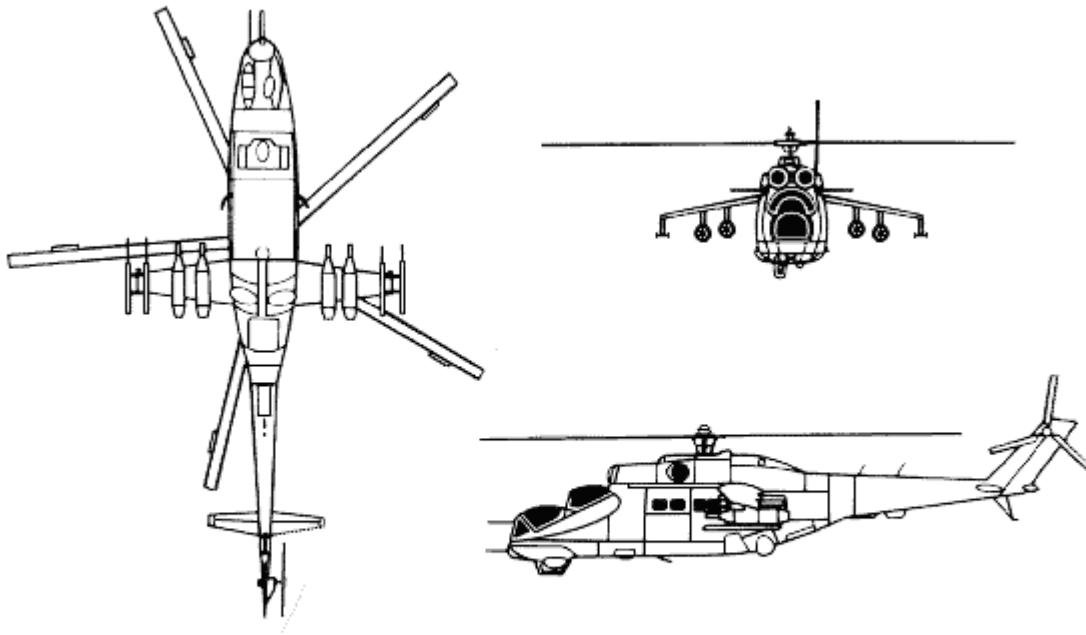


TECHNICAL MANUAL
OPERATOR'S MANUAL
FOR
Mi-24D HIND
HELICOPTERS



Cold War Air Museum
Lancaster Airport
Lancaster, Texas

May 2011

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WARNINGS AND PRECAUTIONS

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.

AVIATION LIFE SUPPORT EQUIPMENT

Aviation life support equipment will be utilized in accordance with AR95-1 anti FM 1-302. Failure to do so may result in personal injury or loss of life.

NOISE

Sound pressure levels around helicopters during some operating conditions exceed the Surgeon General's hearing conservation criteria as defined in TB MED 501. Hearing protection devices, such as the aviator helmet, headset or ear plugs, are required to be worn by all personnel in and around the helicopter during its operation.

FUEL

Turbine engine fuel is toxic and explosive. Do not breathe vapors. Do not get fuel on clothes or skin. Use water to remove fuel from skin. Do not allow sparks or flame near helicopter when servicing. Make certain helicopter is grounded.

ELECTROMAGNETIC INTERFERENCE (EMI)

No electrical/electronic devices of any sort, other than those described in this manual or appropriate airworthiness release are to be operated by crewmembers or passengers during operation of this helicopter.

CARBON MONOXIDE

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

FIRE EXTINGUISHER/DANGEROUS CHEMICALS

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

HIGH VOLTAGE

All ground handling personnel must be informed of high voltage hazards when hooking up external cargo and when working near avionics equipment and ignition system components.

EXTERNAL ELECTRICAL AND HYDRAULIC POWER

Application of external power or APU operation could cause injury to personnel. Make certain all switches and controls are in a safe condition. Inform all persons working on helicopter that external power is being applied.

BATTERY ELECTROLYTE/CAUSTIC MATERIALS

Battery fluid is an acid that harms skin and clothes. People working with batteries must wear special gloves, clothing, and eye protection. A 15-percent mix of boric acid in water must be used to rinse spilled acid. Spill areas must then be well flushed with water.

GROUND OPERATION

The engines shall be started and run by authorized personnel only. When near tail rotor of helicopter, tell person at controls: people are in tail area. Approach tail rotor section of helicopter from aft right side only.

STARTING ENGINES AND AUXILIARY POWER UNIT

Be sure that the rotor and blast area is clear, and a fire guard is posted if available. Stay clear of engine exhaust when engine(s) are operating. Exhaust gases are hot and could cause burns. Particles in the exhaust could damage eyes. Get medical help immediately.

ROTOR BLADES

Rotor blades can cause injury or death. Stay clear of rotating blades. With engines off, blades can still rotate. Make certain rotor brake is on when working in path of blades. If rotor brake is off or inoperative, inform all personnel on or near helicopter that blades can rotate.

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 away from personnel and property in case of accidental firing. Do not walk in front of weapons. SAFE all weapons before servicing. To avoid potentially dangerous situations; follow all procedural warnings in this text.

FIRE EXTINGUISHER, DOOR JETTISON AND MUNITIONS JETTISON CARTRIDGES

Static electricity can fire cartridges. To prevent injury to personnel avoid contact with cartridge primer. Operating instructions must be followed to prevent accidental firing of cartridges.

VERTIGO

The anti-collision strobe lights or rotating beacon should be turned off during flight through clouds to prevent sensations of vertigo as a result of reflections of the light on the clouds.

ELECTROMAGNETIC RADIATION

Do not stand within six feet of transmit antennas when Doppler system or missile guidance system is on. High frequency electromagnetic radiation can cause internal burns without causing any sensation of heat.

ACKNOWLEDGEMENT

This manual has been adapted from a FOIA requested draft of a May 14th, 1999 Mi-24/25 HIND-D/F Operations Manual published by the United States Army Operational Test and Evaluation Command Threat Support Activity (OTSA), Aviation Division at Fort Bliss, Texas 79916-0058. The publication was developed and produced by COBRO® Corporation for the United States Army Threat Systems Management Office (TSMO) Aviation Division.

Chapter 1

Introduction

1-1 General

These instructions are for use by the operator. They apply to Mi-24D/25 and Mi-24F/35 HIND 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:

WARNING

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

CAUTION

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 it is essential to highlight.

1-3 Description

This manual contains the best operating instructions and procedures for the Mi-24/25 D/F helicopters. The primary missions of this helicopter are combat assault, close air support, medical evacuation and cargo transport 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/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, every titled paragraph, figure, and table contained in this manual. Chapter 7 performance data has an additional index within the chapter.

1-7 Army Aviation Safety Program

Reports necessary to comply with the safety program are prescribed in AR 385-40.

1-8 Forms and Records

Aviators flight record and aircraft inspection and maintenance records which are to be used by crew members are prescribed in DA PAM 738-751 and TM 55-1500-342-23.

1-9 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: exception; pages with emergency markings, which consist of black diagonal lines around three edges, may have the vertical line or change symbol placed along the inner margin. Symbols show current changes only. A miniature pointing hand symbol is used to denote a change to an illustration. However, a vertical line in the outer margin, rather than miniature pointing hands, is utilized when there have been extensive changes made to an illustration. Changes to diagrams and schematics have shading or screening to highlight

the area containing the change. Change symbols are not used to indicate changes in the following:

- Introductory material.
- Indexes and tabular data where the change cannot be identified.
- Blank space resulting from the deletion of text, an illustration, or a table.
- Correction of minor inaccuracies, such as spelling, punctuation, relocation of material, etc., unless such correction changes the meaning of instructive information and procedures.

1-10 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.

SYMBOL APPLICATION

117V	Mi-24/25 with TV-117VM engines
117	Mi-24/25 with TV-117MT engines
D	Mi-24D/Mi-25 helicopters
F	Mi-24F/Mi-35 helicopters

1-11 Use of Words Must, Should, and May

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

Chapter 2

Helicopter and Systems Description and Operation

Section 1 Helicopter

2-1 General Description

The Mi-24/25 helicopter is a single main rotor aircraft with a tail rotor. It is designed for employment in close air support, combat assault/troop transport, internal or external cargo transport, medical evacuation, and ferry service. The Mi-24/25D and Mi-35 variants have a gas-operated 12.7 mm machine gun installed in a moveable turret in the lower portion of the nose. The Mi-24F has a

side mounted 30mm cannon on the right side of the fuselage.

2-2 General Arrangement

Figure 2-1 depicts the general arrangement of the helicopter structure and major components. The maximum gross weight is 11,762 kg (25,930.5 lb).

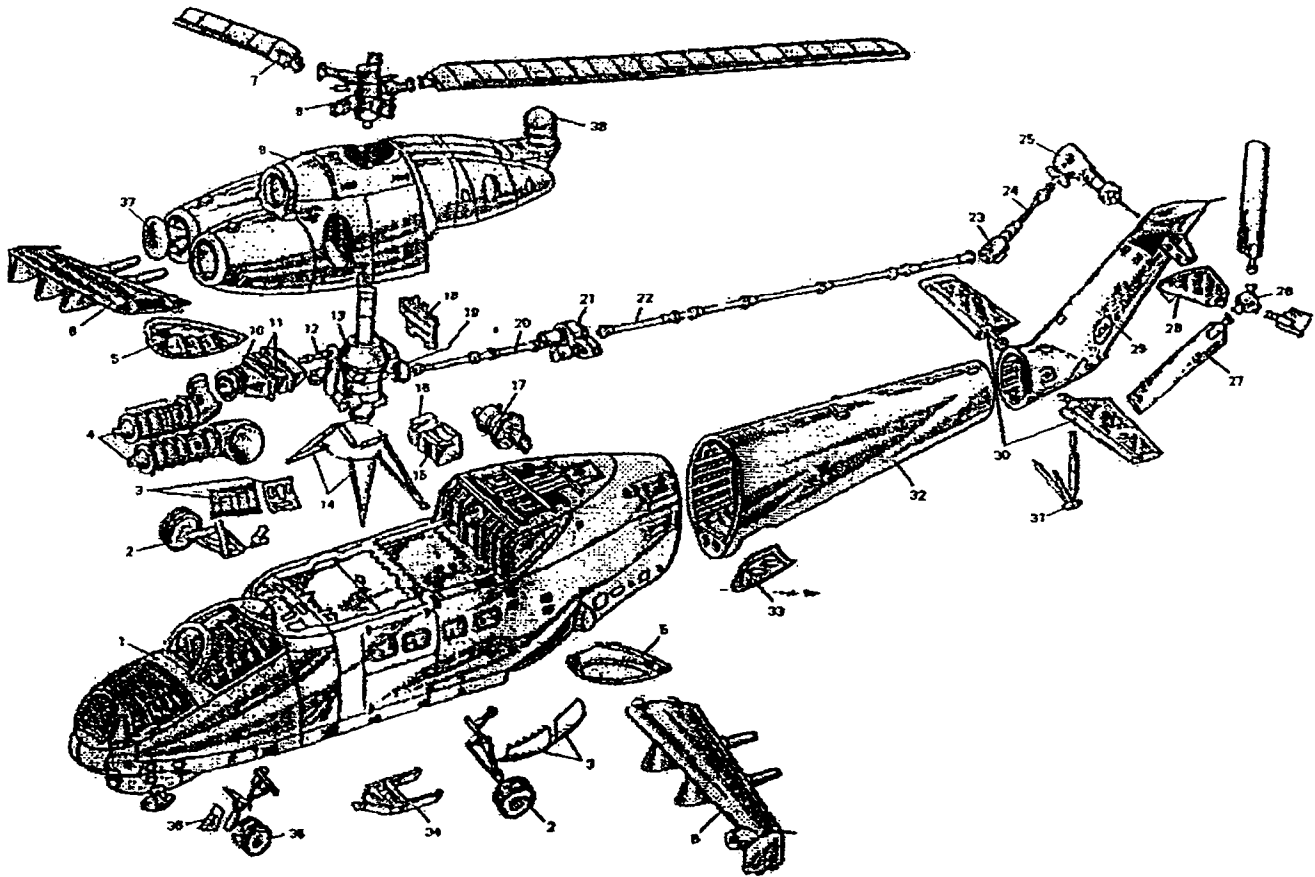


Figure 24 Mi-24/25 Structural Breakdown

- | | | | | |
|----------------------|-----------------------------|----------------------------------|--------------------------------|-----------------------------|
| 1. Fuselage | 9. Nacelle | 17. Auxiliary power unit | 25. Tail rotor gearbox | 33. Doppler antenna fairing |
| 2. Main landing gear | 10. Oil cooler fan | 18. Second stage flight controls | 26. Tail rotor hub | 34. External cargo frame |
| 3. Main gear doors | 11. Oil coolers | 19. Main rotor brake | 27. Tail rotor blades | 35. Nose landing gear |
| 4. Engines | 12. Fan driveshaft | 20. Tail rotor driveshaft | 28. Tail rotor gearbox fairing | 36. Nose landing gear door |
| 5. Wing fairing | 13. Main transmission | 21. Accessory gearbox | 29. Vertical stabilizer | 37. Particle separators |
| 6. Half-wing | 14. Transmission frame | 22. Tail rotor driveshaft | 30. Horizontal stabilizers | |
| 7. Main rotor blades | 15. Main hydraulic block | 23. Intermediate gearbox | 31. Tail strut | |
| 8. Main rotor hub | 16. Utility hydraulic block | 24. Tail rotor driveshaft | 32. Tail boom | |

2-3 Principal Dimensions

Principle dimensions are shown in Figure 2-2. Dimensions are based on cyclic stick and pedals centered and the collective stick set to its lowest position. All given dimensions are approximate.

Helicopter Dimensions:

Length, nose to vertical fin trailing edge.....	59.0 ft
Width, to missile launcher outboard edges....	25.4
Mast height.....	13.0
Tail rotor height.....	18.7
Main rotor diameter.....	56.8
Wheel base.....	14.4
Main wheel track.....	9.9
Cargo cabin interior dimensions	
Length.....	9.2
Width.....	4.8
Height.....	3.9
Door width.....	3.8
RH Door height.....	3.4
LH Door height.....	3.6

2-4 Fuselage

The fuselage is a semi-monocoque, all-metal, riveted structure. The forward and center fuselage sections are structurally inseparable. The main framework of the fuselage consists of a series of frames, transverse bulkheads, support beams, ribs, and stringers. The metal skin is riveted to the framework. Primary structural materials are duralumin sheets and contours, titanium sheets, magnesium alloy castings, high strength steel, and aluminum. Figure 2-3 shows the frame numbering system. To locate a specific frame, count the double rivet seams on the fuselage exterior.

2-5 Wings

The helicopter is equipped with negative dihedral, cantilever wings for easing the main rotor load. The wings are all-metal, composed of right and left trapezoidal-shaped half-wings. There are two vertical weapons pylons mounted on each half-wing. The guided missile launchers are suspended from vertical winglets at the wing tips.

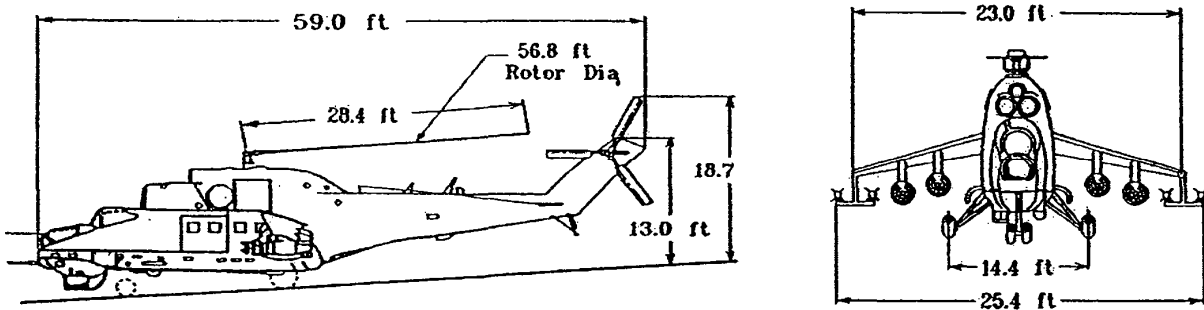


Figure 2-2 Principle Dimensions

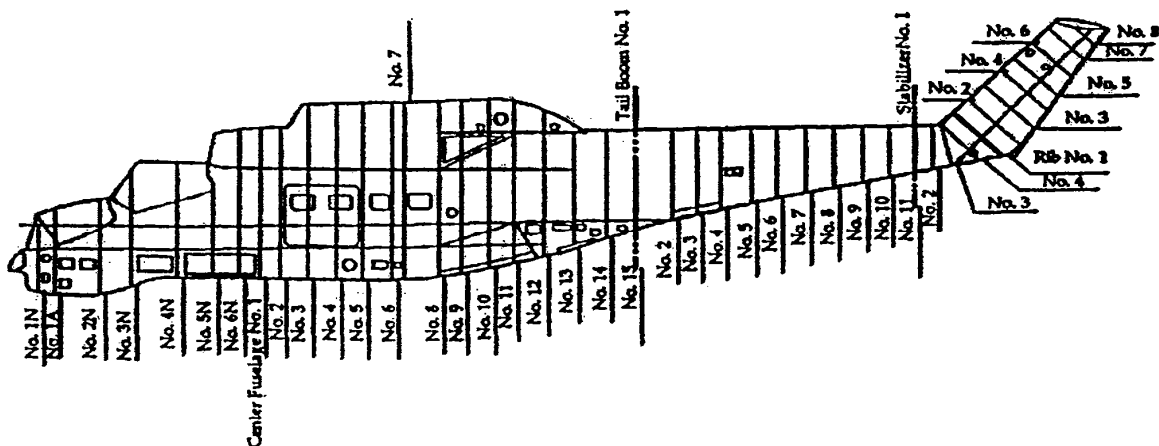


Figure 2-3 Frame Numbering

2-6 Nacelle

The engines, main transmission, oil cooler fan, hydraulic blocks, and the APU are mounted above the fuselage deck and covered by a common nacelle. The open cowlings serve as maintenance platforms. The space within the nacelle is divided by removable firewalls to prevent fires from spreading. The nacelle compartments are: the left and right engine compartments, the transmission compartment, the hydraulic compartment, and the APU compartment. Fire detectors and extinguisher manifolds are installed in each compartment.

2-7 Empennage

The helicopter empennage includes the tail boom, vertical stabilizer, and the synchronized elevator.

2-7.1 Tail Boom

The tail boom is bolted to the aft end of the fuselage. It is a tapered, semi-monocoque structure composed of lateral support frames, longitudinal stringers, and metal skin. The Doppler transceiver / antenna and radar altimeter horn antennas mount in the bottom of the tail boom.

2-7.2 Vertical Stabilizer

The vertical stabilizer is bolted to the aft end of the tail boom. It slants upward at frame 3 at an angle of 42.5° relative to the tail boom longitudinal centerline.

The inclined section forms a vertical fin set at a 6° angle relative to the helicopter's vertical centerline. The vertical stabilizer is a semi-monocoque structure composed of lateral frames, diagonal ribs, longitudinal stringers, and metal skin. The tail rotor gearbox mounts at the upper end of the vertical fin. The tail strut, intermediate gearbox, and synch elevator mount at the base of the vertical stabilizer.

2-7.3 Synchronized Elevator

The synchronized elevator is a single-spar structure consisting of right and left halves mounted on a common control axis. Each elevator half is composed of a spar, metal ribs and reinforcements, a tail stringer, fabric skin, and an aluminum tip cap. The elevator is designed to improve the stability and controllability of the helicopter. The angle of attack is variable within a range of +7°40' to -12°30'. The elevator control system is linked to the main rotor collective pitch control.

2-7.4 Landing Gear

The landing gear system is a tricycle configuration consisting of two retractable main landing gear (M/L/G), a retractable nose landing gear (N/L/G), and a fixed tail strut. The nose gear, main gear, and tail strut have hydraulic shock struts to absorb normal and high impact landings. The tail strut is designed to prevent the tail rotor from striking the ground during takeoff and landing.

A. Wheel Brakes. The main gear wheels are equipped with pneumatic disc brakes. The brakes are applied by squeezing the brake lever on the pilot's cyclic stick. The brakes are disengaged by releasing the brake lever. A retainer holds the lever in the engaged position for parking. A WHEEL BRAKES warning light on the pilot's left console advises the pilot when the brakes are engaged. The light is controlled by a pressure transmitter in the main brake line. The CPG cannot control the wheel brakes.

B. Gear Extension/Retraction. The nose and main landing gear are extended and retracted by hydraulic actuators powered by the utility hydraulic system. In case of utility system failure, the gear can be extended using fluid from the main hydraulic system. Provision has also been made for emergency extension of the gear in the event of electrical system failure. The main controls and indicators for the landing gear are located on the pilot's front left console (see Figure 2-17). The landing gear extension and retraction circuits receive 27 VDC power from Battery Buses I and II via the L/G EXT / RET VALVE and WARN circuit breakers on the left circuit breaker (cb) panel and the L/C RESERVE VALVE circuit breaker on the right cb panel.

(1) Retraction. When the gear control lever is set to the RETRACT position and the PRIMARY-RESERVE switch is set to PRIMARY, fluid from the utility system is supplied to the main and nose gear actuator cylinders to retract the gear. The gear is held in the retracted position by hydraulic uplock cylinders. The main gear doors close and are secured by hydraulic locking cylinders. The locking cylinders are supplied with fluid when the gear uplock microswitches activate. The microswitches also complete the circuit to the red GEAR RETRACTED warning lights.

(2) Extension. When the control lever is set to the EXTENDED position, fluid is supplied first to release the uplock cylinders, then to the gear actuator cylinders. The main gear door locking cylinders are connected to the return line when the microswitches deactivate. The doors open, allowing passage of the gear. Microswitches in the actuator cylinders activate when the gear is fully extended, lighting the green GEAR EXTENDED indicator lights. At the same time, the RI-65 ground proximity warning circuit is disabled and an armament blocking signal is generated.

(3) Reserve Extension. If the utility hydraulic system fails, the landing gear can be extended using main system fluid by setting the PRIMARY-RESERVE switch to the RESERVE position. When the gear control lever is set to the EXTENDED position, a hydraulic solenoid valve activates and supplies main system fluid to the landing gear hydraulic lines. Gear extension occurs in the same manner as described above.

(4) Extension by CPG. If needed, the landing gear can be extended using the EXTEND L/G switch on the CPG's left panel (see Figure 2-27). There are three green GEAR EXTENDED indicator lights on the CPG's left panel for monitoring gear extension.

(5) Emergency Extension (Electrical Power Loss). If the electrical power is lost, the gear extension valve can be opened manually using the manual extension valve, mounted beneath the pilot's instrument panel on the left. Normal position of the valve control lever is CLOSED (up). To manually open the valve, set the lever to the full down (OPEN) position. There must be pressure in the utility system to use the valve.

2-8 Compartments

2-8.1 Crew Compartments

The forward fuselage is divided into two compartments: the cockpit and the copilot/gunner (CPG) station. The CPG station is located in the nose. The cockpit is located behind and above the CPG station. Both compartments contain flight controls and instruments; however, the CPG's controls are designed primarily to allow the CPG to safely fly and land the helicopter in an emergency. Both compartments have armored windshields with electrical heating elements, windshield wipers and a pneumatic washer-sprayer system. A general view of the cockpit is shown in Figure 2-4.

2-8.2 Center Fuselage Compartments

The center fuselage section is divided into two separate compartments: the cargo cabin and the radio compartment. The compartments are separated by a sealed bulkhead. The cargo cabin contains space for crew chief and troop seating, litter installation, and cargo. There are doors on the right and left sides of the cabin. There are four windows on each side of the cabin. They open inward and secure with pin and spring fasteners. Mounting rails and brackets for machine gun pivots are located beneath the windows. The radio compartment is located in the rear section of the center fuselage. Access is via a hatch on the fuselage exterior.

2-9 Doors

2-9-1 Cockpit Door

The cockpit door is a cast magnesium alloy frame with a transparent plexiglass window in the upper section. It mounts on the right side of the forward fuselage. The lower section of the door is armor-plated. The door has a cam-type latch which can be locked with a key. A strut holds the door in the open position. There is a welded steel step on the inside of the door for access to the engine deck. The door is equipped with an inflatable seal and an emergency jettison system.

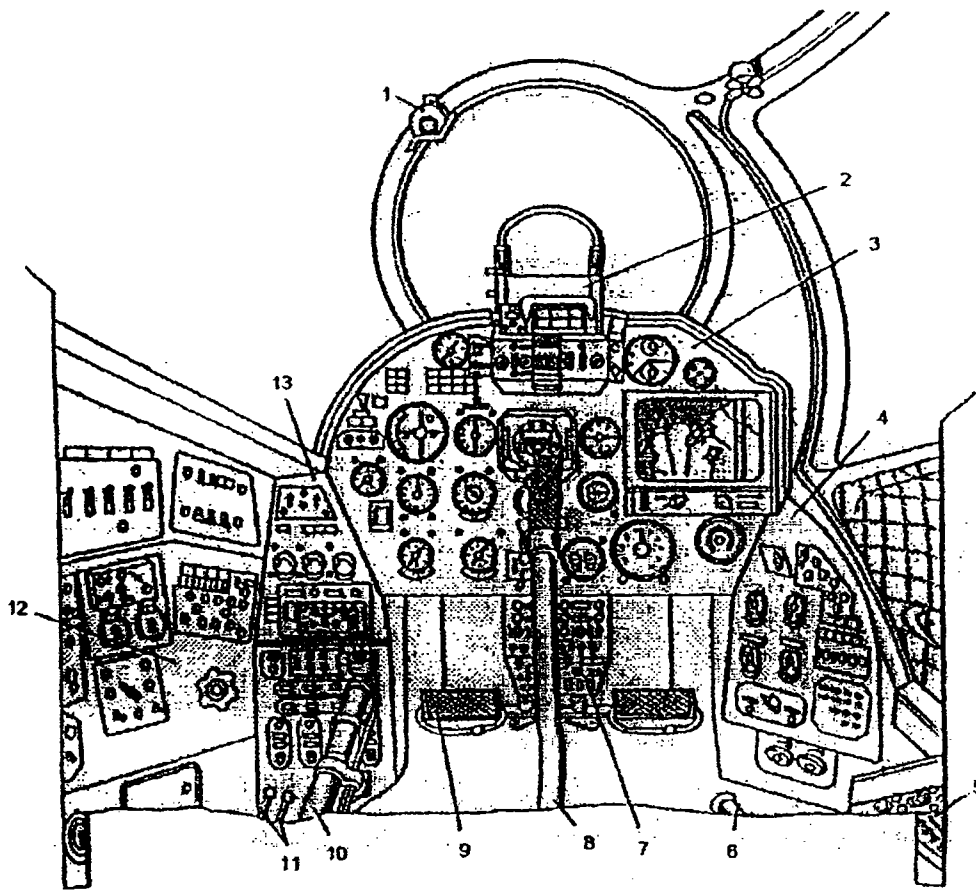
To access the cockpit:

- Face the cockpit door on the right side of the aircraft. (Figure 2-5)
- With the thumb of your left hand, press on the forward, corrugated end (2) of the door handle (1).
- When the handle rotates out of the door, grasp the handle with the rest of your left hand.
- Pull the handle forward as far as it will go.
- Pull out and back to open the door. Once the door is partially open, use your right hand to push the door fully open from the inside.
- When the door is fully open, release the door handle while supporting the door from the inside with the right hand. The door should lock into place.
- With your right hand, grasp the handhold (3), located forward of the door frame and directly above the stirrup step (4).
- Place your right foot in the stirrup step (4).
- With your left hand, grasp the leather handhold (6) on the door.
- Place your left foot into the step (5) directly below the door frame.
- With your right hand, grasp the leather handhold (7) on the upper corner of the door frame.
- Move your right foot up and place it on the door frame step (9). At the same time, grasp the leather handhold (8) at the upper rear corner of the door frame with your left hand.
- Bend at the waist and move your upper body into the pilot's compartment.
- Release the leather handhold (8) and swing your left leg into the compartment, placing your foot on the floor.
- Turn to face forward and place your right foot on the compartment floor.
- Release the handhold (7) and sit down in the pilot's seat.

2-9.2 Copilot/Gunner (CPG) Canopy

The CPG compartment has a hinged canopy for entry/exit. The canopy opens from the left side of the fuselage. The canopy is formed of transparent plexiglass mounted in a cast-magnesium alloy frame. The canopy has a cam-type latch and key rock. A strut holds the canopy in the open position. The canopy has an inflatable seal and an emergency jettison system. To access the CPG station: (Figure 2-6)

- Locate the canopy latch (1) on the left side of the fuselage nose.
- Use the key to unlock the canopy.
- Press the handle release button (2). The handle should pop up.
- Grasp the handle with your right hand and rotate it forward to the stop. Raise the canopy with your right hand.
- Reach in with your left hand and grasp the support strut (8) handle. Push it slightly to release it from the spring clamp, then rotate the strut down and forward.
- Place the free end of the strut in the detent on the front of the canopy frame. Make sure the strut is properly seated.
- Grasp the compartment side wall with both hands.
- Place your left foot on the step (3) on the missile guidance antenna housing (4).
- Place your right foot into the right step (5).
- Grasp the leather handhold (6) at the rear the compartment.
- Raise your left foot into the compartment and place it on the foot support to the left of the CPG's seat.
- Grasp the handhold (7) at the front of the compartment and bring your right foot into the compartment.
- Turn to face forward and place your right foot on the compartment floor.
- Place your left foot on the floor and sit down in the seat.



1. Magnetic compass
2. S-17 Sight (Mi-24F)
3. Instrument panel
4. Right front console
5. Right console
6. Rotor brake lever
7. Weapons panel
8. Cyclic stick
9. Pedal
10. Collective stick
11. Engine condition levers
12. Left side panels
13. Left front console

Figure 2-4 Cockpit Layout (Typical)

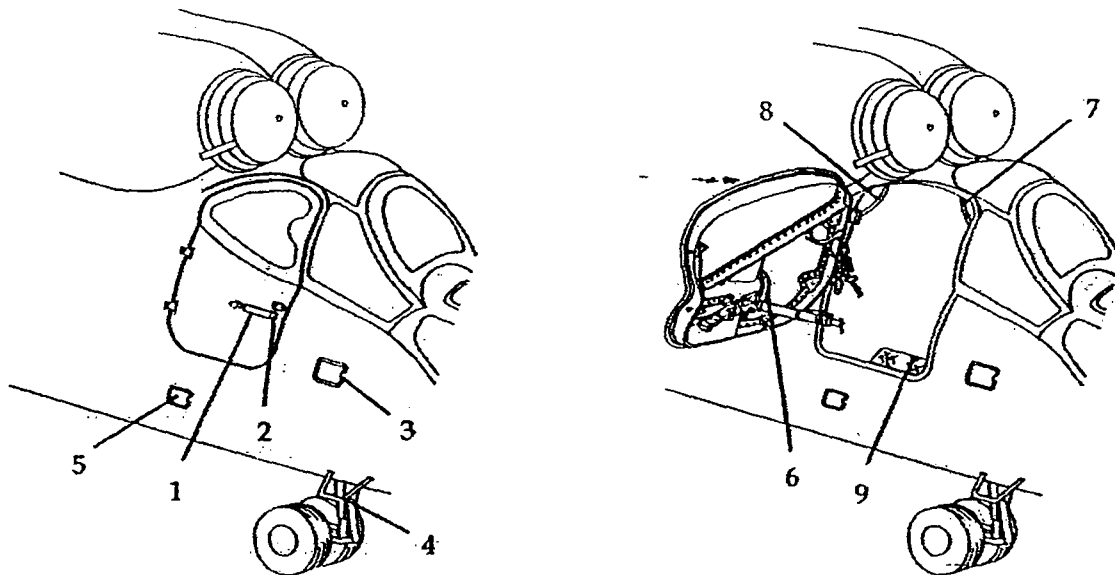


Figure 2-5 Cockpit Access

1. Door handle
2. Corrugated end
3. Handhold/step

4. Stirrup step
5. Step
6. Leather handhold

7. Leather handhold
8. Leather handhold
9. Step

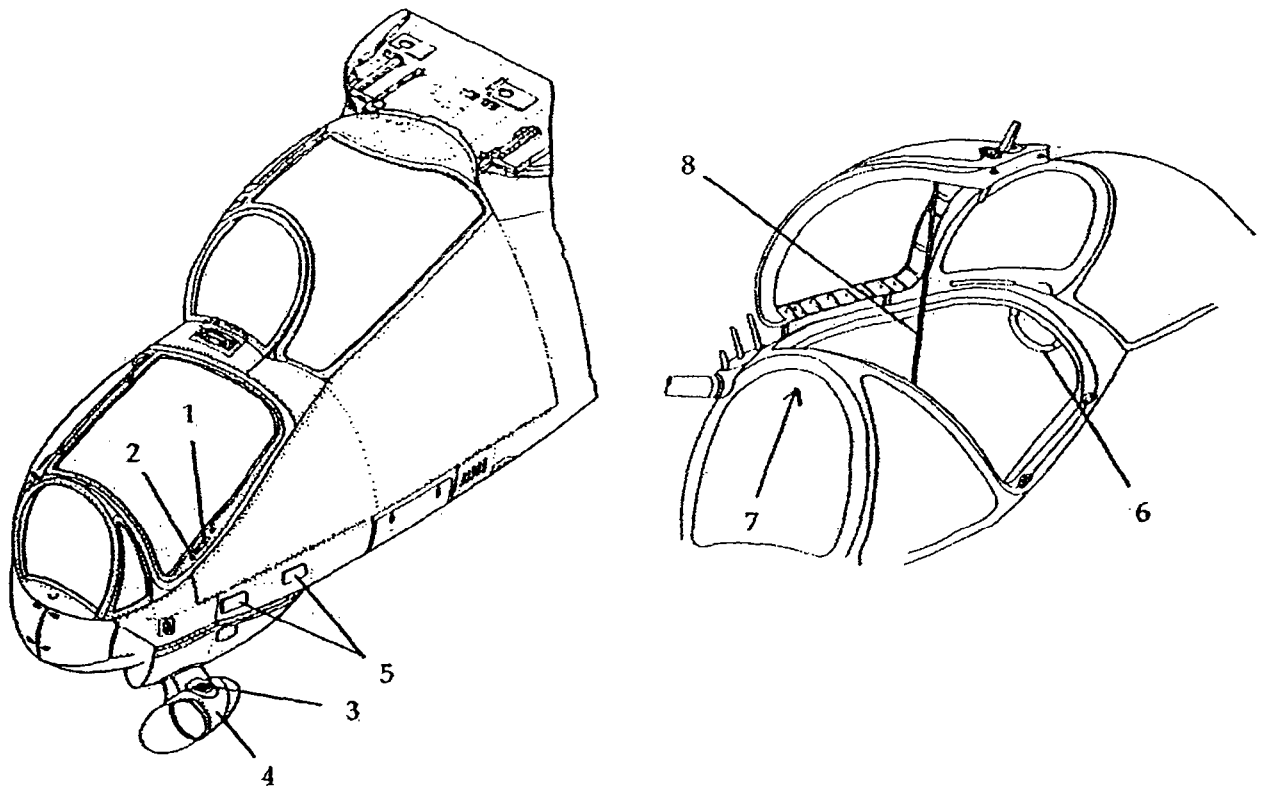


Figure 2-6 CPG Compartment Access

- 1. Canopy latch handle
- 2. Release button
- 3. Step
- 4. Missile antenna fairing
- 5. Step
- 6. Leather handhold
- 7. Leather handhold
- 8. Support strut

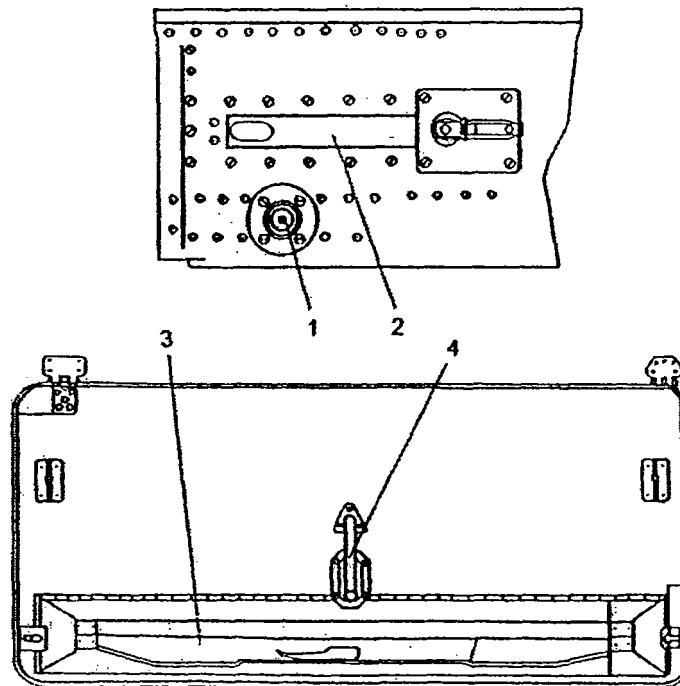


Figure 2-7 Cargo Cabin Access

- 1. Release button
- 2. Door handle
- 3. Step/ledge
- 4. Inside handle

2-9.3 Cargo Cabin Doors

The cargo doors consist of upper and lower panels which open outward. The doors have with cam-type latches with key locks. The lower panels serve as steps when opened. A rod and limiter cable holds the lower panel in the open position. The doors are constructed from duralumin panels mounted in fiberglass frames. There are two transparent windows mounted on each upper door panel. The windows open inward and have spring and pin latches. The cargo doors are equipped with inflatable seals. To access the cargo cabin: (Figure 2-7)

- Unlock the cargo cabin door with the key.
- With the hand that is closest to the nose of the aircraft, locate and press the door handle release button (1). The button is located approximately in the center of the lower door panel.
- With the opposite hand, press on the forward end of the door handle (2).
- When the aft end of the door handle comes out of the door, grasp it and rotate it forward as far as it will go.
- Release the button (1).
- Rotate the lower section of the door out and downward until the door locks into place.
- Place both hands on the cargo cabin floor.
- Raise your forward leg and place your foot on the step (3) on the lower section of the door.
- Raise yourself up and bring your other foot into the cargo cabin.

2-9.4 Door Sealing System

The cockpit door, CPG canopy, and cargo doors have inflatable rubber seals to maintain a pressurized cabin environment. The system uses compressed air from the helicopter pneumatic system. Hollow bolts and hinge pins allow air to pass into and out of the seals. The system operates automatically when the sealing valve handwheel on the pilot's left center panel (see Figure 2-15) is open. The pilot can cut off the supply of compressed air to the seals manually in case of leaks by closing the sealing valve. The cockpit door and CPG canopy seals deflate rapidly via special valves installed in the

emergency jettison systems. A pressure transmitter in the line to each seal controls the DOORS SEALED and DOORS UNSEALED indicator lights, located in the left center area of the pilot's left front console (Figure 2-17).

WARNING

The pilot must make sure the door seals are deflated (DOORS UNSEALED light ON) before opening or allowing ground support personnel to open the pilot's door, CPG's canopy, or cargo cabin doors post-flight. If not deflated, the doors can spring outward with considerable force and result in serious injury to ground support personnel.

2-10 Crew Seats

The pilot and CPG stations are equipped with adjustable, armored seats.

2-10.1 Pilot's Seat

The pilot's seat (Figure 2-8) consists of an armored seat bucket (11), backrest (15), and headrest (1). The seat is designed to use a parachute as a cushion in flight. There is ring on the front of the seat for fastening the parachute cord. A cushion may be placed in the seat pack in lieu of a parachute. The seat has no horizontal adjustment. It is rigidly secured to the floor brackets.

