE CHARTS.

When external equipment or configuration differs from the baseline clean configuration as defined in Section I, a drag correction should be made similarly to the external load drag method. Typical configuration changes that have drag areas established from flight test or analysis along with their drag multiplying factor are shown in Table 7-1.

#### Table 7-1. Configuration Drag Change

Item	Change in Flat Plate Drag Area- $\Delta$ F Sq. Ft.	Drag Multiplying Factor
a. Both cargo doors open	6.0	0.60
b. Cargo doors removed	4.0	0.40
c. Cargo mirror installed	0.3	0.03
d. IR Countermeasure Transmitter (ALQ-144) installed	0.8	0.08
e. Chaff Dispenser Installed	0.3	0.03
f. HIRSS not installed	-2.2	-0.22
g. 🖽 Flare Dispenser	0.3	0.03
n. Ell EH-60A Mission Antennas Only	3.8	0.38
. Blade Erosion Kit	2.0	0.20
j. Skis installed	3.0	0.30

#### 7.22 AIRCRAFT CONFIGURATION DRAG CHANGES FOR USE WITH HIGH DRAG CRUISE CHARTS.

external load drag method. Typical high drag configuration changes that have been established from flight test or analysis along with the drag multiplying factors are shown.

When external equipment differs from the baseline high drag configuration as defined in this Section, a drag correction should be made using Figure 7-32 similar to the

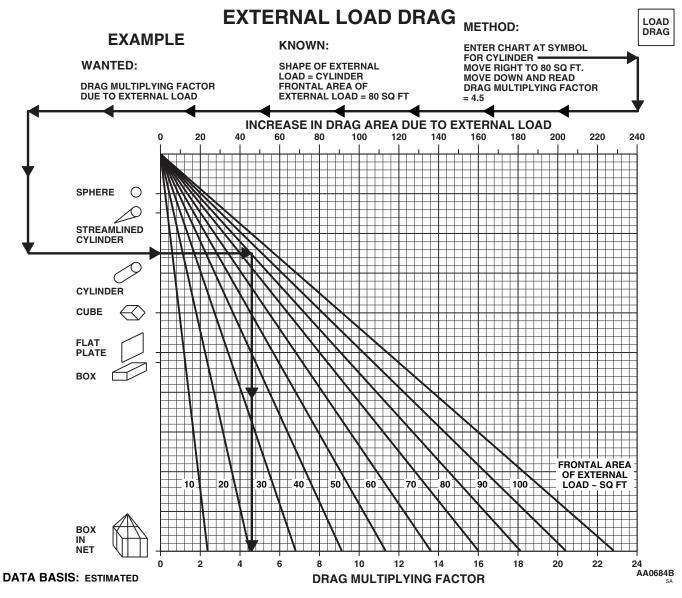


Figure 7-31. External Load Drag

# **DRAG CONFIGURATIONS**



HIGH DRAG CRUISE CHART BASELINE SPECIAL MISSION EQUIPMENT CONFIGURATIONS	CHANGE IN FLAT PLATE DRAG △F SQ FT	DRAG MULTI- PLYING FACTOR
ESSS – CLEAN, PYLONS REMOVED	-4.0	-0.40
ESSS - FOUR PYLONS / NO STORES	-1.7	-0.17
ESSS-TWO 450-GALLON TANKS INBOARD OR OR	0.5 0.0	0.05 0.00
ESSS-TWO 230-GALLON TANKS OUTBOARD -TWO 450-GALLON -TANKS INBOARD	2.5	0.25
ESSS - FOUR 230-GALLON TANKS	2.0	0.20
VOLCANO SYSTEM INSTALLED (BOTH RACKS)  * VOLCANO CORRECTION MUST BE USED WITH HIGH DRAG CHARTS ONL VOLCANO SYSTEM INSTALLED (LOWER RACKS ONLY) VOLCANO SYSTEM INSTALLED (CANISTERS REMOVED)	LY 32.5 10.5 12.5	3.25 1.05 1.25
SKIS INSTALLED	3.0	0.30
BLADE EROSION KIT		0.20
BOTH CARGO DOORS OPEN		0.60
BOTH CARGO DOORS REMOVED	4.0	0.40
CARGO MIRROR INSTALLED	0.3	0.03
IR COUNTERMEASURE TRANSMITTER (ALQ-144) REMOVED	-0.8	-0.08
	-0.3	-0.03

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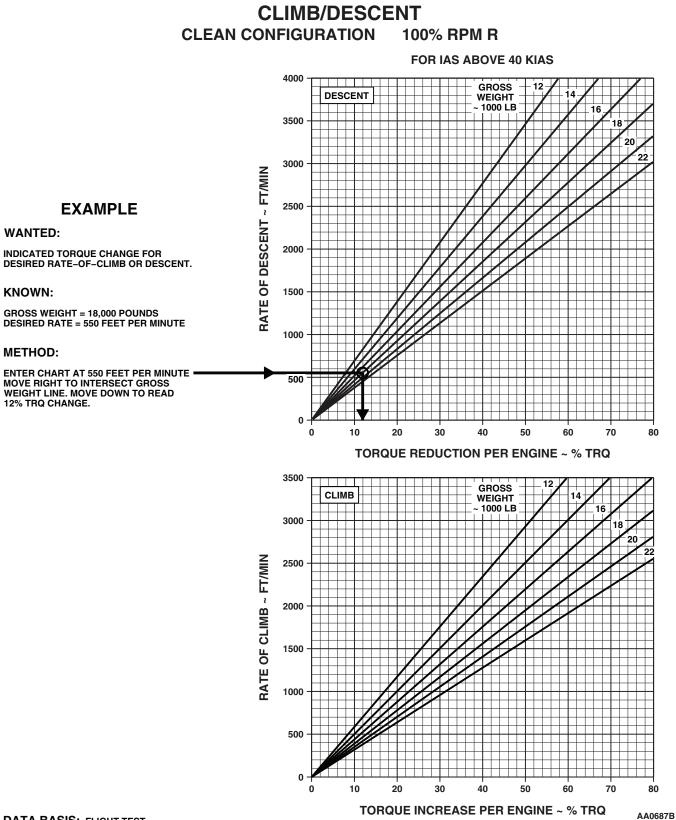
Figure 7-32. Typical High Drag Configurations

#### Section VII CLIMB - DESCENT

#### 7.23 CLIMB/DESCENT CHART.

The CLIMB/DESCENT chart (Figures 7-33 and 7-34) presents the rate of climb or descent resulting from an increase or decrease of engine torque from the value required for level flight above 40 KIAS. The data are presented at 100% RPM R for various gross weights. The charts may also be used in reverse to obtain the torque

increase or reduction required to achieve a desired steady rate of climb or descent. The maximum rate of climb may be determined by subtracting the cruise chart torque required from the maximum torque available at the desired flight conditions. Then enter the difference on the torque increase scale of the climb chart, move up to the gross weight, and read the resulting maximum rate of climb.



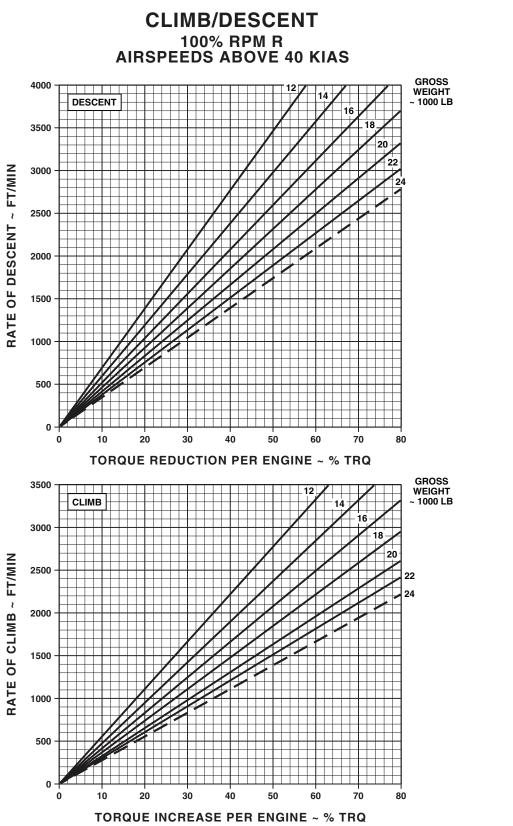
#### **DATA BASIS:** FLIGHT TEST

WANTED:

KNOWN:

**METHOD:** 

Figure 7-33. Climb/Descent



at 19

AA0688A

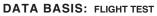


Figure 7-34. Climb/Descent - High Drag

#### 7.24 IDLE FUEL FLOW.

Dual-engine idle fuel flow is presented as a function of altitude at 0°C FAT in Table 7-2. The data are based on operation at 62% to 69% Ng for idle and 85% to 89% for flat pitch (collective full down) at 100%RPM R. Fuel flow for the auxiliary power unit (APU) is also presented for a nominal load of 80% maximum power as a function of altitude and 0°C FAT for general planning.

#### 7.25 SINGLE-ENGINE FUEL FLOW.

a. Engine fuel flow is presented in Figure 7-35 for various torque and pressure altitudes at a baseline FAT of  $0^{\circ}$ C with engine bleed air extraction off. When operating at other than  $0^{\circ}$ C FAT, engine fuel flow is increased 1% for each 20°C above the baseline temperature and, decreased 1% for each 20°C below the baseline temperature.

b. To determine single-engine fuel flow during cruise, enter the fuel flow chart at double the torque required for dual-engine cruise as determined from the cruise 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, single-engine fuel flow increases as follows:

- (1) With bleed-air extracted, fuel flow increases:
- (a) Engine anti-ice on About 30 lbs/hr.
- (b) Cockpit/gunner heater on About 10 lbs/hr.

(c) Cockpit/gunner heater and Option II cabin heater system on - About 14 lbs/hr.

#### NOTE

Option II cabin heater system shuts off when anti-ice is turned on. Power to the heater returns when the anti-ice is turned off.

(d) Anti-ice and cockpit/gunner heater on - About 40 lbs/hr.

(2) When the IR suppressor systemis installed and operating in the benign mode (exhaust baffles removed), the single-engine fuel flow will decrease about 8 lbs/hr.

#### 7.26 DUAL-ENGINE FUEL FLOW.

Dual-engine fuel flow for level flight is presented on the cruise charts in Section IV. For other conditions dualengine fuel flow may be obtained from Figure 7-35 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. When operating at other than the 0° FAT baseline, dual-engine fuel flow is increased 1% for each 20°C above baseline and is decreased 1% for each 20°C below baseline temperature. With bleed air on, dual-engine fuel flow increases as follows:

a. With bleed-air extracted, fuel flow increases:

(1) Engine anti-ice on -About 60 lbs/hr. Example: (760 lbs/hour = 820 lbs/hr).

(2) Cockpit/gunner heater on - About 20 lbs/hr.

(3) Cockpit/gunner heater and Option II cabin heater system on - About 28 lbs/hr.

#### NOTE

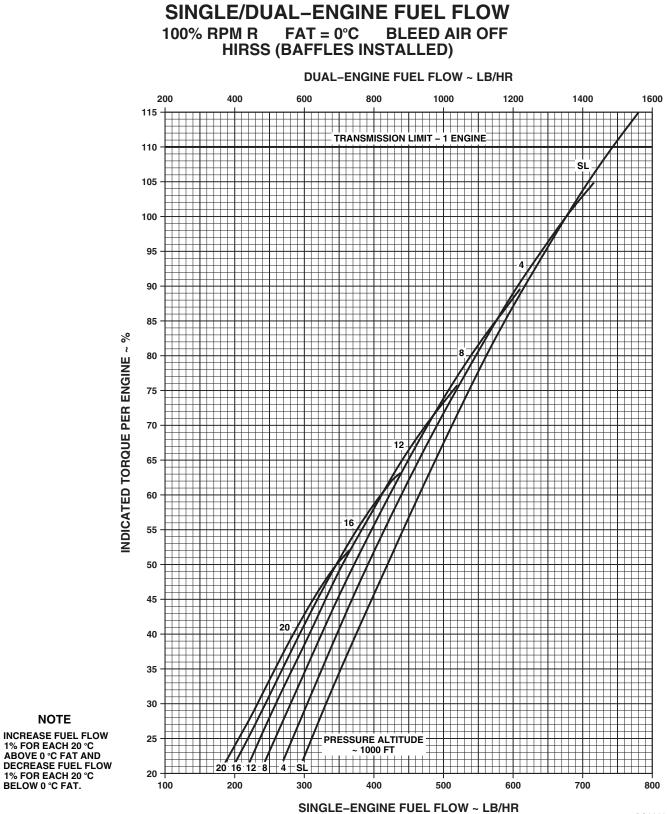
Option II cabin heater system shuts off when anti-ice is turned on. Power to the heater returns when the anti-ice is turned off.

(4) Anti-ice and cockpit/gunner heater on - About 80 lbs/hr.

b. When the cruise or hover IR suppressor system is installed and operating in the benign mode (exhaust baffles removed), the dual-engine fuel flow will decrease about 16 lbs/hr.

#### Table 7-2. Dual Engine Idle and Auxiliary Power Unit Fuel Flow

Pressure Altitude Feet	Ng = 62-69% Ground Idle (No Load) Lb/Hr	Ng = 85-89% Flat Pitch (100%RPM R) Lb/Hr	APU (Nominal) Lb/Hi
0	350	580	120
4,000	326	500	105
8,000	268	440	90
12,000	234	380	75
16,000	206	320	65
20,000	182	270	55



DATA BASIS: ENGINE MANUFACTURER SPEC



AA0689A

## Section IX AIRSPEED SYSTEM DESCRIPTION

#### 7.27 AIRSPEED CHARTS.

#### 7.27.1 Airspeed Correction Charts.

#### NOTE

IAS below 40 KIAS is unreliable. Airspeed conversion data KIAS to KTAS for speeds above 40 KIAS are provided in Section IV CRUISE.

All IAS shown on the cruise charts are based on level flight. Figures 7-36 and 7-37 provide the airspeed correction to be added to the cruise chart IAS values to determine the related airspeed indicator reading for other than level flight mode. There are relatively large variations in airspeed system error associated with climbs and descents. Figures 7-36 and 7-37 are provided primarily to show the general magnitude and direction of the errors associated with the various flight modes. If desired, these figures may be used in the manner shown by the examples to calculate specific airspeed corrections.

#### 7.27.2 Airspeed System Dynamic Characteristics.

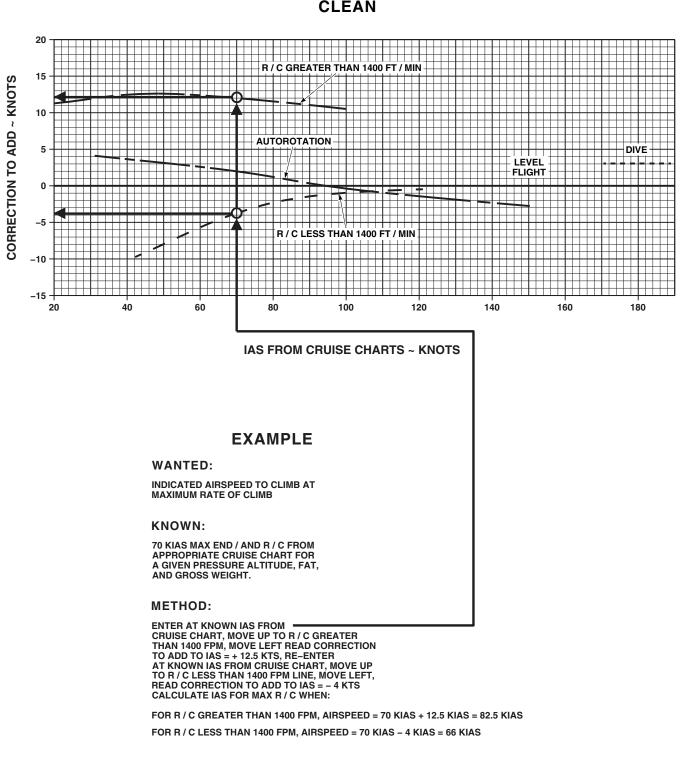
The dynamic characteristics of the pilot and copilot airspeed indicating systems are normally satisfactory. However, the following anomalies in the airspeed and instantaneous VSI (IVSI) indicating system may be observed during the following maneuvers or conditions:

a. During takeoffs, in the speed range of 40 to 80 KI-AS, 5 to 10 KIAS airspeed fluctuation may be observed on the pilot and copilot airspeed indicators.

b. Power changes in high power, low airspeed climbs may cause as much as 30-knot airspeed changes in IAS. Increase in power causes increase in IAS, and a decrease in power causes decrease in IAS.

c. 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.

d. In-flight opening and closing of doors and windows may cause momentary fluctuations of approximately 300 feet per minute (FPM) on the VSIs.



AIRSPEED SYSTEM CORRECTION CLEAN

DATA BASIS: FLIGHT TEST

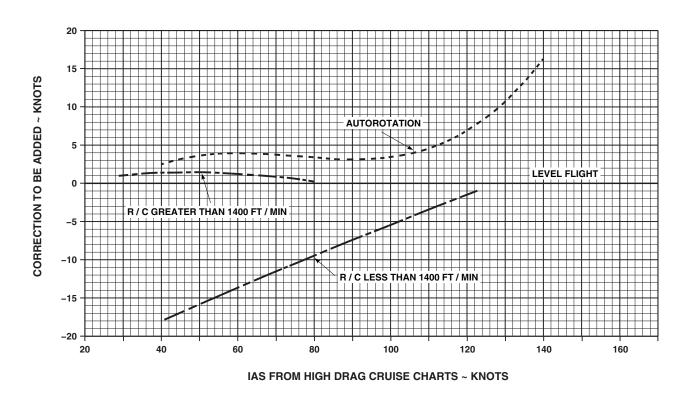
Figure 7-36. Airspeed System Correction - Clean

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# **AIRSPEED SYSTEM CORRECTION**

-4-

AA1029A



DATA BASIS: FLIGHT TEST



#### Section X SPECIAL MISSION PERFORMANCE

#### 7.28 SPECIAL MISSION FLIGHT PROFILES.

Figures 7-38 through 7-40 show special mission flight profiles required to obtain near maximum range when equipped with ESSS in three different tank configurations. The upper segment of each chart provides the recommended altitude profile along with the IAS and average TRQ versus distance traveled. An average value of elapsed time is also presented on the lower axis of the altitude scale. The lower segment of each chart provides the relationship between fuel remaining and distance traveled resulting from the flight profile shown. This portion may be utilized to check actual inflight range data to provide assurance that adequate range is being achieved. The chart is divided into 3 regions of Adequate Range, Inadequate range-return to base, and Inadequate range-requiring emergency action. When an inflight range point is in the Adequate range region, the required mission range can be obtained by staying on the recommended flight profile. However, the range may not be achieved if stronger headwinds are encountered as the flight progresses, and normal pilot judgement must be used. These charts also assume that the flight track is within proper navigational limits. Standard temperature variation with PA is shown on the upper segment of the charts. A general correction for temperature variation is to decrease IAS by 2.5 knots and total distance traveled by 0.5% for each 10°C above standard. Detailed flight planning must always be made for the actual aircraft configuration, fuel load, and flight conditions when maximum range is required. This data is based on JP-4 fuel. It can be used with JP-5 or JP-8, aviation gasoline, or any other approved fuels ONLY IF THE TAKEOFF GROSS WEIGHT AND THE FUEL LOAD WEIGHT MATCH THE DATA AT THE TOP OF THE CHART. The Flight Time and the Distance Traveled data SHOULD NOT be used with any full tank configuration if the fuel density is not approximately 6.5 lbs/gal. (JP-4 fuel).

a. SELF-DEPLOYMENT MISSION. The selfdeployment mission is shown in Figure 7-38 and the ESSS is configured with two 230-gallon tanks outboard and two 450-gallon tanks inboard. In this configuration, the aircraft holds in excess of 11,000 lbs of JP-4 fuel and has a takeoff gross weight of 24,500 lbs in order to achieve the desired mission range of 1,150 Nm. This gross weight is allowed for ferry missions only, requiring low load factors and less than 30 degree angle banked turns. This mission was calculated for a standard day with a constant 10 knot headwind added to be conservative. Since there may not be any emergency landing areas available, the mission should not be attempted if headwinds in excess of 10 knots are forecast. Takeoff must be made with a minimum of fuel used (60 lbs) for engine start and warmup, and a climb to 2,000 feet should be made with maximum power and airspeed between 80 and 105 KIAS. The first segment should be maintained at 2,000 feet and 105 KIAS for 2 hours. The average engine TRQ should be about 79% for this segment, but will initially be a little more and gradually decrease. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel burn. The first 2 segments are for 2 hours each, followed by 1 hour segments until reaching 10,000 feet. At this altitude, the airspeed for best range should also be reduced to 95 KIAS for the remainder of the flight. Engine bleed air was assumed to be off for this mission except for that required for fuel tank pressurization. Electrical cabin heat may be used. Removal of the HIRSS baffles (benign mode) will reduce fuel flow by about 16 lbs/hr. If oxygen is available, continuation of the staircase climb sequence to 15,500 feet PA will result in about 23 additional Nm of range capability.

b. ASSAULT MISSION PROFILE - 4 tanks. The assault mission profile is shown in Figure 7-39 with the ES-SS configured with four 230-gallon tanks. In this configuration, the aircraft holds in excess of 8,300 lbs of JP-4 fuel and assumes a takeoff gross weight of 22,000 lbs which provides a maximum mission range of 1140 Nm with 400 lbs reserve. This mission was calculated for a standard day with a zero headwind. Takeoff must be made with a minimum of fuel used (80 lbs) for engine start and warmup, and a Climb to 4,000 feet should be made with maximum power and airspeed between 80 and 108 KIAS. The first segment should be maintained at 4,000 feet and 108 KIAS for 1 hour. The average engine TRQ should be about 79% for this segment, but will initially be a little more and gradually decrease. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel burn. The segments are for 1 hour each, until reaching 10,000 feet. At this altitude, the airspeed for best range should be reduced to 95 KIAS for the remainder of the flight.

c. ASSAULT MISSION PROFILE - 2 tanks. The assault mission profile is shown in Figure 7-40 with the ES-SS configured with two 230-gallon tanks. In this configuration, the aircraft holds in excess of 5,300 lbs of JP-4 fuel and assumes a takeoff gross weight of 22,000 lbs which provides a maximum mission range of 630 nm with 400 lbs reserve. This mission was calculated for a standard day with a zero headwind. Takeoff must be made with a minimum of fuel used (80 lbs) for engine start and warmup, and a Climb to 4,000 feet should be made with max power and airspeed between 80 and 108 KIAS. The first segment should be maintained at 4,000 feet and 108 KIAS for 1 hour. The average engine TRQ should be about 77% for this segment, but will initially be a little more and gradually decrease as shown on each segment. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel

burn. At this altitude, the airspeed for best range should also be reduced to 95 KIAS for the remainder of the flight.

#### 7.29 SPECIAL MISSION FLIGHT PROFILES. CEFS

Figures 7-41 and 7-42 show special mission flight profiles required to obtain near maximum range when equipped with ESSS in three different tank configurations. The upper segment of each chart provides the recommended altitude profile along with the IAS and average TRQ versus distance traveled. An average value of elapsed time is also presented on the lower axis of the altitude scale. The lower segment of each chart provides the relationship between fuel remaining and distance traveled resulting from the flight profile shown. This portion may be utilized to check actual inflight range data to provide

#### EXAMPLE:

#### WANTED:

Assurance of adequate aircraft range for mission defined.

KNOWN:

Flight position: 300 nm from base Flight Track Within Limits Fuel Remaining= 7,800 lbs Elapsed flight time = 2 hrs, 50 mins (2.83 hrs) Target: Normal Flight Conditions:

> Airspeed = 105 KIAS Press Alt = 4,000 feet Approx Torque = 75%

#### METHOD:

- (1) Enter chart at total distance flown and at fuel remaining, move to intersection and plot point. If point falls on or above fuel remaining line (adequate range), remaining fuel is adequate to complete the mission. If point falls below the fuel remaining line in the inadequate range, abort mission region, immediately return to departure point while continuing to utilize altitude profile using total elapsed flight time (see item 2). If point falls below the fuel remaining line in the inadequate range, region, consult emergency procedures for corrective action.
- (2) To determine target nominal flight conditions, enter upper chart at elapsed flight time and move up to determine target airspeed, approximate torque, and pressure altitude.

#### Figure 7-38. Self-Deployment Mission Profile (Sheet 1 of 2)

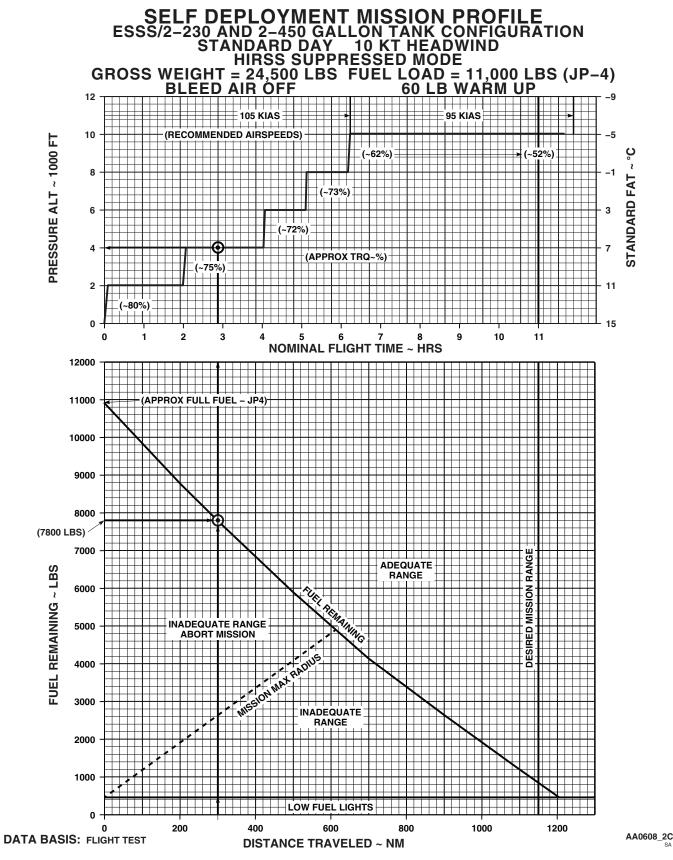


Figure 7-38. Self-Deployment Mission Profile (Sheet 2 of 2)

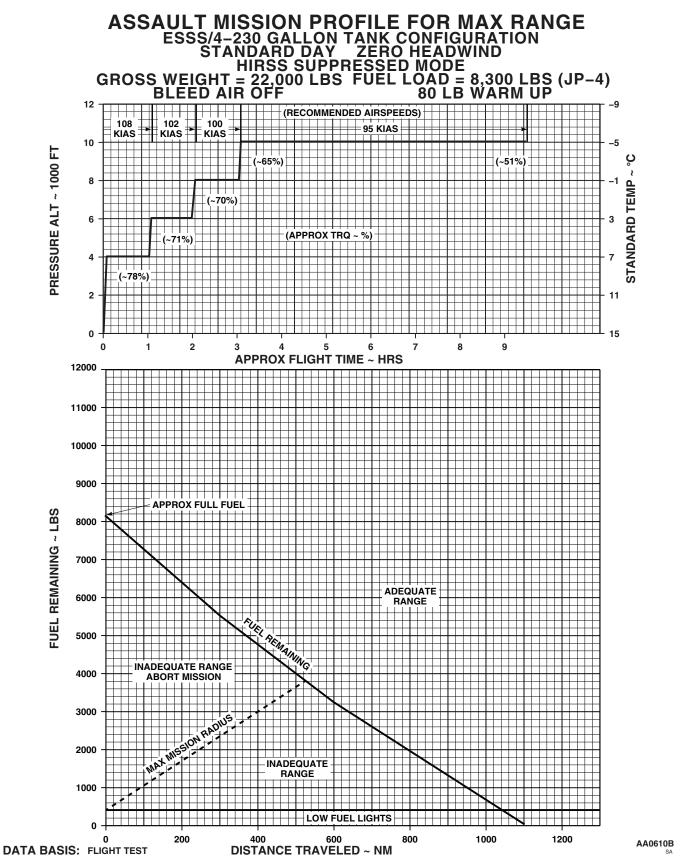


Figure 7-39. Assault Mission Profile (4 - 230 Gallon Tanks)

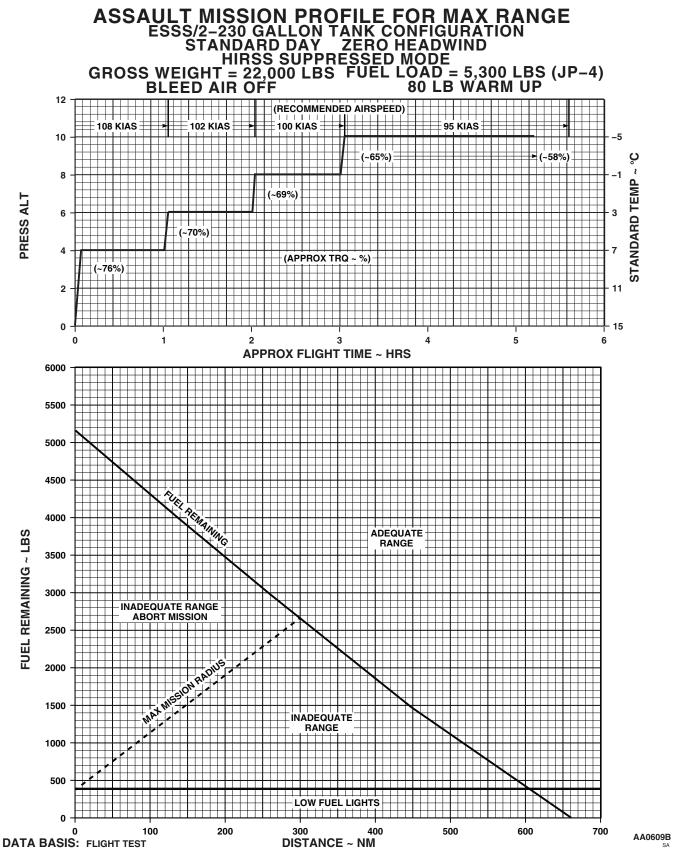


Figure 7-40. Assault Mission Profile (2 - 230 Gallon Tanks)

assurance that adequate range is being achieved. The chart is divided into 3 regions of Adequate Range, Inadequate range-return to base, and Inadequate range-requiring emergency action. When an inflight range point is in the Adequate range region, the required mission range can be obtained by staying on the recommended flight profile. However, the range may not be achieved if stronger headwinds are encountered as the flight progresses, and normal pilot judgment must be used. These charts also assume that the flight track is within proper navigational limits. Standard temperature variation with PA is shown on the upper segment of the charts. A general correction for temperature variation is to decrease IAS by 2.5 KTS and total distance traveled by 0.5% for each 10°C above standard. Detailed flight planning must always be made for the actual aircraft configuration, fuel load, and flight conditions when maximum range is required. This data is based on JP-4 fuel. It can be used with JP-5, JP-8, aviation gasoline, or any other approved fuels ONLY IF THE TAKEOFF GROSS WEIGHT AND THE FUEL LOAD WEIGHT MATCH THE DATA AT THE TOP OF THE CHART. The Flight Time and the Distance Traveled data SHOULD NOT be used with any full tank configuration if the fuel density is not approximately 6.5 lbs/gal (JP-4 fuel).

**7.29.1 Self-Deployment Mission.** CEFS will not be used for self-deployment missions.

**7.29.2 Assault Mission Profile - 4 Tanks.** The assault mission profile is shown in Figure 7-41 with the CEFS configured with four 200-gallon tanks. In this configuration, the aircraft holds in excess of 7,500 lbs of JP-4 fuel and assumes a takeoff gross weight of 22,000 lbs which provides a maximum mission range of 900 nm with

400 lbs reserve. This mission was calculated for a standard day with a zero headwind. Takeoff must be made with a minimum of fuel used (80 lbs) for engine start and warmup, and a climb to 4,000 feet should be made with maximum power and airspeed approximately 65 KIAS. The first segment should be maintained at 4,000 feet and 108 KIAS for 1 hour. The average engine TRQ should be about 78% for this segment, but will initially be a little more and gradually decrease. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel burn. The segments are for 1 hour each, until reaching 10,000 feet. At this altitude, the airspeed for best range should be reduced to 95 KIAS for the remainder of the flight.

7.29.3 Assault Mission Profile – 2 Tanks. The assault mission profile is shown in Figure 7-42 with the CEFS configured with two 200-gallon tanks. In this configuration, the aircraft holds in excess of 4,900 lbs of JP-4 fuel and assumes a takeoff gross weight of 22,000 lbs which provides a maximum mission range of 525 nm with 400 lbs reserve. This mission was calculated for a standard day with a zero headwind. Takeoff must be made with a minimum of fuel used (80 lbs) for engine start and warmup, and a climb to 4,000 feet should be made with maximum power and airspeed of approximately 65 KIAS. The first segment should be maintained at 4,000 feet and 108 KIAS for 1 hour. The average engine TRQ should be about 77% for this segment, but will initially be a little more and gradually decrease as shown on each segment. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel burn. At this altitude, the airspeed for best range should also be reduced to 92 KIAS for the remainder of the flight.

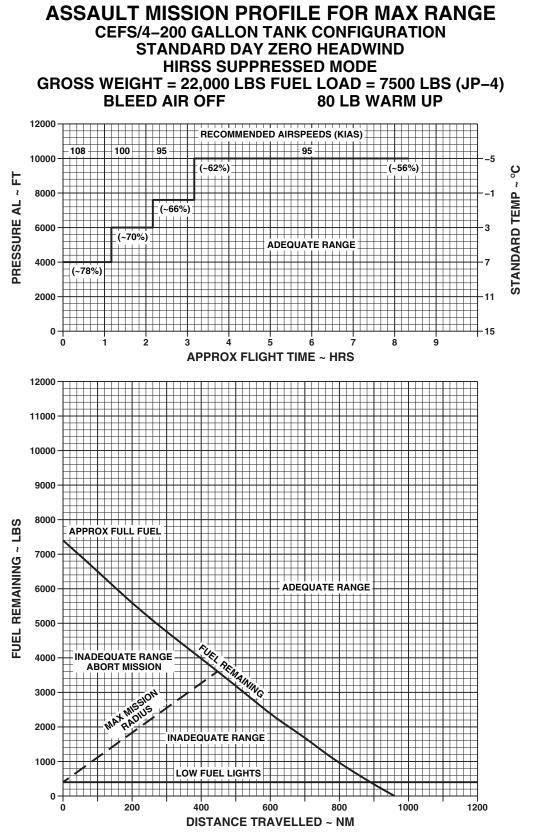


Figure 7-41. Assault Mission Profile (4 - 200 Gallon Tanks)

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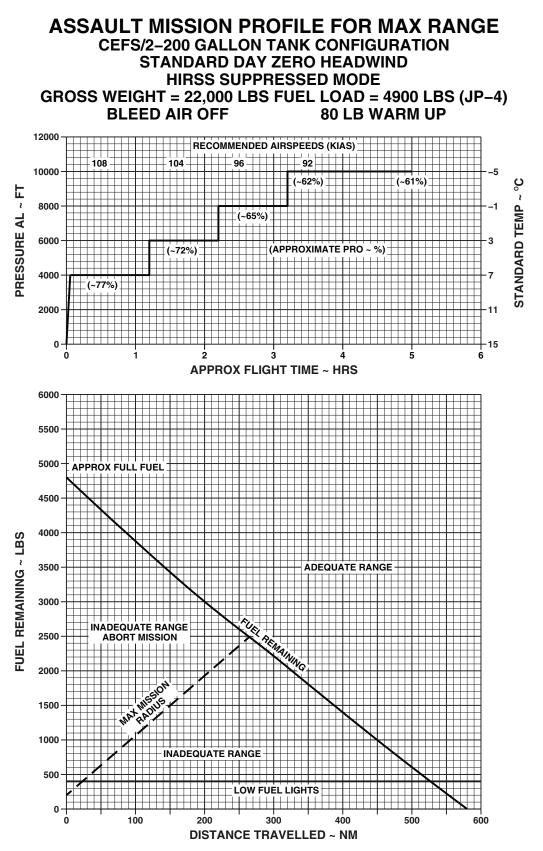


Figure 7-42. Assault Mission Profile (2 - 200 Gallon Tanks)

AB4355

# CHAPTER 7A PERFORMANCE DATA 701C 701D/CC

## Section I INTRODUCTION

#### 7A.1 PURPOSE.

#### NOTE

Chapter 7A contains performance data for helicopters equipped with T700-GE-701C or T700-GE-701D/CC engines. Performance data for other models are contained in Chapter 7. Users are authorized to remove whichever chapter is not applicable to their model helicopter, and are not required to carry both chapters on board.

a. The purpose of this chapter is to provide the best available performance data for the UH-60L or **H-60A+**. Regular use of this information will enable you to receive maximum safe utilization of the helicopter. Although maximum performance is not always required, regular use of this chapter is recommended for these reasons:

(1) Knowledge of your performance margin will allow you to make better decisions when unexpected conditions or alternate missions are encountered.

(2) Situations requiring maximum performance will be more readily recognized.

(3) Familiarity with the data will allow performance to be computed more easily and quickly.

(4) Experience will be gained in accurately estimating the effects of variables for which data are not presented.

b. The information is primarily intended for mission planning and is most useful when planning operations in unfamiliar areas or at extreme conditions. The data may also be used in flight, to establish unit or area standard operating procedures, and to inform ground commanders of performance/risk tradeoffs.

#### 7A.2 CHAPTER 7A INDEX.

The following index contains a list of the sections, titles, figure numbers, subjects, and page numbers of each performance data chart contained in this chapter.

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#### 7A.3 GENERAL.

Section

The data presented covers the maximum range of conditions and performance that can reasonably be expected. In each area of performance, the effects of altitude, temperature, gross weight, and other parameters relating to that phase of flight are presented. In addition to the presented data, your judgment and experience will be necessary to accurately obtain performance under a given set of circumstances. The conditions for the data are listed under the title of each chart. The effects of different conditions are discussed in the text accompanying each phase of performance. Where practical, data are presented at conservative conditions. However, NO GENERAL CONSERVATISM HAS BEEN APPLIED. All performance data presented are within the applicable limits of the helicopter. All flight performance data are based on JP-4 fuel. The change in fuel flow and torque available, when using JP-5 or JP-8 aviation fuel or any other approved fuels, is insignificant.

#### 7A.4 LIMITS.



Exceeding operating limits can cause permanent damage to critical components. Overlimit operation can decrease performance, cause early failure, or failure on a subsequent flight.

Applicable limits are shown on the charts. Performance generally deteriorates rapidly beyond limits. If limits are exceeded, minimize the amount and time. Enter the maximum value and time above limits on DA Form 2408-13-1 so proper maintenance action can be taken.

#### 7A.5 USE OF CHARTS.

**7A.5.1 Dashed Line Data.** On some charts dashed line data are shown for gross weights greater than 22,000 pounds. Weights above 22,000 pounds are limited to external loads in excess of 8000 lbs or ferry missions only. Ferry missions require an Airworthiness Release.

**7A.5.2 Data Basis.** The type of data used is indicated at the bottom of each performance chart under DATA BASIS. The data provided generally is based on one of three categories:

a. Flight test data. Data obtained by flight test of the helicopter by experienced flight test personnel at precise conditions using sensitive calibrated instruments.

b. Calculated data. Data based on tests, but not on flight test of the complete helicopter.

c. Estimated data. Data based on estimates using aerodynamic theory or other means but not verified by flight test.

**7A.5.3 Specific Conditions.** The data presented is accurate only for specific conditions listed under the title of each chart. Variables for which data is not presented, but which may affect that phase of performance, are discussed in the text. Where data is available or reasonable estimates can be made, the amount that each variable affects performance will be given.

#### 7A.6 PERFORMANCE DISCREPANCIES.

Regular use of this chapter will allow you to monitor instrument and other helicopter systems for malfunction, by comparing actual performance with planned performance. Knowledge will also be gained concerning the effects of variables for which data is not provided, thereby increasing the accuracy of performance predictions.

#### 7A.7 PERFORMANCE DATA BASIS - CLEAN.

The data presented in the performance charts are primarily derived for a clean UH-60L or **H-60A+** helicopter and are based on U. S. Army test data. The clean configuration assumes all doors and windows are closed and includes the following external configuration:

a. Fixed provisions for the External Stores Support System (ESSS) .

b. Main and tail rotor deice system.

c. Mounting brackets for infrared (IR) jammer and chaff dispenser.

d. The Hover Infrared Suppressor System (HIRSS) with baffles installed.

e. Includes wire strike protection system.

#### NOTE

Helicopters which have an external configuration which differs from the clean configuration may be corrected for drag differences on cruise performance as discussed in Section VI DRAG.

#### 7A.8 PERFORMANCE DATA BASIS - HIGH DRAG.

The data presented in the high drag performance charts are primarily derived for the UH-60L or **H-60A+** with the ESSS system installed and two 230-gallon tanks mounted on the outboard pylons, and are based on U.S. Army test data. The high drag configuration assumes all doors and windows are closed and includes the following external configuration:

a. External stores support system installed.

b. Two 230–gallon tanks mounted on the outboard pylons.

c. Inboard vertical pylons empty.

- d. IR jammer and chaff dispenser installed.
- e. HIRSS with baffles are installed.

f. Main and tail rotor deice and wire strike protection systems are installed.

#### NOTE

Helicopters with an external configuration that differs from the high drag configuration baseline may be corrected for differences in cruise performance as discussed in Section VI DRAG.

g. Use the high drag configuration hover charts to determine hover performance with the volcano system in-

stalled. Use the high drag cruise charts and the volcano drag correction factor to determine cruise performance with volcano installed. The volcano drag correction factor is based on flight test data obtained with the complete volcano system installed, to include all of the canisters and mines. The drag correction factor may be used to provide a conservative estimate of cruise performance for volcano configurations which do not include all of the canisters and mines.

#### 7A.9 FREE AIR TEMPERATURE.

A temperature conversion chart (Figure 7A-1) is included for the purpose of converting Fahrenheit temperature to Celsius.

# **TEMPERATURE CONVERSION**

#### EXAMPLE

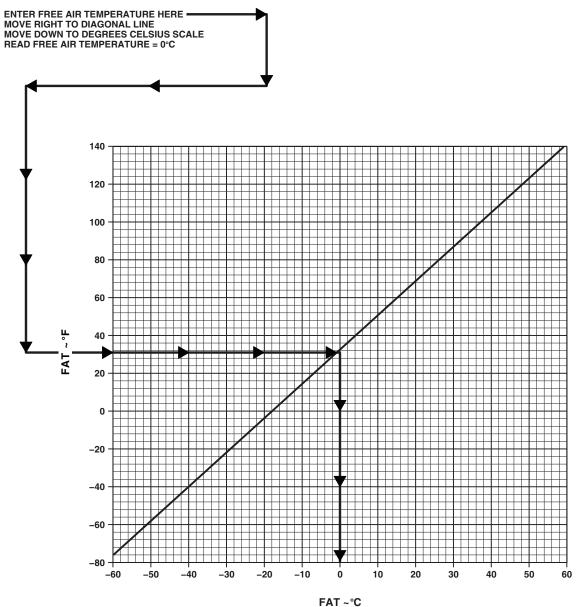
#### WANTED:

FREE AIR TEMPERATURE IN DEGREES CELSIUS

#### KNOWN:

FREE AIR TEMPERATURE = 32°F

METHOD:



AA0674

Figure 7A-1. Temperature Conversion Chart

## Section II MAXIMUM TORQUE AVAILABLE

#### 7A.10 TORQUE FACTOR METHOD.

The torque factor method provides an accurate indication of available power by incorporating ambient temperature effects on degraded engine performance. This section presents the procedure to determine the maximum dual-or single-engine torque available. Specification power is defined for a newly delivered low time engine. The aircraft HIT log forms for each engine provide the engine and aircraft torque factors which are obtained from the maximum power check and recorded to be used in calculating maximum torque available.

**7A.10.1 Torque Factor Terms.** The following terms are used when determining the maximum torque available for an individual aircraft:

a. Torque Ratio (TR). The ratio of torque available to specification torque at the desired ambient temperature.

b. Engine Torque Factor (ETF). The ratio of an individual engine torque available to specification torque at reference temperature of  $35^{\circ}$ C ( $95^{\circ}$ F). The ETF is allowed to range from 0.85 to 1.0.

c. Aircraft Torque Factor (ATF). The ratio of an individual aircraft's power available to specification power at a reference temperature of  $35^{\circ}$ C (95°F). The ATF is the average of the ETFs of both engines and its value is allowed to range from 0.9 to 1.0.

**7A.10.2 Torque Factor Procedure.** The use of the ATF or ETF to obtain the TR from Figure 7A-2 for ambient temperatures between  $-5^{\circ}$ C (23°F) and 35°C (95°F) is shown by the example. The ATF and ETF values for an individual aircraft are found on the engine HIT Log. Use the  $-5^{\circ}$ C (23°F) TR value for temperatures less than  $-5^{\circ}$ C (23°F). The TR equals the ATF or ETF for temperatures of 35°C (95°F) and above.

#### 7A.11 TORQUE AVAILABLE.

a. This section presents the maximum dual-engine torque available for the 2.5-minute, 10-minute, and 30-minute limits at zero airspeed and 100% RPM R for the operational range of pressure altitude and FAT. The single- and dual-engine transmission limits for continuous operation are also shown and should not be exceeded.



Do not exceed the UH-60L or H-60A+ DUAL ENGINE TORQUE LIMITS in Chapter 5. These torque limits are presented in Figure 7A-5 and on the TORQUE PLACARD mounted on the instrument panel.

b. When the TR equals 1.0, the torque available may be read directly from the torque available per engine scales. When the TR is less than 1.0, the actual torque available is determined by multiplying the specification torque available by the TR (example for TR = 0.98: 90% TRQ x 0.98 = 88.2% TRQ). The torque conversion chart (Figure 7A-3) is provided to convert specification data to actual torque available.

**7A.11.1 Torque Available - 2.5 Minutes.** Figure 7A-4 presents the specification torque available at 903°C TGT per engine for the 2.5-minute limit. Contingency (2.5 minute) power is automatically available when any one engine torque is less than 50% or when the pilot selects DEC LOCKOUT and manually maintains the 2.5-minute TGT limit.

**7A.11.2 Torque Available - 10 Minutes.** Figure 7A-4 presents the specification torque available per engine for the 10-minute limit. This is the maximum dual-engine torque available and is set by the TGT limiter in dual-engine operation. For one engine operation, the pilot must maintain the 10-minute TGT limit.

**7A.11.3 Torque Available - 30 Minutes.** Figure 7A-4 presents the specification torque available per engine for the 30-minute limit. The pilot must manually maintain the 30-minute TGT limit.

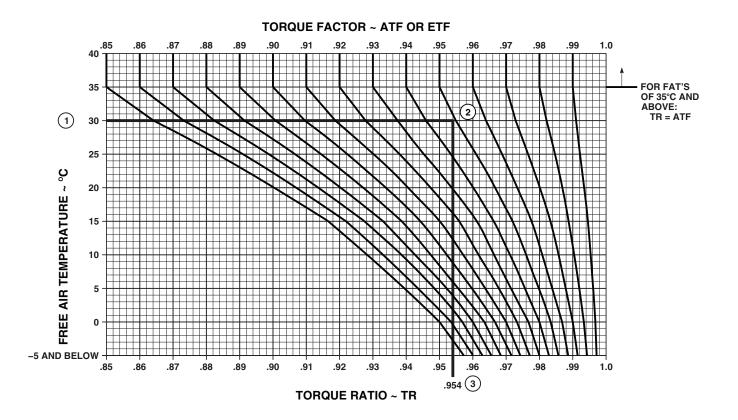
#### 7A.12 ENGINE BLEED AIR.

With engine bleed air on, the available torque per engine is reduced as follows:

a. Engine anti-ice on - 18% TRQ.

Example: 90% TRQ - 18% TRQ = 72% TRQ.

# **TORQUE FACTOR** T700-GE-701C OR T700-GE-701D/CC ENGINE 100% RPM R



#### WANTED:

TORQUE RATIO AND MAXIMUM TORQUE AVAILABLE -**10-MINUTE LIMIT** 

#### KNOWN:

ATF = .95 PRESSURE ALTITUDE = 6000 FT. FAT = 30°C

#### NOTE

EITHER OF THE TWO TORQUE AVAILABLE CHARTS MAY BE USED. MAXIMUM ALLOWABLE DUAL ENGINE TORQUE LIMITS SHALL NOT BE EXCEEDED.

**DATA BASIS:** CALCULATED

#### **EXAMPLE**

#### **METHOD:**

TO OBTAIN TORQUE RATIO:

- 1. ENTER TORQUE FACTOR CHART AT KNOWN FAT 2. MOVE RIGHT TO THE ATF VALUE 3. MOVE DOWN, READ TORQUE RATIO = .954.

TO DETERMINE SPECIFICATION TORQUE AVAILABLE – 10-MINUTE LIMITS:

- 4. ENTER MAXIMUM TORQUE AVAILABLE CHART AT
- KNOWN FAT (FIGURE 7A-4). 5. MOVE RIGHT TO KNOWN PRESSURE ALTITUDE
- 6. MOVE DOWN, READ SPECIFICATION TORQUE = 98%.

TO OBTAIN ACTUAL TORQUE VALUE AVAILABLE FROM THE TORQUE CONVERSION CHART:

- 7. ENTER TORQUE CONVERSION CHART FIGURE 7A-3 AT %
- TORQUE OBTAINED FROM FIGURE 7A-4. 8. MOVE UP TO TORQUE RATIO OBTAINED FROM FIGURE 7A-2 9. MOVE LEFT, READ MAXIMUM TORQUE AVAILABLE 10
- MINUTE LIMIT = 93% 10. ENTER DUAL-ENGINE TORQUE LIMIT CHART FIGURE 7A-5
- AT 30°C. MOVE RIGHT TO INTERSECTION AT 6,000 FT. PA. MOVE DOWN TO READ 90.4% TORQUE. AB3513

Figure 7A-2. Aircraft Torque Factor (ATF)

b. Cockpit/gunner heater on: Reduce torque available by 4% TRQ.

c. Cockpit/gunner heater and Option II cabin heater system on: Reduce torque available by 5.5% TRQ.

#### NOTE

Option II cabin heater system shuts off when anti-ice is turned on. Power to the heater returns when the anti-ice is turned off.

d. Anti-ice and cockpit/gunner heater on: Reduce torque available by 22%TRQ.

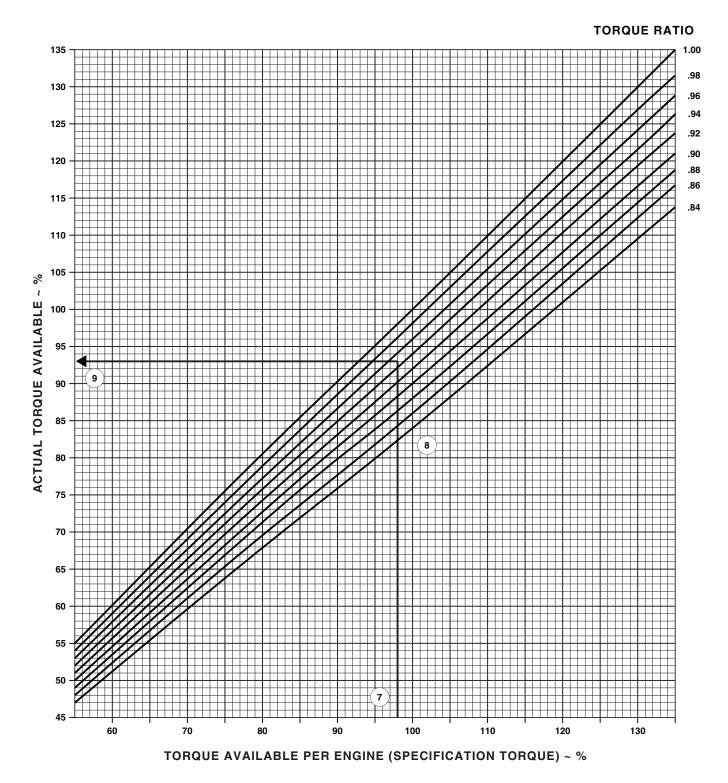
#### 7A.13 INFRARED SUPPRESSOR SYSTEM.

When the IR suppressor is OPERATING IN THE BENIGN MODE (exhaust baffles removed) the torque available is increased by approximately 1% TRQ.

#### 7A.14 DUAL-ENGINE TORQUE LIMITS.

Helicopters prior to S/N 91–26354 that are not equipped with improved main rotor flight controls are further restricted above 80 KIAS to dual-engine continuous torque limits as indicated by a placard on the instrument panel. Figure 7A-5 graphically presents the dualengine torque limits for use with the torque available charts.

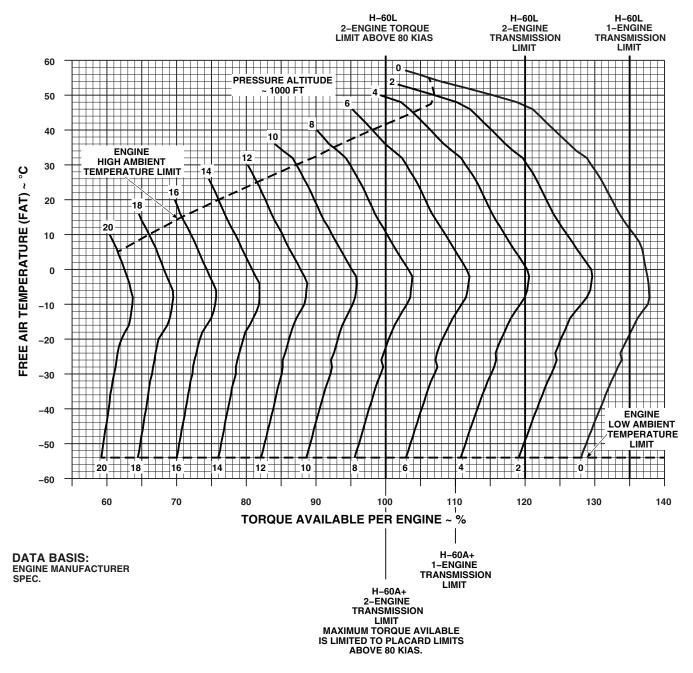
# **TORQUE CONVERSION**



AA1636A

Figure 7A-3. Torque Conversion Chart

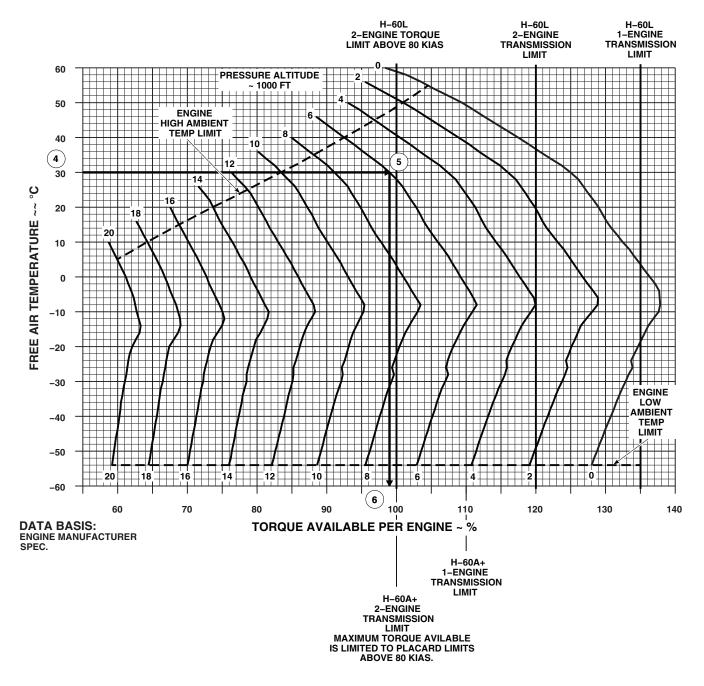
## MAXIMUM TORQUE AVAILABLE – 2.5–MINUTE LIMIT T700–GE–701C OR T700–GE–701D/CC HIRSS (BAFFLES INSTALLED) 100% RPM R BLEED AIR OFF ZERO AIRSPEED



AB3514_1A

Figure 7A-4. Maximum Torque Available (Sheet 1 of 3)

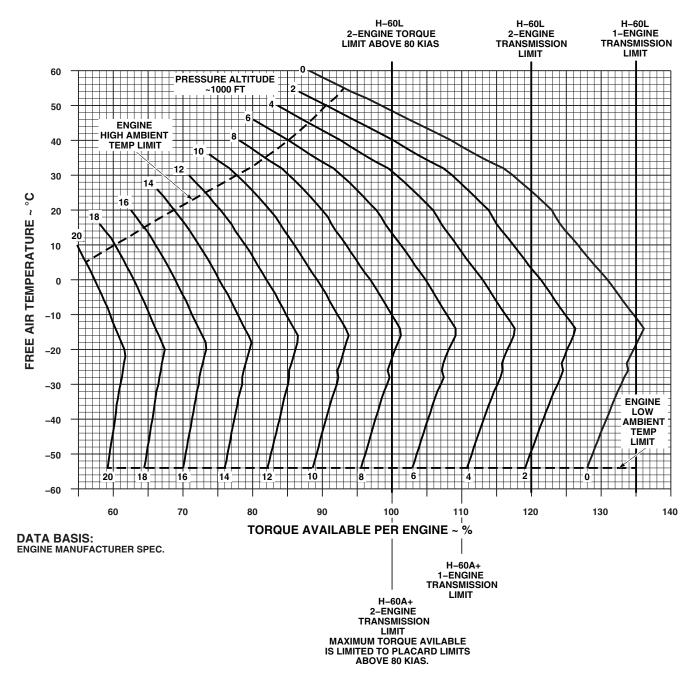
# MAXIMUM TORQUE AVAILABLE – 10–MINUTE LIMIT T700–GE–701C OR T700–GE–701D/CC HIRSS (BAFFLES INSTALLED) 100% RPM R BLEED AIR OFF ZERO AIRSPEED



AB3514_2A

Figure 7A-4. Maximum Torque Available (Sheet 2 of 3)

# MAXIMUM TORQUE AVAILABLE – 30-MINUTE LIMIT T700-GE-701C OR T700-GE-701D/CC HIRSS (BAFFLES INSTALLED) 100% RPM R BLEED AIR OFF ZERO AIRSPEED



AB3514_3A

Figure 7A-4. Maximum Torque Available (Sheet 3 of 3)

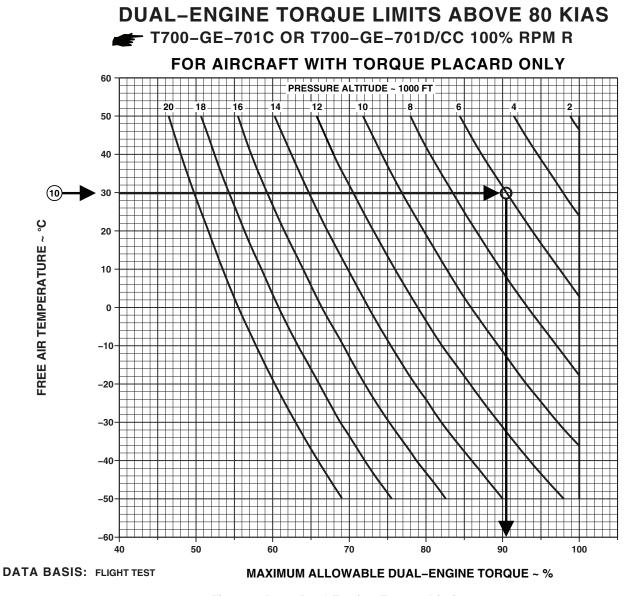


Figure 7A-5. Dual-Engine Torque Limit

AB3515

7A.15 HOVER CHART.

#### NOTE

For performance calculations with the volcano system installed, use the applicable high drag performance charts.

a. The primary use of the chart (Figures 7A-6 and 7A-7) is illustrated by EXAMPLE A. To determine the torque required to hover, it is necessary to know pressure altitude, FAT, gross weight, and desired wheel height. Enter the upper right grid at the known FAT, move right to the pressure altitude, move down to gross weight. For OGE hover, move left to torque per engine scale and read torque required. For IGE hover, move left to desired wheel height, deflect down and read torque required for dualengine or single-engine operation. The IGE wheel height lines represent a compromise for all possible gross weights and altitude conditions. A small torque error up to  $\pm 3\%$  torque may occur at extreme temperature and high altitude. This error is more evident at lower wheel heights.

b. In addition to the primary use, the hover chart may be used to predict maximum hover height. To determine maximum hover height, it is necessary to know pressure altitude, FAT, gross weight, and maximum torque available. Enter the known FAT, move right to the pressure altitude, move down to gross weight, move left to intersection with maximum torque available and read wheel height. This wheel height is the maximum hover height.

c. The hover chart may also be used to determine maximum gross weight for hover at a given wheel height,

pressure altitude, and temperature as illustrated in EXAMPLE B. Enter at known FAT, move right to the pressure altitude, then move down and establish a vertical line on the lower grid. Now enter lower left grid at maximum torque available. Move up to wheel height, then move right to intersect vertical line from pressure altitude/ FAT intersection. Interpolate from gross weight lines to read maximum gross weight at which the helicopter will hover.

#### 7A.16 EFFECTS OF BLADE EROSION KIT.

With the blade erosion kit installed, it will be necessary to make the following corrections. Multiply the torque required to hover determined from the charts by 1.02. (Example: If indicated torque is 90%, multiply 90 x 1.02 = 91.8% actual torque required.) Multiply the maximum gross weight to hover obtained from the charts by 0.98. (Example: If gross weight is 22,000 lbs, multiply by 0.98 = 21,560 lbs actual gross weight to hover.) When determining maximum hover wheel height, enter the chart at 1.02 x gross weight. (Example: If gross weight is 20,000 lbs, multiply 20,000 x 1.02 = 20,400 lbs).

# 7A.17 EFFECTS OF ADDITIONAL INSTALLED EQUIPMENT

To determine maximum gross weight to hover, multiply the maximum gross weight to hover obtained from the applicable chart by 0.995. (Example: If gross weight obtained from chart is 22,000 lbs, multiply 22,000 x 0.995 = 21,890 lbs actual maximum gross weight to hover). For maximum hover height or torque required to hover, enter the applicable chart at 1.005 x actual gross weight. (Example: If actual gross weight is 20,000 lbs, multiply 20,000 x 1.005 = 20,100 lbs).

#### EXAMPLE A

#### WANTED:

#### TORQUE REQUIRED TO HOVER OGE AND AT A 10-FOOT WHEEL HEIGHT

#### KNOWN:

FAT = 30°C PRESSURE ALTITUDE = 3,000 FEET GROSS WEIGHT = 19,500 POUNDS

#### METHOD:

ENTER HOVER CHART AT KNOWN FAT. MOVE RIGHT TO PRESSURE ALTITUDE, MOVE DOWN THROUGH GROSS WEIGHT LINES TO DESIRED GROSS WEIGHT. MOVE LEFT TO INDICATE TORQUE/ENGINE % (OGE) SCALE AND READ OGE HOVER TORQUE (95%). MOVE DOWN FROM INTERSECTION OF 10-FOOT HOVER LINE AND HORIZONTAL LINE TO READ TORQUE REQUIRED TO HOVER 10 FEET (80%).

#### **EXAMPLE B**

WANTED:

MAXIMUM GROSS WEIGHT TO HOVER OGE

KNOWN:

ATF = 1.0 FAT = 20°C PRESSURE ALTITUDE = 5,000 FEET MAXIMUM TORQUE AVAILABLE = 107%

#### METHOD:

ENTER INDICATED TORQUE/ENGINE (IGE) SCALE AT MAXIMUM TORQUE AVAILABLE (107%), MOVE UP TO OGE LINE. ENTER CHART AT KNOWN FAT (20°C). MOVE RIGHT TO PRESSURE ALTITUDE LINE. MOVE DOWN FROM PRESSURE ALTITUDE LINE AND MOVE RIGHT FROM OGE LINE. WHERE LINES INTERSECT, READ MAXIMUM GROSS WEIGHT TO HOVER OGE (20,500 lbs).

Figure 7A-6. Hover - Clean (Sheet 1 of 2)

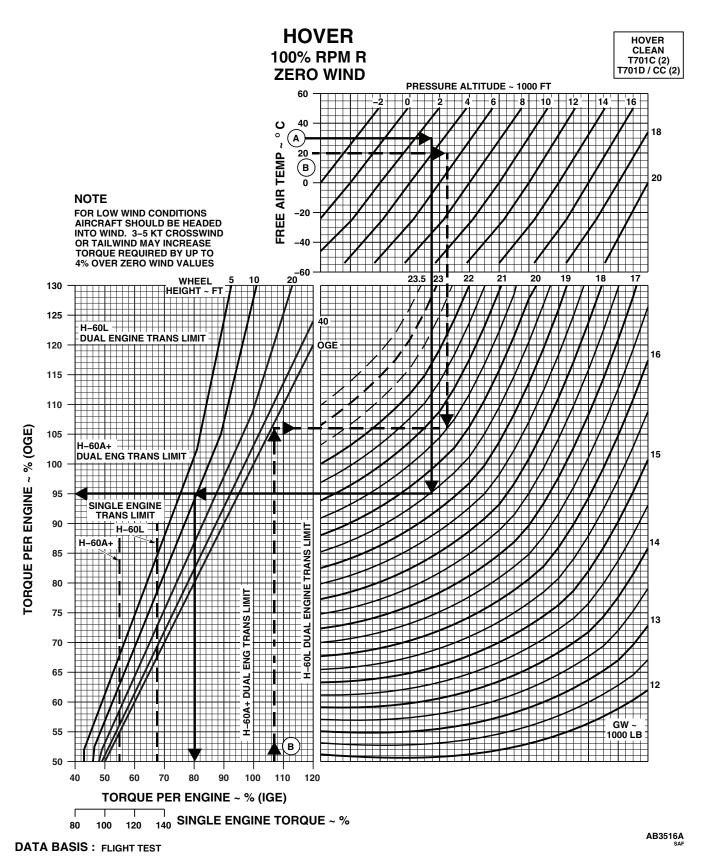


Figure 7A-6. Hover - Clean (Sheet 2 of 2)

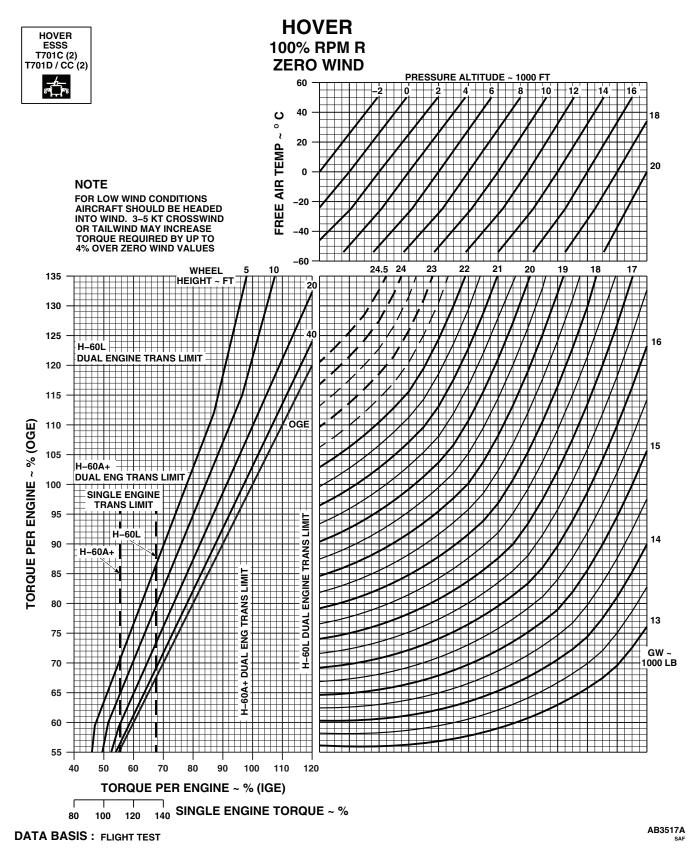


Figure 7A-7. Hover - High Drag

## Section IV CRUISE

#### 7A.18 DESCRIPTION.

The cruise charts (Figures 7A-8 through 7A-30) present torque required and total fuel flow as a function of airspeed, altitude, temperature, and gross weight at 100% rotor speed. Scales for both true airspeed and indicated airspeed are presented. The baseline aircraft configurations for these charts are "clean and high drag" configuration as defined in Section I. Each cruise chart also presents the change in torque (  $\Delta$  TRQ) required for 10 sq. ft. of additional flat plate drag with a dashed line on a separate scale. This line is utilized to correct torque required for external loads as discussed in Section VI DRAG. Maximum level flight airspeed (Vh) is obtained at the intersection of gross weight arc and torque available -10 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. Cruise charts are provided from sea level to 20,000 feet pressure altitude in units of 2,000 feet. Each figure number represents a different altitude. The charts provide cruise data for FATs from -50° to +60°C, in units of 10°. Charts with FATs that exceed the engine ambient temperature limits by more than 10°C are deleted.Data for gross weights above 22,000 lbs are shown as dashed lines. These lines should be utilized for external load missions only on the clean cruise charts, and for external load and ferry mission only on the high drag charts.

