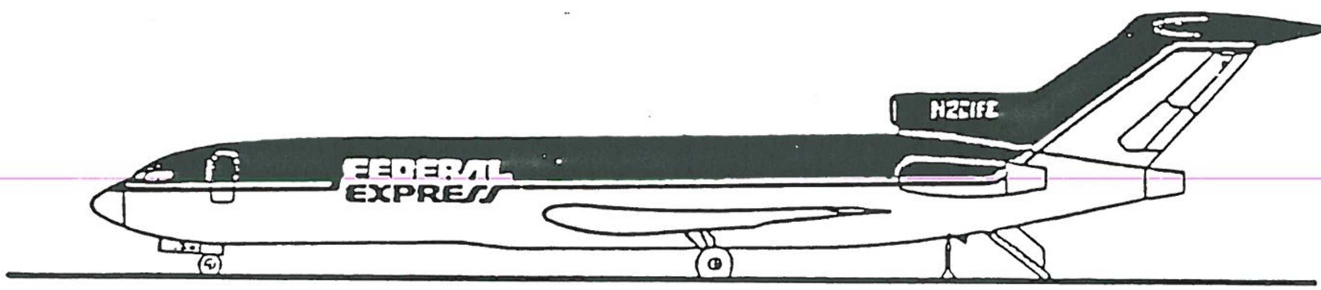
FEDERAL EXPRESS

TECHNICAL TRAINING

ATA 28

FUEL



727-200F SYSTEMS STUDY GUIDE

ATA-28

FUEL SYSTEM

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FUEL SYSTEM

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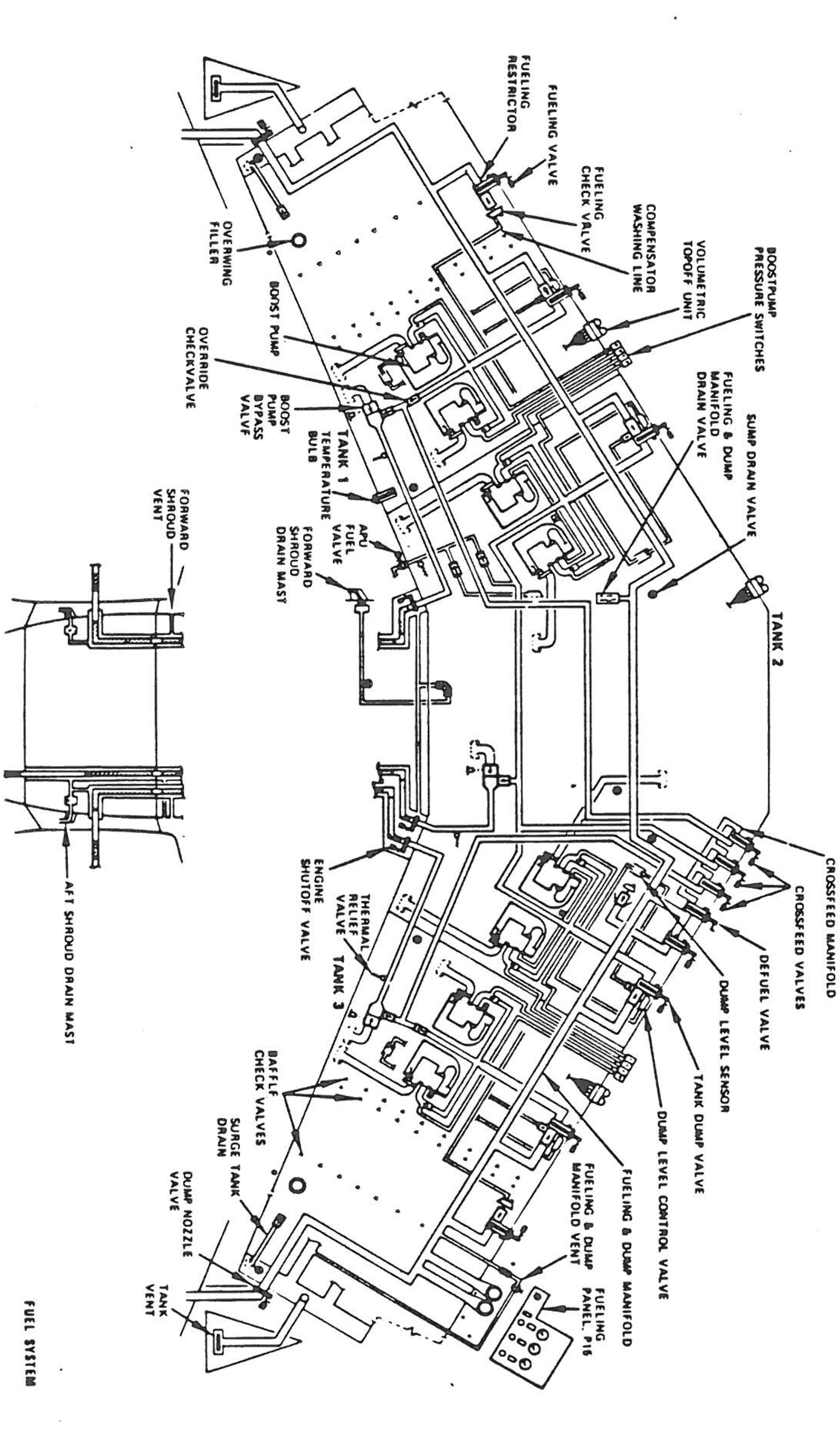
The material furnished here is to be used as a training aid only. Details, values and lengthy discussion of the aircraft systems and equipment have been purposely avoided. It is suggested that in order to achieve maximum training value from this material, it is to be considered a supplement to classroom lecture and a general study guide for a student during formal maintenance training.

NOTE:

NOTHING IN THIS STUDY GUIDE SHALL BE CONSTRUED AS AUTHORITY FOR DEVIATION FROM FEDERAL AVIATION REGULATIONS OR APPROVED AIRCRAFT OR COMPONENT MAINTENANCE AND OVERHAUL MANUAL INSTRUCTIONS.


FUELING RESTRICTOR
FUELING VALVE
FUELING CHECK VALVE
COMPENSATOR WASHING LINE
VOLUMETRIC TOPOFF UNIT
BOOSTPUMP PRESSURE SWITCHES
FUELING & DUMP MANIFOLD DRAIN VALVE
SUMP DRAIN VALVE
TANK 2
CROSSFEED MANIFOLD
CROSSFEED VALVES
DEFUEL VALVE
DUMP LEVEL SENSOR
TANK DUMP VALVE
DUMP LEVEL CONTROL VALVE
FUELING & DUMP MANIFOLD
FUELING PANEL, P16
FUELING & DUMP MANIFOLD VENT
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BAFFLE CHECK VALVES
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THERMAL RELIEF VALVE
ENGINE SHUTOFF VALVE
AFT SHROUD DRAIN MAST
FORWARD SHROUD VENT
FORWARD SHROUD DRAIN MAST
APU FUEL VALVE
TANK 1
TEMPERATURE BULB
BOOST PUMP BYPASS VALVF
OVERRIDE CHECKVALVE
BOOST PUMP
OVERWING FILLER

FUEL SYSTEM

I. FUEL SYSTEM ATA-28

A. Fuel System Differences between 727-100C and 727-200F.

1. The 727-200F fuel system has major differences in tank design and minor differences in components and control. The following is a listing of the differences that will be covered in this text:

   a. Tank volume has been increased by a change in No. 2 tank. The fuel cell bladders have been removed and the entire No. 2 center section is a integral type tank.

   b. Tank No. 2 fuel boost pumps are a higher output pump and will override the fuel pumps in tanks 1 and 3 when the crossfeed manifold system is selected.

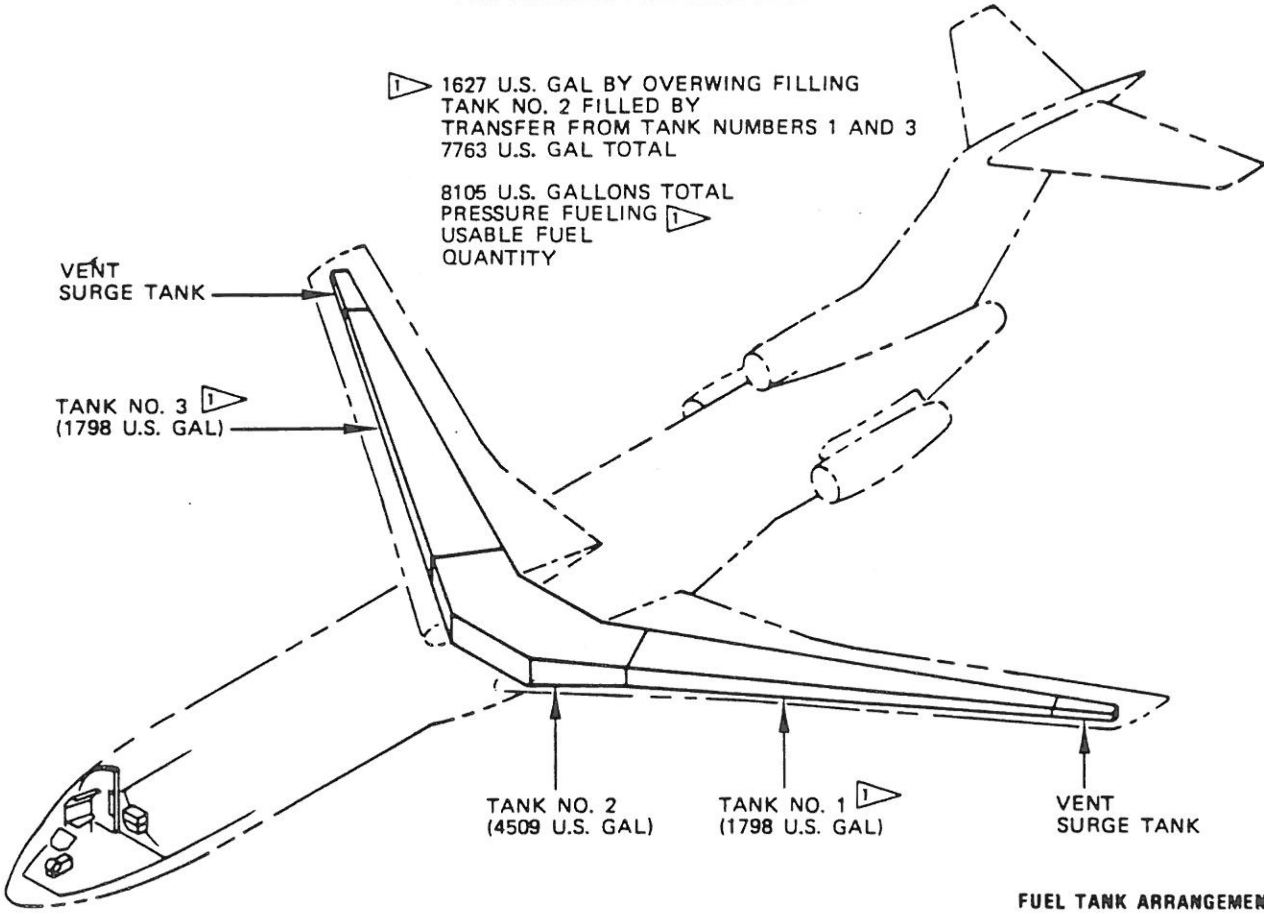
   c. Main fuel shutoff valve control switch normally found on -100C aircraft has been deleted. The main fuel shutoff valve on the -200F is normally controlled by the movement of the Start/Cutoff lever and closed in an emergency by the applicable Fire Switch.

   d. The refueling system incorporates the Volumetric Top off (VTO) capacitance system for automatic fuel shutoff during the fueling operation. Unique to this VTO system is the addition of VTO tank reset switches located on the P-15 refueling panel.

   e. Additional dripsticks have been added in tanks No. 1 and No. 3 and are incorporated in wing tank lower access plates. There are four dripsticks each in tanks No. 1 and No. 3, one dripstick in tank No. 2 for a total of nine.

   f. The APU fuel feed line from No. 2 tank can now be pressurized by use of any No. 2 boost pump.

   g. The fuel quantity indicators are the new "Pre-Calibrated" type which allows the indicator to be changed with only minor adjustment required to the tank unit trimmers.



FUEL TANK ARRANGEMENT

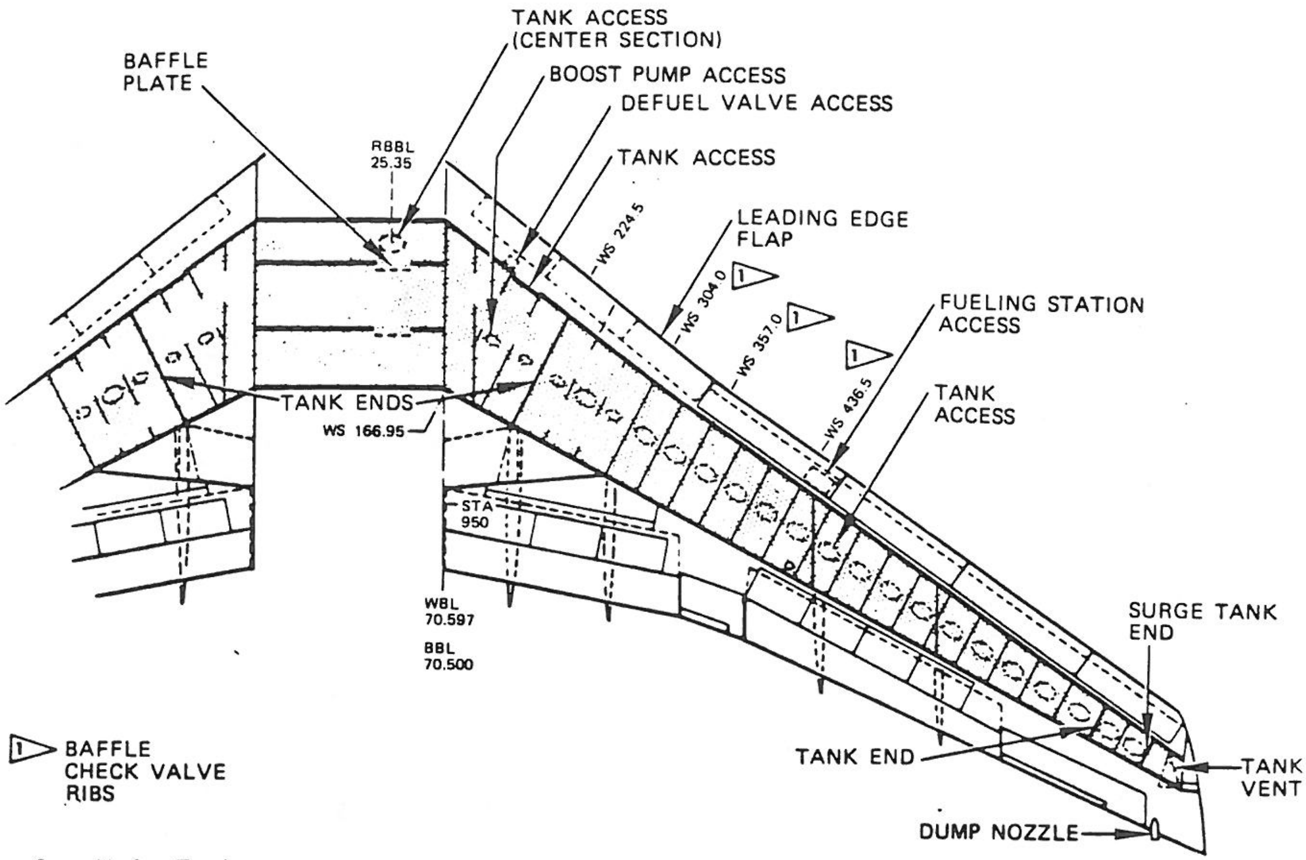
B. General Description

1. Fuel Tank Arrangement

a. Three main fuel tanks and two vent surge tanks are built as an integral part of the wing structure. The No. 1 and No. 3 tanks are located in the left and right wings, from approximately the landing gear pivot area outboard, nearly to the wing tip. The No. 2 tank is located in the inboard sections of both wings and the wing center section between the main landing gears. Vent surge tanks are located in the outboard end of each wing tank at the wing tips.

b. Tanks No. 1 and 3 are each capable of holding 1798 U.S. gallons. Each vent surge tank will hold approximately 35 U.S. gallons. Tank No. 2 is capable of holding 4509 U.S. gallons. The above gallon capacities are considered to be the maximum fuel load allowable.

c. The maximum fuel load allowable in any tank is based on 7.1 pounds per U.S. GAL fuel specific weight (or "density") and the rated volume of the tank. An outboard main tank minimum fuel load requirement exists for wing bending relief in flight and it may apply if the fuel specific weight is below 6.5 pounds per U.S. GAL.



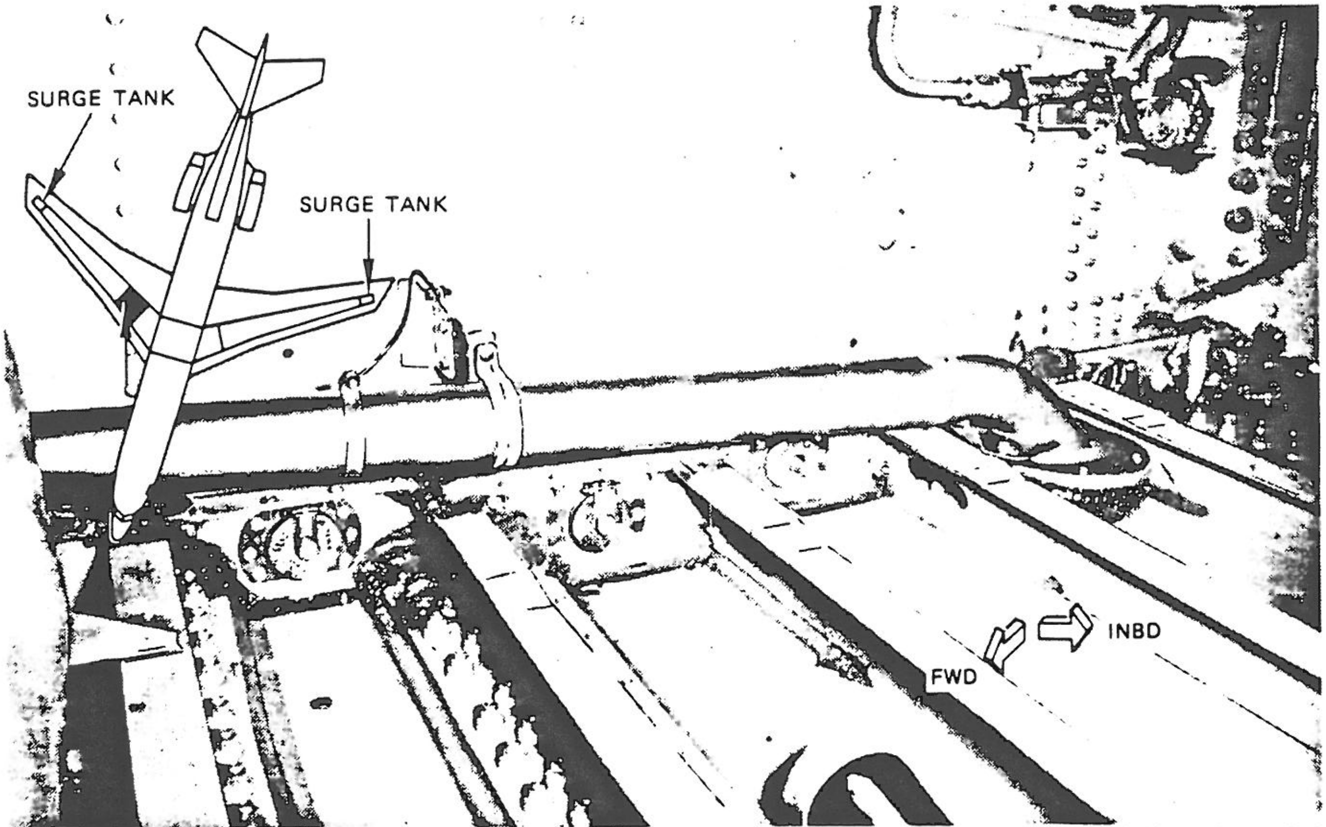
MAIN TANKS

2. Main Tanks

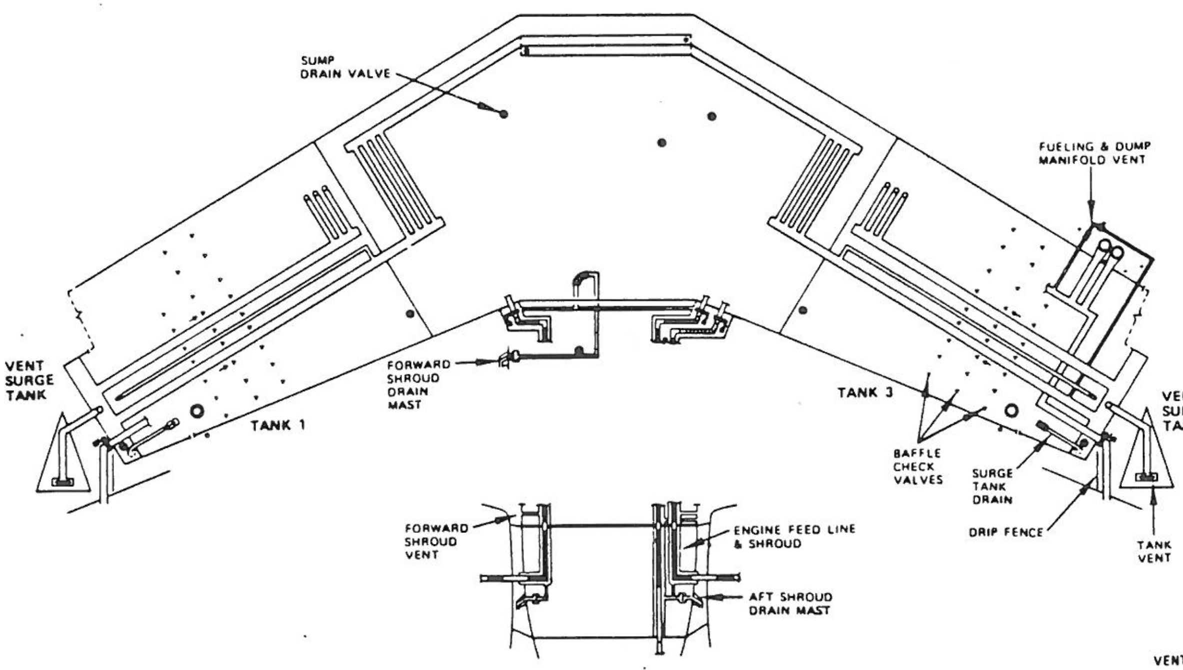
a. Three main TANKS and two vent surge tanks are formed by the structure of the inspar wing. Almost the entire full-span volume within this structure is for fuel storage. The structural joints are made fuel tight by sealant and fluid tight fasteners. Sealed ribs divide the inspar wing into individual tanks. The location of these tank-end-ribs depends on the functional requirements of the tank, the effect on airplane center of gravity of the weight of the fuel, and structural considerations of wing bending, bend-relief and maneuver loads.

b. Some of the upper wing skin structure forms the vent ducts for the tanks. Components passing through a tank boundary are sealed with O-ring packings. Access panels are sealed with reusable molded-in seals. The center section access has sealant applied externally after panel closure.

c. A fuel tank assures maximum fuel availability to the feed system during all allowable flight and ground maneuvers. It assures a drainable sump volume, below the feed sytem inlets, when the airplane is parked in a nominal ramp position. Drain holes in the lower wing skin support structure, assure gravity flow inboard to the feed system inlets and to the sump drain valves. Fuel surge loads within the tanks are baffled by the wing ribs and, in the wing center section, by the spanwise beams. Manholes in the spanwise beams are covered by removable baffle plates.



BAFFLE RIB – TANK NO. 3



VENT SYSTEM

3. Baffle Rib-Tank No. 3

   a. In main tanks No. 1 and No. 3, three ribs have baffle plates between the stiffeners, extending to the upper and lower wing skins. Baffle check valves, opening inboard, are installed in some of these plates. This extra baffling of the inboard rib, forms a flight sump to hold fuel around the feed system inlets. The outboard two baffle ribs assure airplane trim stability especially during nose-up flight or maneuvering.

4. Vent System

   a. The main tank vent system consists of structural ducts and tubes formed by or built into the upper wing skin panel structure.

      An integral SURGE TANK near each wing tip is a holding tank for fuel from the tanks. Later recovery is by gravity drainage into tanks 1 and 3. Fuel in excess of 35 U.S. gallons (approx.) would flow overboard through the TANK VENT in the wing tip.

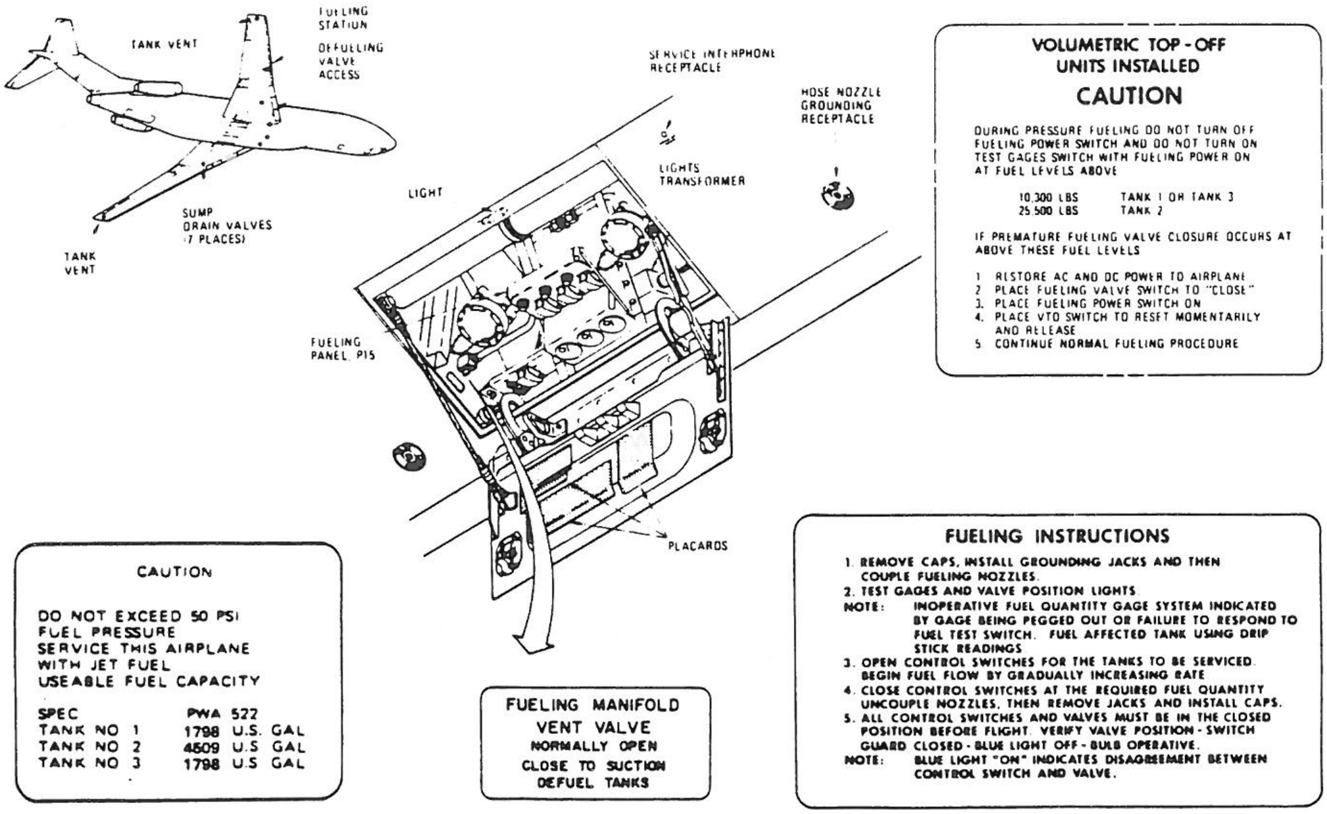
      Screens are installed in each wing tip vent and in each surge tank drain.

      Each tank has two vent port areas, at opposite ends of the tank. Each port is located so that at least one port will be in the air bubble. The other port may be submerged, but fuel would have to flow up-hill to leave the tank. In tanks 1 and 3, two BAFFLE CHECKVALVES are at the top of the second baffle rib to allow air bubble movement to the inboard port area.

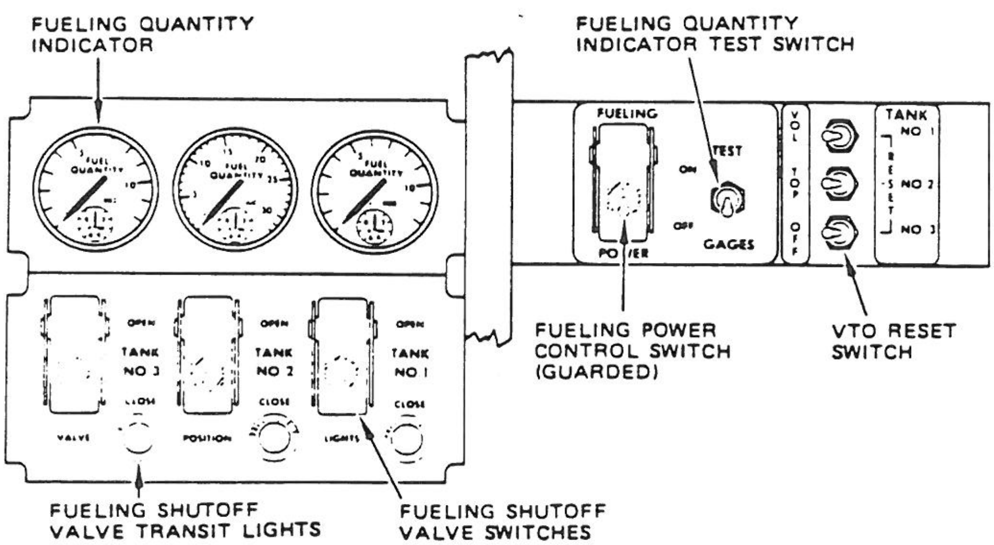
      The SUMP DRAIN VALVES are a reminder; that, as tanks breathe through the vent system, moisture can enter.

      The engine feed line shrouds drain forward of aft from the B Sta 1183 bulkhead. The three aft shrouds are vented and drained through two masts. The three forward shrouds drain to one mast and three vents provide inflight ventilation airflow.

      Each mast has a flame arrestor in the line above it. The drainline through the left wheel well is so nearly horizontal that a drain valve is used to check for fluid accummulation in the line. After usage assure that this valve does not remain locked open.



PRESSURE FUELING STATION



(ROTATED 180°)

Pressure Fueling System Equipment Location

5. Pressure Fueling Station

   a. The Fueling Station consists of:

      Fueling Door
      Fueling Placards
      Hose Receptacles and Caps
      Nozzle Grounding Jacks
      Fueling Panels, P15
      Fueling Power Switch
      Fueling Valve Switches
      Volumetric Topoff Reset Switches
      Valve Position Lights (Blue)
      Fuel Quantity Indicatiors
      Gage Test Switch
      Fueling Manifold Vent Valve
      Fueling Station Lights
      Lights Transformer
      Service Interphone Jack

   b. These components are mounted in or around the fueling bay in the right wing leading edge. The FUELING STATION provides most of the equipment for pressure fueling, hookup, test and operation. The equipment at the fueling station is also used for the filling portion of the fuel transfer operation. It provides the hose connection point for defueling.

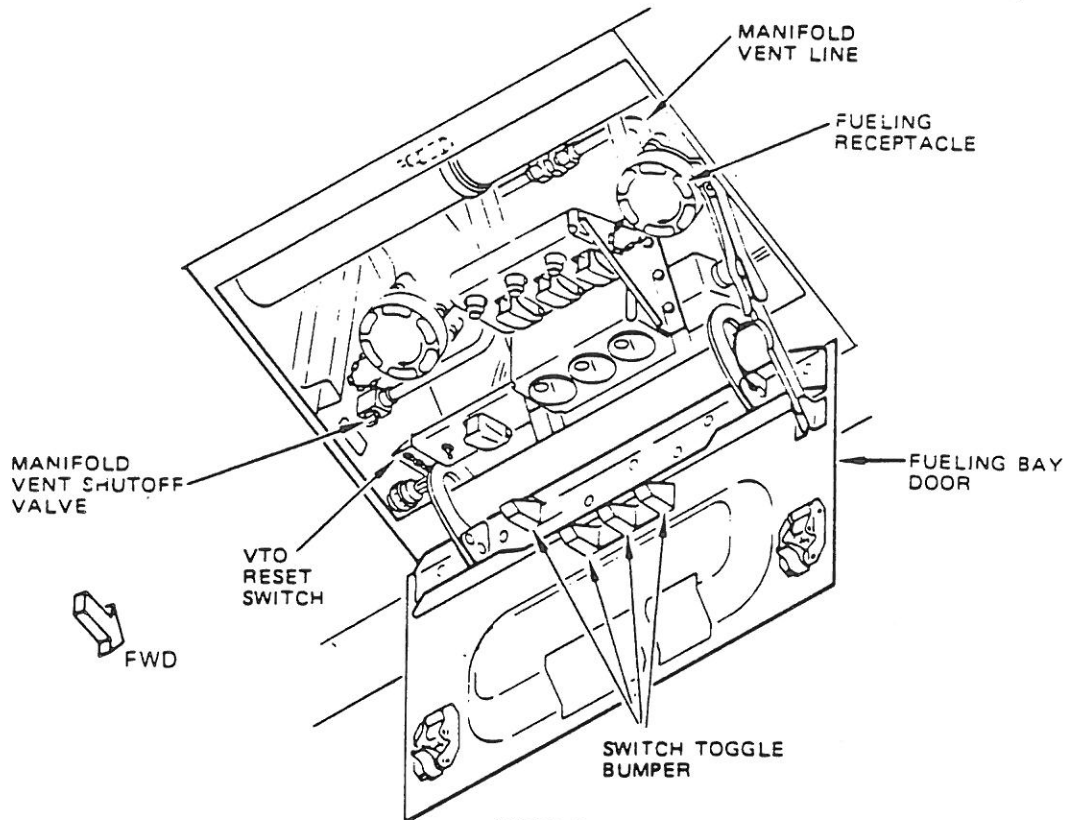
   c. Additionally, 115V AC and 24/28V DC electric power must be available from the APU or the external electrical power systems and the battery.

   d. The fueling power and fueling valve switches are guarded and locked in the OFF or CLOSE positions when either fueling door is closed and latched. This switch/door interlock assures fueling valve closure before flight and inflight by providing 28V DC Bus 2 power to the valve-close circuits.

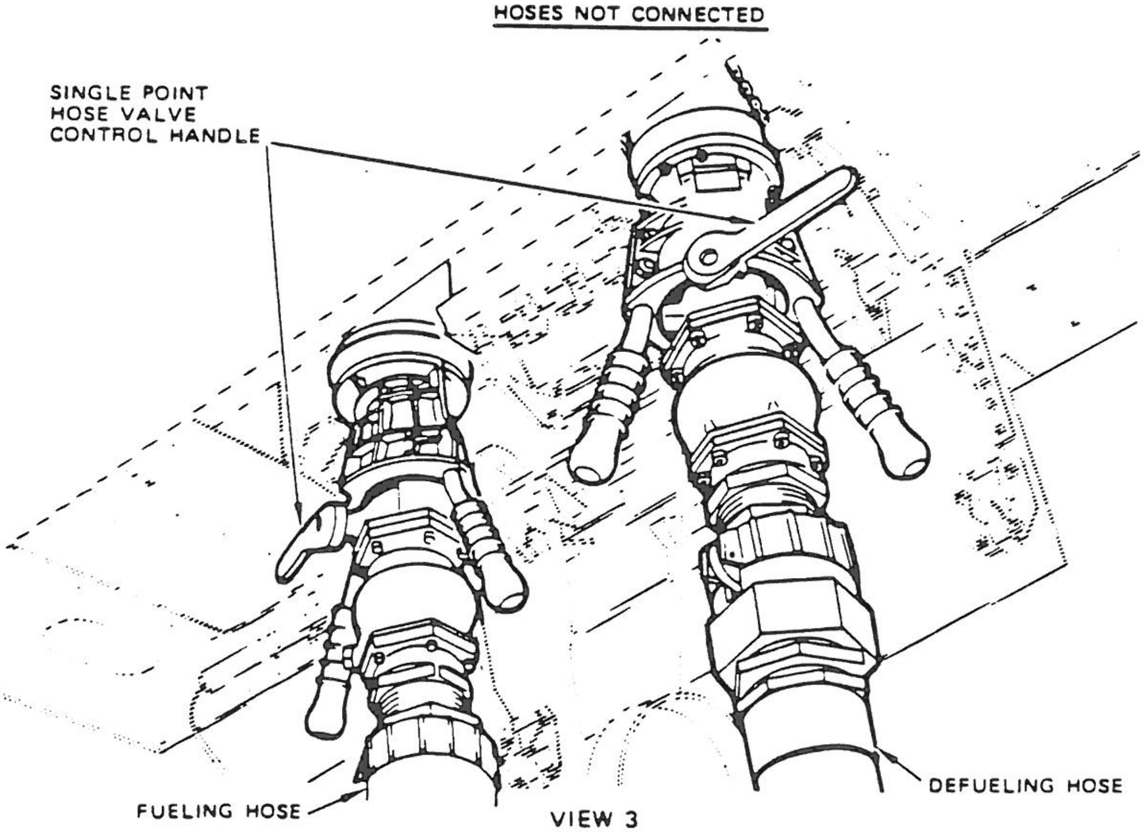
   e. With the fueling power switch ON, the main tank fuel valve switches can open the fueling valves if the tank is not full. But, if the tank is nearly full, empty or nearly empty, the fueling valves will not open. This odd situation is caused by the fuel quantity indicating system/volumetric topoff unit and is normal. A circuit to prevent valve cycling causes this.

      Volumetric top off reset switches allows overriding the lockout of the anti-cycling circuit. Misuse of these momentary-only switches could cause a fuel spill.

      NOTE: Holding the VTO reset switches while refueling with the fuel level near top off can cause a fuel spill. The tank fueling valve will be held open by the VTO reset switch circuitry as long as the switch is being held in the reset position.



VIEW 2
HOSES NOT CONNECTED



VIEW 3
HOSES CONNECTED

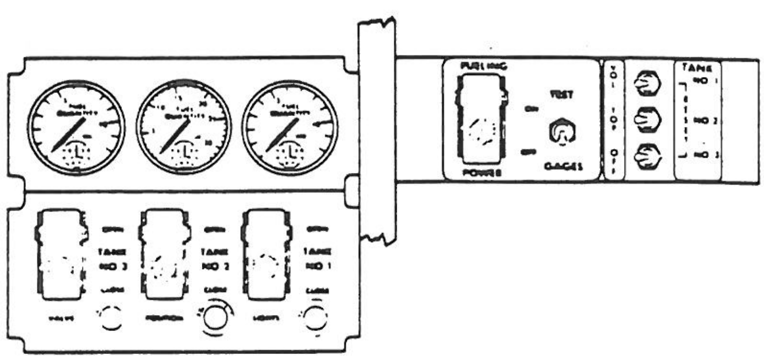
Fueling/Defueling Equipment Installation

f. Each fueling valve may be closed at the desired indicated weight or allowed to close automatically when the tank is at full volume. The full-volume-shutoff indicated weight varies considerably due to the fuel specified weight (or: density, specific gravity), therefore, there is no full mark on the quantity indicators. The fueling valves will close automatically if APU or external power is lost while fueling. This fail-safe feature is provided by fueling power switch and the battery. Do not place the fueling power switch OFF while any tank is fueling, this can cause a fuel spill.

g. The test gage switch checks system operation, not specifically accuracy. For the main tanks, the gage test switch also tests the folumetric topoff units ability to close the main tank fueling valves. Do not test when the main tanks are nearing full, since the fueling valves will not reopen after test. The main tank fueling valves can be reopened by following the procedures on one of the fueling placards for use of the volumetric topoff reset switches.

h. When the fueling power switch is ON, the gage test switch on the Flight Engineer's panel is disabled to eliminate fueling interference. Fuel quantity indicators at the fueling station are repeaters, operating on signals from the "master" indicators on the Flight Engineer's panel. They are also useful as flyaway-spares for the indicators in the Engineer's panel.

i. A Valve Position Light is <u>ON</u> whenever a fueling valve is operating; that is, intransit. It does not indicate specifically that a valve is open or closed. It indicates that the valve motor is responding to a fueling valve switch, or the full-tank shutoff device, or the gage test switch, or the loss of APU/external power. It does not necessarily indicate "disagreement" as the placard states. The fueling pressure, as regulated by the ground facility, should not exceed 50 PSI. This is the normal pressure for most effective fueling.



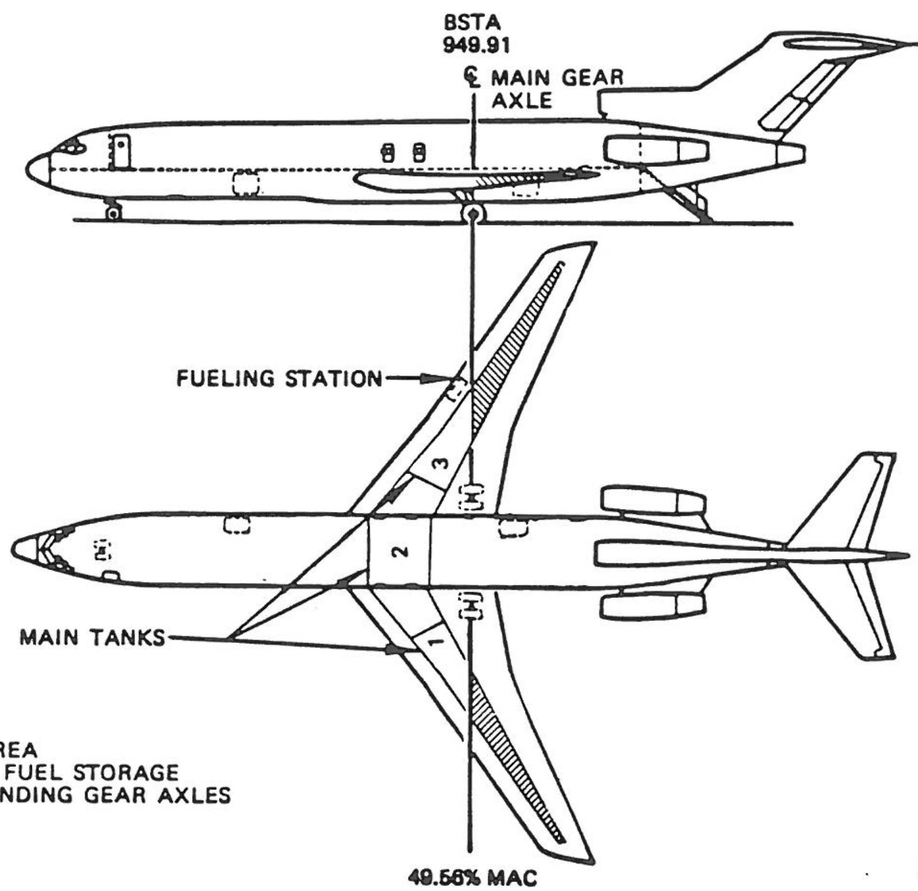
FUELING CONTROL PANEL P15

6. Fuel Distribution and Ballast Requirements

a. Care is required in fueling, defueling, and transfer operations to assure that the airplane does not tip aft. Conditions related to ground operations can, singly and in combination, contribute to an effective aft center of gravity that may result in an aft tipping situation. Consult the Weight and Balance Control and Loading Manual to determine the effects of wind, ramp slope, cargo load, maintenance crew loads, snow load and fuel load on the tipping situation. Utilization of the tail jack is required whenever the aircraft is parked.

b. When transferring fuel from either wing tank 1 or 3 for maintenance purposes without ballast in the lower cargo compartment, or No. 1 cargo positions, the No. 2 tank should be your first choice of the tank to transfer fuel into (see charts below).

c. Federal Express has established a minimum ramp load for tank No. 2 of 13,000 lbs. More fuel should be loaded in tank No. 2 whenever operationally feasible.



