United States Army Aviation Logistics School
Fort Eustis, Virginia

APRIL 1994

THIS DOCUMENT HAS BEEN REVIEWED FOR OPSEC CONSIDERATIONS

STUDENT HANDOUT

FUEL SYSTEMS

071-622-04

The proponent for this SH is USAALS

INTRODUCTION

TERMINAL LEARNING OBJECTIVE:

At the completion of this lesson you will:

ACTION:	Analyze fuel system malfunctions.
CONDITIONS:	Given TM 55-1520-238 and TM 1-1520-238-T series manuals.
STANDARDS:	Analyze by selecting from a list, malfunctions within the AH-64A fuel system, with a minimum of 70% accuracy.
SAFETY REQUIREMENTS:	In addition to specific safety requirements of this lesson plan, aviation shop and flight line safety standards established in the technical manuals shall be reinforced.
RISK ASSESSMENT LEVEL:	Low

WARNING

FUEL

Jet 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. If injury occurs, seek medical aid.

Jet engine fuel is highly flammable, explosive, and, toxic. Work in a well ventilated area away from open flames. Breathing of vapors could cause dizziness. If jet engine fuel comes in contact with eyes or skin, flush with water. If injury occurs, seek medical aid.

Do not allow sparks or flame near helicopter when servicing or maintaining fuel system. Make certain helicopter is grounded. If injury occurs, seek medical aid.

Defueling is a very hazardous operation because of fuel vapors. Trained fire fighting personnel and equipment must stand by during the entire task.

Fuel servicing shall not be performed during thunderstorms or possible lightning conditions.

WARNING

When opening anti-syphoning device on external tank flapper valve, extreme care should be exercised when releasing air pressure to preclude venting of fuel overboard through the filler neck.

WARNING

M The crossfeed switch shall be set to the **NORM** position at all times in flight, unless executing emergency procedures for **FUEL PSI ENG 1** and **FUEL PSI ENG 2** warning advisory. A malfunctioning crossfeed valve could result in a single engine flameout.

M Do not switch directly from **AFT TK** to **FWD TK** crossfeed (or **FWD TK** to **AFT TK**) without pausing for at least 15 seconds in the **NORM** position to insure both valves are sequencing to their proper positions. Failure to follow this procedure may result in a dual engine flameout if one of the crossfeed valves fails to position.

ENVIRONMENTAL CONSIDERATIONS: Dispose of all unusable fuel in accordance with all federal, state, local, and unit SOP regulations and requirements.

071-6

PROPERTIES OF AVIATION FUELS

Property	Gasoline	Kerosene grades		Blends of gasoline and kerosene
	AVGAS	JET A, JP-5, JP-6	JET A-1, JP-8	JET B, JP-4
Flash Point (By Closed-Cup Method at Sea Level)	-50°F	+95° to +145°F		-10° to +30°F
Flash Point (By Air Saturation Method)	-75° to -85°F	None		-60°F
Flammability Limits				
Lower Limit	1.4%	0.6%		0.8%
Upper Limit	7.6%	4.9%		5.6%
Temp Range for Flam Mixtures	-50° to +30°F	+95° to +165°F		-10° to +100°F
Vapor Pressure ASTM D 323	5.5 to 7.0 lb/ sq in	0.1 lb/sq in		2.0 to 3.0 lb/ sq in
Autoignition Temperature	+825° to +960°F	+440° to +475°F		+470° to 480°F
Freeze Point	-76°F	-40°F	-58°F	-60°F
Boiling Points				
Initial	110°F	325°F		135°F
End	325°F	450°F		485°F
Pool Rate of Flame Spread*	700 to 800 ft per min	100 ft per min or less		700 to 800 ft per min

*In mist form, rate of flame spread in all fuels is very rapid.

10-94-01

NOTES

A. Description of fuels

1. Jet or turbine fuels used in turbine-engine-powered Army aircraft have an American Petroleum Institute (API) gravity range of 36E to 57E API and a boiling range of 100EF to 600E F.

2. The types of jet fuels used in Army aircraft are JP-4 (wide-cut gasoline type) and JP-5/JP-8 (kerosene type). Commercial jet fuel procured locally under federal specification follow these guidelines.

B. Contamination of fuels. Water, solids, and microbial growth are the principle types of contamination.

1. Water. Either fresh or salt water may be present in fuel, and either may be present as dissolved or free water.

a. Dissolved water. Dissolved water is water that has been absorbed by the fuel. It cannot be seen and cannot be separated out of the fuel by either filtration or mechanical means. The danger of dissolved water is that it settles out as free water when the fuel is cooled to a temperature lower than that at which the water dissolved. Such a cooling of fuel is likely at high altitudes. Once freed, all the dangers of free water are present.

b. Free water. Free water can be removed from fuel by adequate filtering. It can seen in the fuel as a cloud, an emulsion, droplets or, in large amounts, as water on the bottom of the tank, sample container, or filter/separator. Free water, either fresh or salty, can freeze in the aircraft fuel system, can make certain aircraft instruments malfunction, and can corrode the aircraft fuel system. (Salt water is more corrosive than fresh water.) Ice in the aircraft fuel system can make the engines fail.

2. Solids. Sediment from tanks, pipes, hoses, pumps, people, and the air contaminate fuel. The most common elements of the sediment found in aviation fuels are bits of rust, paint, metal, rubber, dust, and sand.

3. Microbiological growth

a. Microbiological growth is growth of living organisms (protozoa, fungi, or bacteria) at the interface between fuel and water wherever there are pockets of water in fuel tanks. If there is no water in the fuel, microbes cannot grow. The growth is brown, black, or gray and looks stringy or fibrous. Microbiological growth contaminates fuel and causes problems because:

(1) The organisms hold rust and water suspended in the fuel and act as stabilizing agents for fuel/water emulsions.

(2) The organisms can make fuel controls operate sluggishly and make fuel flow-dividers stick.

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10-94-01

NOTES

b. Microbiological growth in aircraft fuel is a reliable indication that the fuel filters have failed, that the water has not been properly stripped from the fuel, or that the fuel storage tanks need to be cleaned more frequently.

c. The use of fuel system icing inhibitor (FSII) helps curb microbiological growth. However, in spite of the effectiveness of FSII, it is still very important to remove all water from aviation fuel and aircraft fuel systems.

C. Fuel additives

1. Department of Defense procured fuel contains the additive fuel system icing inhibitor (FSII). It also contains a static dissipating additive (SDA).

a. FSII prevents the water in fuel from freezing at normal water-freezing temperatures. Frozen water particles which collect on filter screens can cause fuel starvation. This leads to engine failure.

b. SDA increases the fuel's conductivity thereby permitting rapid depletion of any static charge generated during movement. This additive is usually injected by personnel at the supporting Defense Fuel Support Point located closest to the using activity. Low levels of fuel conductivity increase the hazard for explosion. High levels of conductivity can adversely affect aircraft fuel probes.

WARNING

Should it become necessary to inject either FSII or SDA, extreme caution is required. Both of these additives, in the neat form, are extremely dangerous and can cause serious health problems, both near- and long-term.

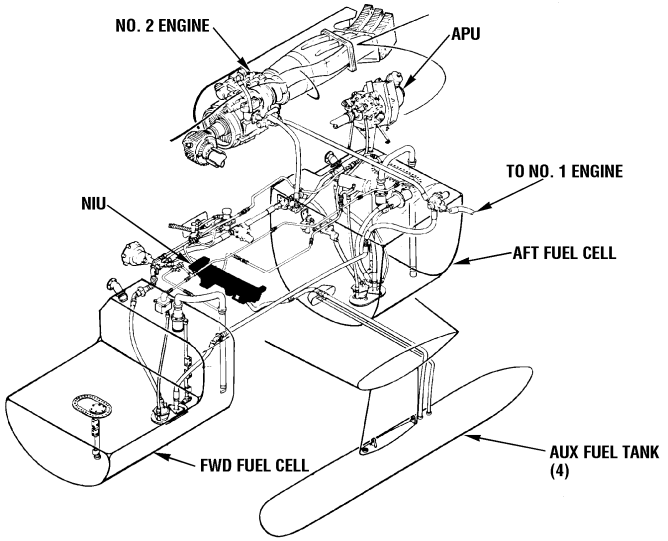
2. Icing inhibitor conforming to MIL-I-27686 shall be added to commercial fuel not containing an icing inhibitor during refuel operations, regardless of ambient temperatures. The additive provides anti-icing protection and also functions as a biocide to kill microbial growths in aircraft fuel systems.

a. The additive (Prist or equivalent) is not available through the Army Supply System; it is to be procured locally when needed.

b. Refueling operations shall be accomplished in accordance with accepted commercial procedures.

071-6

FUEL SYSTEM



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83-85aA

NOTES

A. AH-64A fuel system

1. The fuel system stores and supplies fuel for distribution to the engines and auxiliary power unit.

2. Fuel cells are installed in the bottom of the helicopter, forward and aft of the ammunition bay. Auxiliary fuel tanks are attached to pylons on the bottom of the helicopter wings.

B. Fuel system safety precautions

WARNING

When working on the helicopter, clean up any spilled fuel with cotton rags. Spilled fuel could ignite and cause personnel injury or damage to equipment.

For protection from fuel spills keep your sleeves rolled down and buttoned. Keep your shirt-tail tucked in. Do not carry loose items in your pockets. Loose items could fall out of your pockets and cause sparks. Do not wear jewelry. Jewelry could strike against metal surfaces and cause sparks.

To prevent injury to personnel or damage to equipment, observe normal fire precautions while working on helicopter fuel system.

When using a fire extinguisher in a confined space, wear a respirator. If a fire extinguisher is discharged in a confined space, ventilate space as soon as possible. Serious personnel injury could occur if vapors are inhaled. If injury occurs, seek medical aid.

CAUTION

Jet fuel will cause fuel cell material to swell, delaminate, and leak if allowed to contact fuel cell material more than 72 hours. Keep jet fuel away from the outside of fuel cells.

C. System fuel storage capacity.

1. Internally stored fuel

a. Forward fuel cell capacity is 155 gallons/1007.5 pounds.

b. Aft fuel cell capacity is 220 gallons/1430 pounds.

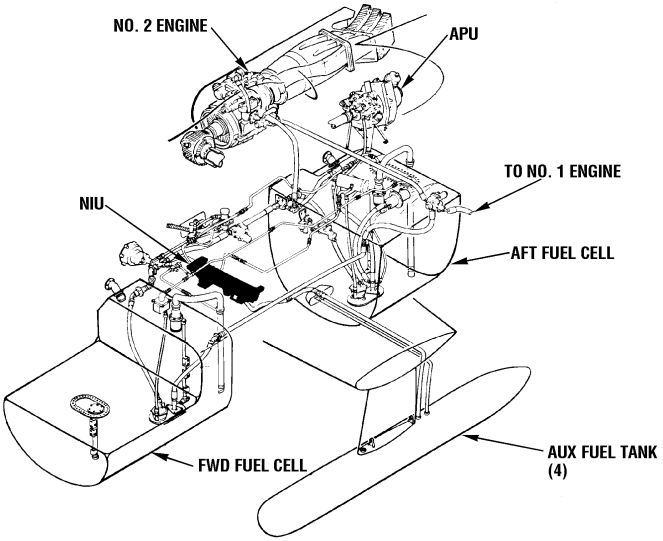
c. Total internal fuel capacity of 375 U.S. gallons/2437.5 pounds.

2. Auxiliary tanks

a. Each tanks capacity is 230 gallons/1495 pounds.

071-6

FUEL SYSTEM



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83-85aA

NOTES

b. Helicopter fuel capacity with four auxiliary tanks and internal fuel is 1295 U.S. gallons/8417.5 pounds. (Weight is based on JP-4 at 6.5 pounds per gallon)

D. The fuel system consists of the following major components.

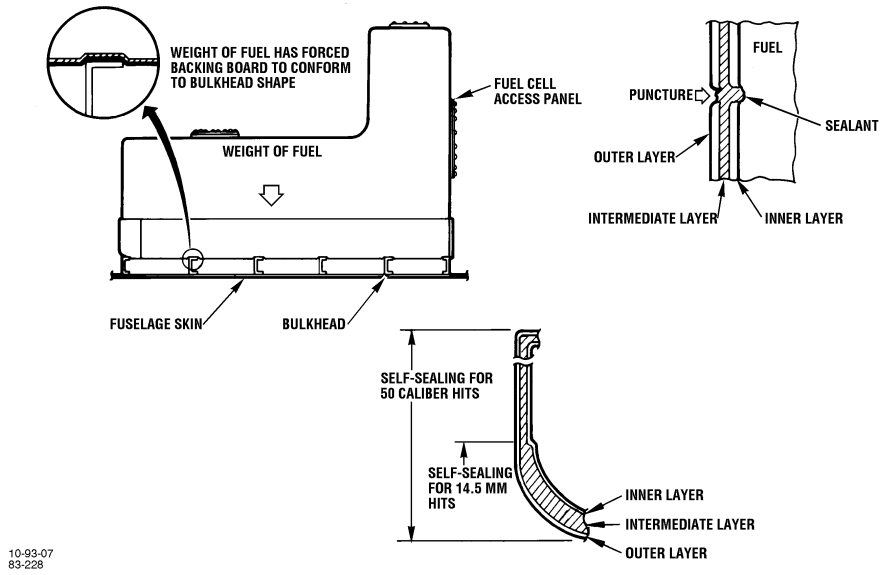
1. Forward fuel cell

2. Aft fuel cell

3. Nitrogen inerting unit (NIU)

4. Auxiliary fuel tanks

FWD FUEL CELL



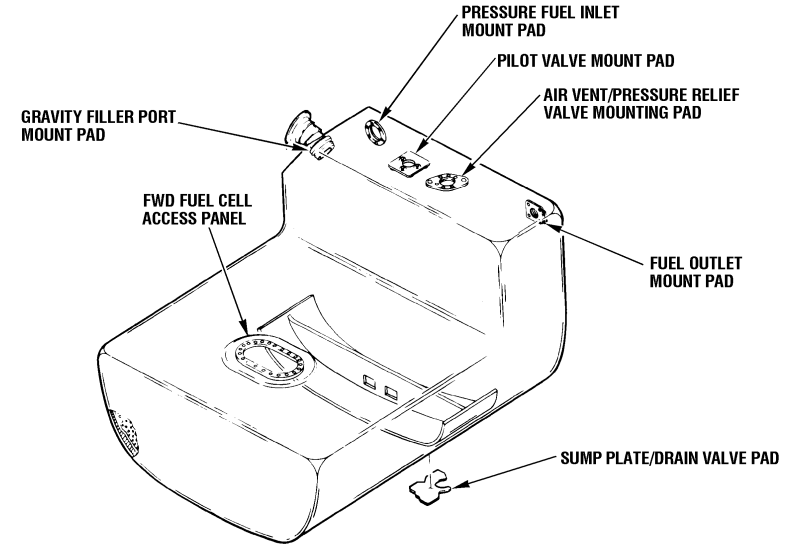
NOTES

E. Forward fuel cell

1. The cell is a bladder that is crash-resistant and self sealing. The outer and inner layers are made of several layers of rubber-impregnated nylon. The intermediate layer consists of uncured rubber which forms a sealant material. The uncured rubber reacts to fuel whenever the fuel cell is punctured. This reaction causes the uncured rubber to swell and seal the hole.

2. The forward fuel cell is surrounded on the bottom and sides by the helicopter skin, rigid foam, Kevlar liner, and backing boards. The rigid foam is used to fill the voids between the bulkheads. The Kevlar liner between the foam and backing boards provides additional ballistic protection. The fiberglass backing boards reduce the possibility of cell chafing.

FWD FUEL CELL MOUNT PADS



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NOTES

3. Forward cell mount pads

   a. The mounting pads provide secure mounting of the fuel cell to the helicopter.

   b. Seven pads are molded into the fuel cell.

      (1) Forward fuel cell access panel

      (2) Gravity filler port mount pad

      (3) Pressure fuel inlet mount pad

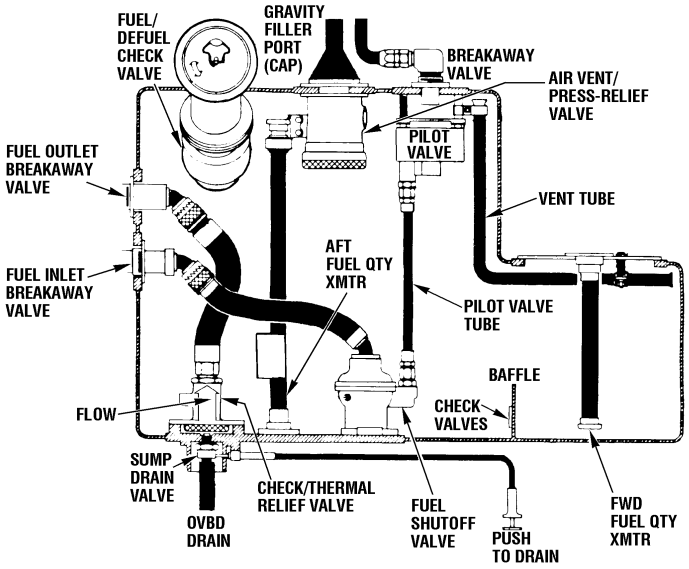
      (4) Pilot valve mount pad

      (5) Air vent/pressure relief valve mount pad

      (6) Fuel outlet mount pad

      (7) Sump plate/drain valve mount pad

FWD FUEL CELL COMPONENTS



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NOTES

4. Forward cell components

   a. Fuel inlet breakaway valve (aft wall)

   b. Fuel outlet breakaway valve (aft wall)

   c. Nitrogen inerting unit breakaway valve (top of cell)

   d. Air vent/pressure relief valve (top of cell)

   e. Gravity filler port/fuel-defuel check valve (aft right side of cell wall)

   f. Sump drain valve (bottom of cell)

   g. Check/thermal relief valve (bottom of cell)

   h. Aft fuel quantity transmitter

   i. Forward fuel quantity transmitter

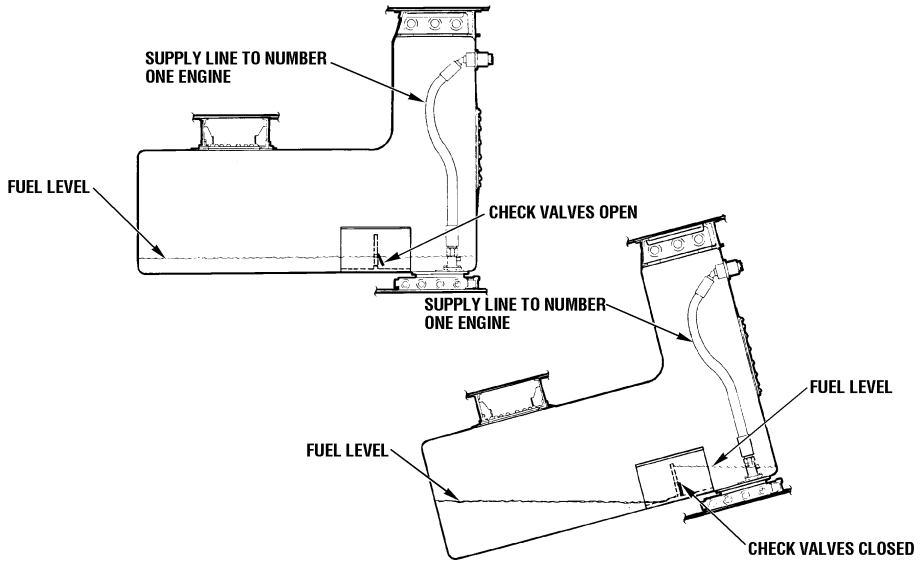
   j. Fuel shutoff valve

   k. Pilot valve with interconnect tube

   l. Vent tube

   m. Baffle and check valve

BAFFLE / CHECK VALVE



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NOTES

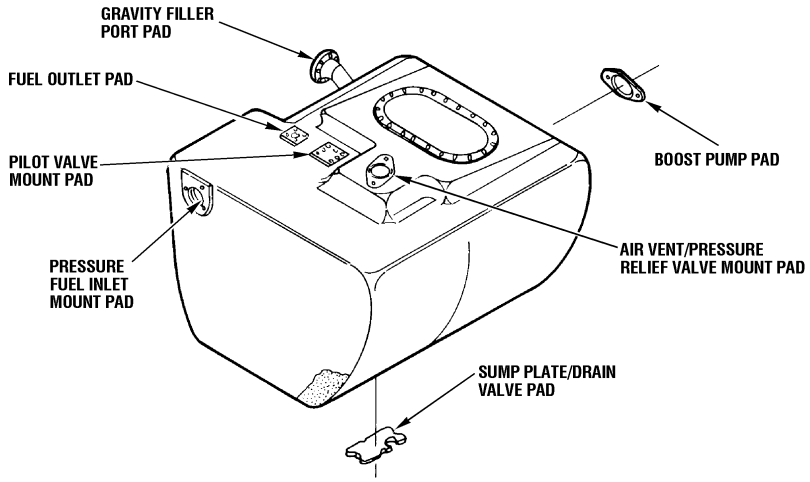
n. Baffle and check valve

(1) The baffle and check valve allow fuel to flow between the forward and aft sections of the forward fuel cell.

(2) It is installed in the lower aft portion of the cell.

(3) During level and nose up flight the valve remains open allowing fuel to flow to the aft portion of the fuel cell. When the fuel level falls below the baffle, and the helicopter is placed in a nose low attitude, the valve closes. This traps fuel in the aft portion of the cell and ensures an uninterrupted supply of fuel to the engines.

AFT FUEL CELL MOUNT PADS



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NOTES

F. Aft fuel cell

1. The cell is a bladder that is crash-resistant and self sealing. The outer and inner layers are made of several layers of rubber-impregnated nylon. The intermediate layer consists of uncured rubber which forms a sealant material. The uncured rubber reacts to fuel whenever the fuel cell is punctured. This reaction causes the uncured rubber to swell and seal the hole.

2. The aft fuel cell is surrounded on the bottom and sides by the helicopter skin, rigid foam, Kevlar liner, and backing boards. The rigid foam is used to fill the voids between the bulkheads. The Kevlar liner between the foam and backing boards provides additional ballistic protection. The fiberglass backing boards reduce the possibility of cell chafing.

3. Aft cell mount pads

   a. The mount pads provide secure mounting of the fuel cell to the helicopter.

   b. Six pads are molded into the fuel cell.