A. Vertical Adjustment. The seat adjustment actuator (9) allows the pilot to adjust the height of the seat. The adjustment range is 160 mm (6.24 in). The actuator receives 27 VDC power from Rectifier Bus II via the PILOT SEAT ADJ circuit breaker on the right cb panel. The vertical adjustment switch is located to the right of the seat bucket. If the range of vertical movement is not sufficient to provide correct posture for the pilot, an insert can be placed in the seat bucket to provide additional height.

B. Seat Tilt Adjustment. The seat is normally reclined at an angle of 26° relative to the vertical. It may also be adjusted to angles of 21° or 16°. The seat tilt adjustment handle (13) is located on the left side of the seat.

C. Seat Belt. The seat has shoulder straps and a lap belt (10) with quick release pressure locks. The shoulder strap adjustment mechanism (5) attaches to the back of the seat. The shoulder strap adjustment handle (12) is located to the left of the seat back.

D. Seat Back and Headrest Release. In an emergency situation, the pilot can exit through the cargo compartment. The seat back and headrest can be dropped by turning the emergency release handle (14) downward. If needed, the headrest can be dropped back separately by pulling down on release handle (6).

WARNING

Make sure no one is behind the seat before releasing the headrest or seat back. Serious injury may result from being struck by headrest or seat back.

2-10.2 CPG's Seat

The CPG's seat (Figure 2-9) consists of a rigid seat bucket (7) and back assembly (1) attached to a cast carriage (9) and two lever assemblies. The carriage is mounted on rails (8) which allow, the seat to be adjusted forward and back. The rails are bolted to the floor of the cabin. There is a removable padded backrest (3) on the inside of the seat back. The CPG's parachute serves as a seat cushion in flight. The seat bucket has a ring for attachment of the parachute chord. A cushion (5) may be placed in the seat bucket in lieu of a parachute. An arm rest may be installed on the right side to facilitate the crew member's work with the missile guidance instrument and control grip.

A. Vertical Adjustment. The seat height is adjustable via a torsion spring and ratchet assembly and two hydraulic struts. To elevate or lower the seat, the aft right handle (10) must be raised (slightly) and rotated upward. The struts will raise the seat. The seat is lowered by the weight of the crew member.

B. Horizontal Adjustment. Horizontal seat adjustment is made within the range of 165 mm (6.4 in) with the seat held in place at both extremes and three intermediate positions at 33 mm (1.3 in) increments. The seat may be moved forward and aft when the forward right handle (6) is rotated upward.

C. Seat Belt. The seat is equipped with lap belts and shoulder straps with a quick release lock. The

shoulder strap adjustment handle (4) is located on the right side of the backrest.

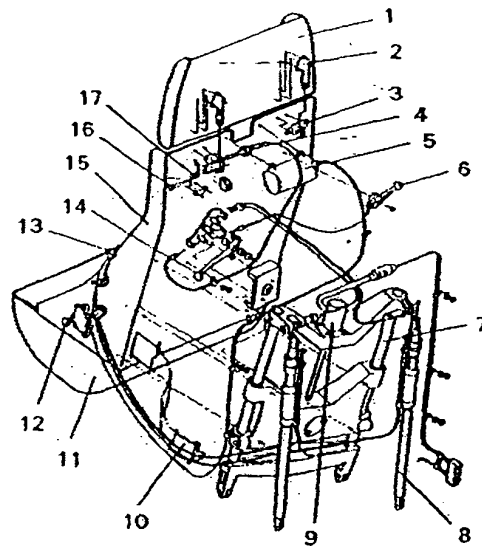


Figure 2-8 Pilot Seat

- | | |
|----------------------------|------------------------------|
| 1. Headrest | 10. Lap belt |
| 2. Hinge bracket | 11. Seat bucket |
| 3. Hinge bracket | 12. Strap adj. Handle |
| 4. Locking pin | 13. Tilt adj. handle |
| 5. Strap adj. Mechanism | 14. Emergency release handle |
| 6. Headrest release handle | 15. Backrest |
| 7. Vertical adj. Guides | 16. Bolt |
| 8. Seat tilt strut | 17. Spring |
| 9. Seat adj. actuator | |

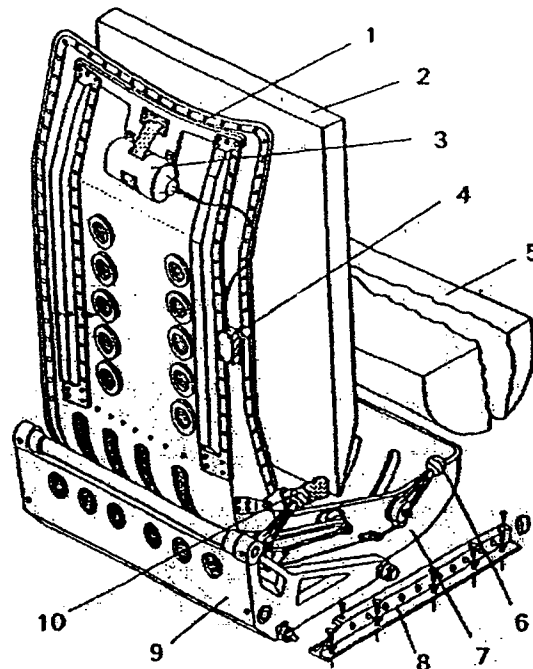


Figure 2-9 CPG Seat

- | | |
|-------------------------|---------------------------|
| 1. Seat back | 6. Horizontal adj. handle |
| 2. Backrest | 7. Seat bucket |
| 3. Strap adj. mechanism | 8. Rail |
| 4. Strap adj. handle | 9. Carriage |
| 5. Cushion | 10. Vertical adj. handle |

2-11 Passenger Seats

The cargo cabin may be used to transport eight passengers or fully equipped assault troops using two folding seat assemblies (Figure 2-10). Each seat will hold four passengers, seated back-to-back, facing outward. The seats are constructed from aluminum tubes with a common back assembly which aligns with the longitudinal centerline of the helicopter. The seat mounts to the floor and cargo compartment ceiling by support struts which seat into fittings on the cabin floor and the ceiling. The back and the seats are manufactured from magnesium alloy sheets and covered with padding and imitation leather. The seats are held in the folded position by springs. All seats have individual safety belts. Bags for collecting shell casings are installed under the seats.

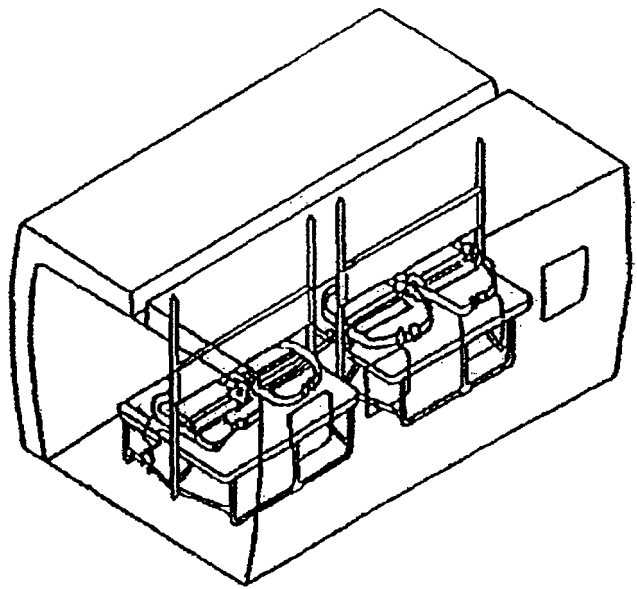


Figure 2-10 Passenger (Troop) Seats

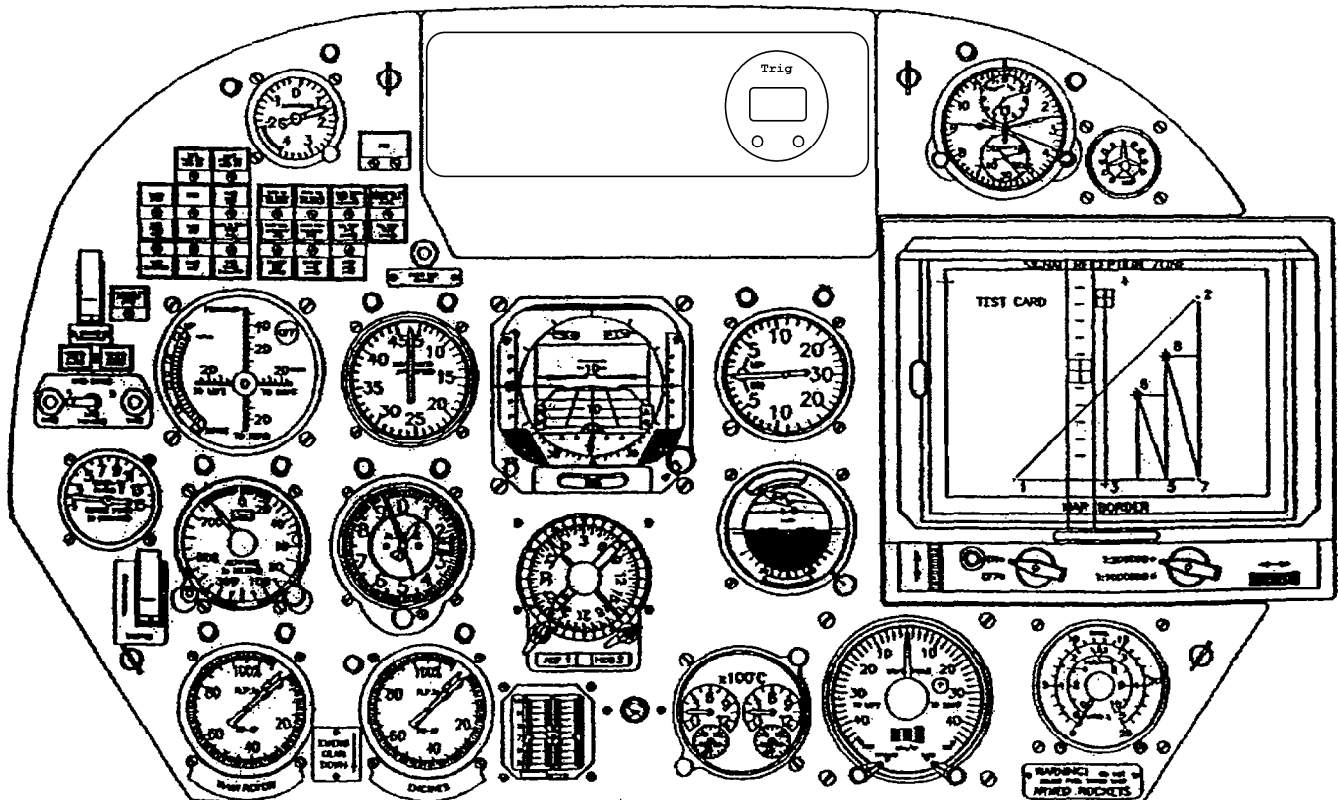


Figure 2-11 Pilot's Instrument Panel

2-12 Instruments and Controls

2-1 2.1 Pilot's instrument Panel

The pilot's instrument panel (Figure 2-11) is installed in the front of the cockpit. It contains the following instruments: accelerometer, Doppler stationary flight and ground speed/drift angle indicators, rotor pitch indicator, airspeed and vertical speed indicators, pressure and radar altimeters, main rotor and engine tachometers, engine pressure ratio indicator, radio-magnetic indicator (RMI), power turbine inlet temperature (PTIT) gauge, main and standby attitude indicators, fuel gauge, the Doppler map display, a radar warning indicator, flight time clock, and the master caution panel. The armament

control panel is mounted below the instrument panel. The manual landing gear extension valve is mounted just to the left of the armament panel. The instrument board can be opened to gain access to the instrument fittings, electrical components, and wiring. The panel is tilted 15° forward. It is equipped with a glare shield and red lighting for day-night operations.

2-12.2 Pilot's Control Panels and Consoles

The typical locations of controls installed on the pilot's control panels and consoles are shown in Figures 2-12 through 2-21.

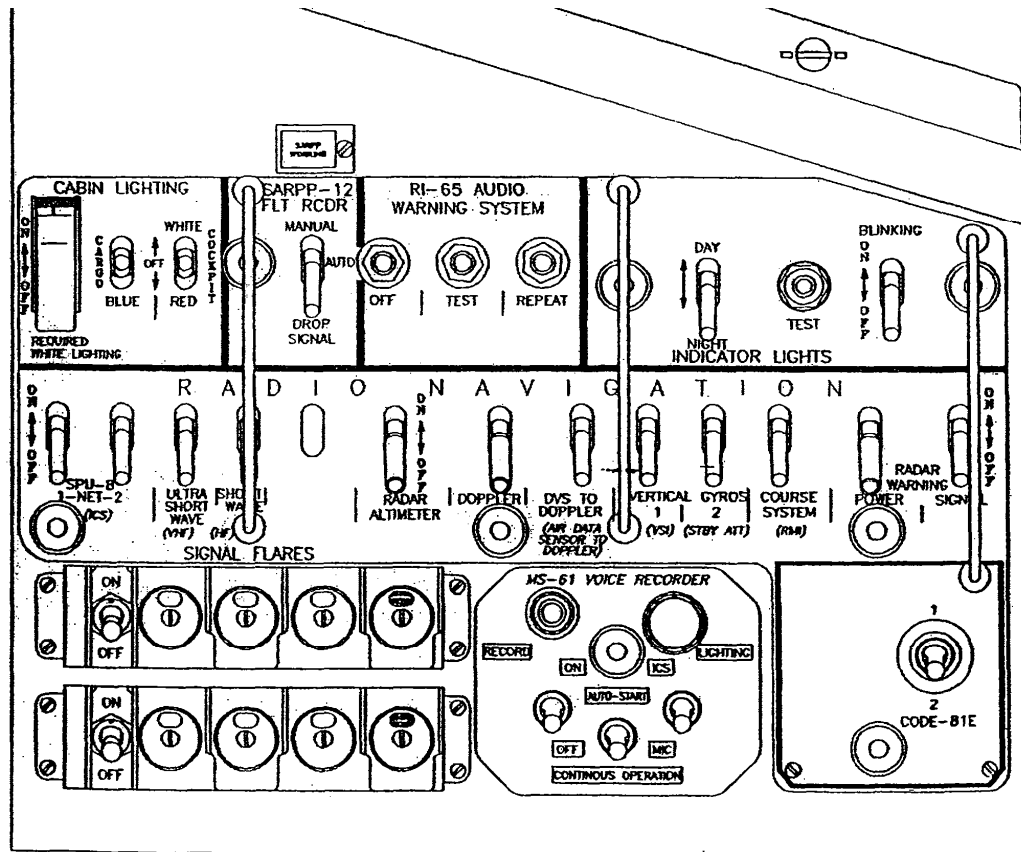


Figure 2-12 Pilot's Upper Left Rear Panel

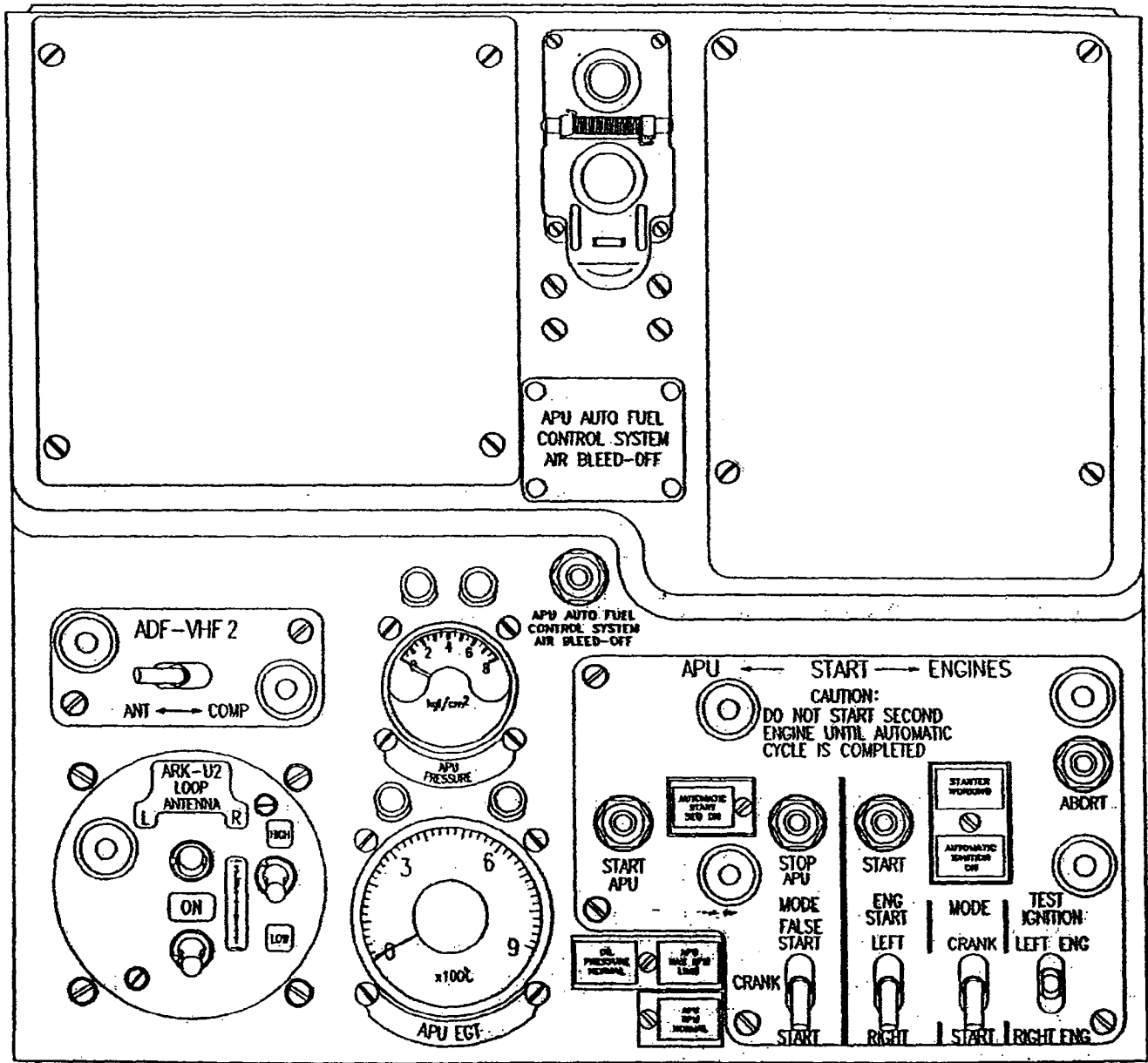


Figure 2-13 Pilot's Center and Lower Left Rear Panels

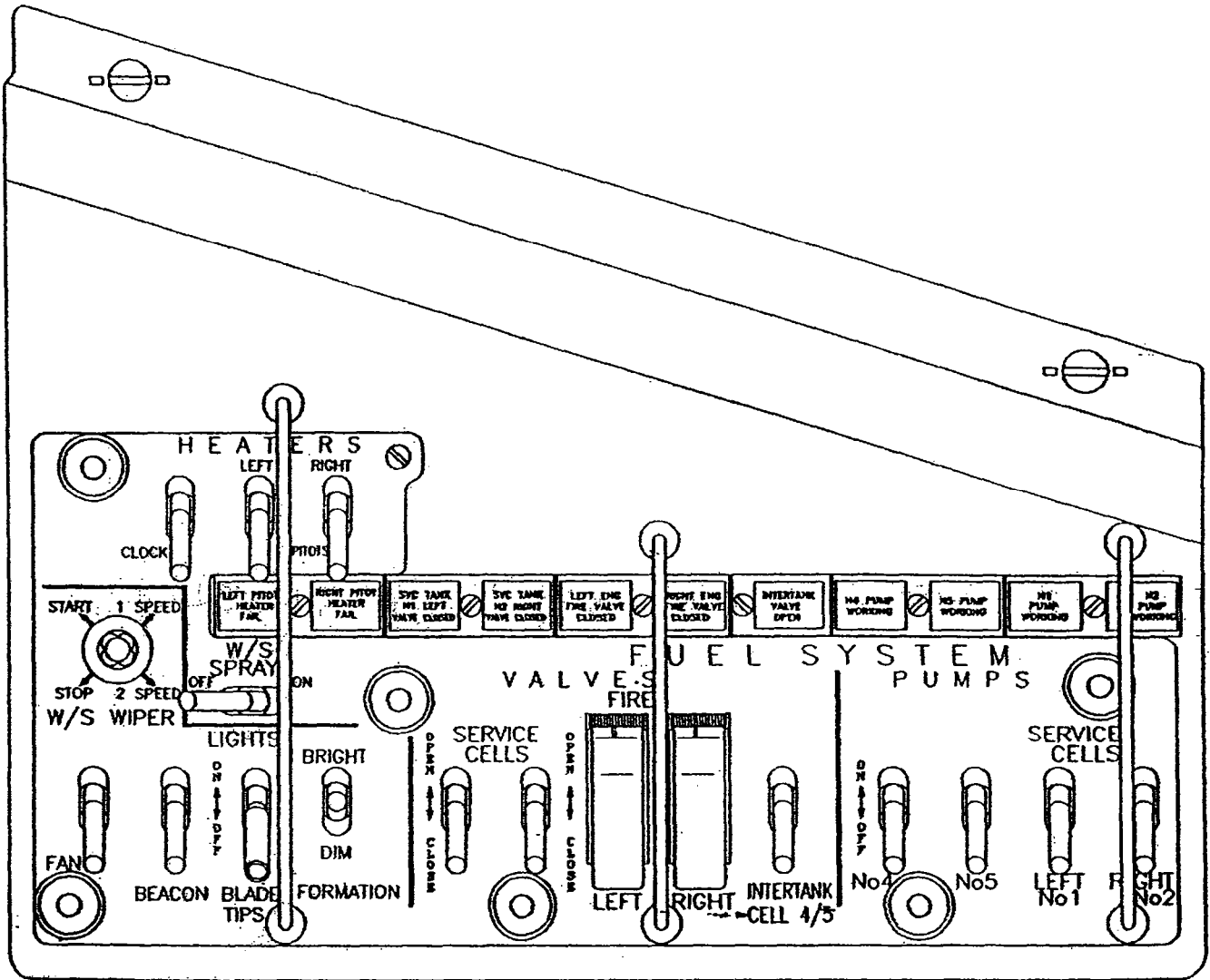


Figure 2-14 Pilot's Upper Left Center Panel

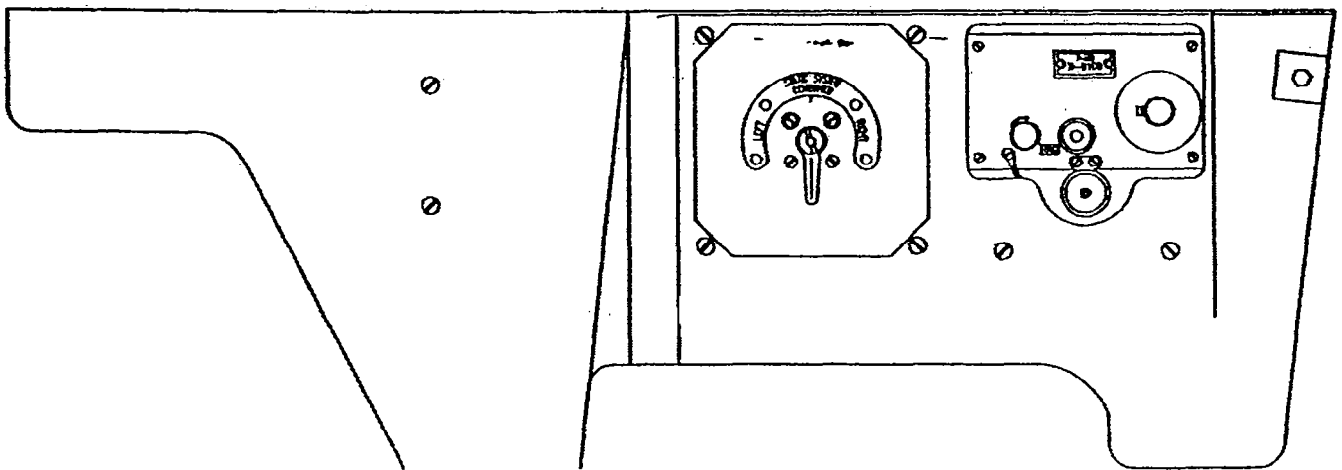
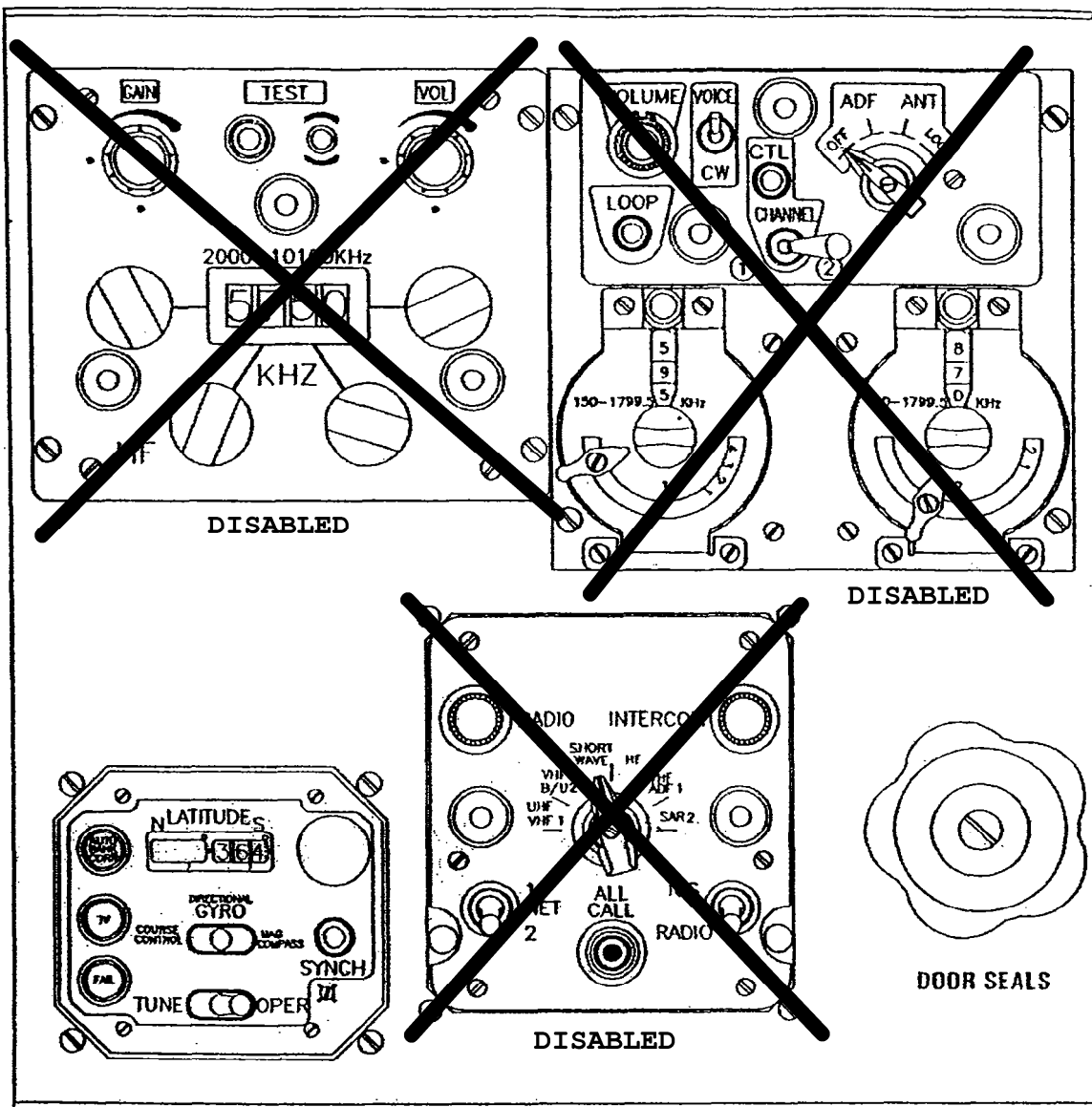


Figure 2-15 Pilot's Left Center Panels

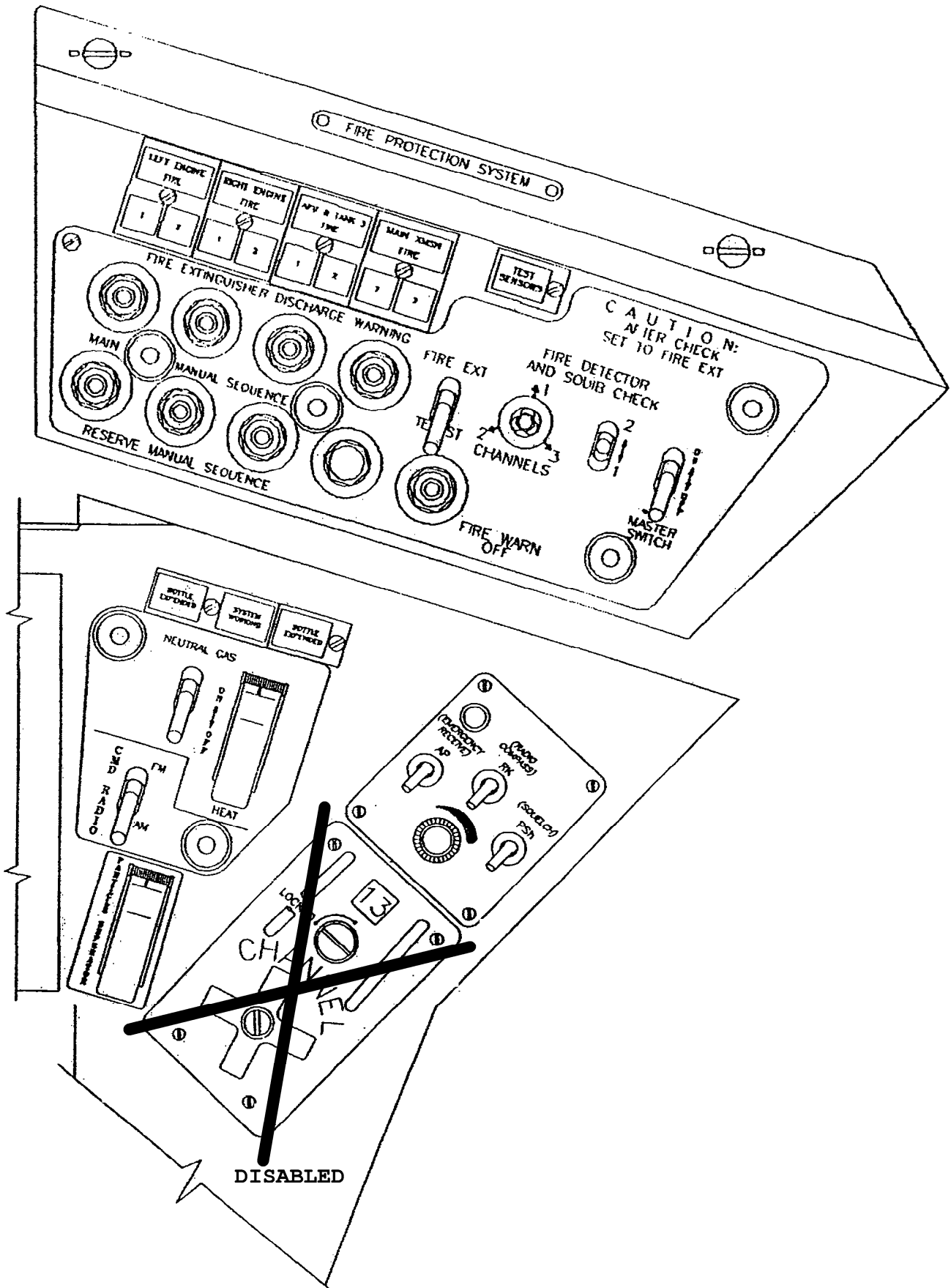


Figure 2-16 Pilot's Left Forward Panels (Typical)