● SHADED AREA
INDICATES FUEL STORAGE
AFT OF LANDING GEAR AXLES

FUEL DISTRIBUTION

6.1 EMERGENCY/STANDBY REQUIRMENTS

a. When the aircraft is static on the ramp for any length of time (e.g. layover) a minimum ballast is required. This minimum ballast will permit the aircraft to be moved in an emergency. For routine or preplanned towing operations, a NORMAL ballast load should be used (Table 201). Any of the following minimum ballast loads is considered satisfactory for an emergency movement of the aircraft.

(1) 2,300 pounds placed in position 1.

(2) 4,200 pounds placed in forward belly.

(3) 5,000 pound pallet placed in position 4 or forward.

(4) 11,300 pounds in tank number 2.

6.2 OPERATING CONDITIONS FOR BALLAST

a. The three operating conditions used with Table 201 and Table 202 are as follows:

(1) COND I. Headwinds greater than 30 knots - OR - snow accumulations greater than 3 inches.

(2) COND II. Headwinds greater than 30 knots - AND - snow accumulations greater than 3 inches.

(3) NORMAL. Conditions other than those defined as COND I or COND II.

727-2S2F

FUEL DISTRIBUTION CHART
TABLE 201

BALLAST FUEL (Pounds)						
AMOUNT EACH IN TANKS No. 1 AND No. 3	AMOUNT REQUIRED IN TANK NO. 2					
	FUEL BALLAST ONLY			5000 LB PALLET POS 2		
	NORMAL	COND I	COND II	NORMAL	COND I	COND II
2000	15000	20000	24500	BALLAST FUEL NOT REQUIRED		4000
3000	14500	19000	24000			3500
4000	13500	18500	23500			**
5000	13000	18000	23000			
6000	12500	17500	22500			
7000	12000	17000	22000			
8000	11500	16500	22000			
9000	11500	16500	22000			
10000	11500	16500	22000			
11000	12000	17000	22500			
12000	13000	18500	24000			

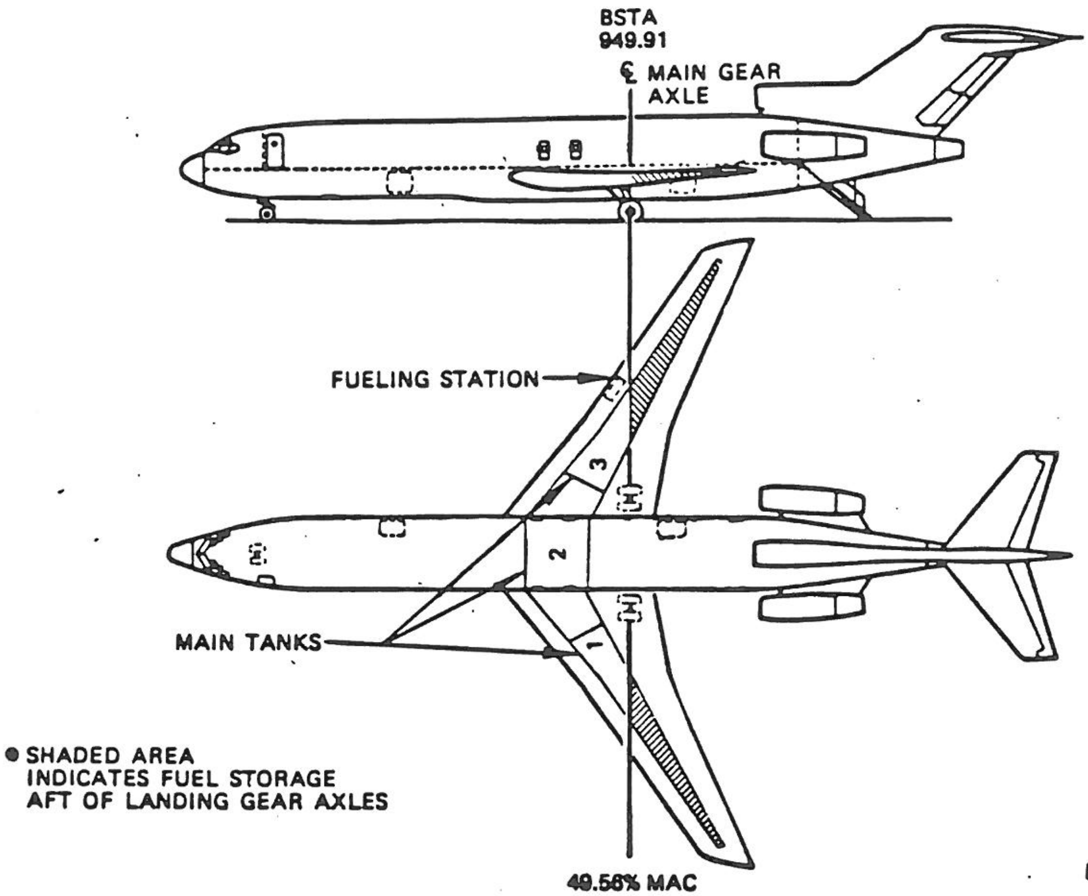
** Higher total fuel distribute normally.

Assumptions:

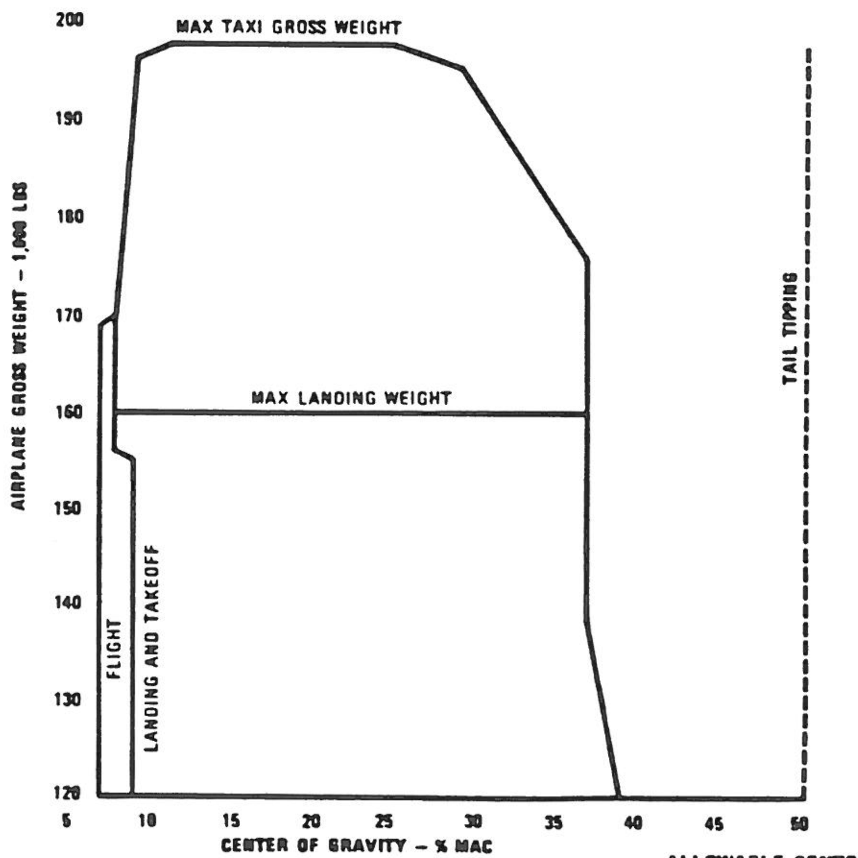
1) 3040 pounds is minimum nose wheel load.
2) One person is in cockpit.
3) Fuel allowance for taxi and/or APU burnout may be included in or added to the fuel distribution. If added, it is suggested that it be loaded as additional tank No. 2 fuel.
4) 2000 pounds minimum fuel in tanks No. 1 and No. 3 are hydraulic heat exchanger requirements.
5) Fuel misdistribution will require ground transfer back to a normal distribution before flight.

Example: Under normal conditions and using fuel ballast only with 4000 pounds each in tanks No. 1 and No. 3, 13500 pounds are required in tank No. 2.

Example: Under COND I and with 5000 pound ballast in position 2, additional fuel ballast is not required.



FUEL DISTRIBUTION



ALLOWABLE CENTER OF GRAVITY LIMITS

727-2S2F

VARIABLE BALLAST REQUIREMENTS FOR TOWING
TABLE 202 (SHEET 1 OF 2)

TYPE DISTRIBUTION	BALLAST IN FORWARD BELLY ONLY - LBS						
	0	1000	2000	3000	4000	5000	2 6000
NORMAL OPERATIONS	**BALLAST FUEL LOAD - LBS**						
TANK #2 ONLY	17000	14900	12500	9900	7100	4000	600
TANKS #1, 2, 3, EQUAL	37300	27100	21900	16700	11300	6100	880
TANKS #1 AND 3 EQUAL 1	N/A	N/A	N/A	N/A	N/A	9600	1100
CONDITION I							
TANK #2 ONLY	21400	19200	16800	14200	11300	8100	4700
TANKS #1, 2, 3, EQUAL	42600	40400	38000	26700	20000	13600	7300
TANKS #1 AND 3 EQUAL 1	N/A	N/A	N/A	N/A	N/A	N/A	13400
CONDITION II							
TANK #2 ONLY	26300	24000	21600	18800	15800	12600	9000
TANKS #1, 2, 3, EQUAL	48300	46100	43600	40900	37900	23900	16000
TANKS #1 AND 3 EQUAL 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A

727-2S2F

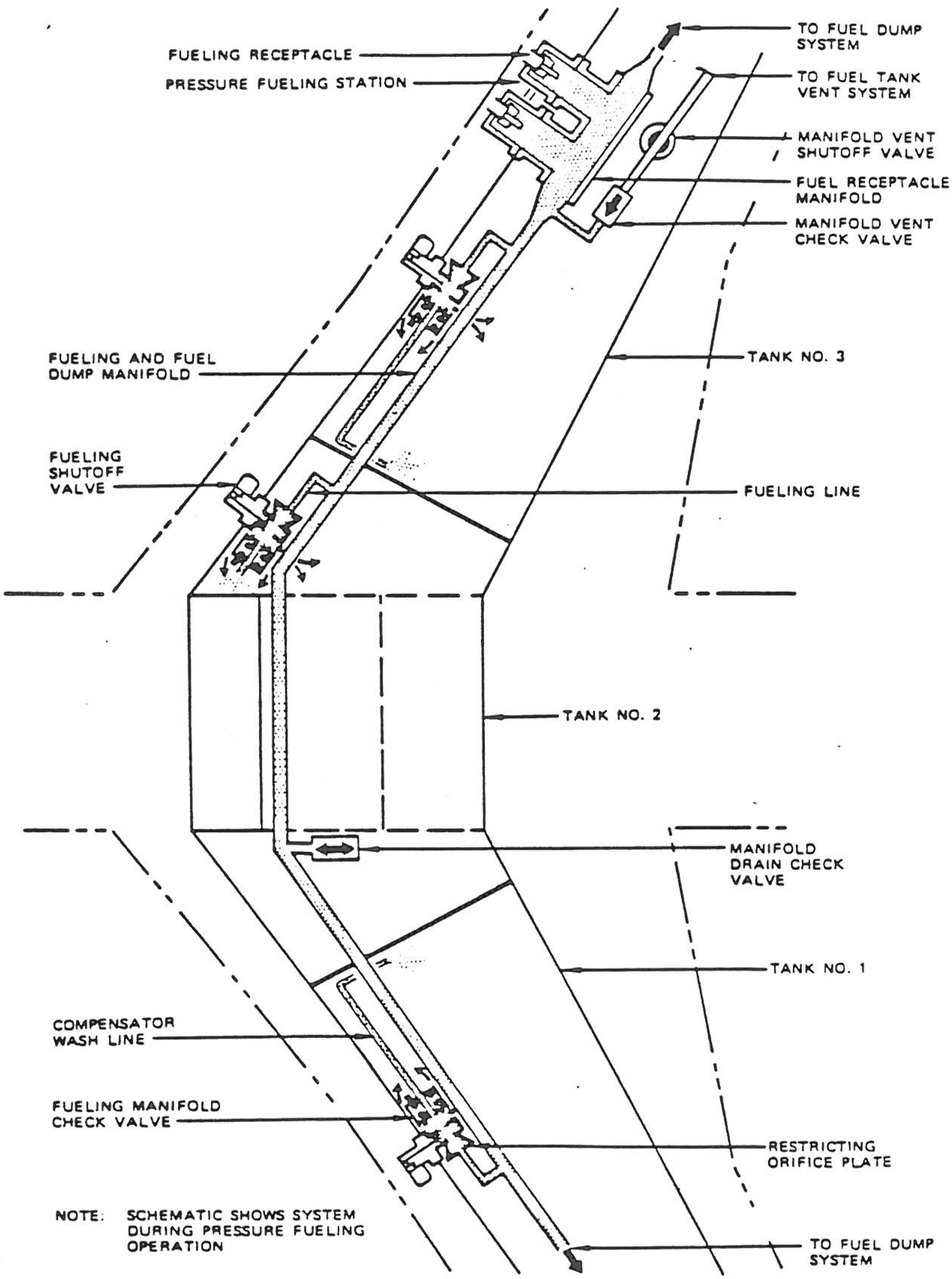
VARIABLE BALLAST REQUIREMENTS FOR TOWING
TABLE 202 (SHEET 2)

TYPE DISTRIBUTION	BALLAST IN POSITION 1 (UPPER DECK) ONLY - LBS						
	0	1000	2000	3000	4000	5000	5500
NORMAL OPERATIONS	**BALLAST FUEL LOAD - LBS**						
TANK #2 ONLY	17000	12400	7900	3400	0	0	0
TANKS #1, 2, 3, EQUAL	37300	21700	12800	5100	0	0	0
TANKS #1 AND 3 EQUAL [1]	N/A	N/A	N/A	7500	0	0	0
CONDITION I							
TANK #2 ONLY	21400	16700	12000	7400	2700	0	0
TANKS #1, 2, 3, EQUAL	42600	37800	21700	12200	4100	0	0
TANKS #1 AND 3 EQUAL [1]	N/A	N/A	N/A	N/A	6000	0	0
CONDITION II							
TANK #2 ONLY	26300	21300	16500	11700	6900	2000	0
TANKS #1, 2, 3, EQUAL	48300	43400	38500	21900	11600	3100	0
TANKS #1 AND 3 EQUAL [1]	N/A	N/A	N/A	N/A	N/A	4500	0

NOTES

[1] N/A = NOT AUTHORIZED

[2] 6000 LBS maximum in forward belly (structural limit)



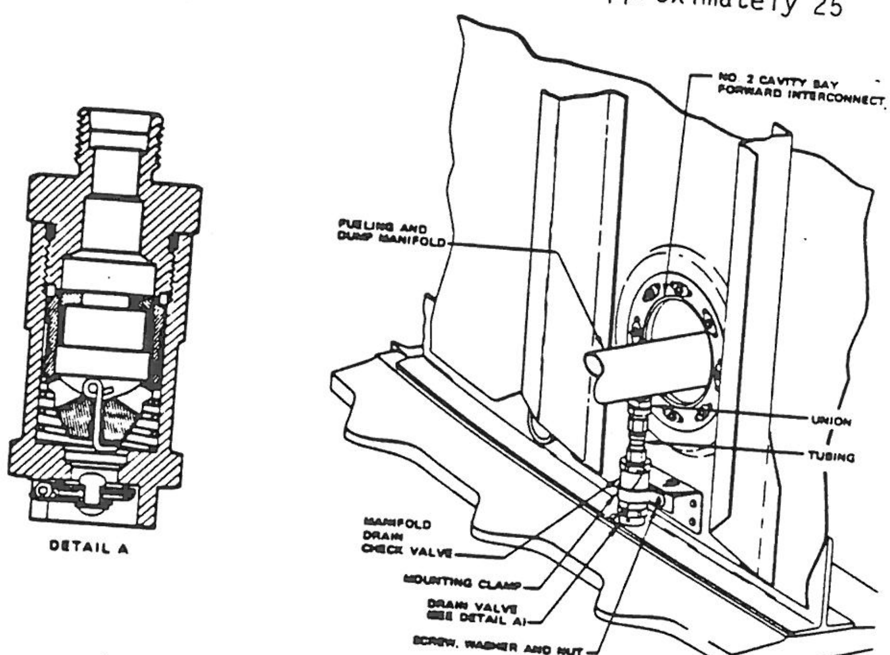
Pressure Fueling System Flow Diagram

7. Fuel System - Fueling

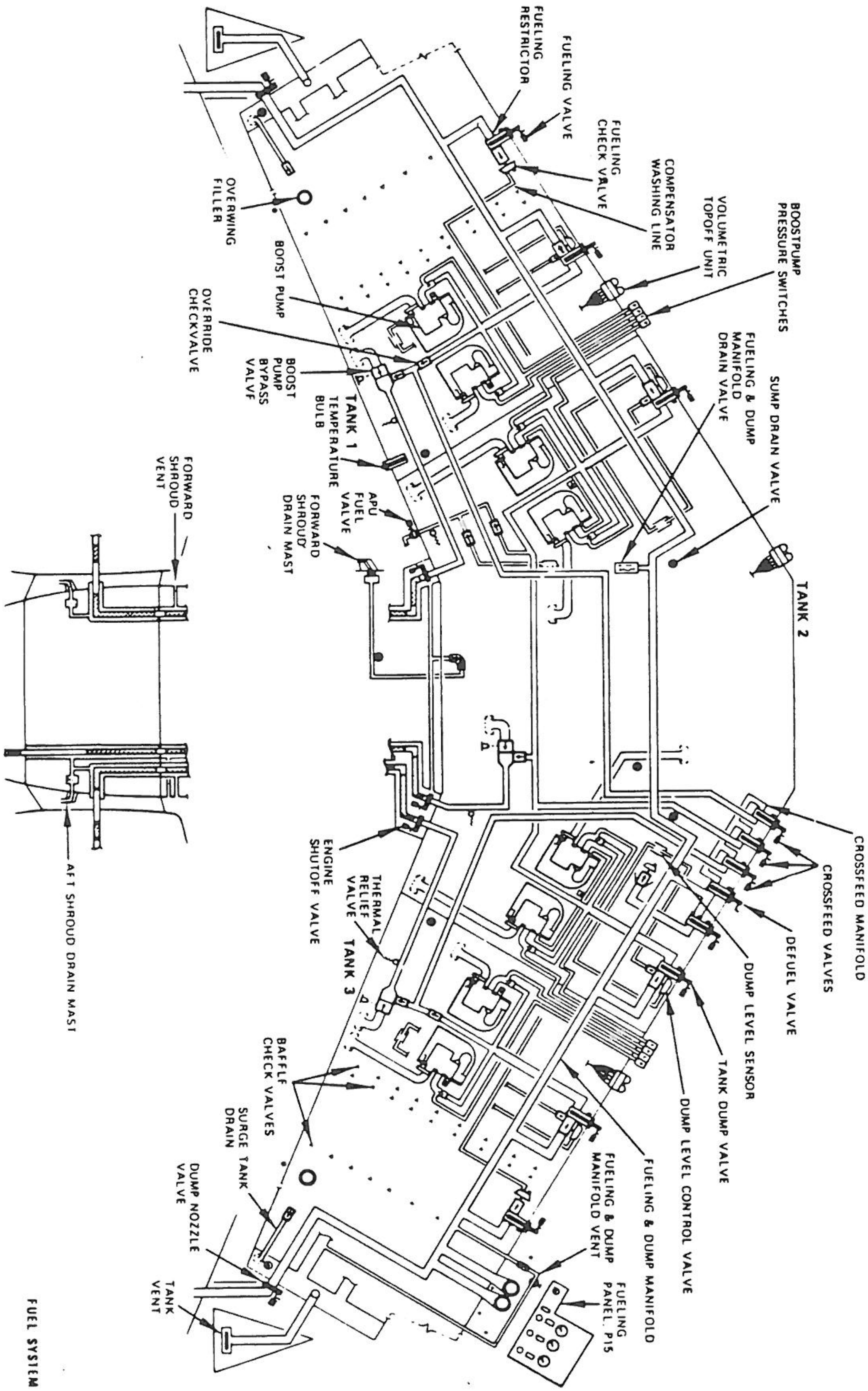
   a. The FUELING AND DUMP MANIFOLD is a large, varying diameter tube assembly routed through the main and vent surge tanks. This manifold approximately parallels nearly the entire length of the front spar. The ports of this manifold are connected to two fueling hose receptacles and three main tank fueling valves. The manifold is also connected to four tank dump level control valves, two dump nozzle valves, the defuel valve and two vent and drain lines. The manifold vent line is routed through the fueling station and contains check and manual vent valves. The manifold drain is located in the left section of Tank No. 2, near the wing-to-body rib. The drain is a short, small diameter tube connected to a drain valve. The MANIFOLD DRAIN VALVE is a variable restrictor and check valve.

   b. The fueling and dump manifold is a multi-way flowpath for fueling, dumping, defueling and transferring. A vent at a high section and a drain in a low section cause the large volume of fuel in the manifold to become usable. The manifold vent valve, (manual, normally open) should be closed for suction defueling and reopened before flight. The drain valve restricts flow into tank No. 2 during fueling and allows free drainage after fueling is shutoff. The drain valve also prevents thermal expansion pressure buildup.

   c. The manifold will not normally drain unless tank No. 2 has a very low fuel level and the vent valve is open. The manifold should be scavenged to a ground facility before removal of dump nozzle, defueling or the fueling valves. The total manifold volume is approximately 25 U.S. gallons.



Manifold Drain Check Valve Inst[illegible]


FUELING RESTRICTOR
FUELING VALVE
FUELING CHECK VALVE
COMPENSATOR WASHING LINE
VOLUMETRIC TOPOFF UNIT
BOOSTPUMP PRESSURE SWITCHES
OVERWING FILLER
BOOST PUMP
OVERRIDE CHECKVALVE
BOOST PUMP BYPASS VALVE
TANK 1
TEMPERATURE BULB
FUELING & DUMP MANIFOLD DRAIN VALVE
SUMP DRAIN VALVE
APU FUEL VALVE
FORWARD SHROUD DRAIN MAST
FORWARD SHROUD VENT
TANK 2
AFT SHROUD DRAIN MAST
ENGINE SHUTOFF VALVE
THERMAL RELIEF VALVE
TANK 3
CROSSFEED MANIFOLD
CROSSFEED VALVES
DEFUEL VALVE
DUMP LEVEL SENSOR
TANK DUMP VALVE
DUMP LEVEL CONTROL VALVE
FUELING & DUMP MANIFOLD
BAFFLE CHECK VALVES
SURGE TANK DRAIN
DUMP NOZZLE VALVE
TANK VENT
FUELING & DUMP MANIFOLD VENT
FUELING PANEL P15

FUEL SYSTEM

f. The FUELING VALVES are 24/28V DC motor operated, sliding gate, semi-submerged, 3 to 5-second valves, with a manual override handle. These valve consist of gate, actuator and port adapter assemblies. The port adapter assembly is mounted inside the tank and supports the fuel lines. The gate assembly slides into the port adapter assembly from the dry side. The actuator assembly couples to the gate shaft with an index-tooth spline. The DEFUEL VALVE is similar, except that the actuator is a "manual" lever and it is smaller than the fueling valves.

g. Tanks No. 1 and No. 3 fueling valves are located approximately mid-span on the front spar of each tank. Tank No. 2 fueling valve is located on the right inboard wing front spar.

h. The FUELING VALVES electrically open or close to control the fueling vlow of a tank. The valve is manually and automatically switched. The valve manual override handle also shows valve position. A blue light on the fueling panel, P15, indicates valve motor operation.

i. The DEFUEL VALVE, opened manually, connects the fueling and dump manifold to the crossfeed manifold. The defuel valve is a two-way flowpath for defueling and transferring fuel. The valve lever is interlocked with its access door to assure closure before flight and inflight.

j. On the FUELING PANEL, P15, the guards on the fueling power switch and the fueling valve switches are interlocked with the fueling access door to assure closed/off status before flight.

k. The fueling line into each tank contains a FUELING RESTRICTOR. These restrictors are orifice plates, indexed where necessary, and mounted between flanges in the fueling lines. In the main tanks, they are mounted between the fueling valve port adapter assembly and the fueling and dump manifold flange.

d. Two capped, self-sealing, quick-disconnect, fueling hose receptacles connect the ground service equipment to the fueling and dump manifold. The self-sealing poppet is opened by the hose nozzle poppet to provide a two-way flowpath for fueling and defueling.

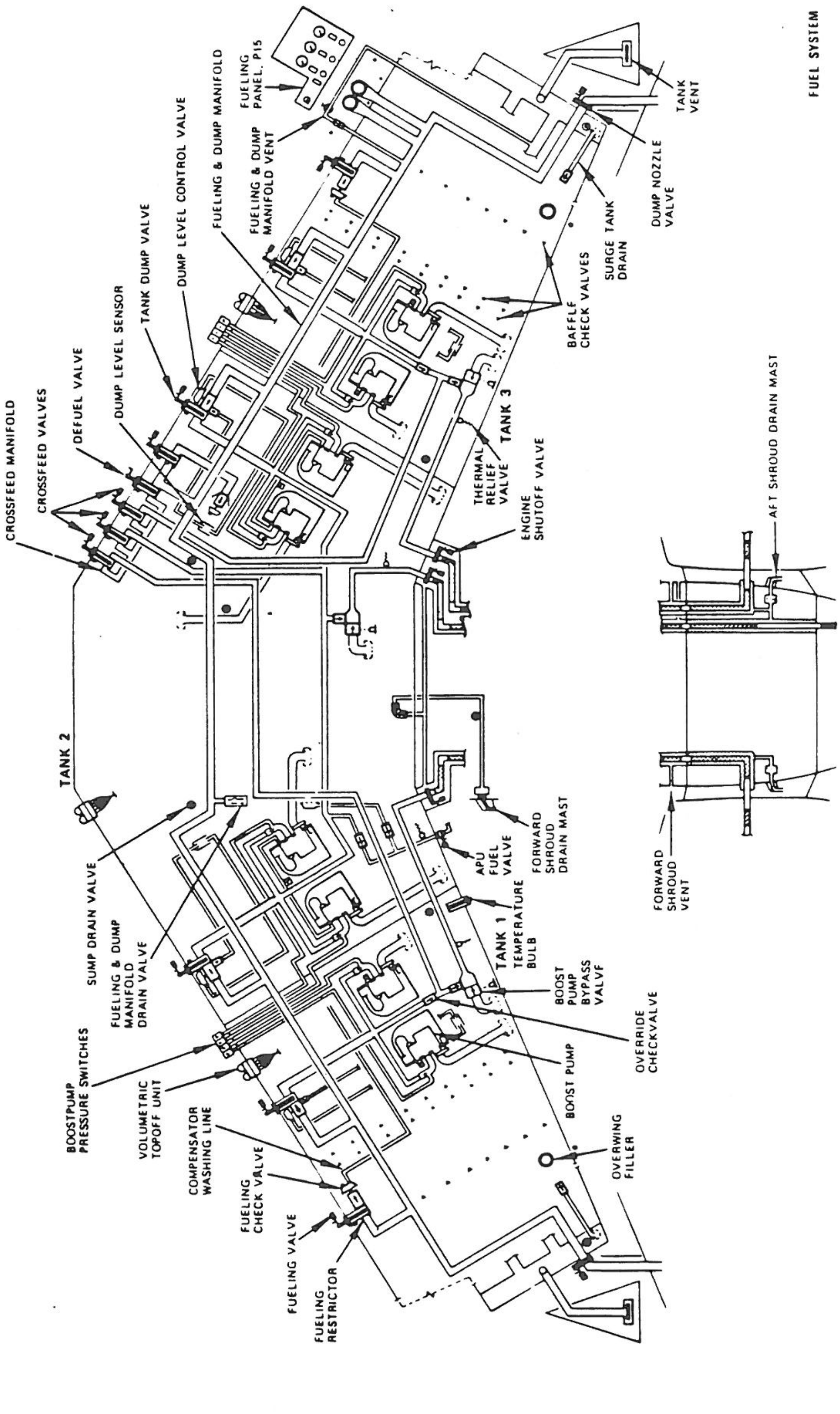
e. The fueling station is located at mid-span in the right wing leading edge and contains the fueling receptacles and the FUELING PANEL, P15, as the major components.

l. The FUELING RESTRICTORS are calibrated to assure that the fueling flow rate into each tank cannot exceed its vent overflow capacity. This is to assure that the tank presssure cannot exceed the structural limit if a fueling valve fails to close. This is also why the fueling delivery, as regulated by the ground facility, must not exceed 50 PSI. The main tank fueling restrictors have an additional purpose of producing balanced fueling flow rates to tanks No. 1 and No. 3. This compensates for pressure drops along the manifold to maintain a laterally balanced airplane. The balanced flow rates into tanks No. 1 and No. 3 occur only when the applied fueling pressure is near or at 50 PSI. The normal and maximum fueling pressure should be 50 PSI.

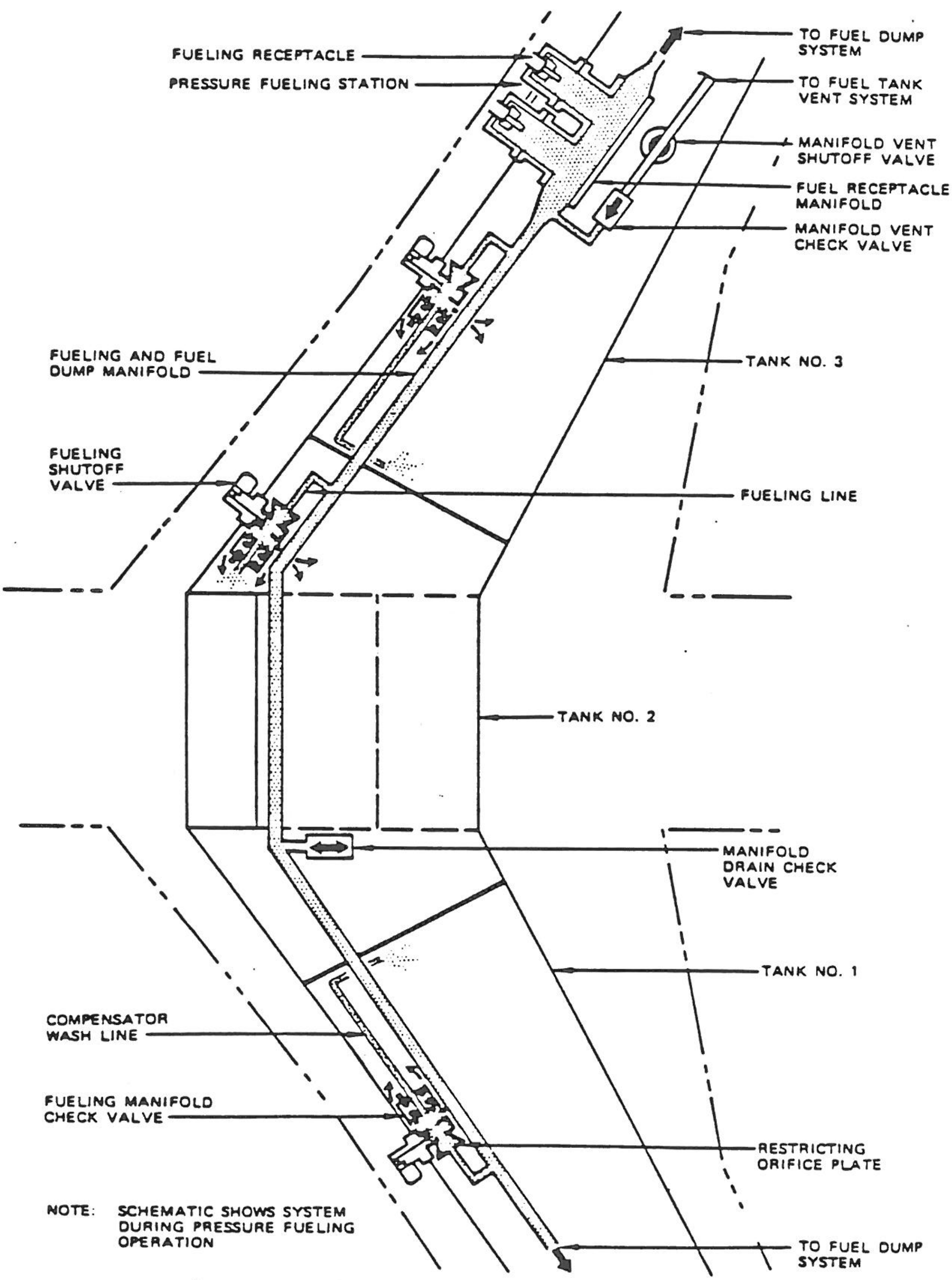
m. A FUELING CHECK VALVE is at the end of each tank fueling line. The main tank fueling check valves were, before the volumetric topoff unit installation, the fueling full-tank shutoff valves. These valves consist of a spring-loaded diaphragm that seats a pin-guided poppet against the inlet fitting. The chamber behind the diagragm is open to the tank and, through a slot in the guide pin, the diaghragm chamber is also open to the valve inlet. In main tanks No. 1 and No. 3, the diaphragm chamber of the fueling check valve is connected to the tank through a compensator washing line. In main tanks No. 1 and No. 3, the fueling check valve is mounted on the fueling valve port adapter assembly. In main tank No. 2, the check valve is on the end of a tube, near the righ sump and is installed under a splash shield and has no washing line.

n. The FUELING CHECK VALVES minimize back flow from a tank into the fueling lines. These check valves primarily provided maintenance convenience, so that fueling valve gate assemblies can be changed without requiring defueling. Unfortunately, the main tank fueling check valves are open to the tank through the diaphragm chamber. This means there is a small back flow through the check valve poppet guide-pin slot. This makes a fueling valve change less convenient by requiring partial defueling of the main tank or changing to a new valve very quickly.

o. These check valves also reduce the rate of fuel spillage if the fueling hose or fueling receptacle fails. They also reduce inter-tank transfer in the remote possibility that fueling valves are open when the tanks are not being fueled. The fueling check valve in tank No. 2 is usually submerged, but has a splash shield to supress the fuel atomizing and electrostatic generating effects of high velocity fluid flow. In tanks No. 1 and No. 3, the nearness of the structure provides this shielding.


FUELING PANEL, P15
FUELING & DUMP MANIFOLD VENT
FUELING & DUMP MANIFOLD
DUMP LEVEL CONTROL VALVE
TANK DUMP VALVE
DUMP LEVEL SENSOR
DEFUEL VALVE
CROSSFEED VALVES
CROSSFEED MANIFOLD
TANK VENT
DUMP NOZZLE VALVE
SURGE TANK DRAIN
BAFFLE CHECK VALVES
TANK 3
THERMAL RELIEF VALVE
ENGINE SHUTOFF VALVE
AFT SHROUD DRAIN MAST
TANK 2
SUMP DRAIN VALVE
FUELING & DUMP MANIFOLD DRAIN VALVE
BOOSTPUMP PRESSURE SWITCHES
VOLUMETRIC TOPOFF UNIT
COMPENSATOR WASHING LINE
FUELING CHECK VALVE
FUELING VALVE
FUELING RESTRICTOR
FORWARD SHROUD DRAIN MAST
APU FUEL VALVE
TEMPERATURE BULB
TANK 1
BOOST PUMP BYPASS VALVE
OVERRIDE CHECKVALVE
BOOST PUMP
OVERWING FILLER
FORWARD SHROUD VENT

FUEL SYSTEM



Pressure Fueling System Flow Diagram

p. The COMPENSATOR WASHING LINES are small diameter tubes routed from the fueling check valves, inboard, near the sump, to the quantity gaging compensator and the volumetric topoff compensator. The open end of this washing line is aimed at these compensators. These compensators are part of the fuel quantity indicating system and fueling shutoff circuit.

q. During fueling a jet of fuel causes local mixing to reduce the effects of fuel stratification and fuel type differences on the full-tank shutoff level and gaging accuracy. This washing action tends to remove water that may not have been removed by sump drain procedures. Fueling pressure at or near 50 PSI is recommended to provided maximum washing action. Tank No. 2 does not need compensator washing since the tank shape, vent configuration, and temperature range are more regular.

r. Proper sump drainage remains extremely important for proper volumetric topoff operation and fuel quantity indicating system accuracy.

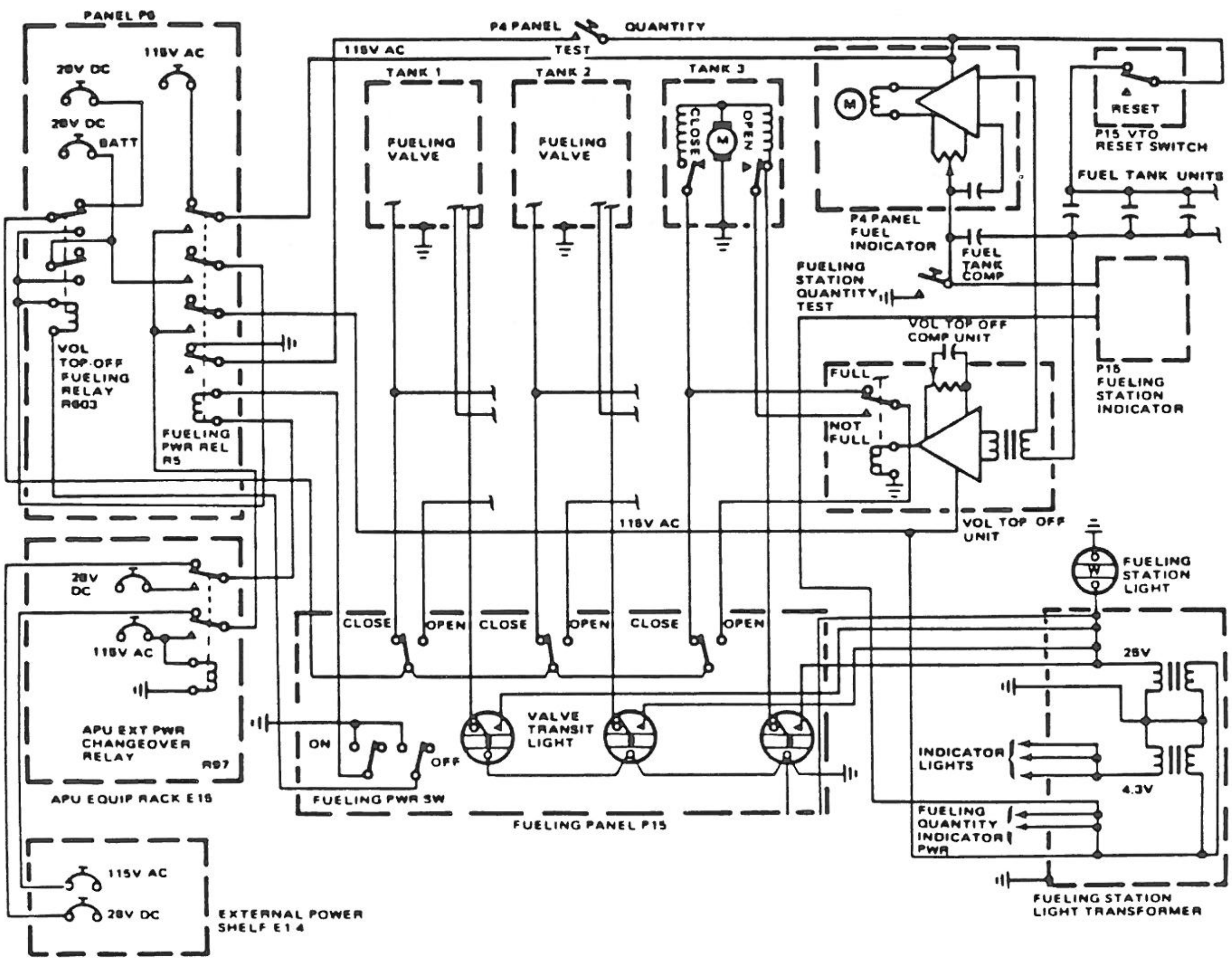
s. The VOLUMETRIC TOPOFF UNIT is part of each main tank fueling shutoff circuit and a part of the fuel quantity indicating system.

t. A volumetric topoff unit controls a main tank fueling valve if the fueling valve switch is positioned OPEN and the fueling power switch is ON. The unit closes the fueling valve when the main tank is at full rated volume. Partial filling of a tank is manually controlled, while observing tank quantity indicators on the FUELING PANEL, P15.

8. Fueling Valve Circuit

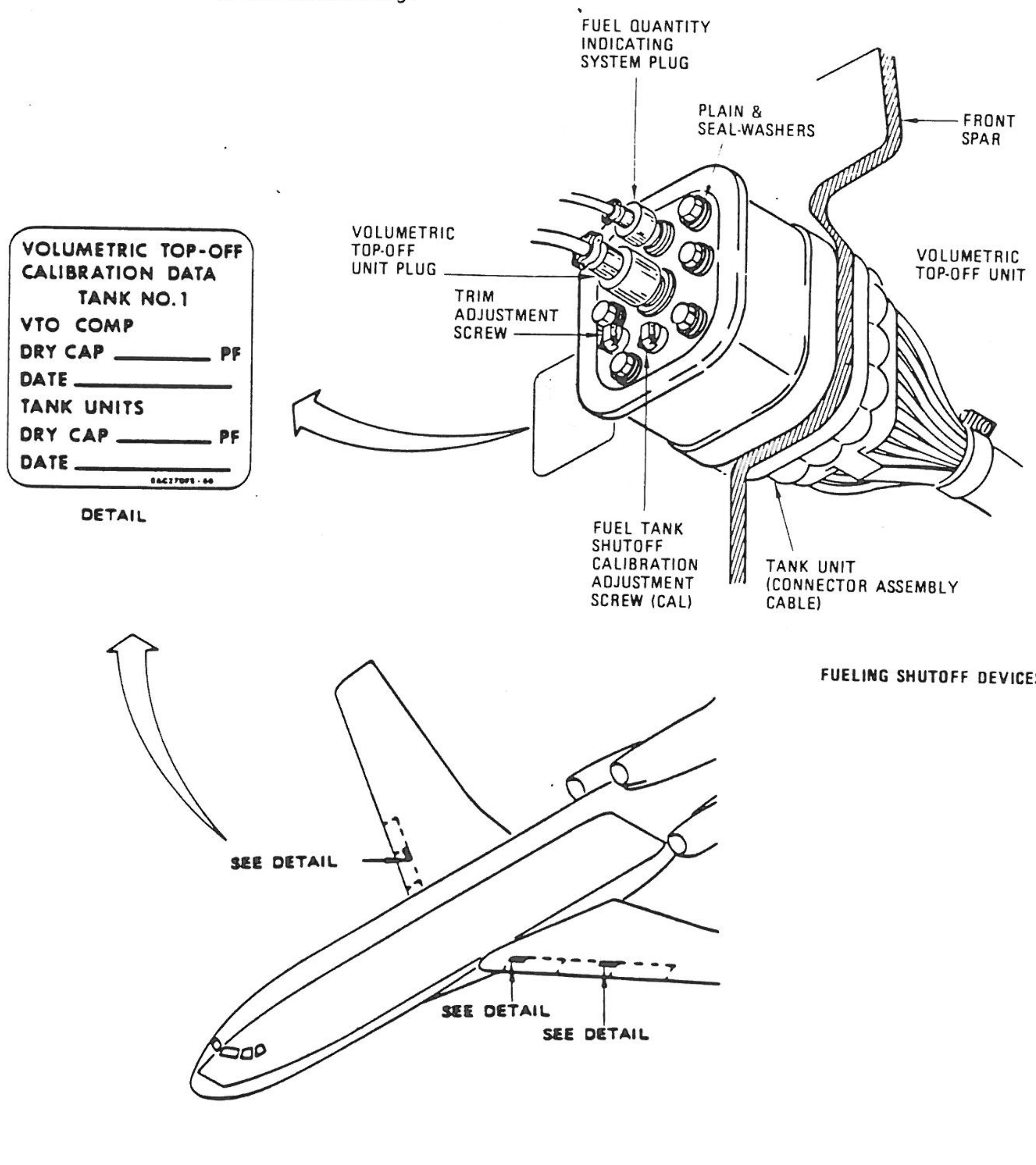
   a. The fueling power switch enables (R5) the fueling function if electrical power is available from the APU generator (R97) or from External Power. The fueling valves operate from an isolated, battery powered circuit. This battery powered circuit is interlocked (R5) with the availability of APU generator and external power to start fueling, but will remain energized (R603, power switch ON) in the event of APU and External Power loss, to power the closing of all fueling valves.

   b. Each fueling valve is opened and closed by a switch and a relay. The main tank fueling valve relays are inside each volumetric topoff unit. These relays are powered by (or from) 115V AC APU generator or External Power with the fueling power switch ON, and they are energized if the tank is not full. A fueling valve can be closed by either the switch or the relay. A fueling valve can be opened only by both the switch and the relay in the proper position.