      (1) Pressure inlet mount pad

      (2) Gravity filler port pad

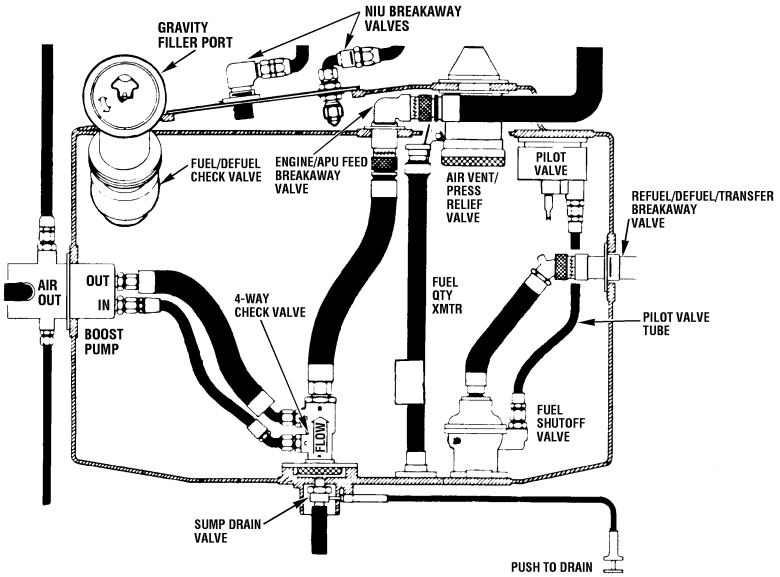
      (3) Boost pump pad

      (4) Air vent/pressure relief valve pad

      (5) Sump plate/drain valve pad

      (6) Pilot valve mount pad

AFT FUEL CELL COMPONENTS



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83-233B

NOTES

4. Aft fuel cell components

   a. Boost pump

   b. Gravity filler port/fuel-defuel check valve

   c. Two (2) nitrogen inerting unit breakaway valves

   d. Engine/auxiliary power unit feed breakaway valve

   e. Refuel/defuel/transfer breakaway valve

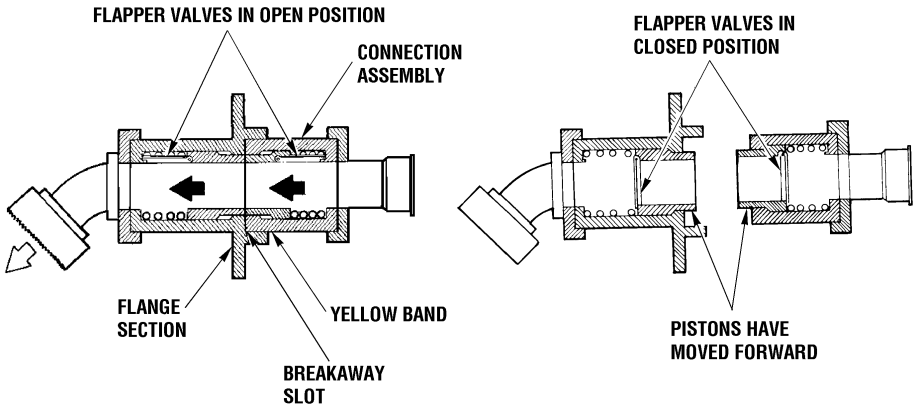
   f. Fuel level control valve (pilot valve, interconnect tube, and fuel shutoff valve)

   g. Fuel quantity transmitter

   h. Four-way check valve

   i. Sump drain valve

BREAKAWAY VALVE OPERATION



NOTES

j. Breakaway valve

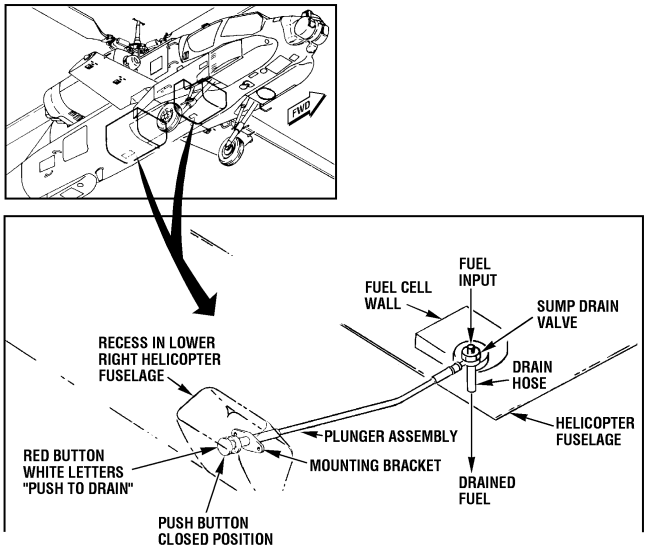
(1) The breakaway valve reduces fire hazards by sealing the fuel cells and lines in the event of a high-impact landing.

(2) They are dual flapper-type valves that are normally open to permit fuel flow.

(3) When valve displacement occurs (1/16 to 1/8 inch or greater), the valve spring tension forces the piston against the flapper allowing the seal to close.

(4) It is possible for the valve body to separate from the flange section without completely separating the valve. When this occurs, a yellow band is visible between the flange and the connection. If the yellow band is visible refer to TM 55-1520-238-23 for corrective action.

FUEL SUMP DRAIN ASSEMBLY



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NOTES

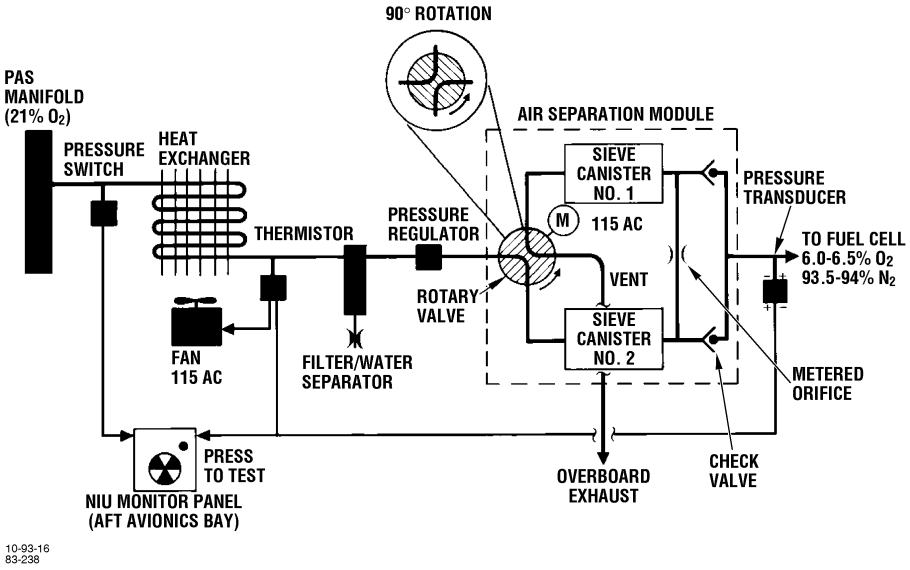
G. Fuel sump drain assembly

1. Provides a means to sample the fuel.

2. One drain is under the forward fuel cell and one is under the aft fuel cell. Each drain has its own PUSH TO DRAIN plunger.

3. The drain plunger is push-and-release operated. Pushing the plunger drains fuel. Releasing the plunger activates the spring loaded mechanism and closes the sump drain valve.

NITROGEN INERTING UNIT (NIU)



NOTES

H. Nitrogen inerting system. The nitrogen inerting system consists of the NIU, the NITROGEN INERT MONITOR indicator, and associated valves, lines, and fittings.

1. NIU

a. The NIU reduces the amount of oxygen in the air supplied to the fuel cells by about 70%. The remaining amount of oxygen cannot support combustion.

b. The NIU is mounted inside the ammunition bay, above the ammunition magazine.

c. Pressurized air from the air pressure manifold enters the NIU and is regulated to 25 " 3 PSI. The NIU depletes most of the oxygen in the air, leaving a 94% nitrogen rich air mixture. The nitrogen-rich air is then forced to the aft fuel cell. The aft cell feeds the forward cell with the nitrogen-rich air.

d. The pressure switch sends a signal to the NIU monitor that activates a timing circuit. The timing circuit provides a 10-second delay that allows the NIU to come on line prior to energizing the monitor.

e. NIU components

(1) Pressure switch

(a) Monitors the pressure air system (PAS) inlet pressure.

(b) Activates the NIU monitor when PAS inlet pressure drops to zero.

(2) Heat exchanger

(a) Cools inlet air from the PAS manifold.

(b) Ambient air passes through the fins of the heat exchanger and cools the PAS air flowing through the exchanger core.

(3) Thermistor

(a) Monitors heat exchanger outlet air temperature.

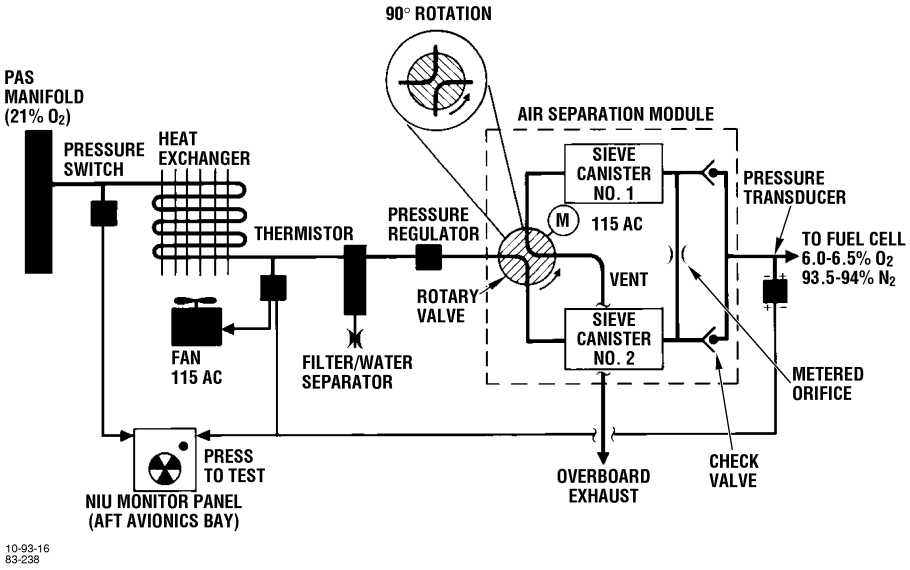
(b) Sends a signal to energize the internal cooling fan if outlet airflow temperature exceeds 140EF (60EC).

(4) Heat exchanger cooling fan

(a) Provides cooling air for the heat exchanger.

(b) Internally mounted, 115 VAC, axial flow type fan.

NITROGEN INERTING UNIT (NIU)



NOTES

(5) Filter/water separator

(a) Removes the majority of the water, normally caused by condensation, from PAS air.

(b) Consists of small glass fibers, tightly wrapped, in a tube. Capable of removing 98% of water droplets 2.0 microns or larger. The water is expelled overboard through a drain line.

(6) Pressure regulator

(a) Regulates PAS manifold air pressure to 25 " 3 PSI.

(b) The regulated air is used in the air separator module.

(7) Air separator module

(a) Reduces the oxygen content of the pressurized air from 21% to 6.0-6.5%.

(b) Module major components include the rotary valve, molecular sieve canisters (2), metered orifice, and one-way check valves (2).

1) Rotary valve

a) Provides for pressurization and exhaust of the sieve canisters.

b) Operated by a 115 VAC constant speed motor. Also acts as a shutoff valve if pressurized air or electrical power is not available.

2) Molecular sieve canisters

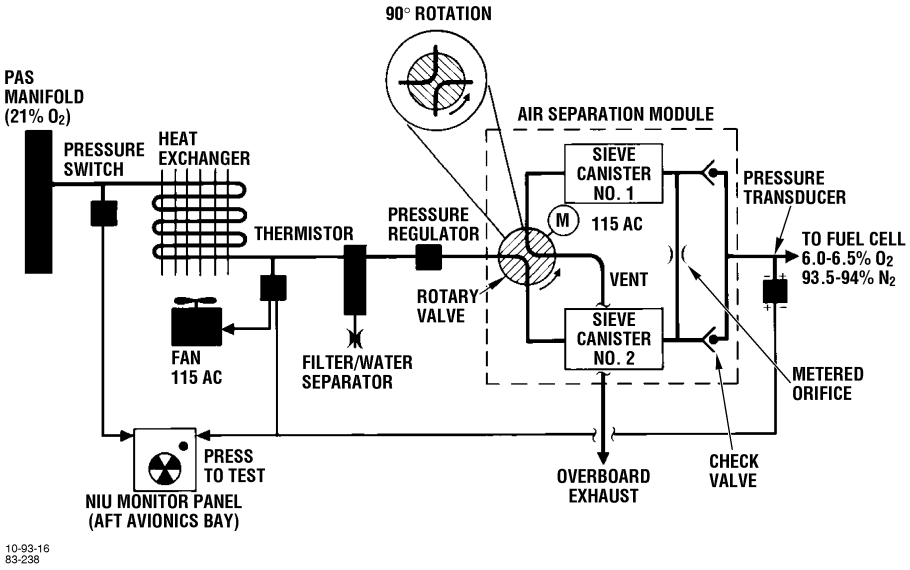
a) Absorbs oxygen molecules from the PAS supplied air.

b) The two canisters contain synthetic zeolite. (Zeolite is a material that attracts and holds oxygen molecules).

3) Metered orifice

a) Provides a means of back flushing the trapped oxygen molecules from the canisters.

NITROGEN INERTING UNIT (NIU)



NOTES

b) The metered orifice controls the amount of air flow used to exhaust the oxygen molecules from the sieve canisters.

4) One-way check valves

a) Prevent excessive back-flow from the pressurized canister to the exhausting canister.

b) Check valves allow air to flow in one direction only.

(8) Pressure transducer

(a) Monitors NIU outlet pressure and provides a signal to the NIU monitor panel.

(b) Detects pressure changes as the rotary valve rotates. Any restriction in the system triggers the NIU monitor panel.

f. NIU Operation

(1) Pressurized air from the PAS manifold enters the NIU.

(2) The pressure switch senses the pressure and closes, sending a signal to the NIU monitor. This activates a timing circuit that provides a 10-second delay. This allows the NIU to come on line before energizing the NIU monitor.

(3) Air flows through the heat exchanger where it is cooled to within 25EF (3.9EC) of the ambient air temperature.

(4) The air exiting the heat exchanger passes the thermistor.

(a) If the temperature is below 40 EF (4.4 EC), the thermistor turns the fan off.

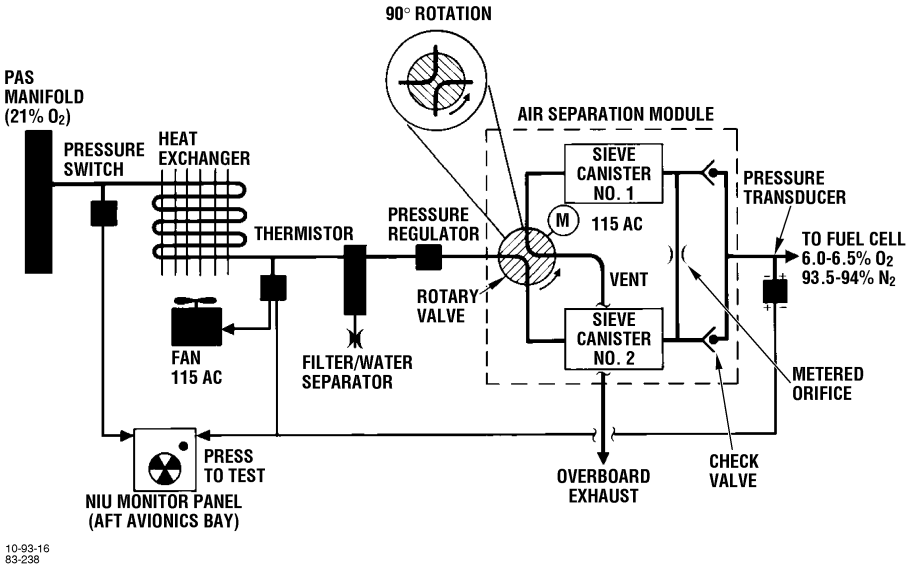
(b) If the temperature is above 140 EF (60 EC), the thermistor turns the fan on.

(5) The air enters the filter/water separator where condensation is drained overboard.

(6) Air enters the pressure regulator which regulates the air pressure to 25 "3 PSI (1.5 to 1.9 kg/cm2).

(7) Regulated air enters the rotary valve and is directed to one of the two (2) molecular sieve canisters. In the canisters approximately 71% of the oxygen molecules are trapped by the molecular sieve.

NITROGEN INERTING UNIT (NIU)



NOTES

(8) The majority of the nitrogen-rich air flows through the one-way check valve to the pressure transducer and into the fuel cells.

(9) A portion of the nitrogen-rich air passes through the metered orifice. The air flushes out the oxygen molecules trapped in the opposite canister and vents the oxygen from the system.

(10) The fuel cells receive an air mixture of 93.5% to 94.0% nitrogen and 6.0% to 6.5% percent oxygen.

2. NIU monitor panel

a. Provides a visual indication of NIU operational status.

b. The panel has two built-in-test (BIT) indicators.

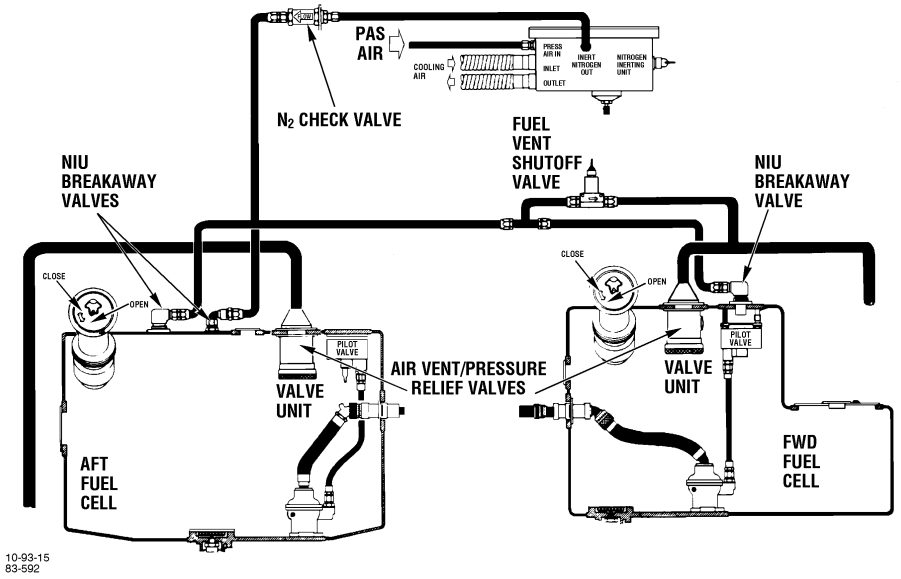
(1) One BIT indicator is located on the NIU.

(2) The second BIT indicator is located in the aft avionics bay.

(3) The BIT indicators provide a visual GO/NO-GO indication.

c. If the NIU pressure transducer senses that pressure output is insufficient, it fails the NITROGEN INERT MONITOR BIT indicator.

NITROGEN INERTING SYSTEM



NOTES

3. Valves

   a. N_2 check valve. The N_2 check valve is an in-line valve that provides one-way flow of nitrogen-rich air to the aft and forward fuel cells.

   b. Fuel vent shutoff valve

      (1) When closed, the valve prevents loss of nitrogen rich air during flight operations.

      (2) When open, the fuel vent shutoff valve allows air trapped in the top of the fuel cells to be vented overboard during refueling.

   c. Air vent/pressure relief valves. The air vent/pressure relief valve vents the fuel cell during NIU operation. It also:

      (1) Equalizes pressure inside the fuel cell by venting excess pressure overboard to prevent overexpansion of the fuel cells.

      (2) Vents excess fuel overboard in the event of automatic fuel shutoff failure and prevents fuel leakage in the event of a rollover.

   d. NIU breakaway valves

      (1) Two breakaway valves are located on top of the aft fuel cell and one breakaway valve is located on top of the forward fuel cell.

      (2) The breakaway valves reduce fire hazards by the fuel cells and lines in the event of a high impact landing.

4. Nitrogen inerting system air flow

   a. Pressurized air from the PAS enters the NIU.

   b. The pressurized air is regulated by the NIU to 25 "3 PSI.

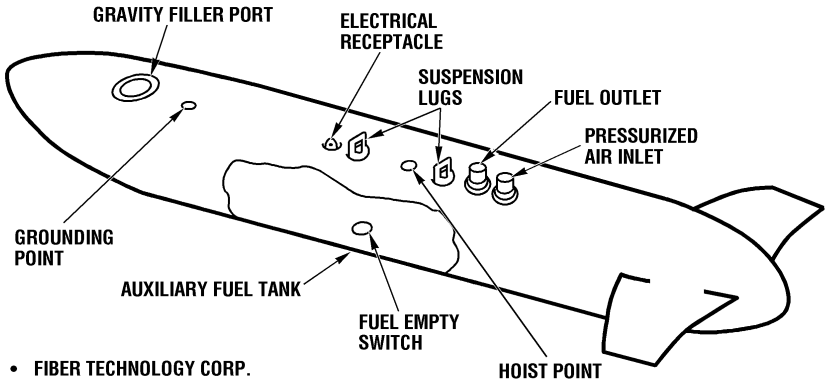
   c. The NIU delivers the air, which is 94% nitrogen, through the N_2 check valve to the aft fuel cell.

   d. From the aft fuel cell, the air flows through the aft-most breakaway valve to the forward fuel cell.

   e. The fuel vent shutoff valve, when closed, prevents the loss of nitrogen rich air. When opened for refueling operations, the fuel vent shutoff valve allows the air to be vented overboard.

   f. The air vent/pressure relief valves vent the fuel cells during NIU operation to prevent overexpansion of the fuel cells.

AUXILIARY FUEL TANK



- FIBER TECHNOLOGY CORP.
- EMPTY WEIGHT 146.5 LB
- COMPOSITE MATERIAL
- 15 FT LONG, 6 FT 3 IN. CIRCUMFERENCE
- FSCM 59297 - P/N 235SFT001-503
- BLACK HAWK COMPATIBLE

10-93-17
83-234

NOTES

071-622-04

I. Auxiliary fuel tanks

1. Store and suppy additional fuel for ferry operations.

2. Attache to the underside of each wing.

3. As many as four may be mounted for extended range operations.

4. The tanks are jettisonable; the pull-away couplings are self-sealing; the quick disconnect couplings are the breakaway type.

5. Helicopter wings house the fuel and air lines necessary for operation of the external system.

6. Several restrictions apply to the use of external fuel tanks. Refer to the Interim Statement of Airworthiness Qualification for details.