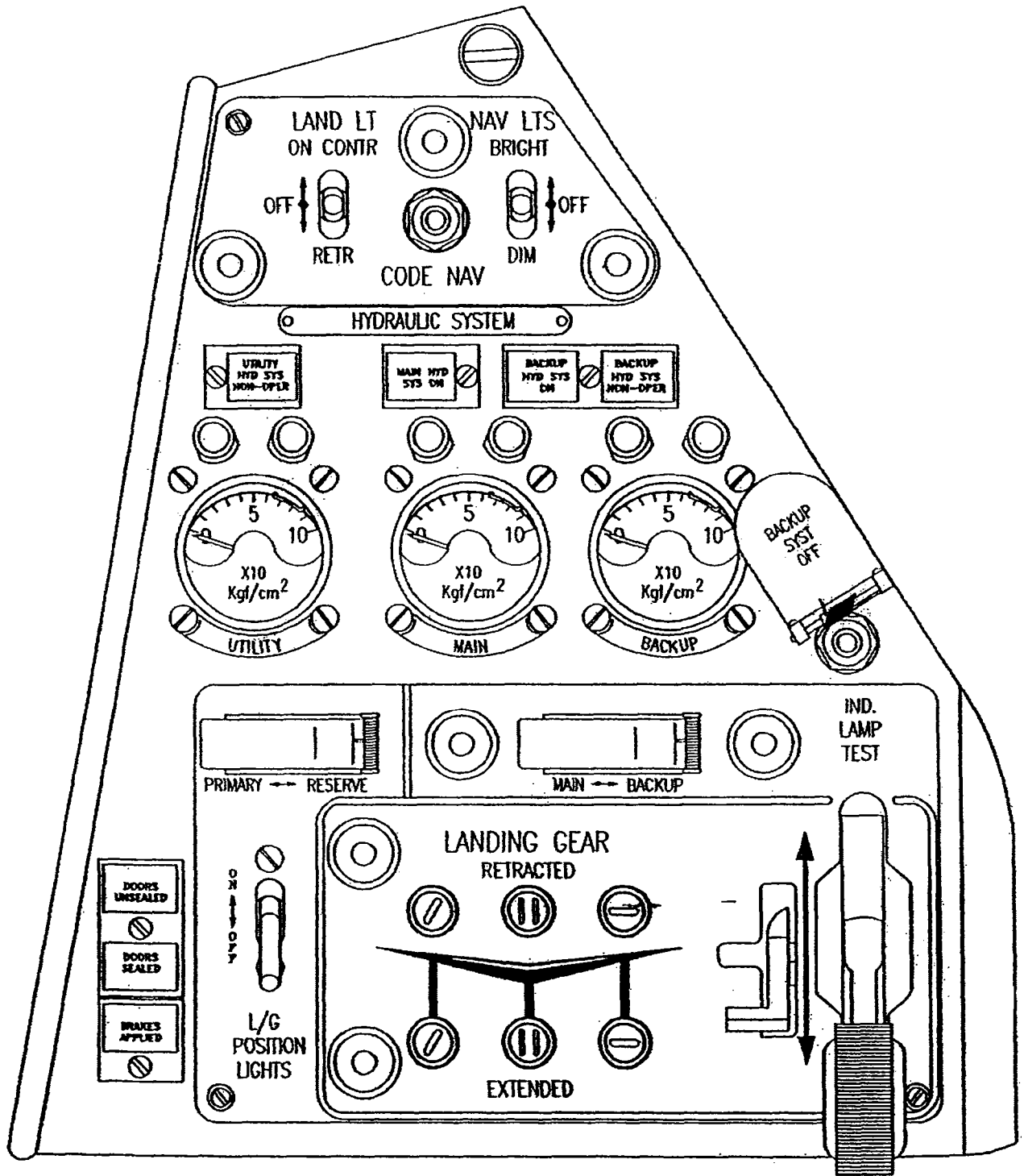


Figure 2-17 Pilot's Left Front Console, Upper Panel

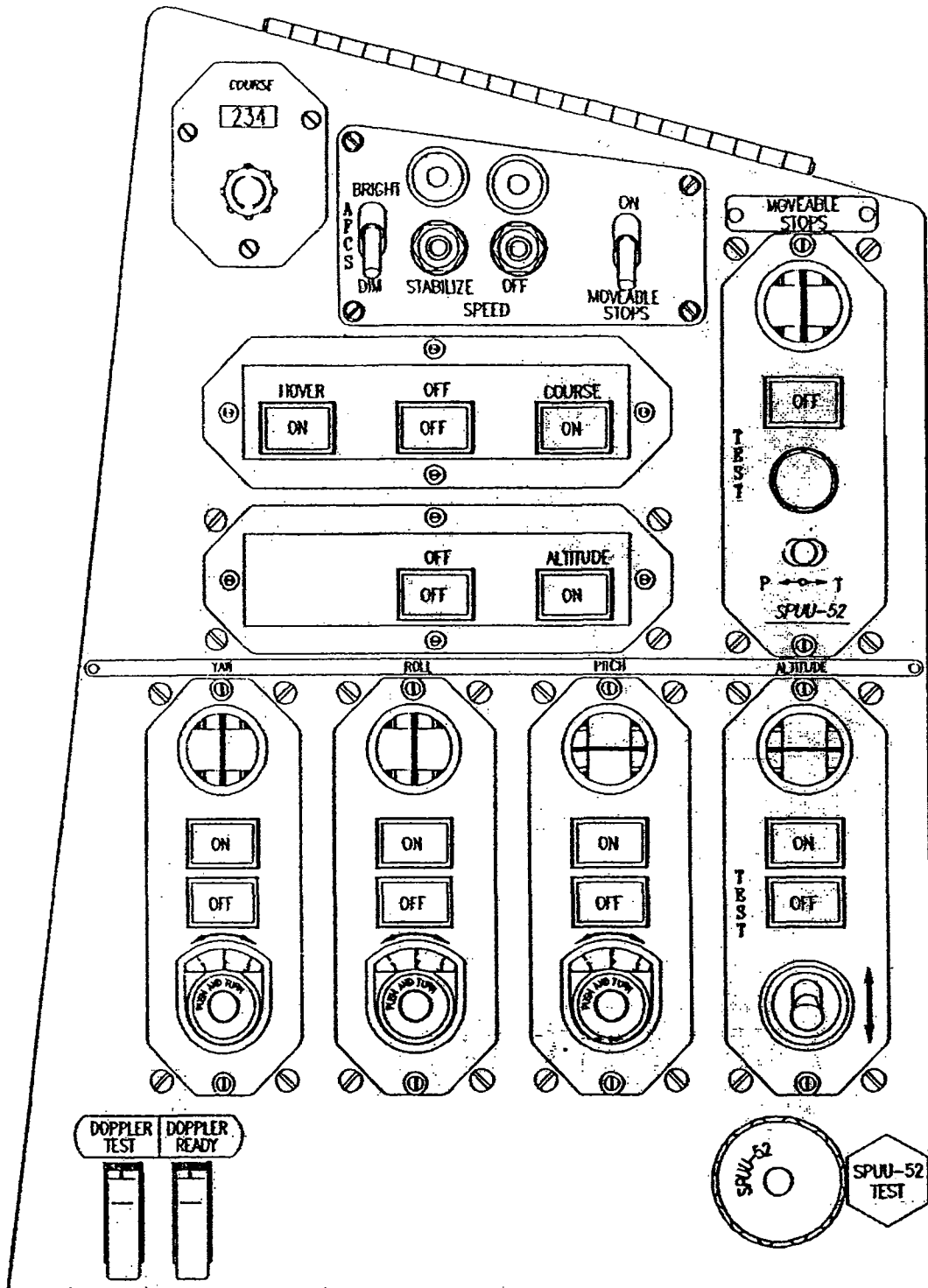


Figure 2-18 Pilot's Left Front Console, Lower Panel

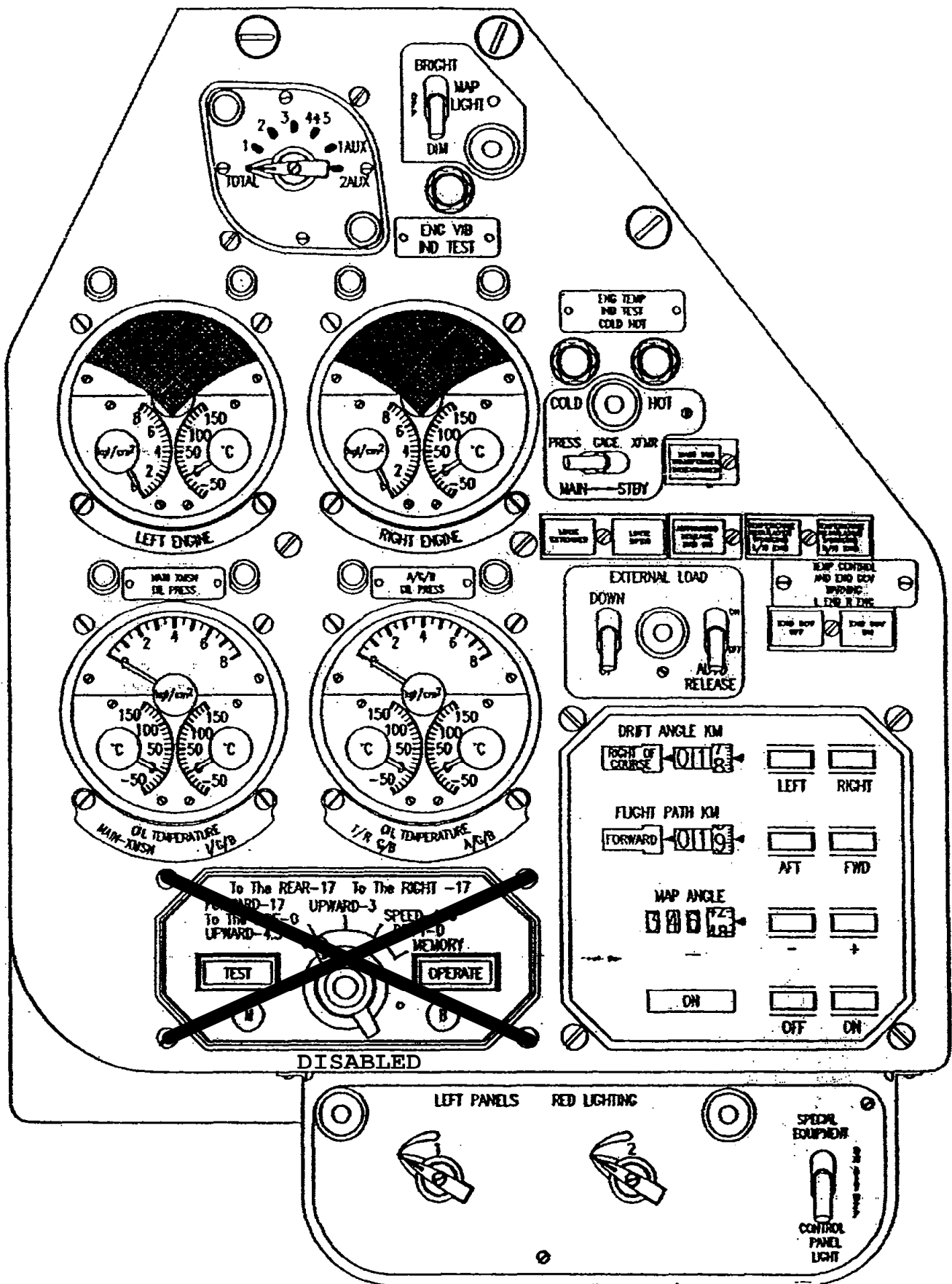


Figure 2-19 Pilot's Right Front Console

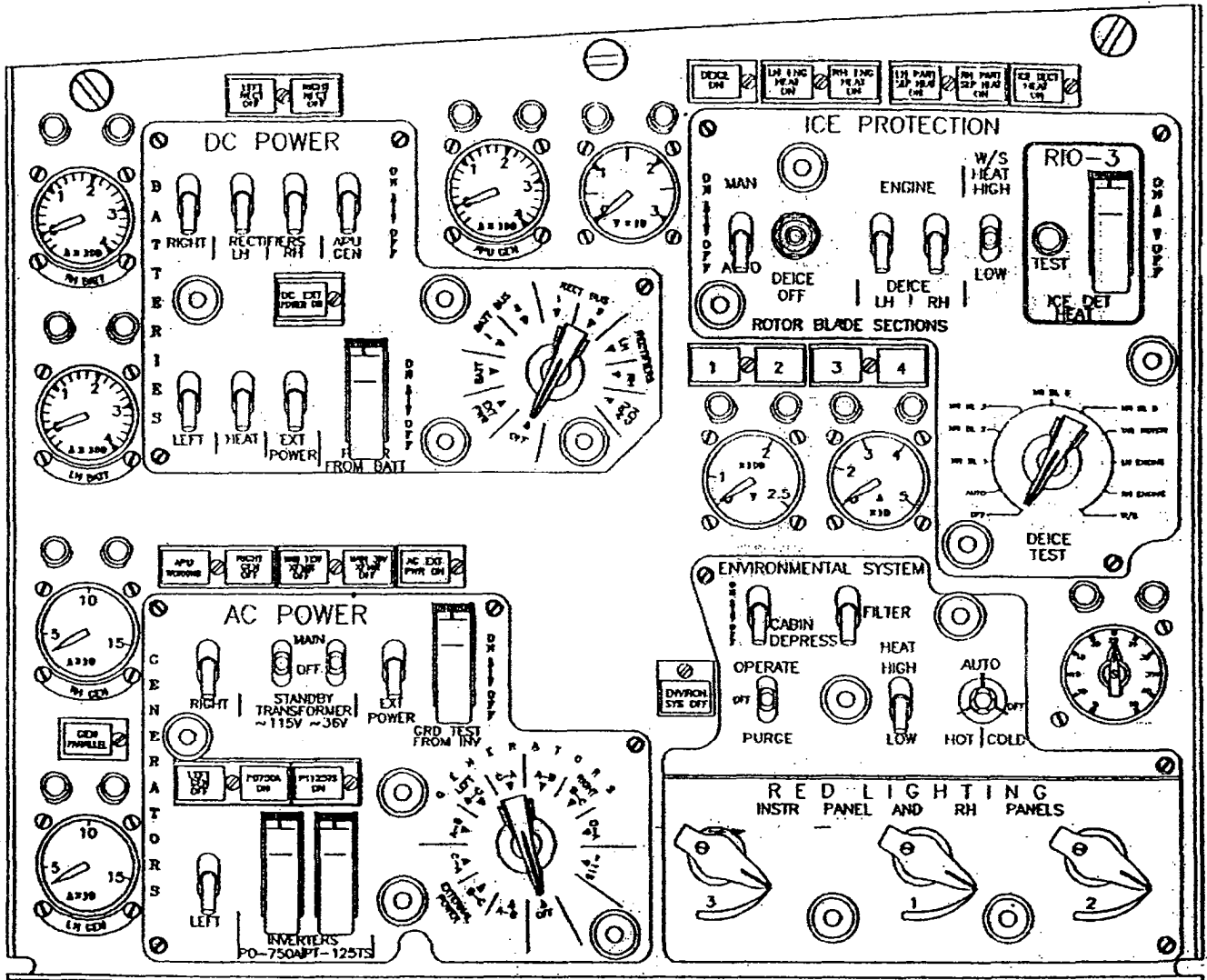


Figure 2-20 Pilot's Right Side Console

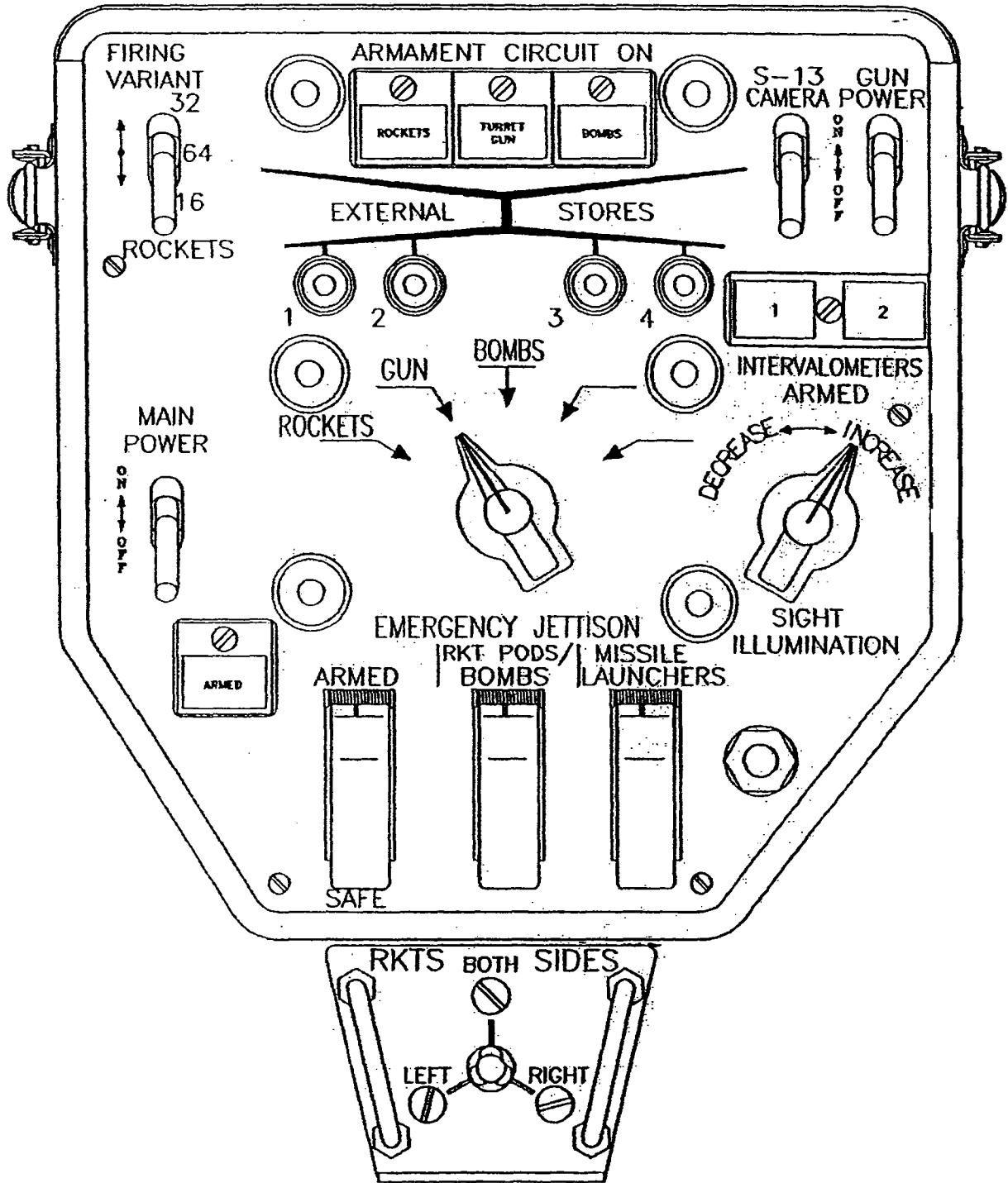


Figure 2-21 Pilot's Weapons Panel
 Note that all weapons systems on this aircraft have been disabled.
 This panel is for display / exhibition purposes ONLY

2-12.3 CPG's Control Panels and Consoles

The CPG station is considered a passenger compartment and has not been translated to English. The English translation is shown here for reference only. The CPG's station is equipped with panels and consoles which house the weapons system controls, as well as instruments and flight controls required to fly and land the helicopter in an emergency. In the Mi-24/25D and Mi-35 variants, the KFS-53AV gun/bomb sight is located at the front of the compartment. In the Mi-24F helicopter, an instrument panel is, located at the front. The missile system control units and control panels for the IR jammer and flare/chaff dispensers are mounted on the right side of the compartment. These units are shown in Chapters 3 and 4. Typical locations of controls are shown in Figures 2-27 through 2-30.

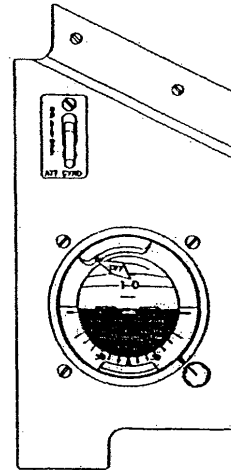


Figure 2-28 CPG's Left Forward Panel (Typical)

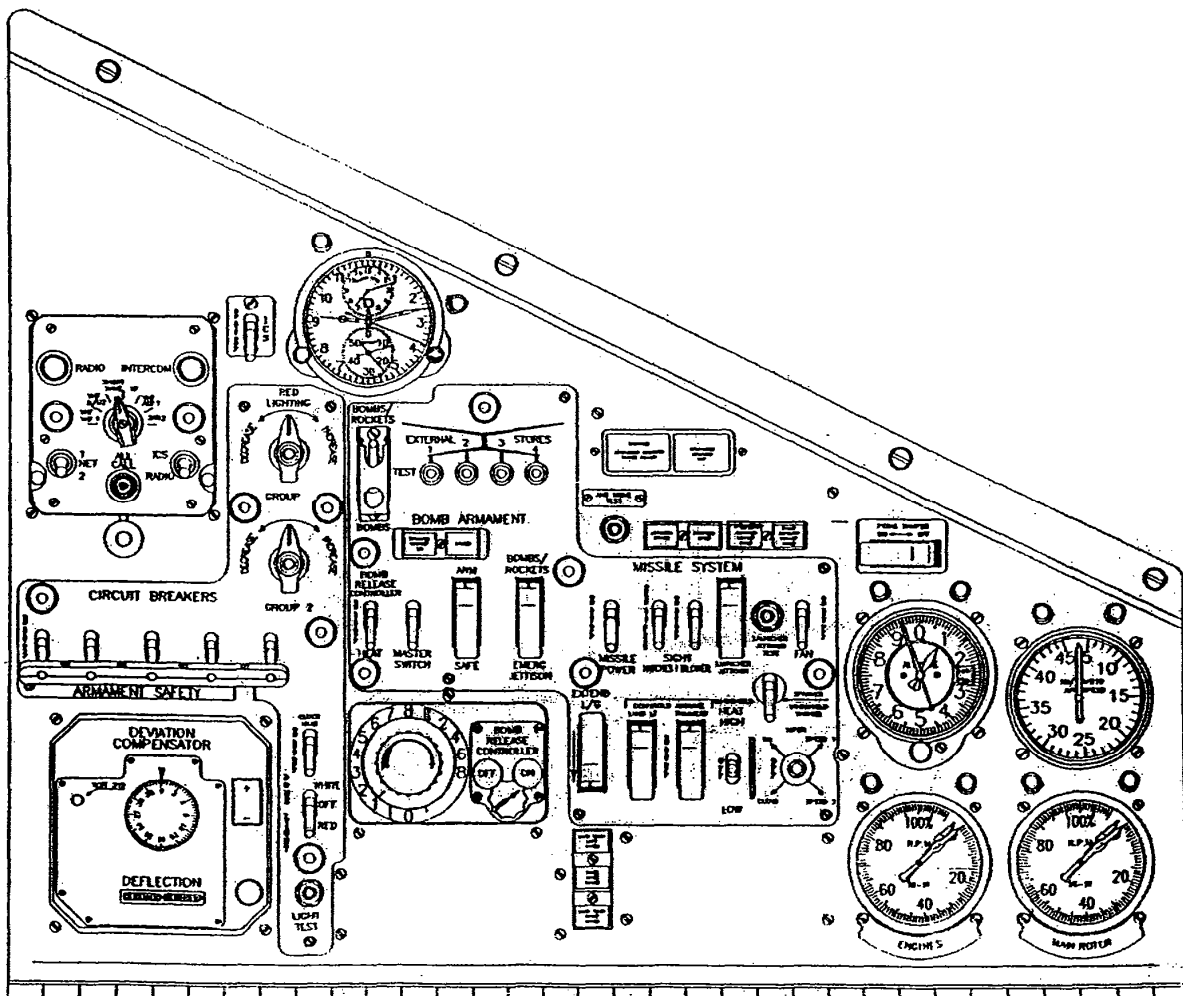


Figure 2-27 CPG's Left Side Panels (Typical)

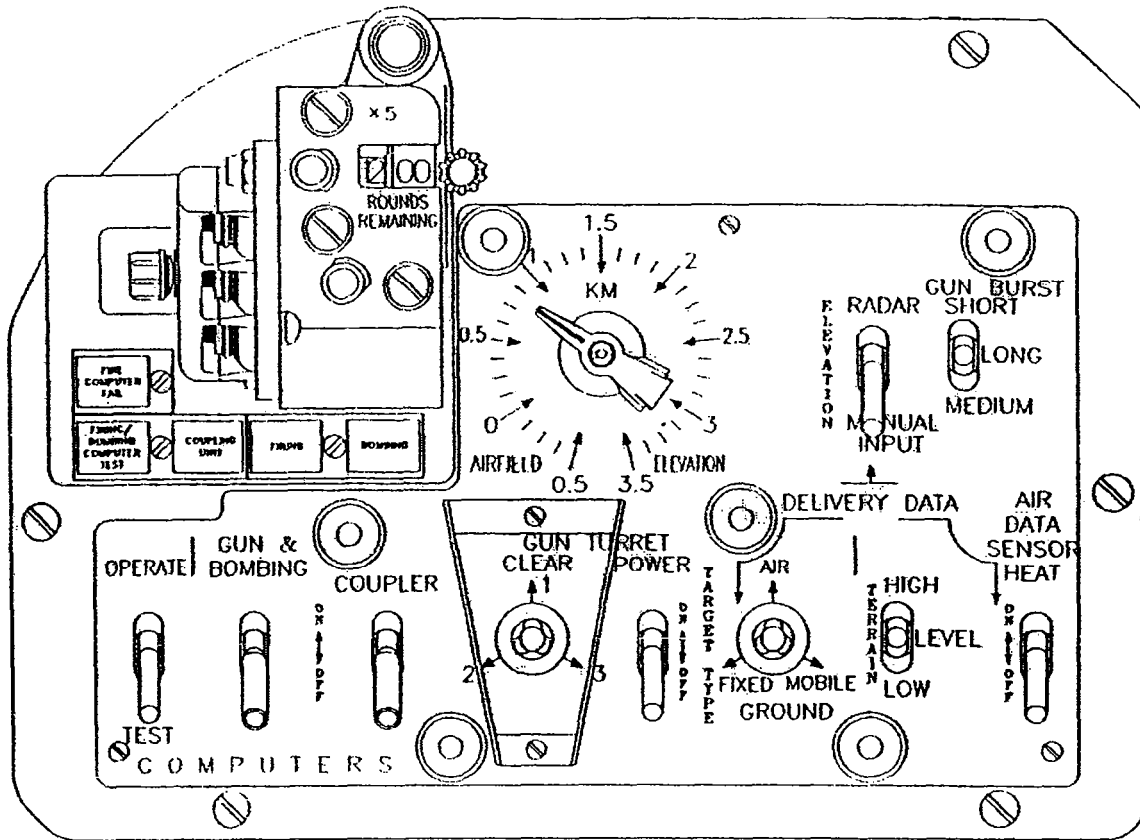


Figure 2-29 CPG's Left Front Console (Typical)

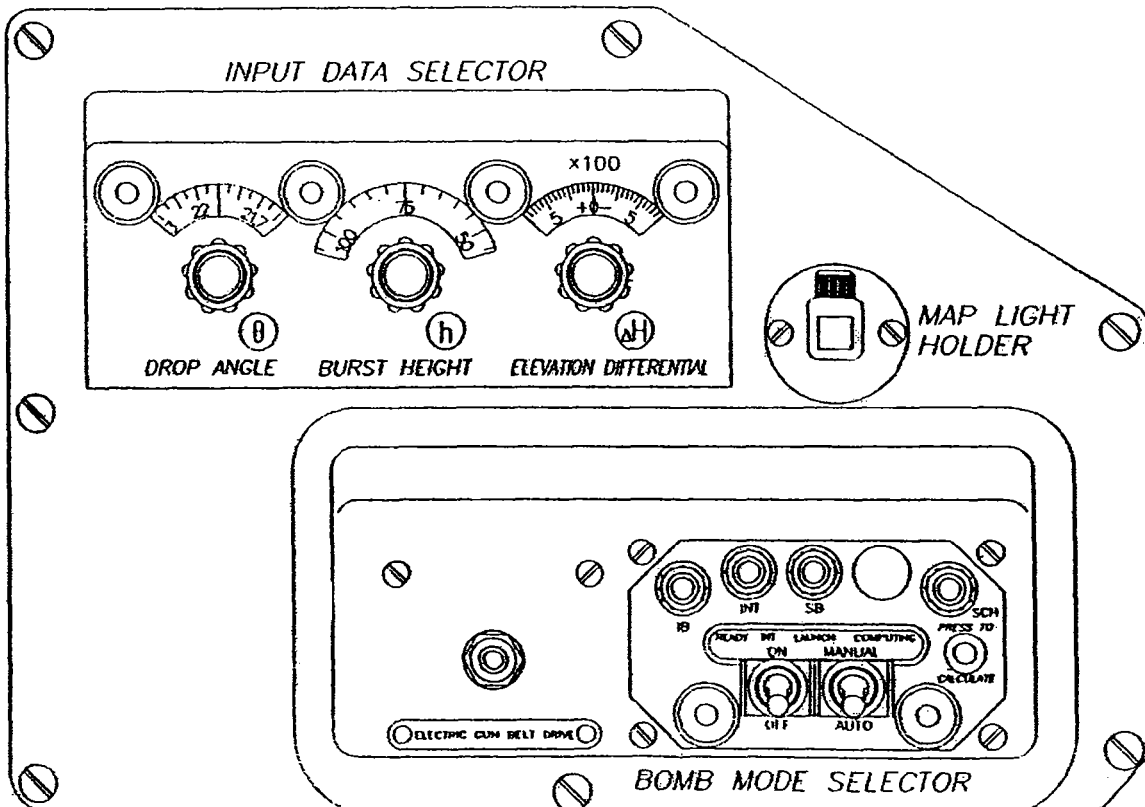


Figure 2-30 CPG's Right Front Console (Typical)

Section II Emergency Equipment

2-13 Emergency Equipment

The Mi-24D helicopter is equipped with fire protection equipment, first aid kits, and jettison systems. Emergency procedures are covered in Chapter 9.

2-14 Fire Protection Systems

Fire protection systems are designed to detect and extinguish a fire in either engine compartment, the transmission compartment, or the APU compartment without affecting the other three areas. The compartments are monitored by bimetallic heat sensing units and protected by a main and reserve high-rate discharge fire extinguisher installation.

2-14.1 Fire Detection System

The fire detection system is designed to warn the pilot of a fire in either engine compartment, the transmission compartment, the APU compartment or fuel cell No. 3, as well as to detonate the squibs in the fire-extinguisher heads to release extinguishing agent into the compartment in which the fire has occurred. The system includes 36 heat detectors, amplifiers, warning circuits, and a control/test panel (see Figure 2-16). The system is powered with 27 VDC from Battery Buses I and II via the FIRE PROTECTION WARN circuit breaker on the left cb panel. Each protected compartment has its own fire alarm sensor group. In case of fire, the detectors react to the rapid heat increase and send a signal to one of the control amplifiers. The control amplifiers activate the FIRE warning light for the appropriate compartment and the master FIRE warning light on the pilot's master caution panel. The system may be reset manually by pressing the FIRE ALARM OFF button on the fire protection system control panel.

2-14.2 Fire Extinguishing System

The helicopter has a centralized fire extinguishing system which includes two four liter (1.06 gal) fire extinguisher bottles with explosive squibs for extinguishing fires in the engine, main transmission, vertical and service fuel-cells and APU areas. The fire extinguishers are filled with Freon 11 and compressed air. Bottle pressure is displayed on a gauge on the bottle head. The head has a remote-action detonating mechanism and a membrane which

self-discharges the bottle in the event of excessive pressure. The protected areas are divided into separate compartments by firewall bulkheads. There are spray manifolds in each protected compartment. The forward fire bottle (in the direction of flight) belongs to the main extinguishing circuit. The main sequence is automatically activated or can be switched on manually. The reserve bottle can only be discharged manually. All system switches, selectors and fire warning inscriptions are located on the fire extinguishing system board on the pilot's left console (see Figure 2-16). The main and reserve sequence push-buttons are located immediately below the compartment fire warning lights. If the fire has not been put out by the main fire extinguisher or if fire has broken out again, the reserve fire extinguisher can be activated by pressing the reserve sequence button for the specified compartment. In case of fire in the APU compartment, the APU fire valve closes automatically to cut off the supply of fuel to the APU. The system is powered with 27 VDC from Battery Buses I and II via the FIRE PROTECTION AUTO and MANUAL circuit breakers on the left and right cb panels.

2-14.3 Heat Detector/Squib Test

The fire protection system includes a built-in test circuit for checking operation of the heat detectors and squibs. When the MASTER switch on the fire protection panel (see Figure 2-16) is set to the ON position and the FIRE EXT/TEST switch is set to TEST, the squibs circuits can be checked by setting the 1-2 switch in position 1, then position 2, in turn, if any 1 (main) or 2 (reserve) warning light on the fire protection panel illuminates during the test, the squib in that circuit is defective. The heat detector circuits can be checked via the CHANNELS selector with the FIRE EXT/TEST switch in the TEST position. When the CHANNELS selector is set to the 1, 2, or 3 position, all the compartment FIRE warning lights should come on. The lights should go off when the selector is reset to the neutral position.

CAUTION

Make sure the FIRE EXT/TEST switch is set to the TEST position before checking the squib and heat detector circuits. If the switch is set to EXT, the squibs will fire and discharge the bottles.

2-14.4 Portable Fire Extinguisher

The helicopter is originally equipped with one portable fire extinguisher (type OU-2) mounted behind the pilot's seat on the right. The OU-2 fire extinguisher is charged with 15 kg (3.3 lb) of carbonic acid. Generally, the original OU-2 fire extinguishers have been replaced with a portable U.S. standard fire extinguisher. The replacement extinguisher is mounted in a quick-release bracket on the forward bulkhead in the cargo cabin.

2-15 First Aid Kits

Two foreign first aid kits (242-7804-00) are provided with the standard Mi-24/25 helicopter. The kits are mounted in the pilot's and CPG's compartments for easy access. In most helicopters, the original first aid kits have been replaced with a U.S. general purpose, panel-mounted first aid kit (aircraft). The replacement kit is usually mounted in the cargo cabin near the right cabin door on the forward bulkhead. The original mounting points may be modified to accept U.S. standard kits.

2-16 Emergency Jettison Systems

2-16.1 Pilot's Door Jettison System

The canopy and door jettison systems in this helicopter have been deactivated.

Section III Engines and Related Systems

2-17 Engines

The standard Mi-24/25 helicopter power plant consists of two TV3-117 series 3 turboshaft engines. For improved operating characteristics in high temperatures and high elevations, the helicopter may be equipped with TV3-117V engines instead. The TV3-117V engines may be installed only on helicopters equipped with an upgraded SPUU-52-3 moveable stop system and the 246-3904-00 tail rotor hub with wide cord blades. The TV3-117V engines are standard on the Mi-24F/Mi-35 variants. Both engine variants are similar in design, with the major differences internal to the fuel controls. A general view of the engine is given in Figure 2-33. The engines are installed on the fuselage deck in a

common nacelle. They are situated parallel to the helicopter's longitudinal centerline and are tilted downward, toward the front, at an angle of $4^{\circ}30'$ relative to the fuselage horizontal reference line. The rear output shafts of the engines are connected, via a uniball coupling, to the main transmission, which transmits power to the main rotor, AC generators, tail rotor, and accessories. The engines have an integrated regulating system which provides main rotor speed control and synchronizes the power output of both engines. They have both automatic and manual throttle control systems. Either engine may be operated independently to allow for flight with one engine inoperative. The engines are equipped with individual air inlet particle separators and anti-ice systems.

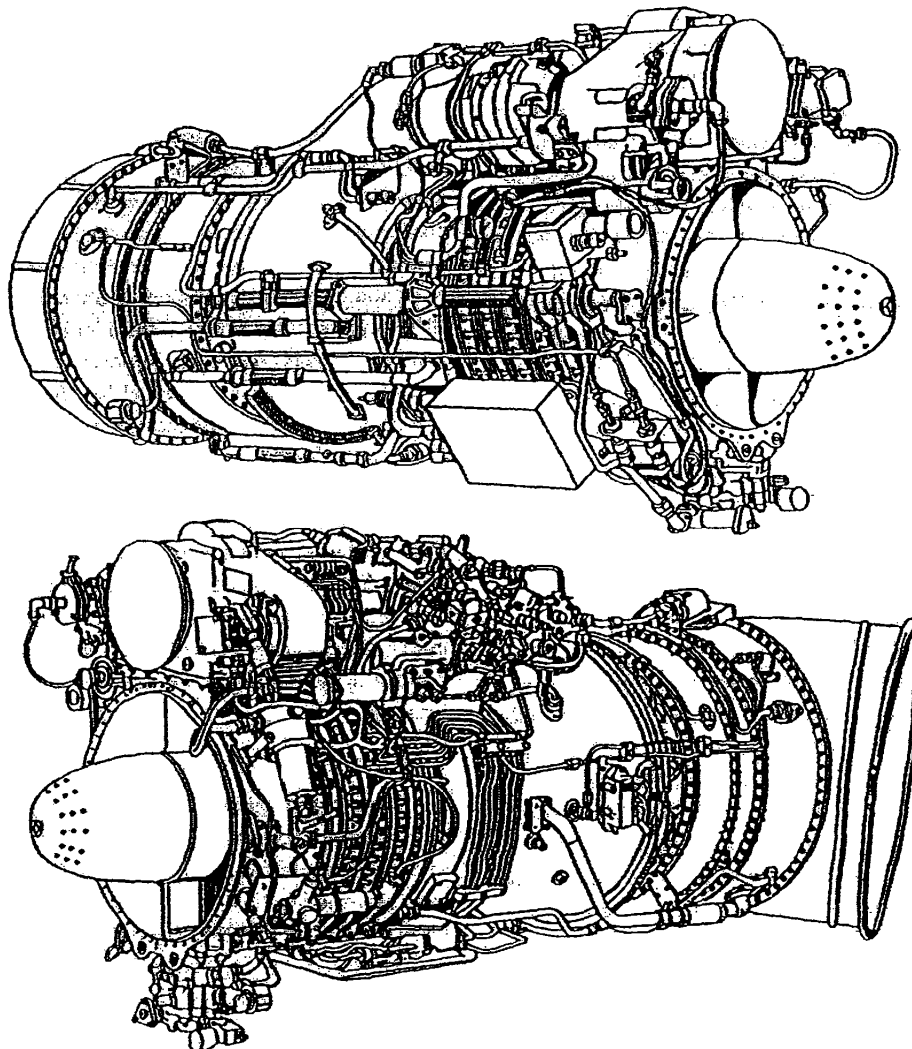


Figure 2-33 TV3-117 Series 3 (TV3-117V) Engine

2-18.1 Air Inlet Particle Separator

The air inlet particle separator system protects the engine inlet during taxiing, takeoff, and landing at unimproved airstrips and in sand/dust areas. The system mounts on the front of the engine, in place of the nosecone assembly. Each engine has an independent particle separator system. The system begins to operate when bleed air is supplied to ejector by opening the flow control valve. The valve is controlled by the covered PARTICLE SEPARATORS switch located on the center forward area of the pilot's left side wall (see Figure 2-16). When the system is running, suction pulls contaminated air into the inlet duct passages. Centrifugal forces throw the dust particles toward the aft dome surface where they are driven by the air flow through the separator baffles. The main portion of the air, with the dust removed, passes through the duct to the engine air inlet. The contaminated air (dust concentrate) is pulled into the dust ejector duct and discharged overboard.

2-18.2 Engine Anti-Ice System

The engine anti-ice system uses both electrical heating elements and bleed air from the combustion chamber to remove and prevent ice build-up on the particle separator and engine inlet. The system operates manually via the ENGINE DEICE switches on the pilot's right console (see Figure 2-20), or automatically using the signal from the ice formation warning sensor, depending on the position of the ENGINE DEICE MANUAL/AUTO switches. The bleed air portion of the system includes a flow control valve, a thermal compensator, and air lines that transport the hot air from the bleed air ports to the heated surfaces. A thermal compensator adjusts the volume of bleed air that flows through the system to keep power loss to a minimum. The electrical portion of the system includes heating elements mounted on the forward dome, separator baffles and aft dome sections of the particle separators and a pair of temperature regulators, one for each engine. See Section IX, Utility Systems, for more information on the Deice/Anti-ice Systems.

2-19 Engine Fuel System

The engine fuel system supplies and controls the fuel flow to the combustion chamber, controls the inlet and compressor variable guide vanes and air discharge valves, and shuts down the engine in the

event of power turbine overspeed. The fuel components mounted on the engine include the fuel control, fuel nozzle/manifold assembly, fuelboost pump, fuel/drain valve, filters, and an emergency fuel shutoff valve. The aircraft fuel system supplies fuel to the input of the fuel boost pump. The fuel boost pump increases the fuel pressure to the required level and feeds it to the main fuel filter. The main fuel filter supplies filtered fuel to the inlet of the fuel control. The fuel control's high pressure pump increases the pressure of the fuel. The fuel control meters the fuel and sends the fuel in two flows through the fuel/drain valve unit into the start and main fuel rings of the fuel nozzle/manifold assembly. Fuel seepage from the accessory seals passes through the drainage system lines to the ejector which discharges it into the exhaust pipe. Fuel drainage from the combustion chamber and the air intake valve reaches the fuel/drain valve unit which sends it to the drainage tank on the left side of the fuselage.

2-19.1 Starting Fuel Flow

To start the engine fuel supply, the fuel boost must be operating, the engine fire valves and service cell shutoff valves open, the twist grip throttle control rotated full left, and the engine fuel shutoff lever (FSL) set to the OPEN (full down) position. During engine start, fuel is supplied to the start fuel nozzles. Air is supplied to the main fuel nozzles during engine start to improve atomization of the start fuel. When N_1 reaches sufficient speed, fuel begins to flow through the main fuel nozzles.

2-19.2 Steady State Operation

The N_1 regulator, droop compensator, engine governor, and temperature limiter automatically control the fuel flow into the combustion chamber during steady state operations. Each element affects the fuel flow only during specific conditions. The N_1 regulator controls the fuel flow at idle power. The droop compensator adjusts the fuel flow at operational power conditions from flight idle up to limited takeoff. This includes flat pitch descents. The engine governor system and the gas temperature limiter control maximum fuel flow at limited takeoff and takeoff power.

2-19.3 Temperature Limiter System Operation

When power turbine inlet gas temperatures reach $985 \pm 3^\circ\text{C}$ ($1805 \pm 5.4^\circ\text{F}$), the temperature limiter begins to send signals to the temp limiter actuator. The TEMP LIMITER ON caution light on the pilot's right front console begins to flash. The N_1 RPM/T° LIMIT warning light on the engine governor control panel in the cargo cabin also comes on. As the PTIT continues to increase, the signal pulse duration and the flashing speed of the caution lights also increase. This results in increased fuel spillage from the throttle control chamber through the temp limiter actuator, decreasing the amount of fuel fed to the combustion chamber. The gas temperature limits at all power settings are between 985 and 1000°C (1805 and 1832°F). The fuel control includes a slide valve that blocks the actuator if the temperature limiter fails. If the temperature limiter sends a constant false signal or a very high temperature signal to the actuator, the slide valve disengages the actuator when the N_1 RPM decreases to $85 \pm 1\%$.

NOTE

117V The activation temperature varies according to engine variant. For TV3-117V engines, the activation temperature is 975°C (1787°F).

2-19.4 Compressor Control System Operation

The variable inlet guide vanes (VIGV), variable guide vanes (VGV), and two air discharge valves maintain the basic engine performance parameters and stability margin. The guide vane controller in the fuel control operates the compressor control system as a function of derived (corrected) N_1 RPM. During engine start, when the N_1 RPM is below 81%, the VIGV and VGV are set against the upper stop (closed) at an angle of 27 to 28.5° . When the N_1 REM reaches 81%, the guide vanes start to open at a linear rate. When the N_1 RPM reaches 100%, the guide vanes are set to an angle of 0° . When N_1 exceeds 102%, the guide vanes are fully open against the lower stop at an angle of $-3 \pm 0.5^\circ$. Reversal of the guide vane setting occurs in a similar manner as the N_1 RPM decreases until the vanes close completely at an N_1 RPM of 81%. The air discharge controller operates the air discharge valves at the seventh compressor stage. During engine start

and low RPM operation, fuel pressure holds the valves open. When the N_1 RPM is between 84 to 87%, (VGV setting of 22°), the air discharge controller diverts the fuel to the drain line and the valves close. The valves open during engine deceleration in the same manner.

NOTE

117V On TV3-117V engines, the variable guide vanes are set to an angle of -6.5° when fully open.

2-19.5 Engine Governor Operation **117**

The RPR-3A engine governor N_1 loop prevents compressor overspeed by reducing the fuel flow to the combustion chamber when the preset maximum RPM is reached. The system uses inputs from the N_1 RPM transducer mounted on the engine accessory drive and temperature readings from the engine inlet temperature probe to monitor and correct the maximum N_1 limit. The temperature limiter actuator controls the amount of fuel reduction. The N_2 loop activates and automatically shuts down the engine in the event of power turbine overspeed. The N_2 loop uses the input from a pair of N_2 transducers mounted in the aft support housing to determine actual N_2 speed. The emergency fuel shutoff valve cuts off the fuel flow into the combustion chamber and the engine shuts down if the maximum N_2 speed is reached.

NOTE

117V TV3-117V engines use the ERD-3V engine governor system. The system is similar to the RPR-3A system in performance and operation. The primary difference is the addition of a pair of pressure transducers installed in the cargo cabin to adjust the RPM limits for lower atmospheric pressures.

2-19.6 Engine Shutdown

Moving the fuel shutoff lever in the cockpit to the STOP (full up) position controls engine shutdown. When this occurs, the stop valve in the fuel control closes, diverting the fuel to the drain line. Fuel flow into the combustion chamber terminates and the engine shuts down.

2-19.7 Fuel Supply Switches

Fuel supply system switches and indicators are located on the pilot's upper left center side wall panel (see Figures 2-14 and 2-24). The panel includes switches for the fuel valves and transfer pumps. Fuel supply system operation is described in Section IV of this Chapter.

2-19.8 Power Controls

Joint engine operation is controlled using the twist grip throttle control on the pilot or CPG collective sticks. The engines are controlled individually by the engine condition levers (ECL). If one engine fails when the engines are operating at power settings above flight idle and the collective pitch remains unchanged, the droop compensator will engage and automatically bring the operating engine to limited takeoff power to maintain the rotor RPM. If the automatic control systems fail, the engine power setting can be controlled by manual adjustment of the twist grip throttle, the collective pitch, and the engine condition levers to maintain the rotor RPM.

A. Twist Grip Throttle/Collective Control. With the throttle turned to the full left position and the collective stick in the full down position, the engines operate at ground idle. An idle stop is incorporated in the throttle linkage to prevent inadvertent throttle closure. Rotating the throttle control to the full open (right) position allows the engine fuel control systems to maintain constant main rotor RPM. With full right throttle and the collective full down, the engines operate at flight idle. Higher power settings are controlled by increasing the collective pitch. At main rotor pitch of 12° and higher, the engines operate at limited takeoff power, with maximum fuel flow controlled by the engine governor and gas temperature limiter.

B. Engine Condition Levers. The ECLs vary the N_1 control lever (throttle) settings from minimum to maximum power separately for each engine. They are used to control the engine power setting during ground testing and in special flight conditions, such as failure of one engine. The normal position of the ECLs is in the center detents. The engines can be brought to takeoff power by moving the engine condition levers to the maximum settings.