9. Fuel Shutoff Devices

   a. The VOLUMETRIC TOPOFF UNITS are main tank fueling valve closure units. They are 115V AC powered, line adjustaable, fuel tight and operate on signals from the fuel quantity capacitance network. The volumetric topoff units are mounted inboard on the front spar on each main tank. The No. 2 volumetric topoff unit is on the left side of tank No. 2. The units are accessible directly if the leading edge flaps are extended. The volumetric topoff units provide access into the main tank fuel quantity circuits for testing, adjustment and troubleshooting.

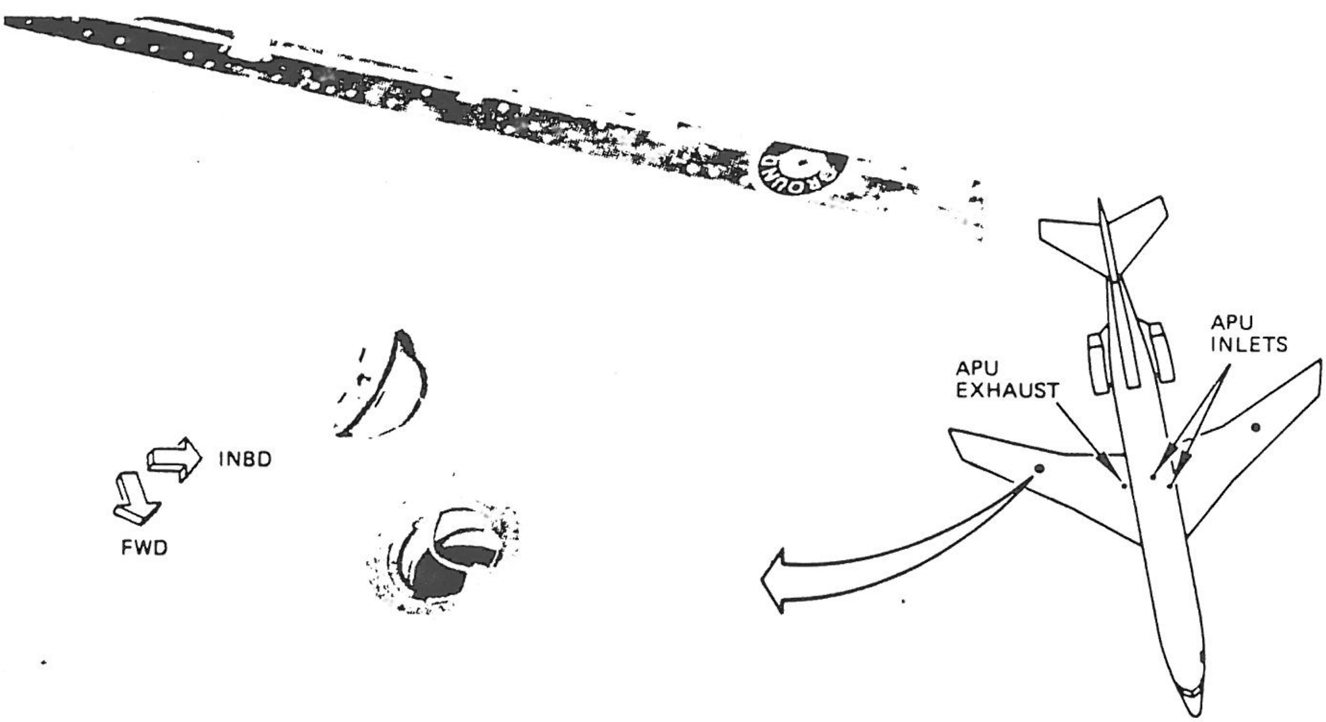


FUELING SHUTOFF DEVICES

10. Overwing Fillers

a. OVERWING FILLERS are installed in Tank No. 1 and No. 3. No screens are installed. Grounding jacks are close by.

b. The service volume through the OVERWING FILLERS is considerably less than by pressure fueling due to port location. Do not open an overwing filler after pressure fueling since possibly 200 U.S. gallons can spill. Fuel in tanks No. 1 and No. 3 can be transferred to tank No. 2 if electrical power is available. But, if tank No. 2 is empty, the APU cannot be the source of the electrical power. Pressure fueling can be totally manual, limited only by access convenience to the fueling and No. 2 crossfeed valves manual override handles. Tank No. 1 and No. 3 overwing filler may have some value for suction defueling if those tanks are not too full. Care is required in the use of the overwing filler due to the nearness of the APU inlet and exhaust, brakes and engine inlets (all reasons why tank No. 2 has no overwing filler).



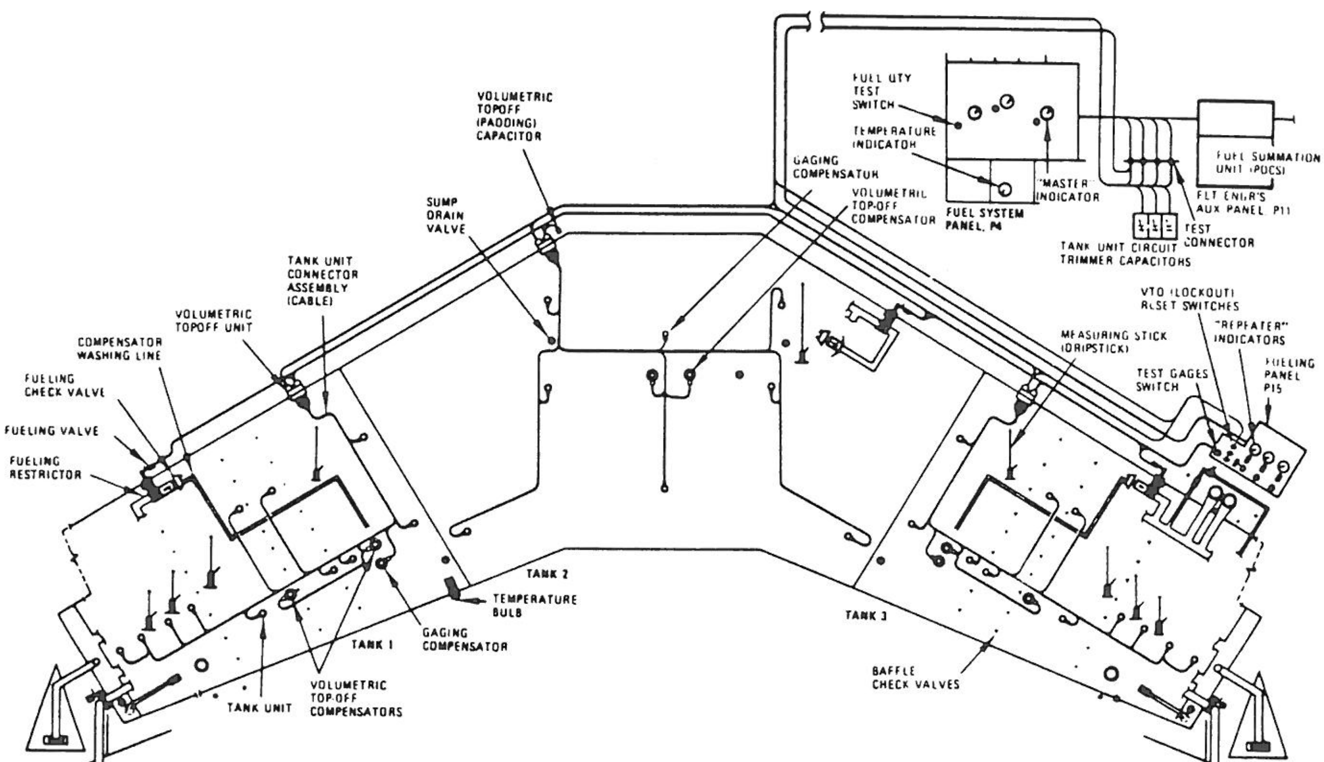
OVERWING FILLER

C. Fuel Quantity Indicating System

1. General Description

a. The FUEL QUANTITY "MASTER" INDICATOR is part of a capacitance bridge circuit which includes a network of capacitors in the tank. This capacitor network contains one GAGING COMPENSATOR in each tank, and as many as eleven TANK UNITS. Each main tank circuit includes a fueling VOLUMETRIC TOPOFF UNIT, and one or two VOLUMETRIC TOPOFF COMPENSATORS.

b. The "master" indicator measures the tank unit capacitance to determine the weight of fuel in the tank. This measurement is shared with the volumetric topoff unit in the main tank circuit. The indicator also measures the capacitance of the gaging compensator to correct for deviations caused by the composition of the fuel from average fuel.



FUEL QUANTITY INDICATING SYSTEM

c. The "master" indicator sends a voltage signal, proportional to the tank fuel weight, to the "REPEATER" INDICATOR on the FUELING PANEL, P15. The sometimes, optional total fuel quantity indication receives this same voltage signal from each "master" indicator for summation.

d. Test switches check indicator and system operation, not accuracy. A TEST GAGES switch on the Flight Engineer's FUEL PANEL, disabled during fueling, should cause each "master" indicator pointer to move downscale, and the total quantity indication to move upscale. A TEST GAGES switch on the fueling panel also checks the indicators. This test switch causes signals that should result in the "repeater" indicator pointers moving downscale. The "master" indicators normally move upscale during this test and the total quantity indication moves downscale. The test switch on the fueling panel also tests the volumetric topoff units by causing the main tank "master" indicators to send a simulated full-tank signal through the tank unit circuit. This test should close any open main tank FUELING VALVE.

e. TANK UNITS are tubular capacitors in the fuel quantity capacitor network. The tank units are mounted nearly vertically in a precise, through apparently random pattern throughout the tank. The tank unit length (i.e., height) is almost wing-skin to wing-skin. The inner tube has a pattern of cylindrical sections of changing diameter and length along its height. The outer tube is a cylinder of constant diameter. The profiling and placement of the tank units, related to tank shape, assures a correct relationship between fuel covered plate area and fuel volume.

f. Each tank unit is unique and indexed in a specific position or symmetrically opposite position. The tank units, if more than one, are wired in parallel via the TANK UNIT CONNECTOR ASSEMBLY (CABLE) and the volumetric topoff unit baseplate. The tank unit arrangement assures accuracy over a wide range of airplane attitudes, maneuvers and wing deflections because several tank units are wetted. The outboard two tank units in tanks 1 and 3 are paralleled in the tank to avoid the need to enlarge the hole and connector in the spar.

g. The tank units measure fuel weight in terms of fuel Dielectric Constant and proportion of network capacitor plate area covered by fuel. The Dielectric Constant of the fuel varies with temperature in nearly the same proportion that specifif weight (density, or specific gravity) varies. The tank unit capacitor network plate area covered by fuel is in proportion to fuel thermal expansion or contraction, inversely proportional to the Dielectric Constant variation.

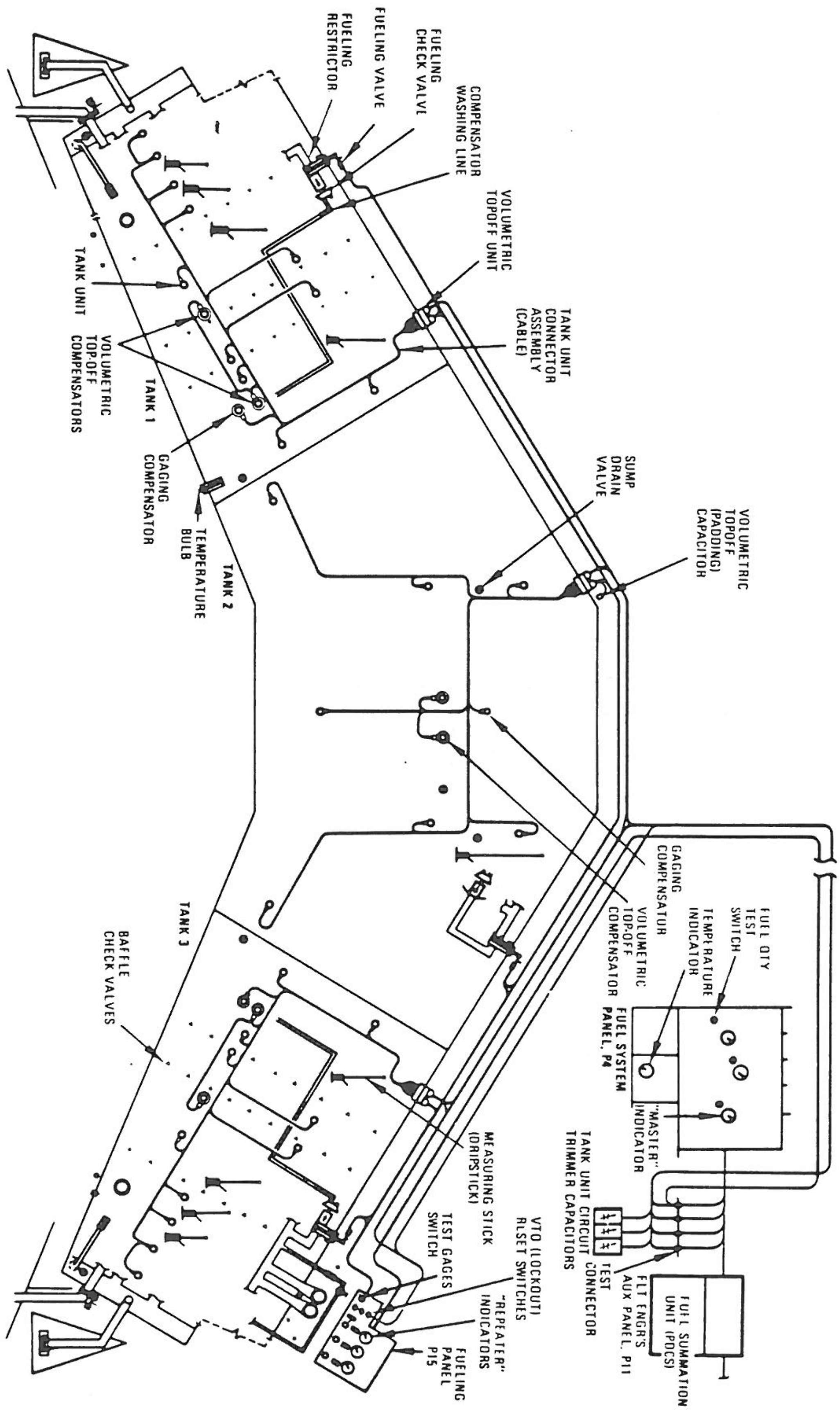
h. The gaging compensators are tubular capacitors mounted low in the tank, near the sump level. The gaging compensators measure the fuel Dielectric Constant to assure a correct relationship between the fuel Dielectric Constant and the fuel specific weight. This improves "master" indicator accuracy.

i. A VOLUMETRIC TOPOFF UNIT is part of each main tank fueling shutoff circuit. Using the fuel quantity indicating system for fueling control allows maximum usage of tank available volume by taking advantage of the multiple sensors in the main tank capacitor network. This reduces errors due to airplane attitude changes and wing deflection on the full-tank shutoff level.

j. The volumetric topoff units are mounted on the inboard wing front spar and form part of the fuel tight tank wall connector. The volumetric topoff unit measures the capacitance of the volumetric topoff compensator to determine the specific weight of the fuel in the tank during fueling. The unit then calculates the weight of fuel that would be a full main tank. The volumetric topoff unit also measures tank unit capacitance to determine the actual weight of fuel in the tank. When the actual fuel weight equals the calculated full-volume, the volumetric topoff unit closes the fueling valve. Unfortunately, the weight signal also equals the calculated weight signal when the tank is empty or nearly empty. This is the reason the main tank fueling valves will not open if the tank is empty or nearly empty.

k. When the Volumetric Topoff Unit closes a main tank fueling valve at full rated volume, it electrically locks the valve circuit closed so that slosh and wave action will not cause the valve to cycle open/close after initial shutoff. This lock-out circuit is the reason, with a near-full tank, the fueling valve will not open by the fueling valve switch. It is also the reason for not using the fueling panel gage test switch when the tank is nearly full. This lock-out circuit is also involved with the nearly-empty valve close signals.

l. The fueling valves, in lockout, can be opened by following the procedures on one of the fueling placards or by operating the manual override handle on the valves. Manual operation of a valve requires that its circuit be de-energized. The most convenient way to override the valve-close and lock-out circuit is to use the volumetric topoff reset switches.



FUEL QUANTITY INDICATING SYSTEM

m. The VOLUMETRIC TOPOFF COMPENSATORS are tubular capacitors mounted low in the tanks, usually near the sump level. Main tanks No. 1 and No. 3 each have a second volumetric topoff compensator that is mounted outboard several rib-bays and slightly higher. The volumetric topoff compensators measure the fuel Dielectric Constant to determine the fuel weight for the volumetric topoff unit calculation of full main tank weight for the rated full volume capacity of the tank. These compensators also have a correcting function similar to the gaging compensators.

n. Tanks 1 and 3 have two compensators to help average the effects of fuel in-the-tank with fuel being added during fueling. The two compensators minimize the effect of fuel stratification. The inboard compensators in tanks No. 1 and No. 3 also have washing lines to improve this averaging.

o. Tank 2 has a VOLUMETRIC TOPOFF (PADDING) CAPACITOR to make the wiring capacitance more like TANK 1 & 3. This capacitor is mounted in the left inboard wing leading edge, near the tank 2 volumetric topoff unit.

p. During fueling, the COMPENSATOR WASHING LINE jet of fuel causes local mixing to reduce the effects of fuel stratification and fuel type differences on the full-tank shutoff level and gaging accuracy. This washing action tends to remove water that may not have been removed by sump drain procedures.

q. The fuel quantity indicators and volumetric topoff units have adjustments. These are: empty and full on each "master" indicator, full on each "repeater" indicator, empty and each active channel of the total fuel indication, calibration (full tank shutoff) and trim on the volumetric topoff units. The indicator adjustments are shopset and sealed. It is intended that only the tank unit trimmer capacitor be adjusted when changing any precalibrated indicator.

r. Proper sump drainage remains extremely important for proper volumetric topoff operation and fuel quantity indicating system accuracy.

s. MEASURING STICKS are for manual measurement of main tank fuel quantity. The graduated fiberglass tubes, stowed in the lower wing surface, measure fuel by locating the height of the fuel surface.

2. Fuel Quantity Indicators

   a. Features of the FUEL QUANTITY INDICATORS are:

      (1) 115V AC, Hz powered, essential bus, APU generator or external power when fueling.

      (2) Capacitance measuring bridge, self-rebalancing, close loop, fuel dielectric variation sensing, fuel dielectric deviation compensated.

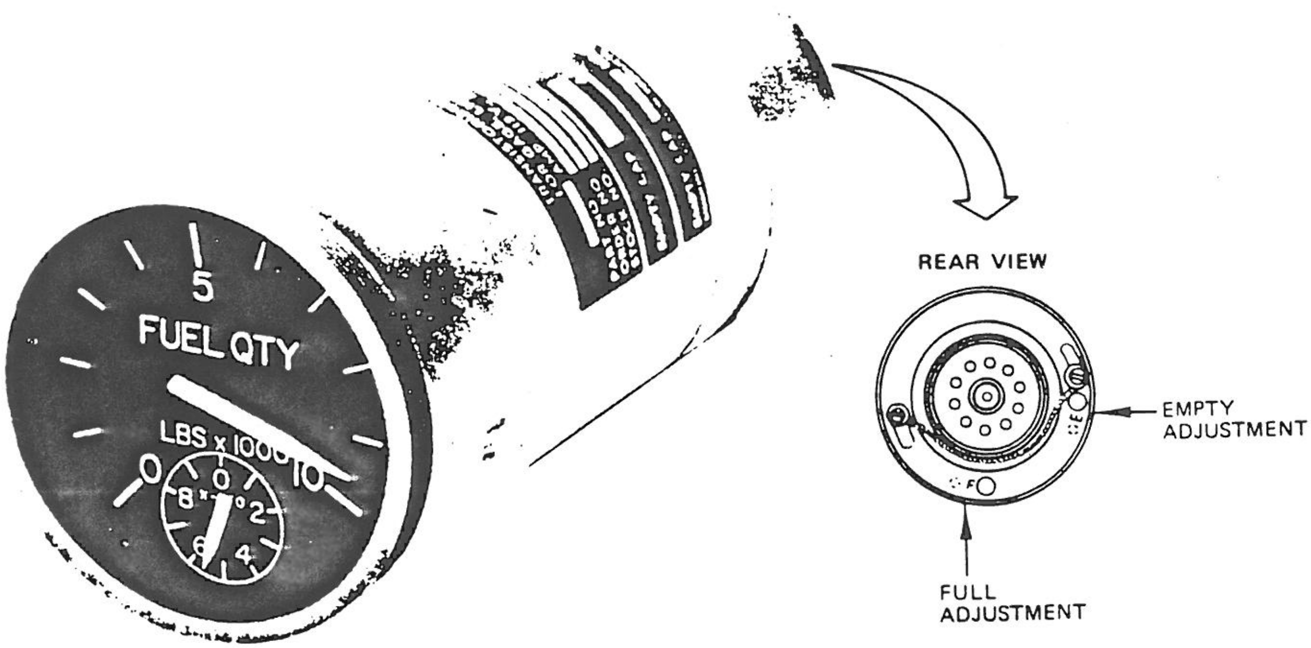
      (3) Split phase, reversible servo motor (phase sensitive), gear train and bridge amplifier driven rebalance potentiometer and pointer.

      (4) Weight graduated dial and pointer, with subdial, (pound or kilogram units - optional).

      (5) Current limiting (explosion proof), low power (low voltage and low current) in tank circuits, limited fault current and voltage.

      (6) Dampened: Full dial sweep in 80-90 seconds.

      (7) Sensitive: Less than 1/2 picofarad capacitance change to cause motor operation, very sensitive to stray pickup (shielding integrity, insulation integrity, fuel/tank contamination, connector integrity).



FUEL QUANTITY INDICATOR
(MASTER AND REPEATER)

(8) Precalibrated: Standardize (shop adjustment) voltage to the tank units and standardized (trimmer capacitor, airplane mounted) tank unit network capacitance allow shop-set empty and full adjustments.

(9) Line adjustment: None intended.

(a) Precalibrated indicators may be used as spares for non-precalibrated airplanes (early or unmodified airplanes). Broken seal on adjustment cover requires shop recalibration or line adjustment procedures as for non-precalibrated indicators.

(b) Non-precalibrated indicators may be used as spares for precalibrated airplanes using appropriate adjustment procedures.

(c) Empty and full, if line adjusted, require special, calibrated, explosion proof test equipment for "calibration" (i.e., adjustment and troubleshooting. Test equipment (units and adapter cables) grounding critical, or return precal-type indicator to shop.

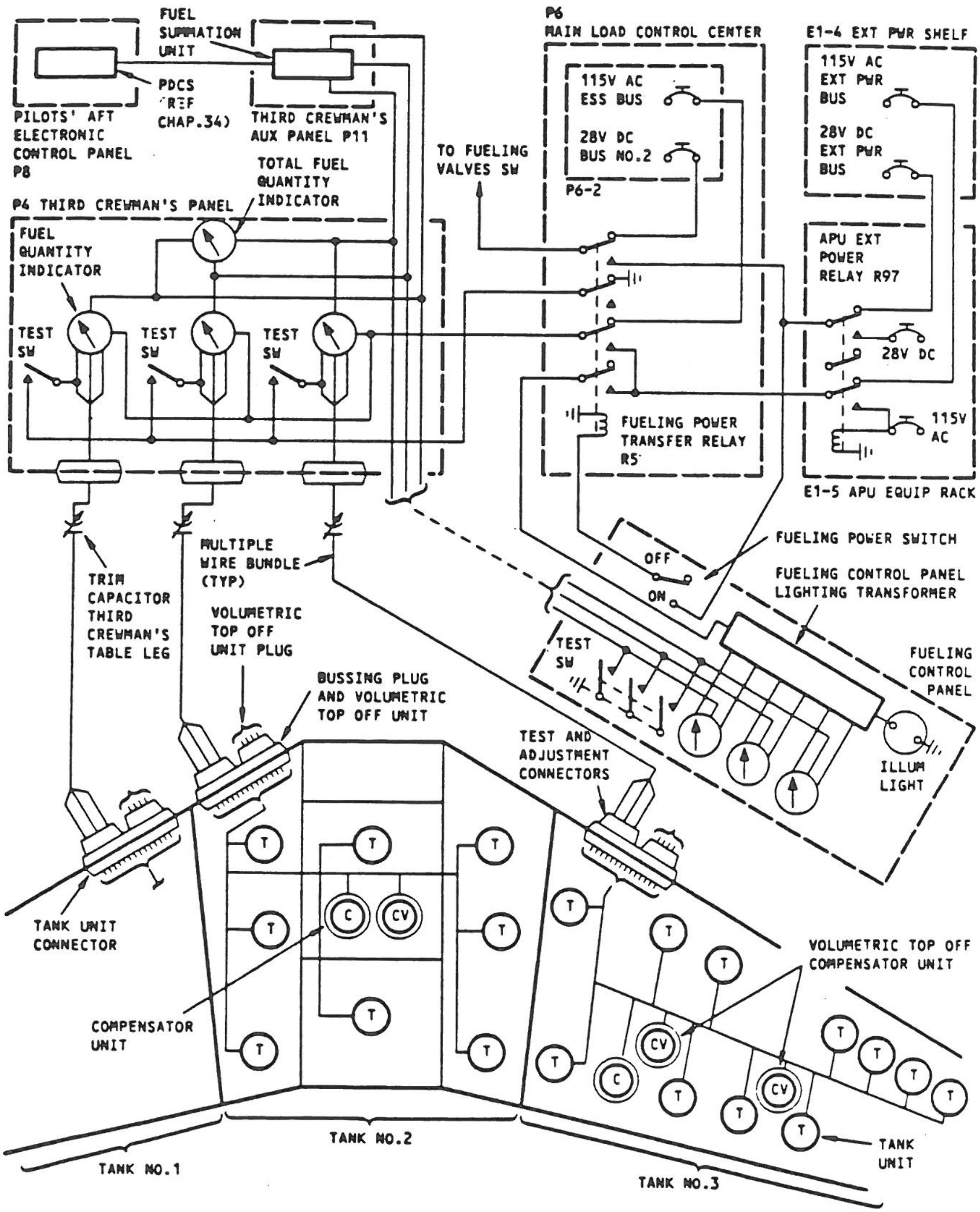
(d) Adjustment data placard on instrument case. Recorded data: blank if indicator remains in precalibrated mode. Line-adjusted mode requires operator to fill in blanks.

(e) Hermetically sealed.

(f) Internally Lighted: Powered from the panel lighting circuit.

(g) 28V AC and DC internal power supplies.

(h) Two indicators are used for each tank quantity indication system. "Master" indicators are installed on the 3rd crewman's fuel panel (P4). The fueling panel (P15) has "repeater" indicators. Master or Repeater indicators are functional modes for the same part numbered units. The "repeaters" can serve as fly-away spares.



Fuel Quantity Indicating System Schematic

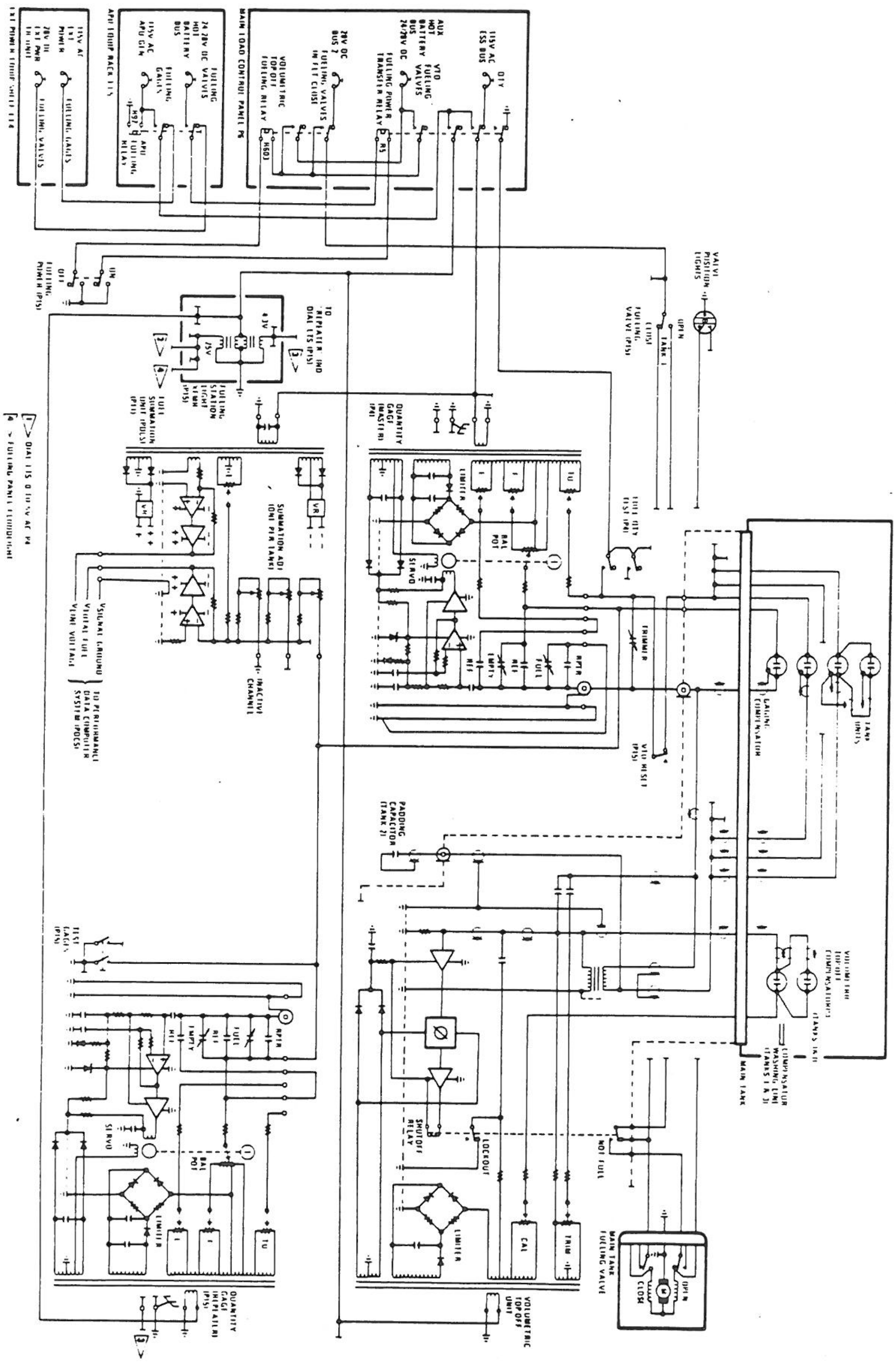
3. Fuel Quantity Circuit

a. The bridge transformer in the FUEL QUANTITY "MASTER" INDICATOR applies a fixed voltage to the TANK UNIT circuit. The resulting current is sensed by the VOLUMETRIC TOPOFF UNIT SHUTOFF RELAY amplifier and the "master" indicator SERVO amplifier as a voltage drop across impedences of the amplifier inputs. Fuel added to the tank will increase this current in proportion to the weight of fuel. The E (Empty) potentiometer of the bridge transformer applies a fixed, but adjustable, voltage to the EMPTY REF (reference) capacitor. The current, in a properly adjusted indicator, is equal in magnitude to the dry tank unit current, but of opposite instantaneous polarity and is sensed at the servo amplifier input. For a nulled empty tank bridge, the SERVO motor has no choice but to run the BAL POT (balance or rebalance potentiometer) pickoff to a zero-volts position. Ideally, this is also the zero weight graduation of the dial.

b. The two current paths, sensing and balance, are completed to the bridge transformer center tap (i.e.; AC zero) through the current LIMITER. Normally, the limiter offers no impedance to the AC current since the normal AC mdulates the forward DC bias below the limit of diode operation.

c. When a ground occurs on any wire between a bridge transformer and the tank units or compensators, the limiter diodes are alternately reverse - biased to cutoff when the AC instantaneous polarity exceeds the DC forward bias. When each limiter diode is in cutoff, the circuit is still complete, but through high-impedance resistors bypassing the diodes. These resistors, in series with the bridge transformer, limit the current to 10 Ma, a safe, explosion-proof level. Current limiters are in all "master" and "repeater" indicators and in the volumetric topoff units.

d. When fuel is added to the tank, the increased current in the tank unit circuit upsets null and causes an amplifier output to one phase of the servo motor. The amplifier output leads (or lags) the reference phase by 90^{o} such that if the tank unit current exceeds balance current, the motor drives the pointer upscale and the potentiometer pickoff upscale to what is normally a higher voltage. The motor drives until the balance potentiometer voltage, applied to the FUEL REF (reference) capacitor and the GAGING COMPENSATOR, now also wetted, results in a nulling current at the amplifier input. As the amplifier input approaches null, the motor slows the eventually stops as the amplifier input sensitivity limit is reached, ideally at null.



FOR TRAINING PURPOSES ONLY

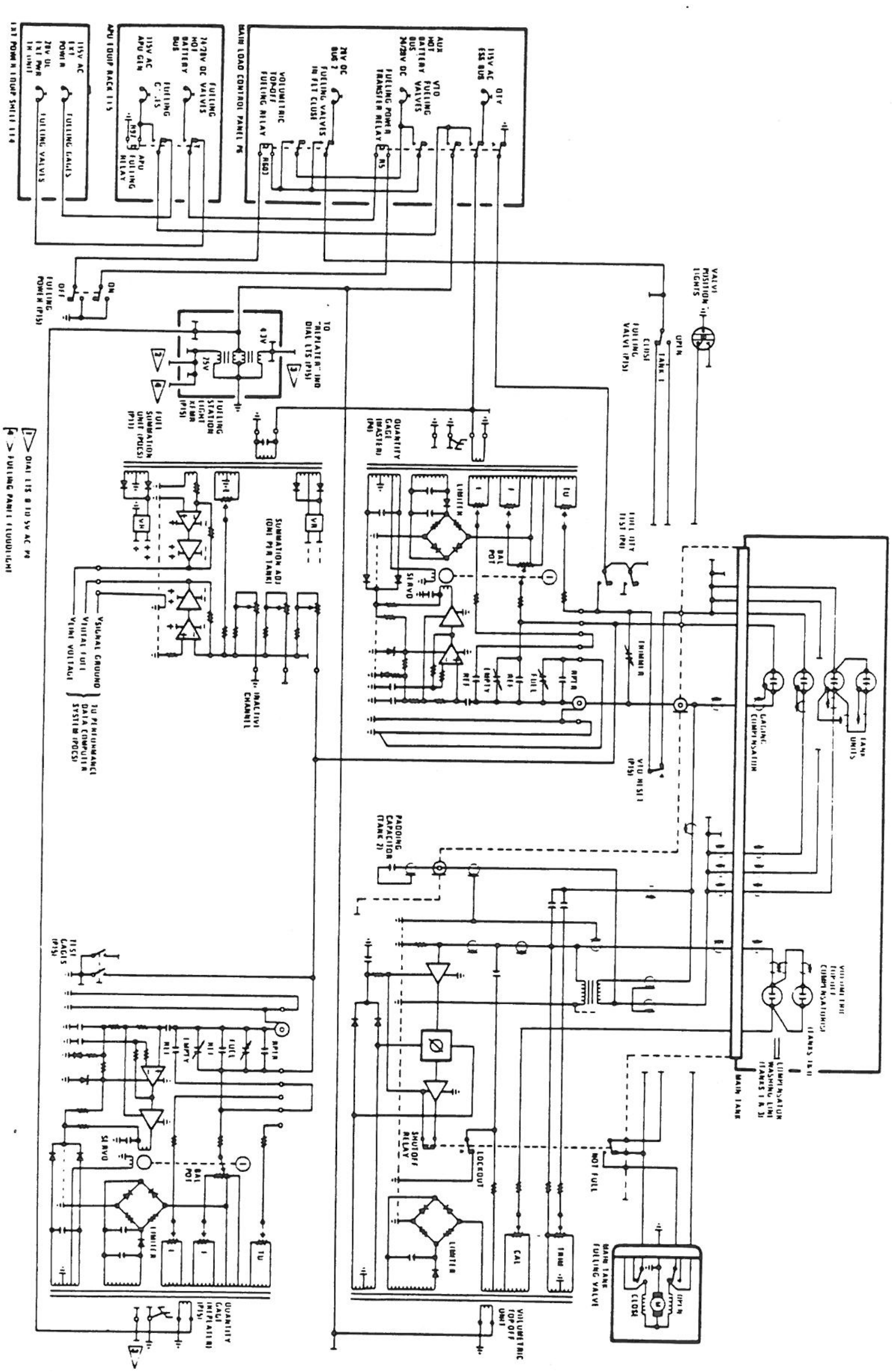
FUEL QUANTITY CIRCUIT

e. The F (full) potentiometer of the bridge transformer applies a fixed, but adjustable, voltage to one end of the balance potentiometer. In a properly adjusted system, the voltage which producesthe nulling current appears on the balance potentiometer at a dial graduation that represents the actual weight of fuel in the tank. Empty, full and tank unit (TU) adjustments correct for manufacturing and installation tolerances of indicators, tank units, compensators and wiring. Empty (E) and Full (F) are line adjustments, but only if this indicator is used in an airplane without a precalibrated indicator system.

f. The precalibrated system indicator has standardized shop-set adjustments. The airplane's tank unit network is "trimmed" to the precalibrated indicator.

g. The currents arriving at an amplifier input, nulling point, from the sensing side and balance (or reference) side of a bridge circuit are, ideally, 180^0 out-of-phase for nulling to occur. A resistor is in each wire to a capacitor or capacitor network to reconcile power-factor differences, to reduce unequal shifting of current and voltage phase angles due to the reactance differences and changes. These resistors also play a part in fault current limiting. An example of this phase - shift effect (called quadrature) is when, at the servo motor, the amplifier phase does not lead or lag the reference phase enough to develop the necessary driving torque. Note that contaminated fuel, fuel tank, tank units or compensators can become "resistors" and change current and power factor too. The contamination is usually water.

h. Water, seldom pure, acts more like an electrolyte than a dielectric, shorting or shunting the tank mounted capacitors and connectors. Water usually causes an obvious gage response (off-scale high or low, no response, slow response) and usually before other water related problems develop (corrosion, engine flame-out, etc...). A hidden characteristic of water is that as ice, the Dielectric Constant is approximately 2, nearly the same as fuel. Ice could be building up unnoticed in the fuel tanks. Pure water has a Dielectric Constant, K=80 approximately. If water is between the plates of the tank units or compensators, it has an effect 40 times greater than fuel covering the same plate area. An additional problem caused by contamination is that a fueling valve may not open for fueling or may not close automatically when the tank is full.



FOR TRAINING PURPOSES ONLY

FUEL QUANTITY CIRCUIT

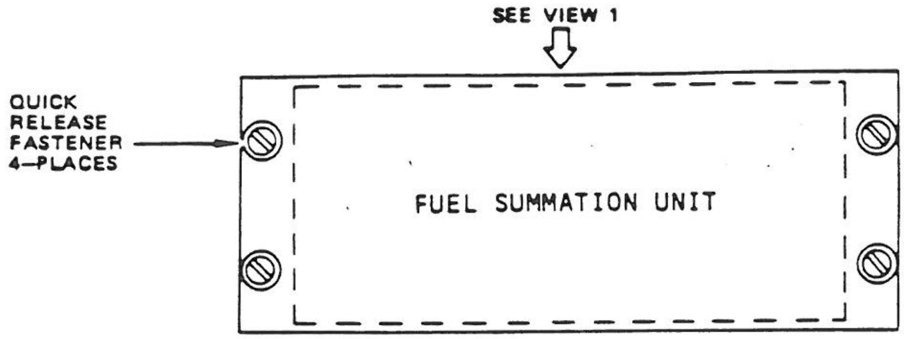
i. The servo motor is coupled to the balance potentiometer and dial pointer through a speed reducer geared assembly. This minimizes cycling of the indication due to overtravel, fuel slosh and wave action, but allows the indicator to respond, without lag, to the fastest fuel quantity changes, as during fueling, defueling or dumping. The gear train contains a clutch that slips if the servo drives the pointer above or below the dial scale ends. During maintenance, when certain connectors are open, while the indicator is powered, causes the pointer to be driven to the stops. Prolonged maintenance operations require the circuit breaker(s) to be pulled to prevent clutch and indicator damage.

j. When fuel is added to the tank, the current developed in the parallel circuit o the fuel reference and GAGING COMPENSATOR capacitors is biased by the effect of fuel in the compensator. This causes the current on both sides of the bridge to change the same amount by fuel-composition caused Dielectric Constant deviations.

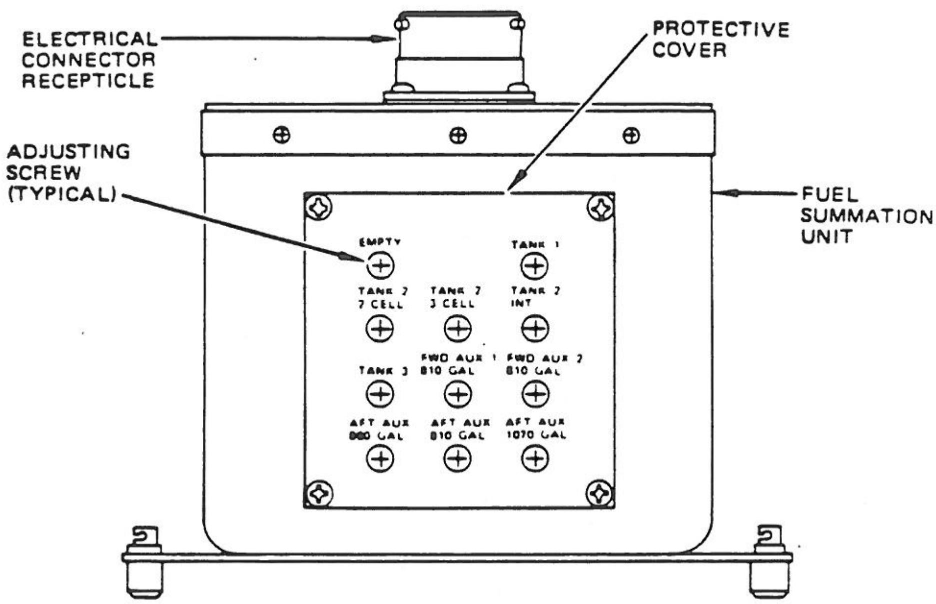
k. Ideally, the effect of fuel deviation in the tank units is nulled by the effect in the gaging compensator. This is often referred to as density compensation, descriptive but not technically correct.

l. When the bridge is nulled, the balance potentiometer voltage is an equivalent (analog) of tank quantity. This voltage is sent to the REPEATER INDICATOR on the fueling panel (P15). This voltage signal is also used for total fuel quantity indication, if installed. TOTAL FUEL QUANTITY INDICATOR(s) are optional. Total fuel indication is a feature of the performance data computer system, another optional system.