7. Auxiliary fuel tank(s) components

a. Gravity filler port

b. Grounding point

c. Electrical receptacle

d. Two suspension lugs

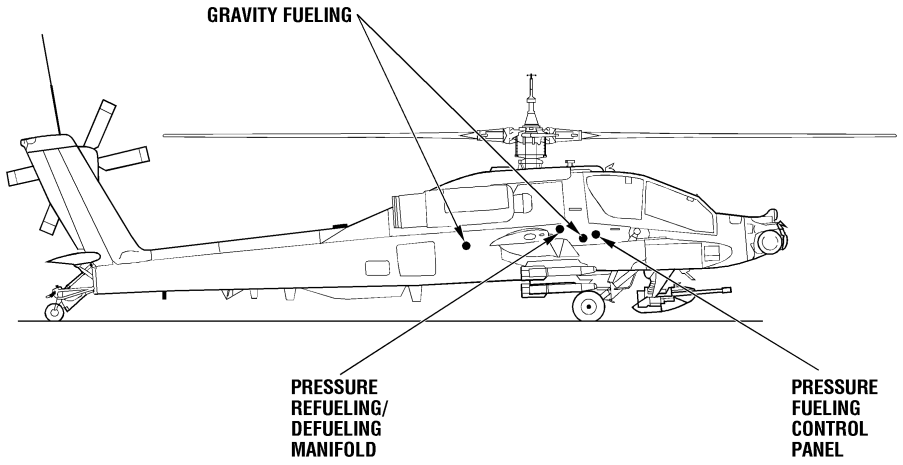
e. Air inlet port

f. Fuel outlet port

g. Hoisting point

h. Fuel empty switch

FUEL SERVICE POINTS



10-93-19
83-239

NOTES

071-622-04

A. Refueling and defueling system

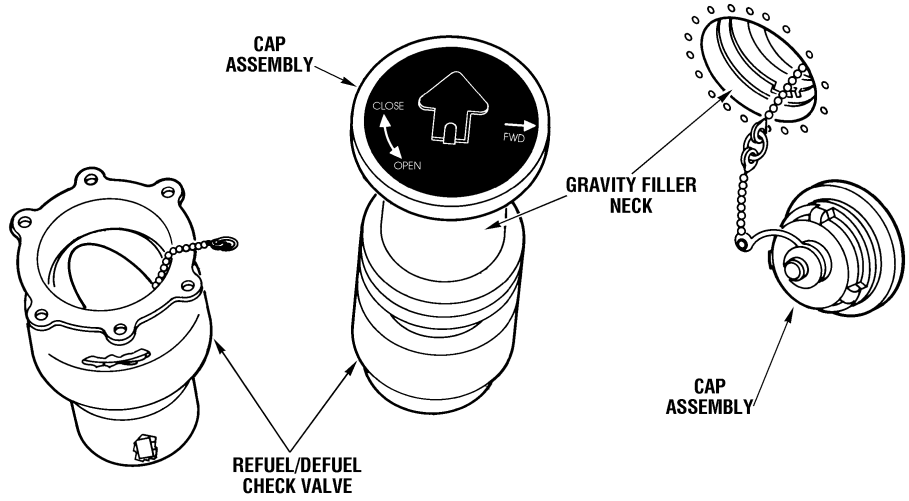
1. Provides controlled pressure refueling, suction defueling, and automatic fuel shutoff.

2. Pressure refueling occurs through a single point adapter or closed circuit adapter.

3. Forward and aft cells have separate gravity fueling filler ports.

B. Fuel service components utilized during refuel and defuel operations are the gravity filler ports, pressure refueling/defueling manifold, and pressure fueling control panel

GRAVITY FILLER PORT



NOTES

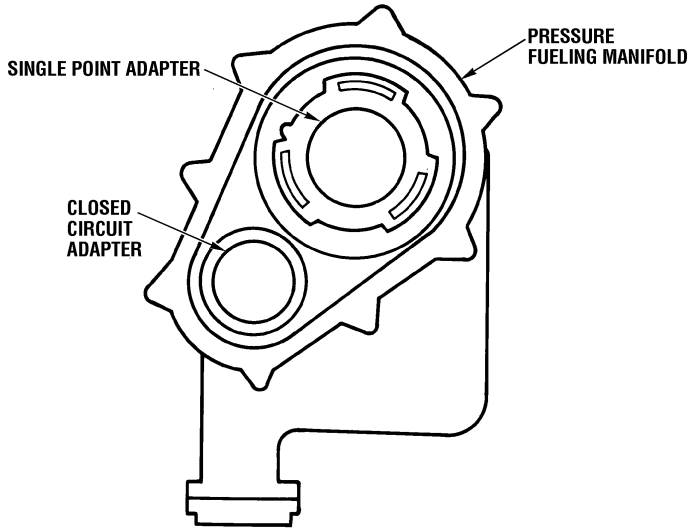
1. Gravity filler ports

   a. Provide a means of gravity fueling or defueling the forward and aft fuel cells.

   b. One filler port for each cell is located on the right side of the fuselage. Each filler port has a cap assembly that provides access to the filler neck.

   c. The refuel/defuel check valve has a flapper valve that is spring-loaded to the closed position. This flapper valve seals the gravity port and allows pressurization of the fuel cell with nitrogen.

PRESSURE REFUELING / DEFUELING MANIFOLD



10-93-21
83-240

NOTES

2. Refuel/defuel manifold

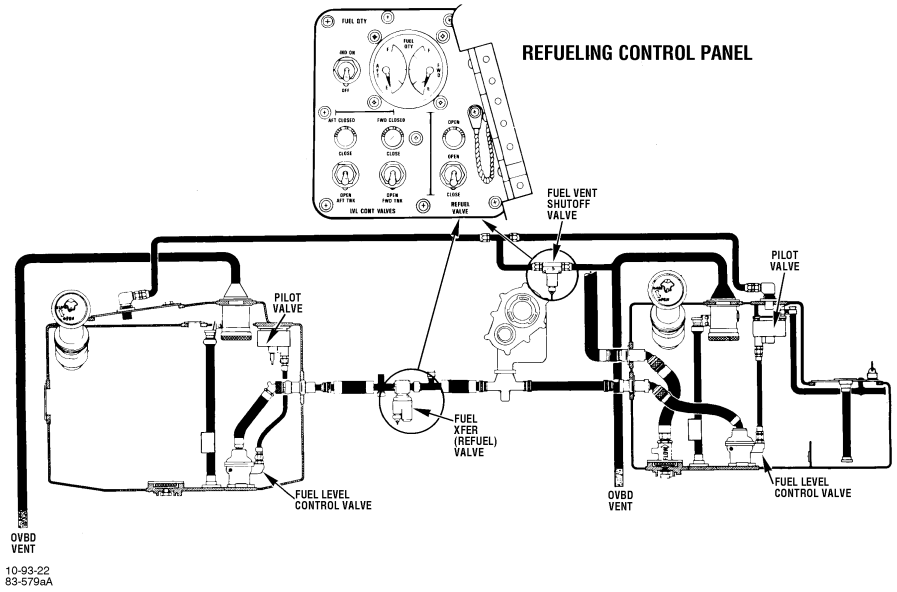
   a. Houses the single point and the closed circuit adapters. Each adapter has a spring-loaded check valve that is forced open when the fuel nozzle is connected.

   b. Mounted on the right side of the fuselage, forward of the wing.

      (1) The single point adapter allows a fueling rate of 100 gpm.

      (2) The closed circuit adapter, used at NATO bases, allows a fueling rate of 60 gpm.

REFUEL/DEFUEL SYSTEM



NOTES

3. Refueling control panel

   a. Controls refuel operations and monitors fuel quantity during refueling. Allows the crew to check automatic fuel shutoff.

   b. Mounted behind an access door on the right side of the fuselage, forward of the wing.

   c. Components of the refuel panel

      (1) IND ON-OFF switch

      (2) FUEL QTY indicator

      (3) Aft and forward tank LVL CONT VALVE switches

      (4) Aft and forward level control valve indicator lights

      (5) REFUEL VALVE switch

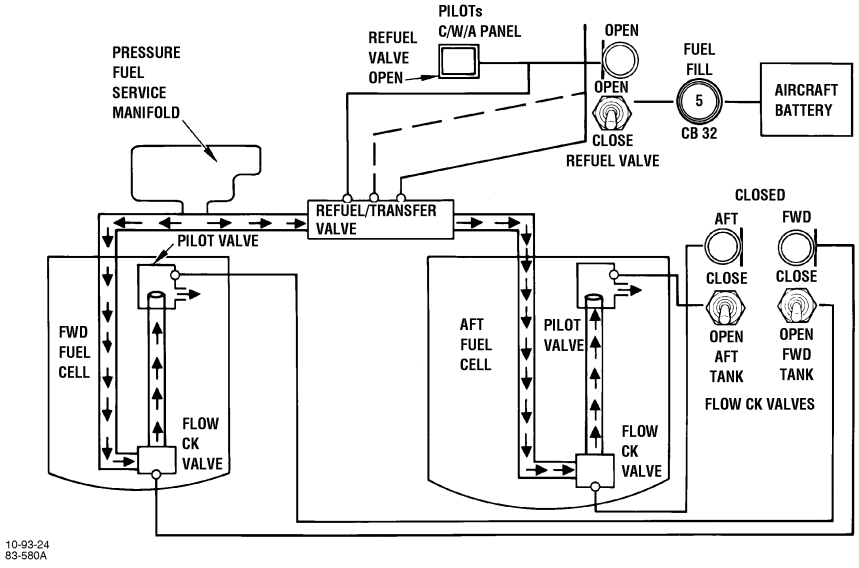
      (6) Refuel valve indicator light

   d. The IND ON/OFF switch and REFUEL VALVE switch are supplied battery power any time the battery is connected. Placing the switch to the ON position enables the fuel quantity indicator to display fuel quantity in both tanks.

   e. Placing the refuel valve switch to the OPEN position energizes the fuel transfer (refuel) valve and the fuel vent shutoff valve, permitting pressure refueling. The REFUEL VALVE indicator light on the refueling panel and the REFUEL VALVE OPEN light on the pilot's caution/warning/advisory panel illuminate when the fuel transfer/refuel valve is open.

   f. The AFT and FWD LVL CONT VALVE switches and indicator lights are used to check the operation of the fuel level control valves. When the switches are placed to the CLOSED position after refueling begins, the fuel level control valves close. This terminates refueling and causes the AFT CLOSED and FWD CLOSED LVL CONT VALVE indicator lights to illuminate. This checks the automatic shutoff function of the refuel system.

PRESSURE REFUELING



NOTES

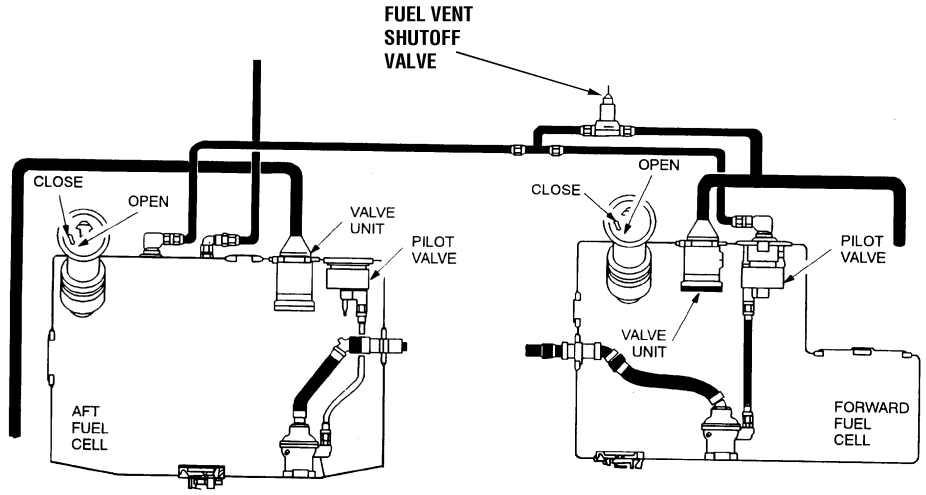
g. Operation during pressure refueling

(1) The fuel transfer valve is open only during refuel/defuel operations. This valve is controlled by the refuel valve switch on the refueling control panel.

(2) When the valve is open, it allows fuel to flow from the refueling manifold to the aft cell, or aft cell to the manifold during suction defuel operations.

(3) After refueling, the refuel valve switch is positioned to the closed position. This action extinguishes the control panel caution light and the pilot caution/warning segment light.

FUEL VENT SHUTOFF VALVE



NOTES

C. Refuel/defuel system components

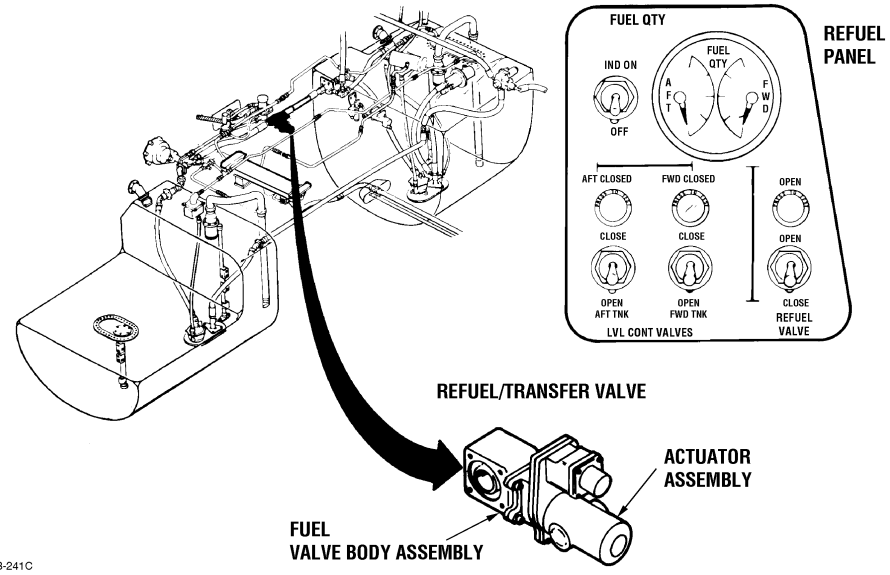
1. Fuel vent shutoff valve

a. When open, the valve allows air trapped in the top of the cell to be vented during refueling. When closed, it prevents loss of nitrogen.

b. Mounted on the right side of the ammunition bay.

c. Controlled by the REFUEL VALVE switch.

REFUEL/TRANSFER VALVE



NOTES

2. Refuel/transfer valve

   a. Open only during refuel or defuel operations and allows pressure fueling and suction defueling of the aft tank.

   b. Motor-operated valve requiring 24 VDC for operation

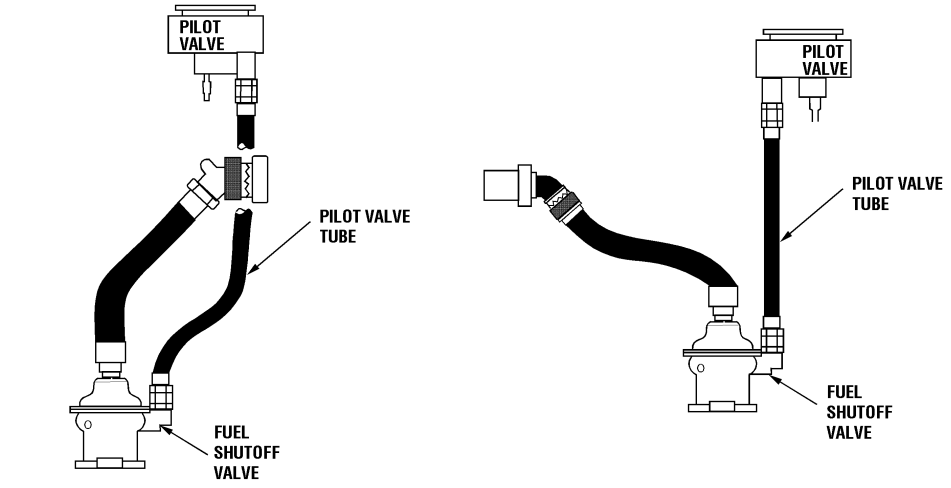
   c. Controlled by the REFUEL VALVE switch on the refueling panel.

   d. Mounted on the upper right side of the ammunition bay.

   e. Anytime the valve is open, an indicator light on the refueling panel and the pilot caution/warning/advisory panel light segment REFUEL VALVE OPEN illuminates.

   f. The valve must be closed in order for the fuel transfer pump to operate.

FUEL LEVEL CONTROL VALVES



AFT FUEL LEVEL CONTROL VALVE

FWD FUEL LEVEL CONTROL VALVE

Note: The pilot valve, pilot valve tube, and fuel shutoff valve are components of the fuel level control valve.

10-94-03

NOTES

3. Fuel level control valves

   a. The fuel level control valves automatically shut off fuel flow into the fuel cells when they reach capacity, during pressure refueling or fuel transfer.

   b. One fuel level control valve is installed in each fuel cell.

   c. Fuel level control valve components

      (1) Pilot valve

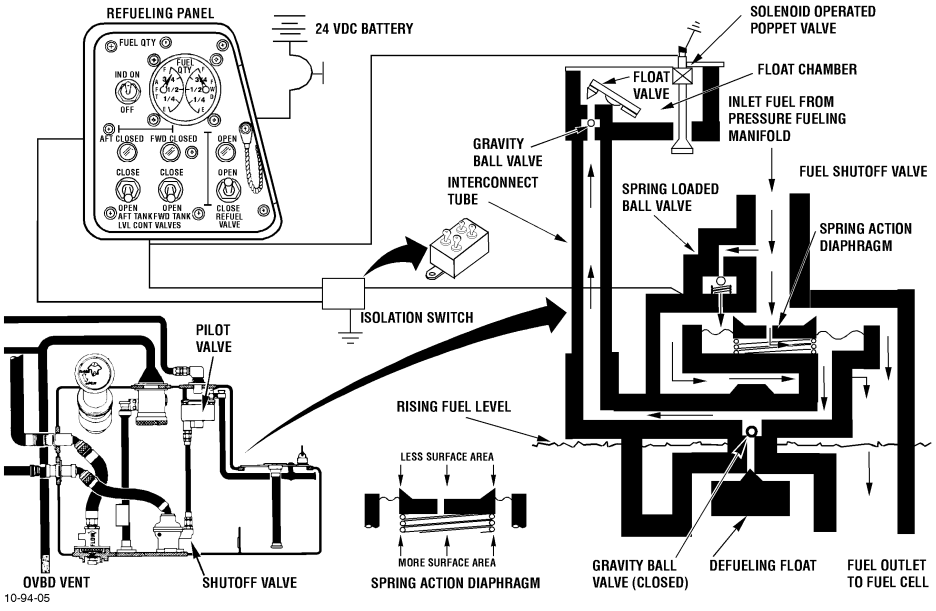
      (2) Fuel shutoff valve

      (3) Pilot valve tube

      (4) Isolation switch (not shown)

   d. Operation of the fuel level control valves does not require electrical power. However, electrical power is required to check the operation of the fuel shutoff valve and indicator lights.

FUEL LEVEL CONTROL VALVE OPERATION (PRESSURE REFUELING)



NOTES

e. Fuel level control valve operation - pressure refueling

(1) Initial conditions

(a) Aircraft safe and grounded

(b) Adequate fire extinguisher present

(c) Aircraft battery connected

(d) FUEL QTY indicator switch IND ON

(e) Refuel valve switch OPEN

1) The refuel valve opens, interconnecting the forward and aft fuel cells to the pressure fuel manifold for single point refueling.

2) The fuel vent shutoff valve opens and fuel cell internal pressure is relieved.

(f) Refuel valve indicator OPEN light illuminated

(g) LVL CONT VALVES switches OPEN (the solenoid-operated poppet valve opens and deactivates the isolation switch electrical circuit).

(h) LVL CONT VALVES CLOSED indicators are extinguished.

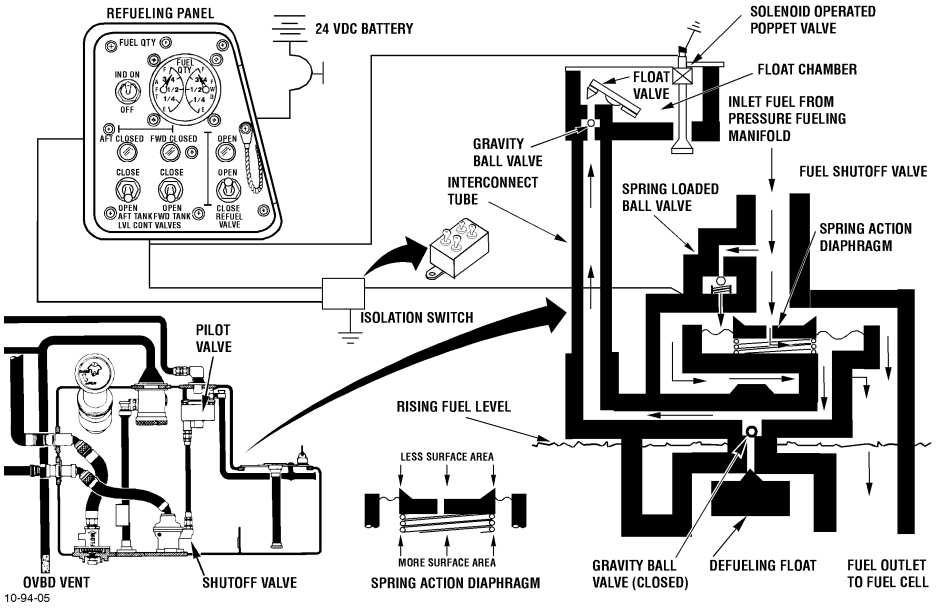
(i) Pressure refueling source connected to the pressure fuel manifold and refueling begins.

(2) Pressurized fuel enters the pressure fuel manifold and is routed through fuel lines and breakaway valves, into the cell through fuel lines, to the fuel shutoff valve.

(3) The force of the incoming fuel works against the spring tension of the spring-action diaphragm. The force of the incoming fuel is greater than the spring tension and forces the diaphragm open.

(4) When the spring-action diaphragm is opened, fuel passes around the diaphragm and flows into the fuel cell.

FUEL LEVEL CONTROL VALVE OPERATION (PRESSURE REFUELING)



NOTES

(5) When the spring-action diaphragm is opened, the isolation switch electrical circuit is opened. The fuel shutoff valve body and the spring action diaphragm serve as the switch contacts for the isolation switch circuit. No effect is noticeable because the circuit has been deactivated by the LVL CONT VALVES switches being in the OPEN position . The LVL CONT VALVES CLOSED indicators remain extinguished.

(6) Fuel also passes through a small bleed hole in the spring-action diaphragm and flows through the interconnect tube.

(7) The fuel shutoff valve gravity ball keeps the fuel pressure from bypassing the interconnect tube.

(8) The fuel flows through the interconnect tube, unseats the gravity ball, and flows into the pilot valve float chamber (the pilot valve controls the opening and closing of the spring-action diaphragm in the fuel shutoff valve).

(9) The fuel flows out through the open solenoid operated poppet valve, and into the fuel cell.

(10) As pressurized refueling continues, the fuel level in the cell continues to rise.

(11) When the rising fuel level reaches the pilot valve, it begins to fill the pilot valve float chamber through the open solenoid operated poppet valve.

(12) As the fuel level continues to rise, the pilot valve float chamber will fill and cause the pilot valve float to close the interconnect tube passage, stopping the flow of fuel through the tube.