2-20 Engine Power Synchronizers

The engine fuel controls are linked by power synchronizers to balance joint engine operation. The power synchronizers measure and compare the compressor delivery pressure of both engines. The engine with the lower delivery pressure (the driven engine) receives an increase in fuel flow which increases the N_1 RPM. This action also causes an increase in the N_1 RPM of the engine with the higher compressor delivery pressure (the driving engine). The droop compensator of the driving engine then reduces the fuel flow and thus, the RPM of the driving engine. The power synchronizers and droop compensators of both engines counterbalance each other until the compressor delivery pressure of both engines is equal. The power synchronizer only affects the fuel flow of the driven engine, while the droop compensator affects the driving engine. If the main rotor RPM surges above 107%, the synchronizer cutoff valve in the engine fuel control disconnects the power synchronizer of the driven engine. The driven engine drops to flight idle, while the driving engine continues to operate at maximum power. To adjust and maintain the correct M/R RPM if the power synchronizer is disengaged, the pilot must manually adjust the collective pitch, twist grip throttle control, or ECL.

2-21 Engine Oil System

The engine oil system provides lubrication, cooling, and ventilation of the engine support bearings, drives, gears, and other moving parts of the engine. Each engine has an independent, self-contained oil system.

2-21.1 Description

The engine oil system is entirely automatic in its operation. The system includes an oil tank with deaeration provisions and sight gauge, breather and vent lines, oil cooler with an inlet chip detector, pressure transmitter, pressure sensor, pressure-

activated relief and cutoff valves, filters, and lines. Drain valves are provided for draining the oil tank and cooler. Pressure for engine lubrication and scavenging of return oil is provided by an integrated oil delivery and scavenge pump unit with pressure regulating and shutoff valves, and by a separate pump which scavenges oil from the engine accessory drive. Tank capacity and oil grades are included in Section XV of this Chapter.

2-21.2 Oil Cooling System

Engine oil cooling is accomplished by an oil cooler with a thermally-activated bypass valve. Hot oil is supplied to the oil cooler from the scavenge section of the oil pump unit. Cooled oil is returned to the oil. If the temperature of the oil scavenged from the engine is below 50°C (122°F), the thermal bypass valve opens and the oil is diverted directly to the return line. Air circulation for oil cooling is supplied by a turbine fan that is driven by the main transmission. The fan is powered at all times when the engine is operating and no additional control is required.

2-22 Ignition - Starting System

The engine and APU start control panel is located on the pilot's lower left rear side wall panel (see Figure 2-13). The ignition system is powered with 27 VDC from Battery Bus II through the AUTO-START and IGNITION circuit breakers on the left circuit breaker panel.

A. Engine Start Cycle. To start the engine, the APU must be operating at normal RPM, the main rotor brake lever full down (disengaged), the engine condition lever centered, throttle full left, collective full down, and the fuel shutoff lever full forward (OPEN). Set the MODE selector on the engine start control panel to the START position and set the ENGINE selector to correspond with the engine being started (LH or RH). Engage the start control program by pressing the START button on the panel. The engine start control box signals the air starter solenoid valve to open. The APU starts supplying compressed air to the air starter turbine and the air starter and compressor rotor begin to rotate. Fuel begins to flow into the start fuel manifold when N_1 RPM is between 15 and 20%. Five seconds after pressing the START button, the ignition exciter begins to function, causing the igniter to fire. After the fuel-air mixture in the combustion chamber ignites, the N_1 RPM and

compressor delivery pressure increase rapidly. When N_1 RPM reaches 60 to 65%, the starter shutoff microswitch contacts open, shutting off the air starter. If the engine has not attained an N_1 RPM of 60% within 55 seconds, the starting cycle is automatically aborted.

CAUTION

Do not start the engines with the APU operating in DC generator mode (APU GEN caution light on pilot's right console illuminated). Damage to the APU may result.

B. Aborting the Start Cycle. The start cycle can be aborted manually at any time by pressing the ABORT START button on the engine start control panel.

C. Cranking Cycle. If the start cycle is aborted, a cranking cycle is required to evacuate excess fuel from the combustion chamber before attempting to start the engine again. The APU must be operating to perform a cranking cycle. The fuelboost pumps should be off, the fuel valves closed, and the engine fuel shutoff lever closed during the cranking cycle. A cranking cycle is performed by setting the MODE selector to the CRANK position and pressing the START button. The cranking cycle is also used during maintenance operations to test the starter RPM and check proper operation of the start control box. During a cranking cycle, voltage is not applied to the ignition circuits.

D. False Start. The false start cycle is used for checking fuel flow during the start cycle and for engine preservation and depreservation operations. The APU must be operating to perform a false start. The service cell fuel boost pumps should be on, the fuel valves open, and the engine fuel shutoff lever open during the false start cycle. A false start cycle is performed by setting the MODE selector to the CRANK position and pressing the START button. A cranking cycle must be performed after a false start to evacuate excess fuel from the combustion chamber before attempting an actual engine start. The ignition circuits remain without power during the false start cycle.

E. Ignition Test. Provision is made in the engine start control circuits to allow testing of the ignition exciter and igniter plugs without starting the APU or feeding fuel to the combustion chamber. The

IGNITION TEST switch on the engine start control panel is used for this purpose. Normal position of the switch is in the center (off) position. When the switch is set to LEFT ENG (up) or RIGHT ENG (down) position, voltage is applied to the ignition exciter arid plugs when the START button is pressed. The ignition check is performed with an external DC power source connected to the helicopter mains.

2-23 Engine Trim Control

The engine control system includes a manual adjustment for N_2 RPM. The pilot introduces trim changes with the INCR-DECR switch on the collective stick. The switch is a three-position type and is held in the INCR (up) position to increase the power turbine speed or down to the DECR position to decrease the power turbine speed. The trim adjustment range is up to 15%. The engine condition levers and manual trim control are used to control the engines during engine testing and during special flight conditions (such as failure of one engine).

2-24 Engine Instruments and Indicators

The engine instruments and indicators are mounted on the pilot's instrument panel and right front console (see Figures 2-11 and 2-19). A limited set of redundant monitoring instruments are mounted in the CPG compartment (see Figures 2-27 and 2-31).

2-24.1 Engine Pressure Ratio (EPR) Indicator

The engine pressure ratio indicator is used to monitor the engine power settings. The indicator displays the limited takeoff (or takeoff), nominal, and cruise power settings of the engines. It is located in the bottom center area of the pilot's instrument panel (see Figure 2-11). The indicator is connected to a pair of pressure tubes, an altitude sensor, and a outside air temperature probe. The readout is based on measurement of the engine compressor delivery pressure. The power setting is determined by comparing the compressor delivery pressure pointers on the side indices (one for each engine, LH and RH) with the power setting pointers displayed in the center scale. The position of the center scale is proportional to the atmospheric pressure and ambient temperature. The center pointer marks, O (or B), H, and K, correspond to limited takeoff (or takeoff), nominal, and cruise

power settings, respectively. The indicator set is powered by 27 VDC from Battery bus II.

2-24.2 Power Turbine Inlet Temperature Gauge

The power turbine inlet temperature (PTIT) gauge (2IA-6) is located in the lower center area of the pilot's instrument panel. The indicator receives temperature indications from the thermocouple probes mounted on the engine power turbine housings. The gauge has two scales for each engine. The large scales read in hundreds of degrees; the small scales read in 5 degree increments. The temperature indications are in degrees centigrade. The gauge set is powered by the 115 VAC Inverter Bus and 27 VDC from Battery bus II. HOT and COLD test buttons, located on the pilot's left front console are used to confirm proper operation of the gauge. With the engines shut down, the needles should move to 950 to 1270° when the COLD button is pressed. The needles should return to zero when the COLD button is released. With the engines running, the needles should move to between 0 and 60° when the HOT button is pressed and return to the actual PTIT readings when it is released.

NOTE

F There are RH and LH ENG HIGH TEMP caution lights located on the pilot's master caution panel on Mi-24F/Mi-35 helicopters. The lights should illuminate during the PTIT COLD test.

2-24.3 Dual Tachometer

A dual tachometer (ITE-2T) is used to simultaneously monitor N_1 RPM of both engines. Rotational speed is expressed as a percentage of maximum speed. The tachometer is located in the bottom left area of the pilot's instrument panel (see Figure 2-11). A second engine dual tachometer is located on the CPG's left panel (Mi-24/25D/35) or instrument panel (Mi-24F). The tachometers receive power from the tach-generators mounted on the engine accessory drives, one on each engine. Connection to the helicopter electrical system is not required. N_1 split should not exceed 2% at Cruise I and Nominal power settings. With the temperature limiter engaged, N_1 split should not exceed 3% at these power settings. At idle and Cruise II settings,

the N_1 split does not require monitoring. At maximum power settings, the automatic throttle control systems use N_2 RPM to regulate the engine power output. This can result in a wider N_1 split between the engines.

2-24.4 Oil Pressure/Temperature Gauge

The engine oil pressure / temperature gauges, one for each engine, are mounted on the pilot's right front console (see Figure 2-19). The gauges receive temperature indications from oil temperature probes installed in the outlet lines to the oil coolers. Pressure indications are provided by transducers mounted in the oil delivery lines. The gauge has three scales. The upper scale is not used. The lower left scale displays the oil pressure in kgf/cm^2 . The lower right scale displays the oil temperature in degrees centigrade. The gauges and sensors are powered by the 36 VAC (DIM) Bus through two fuses in the 115/36 VAC distribution box, and with 27 VDC, through a 2 amp fuse, from Battery bus II.

2-24.5 Engine Chip Detector Caution Light

A magnetic chip detector / filter is installed at the oil cooler inlet. If sufficient metal particles accumulate on the magnets to close the circuit, the LEFT or RIGHT ENGINE CHIP light illuminates. The circuit receives 27 VDC power from the Battery bus via a fuse on the right fuse panel.

NOTE

On some Mi-24/25 helicopters, a RESET CHIP LIGHTS button is located on the pilot's instrument panel near the engine and transmission chip warning lights. The button clears the CHIP signal and shuts off the warning light. The button is to used reset the system after testing the chip detector circuits.

2-24.6 Engine Vibration Monitor Warning Lights

The engine vibration monitor activates the caution and warning lights on the pilot's master caution panel if the vibration increases significantly or reaches a critical level. If the level of vibration reaches 45 mm/sec (1.8 in/sec), the system illuminates the yellow caution light labeled LEFT

(or RIGHT) ENG HIGH VIBRATION. It also sends a signal to the audio warning system which transmits an audio warning over the foreign intercom system. If the level of vibration reaches 60 mm/sec (2.4 in/sec), it illuminates the red warning light labeled SHUT OFF LEFT (or RIGHT) ENG and sends a signal to be recorded by the flight parameter recorder. The vibration monitor system includes a built-in test circuit. When the ENGINE VIBE TEST button in the upper area of the pilot's right console is pressed all four caution/warning lights must illuminate. The vibration monitor system is powered with 115 VAC power from the 115 VAC Inverter bus through a fuse in the 115/36 VAC distribution box. The lights are powered with 27 VDC from BATTERY bus II thru a fuse on the right fuse panel.

2-24.7 Particle Separator Caution Lights

The LH and RH PARTICAL SEPARATOR ON caution lights on the pilot's master caution panel illuminate when the engine particle separator systems are engaged.

2-24.8 Engine Anti-ice Caution Lights

The LH and RH ENG HEAT ON and LH and RH PART SEP HEAT ON caution lights on the pilot's right console illuminate when the engine and particle separator anti-ice systems are engaged.

2-24.9 Temperature Limiter Caution Lights

The LH and RH ENG TEMP LIMITER WORKING caution lights on the pilot's right front console illuminate when an overtemp condition exists and the temperature limiter is trimming the fuel flow to correct the condition.

2-24.10 Engine Governor Indicator Lights

The ENG GOV ON and ENG GOV OFF lights are located on the pilots right front console (Figure 2-19). The lights are controlled by the SYSTEM POWER switches on the engine governor control panel. The control panel (Figure 2-34) is used to operate and test the compressor (N_1) overspeed limiters, engine temperature limiters, and power turbine (N_2) overspeed circuits. The panel is mounted in the cargo cabin on the left forward bulkhead and must be monitored by the crew chef. The T° LIMIT/HIGH N_1 caution lights on the control panel and the LH and RH ENG TEMP

LIMITER WORKING caution lights on the pilot's right front console illuminate when an overtemp and/or N_1 overspeed condition exists and the temp limiter or engine governor is trimming the fuel flow to correct the condition. The HIGH N_2 RPM warning lights on the control panel illuminate when the N_2 loop detects an overspeed condition on one channel. If the second channel also detects an overspeed condition, the governor causes the engine to shut down. Power for the engine governor is provided by the Generator buses (208 VAC 3-phase), via three circuit breakers in the radio compartment, and 27 VDC from Battery bus II via the ENG TEMP LIMITER and RPM GOVERNOR circuit breaker on the right cb panel.

2-24.11 Engine Start Control Panel Indicators

The engine start control panel, located on the pilot's lower left rear side panel (see Figure 2-13), contains indicator lights that allow the pilot to monitor the engine start cycle. The AUTO START light illuminates to advise that the start cycle is in progress. It is controlled by the engine start control box. The STARTER WORKING light illuminates when sufficient air pressure is delivered to the engine starter. The light is connected to a pressure transmitter in the starter.

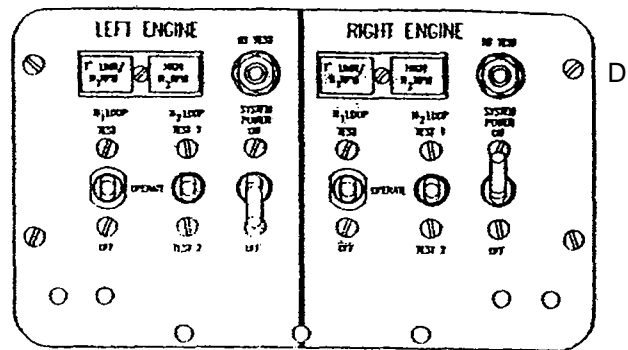


Figure 2-34 Engine Governor Control Panel

2-24.12 Engine Fuel Supply Caution Lights

The LEFT and RIGHT ENG FIRE VALVE CLOSED caution lights are located on the top center area of the pilot's left side wall panel (see Figure 2-14). The lights are controlled by the fire valve solenoids. They illuminate to advise the pilot that the fuel supply to the main engines is cut off. The fire valves can be closed manually using the covered switches on the fuel system control panel.

2-24.13 Engine Fire Warning Lights

The FIRE IN LEFT (RIGHT) ENG COMPARTMENT warning lights on the fire protection panel (see Figure 2-16) illuminate when a fire is detected in the corresponding compartment. The FIRE warning light on the pilot's instrument panel will also illuminate. The lights are controlled by the fire detection system. If the automatic fire extinguishing system fails to activate, or if the fire starts again, the pilot can manually activate the system by pressing the primary (bottle 1) or reserve (bottle 2) button located below the corresponding compartment fire warning light.

Section IV Helicopter Fuel System

2-25 Fuel Supply System

The helicopter fuel system includes five internal fuel cells, optional auxiliary tanks, submerged boost pumps, fuel measuring equipment, valves, low level transmitters, fuel lines and transfer tubing, drain and vent lines, and controls. The Mi-24/25D helicopter has a fuel capacity of 2130 liters (562 gal). The addition of two internal auxiliary tanks increases the maximum fuel capacity to 3830 liters (1011 gal). The Mi-35/Mi-24F helicopter has a fuel capacity of 2055 liters (543 gal). It is equipped to carry two or four external auxiliary tanks on the wing pylons. The maximum fuel capacity with four auxiliary wing tanks is 3955 liters (1045 gal).

NOTE

The internal fuel cells are identical on the Mi-24/25D and Mi-35/Mi-24F models. The reduced capacity of the Mi-35/Mi-24F is due to the fire suppression foam blocks mounted in the fuel cells. The Mi-24/25D uses a CO₂ gas inerting system for fire suppression.

2-26 Fuel System Controls

The fuel supply system controls are located on the fuel system control panel. The panel is located in the top center area of the pilot's left side wall (see Figures 2-14 and 2-24). The panel contains controls for the fuel valves and boost pumps.

2-26.1 Fire Valve Switches and Indicator Lights

The LEFT and RIGHT FIRE VALVE switches control operation of the engine fire valves. The switches are protected from accidental operation by spring-loaded red covers that must be pulled up before switch movement can be effected. When the switches are in the OPEN (up) position, the fire valves open and fuel flows to the engines. If the fire valves are closed the LEFT and RIGHT ENG FIRE VALVE CLOSED caution lights located above the switches will illuminate. The fire valves receive 27 VDC power from Battery Bus I (left) and Battery Bus II (right) via the VALVES SHUTOFF LEFT and SHUTOFF RIGHT circuit breakers on the left and right cb panels.

2-26.2 Service Cell Shutoff Valve Switches/Lights

The No. 1 and No. 2 service fuel cells have individual shutoff valves in the transfer line inlets. The valves must be open to allow transfer of fuel from the lower cells to the service cells. The valves are controlled by the SERVICE CELL No. 1 and No. 2 VALVES switches on the fuel system control panel. The valves open when the switches are set to the OPEN (up) positions. If the valves are closed, the yellow SVC CELL No. 1 and No. 2 caution lights will illuminate. The lights are located above the switches. The service cell shutoff valves receive 27 VDC power from Battery Bus I (cell No. 1) and Battery Bus II (cell No. 2) via the VALVES CELL 1 and CELL 2 circuit breakers on the left and right cb panels.

2-26.3 Inter-Tank Shutoff Valve Switch/Light

A shutoff valve is mounted in the cross-feed line between lower cells No. 4 and 5. The valve must be open during refueling and normal fuel system operations. The valve can be closed manually if damage to one of the lower cells is suspected. The INTER-TANK No. 4/5 VALVE switch controls the valve. When the switch is in the OPEN (up) position the valve opens and fuel flows freely between the two lower cells. The INTER-TANK VALVE OPEN indicator light illuminates when the valve is open. The inter-tank shutoff valve receives 27 VDC power from Battery Bus I via the VALVES INTER-TANK circuit breaker on the left cb panels.

2-26.4 Fuel Boost Pump Switches/Lights

The CELL No. 4, CELL No. 5, and SERVICE CELL No. 1 and No. 2 PUMP switches are located on the right side of the fuel system control panel. The switches control operation of the submerged boost pumps in the service cells and lower cells. When the switches are set to the ON (up) positions, the boost pumps begin to transfer fuel from the cells. The pumps shut off automatically when the fuel is expended. The CELL No. 4, CELL No. 5, and SVC CELL No. 1 and No. 2 PUMP WORKING lights illuminate when there is pressure in the outlet lines from the pumps. The lights are controlled by fuel pressure switches installed in the outlet lines. Fuel from cells No. 4 and 5 is pumped to the service cells. Fuel from the service cells is pumped to the APU and engine supply lines. Check valves installed in

the engine and APU supply lines prevent backflow of fuel and allow the engines and APU to be supplied with fuel from either service cell. The fuel pumps receive 27 VDC power from Rectifier bus I (cells No. 1 and 5) and Rectifier Bus II (cells No. 2 and 4) via the FUEL PUMPS CELL 1 and CELL 5 circuit breakers on the left cb panel and the FUEL PUMPS CELL 2 and CELL 4 circuit breakers on the right cb panel.

2-26.5 Fuel Quantity Gauge

The fuel quantity gauge is located in the lower right corner of the pilot's instrument panel (see Figure 2-11). The gauge continuously indicates the quantity of fuel in the selected cell group in liters. The selector is located on the upper left corner of the pilot's right front console (see Figure 2-19). The fuel gauge is connected to the fuel sensors installed in the individual fuel cells. The fuel gauge receives 27 VDC power from Battery Bus II via the FUEL GAUGE circuit breaker on the right cb panel and 115 VAC from the 115 VAC Inverter Bus. The gauge has three indicator scales. The selector position controls the active scale. The scale indications must be multiplied by 100 liters to obtain the correct quantity of fuel in the cell group.

- External outer scale - displays the combined quantity of fuel in cells No. 1, 2, 3, 4, and 5 when the selector is set to the TOTAL (far left) position.
- External inside scale - displays the quantity of fuel in each cell individually when the selector is set to the 1, 2, or 3 positions.
- Inner scale - displays the combined fuel quantity in cells No. 4 and 5 when the selector is set to the 4+5 position; displays the quantity of fuel in internal aux tank No. 6 when the selector is set to the AUX 1 position or internal aux tank No. 7 when the selector is set to the AUX 2 position.

NOTE

F On Mi-35/Mi-24F helicopters, cell No. 3 and the auxiliary wing tanks are not equipped with fuel sensors. The external outer scale displays the combined fuel quantity in cells No. 1, 2, 4, and 5 with the selector set to the TOTAL position. The 3 position and AUX 1 and AUX 2 positions on the selector are not used.

2-26.6 Low Fuel Warning Lights

The SVC CELL No. 1 120 L and SVC CELL No. 2 120 L warning lights are located in the upper left area of the pilot's instrument panel (see Figure 2-11). The lights illuminate when the low level transmitters in the service fuel cells activate. The transmitters are integrated with the fuel sensors. The low level transmitter activates when there is 120 liters (32 gal) of fuel remaining in the cell.

2-27 Auxiliary Fuel System **D**

The Mi-24/25D can carry one or two 850 liter (224.5 gal) auxiliary tanks in the cargo compartment for extended distance and ferry missions. The auxiliary tank kit contains all required hardware, transfer tubing, fittings, vent lines, and fuel sensors. Auxiliary tank fuel sensor-simulators are installed in the helicopter when the auxiliary tanks are not installed. Fuel from the auxiliary tanks flows by gravity into lower cells No. 4 and 5 as the fuel in the lower cells is expended.

2-28 Auxiliary Wing Tanks **F**

The Mi-35/Mi-24F helicopter can carry two or four 475 liter (125.5 gal) external auxiliary tanks on the wing pylon supports for extended distance. The external auxiliary tank kit contains all required hardware, lines, and fittings. The external wing tanks are not equipped with fuel sensors. The fuel transfer and vent lines, pump, controls, and indicators are part of the permanent fuel system installation.

2-28.1 Wing Tank Pumps Switch **F**

The wing tank transfer pumps are controlled by the WING TANK PUMPS switch on the fuel system control panel (see Figure 2-24). When the switch is set to the ON (up) position, fuel from the wing tanks is transferred into cell No. 3. A float valve in cell No. 3 prevents overfilling.

2-28.2 Wing Tanks Expended Indicator light **F**

Where the fuel in the wing tanks has been expended, the yellow WING TANKS EMPTY light on the fuel system control panel illuminates. The light is controlled by a fuel level transmitter installed in

cell No. 3. The transmitter activates when approximately 150 liters (40 gal) has been expended from cell No. 3. When the WING TANKS EMPTY light illuminates, the pilot must shut off the WING TANK PUMPS switch. The switch is located below the light.

2-28.3 Wing Tanks Jettison Circuit **F**

The wing tanks can be jettisoned in an emergency using the external stores jettison system. Either the pilot or the CPG can jettison the tanks. The external stores jettison system is described in Chapter 4, Section II.

Section V Flight Controls

2-29 Flight Control Systems

The helicopter is equipped with lateral longitudinal, collective pitch, and directional flight, control subsystems. Control inputs are transferred from the cockpit to the rotor blades by mechanical linkages and hydraulic servos. Pilot control is assisted by an automatic flight control system (AFCS) with an integrated four channel autopilot, the hydraulic flight control servos, and pitch and roll trim systems. Both the pilot and CPG have collective, cyclic, and direction controls, which are routed separately to the primary input mixing unit (Figure 2-35). Outputs from the mixing unit are carried by mechanical linkage to the first and second stage control units which combine, sum, and couple the cyclic, collective, and yaw inputs. Resultant output signals are boosted and routed to the main and tail rotors and synch elevators through mechanical linkages with the hydraulic servos. Flight controls in the CPG compartment are designed to allow the CPG to fly and land the helicopter in an emergency.

2-29.1 Engagement of CPG's Controls

The CPG's flight controls can be engaged by pressing the trigger lever on the CPG's collective stick. The CPG's cyclic stick and pedals will then move under hydraulic pressure into the active positions corresponding to the positions of the pilot's controls. When the CPG's controls are active the CONTROLS TO CPG caution light on the left side of the pilot's instrument panel will illuminate. The light is controlled by a microswitch in the hydraulic extension rods which lock the CPG's

controls into the active positions. The CPG can manually engage the controls in the event of electrical failure by working the cyclic until it engages in the active position.

2-29.2 Disengagement of CPG's Controls

The CONTROL DISENGAGE button on the left side of the CPG's cyclic grip disconnects the CPG's controls from the primary control system. After pressing the button, the CPG's cyclic stick may be tilted forward and to the right into the stowed position. The pilot can disengage the CPG's controls using the ASSUME CONTROLS switch in the upper left area of the pilot's instrument panel. The switch is protected by a red cover to prevent inadvertent operation. The normal position of the switch is UP. To assume the controls, the cover must be lifted and the switch set to the ASSUME CONTROLS position (down). The pilot can manually disengage the CPG's controls in case of electrical system failure by applying a force of 55 to 77 lb to the cyclic stick in the cockpit.

2-30 Cyclic Control System

Lateral and longitudinal control of the helicopter is by movement of the cyclic sticks through push rods bellcranks, and servos to the main rotor swash plate. Movement in any direction tilts the plane of the main rotor blades in the same direction, thereby causing the helicopter to move in that direction.

2-30.1 Pilot's Cyclic Stick

The pilot's cyclic stick is mounted directly on the primary input mixing unit (Figure 2-35). The grip (7) includes a wheel brake lever (2) and lock (9), a three position ICS/ RADIO button (3), a TRIM DISENGAGE button (6), an eight position trim control (4), an AUTOPILOT DISENGAGE button (8), and a weapons FIRE button (5). The FIRE button has a guard (10) to prevent accidental activation.

2-30.2 CPG's Cyclic Stick

The CPG's cyclic stick is similar to the pilot's cyclic stick. Under normal conditions, the CPG's cyclic stick is disconnected from the primary control system and fastened in the stowed position. The CPG's cyclic grip includes a CONTROL DISENGAGE button, a three position ICS/ RADIO button, a TRIM DISENGAGE button, an eight position trim control, and covered weapons FIRE button. The CPG's cyclic does not have a wheel brake control lever.

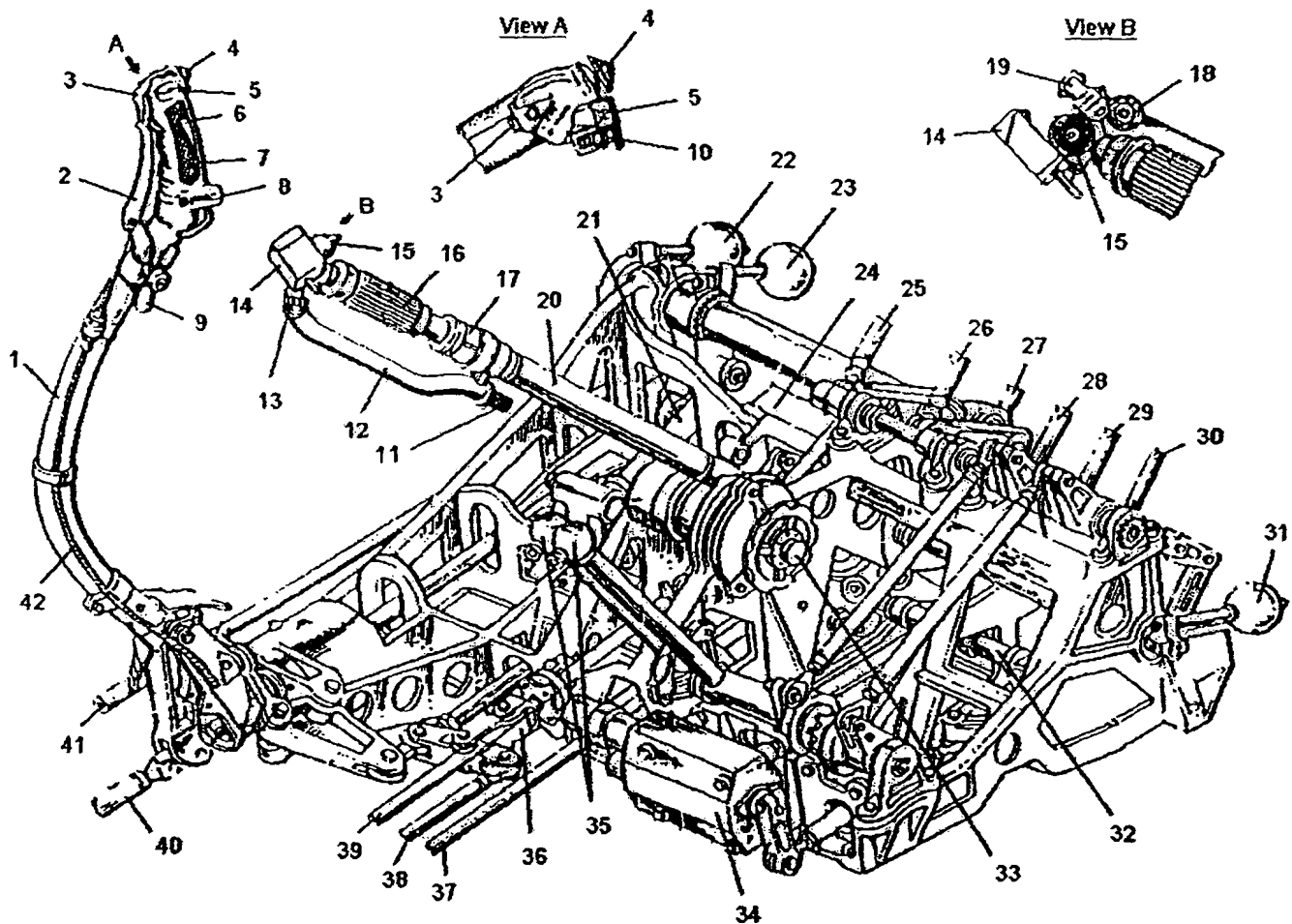


Figure 2-35 Primary Input Mixing Unit

1. Cyclic stick
2. Wheel brake lever
3. ICS/RADIO keying button
4. Trim control (8 position)
5. FIRE button
6. Trim button
7. Grip
8. AUTOPILOT OFF button
9. Brake lever lock
10. Guard
11. Wire bundle
12. Button housing
13. EXT CARGO emergency release
14. Engine trim INCR-DECR switch

15. Searchlight control
16. Twist-grip throttle
17. Friction clutch nut
18. Clutch release button
19. EXT CARGO normal release
20. Collective stick
21. Longitudinal artificial stress spring
22. Directional counterweight
23. Longitudinal counterweight
24. Longitudinal force gradient
25. Longitudinal control rod
26. Directional control rod
27. Collective pitch control rod
28. Lateral control rod

29. LH engine control rod
30. RH engine control rod
31. Engine control counterweight
32. Lateral artificial stress spring
33. Clutch adjustment wheel
34. Lateral force gradient
35. Engine condition levers (ECLs)
36. CFGs lateral control coupling
37. Collective pitch control rod
38. Lateral control rod
39. Engine control rod
40. Longitudinal control rod
41. Directional control rod
42. Wheel brake cable

2-31 Collective Pitch Control System

The collective pitch control system includes integrated throttle, main rotor collective pitch, and synch elevator control linkages. The collective inputs raise or lower the swashplate slide. This changes the pitch of the main rotor blades, causing an increase or decrease in lift on the entire rotor disc. The collective input also changes the lead angle of the synch elevator. When the collective stick is moved upward, main rotor collective pitch increases. At the same time, the engines increase to a higher power setting and the synch elevator lead angle increases. When the collective stick is moved downward, main rotor pitch, engine power, and synch elevator lead angle decreases. The collective control inputs reach the main engine throttle controls via a series of bellcranks and push rods. The collective inputs to the main rotor swashplate are routed via bellcranks and push rods to the collective flight control servo and collective lever/rocker. The control inputs are routed from the servo to the synch elevator via a system of cables, pulleys, and worm gears.

2-31.1 Pilot's Collective Stick.

The pilot's collective stick is mounted on the primary input mixing unit (Figure 2-35). The stick (20) includes the twist-grip throttle control (16) with friction adjustment (17), covered control buttons for external cargo emergency jettison (13) and normal release (19), a spring-loaded N₂ trim INCR-DECR switch (14), a searchlight control button (15), and a CLUTCH RELEASE button (18). A hydraulic clutch holds the stick securely in any position, allowing the pilot to make smooth pitch adjustments and preventing the stick from creeping. Ordinarily, the clutch is adjusted manually using the handwheel (33) to allow the stick to be moved, without releasing the clutch, with a force of 45 to 55 lb. The CLUTCH RELEASE button activates the hydraulic release system, allowing the stick to be moved with a force no greater than 3.3 lb. When the button is released, the clutch re-engages. The clutch release circuit is powered by 27 VDC from Battery Bus I via the COLLECT CLUTCH circuit breaker on the right cb panel.

2-31.2 CPG's Collective Stick

The CPG's collective stick (Figure 2-36) is located to the left of the CPG seat. It includes a twist grip throttle control (1), a covered external cargo emergency jettison button (17), a searchlight control button (18), a CLUTCH RELEASE button (19), and a trigger lever (16) for engaging the CPG's flight controls. The trigger lever is linked via a cable system to the CPG's cyclic stick and pedals.

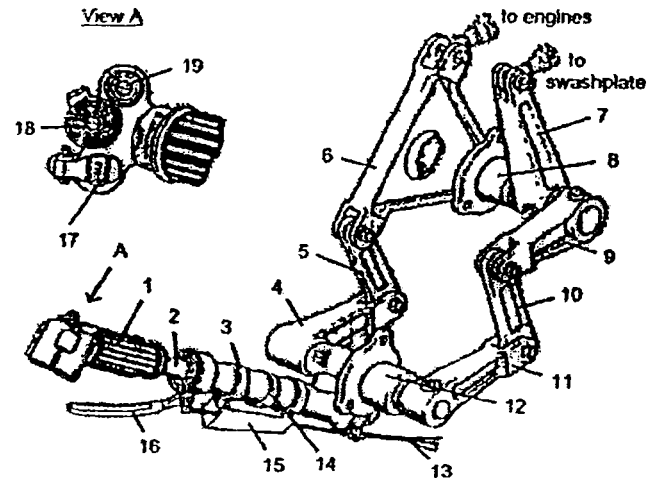


Figure 2-36 CPG's Collective Stick

- | | |
|------------------------|----------------------------------|
| 1. Twist grip throttle | 11. Lever |
| 2. Shaft | 12. Bracket |
| 3. Housing | 13. Cables |
| 4. Bellcrank | 14. Microswitch |
| 5. Rod | 15. Cover |
| 6. Bellcrank | 16. Trigger lever |
| 7. Lever | 17. EXT CARGO emergency jettison |
| 8. Bracket | 18. Searchlight control |
| 9. Lever | 19. CLUTCH RELEASE button |
| 10. Rod | |

2-32 Directional Control System

The directional control system is operated by the pilot or CPG pedals. From the pedals to the directional servo, the control linkage consists of a system of push/pull rods and bellcranks. Cables are used to pass control inputs to the tail rotor gearbox. The pitch change mechanism in the gearbox consists of a chain, sprocket, and worm gear, which extends or retracts the pitch control rod. Rod movement is transmitted via the pitch change links to the blade grips, resulting in a change of blade angle. Pushing the left pedal forward causes the pitch control rod to retract. The blade pitch angle decreases and the helicopter turns to the left. Pushing the right pedal forward extends the pitch control rod, increasing the blade pitch angle, and the helicopter turns to the right. Right pedal movement is limited by a moveable stop system which uses air density and

temperature to adjust the maximum tail rotor pitch angle and prevent overloading the tail rotor and drive system. A hydraulic pedal damper is also incorporated in the system to prevent abrupt directional control movements.

2-32.1 Pilot's Control Pedals

The pilot's pedals are mounted on the cockpit floor in front of the seat. Pedal adjusters are provided to adjust the pedal distance for individual comfort. The adjustment range is ± 2 inches. Microswitches are mounted in each sub-pedal assembly to allow the pilot to introduce directional control inputs while the autopilot yaw channel is engaged.

2-32.2 CPG's Control Pedals

The CPG's pedal assembly mounts on a bracket at the front of the compartment floor. Normally, the pedals are left in the stowed position. The pedals automatically move to the active position when the CPG's flight controls are engaged. The pedals are not adjustable. To stow the pedals after the CPG's controls are disengaged, push the pedal assembly outward until it locks into place.

2-32.3 Pedal Damper

A hydraulic pedal damper is incorporated in the directional control system to dampen abrupt pedal inputs. Abrupt or rapid pedal movement will activate a pressure transmitter in the damper cylinder and illuminate the HIGH PEDAL RATE caution light, located on the tipper left side of the pilot's instrument panel. The damper is located on the first stage control unit. The pilot can disengage the pedal damper if the pedals are too heavy using the covered PEDAL DAMPER switch on the lower left area of the instrument panel. Normal position of the switch is ON (up). When the CPG's flight controls are engaged, the CPG's can disconnect the pedal damper using the covered PEDAL DAMPER switch, located in the top forward area of the CPG's left panel (see Figure 2-27). The pedal damper circuit receives 27 VDC power from Battery Bus I.

NOTE

F The PEDAL DAMPER switch is located in the center area of the CPG's left panel in Mi-24F helicopters (see Figure 2-32).

2-32.4 Tail Rotor Pitch Limit System

The tail rotor pitch limit system is controlled and monitored via the SPUU-52 control panel. The panel is located in the right center area of the pilot's left front console (see Figure 2-18). The main power switch for the system is located to the left of the panel. When the system is disengaged, the red OFF lamp-button on the control panel will illuminate. To engage the system, set the SPUU-52 main power switch to the ON (up) position. The system uses a linear actuator linked to a mechanical stop to adjust the maximum blade pitch angle within a range of 20 to 26°. The adjustment is based on air temperature and density. Increased density results in a decrease in the maximum blade pitch angle. When the system is disengaged, the stop resets to the maximum limit. The system receives 27 VDC power from Rectifier Bus II and Battery Bus I and 36 VAC power from the 36 V 3-phase Buses.

2-33 Force Trim System

Force centering devices are incorporated in the cyclic controls. These devices are installed on the primary input mixing unit (see Figure 2-35). The devices furnish a force gradient or "feel" to the cyclic sticks. The farther the stick is deflected, the more force is applied. A TRIM DISENGAGE button is located on the pilot and CPG cyclic stick grips. Pressing and holding the TRIM DISENGAGE button will immediately reduce the forces on stick to zero. Releasing the button re-engages the trim. The eight position TRIM controls located on both cyclic grips allow for more precise centering of the forces on the cyclic sticks. The force gradients receive 27 VDC power from Battery Bus II via the FORCE TRIM MCU circuit breaker on the right cb panel.

2-34 Automatic Flight Control System

The helicopter is equipped with the SAU-V24-1 automatic flight control system (AFCS). The AFCS stabilizes the helicopter in pitch, heading, roll, altitude, and airspeed. The AFCS also interfaces with the helicopter navigation equipment to hold a selected course, hover point, or altitude above

ground level. The AFCS includes a four-channel autopilot system, a hover-course control panel, an altitude hold control panel, a course selector, a flight computer, a radar altimeter coupler, an airspeed correction unit, and an altitude correction unit. The VUAP-1 autopilot system serves as the executive element of the AFCS. The AFCS receives 27 VDC power from Battery Bus II via the AFCS WARN circuit breaker on the left cb panel. The autopilot receives 27 VDC power from Rectifier Bus I.

WARNING

The AFCS is designed to interact with the No. 1 MGV-1SU vertical gyro, the KZSP airspeed correction unit, the KZP altitude correction unit, the DISS-15 Doppler System, the Greben-1 flight director (course) system, and the RV-5 radar altimeter set. Improper calibration, non-operational status, or absence of signals from interacting systems will limit AFCS capability and may produce system instability.