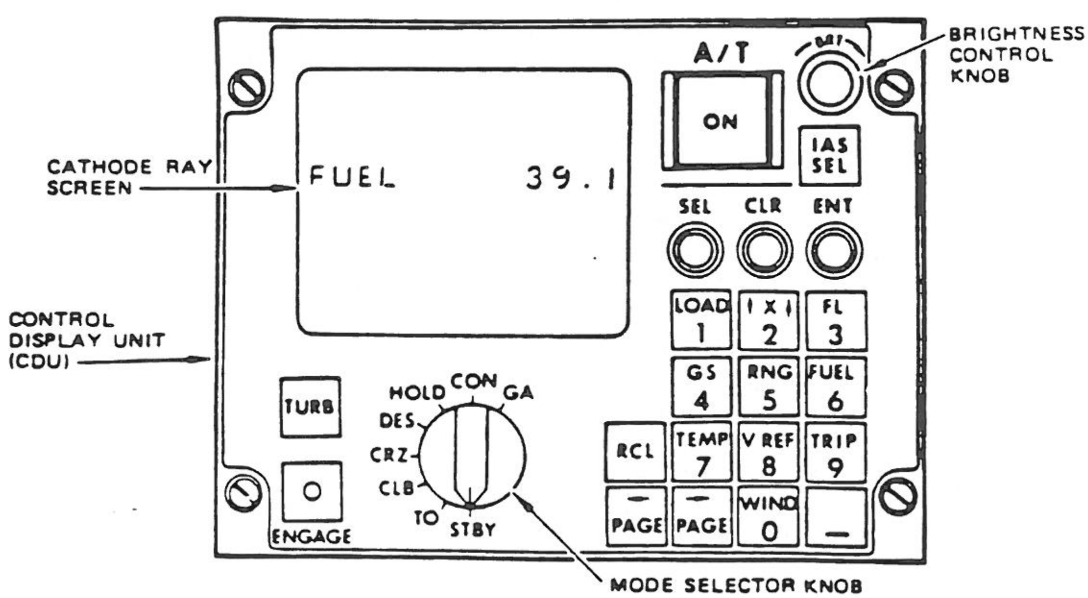
m. The "repeater" indicator measures the "master" indicator balance potentiometer voltage analog of fuel weight. The mating connector at the fueling panel changes the indicator mode from what is basically a capacitance meter in the Flight Engineer's panel (P4) to a ccapacitor-coupled bridge-type voltmeter. As a repeater, the F (full) potentiometer is set as required to make the repeater read the same as the master indicator. The E (empty) potentiometer has no function in the repeater mode. Ideally, if the repeater F potentiometer was adjusted with the master indicator on empty (zero) the repeater dial pointer would not move. For "fly-away spares" purposes the repeater indicator could be adjusted as if it is the master, then reinstalled in the fueling panel without further adjustment. Acceptable repeater accuracy should exist since there is no empty adjust capability.



P11 PANEL



VIEW 1



PILOT'S AFT ELECTRONIC CONTROL PANEL P8

FSU and CDU Components

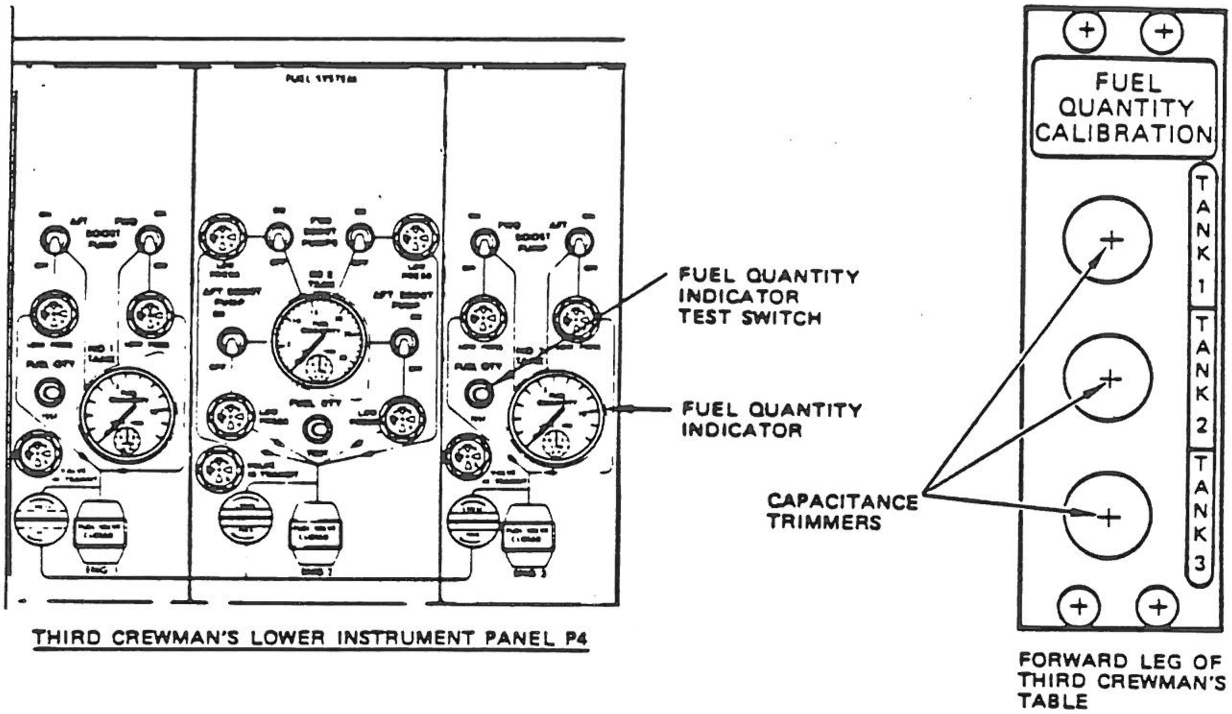
n. Test switches check indicator operation depending on the modes of the system, nonfueling or fueling. The FUEL QTY TEST (P4) circuit in the Flight Engineer's panel is inhibited during fueling, i.e.: FUELING POWER TRANSFER RELAY (R5) energized. In a nonfueling mode, the Engineer's panel test switch causes a short circuit of the voltage applied to the tank units.

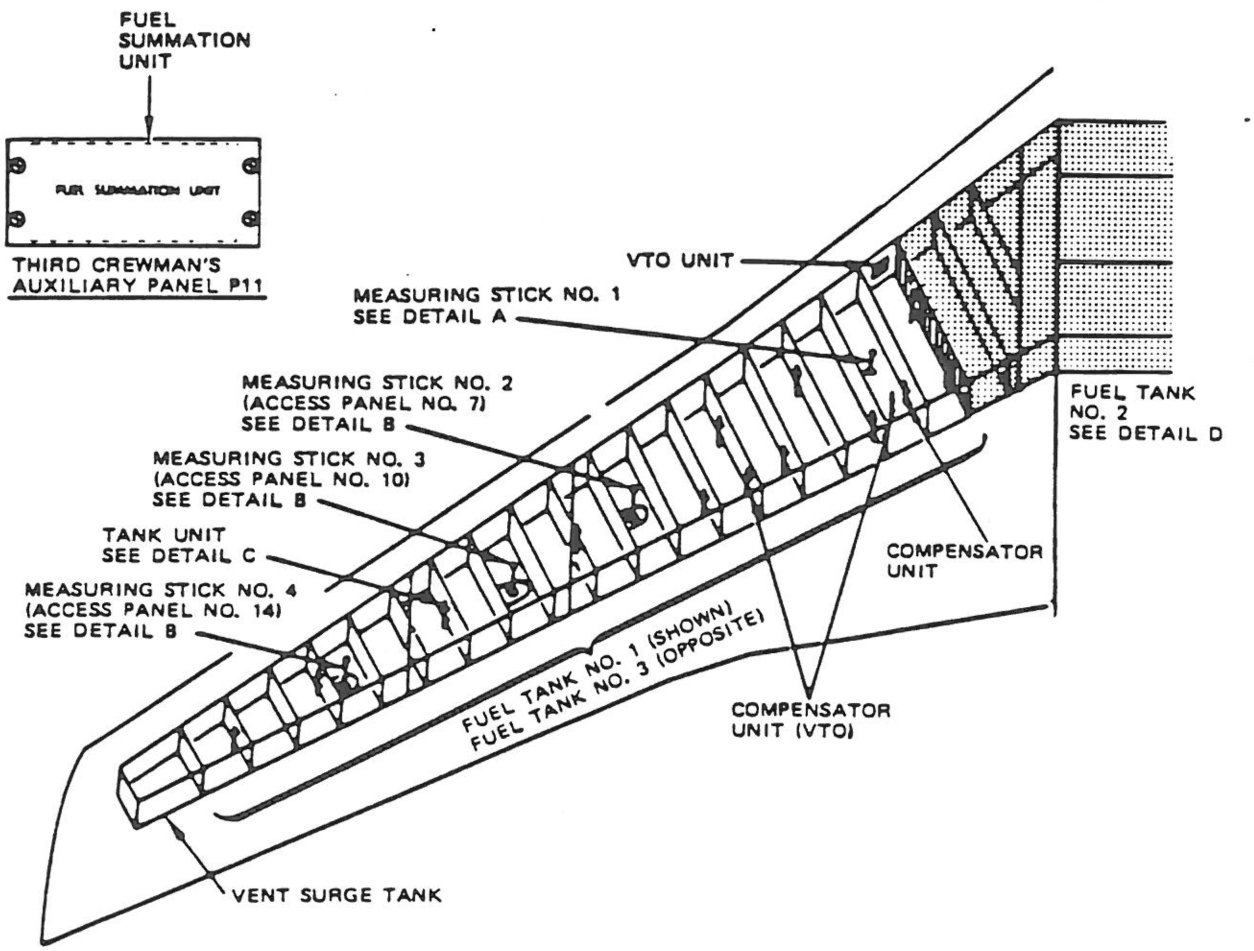
4. Fuel Summation Unit

a. The Fuel Summation Unit provides a total fuel weight proportional voltage analog to the Performance Data Computer System (PDCS, ATA-34-18). The PDCS drives cursors ("bugs") and digital counters of the Engine Pressure Ratio indicators and airspeed indicators to assist the pilots in obtaining optimum performance efficiency for conditions and modes along the flight path. The PDCS Control Display Unit can indicate total fuel and other useful information as required. Total fuel weight voltage is used by the PDCS Computer to derive airplane gross weight related data and rate-of-fuel burn related data. (The fuel flow meters do not input the PDCS.)

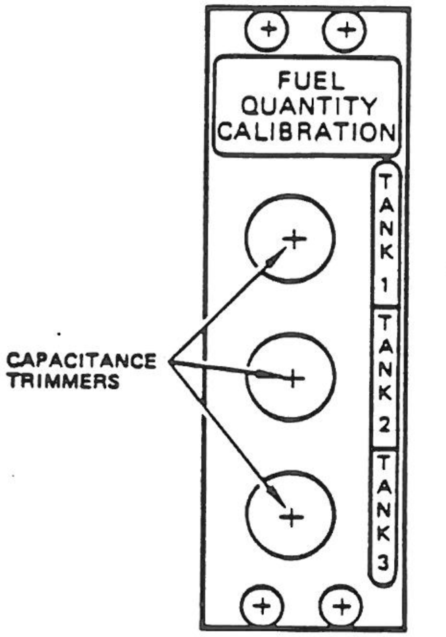
b. The Fuel Summation Unit uses an amplifier to measure the output of a parallel-current-summing network. Each input channel of the summation circuit is line-adjusted, so that the current in a channel is proportional to the total current from the network in the same ratio that an individual tank capaccity is in proportion to the sum of the capacities of all tanks. For example, if one tank changes fuel weight, the "master" and total fuel indication should change the same number of weight units. The empty adjustment (E) is line-adjusted to correct for any zero volts/zero weight discrepancies in the "master" indicators.

c. The amplifier output, sent to the PDCS computer, is proportional to total fuel and, of course, bus-voltage. Therefore a second amplifier sends a compensating bus-voltage proportional reference to the PDCS computer. The summation unit has input channels for optionally installed auxiliary tanks. Unused input pins must be grounded.



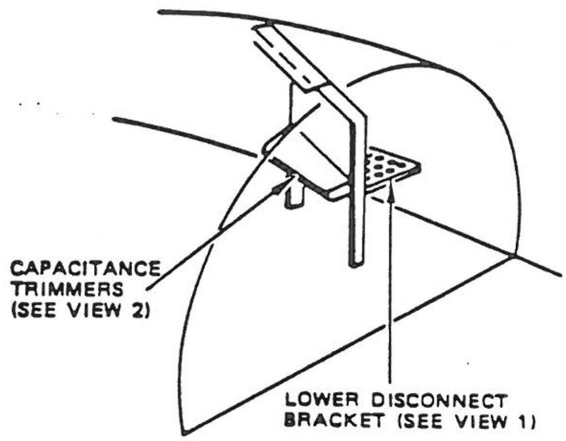


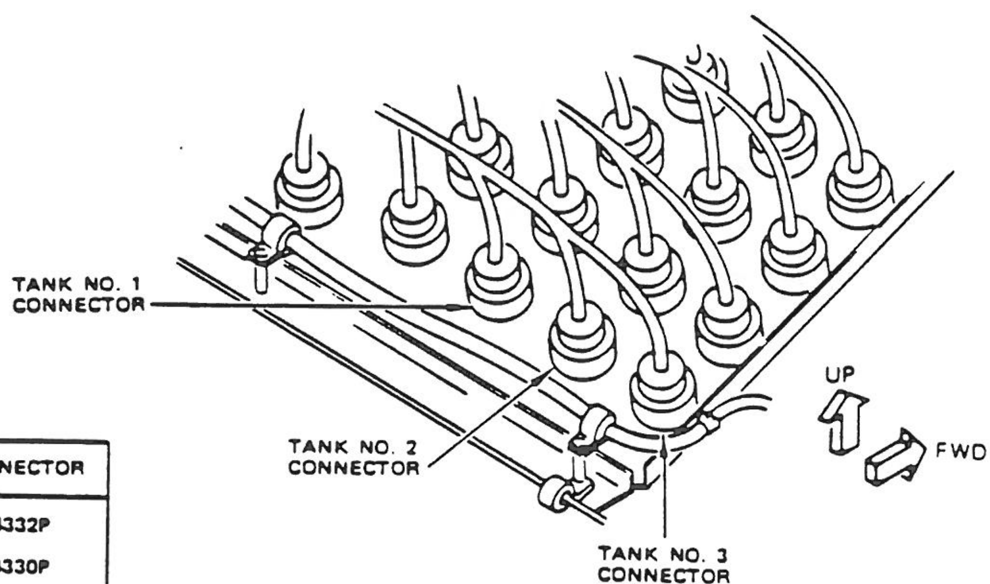
Fuel Quantity Indicating System Equipment Location



FORWARD LEG OF THIRD CREWMAN'S TABLE

VIEW 2

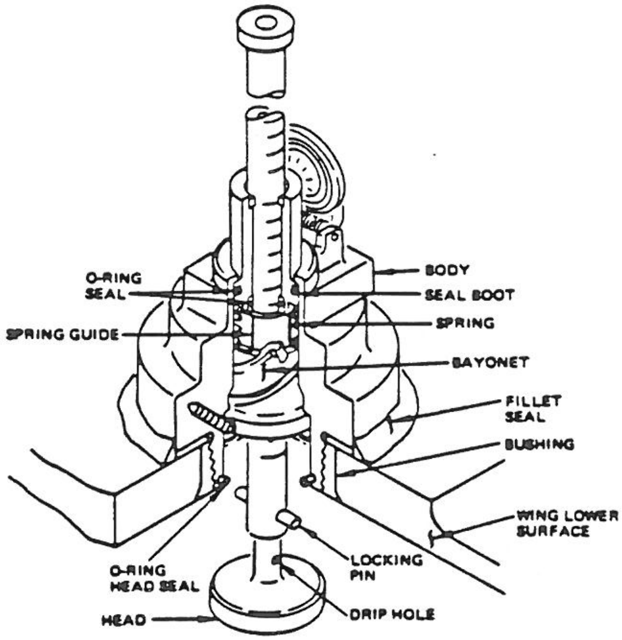




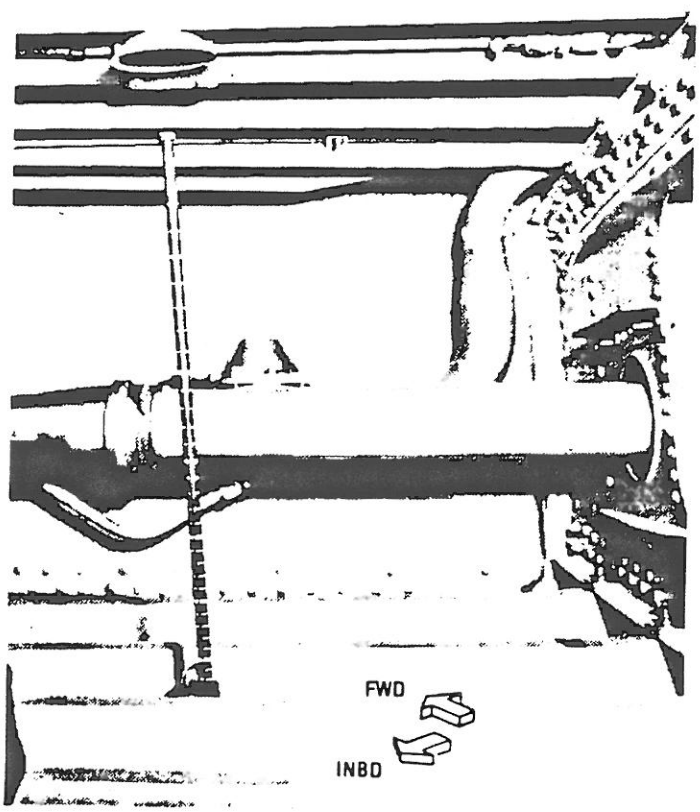
TANK	CONNECTOR
NO. 1	D4332P
NO. 2	D4330P
NO. 3	D4328P

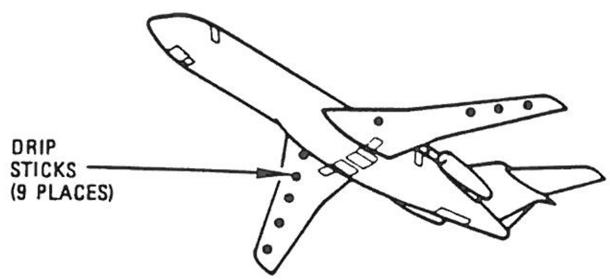
VIEW 1

Third Crewman's Component Locations



MEASURING (DRIP) STICK





MEASURING STICKS

5. Measuring Sticks (Dripsticks)

a. The measuring sticks are graduated fiberglass tubes stowed in adapters in the tank bottom/wing lower skin. Tnaks No. 1 and No. 3 have four dripsticks each. Tank No. 2 has one in the right hand section. The sticks are located by a red circle around the sealing/locking head and tank No. 1 and No. 3 sticks are numbered, inboard to outboard, No. 1 through No. 4. Tank No. 1 and No. 3 dripsticks No. 2, No. 3 and No. 4 are installed in indexed tank access panels.

b. When the dripstick is unlocked and slowly lowered, fuel will appear at the drip-hole in the sealing/locking head stem when the upper end submerges into the fuel. The dripstick scale is read at the flat surface inside the stowage receptacle. Utilizing the appropriate tabales, the amount of fuel can be determined. A secondary use of the dripsticks is to obtain fuel samples other than at the sump drain valves. It is possible to take stratified samples. For example: specific weight averaging measurements. The dripsticks are graduated in inches with 0.2 inch subdivisions. The weight sticks have non-linear scales with subdivisions as required.

c. To read the dripsticks and use the tables, the airplane ground angle of pitch and roll must be known, the airplane must not be rocking or flexing and fueling agitation must have stopped. The tables are used to correct for ground attitude effects. Also, they correct for wing bending due to differential thermal expansion between upper and lower wing structure for tanks No. 1 and 3.

d. The tables convert the inch-dripsticks to fuel volume units. Volume units are coverted to weight units by computation using the fuel specific weight. The weight-unit dripstick readings must be corrected by computation if the fuel specific weight is other than 6.7 pounds per U.S. gallon (or equivalents: 3.039 Kg/USG, 0.8029 Kg/liter, 8.046/pounds/ - imperial gallon).

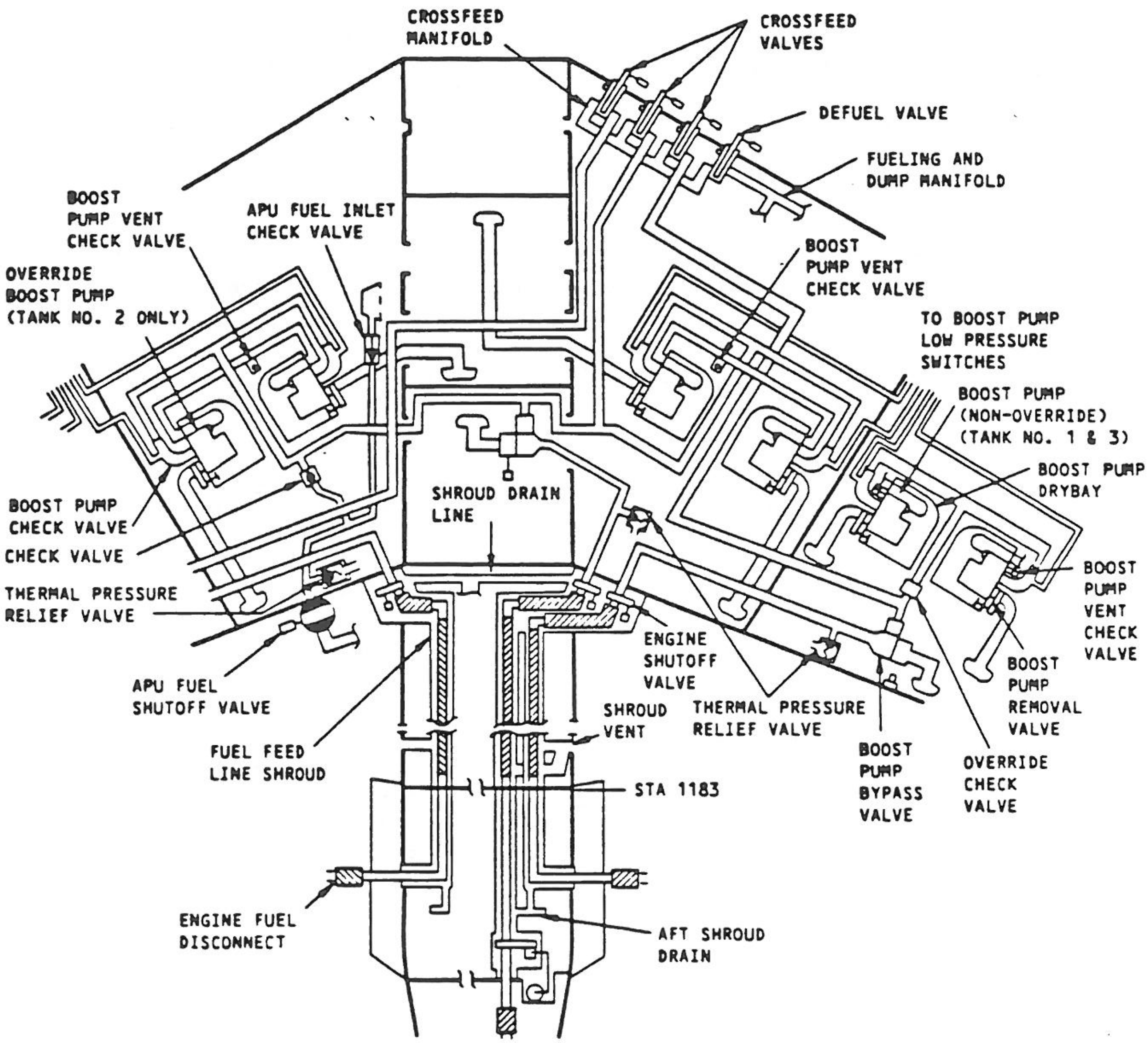
e. The dripsticks in tank No. 1 and No. 3 have considerable overlap of reading levels. At least two sticks are read and compared to provide for correction of differential thermal expansion wing bending error. Tank No. 2 dripstick is unusable at or near full tank volumes at most usual ground angles, as it is submerged. Some of tank No. 1 and No. 3 dripsticks may be submerged at certian ground angles and fuel volumes.

f. Use of the dripsticks requires careful consideration so that unjustified doubt of the Fuel Quantity Indication System does not result. Although the dripsticks are simple devices they have their own limitations in being able to locate the true fuel surface. Consider the possible effect of the baffle check valves. When a dripstick is fully extended and stopped against the adapter, a large amount of fuel is not measurable.

D. Fuel System - Engine Feed

1. Fuel System Schematic

a. The BOOST PUMPS deliver vapor-free fuel to the engines and dump fuel. On the ground, they are used for defueling and transferring operations. Each BOOST PUMP PRESSURE SWITCH turns on an amber light with the discharge pressure is low. After a pump change the BOOST PUMP REMOVAL VALVE must be opened for normal operation. Also, the pump must be primed. The boost pumps in No. 2 tank have a higher pressure rating than those in No. 1 and No. 3 tanks. The higher pressure boost pumps are called "override pumps", but they are not labeled so on the control panels.



Engine Fuel Feed System Flow Diagram

b. The BOOST PUMP CHECK VALVE isolates the pump and its pressure switch from the system. It also prevents back flow into a tank through an inoperative boost pump. This check valve prevents suction feed through an inoperative pump and facilitates boost pump removal.

c. The BOOST PUMP VENT CHECK VALVES facilitate pump removal, but because of their back pressuring effect, a new pump must be primed before use.

d. Fuel feed for the APU is from the No. 2 engine feed line. The APU feed line incorporates a check valve and thermal relief valve. The APU feed line is pressurized anytime the No. 2 engine feed line is pressurized.

e. The OVERRIDE CHECK VALVES (in tank No. 1 and No. 3 systems) assure the override pressure difference between boost pumps over a wide range of engine fuel flows and combinations of operating pumps. The principle of "override" is to facilitate tank sequencing.

f. The BOOST PUMP BYPASS VALVES (in the main tanks) allow an engine to suction feed from its main tank if the boost pumps are OFF or inoperative. They also prevent crossfeed suction. When locked closed, they facilitate engine shutoff valve replacement.

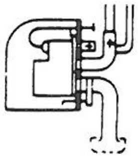
g. THERMAL RELIEF VALVES (in main tanks) limit pressure trapped in the lines between the boost pump bypass valves and the engine fuel control unit outlet, when the engine is shut down.

h. The ENGINE FUEL SHUTOFF VALVES are opened and closed to control fuel feed to an engine. They are controlled by two switches, one start lever operated and the fire switch. A manually operated third switch located on the fuel management panel is a customer option.

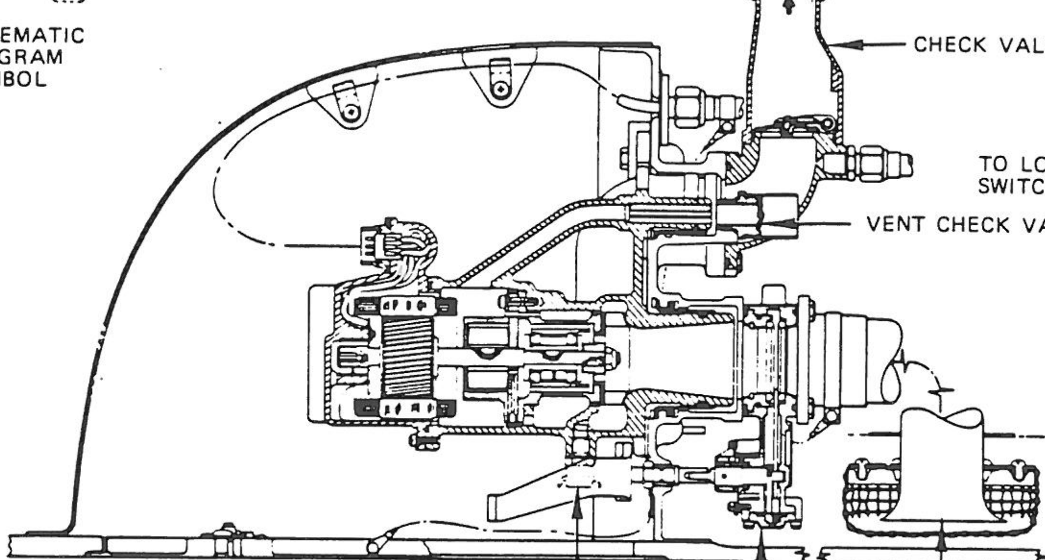
i. The CROSSFEED VALVES are opened and closed to control the flow of fuel to and from the crossfeed manifold. These valves control tank sequencing aided by the boost pump pressure differences (override versus standard).

j. The CROSSFEED MANIFOLD provides a multi-path interconnection between crossfeed valves and, on the ground defueling valve.

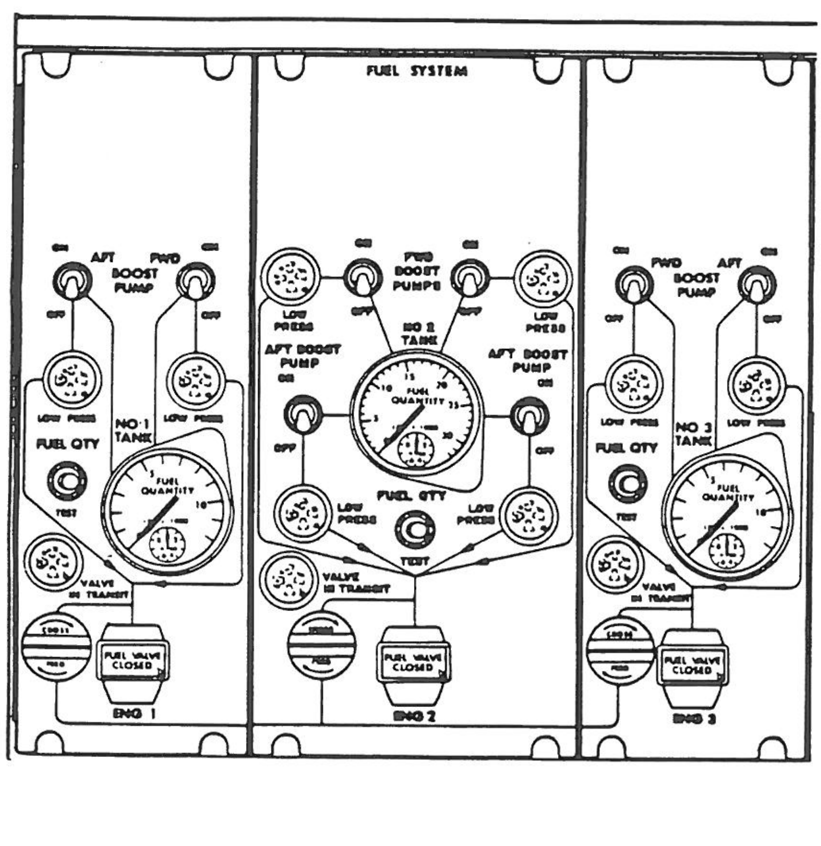
k. The manually operated DEFUEL VALVE provides a two-way flow path between the crossfeed manifold and the fueling and dump manifold. It is opened for defueling and transferring. The defuel valve lever is interlocked with its access door to assure valve closure before flight.



SCHEMATIC DIAGRAM SYMBOL



FUEL BOOST PUMP INSTALLATION

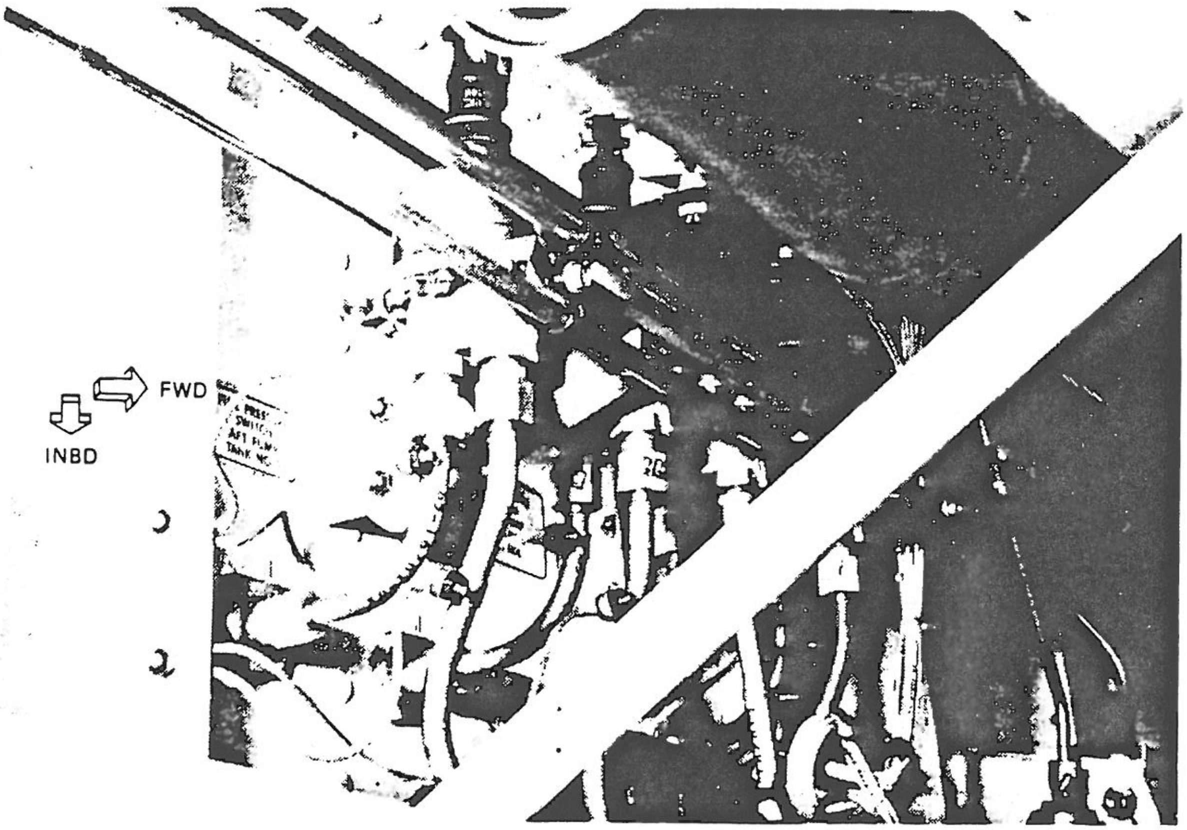


E. Fuel System Components

1. Fuel Boost Pumps

a. The eight BOOST PUMPS are 115V AC, three phase induction motor driven, centrifugal pumps. The pumps are fuel cooled and lubricated. Each pump contains a reprime pumping element between the impeller and the motor. A drain valve is installed in the bottom of the impeller housing. All boost pumps are similar, except for the impeller shape which changes the pressure rating and the indexing of the electrical connector which assures proper pump location. The higher pressure boost pumps are installed in tank No. 2 and are referred to as "override" pumps. The boost pumps in tanks No. 1 and No. 3 are referred to as "standard" pumps. The boost pump discharge at zero flow is approximately 50 psi for the "overrides" and 40 pis for the "standards". This 10 psi difference is maintained at any equal flow rate; for example: 30 psi and 20 psi respectively at 20,000 pounds per hour.

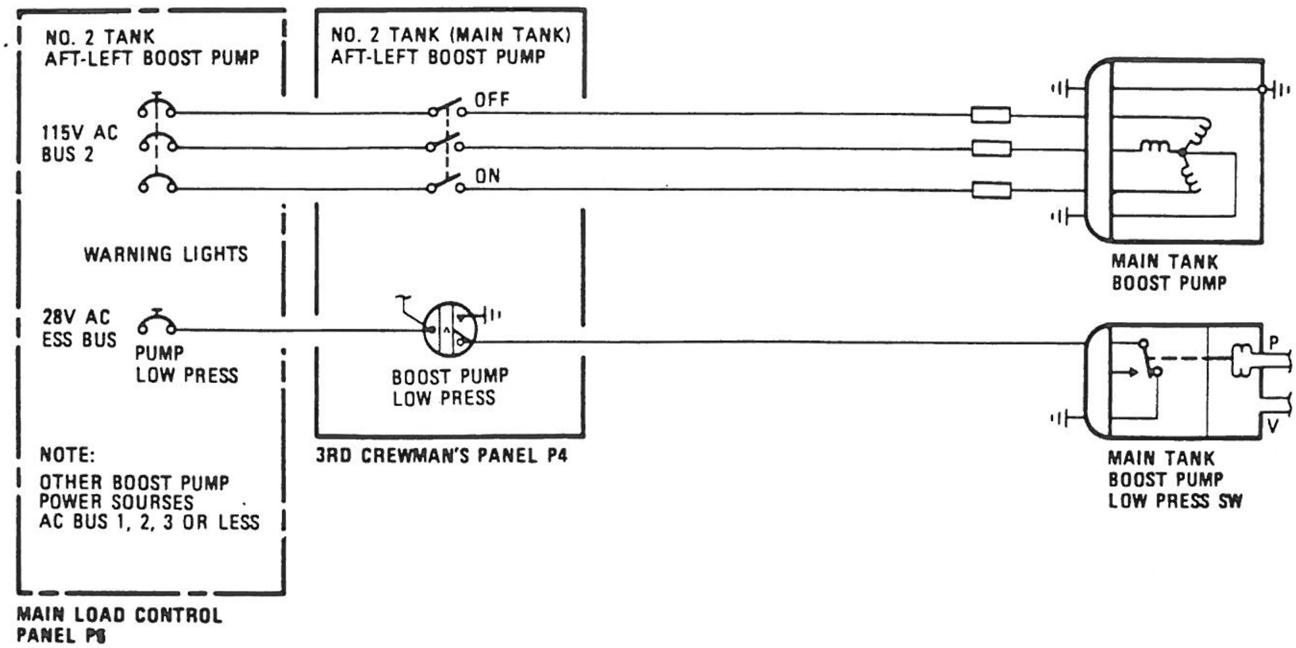
The boost pumps are mounted in equipment dry bays built into the tanks. Three ports on the pump are bosses that plug into ports in the support fitting. The ports in the support fitting contain equipment to isolate the boost pump from the tank and system so that the pump can be replaced without defueling a tank. The inlet port contains a BOOST REMOVAL VALVE that is manually operated by a handle in the equipment dry bay. This handle is interlocked with the access panel. The discharge port contains a BOOST PUMP CHECK VALVE which isolates the pump and is pressure switch from the system. The vent ports of the main tank boost pump support fittings contain a VENT CHECK VALVE. Each boost pump is controlled by a switch on the fuel system panel.



BOOSTPUMP PRESSURE SWITCHES

2. Boost Pump Pressure Switches

a. Each boost pump has a BOOST PUMP PRESSURE SWITCH. The main tank pressure switches operate nominally in the 5 to 7 PSI range (approximately). The eight main tank pressure switches are mounted (four to a side) on the front spar. They are directly accessible if the leading edge flaps are extended. The auxiliary tank pressure switches are mounted in the equipment dry bay of the tank. Access requires removal of cargo compartment partition panels and the equipment bay access panel. The two pressure rated swich types have different electrical connectors to assure proper installation. The boost pump pressure switches are connected to an orificed port on the boost pump check valve. Pressure switch replacement is facilitated by closing the boost pump removal valve (auxiliary tanks close both pump removal valves). The main tank pressure switch vent ports are connected by small diameter tubes to holes through the leading edge lower skin.



3. Boost Pump Circuit

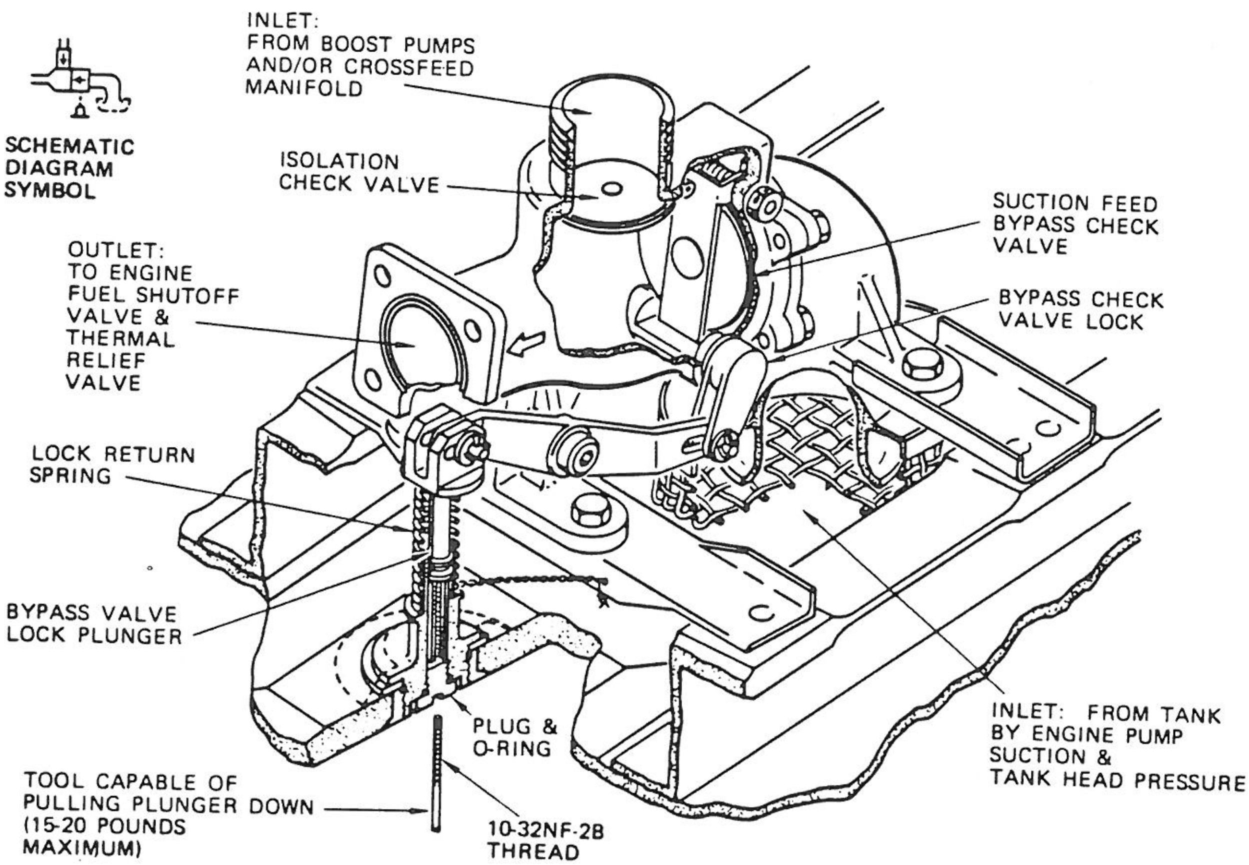
a. The BOOST PUMP circuits are as simple as possible for reliability even though a rather heavy current must flow through the switch contacts. The pump motors are rated at 1-3/4 horsepower.

b. The 115V AC power sources for the boost pumps are arranged so that a single bus or generator failure will not cause a loss of all pumps in one tank. The sources are as follows:

TANK	BOOST PUMP	SOURCE
No. 1	Aft	AC Bus 1
	Fwd	AC Bus 3
No. 2	Aft (left)	AC Bus 2
	Fwd (left)	AC Ess. Bus
	Fwd (right)	AC Bus 1
	Aft (right)	AC Ess. Bus
No. 3	Fwd	AC Bus 2
	Aft	AC Bus 3

c. The boost pump case has two very important grounds to the airframe. One is the contact surface between the pumps and its support fitting. The other is a wire connected to the front or rear spar structure. These grounds assure tripping of the circuit breaker in the event of an electrical fault in the boost pump.

d. The BOOST PUMP PRESSURE SWITCH turns on an amber (caution) light with the discharge pressure is low.