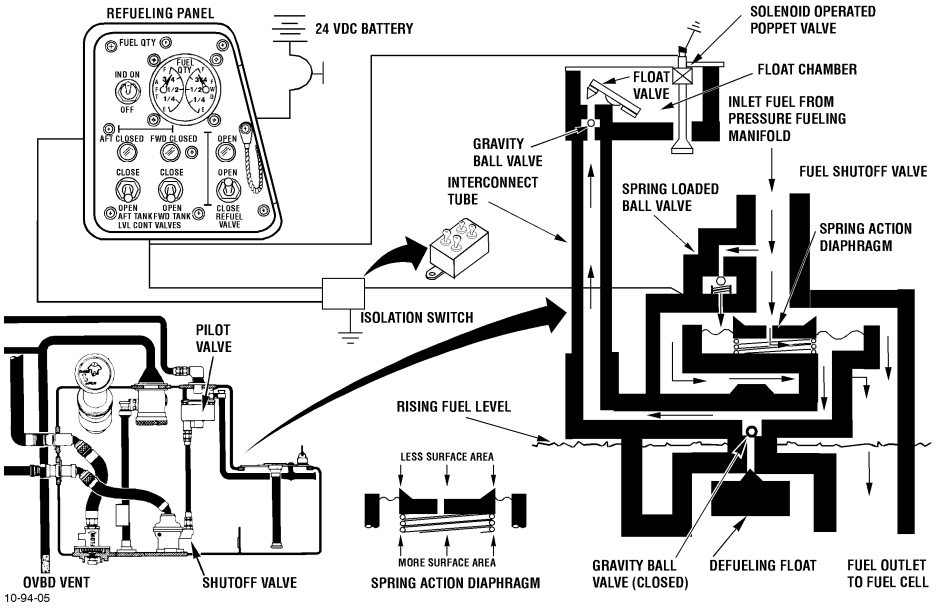
(13) With the interconnect tube passage blocked, fuel cannot escape into the pilot valve, causing the pressure on the bottom of the spring action diaphragm to increase. The pressure on the bottom and the top of the diaphragm is equalized.

(14) The spring pressure on the bottom of the spring action diaphragm causes it to close and stops fuel flow into the fuel cell. This is indicated by a jerk of the fuel nozzle.

(15) When the spring-action diaphragm is closed, the isolation switch electrical circuit is closed. No effect is noticeable because the circuit has been deactivated by the LVL CONT VALVES switches being in the OPEN position . The LVL CONT VALVES CLOSED indicators remain extinguished.

(16) Pressure refueling source is disconnected from the pressure fuel manifold and refueling is complete.

FUEL LEVEL CONTROL VALVE OPERATION (PRESSURE REFUELING)



NOTES

(17) After refueling, a small amount of fuel is trapped in the fuel line between the fuel shutoff valve and the pressure fuel manifold because the spring-loaded ball valve and the spring action diaphragm are closed. When the trapped fuel expands due to heating, the spring-loaded ball valve opens and allows the expanded fuel to flow into the fuel cell.

(18) Selective fuel tank servicing can be accomplished by utilizing the LVL CONT VALVE switches on the refueling panel.

(19) Operation of the fuel level control valves is checked prior to refueling operations by closing the LVL CONT VALVE switches on the refueling panel. This check is to determine that the pilot valve will close the fuel shutoff valve. During the check, observe the following.

CAUTION

The fuel system may be damaged if **FWD CLOSED** and **AFT CLOSED** lights do not light within 8 seconds after fuel servicing begins. If lights do not light, automatic fuel shutoff has not actuated. Stop fuel servicing.

WARNING

Failure of automatic shutoff sequence will be indicated by fuel flowing from cell vent tubes. This failure could damage the airframe and injure personnel. Manually stop fuel flow if this occurs. If injury occurs, seek medical aid.

(20) Fuel shutoff valve operational check

(a) During refueling operations, the fuel shutoff valve operation can be checked by placing the LVL CONT VALVE switch to the CLOSE position.

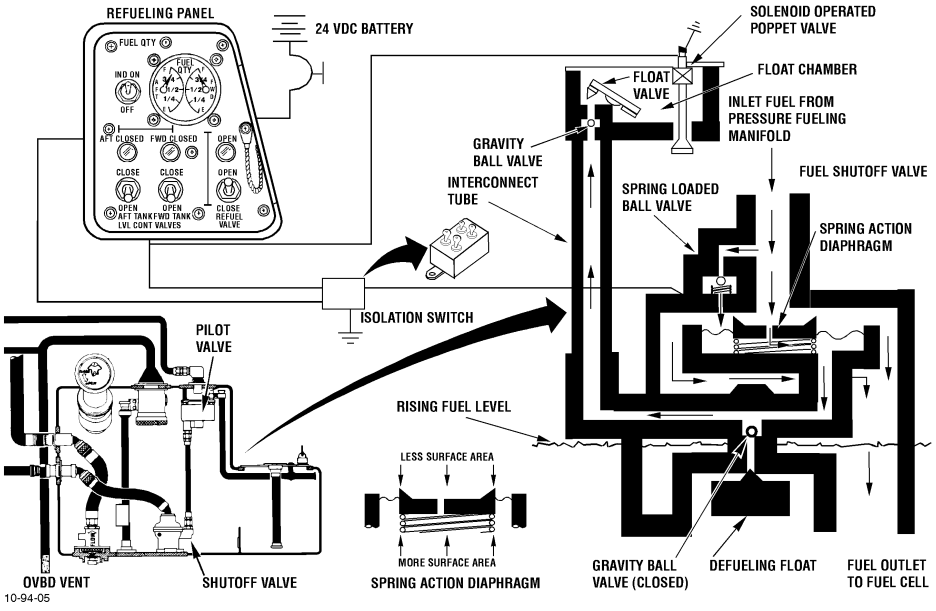
(b) When the LVL CONT VALVE switch on the refueling panel is placed to the CLOSE position the solenoid-operated poppet valve closes and activates the isolation switch electrical circuit.

(c) When the solenoid-operated poppet valve is closed:

1) Fuel from the interconnect tube fills the pilot valve float chamber.

2) As the fuel level in the pilot valve float chamber rises, the float closes the interconnect tube passage, and stops the flow of fuel.

FUEL LEVEL CONTROL VALVE OPERATION (PRESSURE REFUELING)

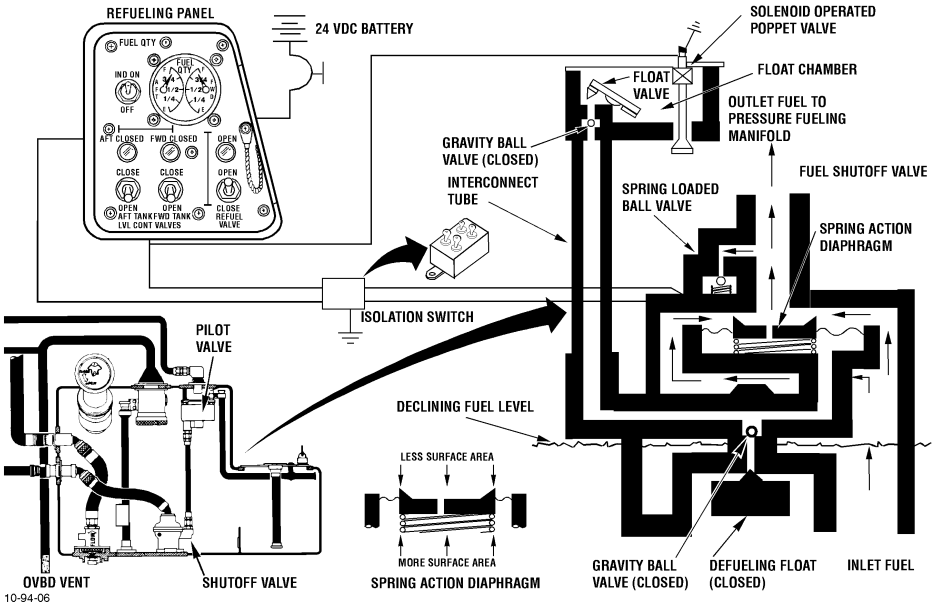


NOTES

(d) With the interconnect tube passage blocked, fuel cannot escape through the pilot valve, pressure on the bottom of the spring action diaphragm increases, causes it to close, and fuel flow into the cell stops.

(e) When the spring action diaphragm closes, the isolation switch electrical circuit is energized, causing the LVL CONT VALVES CLOSED indicator to illuminate.

FUEL LEVEL CONTROL VALVE OPERATION (PRESSURE DEFUELING)



NOTES

f. Fuel level control valve operation - pressure defueling

(1) Initial conditions

(a) Aircraft safe and grounded

(b) Adequate fire extinguisher present

(c) Aircraft battery connected

(d) FUEL QTY indicator switch IND ON

(e) Refuel valve switch OPEN

1) The refuel valve opens, interconnecting the forward and aft fuel cells to the pressure fuel manifold for single point refueling.

2) The fuel vent shutoff valve opens and fuel cell internal pressure relived.

(f) Refuel valve indicator OPEN light illuminated

(g) LVL CONT VALVES switches OPEN (the solenoid-operated poppet valve opens and the isolation switch electrical circuit is deactivated).

(h) LVL CONT VALVES CLOSED indicators are extinguished.

(i) The fuel cell has sufficient fuel to allow defueling (the defueling float must be seated).

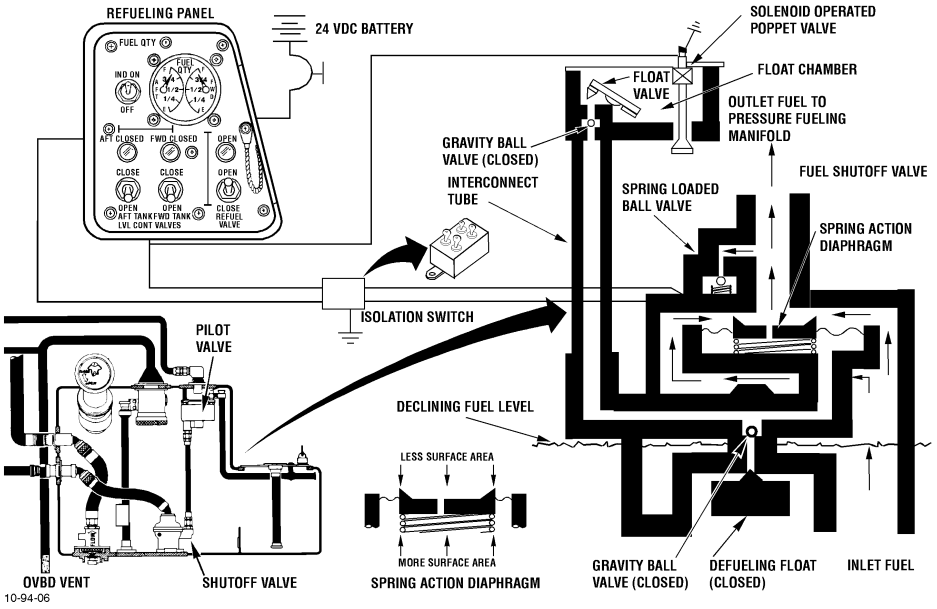
(j) Suction defueling source connected to the pressure fuel manifold and defueling begins.

(2) Suction is applied to the pressure fuel manifold fuel lines and breakaway valves, into the cell through fuel lines, to the fuel shutoff valve.

(3) The spring loaded ball valve, pilot valve gravity ball, and defueling float all work together to maintain the defueling suction inside the fuel shutoff valve and the interconnecting tube.

(4) The suction on the fuel is applied to the top of the spring-action diaphragm. The suction on the fuel is also applied to the bottom of the spring-action diaphragm through the small bleed hole in the diaphragm. The suction on the bottom of the spring-action diaphragm is greater due to it's larger surface area.

FUEL LEVEL CONTROL VALVE OPERATION (PRESSURE DEFUELING)



NOTES

(5) The greater suction on the bottom of the spring-action diaphragm overcomes the spring tension, and the diaphragm is forced open.

(6) When the spring-action diaphragm is opened, fuel passes around the diaphragm and flows out of the fuel cell and the fuel level begins to drop.

(7) The atmospheric pressure inside the fuel cell aids the suction defueling source in drawing the fuel out of the cell. The atmospheric pressure exerts a downward force on the top surface of the fuel, pushing it down toward the fuel shutoff valve, past the open spring-action diaphragm, and out of the tank to the suction defueling source.

(8) When the spring-action diaphragm is opened, the isolation switch electrical circuit is opened. No effect is noticeable because the circuit has been deactivated by the LVL CONT VALVES switches being in the OPEN position . The LVL CONT VALVES CLOSED indicators remain extinguished.

(9) As suction defueling continues, the fuel level in the cell continues to drop.

(10) When the fuel level reaches and drops below the defueling float, the defueling float drops, slightly, away from the bottom of fuel shutoff valve.

(11) When the float drops, it opens the defueling float passage, and the bottom side of the fuel shutoff valve gravity ball to atmospheric pressure.

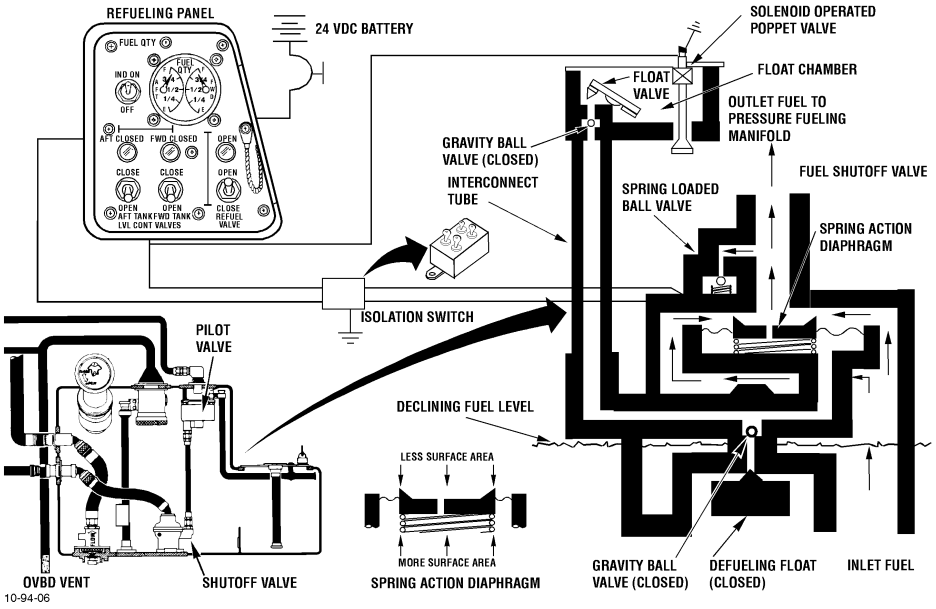
(12) The suction on the top side of the gravity ball and the atmospheric pressure on the bottom side of the gravity ball causes it to unseat and break the suction, opening a path for atmospheric pressure to the bottom side of the spring-action diaphragm.

(13) The spring-action diaphragm closes due to the fuel suction on the top and atmospheric pressure on the bottom. The spring aids in closing the diaphragm.

(14) When the spring-action diaphragm is closed, the isolation switch electrical circuit is closed. No effect is noticeable because the circuit has been deactivated by the LVL CONT VALVES switches being in the OPEN position . The LVL CONT VALVES CLOSED indicators remain extinguished.

(15) Suction defueling source is disconnected from the pressure fuel manifold and defueling is complete.

FUEL LEVEL CONTROL VALVE OPERATION (PRESSURE DEFUELING)



NOTES

(16) Spring action diaphragm, defueling theory of operation:

(a) To better understand how the spring-action diaphragm operates during defueling, it must be remembered that:

(b) Suction causes the spring-action diaphragm to open.

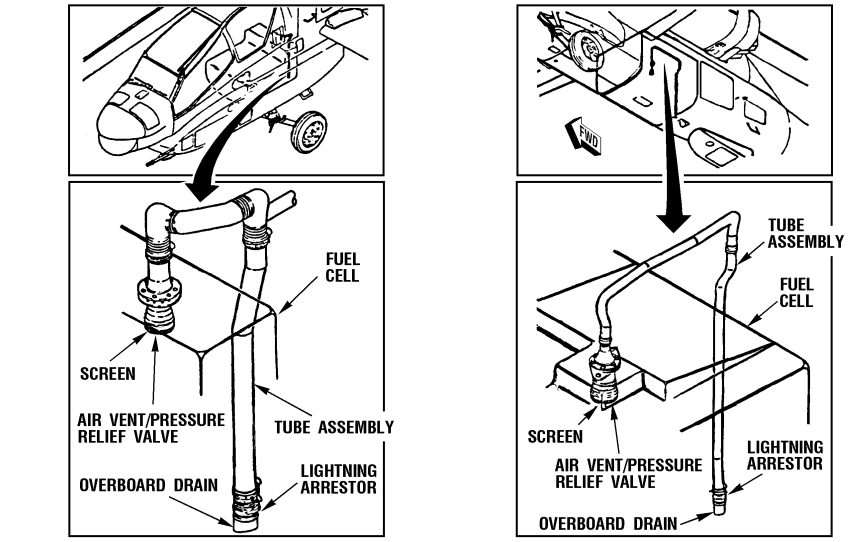
(c) The bleed hole in the center of the diaphragm allows the suction on both sides of the diaphragm to be unequal.

1) Due to the shape of the spring action diaphragm, the surface area on the bottom is greater than on the top.

2) Given A x P = F, the force on the bottom of the diaphragm is greater.

3) The greater force on the bottom of the diaphragm overrides spring force and the diaphragm opens.

AIR VENT/PRESSURE RELIEF VALVES



FORWARD FUEL CELL AIR VENT/PRESSURE RELIEF VALVE

AFT FUEL CELL AIR VENT/PRESSURE RELIEF VALVE

83-243B

NOTES

4. Air vent/pressure relief valves

   a. The air vent/pressure relief valves

      (1) Equalize pressure inside the fuel cells.

      (2) Vent excessive air pressure and fuel overboard due to expansion.

      (3) Vent fuel overboard during fuel shutoff failure.

      (4) Prevent leakage if the helicopter rolls over.

   b. The forward air vent/pressure relief valve:

      (1) Vents nitrogen rich air at a cracking pressure of 1.5 " 0.13 PSI during NIU operation.

      (2) Vents fuel at a cracking pressure of 3.0 " 0.25 psi.

   c. The aft air vent/pressure relief valve:

      (1) Vents nitrogen rich air at a cracking pressure of 2.0 " 0.13 PSI during NIU operation.

      (2) Vents fuel at a cracking pressure of 3.0 " 0.25 psi.

      (3) The aft air vent/pressure relief valve has a higher cracking pressure than the forward air vent/pressure relief valve due to the arrangement of the nitrogen inerting system lines.

         (a) Nitrogen rich air from the NIU goes through the aft cell prior to entering the forward cell.

         (b) If the cracking pressure of the air vent/pressure relief valves was the same in both fuel cells, the forward cell would not pressurize with nitrogen rich air.

5. Lightning arresters

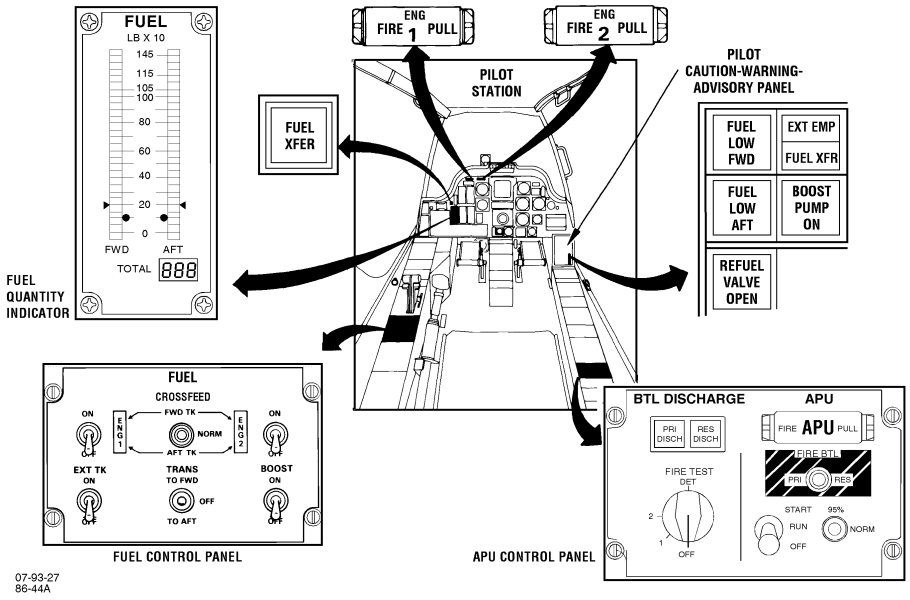
   a. Each fuel vent tube overboard drain has an lighting arrestor.

   b. The lightning arresters prevent fuel vapor ignition from lighting strikes.

   c. Each arrester is filled with a mesh material to prevent entrance of foreign material.

   d. The arrester is grounded to the airframe by a bonding strap to prevent static electricity buildup.

PILOT CONTROLS AND INDICATORS



NOTES

A. Fuel system controls and indicators. The fuel system controls and indicators provide the crew with a means of controlling and monitoring the operation of the fuel system.

B. Pilot controls and indicators

1. Engine 1 and engine 2 fire pull handles

a. When illuminated, indicate a fire is burning in the identified engine nacelle.

b. When the handle is pulled, fuel from the crossfeed/shutoff valve to the engine is stopped. Pushing the handle back in restores the fuel flow to the effective engine.

2. Pilot's caution/warning/advisory panel

a. FUEL LOW FWD caution light illuminates when the fuel level in the forward cell decreases to 280 " 20 pounds.

b. FUEL LOW AFT caution light illuminates when the fuel level in the aft cell decreases to 240 " 20 pounds.

c. REFUEL VALVE OPEN caution light illuminates when the refuel valve is open.

d. EXT EMP caution light illuminates when the external tanks are empty and the external tank (EXT TK) switch is placed in the on position.

e. FUEL XFER caution light illuminates when the fuel transfer is selected and transfer does not occur.

f. FUEL XFER advisory light illuminates when the transfer switch is placed in the TO FWD or TO AFT position.

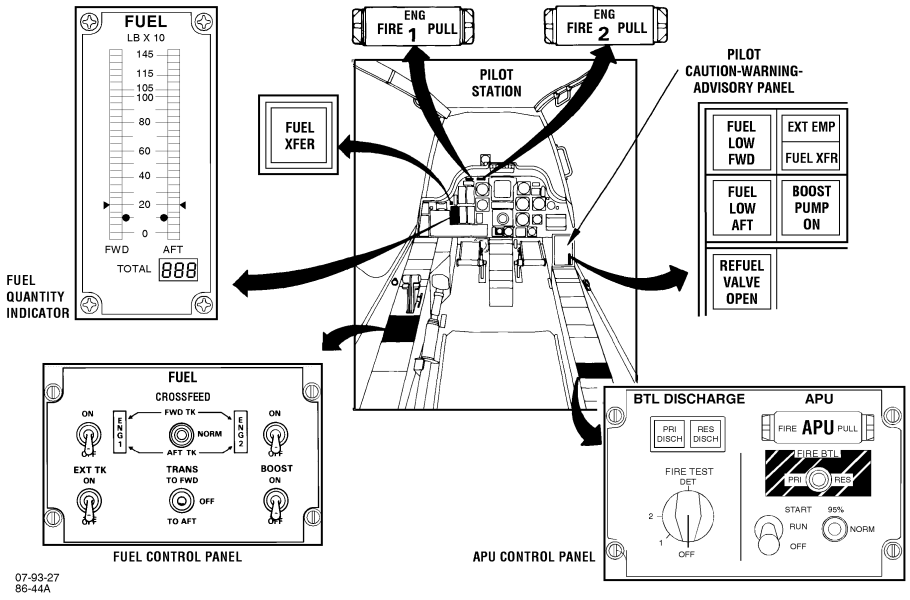
g. BOOST PMP ON caution light illuminates when the boost pump is operating at 8.5 to 10 PSI increasing. The light extinguishes when pressure falls below 7 PSI.