#### 7A.19 USE OF CHARTS.

The primary uses of the charts are illustrated by the examples of Figure 7A-8. To use the charts, it is usually necessary to know the planned pressure altitude, estimated free air temperature, planned cruise speed, true airspeed (TAS), and gross weight. First, select the proper chart on the basis of pressure altitude and FAT. Enter the chart at the cruise airspeed, indicated airspeed (IAS), move horizontal and read TAS, move horizontal to the gross weight, move down and read torque required, and then move up and read associated fuel flow. Maximum performance conditions are determined by entering the chart where the maximum range line or the maximum endurance and rate of climb line 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 FAT or, more conservatively, by selecting the chart with the next higher altitude and FAT. 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, however, it is preferable to determine cruise information for several flight segments to allow for the decreasing gross weight.

a. 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 (or vice versa) by reading directly across the chart without regard for the other chart information.

b. Torque. Since pressure altitude and temperature are fixed for each chart, torque available varies with airspeed, and torque required varies with airspeed, gross weight, and drag. The torque and torque limits shown on these charts are for dual-engine operation. The maximum torque available is presented on each chart as either the transmission continuous torque limit or engine torque available - 10minute. The maximum torque available - 10-minute, maximum torque available - 30-minute, and maximum continuous power (MCP) are presented on each chart for an ATF of 1.0 as a solid line originating from the torque per engine scale and continuing vertically. The maximum torque available - 10-minute, maximum torque available -30-minute, and MCP for aircraft with an ATF value of 0.9 may be derived starting at the ATF = 0.9 reference mark at the bottom of the chart, continuing vertically and paralleling the respective torque available line. The maximum torque available for aircraft with an ATF value between 1.0 and 0.9 must be interpolated by entering the chart at the required airspeed and intersecting the point between the 0.9 ATF and the applicable maximum torque available - 10-minute, maximum torque available - 30-minute, or MCP solid line at the known ATF (Figure 7A-8). The dual-engine torque limit placard value is presented below the torque scale of each chart when applicable. Higher torque than that represented by these lines may be used if it is available without exceeding the limitations presented in Chapter 5. An increase or decrease in torque required as a result of a drag area change is described in 7A.19f.

c. 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 in this section is for two-engine operation. For one-engine fuel flow, refer to paragraph 7A.20 or Section VIII FUEL FLOW.

(1) With bleed-air extracted, fuel flow increases:

(a) Engine anti-ice on - About 100 lbs/hr. Example: (760 lbs/hr + 100 lbs/hr= 860 lbs/hr).

(b) Cockpit/gunner heater on - About 12 lbs/hr.

(c) Cockpit/gunner heater and Option II cabin heater system on - About 20 lbs/hr.

#### NOTE

Option II cabin heater system shuts off when anti-ice is turned on. Power to the heater returns when the anti-ice is turned off.

(d) Anti-ice and cockpit/gunner heater on - About 112 lbs/hr.

(2) When the hover IR suppressor system is operating in the benign mode (exhaust baffles removed), the dualengine fuel flow will decrease about 14 lbs/hr.

d. Maximum Range. The maximum range lines (MAX 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 line is above the maximum torque available, the resulting maximum airspeed should be used for maximum range. A method of estimating maximum range speed in winds is to increase IAS by 2.5 knots per each 10 knots of effective headwind (which reduces flight time and minimizes loss in range) and decrease IAS by 2.5 knots per 10 knots of effective tailwind for economy.

e. 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).

f. Change in Frontal Area. Since the cruise information is given for the "clean and high drag configuration," adjustments to torque should be made when operating with external sling loads or aircraft external configuration changes. To determine the change in torque, first obtain the appropriate multiplying factor from the load drag chart (Figure 7A-33 or Table 7A-1), then enter the cruise chart at the planned cruise speed TAS, move right to the broken  $\Delta$  TRQ line, and move up and read  $\Delta$  TRQ. Multiply  $\Delta$ TRQ by the multiplying factor to obtain change in torque, then add or subtract change in torque from torque required for the primary mission configuration. Enter the cruise chart at resulting torque required, move up, and read fuel

flow. If the resulting torque required exceeds the governing torque limit, the torque required must be reduced to the limit. The resulting reduction in airspeed may be found by subtracting the change in torque from the limit torque; then enter the cruise chart at the reduced torque, and move up to the gross weight. Move left or right to read TAS or IAS. If the reduced torque does not intersect with the gross weight, then as a general rule: for every 10 square foot increase in drag (  $\Delta$  F), reduce the cruise chart Vh airspeed value by the following amounts: 0 to 40  $\Delta$  F reduce 6 KIAS; 60  $\Delta$  F reduce 5 KIAS;120  $\Delta$  F reduce 4 KIAS; 180 to 240  $\Delta$  F reduce 3 KIAS. For example, with a box in net with 100 ft² frontal area  $\Delta F = 228$  ft² reduce Vh by approximately 68 kts (3 kts/10  $\text{ft}^2$  x 228  $\text{ft}^2$  = 68 kts). The engine torque setting for maximum range obtained from the clean configuration cruise chart will generally result in cruise at best range airspeed for the higher drag configuration. To determine the approximate airspeed for maximum range for alternative or external load configurations, reduce the value from the cruise chart by 6 knots for each 10 square foot increase in drag area,  $\Delta$  F. For example, if both cabin doors are open the  $\Delta$  F increases 6  $ft^2$  and the maximum range airspeed would be reduced by approximately 4 knots (6 Kts/10  $\text{ft}^2$ x6  $\text{ft}^2$  = 3.6 Kts). For drag values greater than 30 square feet, use the following data: 0 to 30  $\Delta$  F reduce 6 KIAS; 60  $\Delta$  F reduce 4 KIAS; 120  $\Delta$  F reduce 3 KIAS; 240  $\Delta$  F reduce 2 KIAS.

g. Additional Uses. The low-speed end of the cruise chart (below 40 knots) is shown primarily to familiarize you with the low speed power requirements of the helicopter. It shows the power margin available for climb or acceleration during maneuvers, such as NOE 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 out of ground effect.

#### 7A.20 SINGLE-ENGINE.

a. The maximum single-engine torque available is presented on each chart as an SE  $\sim 2.5$  MIN line at half the actual maximum torque available for an ETF of 1.0 as a solid line originating from the torque per engine scale and continuing vertically. The maximum single-engine torque available for engines with an ETF of 0.85 may be derived by starting at the ETF = 0.85 reference mark at the bottom of the chart, continuing vertically and paralleling the SE  $\sim 2.5$  MIN torque available line. The maximum torque available for engines with an ETF value between 1.0 and 0.85 must be interpolated.

b. Select the cruise chart for the desired flight condition and enter the torque scale at the appropriate ETF. Move up to the intersection of torque available and the mission gross weight arc, and read across for minimum singleengine airspeed. Move up to the second intersection of torque and the mission gross weight arc, and read across to determine the maximum single-engine airspeed. If no intersections occur, there is no single-engine level flight capability for the conditions. Single-engine fuel flow at the desired 10-minute, 30-minute, and continuous conditions may be obtained by doubling the torque required from the cruise chart and referring to Figure 7A-37.

# **CRUISE EXAMPLE** CLEAN CONFIGURATION

100% RPM R

KTS

ł

AIRSPEED

RUE /

FAT: 30 °C ALT: 6000 FT TOTAL FUEL FLOW 100 LB/HR

## EXAMPLE

### WANTED

- A. CRUISE CONDITIONS FOR MAXIMUM RANGE
- B. CONDITIONS FOR MAXIMUM ENDURANCE C. MAXIMUM AIRSPEED IN LEVEL FLIGHT
- D. DETERMINE TORQUE AND FUEL FLIGHT
- D. DETERMINE TORQUE AND FUEL FLOW REQUIRED TO CRUISE WITH CARGO DOORS OPEN

#### KNOWN

FAT = 30 °C PRESSURE ALTITUDE = 6000 FT GW = 19,000 LBS ATF = 0.95 TORQUE PLACARD LIMITS NOT APPLICABLE

#### METHOD

- A. TURN TO CRUISE CHARTS NEAREST KNOWN FLIGHT CONDITIONS, AT INTERSECTION OF MAX RANGE LINE AND KNOWN VALUE OF GROSS WEIGHT: MOVE LEFT, READ TAS = 133 KTS MOVE RIGHT, READ IAS = 117 KTS MOVE DOWN, READ TORQUE = 68% TRQ MOVE UP, READ TOTAL FUEL FLOW = 1020 LBS / HR
- B. AT INTERSECTION OF MAX END AND R / C LINE AND KNOWN VALUE OF GROSS WEIGHT: MOVE LEFT, READ TAS = 85 KTS MOVE RIGHT, READ IAS = 69 KTS MOVE DOWN, READ TORQUE = 46% TRQ MOVE UP, READ TOTAL FUEL FLOW = 800 LBS / HR
- C. ENTER THE TORQUE PER ENGINE SCALE HALF WAY BETWEEN THE 10 MIN TORQUE AVAILABLE LINE AND THE ATF=.9 (10 MIN) TICK MARK. MOVE UP PARALLEL TO THE 10 MIN LINE UP UNTIL INTERSECTING 19,000 LB GW: MOVE LEFT, READ MAXIMUM TAS = 153 KTS MOVE RIGHT, READ MAXIMUM IAS = 135 KTS MOVE RIGHT, READ MAXIMUM TORQUE = 98% TRQ MOVE UP, READ TOTAL FUEL FLOW = 1365 LBS / HR
- D. ENTER  $\triangle$  TRQ% PER 10 SQ FT SCALE AT 133 KTAS MOVE UP READ  $\triangle$  TRQ = 8.0% TURN TO DRAG TABLE IN SECTION VII NOTE CARGO DOORS OPEN = 6.0 SQ FT $\triangle$  F AND HAS A DRAG MULTIPLYING FACTOR VALUE OF 0.60, CALCULATE TOTAL TORQUE REQUIRED USING THE CONDITIONS OF EXAMPLE A: 68% + (0.6 X 8.0%) = 72.8% TOTAL TORQUE READ FUEL FLOW AT TOTAL TORQUE = 1070 LBS / HR

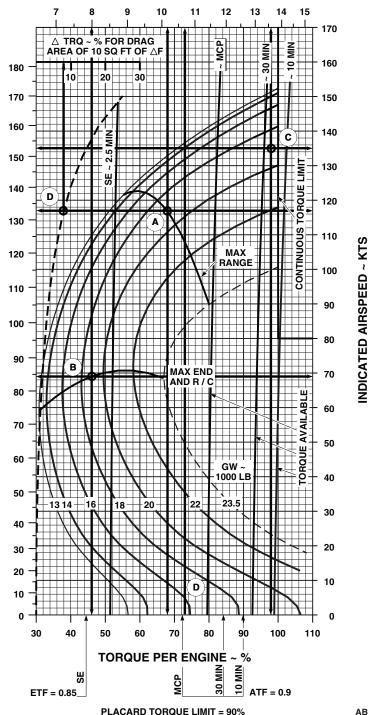
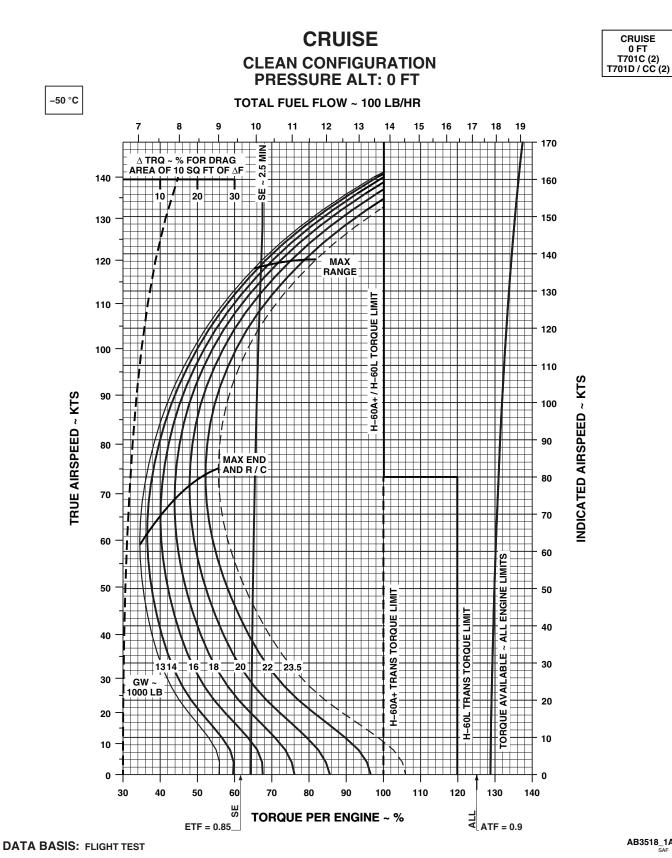
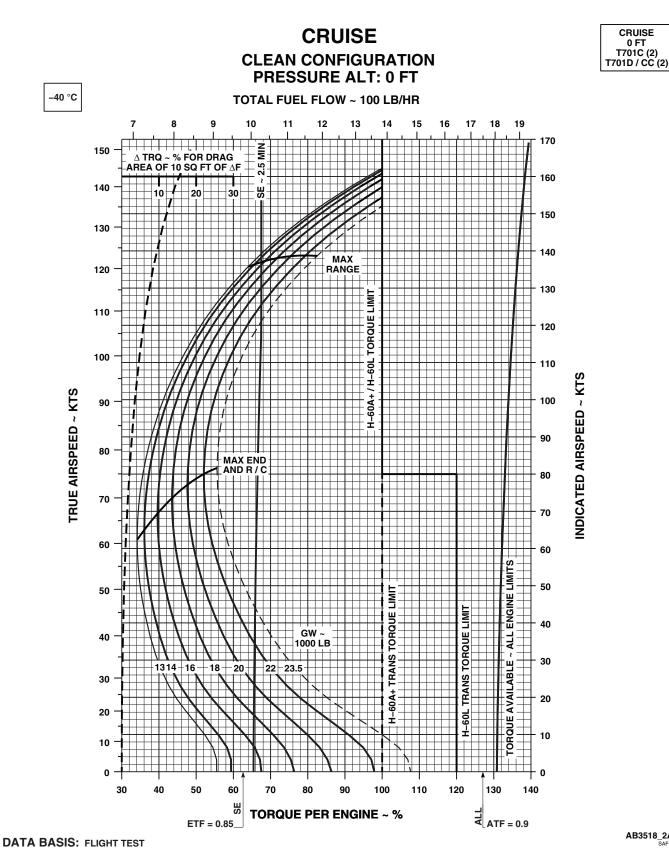


Figure 7A-8. Sample Cruise Chart



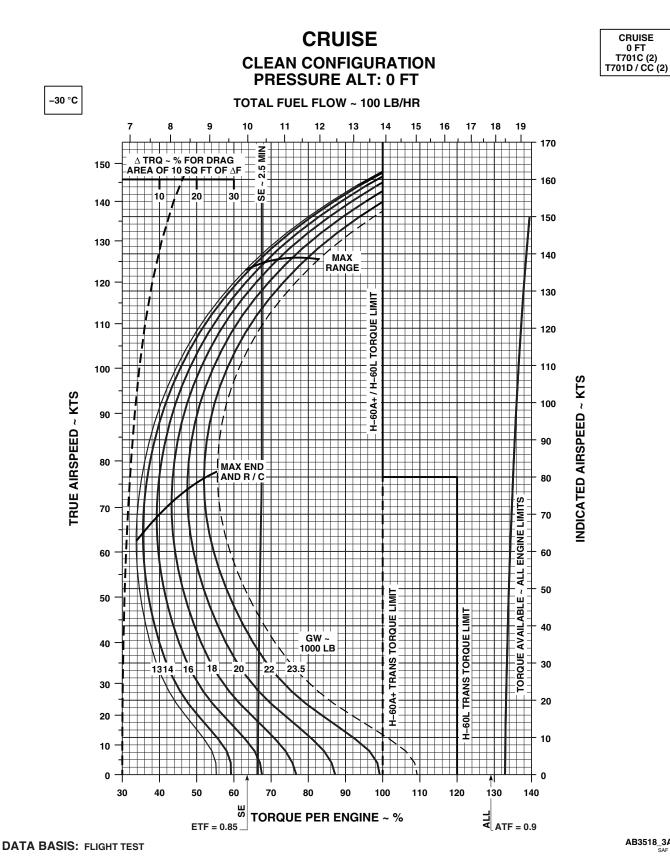
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Figure 7A-9. Cruise - Altitude Sea Level (Sheet 1 of 12)



AB3518_2A

Figure 7A-9. Cruise - Altitude Sea Level (Sheet 2 of 12)



AB3518_3A

Figure 7A-9. Cruise - Altitude Sea Level (Sheet 3 of 12)

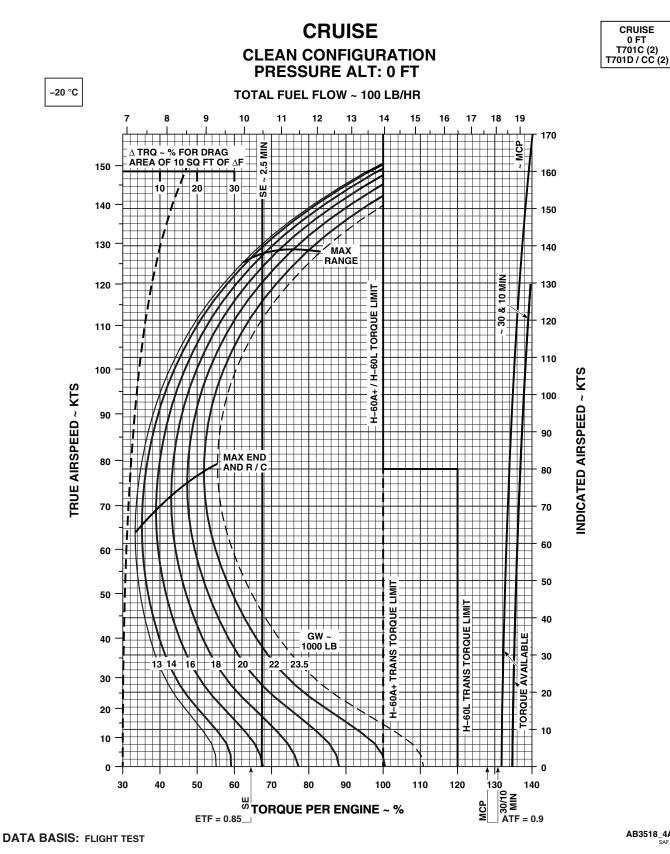
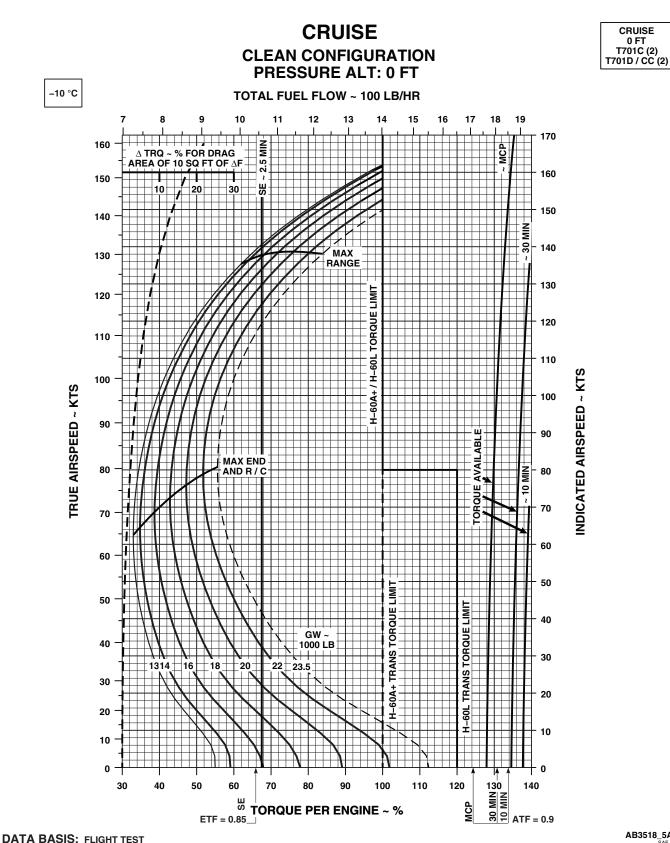


Figure 7A-9. Cruise - Altitude Sea Level (Sheet 4 of 12)



AB3518_5A

Figure 7A-9. Cruise - Altitude Sea Level (Sheet 5 of 12)

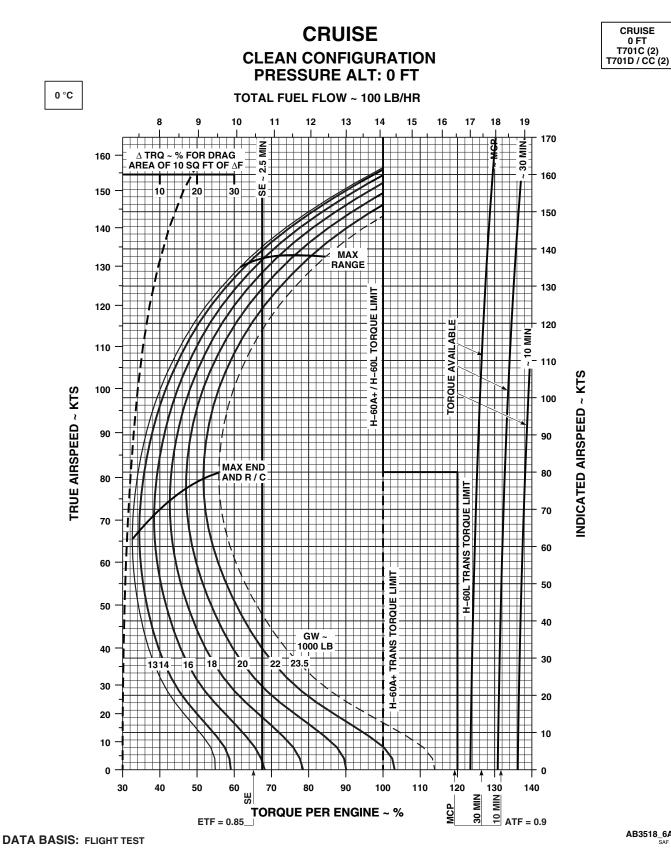
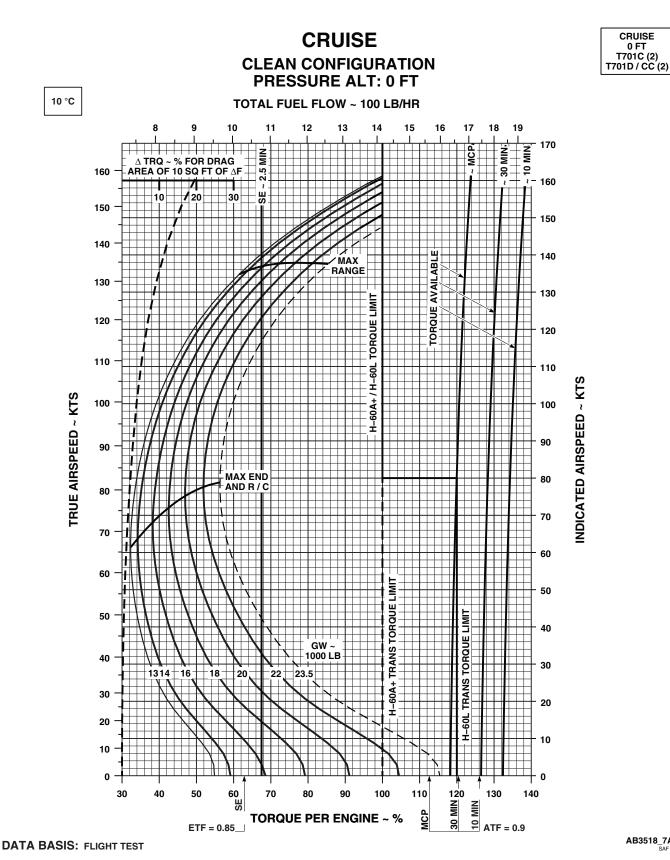


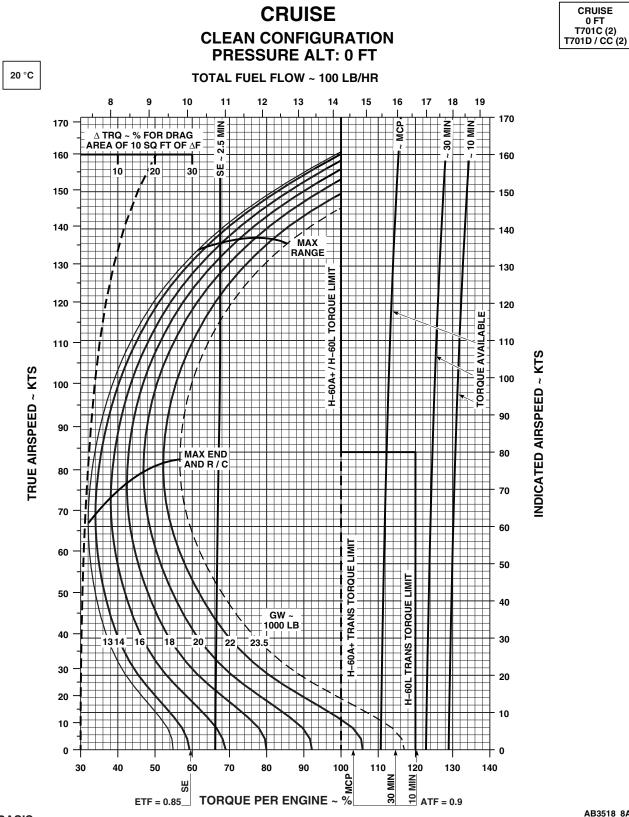
Figure 7A-9. Cruise - Altitude Sea Level (Sheet 6 of 12)

AB3518_6A



AB3518_7A

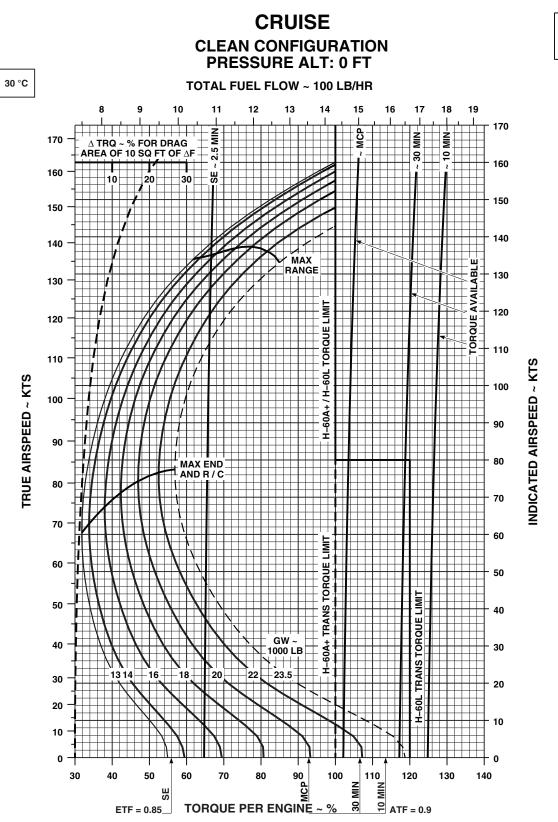
Figure 7A-9. Cruise - Altitude Sea Level (Sheet 7 of 12)



**DATA BASIS:** FLIGHT TEST

Figure 7A-9. Cruise - Altitude Sea Level (Sheet 8 of 12)

AB3518_8A



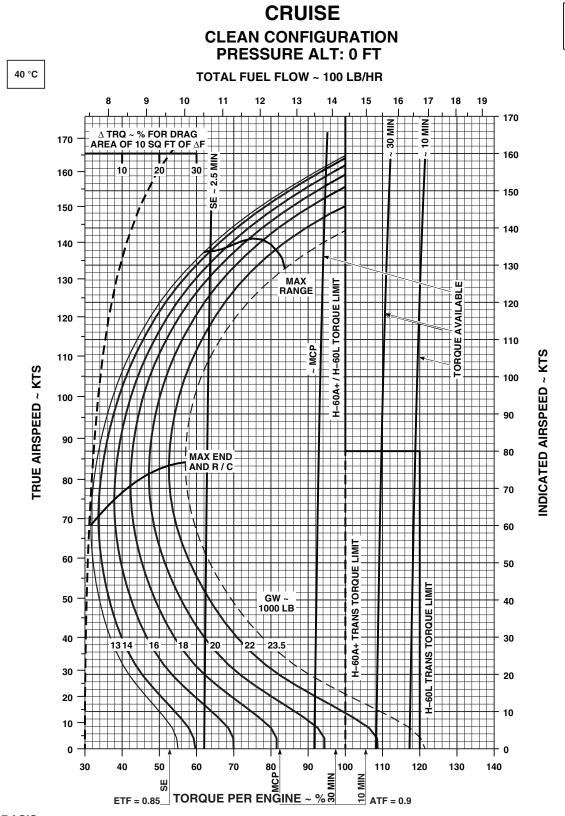
CRUISE 0 FT T701C (2) T701D / CC (2)

AB3518_9A

DATA BASIS: FLIGHT TEST

Figure 7A-9. Cruise - Altitude Sea Level (Sheet 9 of 12)

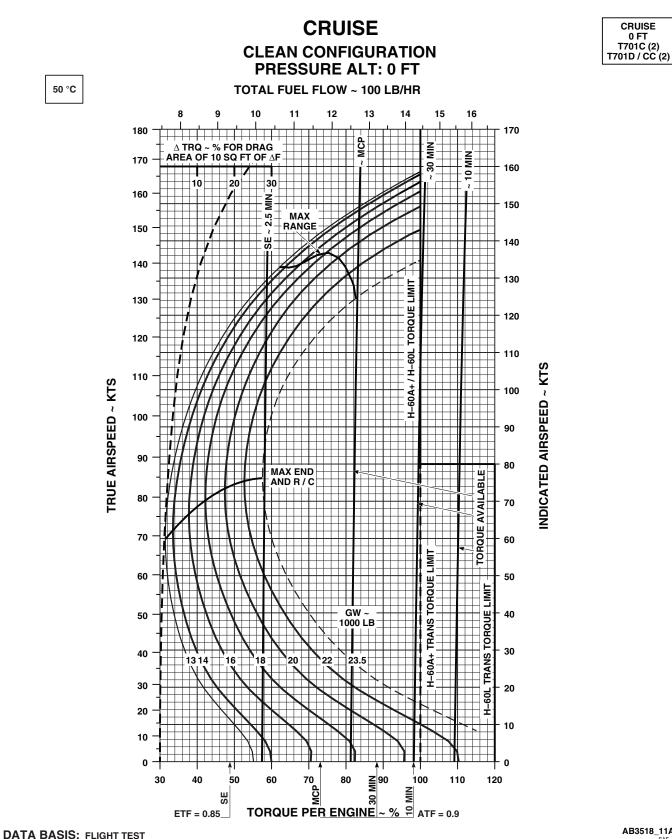
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DATA BASIS: FLIGHT TEST

Figure 7A-9. Cruise - Altitude Sea Level (Sheet 10 of 12)

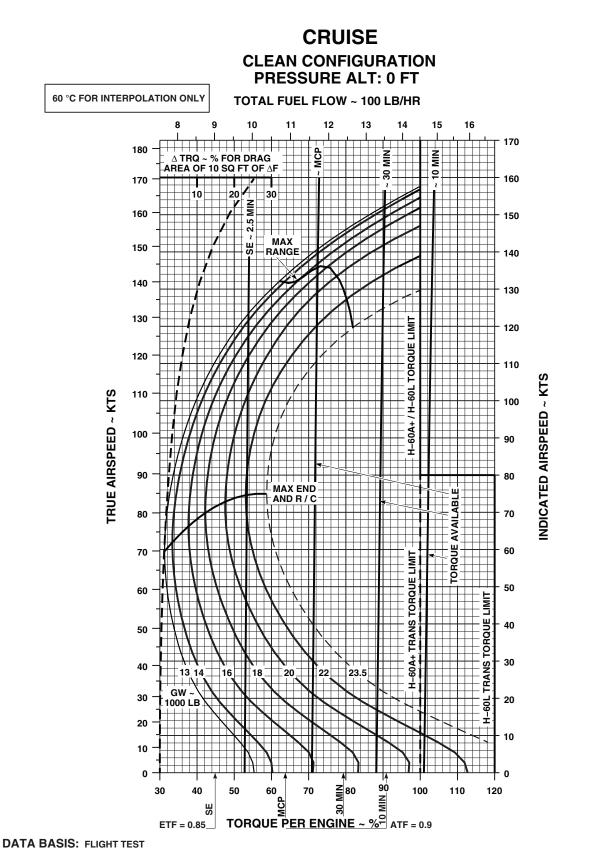
AB3518_10A



AB3518_11A

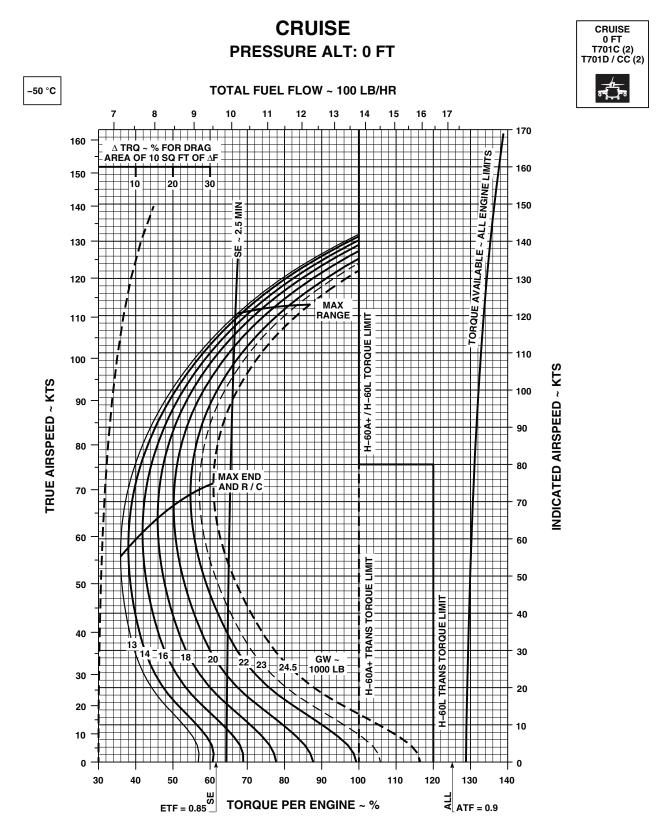
Figure 7A-9. Cruise - Altitude Sea Level (Sheet 11 of 12)

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AB3518_12A

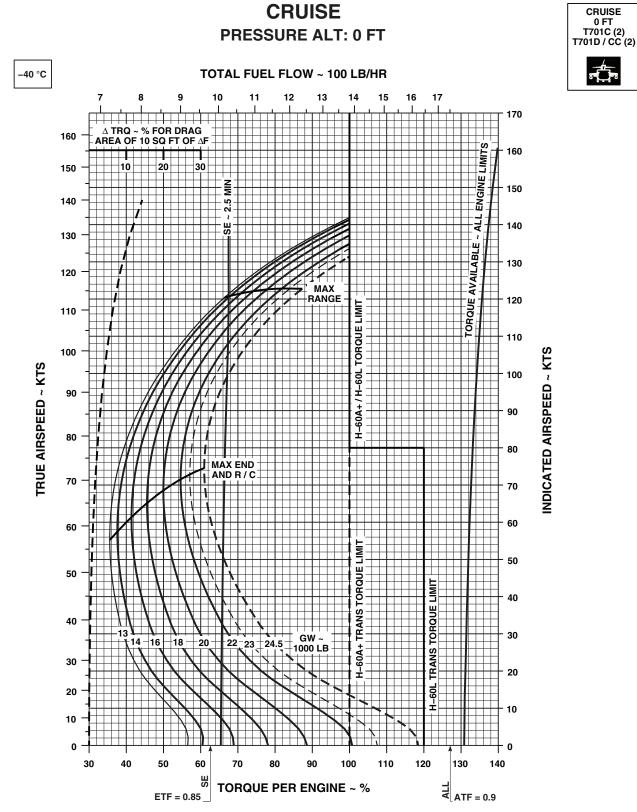
Figure 7A-9. Cruise - Altitude Sea Level (Sheet 12 of 12)



DATA BASIS: FLIGHT TEST

Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 1 of 12)

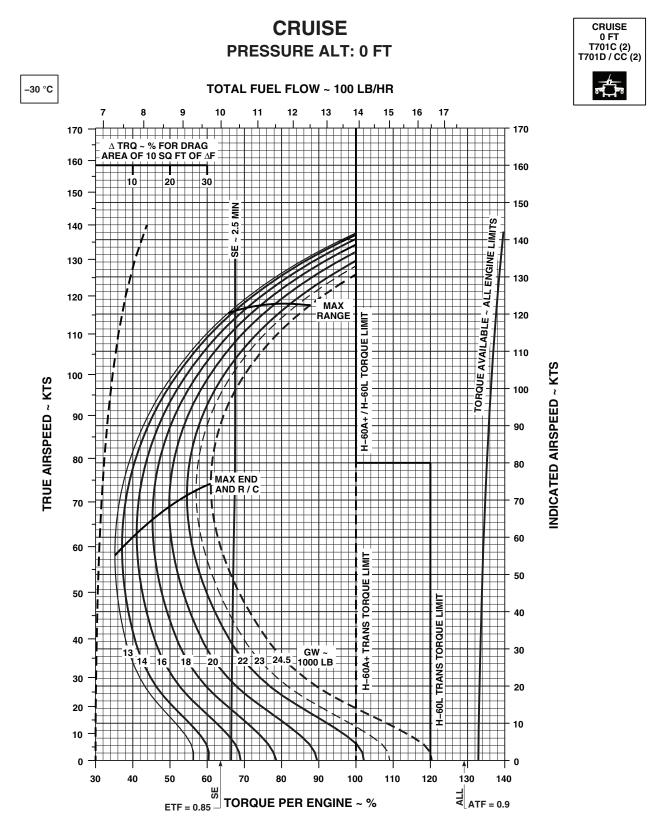
AB3519_1A



DATA BASIS: FLIGHT TEST

Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 2 of 12)

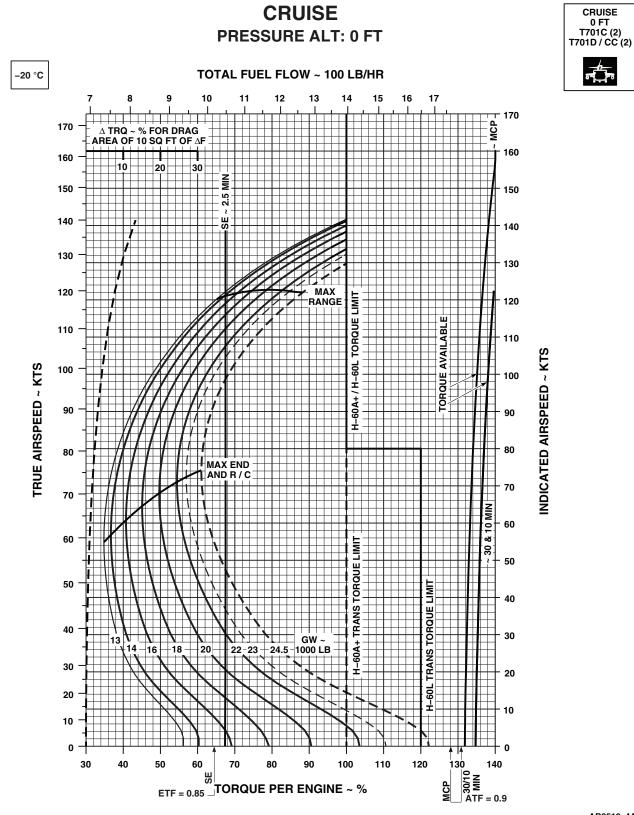




DATA BASIS: FLIGHT TEST

Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 3 of 12)

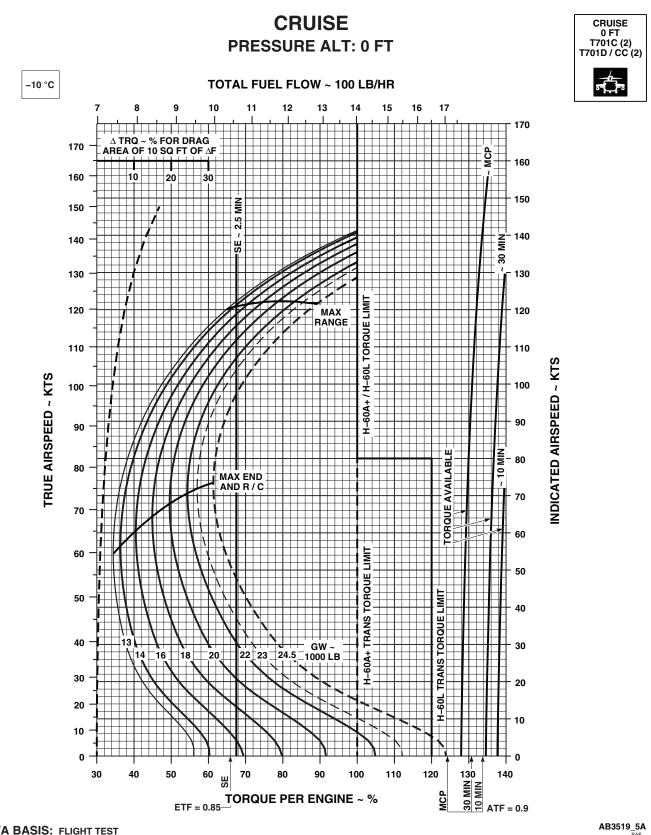
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DATA BASIS: FLIGHT TEST

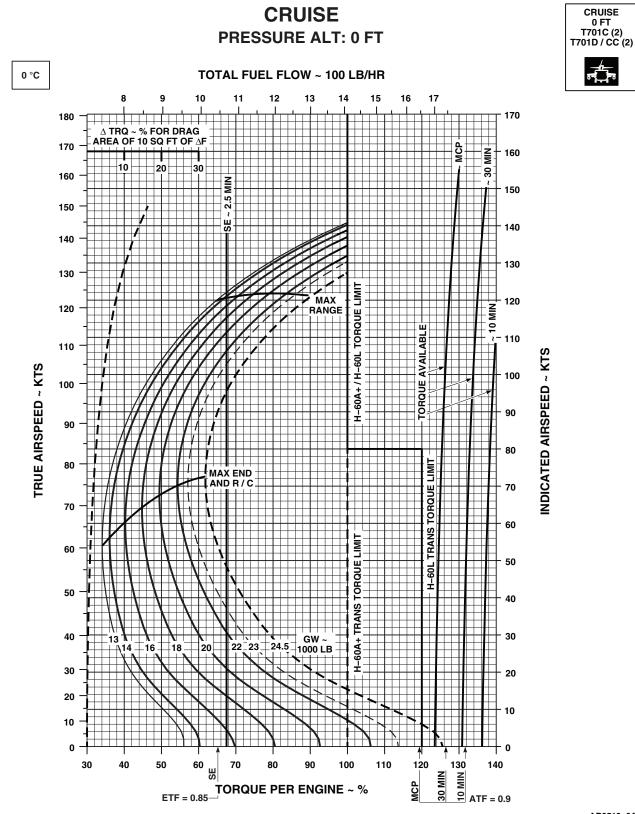
Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 4 of 12)

AB3519_4A



**DATA BASIS:** FLIGHT TEST

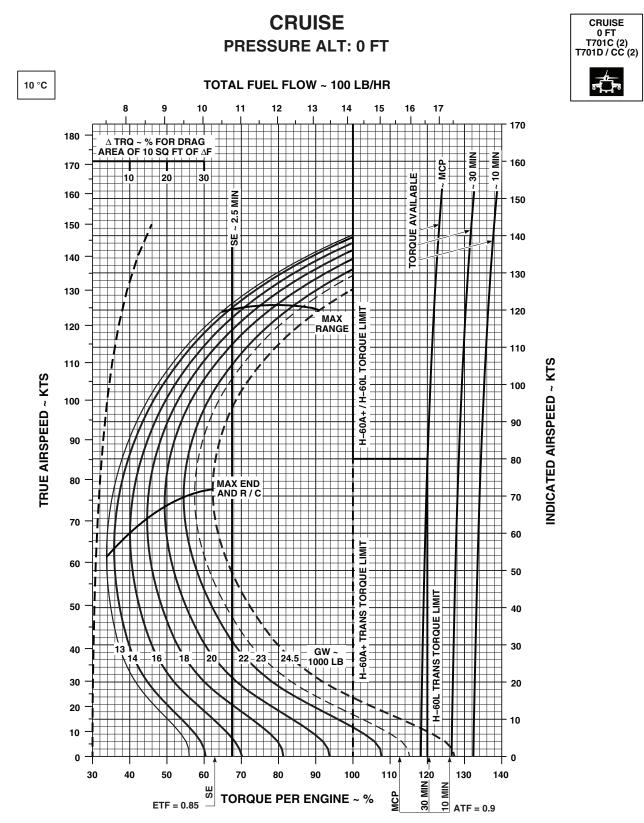
Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 5 of 12)



DATA BASIS: FLIGHT TEST

Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 6 of 12)

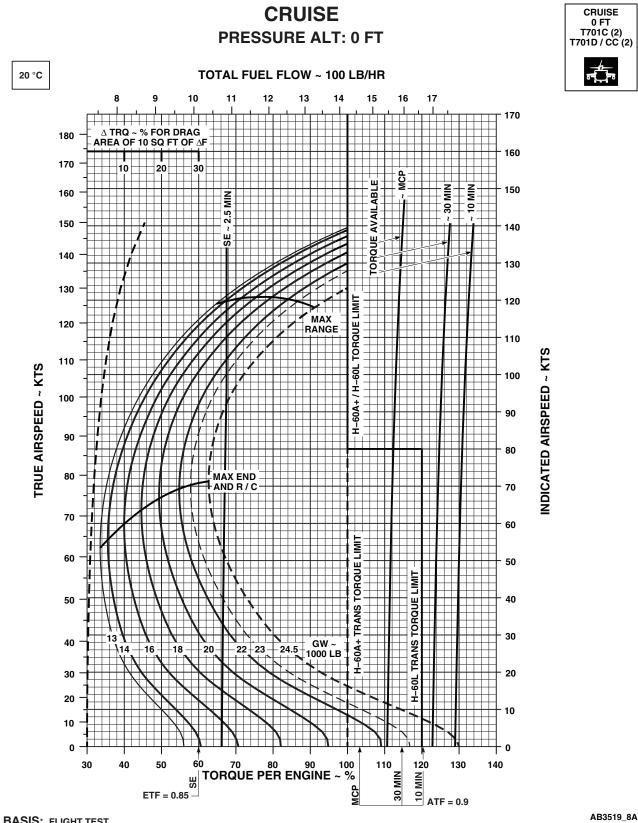
AB3519_6A



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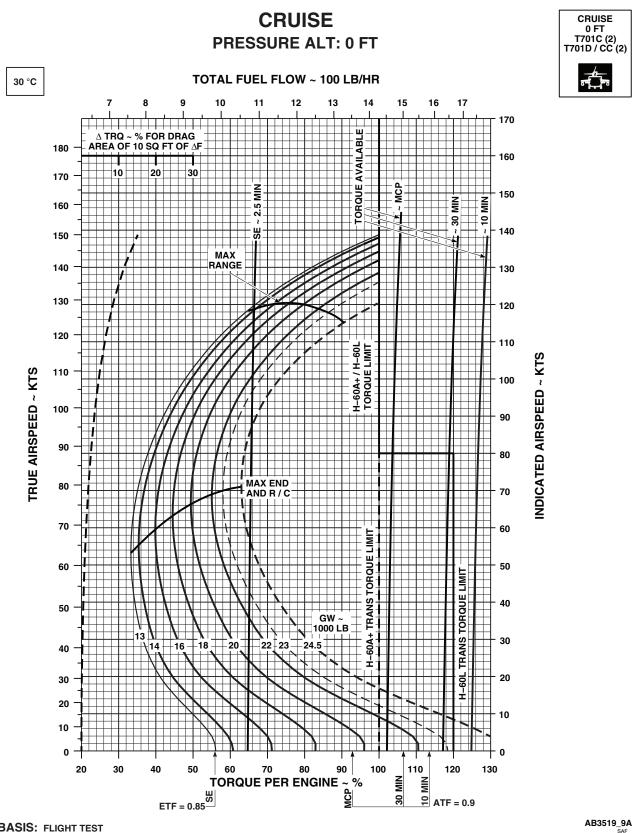
Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 7 of 12)

AB3519_7A



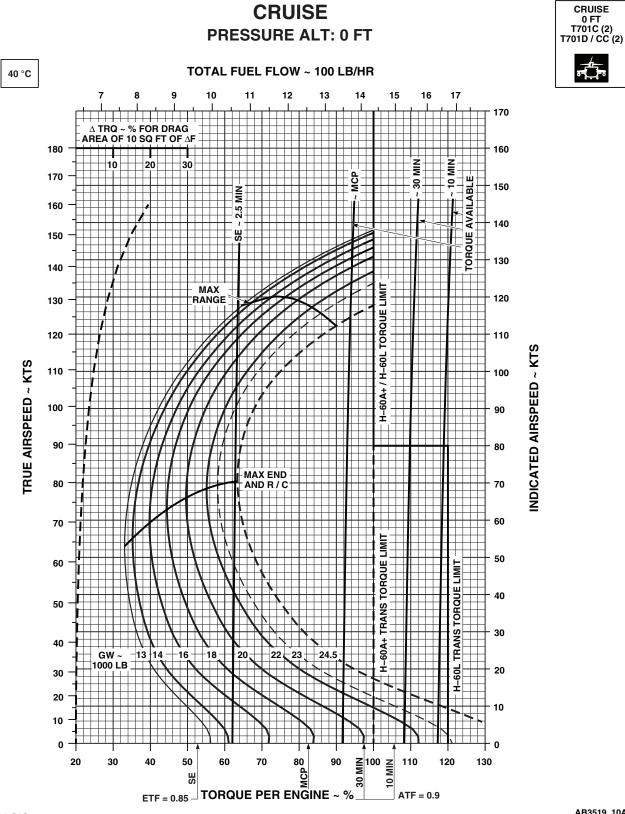
**DATA BASIS:** FLIGHT TEST

Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 8 of 12)



**DATA BASIS:** FLIGHT TEST

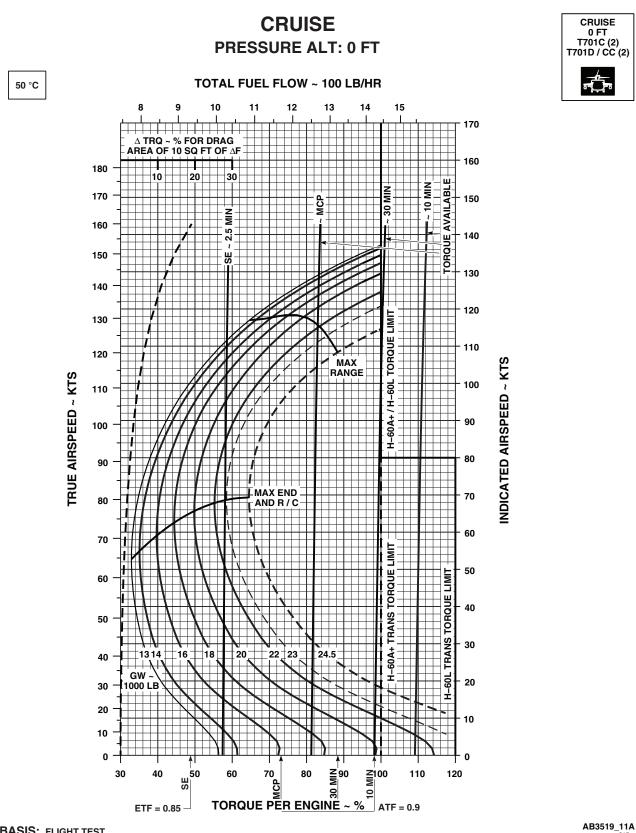
Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 9 of 12)



**DATA BASIS:** FLIGHT TEST

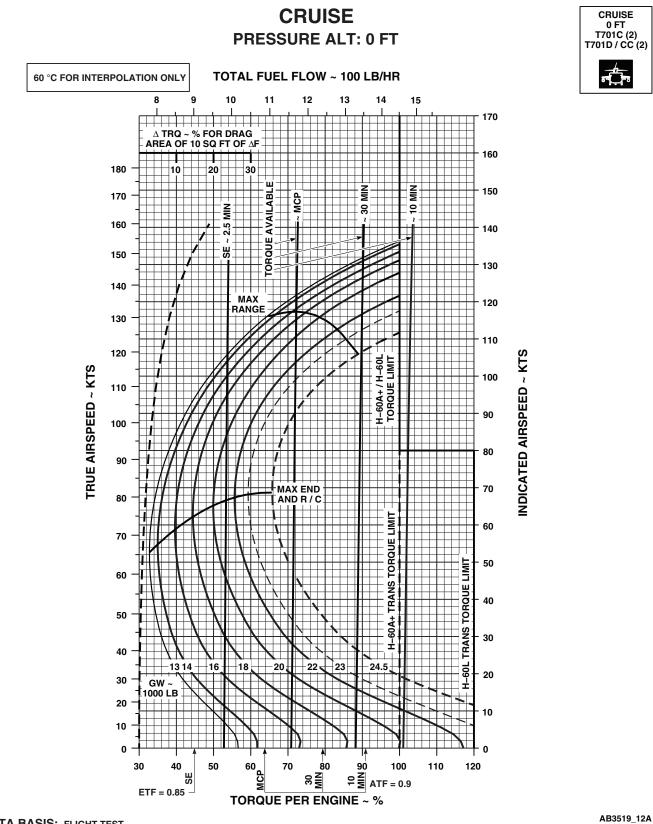
Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 10 of 12)

AB3519_10A



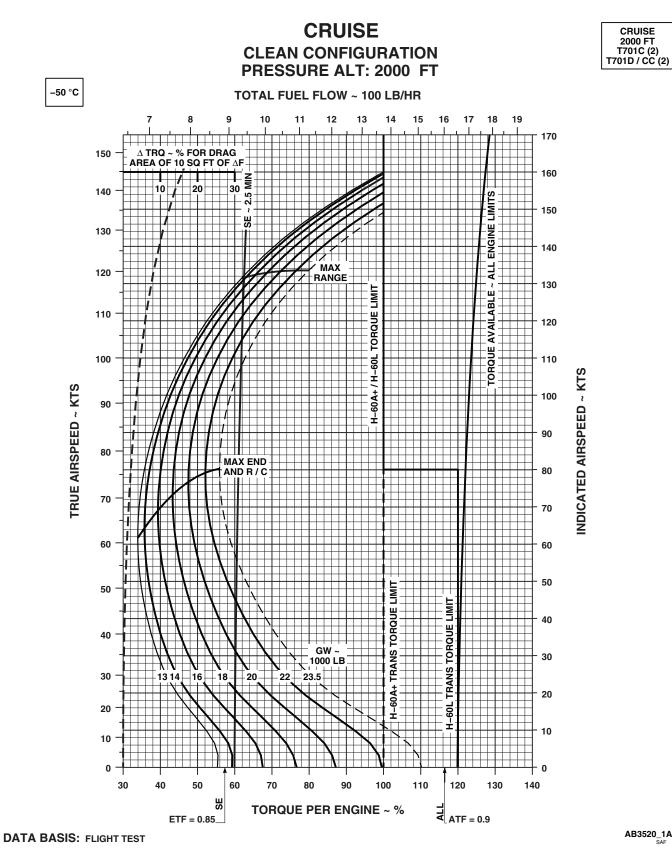
**DATA BASIS:** FLIGHT TEST

Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 11 of 12)



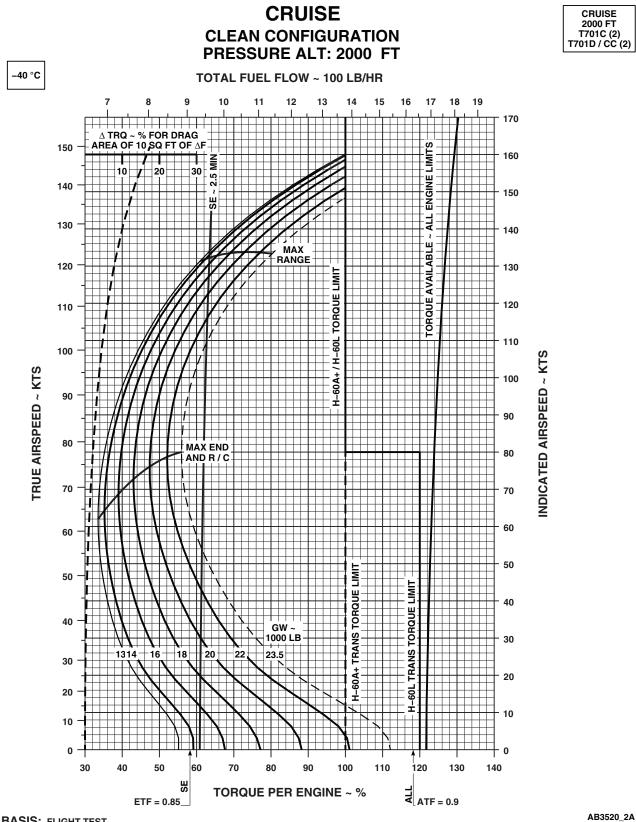
DATA BASIS: FLIGHT TEST

Figure 7A-10. Cruise High Drag - Altitude Sea Level (Sheet 12 of 12)



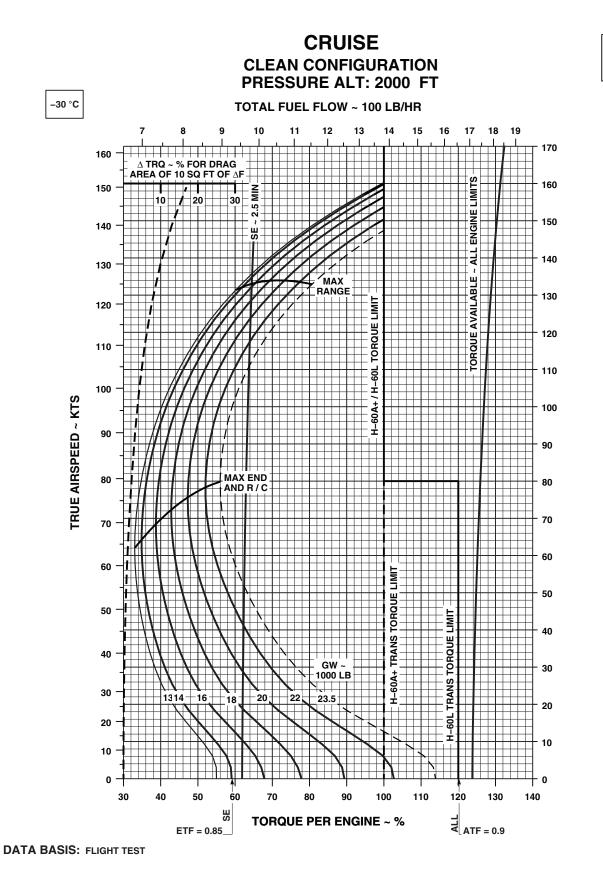
AB3520_1A

Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 1 of 11)



DATA BASIS: FLIGHT TEST

Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 2 of 11)



AB3520_3A

CRUISE 2000 FT T701C (2) T701D / CC (2)

Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 3 of 11)

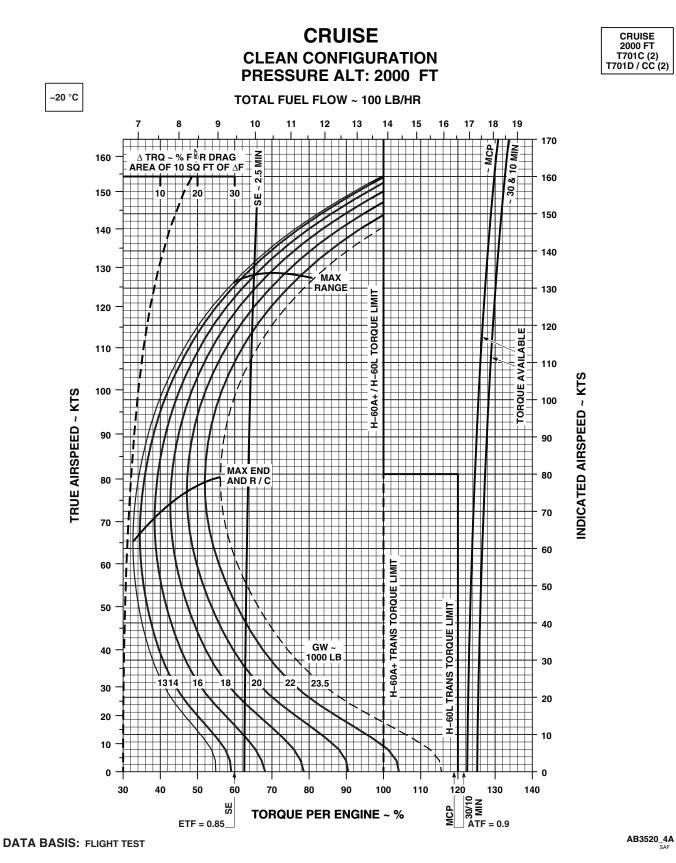
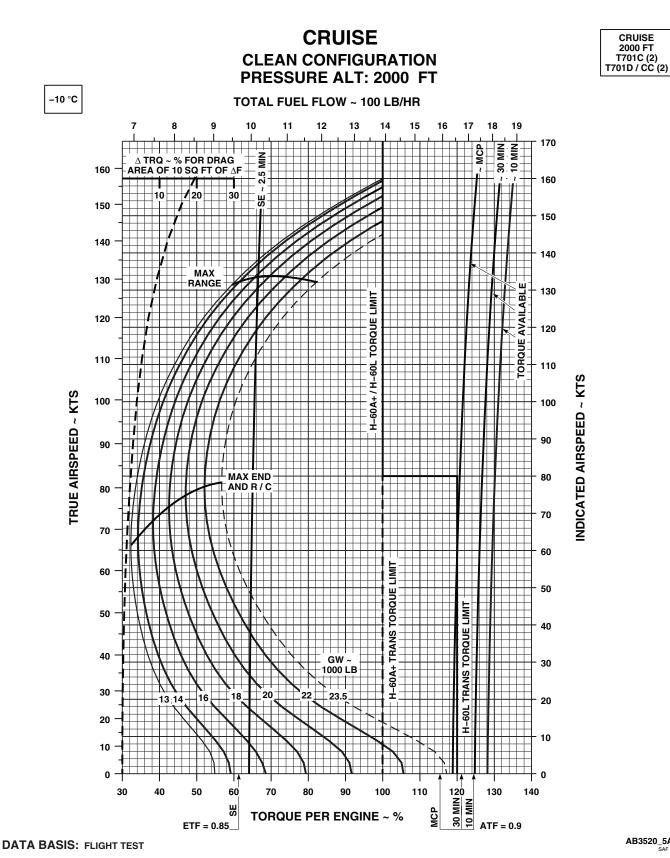


Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 4 of 11)



AB3520_5A

Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 5 of 11)

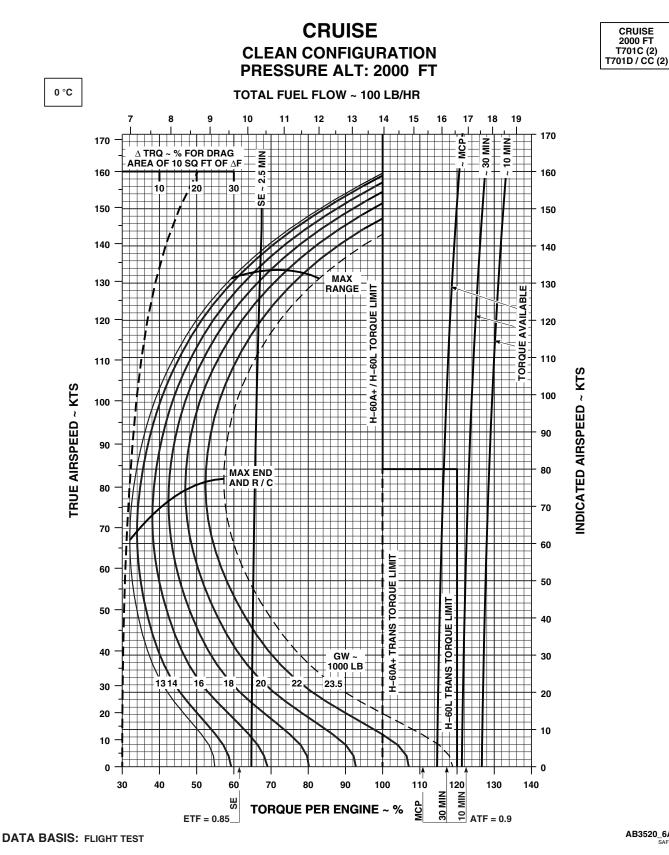
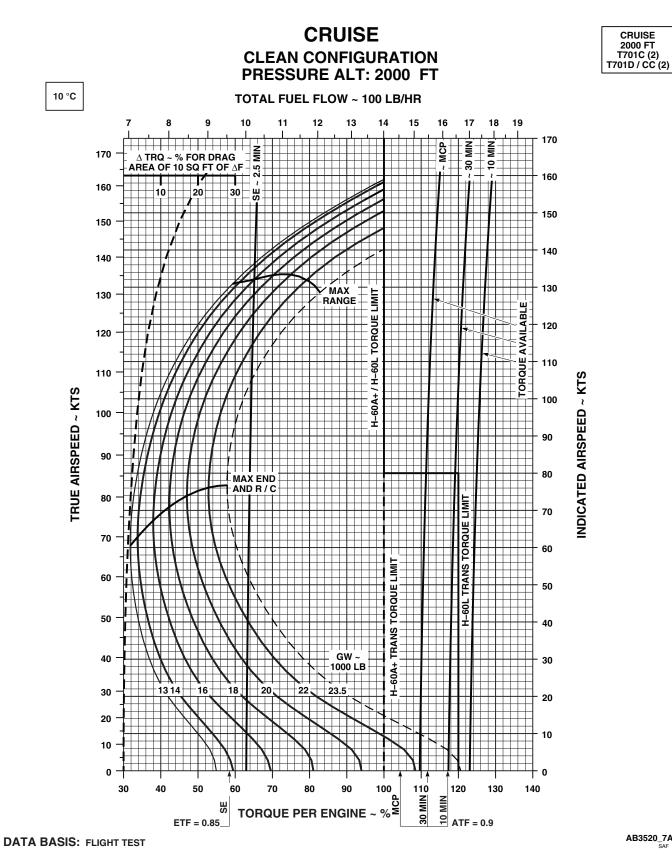
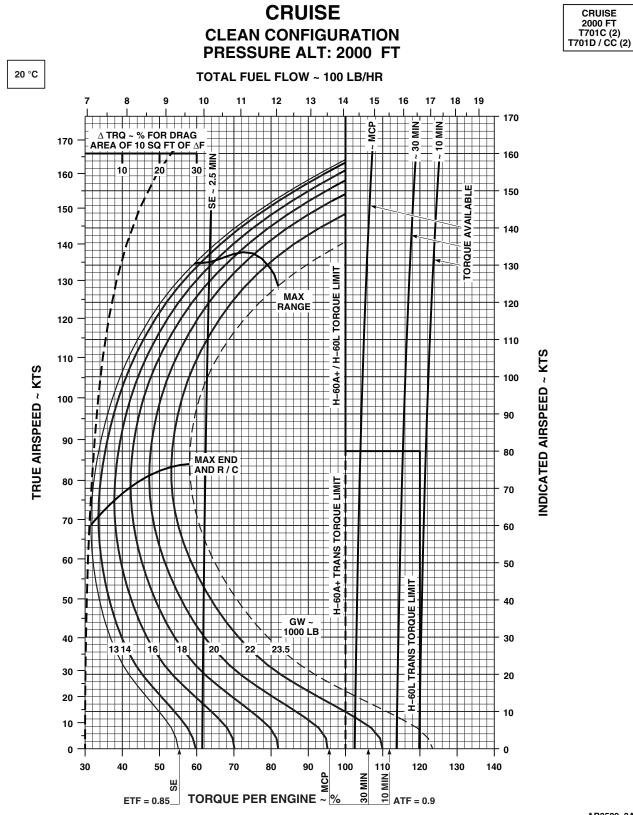


Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 6 of 11)



AB3520_7A

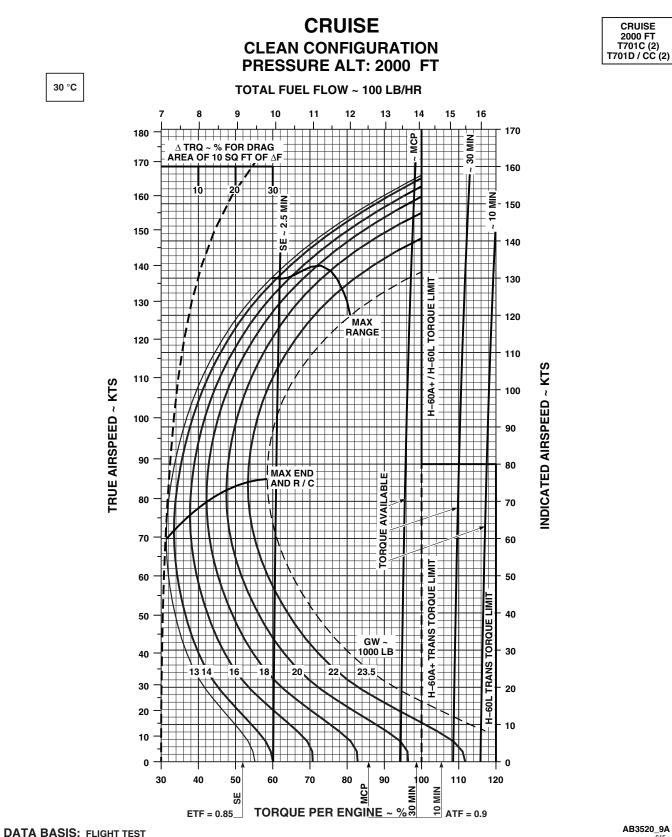
Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 7 of 11)



**DATA BASIS:** FLIGHT TEST

Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 8 of 11)

AB3520_8A



AB3520_9A

Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 9 of 11)

CRUISE 2000 FT T701C (2) T701D / CC (2)