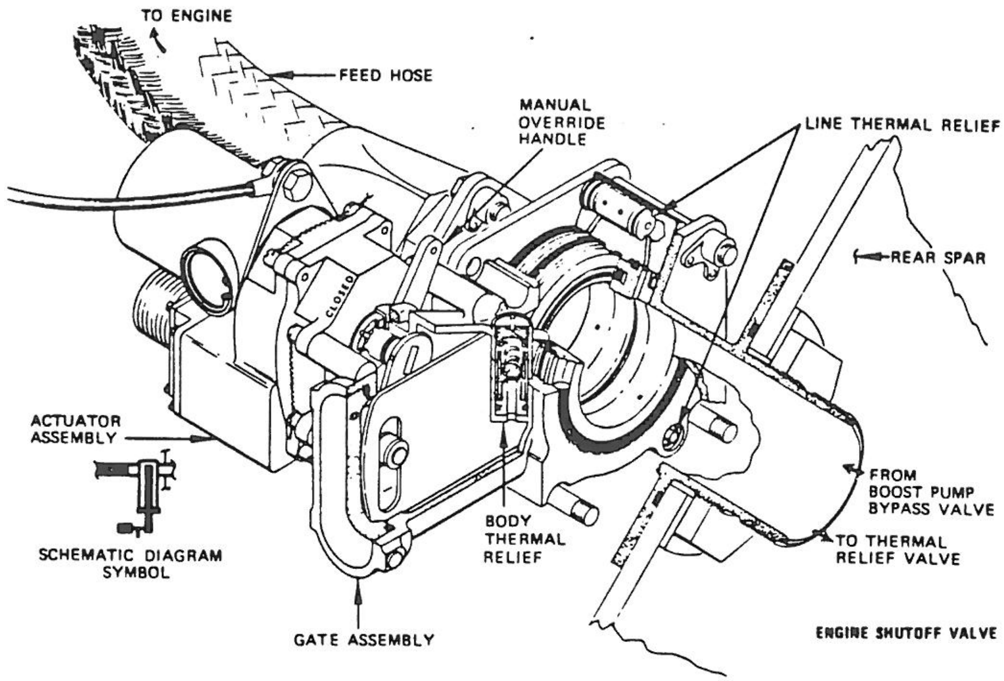
BOOST PUMP BYPASS VALVE

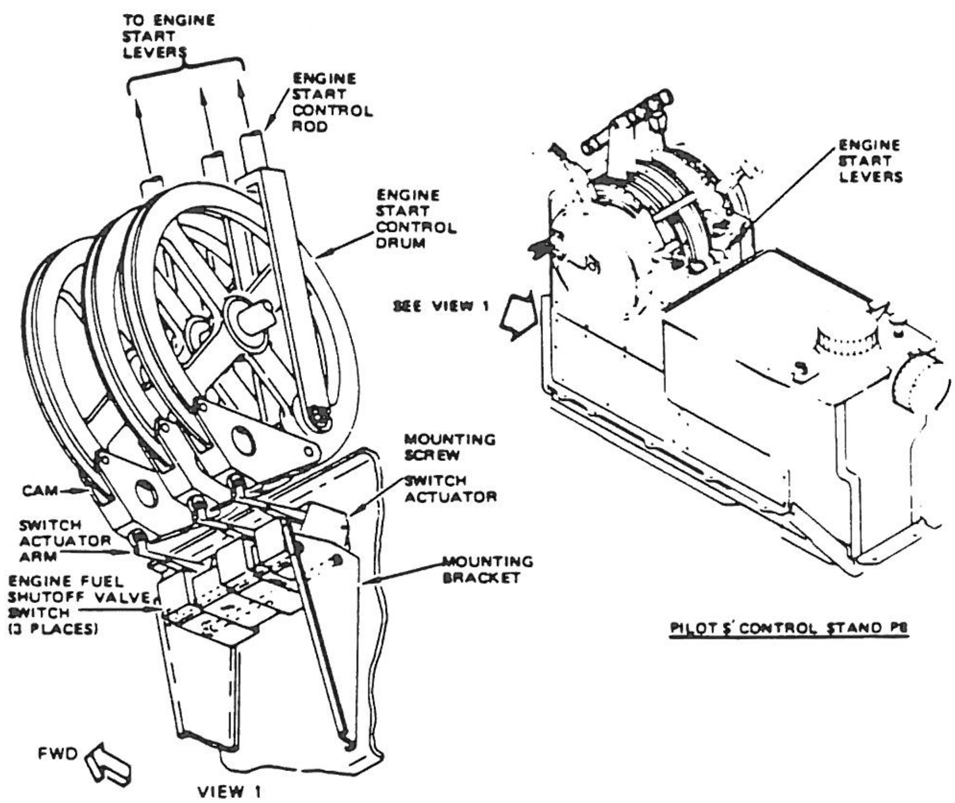
4. Boost Pump Bypass Valve

   a. The main tank BOOST PUMP BYPASS VALVES consist of two flapper check valves in a tee-like housing. The valve has three ports (two inlets and one outlet).

   b. One inlet is connected to the boost pumps in the tank and the crossfeed manifold. The other is connected to the tank through a screened bell-mouth. The outlet is connected to the engine feed line, upstream of the engine shutoff valve. The check valves are spring loaded closed, but to considerable different pressures. The "boost pump" inlet check valve is held closed to a pressure of 1.5 PSI, while the "bypass" inlet check valve is held closed to only 1 inch (approximate) of water pressure. The "bypass" check valve will open so easily; that, to be able to change the engine fuel shutoff valve (the next component downstream) without requiring tank defueling, a manually operated lock is installed. The tool used to operate and hold the lock should have a safety streamer (flag) and should limit the force that can be applied to the lock plunger. The lock should be operated only when <u>no fuel is flowing</u> through the "bypass" port, otherwise the bypass check valve would be locked "open".

   c. The valves in tanks No. 1 and No. 3 are located in the lower rear area of the inboard rib bay. In tank No. 2 the valve is located in the center wing section, lower right side of the aft bay. The lock plungers for tanks No. 1 and No. 3 are directly accessible in the lower wing skin, near the landing gear fairing. Tank No. 2 access to the lock plunger is through a door in the aft end of the right air conditioning pack bay and wing-to-body fairing.





Engine Fuel Feed System Equipment Location

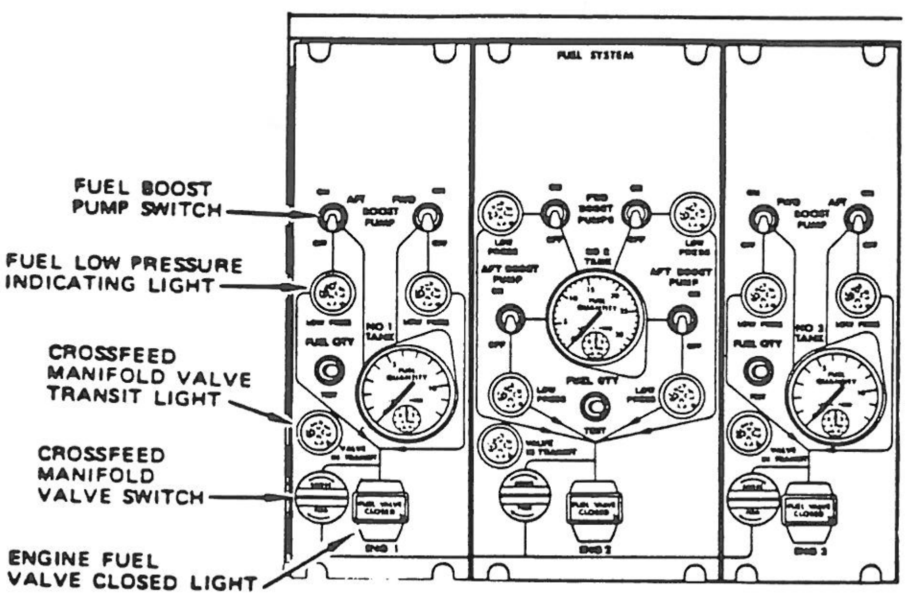
5. Engine Shutoff Valve

a. The three ENGINE SHUTOFF VALVES are 24/28V DC motor operated, sliding gate, line-mounted, one-second valves, with a manual override handle. These valves consist of gate and actuator assemblies joined so that the valve can only be replaced as a complete unit.

b. The shutoff valves are located on the upper inboard rear spar, outboard of the splice to the center wing section (outboard of the body frame/main wheel well forward bulkhead). The No. 1 valve is on the left, No. 2 and No. 3 on the right. The valves (and hoses) are covered with fiberglass shrouds. Access to engine shutoff valves is by unlatching and removing portions of the shroud.

c. Each valve is controlled by two switches: one is start lever operated another is the fire switch. A blue light is "ON" bright when the valve is opening or closing (intransit), "OUT" when "OPEN" and "ON-DIM" when "CLOSED".

d. The thermal releif valves (spring loaded, poppet check valves) are in the valve body. The body thermal relief protects the gate housing. The line thermal relief valves limit the pressure trapped on either side of a closed gate. But, specifically as installed, they limit the pressure trapped between the engine shutoff valve and the engine fuel control unit outlet when the engine is shutdown. These thermal relief valves operate in the 45-85 psi range. Upstream other thermal relief valves open into the tanks at 55 to 75 psi. This means that in the engine feed or engine fuel (ATA 73) systems, residual pressure in the system could be as high as 160 psi and must be carefully released when maintenance is performed.



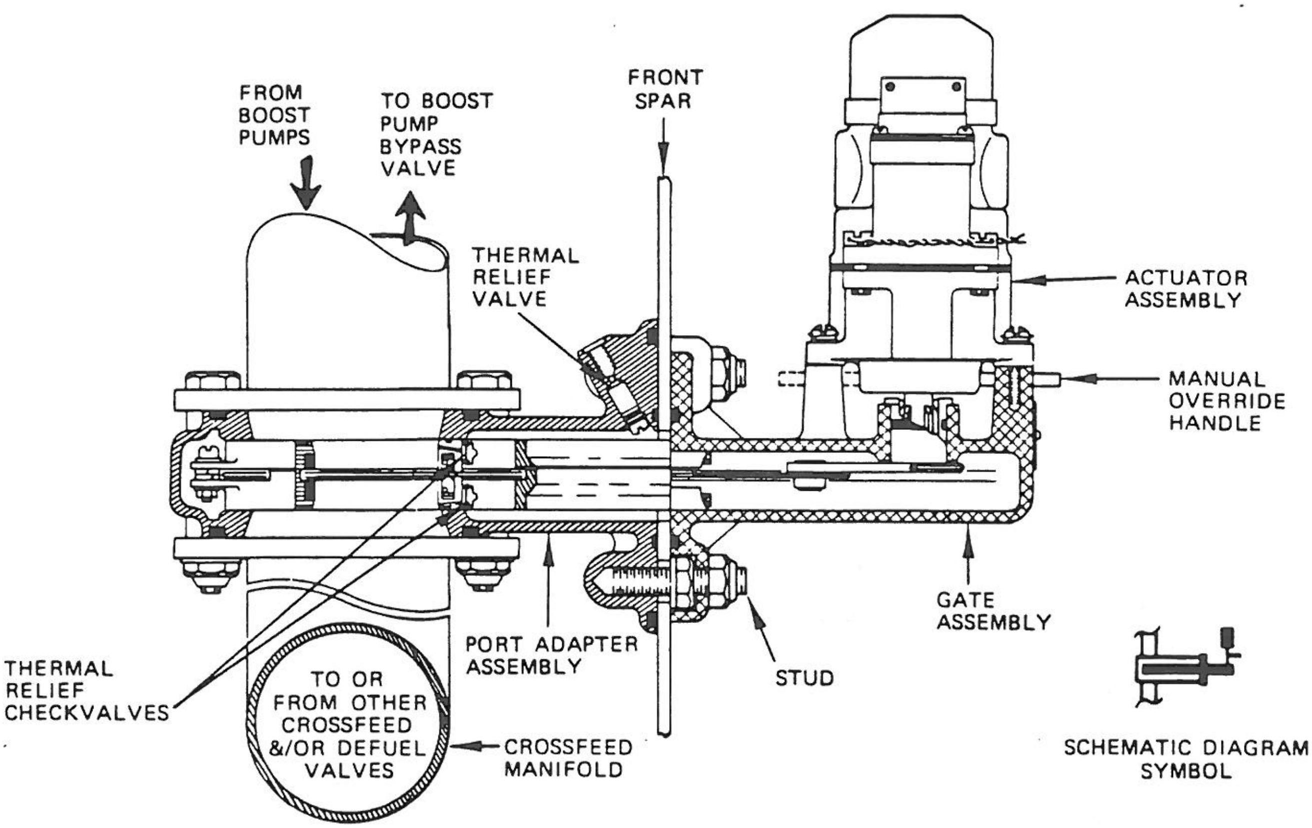
THIRD CREWMAN'S LOWER INSTRUMENT PANEL

6. Crossfeed Valve

a. The three CROSSFEED VALVES are 24/48V DC motor operation, sliding gate, semi-submerged, one-second valves, with a manual override handle. These valve consist of gate, actuator and port adapter assemblies. The port adapter assembly is mounted inside the tank and supports the fuel lines and crossfeed mainfold. The gate assembly slides into the adapter from the dry side. The actuator couples to the gate shaft with an index-tooth spline.

b. The crossfeed valves are located high on the inboard front spar of the right wing. They are directly accessible if the leading edge flaps are extended.

c. Each crossfeed valve is controlled by a rotary switch on the fuel system panel. A blue light, adjacent to the switch, is "ON" when the valve is opening or closing (intransit). Additionally, No. 2 crossfeed valve is opened by an auxiliary tank fueling valve circuit.

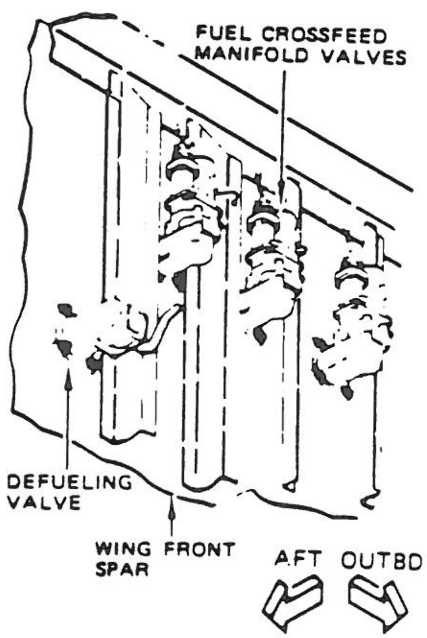


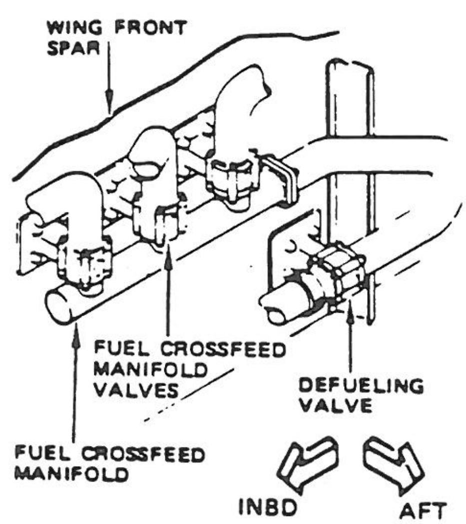
CROSSFEED VALVE

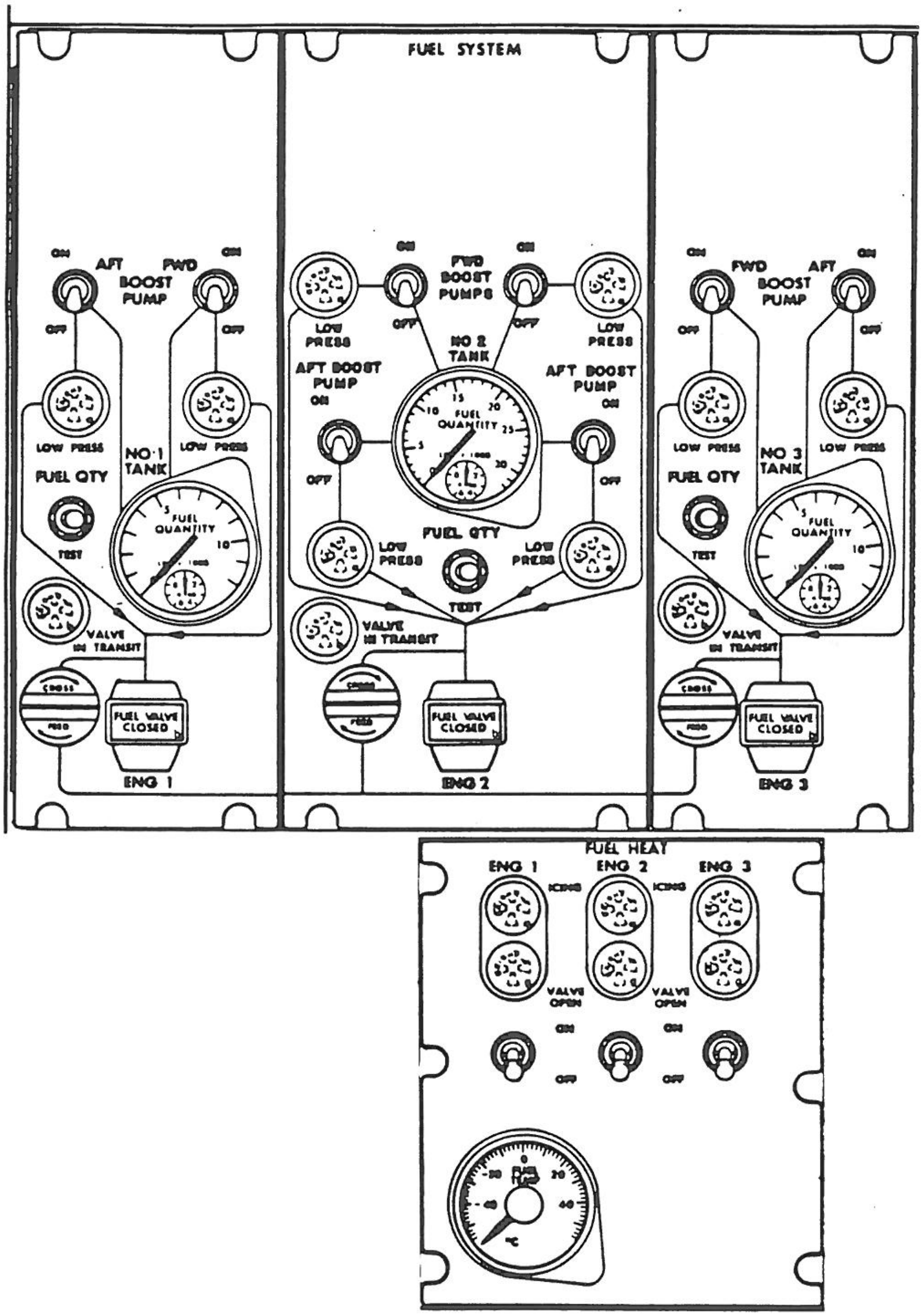
d. The crossfeed valves are similar to the tank dump valves and the tank fueling valves, except these are for smaller tubing, operate faster and have a lower thermal relief valve setting. No assemblies are interchangeable between the two types.

e. A thermal relief valve is in the port adapter and two thermal relief check valves are in the gate assembly. This limits the pressure trapped in the crossfeed manifold and lines to a range of 45-60 PSI with the system shutdown.

f. The CROSSFEED MANIFOLD is a short, tube assembly with four flanged ports. The manifold is supported in tank No. 2 by the port adapter of the three crossfeed valves and the defuel valve.






FUEL SYSTEM
ON
AFT
FWD
BOOST
PUMP
OFF
LOW PRESS
NO 1
TANK
FUEL QTY
TEST
FUEL
QUANTITY
VALVE
IN TRANSIT
CROSS
FEED
FUEL VALVE
CLOSED
ENG 1
FWD
BOOST
PUMPS
NO 2
TANK
AFT BOOST
PUMP
FUEL QTY
ENG 2
NO 3
TANK
ENG 3
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VALVE
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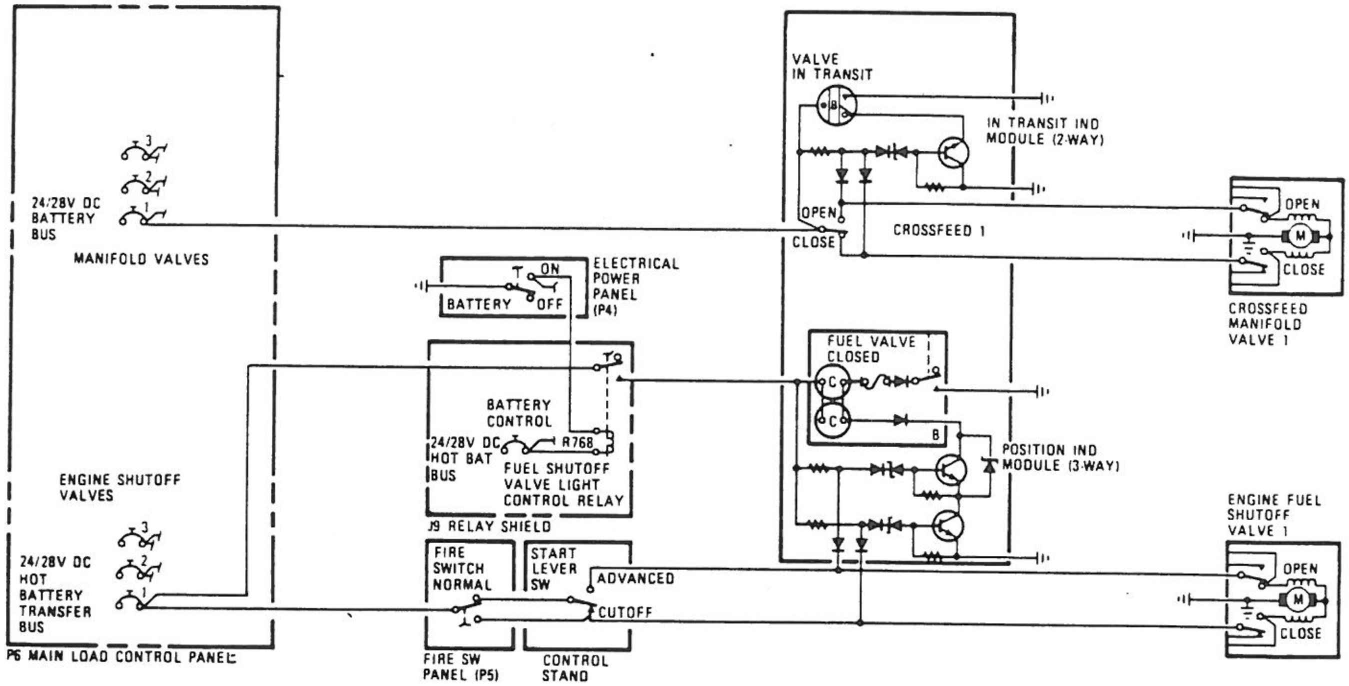


ENGINE FEED VALVE CIRCUITS

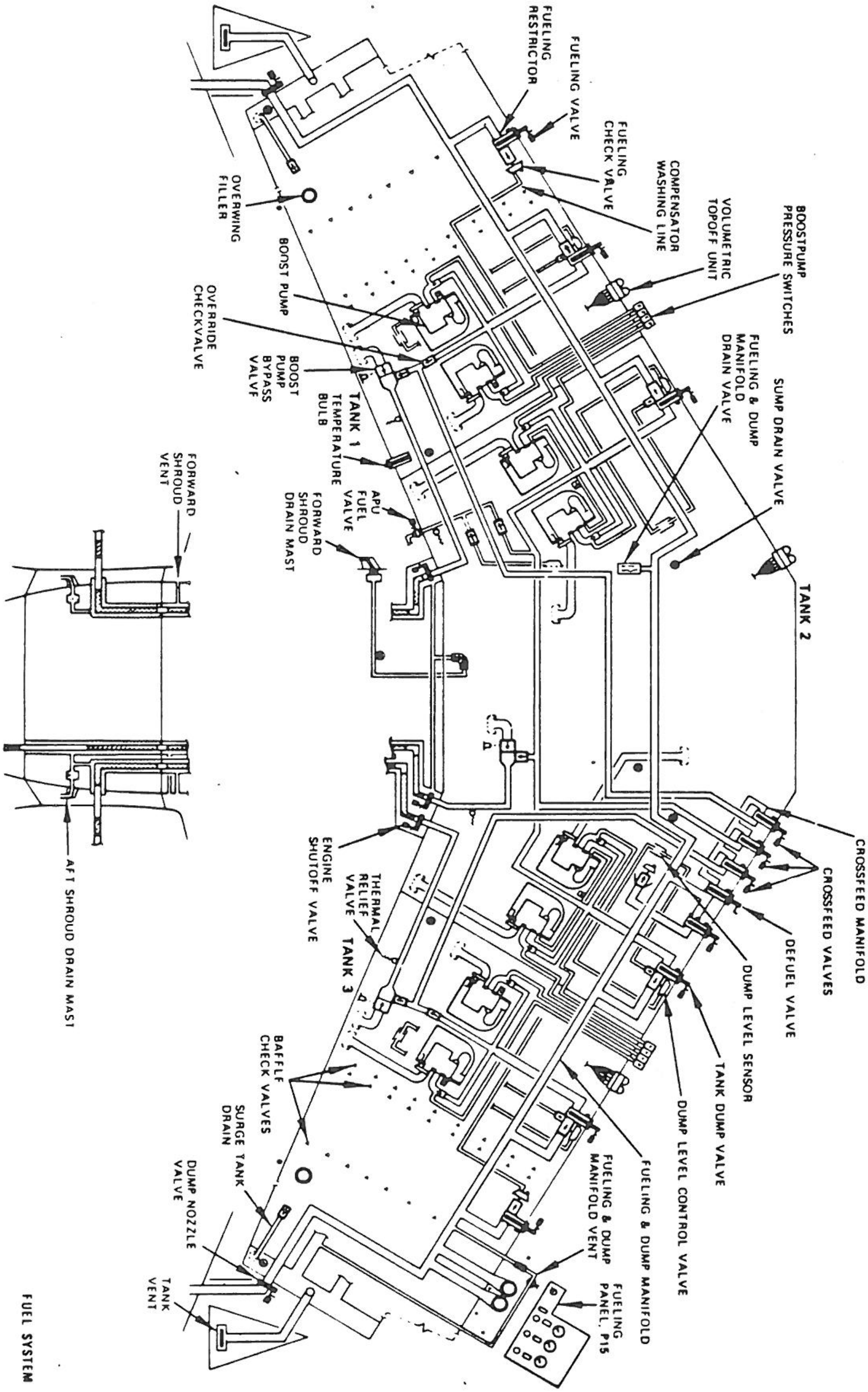
7. Engine Feed Valve Circuits

a. Each ENGINE SHUTOFF VALVE requires two switches to be properly positioned to open the valve. It can be closed by any one of these switches. The valve circuits are always energized as long as there is a charged battery in the airplane. The blue "valve" light will be ON whenever the motor is energized to open or close the valve, out when "OPEN" and "ON DIM" when closed.

b. The POSITION IND. MODULE for each engine fuel shutoff valve and the INTRANSIT IND. MODULE for each crossfeed valve operate through the circuits to both motor fields and limit switches and the armature.

c. A relay energizes the engine shutoff valve light circuit when the battery switch is ON. This prevents a continuous battery drain when the airplane is parked and without electrical power from external power or the APU generator.

d. The CROSSFEED VALVES are each controlled by a single switch. The circuits are energized if the battery switch is ON and/or the 28V DC busses are energized. The crossfeed valve intransit light will be "ON" while each valve is opening or closing.


FUELING RESTRICTOR
FUELING VALVE
FUELING CHECK VALVE
COMPENSATOR WASHING LINE
VOLUMETRIC TOPOFF UNIT
BOOSTPUMP PRESSURE SWITCHES
FUELING & DUMP MANIFOLD DRAIN VALVE
SUMP DRAIN VALVE
TANK 2
CROSSFEED MANIFOLD
CROSSFEED VALVES
DEFUEL VALVE
DUMP LEVEL SENSOR
TANK DUMP VALVE
DUMP LEVEL CONTROL VALVE
FUELING & DUMP MANIFOLD
FUELING & DUMP MANIFOLD VENT
FUELING PANEL, P15
OVERWING FILLER
BOOST PUMP
OVERRIDE CHECKVALVE
BOOST PUMP BYPASS VALVE
TANK 1
TEMPERATURE BULB
APU FUEL VALVE
FORWARD SHROUD DRAIN MAST
FORWARD SHROUD VENT
AFT SHROUD DRAIN MAST
ENGINE SHUTOFF VALVE
THERMAL RELIEF VALVE
TANK 3
BAFFLE CHECK VALVES
SURGE TANK DRAIN
DUMP NOZZLE VALVE
TANK VENT

FUEL SYSTEM

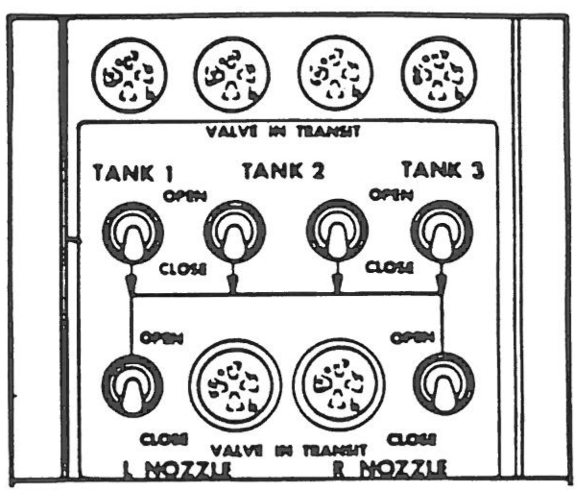
F. Fuel System - Dump

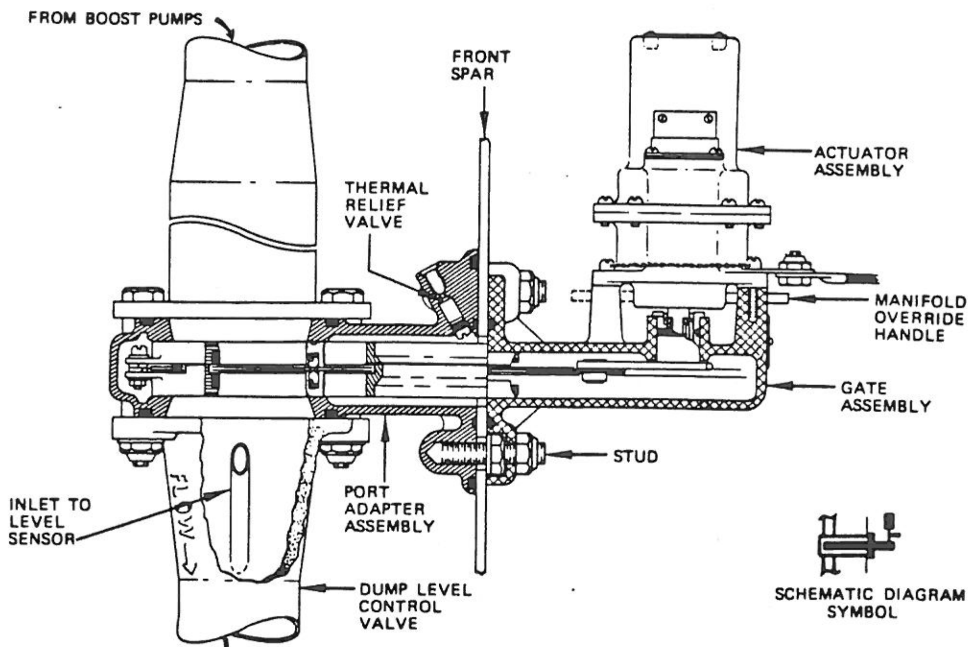
1. General Description

a. The DUMP LEVEL CONTROL VALVES and DUMP LEVEL SENSORS assure priority of the engine feed system over the dumping function. They allow dump flow only if the boost pump pressure is higher than 8-9 PSI and if the fuel level is above the undumpable reserve. With engine feed priority assured, they allow dumping enough fuel to get the airplane near to the maximum design landing weight while retaining enough for a safe landing. The high rate of airplane weight reduction can help maintain climb performance after takeoff.

b. Fuel flowing into the dump level sensor cannot jump the gap when the tank quantity is above the sensor level. The "jet" energy is dissipated when fuel is in the gap. The jet of fuel crossing the gap pressurizes the dump level control valve diaphragm chamber to close the valve. The shroud and orifice in the level sensor reduce the effect of wave action to provide a stable shutoff pressure signal to the level control valve.

c. Use the dump system whenever possible for most rapid defueling and transferring as this is a valid test of otherwise seldom used components.





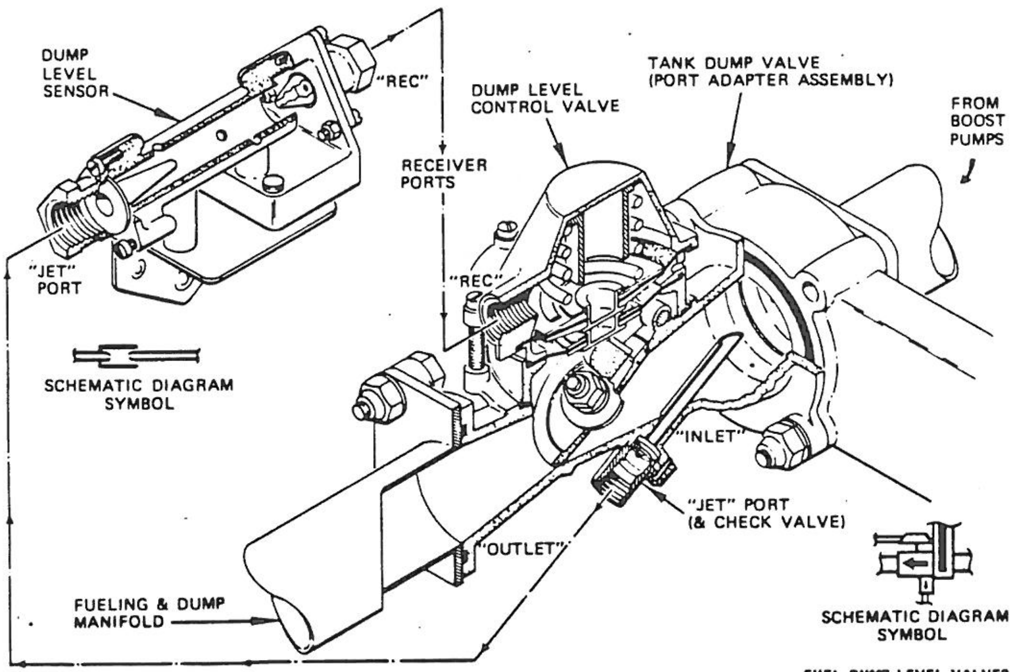
TANK DUMP VALVE

2. Tank Dump Valves

a. The four TANK DUMP VALVES are 28V DC motor operated, sliding gate semi-submerged, 3 to 5-second valves, with a manual override handle. These valve consist of gate actuator and port adapter assemblies. The port adapter assembly is mounted inside the tank and supports fuel lines and dump level control valve. The gate assembly slides into the port adapter assembly from the dry side. The actuator assembly couples to the gate shaft with an index-tooth spline. These valve are the same part number as fueling valves.

b. The tank dump valves are located on the inboard front spar of each tank. They are directly accessable if the leading edge flaps are extended. Tank No. 2, because of its size, has two valves (left and righ). Each tank dump valve is controlled from a switch on the dump panel.

c. These valves are similar to the crossfeed manifold valves except these are for a larger tubing size, operate slower and have a higher thermal relief valve setting. The thermal relief valve operates in the range of 120-160 PSI. This relief primarily protects the valve, since no thermal buildup is probable on the fueling and dump manifold. And, the engine feed system side of the valve has thermal relief at much lower pressure (45 to 60 PSI) through the crossfeed valves thermal relief.

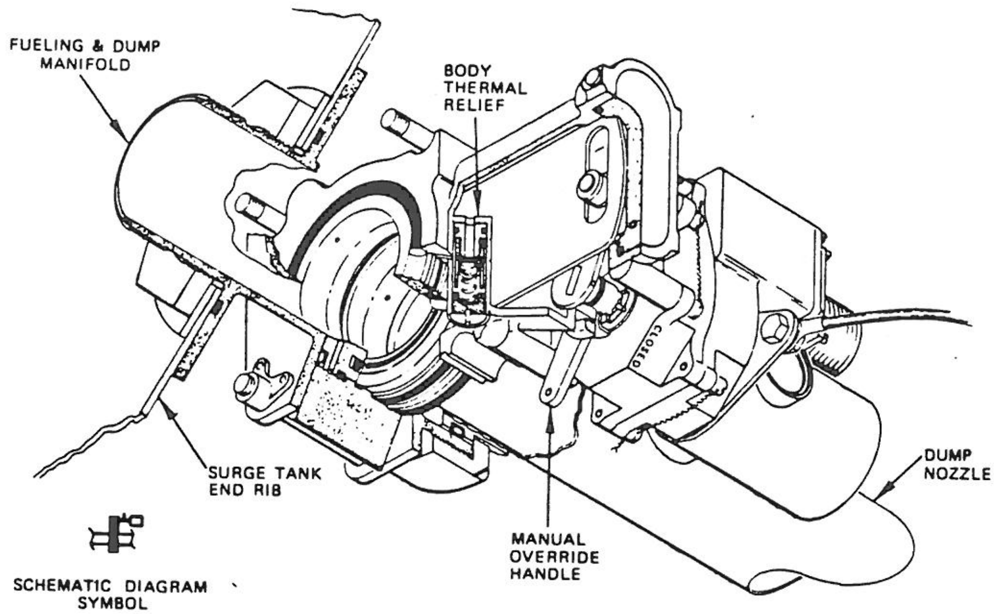


FUEL DUMP LEVEL VALVES

3. Fuel Dump Level Control Valves

   a. The DUMP LEVEL CONTROL VALVES are hydraulically operated bay boost-pump pressure. A spring loaded diaphragm holds a hinged check valve against a seat. The chamber behind the diaphragm is connected to the dump level sensor. Four damp level control valves are mounted inside the tanks, supported by the tank dump valve port adapter assemblies and connected to the fueling and dump manifold.

   b. The four DUMP LEVEL SENSORS are operated by boostpump pressure and the fuel level in a tank. They are kinetic (or fluidic) devices and contain no moving parts. Two aligned ports face each other across a gap. This gap, although shrouded, is exposed to the fuel level in the tank. The port connected to the diaphragm chamber of the level control valve has an orifice. The level sensors are located on the rear inboard side of the inboard baffle check valve rib (W. Sta. 304) in tanks No. 1 and No. 3. In tank No. 2 the left and right level sensors are near the middle inboard side of the first rib outboard of the center wing section (WBL 92.8).



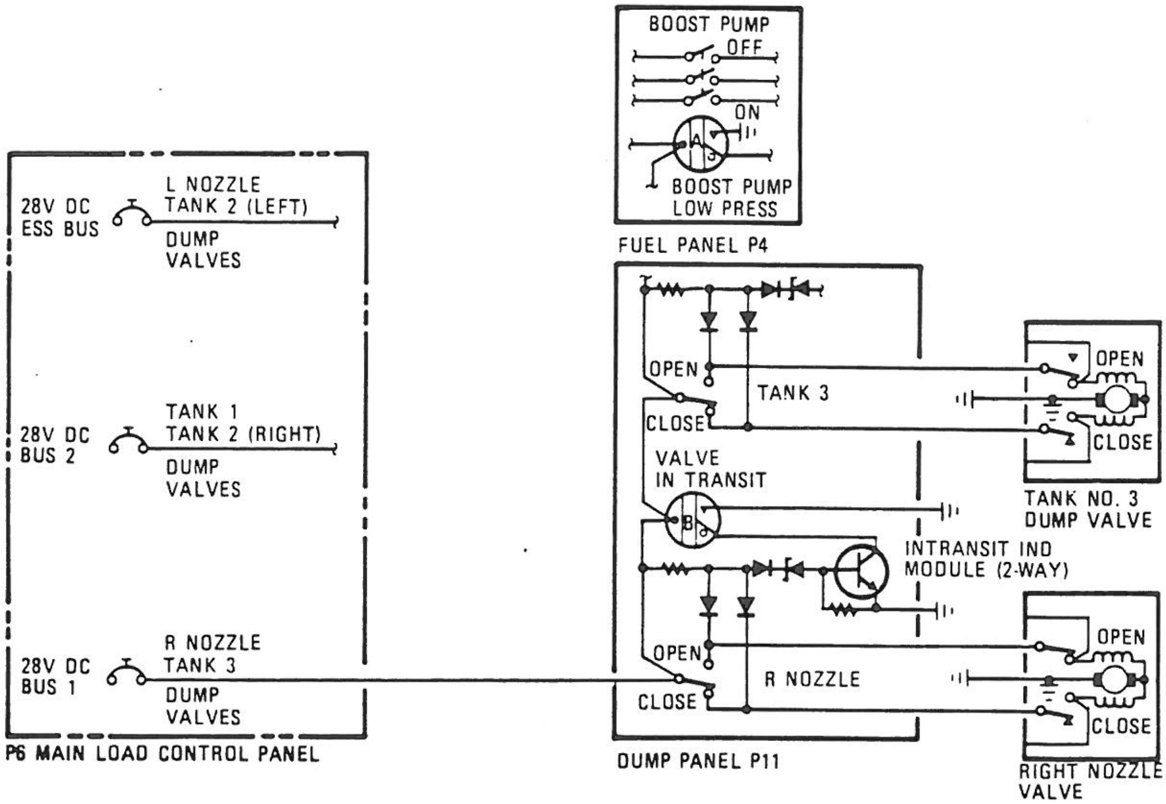
DUMP NOZZLE VALVE

4. Fuel Dump Nozzle Valves

a. The left and right DUMP NOZZLE VALVES are 28V DC motor operated, sliding gate, line mounted, 3 to 5 second valves with a manual override handle. These valves consist of gate and actuator assemblies joined so that the valve can only be replaced as a complete unit. The gage housing contains a thermal relief valve.

b. The dump nozzle valves are located near each wing tip in the inspar area outboard of the surge tank and inboard of the tank vent scoop. Access is by removal of a lower skin panel. An inspection panel is within the access panel.

c. The dump nozzle valves are similar to the engine fuel shutoff valves, except these are for a large tubing size, operate slower, and contain only the body thermal relief valve. This thermal relief valve operates in the range of 125 to 150 PSI.