3. APU control panel

a. FIRE APU PULL handle de-energizes the APU fuel boost pump and closes the APU fuel shutoff valve.

b. START/RUN/OFF switch controls the APU. It energizes the APU fuel boost pump and APU fuel shutoff valve, providing fuel for APU operation.

PILOT CONTROLS AND INDICATORS



NOTES

4. Fuel control panel

   a. ENG 1 and ENG 2 switches

      (1) OFF - Energizes fuel crossfeed/shutoff valve of the respective engine to the closed position, thus shutting off fuel flow to that engine.

      (2) ON - Energizes fuel crossfeed/shutoff valve of the respective engine to the position commanded by the CROSSFEED switch.

   b. CROSSFEED switch

      (1) FWD TK - Both engines feed from the forward fuel cell.

      (2) NORM - ENG No. 1 feeds from the forward fuel cell; ENG No. 2 feeds from the aft fuel cell.

      (3) AFT TK - Both engines feed from the aft fuel cell.

   c. EXT TK switch

      (1) ON - Pressurized air is made available to all external tanks for transfer of fuel to the main fuel cells.

   d. TRANS switch

      (1) TO FWD - Fuel is being pumped from AFT cell to FWD cell by the transfer pump.

      (2) TO AFT - Fuel is being pumped from FWD cell to AFT cell by the transfer pump.

   e. BOOST switch

      (1) Pneumatically driven boost pump (in AFT cell) is delivering fuel to both engine CROSSFEED/SHUTOFF VALVES.

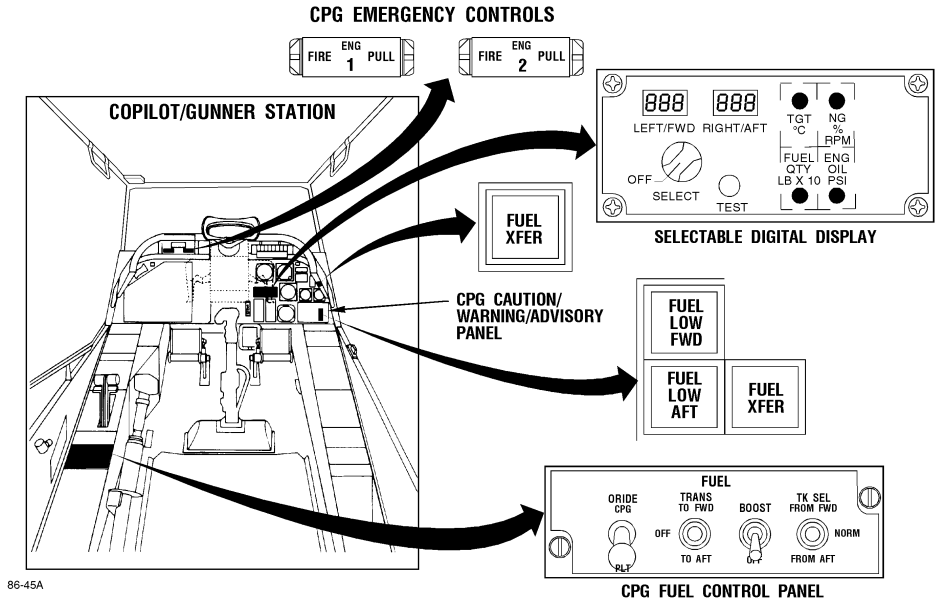
5. Fuel quantity indicator

   a. Provides information on fuel available in either a digital readout or vertical scales.

   b. The digital readout shows total fuel available in pounds.

   c. Vertical scale displays, show fuel in forward cell on left side and aft cell on the right side.

CPG CONTROLS AND INDICATORS



NOTES

C. CPG controls and indicators

1. ENG 1 and ENG 2 FIRE PULL handles work the same as the pilots.

2. Selectable digital display panel

   a. Displays the fuel quantity of the forward and aft fuel cells.

   b. Rotating the select switch causes indicator lights to illuminate, indicating which system has been selected for monitoring. When fuel quantity is selected, the fuel quantity light illuminates and the LEFT/FWD digital display indicates fuel remaining in the forward cell. The aft cell is indicated on the RIGHT/AFT digital display.

3. CPG's caution/warning/advisory panel

   a. Fuel system segment lights are controlled by the respective light on the pilot's panel.

   b. Panel is installed in the lower right corner of the CPG instrument panel.

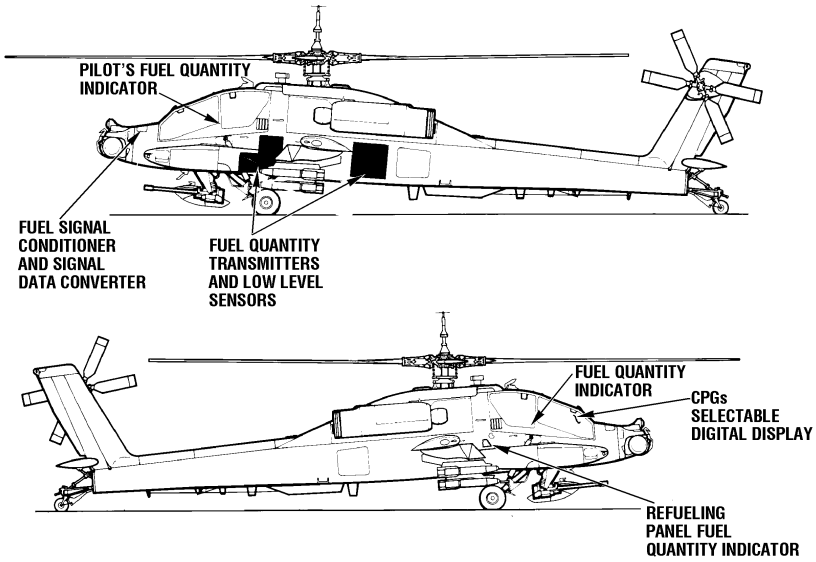
4. CPG fuel control panel

   a. Allows CPG control of all fuel management aspects except external tank transfer.

   b. Selecting OVRD on the CPG's fuel panel enables the panel and disables the pilot's panel.

   c. The transfer switch, boost switch, and tank select switch have the same function as the pilots.

FUEL QUANTITY INDICATING COMPONENTS



10-93-29
83-1807

NOTES

071-622-04

A. Fuel quantity indicating components

1. Provides an indication of the quantity of fuel in the forward and aft cells to the crewstations and to the refueling panel.

2. System components

a. Fuel quantity transmitters

b. Low level sensors

c. Signal data converter (SDC)

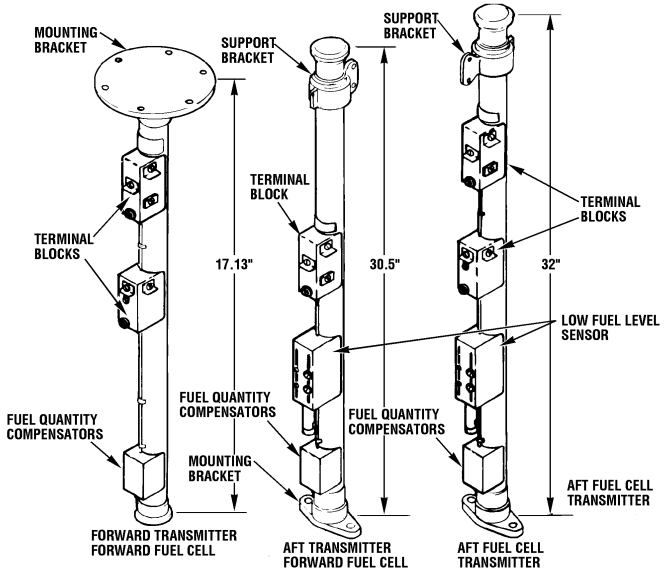
d. Fuel signal conditioner (FSC)

e. Pilot's fuel quantity indicator

f. CPG's selectable digital display (SDD)

g. Refuel panel fuel quantity indicator

FUEL QUANTITY TRANSMITTERS



10-93-30
83-595E

NOTES

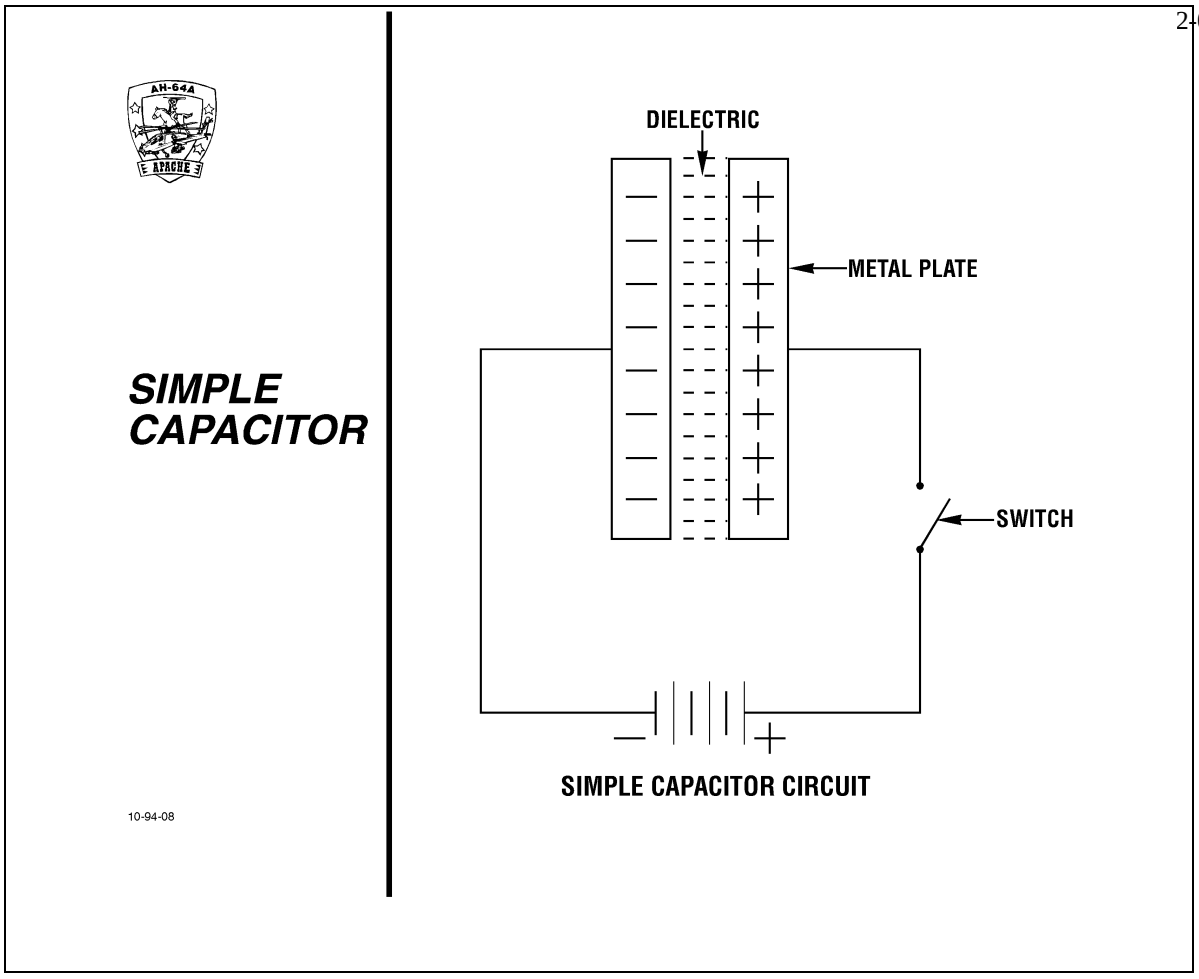
3. Fuel quantity transmitters

   a. Electronically measures the quantity of fuel in the aft and forward fuel cells.

   b. Due to the irregular shape of the forward cell, two transmitters are installed. (The taller transmitter measures fuel volume in the taller vertical portion of the "L" shaped fuel cell…the smaller transmitter measures fuel volume in the lower/forward portion of the fuel cell)

   c. The aft cell has one transmitter.

   d. Fuel quantity transmitters function as capacitors. The fuel in each cell acts as the dielectric. As the fuel quantity changes, the capacitance reactance of the transmitter changes. The resultant signal is applied to the fuel signal conditioner.


AH-64A
APACHE
SIMPLE CAPACITOR
10-94-08
DIELECTRIC
METAL PLATE
SWITCH
SIMPLE CAPACITOR CIRCUIT

NOTES

e. To understand how the fuel quantity transmitters function, an understanding of capacitors is required.

(1) Because they are identical, a capacitor may also be called a condenser. However, the term capacitor is more commonly used and is the term used for this discussion. The term capacitor originated because the device is used to introduce capacitance into AC circuits.

(2) Capacitance is defined as the ratio of the charge on the conductors of a capacitor (there being an equal and opposite charge on the other conductor) to the potential difference between the conductors. Simply stated, the effect of a capacitor, that is, its ability to store an electric charge, is called capacitance.

(3) Slide # 29 shows a simple capacitor consisting of two metal plates separated by air.

(4) A capacitor consists of two conductors (also known as plates) separated by an insulating medium which is capable of holding an electric charge (a quantity of electrons).

(5) The air, or other insulating material, is called the dielectric. To measure a material's dielectric characteristics the terms **dielectric constant** and **dielectric strength** are used.

(a) Dielectric constant

1) Air is given a dielectric constant of 1 and is used as a reference for establishing the dielectric constants of other materials.

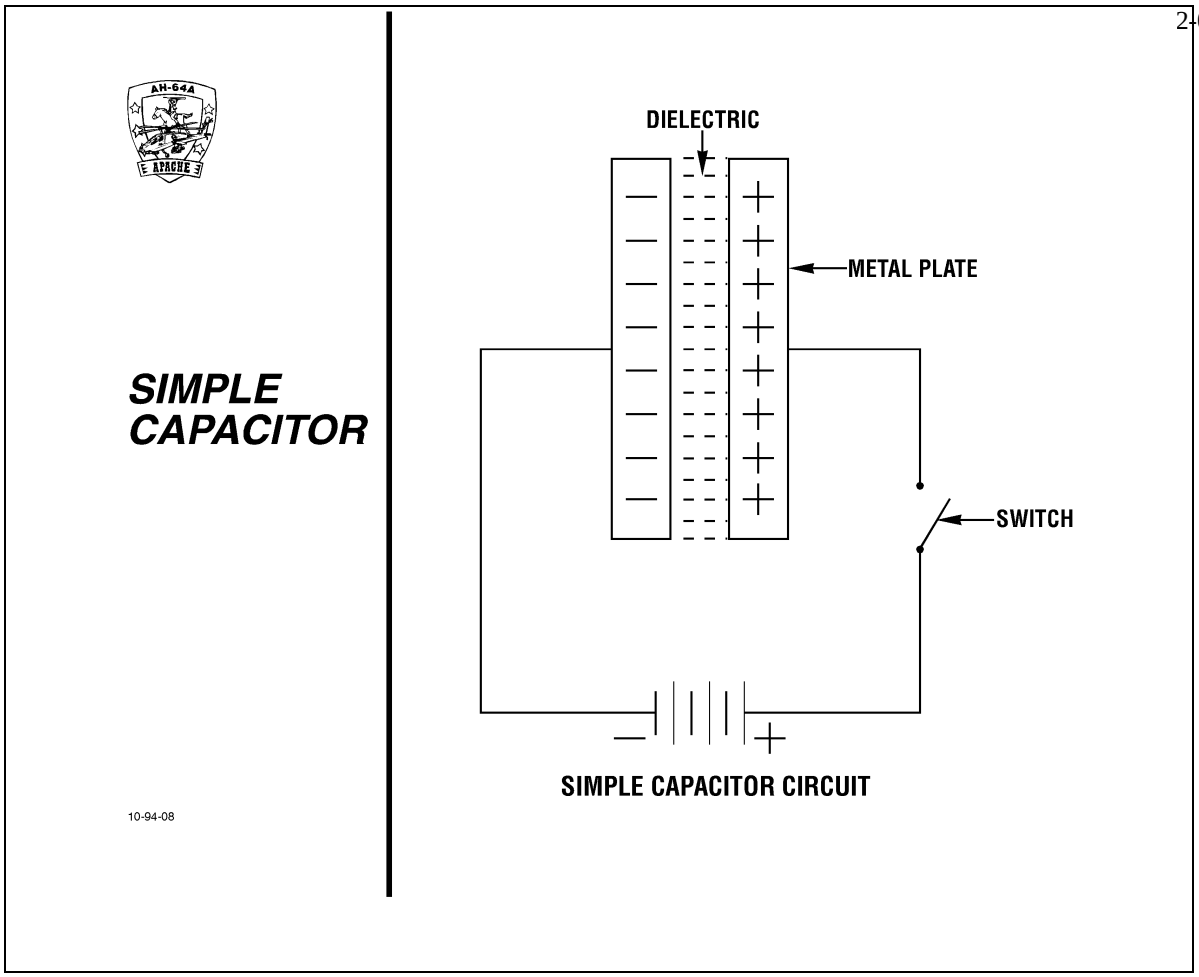
2) Mica, which is commonly used as a dielectric in capacitors, has a dielectric constant of 5.8. This means that a capacitor having mica as a dielectric has 5.8 times the capacitance of a similar capacitor having air as the dielectric.

(b) Dielectric strength

1) The insulating quality of a material is called its dielectric strength.

2) Dielectric strength is measured in terms of the voltage required to rupture (break down) a given thickness of the material.

(6) When the plates of a capacitor are connected to a source of voltage, the capacitor becomes charged.


AH-64A
APACHE
SIMPLE CAPACITOR
10-94-08
DIELECTRIC
METAL PLATE
SWITCH
SIMPLE CAPACITOR CIRCUIT

NOTES

(7) This charge consists of an excess of electrons on the negative plate and a corresponding deficiency of electrons on the positive plate.

(8) If the polarity of the voltage is reversed, current flows through the circuitry, and electrons build up on the opposite plate.

(9) Unless there is a complete vacuum between the plates, the dielectric between the plates of the capacitor consists of a large number of atoms. This is true whether the dielectric is a gas, liquid, or solid.

(10) The dielectric is an insulator and it contains very few free electrons. Allowing normal operation of a capacitor, there is no current (electron) flow through the dielectric.

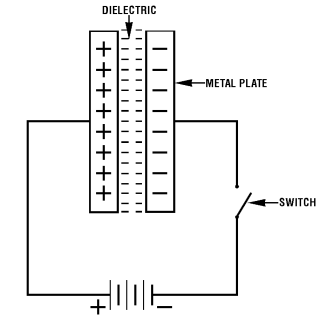
(11) When the capacitor is charged, electromotive force (emf) exists between the plates and acts upon the dielectric. Although the emf is not great enough to cause the electrons in the dielectric to break away from the atoms, it does cause them to shift a small distance in their orbits.

(12) This shifting of electrons toward the positive plate of the capacitor creates what is known as dielectric stress.

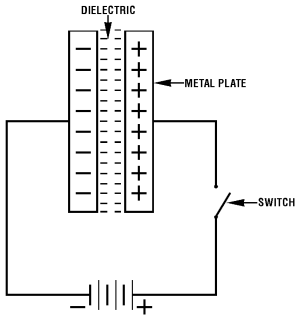
(a) Increasing or decreasing the voltage applied to the capacitor will increase or decrease dielectric stress.

(b) If voltage remains constant, dielectric stress can be varied by changing the type of dielectric material or changing the amount of dielectric material between the plates.

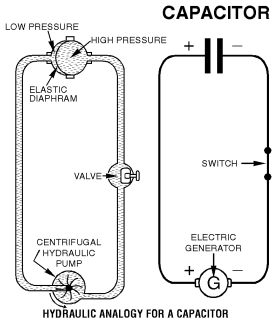
CAPACITOR OPERATION ANALOGY



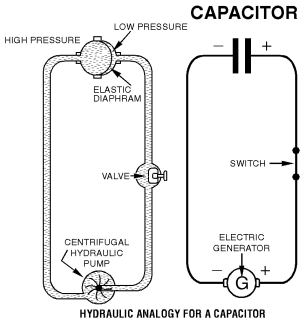
SIMPLE CAPACITOR CIRCUIT
1



SIMPLE CAPACITOR CIRCUIT
2



HYDRAULIC ANALOGY FOR A CAPACITOR
3



HYDRAULIC ANALOGY FOR A CAPACITOR
4

10-94-09

NOTES

(13) A better understanding of the operation of a capacitor may be had by using a hydraulic analogy. (figures 1 and 3)

(14) The capacitor is represented by a chamber separated into two equal sections by an elastic diaphragm representing the dielectric.

(15) These chambers are connected to a centrifugal pump by pipes. The pump represents the generator in an electrical circuit.

(16) When the pump rotates, it forces fluid into the chamber and causes the diaphragm to stretch.

(17) Fluid on the opposite side of the diaphragm flows out of the chamber towards the pump.

(18) One of the chambers contains more fluid than the other. The diaphragm being stretched maintains a pressure differential between the chambers.

(19) When the diaphragm pressure is equal to the pump pressure, the fluid stops flowing.

(20) If the pump is stopped, diaphragm pressure causes the fluid to flow in the opposite direction until system pressure is equalized.

(21) If the centrifugal hydraulic pump is reversed, the system operates the same, but in a reciprocal manner. (figures 2 and 4)

(22) By continuously reversing the direction of the hydraulic pump an alternating action in the fluid results. This is analogous to an AC generator.

DIELECTRIC EFFECT ON CURRENT

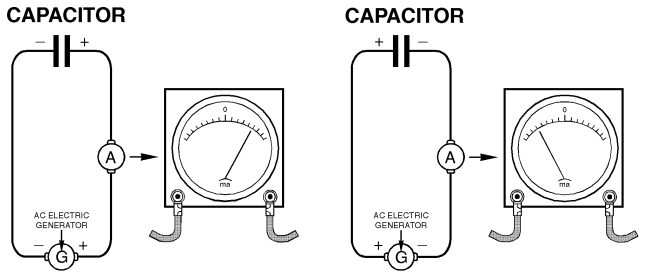


FIG. 1 CAPACITOR CONTAINING A DIELECTRIC MATERIAL WITH A HIGH DIELECTRIC CONSTANT (FUEL)

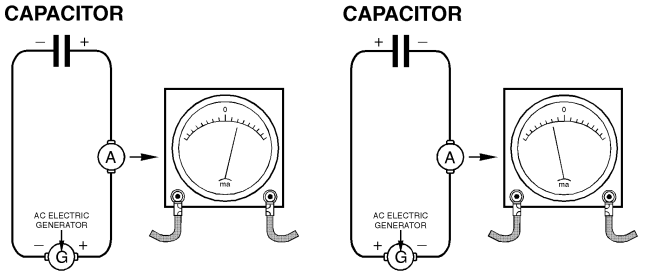


FIG. 2 CAPACITOR CONTAINING A DIELECTRIC MATERIAL WITH A LOW DIELECTRIC CONSTANT (AIR)

10-94-10

NOTES

(23) As shown in the accompaning picture, when the AC generator is running, the electrons are alternately forced from one plate of the capacitor to the other, as they pass through the AC generator.