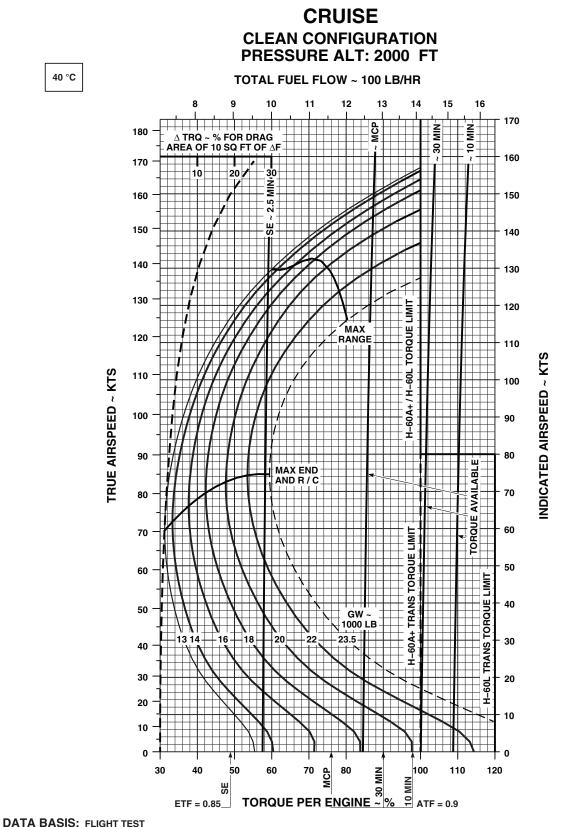


Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 10 of 11)

AB3520_10A

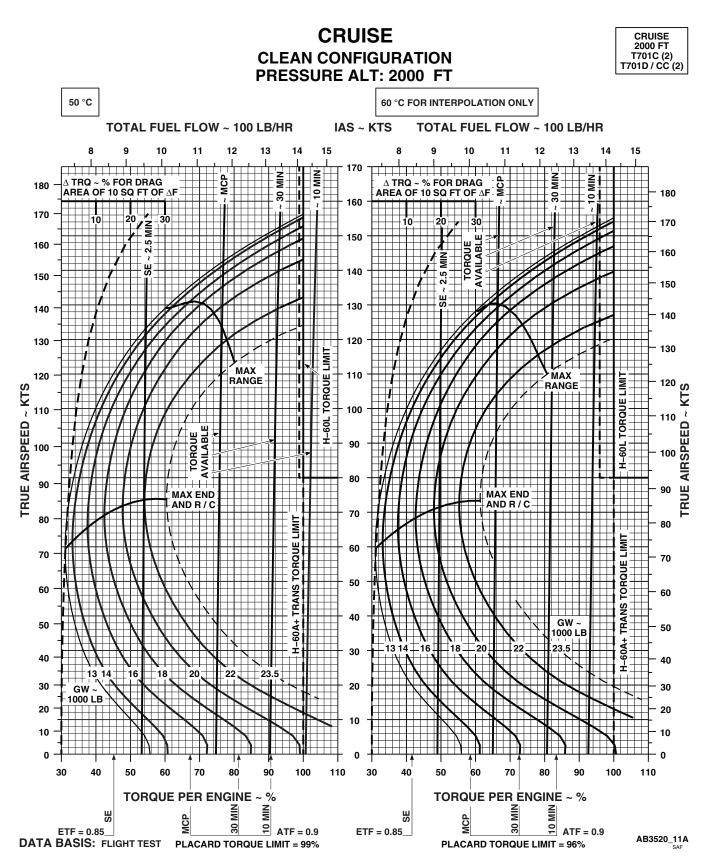
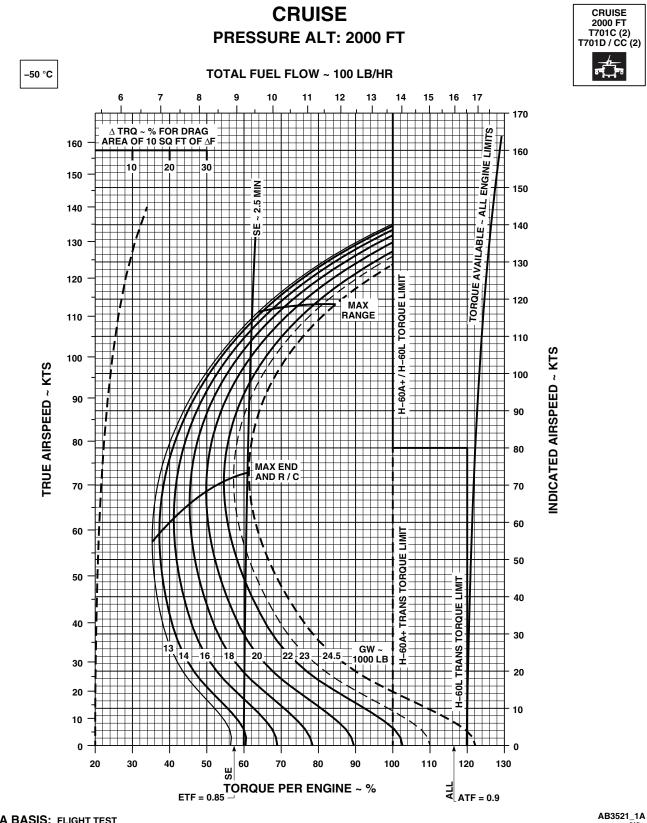
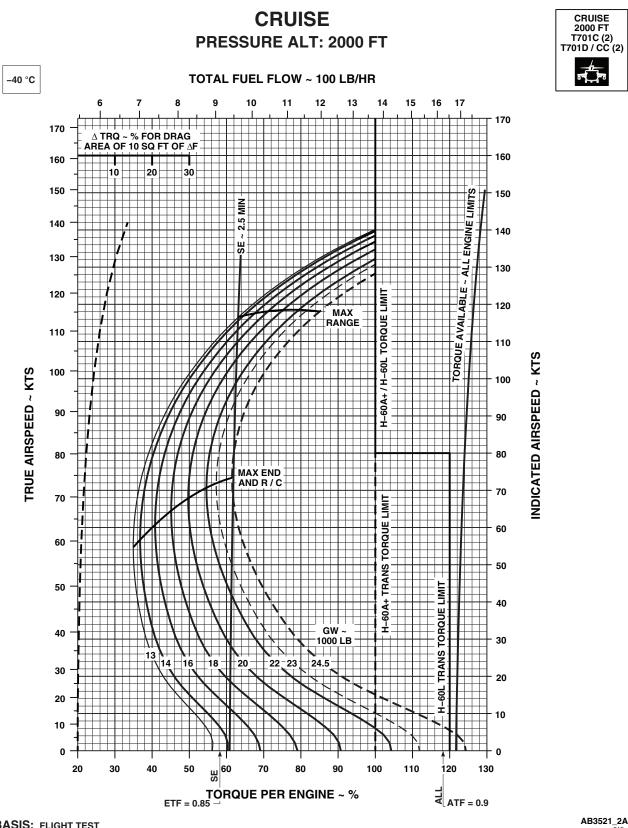


Figure 7A-11. Cruise - Altitude 2,000 Feet (Sheet 11 of 11)



DATA BASIS: FLIGHT TEST

Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 1 of 11)



DATA BASIS: FLIGHT TEST

Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 2 of 11)

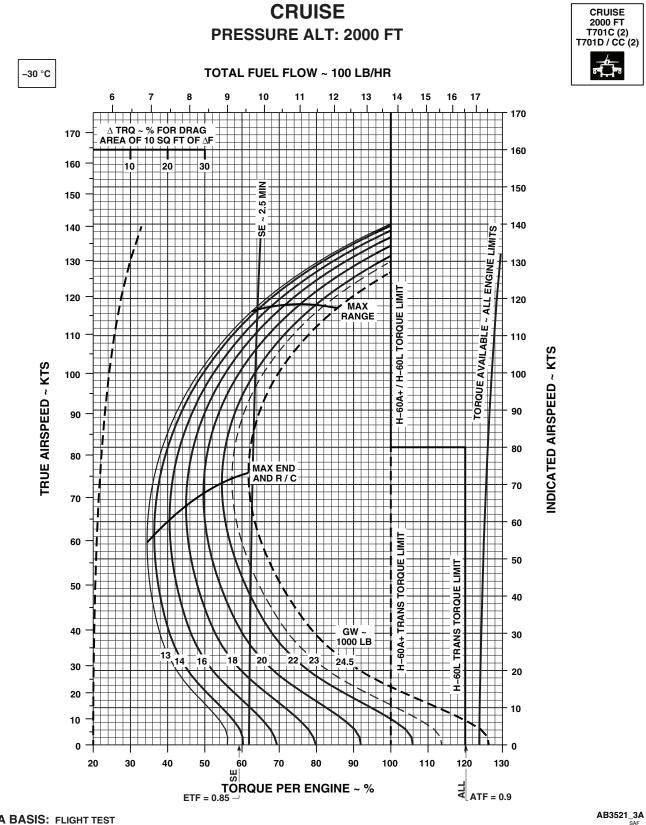
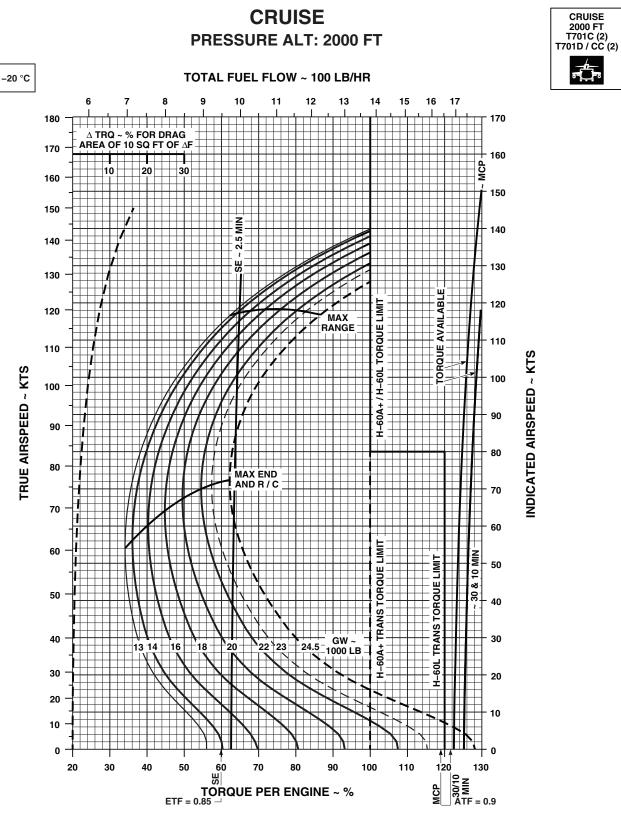


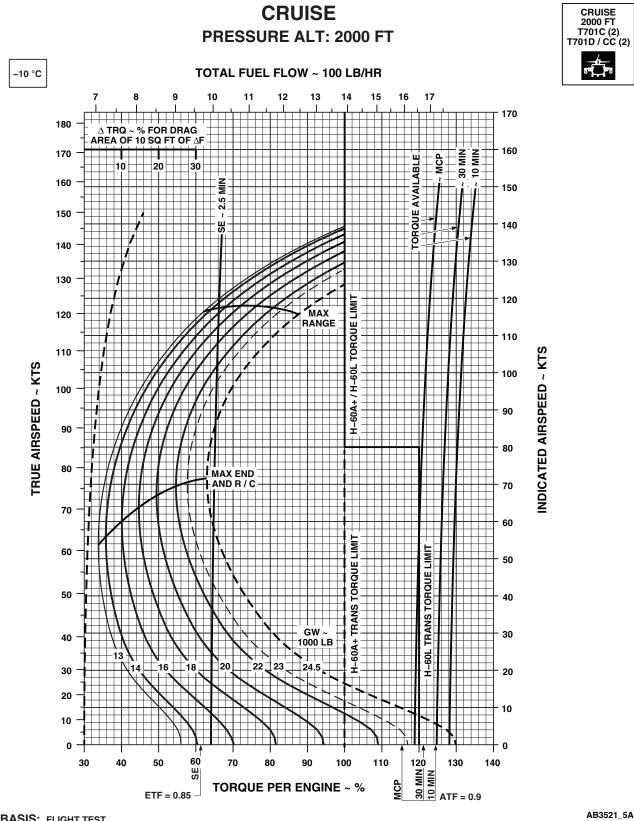
Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 3 of 11)



DATA BASIS: FLIGHT TEST

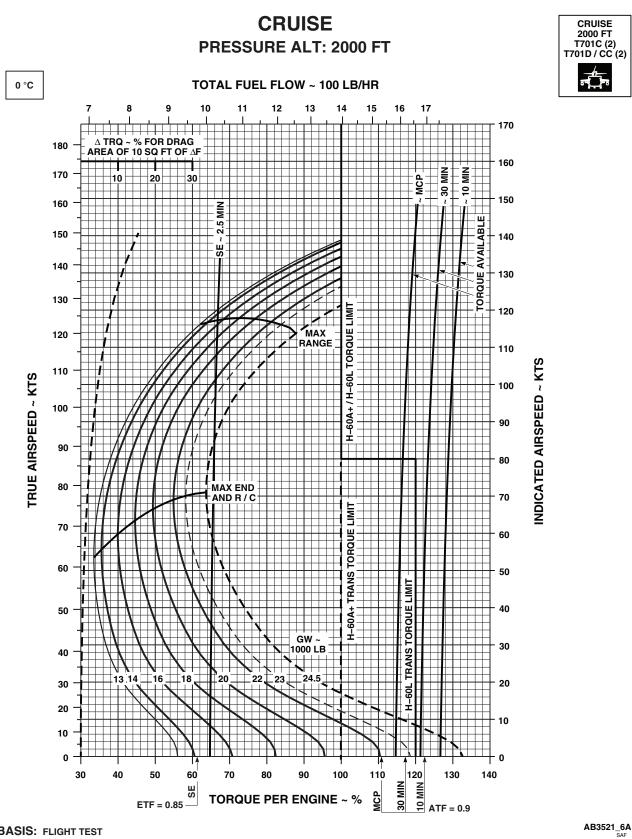
Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 4 of 11)

AB3521_4A



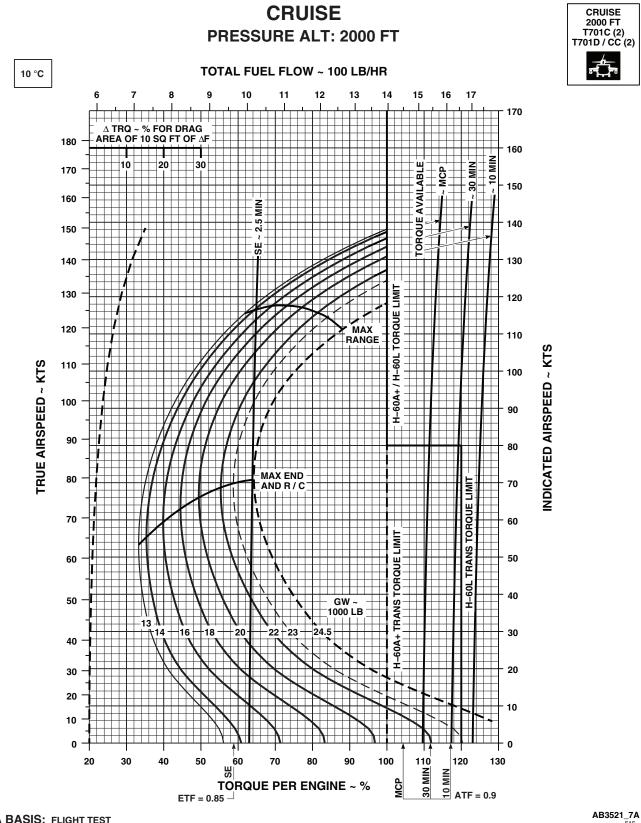
DATA BASIS: FLIGHT TEST

Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 5 of 11)



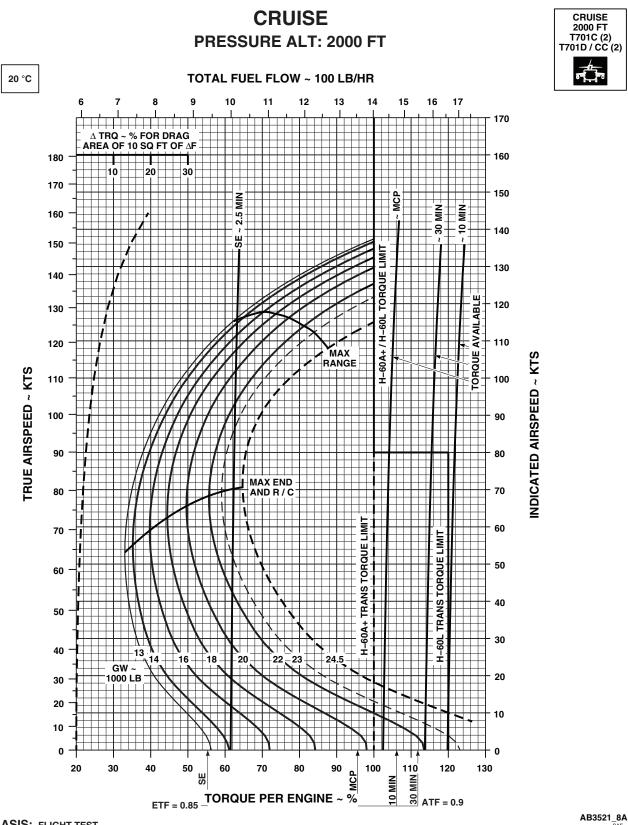
**DATA BASIS:** FLIGHT TEST

Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 6 of 11)



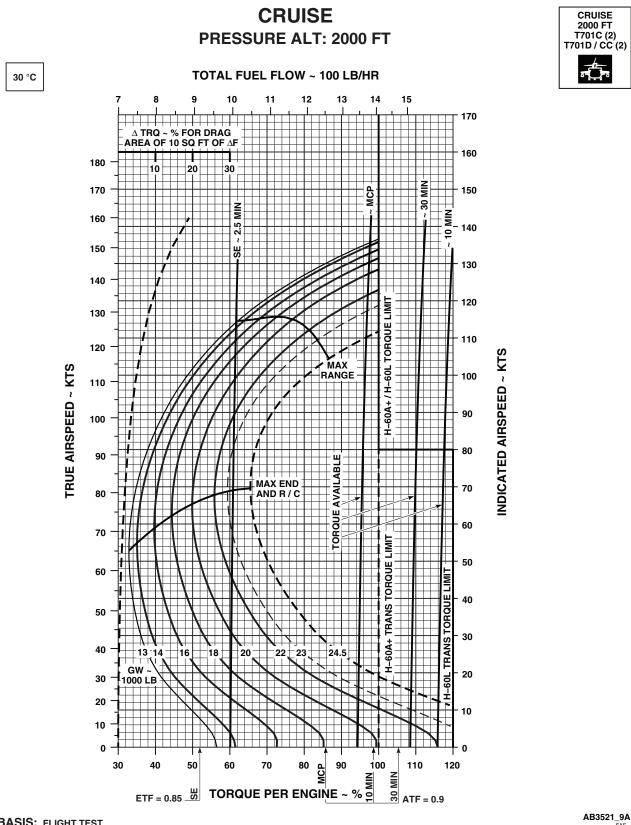
**DATA BASIS:** FLIGHT TEST

Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 7 of 11)



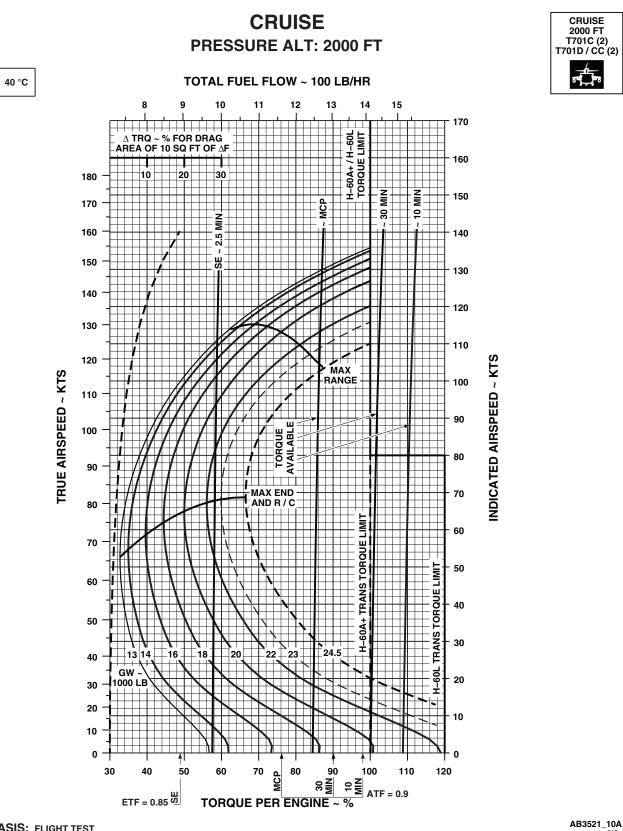
DATA BASIS: FLIGHT TEST

Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 8 of 11)



**DATA BASIS:** FLIGHT TEST

Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 9 of 11)



DATA BASIS: FLIGHT TEST

Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 10 of 11)

CRUISE 2000 FT

## CRUISE PRESSURE ALT: 2000 FT

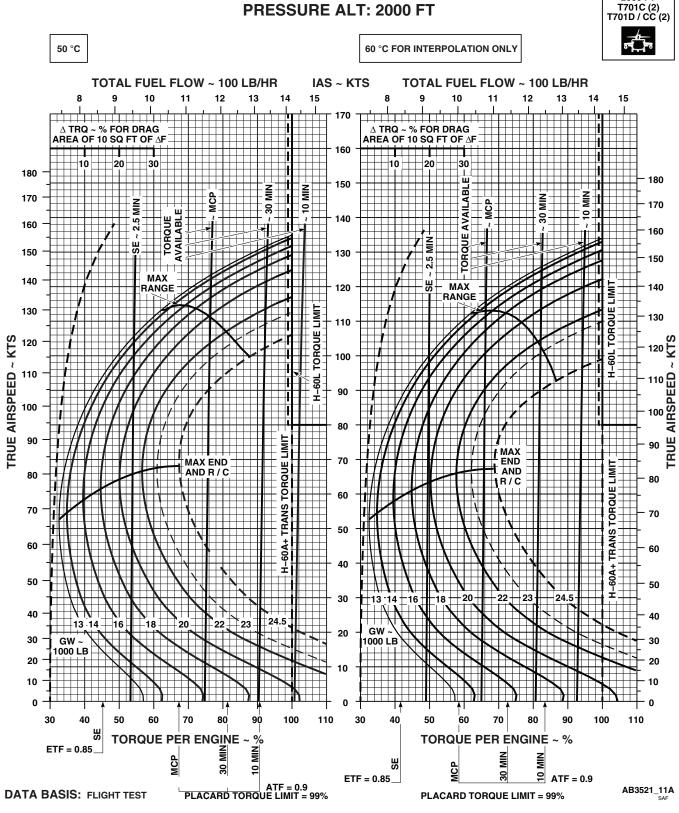
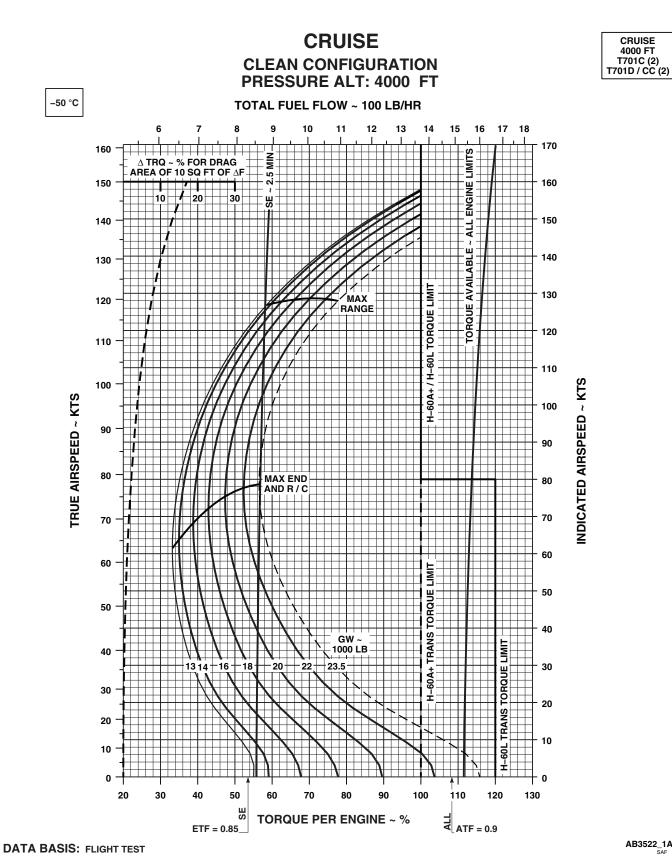


Figure 7A-12. Cruise High Drag - Altitude 2,000 Feet (Sheet 11 of 11)



AB3522_1A

Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 1 of 11)

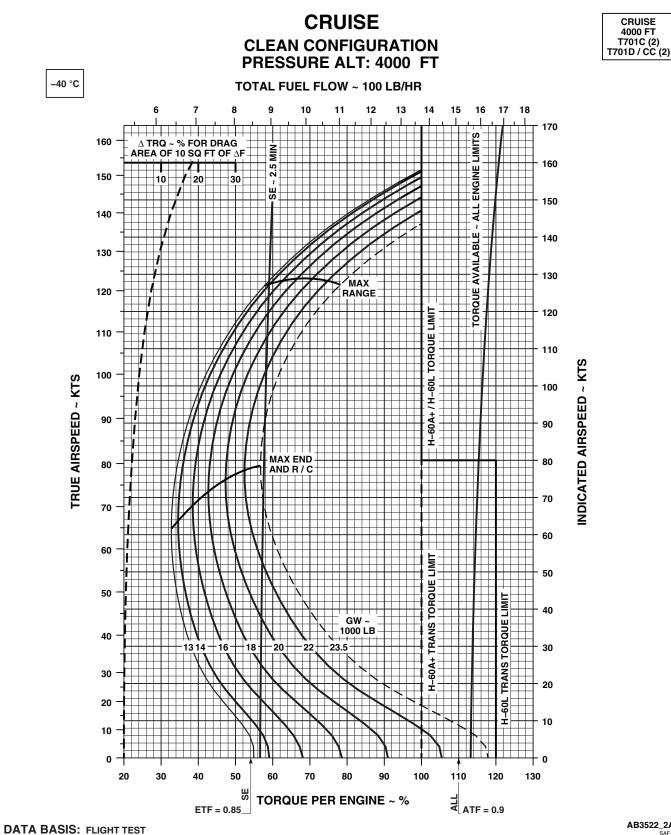
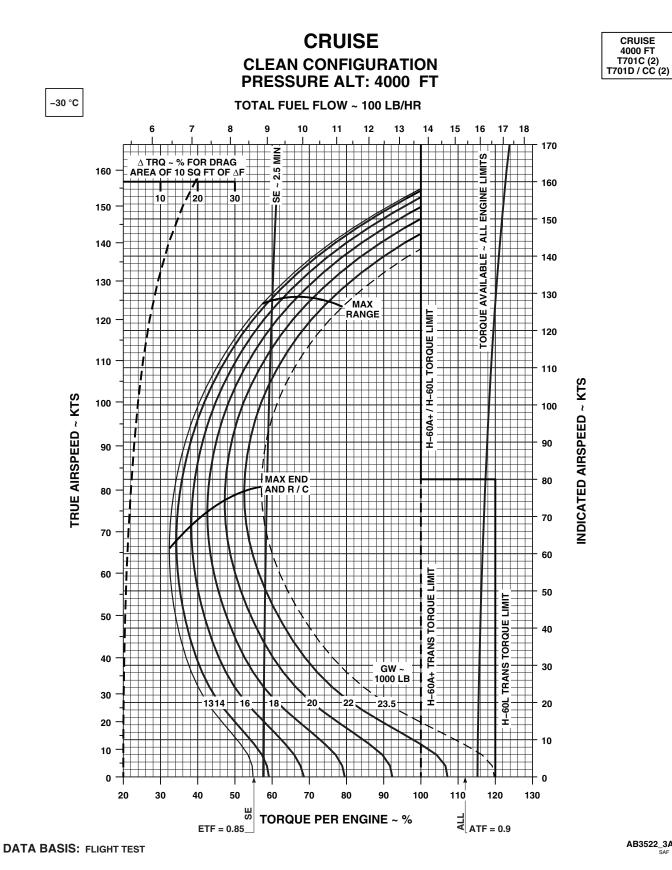


Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 2 of 11)

AB3522_2A



AB3522_3A

Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 3 of 11)

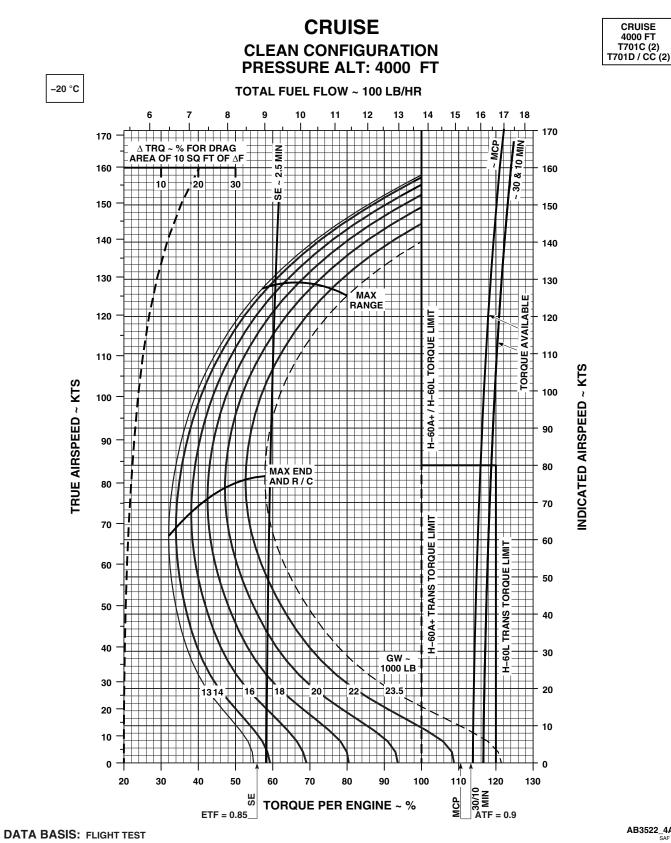
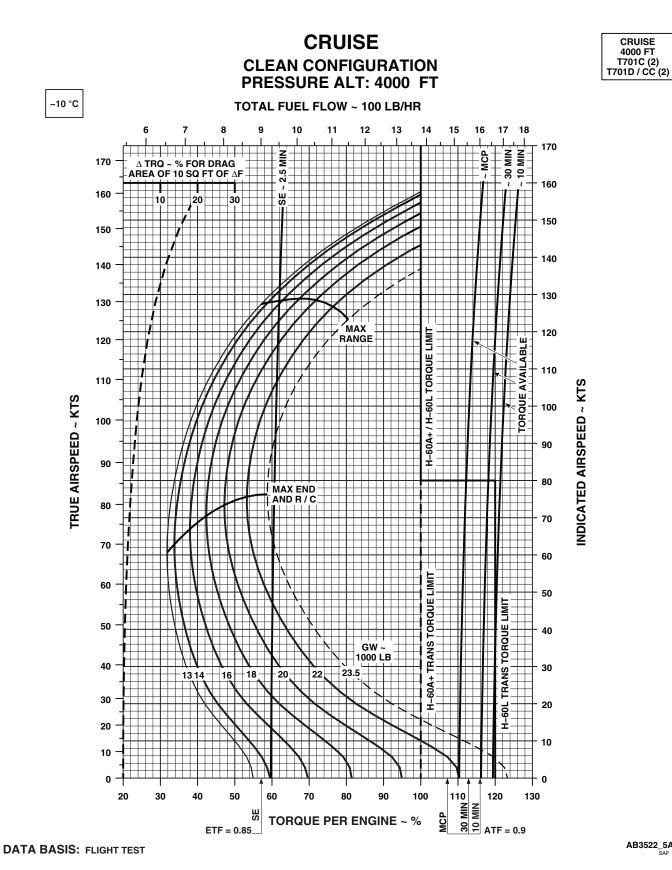


Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 4 of 11)

AB3522_4A



AB3522_5A

Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 5 of 11)

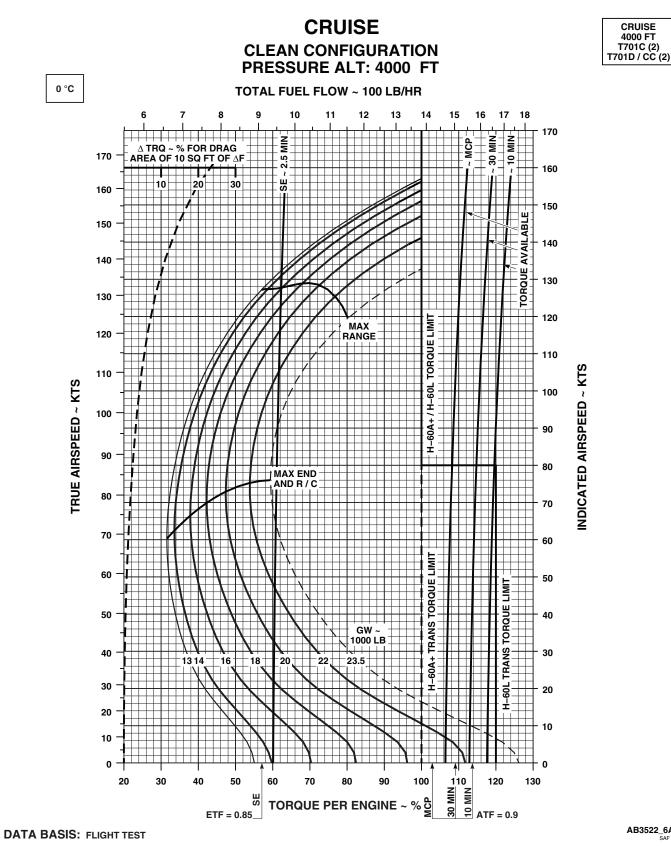


Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 6 of 11)



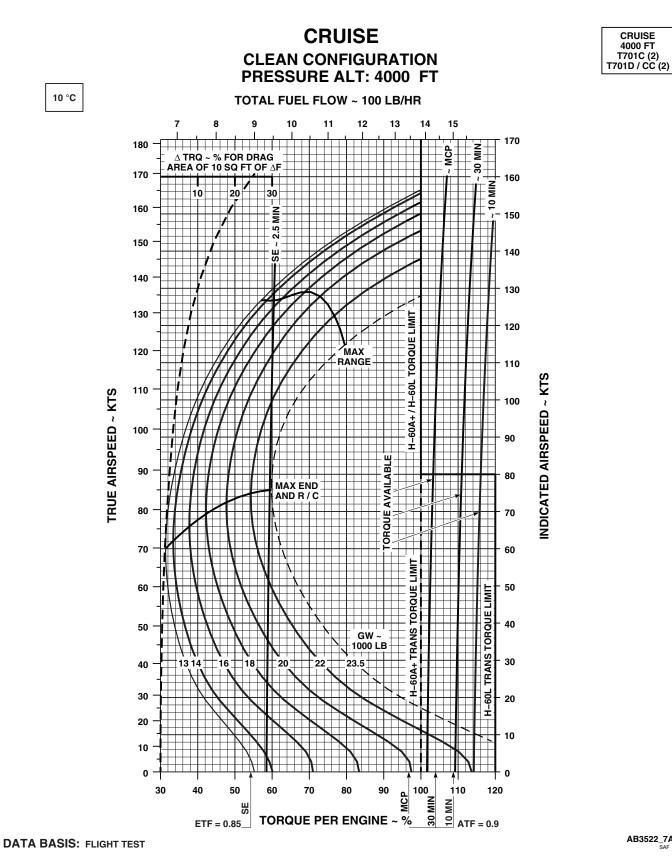
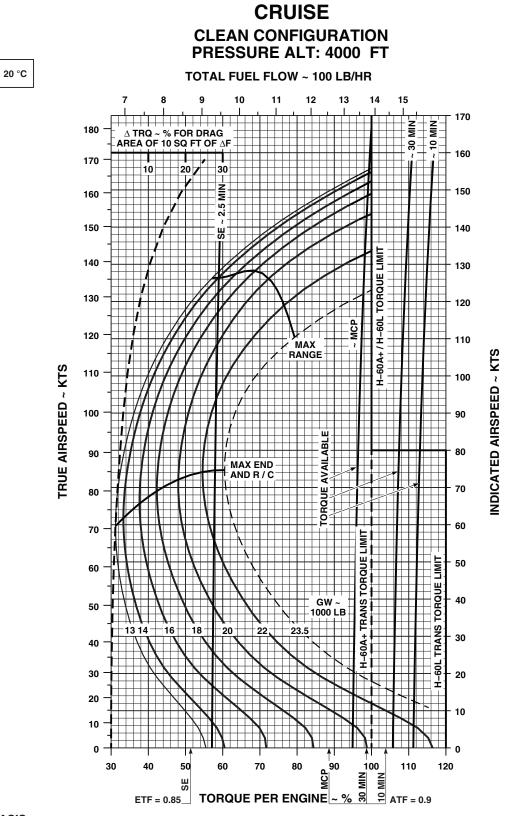


Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 7 of 11)

CRUISE 4000 FT T701C (2) T701D / CC (2)



DATA BASIS: FLIGHT TEST

Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 8 of 11)

AB3522_8A

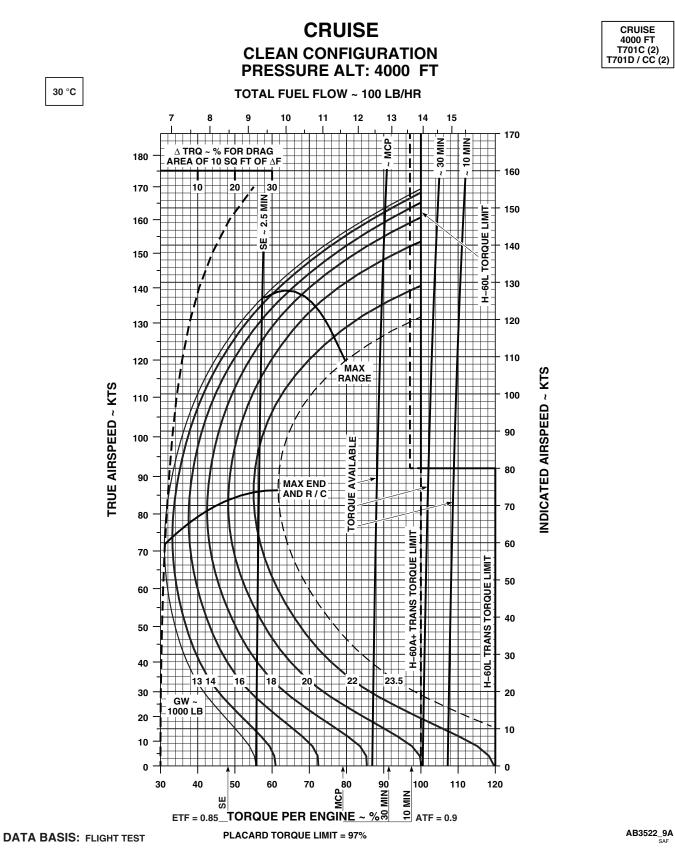
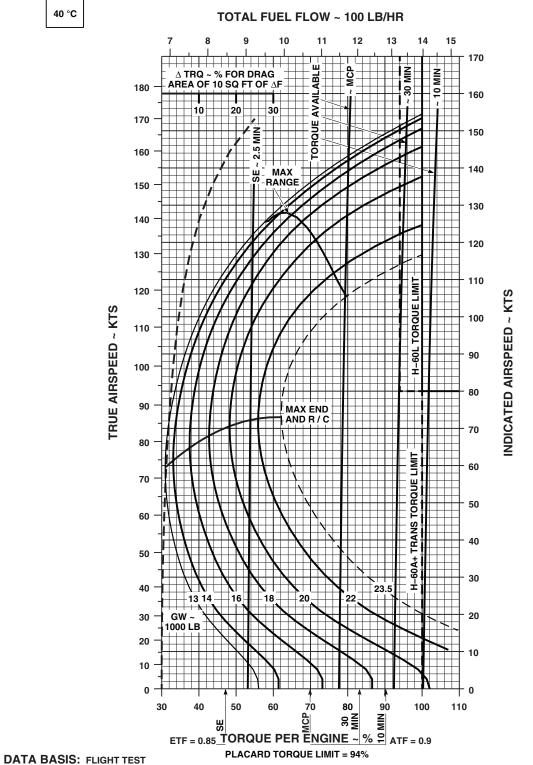


Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 9 of 11)

## **CRUISE CLEAN CONFIGURATION** PRESSURE ALT: 4000 FT

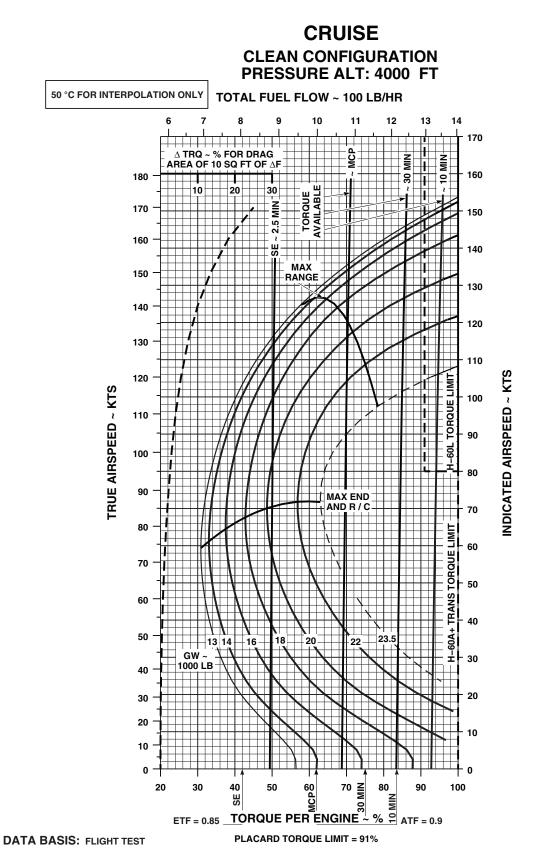
40 °C





AB3522_10A

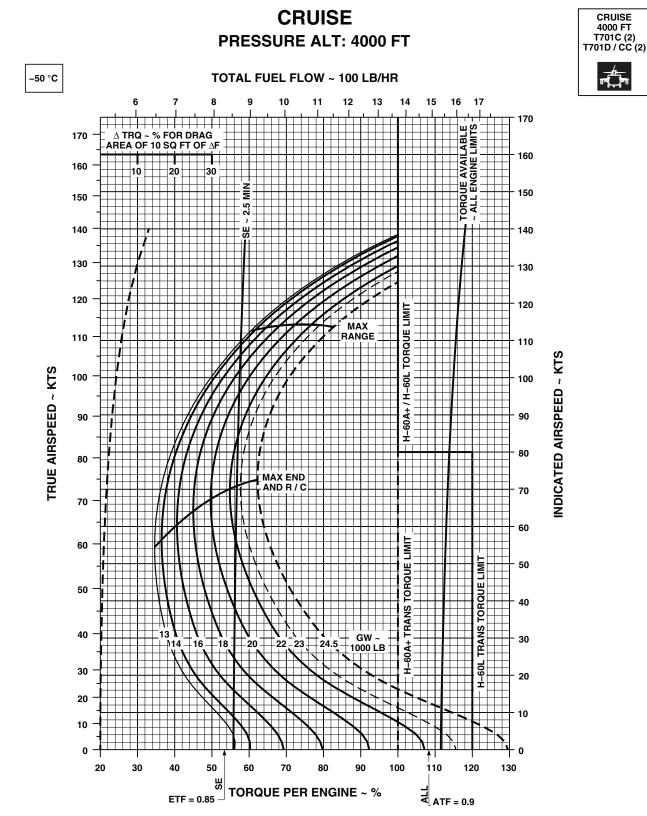
Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 10 of 11)



CRUISE 4000 FT T701C (2) T701D / CC (2)

AB3522_11A SAF

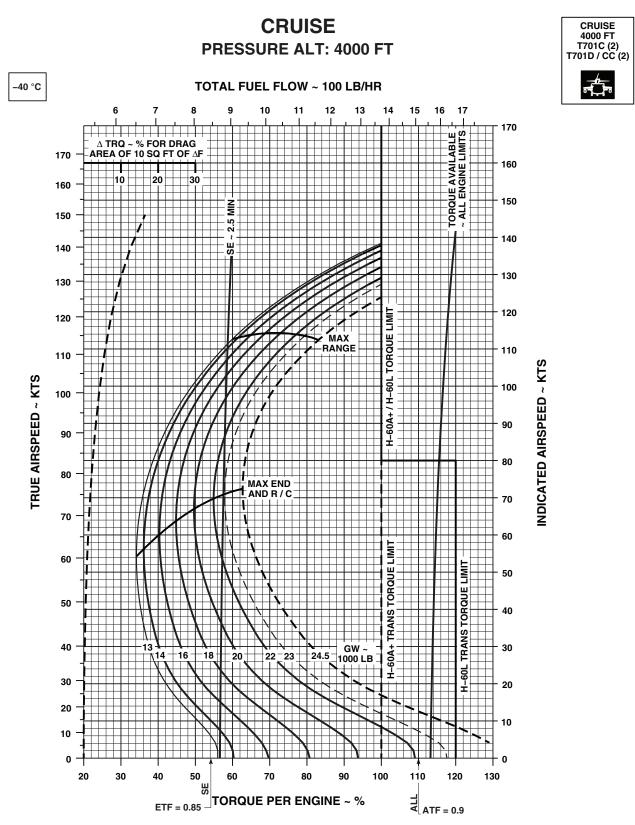
Figure 7A-13. Cruise - Altitude 4,000 Feet (Sheet 11 of 11)



DATA BASIS: FLIGHT TEST

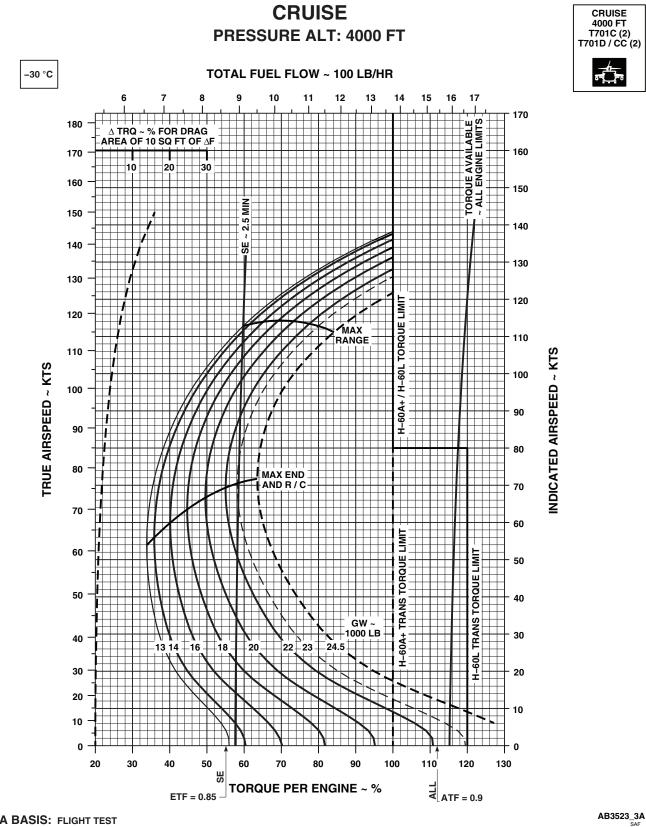
Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 1 of 11)

AB3523_1A



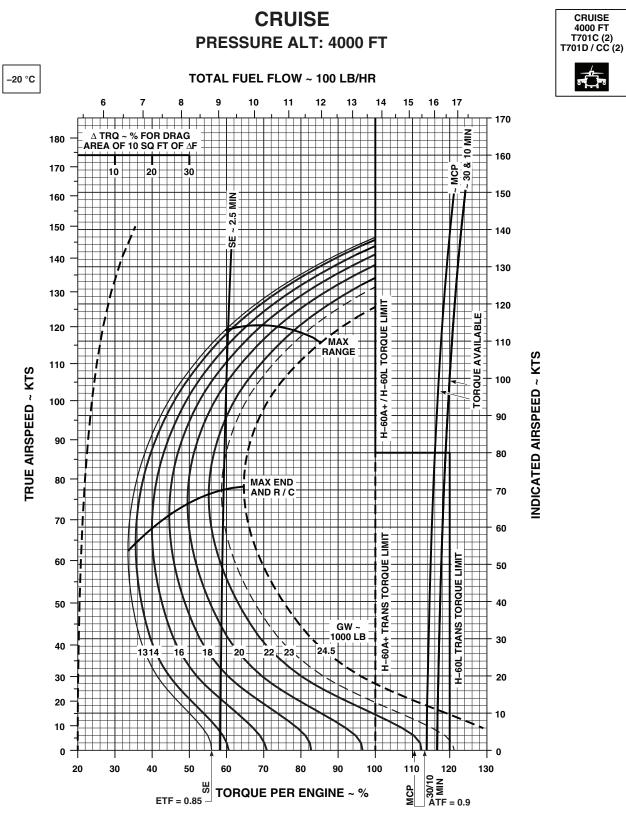
**DATA BASIS:** FLIGHT TEST

Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 2 of 11)



**DATA BASIS:** FLIGHT TEST

Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 3 of 11)



DATA BASIS: FLIGHT TEST

Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 4 of 11)

AB3523_4A

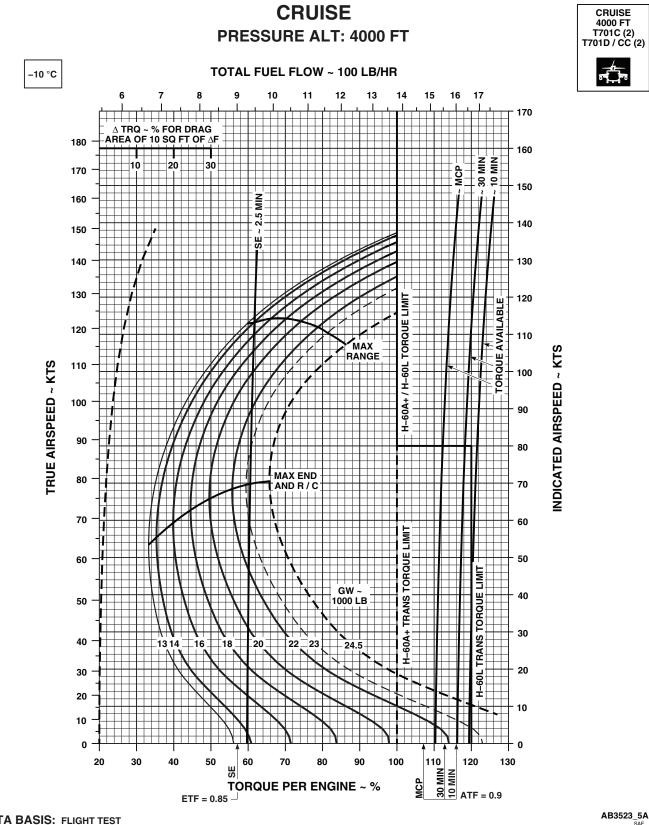


Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 5 of 11)

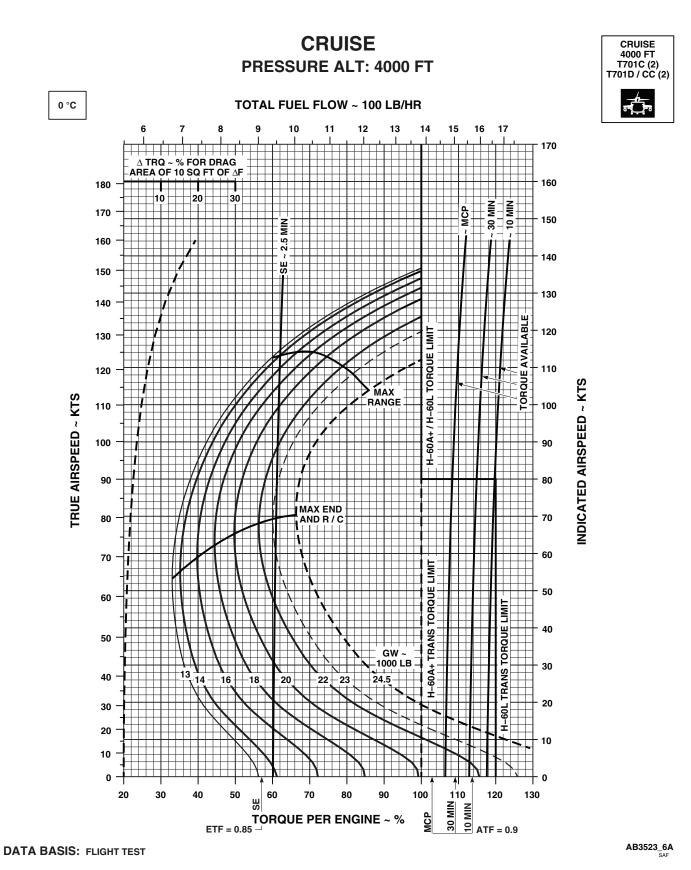
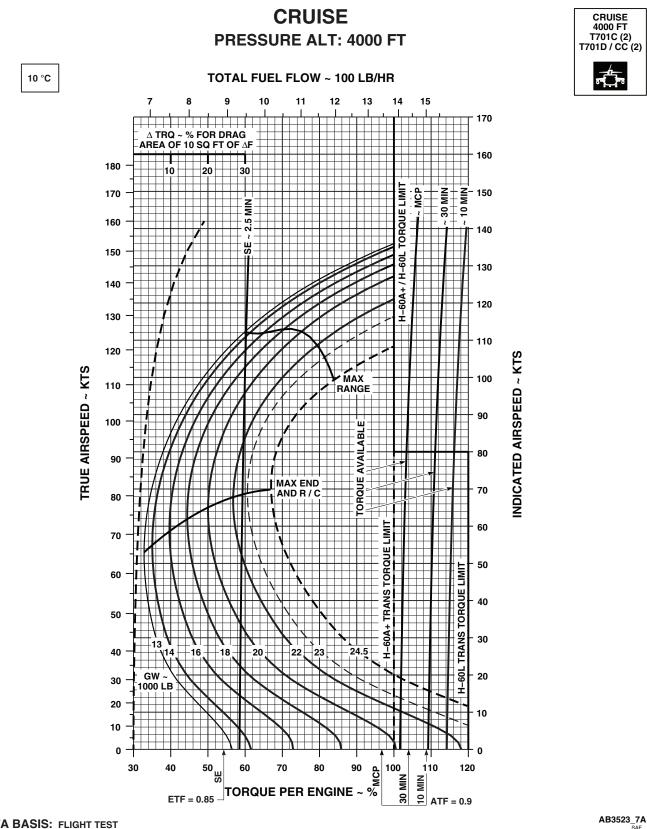


Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 6 of 11)



**DATA BASIS:** FLIGHT TEST

Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 7 of 11)

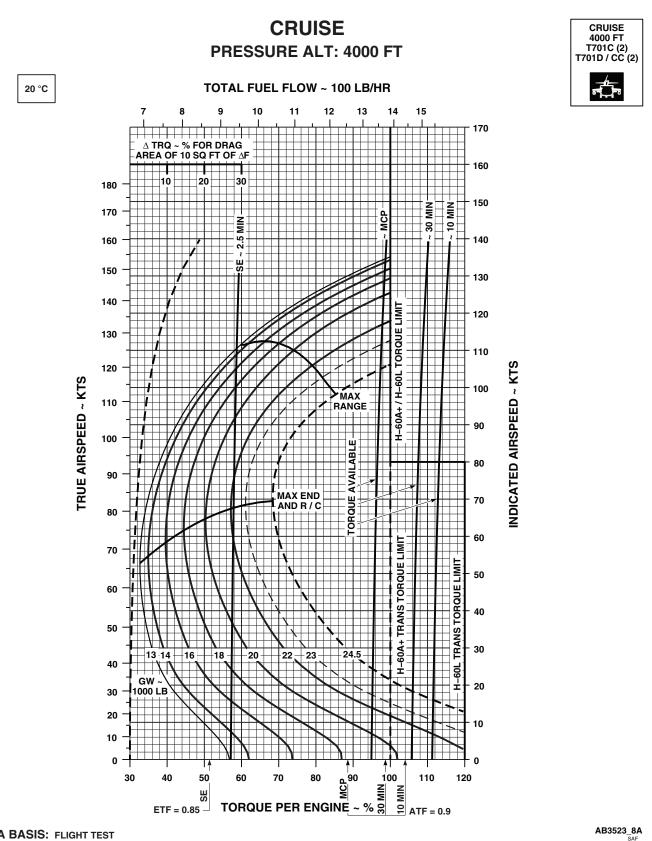


Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 8 of 11)

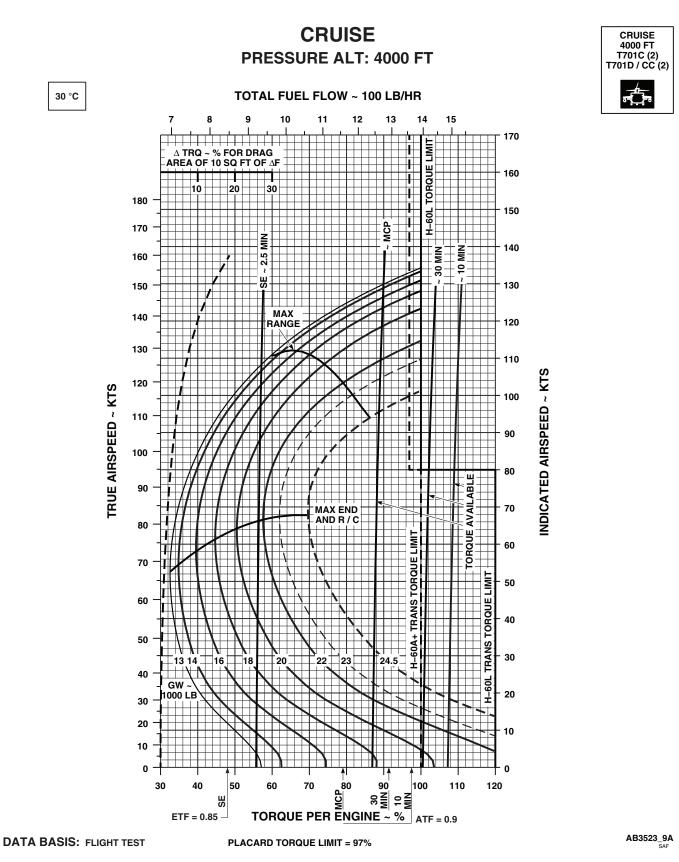
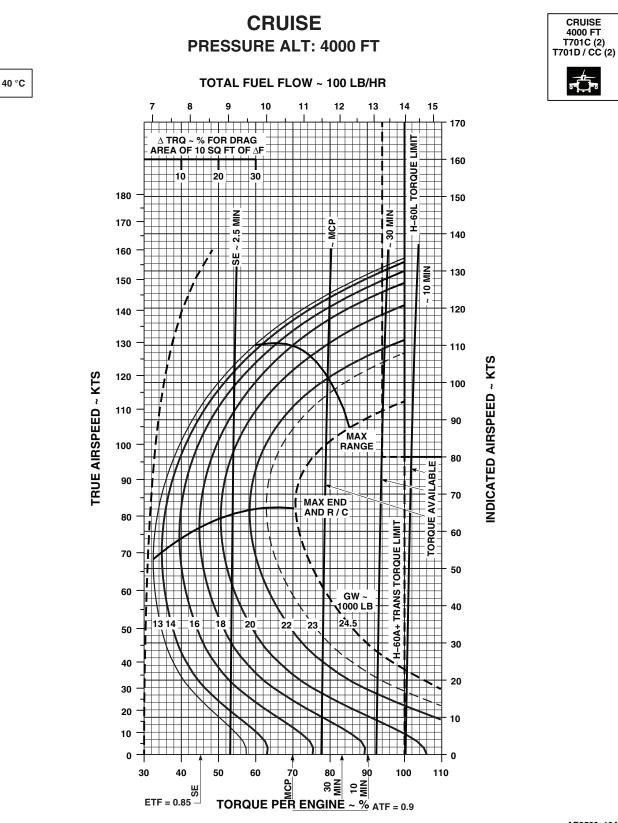


Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 9 of 11)



PLACARD TORQUE LIMIT = 94%

AB3523_10A

Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 10 of 11)

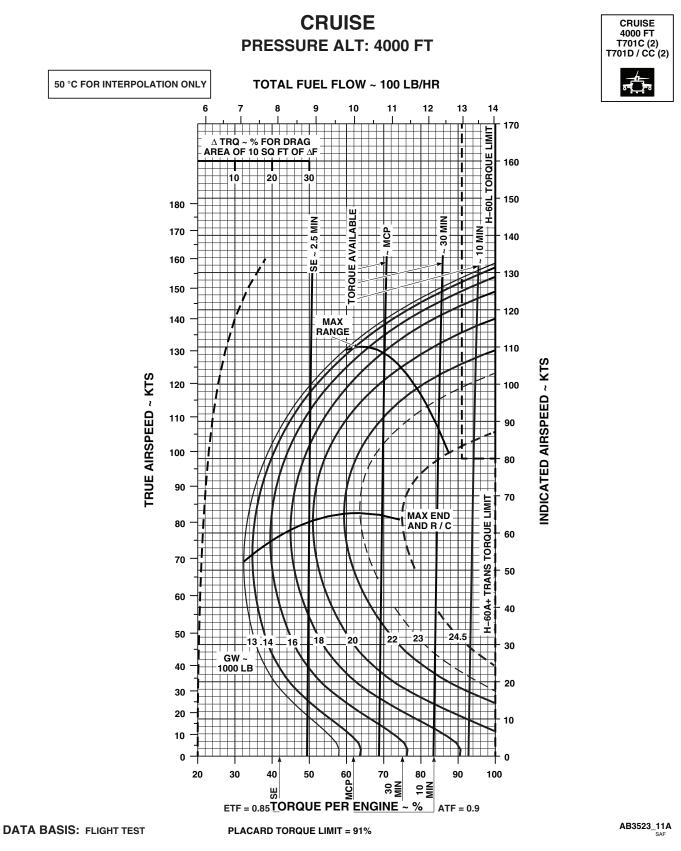
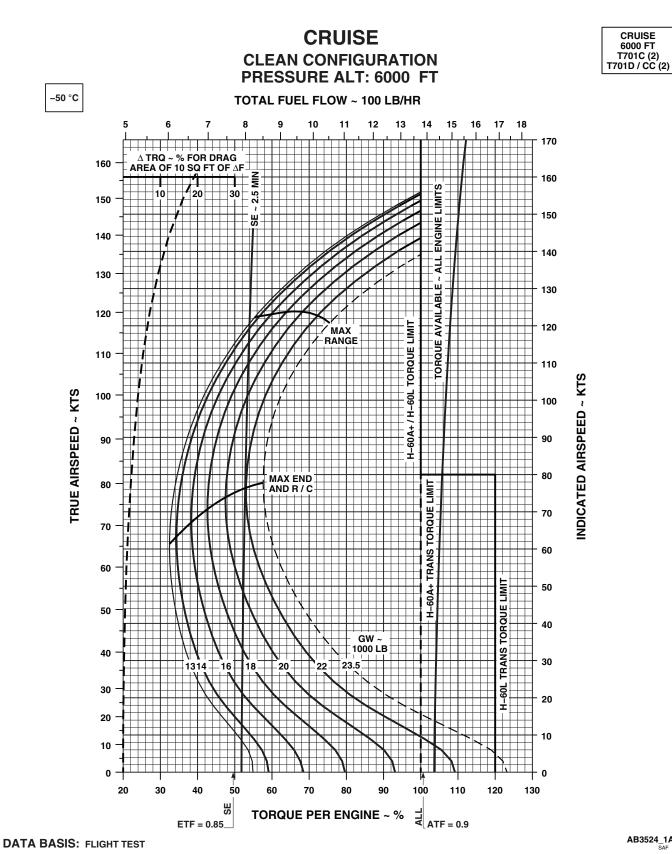


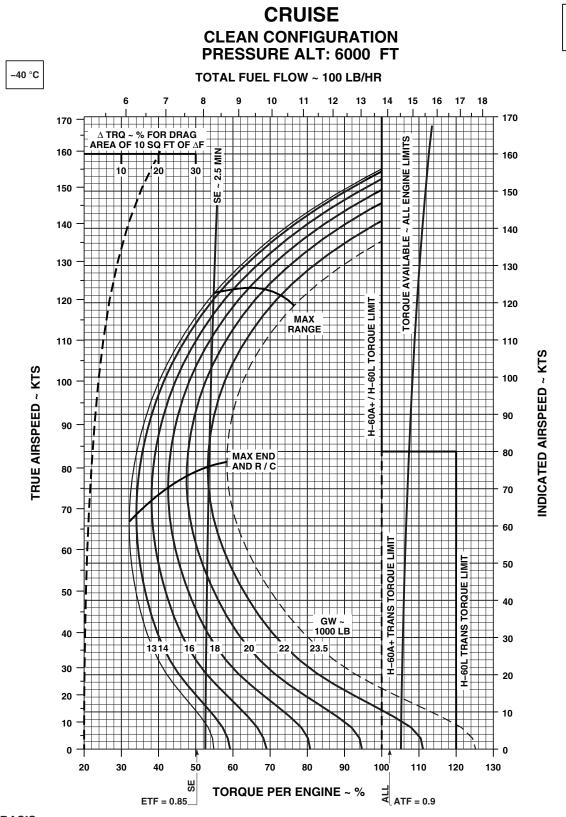
Figure 7A-14. Cruise High Drag - Altitude 4,000 Feet (Sheet 11 of 11)



AB3524_1A

Figure 7A-15. Cruise - Altitude 6,000 Feet (Sheet 1 of 9)

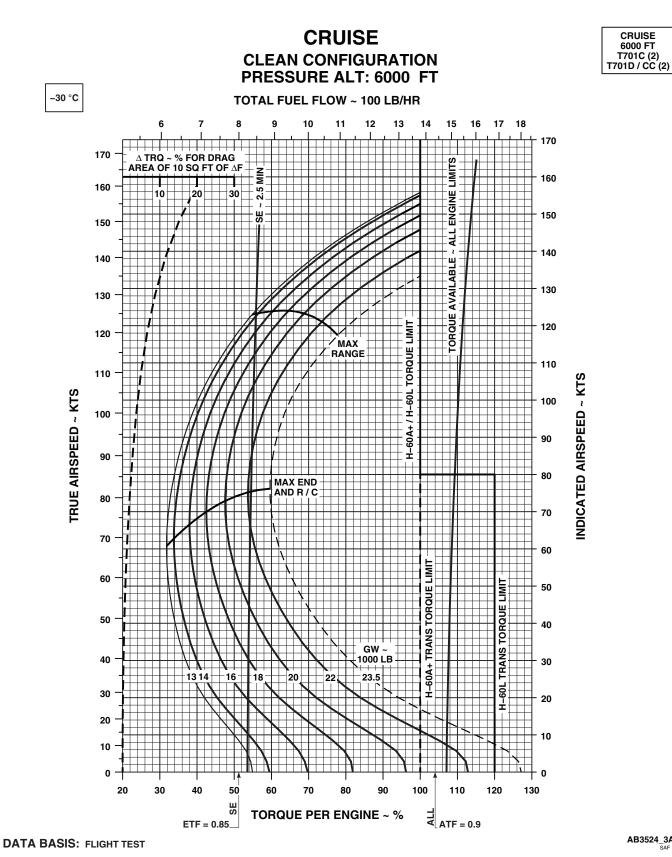
CRUISE 6000 FT T701C (2) T701D / CC (2)



DATA BASIS: FLIGHT TEST

Figure 7A-15. Cruise - Altitude 6,000 Feet (Sheet 2 of 9)

AB3524_2A



AB3524_3A

Figure 7A-15. Cruise - Altitude 6,000 Feet (Sheet 3 of 9)

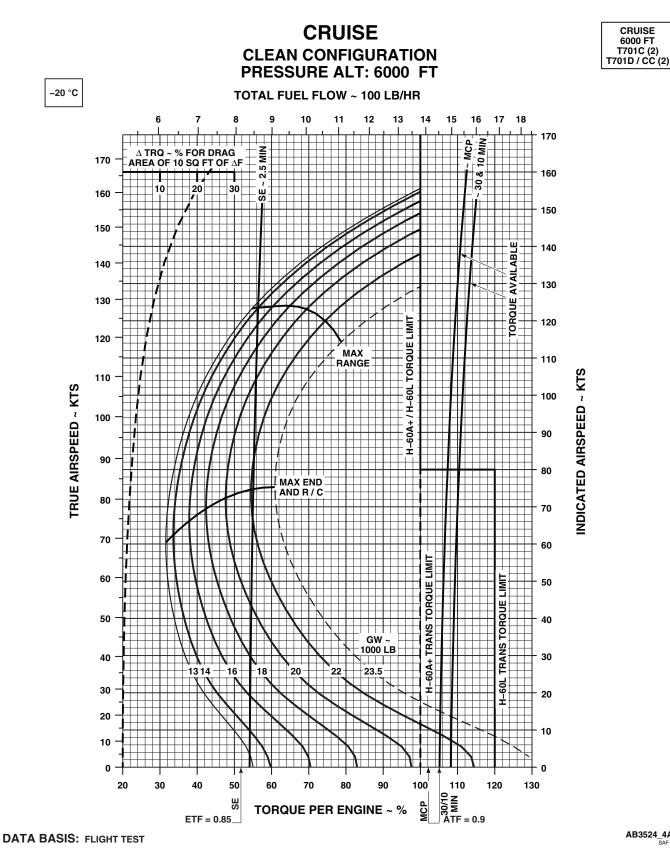
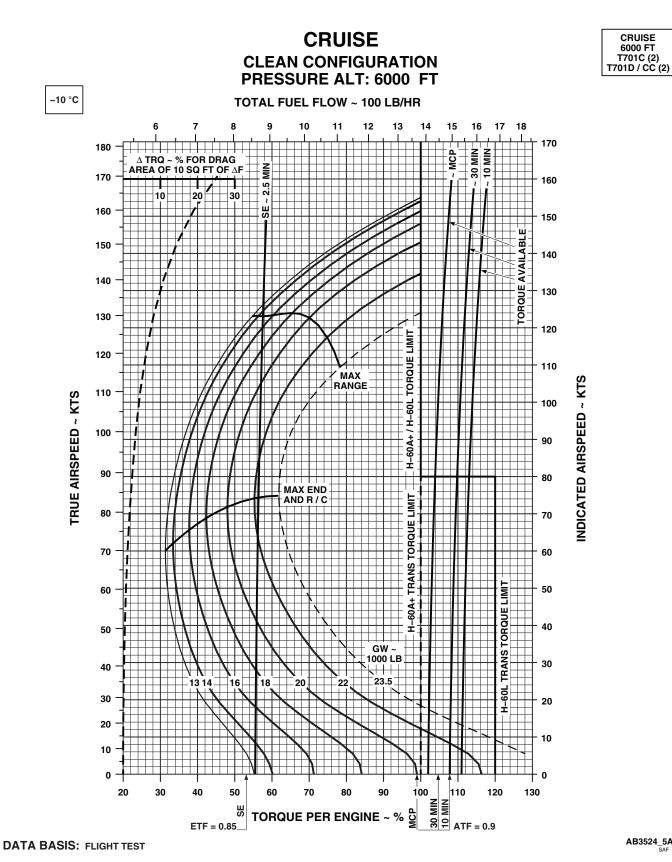