DUMP VALVE CIRCUIT

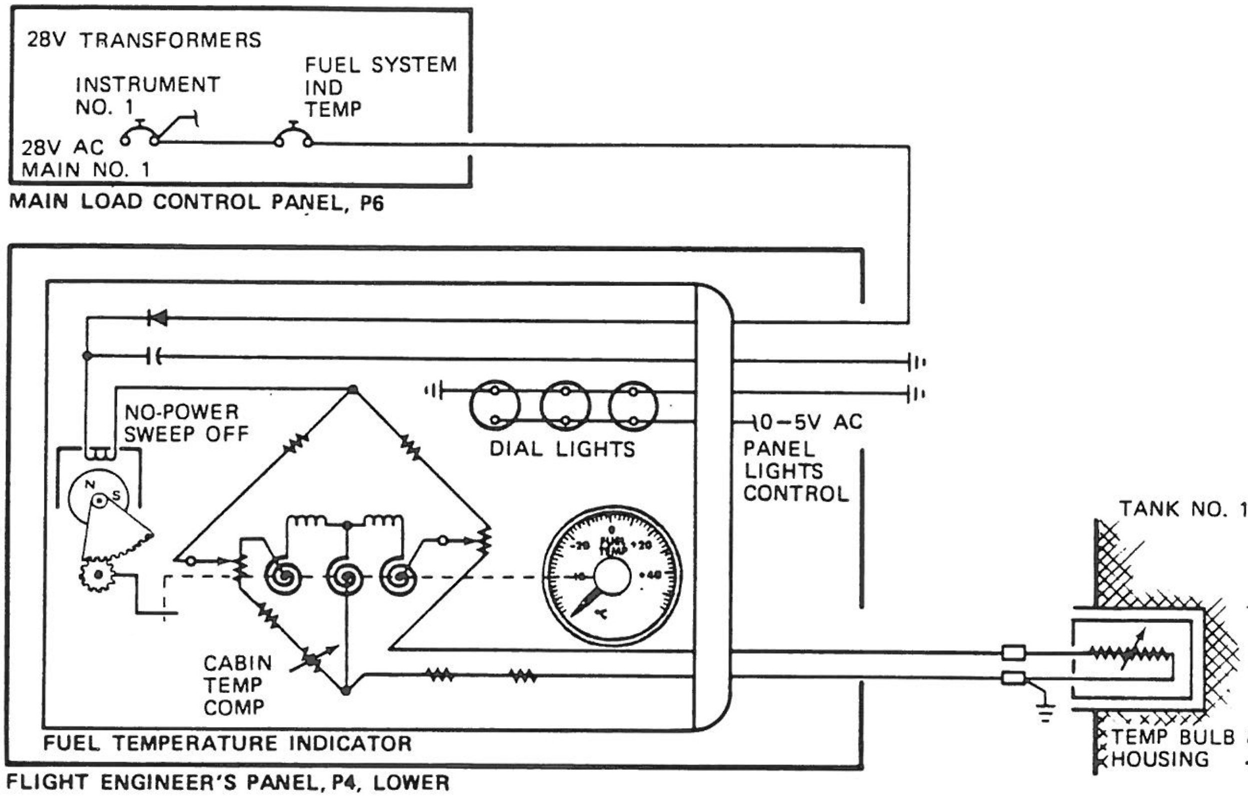
5. Fuel Dump Valve Circuit

a. The TANK DUMP VALVES open or close to control the fuel flow into the fueling and dump manifold. These valves are controlled by switches on the dump panel. Automatic shutoff is the function of the dump level control valves. The tank dump valves can be used for partial ground fuel transfer and partial defueling.

b. The DUMP NOZZLE VALVES open or close to control fuel flow from the fueling and dump manifold overboard through the dump nozzles. These valves are controlled by switches on the dump panel.

c. Each tank dump and dump nozzle valve has a blue intransit light on the dump panel. The light will be ON 3 to 5 seconds while a valve motor is energized to position a valve.

d. The circuits for these valves are not interlocked with any air/ground safety circuits. Care is required when operating this system. Dumping, or operation using the dump valves, requires boost pump operation.



FUEL TEMPERATURE INDICATING CIRCUIT

6. Fuel Temperature Indication

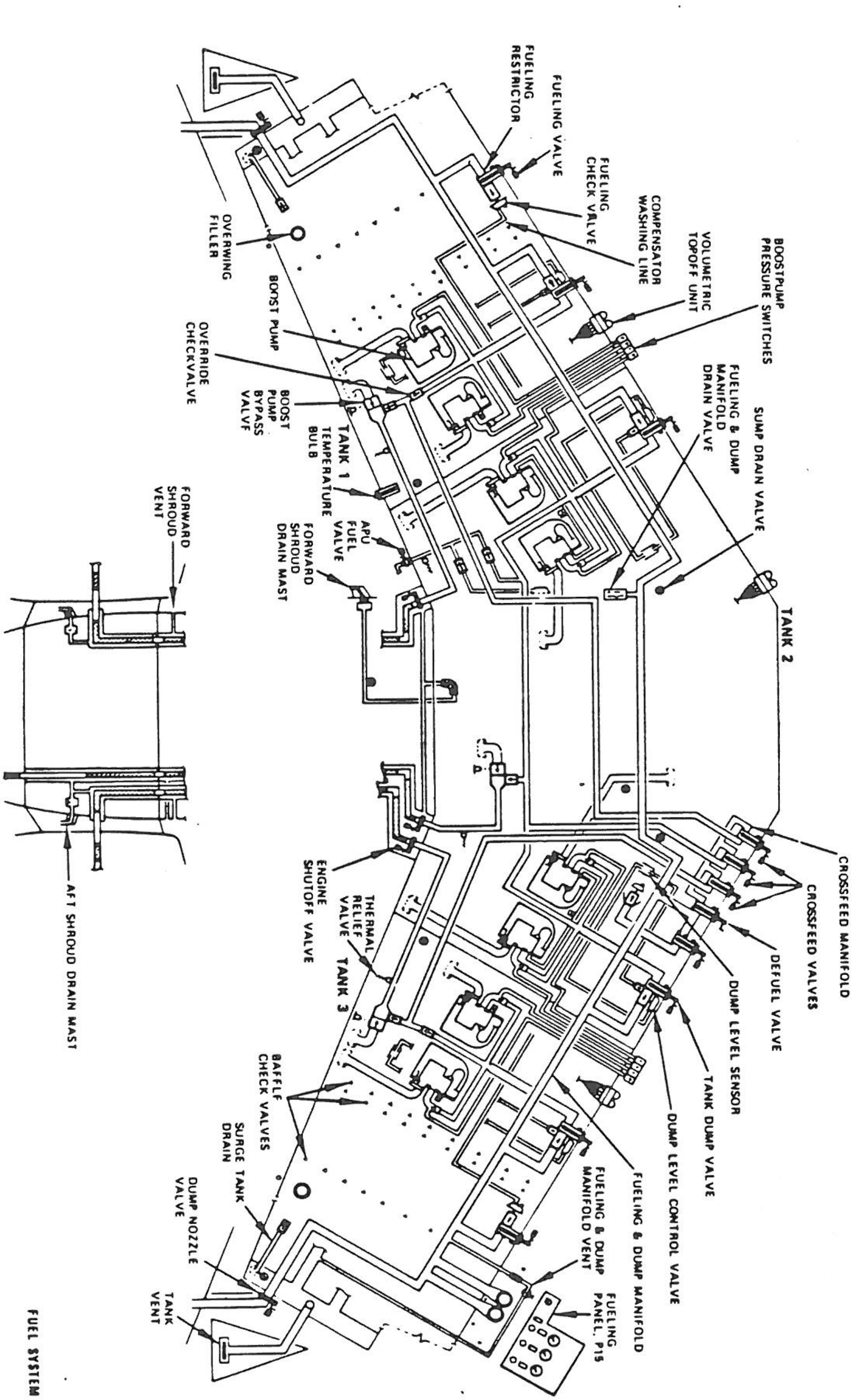
   1. General Description

      a. Fuel temperature information is useful in assessing hot-fuel climb performance, oil cooling capacity (engine and hydraulic), fuel icing from water contamination, and possibility of fuel freezing. The fuel temperature is measured in Main Tank No. 1 and is considered the same or warmer in other tanks. The indicator is mounted on the third crewman's panel, in the fuel heat subpanel. The hermetically sealed indicator is not line-adjustable. The scale is centigrade.

   2. Temperature Bulb and Circuit

      a. The FUEL TEMPERATURE BULB is a temperatue sensitive resistor with resistance increasing with temperature increasing (a positive coefficient, thermal resistor). The bulb is installed in a housing so that it can be replaced without draining fuel. A push-turn quick release cap holds the bulb in the housing. The bulb has no plug type connection, instead, two lead wirtes are spliced into the circuit. Access is directly through the left main landing gear strut well. The bulb is located above and outboard of the left gear forward bearing.

      b. AC power (28V AC, 400Hz) rectified to DC, applied to the metering circuits through an electro-magnetic sweep-off mechanism, frees the low-scale-off pointer to respond to the opposing torques of the rationmeter bridge coils. The bulb resistance as a function of the fuel temperature, determines the voltage applied to sensing coil. The quick release feature of the bulb provides for easy trouble shooting with an ice bath or by ambient temperature comparison.


FUELING RESTRICTOR
FUELING VALVE
FUELING CHECK VALVE
COMPENSATOR WASHING LINE
VOLUMETRIC TOPOFF UNIT
BOOSTPUMP PRESSURE SWITCHES
FUELING & DUMP MANIFOLD DRAIN VALVE
SUMP DRAIN VALVE
TANK 2
OVERWING FILLER
BOOST PUMP
OVERRIDE CHECKVALVE
BOOST PUMP BYPASS VALVE
TANK 1
TEMPERATURE BULB
APU FUEL VALVE
FORWARD SHROUD DRAIN MAST
FORWARD SHROUD VENT
AFT SHROUD DRAIN MAST
CROSSFEED MANIFOLD
CROSSFEED VALVES
DEFUEL VALVE
DUMP LEVEL SENSOR
TANK DUMP VALVE
DUMP LEVEL CONTROL VALVE
FUELING & DUMP MANIFOLD
FUELING & DUMP MANIFOLD VENT
FUELING PANEL, P15
ENGINE SHUTOFF VALVE
THERMAL RELIEF VALVE
TANK 3
BAFFLE CHECK VALVES
SURGE TANK DRAIN
DUMP NOZZLE VALVE
TANK VENT

FUEL SYSTEM

H. Fuel System - Defueling

1. Pressure Defueling

a. Obtain electrical power - connect external power and place external power switch ON - or - run APU and place APU generator switch to CLOSE. NOTE: This powers the entire aircraft.

(1) Hookup grounds an hoses - suction may be used to increase defueling rate and to scavenge the fueling and dump manifold.

(2) Open manual defuel valve, turn on boost pump(s).

(3) Open tank dump valve(s) - CAUTION: not dump nozzle valves.

NOTE: This produces the maximum defueling rate until automatic dump cutoff occurs and gives and opportunity to verify dump cutoff.

(4) Verify dump automatic shutoff - if desired.

NOTE: Tank(s) quantity must be avove dump cutoff level and aircraft attitude must be close to wing level, nose down 3/4 degrees. (See ATA Chapter 28-31-0).

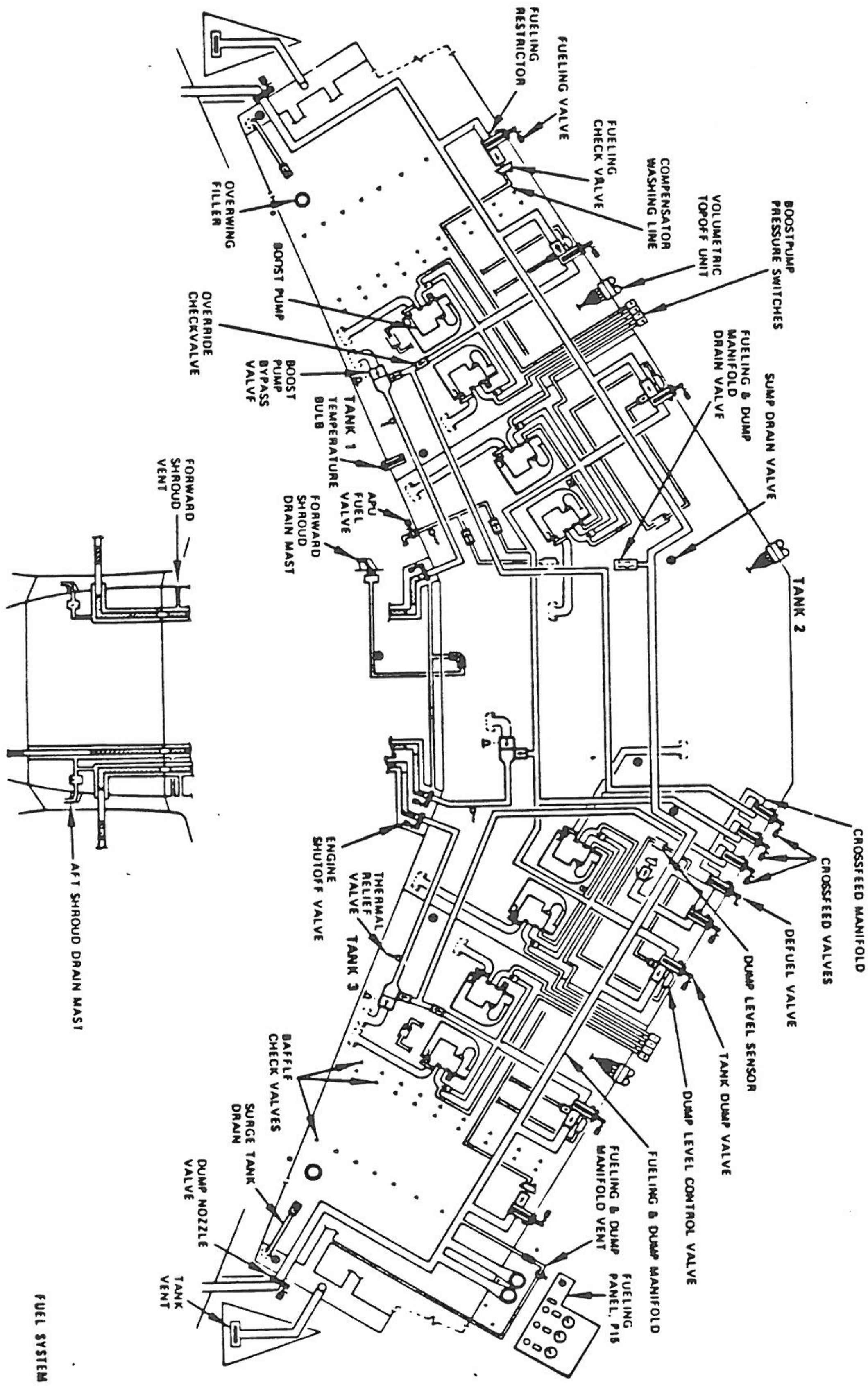
(5) Verify that tank dump flow has stopped. Check quantity against chart in Maintenance Manual 28-31-0.

(6) Open crossfeed valves.

(7) Defuel to desired quantity, then close crossfeed valve(s) - OR - DEFUEL UNTIL BOOST PUMP(s) low pressure light(s) is (are) on steady, then switch off boost pumps.

(8) Drain sumps - NOTE: if tank No. 2 is defueled in this manner, and no suction is used, the fueling and dump manifold will drain approximately 25 U.S. gallons into tank No. 2 over a period of 30-40 minutes.

CAUTION: SEQUENCE TANKS AS NECESSARY TO PREVENT AIRCRAFT TIPPING.


FUELING RESTRICTOR
FUELING VALVE
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FUELING & DUMP MANIFOLD VENT
FUELING PANEL, P15
BAFFLE CHECK VALVES
SURGE TANK DRAIN
DUMP NOZZLE VALVE
TANK VENT

FUEL SYSTEM

2. Suction Defueling

a. Suction defueling does not require electrical power on the aircraft.

(1) Close fueling (and dump) manifold vent valve.

(2) Hook up grounds and hoses - turn on suction.

(3) Open manual defuel valve.

(4) Open crossfeed valve(s).

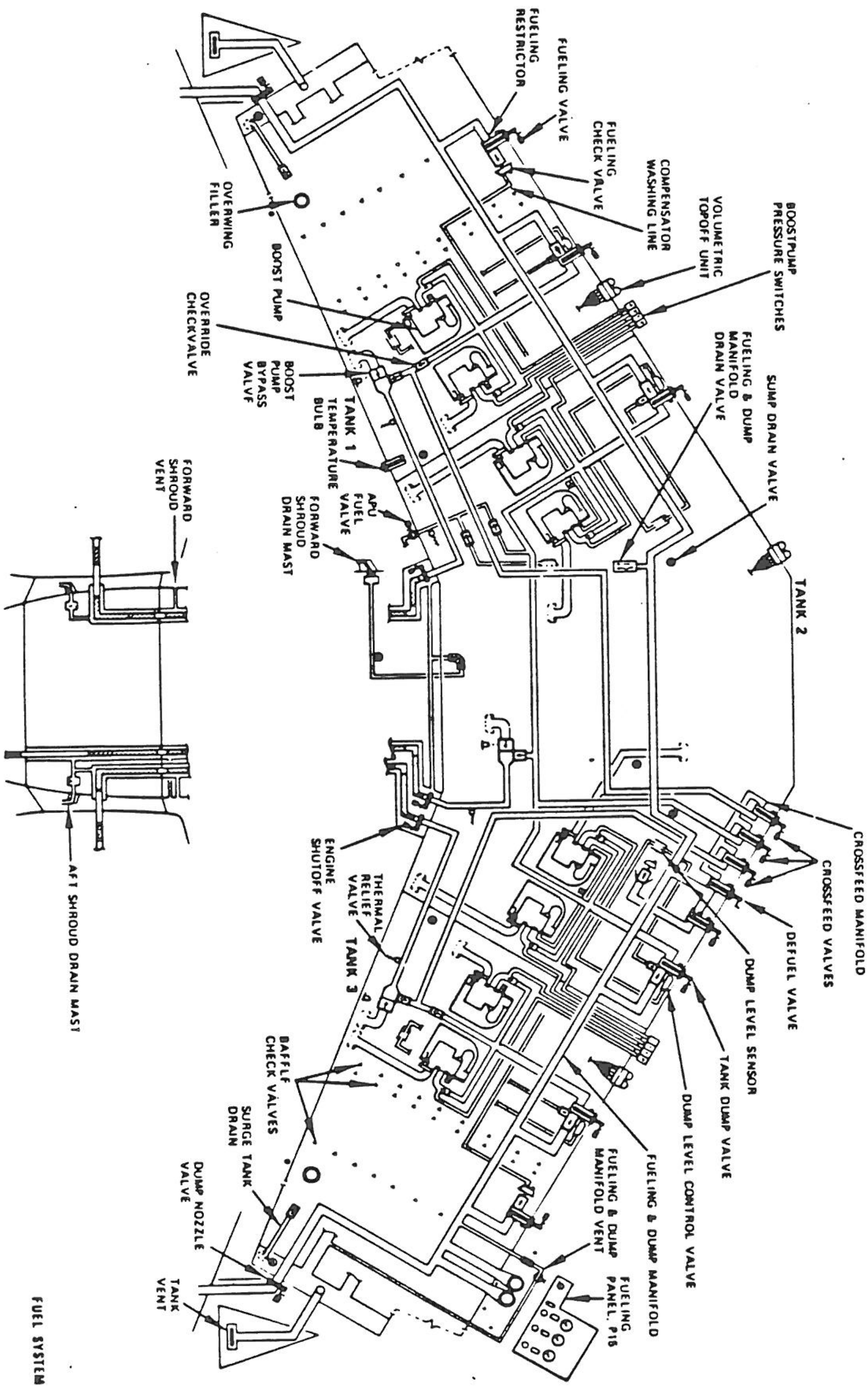
NOTE: Tank(s) No. 1 and/or No. 3 will not suction defuel unless approximately 8 PSI suction (-8 PSIG) can be obtained and maintained. No. 2 crossfeed must be closed.

Tank No. 2 will suction defuel at approximately 1 1/2 PSI suction (-1 1/2 PSIG). A tank (tank No. 2) that is empty or not to be defueled must have all boost pump removal valves closed. As tank No. 2 nears empty, boost pump removal valves may have to be closed dequentially to suction defuel to the lowest possible level.

(5) Drain Sumps

NOTE: Suction defueling is not practical due to very slow defueling rates. Another way to suction defuel is to disconnect the engine flex hose in the nacelle and connect this hose to the defueling facility. Advance start lever to open engine shutoff valve. This method will require electrical power (battery connected only) to open the engine shutoff valve by use of the start lever, or manually selecting the engine shutoff valve to open after removal of the shrouds in the wheel well without the battery connected.

CAUTION: SEQUENCE TANKS AS NECESSARY TO PREVENT AIRCRAFT TIPPING.


FUELING RESTRICTOR
FUELING VALVE
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TANK 1
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APU FUEL VALVE
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FUELING & DUMP MANIFOLD
FUELING & DUMP MANIFOLD VENT
FUELING PANEL, P15
BAFFLE CHECK VALVES
SURGE TANK DRAIN
DUMP NOZZLE VALVE
TANK VENT

FUEL SYSTEM

3. Ground Transfer

   a. For maintenance purposes fuel may transfer from tank to tank by use of the crossfeed system, manual defuel valve, refuel manifold and boost pumps.

      (1) Obtain electrical power either external or APU and power the aircraft.

      (2) Open manual defuel valve.

      (3) At P15 fueling panel, open fueling valve for tank that fuel is to be transferred into.

      (4) At P4 Engineer's panel, open crossfeed selector for tank that fuel is to be transferred from.

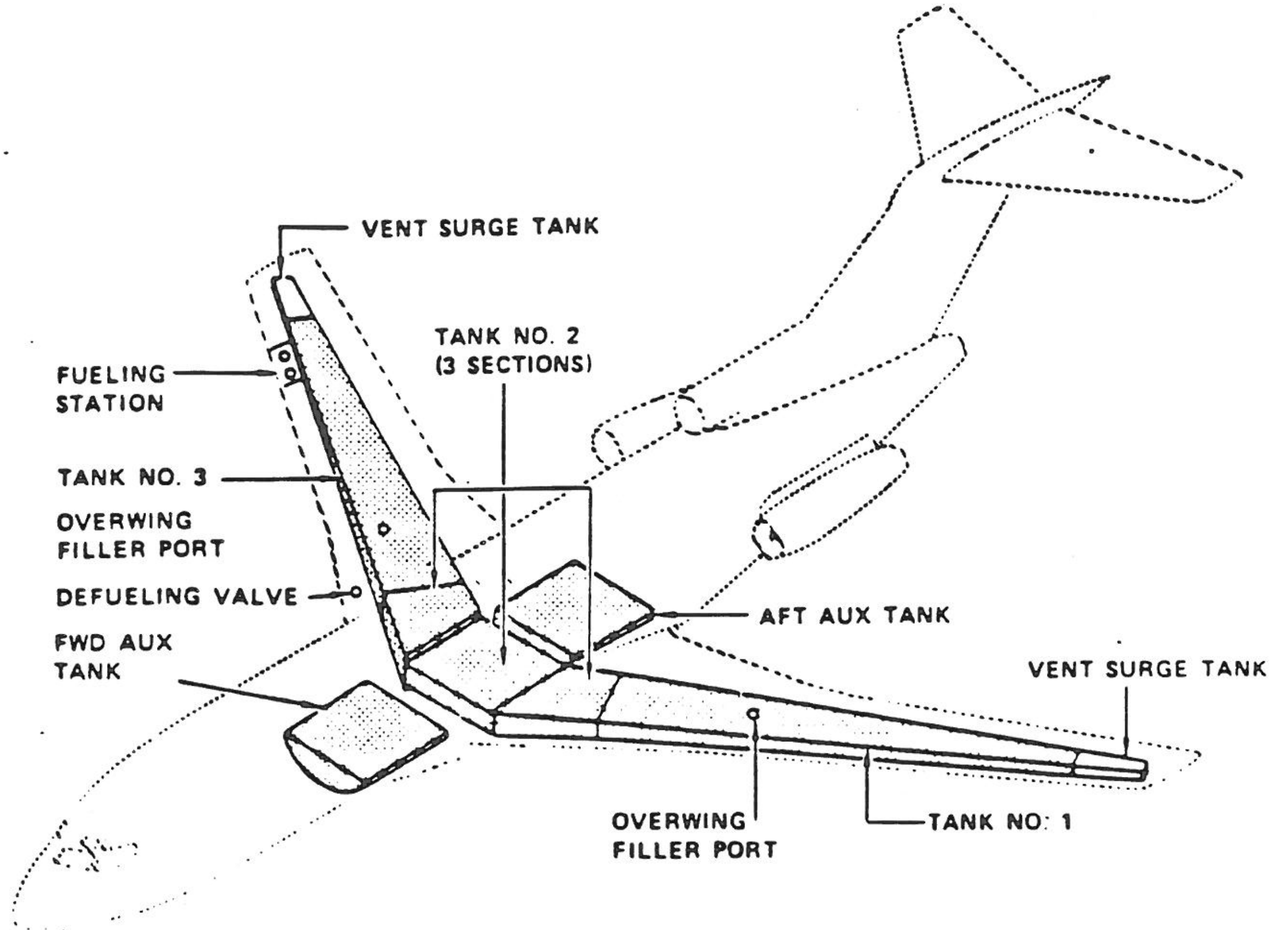
      (5) Turn on boost pumps in tank that fuel is to be transferred from.

      (6) Observe tank quantity indicators to determine transfer of fuel.

      (7) Transfer until desired quantity is reached, or when boost pump low pressure lights are illuminated steady then turn pump(s) off.

      (8) Close crossfeed valve, close manual defuel valve and close applicable fueling valve at P15 panel. Remove electrical power if not required.

   CAUTION: SEQUENCE TANKS AS NECESSARY TO PREVENT AIRCRAFT FROM TIPPING.



USABLE FUEL QUANTITIES IN U.S. GALLONS (POUNDS)							
		NO. 1	NO. 2*	NO. 3	FWD AUX	AFT AUX	TOTAL
PRESSURE FUELING	LB	1775(11,892)	4509(30,210)	1775(11,892)	810(5,427)	860(5,762)	9729(65,184)
OVERWING	LB	1560(10,452)	4509(30,210)	1560(10,452)	810(5,427)	860(5,762)	9299(62,303)

***TANK NO. 2 AND AUX TANK OVERWING FUELING THRU TANK NO. 1 AND/OR NO. 3 BY "TANK-TO-TANK" FUEL TRANSFER ONLY.**

TEMPERATURE OF FUEL = 60° F/15.6° C
SPECIFIC GRAVITY OF FUEL AT 60° F = .803
DENSITY OF FUEL AT 60° F 6.70 LB/GAL

U.S. GALLON X 6.70 = POUNDS

FUEL TANK LOCATION AND QUANTITIES

I. 727-233 FUEL SYSTEM ATA-28

A. Fuel System Differences - 727-200F vs 727-233 Air Canada)

The 727-233 (Air Canada) fuel system has major differences in tank design and minor differences in components and control. These differences are listed below and will be fully discussed later in the text.

1. Two additional auxiliary fuel tanks (810 gal. FWD, 860 gal. AFT) are installed in the forward and aft lower cargo compartment tank cavities. The tanks are bladder type and totally enclosed in the tank cavities with venting and drainage provided. The auxiliary fuel boost pumps operate at a higher pressure (OVERRIDE) than the pumps in tanks 1 and 3, the same pressure output as the No. 2 tank boost pumps.

2. The fuel quantity indicating system is a capacitance type system including the auxiliary tanks. Manual drip-sticks (nine) are provided for tanks 1, 2, and 3 for mechanical gauging. However, the auxiliary tanks do not have drip-sticks and the transfer of a known quantity method must be used when the auxiliary tank capacitance fuel quantity system is inoperative.

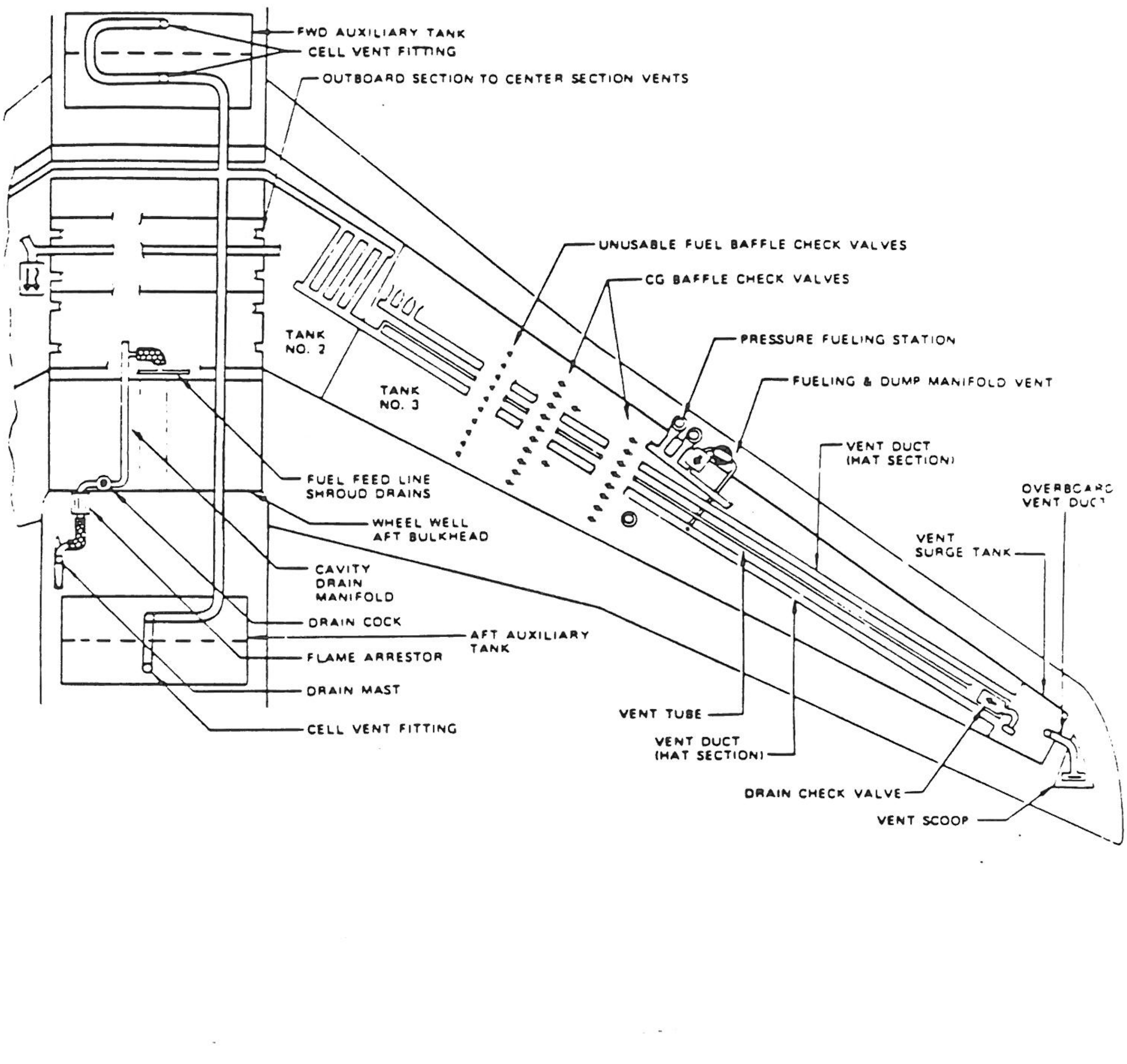
3. Tanks 1, 2, and 3 have the Volumetric Top-Off (VTO) refueling system. The auxiliary tanks are equipped with float switches for fuel shut-off, and are not part of the VTO system. The VTO system does not incorporate the VTO reset switches as found on the 727-200F aircraft.

4. A digital display type fuel totalizer indicator is installed on the P-4 fuel control panel. The auxiliary tank quantity indicators and boost pump control switches are also on the P-4 fuel control panel.

5. Three main fuel shut-off switches and the associated blue intransit lights are provided on the P-4 fuel control panel. However, the main fuel shut-off switch will be overridden to close the main fuel valves when the engine start lever is positioned to cutoff (same as 727-100C).

6. The fuel delivered to the APU is by gravity feed only and is completely independent of the engine fuel feed lines (same as 727-100C).

7. The No. 2 tank boost pumps each incorporate individual vent return check valves (same as 727-100C in this respect only). They do not require the closing of both boost pump removal valves on the same side when changing a single No. 2 boost pump. All No. 2 boost pumps are higher pressure pumps (OVERRIDE) and have the same pressure output as the auxiliary tank pumps.



Fuel Vent System

8. During the refueling operation, selection of either auxiliary tank fueling switches (P-15 panel) to the ON position will cause the No. 2 tank crossfeed valve to open if selected closed.

9. Although not part of ATA-28 fuel system, the fuel flow indicators on the P-2 center instrument panel are different in that they digitally display total fuel consumed for each engine in pounds, in addition to the normal analog display of the actual current consumption rate in pounds.

10. Two additional relays (R632 and R633) are installed at the P-15 fueling panel. These relays are the auxiliary float switch relays, which control the automatic closing of the forward and aft auxiliary tank refueling valves during the refueling operation.

11. The aft auxiliary tank, when fueled, will impose fuel ballast requirements different from the 727-200F for the purpose of towing and taxiing.

B. <u>727-233 Tank Arrangement, Venting, and Drainage Sumps</u>

1. Fuel Vent System

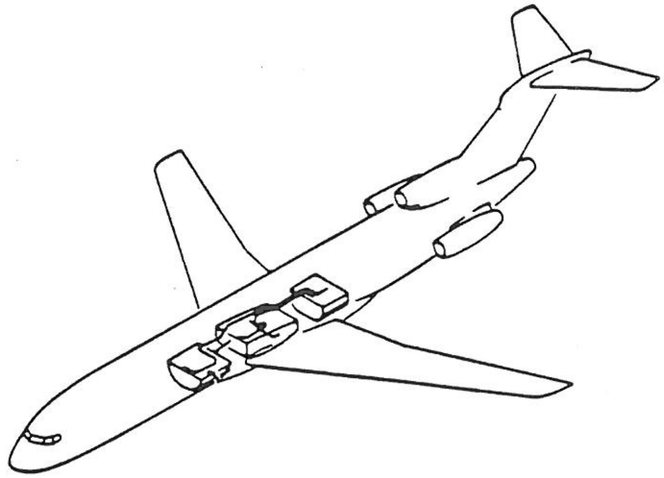
   a. The major change to the vent system is the forward and aft auxiliary tanks, which are connected to the No. 2 tank vent system plumbing.

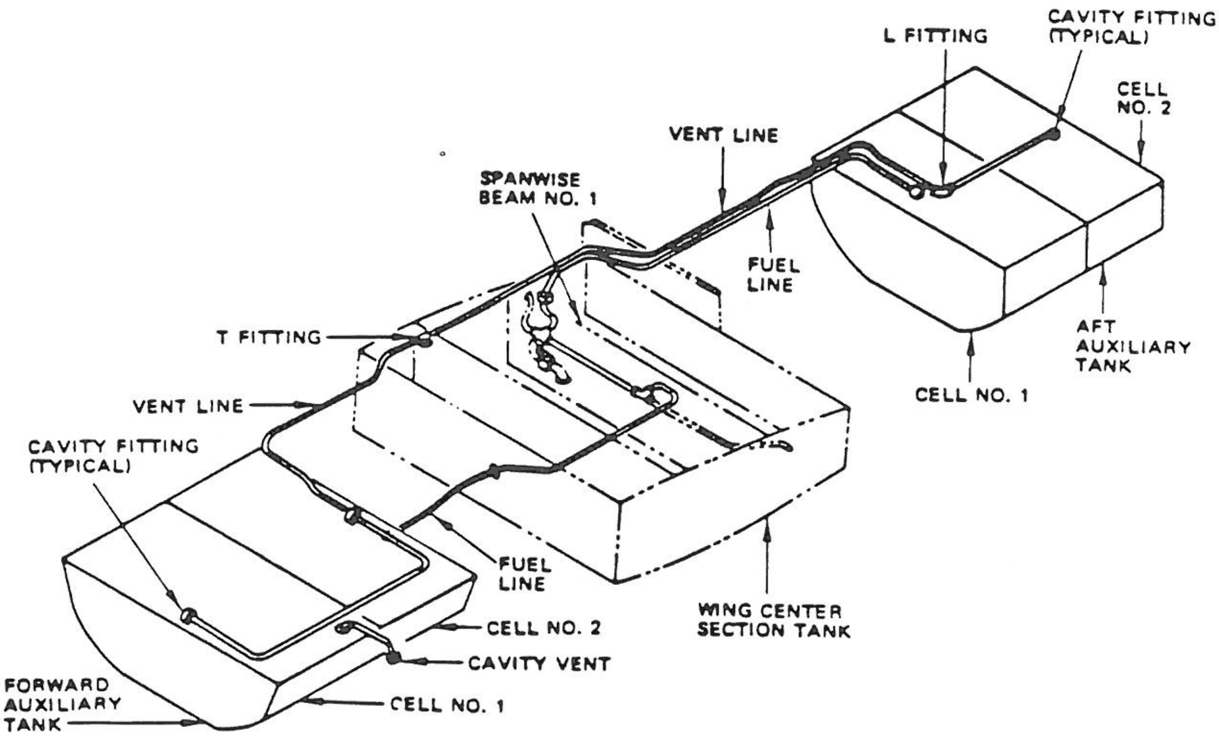
      The remaining vent system for tanks 1, 2, and 3 is the same as the 727-100C/200F aircraft.

2. Vent Ducts and Lines

   a. Vent ducts formed by sealed, hat-shaped, upper wing skin stiffeners, connect the vent surge tanks to each fuel tank. Each wing has two main vent ducts, one extending from the vent surge tank to the inboard end of the outboard tank, and the other extending from the vent surge tank to the outboard section of tank No. 2 in the opposite wing. These ducts vent the system when the airplane is in a normal or a nose high attitude. An additional duct in each wing interconnects with the duct venting tank No. 2 and extends to the outboard end of the outboard tank. This branch duct vents the tanks when the airplane is in a nose low attitude.

   b. External shrouded vent lines interconnect the auxiliary tank(s) with a tee fitting connection to an internal wing (tank No. 2) vent duct. The shrouded vent lines are located under the cabin floor panels where the shroud provides a secondary barrier against leakage of fumes and vapor into the cabin area.





Fuel and Vent Lines

(1) Outer shroud space, between vent tube and enclosing shroud, is vented to the auxiliary tank cavity drain/engine fuel feed line shroud drain system. An air inlet having a "sugar-scoop" configuration on the airplane body skin maintains a slight positive pressure to aid in venting fuel vapor and fumes from the shroud space. The air inlet is forward of the wing, on the left side for airplanes with both forward and aft auxiliary tanks and on the right side for aft auxiliary tank installations only.

3. Vent System Operation

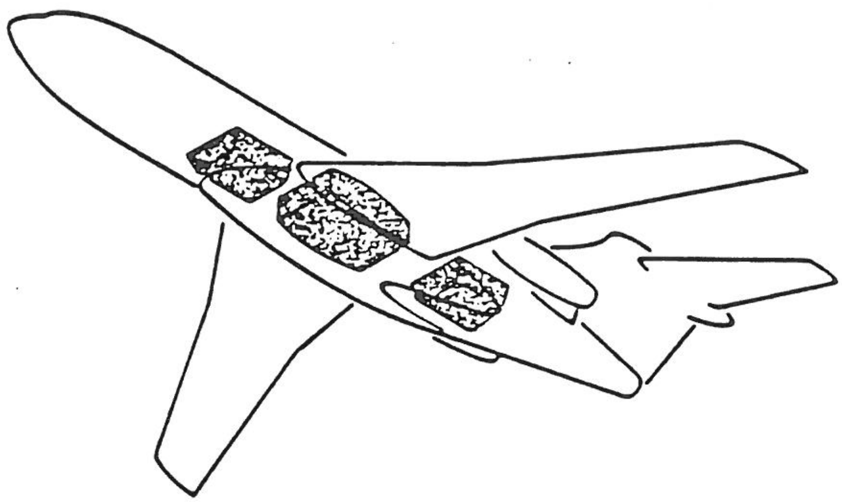
a. During flight, ram air impinging on the vent scoop develops a positive pressure in the plenum chamber and the connected vent surge tank. The vent ducts, connected to each surge tank, distribute the pressure to each fuel tank. As fuel is consumed, it is replaced by a volume of air under a small positive pressure. The ports in the inboard end of the vent ducts in tanks No. 1 and 3, and the ports in the outboard sections of the No. 2 tank vent duct, vent the system when the airplane is in a normal or a nose high attitude since the expansion space above the fuel is at the forward inboard end of the tanks. In a nose low attitude the expansion space moves outboard and aft submerging the inboard vent ports in fuel. The fuel tanks are then vented through a port in the vent duct at the outboard end of tanks No. 1 and 3.

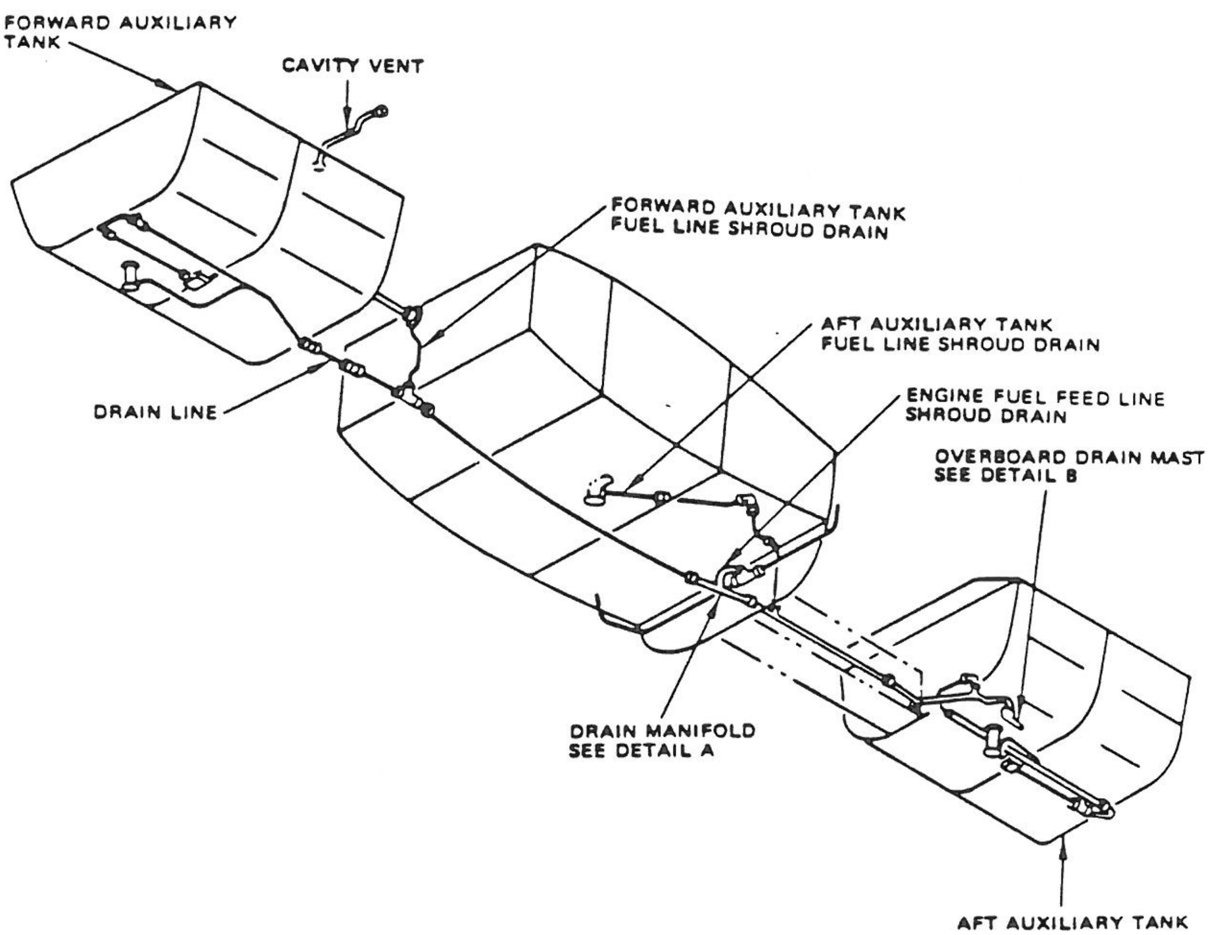
b. During climb or dive flight attitudes, fuel in the auxiliary tanks flows into the low cell and if continued would tend to overfill the cell. A vent float valve in the top of the cell closest to tank No. 2 will pick up with the rising fuel level and prevent fuel entering the vent system.