(24) There is no flow of current directly between the capacitor plates because the dielectric material is insulative. However, dielectric stress occurs and alternates as current flows back and forth.

(25) If an ammeter is added to the circuit, current can be measured. The amount of current is related to the applied voltage, amount of dielectric material, and type of dielectric material.

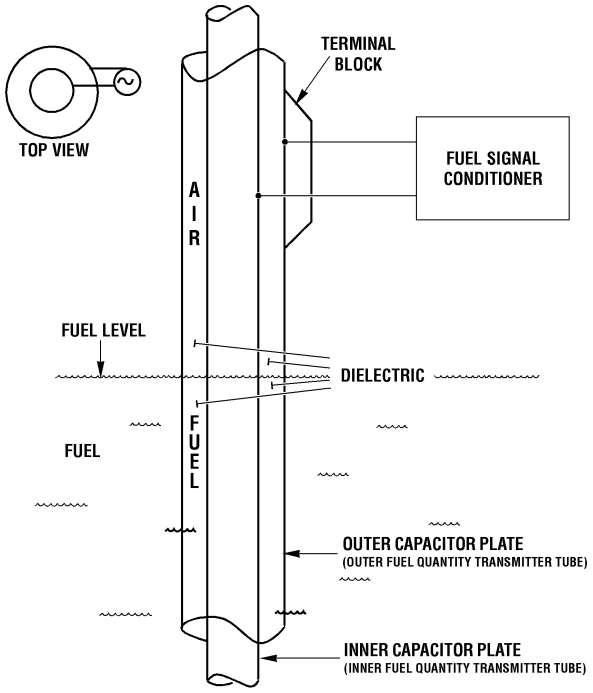
(26) In figures 1 and 2 voltage is constant; the distance between the capacitor plates is constant; the only variable is the type of dielectric material used.

(a) Figure 1 shows a capacitor containing dielectrical material with a high dielectric constant. Many electrons can build on the capacitor plates. This results in a relatively high current.

(b) Figure 2 shows a capacitor containing a dielectric material with a low dielectric constant. Few electrons can build on the capacitor plates. This results in a relatively low current.

FUEL QUANTITY TRANSMITTER OPERATION

10-94-11



NOTES

f. The fuel quantity transmitters on the Apache function like capacitors.

(1) The outer fuel quantity transmitter tube acts as a capacitor plate.

(2) The inner fuel quantity transmitter tube acts as a capacitor plate.

(3) Fuel and air are dielectrics.

g. The fuel quantity transmitters capacitive value is determined by the level of fuel between the inner and outer tubes of the sensor, and fuel density.

h. The transmitters are supplied operating voltage from the fuel signal conditioner (FSC). The FSC derives the operating voltage from an internal power supply.

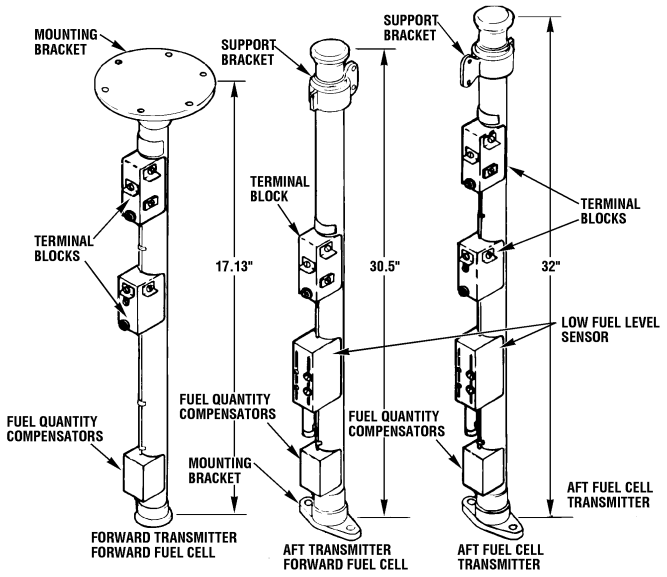
i. An oscillator within the FSC provides a 6 KHz AC voltage to the inner and outer tubes (plates) of the fuel quantity transmitter. The amount of electrons that can be stored on the tubes, and the corresponding current that passes back and forth to the FSC, is directly proportional to the amount of fuel in the tank.

(1) More fuel, more current

(2) Less fuel, less current

j. The fuel signal conditioner amplifies and rectifies the AC current returning from the fuel quantity transmitter and produces a 0 to 5 VDC signal. This signal is sent to the fuel quantity indicators as a measure of fuel level.

FUEL QUANTITY TRANSMITTERS



10-93-30
83-595E

NOTES

4. Low fuel level sensors

   a. Cause the FUEL LOW FWD and FUEL LOW AFT caution segment lights to illuminate when the fuel level is low.

   b. One sensor is attached to the aft transmitter in the forward cell and one sensor is attached to the transmitter in the aft cell.

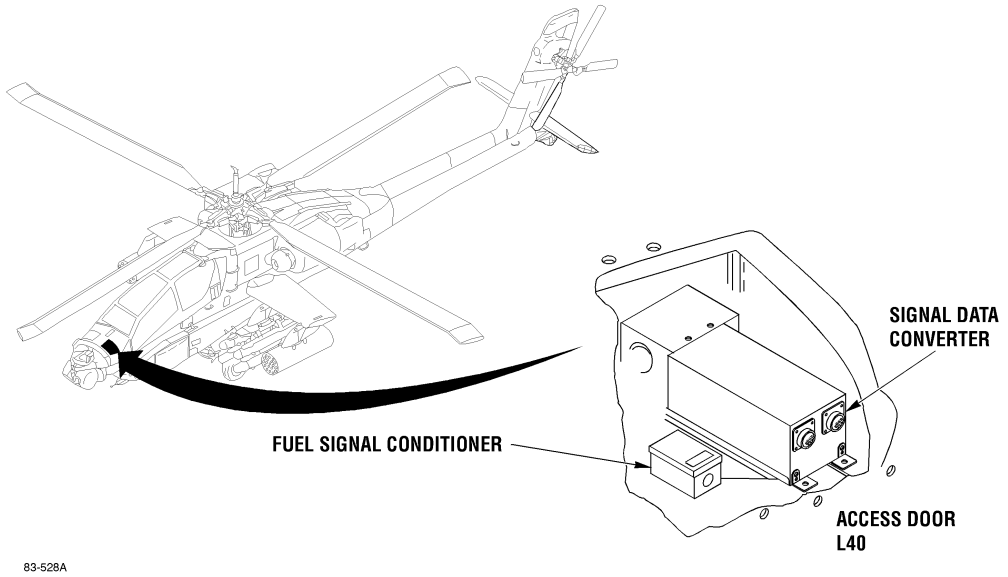
   c. The thermistor-type sensors are normally covered by fuel, keeping them cool. As fuel quantity decreases, the thermistor warms and resistance decreases. At a predetermined set point the caution lights in the crewstations illuminate.

   d. During installation of the fuel quantity transmitters, low level sensor height must be adjusted.

      (1) The sensor on the forward fuel cell aft fuel quantity transmitter must be adjusted to a height of 5.60". The measurement is taken from the transmitter's lower mounting flange to the bottom of the low fuel level sensor.

      (2) The sensor on the aft fuel cell fuel quantity transmitter must be adjusted to a height of 7.00". The measurement is taken from the transmitter's lower mounting flange to the bottom of the low fuel level sensor.

FUEL SIGNAL CONDITIONER/SIGNAL DATA CONVERTER



NOTES

5. Signal data converter

   a. Provides operating voltage to the pilot's and CPG's fuel quantity indicators, signal conditioning unit, low fuel level sensors, and crewstation caution/warning/advisory panel segment lights.

   b. Converter is located on the left side of the helicopter nose, behind access door L40.

   c. The SDC contains two power supplies and an internal fuse panel. The fuse panel protects all instruments from overload.

   d. Low fuel signals are sent to the SDC from the low fuel cell sensors. The SDC transmits these signals to the appropriate caution segment lights on the crew station caution/warning panels.

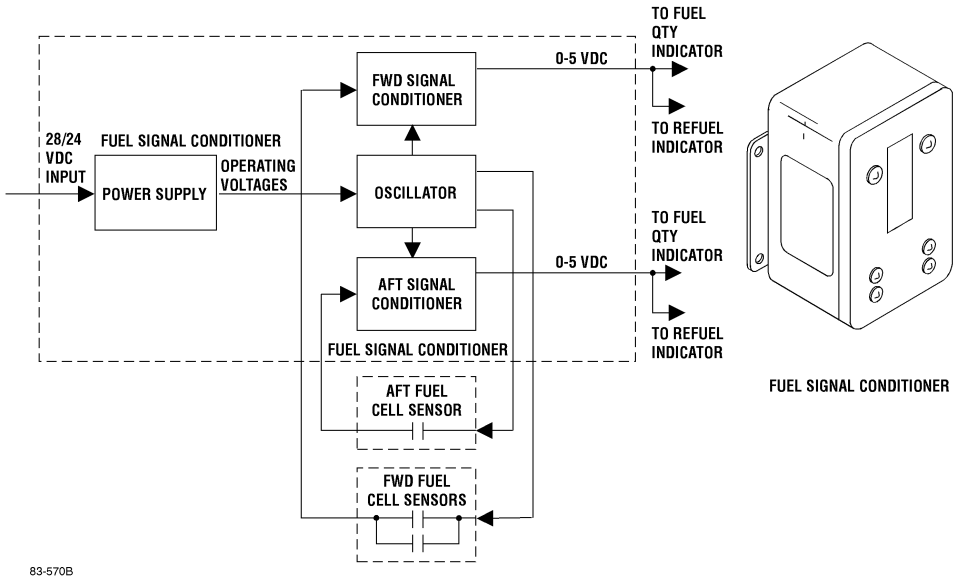
   e. Receives 28 VDC from the emergency DC bus, via circuit breakers CB17 and CB31. The SDC reduces this voltage for operation of the instrument system and routes operating power to the fuel signal conditioner, except during refueling.

6. Fuel signal conditioner

   a. Converts aft and forward fuel quantity transmitter inputs to linear 0-5 VDC to drive the fuel quantity indicators.

   b. Installed on the left side of the helicopter nose behind panel L40.

FUEL SIGNAL CONDITIONER INTERFACE



NOTES

7. Fuel signal conditioner interface

   a. Mounted on the left side of the helicopter nose behind panel L40.

   b. Contains a power supply, oscillator, two signal conditioners, and four screw adjustments used to adjust the full and empty indications.

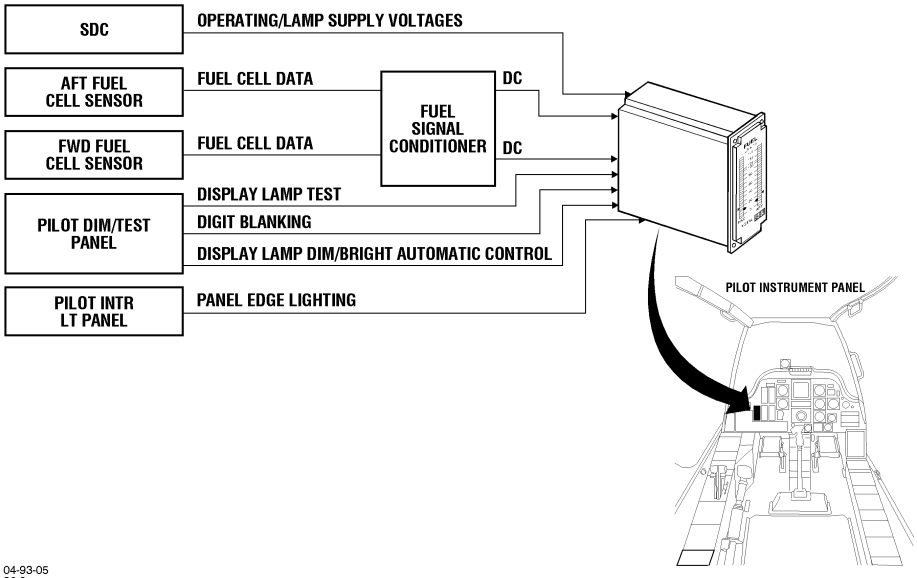
   c. The FSC receives 28 VDC operating power from the SDC, except during refueling. During refueling the FSC operates on battery voltage of 24 VDC.

   d. An oscillator in the FSC converts DC voltage to an AC voltage that is applied to the fuel cell sensors (quantity transmitters).

   e. The FSC converts the AC signals returning from the fuel quantity transmitters into a linear 0-5 VDC signal. This signal represents the amount of fuel in the fuel cells and is sent to the crewstation fuel quantity indicators.

   f. To adjust the fuel signal conditioner, refer to TM 55-1520-238-23-6

PILOTs FUEL QUANTITY INDICATOR



NOTES

8. Pilot's fuel quantity indicator

   a. Provides an indication to the pilot of the fuel quantity in the forward and aft fuel cells.

   b. Located on the left side of the pilot's instrument panel.

   c. The indicator receives the following inputs.

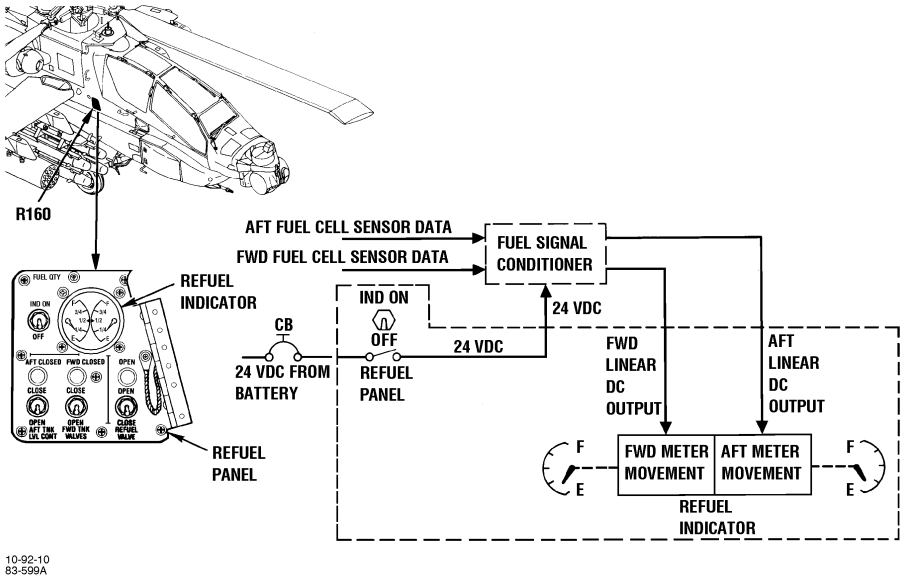
      (1) Operating/lamp supply voltages

      (2) Fuel signal conditioner signals

      (3) Pilot dim/test panel inputs

      (4) Pilot instrument light panel inputs

REFUEL PANEL FUEL QUANTITY INDICATOR



NOTES

9. Refuel panel quantity indicator

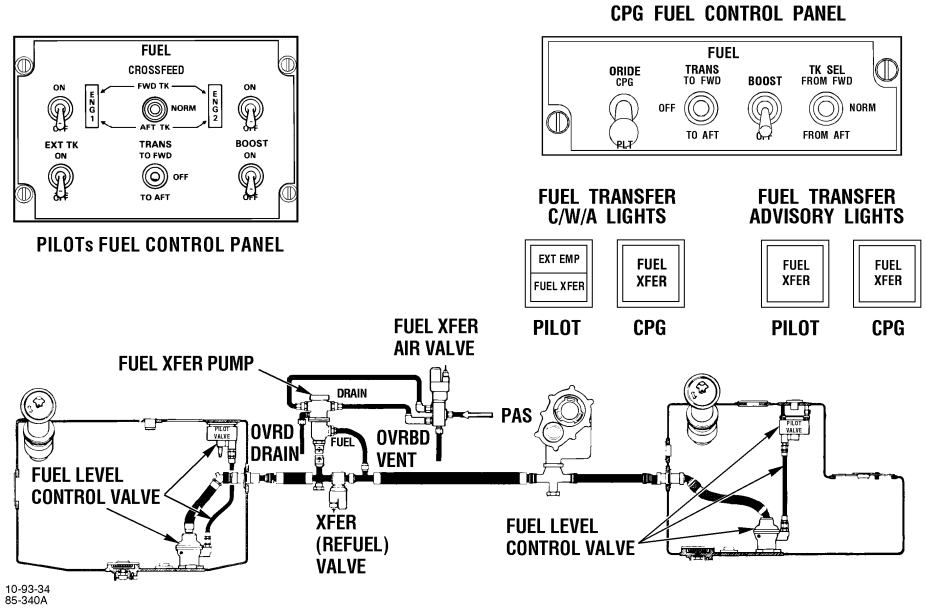
   a. Provides refueling personnel an indication of fuel quantity during refueling operations.

   b. Indicator is located in the refueling panel on the forward right side of the fuselage.

   c. The indicator is equipped with two scales. The left scale is for the aft cell and the right for the forward cell. Each scale has a movable pointer that indicates quantity of fuel in the fuel cells. The scale is graduated in 1/4 increments.

   d. The refuel indicator is controlled by the refuel panel IND ON/OFF switch. When placed in the ON position, the battery supplies operating power for the fuel signal conditioner. The FSC receives inputs from the fuel quantity transmitters and converts the signals to DC voltage for the indicator. The indicator changes the linear signal to mechanical meter movements, which move the pointers.

FUEL TRANSFER SYSTEM



NOTES

071-622-04

A. Fuel transfer system

1. Allows either crew member to move fuel from one cell to the other.

2. Fuel may be transferred from the forward cell to the aft cell, or from the aft cell to the forward cell for the purposes of weight and balance, fuel cell damage, and fuel management.

B. Internal fuel transfer components

1. Fuel transfer switches

a. Provide the crew members a means of controlling fuel transfer.

b. Switches are mounted on the pilot's and CPG's fuel control panels.

c. Whenever a transfer switch is selected TO FWD or TO AFT, the FUEL XFER advisory lights in both crewstations illuminate.

d. If fuel is not transferring, the FUEL XFER caution lights in both crewstations illuminate.

(1) The fuel shutoff valve in the forward fuel cell causes the FUEL XFER caution light to illuminate.

(2) The spring-action diaphragm in the shutoff valve contains a switch. When the spring-action diaphragm is closed it completes a circuit to ground and the FUEL XFER caution light illuminates.

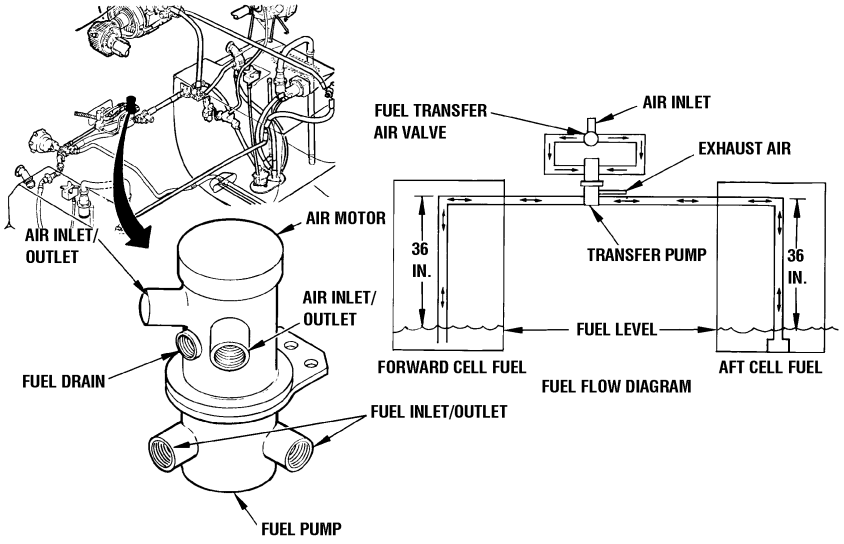
(3) Any time fuel transfer is occurring (either to forward or to aft), the spring-action diaphragm in the forward fuel cell is open. Therefore, the path to ground is open, and the FUEL XFER caution light is extinguished.

2. Fuel transfer air valve

a. Controls the direction of the flow of PAS air into the fuel transfer pump to transfer fuel forward or aft.

b. Valve is mounted on the upper right side of the ammunition bay.

FUEL TRANSFER PUMP



NOTES

3. Fuel transfer pump

   a. Used to transfer fuel from one fuel cell to the other.

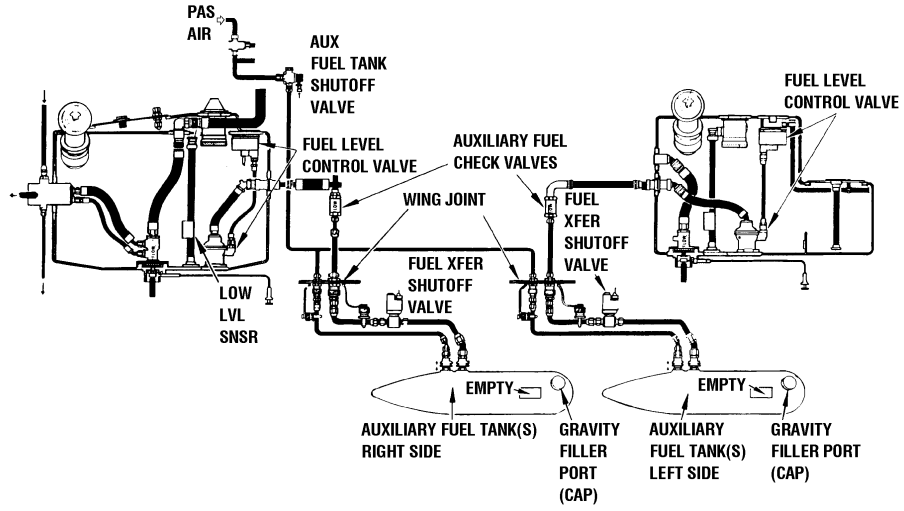
   b. Mounted on the upper right side of the ammunition bay.

   c. Transfer pump consists of a vane-type air-driven motor with a gerotor type fuel pump.

   d. When a crew member selects the TO FWD position, air drives the pump in a direction that pumps fuel from the aft to the forward cell. When TO AFT is selected, air drives the pump in the opposite direction.

   e. The fuel level control valve stops fuel transfer when the cell is full.

AUXILIARY FUEL TANK TRANSFER SYSTEM



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83-249D

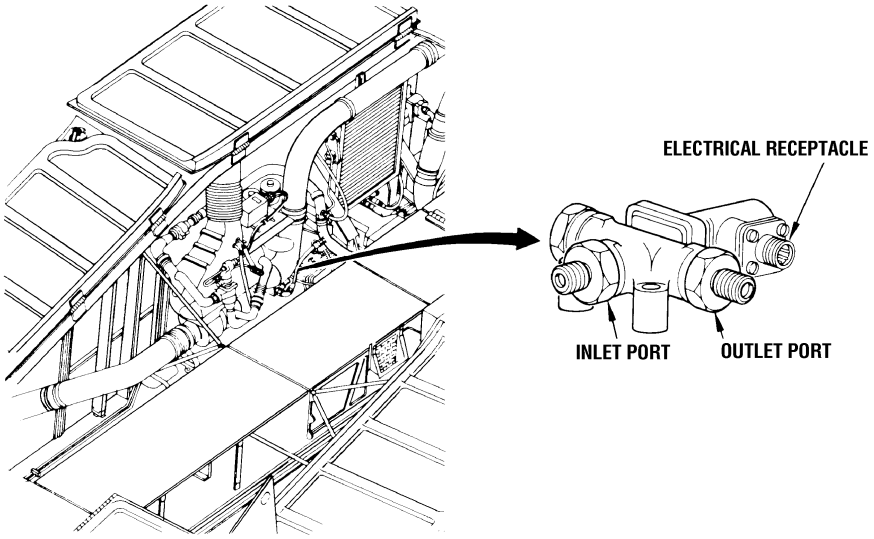
NOTES

C. Auxiliary fuel tank transfer system. The auxiliary fuel tank transfer system provides a method of transferring fuel from the auxiliary fuel tanks to the internal fuel cells.