WARNING

Make sure the autopilot is disengaged when the VERTICAL GYROS selector on the right side of the pilot's instrument panel is set to the No. 2 position. Do not attempt to engage the autopilot or the helicopter may start rocking uncontrollably.

2-35 VUAP-1 Autopilot System

The autopilot system is designed to stabilize control of the helicopter while taxiing, during takeoff, while hovering, in flight, and during landing. Under normal operating conditions, the yaw, pitch, and roll channels are engaged before beginning to taxi and remain engaged throughout the flight and landing. The altitude channel is engaged as needed to maintain the selected barometric altitude. The autopilot system includes separate control panels for yaw, roll, pitch, and barometric altitude; pitch and roll compensation transducers; and yaw and roll rate gyros. The control panels are located at the bottom of the pilot's left front console. The hydraulic flight control servos apply autopilot corrections to the flight control surfaces and provide

feedback signals to the autopilot channels. Autopilot correction signals are limited to a maximum of 18% of control travel for flight safety in the event of false signals or system failure. The pilot may intervene in control at any time while the autopilot is engaged to make manual corrections by operating the flight controls. The autopilot channels are engaged by pressing the green ON lamp-buttons on the front of the control panels. Each channel can operate independently. If the channel is defective or a required input signal is absent, the red OFF lamp-button on the panel will illuminate. Each channel has a zero indicator which shows the relative displacement of the flight control servo spindle. This allows the pilot to easily monitor the amount of correction being applied by each channel.

2-35.1 Yaw Channel Operation

The yaw channel receives signals proportional to the current heading from the flight director system and rate of turn signals from the yaw rate gyro. The yaw channel output signals are sent to the directional flight control servo. If the pilot's feet are not on the pedals, the autopilot maintains the preset yaw angle, switching the directional flight control servo to displacement mode as needed to introduce large corrections. The speed of pedal movement in displacement mode is controlled by the hydraulic pedal damper in the directional control system. The yaw channel includes a relay which prevents the servo from switching to displacement mode if the pedal damper is disengaged. When the pilot's feet are on the pedals, the sub-pedal microswitches activate and the yaw channel operates in stabilization mode. The yaw rate signal passes through a low-pass filter to prevent the servo from drifting to the stops while executing manual turns with the yaw channel engaged.

2-35.2 Roll Channel Operation

The roll channel receives signals proportional to the angle of roll from the No. 1 vertical gyro, rate of roll signals from the roll rate gyro, and signals equal to the inverse of the cyclic stick's lateral deflection from the roll compensation transducer. When the TRIM DISENGAGE button on the cyclic is pressed, the output signal from the roll channel and the roll compensation transducer signal are reset to zero. The output signals from the roll control panel are sent to the lateral flight control servo.

2-35.3 Pitch Channel Operation

The pitch channel receives signals proportional to the angle and rate of pitch from the No. 1 vertical gyro and signals equal to the inverse of the cyclic stick's longitudinal deflection from the pitch compensation transducer. The signal from the pitch compensation transducer serves to reset the channel to the new pitch setting when the pilot moves the cyclic stick and to stabilize abrupt movements. When the TRIM DISENGAGE button on the cyclic is pressed, both the output signal from the roll channel and the signal from the pitch compensation transducer are reset to zero. When the AFCS speed hold mode is engaged, the pitch channel receives correction signals from the KZSP airspeed correction unit. The output signals from the PITCH control panel are sent to the longitudinal flight control servo.

2-35.4 Altitude Channel Operation

The altitude channel receives correction signals from the KZV altitude correction unit and sends its output signal to the collective flight control servo to maintain the selected barometric altitude. When the CLUTCH RELEASE button on the collective stick is pressed, the altitude channel disengages automatically.

2-36 Hover-Course Control Panel

The hover-course control panel is located in the center right area of the pilot's left front console (Figure 2-18). The panel is used to engage and disengage the APS hover and course control modes. Operational status is indicated by three lamp-buttons on the front of the panel. The green HOVER lamp-button or green COURSE lamp-button will illuminate when the either the hover or course mode is engaged and the system is working properly. The hover and course control modes cannot be engaged at the same time. The red OFF lamp-button will illuminate if the system is defective or a required input signal is absent.

2-36.1 Hover Control Mode Operation

To engage the hover control mode, stabilize the helicopter over the desired hover point, engage the autopilot pitch and roll channels, make sure the Doppler system and RV-5 radar altimeter are engaged and working properly, then press the green HOVER lamp-button, located on the left side of the hover course control panel. If the system is working

properly, the HOVER lamp-button will illuminate. In hover mode, the AFCS flight computer receives lateral and longitudinal ground speed signals from the Doppler system. The computer converts these signals into linear positions and subsequently into pitch and roll correction signals that compensate for deviations. The flight computer sends these signals to the autopilot PITCH and ROLL control panels. The correction signals are limited to a maximum of 5° as a safety measure in case of Doppler system failure. The maximum rate of draft from the assigned point is 15 m/min (49.2 ft/min). To disengage the hover control mode, press the red OFF lamp-button on the hover-course control panel.

2-36.2 Course Control Mode Operation

To engage the course control mode, stabilize the helicopter on the desired course, set the course on the course selector, located above the hover-course control panel and make sure the autopilot roll channel, the Doppler system, and the GREBEN-1 flight director system are engaged and working properly. Set the flight director system to course control mode (ZK), then press the COURSE lamp-button on the hover-course control panel. The Doppler system generates a course deviation signal using the course setting on the course selector, the current drift angle, and the current heading signal from the flight director system. The course deviation signal is sent to the AFCS flight computer. The computer converts the signal to a roll correction signal and sends it to the autopilot ROLL channel for execution. The correction signal is limited to a maximum value of 15° as a safety measure in the event of failure of the Doppler system. To disengage the course control mode, press the red OFF lamp-button on the hover-course control panel.

2-37 Altitude Hold Mode Operation

The altitude hold control panel is mounted in the pilot's front left console below the Hover-Course control panel. The panel is used to engage and disengage the AFCS altitude hold mode. The AFCS altitude hold mode maintains the helicopter at a selected altitude above ground level (AGL) using input signals from the Doppler system and RV-5 radar altimeter. To engage the altitude hold mode, stabilize the helicopter at the desired altitude AGL, make sure the autopilot altitude channel, the RV-5 radar altimeter, and Doppler system are engaged and operating properly, then press the ALTITUDE ON lamp-button on the altitude hold control panel.

Engagement is signaled by illumination of the green ALTITUDE ON lamp-button. Loss of power or a problem with an interacting system signaled by illumination of the red OFF lamp-button. In altitude hold mode, the AFCS radar altimeter coupler receives signals proportional to the altitude AGL from the RV-5 radar altimeter and the vertical speed component signals from the Doppler system. The coupler unit converts these inputs into an altitude correction signal which it sends to the autopilot altitude channel for execution. To disengage the altitude hold mode, press the red OFF lamp-button on the altitude hold control panel.

2-38 Airspeed Hold Mode Operation

The airspeed hold ON and OFF buttons are

located on the pilot's left front console, above the hover-course control panel. To engage the airspeed hold mode, make sure the autopilot pitch channel is engaged, stabilize the helicopter at the desired airspeed, then press the AIRSPEED ON button. The SPEED HOLD indicator light on the pilot's instrument panel will illuminate if the system is working properly. To maintain the preset airspeed, the AFCS uses the airspeed deviation signal from the KZSP airspeed correction unit. The correction signal is sent to the autopilot pitch channel for execution. To disengage the airspeed hold mode, press the AIR SPEED OFF button. The SPEED HOLD indicator light on the pilot's instrument panel will go off.

Section, VI Hydraulic and Pneumatic Systems

2-39 Hydraulic Systems

The hydraulic systems include main, backup, and utility systems. The main and backup hydraulic systems are used to minimize the force required by the pilot to move the cyclic, collective, and pedal controls. The utility system provides power for retraction and extension of the landing gear. The electrical circuits of the main, backup, and utility systems are connected to BATTERY Bus I, the BATTERY Bus, and BATTERY Bus II, respectively.

2-40 Main Hydraulic System

The main system provides hydraulic power to the cyclic controls, the collective controls, the pedal controls, the collective lever clutch release, and the autopilot switching valves. The main system can be used to extend the landing gear if the utility system fails. The main and backup hydraulic systems use a common AGS-60A hydraulic block with separate internal reservoirs and accumulators. The main system pump is mounted on the transmission's left power takeoff drive housing.

2-41 Backup Hydraulic System

The backup system includes duplicate components and lines for all main system functions, except the collective clutch release cylinder. If the main system malfunctions, the backup system is activated automatically. The backup system cannot be used to extend the landing gear. The backup

system pump is mounted on the transmission's right power takeoff drive housing.

2-42 Utility Hydraulic System

The utility system provides retraction and extension of the landing gear, power for the hydraulic pedal damper, engagement and release of the CPG's cyclic stick, and control of the missile guidance instrument hatches. The utility system uses an independent BC-13-1 hydraulic block and a separate accumulator. The utility system pump is mounted on the transmission's right power takeoff drive housing.

2-43 Hydraulic Pressure Gauges

The UTILITY, MAIN, and BACKUP system hydraulic pressure gauges are located in the upper area of the pilot's left front console (see Figure 2-17). The gauges receive signals from pressure sensors mounted in the hydraulic blocks. The gauges and sensors receive power from the 36 VAC single-phase bus. The gauges display the system pressure in kgf/cm². Scale indications must be multiplied by 10 to obtain the correct pressure reading.

2-44 Main/Backup System Controls

The MAIN - BACKUP SYSTEM selector, located below the main and backup system pressure gauges, allows for testing operation of the backup system on the ground. The normal position of the

switch is the MAIN (left) setting. The switch is protected by a red hinged guard. A covered BACKUP SYS OFF button is located to the right of the backup system gauge. During engine start with the MAIN - BACKUP SYSTEM selector in the MAIN position, the backup system may engage first. This is most likely to occur when the No. 2 engine is started first. The yellow BACKUP SYS ENGAGED caution light illuminates and pressure will build in both systems. To switch to the main system, open the guard and press and hold the BACKUP SYS OFF button until the green MAIN SYS ENGAGED light comes on and the yellow BACKUP SYS ENGAGED caution light goes off.

2-45 Reserve Gear Extension Selector

The LANDING GEAR PRIMARY/RESERVE selector is located below the utility system pressure gauge. It is protected by a red hinged guard. The selector allows the pilot to extend the landing gear using fluid from the main hydraulic system (RESERVE setting) if the utility system fails. The normal position of the selector is the PRIMARY (left) setting.

2-46 Hydraulic System Indicator Lights

There are four hydraulic system indicator lights on the pilot's left front console, located just above the hydraulic pressure gauges.

2-46.1 Main System Indicator Lights

The green MAIN SYS ENGAGED indicator light is located above the main system pressure gauge. It illuminates when the pressure in the main system reaches 55 kgf/cm² (782 PSI). The light is controlled by a pressure transmitter in the main system pressure manifold. If pressure in the main system drops below 50 kgf/cm² (711 PSI), the pressure transmitter turns off MAIN SYS ENGAGED indicator light. The backup system switches from no-load to active operation and a main system failure signal is sent to the audio warning unit and flight data recorder.

2-46.2 Backup System Caution Lights

The backup system operates under no-load conditions when the main system is operating properly. The yellow BACKUP SYS ENGAGED caution light illuminates when the pressure in the

backup system reaches 55 kgf/cm² (782 PSI). The light is controlled by a pressure transmitter installed in the backup pressure manifold. If pressure in the backup system drops below 50 kgf/cm² (711 PSI), the pressure transmitter turns off the BACKUP SYS ENGAGED caution light. A second pair of pressure transmitters, installed in the backup system accumulator and return manifold, controls the red BACKUP SYS FAIL warning light. The light illuminates if pressure in the return manifold drops by more than 0.4 kgf/cm² (6 PSI) or if nitrogen pressure in the backup system accumulator drops below 28 kgf/cm² (398 PSI).

2-46.3 Utility System Fail Warning Light

The red UTILITY SYS FAIL warning light is located above the utility system pressure gauge. The light is controlled by a pressure transmitter installed in the utility system pressure manifold. If pressure in the utility system drops below 55 kgf/cm² (782 PSI), the light illuminates.

2-47 Emergency Gear Extension Valve

If there is no electrical power aboard the helicopter, the pilot can manually open the landing gear extension valves using the manual extension valve installed beneath the pilot's instrument panel on the left side. To make an emergency extension of the landing gear, place the valve in the EXTEND (down) position. There must be pressure in the utility system to use the utility system to use the manual extension valve.

2-48 Pneumatic System

The helicopter pneumatic system supplies compressed air to operate the wheel brakes, the cabin door seals, and the windshield washers. Compressed air is stored at a pressure of 40 to 54 kgf/cm² (566 to 768 PSI) in an air bottle, mounted in the transmission compartment, and in the main landing gear bracing struts. The air bottle and bracing struts are filled in flight by an air compressor, mounted on the main transmission. The air bottle and bracing struts can be serviced on the ground through a charging valve, located on the left side of the fuselage. A pressure gauge is located next to the valve. It takes approximately 20 minutes to recharge the air bottle and bracing struts in flight.

Section VII Drive System

2-49 Transmission

The main transmission (VR-24) is mounted on top of the center fuselage deck. The mounting struts attach at four points to the fuselage. The transmission is basically a reduction gearbox used to transmit power to main rotor, tail rotor and accessories at a reduced RPM. There are freewheeling clutches in the input quills to provide a quick-disconnect of one or both engine in case of a power failure. This allows for safe flight with one engine inoperative and allows the main and tail rotors to rotate in order to accomplish a safe autorotational landing.

A. Tail Rotor Drive. The tail rotor drive is located on the lower aft section of the transmission. The rotor brake assembly mounts on the tail rotor drive. Power is transmitted to the tail rotor through a series of driveshafts and gearboxes.

B. Accessories. Two rotor tach-generators, three hydraulic pumps, and an air compressor are mounted on and driven by the transmission. The main hydraulic pump is mounted on the left power takeoff drive. The backup and utility system pumps are mounted on the right power takeoff drives. This ensures hydraulic system operation if one engine fails.

C. Lubrication and Cooling. A self-contained pressure oil system is incorporated in the transmission. The transmission oil is cooled by two oil coolers and a turbine fan. The engine and transmission oil coolers, as well as the hydraulic pumps and air compressor, use the same fan. The transmission drives the oil cooler fan via the offset quill at the upper front of the transmission. The oil system has thermal bypass valves which allow the oil to bypass the coolers when the oil is below the operating temperature of 50°C (122°F). The transmission sump serves as an oil tank. An oil filter, oil level sight glass, filler cap, and magnetic chip detector are provided. An oil temperature probe and an oil pressure sensor are incorporated in the transmission oil system. Pressure and temperature readings are displayed on a gauge on the pilot's right front console.

2-50 Gearboxes

2-50.1 Accessory Gearbox

The 24-1512-000 series 2 accessory gearbox (A/G/B) is designed to drive two AC generators and a cooling fan. It also reduces the tail rotor driveshaft RPM, without changing the angle of rotation. Torque is transmitted from the main transmission through tail rotor driveshaft sections 1 and 2 to the A/G/B input flange. Inside the A/G/B, the torque is transmitted separately to the generator, fan, and tail rotor drives. The third section of the tail rotor driveshaft is coupled to the A/G/B output flange. The generators mount on and are driven by the A/G/B. The accessory gearbox and generators are cooled by an independent cooling fan. The fan is also mounted on and driven by the A/G/B. The accessory gearbox has an internal pressure lubrication system. An oil filter, breather, filler cap, oil level sight glass, and magnetic plug are provided. An oil pressure sensor and temperature probe are also incorporated in the A/G/B oil system. Pressure and temperature readings are displayed on a gauge on the pilot's right front console. The accessory gearbox is located inside the center fuselage, between frames No. 12 and No. 13.

2-50.2 Intermediate Gearbox

The 8A-1515-000 intermediate gearbox (I/G/B) is designed to change the angle of the tail rotor driveshaft axis by 45° to conform with the angle of the tail boom. The I/G/B mounts at the base of the vertical stabilizer. Section 5 of the tail rotor driveshaft is coupled to the I/G/B input flange. The sixth section of the driveshaft couples with the I/G/B output flange. The torque is transmitted without changing the driveshaft RPM. Lubrication of the intermediate gearbox is a splash system. A magnetic plug is installed at the lowest point of the gearbox. A breather, located at the top of the gearbox, is used to vent the I/G/B. The gearbox is serviced with oil by removing the breather. The gearbox has a sight glass for checking the oil level. An oil temperature probe mounts on the lower front of the casing. The oil temperature is displayed on a gauge on the pilot's right front console.

2-50.3 Tail Rotor Gearbox

The 246-1517-000 tail rotor gearbox (T/R G/B) is designed to rotate the tail rotor at the required RPM. The T/R G/B mounts at the top of the vertical stabilizer. The gearbox changes the direction of rotation by 90° and reduces the RPM to a nominal speed of 1112 revolutions per minute. The tail rotor

gearbox also incorporates a mechanism for changing the tail rotor pitch. The sixth section of the tail rotor driveshaft is coupled to the T/R G/B input flange. The tail rotor hub mounts on the T/R G/B output flange. The tail rotor deicing system slip ring mounts between the output shaft flange and the drive gear housing. Tail rotor pitch is changed by the control rod, located inside the output shaft. The control rod is activated by a roller chain and sprocket. Translation of the rotary movement of the chain sprocket into axial movement of the control rod is performed by a worm gear. When the sprocket rotates clockwise the control rod extends, increasing the tail rotor pitch, and the helicopter turns to the right. When it rotates counterclockwise, the rod retracts, decreasing the pitch, and helicopter turns to the left. The T/R gearbox is splash lubricated. An oil temperature probe is mounted on the side of the casing. The oil temperature is displayed on a gauge on the pilot's right front console.

2-51 Driveshafts

2-51.1 Engine to Transmission Driveshafts

The engine to transmission driveshafts transmit the engine power to the transmission. The driveshafts are connected to the engine output shafts via splined couplings. They are coupled with the transmission input quills through uniball couplings. The uniball couplings compensate for slight misalignment between the engines and transmission.

2-51.2 Oil Cooler Fan Driveshaft

The 8A-6314-00 oil cooler fan driveshaft transmits power from the transmission to the oil cooler fan. The driveshaft is bolted to the transmission offset quill at the front of the transmission. It connects to the oil cooler fan via a splined coupling. There are access panels in the oil cooler fan's exterior and interior casings for lubricating and inspecting the driveshaft.

2-51.3 Tail Rotor Driveshaft

The 24-1526-000 tail rotor driveshaft (T/R D/S) is designed to pass the torque from the main transmission via the accessory gearbox, the intermediate gearbox, and the tail rotor gearbox to the tail rotor. The tail rotor driveshaft consists of five short, linked sections and one long, rigid section. The rigid section (section 4) is located in

the tail boom between the second and fifth supports. The linked sections are installed between the main transmission and first support (section 1), between the first support and accessory gearbox (section 2), between the accessory gearbox and second support (section 3), between the fifth support and intermediate gearbox (section 5), and between the intermediate gearbox and the tail rotor gearbox (section 6). The driveshaft sections are coupled to each other and to the gearboxes by bolted flanged couplings. Sections 2 and 6 have a moveable splined coupling on one end to compensate for flexing of the tail boom in flight. The T/R driveshaft rests on five supports. The first support is in the center fuselage at frame 8. The other four supports (the second, third, fourth and fifth) are mounted on the center fuselage frame No. 15F and tail boom frames No. 4, 7, and 10. The driveshaft rotates on hanger bearings, seated under pressure on its linked and rigid sections. The hanger bearings fit in the supports on rubber collars which compensate for slight misalignment in the supports and dampen lateral oscillations of the driveshaft.

2-52 Drive System Indicators and Caution Lights

2-52.1 Oil Pressure/Temperature Gauges

Two oil pressure and temperature gauges are installed in the lower area of the pilot's right front console (see Figure 2-19) to monitor drive system parameters. Each gauge has three scales. The upper scale displays the oil pressure in kgf/cm². The lower scales display the oil temperature in degrees centigrade. One gauge displays the oil pressure in the main transmission on the upper scale and the oil temperature in the main transmission and intermediate gearbox (I/G/B) on the lower scales; the other gauge displays the oil pressure in the accessory gearbox (A/G/B) on the upper scale and the oil temperature in the A/G/B and tail rotor gearbox (T/R G/B) on the lower scales. The gauges receive temperature indications from oil temperature probes installed in the transmission and gearboxes. Pressure indications are provided by pressure transducers in the transmission oil system and the A/G/B. The gauges and pressure transducers are powered by the 36 VAC DIM Bus through two fuses in the 115/36 VAC distribution box. The temperature probes are powered with 27 VDC through a 2 amp fuse from Battery bus II.

2-52.2 Low Oil Pressure Caution Light

The XMSN LOW OIL PRESS caution light is located in the upper left area of the pilot's instrument panel (see Figure 2-11). The light illuminates when the oil pressure in the main transmission drops below 2 kgf/cm² (28.4 PSI). A pressure sensing switch installed at the oil pump outlet controls the light.

2.52.3 Transmission Chip Warning Light

The XMSN CHIP warning light is located in the upper left area of the pilot's instrument panel (see Figure 2-11). The light illuminates if sufficient metal particles or shavings collect on the magnets in the transmission chip detector/filter to close the circuit. The chip detector/filter is located in the outlet line to the right oil cooler. The chip detector and warning light are powered with 27 VDC from the Battery Bus, via a 2 amp fuse on the pilot's right fuse panel.

NOTE

On some Mi-24/25 helicopters, a RESET CHIP LIGHTS button is located on the pilot's instrument panel near the engine and transmission chip warning lights. The button clears the CHIP signal and shuts off the warning light. The button is to used reset the system after testing the chip detector circuits.

2-52 Rotor Brake

The rotor brake reduces the time required to stop the main rotor. It is also used to block the transmission while the helicopter is parked and during maintenance operations. The brake assembly consists of a housing, shoes, and drum mounted on the main transmission's tail rotor output quill. The drum is mounted between the output quill flange and the tail rotor driveshaft. Braking occurs when the brake shoes press against the drum. The brake is operated by a cable linkage from the rotor brake control lever, located to the right of the pilot's seat. The brake control lever assembly contains a microswitch that blocks the engine starting circuits if the brake is engaged. The engines can only be started if the brake is fully released, i.e., the brake lever is in the full down position. The rotor brake control lever has a ratchet mechanism to secure the lever in the desired position. To unlock the ratchet, a button at the top of the brake lever grip must be pressed.

Section VIII Main and Tail Rotor Groups

2-53 Main Rotor

The main rotor group consists of a hub assembly, five all-metal blades, and a swashplate / support assembly. It is a fully articulated system that allows the blades to flap, feather, and hunt (lead/lag) independently. Helicopter cyclic pitch and roll is controlled by the main rotor through the cyclic pitch control stick and the rotating swashplate. Collective pitch is controlled using the collective pitch control stick through the swashplate slide assembly. The flapping hinges have droop stops to provide adequate clearance between the blades and tail boom when the rotor is stopped or rotating at low RPM. The drag hinges allow the blades to lead or lag independently within the rotational plane. Blade hunting is limited by individual hydraulic dampers. The dampers are connected to a common fluid reservoir mounted above the hub assembly. The feathering hinges allow the blades to change pitch angle during rotation (cyclic feathering).

Main Rotor Technical Data:

Rotor diameter, m (ft).....	17.3 (56.8)
Direction of rotation	clockwise
Blade chord, mm (in).....	580 (22.8)
Rotor area, m ²	234

A. Swashplate/Support Assembly. The swashplate support assembly mounts to the transmission top casing. A drive link transmits rotation from the hub to the rotating swashplate. Pitch changes are transmitted to the blades via individual pitch change links mounted between the rotating swashplate and hub pitch horns.

B. Mast Nut. The hub assembly is connected to the mast via a bearing-mounted trunnion and secured with a nut. The nut has provisions for mounting a hoist adapter for lifting the helicopter or main transmission.

C. Main Rotor Blades. The blades are secured to the hub feathering hinge grips by two steel alloy blade grip bolts each. The main rotor blades have an electrical deicing system, tip lights, and a pneumatic blade integrity monitor (BIM) system to warn of spar damage. If the BIM system loses pressure, the red cap will be visible in the BIM indicator at the base of the blade.

2-54 Main Rotor Tachometer

The main rotor tachometer is used to monitor the main rotor RPM. Rotational speed is expressed as a percentage of maximum speed. The tachometer is located in the bottom left corner of the pilot's instrument panel. A second main rotor tachometer is located on the CPG's left panel (Mi-24/25D) or instrument panel (Mi-24F). The tachometers receive power from the tach-generators mounted on the main transmission connection to the helicopter electrical system is not required.

2-55 Rotor Pitch indicator

The rotor pitch indicator is used to display the collective pitch of the main rotor in degrees. It is located on the left side of the pilot's instrument panel. The indicator receives signals proportional to vertical movement of the swashplate slide from the pitch transducer mounted on the swashplate support. The rotor pitch indicator and transducer receive 27 VDC from Battery Bus I via a fuse on the right fuse panel.

2-56 Tail Rotor Group

The tail rotor is designed to compensate for main rotor torque and provide directional control of the Helicopter. The tail rotor group consists of a semi-articulated hub assembly and three all-metal blades. The tail rotor mounts on the tail rotor gearbox output flange on the left side of the vertical stabilizer. The blades are attached to the hub feathering hinge grips by two retention bolts each. They are equipped with thermoelectric deicing elements. Variation in blade pitch is accomplished by deflection of the pedals in the cockpit or CPG compartment which are linked, via the direction flight control system, to the pitch change mechanism in the tail rotor gearbox. Pitch changes are transmitted to the blades via a crosshead assembly and individual pitch change links.

Tail Rotor Technical Data:

Type of rotor	traction
Direction of rotation	clockwise
Rotor diameter, mm (in)	3,908 (153.9)
Blade chord, mm (in):	
standard blade	270 (10.630)
wide chord blade.....	305(12.008)

NOTE

117V Mi-24/25 helicopters with TV3-117V engines have an upgraded tail rotor system with wide chord blades.

Section IX Utility Systems

2-57 Pitot Heaters

The pitot tube heaters prevent obstruction of the tube inlets by ice. The heating elements are powered with 27 VDC from Battery buses I and II. The pitot heaters are controlled by the LEFT and RIGHT PITOT HEAT switches on the pilot's upper left side panel, above the windshield wiper controls (see Figure 2-14). Two yellow LH and RH PITOT HEAT FAIL lights indicate failure of the heating elements.

2-58 Clock Heaters

The foreign flight time clocks have electrical heating elements to allow the clocks to operate in cold weather. The clock heaters are controlled by the CLOCK HEAT switches on the pilot's and CPG's left panels (see Figures 2-14 and 2-27). The heaters are powered with 27 VDC from Battery Buses I and II.

2-59 Windshield Wipers

Windshield wipers are provided for the pilot and CPG. The windshield wiper systems use a two-speed DC motor and a wiper blade assembly. The pilot's wiper control is located on the left center control panel (see Figure 2-14). The CPG's control is located on the CPG's left center panel (see Figure 2-27). The wiper controls have three fixed positions: ON, HI, LOW, and a PARK position. When the windshield wiper switch is in the ON position, the motor receives full voltage. When the switch is placed in the HI or LOW position, the wiper operates at 90 to 60 movements per minute on HI or 60 to 30 movements per minute at the LOW position. When the switch is placed in the neutral position (center), the windshield wiper blade will stop immediately, possibly obstructing the view. To move the wiper blade to the side of the windshield, place the switch in the PARK position. The CPG's wiper is powered with 27 VDC from Rectifier Bus I. The pilot's wiper receives 27 VDC power from Battery Bus I. The circuits are protected by the PILOT and CPG W/S WIPERS circuit breakers on the right cb panel.

2-60 Windshield Washers

Windshield washer systems are provided for the pilot and CPG. The sprayer pumps are operated by compressed air from the helicopter's pneumatic system. The SPRAY button for the pilot's windshield washer pump is located on the pilot's upper left center control panel, next to the windshield wiper control. The CPG's SPRAY button is located on the left side panel, above the wiper control.

2-61 Windshield Defrosting System

The pilot and CPG cabin windshield's have separate defrosting systems. The windshields are equipped with electrical heating elements controlled by individual temperature regulators. The pilot's windshield heater is activated manually using the WINDSHIELD HEAT switch on the ice protection panel, located on the pilot's right console (Figure 2-20). The CPG's WINDSHIELD HEAT switch is located on the left side panel, next to the windshield wiper control. The switches have a HIGH (up) and LOW (down) setting. The center position of the switch is the OFF position. The heating elements are powered by 208 VAC from the right generator buses through separate transformers mounted on the right AC distribution panel. Current consumption can be monitored via the ammeter on the pilot's ice protection panel when the DEICE SYSTEM TEST selector is set to the W/S position. The heater control circuits receive 27 VDC power from Rectifier Bus II via a fuse on the pilot's right fuse panel.

CAUTION

In cold weather, the heat should be turned on if the windshields become fogged, there are initial indications of ice formation, or the ICING light comes on. If the windshield cracks or the heating element sparks, the heater must be disconnected immediately.

2-62 Deice/Anti-Ice Systems

The helicopter deice system prevents ice build-up on the main and tail rotor blades. The anti-ice system for the engine inlets and particle separators uses a combination of engine bleed air, warm oil, and electrical heating elements. A radioactive ice formation warning sensor is installed in the oil cooler fan inlet. It provides automatic activation of the rotor deice systems and engine anti-ice system and signals the pilot when ice is beginning to form. The rotor blade and the engine heating elements are powered with 208 VAC directly from the AC generator buses. The deice system controls and indicator lights are powered by 27 VDC from Rectifier Buses I and II via the DEICE SYSTEM WARNING and CONTROL circuit breakers on the pilot's right cb panel and two fuses on the right fuse panel.

2-62.1 Ice Formation Sensor

When the helicopter encounters icing conditions, a coat of ice forms on the element of the deice probe, decreasing the number of beta particles passing through the sensor counter. The red ICE warning light on the pilot's instrument panel illuminates and the deice system control unit activates the engine and rotor deice systems automatically, if the DEICE and ENGINE ANTI-ICE switches are set to the AUTO (down) positions. The pilot can override engagement of the deice systems by pressing the DEICE OFF button on the ice protection panel. The radioactive element of the probe is equipped with a heating element to prevent the build up of ice on the probe, which could break loose and fall into the oil cooler fan. The probe heating element operates automatically when the system is under automatic control. Under manual control, the probe heater can be engaged using the covered ICE PROBE HEAT switch on the ice protection panel. The probe heater receives 27 VDC power from Rectifier Bus I. A

TEST button located to the left of the covered switch allows the pilot to check the heater circuit. When the button is pressed, the RIO-3 HEAT OPERATIONAL light, located above the button, will illuminate if the heater circuit is good.

NOTE

Standard Mi-24/25 helicopters are equipped with the RIO-3 radioactive ice formation warning sensor. The sensor automatically activates the rotor and engine deice / anti-ice systems when ice is detected. The radioactive elements have been removed from the helicopters operated by the U.S. Army. As a result, the engine and rotor deice / anti-ice systems operate in the manual mode only.

2-62.2 Rotor Blade Deice Systems

The main and tail rotor blades have electrical heating elements to prevent ice build-up on the blades. The main rotor blades have four heating elements each. The tail rotor blades have two heating elements. The blade heating elements are controlled by the deice system control box. When the system is operating, the main rotor blade heating element sections operate for approximately 13 seconds each, in turn. The tail rotor blade heating element sections operate for approximately 25 seconds each, in turn. This cycle repeats until the pilot turns off the system or, under automatic control, until the ice formation sensor stops signaling the presence of ice. The rotor blade heating elements are powered by the left generator A and C buses (3~400 Hz 208 V). If the left generator fails, a contactor automatically connects the heating elements to the, right generator A and C buses.

2-62.3 Engine/Particle Separator Anti-Ice Systems

The engine and particle-separator anti-ice system uses both electrical heating elements and bleed air from the combustion chamber to heat the surfaces of the engine inlet and particle separator to prevent ice build-up. The system operates manually or automatically via the ENGINE DEICE switches on the ice protection panel.

2-62.4 Deice/Anti-Ice System Controls

All deice / anti-ice system controls are located on the ice protection panel in the upper right area of the pilot's right console (see Figure 2-20). To activate the system, close the DEICE SYSTEM INDICATORS and DEICE SYSTEM CONTROL circuit breakers on the right cb panel. Set the DEICE CONTROL switch on the ice protection panel to the AUTO or MANUAL position. In automatic mode, the system activates when the ice formation sensor detects the formation of ice. In case of false activation of the system, the pilot can disconnect the system using the DEICE OFF button. To operate the rotor deice system manually, set the DEICE CONTROL switch to the MANUAL position. To operate the engine anti-ice systems manually, set the ENGINE DEICE LH and RH switches to the ON (up) positions.

2-62.5 Deice/Anti-ice Caution and Indicator Lights

There are three deice system caution lights located in the upper left area of the pilot's instrument panel. The red ICE warning light advises the pilot that ice is forming on the ice formation sensor. The red ROTOR DEICE FAIL warning light advises the pilot of damage to the blade heating elements. The yellow DEICE AUTO TEST caution light advises the pilot that the system is operating using the built-in test program. The deice system caution lights receive 27 VDC from Rectifier Bus II. A series of additional indicator lights, located on the ice protection panel, allow the pilot to monitor operation of the system. There are four green panel lights, labeled M/R BLADE SECTIONS – 1, 2, 3, 4,

which indicate connection of the rotor blade heating element sections. The green DEICE SYS ON light illuminates when the system is operating, in either automatic or manual mode. The green LH and RH ENG HEAT ON lights illuminate when the engine anti-ice flow control valves open, providing hot bleed air to the engine inlets. The green LH and RH PZU HEAT ON lights illuminate when power is applied to the electrical heating elements in the engine particle separators. The RIO-3 HEAT OPERATIONAL light illuminates when the RIO-3 HEAT TEST button is pressed, if the circuit is operational. The indicator lights on the ice protection panel are powered with 27 VDC from Rectifier Bus I.

2-62.6 Deice System Ammeter and Test Selector

The rotary DE ICE TEST selector can be used to activate the rotor deice system built-in test program and to check current consumption of the rotor, engine, and windshield heating elements. Current consumption for the selected heating element or system is monitored by checking the ammeter reading. When the selector is set to the AUTO position, the deice control unit will execute a self-test sequence and apply power to each blade heating element section, in turn. The DEICE AUTO TEST caution light on the pilot's instrument panel will illuminate and the green BLADE SELECTION indicator lights on the ice protection panel should each illuminate in turn during the test. If the ROTOR DEICE FAIL warning light illuminates during the test, the helicopter cannot be flown in icing conditions until the fault has been corrected.

Section X Environmental System

2-63 Environmental Control Equipment

The environmental control equipment on the Mi-24/25 helicopter includes individual fans in the cockpit and CPG compartment, an outside air vent for the CPG compartment, and an environmental system for heating and cooling the crew and cargo cabins. The helicopter also has a cabin pressurization system which, in conjunction with the environmental system air filtering capability, provides a safe cabin environment for flight over contaminated areas.

2-63.1 Crew Fans

The helicopter is equipped with two fans (DV-302T), one in the main cockpit and one in the CPG compartment, to circulate air in the cockpit areas. The pilot's fan is controlled by an ON/OFF switch located on the upper left center control panel (see Figure 2-14). The CPG's fan is controlled by an ON/OFF switch located on the left side panel (see Figure 2-27). The fans receive 27 VDC power from Rectifier Bus I through a fuse on the left fuse panel.

2-63.2 Air Vent

An air duct provides ventilation of the cockpit and CPG compartment using outside air. The duct can be opened and closed using the VENT lever located overhead on the light side of the CPG compartment, behind the seat. The vent should be closed (lever fully aft) when the heating, cooling, and cabin pressurization system is in use.

2-63.3 Heating and Cooling System

The integrated heating and cooling system includes a cooling turbine, heat exchangers, air filters, heating/cooling outlets, and temperature control equipment. The system is operated by bleed air from the main engine compressors. If one engine is shut down, the system can operate from the remaining engine. The heating and cooling system components are powered with 27 VDC by Battery Bus II through the 5 amp ENV SYS CONTROL circuit breaker on the right cb panel AC power is provided by the 115 VAC single-phase Bus through the 2 amp ENV SYS TEMP REGULATOR fuse in the 115/36 VAC distribution panel.

2-63.4 Environmental System Controls /

Indicators

All environmental system controls are located, on the environmental system panel in the lower right area of the pilot's right console (see Figure 2-20). The controls include a CABIN PRESSURE ON/OFF switch, a FILTER ON/OFF switch, a three position master switch, a HIGH / LOW HEAT selector, a three position AUTO / HOT / COLD selector, and a thermostat. The indicators include the ENV SYS OFF light on the environmental system panel and a HIGH CABIN PRESSURE warning light, located in the upper left area of the pilot's instrument panel. The filtering capability and cabin pressurization system can be employed with the system operating in either heating or cooling modes. The engines and the AC / DC power sources must be operating before engaging the environmental systems. To operate the system.

- Make sure the ENV SYS CONTROL circuit breaker is closed and the ENV SYS OFF light on the environmental system panel is illuminated.
- Set the thermostat to the desired cabin temperature and the AUTO / HOT / COLD selector to the AUTO (up) position.
- Set the HIGH/LOW HEAT switch to the desired position: HIGH in very low outside temperatures, low if outside temperature is above 45°F.
- Set the master switch to the PURGE (down) position for 3 minutes. This evacuates dust, oil, and exhaust products from the system lines. Purging is required before operating the system.
- After purging the lines, set the master switch to the OPERATE (up) position. The ENV SYS OFF light should go off.
- With the AUTO / HOT / COLD selector in the AUTO position, the thermostat and temperature regulator controls the system. If the HIGH / LOW HEAT switch is in the LOW position, the regulator maintains an air temperature in the main line of 90°C (194°F). If the HIGH / LOW HEAT switch is set to the HIGH position, the temperature regulator maintains a temperature of 130°C (266°F) in the main line. The main line supplies hot air to the secondary heat exchanger and cooling turbine for additional cooling,

depending on the thermostat setting. A mix of air from the secondary exchanger and cooling turbine reaches the heating / cooling outlets in the cabins.

- If the temperature regulator fails, the temperature in the cabins can be regulated manually by setting the AUTO / HOT / COLD selector to the HOT (lower left) or COLD (lower right) position.
- If the odor of oil is noted in the cabins or before entering a contaminated area, the air filters should be activated by turning on the FILTER switch. This diverts the air in the main lines through the filters before entering the heating / outlets and/or secondary heat exchanger. If the lifters are clogged, a pressure switch in the main line will shut down the system and illuminate the ENV SYS OFF light. The system will also shut down automatically if the temperature in the main line exceeds 175°C or if the cabin pressure exceeds 750 mm Hg (32.9 in Hg).
- To reconnect the environmental system after an automatic shutdown, the master switch must be set to the OFF position for a few seconds to reset the relays.

2-63.5 Cabin Pressurization System

The cabin pressurization system operates in conjunction with the cabin door sealing system and the environmental system's air filtering capability to provide a safe cabin environment for flight over NBC contaminated areas. The pressurization system maintains a positive pressure differential of 500 to 650 mm H₂O (0.7 to 0.9 PSI) in the crew and cargo cabins. The pressurization system engages automatically; however, the pilot can override the

system by setting the CABIN PRESSURE switch to the OFF (down) position. If the cabin pressure exceeds 750 mm H₂O (1.0 PSI), the environmental system will shut down automatically and the HIGH CABIN PRESSURE caution light on the pilot's instrument panel will illuminate.

WARNING

The pilot must make sure the door seals are deflated (DOORS UNSEALED light ON) before opening or allowing ground support personnel to open the pilot's door, CPG's canopy, or cargo cabin doors postflight. If not deflated, the doors can spring outward with considerable force and result in serious injury to ground support personnel.