C. Auxiliary Fuel Tanks

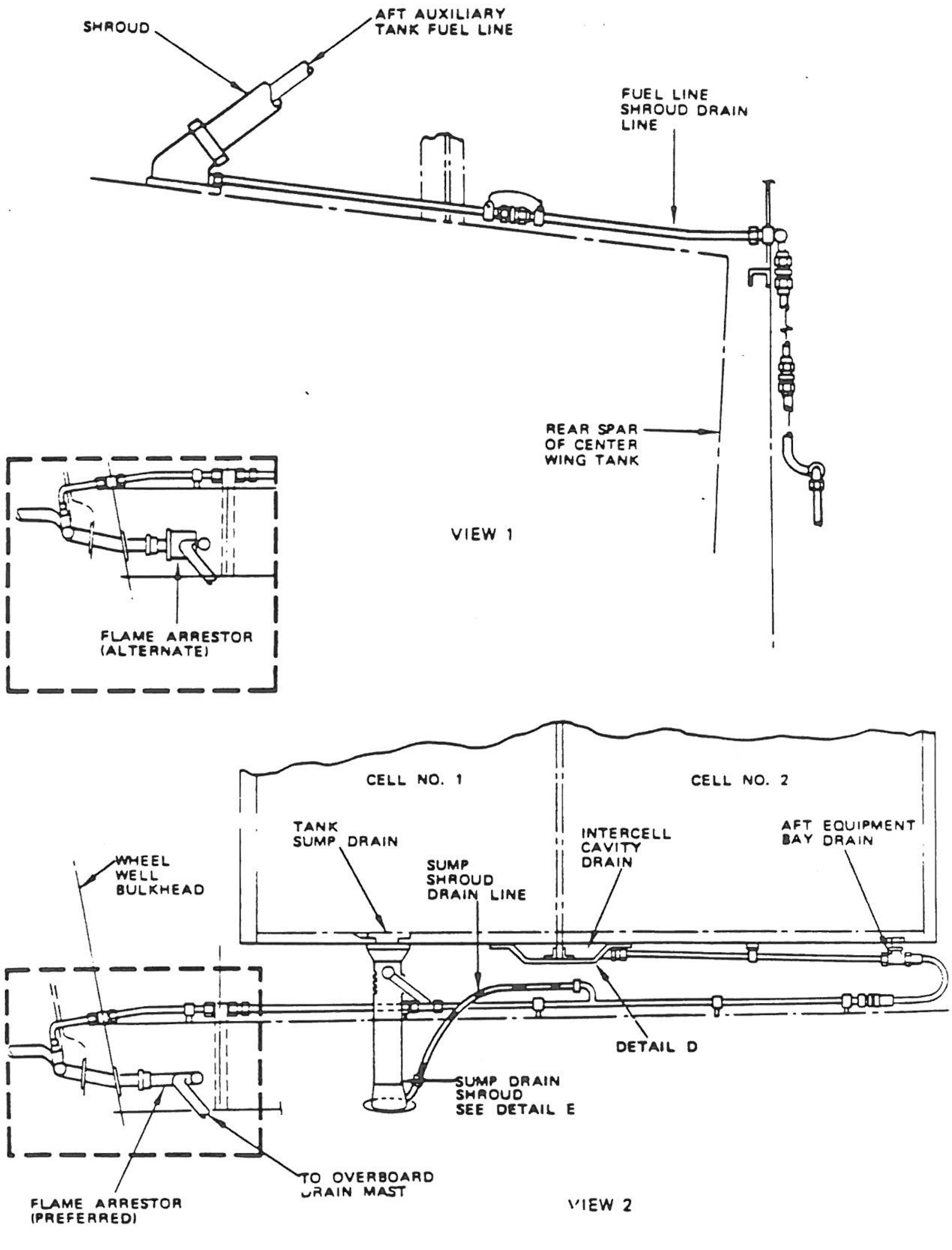
1. General

a. In addition to the integral wing tanks No. 1, 2, and 3, fuel storage is provided by two auxiliary fuel tanks. The forward auxiliary fuel tank is installed in the aft portion of the forward cargo compartment and the aft auxiliary fuel tank is installed in the forward portion of the aft cargo compartment. Each auxiliary fuel tank consists of removable fuel cells contained within a compartmented tank cavity. The forward and aft auxiliary fuel tanks are interconnected to the integral wing tank No. 2 center section by fuel plumbing and a common vent line.

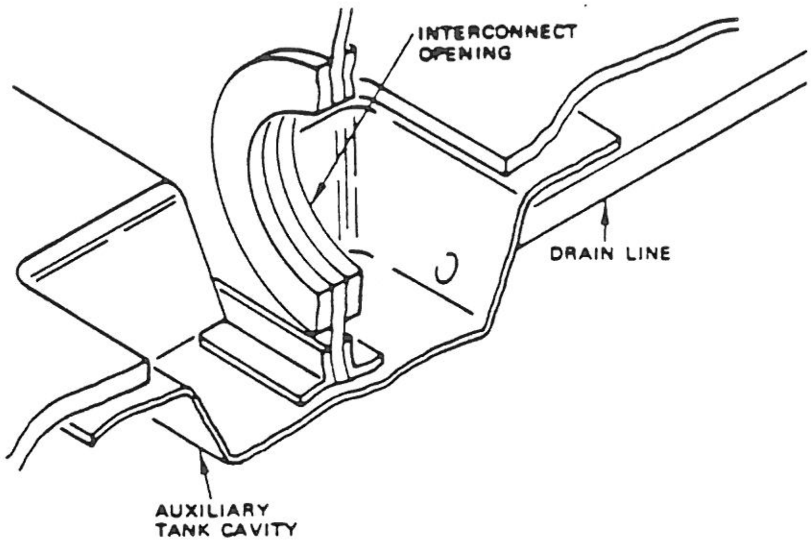




Cavity Vent and Drain System

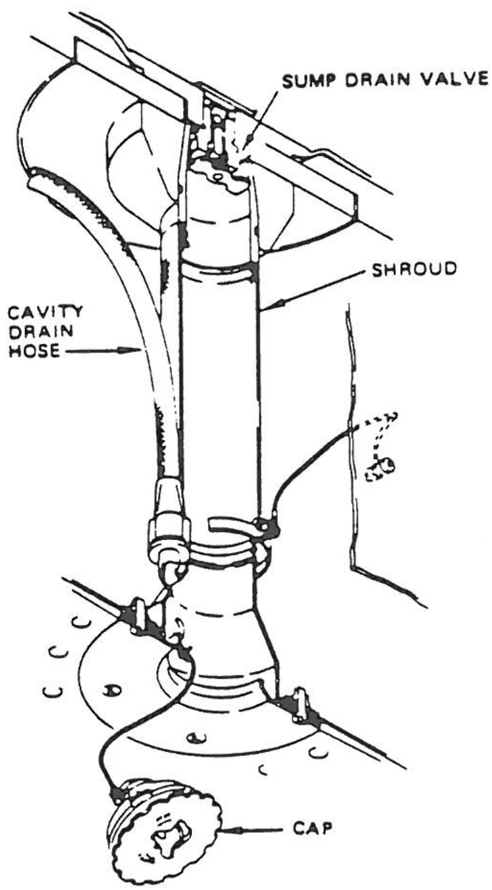


Cavity Vent and Drain System



AUXILIARY TANK DRAIN CONNECTION (TYPICAL)

DETAIL D



AUXILIARY TANK SUMP DRAIN (TYPICAL)

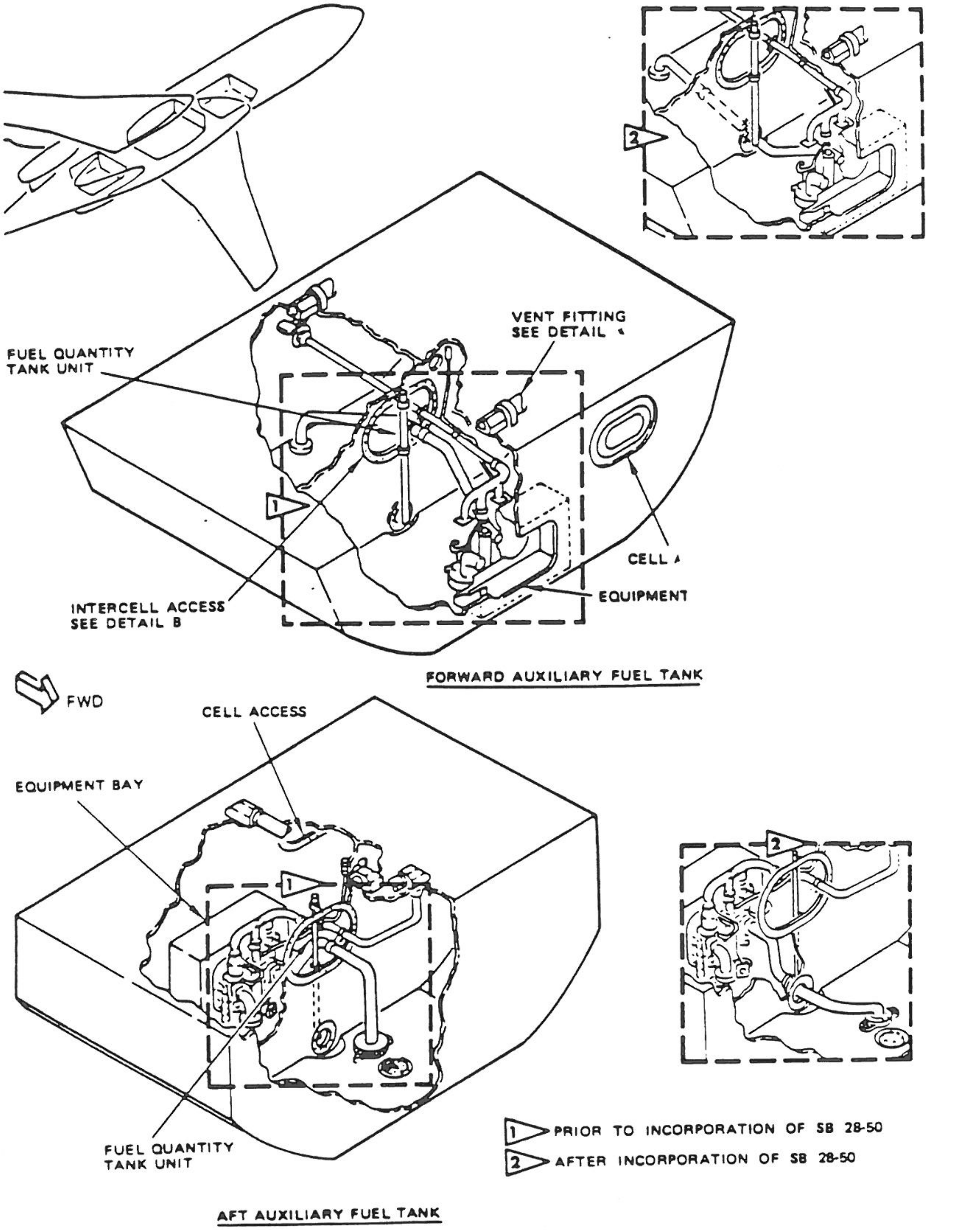
2. Auxiliary Fuel Tank Cavities

   a. Each tank cavity is divided into two individual modules to accommodate two removable fuel cells. For ease of identification the modules are number 1 and 2 starting with the forward module and going aft. The tank cavity incorporates the necessary fittings and openings for the fuel cells. Cutouts in the module common walls serve as intercell access and interconnect openings.

   b. A vent and drain system is provided for each tank cavity to prevent the accumulation of moisture either from condensation or from fuel leakage. Each tank cavity has drain fittings at the equipment bay, each interconnect opening, and sump bellows. The drain fittings for each tank are connected to a common drain line by flexible hose. The common drain lines are connected to the drain manifold which runs to the overboard drain mast. In addition, the engine fuel feed line shroud drain and aft auxiliary fuel tank fuel line shroud drain are connected to the drain manifold. The drain manifold includes a flame arrester located just upstream of the drain mast inside the wing-body fairing. A drain cock is installed in the lower side of the line running along the left wheel well aft bulkhead. The drain cock can be opened to allow the drainage of any accumulated fuel or moisture that has not discharged through the drain mast. The fuel drain cock must be closed when draining is completed. The drain mast prevents fuel drainage re-entry into the wing-body fairing and the aft body area. The forward tank cavity is vented by a flexible hose which runs from a fitting on the upper side of module No. 1 to an outlet in the side of the fuselage.

3. Removable Fuel Cells

   a. Two removable fuel cells carry the fuel in each auxiliary tank cavity. The cavity is divided into two separate modules and each module contains a fuel cell. The fuel cells are non-self-sealing and are of very light weight construction. Extreme care must be exercised in handling. Three primary layers of material, cemented together, make up handling. These are a nylon fabric inner liner, a nylon barrier, and a nylon fabric outer ply. The purpose of the inner liner is to contain the fuel and also act as a protective cover for the nylon film barrier. The nylon film barrier prevents fuel from diffusing through the cell wall, and the outer retainer ply gives strength to the cell and also gives protection to the nylon barrier. The inner liner and outer ply are made of rubber impregnated nylon fabric. This material is very strong but naturally not impervious to sharp objects, chafing or rubbing against metal or rough objects or any material that would tend to damage thin rubber sections.



Removable Fuel Cells

b. In the tank cavity, each fuel cell is attached to the cavity structure with nylon lacing cords. The cords run through ferrules attached to the outer periphery of the cell and through eyebolts and anchors attached to the cavity structure. Several chords of different lengths are required to secure each cell. The length of each cord depends on the size and shape of the individual cell, and the length between the anchor eyebolt and the tie-off eyebolt.

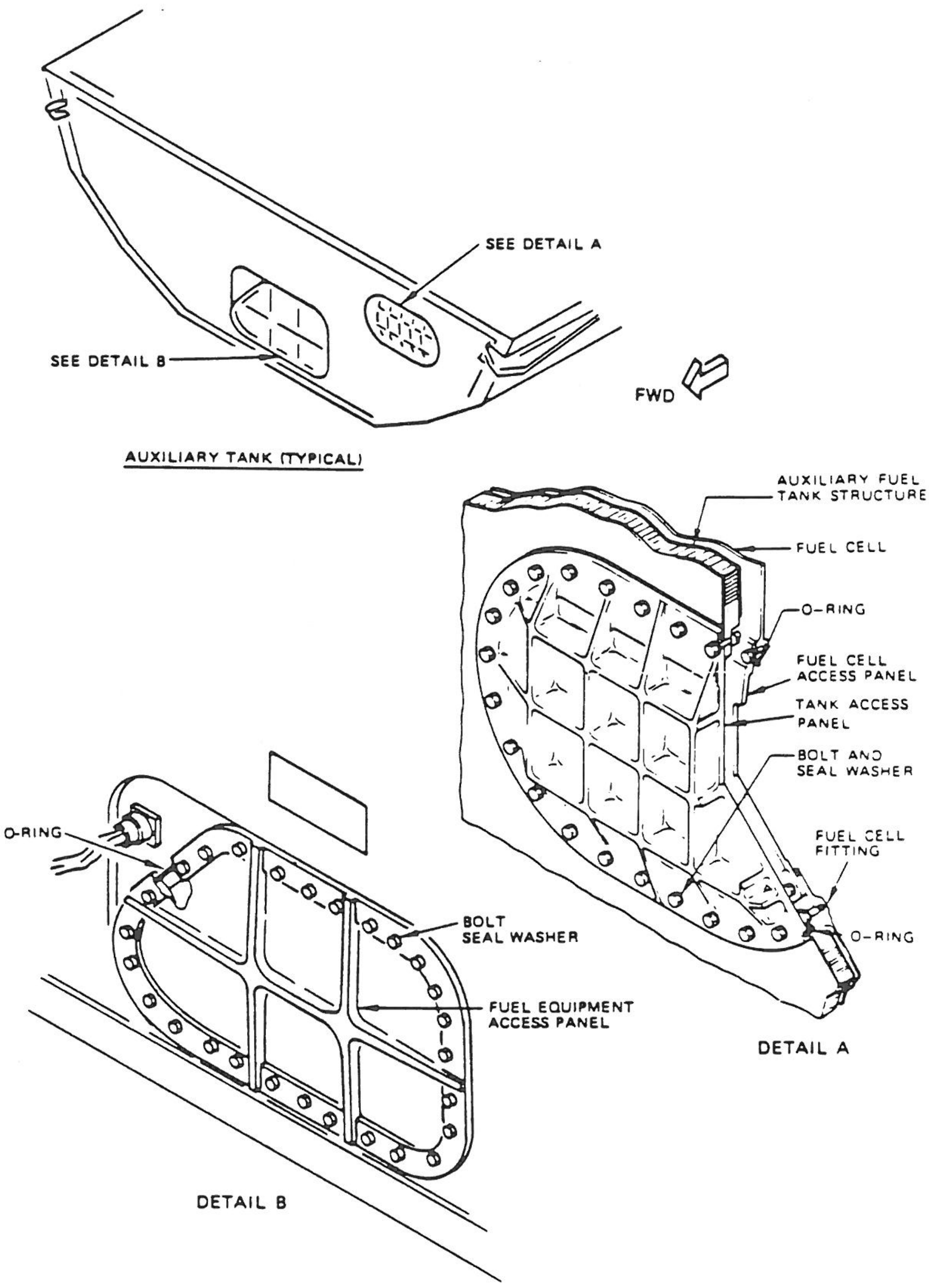
c. The knots used to anchor the fuel cell lacing cord in the anchor and eyebolt fittings are tied in a specific manner to ensure maximum protection from slipping or pulling off the fittings. Anchor knots are used for tieing the cord to the first fitting and the tie-off knots are used at the last fitting. In some instances it is necessary to run two cords through an eyebolt or anchor the cord around the shank of the eyebolt and run another cord through. In the latter cases the cord running through the eyebolt tends to hold the anchor cord in position.

d. Each cell is equipped with an internal crossover vent, intercell access opening, and interconnect fittings. In addition, cell No. 1 (forward tank) is equipped with drain, equipment bay, fuel vent, and cell access opening fittings; cell No. 2 (forward tank) is equipped with fuel tube and fuel vent fittings; cell No. 1 (aft tank) is equipped with drain, fuel tube, and fuel vent fittings; and cell NO. 2 (aft tank) is equipped with cell access opening, equipment bay, fuel vent fittings. The cell fittings are attached to adjoining cell fittings or cavity fittings with the cavity structure sandwiched between the fittings. Nuts, nutplates, or threaded inserts in the cavity fittings are used for installation of the attaching bolts. The cell and cavity fittings are fitted with O-rings which mate against the cavity structure to form a fuel tight seal.

4. Auxiliary Fuel Tank Access Panels

a. The auxiliary fuel tank access panel on the forward side of the forward tank, and aft side of the aft tank, is part of the module structure. Flight or body pressurization is prohibited without the tank access panel installed. It provides access to the fuel cell access panel. The tank access panel is fitted with an O-ring and is attached to the module with seal washers, flat washers, and bolts.

b. The fuel cell access panel provides access to the interior of the fuel cells. An O-ring in the fuel cell fitting forms a fueltight seal when the access panel is installed.



Access Panels

c. A fuel tank equipment access panel is provided at the equipment bay to allow access to the tank boost pumps, fueling shut-off valve and pressure switches. The access panel is fitted with an O-ring which mates with the equipment bay structure to provide a vaportight seal. Nutplates are installed on the equipment bay structure for installation of access panel attaching bolts.

5. Auxiliary Fuel Tank Lines

a. The auxiliary fuel tank fuel lines transfer fuel from the auxiliary tanks to wing tank No. 2 fuel plumbing. The forward auxiliary tank fuel line runs from the aft wall cavity fitting to a fitting on the wing center section tank front spar. From the fitting on the front spar, the fuel line runs inside the wing center section to the aft side of spanwise beam No. 1 where it connects to tank No. 2 fuel plumbing. The aft auxiliary tank fuel line runs from the forward upper panel cavity fitting to a fitting on the upper panel of the wing center section at spanwise beam No. 1. From the fitting on the wing center section upper panel, the fuel line runs inside the wing center section to connect with tank No. 2 fuel plumbing.

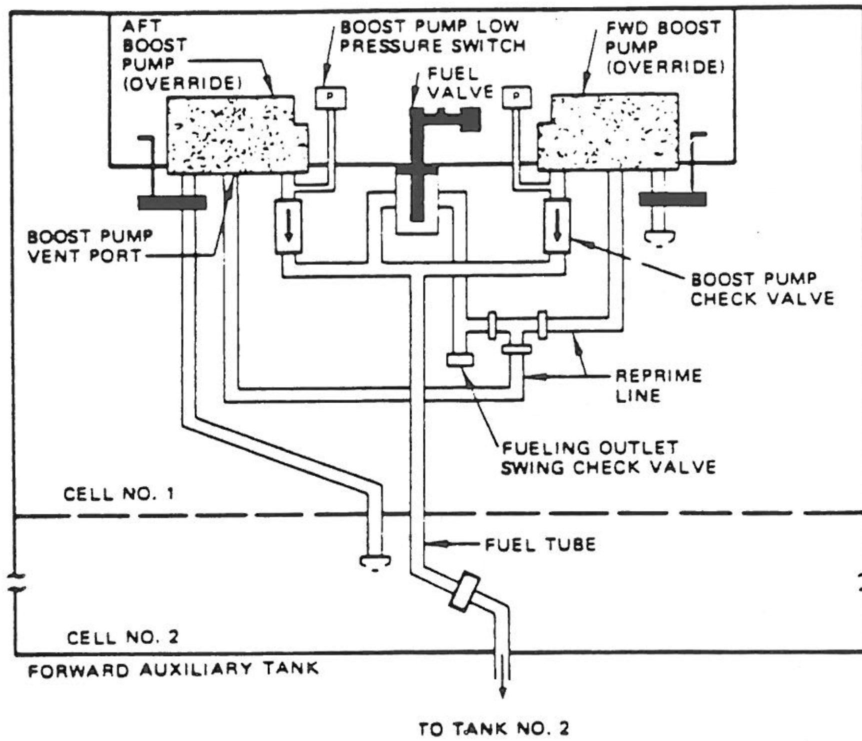
b. All auxiliary tank fuel lines which run outside the tanks are enclosed with a flexible shroud to prevent fuel vapors from entering the fuselage. The shrouds are provided with drains at the cavity fittings which allows leakage to drain into the tank cavity. In addition, the wing center section front spar and upper panel fittings have drain lines which allow leakage to drain directly into the cavity drain system manifold.

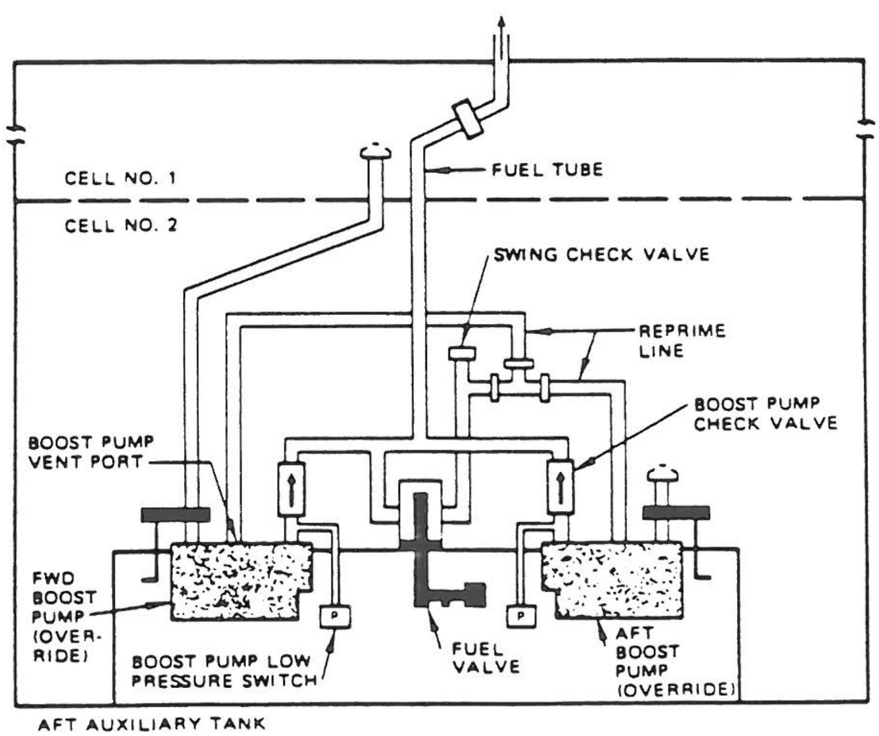
6. Auxiliary Fuel Tank Vent Lines

a. The No. 1 fuel cells in both the forward and aft auxiliary tanks are equipped with a sump drain valve, bellows tube assembly, and locking cap.

b. The cavity drain lines from both forward and aft auxiliary tanks are connected by flexible hose to each bellows tube.

c. In order to sump the forward and aft auxiliary tanks, the cap is removed and a special sump tool must be used to open the sump valve by turning counterclockwise.





Engine Fuel Feed System Flow Diagram

D. Auxiliary Tank Boost Pump

1. General

a. Each auxiliary tank has two boost pumps installed. The forward auxiliary tank boost pumps are installed in a dry bay on the forward end of cell No. 1 and are accessed from the forward lower cargo compartment through the auxiliary tank equipment access panel.

b. The two aft auxiliary tank boost pumps are installed in a dry bay located on the aft end of cell NO. 2 and are accessed through the aft lower cargo compartment.

c. All four auxiliary boost pumps are the same pressure output as the No. 2 tank boost pumps (OVERRIDE) which are 10 psi higher pressure at all flow rates then the pumps (STANDARD) in tanks 1 and 3.

d. Both forward and aft auxiliary tank boost pumps deliver the auxiliary tank fuel through shrouded lines to the NO. 2 tank fuel feed lines.

2. Aux Boost Pump Removal

a. The auxiliary boost pumps are removed the same as the rest of the boost pumps, after gaining access to the forward or aft auxiliary boost pump dry bays. Each pump has a boost pump removal valve that must be closed prior to pump replacement. The pumps are held in place, as are all pumps, with shoulder clamps.

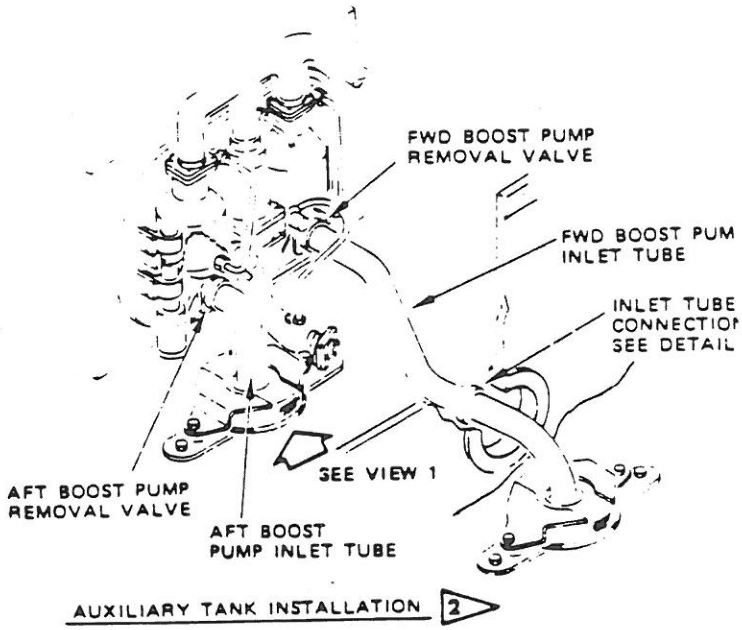
3. Aux Boost Pump Electrical Circuit

a. The auxiliary boost pumps are connected to the 115 vac buses as follows:

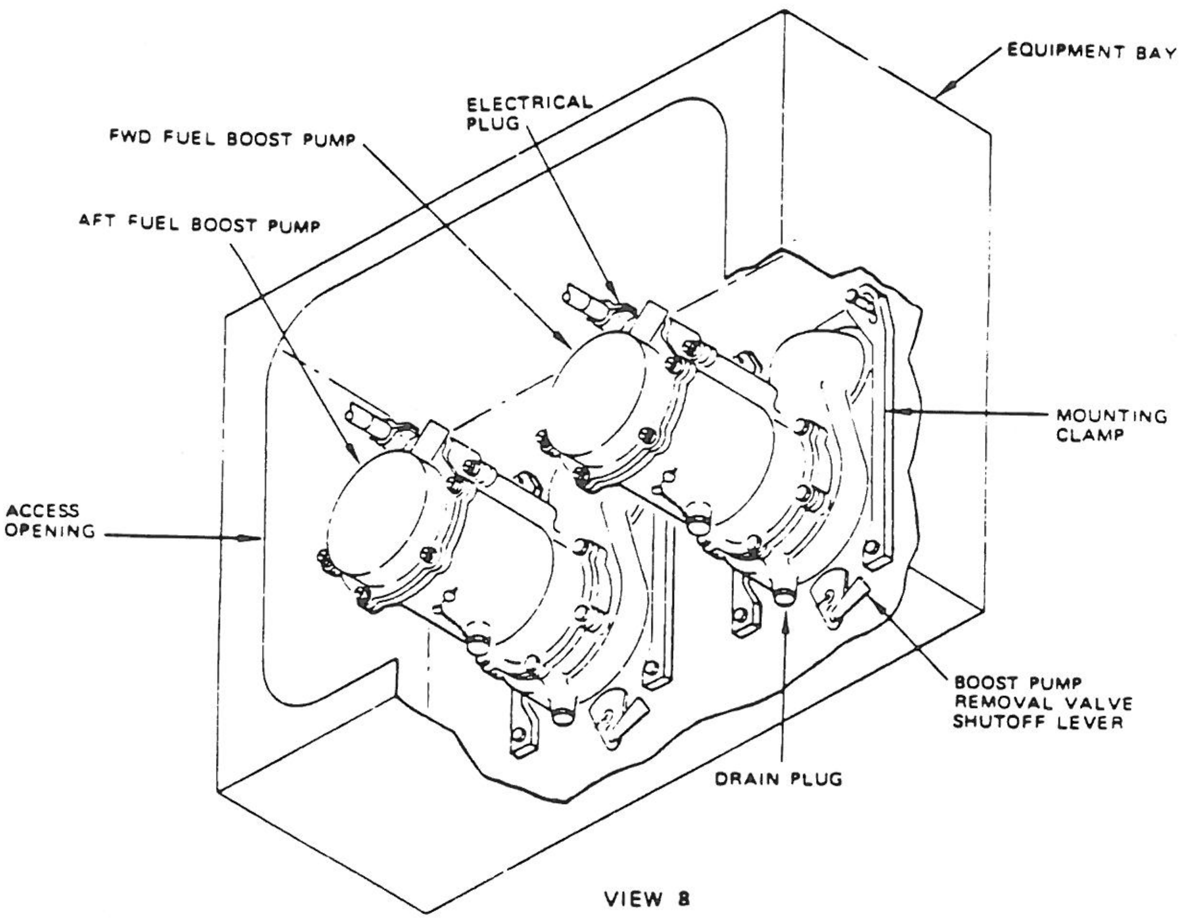
Pump Position	115 vac Bus
Forward Aux Aft Pump	No. 1 ac Bus
Forward Aux Forward Pump	No. 3 ac Bus
Aft Aux Aft Pump	No. 3 ac Bus
Aft Aux Forward Pump	No. 2 ac bus

4. Aux Boost Pump Pressure Switches

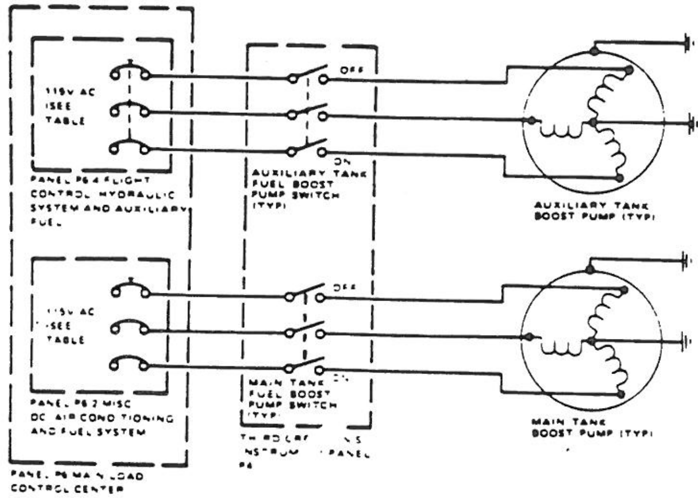
a. Two auxiliary tank pressure switches are mounted on separate brackets in each auxiliary tank equipment dry bay.



Fuel Boost Pump Removal Valve

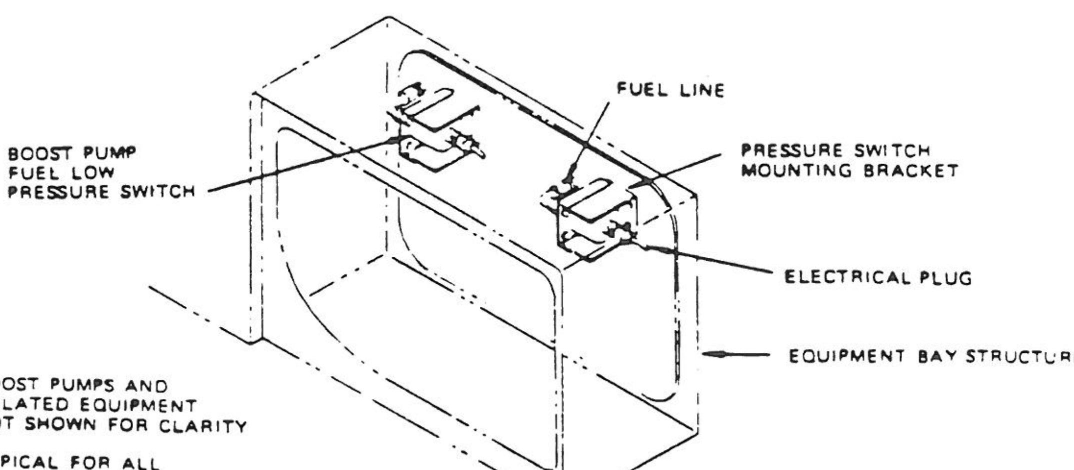


Engine Fuel Feed System Equipment Location



BOOST PUMP POWER SOURCE				
FUEL TANK	115V AC BUS NO			
	ESS	1	2	3
1		AFT PUMP		FWD PUMP
2	RH AFT LH FWD PUMPS	RH FWD PUMP	LH AFT PUMP	
3			FWD PUMP	AFT PUMP
FWD AUX		AFT PUMP		FWD PUMP
AFT AUX			FWD PUMP	AFT PUMP

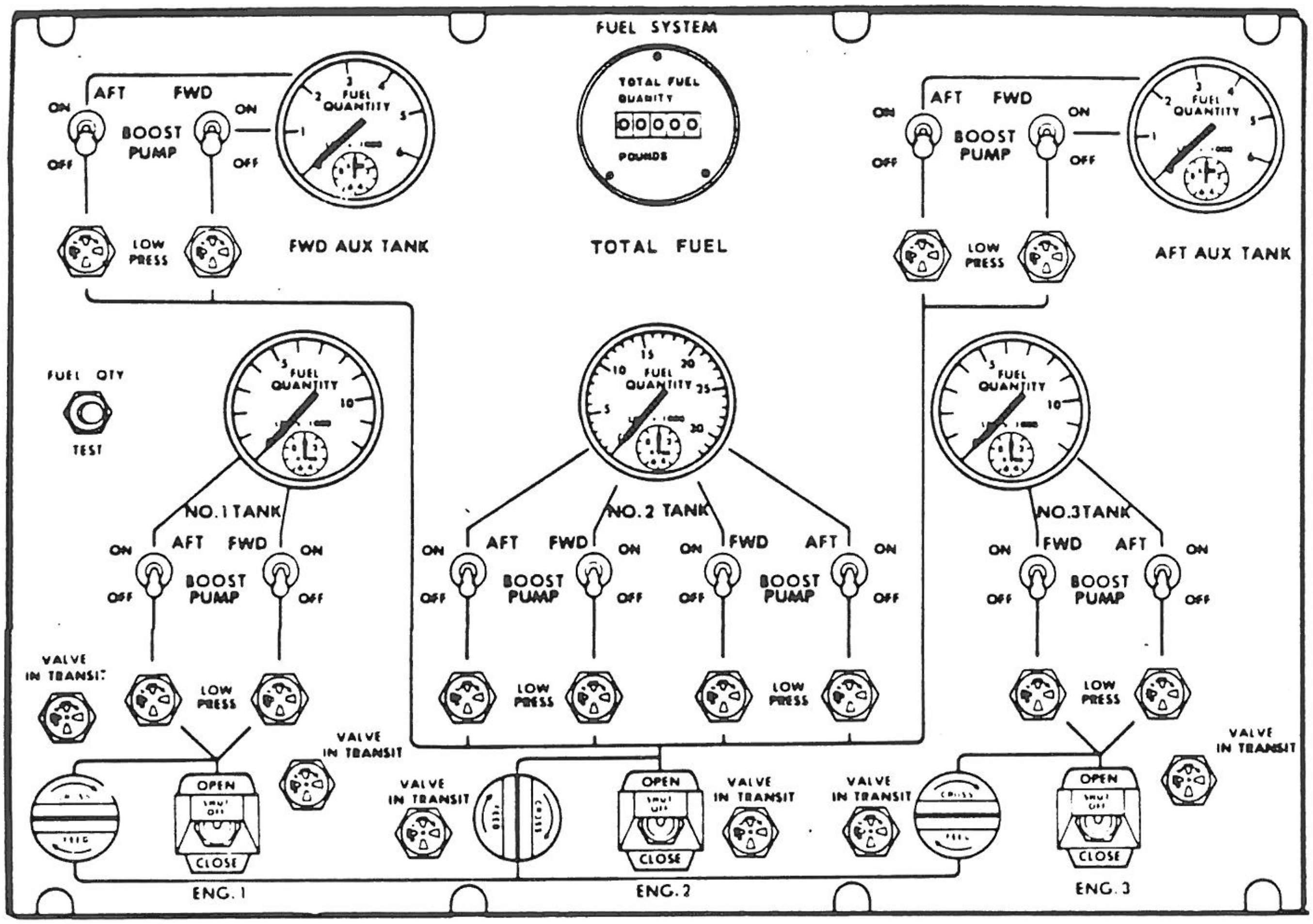
Fuel Boost Pump Circuit

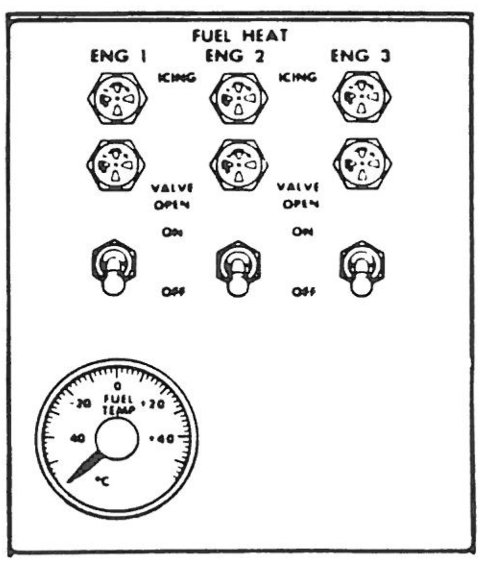


NOTE: BOOST PUMPS AND RELATED EQUIPMENT NOT SHOWN FOR CLARITY

NOTE: TYPICAL FOR ALL AUXILIARY TANKS

AUXILIARY TANK PRESSURE SWITCHES





FUEL CONTROLS & INDICATORS
727-233 FLIGHT ENGINEER P-4 PANEL

E. 727-233 P-4 Panel Controls and Indicators

1. General

a. The fuel quantity indicators, crossfeed, main fuel shut-off, fuel boost pump controls, and indicator lights are located on the lower P-4 panels.

b. There are twelve (12) boost pump control switches and twelve (12) low pressure indicator lights.

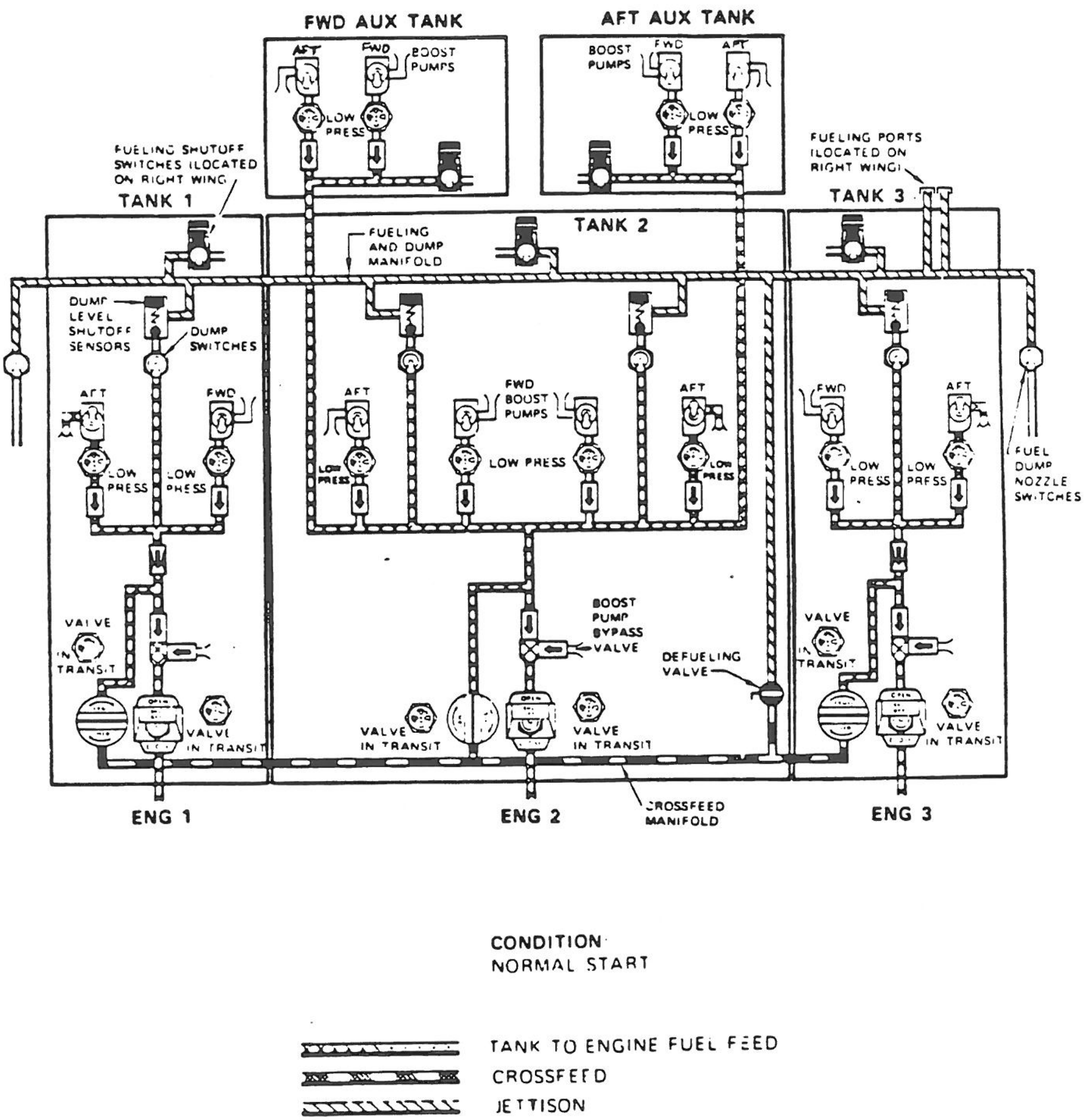
c. The three (3) crossfeed control knobs and the three (3) main fuel shut-off switches and their intransit blue lights are the same as found on the 727-100C.

d. Five individual fuel quantity (analog type) indicators and one digital display totalizer (analog type) indicator are installed at the P-4 panel. Identical tank indicators (5 total) are also installed at the P-15 fuel panel on the right wing. The P-4 indicators are considered the masters and the P-15 indicators are repeaters.

e. Depressing the single fuel quantity test button on the P-4 panel will cause all 4 tank indicators and the totalizer to move downscale. After release of the test button, the indicator reading should return to within 50 pounds of the tank indication and total display that appeared prior to test button depression.