WARNING

A slight increase in the risk of post-crash fire exists if a mishap occurs after tanks are pressurized. Crash-worthiness of the fuel system is reduced by external fuel tanks, which were designed for ferry missions only.

AUXILIARY FUEL TANK AIR SHUTOFF VALVE



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83-250C

NOTES

D. Auxiliary fuel tank transfer system components include the auxiliary fuel tanks air shutoff valve (fuel transfer shutoff valve), auxiliary fuel tanks shutoff valve, auxiliary fuel system check valves (2), and fuel tank empty switches.

1. Auxiliary fuel tanks air shutoff valve (fuel transfer shutoff valve)

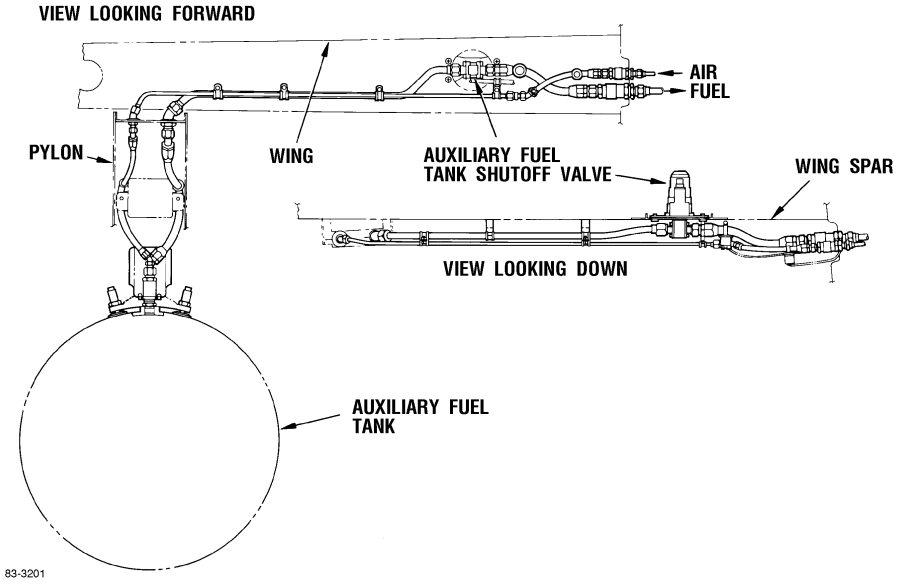
a. Controls the airflow that is used to transfer fuel from the auxiliary tanks to the internal fuel cells.

b. Mounted on the left side of the aft equipment bay.

c. The valve has an electrical receptacle, air inlet port, and air outlet port.

d. Valve is spring-loaded closed and electrically opened.

AUXILIARY FUEL TANKS SHUTOFF VALVE



NOTES

2. Auxiliary fuel tanks shutoff valve

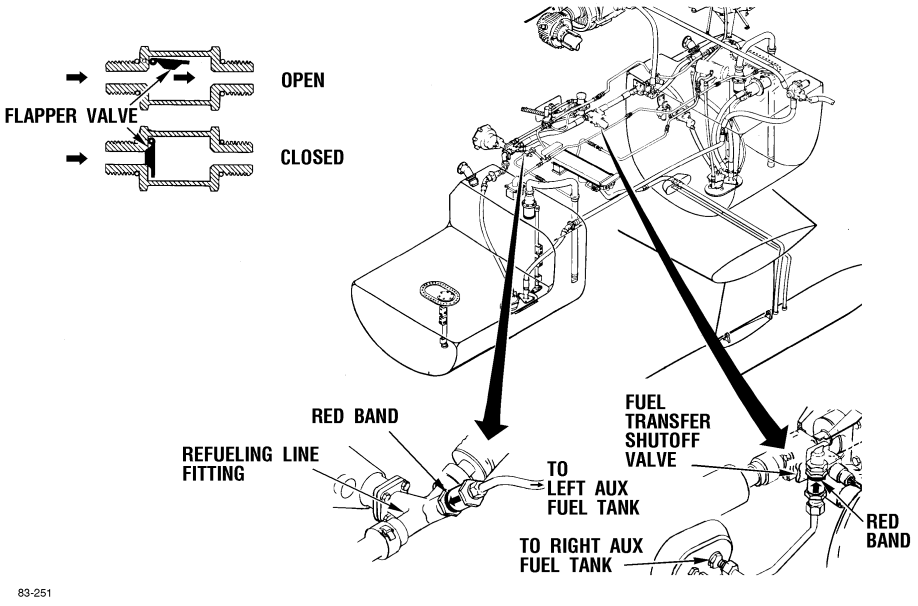
   a. Provides positive fuel shutoff when the EXT TK transfer switch is placed in the OFF position.

   b. Prevents air from being drawn from the auxiliary tanks during internal fuel transfer.

   c. Installed in the trailing edge of each wing when provisions for external fuel tanks are installed on the helicopter.

   d. The auxiliary fuel tanks shutoff valve is part of the auxiliary wing tanks installation kit and is not installed on the helicopter when delivered from the factory.

AUXILIARY FUEL SYSTEM CHECK VALVES



NOTES

3. Auxiliary fuel system check valves (2)

   a. Prevents fuel from entering the auxiliary fuel tanks during refueling or internal fuel transfer operations.

   b. Both check valves are mounted on the upper right side of the ammunition bay.

   c. Valves are marked with a red band to indicate it is a low pressure fuel system check valve.

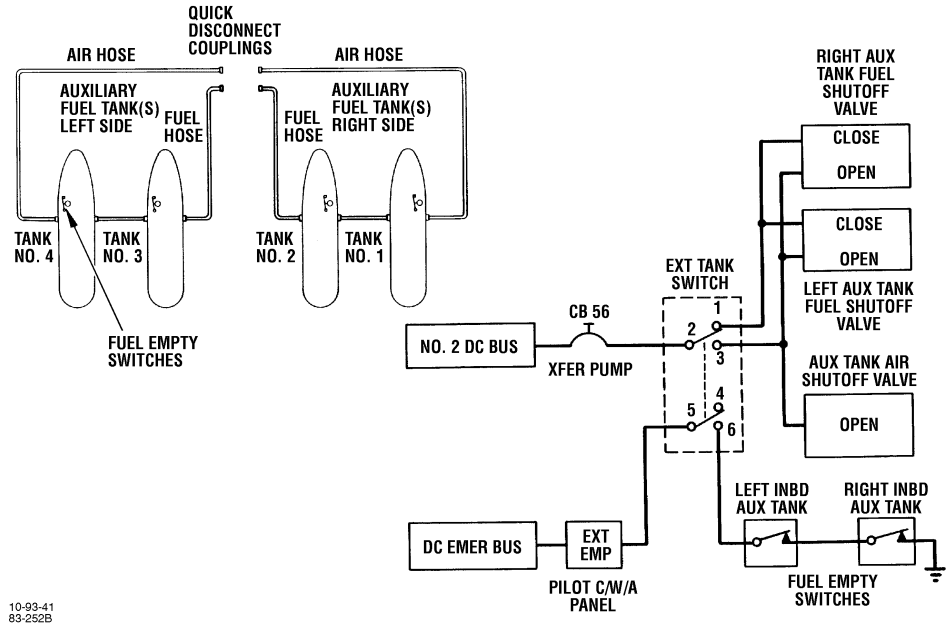
   d. Valve failure symptoms

      (1) Failed open. No effect on the system.

      (2) Failed closed. Fuel cannot be transferred from the tank(s) on the effected side.

   e. The auxiliary fuel system check valves are installed on the helicopter when delivered from the factory.

AUXILIARY TANKS FUEL EMPTY SWITCHES



NOTES

4. Auxiliary tank empty switches

   a. Illuminates the EXT EMP segment light on the pilot's caution/warning/advisory panel when all the auxiliary tanks are empty.

   b. One switch is installed in each auxiliary fuel tank.

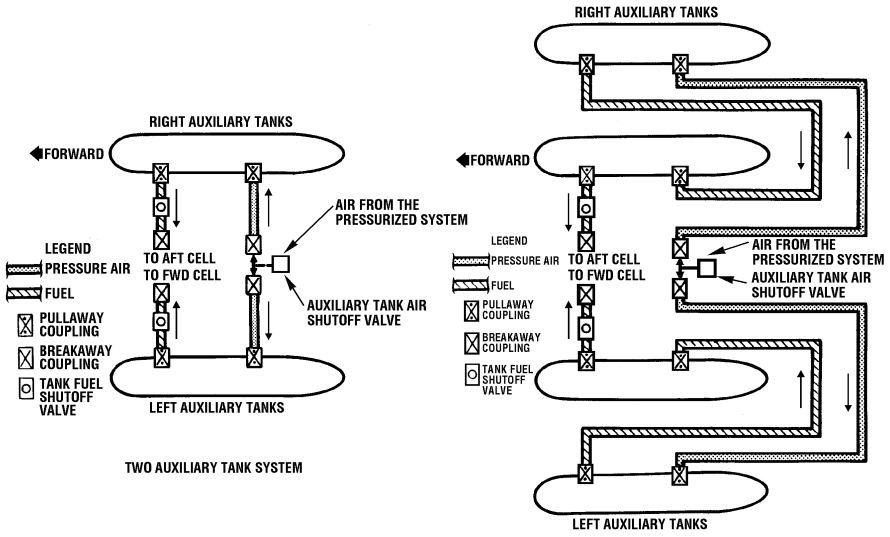
   c. Fuel tank empty switches are float type switches that complete a circuit when the fuel level is below the float. The switches in the inboard tanks are connected in series so that all the tanks must be empty before the electrical circuit for the advisory light is completed.

   d. Power for the external tank switch is available from the No. 2 DC BUS via the fuel transfer pump circuit breaker.

   e. When the external tank switch is placed in the ON position, power is applied to open the auxiliary tank air shutoff valve and auxiliary tank fuel shutoff valves. Contacts 5/6 complete a circuit from the EXT EMP advisory light to both inboard auxiliary tank fuel empty switches.

   f. The auxiliary tank empty switches are not installed on the helicopter when delivered from the factory.

AUXILIARY FUEL TANKS SCHEMATIC



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NOTES

5. Auxiliary fuel tanks schematic

   a. When the external tank switch is placed ON, the auxiliary tank air shutoff valve and the tank fuel shutoff valves are energized open.

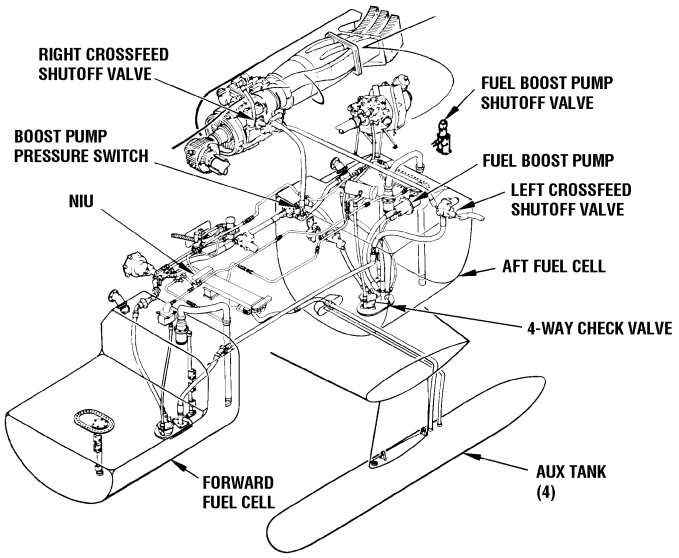
   b. Pressurized air (16 to 22 psi) from the PAS system pressurizes the auxiliary tanks to force the fuel to flow through the fuel shutoff valves into the internal cells.

   c. If four tanks are installed, the PAS air hoses are connected to the outboard tanks only. PAS air forces the fuel from the outboard tanks into the inboard and then into the internal fuel cells.

   d. When the internal fuel cells are full, the fuel level control valves close and terminate the transferring of fuel.

   e. Refer to Interim Statement of Airworthiness Qualification for restrictions and proper wiring changes for use of auxiliary fuel tanks.

FUEL DISTRIBUTION SYSTEM



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NOTES

071-622-04

A. Fuel distribution system

1. Provides management of fuel for engine starting and operation.

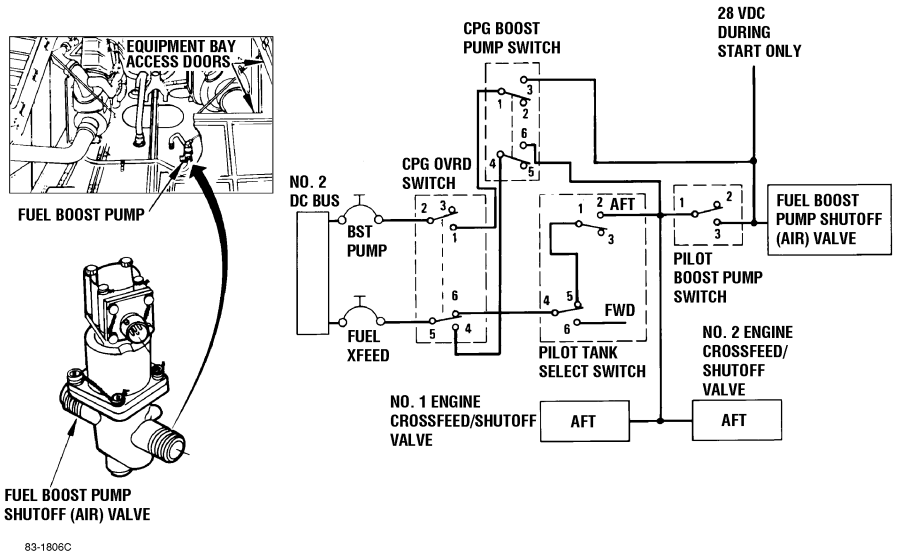
2. Distribution system consists of the forward and aft fuel cells, distribution and monitoring components.

3. The forward fuel cell normally supplies fuel to the No. 1 (left) engine. The aft cell supplies fuel to the No. 2 engine. If desired, either cell can supply fuel to both engines through the crossfeed mode.

4. The aft cell provides fuel for the auxiliary power unit and to both engines during start.

B. System components include the fuel boost pump shutoff valve (air), fuel boost pump, 4-way check valve (not shown), fuel boost pump pressure switch, and crossfeed/shutoff valves (2).

FUEL BOOST PUMP SHUTOFF (AIR) VALVE



NOTES

1. Fuel boost pump shutoff valve (air)

   a. Controls the airflow to the air-driven motor of the boost pump.

   b. Mounted on the right aft side of the main transmission deck.

   c. Valve is a solenoid-operated poppet valve that is electrically energized open and spring-loaded closed.

   d. Operation from pilot's fuel control panel

      (1) 28 VDC from the fuel crossfeed circuit breaker (CB55) is applied to the CPG's ORIDE switch. The ORIDE switch must be in the PLT position to complete the circuit to the pilot's tank select switch. The tank select switch must be in the AFT position to complete the circuit to the pilot's boost pump switch.

      (2) With the CPG's ORIDE switch in PLT and the pilot's tank select switch in the AFT position, placing the pilot's boost pump switch to the ON position applies 28 VDC to the valve motor and drives the valve to the open position. With the valve open, PAS air is applied to the air-driven boost pump.

   e. Operation from the CPG's fuel panel

      (1) 28 VDC from the BST pump circuit breaker (CB57) is applied to the CPG's ORIDE switch. This switch must be placed in the CPG position to complete the circuit to the CPG's boost pump switch.

      (2) Placing the CPG boost pump switch to ON applies power from contact 3 of the ORIDE switch, through contacts 1/3 of the CPG boost pump switch, to the fuel boost pump (air) shutoff valve. The shutoff valve is energized open.

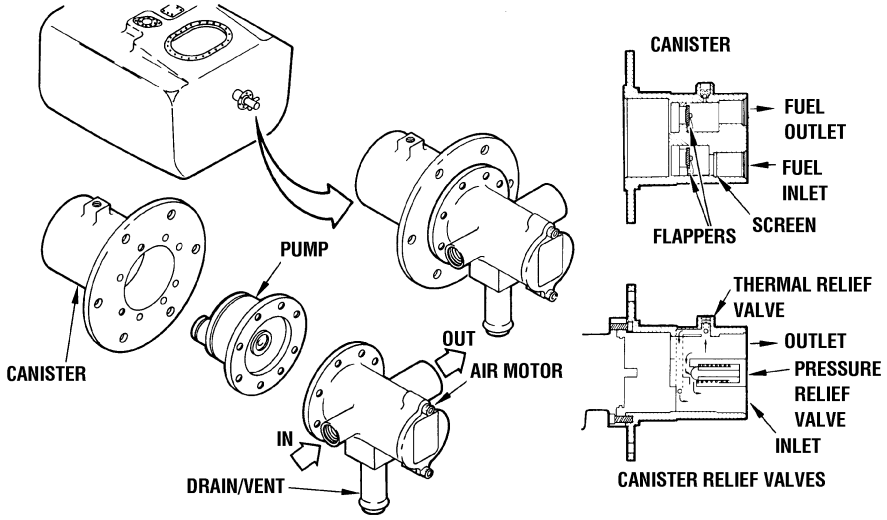
   f. Automatic operation during start

      (1) Operation during start is independent of the CPG's and pilot's fuel switches.

      (2) When a start is initiated for either engine, the respective start relay energizes and applies 28 VDC directly to the motor and drives the valve to the open position.

      (3) As soon as power is removed from the solenoid, the spring-loaded valve closes.

FUEL BOOST PUMP ASSEMBLY



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NOTES

2. Fuel boost pump assembly

   a. Provides fuel under pressure to the engines during starting and high altitude operation. (over 10,000 feet msl)

   b. Mounted on the right aft area of the aft fuel cell.

   c. Pump assembly consists of

      (1) Air motor

      (2) Fuel boost pump

      (3) Fuel boost pump canister

   d. The air motor is a vane type motor, driven by PAS air regulated to 19 "3 PSI. It has an air inlet port, air outlet port, and a drain/vent port for seal leakage.

   e. The boost pump is a positive displacement gerotor type pump.

   f. The fuel boost pump canister contains

      (1) 100 mesh inlet screen

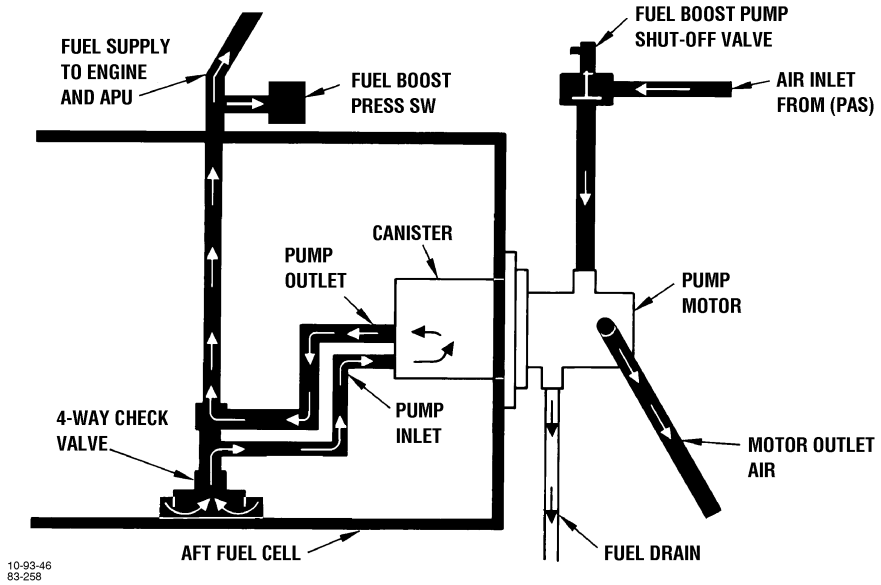
      (2) Spring-loaded outlet flapper valve

      (3) Spring-loaded inlet flapper valve

      (4) Pressure relief valve

      (5) Thermal relief valve

BOOST PUMP OPERATION



NOTES

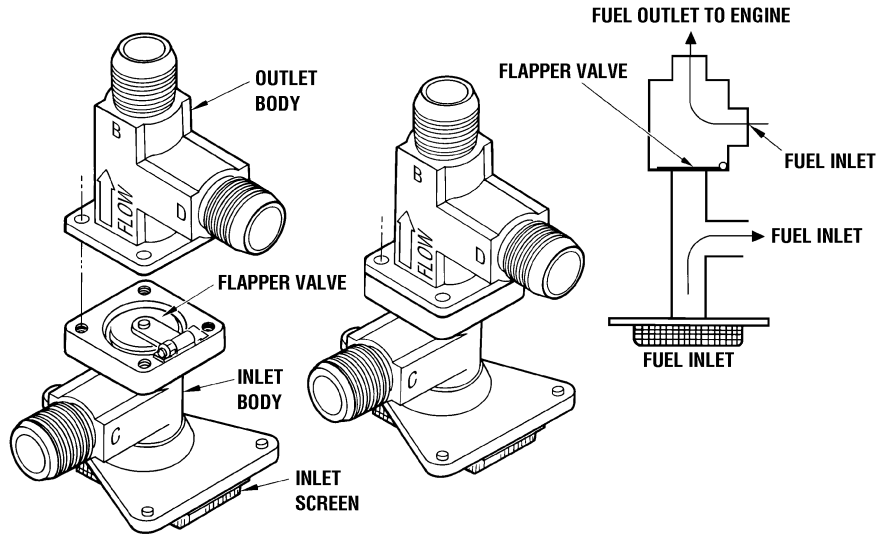
g. The inlet screen prevents large particles in the fuel from entering the APU or engine fuel lines.

h. Flapper valves allow boost pump removal without draining and purging the aft fuel cell.

i. The pressure relief valve relieves excess fuel pressure at the boost pump inlet and recirculates the fuel. This spring-loaded poppet valve is set to crack at 10 PSI and is fully open at 23 PSI.

j. The thermal relief valve, attached to the canister, relieves pressure buildup caused by heat expansion in the fuel line. The valve begins to open at 5 PSI increasing and closes when the pressure drops below 3 PSI.

4-WAY CHECK VALVE



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NOTES

3. 4-way check valve

   a. Permits fuel to bypass the fuel boost pump when the pump is not being used.
   b. Allows fuel to flow to the fuel boost canister during normal operations.

   c. In conjunction with the canister flapper valves prevents draining of the fuel lines after engine/APU shutdown.