Figure 7A-15. Cruise - Altitude 6,000 Feet (Sheet 4 of 9)

AB3524_4A



AB3524_5A

Figure 7A-15. Cruise - Altitude 6,000 Feet (Sheet 5 of 9)

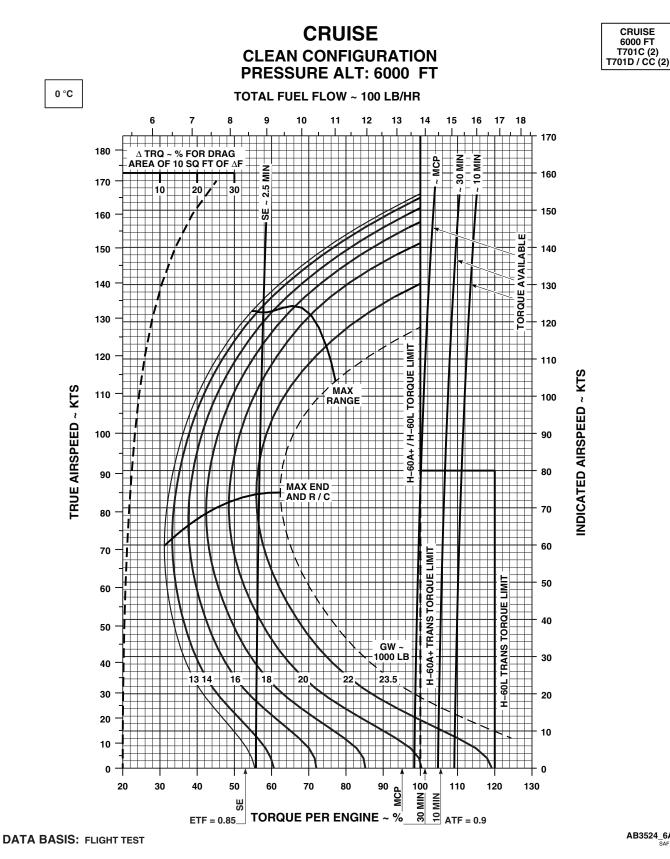


Figure 7A-15. Cruise - Altitude 6,000 Feet (Sheet 6 of 9)

7A-95

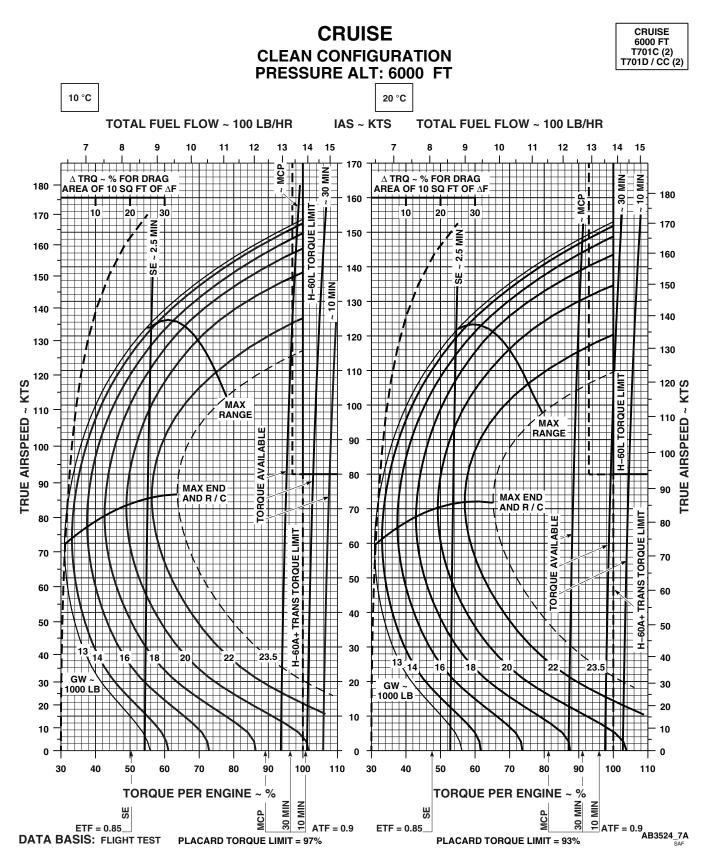


Figure 7A-15. Cruise - Altitude 6,000 Feet (Sheet 7 of 9)

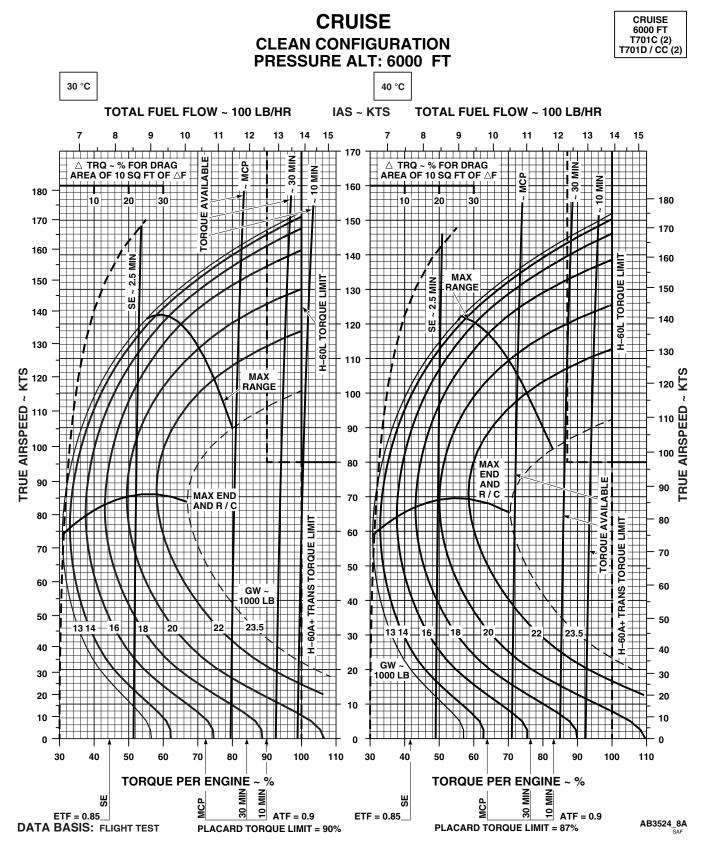
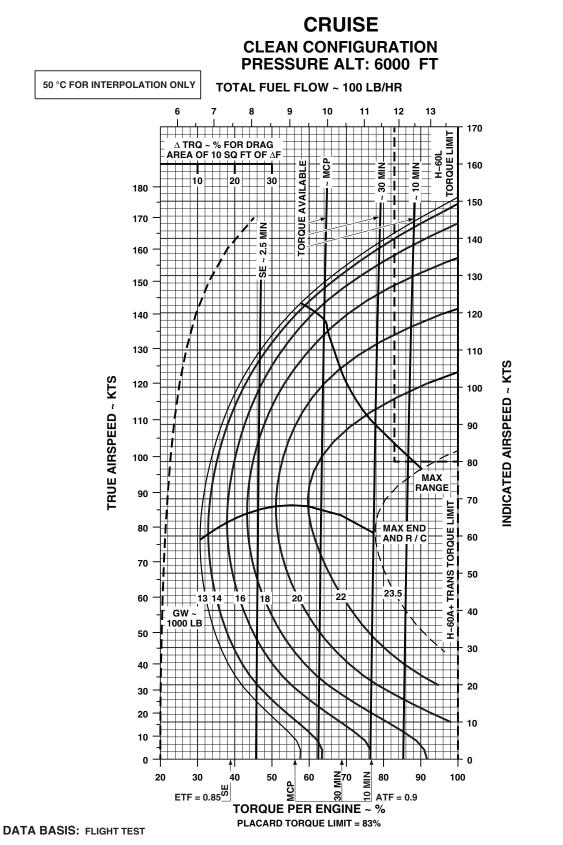
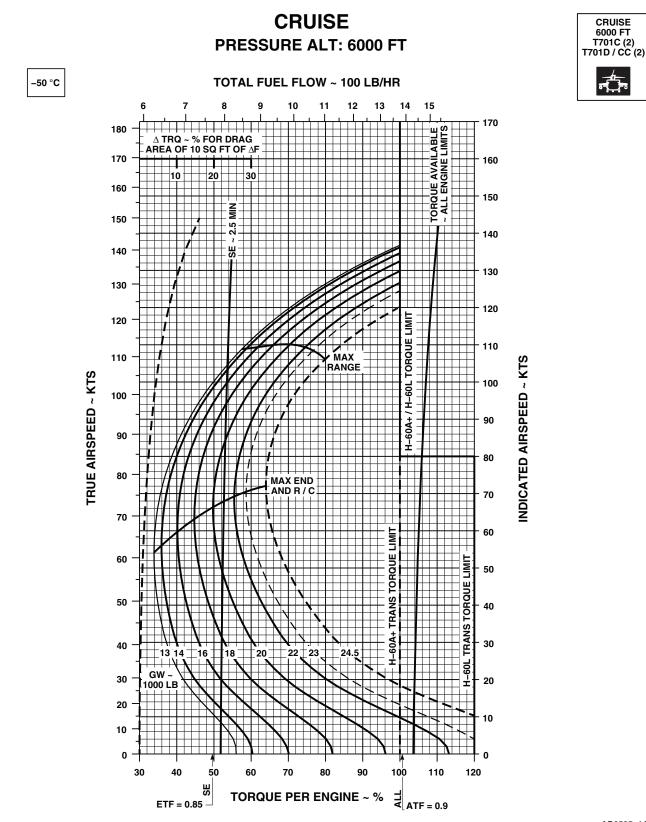


Figure 7A-15. Cruise - Altitude 6,000 Feet (Sheet 8 of 9)



CRUISE 6000 FT T701C (2) T701D / CC (2)

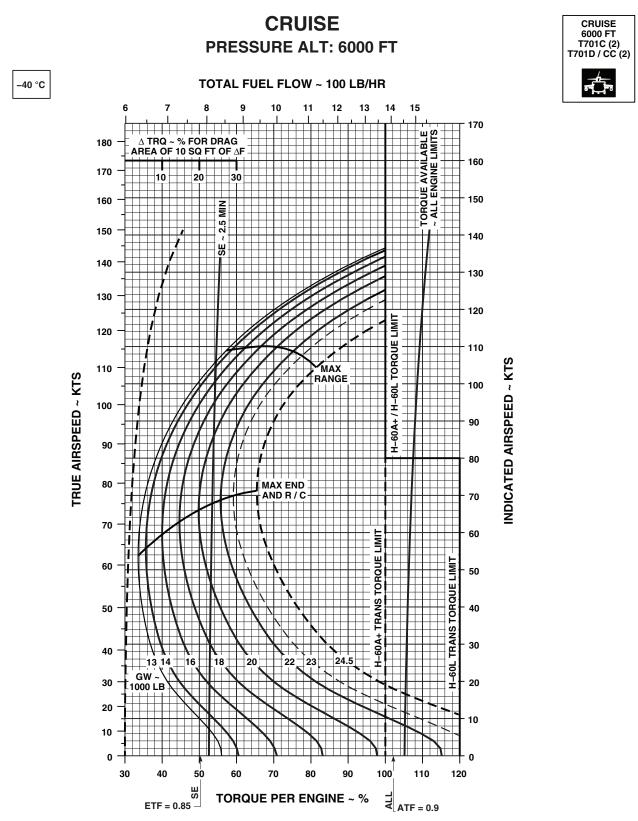
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DATA BASIS: FLIGHT TEST

Figure 7A-16. Cruise High Drag - Altitude 6,000 Feet (Sheet 1 of 9)

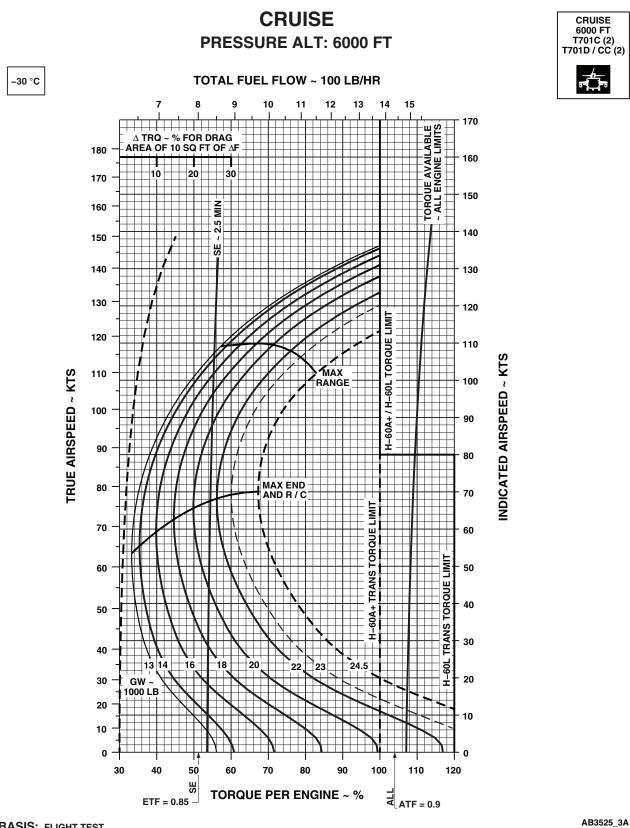




DATA BASIS: FLIGHT TEST

Figure 7A-16. Cruise High Drag - Altitude 6,000 Feet (Sheet 2 of 9)

AB3525_2A



DATA BASIS: FLIGHT TEST

Figure 7A-16. Cruise High Drag - Altitude 6,000 Feet (Sheet 3 of 9)

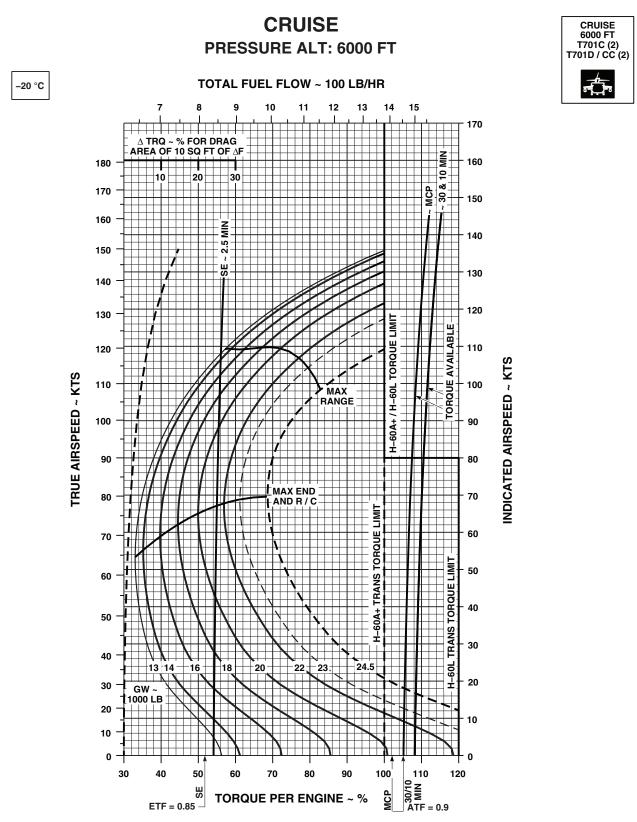


Figure 7A-16. Cruise High Drag - Altitude 6,000 Feet (Sheet 4 of 9)

AB3525_4A

CRUISE 6000 FT T701C (2) T701D / CC (2)

## **CRUISE** PRESSURE ALT: 6000 FT TOTAL FUEL FLOW ~ 100 LB/HR $\Delta$ TRQ ~ % FOR DRAG AREA OF 10 SQ FT OF $\Delta$ F 10 MIN **30 MIN** MIN 2.5 -+ H-60A+ / H-60L TORQUE INDICATED AIRSPEED ~ KTS TRUE AIRSPEED ~ KTS MAX RANGE щ LABI AVAII MAX END TORQUE AND R / C TRANS TORQUE LIMIT LIMIT Г H-60L TRANS TORQUE - H-60A+ GW 1000 LB NIW OF ATF = 0.9 ŝ TORQUE PER ENGINE ~ % မ္မီ

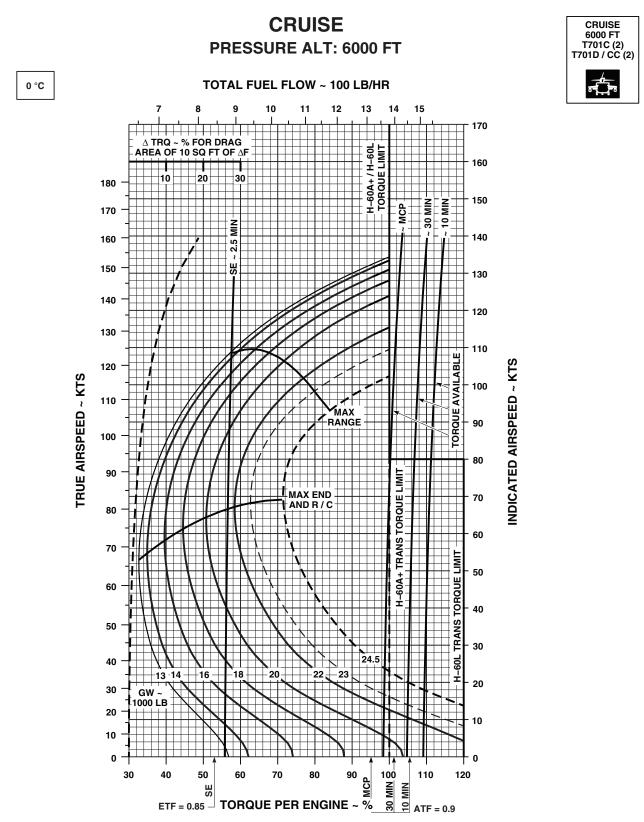
AB3525_5A

**DATA BASIS:** FLIGHT TEST

–10 °C

Figure 7A-16. Cruise High Drag - Altitude 6,000 Feet (Sheet 5 of 9)

ETF = 0.85



DATA BASIS: FLIGHT TEST

Figure 7A-16. Cruise High Drag - Altitude 6,000 Feet (Sheet 6 of 9)

AB3525_6A

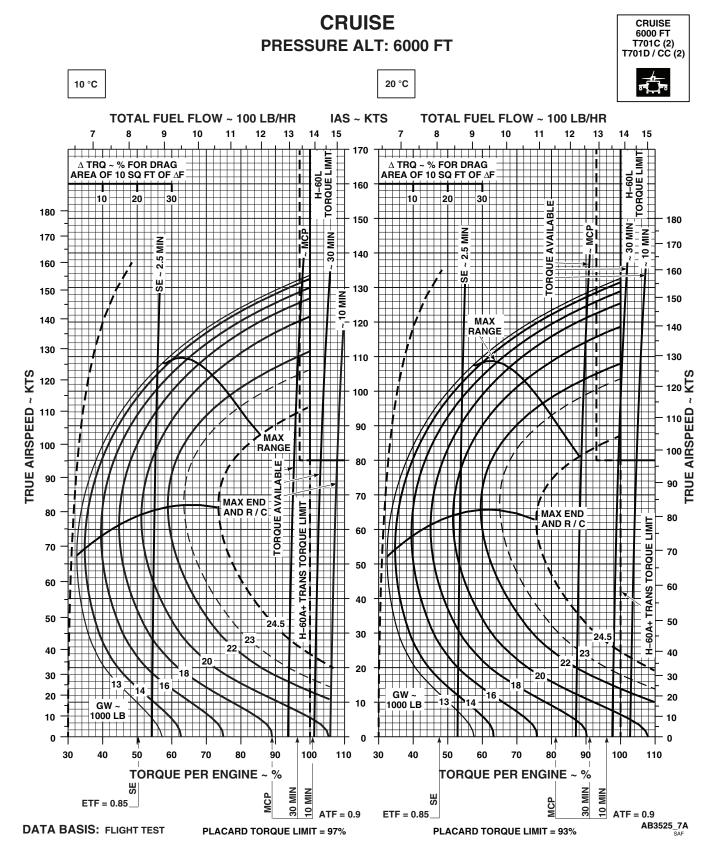


Figure 7A-16. Cruise High Drag - Altitude 6,000 Feet (Sheet 7 of 9)

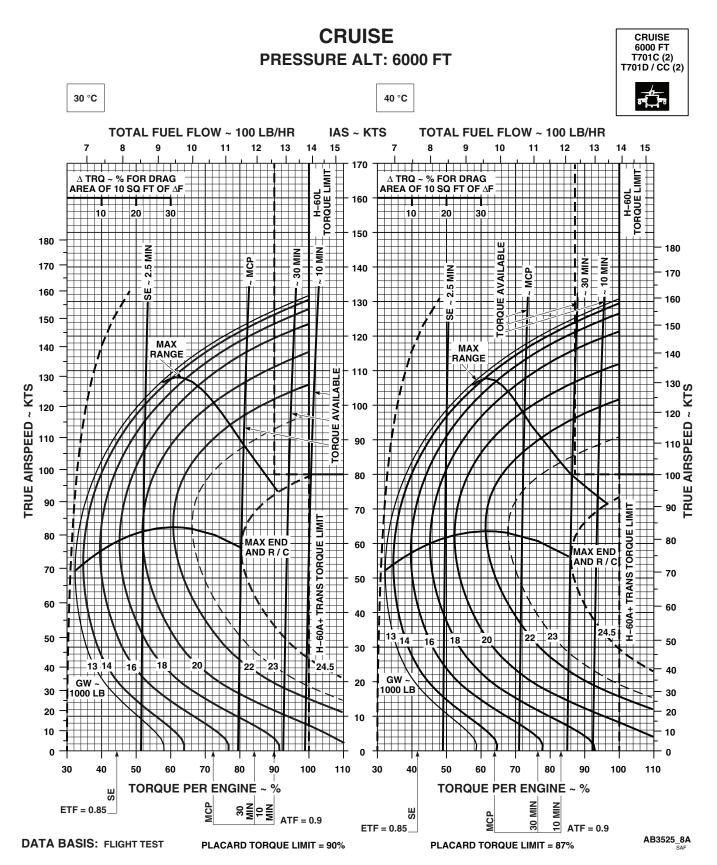


Figure 7A-16. Cruise High Drag - Altitude 6,000 Feet (Sheet 8 of 9)

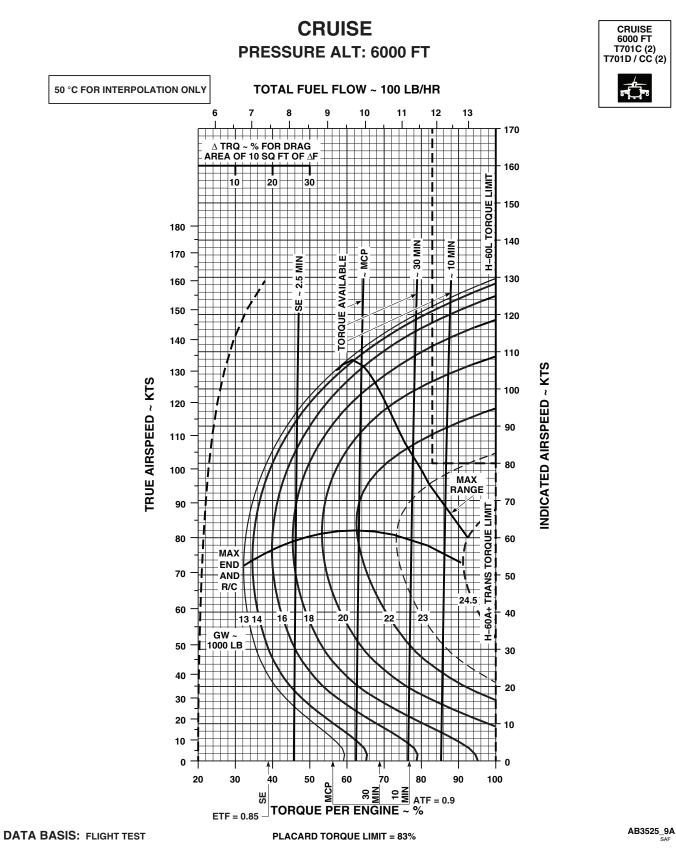


Figure 7A-16. Cruise High Drag - Altitude 6,000 Feet (Sheet 9 of 9)

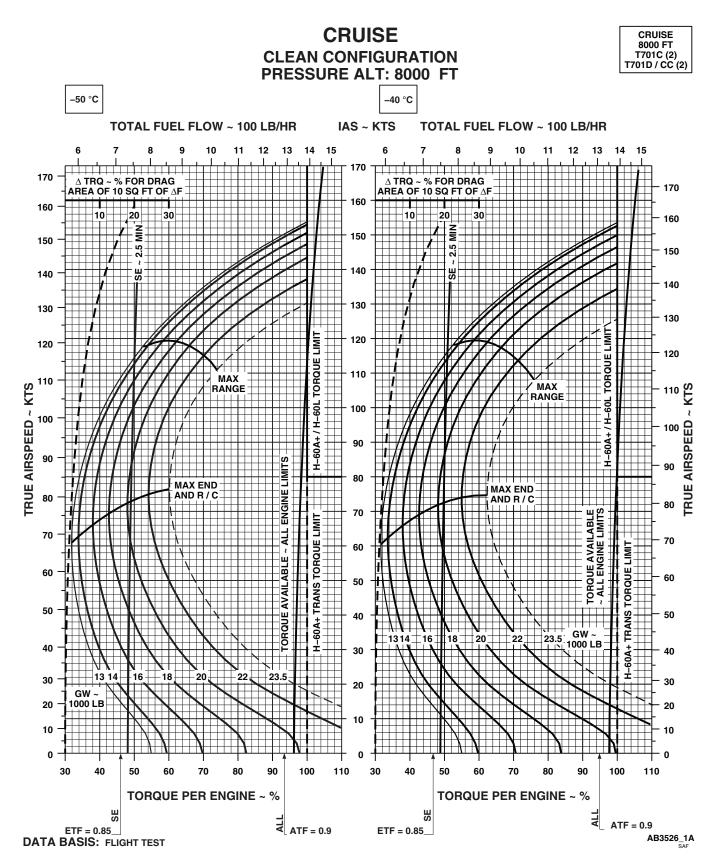


Figure 7A-17. Cruise - Altitude 8,000 Feet (Sheet 1 of 5)

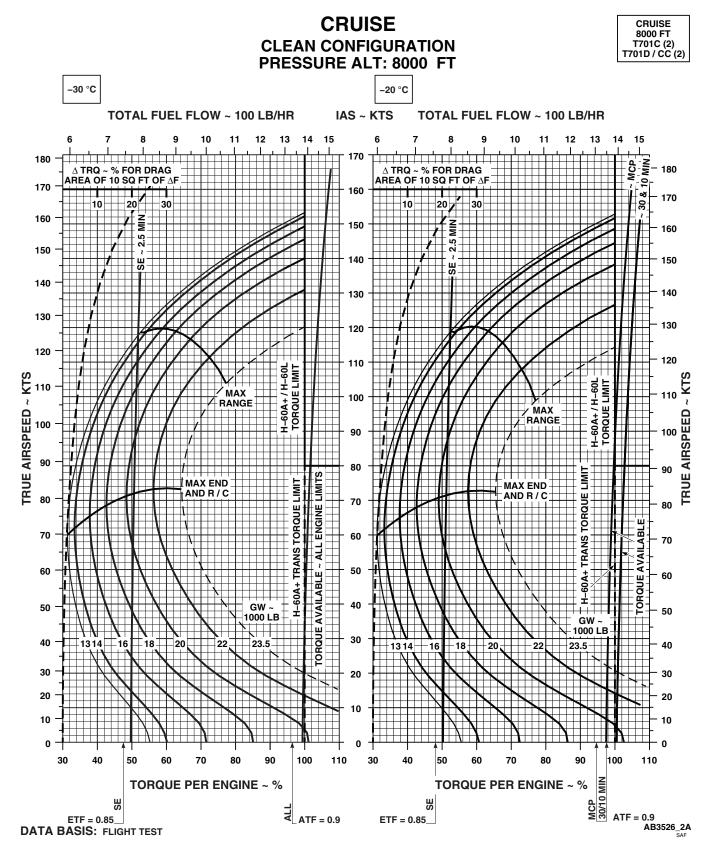


Figure 7A-17. Cruise - Altitude 8,000 Feet (Sheet 2 of 5)

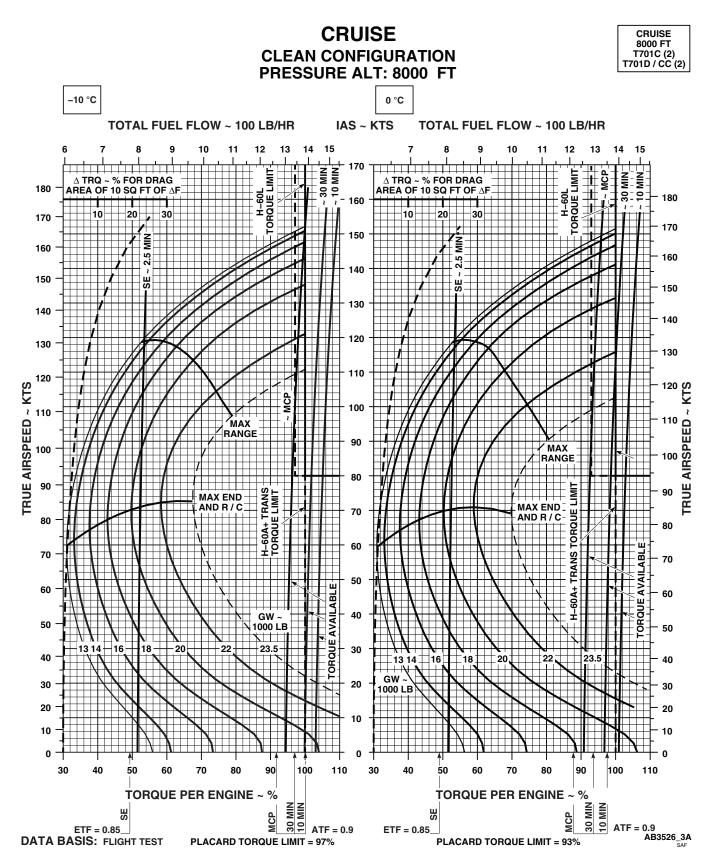


Figure 7A-17. Cruise - Altitude 8,000 Feet (Sheet 3 of 5)

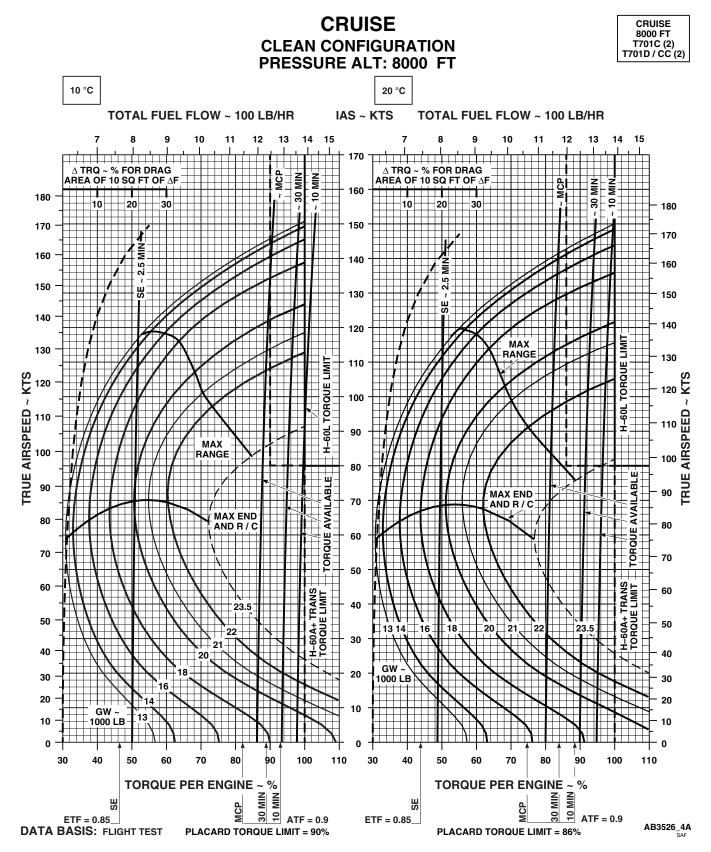


Figure 7A-17. Cruise - Altitude 8,000 Feet (Sheet 4 of 5)

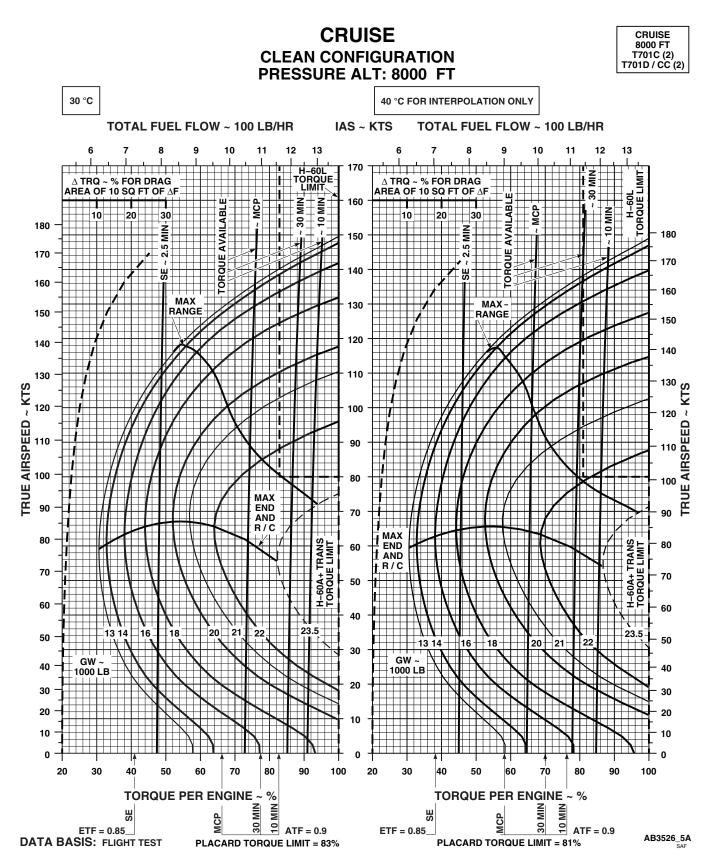


Figure 7A-17. Cruise - Altitude 8,000 Feet (Sheet 5 of 5)

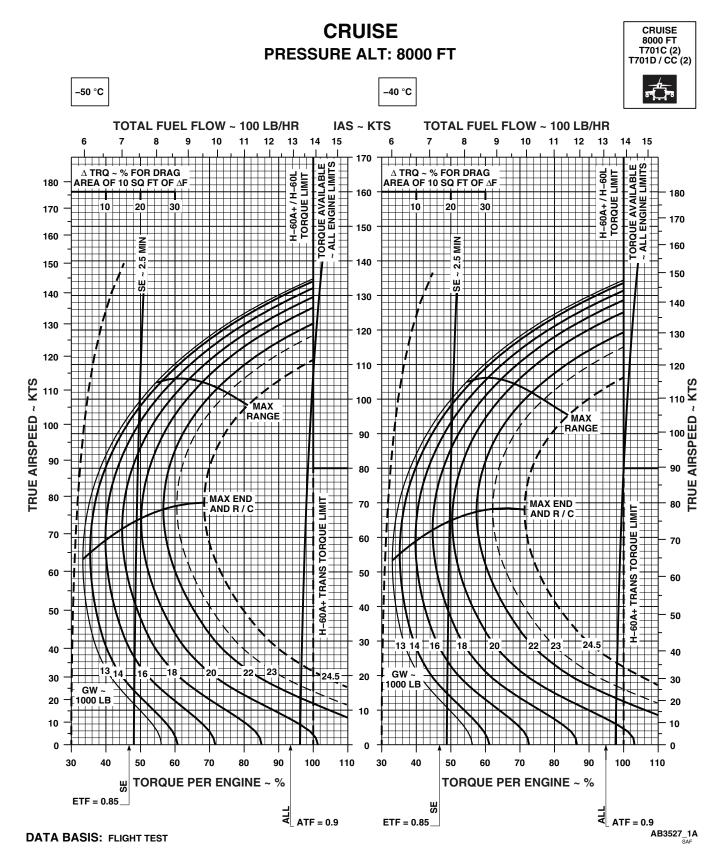
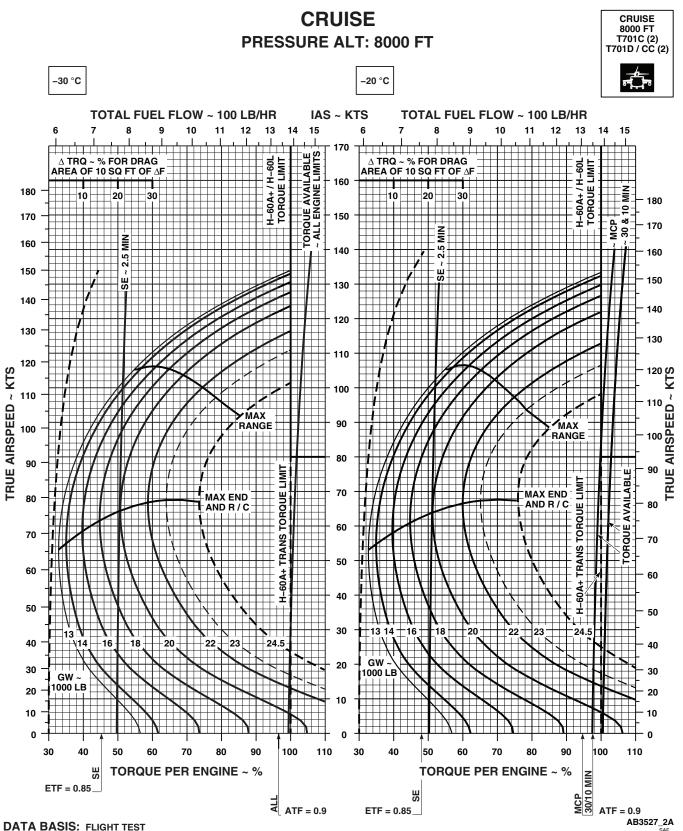


Figure 7A-18. Cruise High Drag - Altitude 8,000 Feet (Sheet 1 of 5)



**DATA BASIS:** FLIGHT TEST

Figure 7A-18. Cruise High Drag - Altitude 8,000 Feet (Sheet 2 of 5)

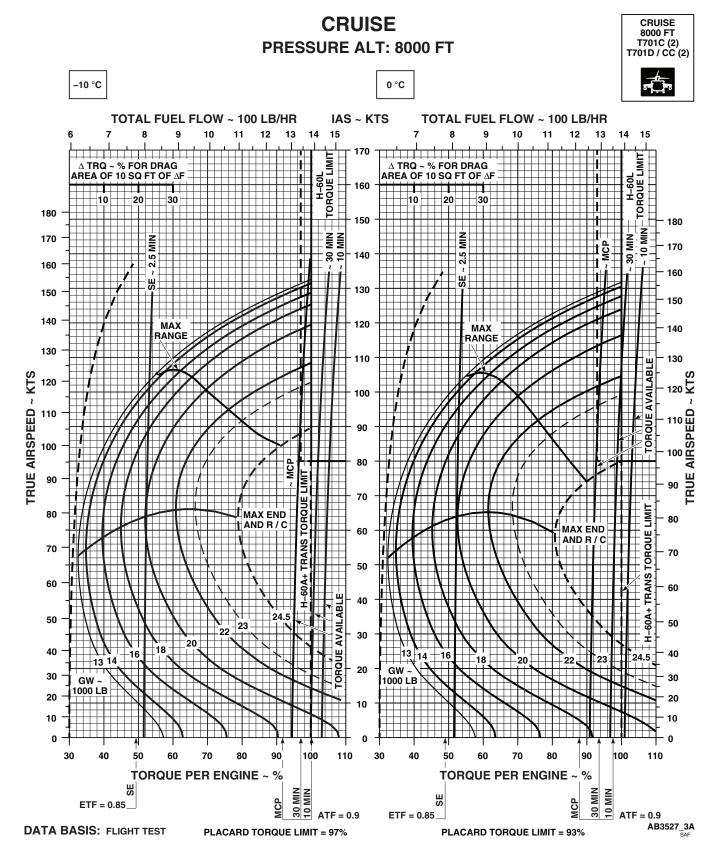


Figure 7A-18. Cruise High Drag - Altitude 8,000 Feet (Sheet 3 of 5)

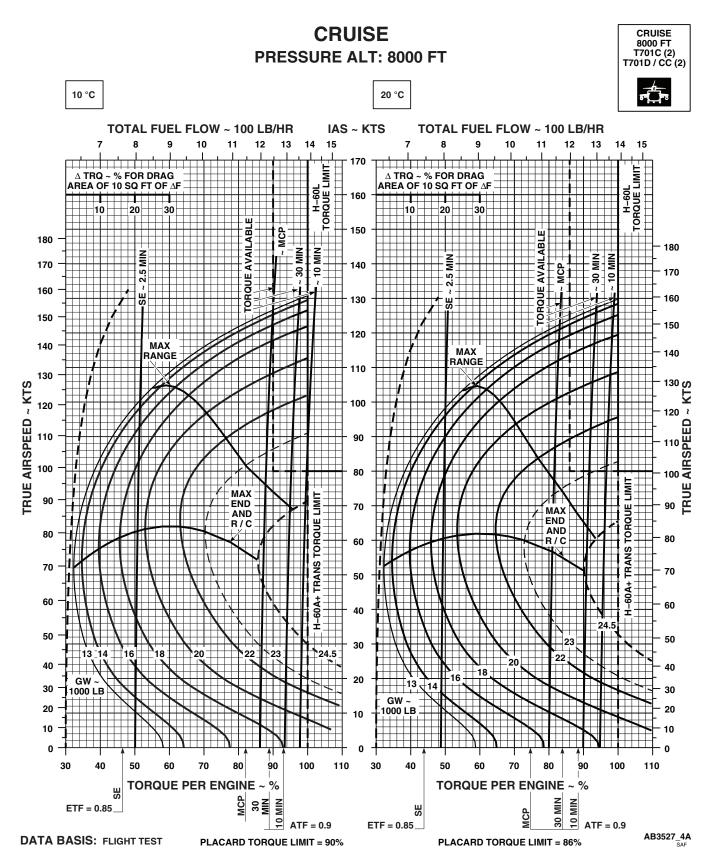


Figure 7A-18. Cruise High Drag - Altitude 8,000 Feet (Sheet 4 of 5)

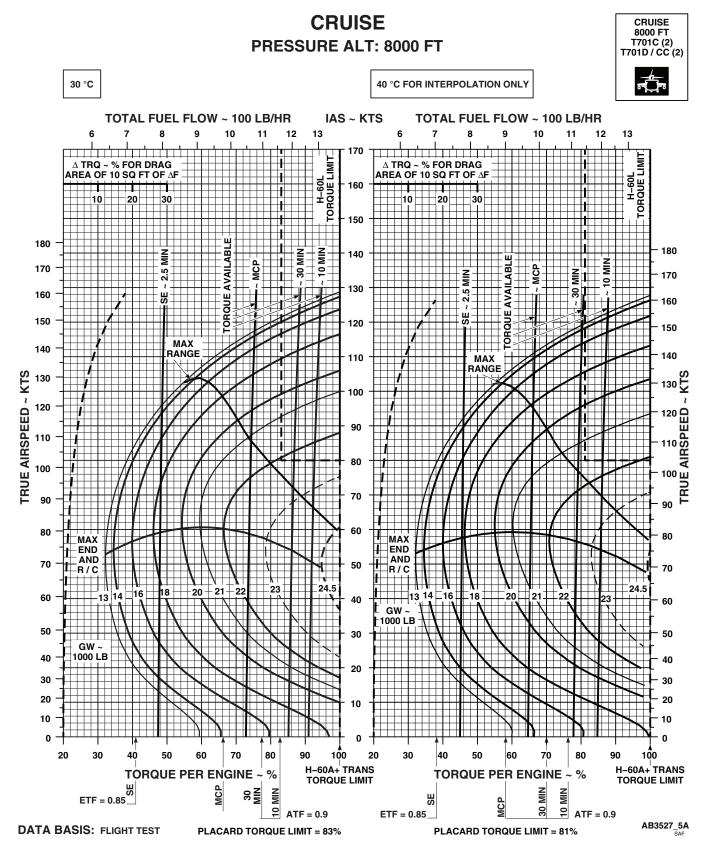


Figure 7A-18. Cruise High Drag - Altitude 8,000 Feet (Sheet 5 of 5)

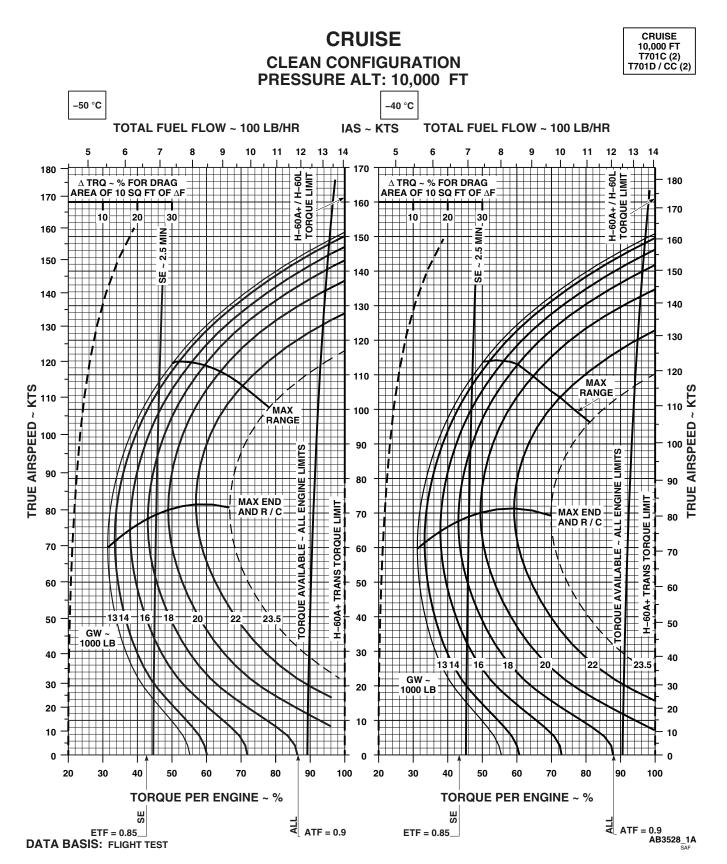


Figure 7A-19. Cruise - Altitude 10,000 Feet (Sheet 1 of 5)

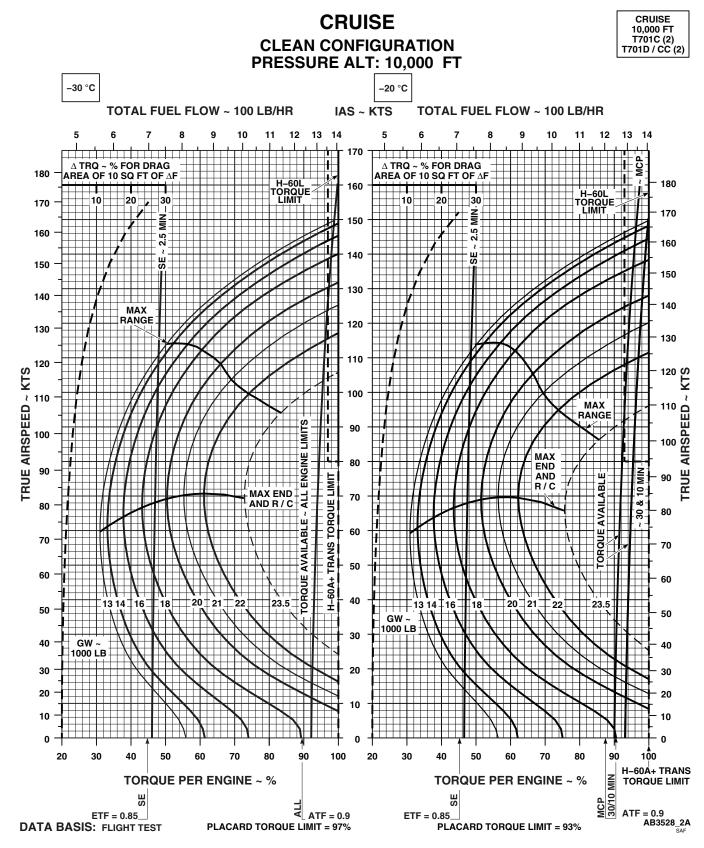


Figure 7A-19. Cruise - Altitude 10,000 Feet (Sheet 2 of 5)

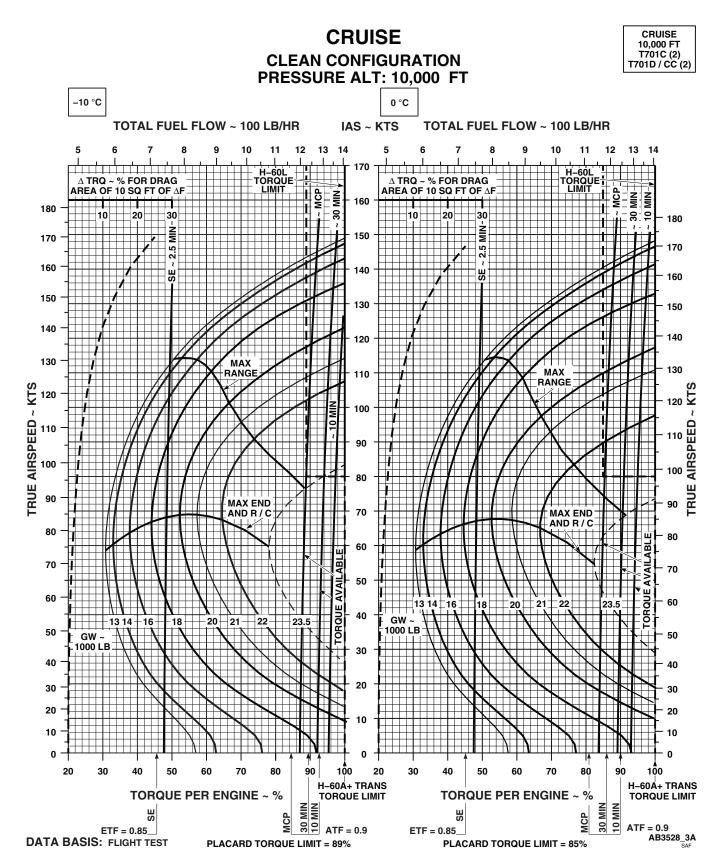


Figure 7A-19. Cruise - Altitude 10,000 Feet (Sheet 3 of 5)

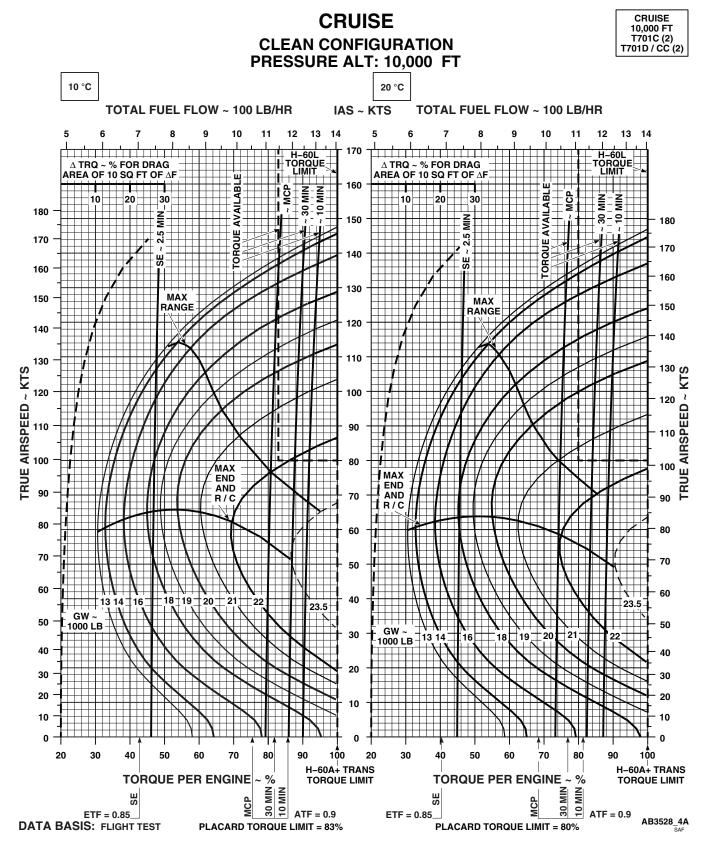


Figure 7A-19. Cruise - Altitude 10,000 Feet (Sheet 4 of 5)

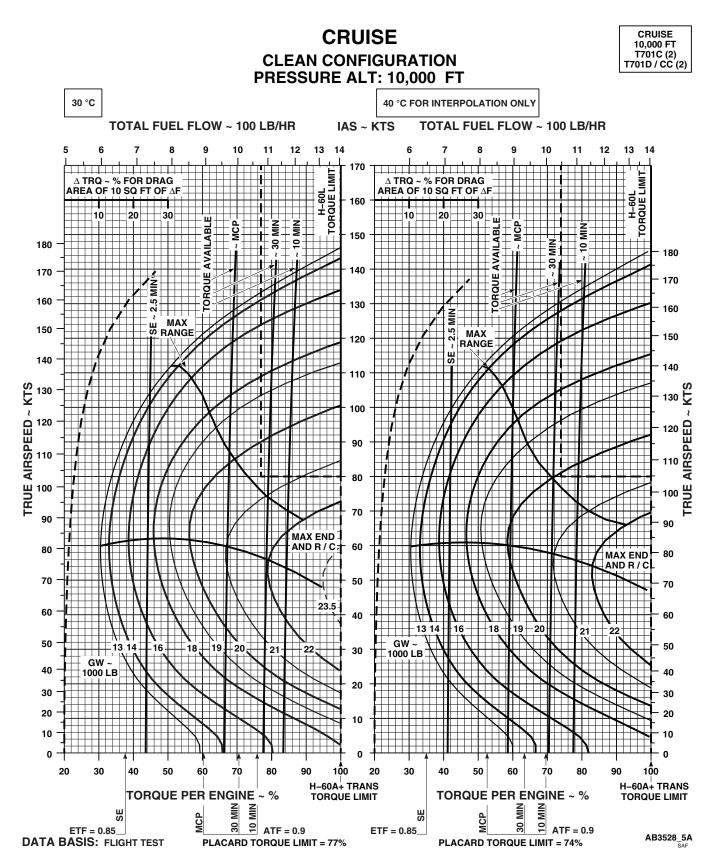


Figure 7A-19. Cruise - Altitude 10,000 Feet (Sheet 5 of 5)

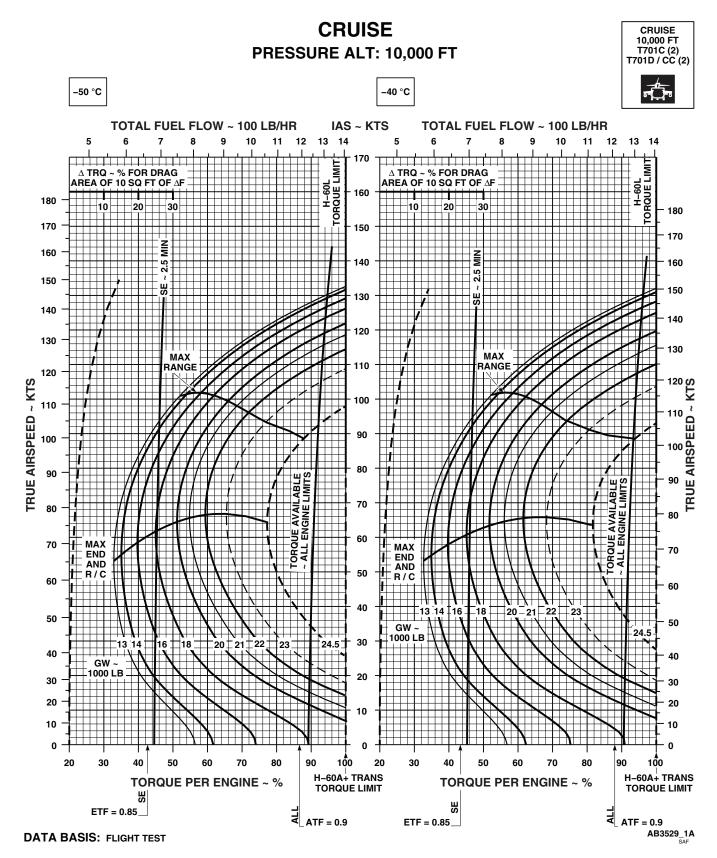


Figure 7A-20. Cruise High Drag - Altitude 10,000 Feet (Sheet 1 of 5)

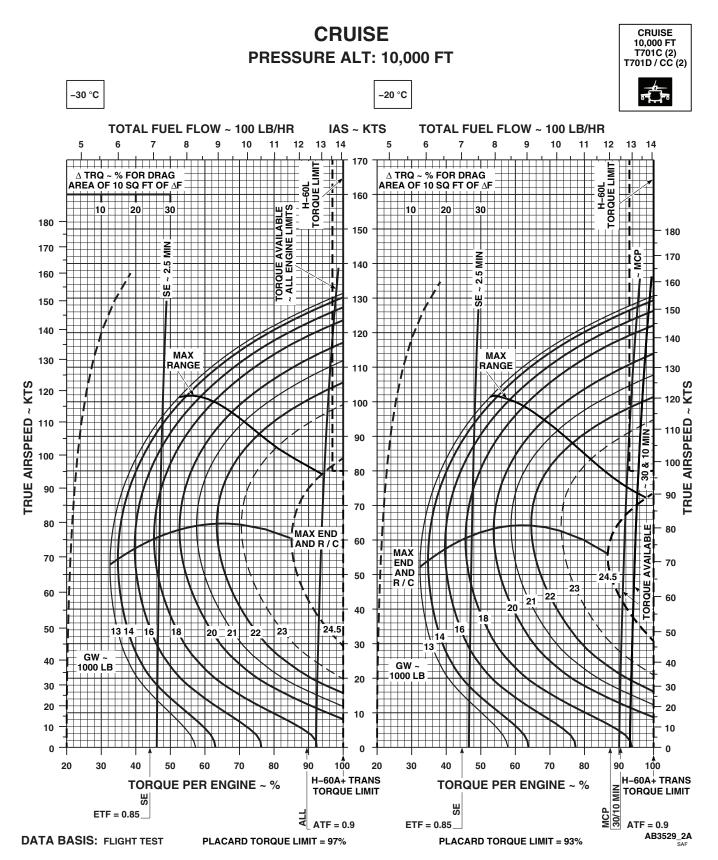


Figure 7A-20. Cruise High Drag - Altitude 10,000 Feet (Sheet 2 of 5)

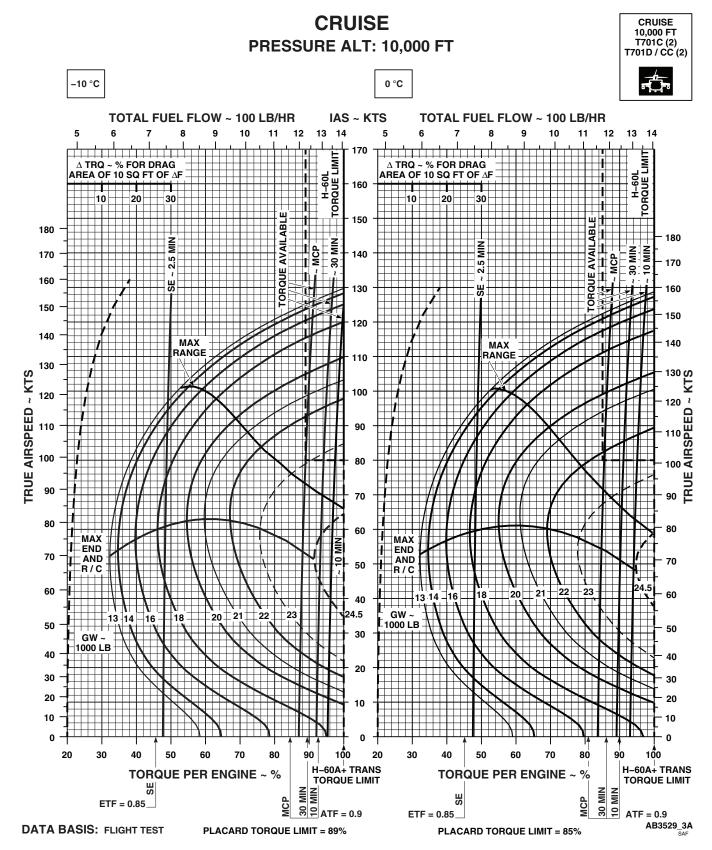


Figure 7A-20. Cruise High Drag - Altitude 10,000 Feet (Sheet 3 of 5)

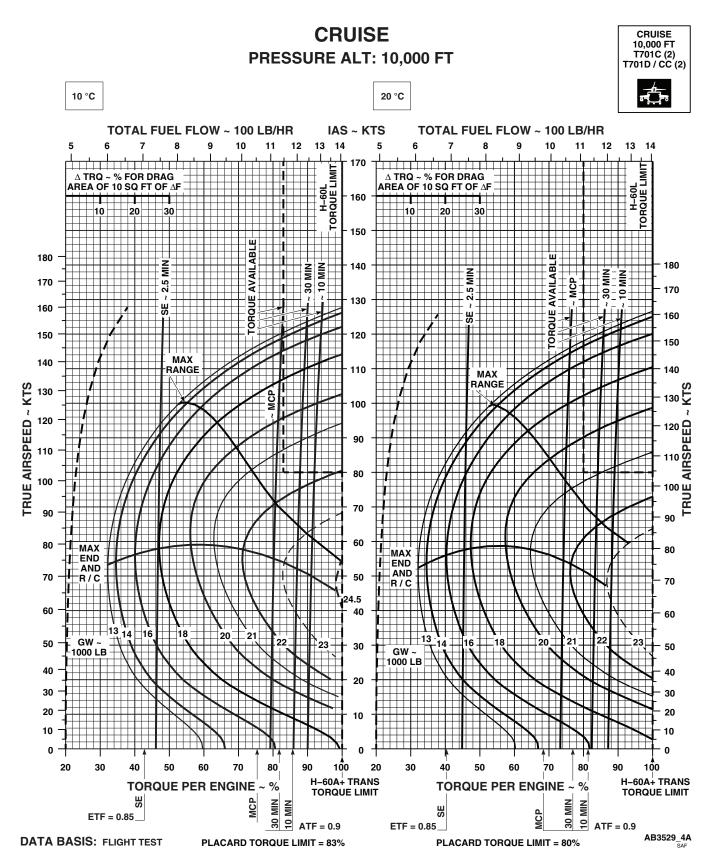


Figure 7A-20. Cruise High Drag - Altitude 10,000 Feet (Sheet 4 of 5)

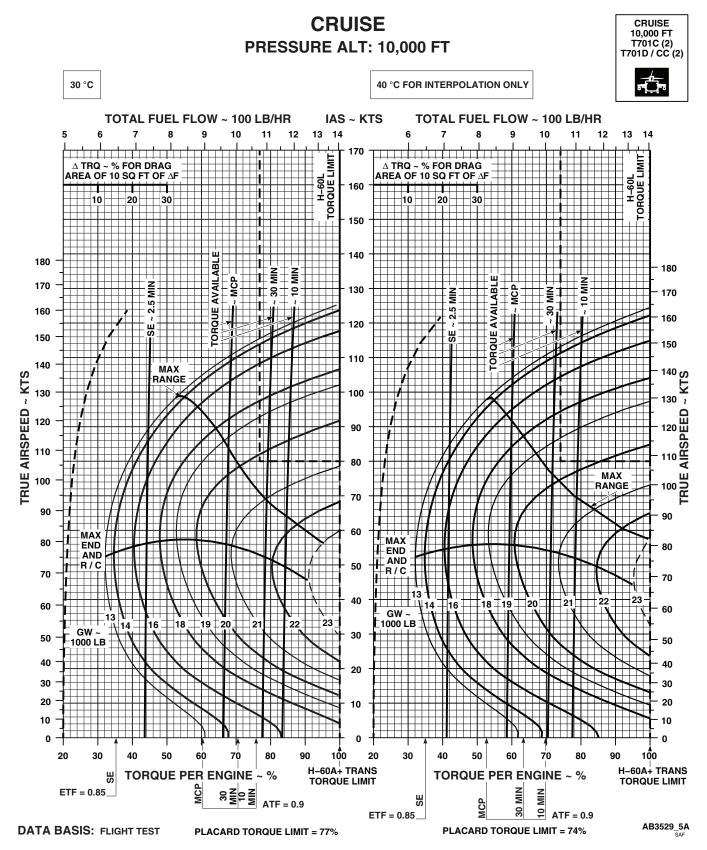


Figure 7A-20. Cruise High Drag - Altitude 10,000 Feet (Sheet 5 of 5)

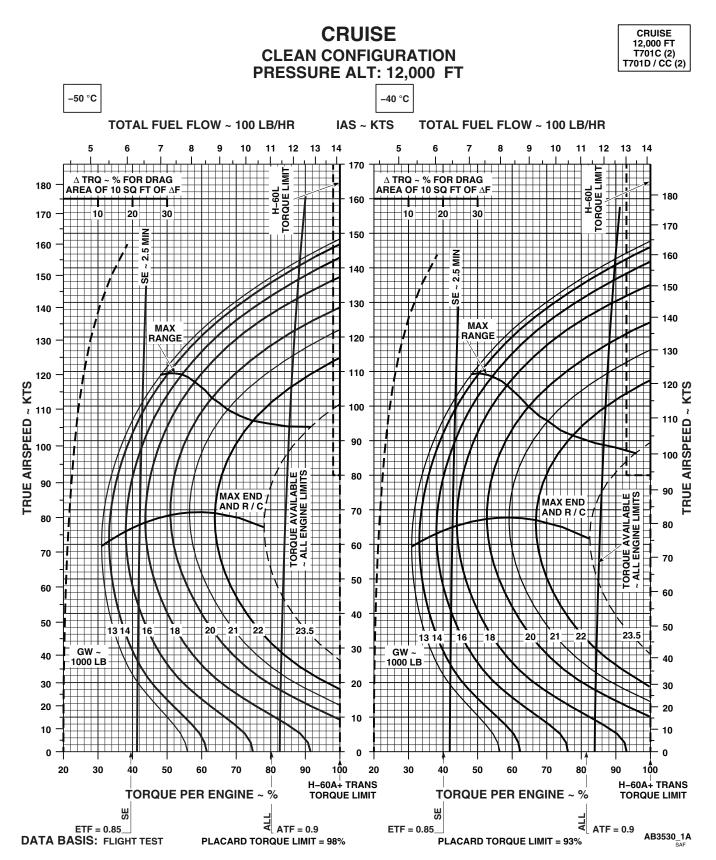


Figure 7A-21. Cruise - Altitude 12,000 Feet (Sheet 1 of 5)

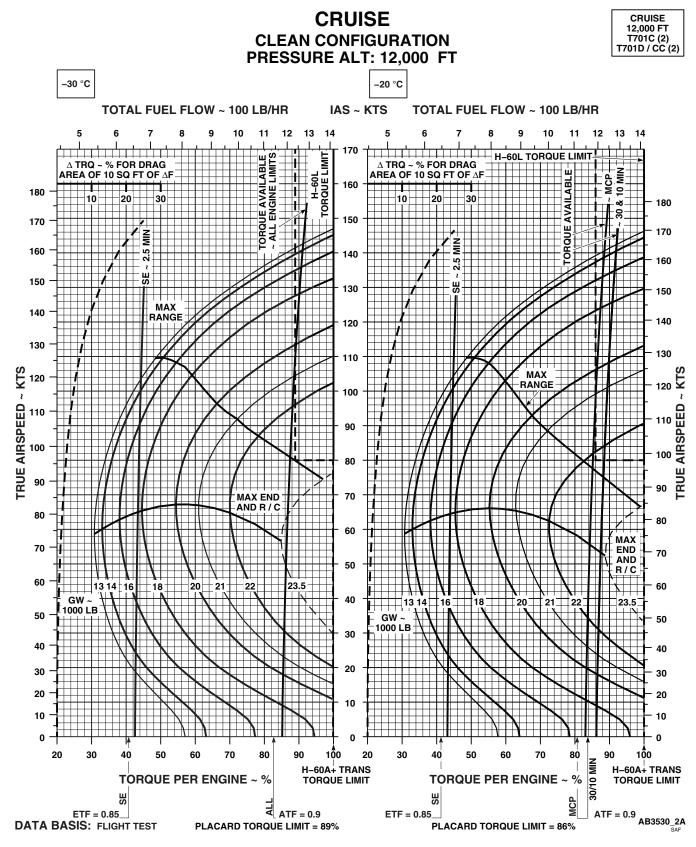


Figure 7A-21. Cruise - Altitude 12,000 Feet (Sheet 2 of 5)