2. Fuel Low Pressure Switches

a. Fuel feed low pressure switches control the fuel low pressure indicating lights on the Third Crewman's lower panel. Each switch assembly consists of a cylindrical housing containing a diaphragm and a switch. The housing has two ports, one for inlet pressure and one for venting. The pressure inlet port is connected to a sensing line coming from a fuel boost pump check valve. The vent port is connected to a line leading overboard. Four main tank pressure switches are mounted on a bracket on each wing front spar and are arranged in the same sequence, going outboard, as the boost pumps to which they are connected. Two auxiliary tank pressure switches are mounted on separate brackets in each auxiliary tank equipment bay.



CONDITION
NORMAL START

FUEL SYSTEM

b. Main Tank Low Pressure Switches

(1) The main tank low pressure swiches will actuate when the related boost pump output pressure drops to 5.5 psi, completing the circuit to illuminate the related low pressure indicating light. When pump pressure increases to 6.5 psi, the switch opens and the indicating light is extinguished.

c. Aux Tank Low Pressure Switches

(1) The auxiliary tank low pressure switches will actuate when the related boost pump output pressure drops to 19.5 psi, completing the circuit to illuminate the related low pressure indicating light. When pump pressure increases the 20.5 psi, the switch opens and the indicating light is extinguished. Differences in electrical connectors prevent interchanging main tank switches with auxiliary tank switches.

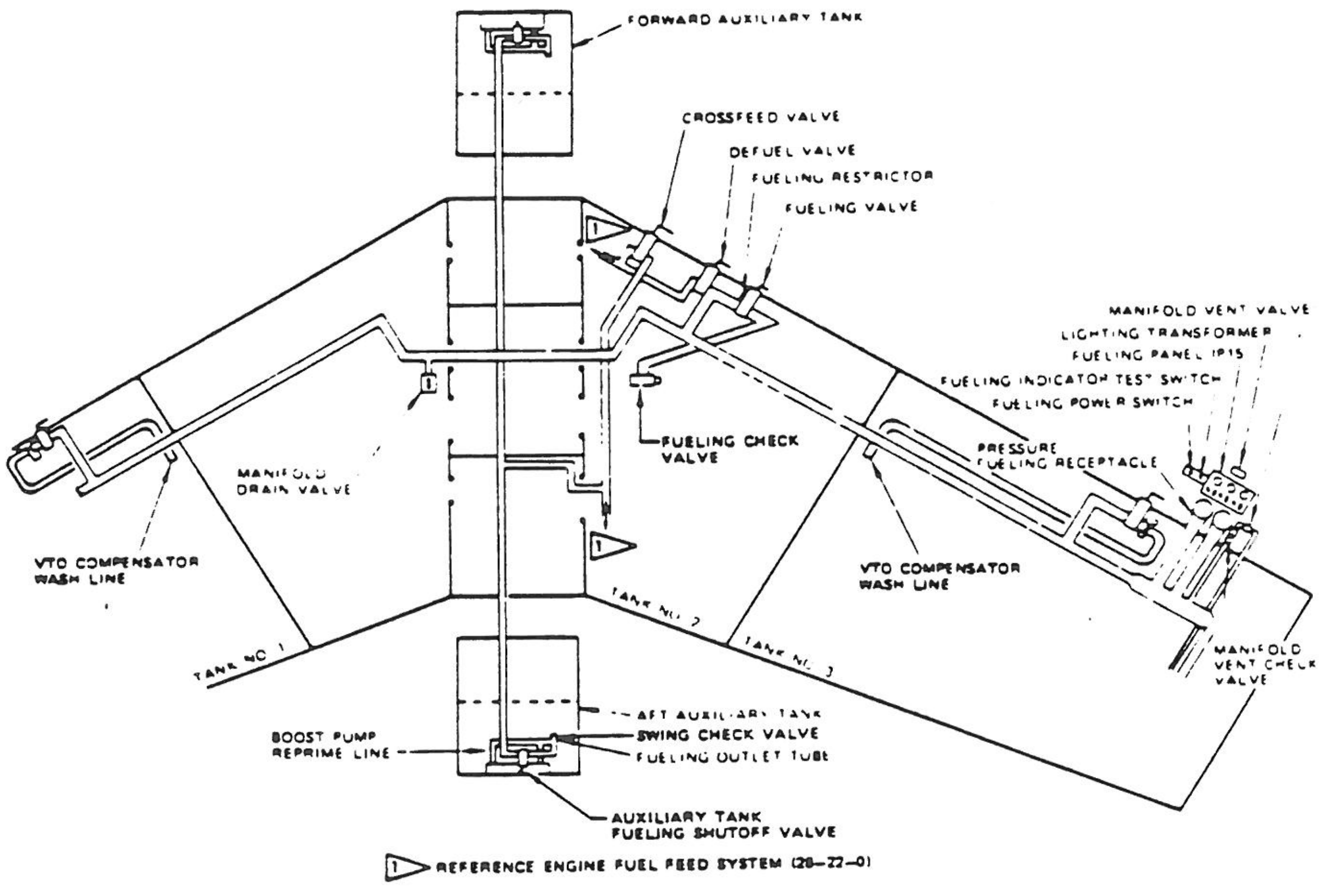
3. Engine Fuel Shut-off Switches

a. Three fuel shut-off switches and three round valve intransit (blue) lights are provided on the P-4 panel. In addition, three microswitches located on the start lever drum assembly will override the P-4 shut-off switch when selected in OPEN position to cause the respective fuel shut-off to CLOSE when the respective start lever is selected to the cutoff position. This is identical to the 727-100C aircraft (after super-mod).

4. Engine Crossfeed Switches

a. Three crossfeed rotary switches and three valve intransit (blue) lights are provided on the P-4 panel. These switches and lights are identical to the 727-100C with one exception:

(1) The No. 2 crossfeed valve, if closed, will be overridden to open when either auxiliary tank fueling switch at the P-15 is selected to open.



Pressure Fueling System Flow Diagram

F. Pressure Fueling System

1. General

a. The main tanks 1, 2, and 3 utilize the Volumetric Top Off system (VTO) to provide automatic shut-off when full tanks are required. A difference between the 727-233 and 727-200F VTO shut-off system is that the 727-233 does not incorporate the VTO reset switches at the P-15 panel.

b. The auxiliary tanks, both forward and aft, use a float switch located internally in each tank to provide automatic fuel shut-off when the respective tank is full.

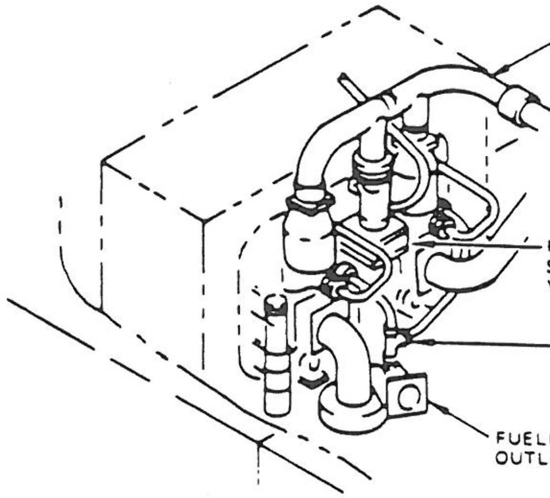
c. The fueling rate is 700 gpm at a maximum delivery pressure of 50 psi.

2. Aux Tank Automatic Shut-off

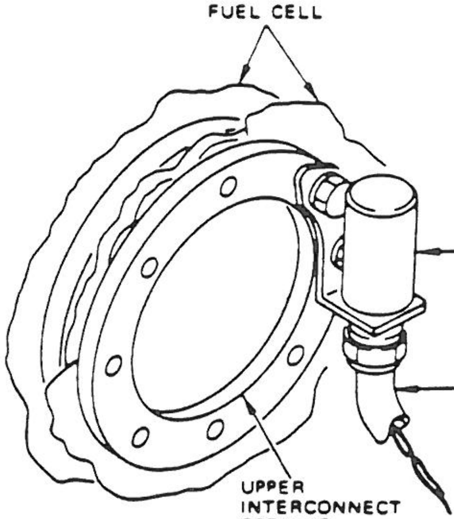
a. Each auxiliary tank has a fueling shut-off valve installed in the auxiliary tank access cavity dry bay. The fueling shut-off valves are controlled by two switches located at the P-15 panel. Each valve is an electric (28 vdc) motor-driven slide shut-off valve with a manual override handle. The manual override handle provides a visual check of the valve position, and a manual method of positioning the valve when the electric motor is not energized. the inlet and outlet ports of the valve are contained in a fitting mounted inside the fuel tank, while the motor and gate assemblies are mounted outside the tank. Each valve contains a thermal relief valve to relieve valve housing pressure due to thermal expansion of the fuel in the fueling lines and manifold.

b. The valves are operated by 28 volt dc power from the airplane power supply or external power supply, and are controlled by individual switches on the fueling control panel. Indicator lights mounted on the fueling control panel adjacent to the switches, are illuminated any time the valve motor is energized.

c. The fueling shut-off valves are similar to the fuel crossfeed manifold valves, except they do not have the thermal relief check valve.



(TYPICAL AUXILIARY TANK)



(TYPICAL AUXILIARY TANK)

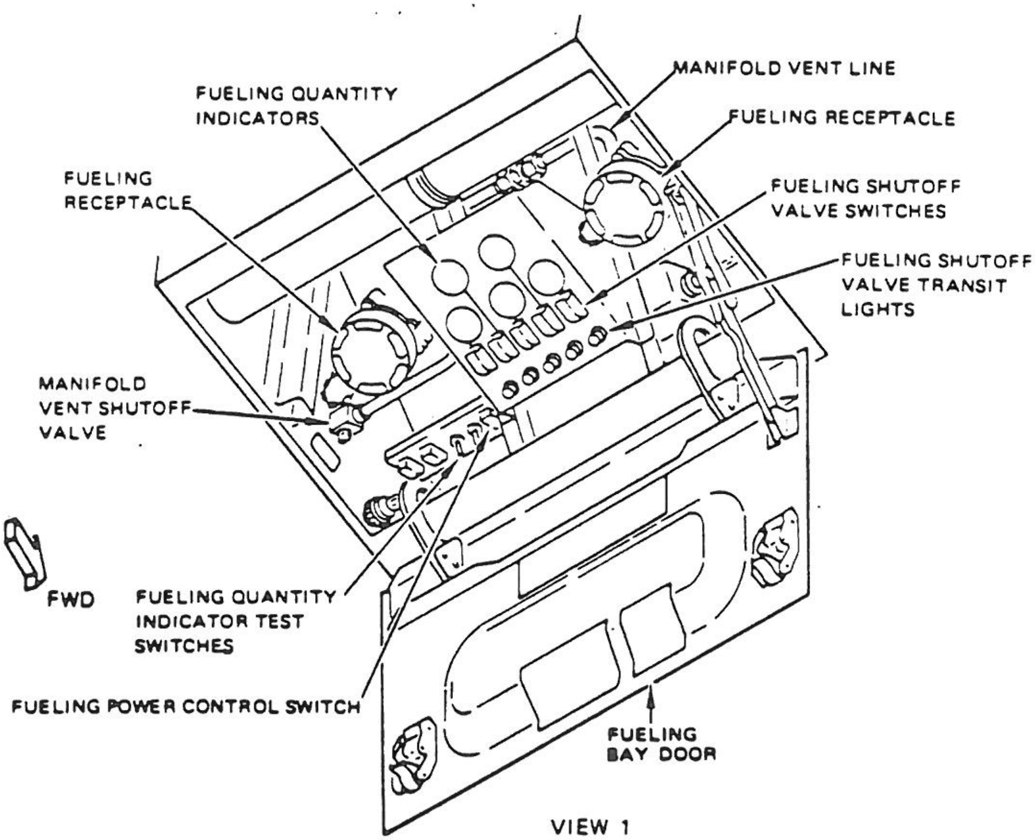
3. Aux Tank Float Switches

   a. Two float switches, one for each auxiliary tank, are provided to automatically close the individual fueling shut-off valves when the fuel level in the tank reaches full. When actuated, the float switch activates a relay which switches to energize the fueling shut-off valve motor and operate valve to the closed postion.

   b. The two relays controlled by their respective float switches are R632 (forward auxilary) and R633 (aft auxiliary). Both relays are mounted on the P-15 fueling control panel adjacent to the test switch for auxiliary fuel quantity indicators.

3. Aux Tank Fueling Outlet Tube

   a. A fueling outlet tube in each auxiliary tank is mounted on the outlet side of the fueling shut-off valve. A spring-loaded swing-type check valve is installed on the outlet end of the tube to prevent reverse flow from the auxiliary tank through the fueling shut-off valve. The fueling outlet tube is connected to the boost pump vapor discharge port. When the auxiliary tanks are fueled, a fuel prime is provided to the boost pump.



Pressure Fueling System Equipment Location

4. Fueling Control Panel (P-15)

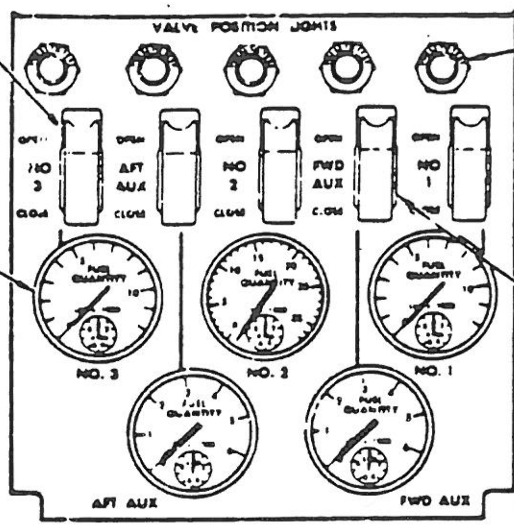
   a. The fueling control panel is located in the fueling bay and contains all the controls required for operation of the pressure fueling system. Components mounted on the panel are fueling quantity indicators, an indicator test switch, fueling shut-off valve switches, fueling shut-off valve position indicator lights, and a fueling power control switch. An illumination light mounted above the control panel provides illumination for the fueling bay.

FUELING SHUTOFF SWITCH

OPEN – Fueling shutoff valve open for fueling tank.

FUELING QUANTITY INDICATORS

Indicates usable fuel quantity in tank if:
External power or APU is connected. Fueling power switch is ON.



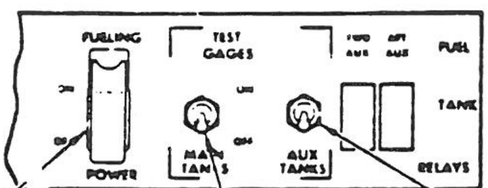
FUELING SHUTOFF VALVE POSITION LIGHT (Blue)

ILLUMINATED – Fueling shutoff valve in transit.

EXTINGUISHED – Fueling shutoff valve fully open or closed.

AUX FUELING SHUTOFF SWITCH

OPEN – Fueling shutoff valve and No. 2 crossfeed valve open for fueling aux tank.



FUELING POWER SWITCH

Controls power for fueling operation with external or APU power connected.

ON – Provides AC power for fueling quantity indicators and test circuitry. Connects battery power to the fueling valves.

MAIN TANK FUELING QUANTITY INDICATORS TEST SWITCH

ON – Test main tank fuel quantity indicators. Drives fueling station indicators towards zero. Drives Flight Engineer's lower panel indicators towards full. Closes any main tank fueling shutoff valve that is open.

OFF – Main tank fuel quantity indicators return to original reading. Fueling shutoff valves re-open.

AUXILIARY TANK FUELING QUANTITY INDICATORS TEST SWITCH

ON – Test auxiliary tank fuel quantity indicators. Drives fueling station indicators towards zero. Drives Flight Engineer's lower panel indicators towards full.

OFF – Auxiliary tank fuel quantity indicators return to original reading.

NOTE

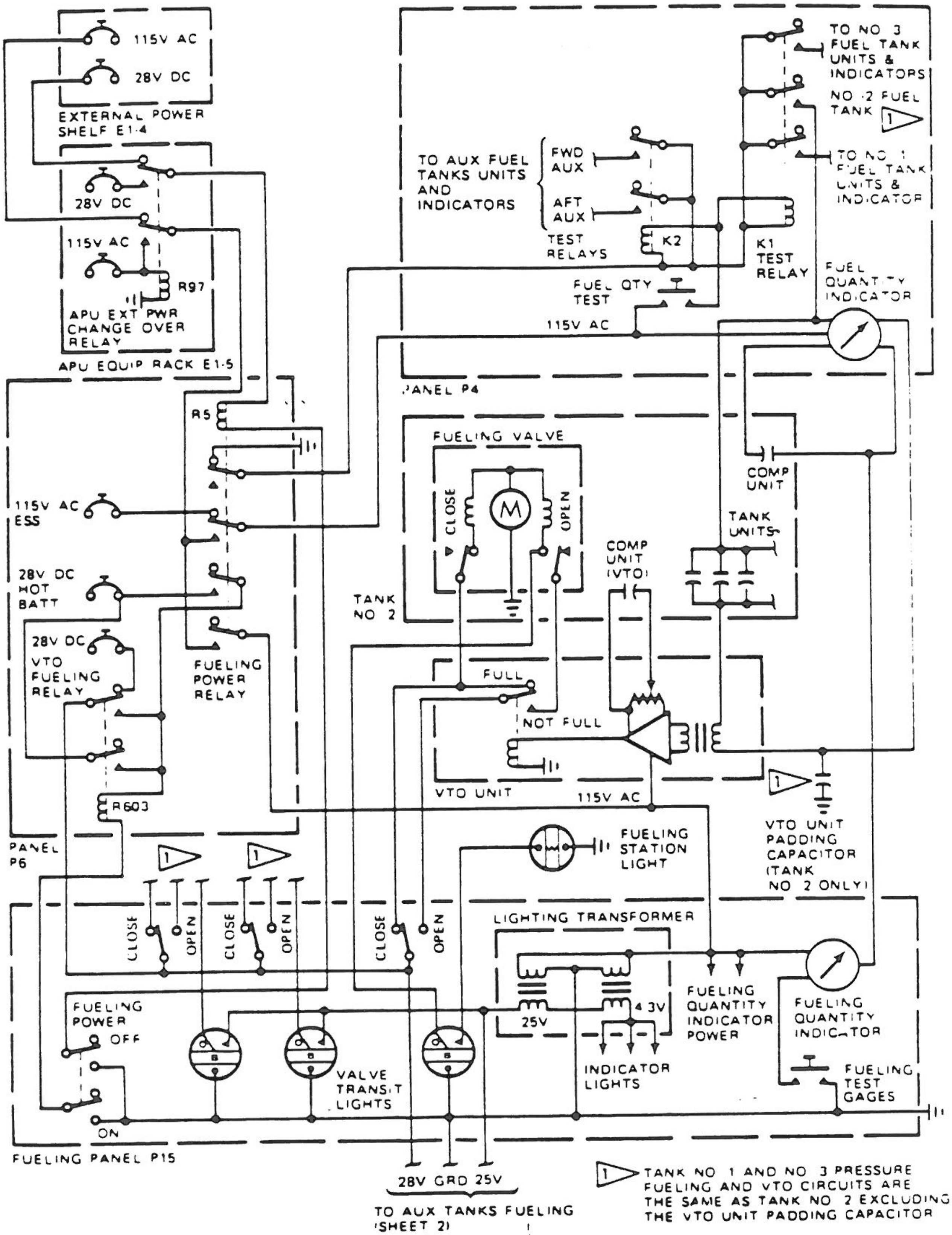
When the original reading is zero, the fueling station pointers may or may not move. If pointer movement is evidenced, it may be either up or down scale.

FUELING STATION CONTROL PANEL
(RIGHT WING)

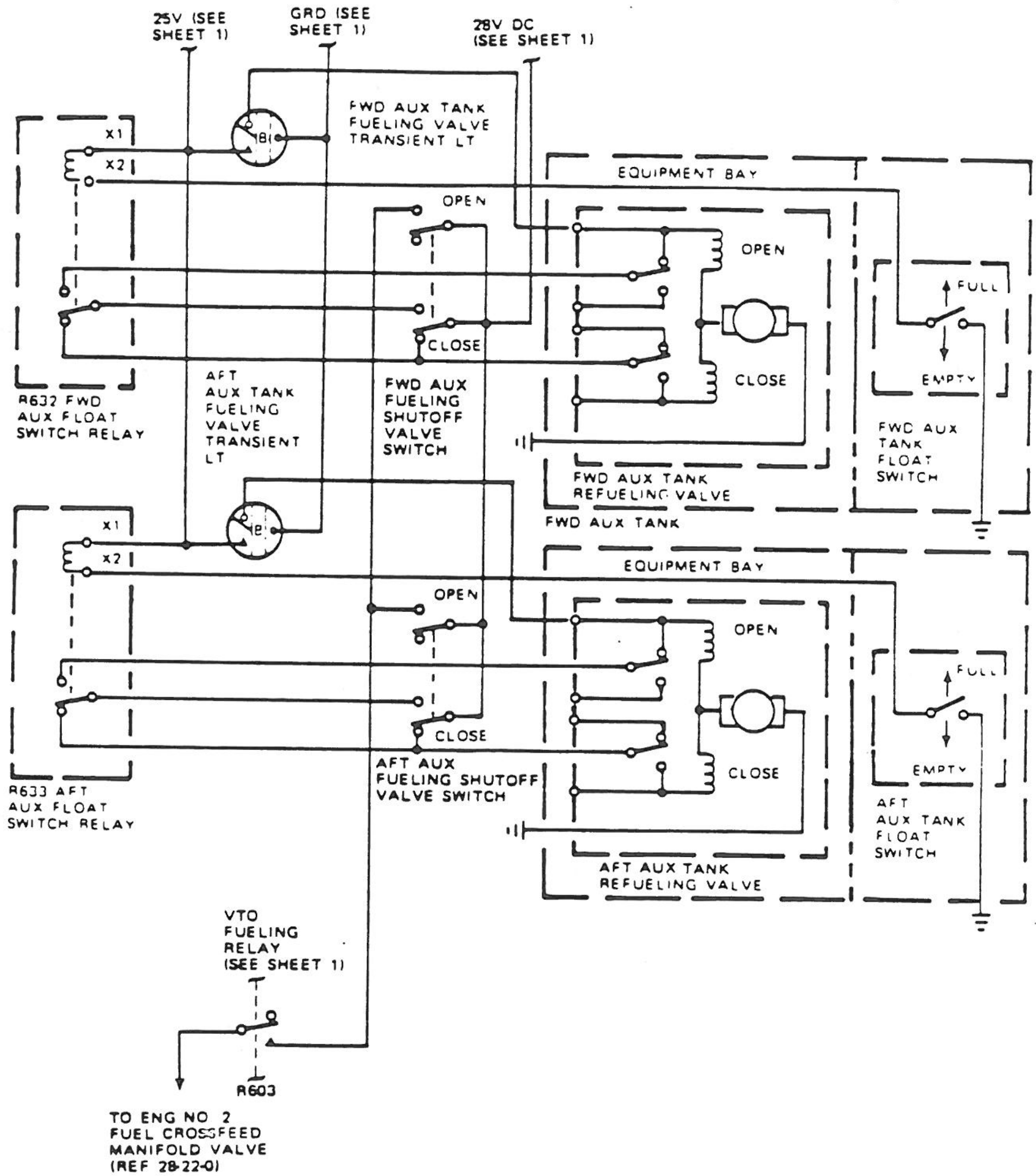
b. The fueling quantity indicators provide an indication of the fuel quantity in the individual tanks. The indicators are connected to their corresponding indicators on the Third Crewman's instrument panel and obtain their signals from the fuel quantity indicating system tank units (Fuel Quantity Indicating System). The indicators test switches provides a means of checking if the indicators are operating; operation of the switches will cause the pointer of operating indicators to move toward zero. One test switch is used for all main tank indicators and another test switch is used for all auxiliary tank indicators.

c. The fueling power control switch allows external, APU, or battery power to the fueling system. When fueling the auxiliary tank, the No. 2 engine fuel control unit by excess pressure surges. Switches at the aisle stand ensure that the fuel shut-off valves are closed when the start lever is in CUTOFF.

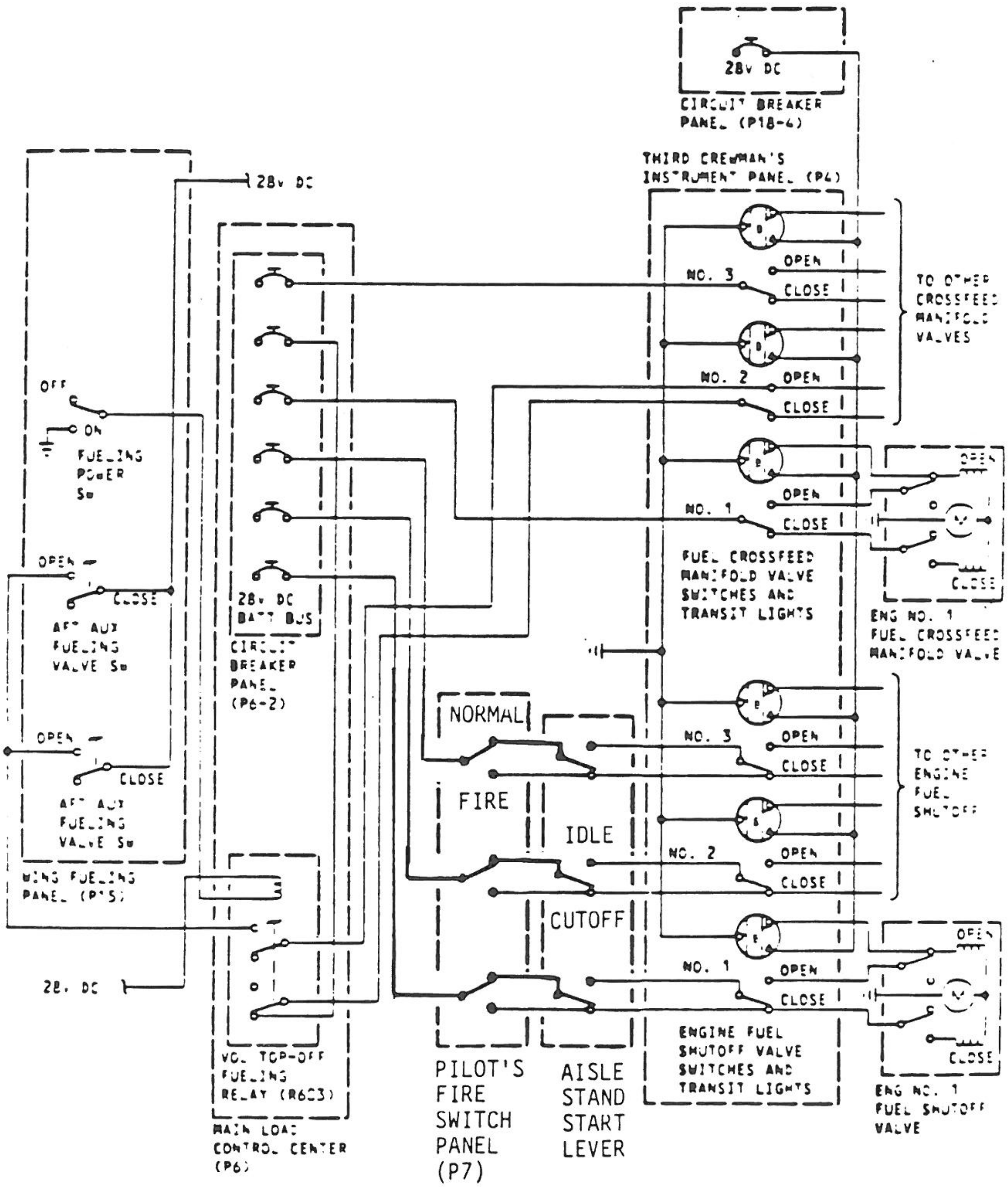
d. The fueling shut-off valve switches control the operation of the shut-off valves. In addition, the auxiliary tank fueling shut-off valve switch circuit contains a relay (R603) which will open (if closed) the tank No. 2 crossfeed manifold valve when either of the auxiliary tank fueling shut-off valve switches is placed in the OPEN position to allow fueling of an auxiliary tank through tne No. 2 engine crossfeed valve on airplanes not equipped with the pressure actuated check valves. When both auxiliary tank switches are placed in the CLOSE position, the tank No. 2 crossfeed manifold valve will remain open or close depending upon the position of the tank No. 2 crossfeed valve switch. The switches are toggle-type switches with a guard mounted over the toggle lever. If the switches are unintentionally left in the OPEN position after fueling is completed, closing the fueling bay door automatically moves the switches to the CLOSED position and closes the fueing shut-off valves.



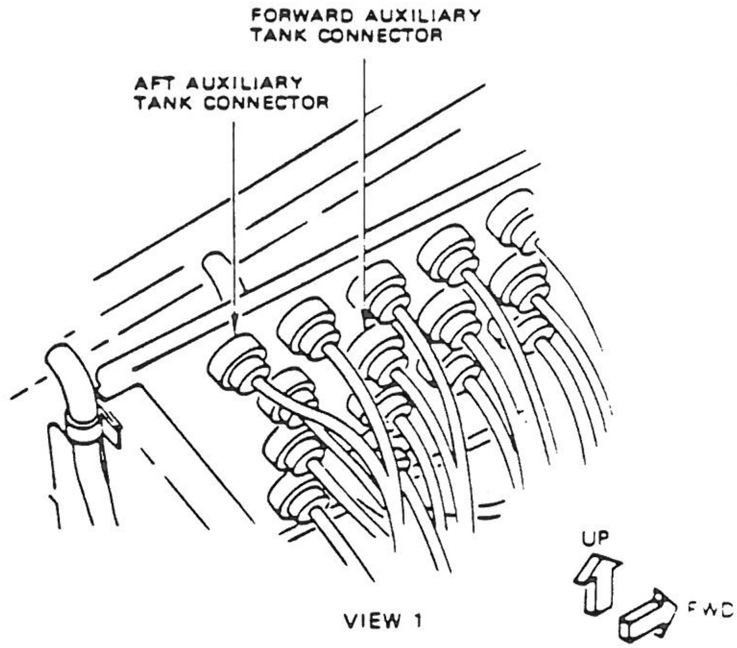
Pressure Fueling System Circuit



Pressure Fueling System Circuit

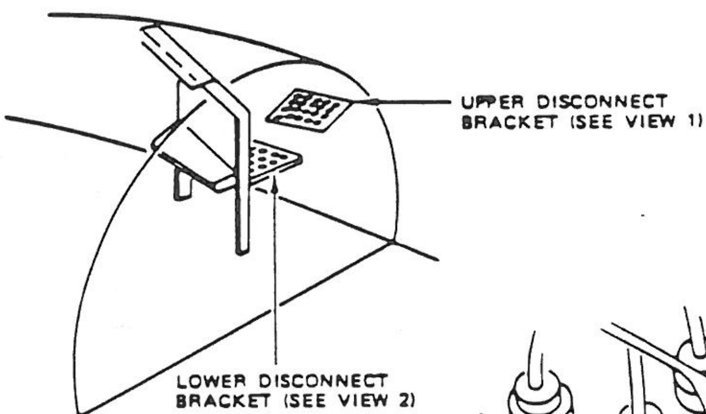


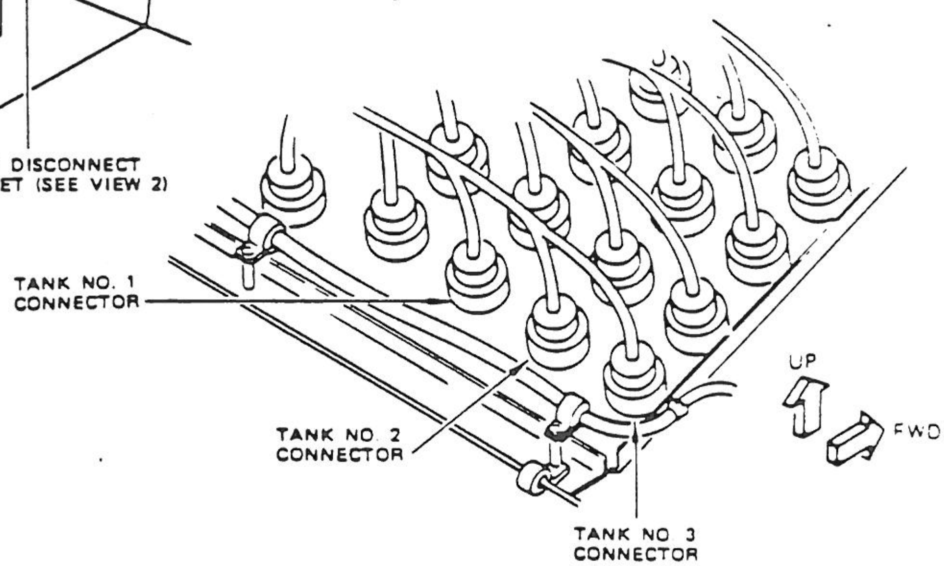
Fuel Shutoff Valve Schematic



VIEW 1

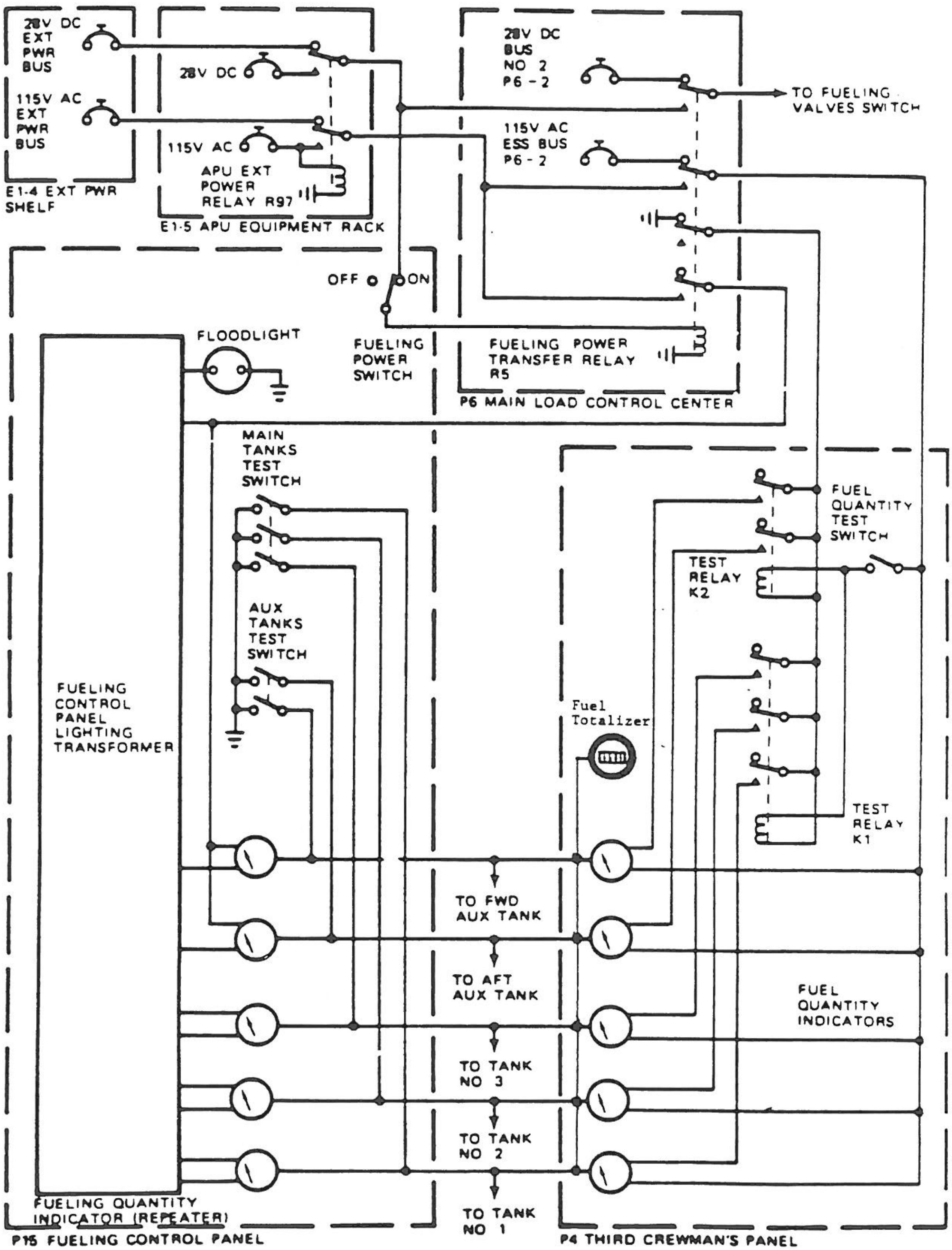
TANK	CONNECTOR
NO. 1	D4332P
NO. 2	D4330P
NO. 3	D4328P
FWD AUX	D5092P
AFT AUX	D5090P



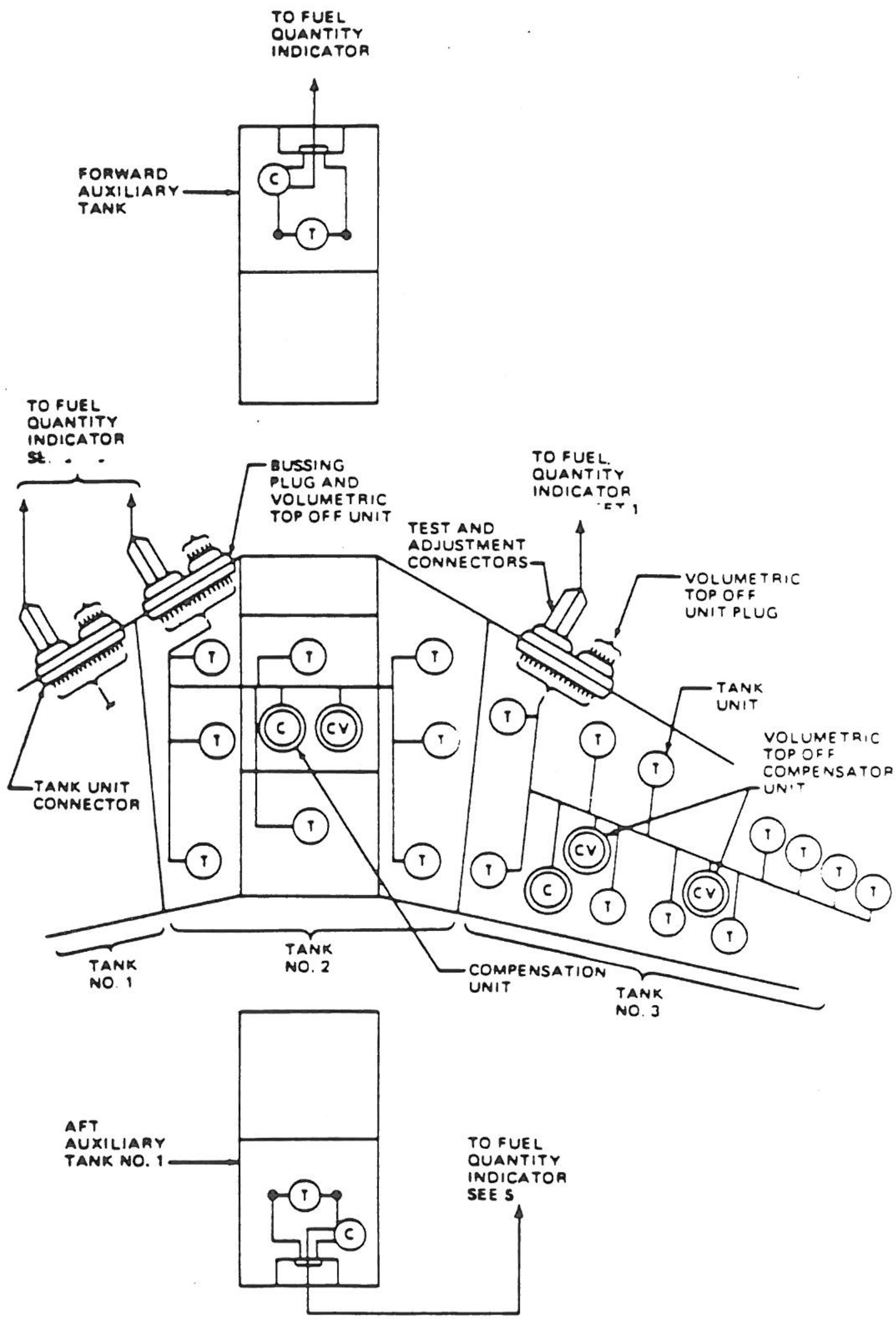


VIEW 2

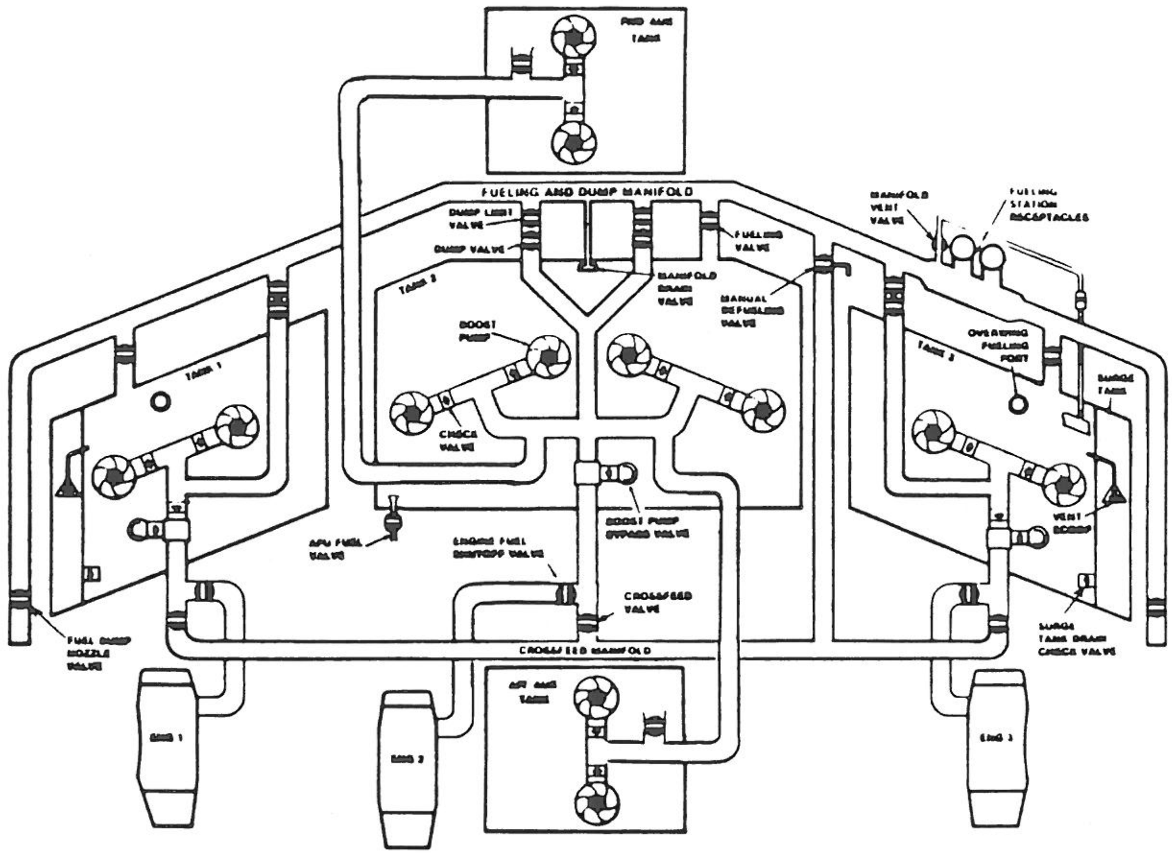
Third Crewman's Panel Integration Area



Fuel Quantity Indicating System Schematic



Fuel Quantity Indicating System Schematic



FUEL SCHEMATIC - AUX TANKS INSTALLED