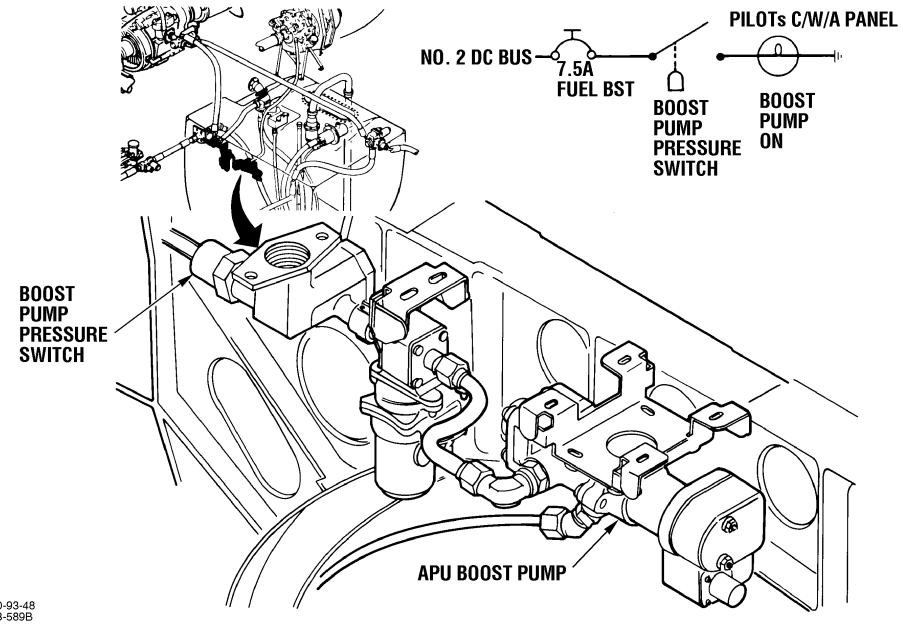
   d. Mounted to the bottom of the aft fuel cell.

   e. During fuel boost pump operation, boost pump suction draws fuel through the inlet screen on the bottom of the 4-way check valve.

   f. Suction created by the boost pump holds the flapper valve closed, dividing the 4-way check valve into two separate chambers.

   g. Fuel is drawn into the boost pump through the bottom portion of the 4-way check valve, pressurized and pumped through the top portion of the valve and into the fuel feed lines. During normal operations, when the fuel boost pump is not needed, the flapper valve stays open allowing fuel to bypass the fuel boost pump.

BOOST PUMP PRESSURE SWITCH



NOTES

4. Boost pump pressure switch

   a. Provides a signal to the BOOST PMP ON caution light on the pilot's caution/warning/advisory panel. The BOOST PMP ON caution light alerts the pilot that boost pump pressure is available.

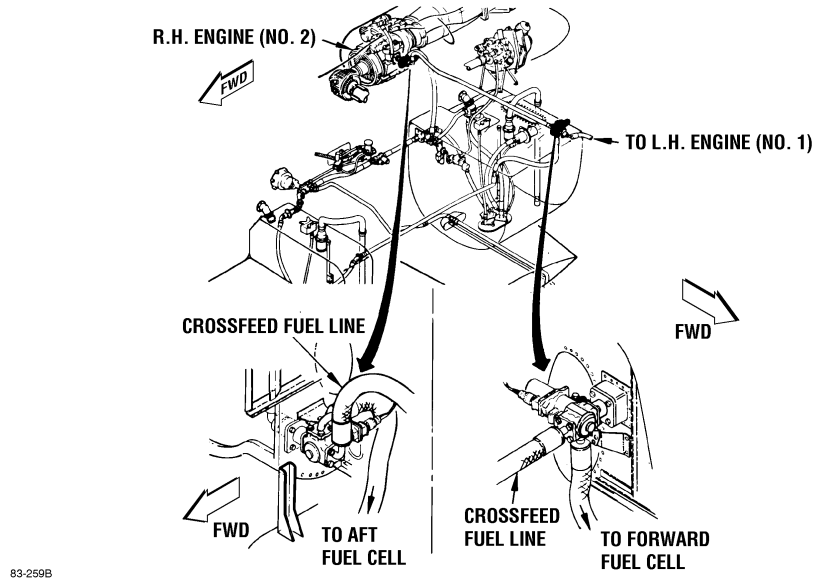
   b. Mounted in the ammunition bay in the aft upper right side.

   c. The boost pump pressure switch is a normally open switch that closes when the boost pump pressure reaches 8.5 to 10 PSI increasing. The switch opens when pressure decreases to 7 PSI.

   d. Electrical power is applied to the pressure switch from the FUEL BST circuit breaker (CB57).

   e. The boost pump pressure switch is not actuated when the APU is on due to its location in the fuel supply line and the APU boost pump creating flow past the switch.

CROSSFEED/SHUTOFF VALVES



NOTES

5. Crossfeed/shutoff valves

   a. Provide a means of selecting a fuel source for the engines and for positive fuel shutoff during maintenance or emergencies.

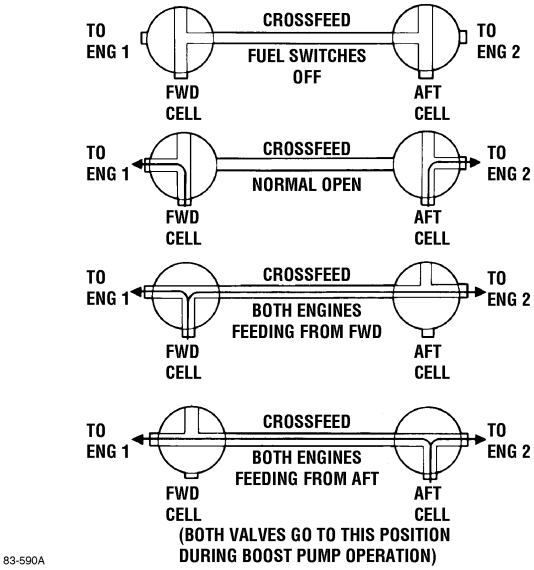
   b. The right crossfeed/shutoff valve is mounted on the left forward section of the No. 2 engine fire wall.

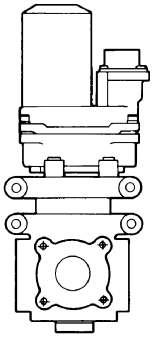
   c. The left crossfeed/shutoff valve is mounted on the right forward section of the No. 1 engine fire wall.

   d. The crossfeed/shutoff valves are three-way, four-position ball valves, that are electrically controlled from either crew station.

   e. Valves are automatically driven closed when the respective engine fire pull handle is pulled.

FUEL CROSSFEED/SHUTOFF VALVES





NOTES

6. Fuel crossfeed/shutoff valve positions

   a. Engine FUEL switches OFF - Both crossfeed valves are closed.

   b. Engine FUEL switches ON, CROSSFEED switch NORM -

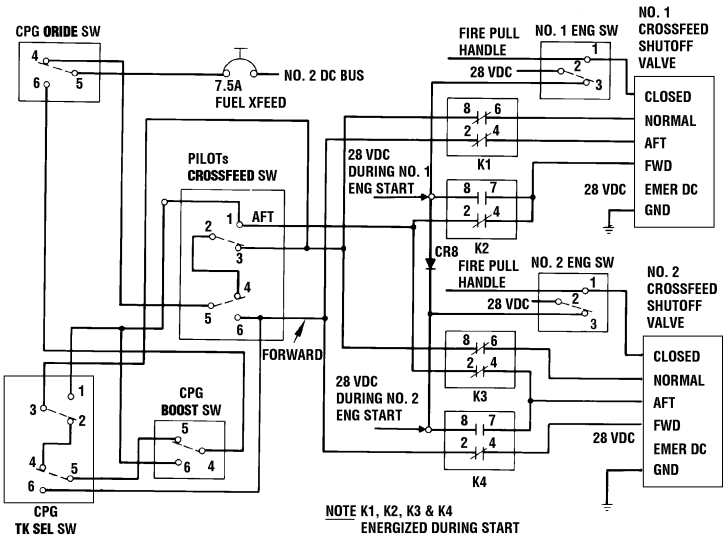
      (1) Forward fuel cell feeds the No. 1 engine.

      (2) Aft fuel cell feeds the No. 2 engine.

   c. Engine FUEL switches ON, CROSSFEED switch FWD TK - Both engines receive fuel from the forward cell.

   d. Engine FUEL switches ON, CROSSFEED switch AFT TK - Both engines receive fuel from the aft cell. (During boost pump operation both valves are in this position).

CROSSFEED/SHUTOFF VALVE ELECTRICAL SCHEMATIC



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NOTES

7. Crossfeed/shutoff valve electrical operation

   a. Power from the FUEL XFEED circuit breaker (CB55) is available to pin 5 of the CPG ORIDE switch. The ORIDE switch must be in the PLT position for operation of the fuel crossfeed/shutoff valves from the pilot's station.

   b. With the ORIDE switch in the PLT pilot position, power is applied to pin 5 of the pilot's CROSSFEED switch.

   c. The pilot's CROSSFEED switch is shown in the NORM position. From pin 5, power goes through internal contacts and out pin three to a junction point. From the junction point, power goes to the normally closed contacts 8/6 of relay K1 (No. 1 start) and relay K3 (No. 2 start).

   d. From contact 6 of K1, 28 VDC is applied to the No. 1 crossfeed/shutoff valve to drive it to the normal position. From contact 6 of K3, power is applied to the No. 2 crossfeed/shutoff valve to drive it to the normal position.

   e. With both valves in the normal position, The No. 1 engine draws fuel from the forward cell and the No. 2 engine draws fuel from the aft cell.

   f. If the pilot selects FWD TK with the CROSSFEED switch, contacts 5/6 of the tank select switch close. 28 VDC is routed from the circuit breaker through the CPG's ORIDE switch, through contacts 5/6 of the tank select switch to a junction point.

      (1) From the junction point, power is applied to the normally closed contacts 2/4 of relay K1 and relay K4 (No.1 and No. 2 start).

      (2) From contact 4 of K1, power is routed to drive the No. 1 crossfeed/shutoff valve to the forward position.

      (3) Simultaneously, power from contact 4 of K4 drives the No. 2 crossfeed/shutoff valve to the forward position.

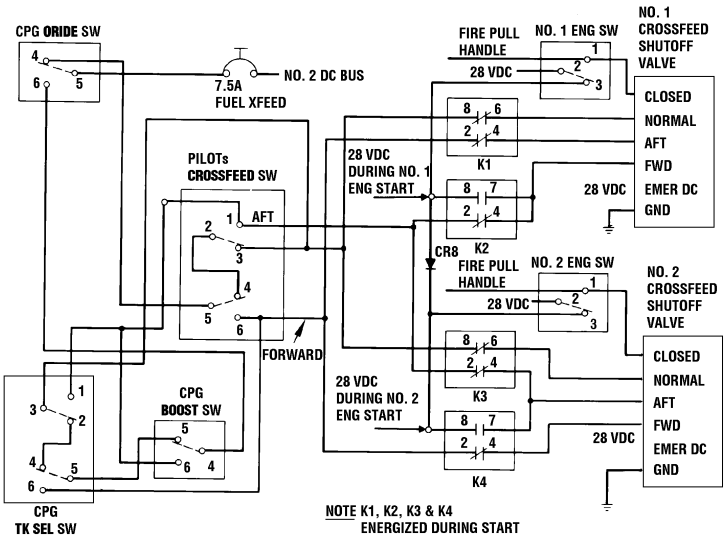
      (4) With the valves in the forward position, both engines are supplied fuel from the forward tank.

   g. If the pilot selects AFT TK with the CROSSFEED switch, contacts 2/1 and 5/4 close. 28 VDC is routed from the circuit breaker through closed contacts 5/4 of the pilot's tank select switch through contacts 2/1 to the de-energized closed contacts 2/4 of relays K2 and K3.

      (1) From contact 4 of K2, power is applied to the No. 1 crossfeed/shutoff valve to drive it to the aft position.

      (2) Simultaneously, power from contact 4 of K3 drives the No. 2 crossfeed/shutoff valve to the aft position.

CROSSFEED/SHUTOFF VALVE ELECTRICAL SCHEMATIC



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NOTES

(3) With the crossfeed/shutoff valves in the aft position, both engines receive fuel from the aft cell.

h. If the CPG moves the ORIDE switch to the CPG position, operation of the crossfeed/shutoff valve can only be accomplished through the CPG's TK SEL switch.

i. No. 1 engine start operation

(1) When a start on the No. 1 engine is initiated, relays K1, K2, K3, and K4 will energize from the start circuitry automatically.

(2) 28 VDC is supplied to pin 8 of relay K2, through diode CR8, to pin 8 of relay K4.

(a) When K1 and K3 energize, the circuits to both crossfeed/shutoff valve normal positions are interrupted by contacts 8/6 of both relays, causing them to open. Contacts 2/4 of both relays also open. Contacts 2/4 of K1 open the circuit to the forward No. 1 crossfeed/shutoff valve and contacts 2/4 of K3 open the circuit to the aft position of the No. 2 crossfeed/shutoff valve.

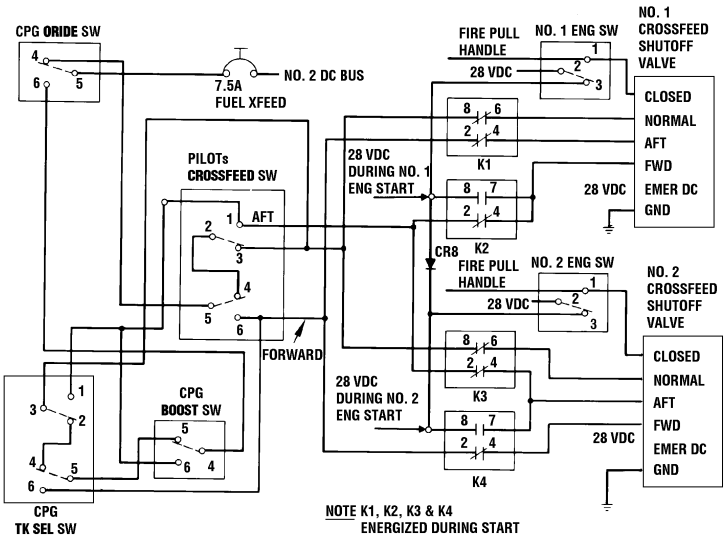
(b) When relays K2 and K4 energize, contacts 2/4 of both relays open and contacts 8/7 close. Contacts 8/7 apply 28 VDC from the No. 1 engine start circuitry to drive both crossfeed/shutoff valves to the aft position.

(c) When the start is completed, relays K1, K2, K3, and K4 de-energize.

(d) When K1 and K3 de-energize, contacts 8/6 and 2/4 of both relays close. Contacts 8/6 of each relay complete a circuit to the normal position of the respective crossfeed/shutoff valve. If the CROSSFEED switch is in the NORM position, both valves drive to the normal position. Contacts 2/4 of relay K1 close the circuit to the forward position on the No. 1 crossfeed/shutoff valve and contacts 2/4 of K3 close the circuit to the normal position of the No. 2 crossfeed/shutoff valve.

(e) When K2 and K4 de-energize, contacts 8/7 of both relays open and contacts 2/4 close. Contacts 8/7 open the circuit from the start circuitry to the aft position of both valves. Contacts 2/4 of relay K2 complete the circuit from the tank select switch to the aft position of the No. 2 valve. Contacts 2/4 of relay K4 complete the circuit from the CROSSFEED switch to the forward position of the No. 2 valve.

CROSSFEED/SHUTOFF VALVE ELECTRICAL SCHEMATIC



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NOTES

j. No. 2 engine start operation

(1) When a start is initiated on the No. 2 engine, relays K3 and K4 energize from the start circuitry.

(2) When K3 energizes, contacts 8/6 and contacts 2/4 open. Contacts 8/6 open the circuit to the normal position of the No. 2 crossfeed/shutoff valve. Contacts 2/4 open the circuit from the CROSSFEED switch to the aft position of the crossfeed/shutoff valve.

(3) When K4 energizes, contacts 2/4 open and contacts 8/7 close. Contacts 2/4 open the circuit to the forward position of the crossfeed/shutoff valve and contacts 8/7 complete the circuit to drive the valve to the aft position.

(4) When the start is completed, relays K3 and K4 de-energize.

(5) When K3 de-energizes, contacts 8/6 and 2/4 close. Contacts 8/6 complete the circuit to the normal position of the valve. If the CROSSFEED switch is in the center NORM position, the valve drives to the normal position. Contacts 2/4 complete the circuit to the aft position of the valve. If the CROSSFEED switch is in the AFT TK position, the valve remains in the aft position.

(6) When K4 de-energizes, contacts 8/7 open and contacts 2/4 close. Contacts 8/7 open the path for the start circuitry to the aft position of the valve. Contacts 2/4 complete the circuit from the tank select switch to the forward position of the valve. If the switch is in the FWD TK position when the start terminates, the valve is driven to the forward position.

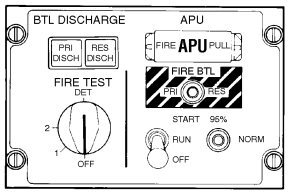
(7) When the No. 1 or No. 2 Engine fuel switch is placed in the OFF position, 28 VDC is applied directly to the close position, regardless of CROSSFEED switch position.

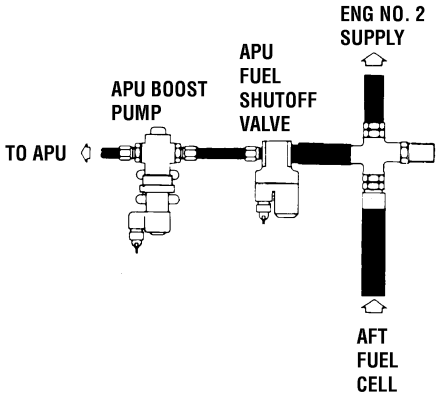
k. Fire pull handle operation

(1) When the No. 1 ENG FIRE PULL handle is activated, 28 VDC is routed to contact one of the No. 1 engine switch, then directly to the crossfeed/shutoff valve to drive it to the closed position.

(2) Operation of the No. 2 ENG FIRE PULL handle is the same as the No. 1.

APU FUEL SYSTEM





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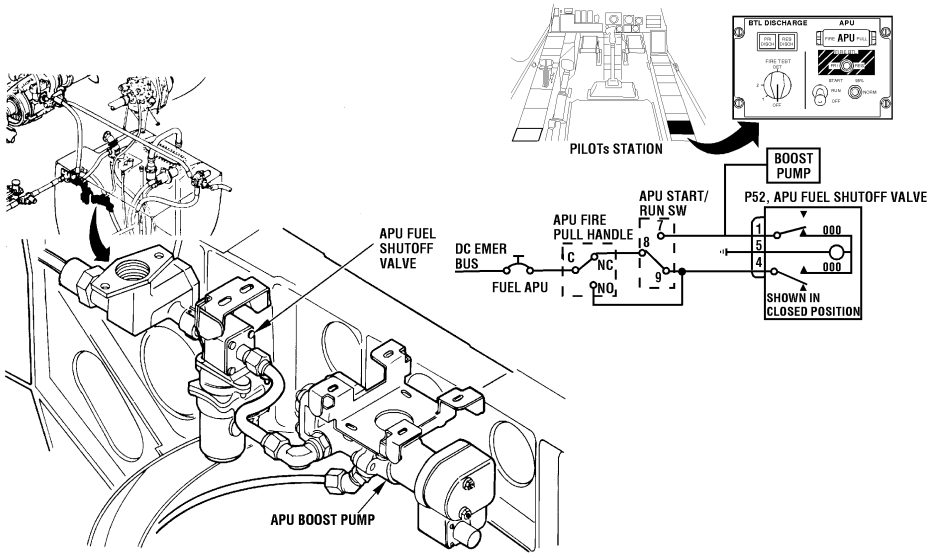
NOTES

A. APU fuel system. The APU fuel system provides pressurized fuel for starting and continuous operation of the APU.

APU BOOST PUMP AND FUEL SHUTOFF VALVE



NOTES

B. Major APU fuel system components include the APU boost pump and APU fuel shutoff valve.

1. APU boost pump

a. Provides pressurized fuel to the APU.

b. Mounted in the ammunition bay on the upper aft right hand side.

c. The APU boost pump is a DC motor-operated, vane-type pump with a regulated output pressure of 10 " 3 PSI.

2. APU fuel shutoff valve

a. Controls fuel flow to the APU boost pump.

b. Mounted in the ammunition bay on the upper aft right hand side, in front of the APU boost pump.

c. The shutoff valve is a motor-operated, ball-type valve requiring DC power for operation.

C. The boost pump and shutoff valve are controlled by the APU START/RUN/OFF switch.

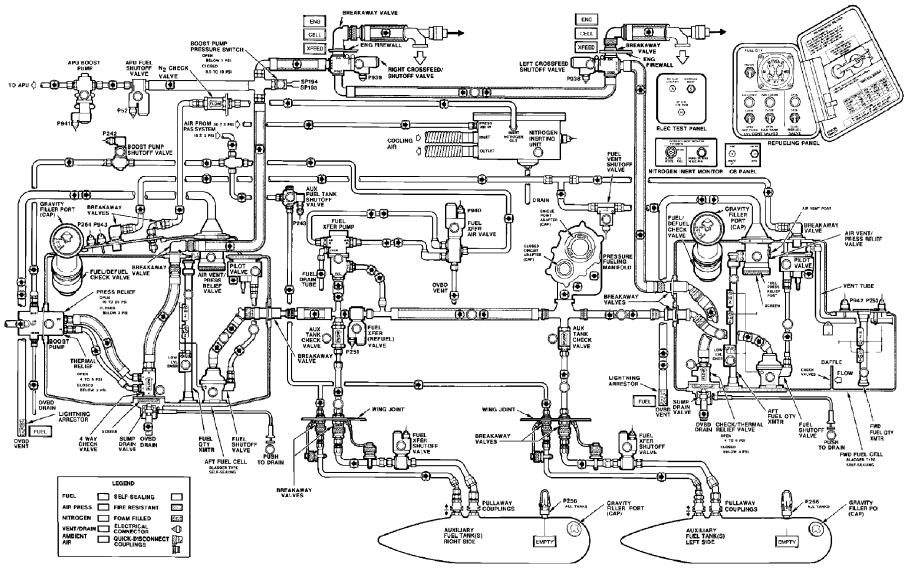
1. DC emergency bus power is available to the APU START/RUN/OFF switch via the FUEL APU circuit breaker (CB 9) and the normally closed contacts of the FIRE APU PULL handle.

2. Placing the APU START/RUN/OFF switch in the RUN or START position supplies DC power to open the fuel shutoff valve and energizes the pump motor. This allows fuel to be drawn from the aft fuel cell by the boost pump.

3. When the APU START/RUN/OFF switch is placed to OFF, power is removed from the fuel boost pump motor and closes the fuel shutoff valve.

4. Regardless of the position of the APU START/RUN/OFF switch, if the FIRE APU PULL handle is pulled, power is removed from the fuel boost pump and the fuel shutoff valve closes.

AH-64A FUEL SYSTEM



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NOTES