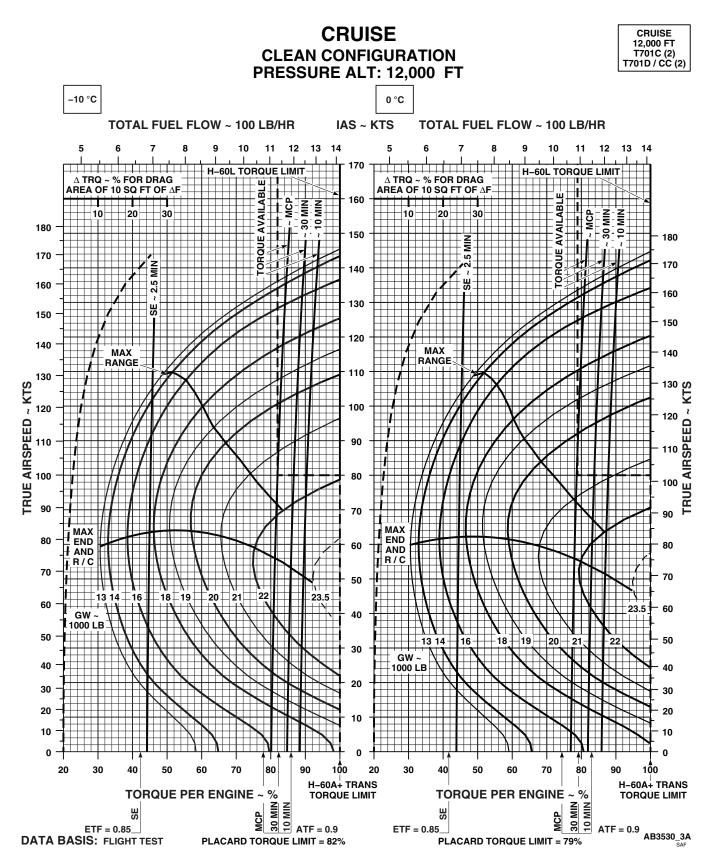


Figure 7A-21. Cruise - Altitude 12,000 Feet (Sheet 3 of 5)

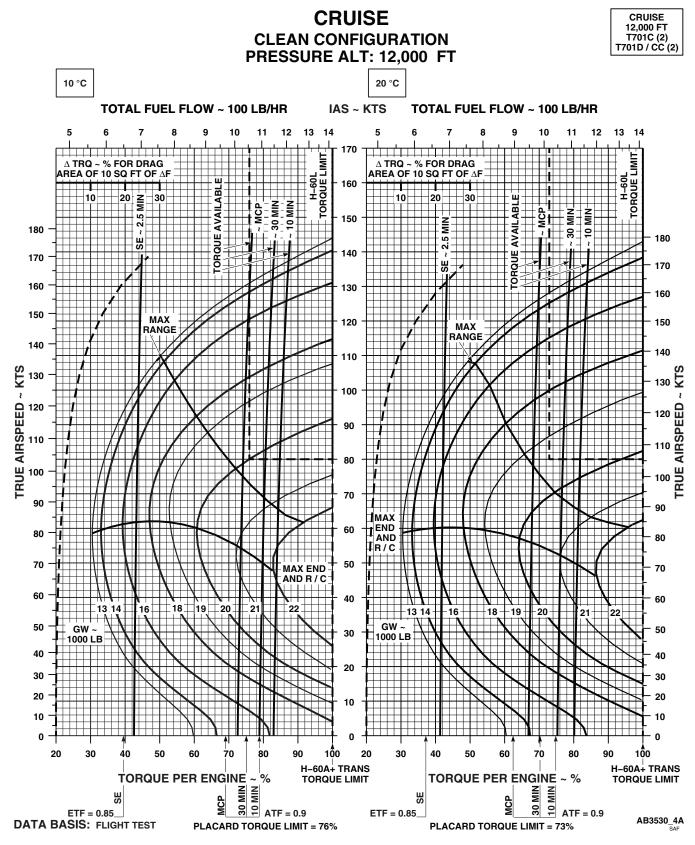
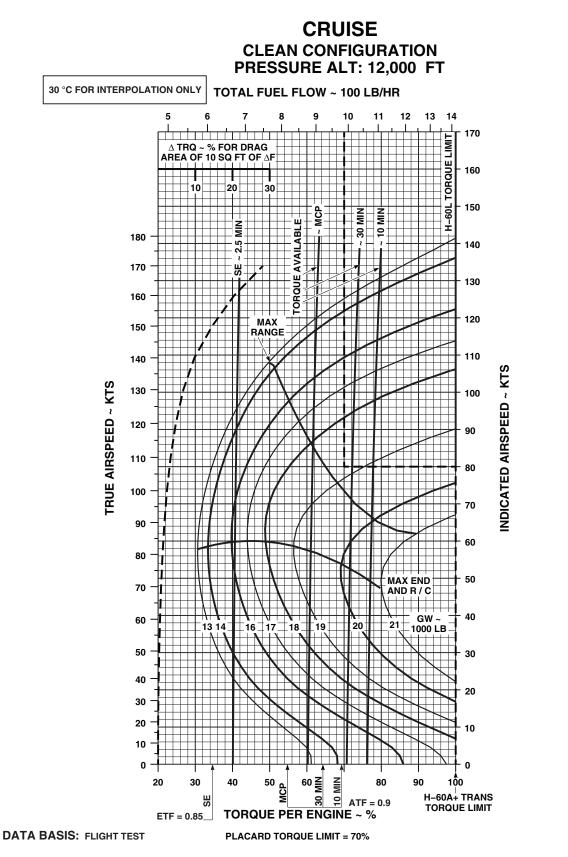


Figure 7A-21. Cruise - Altitude 12,000 Feet (Sheet 4 of 5)





CRUISE 12,000 FT T701C (2) T701D / CC (2)

Figure 7A-21. Cruise - Altitude 12,000 Feet (Sheet 5 of 5)

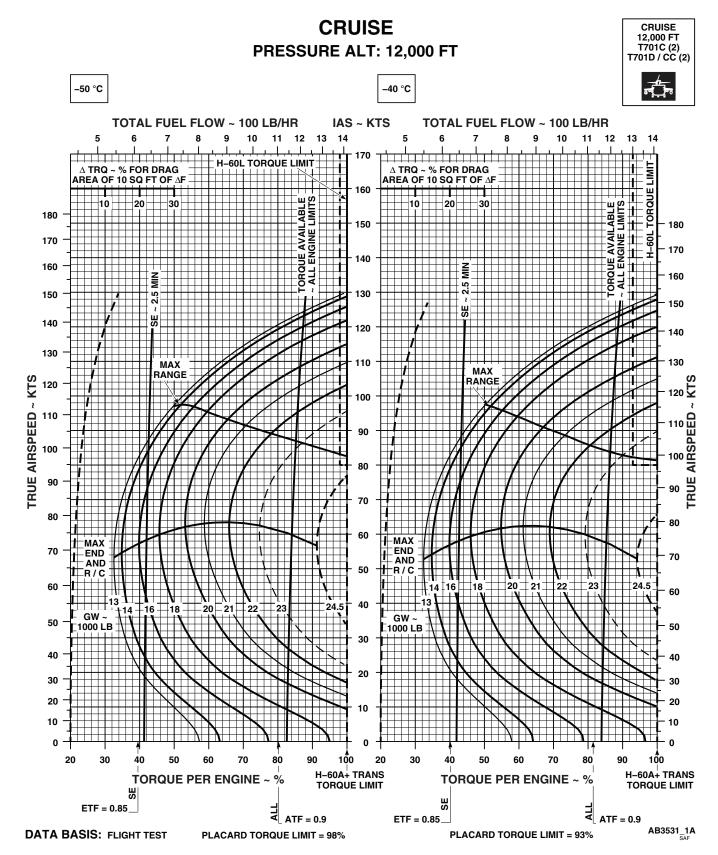


Figure 7A-22. Cruise High Drag - Altitude 12,000 Feet (Sheet 1 of 5)

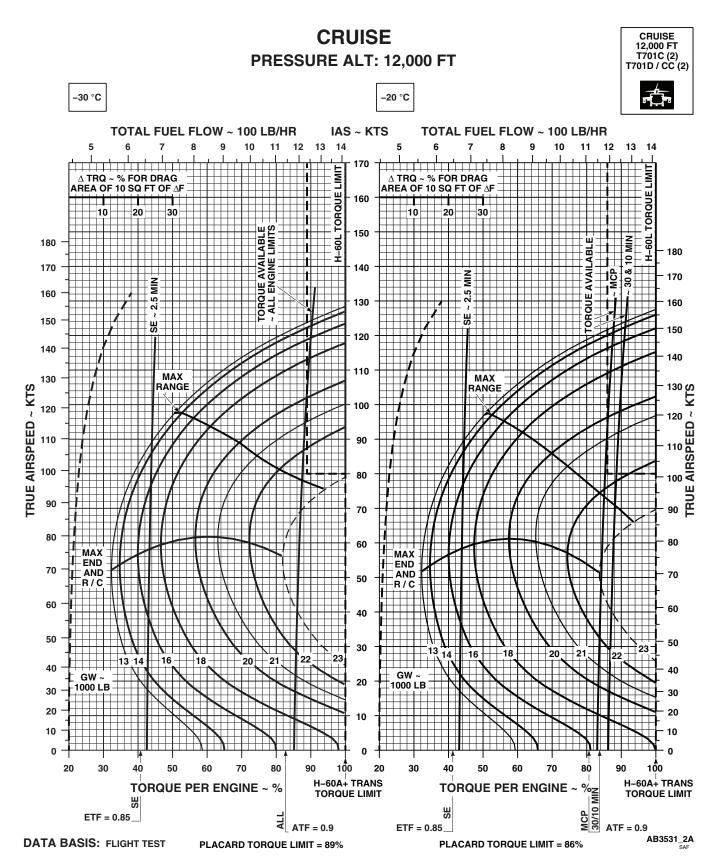


Figure 7A-22. Cruise High Drag - Altitude 12,000 Feet (Sheet 2 of 5)

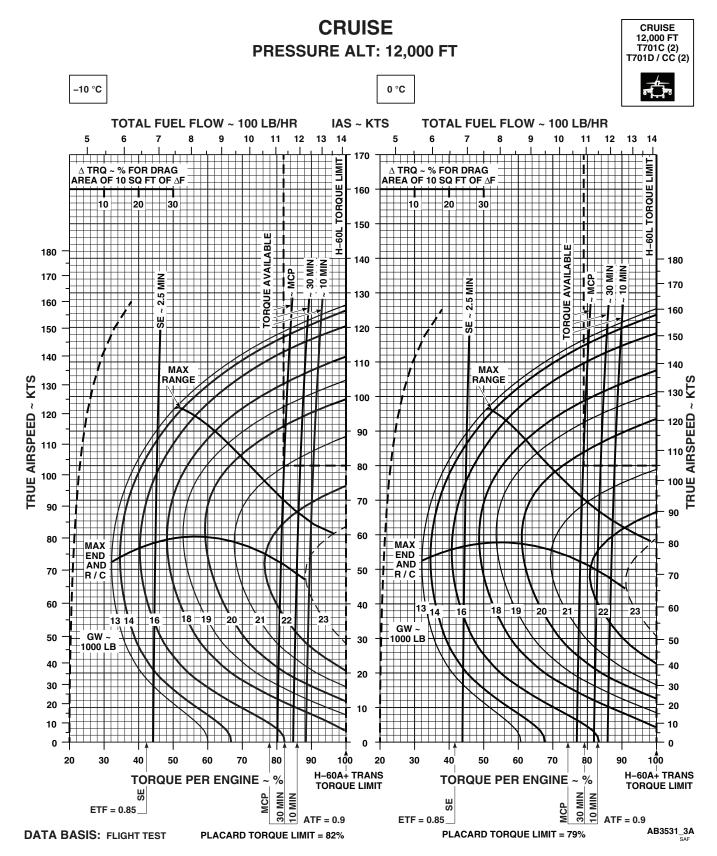


Figure 7A-22. Cruise High Drag - Altitude 12,000 Feet (Sheet 3 of 5)

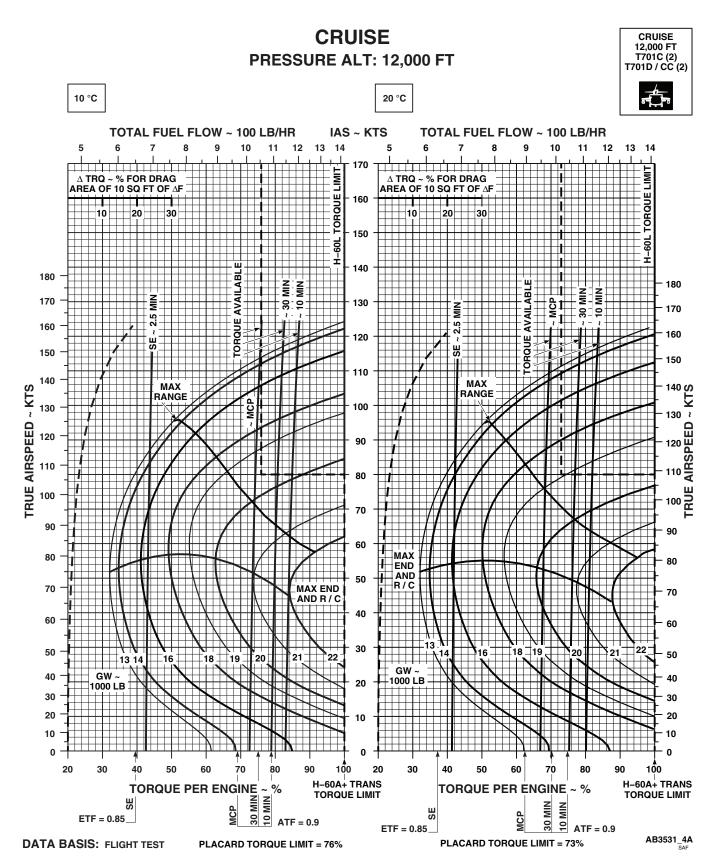


Figure 7A-22. Cruise High Drag - Altitude 12,000 Feet (Sheet 4 of 5)

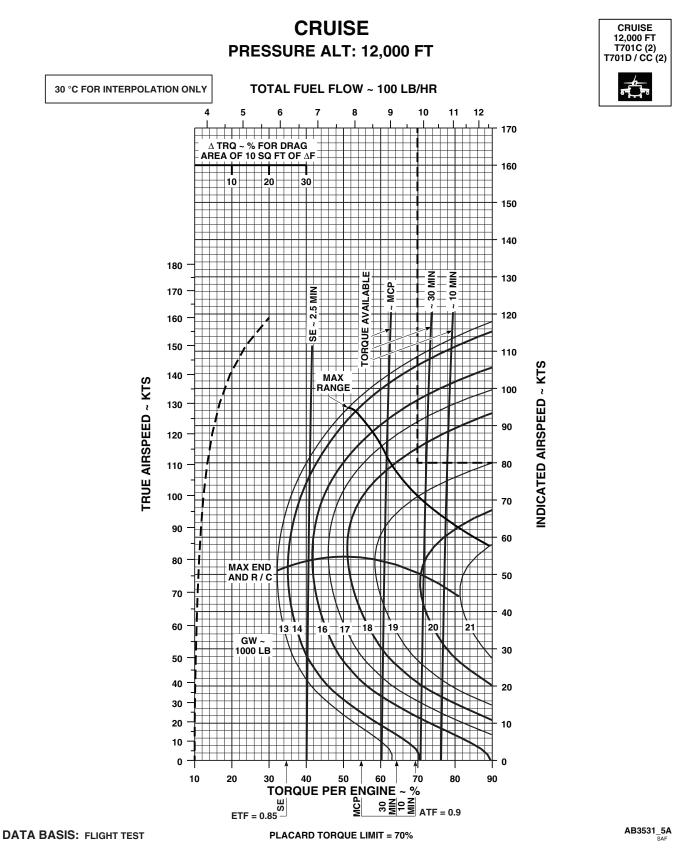


Figure 7A-22. Cruise High Drag - Altitude 12,000 Feet (Sheet 5 of 5)

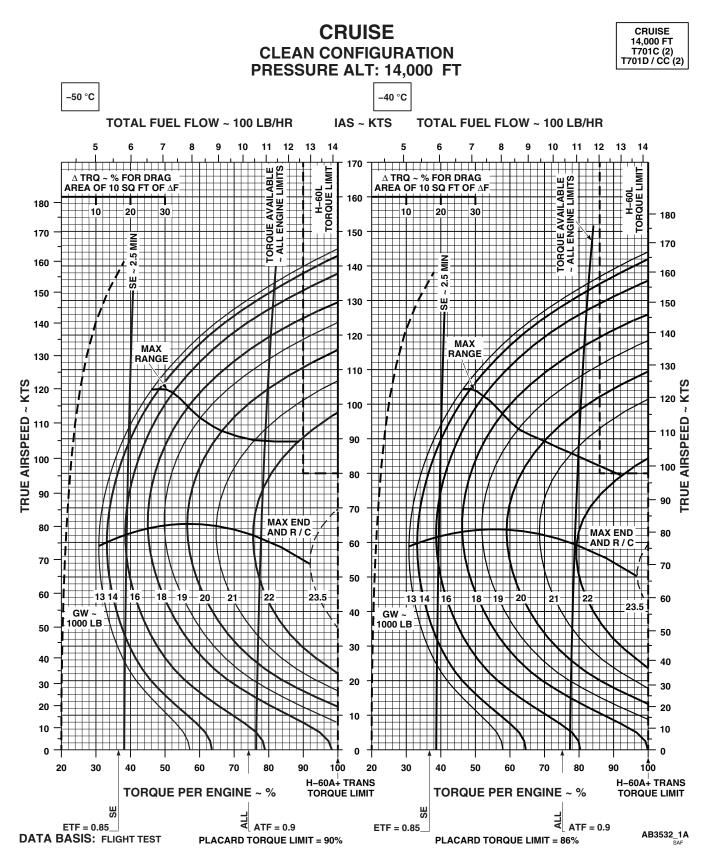


Figure 7A-23. Cruise - Altitude 14,000 Feet (Sheet 1 of 5)

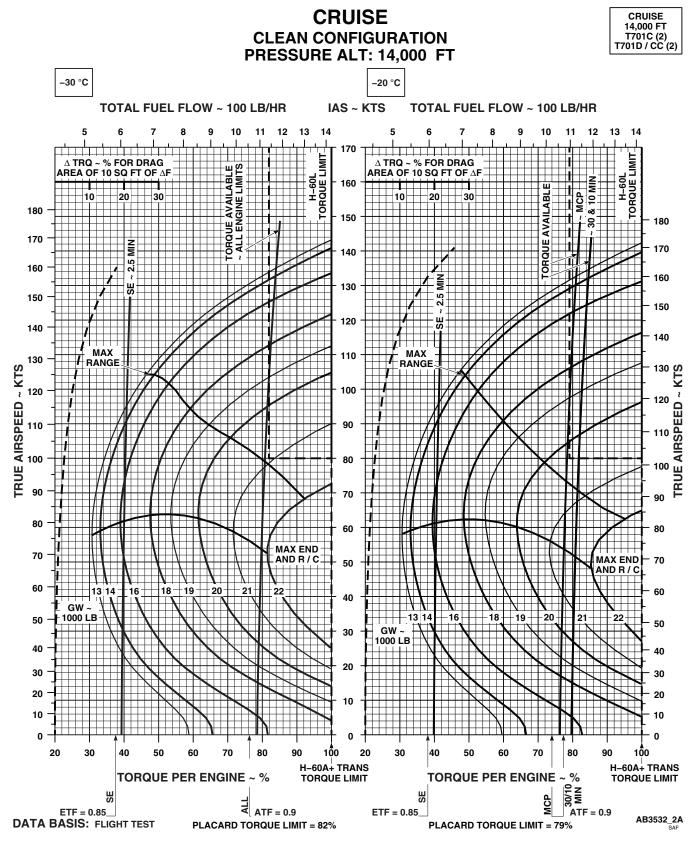


Figure 7A-23. Cruise - Altitude 14,000 Feet (Sheet 2 of 5)

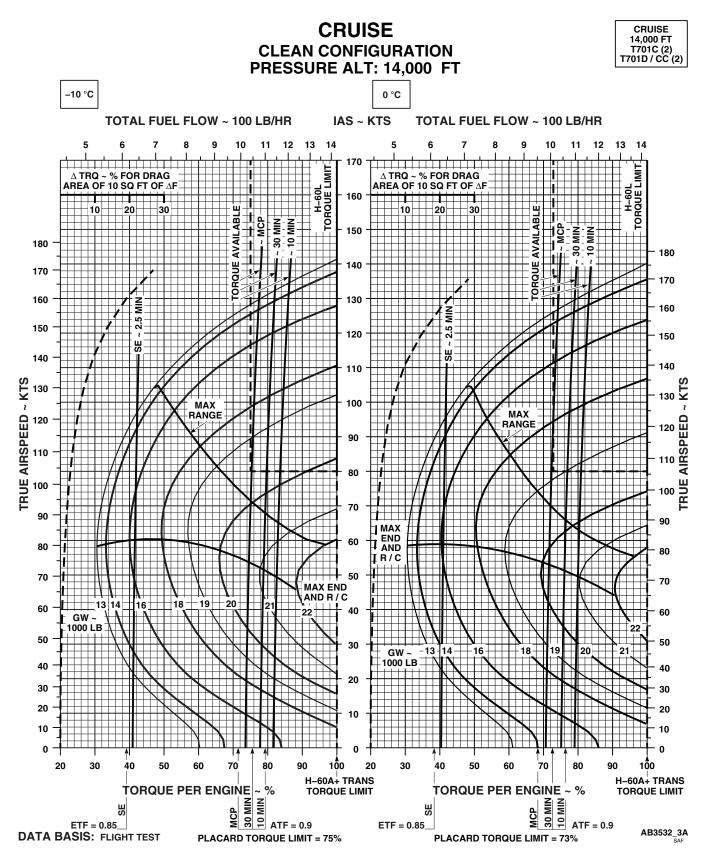


Figure 7A-23. Cruise - Altitude 14,000 Feet (Sheet 3 of 5)

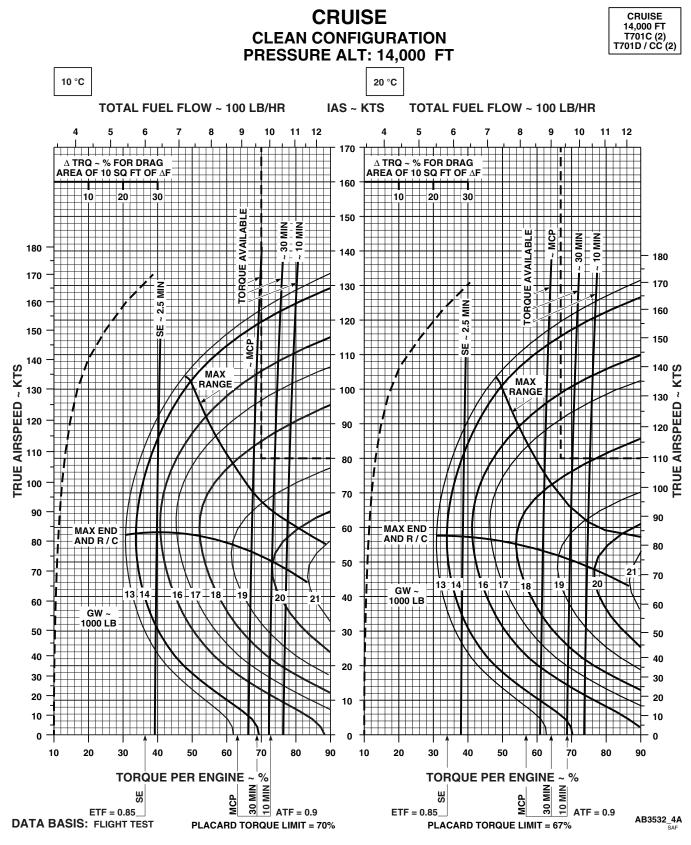


Figure 7A-23. Cruise - Altitude 14,000 Feet (Sheet 4 of 5)

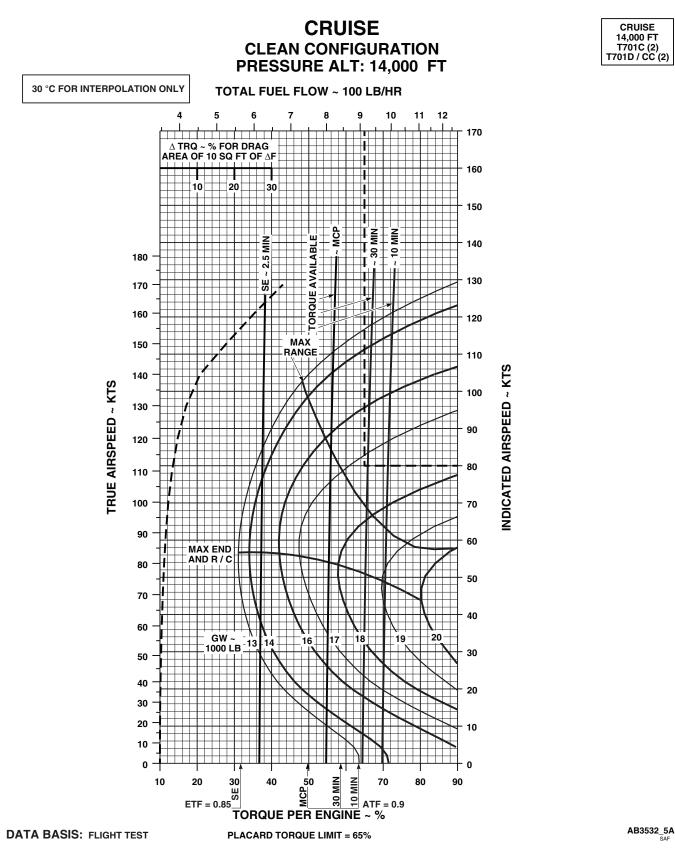


Figure 7A-23. Cruise - Altitude 14,000 Feet (Sheet 5 of 5)

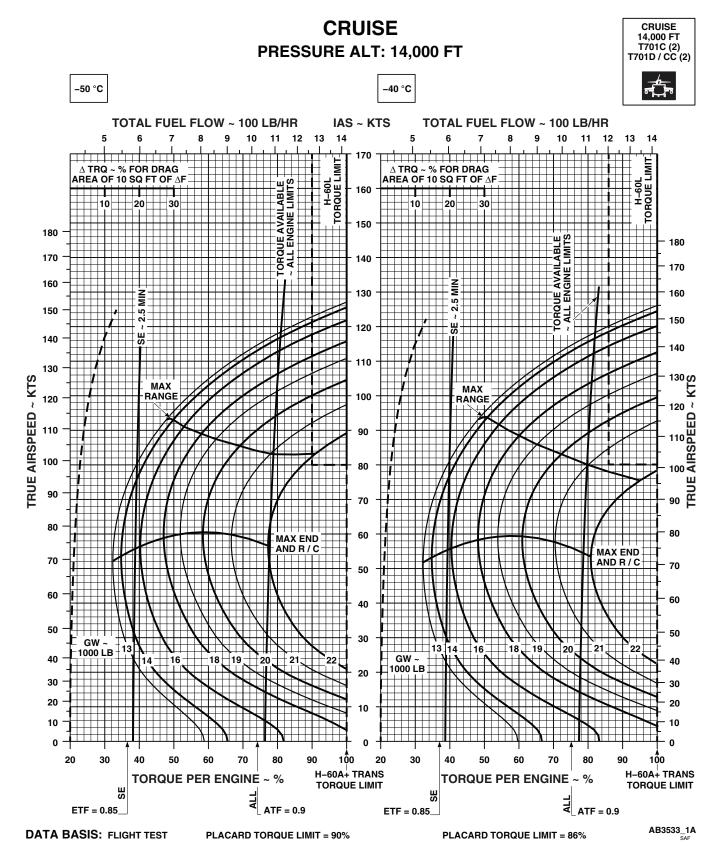


Figure 7A-24. Cruise High Drag - Altitude 14,000 Feet (Sheet 1 of 5)

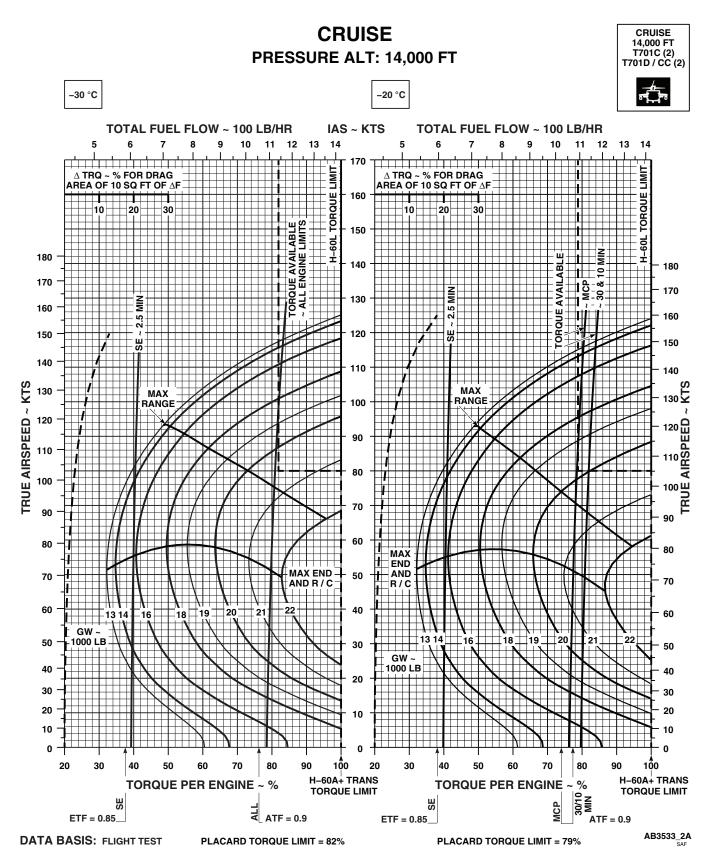


Figure 7A-24. Cruise High Drag - Altitude 14,000 Feet (Sheet 2 of 5)

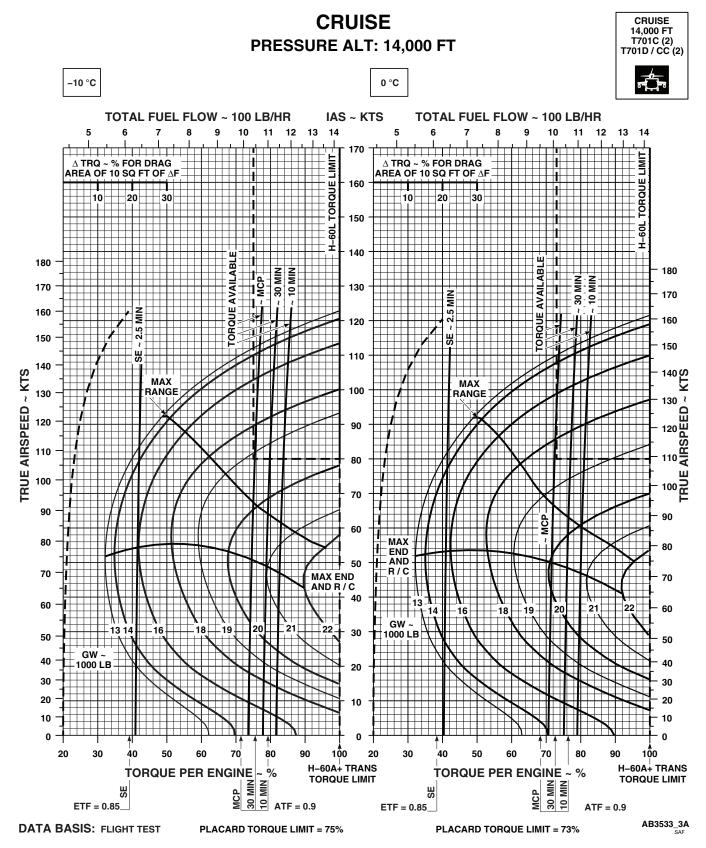


Figure 7A-24. Cruise High Drag - Altitude 14,000 Feet (Sheet 3 of 5)

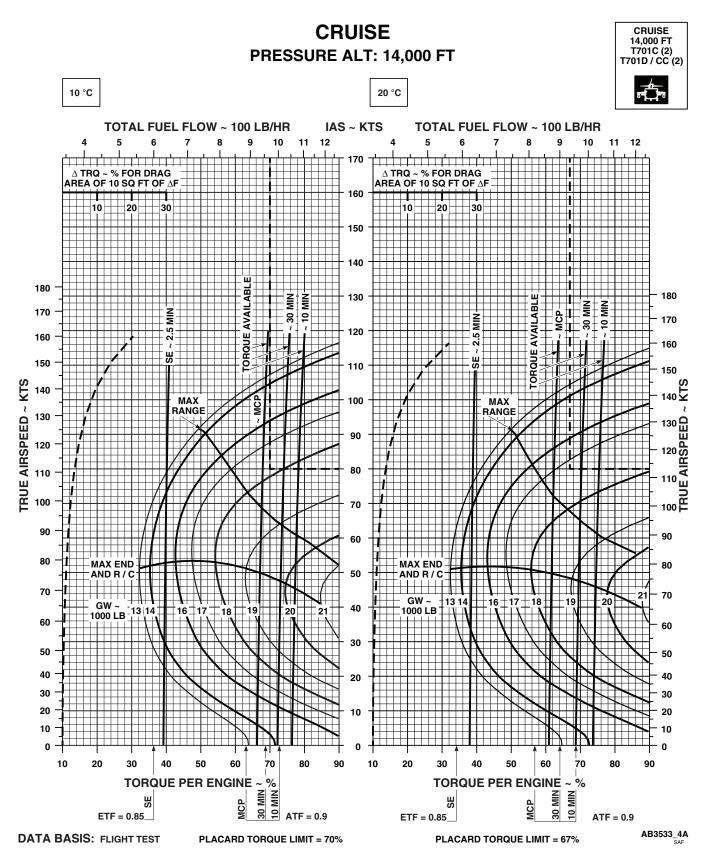


Figure 7A-24. Cruise High Drag - Altitude 14,000 Feet (Sheet 4 of 5)

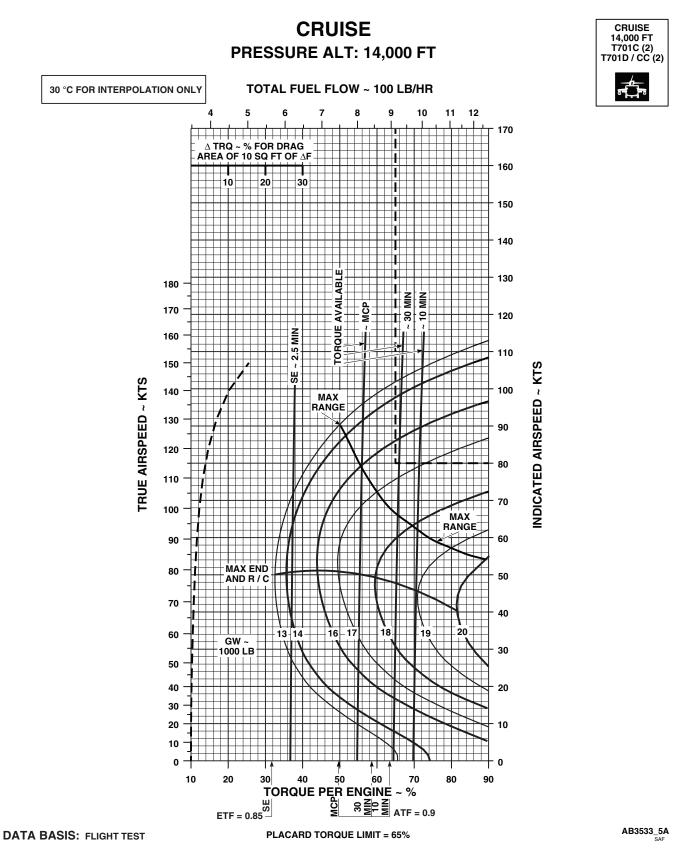


Figure 7A-24. Cruise High Drag - Altitude 14,000 Feet (Sheet 5 of 5)

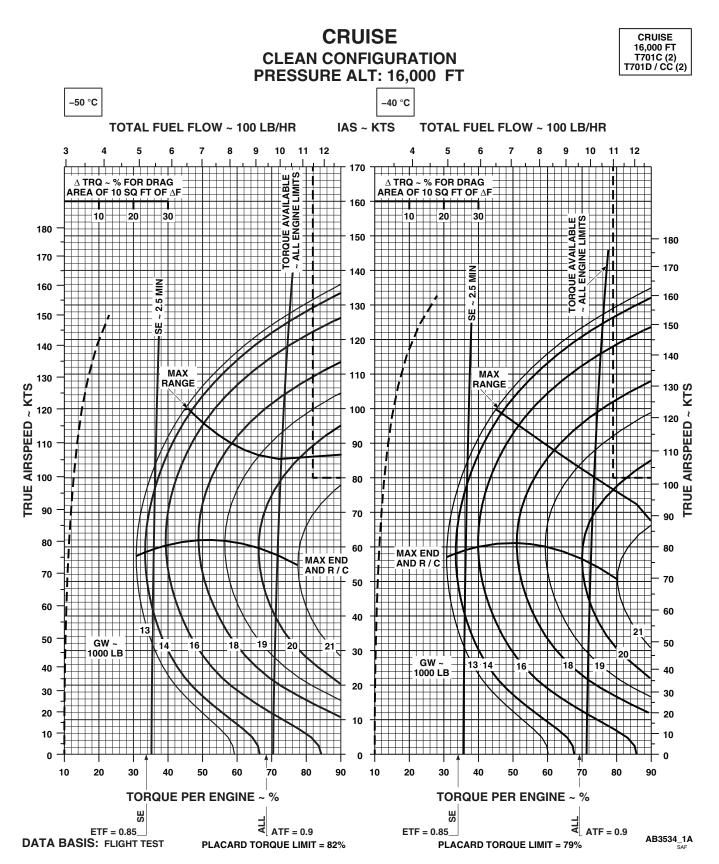


Figure 7A-25. Cruise - Altitude 16,000 Feet (Sheet 1 of 4)

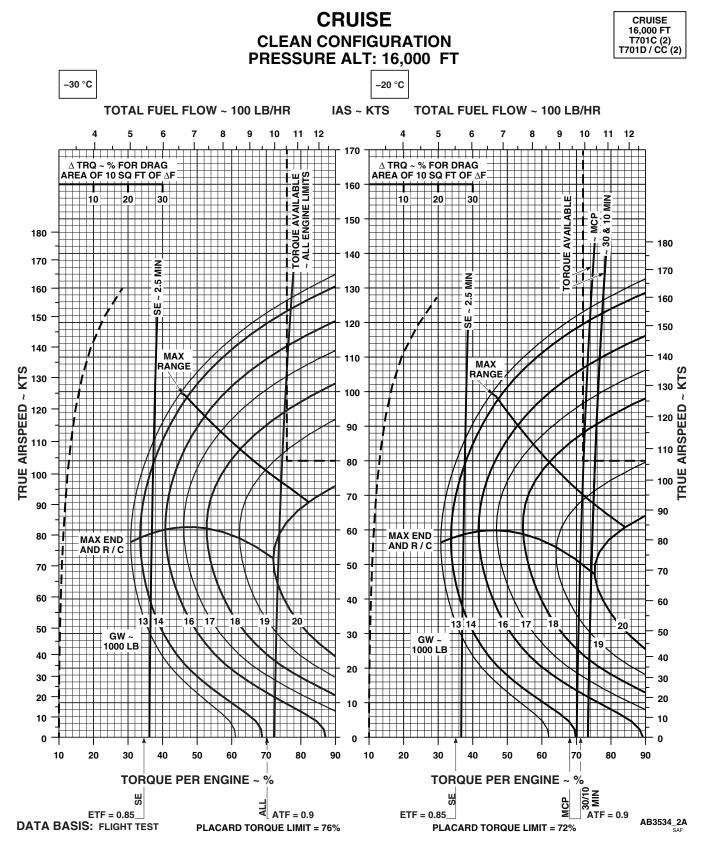


Figure 7A-25. Cruise - Altitude 16,000 Feet (Sheet 2 of 4)

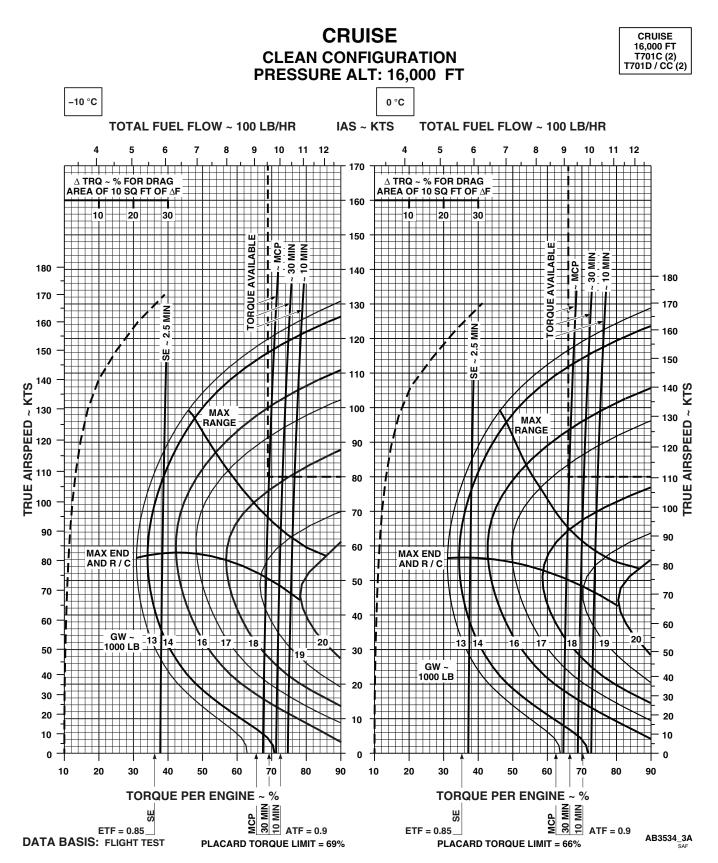


Figure 7A-25. Cruise - Altitude 16,000 Feet (Sheet 3 of 4)

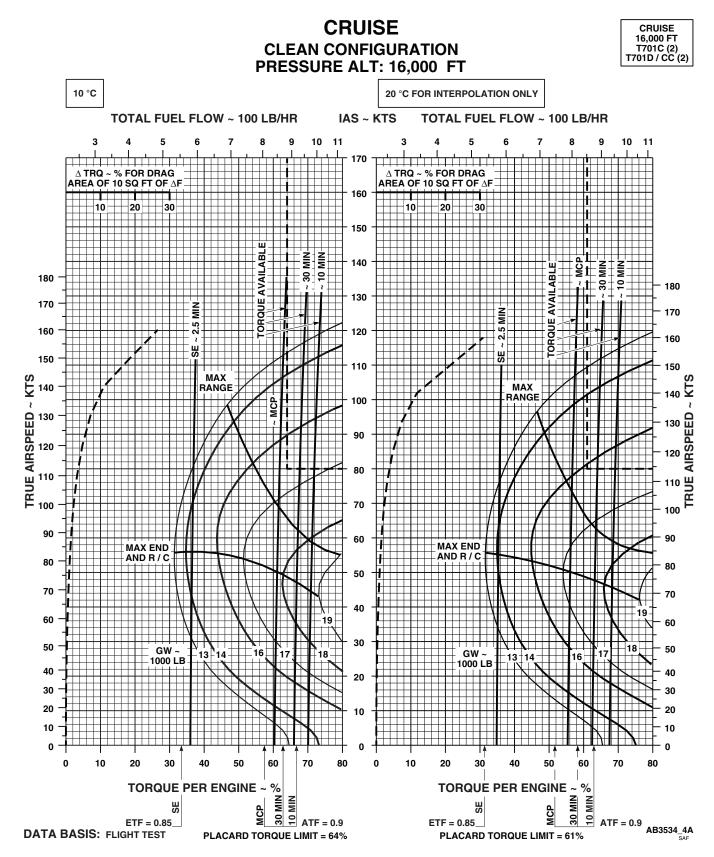


Figure 7A-25. Cruise - Altitude 16,000 Feet (Sheet 4 of 4)

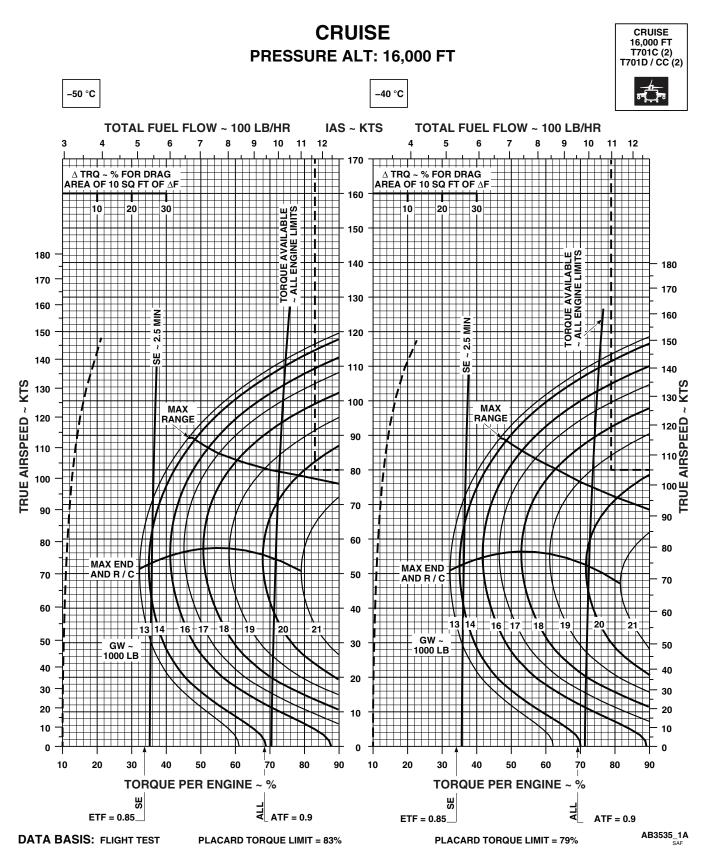


Figure 7A-26. Cruise High Drag - Altitude 16,000 Feet (Sheet 1 of 4)

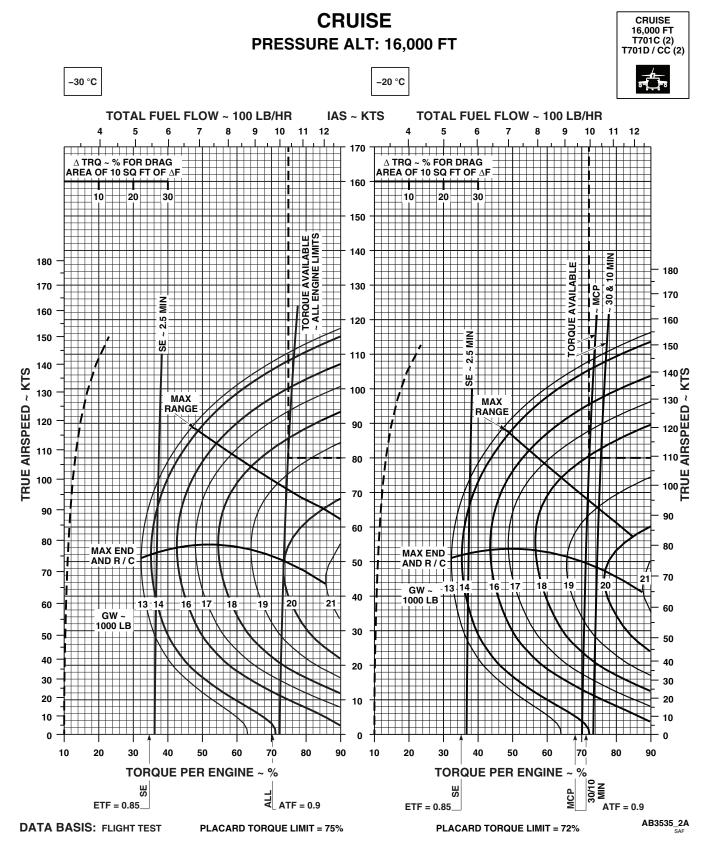


Figure 7A-26. Cruise High Drag - Altitude 16,000 Feet (Sheet 2 of 4)

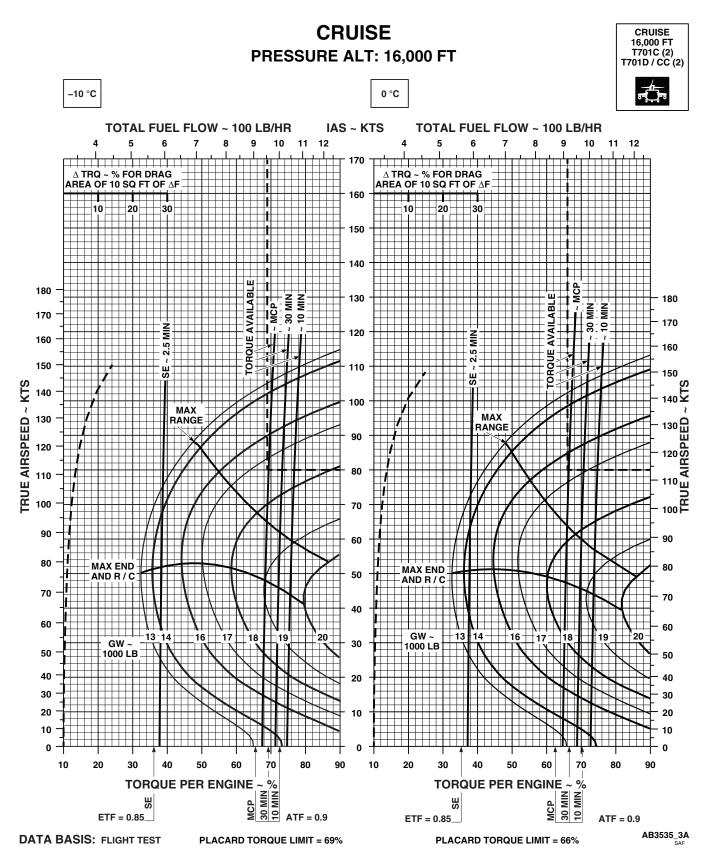
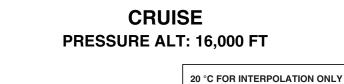


Figure 7A-26. Cruise High Drag - Altitude 16,000 Feet (Sheet 3 of 4)

CRUISE 16,000 FT T701C (2) T701D / CC (2)



10 °C

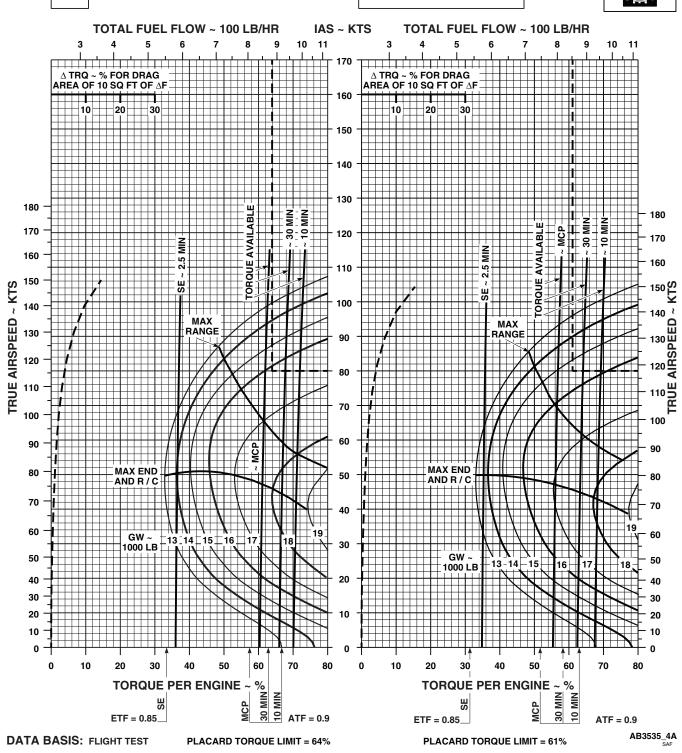


Figure 7A-26. Cruise High Drag - Altitude 16,000 Feet (Sheet 4 of 4)

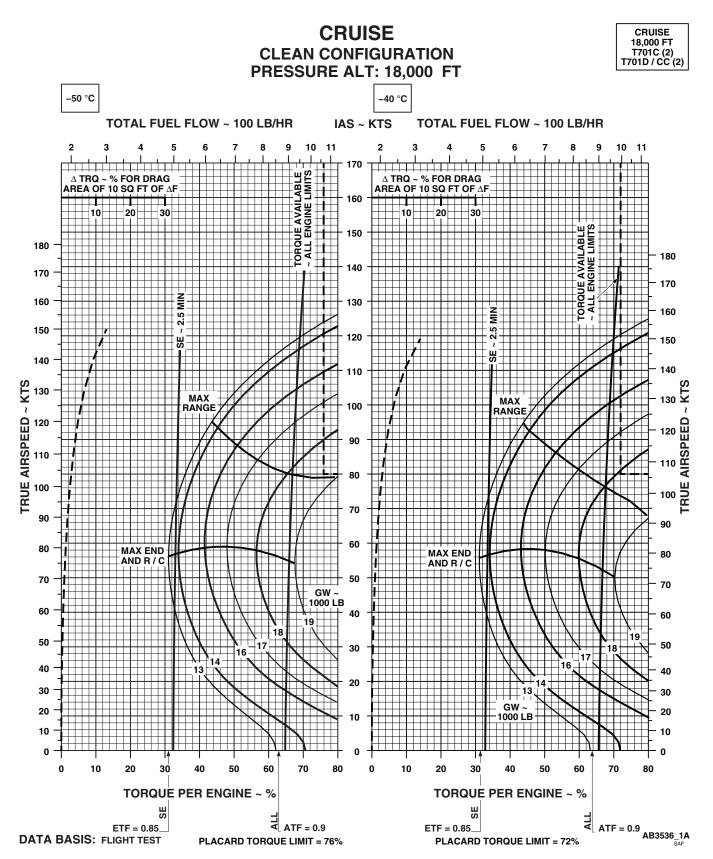


Figure 7A-27. Cruise - Altitude 18,000 Feet (Sheet 1 of 4)

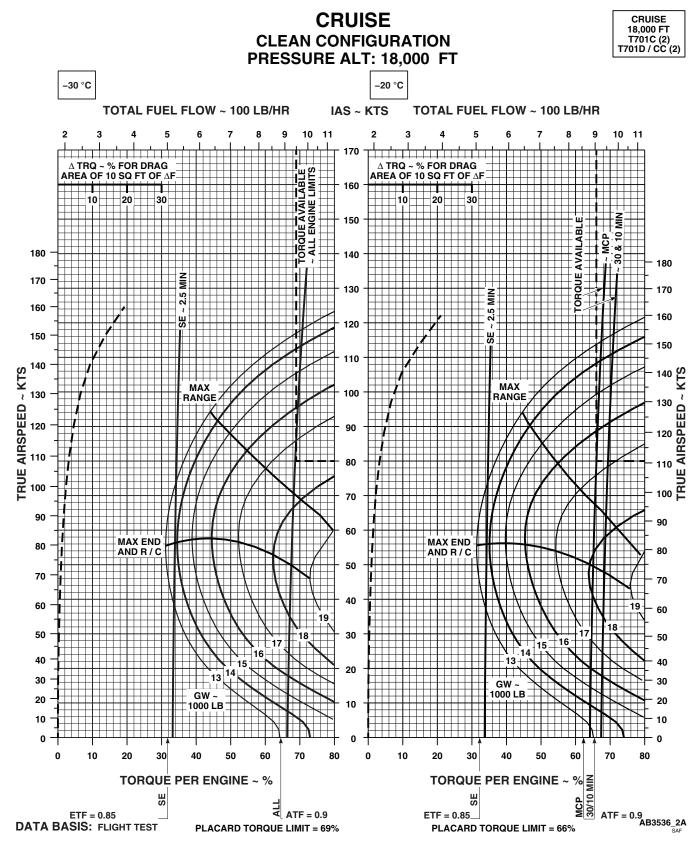


Figure 7A-27. Cruise - Altitude 18,000 Feet (Sheet 2 of 4)

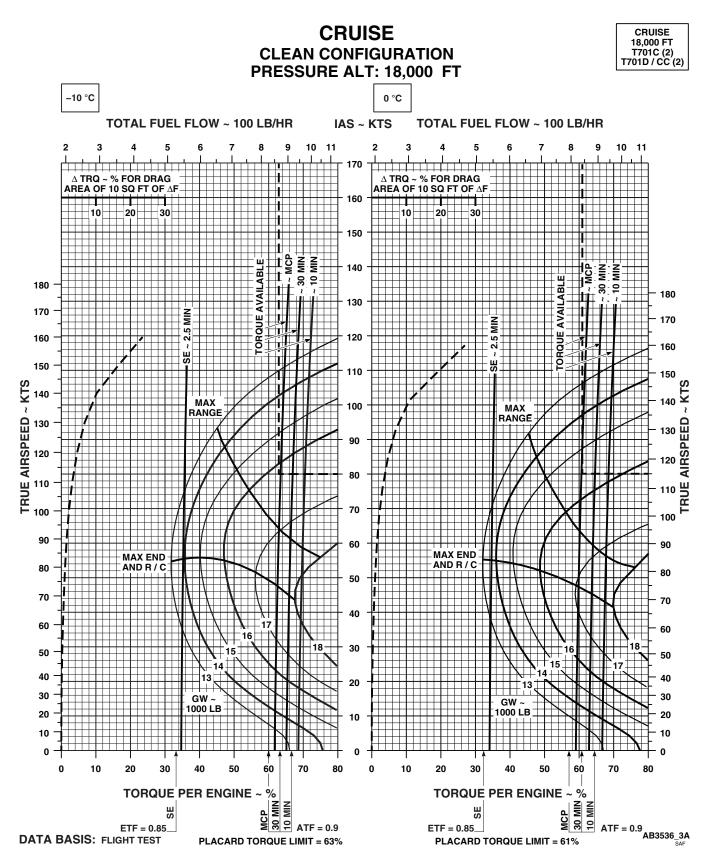


Figure 7A-27. Cruise - Altitude 18,000 Feet (Sheet 3 of 4)

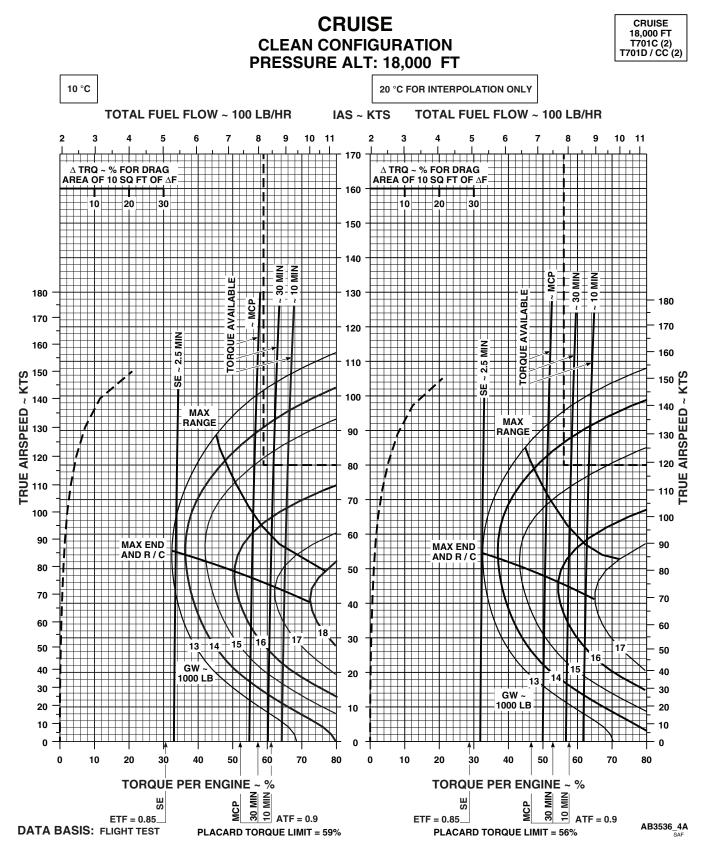


Figure 7A-27. Cruise - Altitude 18,000 Feet (Sheet 4 of 4)

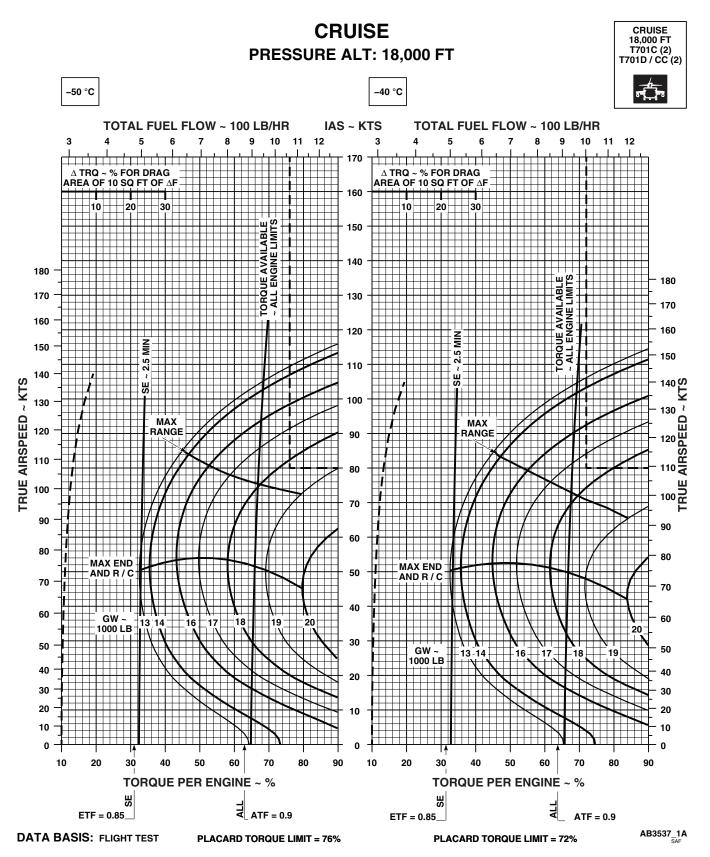


Figure 7A-28. Cruise High Drag - Altitude 18,000 Feet (Sheet 1 of 4)

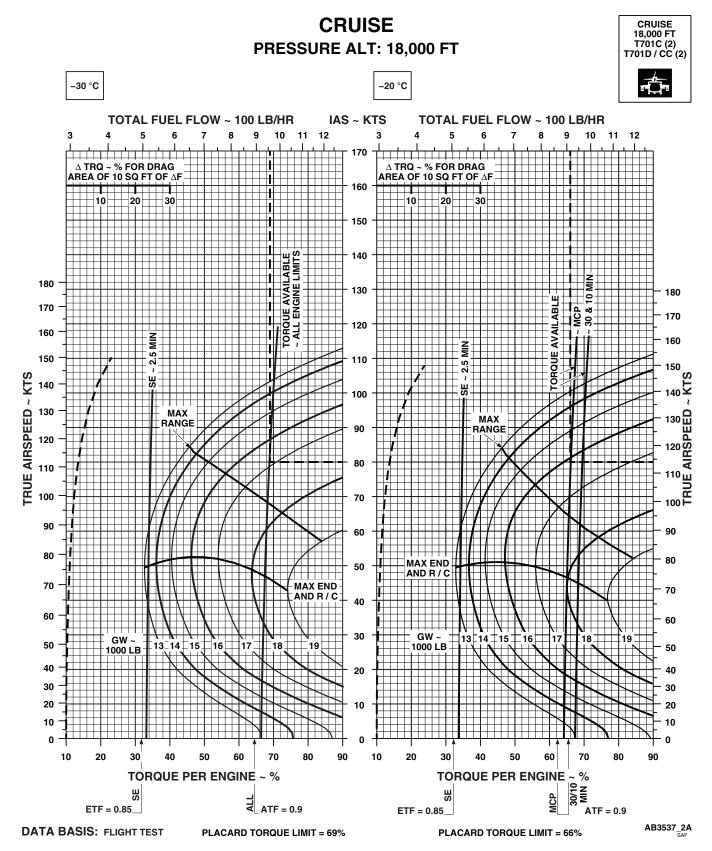


Figure 7A-28. Cruise High Drag - Altitude 18,000 Feet (Sheet 2 of 4)

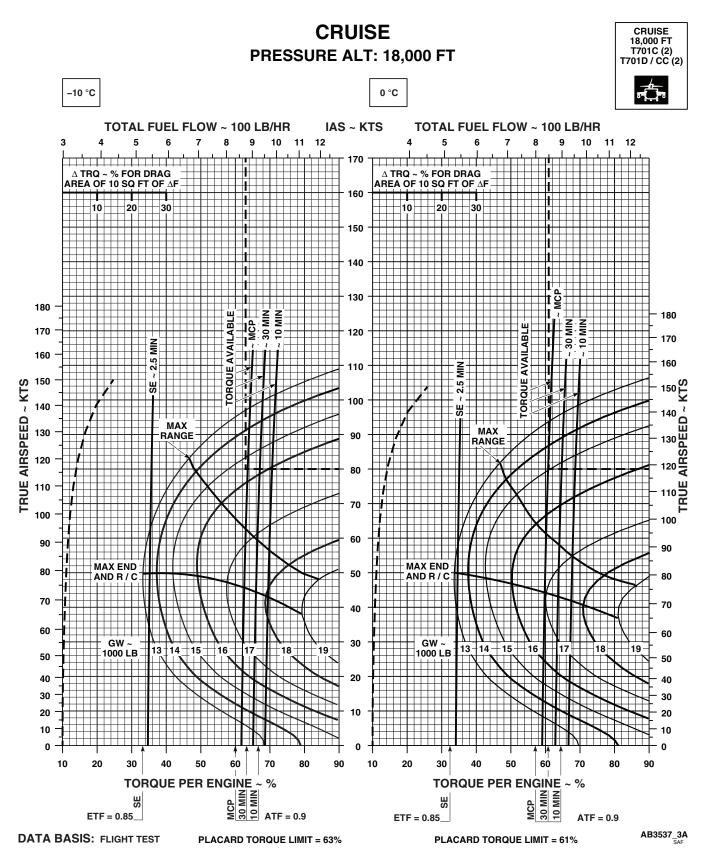


Figure 7A-28. Cruise High Drag - Altitude 18,000 Feet (Sheet 3 of 4)

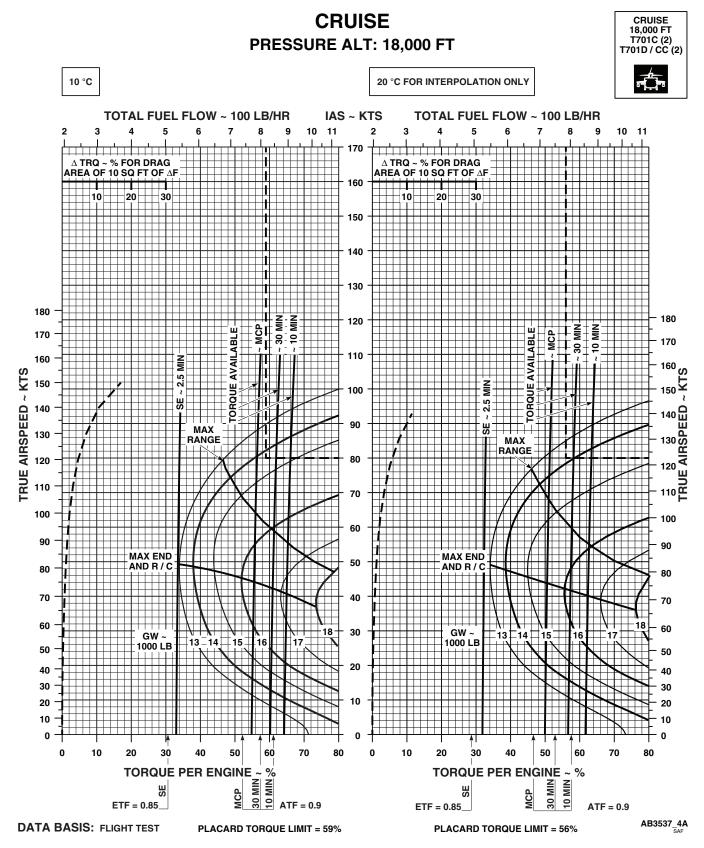


Figure 7A-28. Cruise High Drag - Altitude 18,000 Feet (Sheet 4 of 4)

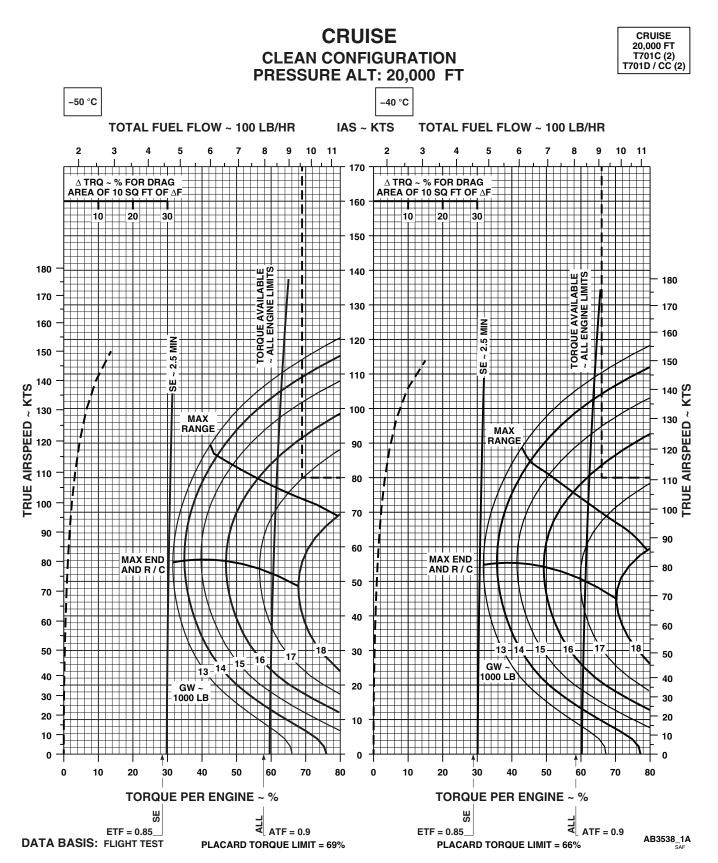


Figure 7A-29. Cruise - Altitude 20,000 Feet (Sheet 1 of 4)