2-63.6 Heating / Cooling Outlets

There are two types of heating / cooling outlets in the helicopter. Multiport or fixed manifold type outlets are used to heat the cargo cabin and CPG floor areas, the missile guidance instrument head, and the canopies. These outlets can be opened or closed via hand-operated butterfly valves. The second type is an individual outlet. There are twelve individual outlets installed in the cabins: one in the CPG compartment, three in the cockpit, and eight in the cargo cabin. To close an individual heating / cooling outlet, turn the ring on the outlet nozzle clockwise. To open, turn the ring counterclockwise. The individual outlets can be adjusted to direct the flow of air in the desired direction.

Section XI Electrical Power Supply and Distribution System

2-64 Power Supply and Distribution Equipment

The electrical systems include 208 VAC 400 Hz 3~phase power provided by two AC generators; main and standby transformers to provide 115 VAC 400 Hz single-phase, 36 VAC 400 Hz 3~phase, and 36 VAC 400 Hz single-phase power; inverters to provide emergency 115 VAC single-phase and 36 VAC 3~phase power; and rectifiers and batteries to provide 27 VDC power. The DC system and AC inverters can be operated on the ground with the main engines shut down using the APU starter / generator. The helicopter is also equipped with 208 VAC 3~phase and 27 VDC external power receptacles for ground operations. The main circuit breaker and fuse panels located in the cockpit are shown in Figures 2-37 and 3-38. The electrical power supply and distribution systems are designed for normal, standby, and emergency operating modes.

A. Normal Operating Mode. The normal operating mode uses both AC generators operating under a parallel load as the main power source, the main 115 VAC and 36 VAC transformers, and two 27 VDC rectifiers to provide power to all aircraft systems. The batteries are connected to the DC power mains for recharging during normal operation.

B. Standby Operating Mode. The standby mode is engaged in event of failure of one transformer or rectifier, or failure of the power switching and control equipment. The buses are switched, either automatically or manually, to the remaining rectifier and/or the standby transformers. Prolonged operation in standby mode is likely to necessitate switching to the emergency mode of operation.

C. Emergency Operating Mode. The emergency mode is engaged as a result of failure of one or both AC generators, both rectifiers, both 115 VAC transformers, both 36 VAC 3-phase transformers, or if a combination of these components fail at the same time, causing the loss of main power. Emergency power for flight essential components and systems is supplied through the battery and inverter buses. These buses receive power from the main power sources during normal operation. The systems are switched to emergency mode automatically, or manually if the automatic switching equipment fails.

During emergency operation, the non-essential AC and DC buses remain without power.

2-65 Master Electrical Caution Light

The ATTN TO ELECTRIC PANEL caution light, located in the upper left area of the pilot's instrument panel, illuminates whenever a fault condition exists in the electrical power supply systems. The pilot must check the AC and DC power control panels to determine the exact nature of the fault condition.

2-66 AC Power Controls and Indicators

The AC power supply systems are controlled and monitored using the AC power panel (Figure 2-20), located on the left side of the pilot's right console. The AC system controls, switching devices, and indicators are powered with 27 VDC from the Battery Buses.

2-67 208 VAC 3~phase Power System

The 208 VAC 400 Hz 3~phase system uses two GT40PCh6 AC generators, operating in parallel, as its primary source of stabilized voltage. The generators are rated at 40 to 50 kva each. Each generator is connected to its own control unit, a current transformer, a voltage regulator, and switching apparatus to ensure parallel operation and disconnect it from the system in case of failure.

2-67.1 AC Generator Power Switches/Lights

The LEFT and RIGHT GENERATOR switches on the AC power panel are used for individually engaging the right and left generators. The generators can be engaged when main rotor RPM reaches 95% by setting the switches to the ON (up) positions. The red LEFT and RIGHT GEN Off lights illuminate when the generators are disengaged. The lights are controlled by the generator control units. The green GEN PARALLEL indicator light illuminates when the AC generators are engaged and operating in parallel under an even load. The GEN PARALLEL light is controlled by the generator bus linking relay through both generator control units.

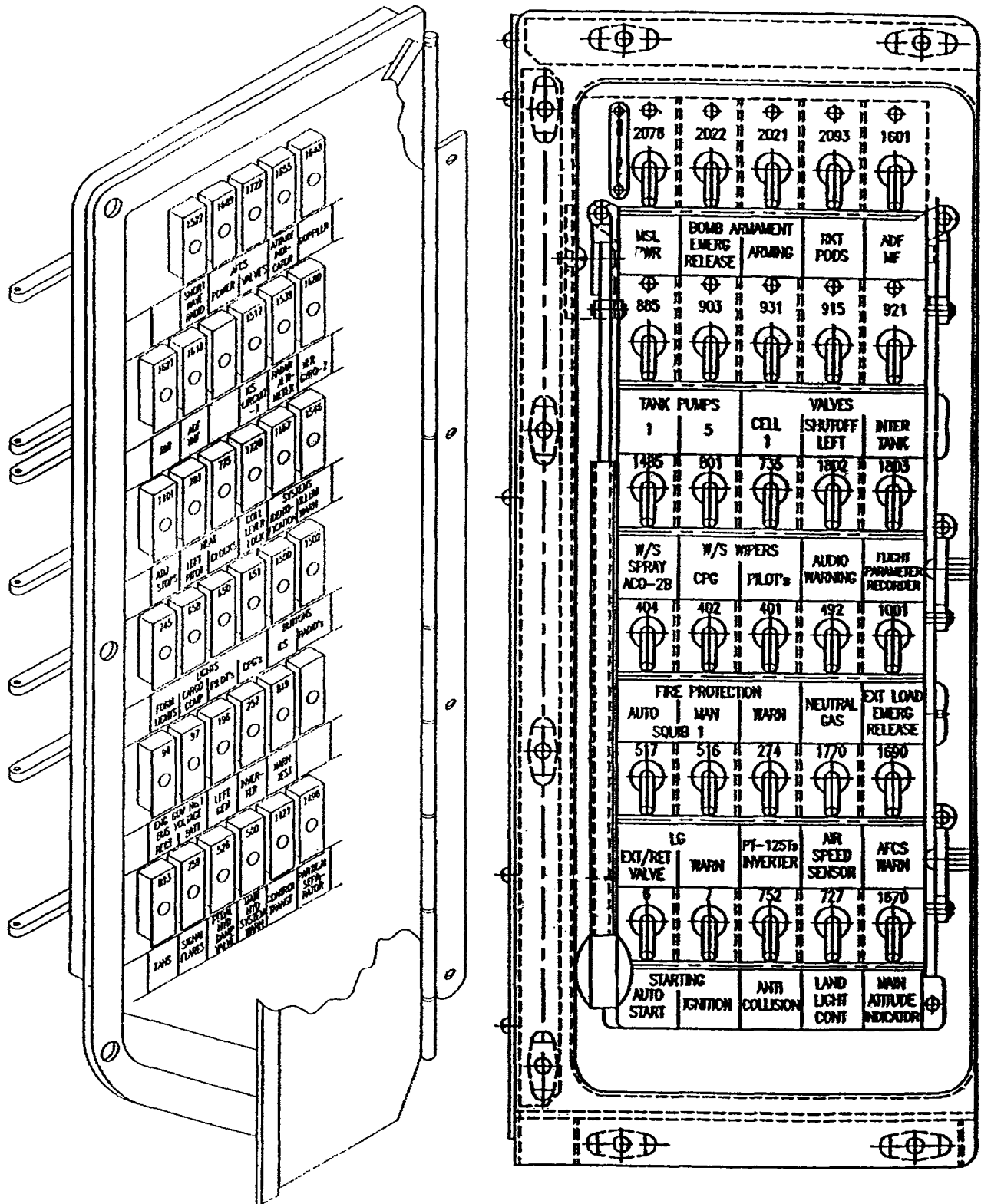


Figure 2-37 Left Fuse and Circuit Breaker Panels

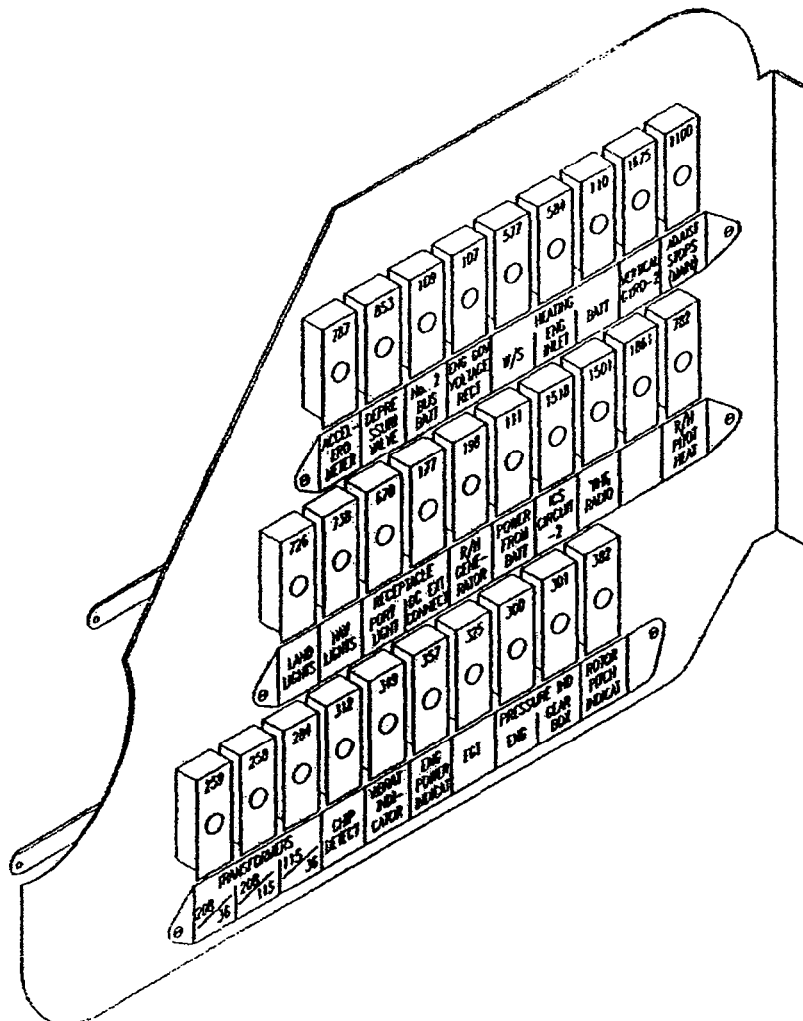
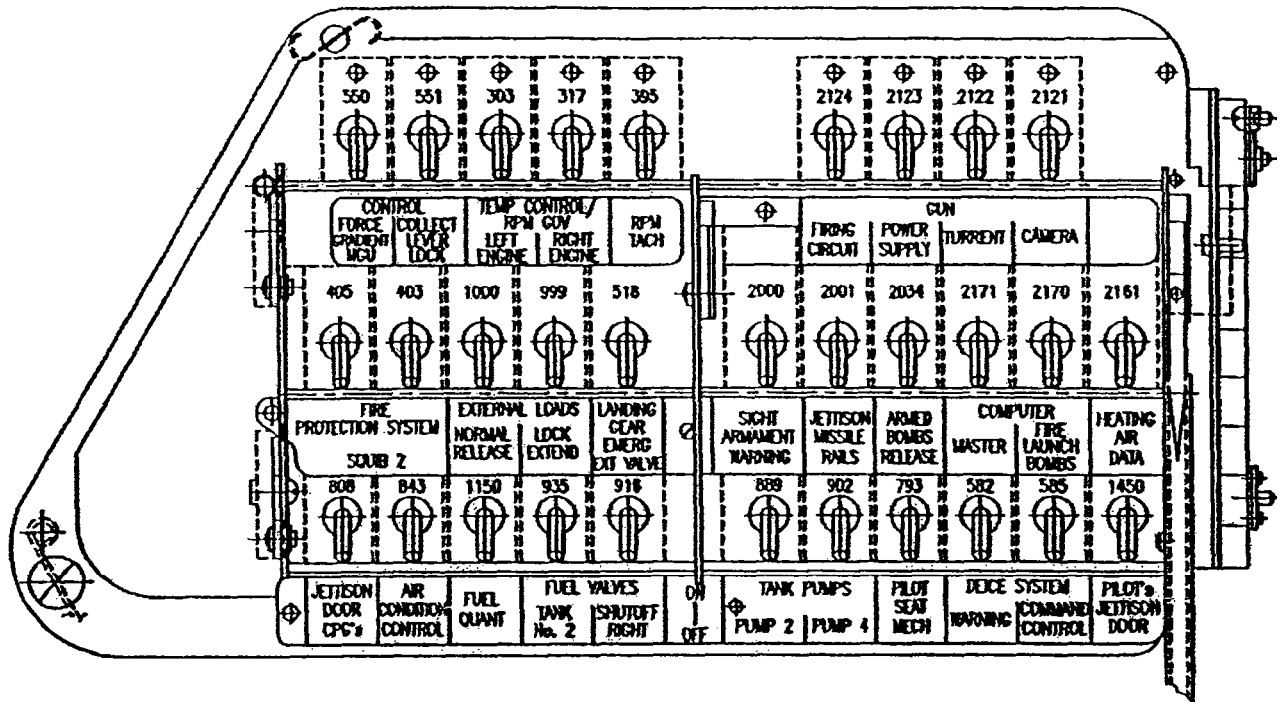


Figure 2-38 Right Fuse and Circuit Breaker Panels

2-67.2 AC Generator Power Distribution

The 208 VAC 400 Hz 3~phase main power is distributed through the Right and Left Generator A, B, and C buses. The Generator Buses are linked by contactors for even load distribution and to automatically switch the load to the active generator in the event of failure of one generator. The generator buses are located in the generator distribution boxes in the radio compartment. The following components and systems are powered by the Generator Buses:

- 115 VAC single-phase main and standby transformers
- 36 VAC 3~phase main and standby transformers
- Two 27 VDC rectifiers
- Main and tail rotor deice system
- Armament circuits
- Pilot and CPG windshield defrosting systems
- CO₂ inerting system for fuel cells (if present)
- The RPR-3A engine governor systems **117**
- Particle separator deice systems

2-67.4 AC Generator Monitoring Instruments

Phase voltage at each generator bus can be checked using the voltmeter in the center right area of the pilot's right console and the rotary selector on the AC power panel by setting the selector to the GENERATORS LEFT and RIGHT A-B, B-C, and C-A positions in turn. The voltmeter reading must be multiplied by 100 to obtain the actual voltage. This voltmeter is used to check the AC buses and the deice system voltages. Phase voltage should be between 203 and 204 VAC under no load conditions. Generator load current can be monitored using the RH and LH GEN ammeters located on the right side of the AC power panel. Normal load current should be 111 to 138 amps. Ammeter readings must be multiplied by 10 to obtain the actual amperage.

2-67.5 External AC Power Connection

The external AC power receptacle (ShRAP-400-3F) is located on the left side of the fuselage between frame No. 13 and No. 15. It is a standard

international socket which can be connected to an external 208 VAC 3~phase power source. To connect the external power supply to the 208 VAC 3~phase mains, set the EXT AC POWER switch on the AC power panel to the ON (up) position. The external AC power is linked via a relay and contactor to the left generator buses. The EXT AC PWR caution light on the AC power panel illuminates. Phase voltage of the external power source can be checked by setting the rotary selector on the AC power panel to the EXT POWER A-B, B-C, and C-A positions in turn and checking the voltmeter reading. The external AC power source can be used to check all AC components and systems. It can also be used to power the rectifiers to allow testing of the DC systems and components.

2-68 115 VAC 400 Hz Power System

The 115 VAC 400 Hz single-phase system uses a TS/1-2 (208/115 VAC) transformer as its source of stabilized voltage. The system includes two TS/1-2 transformers to provide a main and standby power source. The main transformer is supplied with 208 VAC power by the Left Generator Bus. The standby TS/1-2 transformer is powered by the Right Generator Bus. The transformers are rated at 2000 va. If the main 115 VAC transformer fails, the standby transformer is engaged automatically by an automatic power switching unit. If both 115 VAC transformers fail, essential 115 VAC components are powered by the PO-750A inverter. The inverter must be turned on manually. It is rated at 750 va and operates using 27 VDC power from Battery Bus I.

2-68.1 115 VAC Power Switches and Lights

The three position 115 VAC XFMR switch is used to engage the main or standby 115 VAC transformers. The switch should be set to the MAIN (up) position after engagement of the AC generators, indicated by illumination of the GEN PARALLEL indicator light. The STANDBY position of the switch is used to manually switch to the standby transformer if the automatic switching device fails, and to check operation of the standby transformer on the ground. The MAIN and STANDBY 115 VAC XFMR OFF caution lights illuminate when the main and standby transformers are disengaged. If both the MAIN and STANDBY 115 VAC XFMR OFF caution lights illuminate in flight, the P0-750 inverter must be engaged manually to power the

flight essential equipment. The PO-750 INVERTER switch is used to engage the inverter. The switch is protected by a hinged cover. To engage the inverter, open the cover and set the switch to the ON (up) position. The PO-750 INV ON indicator light illuminates when the inverter is engaged. The light is controlled by the contactor which connects the inverter to the 115 VAC Inverter Bus.

2-68.2 115 VAC Power Distribution

The main 115 VAC transformer provides power to the 115 VAC Bus, located in the AC distribution box. If the main transformer fails, a linking contactor switches the bus to the standby transformer automatically. The 115 VAC Bus supplies power to the following equipment:

- Main 36 VAC 3~phase transformer
- 115 VAC Inverter Bus (during normal operation)
- Ice formation sensor control unit
- M/R blade tip lights
- Pilot's and CPG's group 1 red panel lighting
- Environmental system primary temperature regulator
- DISS-15D Doppler equipment
- ARK-U2 VHF homing set
- Armament circuits

2-68.3 115 VAC Emergency Power Distribution

The 115 VAC Inverter Bus distributes power to all 115 VAC flight essential equipment. When the 115 VAC transformer (either main or standby) is engaged, the 115 VAC Inverter Bus is linked via a contactor to the 115 VAC Bus to supply power to the flight essential components. If both transformers fail, the PO-750 inverter supplies power to the 115 VAC Inverter Bus. The 115 VAC Inverter Bus supplies power to the following flight essential components and systems:

- Standby 36 VAC 3~phase transformer
- SRO-2 transponder set
- RV-5 radar altimeter
- L-006M IR jammer

- SZM-3M radar warning gear **D**
- Engine vibration monitor equipment
- Pilot's instrument panel lighting (group 3)
- The fuel gauge
- Pilot and CPG group 2 red lighting systems
- Engine PTIT gauge amplifier

2-68.4 115 VAC Voltage Monitoring Instruments

Voltage at the 115 VAC Bus can be checked, by setting the rotary selector on the AC power panel to the ~115 position and checking the voltmeter reading. Voltage should be between 112 and 118 VAC under no load conditions.

2-68.5 Ground Test From Inverter Switch

CAUTION

The equipment powered by the 115 VAC Bus can be checked one system at a time using the PO-750 inverter. Do not overload the inverter.

The equipment connected to the 115 VAC Bus can be tested on the ground when an external AC power source is not available and the engines are shut down using the PO-750 inverter. The PO-750 inverter can be connected to the 115 VAC Bus by closing the GRD TEST FROM INV switch. The switch is located at the upper right corner of the AC power panel. It is protected by a hinged guard. The inverter should only be engaged if an external DC source or the APU starter-generator is being used to power the DC mains.

2-69 36 VAC 3~Phase Power System

Two TS330S04B transformers (main and standby) are used to supply 36 VAC 400 Hz 3~phase power to aircraft systems. The transformers are rated at 3000 va and have a reverse phase sequence. The main 36 VAC 3~phase transformer is connected to the Left Generator A, B, and C buses. The standby 36 VAC 3~phase transformer is connected to the Right Generator A, B, and C buses. If the main transformer fails, the standby transformer is engaged by an automatic power switching device. If both the main and standby 36 VAC 3~phase transformers fail, the PT-125Ts inverter is used as

an emergency source of 36 VAC 3-phase power. The inverter is engaged by the automatic power switching device. It can be engaged manually if the power switching unit fails. The inverter receives 27 VDC power from Battery Bus I. It is rated at 125 va.

2-69.1 36 VAC 3~Phase Power Switches/Lights

The three position 36~3 VAC XFMR switch is used to engage the main or standby 115 VAC transformers. The switch should be set to the MAIN (up) position after engagement of the AC generators, indicated by illumination of the GEN PARALLEL indicator light. The STANDBY position of the switch is used to manually switch to the standby transformer if the automatic switching device fails, and to check operation of the standby transformer on the ground. The MAIN and STANDBY 36~3 VAC XFMR OFF caution lights illuminate when the main and standby transformers are disengaged. The PT-125 INVERTER switch is used to engage the inverter if the automatic switching device fails and for ground testing. The switch is protected by a hinged cover. To engage the inverter, open the cover and set the switch to the ON (up) position. The PT-125 INV ON indicator light illuminates when the inverter is engaged. The light is controlled by the contactor which connects the inverter to the 36 VAC 3~phase Inverter Buses.

2-69.2 36 VAC 3~Phase Power Distribution

The 36 VAC 3~phase components are supplied with power through the 36 VAC 3~phase A, B, and C Buses in the AC distribution box. The buses may be supplied by either the main or standby transformer through a linking contactor. The 36 VAC 3~phase A, B, and C Buses supply power to the following equipment:

- 36 VAC 3~phase Inverter Buses (during normal operation)
- ARK-15 automatic direction finder set
- Greben-1 flight director system
- DVS-24 airspeed sensor
- DISS-15D Doppler equipment
- MGV-1SU vertical gyro No. 1
- AFCS AC circuits
- Armament circuits

2-69.3 36 VAC 3~Phase Emergency Distribution

When the 36 VAC 3~phase transformer (either main or standby is engaged) is engaged, the 36 VAC 3~phase Inverter Buses are linked to the 36 VAC 3~phase Buses, through a contactor, to supply power to essential 36 VAC 3~phase components. If both transformers fail, the 36 VAC 3~phase Inverter Bus is powered by the PT-125Ts inverter. The 36 VAC 3~phase Inverter Bus supplies power to the following flight essential components:

- PKP-72M main attitude indicator
- UKT-2 standby attitude indicator
- MGV-1SU vertical gyro No. 2
- VK-53RV gyro correction cutout switch

2-69.4 External 36 VAC 3~Phase Inverter

A PT-500Ts 36 VAC 3~phase inverter can be connected to the 36 VAC 3~phase Buses to allow ground testing of the navigational instruments in the field when external AC and DC power sources are not available. The inverter can be connected to a receptacle located in the AC/DC distribution panel on the left forward bulkhead in the cargo cabin. The APU starter-generator must be used to power the DC mains when using the external inverter. After connecting the inverter to the receptacle, open the cover and set the GRD TEST FROM INV switch to the ON (up) position to power the 36 VAC 3~phase buses.

CAUTION

To avoid overloading the APU starter-generator, do not turn on the PO-750A inverter or portable hydraulic servicing unit while the PT-500Ts inverter is operating. The 36 VAC 3~phase components can be tested in any order. To avoid overloading the PT-500Ts inverter, the power used by the components tested should not exceed 500 va.

2-70 36 VAC Single-Phase 400 Hz Power System

The 36 VAC 400 Hz single-phase system uses the main or standby TR115/36 transformer (DIM) as its electrical supply source. The main transformer is powered by the 115 VAC Bus. The standby TR115/36 transformer is connected to the 115 VAC Inverter Bus. If the main TR115/36 transformer fails, the standby transformer is engaged automatically by a relay. The standby transformer can be engaged manually if the relay fails.

2-70.1 DIM Transformer Power Switch/Light

The three position DIM XFMR switch is located in the upper right area of the pilot's right front console (see Figure 2-19). The switch should be set to the MAIN (left) position after the main 115 VAC transformer is engaged. The STANDBY (right) position of the switch is used to manually engage the standby transformer. The MAIN DIM XFMR OFF caution light illuminates when the main transformer is disengaged. The light is controlled by a relay.

2-70.2 DIM Transformer Power Distribution

The main DIM transformer supplies power to the 36 VAC DIM Bus. If the main transformer fails, the 36 VAC DIM Bus is automatically connected to the standby transformer by a relay. Power is supplied through the 36 VAC DIM Bus, located in the AC distribution box, to the following equipment:

- Engine and drive system oil pressure and temperature gauges
- Hydraulic system pressure gauges
- APU air pressure gauge

- L-168V1AE radar warning set **F**

2-72 DC Power Systems

The direct current (DC) systems provide power to the equipment that requires 27 VDC. The DC power sources include two rectifiers, two batteries, and the APU starter-generator. Under normal flight conditions, all 27 VDC equipment is powered by the rectifiers and batteries operating in parallel. The batteries provide power for the external power connection and switching equipment, starting the APU, reserve power for flight essential DC equipment if both rectifiers fail, and for limited ground testing of equipment when external power sources are not available. The APU starter-generator provides emergency 27 VDC power in flight if both generators fail. It provides power for starting the main engines and recharging the batteries under field conditions. It powers the battery buses after main engine start when M/R RPM is too low for connection of the AC generators. The APU starter-generator can also be used for limited ground testing of electrical equipment when external power sources are not available.

2-72 DC Power Controls and Indicators

The DC power supply systems are controlled and monitored using the DC power panel (Figure 2-20), located on the left side of the pilot's right console, above the AC power panel. The DC system controls, switching devices, and indicators are powered with 27 VDC from the Battery Buses.

2-73 Rectifiers

Two VU-6A rectifiers are used to convert the 208 VAC 3~phase power from the AC generators into 27 VDC to supply the direct current equipment on the helicopter and to recharge the batteries in flight. Each rectifier is connected to a reverse current relay which ensures parallel operation and disconnection of a defective rectifier from the system. The rectifiers are used under normal conditions in parallel with the batteries. Each rectifier has a sufficient load capacity to power all of the helicopter's DC equipment if one of the rectifiers fails.

2-73.1 Rectifier Power Switches and Indicators

The rectifiers are connected to the electrical system by means of the LEFT and RIGHT RECTIFIER switches. The AC generators or an external AC power source and the batteries must be engaged before connecting the rectifiers. Warning of failure of each rectifier is provided by yellow LEFT RECT OFF and RIGHT RECT OFF lights. The switches and warning lights are mounted on the DC control panel.

2-73.2 Rectifier Power Distribution

Rectified 27 VDC voltage is distributed through Rectifier Buses I and II. The right and left rectifiers can be connected to either bus automatically by means of linking contactors. A second pair of contactors link the rectifier buses to the main Battery Bus and Battery Buses I and II to provide power to these buses if the battery output current drops below 10 to 15 amps.

A. Rectifier Bus I. The following equipment is powered by RECTIFIER Bus I:

- Battery Bus and Battery Bus I (when batteries are low)
- Service cell No. 1 fuel pump **D**
- Cell No. 5 fuel pump
- Pilot and CPG fans
- Formation lights
- CPG's windshield wiper
- Pilot and CPG's windshield washers
- Radiomagnetic indicator (RMI-2)
- ARK-U2 VHF homing set
- Blue and white lighting for the cargo cabin
- Guided missile power supply
- Greben-1 Flight director system
- Window and particle separator bleed air deice control equipment
- Karat-M24 or Yadro-1A HF radio set
- R-828 UHF radio set **F**
- Autopilot DC circuits
- SPUU-52 tail rotor pitch limit system

B. Rectifier Bus II. The following equipment is powered by RECTIFIER Bus II:

- Battery Bus and Battery Bus II (when batteries are low)
- Service cell No. 2 and Cell No. 4 fuel pumps
- CPG cabin lighting
- Computers
- Pilot's sight
- Gun turret **D**
- MGV-1SU vertical gyro No. 1 control circuit
- Windshield and engine inlet deice control equipment
- Doppler equipment (DISS-15D)
- Battery heating circuits
- Pilot's seat adjustment mechanism
- Rotor deice system control equipment
- DUAS-V air data probe heater

2-73.3 Rectifier Voltage Monitoring Instruments

The voltage output from each rectifier and at the Rectifier Buses can be checked by setting the rotary selector on the DC control panel in the RECTIFIER LH, RECTIFIER RH, RECT Bus I, and RECT Bus II positions in turn, and checking the voltmeter readings. The voltmeter is located on the DC power panel above the rotary selector. The voltmeter reading must be multiplied by 10 to obtain the correct voltage. Under no load conditions, the voltage readings should be between 24.3 to 29.7 VDC at each selected position.

2-74 Batteries

The standard Mi-241 25 helicopter is equipped with lead-acid batteries as reserve sources of DC power when the AC generators or external power sources are not in operation. The battery containers can be adapted to use two aircraft nickel-cadmium in place of the standard lead-acid batteries. The battery containers are equipped with electrical heating elements for use in low ambient temperatures. Under normal operating conditions, the batteries operate in parallel with the rectifiers. Under emergency conditions, the standard lead-acid

batteries can power the flight-essential components supplied by the Battery Buses for no more than 9 minutes. All non-essential equipment must be turned off.

2-74.1 Battery Power Switches

The batteries are connected by setting the LEFT and RIGHT BATTERY switches located on the DC power panel (see Figure 2-20) in the ON (up) positions. The batteries must be connected before starting the engines or testing the electrical equipment on the ground. The battery heaters are connected by setting the BATTERY HEAT switch on the DC power panel to the ON (up) position.

2-74.2 Battery Power Distribution

Battery power is distributed through the main Battery Bus and Battery Buses I and II to flight essential DC equipment and systems. During normal operations, the batteries provide power to all three battery buses. The rectifiers recharge the batteries as needed in flight. All three battery buses are linked to the rectifier buses. If the output current from the batteries drops below 15 amps, the reverse current relays direct rectifier power through the linking contactors to the battery buses to power the flight essential equipment.

A. Battery Bus. The following equipment is powered by the main BATTERY Bus:

- Battery Buses I and II
- AC generator control units (BZU-4A)
- APU start-generator circuit
- Radio compartment and tail boom lighting
- PT-500Ts external AC inverter connector
- Landing / searchlight (FPP-7) power circuit
- APU oil pressure and RPM signals
- Main engine air starters
- Avionics / weapons systems fan
- PO-750 inverter
- Backup hydraulic system valves and signals
- Wing tank fuel pumps **F**
- Fuel gauge DC circuits
- MS-61 voice recorder

B. Battery Bus I. The following equipment is powered by BATTERY Bus 1:

- Audio warning equipment
- Flight data recording system
- Collective clutch release solenoid
- Service fuel cell No. 1 fuel pump **F**
- Transponder equipment (SRO-2)
- Radar warning equipment (SZM) **D**
- 36 VAC 3~phase inverter (PT-125Ts)
- Main attitude indicator (PKP-72M)
- Radiomagnetic indicator (RMI-2)
- No. 2 vertical gyro (MGV-1SU) control circuit
- Voice recorder (MS-61)
- Automatic switching device (APP-1A) for 115 VAC transformers
- Radar altimeter (RV-5)
- Emergency bomb jettison circuits, arming circuit
- Airspeed sensor (DVS-24)-
- Pilot's clock heater
- Left pitot tube heater
- Mechanism for extending the landing / searchlight
- Anti-collision light (MSL-3)
- Signal fares
- Rocket launchers
- External cargo emergency jettison circuit
- Cockpit and CPG cabin lighting equipment
- Utility / trouble light sockets
- Caution and warning lights
- ARK-15M ADF set
- ICS net No. 1
- Switching contactors for left rectifier and left generator
- 115 VAC single-phase inverter (PO-750A) control equipment
- Main hydraulic system valves and indicators

- T/R pedal damper valve solenoid
- Landing gear hydraulic valves
- Left engine fire valve, fuel cell No. 1 shutoff valve, and cell No. 4 and No. 5 intertank valve
- Fire extinguishing system explosive cartridges (first sequence)
- Fire alarm system (channel 1)
- Main engine start control circuits
- CO₂ inerting system **D**
- Pilot's windshield wiper
- CPG's flight control engagement circuit
- APU fire valve
- Landing Gear external position lights

C. Battery Bus II. The following components are powered by BATTERY bus II:

- UHF/VHF command radio set (R-.863)
- ICS net No. 2
- Switching contactors for right rectifier and right generator
- Automatic power switching devices (APP-1A) for 208/36 V 3~phase transformers and PT-125Ts inverter
- Electrical supply contactor for the external AC power receptacle
- Control valves for the environmental system
- Valve (GA-142) for RESERVE landing gear extension
- Fire valve for right engine and cell No. 2 cut off valve
- Fire alarm system (channel 2).
- Utility hydraulic system signals
- Landing gear signals
- Automatic flight control system (AFCS) signals
- Engine governor (RPR-3A)
- Fire extinguisher explosive cartridges (second sequence)
- Navigation lights
- External cargo tactical release equipment

- Switching relay for MAINS TO BATT switch
- Force gradient mechanisms
- Fuel gauge
- Engine and transmission operation signals
- Engine trim linear actuator (MP-100M)
- Cabin pressurization control circuits
- Armament warning system
- Explosive cartridges for missile launcher emergency jettison
- Bomb launch circuits.
- Explosive cartridges for CPG canopy and pilot door jettison
- Right pitot tube heater
- Roentgen meter

2-74.4 Battery Monitoring Instruments

The voltage output at the Battery Buses can be checked by setting the rotary selector on the DC control panel in the BATT, BATT BUS 1, and BATT BUS II positions, in turn, and checking the voltmeter readings. The voltmeter is located on the DC power panel above the rotary selector. The voltmeter reading must be multiplied by 10 to obtain the correct voltage. The voltage readings should be no less than 24 VDC at each selected position. The current output of the batteries can be monitoring using the RH BATT and LH BATT ammeters located to the left of the DC power panel. Battery output should be 21 to 28 amps. The ammeter readings must be multiplied by 100 to obtain the correct amperage.

2-74.5 Mains to Batteries Switch

The MAINS TO BATT switch is located on the DC power panel. It is protected by a hinged guard. Normal position of the switch is OFF (down and covered). The switch is used to provide 27 VDC power from the batteries, APU starter-generator, or an external DC power source to operate the electrical components connected to the Rectifier Buses.

2-75 External DC Power Connection

The external DC power receptacle (ShRAP-500) is located on the left side of the fuselage between frame No. 13 and No. 15. It is a standard

international socket which can be connected to an external 27 VDC power source. To connect the external power supply to the DC mains, set the EXT AC POWER switch on the AC power panel to the ON (up) position. The external DC power is linked via a relay and contactor to the Battery Buses and the EXT DC PWR caution light on the DC power panel illuminates. Voltage of the external power source can be checked by setting the rotary selector on the DC power panel to the EXT POWER position and checking the DC voltmeter reading. The external DC power source can be used to check all DC components and systems by setting the MAINS TO BATT switch to the ON (up) position. It can also be used to power the 115 VAC and 36 VAC 3-phase inverters to allow limited testing of AC systems and components. A blocking circuit in the external DC power switching equipment prevents simultaneous connection of the external power source and the batteries. It also prevents connection of a power source with reversed polarity.

2-76 APU Starter-Generator Power

The APU starter-generator (STG-3) is used to supply the helicopter electrical system with 27 VDC on the ground when the main engines are shut off. It can also be used as an emergency power source in flight if both generators fail. Maximum continuous operating time is 30 minutes. The starter-generator is mounted on the APU engine.

2-76.1 Starter-Generator Switches / Indicators

To use the starter-generator as a source of 27 VDC power, start and warm up the APU, then turn on the APU GEN switch on the DC control panel. The APU GEN caution light located above the AC power panel illuminates when the APU starter-generator is operating in generator mode. If the voltage output of the starter-generator is greater than the battery voltage, a reverse current relay links the starter-generator output to the Battery Buses. An overvoltage protection circuit disconnects the starter-generator if the voltage rises to an unsafe level. To use the starter-generator to power the equipment connected to the Rectifier Buses, the MAINS TO BATT switch on the DC power panel must be set to the ON (up) position.

CAUTION

Do not attempt to start the main engines when the APU is operating in generator mode. Overload of the APU may result. Do not operate the APU in generator mode for more than 30 minutes.

2-76.2 Starter-Generator Monitoring Instruments

The voltage output of the starter-generator can be checked by setting the rotary selector on the DC power panel to APU GEN position and checking the reading of the DC voltmeter. The reading must be multiplied by 10 to obtain the actual voltage. The current output can be checked using the APU GEN ammeter located to the right of the voltmeter. The amperage reading must be multiplied by 100 to obtain the correct reading. Normal current output is 100 amps.

Section XII Auxiliary Power Unit

2-77 Auxiliary Power Unit

The AI-9V auxiliary power unit (APU) is used as the source of compressed air to crank the main engine compressor rotors during engine start. It can also be used to supply 27 VDC power to the onboard electrical systems on the ground and in flight if the generators fail. The APU has its own fuel control, oil system, regulating system, starter-generator unit, and ignition unit. It consists of a centrifugal-type compressor, single stage axial turbine, ring-shaped combustion chamber, exhaust nozzle, drive housing, and integrated oil tank. The APU is mounted in the aft nacelle compartment. It is separated from the transmission compartment by a lateral firewall. The APU starting circuits are powered by 27 VDC from the Battery Buses. The APU is designed for up to 30 minutes of continuous operation.

2-78 APU Starting System

The starting system includes the start control panel, APU starter-generator, the ignition system, and the start control box.

2-78.1 APU Start Controls and Indicator Lights

The APU start controls and indicators are located on the APU - Main Engines Start Panel (see Figure 2-13), located in the lower aft area of the pilot's left side wall. The panel contains a START APU button, a STOP APU button, a start mode selector, and four indicator lights. The AUTOSTART ON light illuminates after the APU START button is pressed to advise that the starting program is engaged and running. The OIL PRESSURE NORMAL and APU RPM NORMAL lights illuminate during the starting sequence when the engine reaches normal oil pressure and idle RPM. The APU OVERSPEED caution light illuminates in the event of excess APU RPM and the APU automatically shuts down. The STOP APU button is used to shut down the APU. The STOP APU button also allows the pilot to abort the start sequence.

2-78.2 Starter-Generator

The starter-generator cranks the compressor rotor during the APU starting cycle. It uses external DC power or battery power. The starter-generator can also be used as a reserve source of DC power for

the onboard electrical systems (see Section XI of this Chapter).

2-78.3 Ignition System

The ignition system includes an ignition exciter and an integrated igniter / start fuel nozzle assembly. The exciter is mounted on the right side of the compressor housing. The igniter assembly mounts in the combustion chamber. The exciter is connected to the igniter assembly via a high voltage wiring harness.

2-78.4 APU Start Control Box

The APU start control box is located in the radio compartment. It controls the APU start, false start, and cranking cycles. It also controls APU shutdown.

A. APU Starting Cycle. Before starting the APU, connect the DC power supply to the helicopter. Set the APU start mode selector on the APU start panel to the START (down) position. Press the APU START button for 1 to 2 seconds. The AUTOSTART ON light should illuminate. The EGT gauge should start registering within 5 seconds. Within 20 seconds, the APU RPM NORMAL light should illuminate and the AUTOSTART ON light should go off. The starting cycle can be aborted at any time by pressing the APU STOP button. After an aborted start, a cranking cycle must be performed to clear excess fuel from the combustion chamber.

B. False Start. A false start cycle is used to check operation of the starting system and during APU preservation / depreservation operations. During a false start the start and main fuel systems operate normally but the APU ignition system is disengaged. To false start the APU, set the mode selector on the APU start panel to the FALSE START (up) position and press the APU START button. The duration of the false start sequence is 20 seconds. After a false start, a cranking cycle must be performed to clear excess fuel from the combustion chamber.

C. Cranking Cycle. A cranking cycle is used to clear excess fuel from the combustion chamber after an aborted start or false start. To carry out a cranking cycle, set the mode selector in the CRANK (center) position and press the APU START button.

The ignition system and start and main fuel systems are disengaged during a cranking cycle. The duration of the cranking cycle is 20 seconds.