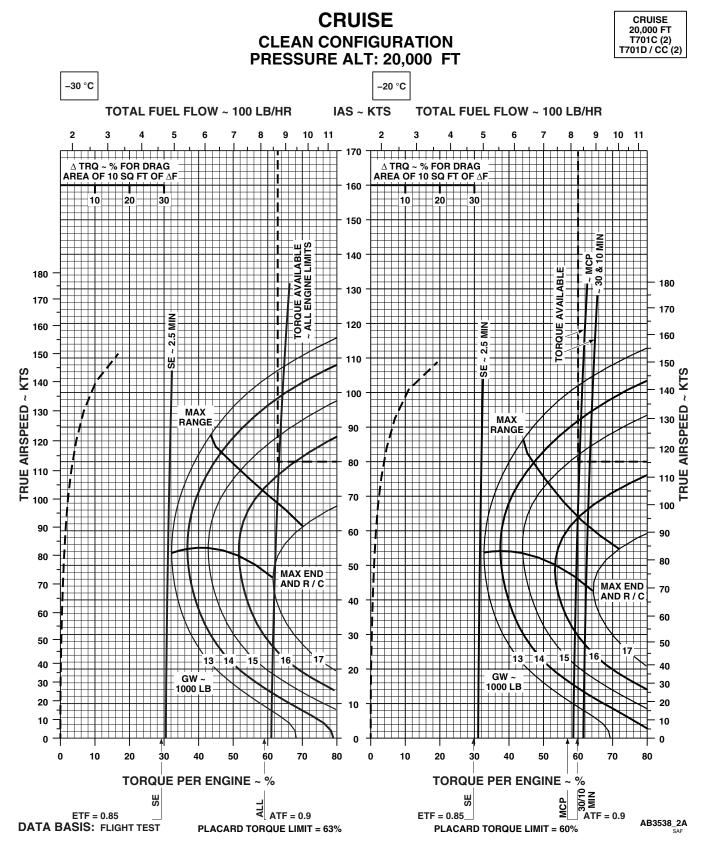


Figure 7A-29. Cruise - Altitude 20,000 Feet (Sheet 2 of 4)

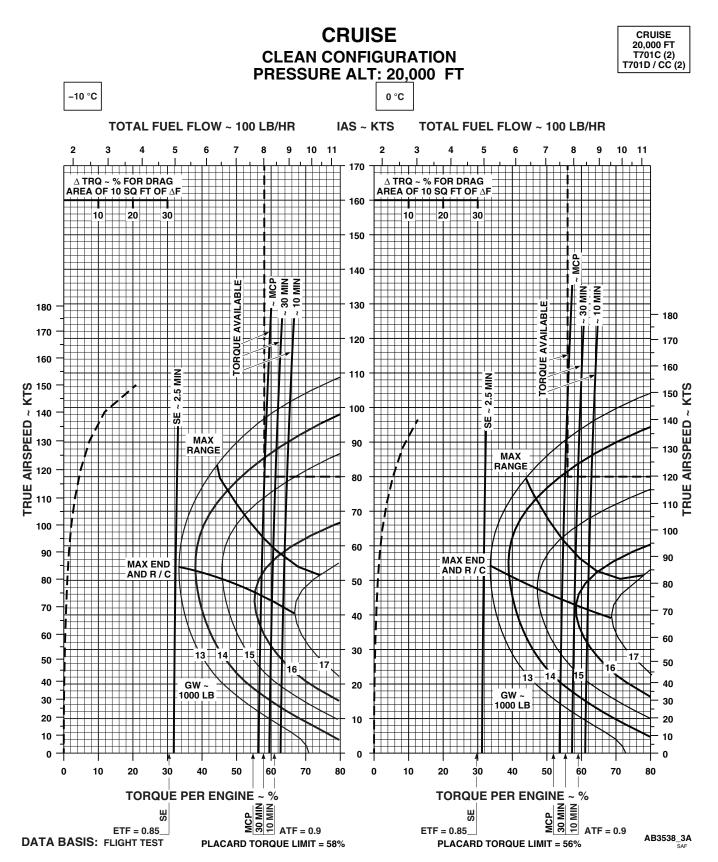


Figure 7A-29. Cruise - Altitude 20,000 Feet (Sheet 3 of 4)

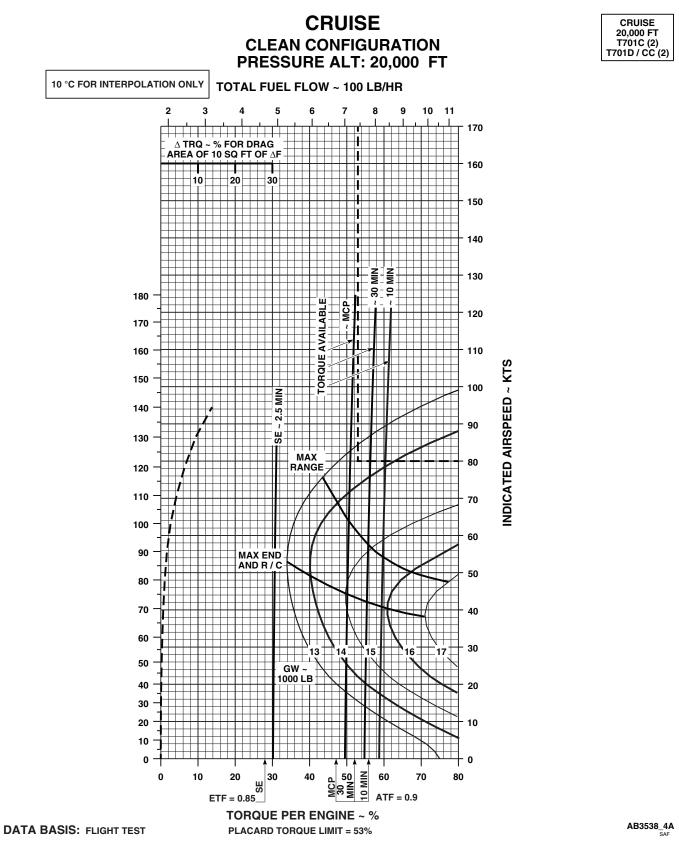


Figure 7A-29. Cruise - Altitude 20,000 Feet (Sheet 4 of 4)

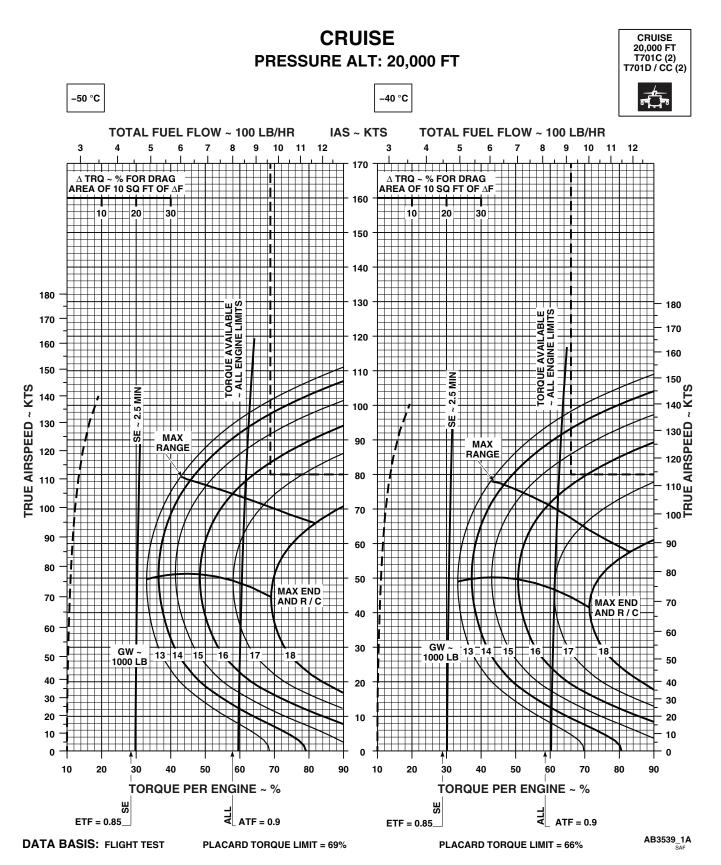


Figure 7A-30. Cruise High Drag - Altitude 20,000 Feet (Sheet 1 of 4)

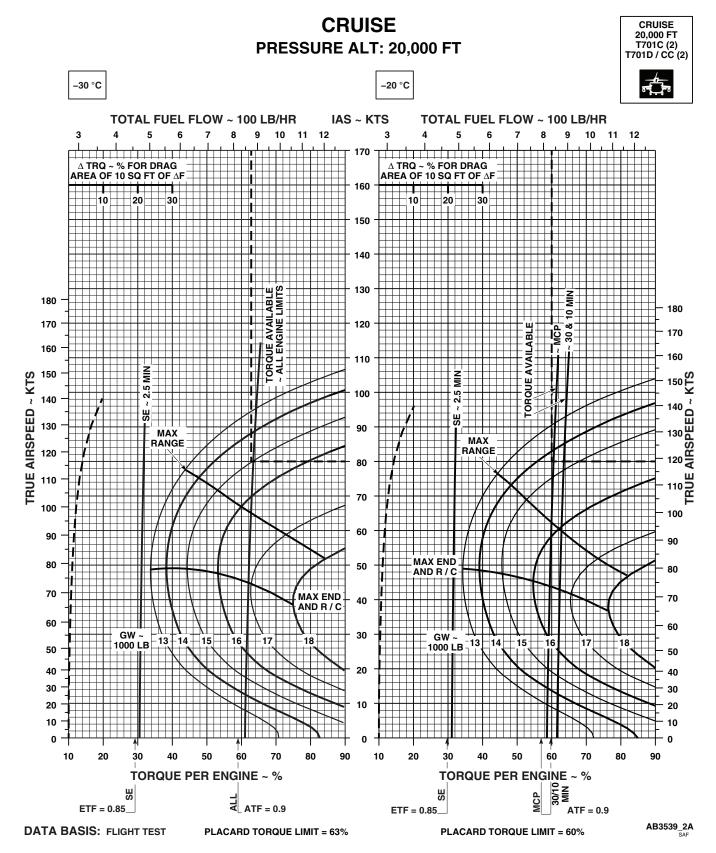


Figure 7A-30. Cruise High Drag - Altitude 20,000 Feet (Sheet 2 of 4)

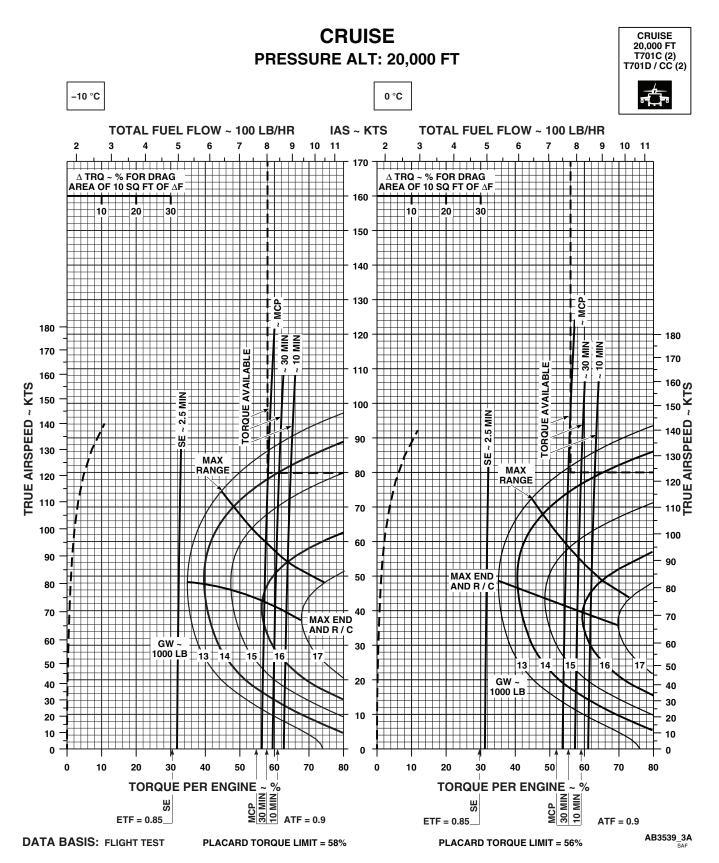


Figure 7A-30. Cruise High Drag - Altitude 20,000 Feet (Sheet 3 of 4)

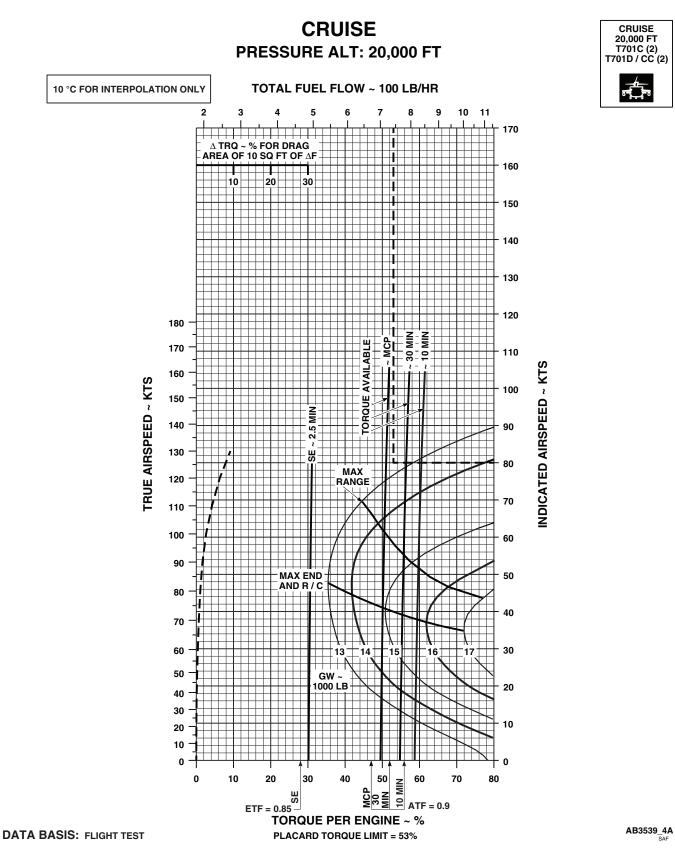


Figure 7A-30. Cruise High Drag - Altitude 20,000 Feet (Sheet 4 of 4)

## Section V OPTIMUM CRUISE

### 7A.21 OPTIMUM RANGE CHARTS.

This section presents a method to optimize cruise performance for long range missions when the altitudes flown are not restricted by other requirements. The optimum altitude for maximum range charts (Figures 7A-31 and 7A-32) provide the pressure altitude at which to cruise to obtain the maximum possible range for any gross weight and FAT conditions. The altitude determined for optimum range may also be used for optimum endurance. Enter the chart at a current cruise or takeoff temperature condition and move along the temperature guidelines to the anticipated gross weight for cruise and obtain the optimum pressure altitude. Turn to the cruise chart closest to the altitude and temperature predicted by the optimum range chart for specific cruise information. The use of this chart is shown by the example.

## OPTIMUM RANGE 100% RPM R HIRSS (BAFFLES INSTALLED)

#### 22 21 20 19 18 17 16 15 14 13 60 50 40 30 20 ပ **AIR TEMPERATURE** 10 0 -10 FREE -20 TEMPERATURE TREND LINES -30 -40 -50-60 0 2 4 6 8 10 12 14 16 18 20 22 **OPTIMUM PRESSURE ALTITUDE ~ 1000 FT**

**GROSS WEIGHT ~ 1000 LBS** 

## EXAMPLE

### WANTED

CRUISE ALTITUDE FOR OPTIMUM RANGE AND CORRESPONDING CRUISE CHART FOR FLIGHT CONDITIONS

#### KNOWN

REFERENCE CONDITIONS OF: PRESSURE ALTITUDE = 1,500 FT FAT = 24°C GW = 16,600 LBS

### METHOD

ENTER CHART AT FAT (24°C). MOVE — RIGHT TO REFERENCE / OPTIMUM PRESSURE ALTITUDE (1,500 FT). MOVE PARALLEL WITH THE TEMPERATURE TREND LINE TO AIRCRAFT GROSS WEIGHT (16,600 LBS). MOVE LEFT OR RIGHT PARALLELING THE TEMPERATURE TREND LINE TO THE NEAREST EVEN THOUSAND REFERENCE / OPTIMUM PRESSURE ALTITUDE LINE (12,000). MOVE LEFT TO FREE AIR TEMPERATURE LINE (3°C). MOVE UP OR DOWN TO NEAREST TEN VALUE ON THE FREE AIR TEMPERATURE SCALE (0°C).

SELECT CRUISE CHART WITH ALTITUDE AND TEMPERATURE DATA AT THE NEAREST REFERENCE / OPTIMUM PRESSURE ALTITUDE (12,000 FT) AND THE NEAREST TEN DEGREE FREE AIR TEMPERATURE (0°C).

DATA BASIS: FLIGHT TEST

Figure 7A-31. Optimum Altitude For Maximum Range

AA1256C

# OPTIMUM RANGE HIGH DRAG CONFIGURATION 100% RPM R HIRSS (BAFFLES INSTALLED)

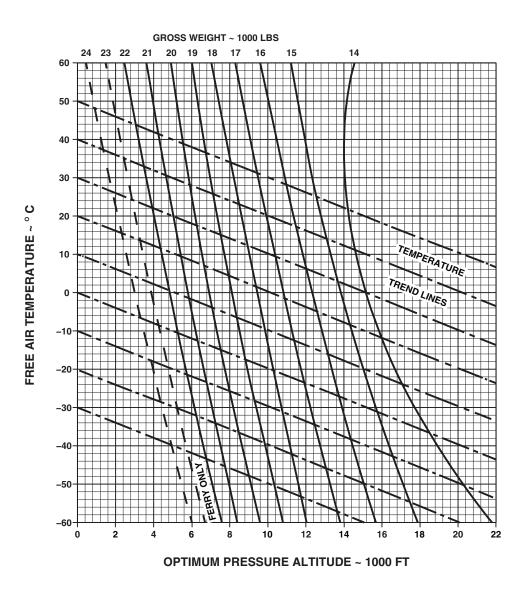


Figure 7A-32. Optimum Altitude For Maximum Range - High Drag

AA1026B

### Section VI DRAG

### 7A.22 EXTERNAL LOAD DRAG CHART.

The general shapes of typical external loads are shown on Figure 7A-33 as a function of the load frontal area. The frontal area is combined with the typical drag coefficient of the general shapes to obtain a drag multiplying factor for use with the 10 sq. ft. drag scale on each cruise chart. The  $\Delta$  TRQ% value obtained from the cruise chart is multiplied by the drag multiplying factor and added to indicated torque to obtain total torque required at any airspeed.

### 7A.23 AIRCRAFT CONFIGURATION DRAG CHANGES FOR USE WITH CLEAN CRUISE CHARTS.

When external equipment or configuration differs from the baseline clean configuration as defined in Section I, a drag correction should be made similarly to the external load drag method. Typical configuration changes that have drag areas established from flight test or analysis along with their drag multiplying factor are listed in Table 7A-1.

### Table 7A-1. Configuration Drag Change

DRAG CHANGES FOR USE WITH CLEAN CRUISE CHARTS

Item	Change in Flat Plate Drag Area - $\Delta$ F Sq. Ft.	Drag Multiplying Factor	
a. Both cargo doors open	6.0	0.60	
b. Cargo doors removed	4.0	0.40	
c. Cargo mirror installed	0.3	0.03	
d. IR countermeasure transmitter (ALQ-144) installed	0.8	0.08	
e. Chaff dispenser installed	0.3	0.03	
f. Blade Erosion Kit	2.0	0.20	
g. Skis installed	3.0	0.30	

# 7A.24 AIRCRAFT CONFIGURATION DRAG CHANGES FOR USE WITH HIGH DRAG CRUISE

CHARTS.

external load drag method. Typical high drag configuration changes that have been established from flight test or analysis along with the drag multiplying factors are shown.

When external equipment differs from the baseline high drag configuration as defined in this Section, a drag correction should be made using Figure 7A-34 similar to the

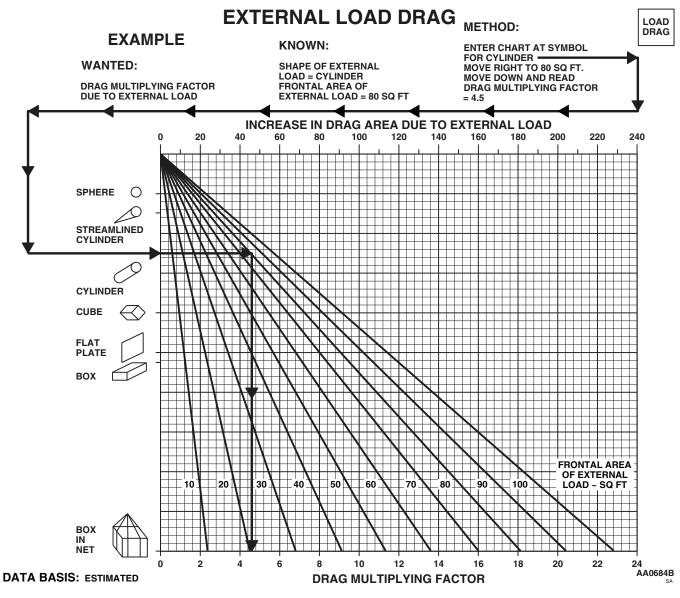


Figure 7A-33. External Load Drag

# **DRAG CONFIGURATIONS**



	HIGH DRAG CRUISE CHART BASELINE SPECIAL MISSION EQUIPMENT CONFIGURATIONS	CHANGE IN FLAT PLATE DRAG △F SQ FT	DRAG MULTI- PLYING FACTOR
	ESSS – CLEAN, PYLONS REMOVED	-4.0	-0.40
E	ESSS – FOUR PYLONS / NO STORES	-1.7	-0.17
OR NOR	ESSS-TWO 450-GALLON TANKS INBOARD -TWO 230-GALLON TANKS INBOARD	0.5 0.0	0.05 0.00
	ESSS-TWO 230-GALLON TANKS OUTBOARD -TWO 450-GALLON -TANKS INBOARD	2.5	0.25
	ESSS – FOUR 230-GALLON TANKS	2.0	0.20
JE	VOLCANO SYSTEM INSTALLED (BOTH RACKS) * VOLCANO CORRECTION MUST BE USED WITH HIGH DRAG CHARTS ONLY VOLCANO SYSTEM INSTALLED (LOWER RACKS ONLY) VOLCANO SYSTEM INSTALLED (CANISTERS REMOVED)	32.5 10.5 12.5	3.25 1.05 1.25
	SKIS INSTALLED	3.0	0.30
	BLADE EROSION KIT	2.0	0.20
	BOTH CARGO DOORS OPEN	6.0	0.60
	BOTH CARGO DOORS REMOVED	4.0	0.40
	CARGO MIRROR INSTALLED	0.3	0.03
	IR COUNTERMEASURE TRANSMITTER (ALQ-144) REMOVED	-0.8	-0.08
	CHAFF DISPENSER REMOVED	-0.3	-0.03

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Figure 7A-34. Typical High Drag Configurations

## Section VII CLIMB - DESCENT

### 7A.25 CLIMB/DESCENT CHART.

The CLIMB/DESCENT chart (Figures 7A-35 and 7A-36) presents the rate of climb or descent resulting from an increase or decrease of engine torque from the value required for level flight above 40 KIAS. The data are presented at 100% RPM R for various gross weights. The charts may also be used in reverse to obtain the torque

increase or reduction required to achieve a desired steady rate of climb or descent. The maximum rate of climb (R/C) may be determined by subtracting the cruise chart torque required from the maximum torque available at the desired flight conditions. Then enter the difference on the torque increase scale of the climb chart, move up to the gross weight, and read the resulting maximum R/C.

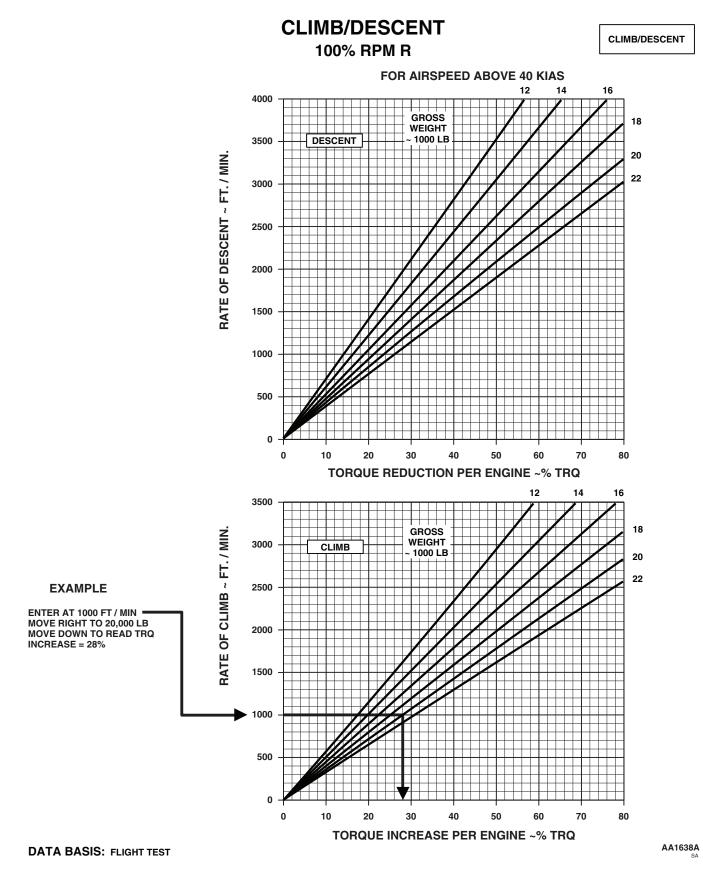
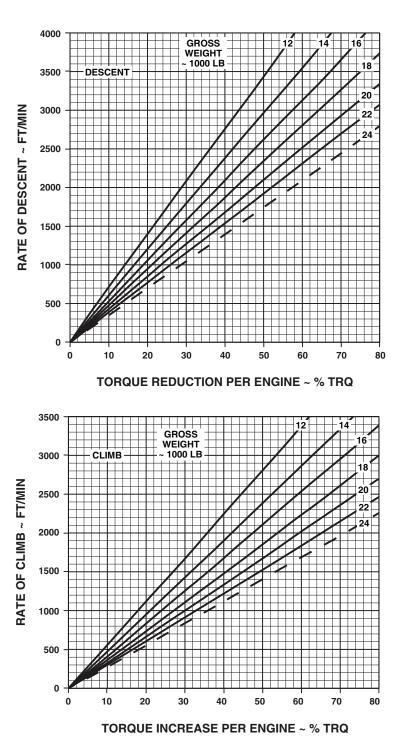


Figure 7A-35. Climb/Descent

# CLIMB/DESCENT 100% RPM R FOR AIRSPEED ABOVE 40 KIAS





DATA BASIS: FLIGHT TEST



7A-180

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### Section VIII FUEL FLOW

### 7A.26 IDLE FUEL FLOW.

Dual-engine idle fuel flow is presented as a function of altitude at 0°C FAT in Table 7A-2.

### 7A.27 SINGLE-ENGINE FUEL FLOW.

a. Engine fuel flow is presented in Figure 7A-37 for various torque and pressure altitudes at a baseline FAT of  $0^{\circ}$ C with engine bleed air extraction off. When operating at other than  $0^{\circ}$ C FAT, engine fuel flow is increased 1% for each 20°C above the baseline temperature and decreased 1% for each 20°C below the baseline temperature.

b. To determine single-engine fuel flow during cruise, enter the fuel flow chart at double the torque required for dual-engine cruise as determined from the cruise charts and obtain fuel flow from the single-engine scale. The single-engine torque may not exceed the transmission limit shown on the chart.

(1) With bleed air extracted, fuel flow increases as follows:

(a) Engine anti-ice on - +50 lbs/hr.

(b) Cockpit/gunner heater on - About 6 lbs/hr.

(c) Cockpit/gunner heater and Option II cabin heater system on - About 10 lbs/hr.

### NOTE

Option II cabin heater system shuts off when anti-ice is turned on. Power to the heater returns when the anti-ice is turned off.

(d) Anti-ice and cockpit/gunner heater on - About 56 lbs/hr.

(2) When the IR suppressor system is operating in the benign mode (exhaust baffles removed), the fuel flow will decrease about 7 lbs/hr.

### 7A.28 DUAL-ENGINE FUEL FLOW.

Dual-engine fuel flow may be obtained from Figure 7A-37 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. When operating at other than the 0° FAT baseline, dual-engine fuel flow is increased 1% for each 20°C above baseline and is decreased 1% for each 20°C below baseline temperature.

a. With bleed air extracted, dual-engine fuel flow increases as follows:

- (1) Engine anti-ice on +100 lbs/hr.
- (2) Cockpit/gunner heater on About 12 lbs/hr.

(3) Cockpit/gunner heater and Option II cabin heater system on - About 20 lbs/hr.

### NOTE

Option II cabin heater system shuts off when anti-ice is turned on. Power to the heater returns when the anti-ice is turned off.

(4) Anti-ice and cockpit/gunner heater on - About 112 lbs/hr.

b. When the IR suppressor system is installed and operating in the benign mode (exhaust baffles removed), the fuel flow decreases about 14 lbs/hr.

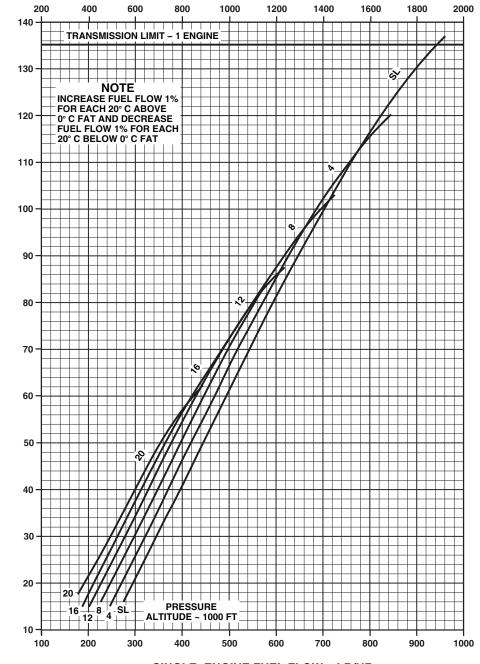
Pressure Altitude Feet	Ng = 63-71% Ground Idle (66% RPM R) Lb/Hr	Ng = 79-88% Flat Pitch (100% RPM R) Lb/Hr	APU (Nominal) Lb/Hr
0	360	590	120
4,000	310	515	105

### Table 7A-2. Idle Fuel Flow and APU Fuel Flow

Pressure Altitude Feet	Ng = 63-71% Ground Idle (66% RPM R) Lb/Hr	Ng = 79-88% Flat Pitch (100% RPM R) Lb/Hr	APU (Nominal) Lb/Hr
8,000	280	445	90
12,000	250	400	75
16,000	220	340	65
20,000	185	280	55

## Table 7A-2. Idle Fuel Flow and APU Fuel Flow (Cont)





**DUAL-ENGINE FUEL FLOW ~ LB/HR** 

SINGLE-ENGINE FUEL FLOW ~ LB/HR

DATA BASIS: ENGINE MANUFACTURER SPEC.

INDICATED TORQUE PER ENGINE ~ %

Figure 7A-37. Single/Dual-Engine Fuel Flow

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## Section IX AIRSPEED SYSTEM CHARACTERISTICS

### 7A.29 AIRSPEED CHARTS.

### 7A.29.1 Airspeed Correction Charts.

### NOTE

Indicated airspeeds below 40 KIAS are unreliable. Airspeed conversion data KIAS to KTAS for speeds above 40 KIAS are provided in Section IV CRUISE.

All IAS shown on the cruise charts are based on level flight. Figures 7A-38 and 7A-39 provide the airspeed correction to be added to the cruise chart IAS value to determine the related airspeed indicator reading for other than level flight mode. There are relatively large variations in airspeed system error associated with climbs and descents. These errors are significant and Figures 7A-38 and 7A-39 are provided primarily to show the general magnitude and direction of the errors associated with the various flight modes. If desired, these figures may be used in the manner shown by the examples to calculate specific airspeed corrections. **7A.29.2** Airspeed System Dynamic Characteristics. The dynamic characteristics of the pilot and copilot airspeed indicating systems are normally satisfactory. However, the following anomalies in the airspeed and IV-SI indicating system may be observed during the following maneuvers or conditions:

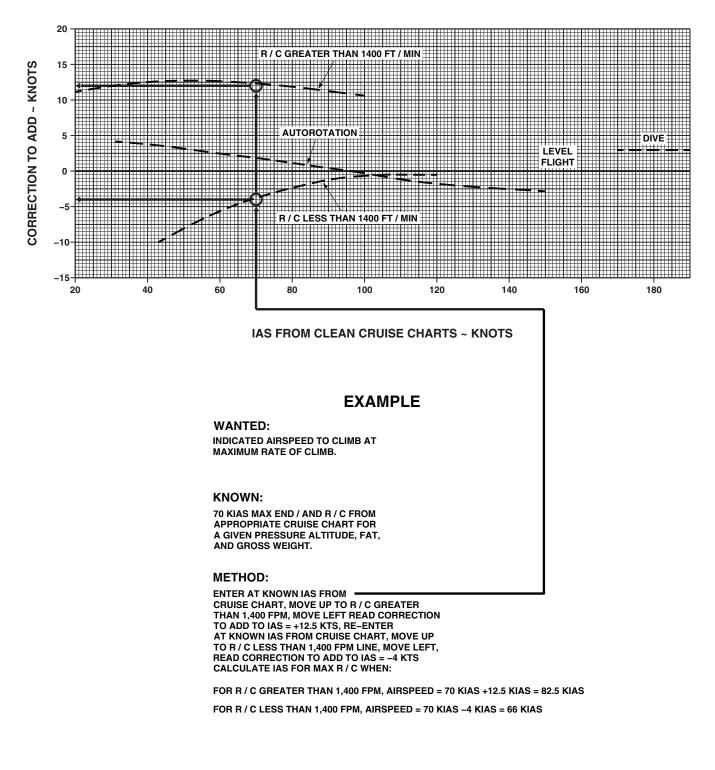
a. During takeoffs, in the speed range of 40 to 80 KI-AS, 5 to 10 KIAS airspeed fluctuation may be observed on the pilot and copilot airspeed indicators.

b. Power changes in high power, low airspeed climbs may cause as much as 30-knot airspeed changes in IAS. Increase in power causes increase in IAS, and a decrease in power causes decrease in IAS.

c. 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.

d. In-flight opening and closing of doors and windows may cause momentary fluctuations of approximately 300 feet-per-minute (FPM) on the vertical speed indicators.

**AIRSPEED SYSTEM CORRECTION** 



DATA BASIS: FLIGHT TEST

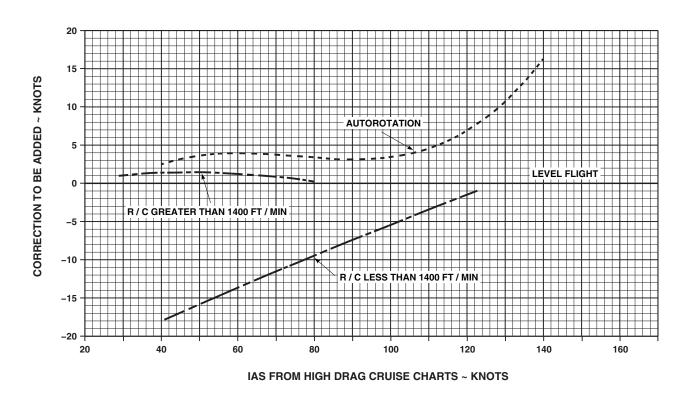
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Figure 7A-38. Airspeed Correction Chart

# **AIRSPEED SYSTEM CORRECTION**

-4-

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DATA BASIS: FLIGHT TEST



### Section X SPECIAL MISSION PERFORMANCE

### 7A.30 SPECIAL MISSION FLIGHT PROFILES.

Figures 7A-40 through 7A-42 show special mission flight profiles required to obtain near maximum range when equipped with ESSS in three different tank configurations. The upper segment of each chart provides the recommended altitude profile along with the IAS and average TRQ versus distance traveled. An average value of elapsed time is also presented on the lower axis of the altitude scale. The lower segment of each chart provides the relationship between fuel remaining and distance traveled resulting from the flight profile shown. This portion may be utilized to check actual inflight range data to provide assurance that adequate range is being achieved. The chart is divided into 3 regions of Adequate Range, Inadequate range-return to base, and Inadequate rangerequiring emergency action. When an inflight range point is in the Adequate range region, the required mission range can be obtained by staying on the recommended flight profile. However, the range may not be achieved if stronger headwinds are encountered as the flight progresses, and normal pilot judgement must be used. These charts also assume that the flight track is within proper navigational limits. Standard temperature variation with PA is shown on the upper segment of the charts. A general correction for temperature variation is to decrease IAS by 2.5 KTS and total distance traveled by 0.5% for each 10°C above standard. Detailed flight planning must always be made for the actual aircraft configuration, fuel load, and flight conditions when maximum range is required. This data is based on JP-4 fuel. It can be used with JP-5, JP-8, aviation gasoline, or any other fuels ONLY IF THE TAKEOFF GROSS WEIGHT AND THE FUEL LOAD WEIGHT MATCH THE DATA AT THE TOP OF THE CHART. The Flight Time and the Distance Traveled data SHOULD NOT be used with any full tank configuration if the fuel density is not approximately 6.5 lbs/gal (JP-4 fuel).

**7A.30.1 Self-Deployment Mission.** The self-deployment mission is shown in Figure 7A-40 and the ESSS is configured with two 230-gallon tanks outboard and two 450-gallon tanks inboard. In this configuration, the aircraft holds in excess of 11,000 lbs of JP-4 fuel and has a takeoff gross weight of 24,500 pounds in order to achieve the desired mission range of 1,150 nm. This gross weight is allowed for ferry missions only, requiring low load factors and less than 30° angle banked turns. This mission was calculated for a standard day with a constant 10 knot headwind added to be conservative. Since there may not be any emergency landing areas available, the

mission should not be attempted if headwinds in excess of 10 knots are forecast. Takeoff must be made with a minimum of fuel used (60 pounds) for engine start and warmup, and a climb to 2,000 feet should be made with maximum power and airspeed between 80 and 105 KIAS. The first segment should be maintained at 2,000 feet and 105 KIAS for 2 hours. The average engine TRQ should be about 79% for this segment, but will initially be a little more and gradually decrease. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel burn. The first 2 segments are for 2 hours each, followed by 1 hour segments until reaching 10,000 feet. At this altitude, the airspeed for best range should also be reduced to 100 KIAS for the remainder of the flight. Engine bleed-air was assumed to be off for this mission except for that required for fuel tank pressurization. Electrical cabin heat may be used. Removal of the HIRSS baffles (benign mode) will reduce fuel flow by about 14 lbs/hr. If oxygen is available, continuation of the staircase climb sequence to 15,500 feet PA will result in about 23 additional nm of range capability.

7A.30.2 Assault Mission Profile - 4 Tanks. The assault mission profile is shown in Figure 7A-41 with the ESSS configured with four 230-gallon tanks. In this configuration, the aircraft holds in excess of 8,300 lbs of JP-4 fuel and assumes a takeoff gross weight of 22,000 lbs which provides a maximum mission range of 980 nm with 400 lbs reserve. This mission was calculated for a standard day with a zero headwind. takeoff must be made with a minimum of fuel used (80 lbs) for engine start and warmup, and a climb to 4,000 feet should be made with maximum power and airspeed between 80 and 108 KIAS. The first segment should be maintained at 4,000 feet and 108 KIAS for 1 hour. The average engine TRQ should be about 79% for this segment, but will initially be a little more and gradually decrease. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel burn. The segments are for 1 hour each, until reaching 10,000 feet. At this altitude, the airspeed for best range should be reduced to 100 KIAS for the remainder of the flight.

**7A.30.3 Assault Mission Profile – 2 Tanks.** The assault mission profile is shown in Figure 7A-42 with the ESSS configured with two 230-gallon tanks. In this configuration, the aircraft holds in excess of 5,300 lbs of JP-4 fuel and assumes a takeoff gross weight of 22,000 lbs which provides a maximum mission range of 580 nm with 400 lbs reserve. This mission was calculated for a standard

day with a zero headwind. Takeoff must be made with a minimum of fuel used (80 lbs) for engine start and warmup, and a climb to 4,000 feet should be made with maximum power and airspeed between 80 and 108 KIAS. The first segment should be maintained at 4,000 feet and 108 KIAS for 1 hour. The average engine TRQ should be about 77% for this segment, but will initially be a little more and gradually decrease as shown on each segment. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel burn. At this altitude, the airspeed for best range should also be reduced to 100 KIAS for the remainder of the flight.

# 7A.31 SPECIAL MISSION FLIGHT PROFILES.

Figures 7A-43 and 7A-44 show special mission flight profiles required to obtain near maximum range when equipped with ESSS in three different tank configurations. The upper segment of each chart provides the recommended altitude profile along with the IAS and average TRQ versus distance traveled. An average value of elapsed time is also presented on the lower axis of the altitude scale. The lower segment of each chart provides the relationship between fuel remaining and distance traveled resulting from the flight profile shown. This portion may be utilized to check actual inflight range data to provide assurance that adequate range is being achieved. The chart is divided into 3 regions of Adequate Range, Inadequate range-return to base, and Inadequate range-requiring emergency action. When an inflight range point is in the Adequate range region, the required mission range can be obtained by staying on the recommended flight profile. However, the range may not be achieved if stronger headwinds are encountered as the flight progresses, and normal pilot judgment must be used. These charts also assume that the flight track is within proper navigational limits. Standard temperature variation with PA is shown on the upper segment of the charts. A general correction for temperature variation is to decrease IAS by 2.5 KTS and total distance traveled by 0.5% for each 10°C above standard. Detailed flight planning must always be made for the actual aircraft configuration, fuel load, and flight conditions when maximum range is required. This data is based on JP-4 fuel. It can be used with JP-5, JP-8, aviation gasoline, or any other approved fuels ONLY IF THE TAKEOFF GROSS WEIGHT AND THE FUEL LOAD WEIGHT MATCH THE DATA AT THE TOP OF THE CHART. The Flight Time and the Distance Traveled data SHOULD NOT be used with any full tank configuration if the fuel density is not approximately 6.5 lbs/gal (JP-4 fuel).

**7A.31.1 Self-Deployment Mission.** CEFS will not be used for self-deployment missions.

7A.31.2 Assault Mission Profile - 4 Tanks. The assault mission profile is shown in Figure 7A-43 with the CEFS configured with four 200-gallon tanks. In this configuration, the aircraft holds in excess of 7,500 lbs of JP-4 fuel and assumes a takeoff gross weight of 22,000 lbs which provides a maximum mission range of 900 nm with 400 lbs reserve. This mission was calculated for a standard day with a zero headwind. Takeoff must be made with a minimum of fuel used (80 lbs) for engine start and warmup, and a climb to 4,000 feet should be made with maximum power and airspeed approximately 65 KIAS. The first segment should be maintained at 4,000 feet and 108 KIAS for 1 hour. The average engine TRQ should be about 78% for this segment, but will initially be a little more and gradually decrease. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel burn. The segments are for 1 hour each, until reaching 10,000 feet. At this altitude, the airspeed for best range should be reduced to 95 KIAS for the remainder of the flight.

7A.31.3 Assault Mission Profile – 2 Tanks. The assault mission profile is shown in Figure 7A-44 with the CEFS configured with two 200-gallon tanks. In this configuration, the aircraft holds in excess of 4,900 lbs of JP-4 fuel and assumes a takeoff gross weight of 22,000 lbs which provides a maximum mission range of 525 nm with 400 lbs reserve. This mission was calculated for a standard day with a zero headwind. Takeoff must be made with a minimum of fuel used (80 lbs) for engine start and warmup, and a climb to 4,000 feet should be made with maximum power and airspeed of approximately 65 KIAS. The first segment should be maintained at 4,000 feet and 108 KIAS for 1 hour. The average engine TRQ should be about 77% for this segment, but will initially be a little more and gradually decrease as shown on each segment. Altitude is increased in 2,000 feet increments to maintain the optimum altitude for maximum range to account for fuel burn. At this altitude, the airspeed for best range should also be reduced to 92 KIAS for the remainder of the flight.

### EXAMPLE:

### WANTED:

Assurance of adequate aircraft range for mission defined.

### KNOWN:

Flight position: 300 nm from base Flight Track Within Limits Fuel Remaining= 7,900 lbs Elapsed flight time = 2 hrs, 50 mins (2.83 hrs) Target:Normal Flight Conditions:

> Airspeed = 105 KIAS Press Alt = 2,000 feet Approx Torque= 74%

### METHOD:

- (1) Enter chart at total distance flown and at fuel remaining, move to intersection and plot point. If point falls on or above fuel remaining line (adequate range), remaining fuel is adequate to complete the mission. If point falls below the fuel remaining line in the inadequate range, abort mission region, immediately return to departure point while continuing to utilize altitude profile using total elapsed flight time (see item 2). If point falls below the fuel remaining line in the inadequate range, region, consult emergency procedures for corrective action.
- (2) To determine target nominal flight conditions, enter upper chart at elapsed flight time and move up to determine target airspeed, approximate torque, and pressure altitude.

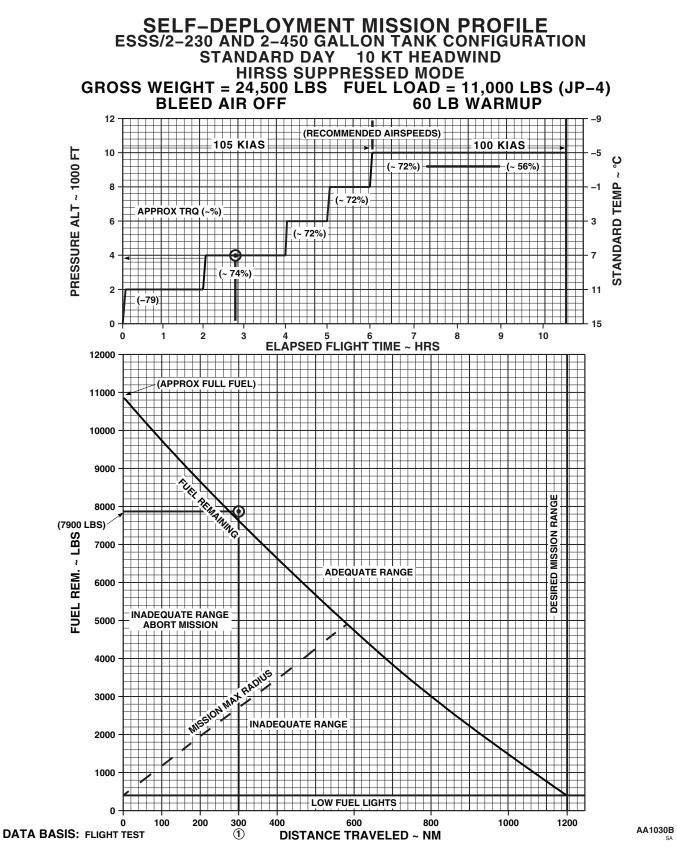


Figure 7A-40. Self-Deployment Mission Profile (Sheet 2 of 2)

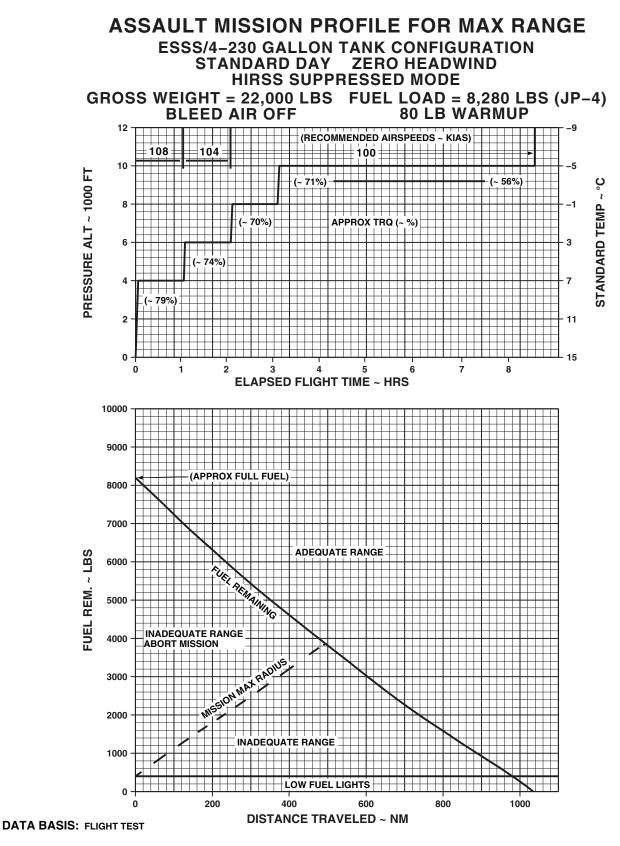


Figure 7A-41. Assault Mission Profile (4 - 230 Gallon Tanks)

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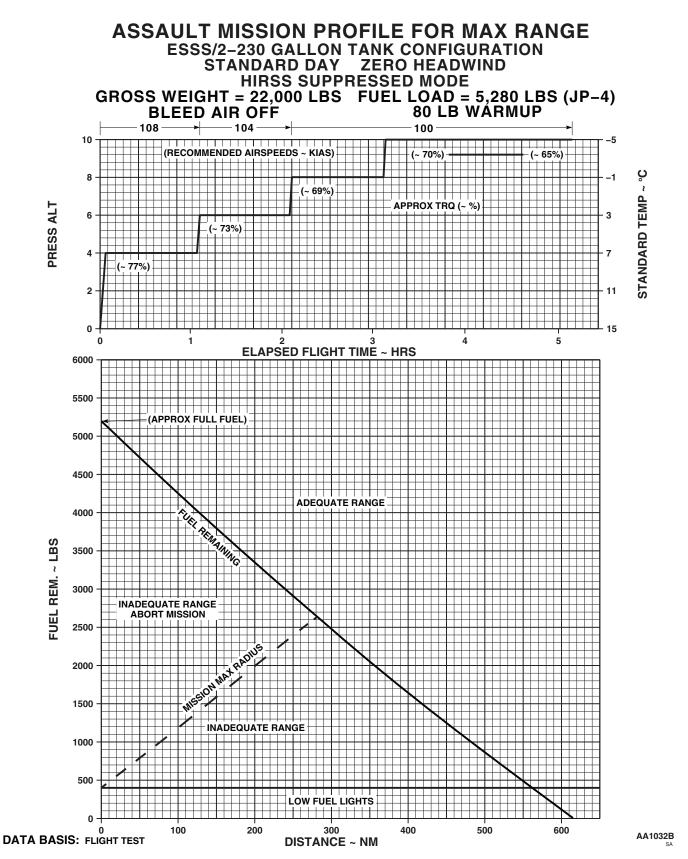


Figure 7A-42. Assault Mission Profile (2 - 230 Gallon Tanks)

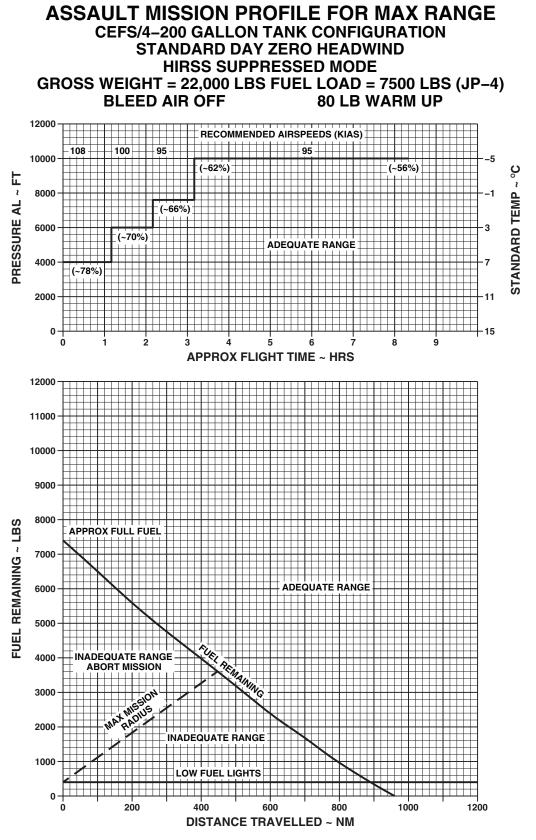


Figure 7A-43. Assault Mission Profile (4 - 200 Gallon Tanks)

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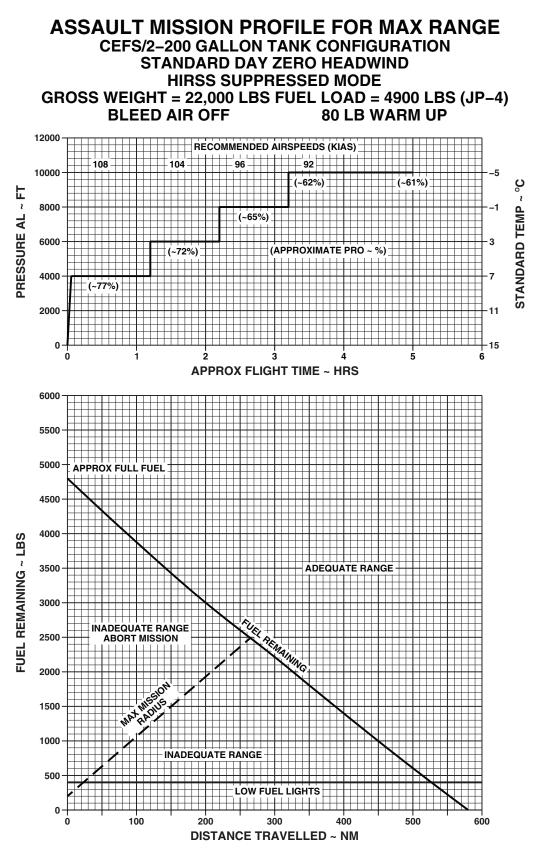


Figure 7A-44. Assault Mission Profile (2 - 200 Gallon Tanks)

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# CHAPTER 8 NORMAL PROCEDURES

### Section I MISSION PLANNING

### 8.1 MISSION PLANNING.

Mission planning begins when the mission is assigned and extends to the preflight check of the helicopter. It includes, but is not limited to checks of operating limits and restrictions; weight, balance, and loading; performance; publications; flight plan; and crew and passenger briefings. The pilot in command shall ensure compliance with the contents of this manual that are applicable to the mission and all aviation support equipment required for the mission (e.g., helmets, gloves, survival vests, survival kits, etc).

# 8.2 AVIATION LIFE SUPPORT EQUIPMENT (ALSE).

All aviation life support equipment required for mission; e.g., helmets, gloves, survival vests, survival kits, etc., shall be checked.

### 8.3 CREW DUTIES/RESPONSIBILITIES.



When performing a combat mission or overwater mission, aviator worn gear can restrict head and torso movement. Users should conduct ground familiarity drills (blind switch/control identification) and crew coordination exercises before flight since field of regard can be restricted by aviator worn mission equipment. The user must strictly adhere to proper crew coordination procedures during switch identification. The minimum crew required to fly the helicopter is two pilots. Additional crewmembers, as required, may be added at the discretion of the commander. The manner in which each crewmember performs his related duties is the responsibility of the pilot in command.

a. The pilot in command is responsible for all aspects of mission planning, preflight, and operation of the helicopter. He will assign duties and functions to all other crewmembers as required. Prior to or during preflight, the pilot will brief the crew on items pertinent to the mission; e.g., performance data, monitoring of instruments, communications, emergency procedures, taxi, and load operations.

b. The pilot in command must be familiar with pilot duties and the duties of the other crew positions.

c. The crew chief will perform all duties as assigned by the pilot.

d. EI AN/ALQ-151(V)2; mission operator duties, equipment checks, system initialization procedures, and self-test procedures are outlined in TM 32-5865-012-10.

**8.3.1 Crew Briefing.** A crew briefing shall be conducted to ensure a thorough understanding of individual and team responsibilities. The briefing should include, but not be limited to, pilots, crew chief, mission equipment operator, ground crew responsibilities, and the coordination necessary to complete the mission in the most efficient manner. A review of visual signals is desirable when ground guides do not have direct voice communications link with the crew.

**8.3.2 Passenger Briefing.** The following guide may be used in accomplishing required passenger briefings.

Items that do not pertain to a specific mission may be omitted.

- 1. Crew introduction.
- 2. Equipment.
  - a. Personal, to include ID tags.
  - b. Professional.

c. Survival.

- 3. Flight data.
  - a. Route.
  - b. Altitude.
  - c. Time en route.
  - d. Weather.
- 4. Normal procedures.
  - a. Entry and exit the helicopter.
  - b. Seating.
  - c. Seatbelts.

- d. Movement in helicopter.
- e. Internal communications.
- f. Security of equipment.
- g. Smoking.
- h. Oxygen.
- i. Refueling.
- j. Weapons.
- k. Protective masks.
- 1. Parachutes.
- m. Hearing protection.
- n. Aviation life support equipment (ALSE).
- 5. Emergency procedures.
  - a. Emergency exits.
  - b. Emergency equipment.
  - c. Emergency landing/ditching procedures.

### Section II OPERATING PROCEDURES AND MANEUVERS

# 8.4 OPERATING PROCEDURES AND MANEUVERS.

This section deals with normal procedures and includes all steps necessary to ensure safe and efficient operation of the helicopter from the time a preflight begins until the flight is completed and the helicopter is parked and secured. Unique feel, characteristics, and reaction of the helicopter during various phases of operation and the techniques and procedures used for taxiing, takeoff, climb, etc., are described, including precautions to be observed. Pilot flying experience is recognized; therefore, basic flight principles are avoided. Only the duties of the minimum crew necessary for the actual operation of the helicopter are included. Additional crew duties are covered as necessary in Section I Mission Planning. Mission equipment checks are contained in Chapter 4 Mission Equipment. Procedures specifically related to instrument flight that are different from normal procedures are covered in this section, following normal procedures. Descriptions of functions, operations, and effects of controls are covered in Section IV Flight Characteristics, and are repeated in this section only when required for emphasis. Checks that must be performed under adverse environmental conditions, such as desert and cold-weather operations, supplement normal procedures checks in this section and are covered in Section V Adverse Environmental Conditions.

### 8.5 SYMBOLS DEFINITION.

Items which apply only to night or only to instrument flying shall have an N or an I, respectively, immediately preceding the check to which it is pertinent. The symbol O shall be used to indicate "if installed". Those duties which are the responsibility of the pilot not on the controls, will be indicated by a circle around the step number; i.e., . The symbol star  $\bigstar$  indicates an operational check is required. Operational checks are contained in the performance section of the condensed checklist. The asterisk symbol * indicates that performance of step is mandatory for all thru-flights. The asterisk applies only to checks performed prior to takeoff. Placarded items such as switch and control labels appear in boldface.

### 8.6 CHECKLIST.

Normal procedures are given primarily in checklist form, and amplified as necessary in accompanying paragraph form, when a detailed description of a procedure or maneuver is required. A condensed version of the amplified checklist, omitting all explanatory text, is contained in the operator's checklist. To provide for easier cross-referencing, the procedural steps in the checklist are numbered to coincide with the corresponding numbered steps in this manual.

### 8.7 PREFLIGHT CHECK.

The pilot's walkaround and interior checks are outlined in the following procedures. The preflight check is not intended to be a detailed mechanical inspection. The preflight order is a recommended sequence only. The expanded substeps do not need to be memorized or accomplished in order. The steps that are essential for safe helicopter operation are included. The preflight may be made as comprehensive as conditions warrant at the discretion of the pilot.

### 8.8 BEFORE EXTERIOR CHECK.

# WARNING

Do not preflight until armament systems are safe, switches off, safety pins installed, and locking levers in locked position.

- 1. Publications Check.
  - a. Required forms and publications.
  - b. Availability of operator's manual(s) (-10) and checklist (-CL).
- *2. Helicopter covers, locking devices, tiedowns, and grounding cables Removed and secured.
- *3. Fuel Check quantity as required.
- 4. Fuel sample (main and external) Check.
  - a. For contamination before first flight of the day.
  - b. For contamination after adequate settling time after cold refueling.
  - c. If the fuel source is suspected to be contaminated.

### 8.9 EXTERIOR CHECK.

Exterior walkaround diagram is shown in Figure 8-1.

### 8.10 NOSE SECTION (AREA 1).

CAUTION

Do not deflect main rotor blade tips more than 6 inches below normal droop position when attaching tiedowns. Do not tie down below normal droop position.

- *1. Main rotor blades Check.
- 2. Fuselage Nose area, check.
  - a. Windshield and wipers Check.
- O b. Blade deice OAT sensor, FAT indicator probe(s) Check.
  - c. Avionics compartment Check equipment as required; secure door.
  - d. Antennas Check.
  - e. Landing and searchlights Check.

### 8.11 COCKPIT - LEFT SIDE (AREA 2).

- 1. Cockpit area Check.
  - a. Cockpit door Check.
  - b. Copilot seat, belts, and harness Check.
  - O c. CABS Check.
    - d. FM and EH antennas Check.
    - e. Landing gear support fairing and step Check.
    - f. Position light Check.
    - g. Main landing gear Check.
  - O h. HSS, VSP, ejector rack locking levers locked, fairings, and external tanks -Check; **AFMS** modification and refueling caps secure.
    - i. Gunner's window Check.
    - j. Ambient sense port Check.

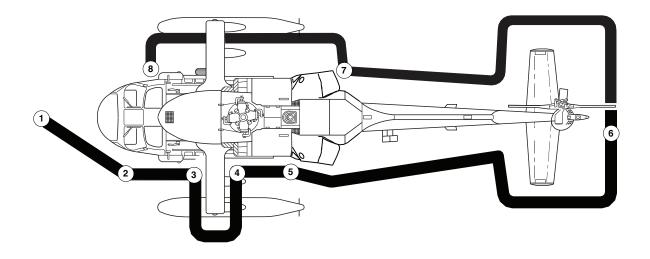
- *2. Left engine oil level Check.
- *3. Check main landing gear drag beam for cracks.

### 8.12 CABIN TOP (AREA 3).

- 1. Cabin top Check.
  - a. Left engine Check inlet.
  - b. Left pitot tube Check.
  - c. Control access Check flight controls, hydraulic reservoir, and filter indicators. Check tempilabels for safe indication and security. Check area.
  - d. Control access cover Close and check secured.
  - e. Right pitot tube Check.
  - f. Right engine Check inlet.
- O g. IRCM Check.
- 2. APU Check; oil level, use dipstick.
- 3. APU compartment Check for debris and FOD.
- 4. Section I driveshaft Check for damage, debris or FOD.
- O 5. APU IPS Check.
  - 6. Gust lock Check.
  - 7. Main transmission Check; oil level, use dipstick.
  - *8. Main rotor system Check.
    - a. Controls, dampers, head, and blades.
    - b. BIM[®] indicators for safe indication (yellow color).

### 8.13 INTERIOR CABIN (AREA 4).

- 1. Cabin Check.
  - a. Fire extinguishers Check.
  - b. First aid kits Check.



AREA 1	NOSE SECTION
AREA 2	COCKPIT – LEFT SIDE
AREA 3	CABIN TOP
AREA 4	INTERIOR CABIN

AREA 5 FUSELAGE - LEFT SIDE AREA 6 TAIL PYLON AREA 7 FUSELAGE - RIGHT SIDE AREA 8 COCKPIT - RIGHT SIDE

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### Figure 8-1. Exterior Check Diagram

- c. Pilot's and copilot's tilt-back release levers Lock position.
- d. Cabin interior Check security of stowed equipment.
- e. Cabin seats and belts Check.
- 2. APU accumulator pressure gage Check minimum 2,800 psi.
- 3. Transmission oil filter impending bypass indicator Check.
- 4. Cargo hook Check.
  - a. General condition and security.
  - b. Electrical connections condition and security.
- 5. Survival gear and mission equipment Check as required.

### 8.14 FUSELAGE - LEFT SIDE (AREA 5).

1. Fuselage - Check.

- a. Cabin door Check.
- O*b. Volcano armament system Check.
  - c. Fuel tank filler ports Check; caps secure, doors secured.
  - d. External pneumatic inlet port Door secured.
  - e. Engine exhaust Check.
- O f. APU IPS exhaust Check.
  - g. APU exhaust Check.
- O h. Chaff, flare dispensers Check; number and programmer settings.
  - i. Lower anticollision light Check.
  - j. Antennas Check.
  - k. Tail landing gear Check.
- 2. Section II driveshaft Check for damage, debris or FOD.

- 3. Section III driveshaft Check for damage, debris or FOD.
- *4. Intermediate gear box Check; oil level.

### 8.15 TAIL PYLON (AREA 6).

- 1. Section IV driveshaft Check for damage, debris or FOD.
- 2. Tail pylon Check.
  - a. Stabilator Check.
- O b. Radar detector and En antennas Check.
  - c. Position light Check.
  - d. Upper anticollision light Check.
- *3. Tail rotor Check.
- *4. Tail rotor gear box Check; oil level.

### 8.16 FUSELAGE - RIGHT SIDE (AREA 7).

- 1. Fuselage Check.
  - a. Antennas Check.
  - b. En Aft avionics compartment circuit breakers and ECS fluid level Check.
  - c. Fire extinguisher containers thermal plug Check.
  - d. Engine exhaust Check.
  - e. Fuel tank gravity filler port Check cap secure; door secured.
  - O*f. Volcano armament system Check.
    - g. Cabin door Check.

### 8.17 COCKPIT - RIGHT SIDE (AREA 8).

- *1. Right engine oil level Check.
- *2. Check main landing gear drag beam for cracks.

- 3. Cockpit area Check.
- O a. Ice detector Check.
  - b. Ambient sense port Check.
- O c. HSS, VSP, ejector rack locking levers locked, fairings, and external tanks -Check; **AFMS** modification and refueling caps secure.
  - d. Gunner's window Check.
  - e. External electrical power receptacle Door secured.
  - f. Main landing gear Check.
  - g. Position light Check.
  - h. Landing gear support fairing and step Check.
  - O i. CABS Check.
    - j. FM and EH antennas Check.
    - k. Cockpit door Check.
    - l. Pilot seat, belt, and harness Check.
  - m. Set switch on dimmer control box as desired. **NORM** for IR dimming.
- 4. Ensure all access covers and maintenance platforms are closed and checked.
- ★*5. Crew and passenger briefing Complete as required.

### 8.18 BEFORE STARTING ENGINES.



Before engine operation can be performed, all main rotor tie downs shall be removed. *1. Copilot's collective - Extended and locked.



- If performing a mission with an Air Warrior ballistic upgrade plate (BUP), the seat belt buckle must be positioned below the BUP to prevent potential aft cyclic restriction.
- Prior to putting on the safety belt, all loose straps must be secured properly to eliminate emergency egress snag hazards.
  - 2. Shoulder harness locks Check.
  - 3. PARKING BRAKE Release, then set.
  - $\bigstar$ 4. Circuit breakers and switches Set.
    - a. Circuit breakers In.
    - b. Avionics Off, frequencies set.
    - c. BLADE DEICE POWER switch OFF.
    - *d. Radar altimeter Set. En Left LO bug 200 feet.
    - e. BACKUP HYD PUMP switch AUTO.
    - *f. ANTICOLLISION/POSITION LIGHTS - As required.
    - *g. EH Q/F PWR switch OFF.
    - O*h. **EH** ECS panel switches OFF.
      - i. CARGO HOOK EMERG REL switch OPEN, ARMING switch SAFE.
      - j. APU CONTR switch OFF; APU T-handle - In.
      - *k. GENERATORS NO. 1 and NO. 2 switches ON.
      - l. Ground power unit Connected if required.
    - *m. AIR SOURCE HEAT/START switch -APU (OFF for external air source).

- n. EMER OFF T-handles Full forward.
- *o. BATT switch ON.

#### 8.19 COCKPIT EQUIPMENT CHECKS.

*1. FUEL PUMP switch - APU BOOST.



Ensure that the mask blowers are disconnected and position the BCA MCU control knobs to OFF prior to switching from main power to APU power.

#### NOTE

- If the APU does not start and the APU ACCUM LOW advisory does not appear with the APU CONTR switch ON, the manual override lever on the accumulator manifold should be pulled to attempt another start, and held until the APU has reached self-sustaining speed.
- If APU fails, note and analyze BITE indications before cycling **BATT** switch or before attempting another APU start.
  - *2. APU CONTR switch ON.



Stabilator will move to full trailing edge down position upon application of AC power. Assure stabilator area is clear prior to energizing stabilator system.

- *3. APU generator switch ON.
- *4. **EXT PWR** switch **OFF** and cable disconnected.
- *5. Doppler/GPS On and program.

#### NOTE

Only use map datums WGS-84 and NAD-27. Other map datums were not verified using the Aviation Mission Planning System (AMPS), and should not be used.

- O★6. ERFS AUXILIARY FUEL MANAGE-MENT control panel - TEST.
- O*7. ERFS AUXILIARY FUEL MANAGE-MENT control panel - Set fuel as required.
  - *8. EI IINS SYSTEMS SELECT switches DG and VG.
- ★*9. 🖽 IINS Align.
  - 10. Caution/advisory/warning panels Check as required.

#### NOTE

- Pulsating of any cautions or advisories in unison with the LOW ROTOR RPM warnings may occur in the DIM mode.
- The switch legend on the VSI/HSI and CISmode select panels may change when the caution/advisory panel **BRT/DIM**-**TEST** switch is set to **TEST**. This can also occur in flight. The original indications may be restored by pressing the applicable switches.
  - a. Caution/advisory panel BRT/DIM-TEST switch - TEST. Caution/advisory/warning, CIS/MODE SEL, and VSI lights on. #1 and #2 FUEL LOW cautions flashing. AFCS FAILURE ADVISORY lights will illuminate. ED SYSTEMS SELECT switches will illuminate. ED ASE advisory light - Press to test.
  - N b. INSTR LT PILOT FLT control ON.
  - N c. Caution/advisory **BRT/DIM-TEST** switch - **BRT/DIM** momentarily and then to **TEST**.
  - N d. All caution/advisory/warning panels CIS/ MODE SEL and VSI lights on at decreased intensity. AFCS FAILURE ADVISORY lights will not dim.

CAUTION

**701C 701D/CC** If DEC signal validation codes are displayed on the % TRQ indicator, do not fly the helicopter.

- 11. **701C 701D/CC** DEC engine fault indicator codes Check for signal validation as required.
- N 12. Interior/exterior lighting Set.
- *13. Avionics On.
- 14. Clocks Set and running.
- $O \bigstar 15$ . Mission equipment Check.
- ★*16. Cold weather control exercise Check if temperature is below -17°C (1°F).
  - *17. AFCS FAILURE ADVISORY lights If on, POWER ON RESET.
  - *18. SAS1 off, SAS2, TRIM, FPS, and BOOST switches Push ON.

# WARNING

Prior to flight, the user must perform control sweeps to ensure there are no flight control interference problems with aviator worn gear. If a restriction is found, the interfering gear must be adjusted/moved to eliminate the restriction.

- ★19. Flight controls Check first helicopter flight of day.
  - a. Collective Midposition, pedals centered, friction off.
  - b. **BOOST** switch Press off. There will be a slight increase in collective and pedal forces. **BOOST SERVO OFF** caution and **MASTER CAUTION** should appear.
  - c. Right SVO OFF switch 1ST STG. No allowable cyclic stick jump. #1 PRI SERVO PRESS caution and MASTER CAUTION should appear.
  - d. Move cyclic and pedals slowly through full range. There should be no binds or restrictions. Move collective full up to full down in about 1 to 2 seconds. Check #2 PRI SERVO PRESS caution does not appear during movement of collective.

- e. Right SVO OFF switch 2ND STG. No allowable cyclic stick jump. #2 PRI SERVO PRESS caution and MASTER CAUTION should appear.
- f. Repeat step d. above. Check #1 PRI SERVO PRESS caution does not appear during movement of collective.



If #1 PRI SERVO PRESS or #2 PRI SERVO PRESS caution appears during collective movement, a servo bypass valve may be jammed. If this situation occurs, do not fly the helicopter.

g. SVO OFF switch - Center.

#### NOTE

During steps h. and i., check for not more than 1.5 inches of freeplay in control.

- h. Collective both sides Move through full range in no less than 5 seconds. There should be no binding.
- i. Pedals both sides Move both pedals through the full range in no less than 5 seconds. There should be no binding.
- j. TAIL SERVO switch BACKUP. #1 TAIL RTR SERVO caution, both MASTER CAUTION cautions, and #2 TAIL RTR SERVO ON advisory appear. Move pedals through full range in no less than 5 seconds. There should be no binding.
- k. **TAIL SERVO** switch **NORMAL**. Cautions and advisories should disappear.
- 1. **BOOST** switch **ON**. **BOOST SERVO OFF** caution should disappear.
- *20. Cyclic centered. Collective, from full down position, raise no more than 1 inch (to prevent droop stop pounding) and friction.
- *21. COMPASS switch AHRS AHRS Mode -SLAVED. Set as required.

22. BACKUP HYD PUMP switch - OFF.

 $\bigstar$ 23. Stabilator - Check.



If any part of stabilator check fails, do not fly helicopter.

#### NOTE

For the purpose of this check, the right **STAB POS** indicator shall be used. The left **STAB POS** indicator may vary from right indicator as much as  $\pm 2^{\circ}$  throughout the check.

- a. **STAB POS** indicator should be between 34° and 42° **DN**.
- b. TEST button Press and hold. Check STAB POS indicator moves up 5° to 12°.
   STABILATOR caution and MASTER CAUTION appear; stabilator audio heard.
- c. AUTO CONTROL RESET switch -Press ON. Note that the STABILATOR caution disappears and audio is off, and STAB POS indicator moves to 34° to 42° down.
- d. Either cyclic mounted stabilator slew-up switch Press and hold until STAB POS indicator moves approximately 15° trailing edge up, release, stabilator should stop. STABILATOR caution and MASTER CAUTION appear and beeping audible warning in pilot's and copilot's headsets. MASTER CAUTION Press to reset audio tone.
- e. Other cyclic mounted stabilator slew-up switch - Press and hold until **STAB POS** indicator moves approximately 15° trailing edge up, release, stabilator should stop.
- f. **MAN SLEW** switch **UP** and hold until stabilator stops. **STAB POS** indicator should be 6° to 10° up.
- g. MAN SLEW switch DN and hold until STAB POS indicator reads 0°.

- h. AUTO CONTROL RESET switch -Press ON. STAB POS indicator should move 34° to 42° DN. STABILATOR caution disappears.
- *24. GPS/DPLR NAV MODE selector OFF.
- 25. Barometric altimeters Set.
- 26. Attitude reference Check.
- O★27. Blade deice system Test as required.



- Do not perform blade deice test when blade erosion kit is installed.
- To prevent overheating of droop stops, blade deice test shall not be done more than one time within a 30-minute period when rotor head is not turning.
  - a. Ice rate meter **PRESS TO TEST** button Press and release.
  - b. Ice rate meter indicator Moves to half scale (1.0) holds about 50 seconds; then falls to 0 or below. **ICE DETECTED** caution and **MASTER CAUTION** appear after 15 to 20 seconds into the test, and **FAIL** flag should not be visible in flag window. Ice rate meter should move to zero within 75 seconds after pressing **PRESS TO TEST** button.

#### NOTE

#### PWR MAIN RTR and PWR TAIL RTR

monitor lights may flicker during tests in steps f. through s.

- c. **BLADE DE-ICE TEST** panel select switch **NORM**.
- d. **PWR MAIN RTR** and **TAIL RTR** monitor lights Press to test.
- e. BLADE DEICE POWER switch TEST.
- f. **PWR MAIN RTR** and **TAIL RTR** monitor lights Check. **MAIN RTR**

monitor light may go on for 2 to 4 seconds. If either light remains on for 10 seconds or more:

- (1) **BLADE DEICE POWER** switch **OFF**. If either light is still on:
- (2) **APU** generator switch and/or **EXT PWR** switch **OFF**.
- g. TEST IN PROGRESS light Check. The light should be on for 105 to 135 seconds. No other blade deice system lights should be on. PWR MAIN RTR and TAIL RTR monitor lights may go on momentarily near end of test. The TEST IN PROGRESS light should then go off.



Droop stop hinge pins and cams may become very hot during test. Use care when touching those components.

- h. Crewman touch each droop stop cam Cams should be warm to touch.
- i. BLADE DEICE POWER switch OFF.

#### NOTE

The **MR DE-ICE FAULT** caution may appear during tests in steps j. through s.

- j. BLADE DE-ICE TEST panel select switch SYNC 1.
- k. BLADE DEICE POWER switch -TEST. MR DE-ICE FAIL caution and MASTER CAUTION appear.
- 1. BLADE DEICE POWER switch OFF. MR DE-ICE FAIL caution and MASTER CAUTION disappear.
- m. **BLADE DE-ICE TEST** panel select switch **SYNC 2**.
- n. BLADE DEICE POWER switch -TEST. MR DE-ICE FAIL caution and MASTER CAUTION appear.

- o. BLADE DEICE POWER switch OFF. MR DE-ICE FAIL caution and MASTER CAUTION disappear.
- p. BLADE DE-ICE TEST panel select switch OAT.
- q. BLADE DEICE POWER switch -TEST. MR DE-ICE FAIL caution, TR DE-ICE FAIL caution, and MASTER CAUTION appear.
- r. BLADE DEICE POWER switch OFF. MR DE-ICE FAIL caution, TR DE-ICE FAIL caution, and MASTER CAUTION disappear.
- s. **BLADE DE-ICE TEST** panel select switch **NORM**.
- 28. Avionics Check and set as required.
- $O \star *29$ . **AFMS CEFS** Auxiliary Fuel Management Panel **TEST**, set as required.

#### 8.20 STARTING ENGINES.

- *1. ENG FUEL SYS selector(s) As required. XFD for first start of day.
- *2. ENGINE IGNITION switch ON.
- *3. **GUST LOCK** caution Verify does not appear.
- *4. Fire guard Posted if available.
- *5. Rotor blades Check clear.
- $\star$ * (6.)Engine(s) Start.



If start is attempted with ENGINE IGNITION switch OFF, do not place switch ON. Abort the start.

#### NOTE

During engine start, the **#1 or # 2 FUEL PRESS** cautions may appear briefly during an engine start. The **FUEL BOOST PUMP**  **CONTROL** switches shall not be used to extinguish the **#1 or # 2 FUEL PRESS** cautions during an engine start sequence.

- a. If any of the emergency shutdown criteria/indicators occur, abort the start.
  - (1) No **TGT TEMP** increase (light off) within 45 seconds.
  - (2) No **ENG OIL PRESS** within 45 seconds.
  - (3) No % **RPM 1** or **2** or % **RPM R** within 45 seconds.
  - (4) ENGINE STARTER caution disappears before reaching 52% Ng SPEED.
  - (5) TGT TEMP reaches 700 850°C or
     701C 701D/CC 851°C before idle is attained (63% Ng SPEED).



- To avoid damage to the engine start switch actuators, do not move the ENG POWER CONT lever from IDLE to OFF while pressing the starter button.
- During engine start and runup, ensure that cyclic is kept in neutral, collective no more than one inch above full down and pedals centered until % RPM R reaches 50% minimum to prevent damage to anti-flap bracket bushings.
  - b. Starter button(s) Press until Ng SPEED increases; release.

#### NOTE

If an **ENGINE STARTER** caution disappears when the starter button is released, and the **ENG POWER CONT** lever is **OFF**, the start attempt may be continued by pressing and holding the starter button until 52% to 65% **Ng SPEED** is reached; then release button.

c. **TGT TEMP** - Check below **700** 150°C or **701C 701D/CC** 80°C before advancing ENG POWER CONT levers. **701C 701D/CC** If engine is being started one hour or less since previous shutdown, motor the starter for 60 seconds prior to advancing ENG POWER CONT levers.

- d. ENG POWER CONT lever(s) IDLE. Start clock.
- e. System indications Check.
- f. ENGINE STARTER caution(s) Check disappear at 52% to 65% Ng SPEED. If ENGINE STARTER caution remains after 65% Ng:
  - (1) ENG POWER CONT lever Pull out.

If caution remains:

- (2) **APU CONTR** switch **OFF** or engine air source remove as required.
- * (7.) If single-engine start was made, repeat step 6 for other engine.
- * (8.)Systems Check.
  - a. **Ng SPEED** 63% or greater and within 3% of each other.
  - b. % RPM 1 or 2 Check not in the range of 20% to 40% and 60% to 90%. Advance ENG POWER CONT lever(s) as required.
  - c. XMSN PRESS Check.
  - d. ENG OIL PRESS Check.
  - e. **#1** and **#2 HYD PUMP** cautions Check do not appear.
- * (9.)BACKUP HYD PUMP switch AUTO.
- $\star$  (10)Hydraulic leak test system Check.

#### NOTE

• It is normal for the IINS CDU screen to blank momentarily during the hydraulic leak test system check.

- When performing the HYD LEAK TEST, all leak detection/isolation system components are checked electrically. Manually holding the **HYD LEAK TEST** switch in the test position does not allow the leak detection/isolation system to be checked automatically. It manually holds the circuits open. The switch must be placed in the **TEST** position and released.
  - a. HYD LEAK TEST switch TEST. #1 TAIL RTR SERVO, BOOST SERVO OFF, SAS OFF, #1 and #2 RSVR LOW, and BACK-UP RSVR LOW cautions, #2 TAIL RTR SERVO ON and BACK-UP PUMP ON advisories, and MASTER CAUTION appear. During this check it is normal for the collective and pedals to move slightly.
  - b. **HYD LEAK TEST** switch **RESET**. The cautions and advisories in a. should disappear.

#### NOTE

If the backup pump is still running following the hydraulic leak test, cycle the **BACKUP HYD PUMP** switch to **OFF** then back to **AUTO**.

- $\star$  (11)Tail rotor servo transfer Check.
  - a. **BACKUP HYD PUMP** switch **AUTO** with backup pump not running.

#### NOTE

Failure of the **BACK-UP PUMP ON** advisory or the **#2 TAIL RTR SERVO ON** advisory to appear indicates a failure in the leak detection/isolation system.

- b. TAIL SERVO switch BACKUP. #1 TAIL RTR SERVO caution, #2 TAIL RTR SERVO ON and BACK-UP PUMP ON advisories, and MASTER CAUTION appear within 3 to 5 seconds.
- c. TAIL SERVO switch NORMAL. #1 TAIL RTR SERVO caution, #2 TAIL RTR SERVO ON advisory, and MASTER CAUTION disappear. BACK-UP PUMP ON advisory disappears after approximately 90 seconds.

- * 12. Engine warmup Check if temperature is below -17°C (1°F).
  - a. At temperatures between  $-17^{\circ}C$  (1°F) and  $-43^{\circ}C$  (-45°F), warm engines at **IDLE** for 3 minutes.
  - b. At temperatures between -43°C (-45°F) and -54°C (-65°F), warm engines at **IDLE** for 5 minutes.

#### 8.21 ENGINE RUNUP.

*1. Flight controls - Hold.



Restrict the rate of ENG POWER CONT lever's movement, when the tailwheel lockpin is not engaged. Rapid application of ENG POWER CONT levers can result in turning the helicopter, causing personnel injury or loss of life.

- * (2.)ENG POWER CONT lever(s) FLY.
- *3. Droop stops Check out 70% to 75% **RPM R**.
- * (4) #1 and #2 GEN cautions Disappear.
- O (5.)AUX CABIN HEATER switch As desired.

#### NOTE

- Cabin temperature must be below 29°C (84°F) for heat to go on, and above 10°C (50°F) for the heater to shut off.
- The auxiliary cabin heater circuit is reset when bleed air transitions to and from the APU. Crew reset of the auxiliary cabin heater switch may be required after switching to or from the APU.



**E** During operation of the air conditioner system, the right cabin door should remain closed. If opening is required, the right cabin door should not remain open for more than 1 minute. *6. **EH** ECS panel switches - As desired.

#### NOTE

ECS heater will operate with either backup pump or windshield anti-ice operating, but not with both at the same time.

 $O \bigstar$  (7.) DEICE EOT - Check as required.



In ambient temperatures above  $21^{\circ}$ C (70°F), operate rotor at 100% RPM R for 5 minutes before doing the deice EOT check, to prevent blade overheating. Do not do the deice EOT check if OAT is above  $38^{\circ}$ C (100°F).

- a. BLADE DE-ICE TEST select switch EOT.
- b. BLADE DEICE MODE select switch MANUAL M.
- c. BLADE DEICE POWER switch ON.
- d. TR DE-ICE FAIL caution and MASTER CAUTION appear after 15 to 30 seconds, MR DE-ICE FAIL caution appears after 50 to 70 seconds, and MR DE-ICE FAULT caution may appear.
- e. BLADE DEICE POWER switch OFF. TR DE-ICE FAIL caution, MR DE-ICE FAIL caution, and MASTER CAUTION disappear.
- f. BLADE DE-ICE TEST select switch NORM.

#### NOTE

If helicopter engine was started using external air source and/or external ac power, the APU must be started to do APU generator backup check.

> g. GENERATORS NO. 1 or NO. 2 switch -OFF. Applicable GEN caution and MASTER CAUTION appear.

- h. **BLADE DEICE POWER** switch **ON**. Wait 30 seconds, no deice cautions appear.
- i. **GENERATORS** switch(es) **ON**. Applicable **GEN** caution disappears.
- j. BLADE DEICE POWER switch OFF.
- k. BLADE DEICE MODE select switch AUTO.
- *8. % **TRQ 1** and **2** Matched within 5%.
- * (9.) **ED** Q/F PWR switch As desired.
- * (10)FUEL PUMP switch OFF.
- * (11)APU CONTR switch OFF.
- * (12)**AIR SOURCE HEAT/START** switch As required.
- * (13) ENG FUEL SYS selectors As required.
- * (14)SAS 1 ON.

#### NOTE

If a consecutive or random route was programmed, do not allow the system to perform the test function. Performing the test function will delete any preprogrammed routes.

*15. GPS/DPLR NAV MODE selector - As desired.

#### NOTE

A slight amount of collective friction (approximately 3 pounds) should be used to prevent pilot induced collective oscillations.

- *16. Collective friction As required.
- N O*17. HUD Adjust brightness, mode, barometric altitude, pitch, and roll as necessary.

- O * (18) EIINS NAVRDY light flashing CDU mode select switch to NAV.
- O * (19) EII IINS SYSTEMS SELECT switches -IINS.



Engine anti-ice bleed and start valve malfunction can cause engine flameout.

#### NOTE

Refer to ENGINE HEALTH INDICATOR TEST/ANTI-ICE CHECK IN HELICOP-TER LOG BOOK. HIT/ANTI-ICE checks while operating in adverse conditions (e.g., dust, desert, coastal beach area, dry river beds) may be deferred (maximum of 5 flight hours) until a suitable location is reached.

(20) Engine Health Indicator Test (HIT)/Anti-Icing Check - Accomplish.



FUEL BOOST PUMP CONTROL switches shall remain on during all pressurized fuel transfer operations and remain on for 10 minutes after transfer operations have ceased. Failure to observe this warning may cause engine flameout.

 * (21)FUEL BOOST PUMP CONTROL switches
 Check before every flight to determine operability. Leave on if required.

 $O \star (22)$  ERFS AFMS CEFS External extended range fuel transfer - Check.

 * (23)Microclimate cooling system (if use is anticipated) - Check. Turn BCA MCU control knob clockwise and check for leaks; note change in temperature. Adjust to desired cooling position.

### 8.22 BEFORE TAXI.

# WARNING

When on the ground, the ejector rack lock lever should be turned inward to allow the pilot visual confirmation from the cockpit. Prior to flight, the ejector rack lock lever must be in the unlock (vertical) position to allow emergency jettisoning of the tanks in flight.

- O*1. Ejector rack lock levers unlocked.
- O*2. Volcano jettison safety pins Remove and red arming levers to arm.



Ensure the chaff arm switch is in the SAFE position before the chaff pin is removed.

- O*3. Chaff, flare electronic module(s) safety pin(s) Remove.
  - *4. Chocks Removed.
  - *5. Doors Secure.
  - *6. PARKING BRAKE Release.
- * (7.)**TAIL WHEEL** switch As required.
  - 8. Wheel brakes Check as required.

#### 8.23 GROUND TAXI.



• When performing these maneuvers, cyclic inputs should be minimized to prevent droop-stop pounding.

• Landing and searchlight have less than one foot ground clearance when extended. Use caution when taxiing over rough terrain when landing light and/or searchlight are extended.

Increase collective and place cyclic forward of neutral to start forward movement. Minimize forward cyclic movement to prevent droop stop pounding. Reduce collective to minimum required to maintain forward movement. Soft or rough terrain may require additional collective pitch. The use of excessive collective pitch during taxi, especially at light gross weights, can cause the tailwheel to bounce. Regulate taxi speed with cyclic and collective and control heading with pedals. Use brakes as required.

#### 8.24 HOVER CHECK.

- (1.) Systems Check cautions/advisories, CDU, and PDU(s) for normal indications.
- (2.) Flight instruments Check as required.
- 3.)Power Check. The power check is done by comparing the indicated torque required to hover with the predicted values from performance charts.

#### 8.25 BEFORE TAKEOFF.

# WARNING

Pitot heat and anti-ice shall be on during operations in visible moisture with ambient temperature of  $4^{\circ}C$  ( $39^{\circ}F$ ) and below. Failure to turn pitot heat on in icing conditions can cause the stabilator to program trailing edge down during flight. If this occurs, manually slew the stabilator to  $0^{\circ}$ .

- * (1.) ENG POWER CONT levers FLY.
- * (2)Systems Check.
- (3.) Avionics As required.
- * (4.)Crew, passengers, and mission equipment -Secure.

O (5.) ERFS AFMS CEFS AUXILIARY FUEL MANAGEMENT control panel - Set as required.

#### 8.26 TAKEOFF.



If the stabilator has not begun trailing edge up movement by 30 to 50 KIAS and manual control is not available, do not exceed placard KIAS limits or longitudinal control may be lost.

Refer to the height-velocity diagram, Figures 9-2 and 9-3, for avoid areas. Since suitable landing areas are often not available, operating outside avoid areas during takeoff and climb will provide the highest margin of safety.

#### 8.27 AFTER TAKEOFF.

# WARNING

**ERFS AFMS CEFS** Fuel transfer sequence must be carefully planned and executed in order to maintain CG within limits.

- $O \star$  (1.) ERFS AFMS CEFS Extended range fuel system transfer As required.
  - 2.) ASE As required.
- O★ (3.)Volcano mine launch, post mine launch As required.

#### 8.28 BEFORE LANDING.

- (1.)**TAIL WHEEL** switch As required.
- 2. PARKING BRAKE As required.
- ★ (3.)Crew, passengers, and mission equipment -Secure.

- a. ASE Check as required.
- Ob. ET ECM ANTENNA switch -RETRACT. Check ANTENNA RETRACTED advisory - Appears. ECM operator report antenna deployed light-Off.

#### O c. EH IINS TACAN - OFF.

O (4.) ERFS AFMS CEFS AUXILIARY FUEL MANAGEMENT control panel switches - OFF.

#### 8.29 LANDING.



During roll-on landing aerodynamic braking with aft cyclic is permitted with the tail wheel contacting the ground. Once the main wheels touch down, the cyclic must be centered prior to reducing collective. Excessive aft cyclic may cause droop stop pounding and contact between main rotor blades and other portions of the helicopter. Aerodynamic braking is prohibited once the main landing gear touches down. Use brakes to stop the helicopter.

#### NOTE

Because of the flat profile of the main transmission, pitching the helicopter nose up as in hover, may cause a transient drop in indicated main transmission oil pressure, depending on degree of nose-up attitude.

a. Roll-on landing. A roll-on landing may be used when the helicopter will not sustain a hover; to avoid hovering in snow or dust; if tail rotor control is lost; or when operating with one heavy external tank.

# CAUTION

E When landing the EH-60A in a nose downslope configuration, exercise extreme caution to prevent the main rotor blades from contacting the aft DF antennas. When the main wheels contact the ground, center the cyclic prior to reducing collective. The cyclic should be centered before the collective is placed in full down to prevent possible rotor/ airframe contact. If droop stop contact is felt prior to the main wheels touching the ground, abort landing attempt.

b. Slope landing. The tailwheel should be locked and the parking brake should be set. For slope landings and all ground operations, avoid using combinations of excessive cyclic and low collective settings. Where minimum collective is used, maintain cyclic near neutral position and avoid abrupt cyclic inputs. During nose-down slope landings, low-frequency oscillations may be eliminated by moving cyclic toward neutral and lowering collective.

#### 8.30 AFTER LANDING CHECK.

(1.)**TAIL WHEEL** switch - As required.

2.)Exterior lights - As required.

(3.) Avionics/mission equipment - As required.

#### 8.31 PARKING AND SHUTDOWN.

(1.)**TAIL WHEEL** switch - As required.

(2.) PARKING BRAKE - Set.

3. FUEL BOOST PUMP CONTROL switches - OFF.

- 4. Landing gear Chocked.
- O 5. Volcano red arming levers **SAFE** and jettison safety pins install.
- O 6. Ejector rack locking levers Locked.

## WARNING

Ensure the chaff arm switch is in the SAFE position before the chaff pin is installed.

- O 7. Chaff, flare electronic module(s) safety pin(s) Install.
- (8.) EI IINS SYSTEMS SELECT switches -DG/VG.
- O (9.) EH IINS OFF.
- O (10) **ELE ECS** panel switches **OFF**.
- O (11)AUX CABIN HEATER switch OFF.
  - (12)**SAS 1** Off.
  - (13)GPS/DPLR NAV MODE selector OFF.
  - (14) **DEICE**, **PITOT**, **ANTI-ICE**, **HEATER** and **EH Q/F PWR** switches - **OFF**.
  - (15) AIR SOURCE HEAT/START switch APU.
  - (16) FUEL PUMP switch APU BOOST.
  - (17) APU CONTR switch ON. The APU ON, BACK-UP PUMP ON, and APU ACCUM LOW advisories should appear.

#### NOTE

If external electrical power is required for shutdown, it shall be connected and **EXT PWR** switch placed to **RESET**; then **ON**. If external ac power is not available, complete normal shutdown on right engine before continuing.

- 18. Collective raise no more than 1 inch.
- 19. Flight controls Hold.
- (20) GENERATORS NO. 1 and NO. 2 switches OFF.



- During shutdown ensure that cyclic is kept in neutral or displaced slightly into prevailing wind, collective no more than one inch above full down and pedals centered.
- Restrict the rate of ENG POWER CONT lever movement, when the tailwheel lockpin is not engaged. Abrupt application of ENG POWER CONT lever can result in turning the helicopter.

#### NOTE

**AHRS** During shutdown, when ENG POWER CONT levers are moved from FLY to IDLE position, or generator switch is changed to OFF position, and electrical power assignment is changed from Main Generator to APU Generator. An uncommanded right of left pedal drive of up to ¹/₄ inch may occur, returning to neutral position within 3 seconds.

- (21) ENG POWER CONT levers IDLE.
- (22) ENGINE IGNITION switch OFF.
- 23. Cyclic As required to prevent anti-flap pounding.

#### NOTE

If one or more droop stops do not go in during rotor shutdown, shut down an engine to lower rotor idling RPM in an attempt to seat the droop stops. If droop stops still do not go in, accelerate rotor to above 75% **RPM R**. Repeat rotor shutdown procedures slightly displacing cyclic in an attempt to dislodge jammed droop stop. If droop stops still do not go in, make certain that rotor disc area is clear of personnel and proceed with normal shutdown procedures while keeping cyclic in neutral position.

24. Droop stops - Verify in, about 50% RPM R.

# CAUTION

To prevent damage to anti-flap stops, do not increase collective pitch at any time during rotor coast-down.

- (25)BACKUP HYD PUMP switch OFF.
- 26. Stabilator Slew to  $0^{\circ}$  after last flight of the day.
- (27) **BACK-UP PUMP ON** advisory Check disappears.



Before moving ENG POWER CONT lever OFF, engine must be cooled for 2 minutes at an Ng SPEED of 90% or less. If an engine is shut down from a high power setting (above 90%) without being cooled for 2 minutes, and it is necessary to restart the engine, the restart should be done within 5 minutes after shutdown. If the restart cannot be done within 5 minutes, the engine should be allowed to cool for 4 hours before attempting an engine restart.

- (28) ENG POWER CONT levers OFF after 2 minutes at Ng SPEED of 90% or less.
- (29) **CEFS** On AFMP, **PRESS** switch Select the external tanks for pressure refueling as desired for next flight.

(30) ENG FUEL SYS selectors - OFF.

(31)**TGT TEMP** - Monitor.

If **TGT TEMP** rises above 538°C:

- a. Start button Press.
- b. ENG POWER CONT lever(s) Pull after TGT TEMP is below 538°C.
- 32. **701C 701D/CC** DEC torque indicator fault code Check.

- 33. Avionics Off.
- O 34. HUD ADJ/ON/OFF switch OFF.
  - 35. Overhead switches As required.
    - a. ANTICOLLISION/POSITION LIGHTS.
    - b. Left panel light controls.
    - c. WINDSHIELD WIPER.
    - d. VENT BLOWER.
    - e. Right panel light controls.
  - 36. APU generator switch OFF.

- 37. FUEL PUMP switch OFF.
- 38. APU CONTR switch OFF.
- 39. BATT switch OFF.

#### 8.32 BEFORE LEAVING HELICOPTER.

- 1. Walkaround Complete, checking for damage, fluid leaks and levels.
- 2. Mission equipment Secure.
- 3. Complete log book forms.
- 4. Secure helicopter As required.

## Section III INSTRUMENT FLIGHT

### 8.33 INSTRUMENT FLIGHT.

Refer to FM 3-04.240 for instrument flying and navigation techniques.

#### Section IV FLIGHT CHARACTERISTICS

8.34 GENERAL.



Pedal trim switches must be pressed while changing the helicopter heading during hover. Do not hold hover heading against yaw trim force. A rapid release of pedal trim force will allow the FPS heading hold feature to immediately correct to the last known engaged heading. This can result in rapid, divergent helicopter heading deviations.

a. Refer to FM 3-04.203 Fundamentals of Flight for explanation of aerodynamic flight characteristics.

b. The safe maximum operating airspeed range is described in Chapter 5. While hovering in high wind, sideward and rearward flight should be limited to low ground speeds. The helicopter is directionally stable in forward flight. In sideward and rearward flight, directional control is more difficult. During approach, or slow flight as the airspeed reaches about 17 to 20 KIAS, a mild vibration will be felt.

#### 8.35 GROUND RESONANCE.

Ground resonance is a self-excited vibration created when a coupling interaction occurs between the movement of the main rotor blades and the helicopter. For this to happen, there must be some abnormal lead/lag blade condition which would dynamically unbalance the rotor and a reaction between the helicopter and ground, which could aggravate and further unbalance the rotor. Ground resonance can be caused by a blade being badly out of track, a malfunctioning damper, or a peculiar set of landing conditions. Ground resonance may occur when a wheel reaction aggravates an out-of-phase main rotor blade condition such as a hard one-wheel landing, resulting in maximum lead and lag blade displacement. This helicopter does not have a history of ground resonance. If it should occur, get the helicopter airborne. If this is not possible, immediately reduce collective pitch, place ENG POWER CONT levers OFF, and apply wheel brakes.

#### 8.36 MANEUVERING FLIGHT.

**8.36.1 Flight with External Loads.** Refer to FM 55-450-1.

## WARNING

- Static electricity generated by the helicopter should be discharged before attempting a sling or rescue hoist pickup. Use a conductor between helicopter and the ground to discharge the static electricity.
- Caution must be exercised when transporting external loads that exhibit unstable characteristics. These loads may amplify any oscillation and cause the load to contact the helicopter.

a. Load bobble. In forward flight at the higher external cargo hook load weights, a slight vertical bobble may occasionally be noticed. If experienced, this bobble will increase in amplitude with a corresponding increase in airspeed or aggressiveness of maneuver. This bobble is caused by an external disturbance (e.g. turbulence or a control input) that triggers the natural elastic response of the sling. To correct, airspeed shall be decreased or limit aggressiveness of maneuver until bobble is eliminated and pilot is comfortable with the helicopter's control.

b. Stabilator angle in level flight. Due to the increased drag of external loads, collective position for a given level flight speed will be higher. Correspondingly, the stabilator angle will be more trailing edge down than usual. Since the surface area and inherent drag of each external load varies, exact guidance relative to how much more trailing edge down angle that results is not possible.

c. Collective friction. With external cargo hook sling loads, it is especially important to have collective friction set at a minimum of three pounds.

# 8.36.2 Flying Qualities with External ERFS Installed.

a. Pitch Attitude vs. Airspeed. The ERFS installation naturally results in increased drag. Since this drag vector is below the center of gravity of the helicopter, the pitch attitude will be more nose-down for any speed beyond 60 to 70 KIAS. At mid to high gross weights (and most especially at a forward CG) there is a slight pitch down at 50 to 55 KIAS. The installation of the ERFS results in a small increase in this nose-down tendency.

b. Tank Vibration. It will be observed that the right hand tank(s) will vibrate more than the left tank(s). This is a normal occurrence.

c. Stabilator Angle vs. Airspeed. With the increased drag of the ERFS, a given airspeed will require more collective which, due to the collective to stabilator coupling, results in a more trailing edge down stabilator angle. In the ferry configuration (full inboard 450-gallon tanks, full outboard 230-gallon tanks) the stabilator angle at higher speeds may be increased because of higher collective positions signal. This is normal as no stabilator program changes were made for the ERFS.

d. Roll Attitude Hold (FPS ON). With only the ERF-Swings installed, the roll attitude hold feature of the FPS is not noticeably affected. With full outboard 230-gallon tanks there is a very slight degradation of roll attitude stability, evidenced by a slower return to trim after an excitation (gust). With four full 230-gallon tanks the return to trim is a bit slower and with full inboard 450-gallon tanks and full outboard 230-gallon tanks the return to trim is slower. Since the return to trim is affected by the roll inertia of the helicopter, it is therefore recommended that for a four tank configuration the outboard tanks be used first.

#### 8.36.3 Collective Bounce/Pilot Induced Oscillation.

#### NOTE

The friction force refers to the breakaway force required to move the collective stick in an upward direction. The three pounds force is measured with the BOOST servo and SAS amplifiers operating and collective at mid-range.

To prevent vertical oscillation (collective bounce), the collective control system requires a minimum friction of three pounds measured at the collective head.Vertical oscillation can occur in any flight regime and may be caused by such events as SAS oscillation, turbulence, external load oscillation, and inadvertent pilot input into the collective. The oscillation causes the helicopter to vibrate. This vibration will be felt as a vertical bounce at approximately three cycles per second. If the severity of the oscillation is allowed to build, very high vibration levels will be experienced. During flight, if vertical oscillation is encountered, the pilot should remove the hand from the collective grip; this should eliminate the oscillation.

#### 8.37 TRANSIENT ROTOR DROOP CHARACTERISTICS 700.

a. The T700 engine control system accurately maintains 100 % **RPM R** throughout the flight envelope for most maneuvers. However, pilots should be aware that certain maneuvers performed with minimum collective applied will result in significant transient rotor droop. High density altitudes, heavy gross weights and operation at less than 100% **RPM R** will aggravate this condition.

b. During descent with little or no collective applied, Ng SPEED will be less than 80%. If % RPM R increases above 100%, the ECU torque motor input to the HMU is trimmed down in an attempt to restore 100% RPM 1/2 and % RPM R. When collective is increased, the LDS input demands more power, but the ECU continues to trim down until % RPM 1/2 returns to 100%. Since the Ng SPEED is at a slow speed, engine response time is greater. If rotor drag increases faster than the engine controller response, rotor droop occurs.

c. During aggressive level deceleration (quick stop) or right turn approach maneuvers as the collective is raised and the nose lowered, % **RPM R** may droop to 95% or lower for 1-2 seconds. % **RPM R** may then momentarily increase to 105-106% as the engine control system overcompensates for the reduced % **RPM 1/2**. Similar conditions of low collective, high % **RPM R**, and low **Ng SPEED** may be present during practice autorotations to a power recovery. After the flare as the nose is leveled and collective is increased, significant transient droop can occur. A rapid collective pull will aggravate the rotor droop.

d. Maneuvers that rapidly load the rotor system with no collective input can result in transient droops as low as 92%. Transient droop is more pronounced at higher altitudes since the HMU reduces **Ng SPEED** acceleration as barometric pressure decreases.

e. To minimize transient rotor droop, avoid situations which result in rapid rotor loading from low Ng SPEED and % TRQ conditions. Initiate maneuvers with collective inputs leading or simultaneous to cyclic inputs. During approach and landing, maintain at least 15% - 20% TRQ and transient droop will be minimal as hover power is applied.

### Section V ADVERSE ENVIRONMENTAL CONDITIONS

#### 8.38 GENERAL.

This section informs the crewmembers of the special precautions and procedures to be followed during the various weather and climatic conditions that may be encountered. This will be additional material to that already covered in other chapters regarding the operation of the various helicopter systems. Refer to FM 3-04.203 for cold weather operations.

#### 8.38.1 Shipboard Operations.

#### 8.38.1.1 Helicopter Shutdown.



To avoid damage caused by slowing rotor blades, crews shall exercise extreme caution when shutting down the helicopter on board ships.

During rotor coast down on board ship, changing wind conditions, gusts, flight deck turbulence, and rotor downwash from other helicopters can create excessive blade flapping and cause helicopter damage.

#### 8.38.1.2 Blade Folding.



- Crews shall exercise extreme caution when folding or spreading blades in high wind/severe deck motion conditions.
- Takeoff and landing adjacent to helicopters with folded blades should not be conducted on board ship. The folded blades could contact each other and cause damage.

Folding or spreading of main rotor blades may be required on board ship to conserve flight deck space, to use the ship's elevator, or to hangar the helicopter. Controlling the main rotor blades is significantly more difficult than on land due to the effects of wind speed and direction, and ship motion. High winds and/or ship motion can also cause damage to folded blades. 8.38.1.3 Inboard External Fuel Tanks or Stores.



During significant deck motion conditions, chocking must be accomplished expeditiously. On board ship operations will expose flight deck personnel to risk of injury in the event of inadvertent jettison or helicopter movement while chocking.

Inboard mounted external fuel tanks or stores significantly impede access to main wheels. Under severe deck motion, the risk of helicopter movement may exceed the risk of inadvertent stores jettison circuits prior to chocking. Consideration should be given to not carrying inboard mounted tanks or stores when severe deck motion is expected.

#### 8.39 COLD WEATHER OPERATION.

The basic helicopter with normal servicing can operate at temperatures down to  $-34^{\circ}$ C ( $-29^{\circ}$ F).



Static electricity generated by the helicopter should be discharged before attempting a sling or rescue hoist pickup. In cold, dry climatic conditions static electricity buildups are large. Use a conductor between the helicopter and the ground to discharge the static charge. Delay lowering rescue hoist hook until helicopter is over the load, to lessen static charge buildup.

#### NOTE

During operation in cold weather, particularly when snow or moisture is present, the tail wheel locking indicating systems may give erroneous cockpit indications. 8.39.1 Cold Weather Preflight Check.



- Ice removal shall never be done by scraping or chipping. Remove ice by applying heat or deicing fluid.
- Blade deice operation with erosion strips installed may cause blade damage.

a. In addition to the checks in Section II, check helicopter for ice or snow. If ice or snow is found, remove as much as possible by hand and thaw helicopter with heated air or deicing fluid before attempting start. Failure to remove ice and snow may cause damage.

b. Check main rotor head and blades, tail rotor, flight controls, oil cooler vanes, engine inlets, and hand holds for ice and snow. Failure to remove snow and ice accumulations can result in serious aerodynamic, structural effects in flight and serious foreign object damage if ice is ingested into the engine. Check **ENG POWER CONT** levers for freedom of movement.

c. On helicopters equipped with Extended Range Fuel System, check ESSS and 230/450-gallon fuel tank for ice or snow. Remove as much as possible by hand and then use heated air. Start APU and turn on pressure to both IN-BD and OUTBD fuel tanks. Wing-mounted pressure regulator may require heated air applied directly onto the exhaust vent protruding from the ESSS wing. After regulator valve is operating and fuel tanks are pressurized, leave system on. DO NOT TURN OFF PRESSURE SWITCHES OR PRESSURE REGULATORS MAY FREEZE.

d. When parking the helicopter in temperatures below freezing, the gust lock may seize due to frozen moisture in the rod assembly. Normal operations may be returned by warming the assembly. Main rotor tiedowns may be used in lieu of gust lock to meet parking requirements.

**8.39.2 Cold Weather Control Exercise.** After starting the APU, the controls must be exercised when operating in a temperature range of  $-17^{\circ}C$  (1°F) and below. The control exercise is required:

- a. At temperatures between -17°C (1°F) and -31°C (-24°F), cycle collective slowly for 1 minute.
  - (1) Move collective stick grip up about 3 inches from lower stop, and down again

30 times during 1 minute of control cycling in step a.

- (2) Move each tail rotor pedal alternately through ³/₄ inch of travel from neutral position 30 times during 1 minute of control cycling in step a.
- b. At temperatures between -31°C (-24°F) and -43°C (-45°F), cycle collective slowly for 2 minutes.
  - Move collective stick grip up about 1¹/₂ inches from lower stop and down again during first minute, and 3 inches of travel during second minute of control cycling in step b.
  - (2) Move each tail rotor pedal alternately through ³/₈ inch of travel from neutral position during first minute and ³/₄ inch of travel during second minute of control cycling in step b.
- c. At temperatures between -43°C (-45°F) and -54°C (-65°F), cycle collective slowly for 5 minutes.

Move collective and pedals through travel for times shown below:

<u>Collective Travel</u> (Approximately)	<u>Pedals Travel</u> (Approximately)	<u>Time</u> Duration
³ / ₄ inch	¹ / ₈ inch	First minute
1 ¹ / ₂ inches	¹ / ₄ inch	Second minute
1 ³ / ₄ inches	¹ / ₂ inch	Third minute
2 ¹ / ₂ inches	5/8 inch	Fourth minute
3 inches	³ / ₄ inch	Fifth minute

#### 8.39.3 Engine Operation.

a. Even though cold weather does not particularly affect the engine itself, it still causes the usual problems of ice in the fuel lines, control valves, and fuel sumps, which frequently prevent a successful cold weather start. It may be found that certain elements or accessories need preheating.



When starting an engine that has been exposed to low temperatures, watch for rise in TGT TEMP within 45 seconds. If no TGT TEMP rise is evident, manually 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 warmup period to bring transmission oil temperature up to desired operating range. Refer to Chapter 5. Monitor oil pressure and temperature closely. When advancing the power control levers, maintain transmission oil pressure in normal operating range.

b. When starting in cold weather below -40°C (-40°F), if light-off does not occur within 45 seconds after initial indication of Ng SPEED, move ENG POWER CONT lever for the affected engine back to OFF. With the engine shut down, move the ENG POWER CONT lever from OFF to FLY. If the force required to move the ENG POWER CONT lever is higher than normal, suspect possible frozen PAS cable. This situation may require maintenance prior to attempting another start. If force is normal, then attempt another start. If light-off still does not occur within 45 seconds, abort start and do the following:

- (1) ENG FUEL SYS selector(s) DIR.
- (2) ENG POWER CONT lever(s) Hold at LOCKOUT.
- (3) **FUEL BOOST PUMP CONTROL** switch(es) - **ON** until crewmember reports fuel from the overflow drain.
- (4) FUEL BOOST PUMP CONTROL switch(es) OFF.
- (5) ENG POWER CONT lever(s) OFF.
- (6) Attempt another start.

#### 8.39.4 Engine Oil System Characteristics.

a. It is normal to observe high engine oil pressure during initial starts when the ambient temperature is  $0^{\circ}C$ 

(32°F) or below. 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 warmup will depend on temperature of the engine and lubrication system before start.

b. During starts in extreme cold weather (near  $-54^{\circ}C$  (-65°F)), the following oil pressure characteristics are typical:

- (1) Oil pressure may remain at zero for the first 20 to 30 seconds after initiating the start. Abort the start if oil pressure does not register within 1 minute after initiating a start.
- (2) Once oil pressure begins to indicate on the gage, it will increase rapidly and it will exceed the limit. This condition is normal. The time for oil pressure to decrease will depend on the ambient temperature, but should be normal within 5 minutes after starting the engine.
- (3) Oil pressure may increase above the maximum pressure limit if the engine is accelerated above idle while oil temperature is within normal operating range. The pressure will decrease to within the normal operating range as the oil temperature increases.

c. It is normal for the **OIL FLTR BYPASS** caution to appear when starting an engine with oil temperatures below normal because of high oil viscosity and the accumulation of oil filter contaminants. When the engine oil temperature reaches about 38°C (100°F) during warmup, the caution should disappear.

**8.39.5 Taxiing.** The helicopter should not be taxied until all engine temperatures and system pressures are within the normal range. All taxiing should be done at low speeds with wide-radius turns. If the tires are frozen to the surface, a slight yawing motion induced by light pedal application should break them free. Taxiing in soft snow requires higher than normal power.

#### 8.40 DESERT AND HOT WEATHER OPERATION.

**8.40.1 Hovering.** Prolonged hovering flight in hot weather 35°C (95°F) at higher gross weight may cause transmission oil temperature to rise into the yellow precautionary range. Hovering operations in the precautionary range under those conditions may be considered normal.

**8.40.2 Taxiing and Ground Operation.** Braking and ground operation should be minimized to prevent system

overheating. During ground operations, if engine oil pressure falls into the red range when the power control lever is in the idle position and/or the engine oil pressure caution appears when the power control lever is in the idle position, slightly advance the power control lever. If the engine oil pressure returns to the yellow range and the engine oil pressure caution disappears, engine oil pressure is acceptable.

**8.40.3 ECS Operation. ID** To avoid system blockage, the ECS should be turned off when encountering conditions of extreme airborne sand and dust.

#### 8.41 IN-FLIGHT.

#### 8.41.1 Thunderstorm Operation.



Avoid flight in or near thunderstorms, especially in areas of observed or anticipated lightning discharges.

a. Tests have shown that lightning strikes may result in loss of automatic flight controls (including stabilator), engine controls or electrical power. The high currents passing through the helicopter structure are expected to produce secondary effects whereby damaging voltage surges are coupled into helicopter wiring.

b. If a lightning strike occurs whereby all helicopter electrical power and electronics subsystems and controls are lost (including the engine 700 ECU/ 701C 701D/CC DEC and the engine-driven alternator), both engines go immediately to maximum power with no temperature limiter or overspeed protection. In addition, the 701C or 701D/CC engine overspeed may result in single or dual-engine shutdown without automatic relight.

#### 8.41.2 Turbulence.

a. For moderate turbulence, limit airspeed to the MAX RANGE ( Chapter 7 or **701C 701D/CC** Chapter 7A) or  $V_{ne}$  minus 15 knots, whichever is less.

b. In turbulent air, maintain constant collective and use the vertical situation indicator as the primary pitch instrument. The altimeter and vertical velocity indicator may vary excessively in turbulence and should not be relied upon. Airspeed indication may vary as much as 40 KIAS. By maintaining a constant power setting and a level-flight attitude on the vertical situation indicator, airspeed will remain relatively constant even when erroneous readings are presented by the airspeed indicator.

#### 8.41.3 Ice and Rain Operation.



- Operation in rain will result in significant damage to the blade erosion kit materials and should be avoided.
- At airspeeds greater than 120 KIAS or during periods of reduced rain intensity the windshield wipers may slow noticeably. If this occurs, wipers must be parked immediately to avoid wiper motor failure.

8.41.4 In-Flight Icing.



Activation of anti-ice systems after entry into potential icing conditions creates the possibility of engine FOD caused by ice shedding. The ice detector has been designed primarily as a sensor to indicate the requirement for activation of the blade deice system.

a. All anti-ice systems must be turned on prior to entering visible moisture at ambient temperatures of  $4^{\circ}C$  (39°F) or less.

b. If icing conditions are encountered, turn on all antiicing equipment immediately. If torque required increases 20% above that required for level flight at the airspeed being maintained before entering icing, exit the icing environment or land as soon as possible. A 20% torque increase indicates that normal autorotational rotor rpm may not be possible, should dual-engine failure occur.

c. When the helicopter is equipped with an operating blade deice and icing conditions are encountered, a recurring torque increase up to 14% per engine may be experienced during normal operation of the blade deice system because of ice build-up. The crew should closely monitor engine instruments to prevent exceeding limits and/or rotor droop. Significant power losses and increased fuel consumption will occur with the activation of engine

inlet anti-icing systems. Refer to Chapter 7 or 7A for torque available. The main rotor hub and the blades collect ice before initiation of a deice cycle. When enough ice has collected on the blades, moderate vibration levels of short duration can be expected in controls and airframe during normal deicing cycles. If the blade deice system is not operating, unbalanced loads of ice resulting from asymmetric shedding may cause severe vibrations. However, these vibrations normally subside after 30 to 60 seconds when ice from other blades is shed.

d. When helicopter is equipped with external extended range fuel system turn on pressure to both INBD and OUTBD fuel tanks. This will prevent ice accumulation and assure pneumatic pressure for fuel transfer.

#### NOTE

After pressurizing the external extended range fuel tanks, DO NOT TURN OFF if ambient temperature is below 4°C (39°F).

#### 8.41.5 Flight Through Extreme Air Temperatures.

## WARNING

Flight through extreme air temperature environments may cause rapid engine inlet air temperature changes and increases in the probability of compressor stalls on one or both engines. This may exceed engine limitations causing damage to engine components and, in extreme cases, can also increase the probability of engine power loss or engine shutdown.

Flight through extreme air temperature environments, such as in close proximity to intense fires, volcanic activity or over smoke or fire stacks, may cause rapid engine inlet air temperature changes. This condition can cause compressor stalls and should be avoided. Compressor stalls are normally recognized by a noticeable bang or popping noise and possible aircraft yaw. In the event compressor stalls are encountered, flight paths and altitude must be adjusted to prevent recurrence. Due to the variable conditions and terrain features that can be encountered, specific operational procedures can best be determined by operators. Any occurrence of an engine stall requires engine inspection in accordance with aircraft/engine manuals.

#### 8.41.6 Ground Operations.

a. Strong gusty winds may cause increased flapping of the main rotor blades during shutdown following an icing encounter, because the anti-flap restrainers may be frozen in the fly position.

b. During flight in icing conditions when droop stop heaters are not installed or fail to operate properly, the droop stop hinges may become iced, resulting in the droop stops not returning to the static position during rotor coast down. When the droop stops do not return to the static position, the main rotor blades may droop to within 4 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 fly position, caution must be taken during shutdown to be sure personnel remain clear of the helicopter.

# 8.42 FLIGHT NEAR SALT WATER OR VOLCANIC ACTIVITY.

#### NOTE

Pilot will annotate on the 2408-13-1 anytime the helicopter is operated within 200 miles of volcanic activity or 10 miles of salt water.

## CHAPTER 9 EMERGENCY PROCEDURES

### Section I AIRCRAFT SYSTEMS

#### 9.1 HELICOPTER SYSTEMS.

This section describes the helicopter systems emergencies that may reasonably be expected to occur and presents the procedures to be followed. Emergency operation of mission equipment is contained in this chapter, insofar as its use affects safety of flight. Emergency procedures are given in checklist form when applicable. A condensed version of these procedures is contained in the condensed checklist TM 1-1520-237-CL.

#### 9.2 IMMEDIATE ACTION EMERGENCY STEPS.

#### NOTE

The urgency of certain emergencies requires immediate and instinctive action by the pilot. The most important single consideration is helicopter control. All procedures are subordinate to this requirement. The **MASTER CAUTION** should be reset after each malfunction to allow systems to respond to subsequent malfunctions. If time permits during a critical emergency, transmit MAYDAY call, set transponder to emergency, jettison external stores if required, turn off boost pumps, and lock shoulder harnesses.

Those steps that shall be performed immediately in an emergency situation are underlined. These steps must be performed without reference to the checklist. Nonunderlined steps should be accomplished with use of the checklist.

#### 9.3 DEFINITION OF EMERGENCY TERMS.

For the purpose of standardization, these definitions shall apply.

a. The term <u>LAND AS SOON AS POSSIBLE</u> is defined as landing at the nearest suitable landing area (e.g., open field)without delay. (The primary consideration is to ensure the survival of occupants.)

b. The term LAND AS SOON AS PRACTICABLE is defined as landing at a suitable landing area. (The primary consideration is the urgency of the emergency.)

c. The term <u>AUTOROTATE</u> is defined as adjusting the flight controls as necessary to establish an autorotational descent and landing.

d. The term <u>EMER ENG SHUTDOWN</u> is defined as engine shutdown without delay. Engine shutdown in flight is usually not an immediate-action item unless a fire exists. Before attempting an engine shutdown, identify the affected engine by checking ENG OUT warnings, % RPM, % TRQ, ENG OIL PRESS, TGT TEMP, and Ng SPEED.

- 1. ENG POWER CONT lever(s) OFF.
- 2. ENG FUEL SYS selector(s) OFF.
- 3. FUEL BOOST PUMP CONTROL switch(es) - OFF.

If TGT is above 538°C after shutdown:

- 4. <u>AIR SOURCE HEAT/START switch(es) -</u> <u>As required.</u>
- 5. ENGINE IGNITION switch OFF.
- 6. <u>Starter button Press</u> to motor engine for 30 seconds or until **TGT TEMP** decreases below 538°C.

e. The term <u>LOCKOUT</u> is defined as manual control of engine RPM while bypassing **700** ECU, or **701C 701D/CC** DEC functions. Bypass of the engine control will be required when % **RPM 1** or **2** decreases below normal demand speed.



When engine is controlled with ENG POWER CONT lever in LOCKOUT, engine response is much faster and TGT limiting system is inoperative. Care must be taken not to exceed TGT limits and keeping % RPM R and % RPM 1 and 2 in operating range.

ENG POWER CONT lever - Pull down and advance full forward while maintaining downward pressure, then adjust to set % RPM R as required. Engine control malfunctions can result in % RPM R increasing or decreasing from normal demand speed. Under certain failure conditions, % TRQ, % RPM, and Ng SPEED may not be indicating and the possibility of the ENG OUT warning and audio activating exists. The most reliable indication of engine power will be TGT TEMP.

f. The term <u>EMER APU START</u> is defined as APU start to accomplish an emergency procedure.

#### 1. FUEL PUMP switch - APU BOOST.



Ensure that the mask blowers are disconnected and position the BCA MCU control knobs to OFF prior to switching from main power to APU power.

2. APU CONTR switch - ON.

#### 9.4 AFTER EMERGENCY ACTION.

After a malfunction of equipment has occurred, appropriate emergency actions have been taken and the helicopter is on the ground, an entry shall be made in the Remarks Section of DA Form 2408-13-1 describing the malfunction. Ground and flight operations shall be discontinued until corrective action has been taken.

#### 9.5 EMERGENCY EXITS.

Emergency exits are shown in Figure 9-1. Emergency exit release handles are yellow and black striped.



For helicopters with a non-operational roll-trim actuator, the cyclic shall be continuously held while on the ground with rotor turning. In cases where emergency exit is required prior to rotor coasting to a stop, make sure that the cyclic stick is centered until the last crewmember can depart the cockpit. Since the main rotor shaft has a 3° forward tilt, an exit to the right rear or left rear will provide the greatest rotor clearance safety.

a. Each cockpit door is equipped with a jettison system for emergency release of the door assembly. Jettison is done by pulling a handle marked **EMERGENCY EXIT PULL** on the inside of the door. To release the door, the jettison handle is pulled to the rear; the door may then be jettisoned by kicking the lower forward corner of the door. If the door fails to jettison and removable window is installed, the cockpit door windows may be removed by grabbing the **PULL** area of the red strap. Pull strap away from sill in an inboard, downward motion across chest at approximately 45°. Continue pulling the strap until the window is fully detached from the sill. The cockpit door window is pulled into the helicopter and the pilot must rotate the window and push it out of the helicopter.

b. Cabin door window jettison. To provide emergency exit from the cabin, two jettisonable windows are installed in each cabin door. To release the windows, a handle (under a jettison lever guard) marked EMERGENCY EXIT PULL AFT, (left side; right side, PULL FWD) on the inside of the cabin door, is moved in the direction of the arrow, releasing the windows. The windows can then be pushed out.

c. Upon exiting the helicopter, the MCU umbilical will detach (breakaway)at the L-QDC with a moderate (5-20 pounds) application of force. The mask blower power connector will easily separate without otherwise touching the wires. For underwater egress, a stronger separation pull force is required due to the suction forces of the water on the connector.

#### 9.6 EMERGENCY EQUIPMENT (PORTABLE).

Emergency equipment consists of two hand held fire extinguishers, one crash ax, and three first aid kits, as shown in Figure 9-1.

# 9.7 ENGINE MALFUNCTION - PARTIAL OR COMPLETE POWER LOSS.

## WARNING

Single engine capability must be considered prior to movement of the engine power control lever. Prior to movement of either power-control lever, it is imperative that the malfunctioning engine and the corresponding powercontrol lever be identified. If the decision is made to shut down an engine, take at least five full seconds while retarding the ENG POWER CONT lever from FLY to IDLE, monitoring % TRQ, Ng SPEED, TGT TEMP, % RPM, and ENG OUT warning appearance.

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. The engine instruments often provide ample warning of a malfunction before actual engine failure. The indications of engine malfunction, either partial or complete power loss, may be as follows: Changes in affected engine % RPM, TGT TEMP, Ng SPEED, % TRQ, ENG OIL PRESS, % RPM R, LOW ROTOR RPM and/or ENG OUT warnings and audio, and change in engine noise. The amount of change in each depends upon the type of failure, e.g., compressor stall, as opposed to complete power loss on one or both engines.

#### 9.8 FLIGHT CHARACTERISTICS.

**9.8.1 Dual-Engine Failure.** The flight characteristics and the required crewmember control responses after a dual-engine failure are similar to those during a normal power-on descent. Full control of the helicopter can be maintained during autorotational descent. In autorotation, as airspeed increases above 70 - 80 KIAS, the rate of descent and glide distance increase significantly. As airspeed decreases below 64 KIAS, the rate of descent will increase and glide distance will decrease.

**9.8.2 Single-Engine Failure.** When one engine has failed, the helicopter can often maintain altitude and airspeed until a suitable landing site can be selected. Whether or not this is possible becomes a function of such combined variables as aircraft weight, density altitude,

height above ground, airspeed, phase of flight, single engine capability, and environmental response time and control technique may be additional factors. In addition, these factors should be taken into consideration should the functioning engine fail and a dual-engine failure results.

#### 9.9 SINGLE-ENGINE FAILURE - GENERAL.

# WARNING

When the power available during single engine operation is marginal or less, consideration should be given to jettisoning the external stores. The engine antiice and cockpit heater switches should be turned off as necessary to ensure maximum power is available on the remaining engine.

Crewmember recognition of a single-engine failure and subsequent action are essential and should be based on the following general guidelines. At low altitude and low airspeed, it may be necessary to lower the collective only enough to maintain % **RPM R** (normal range). At higher altitude, however, the collective may be lowered significantly to increase % **RPM R** to 100%. When hovering in ground effect, the collective should be used only as required to cushion the landing, and the primary consideration is in maintaining a level attitude. In forward flight at low altitude (as in takeoff), when a single-engine capability to maintain altitude does not exist, a decelerating attitude will initially be required to prepare for landing. Conversely, if airspeed is low and altitude sufficient, the helicopter should be placed in an accelerating attitude to gain sufficient airspeed for single-engine fly away to a selected landing site. The area outside of the appropriate gross weight line (Figures 9-2 and 9-3) defines the airspeed and wheel-height combinations that will permit a safe landing in the event of an engine failure for various gross weights at both sea level 15°C (59°F), and 4,000 feet/35°C (95°F), ambient condition.

#### 9.10 SINGLE-ENGINE FAILURE.



Do not respond to ENG OUT warning and audio until checking TGT TEMP, Ng SPEED, and % RPM 1 and 2.

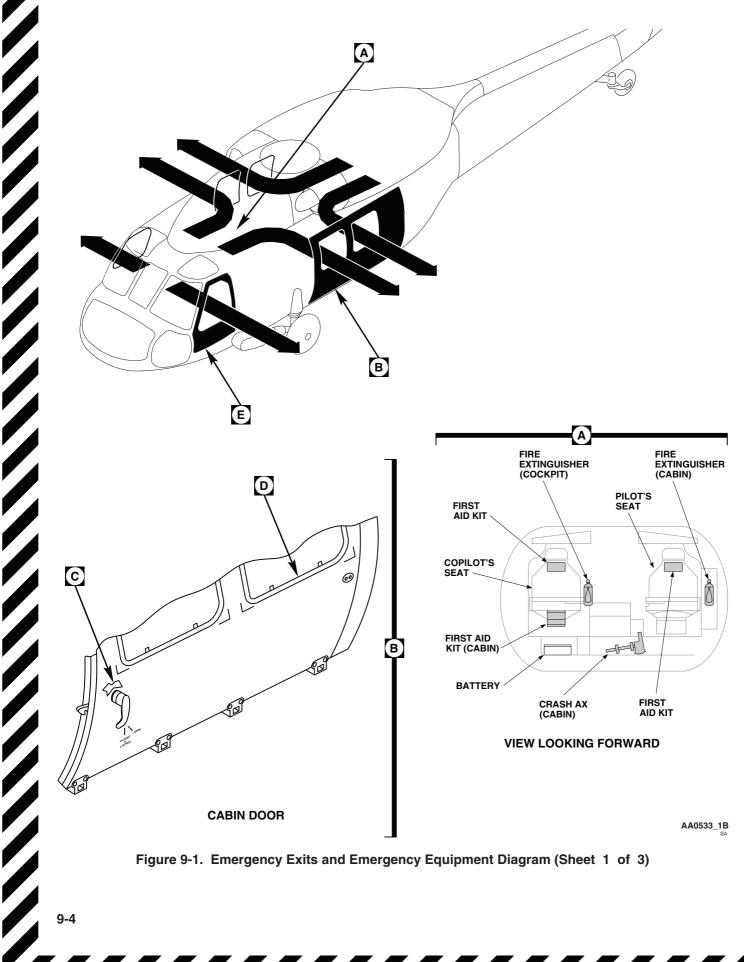
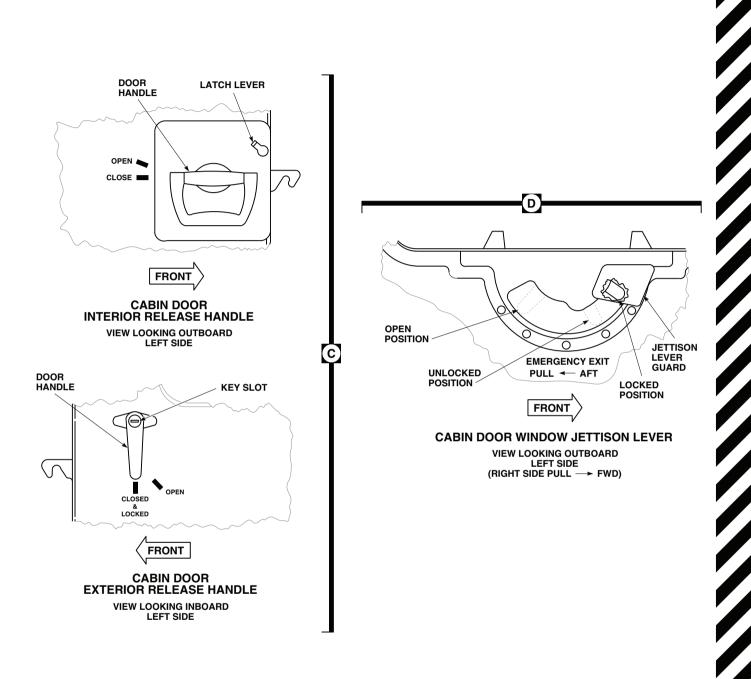


Figure 9-1. Emergency Exits and Emergency Equipment Diagram (Sheet 1 of 3)



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Figure 9-1. Emergency Exits and Emergency Equipment Diagram (Sheet 2 of 3)

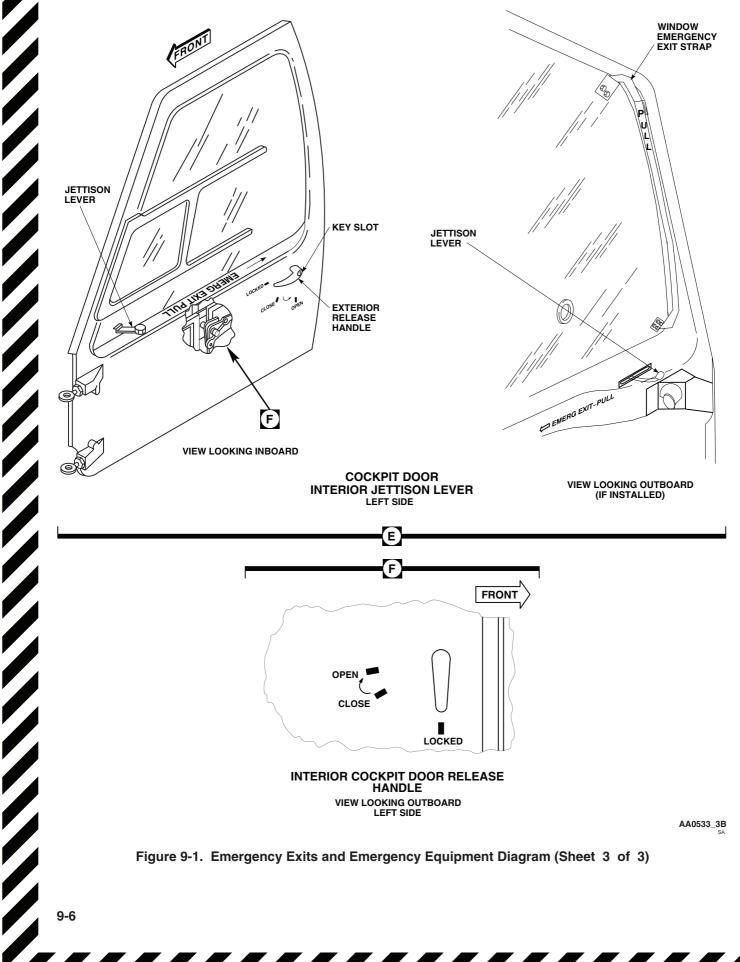


Figure 9-1. Emergency Exits and Emergency Equipment Diagram (Sheet 3 of 3)

### TM 1-1520-237-10

1. Collective - Adjust to maintain % RPM R.

(2.) External cargo/stores - Jettison (if required).

If continued flight is not possible:

#### 3. LAND AS SOON AS POSSIBLE.

If continued flight is possible:

- 4. Establish single-engine airspeed.
- 5. LAND AS SOON AS PRACTICABLE.

#### 9.11 ENGINE RESTART DURING FLIGHT.

After an engine failure in flight, an engine restart may be attempted. If it can be determined that it is reasonably safe to attempt a start, the APU should be used. Use of a crossbleed start could result in a power loss of up to 18% **TRQ** on the operational engine.

#### 9.12 DUAL-ENGINE FAILURE - GENERAL.

a. If both engines fail, immediate action is required to make a safe autorotative descent (Figures 9-4 and 9-5). The altitude and airspeed at which a two-engine failure occurs will dictate the action to be taken. After the failure, main rotor rpm will decay rapidly and the aircraft will yaw to the left. Unless a two-engine failure occurs near the ground, it is mandatory that autorotation be established immediately. During cruise, reduce collective immediately to regain % **RPM R** and then adjust as required to maintain % RPM within power off rotor speed limits. The cyclic should be adjusted as necessary to attain and maintain the desired airspeed. The recommended airspeed for autorotation is 80 KIAS. Autorotation below 80 knots is not recommended because the deceleration does not effectively arrest the rate of descent. Adjusting the cyclic and collective control to maintain 100% RPM R and 110 KIAS (100 KIAS high drag) will result in achieving the maximum glide distance. A landing area must be selected immediately after both engines fail. Throughout the descent, adjust collective as necessary to maintain % **RPM R** within normal range. Figure 5-1 shows the rotor limitations. % **RPM R** should be maintained at or slightly above 100% to allow ample rpm before touchdown.

b. Main rotor rpm will increase momentarily when the cyclic is moved aft with no change in collective pitch set-

ting. An autorotative rpm of approximately 100% provides for a good rate of descent. % RPM R above 100% will result in a higher rate of descent. At 50 to 75 feet AGL. use aft cyclic to decelerate. This reduces airspeed and rate of descent and causes an increase in % RPM R. The degree of increase depends upon the amount and rate of deceleration. An increase in % RPM R can be desirable in that more inertial energy in the rotor system will be available to cushion the landing. Ground contact should be made with some forward speed. Pitch attitudes up to 25° at the point of touchdown normally result in an adequate deceleration and safe landing. If a rough area is selected, a steeper deceleration and a touchdown speed as close to zero as possible should be used. With pitch attitude beyond 25° there is the possibility of ground contact with the stabilator trailing edge. It is possible that during the autorotative approach, the situation may require additional deceleration. In that case, it is necessary to assume a landing attitude at a higher altitude than normal. Should both engines fail at low airspeed, initial collective reduction may vary widely. The objective is to reduce collective as necessary to maintain % RPM R within normal range. In some instances at low altitude or low airspeed, settling may be so rapid that little can be done to avoid a hardimpact landing. In that case, it is critical to maintain a level landing attitude. Cushion the landing with remaining collective as helicopter settles to the ground. At slow airspeeds, where altitude permits, apply forward cyclic as necessary to increase airspeed to about 80 KIAS. Jettison external cargo and stores as soon as possible to reduce weight and drag, improve autorotational performance, and reduce the chance of damage to the helicopter on landing.

#### 9.13 DUAL-ENGINE FAILURE.



Do not respond to ENG OUT warnings and audio until checking TGT TEMP and % RPM R.

#### AUTOROTATE.

#### 9.14 DECREASING % RPM R.

If an engine control unit fails to the low side and the other engine is unable to provide sufficient torque, % **RPM R** will decrease.

### UH-60A/EH-60A HEIGHT VELOCITY AVOID REGIONS SINGLE-ENGINE FAILURE

### EXAMPLE

#### WANTED:

A TAKEOFF PROFILE WHICH WILL PERMIT A SAFE LANDING AFTER AN ENGINE SUDDENLY BECOMES INOPERATIVE.

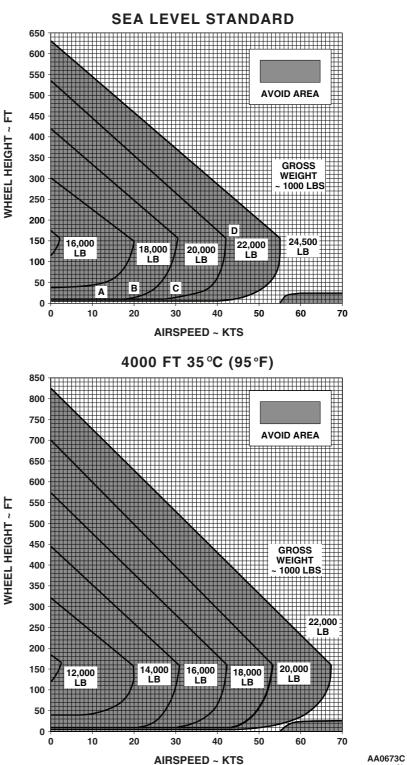
#### KNOWN:

AIRCRAFT GROSS WEIGHT = 22,000 LBS AMBIENT CONDITIONS: TEMPERATURE = 15°C PRESSURE ALTITUDE = SEA LEVEL WIND = 0 KTS

#### **METHOD:**

TRACE ALONG GROSS WEIGHT LINE NOTING WHEEL HEIGHT / AIRSPEED COMBINATIONS WHICH WILL KEEP THE TAKEOFF PROFILE BELOW AND TO THE RIGHT OF THE AVOID REGION.