D. APU Shutdown. To abort a start or to initiate a normal shut down, press the APU STOP button on the start panel. When the button is pressed, the power is cut off from all APU starting system components and the main fuel valve closes. Fuel flow to the main fuel nozzles stops and the APU shuts down. The APU also has overspeed governor that shuts down the APU if RPM reaches a critical limit. If the APU reaches the maximum speed, power is supplied to the APU OVERSPEED indicator light and to a relay which closes the main fuel valve, causing the APU to shut down. To restart the APU, the DC power supply must be cycled OFF and back ON to reset the starting system relays.

2-79 APU Fuel Control System

The APU fuel system consists of a fuel supply system, a start fuel system, and a main fuel system. The fuel supply system includes the helicopter fuel cells and boost pumps, the APU fire valve, and the APU fuel filter. The fire valve opens and doses automatically during the APU start and shut down cycles. The start fuel system consists of a start fuel pump, start fuel solenoid valve, start fuel nozzle, and a start fuel supply valve. The main fuel system includes the APU fuel control, main fuel valve, and the main fuel nozzles. During the APU start cycle, the starter-generator rotates the compressor rotor and the start fuel pump supplies fuel to the start fuel nozzle through the start fuel solenoid valve, and to the main fuel nozzles via the start fuel supply valve. The start fuel system operates only during APU start. When the APU reaches idle RPM, the starter-generator disengages and the fuel control takes over the fuel metering through an internal pump and the main fuel valve. An RPM governor internal to the fuel control activates the APU RPM NORMAL and APU OVERSPEED lights on the start control panel. If an overspeed condition exists, the governor closes the main fuel valve and shuts down the APU.

2-80 APU Lubrication and Ventilation

The APU employs a self-contained, closed circulation, pressure fed oil system. Areas that carry minor loads are lubricated by splashed oil. The oil from the tank flows by gravity to the accessory drive sump, where it is drawn by the oil pump delivery section and delivered in two flows. The first flow is directed to the accessory drive gears and starter / generator reduction gear. The other flow is delivered via an external line and filter to the compressor rotor bearings. A bypass valve maintains the oil pressure within 2.5 to 5.0 kgf/cm² (35.6 to 71.1 PSI). A pressure transmitter is installed aft of the filter to signal normal oil delivery pressure to the rotor bearings. The transmitter illuminates the APU OIL PRESSURE NORMAL light on APU start panel when the pressure reaches the operating range. Oil from the accessory drive drains into the oil sump. Oil is scavenged from the rotor bearings by the oil pump scavenge section. It returns to the oil tank via the air / oil separator. The air is released from the oil system through an integrated breathing vent. The oil tank has a filling point and sight gage for checking the oil level. Capacities and oil types are included in Section XV of this Chapter.

2-81 APU Exhaust Gas Temperature Gauge

The APU exhaust gas temperature (EGT) gauge is located to the left of the APU start panel. The gauge reads out in degrees centigrade. Gauge readings must be multiplied by 100 to obtain the correct temperature. The gauge receives signals proportional to the APU EGT from a pair of thermocouples mounted in the APU exhaust housing. During APU start, the EGT should not exceed 880°C. Normal EGT readings should not exceed 720°C. When operating in generator mode, EGT should not exceed 750°C.

2-82 APU Bleed Air System

Bleed air from the APU is used to crank the main engine compressor rotors during main engine start. The APU bleed air system includes an air discharge valve, a pressure gauge, and bleed air channels which direct the air to the main engine starters. When the main engine START button is pressed, the air discharge valve opens and supplies air to the main engine pressurized air channel. The APU AIR PRESSURE gauge, located on the pilot's left side wall above the APU EGT gauge, displays

the pressure in the main channel. The gauge reads in kgf/cm². Pressure indications are provided by a pressure transducer installed in the main air channel. A minimum pressure of 2.9 kgf/cm² is required for main engine start. During APU start and when the APU is operating at idle or in generator mode, the air discharge valve vents excess pressure from the compressor into the atmosphere to stabilize compressor operation and prevent stall.

2-83 APU Fuel Control Air Bleed Button

The APU FUEL CONTROL AIR BLEED button on the pilot's left console is used to bleed air from the APU fuel control during maintenance operations. The bleeding circuit operates using battery power. The service cell fuel boost pumps must be ON and the service cell valves OPEN to bleed air from the system. The button opens the APU fire valve, allowing fuel to flow through the APU fuel control without requiring an APU false start cycle.

Section XIII Lighting

2-84 Interior Lighting

The interior lighting systems are used for general interior illumination in the cockpit, CPG compartment, and cargo cabin areas. The interior lighting equipment includes red lighting for the instrument panels and other control panels, red and white crew cabin dome lights, cargo cabin blue and white dome lights, radio compartment and tail boom lighting, and outlets for connecting portable utility lights.

2-84.1 Red Lighting System

This system is designed to illuminate the inscriptions of the instruments and control elements in the cockpit and CPC compartment. The red lighting system is divided into three groups which have independent electrical supply circuits. The first group is powered by the 115 VAC single-phase bus. The second and third groups are powered by the 115 VAC inverter bus. If one group fails, the instruments and panels are illuminated by The other group.

A. Pilot Controls. There are two sets of red lighting controls in the cockpit. The group 1 and 2 controls located at the bottom of the pilot's right front console are used to control the group 1 and 2 lights on the pilot's left side console. The group 1 and 2 controls on the pilot's right console are used to control the lights on the right panel. The group 3 control is used for the instrument panel lights. The knobs control the brightness of the lighting from OFF (full left) to MAXIMUM (full right).

B. CPG Controls. The CPG's group 1 and 2 lighting controls are located on the left side panel in the CPG compartment. The knobs control the brightness of the lighting from OFF (full left) to

MAXIMUM (full right).

2-84.2 Crew Cabin Dome Lights

The cockpit and CPG compartment have dome lights for general illumination. The dome lights have one white and one red bulb each. The cockpit dome light is powered by 27 VDC from Battery Bus I. The CPG's dome light is powered with 27 VDC from Rectifier Bus II.

A. Pilot Controls. The pilot's dome light is controlled by the COCKPIT LIGHTING switch on the upper left rear panel (Figure 2-12). The center position of the switch is OFF. For white lighting, set the switch to WHITE (up) position. For red, set it to the RED (down) position.

B. CPG Controls. The CPG compartment dome light is controlled by the DOME LIGHT switch on the CPG's left side panel (Figure 2-27). The switch has three positions: WHITE (up), OFF (center), and RED (down).

2-84.3 Map Light

A map light is located in the rear of the cockpit on the right side. The light can be used to illuminate the pilot's instrument panel if the red lighting system fails. The light is powered by Battery Bus I. An ON/OFF switch and a rheostat for adjusting the brightness are located at the back of the light. An adjustable ring at the front of the light allows adjustment between white, diffuse red, or directional red filters.

2-84.4 Cargo Cabin Dome Lights

There are four dome lights mounted in the cargo

cabin ceiling. Each fixture has one white and one blue bulb. The lights are controlled by the CARGO CABIN LIGHTING switch on the pilot's upper left rear panel. The switch has three positions: WHITE (up), OFF (center), and BLUE (down). There are microswitches incorporated in the cargo cabin lighting circuits that automatically turn off the white dome lights when the cabin doors are opened. The covered REQUIRED WHITE LIGHTING switch on the pilot's upper left rear panel can be used to override the microswitches and allow the white dome lights to be on with the doors open. The cargo cabin dome lights are powered with 27 VDC from Rectifier Bus I.

2-84.5 Tail Boom Dome Lights

The radio compartment and tail boom are illuminated during maintenance procedures by four white dome lights, three in the radio compartment and one in the tail boom. The lights are controlled by the RADIO COMPARTMENT and TAIL BOOM LIGHTING switches located in the radio compartment. The lights are powered with 27 VDC from the Battery Bus.

2-84.6 Utility Lighting

A utility light can be connected to the socket located on the right side of the cargo cabin. There are also utility light sockets located in the radio compartment between frames No. 12 and No. 13 and in the tail boom on frame No. 1. The utility light sockets receive 27 VDC power from Battery Bus I.

2-85 Exterior Lighting

The standard Mi-24/25 exterior lighting systems include a searchlight, navigation lights, formation lights, blade tip lights, landing gear position lights, and an anti-collision light.

2-85.1 Searchlight

The FPP-7 searchlight is located under the front of the helicopter between frames No. 1A and No. 2N, just in front of the nose landing gear wheel well. The light is used for search operations during low visibility conditions and to illuminate landing sites and taxiing areas at night. The light can be extended and rotated by either the pilot or the CPG. The light is powered with 27 VDC from Battery Buses I and II. The light control circuit is protected by the SEARCHLIGHT circuit breaker on the left cb panel.

A. Pilot Controls. The SEARCHLIGHT CONTROL switch is located in the upper area of the pilot's left front console (see Figures 2-17 and 2-25). The switch has three positions: ON (up), OFF (center), and RETRACT (down). When the switch is set to the ON position the light illuminates. Setting the switch to the OFF position turns off the bulb. To stow the light, set the switch to the RETRACT position. The pilot can control extension/retraction and rotation of the light using the LIGHT CONTROL knob located at the top of the collective stick grip when the SEARCHLIGHT CONTROL switch is set to the ON position. Pressing the knob forward extends the light, pressing it aft retracts the light. To rotate the light to the left or right, press the knob to the left or right.

B. CPG Controls. The CPG can control operation of the searchlight using the SEARCHLIGHT CONTROL ASSUME ON/OFF switch in the center area of the CPG's left panel. The switch is guarded in the OFF (down) position by a hinged red cover. The pilot's SEARCHLIGHT CONTROL switch and the CPG's CONTROL ASSUME switch must be set to the ON positions for the CPG to control the light. The CPG can control extension/retraction and rotation of the light using the LIGHT CONTROL knob located at the top of the collective stick grip. The control knob functions the same way as the pilot's control knob. The SEARCHLIGHT CONTROL ASSUME switch creates a block in the circuit which prevents the pilot's control knob from affecting the searchlight movement. The pilot and CPG cannot control the light simultaneously. To return control to the pilot, the CPG must set the SEARCHLIGHT CONTROL ASSUME switch back to the OFF (down) position.

2-85.2 Landing/Taxi Light **F**

The Mi-35 and Mi-24F model helicopters have an additional FPP-9 landing/taxi light mounted on the missile control equipment hatch on the left side of the forward fuselage. The light is used for general illumination of the landing and taxiing areas in low visibility conditions. The direction of the light can only be adjusted manually, on the ground. The light is powered by 27 VDC from Battery Bus II.

A. Pilot Controls. The light is controlled by the TAXI LIGHT switch located on the pilot's left front console (Figure 2-25). The switch has two positions: ON (up) and OFF (down).

B. CPG Controls. The CPG can control the light using the TAXI LIGHT ON (up)/OFF (down) switch located in the forward area of the left side panel (Figure 2-32).

2-85.3 Navigation Lights

The helicopter is equipped with three navigation lights to indicate its position on the ground or in the air. A KhS-39 white navigation light is installed on the trailing edge of the vertical stabilizer. A BANO-45 navigation light is installed on each wing tip; red on the left and green on the right. Power is supplied to the navigation lights from Battery Bus II. To turn on the lights, place the NAV LIGHTS switch, located in the upper area of the pilot's left front console (Figures 2-17 and 2-25), in either the BRIGHT or DIM position. The center position of the switch turns the navigation lights off. In the BRIGHT position, the lights receive full power. When the switch is placed in the DIM position, an attenuating resistor reduces the voltage, dimming the lights. The navigation lights may be used for signaling in morse code using the NAV LIGHTS - CODE button located next to the BRIGHT - DIM selector.

2-85.4 Formation Lights

The OPS-57 formation lights are designed to assist pilots in maintaining formation while flying at night and in poor visibility conditions. The formation lights are located one each on the right and left wings and the top of the aft nacelle cowling. There are two-formation lights on the top of the tail boom, one at the forward end and one at the mid-point. All the formation lights have half-round, amber lens covers. The formation lights receive 27 VDC power from Battery Bus I. The formation lights are controlled by the FORMATION LIGHTS switch located in the upper area of the pilot's left center panel (Figure 2-14), next to the fuel system control panel. The switch has three positions: BRIGHT (up), OFF (center), and DIM (down).

2-85.5 Blade Tip Lights

The blade tip lights are used to indicate the position of the main rotor blades for movement of the helicopter at night or in poor visibility. A blade tip light is installed inside the removable fairing of each blade tip cap. The blade tip lights are powered from the 115 VAC single-phase bus through a 115 to 7.5V transformer installed on the cargo cabin ceiling and the M/R deice slip ring. The lights are turned on using the BLADE TIP LIGHTS switch located on the pilot's upper left center panel (Figure 2-14), next to the formation lights switch. The switch has two positions, ON (up) and OFF (down).

2-85.6 Landing Gear External Position Lights

An external position light is mounted on the nose and left and right main landing gear to indicate to a ground observer that the landing gear is extended. The lights on the main gear are mounted on the forward lever supports. The nose gear light is mounted on the outside of the nose gear fairing. The lights are controlled by the L/G POSITION LIGHTS switch located in the left area of the pilot's left front console (Figure 2-17), next to the landing gear control panel. The switch has two positions, ON (up) and OFF (down). When the switch is set to the ON position and the landing gear is extended, the external position lights will illuminate. The lights are turned on by the downlock microswitches in the gear actuators. The light circuits are powered with 27 VDC from Battery Bus I through the LANDING GEAR WARN circuit breaker on the left cb panel.

2-85.7 Anti-Collision Light

The MSL-3 anti-collision light (MSL-3) is designed to indicate the direction of travel and the position of the helicopter at night, during inclement weather, and in poor visibility. The light is installed on top of the tail boom between frames No. 6 and 7. The power supply for the light comes from Battery

Bus I through the ANTI-COLLISION (beacon) circuit breaker on the left cb panel. It is controlled by the BEACON switch located on the pilot's upper left center panel (Figure 2-14), next to the blade tip light switch. The switch has two positions, ON (up) and OFF (down). When the switch is turned on, the beacon rotates, creating a flashing effect.

Section XIV Flight Instruments

NOTE

Some of the standard Mi-24/ 25 foreign instruments have been replaced with U.S. military standard instruments. Check actual aircraft configuration to determine applicable, paragraphs in this Section.

2-86 Pilot-Static System

The pitot-static system (Figure 2-39) is the source of dynamic and static pressure for operation of the differential pressure instruments: the pressure altimeters, vertical speed indicator, and the airspeed indicators. The pressure used in these instruments is created either by impact (dynamic), or taken from the ambient air (static) pressure. Dynamic pressure is obtained through the pitot tubes located on the left and right sides, of the fuselage nose. Static pressure is taken from the outside air through the static ports located, on the left and right sides of the fuselage, forward of the cargo doors.

2-86.1 Pitot Tubes

The pitot tubes (1,4) (Figure 2-39) supply the dynamic pressure of the incidental air flow while in flight. They use complete deceleration of the incident air flow. Due to the deceleration, the energy of moving air is transformed into excessive dynamic pressure which is proportional to the speed of the incidental air flow. The pitot tubes are equipped with electrical heaters to protect them from freezing. The heaters are described in Section IX, Utility Systems. There are damper chambers (10, 14) installed in the dynamic pressure tubing to eliminate airspeed indicator needle oscillations.

2-86.2 Static Ports

The static ports (12, 16) are used to obtain the ambient air pressure from the environment for operation of the pressure instruments. To increase reliability, there is a static port on each side of the center fuselage between frames No. 1 and 2. The static ports are connected to the instruments through a 3-position switching valve.

2-86.3 Static Port Switching Valve

The static port switching valve (13) allows the pilot to select a specific port or both ports as the source of static pressure for the instruments. With the lever in the middle position, static pressure from the left and right ports is combined by the valve and supplied to all of the instruments. When the lever is placed in the left or right position, static pressure is supplied only from the left or right port, respectively. The static port switching valve is located in the lower area of the pilot's left side wall (see Figure 2-15).

2-87 Airspeed Indicator

Two airspeed indicators are installed on the helicopter, one on the pilot's instrument panel and one in the CPG compartment. The foreign airspeed indicators display indicated airspeed in kilometers per hour (KPH). The U.S. replacement airspeed indicators display the indicated airspeed in knots. The foreign and U.S. airspeed indicators are differential pressure instruments, measuring the difference between dynamic and static pressure. The pilot's airspeed indicator is connected directly to the left pitot tube. The CPG's airspeed indicator is connected to the right pitot tube. Static pressure is supplied to both airspeed indicators from either or both static ports depending on the position of the static port switching valve. Airspeed operating limits contained in Chapter 5. Section II, System Limits.

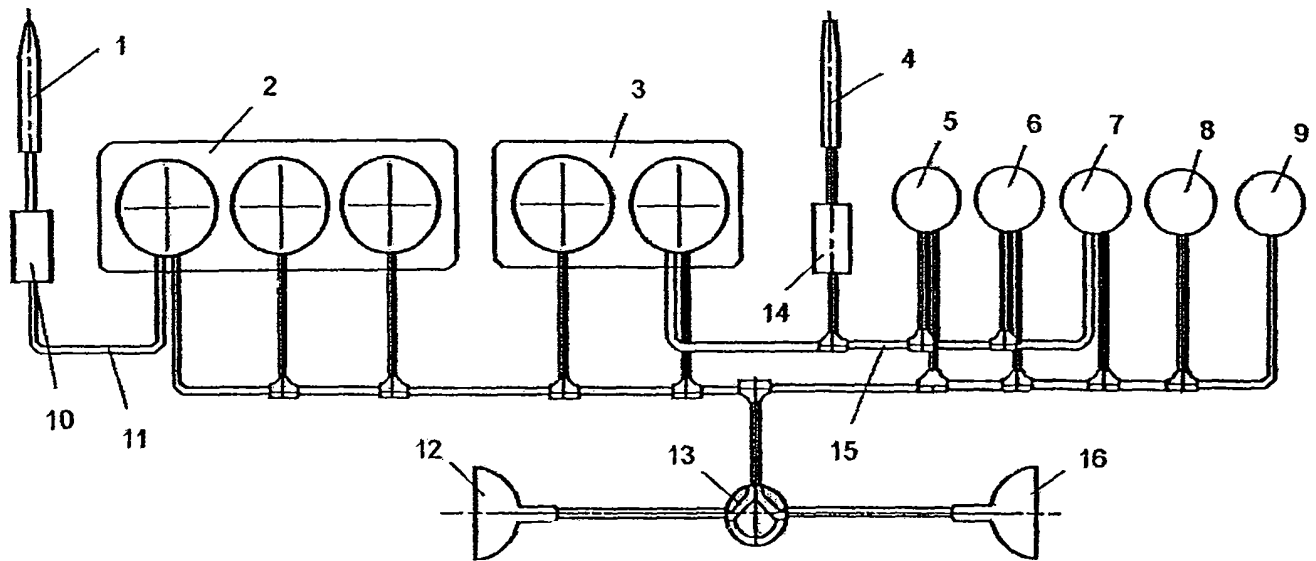


Figure 2-39 Pitot-Static System

1. Left pilot tube
2. Pilot's differential pressure instruments
3. CPG's differential pressure instruments
4. Right pilot tube
5. DVS-24 airspeed sensor
6. KZSP airspeed correction unit
7. SSA 0.7-2.2 airspeed sensor
8. DV-15M altitude sensor

9. DYK air pressure sensor
10. Damping chamber
11. Dynamic pressure tubing
12. Left static port
13. Static port switching valve
14. Damping chamber
15. Dynamic pressure tubing
16. Right static port

2-88 Pressure Altimeters

2-88.1 Pressure Altimeter

There are two pressure altimeters installed on the standard Mi-24/25 helicopter, one on the pilot's instrument panel and one in the CPG compartment. Correction cards for the altimeters are located in the logbooks. The foreign altimeter in the CPG compartment displays the altitude in meters (long needle) and kilometers (short needle). The barometric pressure in millimeters of mercury (mm Hg) is displayed in a window on the right side of the scale. There is a knob on the front of the instrument, which is used to set the needles to the airfield elevation. The operating range of the altimeter is 0 to 10,000 m (0 to 32,028 ft). The altimeter is connected to the static pressure system.

2-88.2 Trig Transponder/Altimeter Encoder

The foreign transponder has been replaced with a Trig TT21 Mode S transponder / altimeter encoder. The altimeter/encoder functions as an altitude sensor for the transponder in Mode C. The altimeter's operating range is from surface to 15,000 feet. The operating indicators and controls include mode selector knob, display of active mode and squawk. Push buttons for Ident (ID) and VFR (squawks

1200) are included. Use the right knob and the ENT button to set the squawk code.

2-89 Vertical Speed Indicator

The standard Mi-24/25 helicopter is equipped with a VAR-30MK vertical speed indicator (VSI). The foreign VSI is mounted in the pilot's instrument panel. It displays the helicopter's rate of ascent/decant in meters per second (m/s). The indicator is actuated by the rate of atmospheric pressure change. It is connected to the static pressure system.

2-90 Turn and Slip Indicator

The standard helicopter is not equipped with a turn and slip indicator.

2-91 Magnetic Compass

The helicopter is equipped with two foreign Ki-13K magnetic compasses, one in the cockpit and one in the CPG compartment. The magnetic compasses are used to indicate the helicopter heading if the radio magnetic indicator fails. The compass scale is graduated in five degree increments with number markings every 30 degrees. The cardinal points are marked with Cyrillic characters: C – North, IO –

South, B – East, and 3 – West. Compass correction cards are located in holders in the cockpit and the CPG compartment. The foreign magnetic compasses have replaced with U.S. military specification compasses in some Mi24/25 helicopters.

2-92 Clock

The helicopter is equipped with two foreign AChS-1 flight time clocks, one on the pilot's instrument panel and one in the CPG compartment. The clocks are equipped with electrical heating elements for cold weather operation. The clock heaters are described in Section IX, Utility Systems. To provide continuous accurate operation, the clocks must be wound every two days. Complete winding of the clock will keep it running for up to three days. On some Mi-24/25 helicopters, the foreign clocks have been replaced with U.S. military specification windup or digital clocks.

2-93 Outside Air Temperature Indicator

The TVN-45 outside air temperature (OAT) indicator measures the temperature of the air outside the helicopter. It is mounted on the pilot's left side canopy. The indicator uses a bimetallic spring as a temperature sensor. It displays the temperature in degrees centigrade. The operating range is from -60 to 50°C. The scale divisions are calibrated in 2 degree increments with numbers placed every ten degrees.

2-94 Accelerometer

The ADP-4 accelerometer set is used to measure the g-forces which act on the center of gravity of the helicopter perpendicular to the blade plane. The operation of the accelerometer is based on the movement of a suspended weight, which surges due to the action of acceleration on the helicopter and generates an electrical signal proportional to the acceleration. The field of measure is from -2 to +4 g. The accelerometer is powered by direct current from the Battery Bus and with 115 VAC from the 115 VAC Inverter Bus. The indicator is mounted in the upper right corner of the pilot's instrument panel. The sensor is installed on the cargo cabin ceiling on frame No. 5.

2-95 Attitude Indicating System

The helicopter is equipped with an altitude

indicating system that uses input from the vertical gyros, radar altimeter, and the weapons control systems to display the attitude of the helicopter relative to the horizon, to indicate ground proximity when the helicopter is flying at or below 60 m (297 ft) AGL, and to assist the pilot in bringing the helicopter into position for weapons employment. The main attitude indicator is mounted in the center area of the pilot's instrument panel. Standby altitude indicators are located on the pilot's instrument panel and in the CPG compartment in case of main attitude indicator failure.

2-95.1 Main Attitude Indicator

The PKP-72M main attitude indicator displays the helicopter's roll angle within a range of $\pm 180^\circ$ and pitch angles within a range of $\pm 90^\circ$. The indicator has warning flags to indicate loss of the roll (K flag) and pitch (T flag) control signals and vertical gyro failure (AI flag). The indicator displays the optimal angle of attack from the fire control computer or missile guidance computer. It also displays ground proximity from the radar altimeter and has a warning flag to indicate loss of the radar altimeter signal (PB flag). A slip indicator with a range, of $\pm 15^\circ$ is located at the bottom of the instrument. The main attitude indicator is located in the center of the pilot's instrument panel. The indicator is illuminated by built-in lighting. Battery Bus I supplies 27 VDC current to the PKP-72M through the MAIN ATT IND circuit breaker located on the left cb, panel. The AC electrical supply is provided from the 36 VAC 3-phase Buses through three fuses, located in the AC (115/ 36V) distribution box. Under emergency conditions, AC power is supplied to the attitude indicator by the standby PT-125Ts inverter. When supplied by the inverter, the VERTICAL GYROS selector must be set to the No. 2 (right) position. Only the pitch and roll scales will be active.

A. Controls. The main attitude indicator is engaged simultaneously with connection of the No. 1 vertical gyro using the VERT GYRO 1 switch located the radio navigation panel in the upper rear area of the pilot's left side wall (Figure 2-12). The switch has two positions, ON (up) and OFF (down). The indicator should begin displaying the actual pitch and roll within 2 to 3 seconds after the gyro is caged. The VERTICAL GYROS No. 1 (left) – No. 2(right) selector is located on the right side of the instrument panel (Figure 2-11). It is used to select the operational gyro for the indicator. The gyro

should be allowed to warm up for 2 to 3 minutes before pressing the CAGE button, located next to the gyro selector. The No. 1 vertical gyro provides the roll and pitch signals under normal operating conditions. The No. 2 vertical gyro can be connected to the main attitude indicator in case of failure of the No. 1 vertical gyro by placing the selector in the No. 2 position. The VERT GYRO 2 switch located on the radio navigation panel in the upper rear area of the pilot's left side wall must be ON (up). Wait 3 to 4 minutes for the gyro to stabilize before pressing the No. 2 gyro CAGE button.

WARNING

Make sure the autopilot is disengaged when the VERTICAL GYROS selector is set to the No. 2 position. Do not attempt to engage the autopilot or the helicopter may start rocking uncontrollably.

B. Self-Test. The indicator has a built-in self-test that is activated by pressing the TEST button located in the lower left corner of the instrument bezel. When the button is pressed, the display elements should deflect as noted below and return to their, original position when the button is released.

- Aircraft silhouette should roll $10 \pm 5^\circ$ counter clockwise.
- Pitch scale should rotate downward $10 \pm 5^\circ$.
- Control pointers should deflect clockwise 10 ± 5 mm (0.20 to 0.59 in) clockwise and 15 ± 5 mm (0.59 to 0.79 in) upward.
- Ground proximity and course deviation index should deflect 10 ± 5 mm downward and 10 ± 5 mm to the left.
- The warning flags for roll, pitch and gyro failure should appear.

2-95.2 Standby Attitude Indicator

The UKT-2 standby attitude indicator is used to indicate the attitude of the helicopter relative to the horizon. Electrical signals from the No. 2 MGV-1SU vertical gyro are transformed by the indicator into the pitch and roll angles of the helicopter which are displayed on indicator. An adjustment knob in the lower right corner of the indicator bezel allows

the horizon indicator to be raised or lowered to coincide with the aircraft silhouette. Two standby attitude indicators are installed in the helicopter. One is located in the center area of the pilot's instrument panel. It is used as a standby in case of main attitude indicator failure. The other UKT-2 attitude indicator is located in the CPG compartment (see Figures 2-28 and 2-32).

A. Pilot Controls. The pilot's standby attitude indicator is activated when the No. 2 VERT GYRO switch located on the radio navigation panel in the upper rear area of the pilot's left side wall is turned ON (up) (see Figure 2-12).

B. CPG Controls. The CPG's indicator is turned on by setting the ATT IND (YKT-2) switch in the ON (up) position. The switch disconnects the pilot's standby attitude indicator to avoid overloading the No. 2 vertical gyro.

NOTE

D The ATT IND (YKT-2) switch is located near the upper left corner of the indicator on Mi-24/25D and Mi-35 helicopters.

F On Mi-24F helicopters, the switch is located on the right side of the CPG's instrument panel.

2-96 Master Warning System

The caution and warning panels indicate operation or failure of critical systems and important flight parameters. The advisory panels are composed of colored, labeled filters with incandescent bulbs. The electrical circuitry and construction of the panels allows for quickly testing the lights and for easy bulb replacement. Red, green, and yellow filters are used on the panels to signify the relative importance of the information. Red is used to warn of an emergency, i.e., failure of a critical system or component, which requires immediate reaction by the crew. Yellow lights warn of the abnormal operation of systems or components which do not produce an emergency situation or advise of the need to turn on a system or component, or indicate which components or systems are required to activate a planned program. Yellow lighting is also used to indicate that an objective has been reached or planned points have been passed over. Green lights are used to indicate the normal operation of certain critical components.

2-96.1 Blinking System

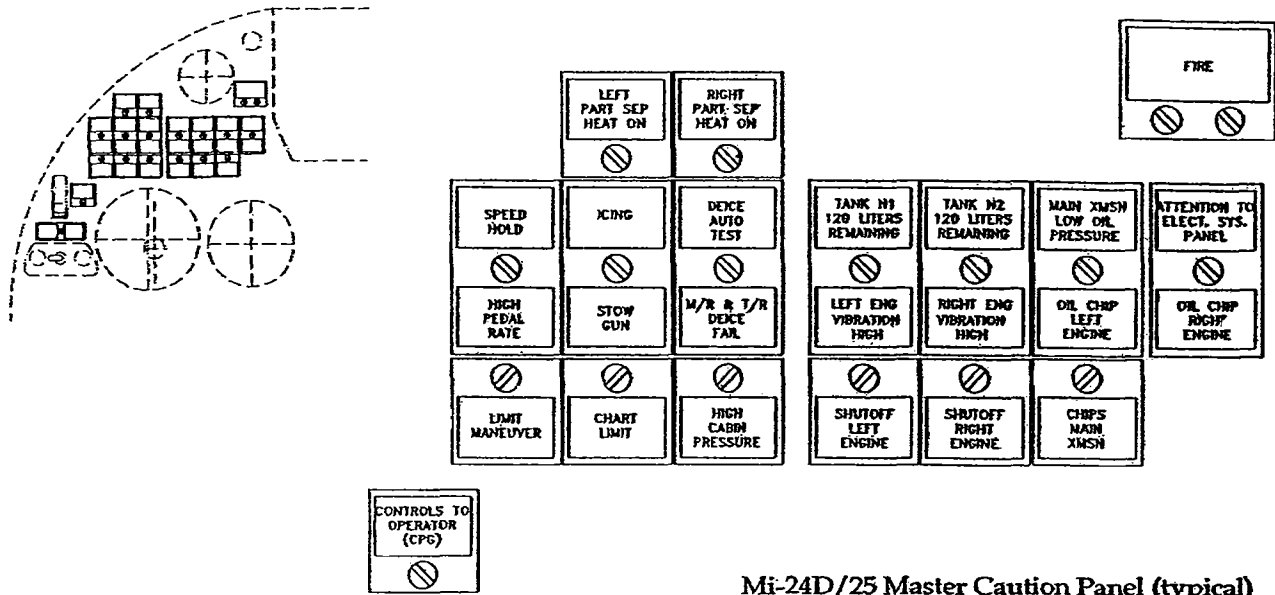
To draw immediate attention to critical advisories, a blinking circuit is connected to certain caution and warning panels. The blinking circuitry functions independently of the circuits which turn the individual advisories on and off. The blinking system is engaged using the BLINKER ON (up) - OFF (down) switch on the pilot's upper left rear panel (Figure 2-12). When the BLINKER switch is ON, if a caution / warning panel connected to the

system illuminates it will continue to blink until the fault is cleared. The pilot can turn off the blinking by setting the BLINKER switch to the OFF position. The following caution and warning panels are connected to the blinking circuitry:

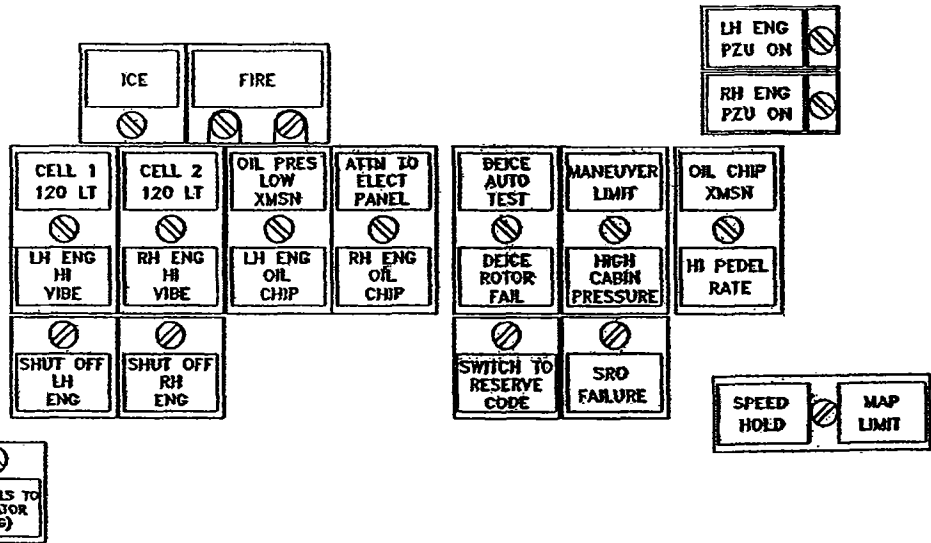
- VERTICAL GYRO 1 FAILURE (pilot's instrument panel)
- VERTICAL GYRO 2 FAILURE (pilot's instrument panel)
- FIRE (pilot's instrument panel)
- ICE (pilot's instrument panel)
- CELL N1 120 LT FUEL (pilot's instrument panel)
- CELL N2 120 LT FUEL (pilot's instrument panel)
- ATTN TO ELECT SYS PANEL (pilot's instrument panel)
- APU GEN WORKING (pilot's right console)
- LEFT GENERATOR OFF (pilot's right console)
- RIGHT GENERATOR OFF (pilot's right console)

2-96.2 Day-Night Dimmer System

The caution and warning panels are connected to a DAY-NIGHT system for varying the brightness of the bulbs. The lights are dimmed by attenuating resistors which are connected in series with the lights. The DAY-NIGHT system is used to eliminate glare on the cabin windows and improve visibility for night flying. When the DAY-NIGHT switch on the pilot's upper left rear panel (Figure 2-12) is placed in the NIGHT (down) position, the resistors are connected to the light circuitry, causing the lights to dim. When the switch is placed in the DAY (up) position, the resistors are shunted resulting in full brightness of the lights.



Mi-24D/25 Master Caution Panel (typical)



Mi-24F Master Caution Panel



Figure 2-40 Master Caution Panel

2-96.3 Light Test Buttons

There are three light test buttons for the checking the advisory panel bulbs. The LIGHT TEST button on the pilot's upper left rear panel is used to check all the advisory lights in the cockpit, except the landing gear indicator lights. The LIGHT TEST button for checking the landing gear indicator lights is located on the left front console (Figure 2-17) above the gear control lever. The LIGHT TEST button for checking the CPG's advisory panels is located on the CPG's left panel (see Figures 2-27 and 2-32). The lights can be tested using battery power.

2-97 Audio Warning System

The RI-65 audio warning system is designed to alert the crew of in-flight emergency situations over the intercom system. The audio warning system consists of a control unit which receives input from the onboard sensors and plays back the appropriate advisories and a control panel which allows for testing, repeating an advisory, and shutting off an advisory, message. The audio warning unit is installed in the radio compartment on the right side. The control panel is located in the upper aft area of the pilot's left side wall. The control panel has an OFF button, a TEST button, and a REPEAT button. The audio warning unit automatically broadcasts the recorded advisory message over the intercom when an activation signal is received from the onboard sensors. The channel 1 (Fire) message is also automatically broadcast over the VHF (R-860 or R-863) radio. The audio warning system receives 27 VDC from the Battery Bus via the AUDIO WARN circuit breaker on the left cb panel. The following advisories are recorded:

- Fire, aircraft (tail #). Check fire protection system panel. The FIRE advisory is confirmed by the FIRE warning light on the pilot's instrument panel and the light on the fire protection panel indicating which compartment the fire is in.

- Dangerous vibration, left (or right) engine. These advisories are confirmed by The LEFT or RIGHT ENG HIGH VIBRATION lights on the pilot's instrument panel.
- Main hydraulic system failure. This advisory is confirmed by the MAIN HYD SYS ON light going out and the BACKUP HYD SYS ON light coming on. Both lights are located on the pilot's front left control panel.
- Backup hydraulic system failure. This advisory is confirmed by lighting of The BACKUP HYD SYS FAIL caution light on the pilot's front left panel.
- Low fuel emergency. The low fuel advisory is confirmed by lighting of either or both of the CELL N1 120 LT FUEL and CELL N2 120 LT FUEL caution lights on the pilot's instrument panel.
- Low oil pressure main transmission. This advisory is confirmed by illumination of the LOW OIL PRES MAIN XMSN warning light on the pilot's instrument panel and a low or zero pressure reading on the transmission oil pressure/temperature gauge.
- Service cell fuel pump failure, check remaining fuel. This advisory is confirmed when the green SVC CELL PUMP No. 1 or No. 2 advisory lights on the fuel system panel go off.
- Extend landing gear. This advisory is activated when the flight altitude drops below the preset level on the RV-5 radar altimeter and indicated airspeed is less than 70 km/hr (37.8 knots). The signals for this advisory come from the RV-5 radar altimeter and SSA airspeed sensor.
- Audio warning system operational. This advisory plays to confirm system operation when the TEST button on the control panel is pressed.

Section XV Servicing, Parking, and Mooring

2-98 Servicing

Servicing information is given by systems or components. Fluid and lubricant specifications and listing of acceptable commercial types are shown in Table 2-1. Table 2-2 shows the Mi-24/25 helicopter's oil and fluid capacities. Table 2-3 lists the fuel capacities. Points used in frequent servicing of fuel, oil, and hydraulic fluid are shown in Figure 2-41.

2-99 Service Platforms and Fairings

Service platforms are a part of the engine, transmission, and hydraulic block cowlings providing access to the deck areas. The engine and transmission service platforms are capable of supporting a static weight of 400 pounds on the marked areas. The hydraulic block / APU service platforms can support a static weight of 200 lb. The cowlings are opened by releasing a latch on the side and pulling outward on the locking handle. The cowlings open outward and downward, providing a

limited standing area. The standing areas are covered with a non-skid material. When closed, the cowling locks prevent the cowling from opening in flight.

2-100 Fuel Servicing

All fuel servicing is by gravity. The No. 1 and No. 2 service cells and the No 3 cell have individual filling ports. There are TANK FULL lights located next to the filling ports. Cells No. 4 and 5 are filled by gravity through Cell No. 3. The INTERTANK VALVE switch on the fuel system panel must be set to the OPEN (up) position to fill cell No. 5. The internal auxiliary tanks are filled through the tank No. 6 filling port. The wing tanks have individual filling ports. The LEFT and RIGHT BATTERIES switches must be ON (UP) for operation of the TANK FULL lights during servicing. Always confirm the fuel type and grade, in the helicopter logbook. Use only those fuels or fuel mixtures that are authorized in the logbook.

Foreign Fluid or Lubricant	U.S. Equivalent Designation	Authorized Substitution
B-3 oil (engines, APU, transmission)	MIL-PRF-23699	Castrol 98
TsGIP hypoid gear oil (gearboxes, main rotor flap and drag)	MIL-PRF-2105 (GO 80/90)	Spiroy 90EP, Esso Expee, Compound-90, Mobile GX90, Castro 890
MS-20 aviation oil (main & tail rotor grips-summer)	MIL-PRF 6082 Grade 1100	AeroShell Oil 100, Esso Aviation Oil 100, Red Band Mobile
MS-14 aviation oil (main & tail rotor grips-winter)	MIL-PRF-22651 Type III	AeroShell Oil 80, Esso Aviation Oil 80, Mobile Oil Aero White Band
MK-8 preservation oil (engine/APU fuel system preservation)	MIL-PRF-2104 (1010)	AeroShell Turbine Oil 3
IPM-10 oil (environmental system cooling turbine)	MIL-PRF-7808	AeroShell Turbine Oil 390, Esso Turbo Oil 2380
AMG-10 hydraulic fluid (hydraulic systems)	MIL-PRF-83282	AeroShell fluid 41
AMG-10 hydraulic fluid (L/G shock struts, M/R dampers)	MIL-PRF-5606	
TsiATIM-201 grease (general purpose: flight control linkages, landing gear, driveshaft couplings, hinges, etc.)	MIL-PRF-25537	AeroShell Grease 6B, AeroShell Grease 14 Starplex 2
ST (NK-50) aircraft grease (wheel bearings)	MIL-PRF-81322	AeroShell Grease 22, AeroShell Grease 5A or 5B, Mobile Grease 22, Starplex HD

Table 2-1 Fluid and Lubricant Specifications

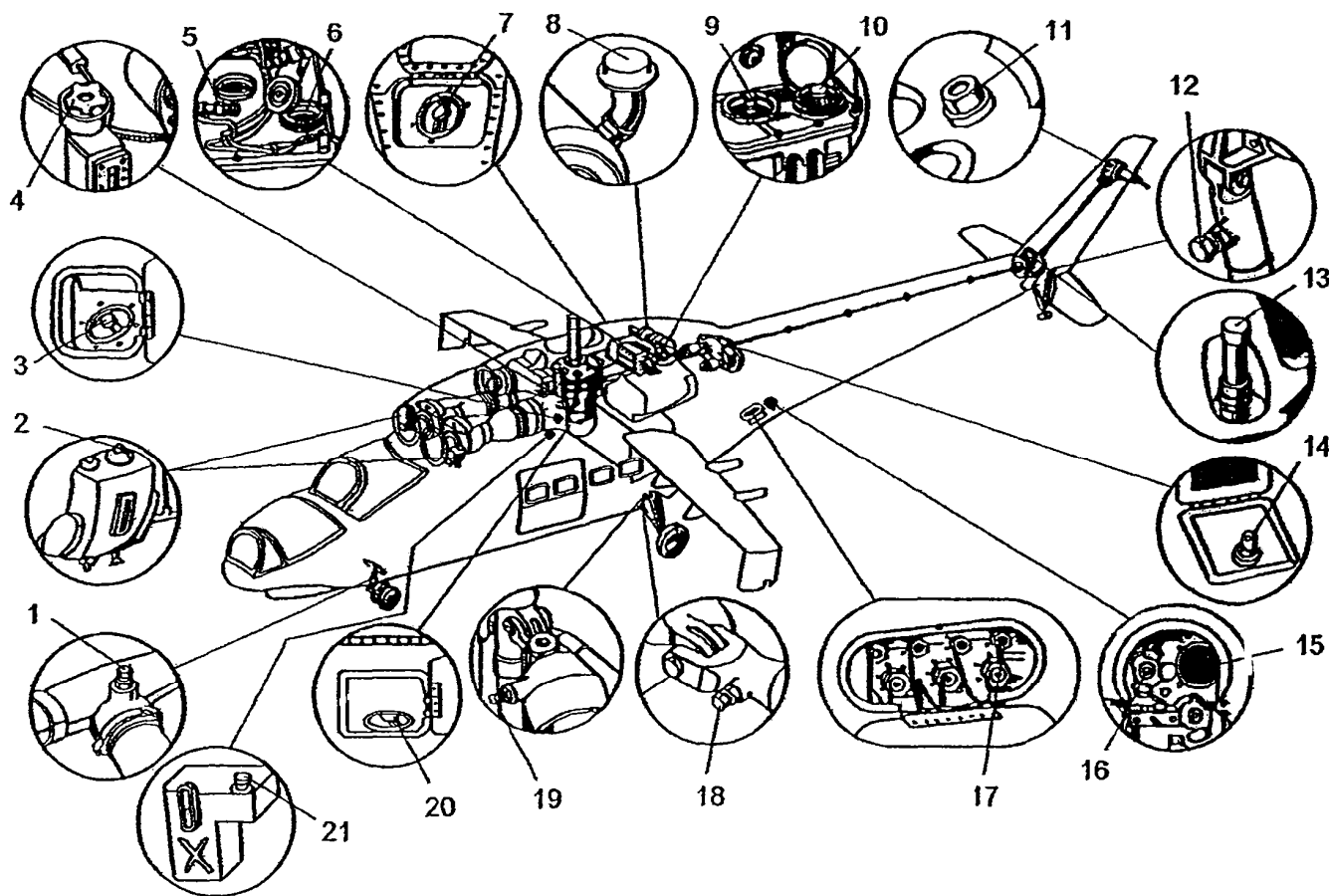


Figure 2-41 Servicing Points

1. N/L/G shock strut charging valve*
 2. Engine oil tanks
 3. Auxiliary fuel tanks (No. 6 and No. 7)
 4. Main transmission oil sump
 5. Utility hydraulic accumulator charging valve
 6. Utility hydraulic block reservoir
 7. Service fuel cells (No. 1 and No. 2)
 8. APU oil tank
 9. Main hydraulic accumulator charging valve**
 10. Main/back-up hydraulic block reservoir
 11. T/R gearbox breather plug
 12. Tail shock strut charging valve
 13. I/G/B filling point
 14. A/G/B eyebolt / filler cap
 15. Pneumatic system pressure gauge
 16. Pneumatic system charging valve
 17. Hydraulic system pressure filling
 18. M/L/G lever cylinder charging valve
 19. M/L/G shock strut charging valve*
 20. Vertical and lower fuel cells (No. 3, 4, and 5)
 21. Windshield washer alcohol tank
- * With pressure discharged and valve removed, this point is also used for hydraulic servicing
 ** Back-up hydraulic accumulator charging valve (not shown) is located on the opposite side of the AGS-60A hydraulic block

Servicing Point	Quantity (qt)	Fluid Type
Engine (each)	11 - 17	MIL-PRF-23699
Transmission	39 - 45	MIL-PRF-23699
Accessory Gearbox	5.3	GO 80/90
Intermediate Gearbox	1.4	GO 80/90
Tail Rotor Gearbox	1.8	GO 80/90
APU	2.6	MIL-PRF-23699
Main Hydraulic System	8.5 - 9	MIL-PRF-83282
Backup Hydraulic System	8.5 - 9	MIL-PRF-83282
Utility Hydraulic System	12.7 - 14.8	MIL-PRF-83282

Table 2-2 Oil and Fluid Capacities

Cell/Tank	Mi-24/25D		Mi-24F/35	
	Gallons	Liters	Gallons	Liters
Service Cell 1	84.5	320	84.5	320
Service Cell 2	84.5	320	84.5	320
Cell 3	134.7	510	128.1	485
Cell 4 (aft floor)	124	470	117.6	445
Cell 5 (forward floor)	134.7	510	128.1	485
TOTAL	562.4	2130	542.8	2055
Aux Tank 6/7 (each)	224.5	850	-	-
Wing Tanks 6/7/8/9 (each)	-	-	125.5	475
Maximum Fuel Capacity	1011.4	3830	1044.8	3955

Table 2-3 Fuel Capacities

2-100.1 Safety Precautions

- Both the helicopter and the fueling truck must be grounded.
- Fire extinguishing equipment must be readily available during all fueling / defueling operations.
- All unnecessary electrical equipment in the helicopter must be disconnected.
- Do not fuel or defuel the helicopter with the engines running, during thunderstorms, or within 5 minutes of shutdown.
- Do not perform any work which may generate sparks on the helicopter or within 25 m (82 ft) of the helicopter during fueling / defueling operations.

WARNING

Jet fuel is toxic and explosive. Do not breathe vapors. Do not get fuel on clothing or skin. If fuel spills on skin, remove with water and seek medical attention.

Do not allow sparks or open flame near the helicopter during fueling or defueling operations. Make sure the helicopter is grounded.

2-100.2 Fuel Servicing Procedure

NOTE

When servicing cells No. 3, 4, and 5, attach the filling nozzle extension to the fuel pump nozzle. Make sure the Cell No. 4/5 intertank valve is open before fueling.

- Turn ON the LEFT and RIGHT BATTERIES switches on the DC control panel. If cell No. 5 is to be filled, make sure the INTER-TANK VALVE switch on the fuel system panel is OPEN (up) and the FUEL GAUGE circuit breaker on the right cb panel is on (up). All other electrical equipment on the helicopter should be off.
- Ground the helicopter and fuel truck, ground the helicopter to the fuel truck, and ground the filling nozzle to the helicopter.
- Fill service cells No. 1 and No. 2 individually through the filling ports on the right and left sides of the fuselage above the wings. Fueling time for the each service cell is approximately 2 minutes. When the cell is full, the TANK FULL indicator light next to the filling port will come on.
- Fill vertical cell No. 3 and lower cells No. 4 and No. 5 as a group through the filling port for cell No. 3, located on the right side of the fuselage. Fueling time is approximately 5 minutes. When all three cells are full, the TANK FULL indicator light next to the filling port will come on.
- **D** Fill the internal aux tanks through the tank No. 6 filling port on the right side of the fuselage. Fueling time is approximately 3 minutes per tank. When the tanks are full the AUX TANK FULL indicator light next to the filling port will illuminate.
- **F** Fill external wing tanks through the individual filling port on each installed tank. Fill wing tanks symmetrically. Check visually for complete filling.
- After fueling, reinstall the filler cap. Close and secure the access panel. The TANK FULL light should go off when the access panel is closed.
- Check the quantity of fuel using the fuel gauge

in the cockpit. The TOTAL position of gauge does not include the fuel in the internal auxiliary tanks. On Mi-24F/35 helicopters, the TOTAL position does not include the fuel in cell No. 3 or the wing tanks. When using external drop tanks, all five internal fuel cells should be filled to full capacity to preclude premature activation of the WINGS TANKS EMPTY advisory light in the cockpit.

2-101 Oil Servicing

The helicopter must be level to get accurate oil level readings.

CAUTION

The engines, transmission, and APU are serviced with MIL-PRF-23699 or Castrol 98. Before adding oil, check the logbook to determine which type the system contains. Do not mix oil types. Do not overfill the oil systems. Damage to seals may result.

2-101.1 Engine Oil Servicing

Each engine has its own oil tank with a filling port and sight gage. Oil level must be between the FULL (11 lt) and ADD (8 lt) marks on the sight gages. Check oil levels before each flight and top off as needed. Make sure the oil level is at the FULL line before flights of over 6 hours duration.

2-101.2 Transmission Oil Servicing

The mission oil sump serves as the oil tank. The sight gage is located on the filler port on the lower right side of the transmission. Oil level must be between the FULL and ADD marks on the sight gage. Check the oil level before each flight and add oil as needed.

2-101.3 APU Oil Servicing

The APU has an internal oil tank with a filling port and sight gage. Oil level must be between the FULL and ADD marks on the sight gage. Check the oil level before each flight and add oil as needed.

2-101.4 Gearbox Oil Servicing

The accessory gearbox, intermediate gearbox,

and tail rotor gearbox are serviced with hypoid gear oil (MIL-PRF-2105 or GO 80/90). All three gearboxes have sight gages for checking the oil level. Oil levels must be between the upper (full) and lower (add) lines on the gages. The levels must be checked before each flight. Access to the A/G/B sight gage is via an inspection hatch on the right side of the fuselage. The servicing point is accessible through an access panel on the deck behind the APU. The I/G/B sight glass is accessible via an access hatch on the right side of the vertical stabilizer. The servicing point is accessed via a removable panel on the top of the tail boom. The T/R G/B sight gage is located at the rear of the gearbox. Access to the servicing point is via a removable panel at the top of the vertical stabilizer.

2-102- Hydraulic Servicing

WARNING

Prolonged contact with hydraulic fluid (MIL-PRF-83282) liquid or mist can irritate eyes and skin. After any prolonged contact with skin, wash affected area with soap and water. If liquid contacts eyes, flush immediately with clear water. If liquid is swallowed, do not induce vomiting; get immediate medical attention.

2-102.1 Hydraulic Block Reservoirs

The hydraulic systems are serviced with MIL-PRF-83282 hydraulic fluid. The sight gages are located on the main backup and utility system reservoirs. Fluid level must be within the yellow area of the gages. The levels must be checked before each flight, with no pressure in the hydraulic systems. The filling points are located on top of the reservoirs.

2-102.2 Hydraulic Damper Reservoir

The hydraulic damper reservoir is located on the mast above the main rotor hub. It is serviced with MIL-PRF-5606 hydraulic fluid. The level must be checked before each flight. Fluid level must be between the line inscribed on the transparent casing and the lower edge of the housing.

2-103 Main Rotor BIM Servicing

The main rotor blade integrity monitor (BIM) systems are serviced with dry, filtered air or nitrogen. A charging valve and pressure indicator is located at the base of each blade. Servicing pressure is based on ambient temperature and activation pressure of the system. If the red ring is visible in the indicator, the system has lost pressure and the helicopter is not allowed to fly.

CAUTION

Never charge the blade spar to a pressure exceeding 11.37 PSI. Damage to the BIM system may result.

2-104 Tail Rotor Hinge Servicing

The tail rotor grip hinges have individual oil reservoirs. Oil levels must be checked before and after each flight with each blade positioned vertically, pointing downward, in turn. The oil level must be between the upper (full) and lower (add) lines inscribed on the reservoir casing. The grips are serviced with hypoid gear oil (MIL-PRF-2105 or GO 80/90).

2-105 Tire Servicing

WARNING

Do not overinflate tires. Destruction of the tire, damage to the helicopter, and serious injury or death of personnel may result.

The tires should be serviced with nitrogen. The main landing gear tire pressure should be 78.2 to 85.3 PSI. The nose gear tire pressure should be 56.9 to 71 PSI. Under field conditions, the tires may be inflated with compressed air.

2-106 Pneumatic System Servicing

The pneumatic system should be charged with compressed air to a pressure of 50 to 54 kgf/cm² (711 to 768 PSI). Pressure must be checked preflight using the gauge located on the left side of the fuselage. Service the system if pressure is below 40 kgf/cm² (567 PSI).

2-106 Parking/Securing the Helicopter

The helicopter should be parked on pavement or firm dry ground in an area that is sheltered from the wind whenever possible. Ground and secure the helicopter in accordance with local requirements and weather conditions. Main rotor blades should be moored and gust locks installed on the hub and swashplate whenever the helicopter is parked outdoors, regardless of anticipated weather. Tie down the fuselage in accordance with local requirements (see paragraph 2-107 for mooring instructions). Ground support equipment should be placed at least 10 feet away from turning rotors. Remove or wet down loose soil, sand, or dry snow before starting the APU and engines to prevent FOD.

2-106.1 Securing the Cockpit

The cyclic must be centered and the collective full down. The rotor brake and wheel brakes must be engaged. All switches and circuit breakers must be OFF. Close and lock the cockpit door.

2-106.2 Securing the CPG Compartment

Controls must be stowed and the collective full down. All switches and circuit breakers must be OFF. Close and lock the canopy.

2-106.3 Securing the Helicopter

The helicopter must be turned into the wind and grounded. Wheel chocks must be in place on both main tires. Crew and cargo cabin doors must be closed and locked. All guns, wing stores, and flare/chaff dispensers must be unloaded.

2-106.4 Protective Covers

Protective covers must be installed in engine inlets and exhaust, APU exhaust, oil cooler fan inlet, A/G/B cooling duct, and flare/chaff dispensers, and on pitot tubes and air data probe. Canopy, blade, and fuselage covers may be installed based on anticipated weather. As a minimum, the canopies and windshields should be covered for UV protection when the helicopter is parked outdoors. If the helicopter will be parked for seven days or longer, install the full set of blade, tire, and fuselage covers.

2-107 Mooring

The blades must be moored whenever the

helicopter is parked outdoors. When wind speeds or gusts in excess of 35 knots are anticipated, also install the gust locks. In addition to tying down the blades, the fuselage should be moored when severe weather or very high winds are anticipated and the helicopter cannot be moved into a hangar. Use standard approved mooring cables to tie down the fuselage. If the parking area is not equipped with mooring rings, use approved ground anchors. The mooring points are located at the forward and aft areas of the center fuselage section on the left and right sides of the helicopter. The same mooring points are used to tie down the blades and to moor the fuselage. The blade tie-down straps, gusts locks, mooring cables are included in the mooring kit.

2-107.1 Blade Mooring

- Make sure the helicopter is turned into the wind and the main landing gear wheel chocks are in place.
- Turn the main rotor to ensure no blade is positioned directly over the tail boom. One blade should be offset approximately 30°.
- Apply the main rotor brake.
- Insert the tie-down strap pins in the blade tip fittings and turn 180° to secure
- Pull down on the blade tip, applying a force of 22 to 33 lb, and attach the tie-down strap snap hook to the nearest fuselage mooring point. Repeat for remaining blades.
- Adjust the straps to remove slack.

2-107.2 Installing Gust Locks

- Attach the upper end of one gust lock to the stud on the M/R flapping hinge of the forward-most blade (to prevent longitudinal movement).
- Secure the lower clevis of the gust lock to the pitch change link attachment point on the swashplate.
- Install a second gust lock on either the right or left side of side of the rotor hub to prevent lateral movement.

Chapter 3 Avionics

Section 1 General

Section II Communications

Communications radios have not yet been installed in this helicopter.

Section III Navigation Systems

A GPS has not yet been installed in this helicopter.

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 aircraft.

5-3 Exceeding Operational Limits

Any time an operational limit is exceeded an appropriate entry shall be made on DA Form 2408-13. Entry shall state what limits were exceeded, range, time beyond limits, and any additional data that would aid maintenance personnel in the maintenance action that may be required.

5-4 Minimum Crew Requirements

The minimum crew required to fly the helicopter is one pilot.

Section II System Limits

5-5 Instrument Marking Color Codes

Operating limitations are shown as colored strips on the instrument face plate of engine, flight and utility system instruments. The colors are GREEN for normal or safe range of operation, YELLOW markings indicate a range when special attention should be given to the operation covered by the instrument, and RED markings indicate the limit above or below which continued operation is likely to cause damage or shorten component life.

NOTE

Instrument markings may differ from actual limits.

5-6 Rotor Limitations

It is not abnormal to observe %N₁ and N₂ speed split during autorotational descent when the engines are fully decoupled from the main rotor. Observe that this split does not exceed 2% and that the engines remain within PPC limits.

Rotor Limits

Max Power On 103% RPM for 20 sec.
 Min Power On 88% RPM for 30 sec.

Rating	%RPM
Idle	45 to 65
Cruise	93 to 97
Normal	93 to 97
Takeoff	92 to 94
Autorotation	90 to 98. Avoid transient overspeeds of 115% RPM and underspeeds of 85% RPM during autorotations
Rotor "Beep" trim range	89 to 99%

5-6.1 Rotor Start and Stop Limits

Maximum wind velocity limits for rotor start and stop are as follows:

Headwind.....48 kts
 Tailwind.....20 kts
 Crosswind.....20 kts

NOTE

Application of rotor brake prohibited above 20% RPM.

5-6.2 Rotor Speed Limitations

Refer to Figure 5-1 for rotor speed limits.

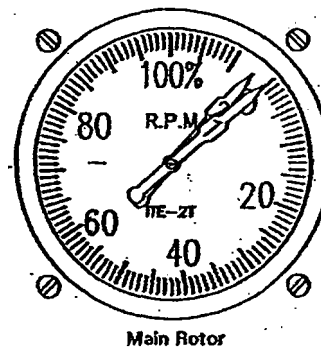


Figure 5-1 RotorSpeed Limitations

Section III Power Limits

5-7 Engine Limitations

NOTE

5-7.1 Engine Power Limitations

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 performance charts in Chapter 7.

The engine start sequence is limited also by the APU. In case of necessity it is allowed to perform 5 consecutive air bleeding cycles, each not exceeding 45 seconds in duration with intervals not less than 1 minute. In this case continuous operation time should not exceed 13 minutes followed by a 15 minute cool down.

5-7.2 Engine Starter Limits .

It is allowed to make 5 consecutive starting cycles, with intervals not less than 1 minute between start cycles. After 5 cycles a 15-minute cool down is required. The engine starter cycle should be completed within 33 seconds with a maximum time of 45 seconds. Refer to engine starter operations in Chapter 2 of this manual.

5-7.3 Fuel Limitations.

Only JP-8 or Jet A fuel is permitted. Fuel capacities are shown in Table 2-3 in Chapter 2 Section XV.

Engine Limitations

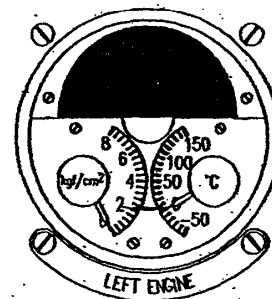
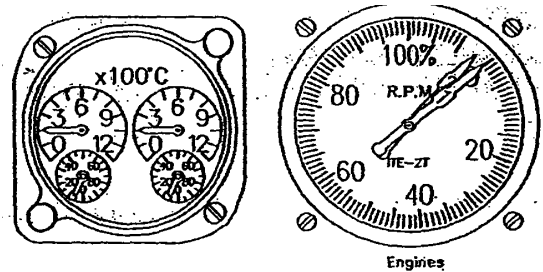
Rating	PTIT	NG%	Time
Takeoff	990°C	101%	6 min.
Normal	995°C	98.0%	60 min.
Cruise	910°C	96.0%	no limit
Idle	780°C	PPC	20 min.

Engine Oil Temperatures

Minimum to exceed idle RPM.....	30°C
Normal.....	80 to 140°C
Maximum	150°C for 30 min.

Engine Oil Pressures (kgf/cm²)

Minimum at 45% Ng during start.....	1
Minimum at idle	2
Normal at idle	2-4
Minimum at full RPM	3
Normal at full RPM	3 to 4
Maximum	4



NOTE
Upper scale
not used.

Figure 5-2 Engine Limitations

Transmission Oil Temperature

Minimum 30°C
 Normal..... 50 to 85°C
 Maximum 90°C

Transmission Oil Pressure

Minimum 5 kgf/cm²
 Normal..... 3 to 4 kgf/cm²
 Maximum 4 kgf/cm²

Intermediate G/B Temperature

Intermediate (45) 115°C Max.

Tail Rotor and Accessory Gearbox Temperature

T/R G/B (90)..... 115°C Max.
 A/G/B 100°C Max.

Accessory Gearbox Oil Pressure

A/G/B pressure 2.3 to 4.7 kgf/cm²

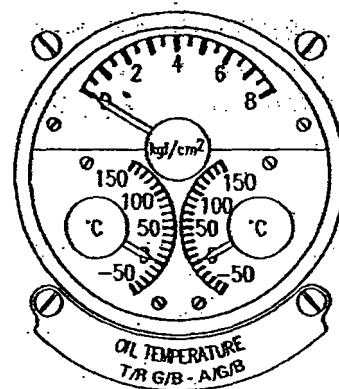
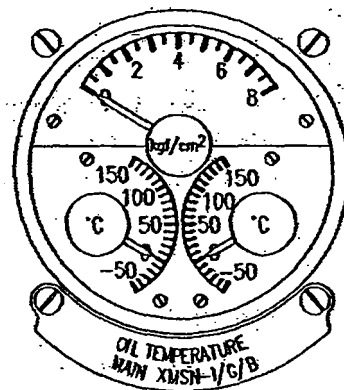


Figure 5-3 Drive System Limitations

Section IV Loading Limits

5-8 Center of Gravity Limitations

Center of gravity limits for the aircraft to which this manual applies and instructions for computation of the center of gravity are contained in Chapter 6.

5-8.1 Gross Weight Limits

The gross weights for the Mi-24 are listed below for the following configurations.

Ferry Configuration	26,014 lbs.
Combat Configuration	25,353 lbs.
Standard Configuration	24,692 lbs.

5-8.2 Cargo Weight Limitations

Maximum internal cargo weight.....3,307 lbs.
 Maximum external cargo weight4,409 lbs.

5-8.3 Cargo Floor Weight Capacity

Maximum cargo floor loading capacity pounds per square foot47

5-8.4 Cargo Floor Tiedown Fittings

Cargo floor tiedown fittings are rated at 5,000 pounds.

Section V Airspeed Limitations

5-9 Airspeed Operating Limits

The airspeed operating limits and forward flight Envelop charts in Chapter 7, Performance Data, define velocity never exceed (Vne) as a function of altitude, temperature, gross weight, and external stores configuration. Additional airspeed limits not shown on the charts are:

- Vne 24,692 lbs or less 181 KIAS
- Vne 24,692 lbs or more 170 KIAS
- Vte (Turbulence Penetration) 108 KIAS
- Vy (Best R/C) 70 to 75 KIAS
- Vyse (Best single eng R/C) 70 KIAS
- Vle (Max speed, gear extended) 86 KIAS
- Single eng approach speed 55-65 KIAS
- Roll on touchdown speed 20-27 KIAS
- Maximum touchdown speed 43 KIAS
- Maximum braking speed 27 KIAS

NOTE

Refer to the Forward Flight Envelope Chart in Chapter 7. The chart depicts Vne airspeeds minus 10%. This reduction in Vne is a built in safety margin for Airborne Systems flight operations.

5.10 Sideward/Rearward Flight Limits

The aircraft is limited to a maximum speed of 10 KIAS during sideward/rearward flight.

Section VI Maneuvering Limits

5-11 Prohibited Maneuvers

- a. Rearward ground taxi is prohibited
- b. Hovering turns greater than 18° per second (360° in 20 sec.) are prohibited.
- c. Aerodynamic braking during roll-on landings is prohibited once the aircraft nose gear is on the ground and collective is reduced.
- d. Engagement of the AFCS altitude hold mode with the CPG's flight controls engaged is prohibited.
- e. Never change the main rotor speed by the speed setting switch while executing the following maneuvers:
 - Dives.
 - Zooms.
 - Chandells.
 - Climbing or diving turns.
 - Accelerated turns or spirals.

CAUTION

Never use the trim button on recovery from a dive since this may cause abnormal vertical G-Load factors

5-12 Maneuvering Limitations.

- a. When flying at airspeeds of 160 KIAS and above, do not allow the slip indicator bubble to shift to the left more than 2 diameters.
- b. At gross weights exceeding 25,350 lbs the bank angle should not exceed 30° .
- c. During execution of vertical maneuvers, avoid sudden application of the cyclic or its movement through large distances in the longitudinal direction which may lead to main rotor blades striking, the tail boom.

5-13. Bank Angle Limitations

Refer to Chapter 7, Bank Angle Limits chart corrected for pressure altitude. Maximum bank angle uncorrected is 45° .

5-14 Landing Gear Limitations

Do not exceed a touchdown sink rate of 300 feet-per-minute on level terrain.

5-15 Landing Speed Limitations

Maximum forward touchdown speed is limited to 43 KIAS.

5-16 Slope Landing Limitations

The following slope limitations apply regardless of gross weight or CG, with or without wing stores.

CAUTION

When performing slope landings with external stores, check for adequate stores-to-ground clearance.

a. Engines operating:

- Nose Up 8°
- Nose Down 6°
- Left or Right 4°

b. Engines shut down:

- Nose Up 6°
- Nose Down 4°
- Left or Right 4°

Section VII Environmental Restrictions

5-17 Flight in Instrument Meteorological Conditions (IMC).

The aircraft is prohibited from intentional flight in instrument meteorological conditions.

5-18 Flight in Icing Conditions.

a. When ambient air temperature is $\pm 4^{\circ}\text{C}$ 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/m^3).

- Trace LWC 0 to $0.25 \text{ g}/\text{m}^3$
- Light LWC 0.25 to $0.5 \text{ g}/\text{m}^3$
- Moderate LWC 0.5 to $1.0 \text{ g}/\text{m}^3$
- Heavy LWC greater than $1.0 \text{ g}/\text{m}^3$

b. Helicopters equipped with operational engine inlet anti-ice, but not equipped with an operational blade deice system are permitted for flight into trace icing conditions. Flight into light icing conditions with an operational blade deice system is not recommended. Flights into moderate icing conditions are prohibited.

c. All other anti-icing equipment (i.e.; windshield, pitot heat, engine anti-ice) shall be installed and operational before flight into known or forecasted icing conditions.

Chapter 6

Weight/Balance and Loading

Section I General

6-1 General

Chapter 6 contains sufficient instructions and data so that an aviator knowing the basic weight and moment of the helicopter can compute any combination of weight and balance.

6-2 Classification of Helicopter

The Mi-24 helicopter is in class 2.

6-3 Helicopter Station Diagram

Figure 6-1 shows the helicopter reference datum lines, fuselage stations, wing stations and jack pad locations. The primary purpose of the figure is to aid personnel in the computation of helicopter weight/balance and loading.

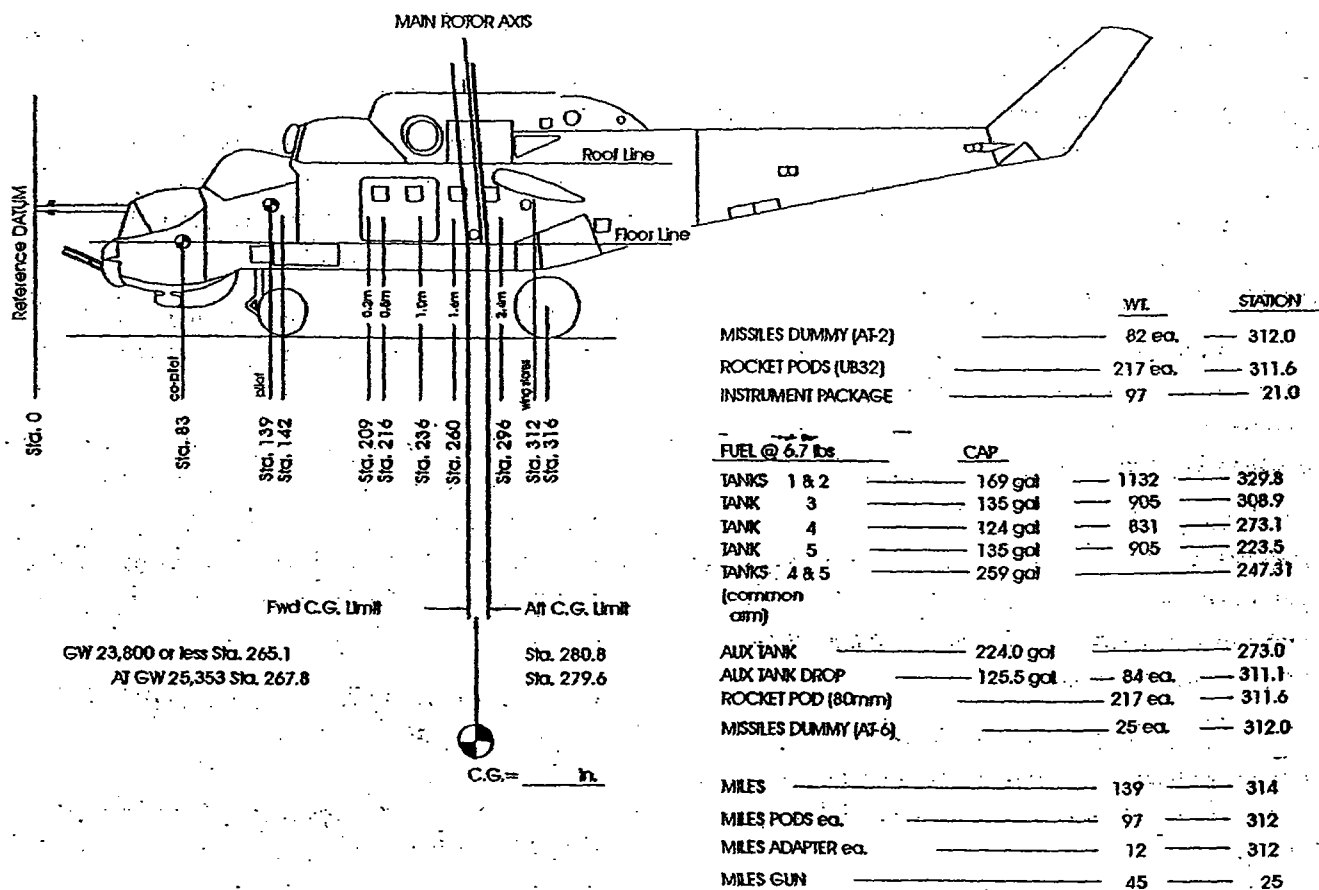


Figure 6-1 Mi-24/25/35 Weight and Balance Worksheet

Section II Weight and Balance

6-4 Weight Definitions

A. Basic Weight. Basic weight of an aircraft 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 to determine the gross weight for the aircraft. The basic weight varies with structural modifications and changes of fixed aircraft 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, or cargo.

C. Gross Weight. Gross weight is the total weight of an aircraft and its contents.

6-5 Balance Definitions

A. 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.

B. 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.

C. 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.

D. 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.

E. Basic Moment. Basic moment is the sum of the moments for all items making up the basic weight. When using the 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 the DD Form 365-3 for the specific helicopter.

F. Center of Gravity (CC). Center of gravity 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.

G. CG limits. CG limits (Figure 6-2) define the permissible range for CC stations. The CG of the loaded helicopter must be within these limits at takeoff, in flight, and on landing.

6-6 Loading Charts

A. Information. The loading data contained in this chapter is intended to provide information necessary to work a loading problem for the helicopter to which this manual is applicable.

B. Use. From the figures contained in this chapter, weight and moment are obtained for all variable load items and are added to the current basic weight and moment (DD Form 365-4).

(1) The gross weight and moment are checked on DD Form 365-3 to determine the approximate center of gravity (CG).

(2) The effect on CG by the expenditures in flight of such items as fuels, ammunition, etc., maybe checked by subtracting the weights and moments of such items from the takeoff weight and moments and checking the new weight and moment on the CG Limits Chart.

6-7 DD Form 365-1 Basic Weight Checklist

This form is initially prepared by the manufacturer before the helicopter is delivered. The form is a tabulation of equipment that is, or may be, installed and for which provision for fixed stowage has been made in a definite location. The form gives the weight, arm, and moment/100 of individual items, for use in correcting the basic weight and moment on DD Form 365-3 as changes are made.

6-8 DD Form 365-3 Basic Weight and Balance Records

The form is initially prepared by the

manufacturer at time of delivery of the helicopter. The form is a continuous history of the basic weight and moment resulting from structural and equipment changes. At all times, the last entry is considered current weight and balance status of the basic helicopter.

6-9 DD Form 365-4 Weight and Balance Clearance Form F

A. General. The form is a summary of actual disposition of the load in the helicopter. It records the balance status of the helicopter, step-by-step. It serves as a worksheet on which to record weight and balance calculations, and any corrections that must be made to ensure that the helicopter will be within weight and CC limits.

B. Allowable Gross Weight. Allowable gross weight for takeoff and landing is:

- 11,800 kg or 26,014 lbs for Ferry Configuration
- 11,500 kg or 25,353 lbs for Combat Configuration
- 11,200 kg or 24,692 lbs for Standard Configuration

NOTE

The PPC book for each aircraft has precomputed Forms F for the most typical aircraft configurations. Unique configurations will require the pilot to fill out a new Form F.

Section III Fuel/Oil

6-10 Fuel

OTSA aircraft are always refueled to a full fuel status. This is 563 gallons or 2130 liters (3826 lbs). An internal auxiliary tank can be installed that holds 259 gallons or 980 liters. Figure 6-1 shows fuel arm for normal and auxiliary fuel.

Section IV Personnel

6-11 Personnel

OTSA personnel are permitted to ride in the cargo compartment of Mi-24/25 aircraft on a mission required basis, following normal passenger procedures. Non-OTSA passengers must obtain GFR approval before riding in OTSA aircraft. Refer to the OTSA passenger policy letter for current guidelines.

Section V Armament

6-12 Armament

All armament is loaded on appropriate wing stations. Weights and arms for typical stores are shown in Figure 6-1.

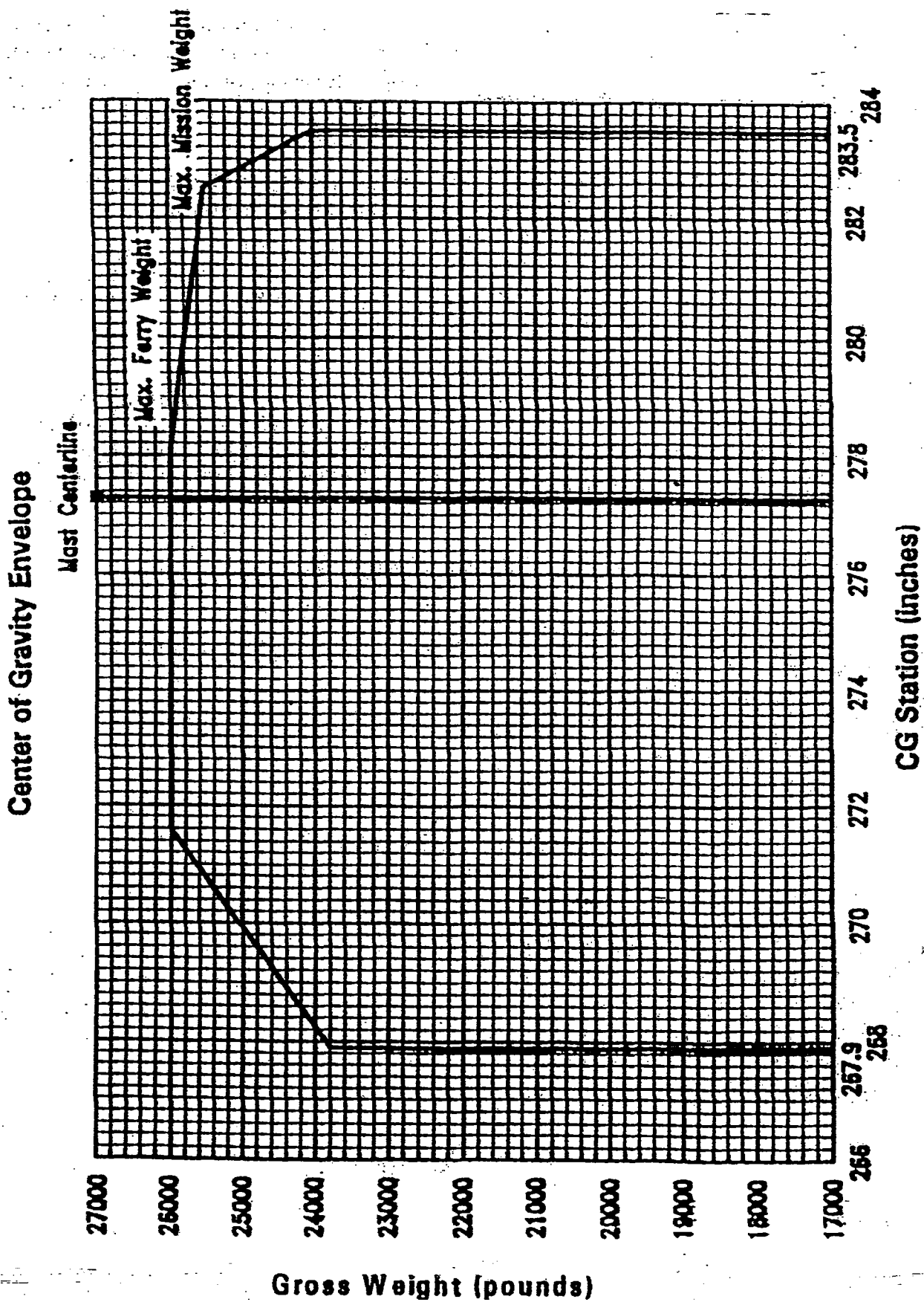


Figure 6-2 Center of Gravity Envelope

Section VI Cargo

6-13 Cargo Loading

The large cargo doors and open loading area preclude the need for special loading aids. Cargo tiedown fittings are located on the cabin floor for securing cargo. The small size of the cargo area makes it almost impossible to load the aircraft so as to exceed the CG limit, unless the cargo to be loaded is very heavy. Normal loading only requires that cargo be loaded from rear to front and be evenly distributed left to right. Internal cargo is limited to 1,500 kg or 3307 lbs.