POINT	AIRSPEED	WHEEL HEIGHT
Α	10	10
В	20	10
С	30	15
D	42	155



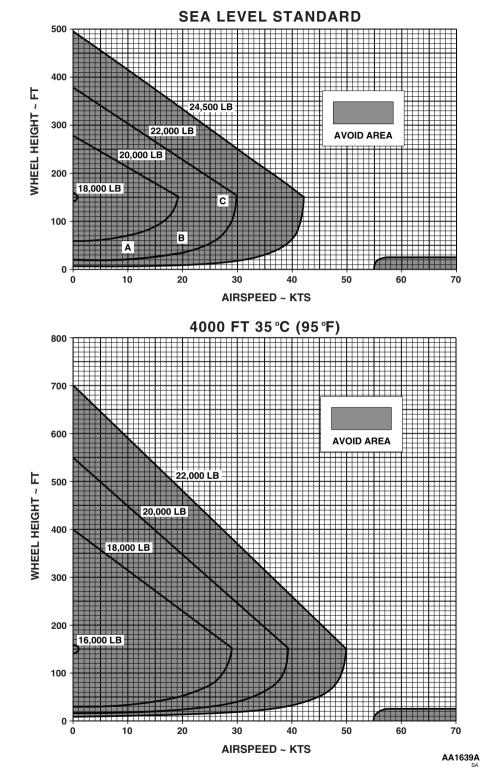
BASED ON AN ETF OF .85 OF MAXIMUM RATED POWER. WEIGHTS GREATER THAN 22,000 LBS ARE FOR FERRY MISSION ONLY, FOR WHICH A FLIGHT RELEASE IS REQUIRED.

DATA BASIS: CALCULATED



NOTE:

### UH-60L/UH-60A+ HEIGHT VELOCITY AVOID REGIONS SINGLE ENGINE FAILURE



**EXAMPLE** 

#### WANTED

A TAKEOFF PROFILE WHICH WILL PERMIT A SAFE LANDING AFTER AN ENGINE SUDDENLY BECOMES INOPERATIVE.

#### KNOWN

AIRCRAFT GROSS WEIGHT = 22,000 LBS AMBIENT CONDITIONS: TEMPERATURE = 15°C PRESSURE ALTITUDE = SEA LEVEL WIND = 0 KTS

#### METHOD

TRACE ALONG GROSS WEIGHT LINE NOTING WHEEL HEIGHT / AIRSPEED COMBINATIONS WHICH WILL KEEP THE TAKEOFF PROFILE BELOW AND TO THE RIGHT OF THE AVOID REGION.

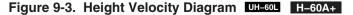
POINT	AIRSPEED	WHEEL HEIGHT
Α	10	21
в	20	33
С	30	150

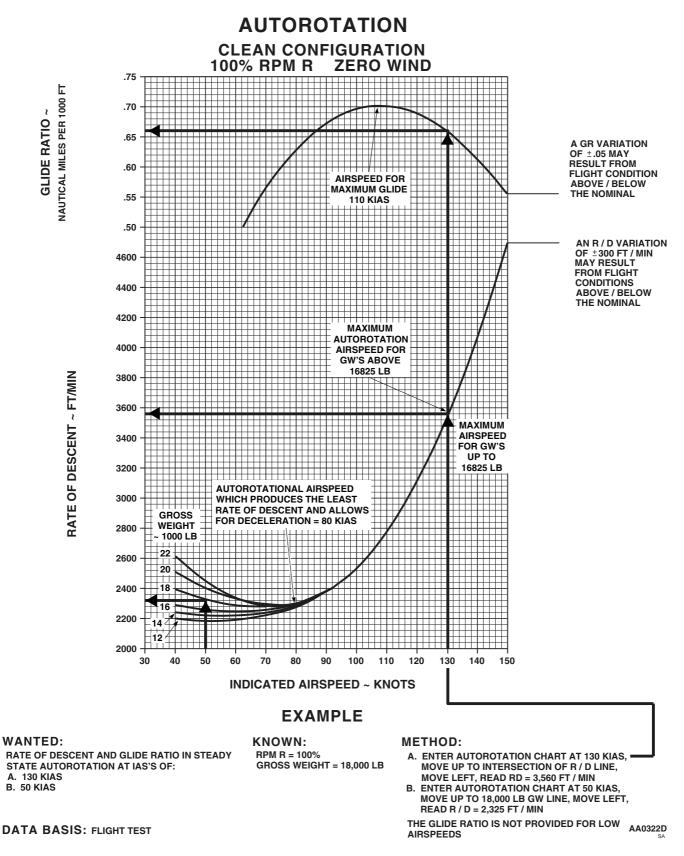
NOTE

BASED ON AN ETF OF .90 OF MAXIMUM

**DATA BASIS: ESTIMATED** 

RATED POWER.







-4-

### AUTOROTATION HIGH DRAG CONFIGURATION 100% RPM R ZERO WIND

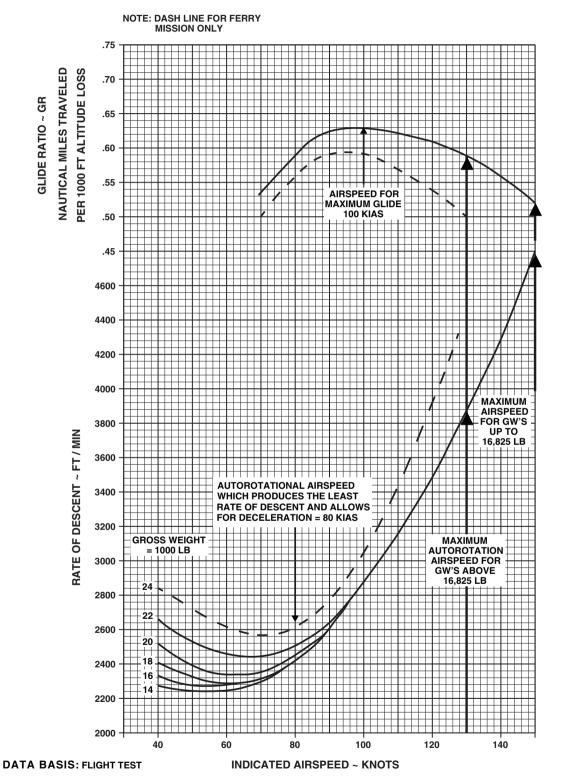


Figure 9-5. Autorotative Glide Distance Chart-High Drag

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When engine is controlled with ENG POWER CONT lever in LOCKOUT, engine response is much faster and the TGT limiting system is inoperative. Care must be taken not to exceed TGT limits and keeping % RPM R and % RPM 1 and 2 in operating range.

#### NOTE

If % **RPM R** reduces from 100% to 95-96% during steady flight, check % **TRQ 1** and **2**. If % **TRQ 1** and **2** are equal, attempt to increase % **RPM R** with **ENG RPM** trim switch.

1. Collective - Adjust to control % RPM R.

2. ENG POWER CONT lever (low % TRQ/ <u>TGT TEMP engine</u>) - LOCKOUT. Maintain % TRQ approximately 10% below other engine.

3. LAND AS SOON AS PRACTICABLE.

#### 9.15 INCREASING % RPM R.

% **RPM R** increasing will result from an engine control system failing to the high side. % **RPM 1** and 2 (Np) will increase with the rotor % **RPM R**. Increasing the collective will probably increase the malfunctioning engine's **TGT TEMP** above 900°C. If an engine control unit fails to the high side:

> 1.) ENG POWER CONT lever (high % TRQ/ TGT TEMP engine) - Retard. Maintain % TRQ approximately 10% below other engine.

2. LAND AS SOON AS PRACTICABLE.

If the affected engine does not respond to ENG POWER CONT lever movement in the range between FLY and IDLE, the HMU may be malfunctioning internally.

If this occurs:

3. Establish single engine airspeed.

(4.)Perform EMER ENG SHUTDOWN (affected engine).

(5.)Refer to single-engine failure emergency procedure.

# 9.16 % RPM INCREASING/DECREASING (OSCILLATION).

It is possible for a malfunction to occur that can cause the affected engine to oscillate. The other engine will respond to the change in power by also oscillating, usually with smaller amplitudes. The engine oscillations will cause torque oscillations. The suggested pilot corrective action is to pull back the ENG POWER CONT lever of the suspected engine until oscillation stops. If the oscillation continues, the ENG POWER CONT lever should be returned to FLY position and the other ENG POWER CONT lever pulled back until the oscillation ceases. Once the malfunctioning engine has been identified, it should be placed in LOCKOUT and controlled manually.

If the oscillation stops:

- (2.)Place that engine in **LOCKOUT** and manually control the power.
- 3. LAND AS SOON AS PRACTICABLE.

If the oscillation continues:

(4.) Place the ENG POWER CONT lever back to **FLY** and retard the ENG POWER CONT lever of the other engine.

When the oscillation stops:

(5.)Place the engine in **LOCKOUT**, manually control the power.

6. LAND AS SOON AS PRACTICABLE.

#### 9.17 % TRQ SPLIT BETWEEN ENGINES 1 AND 2.

It is possible for a malfunction to occur that can cause a % **TRQ** split between engines without a significant change in % **RPM R**. The % **TRQ** split can be corrected by manual control of the **ENG POWER CONT** lever on the affected engine.

^{1.)}Slowly retard the ENG POWER CONT lever on the suspected engine.

9-13

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 If TGT TEMP of one engine exceeds the limiter ( 700 852°C, 701C 701D/CC 875°C with low power engine above 50% TRQ or 901°C with low power engine below 50% TRQ), retard ENG POWER CONT lever on that engine to reduce TGT TEMP. Retard the ENG POWER CONT lever to maintain torque of the manually controlled engine at approximately 10% below the other engine.

- 2.)If TGT TEMP limit on either engine is not exceeded, slowly retard ENG POWER CONT lever on high % TRQ engine and observe % TRQ of low power engine.
- (3.) If % TRQ of low power engine increases, ENG POWER CONT lever on high power engine - Retard to maintain % TRQ approximately 10% below other engine (the high power engine has been identified as a high side failure).
- (4.) If % **TRQ** of low power engine does not increase, or % **RPM R** decreases, **ENG POWER CONT** lever - Return high power engine to **FLY** (the low power engine has been identified as a low side failure).
- (5.) If additional power is required, low power ENG POWER CONT lever, momentarily move to LOCKOUT and adjust to set % TRQ approximately 10% below the other engine.
- 6. LAND AS SOON AS PRACTICABLE.

#### 9.18 ENGINE COMPRESSOR STALL.

An engine compressor stall is normally recognized by a noticeable bang or popping noise and possible aircraft yaw. These responses are normally accompanied by the rapid increase in **TGT TEMP** and fluctuations in **Ng SPEED**, **% TRQ**, and **% RPM** reading for the affected engine. In the event of a compressor stall:

1. Collective - Reduce.

If condition persists:

2.) ENG POWER CONT lever (affected engine) - Retard (TGT TEMP should decrease). 3. ENG POWER CONT lever (affected engine) - FLY.

If stall condition recurs:

- 4. Establish single engine airspeed.
- (5.)<u>EMER ENG SHUTDOWN</u> (affected engine).
- 6. Refer to single-engine failure emergency procedure.

#### 9.19 ENGINE OIL FILTER BYPASS CAUTION APPEARS, ENGINE CHIP CAUTION APPEARS, ENG OIL PRESS HIGH/LOW, ENGINE OIL TEMP HIGH, ENGINE OIL TEMP CAUTION APPEARS, ENGINE OIL PRESS CAUTION APPEARS.

(1.) ENG POWER CONT lever (affected engine) - Retard (to reduce torque).

If oil pressure is below minimum limits or if oil temperature remains above maximum limits:

- 2. Establish single engine airspeed.
- (3.) EMER ENG SHUTDOWN (affected engine).
- (4.) Refer to single-engine failure emergency procedure.

#### 9.20 ENGINE HIGH-SPEED SHAFT FAILURE.

Failure of the shaft may be complete or partial. A partial failure may be characterized at first by nothing more than a loud high-speed rattle and vibration coming from the engine area. A complete failure will be accompanied by a loud bang that will result in a sudden % **TRQ** decrease to zero on the affected engine. % **RPM** of affected engine will increase until overspeed system is activated.

- 1. Collective Adjust.
- 2. Establish single engine airspeed.
- (3.)<u>EMER ENG SHUTDOWN</u> (affected engine). Do not attempt to restart.
- (4.)Refer to single-engine failure emergency procedure.

9.21 LIGHTNING STRIKE.



Lightning strikes may result in loss of automatic flight control functions, engine controls, and/or electric power.

Lightning strike may cause one or both engines to immediately produce maximum power with no TGT limiting or overspeed protection. Systems instruments may also be inoperative. If this occurs, the flight crew would have to adjust to the malfunctioning engine(s) **ENG POWER CONT** lever(s) as required to control % **RPM** by sound and feel. If practical, the pilot should reduce speed to 80 KIAS. This will reduce the criticality of having exactly correct rotor speed 100%.

# 1. ENG POWER CONT levers - Adjust as required to control % RPM.

#### 2. LAND AS SOON AS POSSIBLE.

## 9.22 ROTORS, TRANSMISSIONS, AND DRIVE SYSTEMS.

#### Tail Rotor Malfunctions - General.

The tail rotor malfunctions listed in this Chapter can be grouped into two general categories: Loss of Thrust and Fixed Pitch malfunctions.

1. Loss of Thrust will be caused by a failure of the tail rotor gearbox, intermediate gearbox or tail rotor drive shaft. 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 airspeed and at a hover will result in a rapid right yaw. At higher airspeed, a right yaw may develop more slowly but may continue to increase. When the yaw rate cannot be controlled an autorotation must be entered promptly. In situations where tail rotor components are lost the nose will pitch down which may necessitate a descending right turn to an acceptable landing area. Every effort should be made to establish and maintain an airspeed that allows for trimmed flight and an autorotative glide above 80 KIAS to maximize the effectiveness of the deceleration during the landing sequence. If large sideslip angles are allowed to develop causing low indicated airspeed, the stabilator will program down and make it more difficult to increase airspeed and to maintain adequate autorotative airspeed. Seeking a

headwind or left quartering wind crosswind component may aid in maintaining heading control for landing.

2. Fixed Pitch malfunctions may be caused by a jam, binding, or failure in the flight controls or tail rotor quadrant. The amount of anti-torque applied, aircraft gross weight, forward airspeed, and altitude at the time of the malfunction will determine the appropriate action. In most cases, except low airspeed and altitude combinations where acceleration is not possible continued flight will be possible. When altitude and time permit, every effort should be made to achieve level trimmed flight between 25-145 KIAS. In all fixed pitch situations the nose of the helicopter will turn to the right when power or airspeed is increased and turn to the left when collective or airspeed is decreased. Complete collective travel is available for most control combinations during a quadrant jam provided the pedals are allowed to move as the collective is displaced. If large sideslip angles are allowed to develop causing low indicated airspeed, the stabilator will program down and make it more difficult to increase airspeed and to maintain airspeed. Landing the aircraft into the wind or with a crosswind component opposite the yaw may aid in maintaining heading control for landing. Aircraft gross weight, amount of anti-torque applied at time of failure, and airspeeds that allow for trimmed flight must be considered when determining the type of landing.

a. Fixed Right Pedal/Decreased Power (Approximate Hover Power or Less Anti-Torque Applied) - If the tail rotor pitch becomes fixed or jammed during decreased or low power situations (right pedal applied) the nose of the helicopter will turn to the right when collective or airspeed is increased and turn to the left when collective or airspeed is decreased. Some conditions may require entry into autorotation to control yaw rate. If continued flight is possible, a shallow approach at about 80 KIAS to a roll-on landing should be made. Attempt to land with aircraft into the wind or a left quartering crosswind to aid in heading control. As the touchdown point is approached, a mild deceleration should be executed at about 15 to 25 feet to reduce airspeed to about 40 KIAS. As collective is increased to cushion touchdown, the nose of the helicopter will turn to the right. Careful adjustment of collective and deceleration should allow a touchdown with approximate runway alignment. Upon touchdown, lower collective carefully and use brakes to control heading.

b. Fixed Left Pedal/Increased Power (Approximate Hover Power or Greater Anti-Torque Applied) - If the tail rotor pitch becomes fixed or jammed during increased or high power situations (left pedal applied), the nose of the helicopter will turn to the right when collective or airspeed is increased and turn to the left when collective or airspeed is decreased. During low airspeeds or at a hover the aircraft may be in a non-recoverable profile. If this is experienced, the engine power control lever(s) must be retarded to begin a descent and decrease main rotor torque and then the collective reduced to allow the aircraft to descend while preserving **RPM R** for the landing. The crew should attempt to maintain a level attitude and increase collective just prior to touchdown to attempt to cushion the landing. If continued flight is possible adjust approach speed and rate of descent to maintain a right sideslip (nose pointed left) angle of less than 20°. The sideslip angle may be reduced by either increasing collective or airspeed. Attempt to land with aircraft into the wind or a right quartering crosswind to aid in heading control. Careful adjustment of collective and deceleration should allow a touchdown with approximate runway alignment. Upon touchdown, lower collective carefully and use brakes to control heading. In some cases, (approximate hover power anti-torque applied) it may be possible to slow the aircraft and land from a hover.

#### 9.22.1 Loss of Tail Rotor Thrust in Cruise Flight.

If autorotation entry is delayed, large sideslip angles can develop causing low indicated airspeed with the stabilator programming down. This will make it more difficult to establish or maintain adequate autorotative airspeed.

- 1. Airspeed Adjust to 80 KIAS or above.
- 2. <u>AUTOROTATE Maintain airspeed at or</u> <u>above 80 KIAS</u>.
- (3.) ENG POWER CONT levers OFF (during deceleration when intended point of landing is assured).

#### 9.22.2 Loss of Tail Rotor Thrust or TAIL ROTOR QUADRANT Caution Appears with Loss of Control at Low Airspeed/Hover (Right Rotation).

Loss of tail rotor thrust at low airspeed may result in extreme yaw angles and uncontrolled rotation to the right. Immediate collective pitch reduction must be initiated to reduce the yaw and begin a controlled rate of descent. If the helicopter is high enough above the ground, initiate a power-on descent. Collective should be adjusted so that an acceptable compromise between rate of turn and rate of descent is maintained. At approximately 5 to 10 feet above touchdown, initiate a hovering autorotation by moving the **ENG POWER CONT** levers - **OFF**.

1. Collective - Reduce.

(2.) ENG POWER CONT levers - OFF (5 to 10) feet above touchdown).

9.22.3 TAIL ROTOR QUADRANT Caution Appears in Cruise Flight.



If the helicopter is shut down and/or hydraulic power is removed with one tail rotor cable failure, disconnection 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 boost servo piston enough to unlatch the quadrant cable.

a. Loss of one tail rotor cable will be indicated by appearance of the **TAIL ROTOR QUADRANT** caution. No change in handling characteristics should occur if only one cable fails.

b. If both tail rotor control cables fail, a centering spring will position the tail rotor servo linkage to provide  $10\frac{1}{2}$  degrees of pitch. This will allow trimmed flight at about 25 KIAS up to 145 KIAS (these speeds will vary with gross weight). At airspeed below 25 and above 145 KIAS, right yaw can be controlled by reducing collective. Between 25 and 145 KIAS, left yaw can be controlled by increasing collective.

- 1. <u>Collective Adjust to determine controllability</u> (Fixed Right or Left).
- 2. LAND AS SOON AS PRACTICABLE.

9.22.4 TAIL ROTOR QUADRANT Caution Appears or Loss of Control at Low Airspeed/Hover (Left Rotation).



Reducing collective in a left rotation will increase rate of turn with the ENG POWER CONT lever(s) at fly depending on the rate at which the ENG POWER CONT lever(s) are retarded. It is critical that the pilot on the controls maintain a level attitude, preserve RPM R, and apply cushion for the landing.

(1.) ENG POWER CONT lever(s) - Retard to begin a partial power descent.

- 2. Collective Adjust to preserve **RPM R**.
- 3.) <u>ENG POWER CONT levers OFF (5 to 10</u> feet above touchdown).
- 4. Collective Adjust for landing.

**9.22.5 Pedal Bind/Restriction or Drive With No Accompanying Caution.** A malfunction within the yaw boost servo or tail rotor servo can produce much higher force at the pedals and the affected servo must be turned off. A hardover failure of the yaw boost servo will increase control forces as much as 250 pounds on the pedals.

1. Apply pedal force to oppose the drive.

2.)Check other pedals for proper operation.

(3.)**TAIL SERVO** switch - **BACKUP**.

If normal control authority is not restored:

(4.) **TAIL SERVO** switch - **NORMAL**.

(5.)**BOOST** switch - OFF.

If normal control forces are not restored:

(6.)**BOOST** switch - ON.

- 7. Collective Adjust to determine controllability for landing.
- 8. LAND AS SOON AS PRACTICABLE.

9.22.6 #1 TAIL RTR SERVO Caution Appears and BACK-UP PUMP ON Advisory Does Not Appear or #2 TAIL RTR SERVO ON Advisory Does Not Appear. Automatic switch over did not take place.

(1.)**TAIL SERVO** switch - **BACKUP**.

(2.)BACKUP HYD PUMP switch - ON.

3. LAND AS SOON AS PRACTICABLE.

**9.22.7 MAIN XMSN OIL PRESS Caution Appears/ XMSN OIL PRESS LOW/XMSN OIL TEMP HIGH or XMSN OIL TEMP Caution Appears.** Loss of cooling oil supply will lead to electrical and/or mechanical failure of main generators. If the malfunction is such that oil pressure decays slowly, the generators may fail before **MAIN XMSN OIL PRESS** caution appears. 1. LAND AS SOON AS POSSIBLE.

If time permits:

2. Slow to 80 KIAS.

(3.)<u>EMER APU START</u>.

(4.) GENERATORS NO. 1 and NO. 2 switches - OFF.

9.22.8 CHIP INPUT MDL LH or RH Caution Appears.

(1.) ENG POWER CONT lever (affected engine) - IDLE.

2. LAND AS SOON AS POSSIBLE.

9.22.9 CHIP MAIN MDL SUMP, CHIP ACCESS MDL LH or RH, CHIP TAIL XMSN or CHIP INT XMSN/TAIL XMSN OIL TEMP or INT XMSN OIL TEMP Caution Appears.

LAND AS SOON AS POSSIBLE.

9.22.10 Main Transmission Failure.



If % RPM R decreases from 100% to below 96% with an increase in torque during steady flight with no engine malfunction, the main transmission planetary carrier may have failed. During a main transmission planetary carrier failure, it may be impossible to maintain % RPM R at 100%

#### NOTE

Decreasing % **RPM R** may be accompanied by a drop in transmission oil pressure of 10 psi or more, and possible unusual helicopter vibrations.

- 1. Collective Adjust only enough to begin a descent with power remaining applied to the main transmission throughout the descent and landing.
- 2. LAND AS SOON AS POSSIBLE.

9.23 FIRE.

# WARNING

If AC electrical power is not available, only the reserve fire bottle can be discharged and fire extinguishing capability for the #2 engine will be lost.

The safety of helicopter occupants is the primary consideration when a fire occurs; therefore, it is imperative that every effort be made to extinguish the fire. On the ground, it is essential that the engine be shut down, crew and passengers evacuated, and fire fighting begun immediately. If time permits, a "Mayday" radio call should be made before the electrical power is OFF to expedite assistance from firefighting equipment and personnel. If the helicopter is airborne when a fire occurs, the most important single action that can be taken by the pilot is to land. Consideration must be given to jettisoning external stores and turning FUEL BOOST PUMPS and XFER PUMPS off prior to landing.

#### 9.23.1 Engine/Fuselage Fire On Ground.

(1.) ENG POWER CONT levers - OFF.

(2.)**ENG EMER OFF** handle - Pull if applicable.

3. FIRE EXTGH switch - MAIN/RESERVE as required.

#### 9.23.2 APU Compartment Fire.

(1.)**APU** fire T-handle - Pull.

2. FIRE EXTGH switch - MAIN/RESERVE as required.

#### 9.23.3 APU OIL TEMP HI Caution Appears.

**APU CONTR** switch - **OFF**. Do not attempt restart until oil level has been checked.

9.23.4 Engine Fire In Flight.



Attempt to visually confirm fire before engine shutdown or discharging extinguishing agent.

1. Establish single engine airspeed.

2. ENG POWER CONT lever (affected engine) - OFF.

- (3.) ENG EMER OFF handle Pull.
- 4.) FIRE EXTGH switch MAIN/RESERVE as required.
- 5. LAND AS SOON AS POSSIBLE.

**9.23.5 Electrical Fire In Flight.** Prior to shutting off all electrical power, the pilot must consider the equipment that is essential to a particular flight environment which will be affected, e.g., flight instruments, flight controls, etc. If a landing cannot be made as soon as possible, the affected circuit may be isolated by selectively turning off electrical equipment and/or pulling circuit breakers.

#### (1.)BATT and GENERATORS switches - OFF.

2. LAND AS SOON AS POSSIBLE.

#### 9.24 SMOKE AND FUME ELIMINATION.



If battery overheats, do not remove battery cover or attempt to disconnect or remove battery. Battery fluid will cause burns, and an overheated battery could cause thermal burns and may explode.

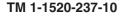
Smoke or fumes in the cockpit/cabin can be eliminated as follows:

- 1. Airspeed 80 KIAS or less.
- 2. Cabin doors and gunner's windows Open.
- 3. Place helicopter out of trim.
- 4. LAND AS SOON AS PRACTICABLE.

#### 9.25 FUEL SYSTEM.

# 9.25.1 #1 or #2 FUEL FLTR BYPASS Caution Appears.

(1.) ENG FUEL SYS selector on affected engine - XFD.



2. LAND AS SOON AS PRACTICABLE.

9.25.2 #1 and #2 FUEL FLTR BYPASS Cautions Appear.

#### LAND AS SOON AS POSSIBLE.

9.25.3 #1 FUEL LOW and #2 FUEL LOW Cautions Appear.

LAND AS SOON AS PRACTICABLE.

9.25.4 #1 or #2 FUEL PRESS Caution Appears.



Consideration must be given to any suspected fuel system compromise. If a compromise is suspected, the pilot must make every attempt to avoid or reduce the possibility of an ignition source. A fuel leak occurring in the oil cooler access area may result in fuel and/or fumes accumulating in or around the APU/engine compartments. In such cases, APU/engine operation may result in fire.

a. If the caution appears, flameout is possible. Do not make rapid collective movements. Critical situations are those where single engine flight is not possible, and the potential for fire resulting from a fuel leak is secondary to engine flameout.

If the caution appears and the situation is critical:

1.) ENG FUEL SYS selector on affected engine -XFD.

- 2. FUEL BOOST PUMP CONTROL switches - NO. 1 PUMP or NO. 2 PUMP - ON (As applicable).
- 3. LAND AS SOON AS POSSIBLE.

4.)EMER ENG SHUTDOWN after landing.

b. Non-critical situations are those where single engine flight is possible.

If the caution appears, and the situation is not critical:

(1.)ENG FUEL SYS selector on affected engine - XFD.

- (2.) FUEL BOOST PUMP CONTROL switches - NO. 1 PUMP or NO. 2 PUMP - OFF (As applicable).
- 3. LAND AS SOON AS PRACTICABLE.

#### 9.25.5 #1 and #2 FUEL PRESS Cautions Appear.

- 1. LAND AS SOON AS POSSIBLE.
- (2.) EMER ENG SHUTDOWN after landing.

#### 9.26 ELECTRICAL SYSTEM.

# 9.26.1 #1 and #2 Generator Failure (#1 and #2 CONV and AC ESS BUS OFF Cautions Appear).

(1.)**SAS 1** switch - Press off.

2. Airspeed - Adjust (80 KIAS or less).

3. GENERATORS NO. 1 and NO. 2 switches -RESET; then ON.

If cautions still appear:

4. GENERATORS NO. 1 and NO. 2 switches - OFF.

(5.)<u>EMER APU START</u>.

(6.)SAS 1 switch - ON.

- 7. If MCUs are in use: BCA MCU control knobs (pilot, copilot, and crewmembers) **OFF**.
- 8. LAND AS SOON AS PRACTICABLE.

9.26.2 #1 or #2 GEN Caution Appears.



When the #1 ac generator is failed, and the backup pump circuit breaker is out, turn off ac electrical power before resetting the backup pump power circuit breaker, to avoid damaging the current limiters.

(1.) Affected GENERATORS switch - RESET; then ON.

If caution still appears:

(2.) Affected **GENERATORS** switch - **OFF**.

#### 9.26.3 #1 and #2 CONV Cautions Appear.

1. Unnecessary dc electrical equipment - OFF.

#### NOTE

When only battery power is available, NICAD battery life is about 22 minutes day and 14 minutes night for a battery 80% charged.SLAB battery life is about 38 minutes day and 24 minutes night for a battery 80% charged.

2. LAND AS SOON AS PRACTICABLE.

#### 9.26.4 BATTERY FAULT Caution Appears.

1. BATT switch - OFF; then ON. If BATTERY FAULT caution appears, cycle BATT switch no more than two times.

If caution still appears:

(2.)BATT switch - OFF.

#### 9.26.5 BATT LOW CHARGE Caution Appears.

If caution appears after ac power is applied:

(1.)**BATT** switch - **OFF**; then **ON**. About 30 minutes may be required to recharge battery.

If caution appears in flight:

2. BATT switch - OFF, to conserve remaining battery charge.

#### 9.27 HYDRAULIC SYSTEM.

#### 9.27.1 #1 HYD PUMP Caution Appears.

(1.) TAIL SERVO switch - BACKUP; then NORMAL.

2. LAND AS SOON AS PRACTICABLE.

#### 9.27.2 #2 HYD PUMP Caution Appears.

1. **POWER ON RESET** switches -Simultaneously press, then release.

*_____* 

2. LAND AS SOON AS PRACTICABLE.

#### 9.27.3 #1 and #2 HYD PUMP Cautions Appear.

LAND AS SOON AS POSSIBLE. Restrict control movement to moderate rates.

# 9.27.4 #1 or #2 HYD PUMP Caution Appears and BACK-UP PUMP ON Advisory Does Not Appear.

Loss of both the No. 1 hydraulic pump and backup pump results in both stages of the tail-rotor servo being unpressurized. The yaw boost servo is still pressurized and the mechanical control system is still intact allowing limited tail-rotor control. Because of the limited yaw control range available, a roll-on landing 40 KIAS or above is required. Loss of both the No. 2 hydraulic pump and the backup pump results in the loss of pilot-assist servos.

1. <u>Airspeed - Adjust</u> to a comfortable airspeed.

#### (2.) BACKUP HYD PUMP switch - ON.

If **BACK-UP PUMP ON** advisory still does not appear:

3. FPS and BOOST switches - Off (for #2 HYD PUMP caution).

4. LAND AS SOON AS POSSIBLE.

**9.27.5 #1 or #2 PRI SERVO PRESS Caution Appears.** Appearance of **#1** or **#2 PRI SERVO PRESS** caution can be caused by inadvertently placing the **SVO OFF** switch on either collective control head in **1ST STG** or **2ND STG** position. Before initiating emergency procedure action, the pilots should check that both **SVO OFF** switches are centered.

- 1. SVO OFF switches Check both are centered.
- 2. If the caution appears with the SVO OFF switch centered, move the SVO OFF switch to turn off the malfunctioning servo.
- 3. LAND AS SOON AS POSSIBLE.

### 9.27.6 #1 RSVR LOW and #1 HYD PUMP Cautions Appear With BACK-UP PUMP ON Advisory Appearing.

1. LAND AS SOON AS PRACTICABLE.

If the **BACK-UP RSVR LOW** caution also appears:

(2.) SVO OFF switch - 1ST STG.



If #2 PRI SERVO PRESS caution appears, establish landing attitude, minimize control inputs, and begin a descent.

#### 3. LAND AS SOON AS POSSIBLE.

9.27.7 #2 RSVR LOW and #2 HYD PUMP Cautions Appear With BACK-UP PUMP ON Advisory Appearing.

> 1. POWER ON RESET switches -Simultaneously press then release.

2. LAND AS SOON AS PRACTICABLE.

If **BACK-UP RSVR LOW** caution also appears:

(3.) SVO OFF switch - 2ND STG.



If #1 PRI SERVO PRESS caution appears, establish landing attitude, minimize control inputs, and begin a descent.

4. LAND AS SOON AS POSSIBLE.

#### 9.27.8 #2 RSVR LOW Caution Appears.

Pilot assist servos will be isolated; if they remain isolated, proceed as follows:

(1.)BOOST and FPS switches - Off.

2. LAND AS SOON AS PRACTICABLE.

#### NOTE

Because the logic module will close the valve supplying pressure to the pilot-assist servos, **BOOST SERVO OFF**, **SAS OFF**, and **TRIM FAIL** cautions will appear.

**9.27.9 Collective Boost Servo Hardover/Power Piston Failure.** Hardover failure of the collective boost servo will increase control forces (as much as 150 pounds) in the collective. The increased control forces can be immediately eliminated by shutting off the boost servo. Resulting control loads will be the same as for in-flight boost servo off.

(1.)**BOOST** switch - Off.

2. LAND AS SOON AS PRACTICABLE.

**9.27.10 Pitch Boost Servo Hardover.** Hardover failure of the pitch boost servo will increase the longitudinal cyclic control forces (approximately 20 pounds). The increased control forces can be immediately eliminated by shutting off SAS.

(1.)SAS (1 and 2) and FPS switches - Off.

2. LAND AS SOON AS PRACTICABLE.

#### 9.27.11 BOOST SERVO OFF Caution Appears.

Appearance of the **BOOST SERVO OFF** caution with no other cautions appearing indicates a pilot valve jam in either the collective or yaw boost servo. Control forces in the affected axis will be similar to flight with boost off.

(1.)**BOOST** switch - Off.

2. LAND AS SOON AS PRACTICABLE.

#### 9.28 LANDING AND DITCHING.

# 9.28.1 Emergency Landing In Wooded Areas - Power Off.

- 1. <u>AUTOROTATE</u>. Decelerate helicopter to stop all forward speed at treetop level.
- 2. <u>Collective adjust</u> to maximum before main rotor contacts tree branches.

**9.28.2 Ditching - Power On.** The decision to ditch the helicopter shall be made by the pilot when an emergency makes further flight unsafe.

- 1. Approach to a hover.
- 2. Cockpit doors jettison and cabin doors open prior to entering water.
- 3. Pilot shoulder harness Lock.
- 4. Survival gear Deploy.

5. Personnel, except pilot, exit helicopter.

6. Fly helicopter downwind a safe distance and hover.

- 7. ENG POWER CONT levers OFF.
- 8. Perform hovering autorotation, apply full collective to decay rotor RPM as helicopter settles.
- 9. Position cyclic in direction of roll.
- 10. Exit when main rotor has stopped.

**9.28.3 Ditching - Power Off.** If ditching is imminent, accomplish engine malfunction emergency procedures. During descent, open cockpit and cabin doors. Decelerate to zero forward speed as the helicopter nears the water. Apply full collective as the helicopter nears the water. Maintain a level attitude as the helicopter sinks and until it begins to roll; then apply cyclic in the direction of the roll.Exit when the main rotor is stopped.

- 1. AUTOROTATE.
- Cockpit doors jettison and cabin doors open prior to entering water.
- 3. Cyclic Position in direction of roll.
- 4. Exit when main rotor has stopped.

# 9.29 FLIGHT CONTROL/MAIN-ROTOR SYSTEM MALFUNCTIONS.

a. Failure of components within the flight control system may be indicated through varying degrees of feedback, binding, resistance, or sloppiness. These conditions should not be mistaken for malfunction of the AFCS.

b. Failure of a main rotor component may be indicated by the sudden onset or steady increase in main rotor vibration or unusual noise. Severe changes in lift characteristics and/or balance condition can occur due to blade strikes, skin separation, shift or loss of balance weights, or other material. Malfunctions may result in severe main rotor flapping. The severity of vibrations may be minimized by reducing airspeed.

If the main rotor system malfunctions:



Danger exists that the main rotor system could collapse or separate from the aircraft after landing. Exit when main rotor has stopped.

1. LAND AS SOON AS POSSIBLE.

(2.) EMER ENG(S) SHUTDOWN after landing.

**9.29.1 SAS Failure With No Failure Advisory Indication.** Erratic electrical input to a SAS actuator can result in moderate rotor tip path oscillations that are often accompanied with pounding sounds or "knocking" which may be felt in the cyclic or pedal controls. No SAS malfunction, however, can physically drive the pilots' flight controls. Failure of **SAS 2** is usually, but not necessarily, followed by a failure/advisory indication. Failure of a **SAS 1** component will not be accompanied by a failure/ advisory indication as **SAS 1** does not contain diagnostic capabilities.

If the helicopter experiences erratic motion of the rotor tip path without failure/advisory indication:

(1.)**SAS 1** switch - Off.

If condition persists:

(2.)**SAS 1** switch - **ON**.

(3.)SAS 2 switch - Off.

If malfunction still persists:

(4.)SAS 1 and FPS switches - Off.

#### 9.29.2 SAS 2 Failure Advisory Light On.

**POWER ON RESET** switches Simultaneously press and then release.

#### 9.29.3 SAS OFF Caution Appears.

FPS switch - Off.

#### 9.29.4 FLT PATH STAB Caution Appears.

a. An **FPS** malfunction will be detected by the SAS/ FPS computer, which will disengage **FPS**function in the applicable axis and activate the **FLT PATH STAB** caution and corresponding **FAILURE ADVISORY** light.

b. ET With the Mode Select Panel switch in the IINS/IINS position, a failure of the IINS gyro will cause a failure of the FPS and may possibly cause FPS/SAS 2 to become erratic in roll motion. In addition to the failure indications on the IINS Control Display screen, the GY-ROsegment on the Failure Advisory Panel will illuminate. The copilot's VSI will fail with an ATT warning flag and both HSIs will fail with HDG warning flags. The aircraft may drift in pitch, roll, and/or yaw axis due to FPS failure.

#### (1.) E SYSTEMS SELECT - DG/VG.

2. POWER ON RESET switches -Simultaneously press and then release.

If failure returns, control affected axis manually.

### WARNING

If the airspeed fault advisory light is illuminated, continued flight above 70 KI-AS with the stabilator in the AUTO MODE is unsafe since a loss of the airspeed signal from the remaining airspeed sensor would result in the stabilator slewing full-down.

If the airspeed fault light remains illuminated on the AFCS panel:

#### NOTE

Use of the cyclic mountedstabilator slew-up switch should be announced to the crew to minimize cockpit confusion.

- 3. Manually slew stabilator Adjust to 0° if above 40 KIAS. The preferred method of manually slewing the stabilator up is to use the cyclic mounted stabilator slew-up switch.
- 4. LAND AS SOON AS PRACTICABLE.

#### 9.29.5 Pitch, Roll, or Yaw/Trim Hardover.

a. A pitch **FPS**/trim hardover will cause a change in pitch attitude and a corresponding longitudinal cyclic movement of about ¹/₂ inch. This condition will be detected by the SAS/FPS computer which will disengage **FPS** and trim functions in the pitch axis and activate the **FLT PATH STAB** and **TRIM FAIL** cautions.

b. A roll **FPS**/trim hardover will be characterized by a ¹/₂ inch lateral stick displacement, resulting in a corresponding roll rate and a constant heading sideslip condition, caused by the yaw **FPS** attempting to maintain heading. The SAS/FPS computer will detect the hardover condition and disengage lateral trim and activate the **FLT PATH STAB** and **TRIM FAIL** cautions.

c. A yaw **FPS**/trim hardover is characterized by an improper motion of the pedals, resulting in about ¹/₄ inch of pedal motion followed by a corresponding change in helicopter heading trim. This condition will be detected by the SAS/FPS computer, which will disengage trim and **FPS** functions in the yaw axis and activate the **FLT PATH STAB** and **TRIM FAIL** cautions.

If failure occurs:

**POWER ON RESET** switches - Simultaneously press and then release.

If failure returns, control affected axis manually.

**9.29.6 Trim Actuator Jammed.** Both yaw and roll trim actuators incorporate slip clutches to allow pilot and copilot inputs if either actuator should jam. The forces required to override the clutches are 80-pounds maximum in yaw and 13-pounds maximum in roll.

#### LAND AS SOON AS PRACTICABLE.

# 9.30 STABILATOR MALFUNCTION - AUTO MODE FAILURE.

An Auto Mode Failure will normally result in the stabilator failing in place. The indications to the pilots of the failure are a beeping audio warning, and **MASTER CAU-TION** and **STABILATOR** caution appearing when the automatic mode fails. The position of failure may vary from the ideal programmed position by 10° at 30 KIAS to 4° at 150 KIAS. If an approach is made with the stabilator fixed 0°, the pitch attitude may be 4° to 5° higher than normal in the 20 to 40 KIAS range.

# WARNING

- If acceleration is continued or collective is decreased with the stabilator in a trailing edge down position, longitudinal control will be lost. The stabilator shall be slewed to 0° above 40 KIAS and fulldown when airspeed is less than 40 KI-AS. If the stabilator is slewed up to the 0° position and the AUTO CONTROL switch is pressed during acceleration, the helicopter may pitch to a nose down attitude.
- Pressing the AUTO CONTROL RESET switch after a failure occurs results in the automatic mode coming on for one second. If a hardover signal to one actuator is present, the stabilator could move approximately 4° to 5° in that one second before another auto mode failure occurs. Subsequent reset attempts could result in the stabilator moving to an unsafe position.
- If the stabilator AUTO mode repeatedly disengages during a flight, flight above 70 KIAS is prohibited with the stabilator in AUTO mode.

If an AUTO Mode Failure Occurs:

#### NOTE

Use of cyclic mounted stabilator slew-up switch should be announced to the crew to minimize cockpit confusion.

- 1. <u>Cyclic mounted stabilator slew-up switch -</u> <u>Adjust if necessary</u> to arrest or prevent nose down pitch rate.
- 2. <u>AUTO CONTROL switch Press ON once</u> after establishing a comfortable airspeed.

If automatic control is not regained:

3. Manually slew stabilator - Adjust to 0° for flight above 40 KIAS or full down when airspeed is below 40 KIAS. The preferred method of manually slewing the stabilator up is to use the cyclic mounted stabilator slew-up switch.

#### 4. LAND AS SOON AS PRACTICABLE.

If manual control is not possible:

5. **STAB POS** indicator - Check and fly at or below **KIAS LIMITS** shown on placard.

#### 6. LAND AS SOON AS PRACTICABLE.

# 9.31 UNCOMMANDED NOSE DOWN/UP PITCH ATTITUDE CHANGE.

a. An uncommanded nose down/up pitch attitude change could be the result of a stabilator or other AFCS malfunction (SAS or FPS). There is a remote possibility that a stabilator malfunction could occur in the automatic or manual mode without audio warning or caution appearance.

b. If an uncommanded nose down pitch attitude change is detected, the pilot should initially attempt to stop the rate with aft cyclic. Maintaining or increasing collective position may assist in correcting for a nose down pitch attitude. If the nose down pitch rate continues, and/or inappropriate stabilator movement is observed, activate the cyclic mounted stabilator slew-up switch to adjust the stabilator to control pitch attitude. Continue to monitor the stabilator position when the cyclic mounted stabilator slew-up switch is released to ensure movement stops.

c. Uncommanded nose up pitch attitude changes at airspeeds of 140 KIAS and less should not become severe even if caused by full up slew of the stabilator and can be corrected with forward cyclic. If the nose up pitch attitude is caused by full up stabilator slew at airspeeds above 140 KIAS, full forward cyclic may not arrest the nose up pitch rate.

d. If an uncommanded nose up pitch attitude change is detected, the pilot should initially attempt to stop the rate with forward cyclic. At airspeeds above 140 KIAS, a collective reduction of approximately 3 inches, simultaneously with forward cyclic will arrest the nose up pitch rate. If these control corrections are delayed and/or a large nose up attitude results, a moderate roll to the nearest horizon will assist in returning the aircraft to level flight. After the nose returns to the horizon, roll to a level attitude. After coordination with the pilot, the copilot should adjust the stabilator to  $0^{\circ}$  at airspeeds above 40 KIAS and full down at airspeeds below 40 KIAS.

If an uncommanded nose down pitch attitude occurs:

1. Cyclic - Adjust as required.

- 2. Collective Maintain or increase.
- 3. <u>Cyclic mounted stabilator slew-up switch -</u> <u>Adjust as required</u> to arrest nose down pitch rate.
- (4.) MAN SLEW switch Adjust to 0° at airspeeds above 40 KIAS and full down at airspeeds below 40 KIAS.
- 5. LAND AS SOON AS PRACTICABLE.

If an uncommanded nose up pitch attitude occurs:

- 1. Cyclic Adjust as required.
- 2. Collective Reduce as required.
- (3.) MAN SLEW switch Adjust to 0° at airspeeds above 40 KIAS and full down at airspeeds below 40 KIAS.
- 4. LAND AS SOON AS PRACTICABLE.

#### Section II MISSION EQUIPMENT

#### 9.32 EMERGENCY JETTISONING.

When conditions exist which require the jettisoning of external loads to ensure continued flight or execution of emergency procedures, the crew should jettison the load as follows:

#### CARGO REL or HOOK EMER REL switch - Press.

# 9.33 EMERGENCY RELEASE OF RESCUE HOIST LOAD.

If the rescue hoist becomes jammed, inoperative, or the cable is entangled and emergency release is required:

To cut cable from cockpit:

#### CABLE SHEAR switch - FIRE.

To cut cable from hoist operator's position:

#### CABLE CUT switch - FIRE.

#### 9.34 BLADE DEICE SYSTEM MALFUNCTIONS.

# 9.34.1 MR DE-ICE FAULT, MR DE-ICE FAIL, or TR DE-ICE FAIL Caution Appears.

a. If the **MR DE-ICE FAULT** caution appears, the system will continue to function in a degraded mode. The pilot must be aware of vibration levels and % TRQ requirements, which could be a result of ice buildup.

b. If the **MR DE-ICE FAIL** caution appears, the main rotor deice will automatically turn off. Tail rotor deice will remain on.

c. If the **TR DE-ICE FAIL** caution appears, tail rotor deice will automatically turn off. Main rotor deice will remain on.

1. Icing conditions - Exit.

2. BLADE DEICE POWER switch - OFF, when out of icing conditions.

If vibrations increase:

3. LAND AS SOON AS POSSIBLE.

#### 9.34.2 PWR MAIN RTR and/or TAIL RTR MONI-TOR Light On.

If a **PWR** monitor light is illuminated with **BLADE DEICE POWER** switch **ON** to stop power from being applied to blades:

1. Icing conditions - EXIT.

(2.) BLADE DEICE POWER switch - OFF.

If a **PWR** monitor light is still illuminated with **BLADE DEICE POWER** switch **OFF**:

(3.)GENERATORS NO. 1 or NO. 2 switch - OFF.

(4.) **APU** generator switch - **OFF** (if in use).

5. LAND AS SOON AS PRACTICABLE.

**9.34.3 Ice Rate Meter Fail or Inaccurate.** Failure of the ice rate meter should be indicated by appearance of the **FAIL** flag on the meter face. Inaccuracy of the meter will be indicated by increased torque required and/or increase of vibration levels due to ice buildup. If failure or inaccuracy is suspected, with no other indicated failures, the system can be manually controlled.

(1.) BLADE DEICE MODE switch - MANUAL as required.

If vibration levels increase or % TRQ required increases:

2. BLADE DE-ICE MODE switch - Select higher setting.

If ice buildup continues:

3. LAND AS SOON AS PRACTICABLE.

9.34.4 Loss of NO. 1 or NO. 2 Generator During Blade Deice Operation.



Ensure that the mask blowers are disconnected and position the BCA MCU control knobs to OFF prior to switching from main power to APU power.

Loss of one generator during blade deice operation will result in loss of power to the system. To restore system operation, the APU must be started and the **APU** generator switch **ON**. The **APU GEN ON** advisory will not appear because one main generator is still operating. The APU generator will supply power only for blade deice operation.

#### 1.)EMER APU START.

2.)BLADE DE-ICE POWER switch - OFF then ON.

#### 9.35 EXTERNAL EXTENDED RANGE FUEL SYSTEM FAILURE TO TRANSFER SYMMETRICALLY. ERFS

a. Total failure of a single external extended range fuel system tank to transfer fuel could be the result of a loose filler cap, bleed-air regulator/shutoff valve, fuel shutoff valve, or line blockage failure.

b. Total failure of one tank to transfer fuel will turn on the associated tank's **NO FLOW** light. Reduced flow from one tank may not cause a **NO FLOW** light to illuminate, but will change the lateral CG of the helicopter. The pilot will notice a migration of the lateral cyclic stick position as the lateral CG offset from neutral increases. For example, a fully asymmetric outboard 230-gallon tank set (one tank full, one tank empty), on an otherwise neutrally balanced helicopter, will result in a level flight lateral stick position offset of approximately two inches. If asymmetric transfer is suspected, stop transfer on the selected tank set and initiate transfer on the other tank set, if installed.

If asymmetric fuel transfer is suspected:

(1.) Stop transfer on tank set.

2.)Select other tank set and initiate transfer.

3. LAND AS SOON AS PRACTICABLE.

### WARNING

With asymmetric fuel loading, lateral control margin will be reduced in the direction opposite the heavy side. The helicopter has been flown from hover to 138 KIAS, with lateral CG equivalent to a fully asymmetric outboard 230-gallon tank set, (full right tank, no stores on left side). The most critical maneuvers are turns toward the heavy side and approaches with a crosswind from the lighter side. These maneuvers are not recommended. The most adverse condition for lateral controllability is right side heavy, in the 20 to 50 KIAS range. Do not exceed 30° angle of bank. If controllability is in question, jettison the asymmetric tank set.

Should controlled flight with one heavy external tank become necessary, proceed as follows:

- 1. Make all turns shallow (up to standard rate), and in the direction away from heavy side (particularly when a right tank remains full).
- 2. Avoid abrupt control motions, especially lateral cyclic.
- 3. If possible, shift personnel to the light side of the helicopter.
- 4. Select a suitable roll-on landing area, and make a roll-on landing with touchdown speed in excess of 30 KIAS. To increase control margin, execute the approach into the wind or with a front quartering wind from the heavy side and align the longitudinal axis of the helicopter with the ground track upon commencing the approach. If a suitable roll-on landing area is not available, make an approach to a hover into the wind, or with a front quartering wind from the heavy side.

#### 9.36 AUXILIARY FUEL MANAGEMENT SYSTEM FAILURE TO TRANSFER SYMMETRICALLY. AFMS CEFS

a. Total failure of a single external extended range fuel system tank to transfer fuel could be the result of a loose

filler cap, bleed-air regulator/shutoff valve, fuel shutoff valve, or line blockage failure.

b. Total failure of one tank to transfer fuel will turn on the associated tank's **NO FLOW** light. Reduced flow from one tank may not cause a **NO FLOW** light to illuminate, but will result in a lateral imbalance between tank pairs whether **AUTO** or **MAN** mode is selected. Occasional monitoring of the auxiliary fuel management panel (AFMP) fuel quantity displays provides the crew an accurate means of identifying a developing imbalance condition.

When an asymmetric fuel condition AFMS (greater than 400-pound difference between external tank pairs) ◀ CEFS (270 pounds difference for outboard tanks or 375 pounds difference for inboard tanks) ◀ is identified:

1. XFER MODE switch - MAN.



Monitor fuel transfer to remain within CG limits and avoid asymmetric loading.

 MAN XFER switch - Select heavy tank LEFT or RIGHT until imbalance condition is corrected.

If the imbalance condition cannot be corrected:

- 3. XFER MODE switch OFF.
- 4. LAND AS SOON AS PRACTICABLE.



With asymmetric fuel loading, lateral control margin will be reduced in the direction opposite the heavy side. The helicopter has been flown from hover to 138 KIAS, with lateral CG equivalent to a fully asymmetric outboard 230-gallon tank set, (full right tank, no stores on left side). The most critical maneuvers are turns toward the heavy side and approaches with a crosswind from the lighter side. These maneuvers are not recommended. The most adverse condition for lateral controllability is right side heavy, in the 20 to 50 KIAS range. Do not exceed  $30^{\circ}$  angle of bank. If controllability is in question, jettison the asymmetric tank set.

Should controlled flight with one heavy external tank become necessary, proceed as follows:

- 1. Make all turns shallow (up to standard rate), and in the direction away from heavy side (particularly when a right tank remains full).
- 2. Avoid abrupt control motions, especially lateral cyclic.
- 3. If possible, shift personnel to the light side of the helicopter.
- 4. Select a suitable roll-on landing area, and make a roll-on landing with touchdown speed in excess of 30 KIAS. To increase control margin, execute the approach into the wind or with a front quartering wind from the heavy side and align the longitudinal axis of the helicopter with the ground track upon commencing the approach. If a suitable roll-on landing area is not available, make an approach to a hover into the wind, or with a front quartering wind from the heavy side.

#### 9.37 EXTERNAL STORES JETTISON.

At high gross weights and with one engine inoperative, or in an emergency or performance limited situation, it may be necessary to jettison a tank set. Circuitry prevents the release of any individual tank even if a single tank jettison has been selected at the STORES JETTISONcontrol panel. The helicopter will remain controllable even if a single tank fails to release because of a malfunction in the jettison system. In the case of a four tank configuration, and depending on the amount of fuel in the tanks, lateral control may be lost if both tanks on one side fail to release. For this reason the use of the EMER JETT ALL or JETT ALL switches is not recommended. Only in circumstances where failure to do so would result in certain damage to aircraft and crew, should the use of these switches be considered, at the discretion of the pilot in command.

If jettisoning of tanks is required:

(1.) STORES JETTISON switch - Select INBD BOTH, OUTBD BOTH or ALL as applicable. (2.) **JETT** switch - Actuate.

If primary jettison system does not operate:

#### (3.) EMER JETT ALL switch - Actuate.

#### 9.38 FUEL FUMES IN COCKPIT/CABIN WITH EXTERNAL EXTENDED RANGE FUEL SYSTEM PRESSURIZED. ERFS AFMS CEFS

If the bleed air check valve(s) is stuck in the open position when the heater is turned on, the resulting bleed air manifold pressure drops due to the heater bleed air demands. This allows fumes/mist above the tanks to backflow through the bleed air manifold, through the heater, and into the cabin. If fuel fumes or mist are noted during external extended range fuel system operation, perform the following:

If heater is on:

1.)**HEATER** switch - **OFF**.

If heater is off or fumes persist:

- ERFS PRESS OUTBD and INBD switches
   OFF. 
   AFMS
   CEFS
   PRESS switch OFF. 
   OFF. 
   AFMS
   CEFS
   PRESS switch AFMS
   CEFS
   PRESS
   AFMS
   CEFS
   PRESS
   AFMS
   CEFS
   PRESS
   AFMS
   <li
- 3. AFMS CEFS XFER MODE switch OFF.

4. FUEL BOOST PUMP CONTROL switches - As required.

#### 9.39 VOLCANO LAUNCHER RACKS JETTISON.

At high gross weights and with one engine inoperative or in an emergency, it may be necessary to jettison the volcano launcher racks. Both lower launcher racks must separate from helicopter before upper racks are activated. If one lower rack remains, upper racks will not jettison. If jettisoning of launcher rack is required:

#### 1. JETTISON switch - JETTISON.

If jettison procedure above fails, do the following immediately:

#### 2. EMER JETTISON switch - JETTISON.

#### 9.40 INFLIGHT CABS ACTIVATION.

Gas generators produce a loud noise and the air bags expand rapidly when activated.

If inadvertent deployment occurs:

1. If at terrain flight altitude, initiate climb if appropriate.

(2.)CABS circuit breaker - Pull.

#### NOTE

Air bags will deflate in 3-5 seconds, however, forward or lateral air bags may be punctured with a survival knife to facilitate deflation.

(3.) Fold the deflated forward air bag over the top of the glare shield to minimize flight control and flight instrument interference.

(4.)Push the lateral air bag down and rear into the space between the armor panel and door.

(5.) Transfer controls and repeat steps 3. and 4. for other side of helicopter.

### APPENDIX A

### REFERENCES

AR 385-10	The Army Safety Program
AR 70-50	Designating and Naming Defense Military Aerospace Vehicles
AR 95-1	Army Aviation General Provisions and Flight Regulations
DA FORM 2408-13-1	Aircraft Maintenance and Inspection Record
DD FORM 365-1	Chart A - Basic Weight Checklist Record
DD FORM 365-3	Chart C - Basic Weight And Balance Record
DD FORM 365-4	Weight and Balance Clearance Form F-Transport/Tactical
DOD FLIP	Flight Information Publication
FAR Part 91	Federal Air Regulation, General Operating and Flight Rules
FM 1-230	Meteorology for Army Aviators
FM 3-04.203	Fundamentals of Flight
FM 3-04.240	Instrument Flying and Navigation for Army Aviators
FM 4-20.197	Multiservice Helicopter Sling Load: Basic Operations and Equipment
FM 4-20.198	Multiservice Helicopter Sling Load: Single-Point Load Rigging Procedures
FM 4-20.199	Multiservice Helicopter Sling Load: Dual-Point Rigging Procedures
FM 10-67-1	Concepts and Equipment of Petroleum Operations
FM 55-450-2	Army Helicopter Internal Load Operations
PAM 40-501	Hearing Conservation Program
PAM 738-751	Functional Users Manual for the Army Maintenance Management System Aviation (TAMMS-A)
TB 55-9150-200-24	Engine and Transmission Oils, Fuels, and Additives for Army Aircraft
TM 1-1500-250-23	Aviation Unit and Aviation Intermediate Maintenance for General Tiedown and Moor- ing On All Series Army Models, AH-64, UH-60, CH-47, UH-1, AH-1, OH-58 Helicop- ters
TM 1-1500-328-23	Aeronautical Equipment Maintenance Management Policies and Procedures
TM 1-1520-237-CL	Operator's and Crewmember's Checklist, Army Model UH-60A, UH-60L and EH-60A Helicopters
TM 1-1680-320-13&P	Operator's, Unit, and Direct Support Maintenance Manual (Including Repair Parts And Special Tools List) For High Performance Rescue Hoist Assembly, Part No. 42305-1 (NSN 1680-01-058-3671) and Part No. 42305-5 (NSN 1680-01-552-3442)
TM 9-1005-224-10	Operator's Manual For Machine Gun, 7.62-MM, M60 W/E (NSN 1005-00-605-7710) (EIC: 4AJ) AND MACHINE GUN, 7.62-MM, M60D W/E (1005-00-909-3002)

TM 9-1005-262-13	Operators, Aviation Unit And Aviation Intermediate Maintenance Manual For Arma- ment Subsystem, Helicopter, 7.62 MM Machine Gun Mounts: Door Mounted, Lightweight, Model M23 P/N 11691604 (NSN 1005-00-907-0720); Door Mounted, Lightweight, Model M24 P/N 11691606 (NSN 1005-00-763-1404); Ramp Mounted, Lightweight, Model M41 P/N 8436598 (NSN 1005-00-087-2046), And Window Mounted, Lightweight, Model M144 P/N 12011812 (NSN 1005-01-193-4878)
TM 9-1095-204-13&P	Operator's, Organizational, And Direct Support Maintenance Manual Including Repair Parts And Special Tools List For Antitank Mine Dispensing System, M57 (NSN 1095- 00-169-0300)
TM 9-1095-206-12&P	Operator's And Aviation Unit Maintenance Manual (Including Repair Parts And Special Tools List) For Dispenser, General Purpose Aircraft: M130
TM 9-1095-208-13&P	Dispenser, Mine: M139 with Mounting Kits for 5-Ton Vehicle and M548A1 Vehicle Ground Volcano and UH-60A/L Air Volcano
TM 11-5810-262-10	Operator's Manual for Communication Security Equipment TSEC/KY 58
TM 11-5810-389-13&P	Refer to Index of Communications Security (COMSEC) Publications (U)
TM 11-5841-281-12	Operator's And Organizational Maintenance Manual For Doppler Navigation Set, AN/ ASN-128 (NSN 5841-01-064-9738) (EIC: JK4)
TM 11-5841-283-12	Aviation Unit Maintenance Manual For Radar Signal Detecting Set, AN/APR-39(V) (NSN 5841-01-023-7112) {NAVAIR 16-30APR39-1}
TM 11-5841-288-12	Aviation Unit Maintenance Manual For Radar Signal Detecting Set AN/APR-39(V)2 (NSN 5841-01-054-8540)
TM 11-5841-294-12	Operator And Aviation Unit Maintenance Manual For Radar Signal Detecting Set AN/ APR-39A(V)1 (NSN 5841-01-236-8951) (EIC: 1A9)
TM 11-5841-294-30-2	Aviation Intermediate Maintenance Manual For Radar Signal Detecting Set AN/APR-39(V)1 (NSN 5841-01-236-8951)
TM 11-5855-300-10	Operator's Manual For Heads Up Display AN/AVS-7
TM 11-5865-200-12	Operator's And Aviation Unit Maintenance Manual For Aviation Unit Maintenance (AVUM) Countermeasures Sets, AN/ALQ-144A(V)1 (NSN 5865-01-299-5859) AND AN/ALQ-144A(V)3 (5865-01-299-5860)
TM 11-5895-1037-12&P	Operator's And Aviation Unit Maintenance Manual (Including Repair Parts And Special Tools List) For Transponder Set AN/APX-100(V)
TM 11-5895-1199-12	Operator's And Organizational Maintenance Manual For The Mark XII IFF System
TM 55-1500-342-23	Army Aviation Maintenance Engineering Manual: Weight and Balance
TM 750-244-1-5	Procedures for the Destruction of Aircraft and Associated Equipment to Prevent Enemy Use

### APPENDIX B

#### **ABBREVIATIONS AND TERMS**

ac	alternating current	BIM®	blade inspection method
ADF	automatic direction finder	BIT	built-in test
AFCS	automatic flight control system	BITE	built-in-test equipment
AFMP	auxiliary fuel management	BL	butt line
	panel	BTU	British thermal unit
AFMS	auxiliary fuel management	С	clock mode
	system	°C	degrees Celsius
AIM	airborne interceptor missiles	CABS	cockpit air bags system
AJ	anti-jam	CBIT	continuous built-in test
ALE	automatic link establishment	CCU	converter control unit
ALSE	aviation life support equipment	CDU	central display unit
ALT	altitude	CG	center of gravity
AM	amplitude modulated	CIS	command instrument system
AME	amplitude modulation equivalent	CISP	command instrument system processor
AMPS	aviation mission planning system	CL	center line
ANT	antenna	CNV	crypto-net variable
APU	auxiliary power unit	CRT	cathode ray tube
ARINC	aeronautical radio incorporated	CW	continuous wave
ASTM	American Society for Testing	dc	direct current
	and Materials	DCU	dispenser control unit
ATF	aircraft torque factor	DEC	digital electronic control (for
ATT	attitude		engine)
BARO	barometric	DF	direction finder
BATH	best available true heading	DGNS	Doppler/GPS navigation set
BDHI	bearing, distance, heading	DH	decision height
	indicator	DRVS	Doppler radar velocity sensor
BCA	bypass control assembly	DTD	data transfer device

DU	display unit	GPS	global positioning system
ECCM	electronic counter	GS	ground speed
	countermeasures	HF	high frequency
ECM	electronic countermeasures	HIRSS	hover infrared suppressor
ECU	electrical control unit		subsystem
ECSU	electronic crash sensor unit	HIT	health indicator test
EGR	embedded GPS receiver	HMU	hydromechanical unit
EID	emitter identification data	hr	hour
EM	electronic module	HSI	horizontal situation indicator
EMCON	emissions control	HSP	hot start preventor
EMI	electromagnetic interference	HSS	horizontal stores support
EOD	explosive ordnance disposal	HUD	heads up display
ЕОТ	element-on-time	IAC	inbound approach course
ERFS	extended range fuel system	IAS	indicated airspeed
ESSS	external stores support system	IAW	in accordance with
ESU	electronic sequence unit	IB	inboard
ET	elapsed time	IBIT	initiated built in test
ETF	engine torque factor	ICAO	International Civil Aeronautic
EWO	electronic warfare officer		Organization
$\Delta$ F	change in flat plate drag area	ICP	interface control panel
°F	degrees Fahrenheit	ICS	intercommunication system
FAT	free-air temperature	ID	identification
FM	frequency modulated	IDGB	improved durability gear box
FOD	foreign object damage	IFF	identification friend or foe
FPM/fpm	feet-per-minute	IFM	improved frequency modulation
fps	feet-per-second	IFR	instrument flight rule
FPS	flight path stabilization	IGE	in ground effect
ft	feet	IINS	integrated inertial navigation system
GA	go around	ILS	instrument landing system
GCU	generator control unit	11.5	monument fanding system
	-		

IMC	instrument meteorological	MAX	maximum
	conditions	MB	marker beacon
IN	inch	MCG	microclimate cooling garment
IN HG	inch of mercury	MCP	maximum continuous power
INS	inertial	MCS	microclimate cooling system
INU	inertial navigation unit	MCU	microclimate cooling unit
IP	identification of position	MGRS	military grid reference system
IPS	inlet particle separator	MN	manual navigation
IR	infrared	MOC	maintenance operational check
IRCM	infrared countermeasures	MSL	mean sea level
IVSI	instantaneous vertical speed indicator	MV	magnetic variation
KCAS	knots calibrated airspeed	MWOD	multiple word of day
KIAS	knots indicated airspeed	Ng SPEED 1 or 2	No. 1 or No. 2 engine compressor speed % rpm
KT	knot	NM/Nm	nautical miles
KTAS	knots true airspeed	Np	power turbine speed
LAT	latitude	NPU	navigation processor unit
lb	pound(s)	NVG	night vision goggles
lb/gal	pounds-per-gallon	0	degree
lb/hr	pounds-per-hour	% RPM R	rotor rpm, percent
LCD	liquid crystal display	% RPM 1 or 2	No. 1 or No. 2 engine Np %
LDI	leak detection/isolation		rpm
LDS	load-demand spindle	OAT	outside air temperature
LF	low frequency	OB	outboard
LOC	localizer	OD	outside diameter
LONG	longitude	ODV	overspeed and drain valve
L-QDC	liquid quick disconnect	OEI	one engine inoperative
LRU	line replaceable unit	OFP	operational flight program
LSB	lower side band	OGE	out of ground effect
LWC	liquid water content	PA	pressure altitude
MALT	manually entered altitude	PAS	power available spindle

PBIT	power up built-in test	SQ FT	square feet
PDB	power distribution box	STA	station
PDU	pilot display unit	STD INS	standard inertial navigation system
PMCS	preventive maintenance checks and services	STD TEMP	15°C at sea level
POU	pressurizing and overspeed	TACAN	tactical air navigation
	unit	TAS	true airspeed
PPM (ppm)	pounds-per-minute	TD	time delay
PSCU	power supply calibration unit	TGT	turbine gas temperature
PSI (psi)	pounds per square inch	TOD	time of day
PSID (psid)	pounds per square inch differential	TR	torque ratio
PSIG (psig)	pounds per square inch gage	$\Delta$ TRQ	change in torque
PTT	push-to-transmit	% TRQ	torque, percent
R/T	receiver/transmitter	TRQ	torque
RAM	random access memory	TTG	time to go
RCU	remote control unit	UDM	user data module
RDW	ram dump waypoints	USB	upper side band
RF	radio frequency	UTC	universal coordinated time
RPM (rpm)	revolutions-per-minute	UTM	universal transverse mercator
RSDS	radar signal detecting set	vac	volts alternating current
RTA	receiver transmitter antenna	vdc	volts direct current
RWR	radar warning receiver	Vh	maximum level flight speed using torque available - 30
SAM	surface to air missile		minutes
SAS	stability augmentation system	VHF	very high frequency
SCU	signal converter unit	VIDS	vertical instrument display
SDC	signal data converter		systems
SEL	select	Vne	velocity never exceed
SINCGARS	single channel ground airborne	VOR	VHF omnirange
	radio sets	VSI	vertical situation indicator
SLAB	sealed lead acid battery	VSP	vertical support pylon

WLwater lineWOWweight-on-wheelsWODword of dayXMSNtransmission

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Official:

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Subject: DA Form 2028

- 1 From: Joe Smith
- 2 Unit: home
- 3 Address: 4300 Park
- 4 *City*: Hometown
- 5 **St: MO**
- 6 Zip: 77777
- 7 **Date Sent**: 19--OCT--93
- 8 **Pub no**: 55--2840--229--23
- 9 Pub Title: TM
- 10 **Publication Date**: 04--JUL--85
- 11 Change Number: 7
- 12 Submitter Rank: MSG
- 13 Submitter FName: Joe
- 14 Submitter MName: T
- 15 **Submitter LName**: Smith
- 16 **Submitter Phone**: 123--123--1234
- 17 **Problem: 1**
- 18 *Page:* 2
- 19 Paragraph: 3
- 20 Line: 4
- 21 NSN: 5
- 22 Reference: 6
- 23 Figure: 7
- 24 *Table:* 8
- 25 *Item:* 9
- 26 Total: 123

### 27 **Text**:

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### The Metric System and Equivalents

### Linear Measure

- 1 centimeter = 10 millimeters = .39 inch
- 1 decimeter = 10 centimeters = 3.94 inches
- 1 meter = 10 decimeters = 39.37 inches
- 1 dekameter = 10 meters = 32.8 feet
- 1 hectometer = 10 dekameters = 328.08 feet 1 kilometer = 10 hectometers = 3,280.8 feet
- 1 knometer = 10 nectometers = 3,280.8 leet

#### Weights

- 1 centigram = 10 milligrams = .15 grain
- 1 decigram = 10 centigrams = 1.54 grains
- 1 gram = 10 decigram = .035 ounce
- 1 decagram = 10 grams = .35 ounce 1 hectogram = 10 decagrams = 3.52 ounces
- 1 kilogram = 10 hectograms = 2.2 pounds
- 1 quintal = 100 kilograms = 220.46 pounds
- 1 metric ton = 10 quintals = 1.1 short tons

### Liquid Measure

- 1 centiliter = 10 milliters = .34 fl. ounce
- 1 deciliter = 10 centiliters = 3.38 fl. ounces
- 1 liter = 10 deciliters = 33.81 fl. ounces 1 dekaliter = 10 liters = 2.64 gallons
- 1 hectoliter = 10 dekaliters = 26.42 gallons
- 1 kiloliter = 10 hectoliters = 264.18 gallons

#### Square Measure

- 1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
- 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
- 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
- 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
- 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
- 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

### **Cubic Measure**

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

### **Approximate Conversion Factors**

To change	То	Multiply by	To change	То	Multiply by
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29,573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

### **Temperature (Exact)**

F	Fahrenheit	5/9 (after	Celsius	C
	temperature	subtracting 32)	temperature	

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