

12.9 (ATA 28) FUEL

12.9.1 Introduction

Fuel is contained in two integral main wing tanks designated No. 1 and No. 2. The fuel system provides for indicating, storing, venting, fuel feeding and scavenging, refueling/defueling, and transferring. Only tank to tank transfer is available; there is no engine crossfeed capability. The aircraft may be gravity or pressure refueled.

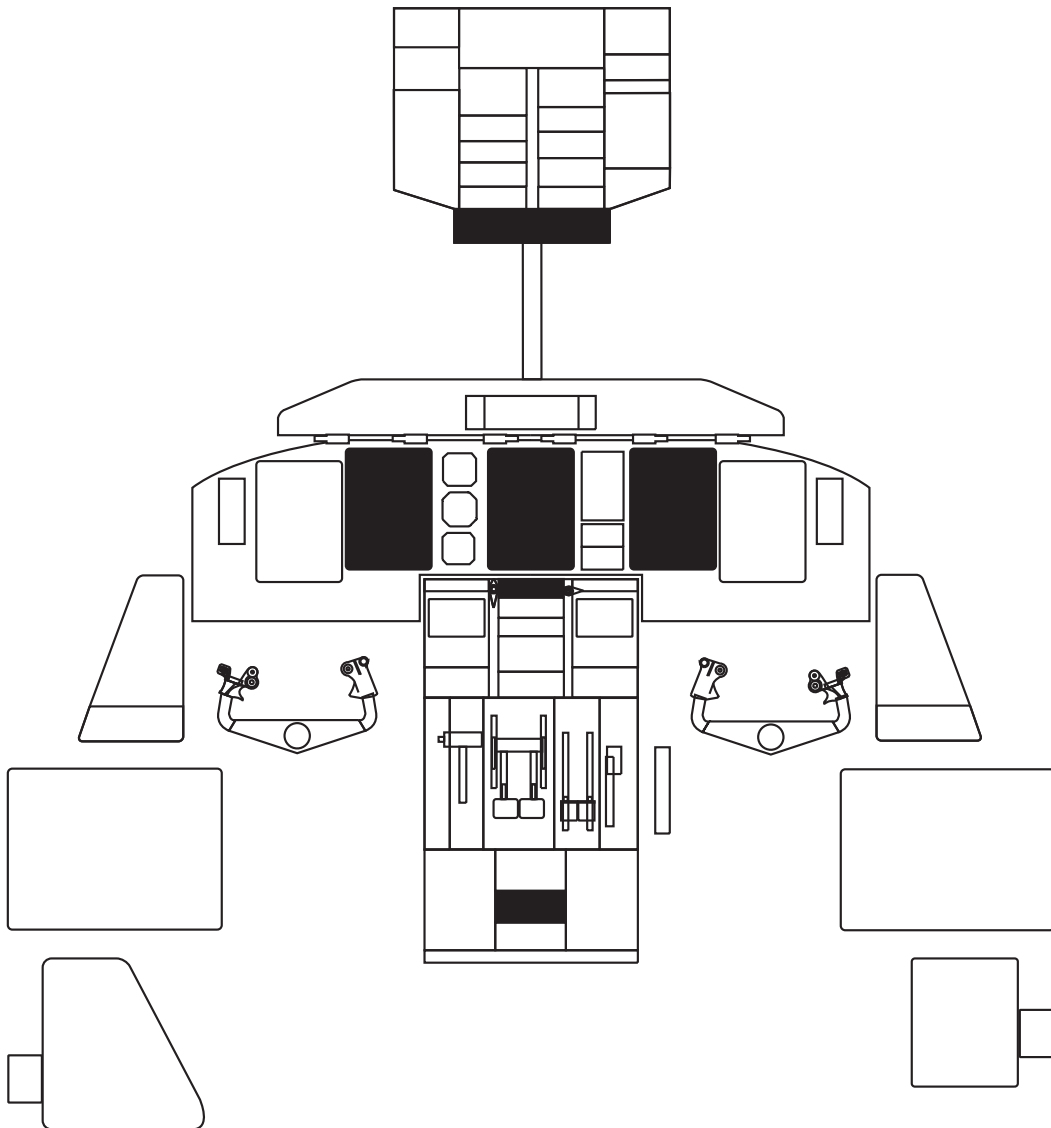
12.9.2 General

A fuel gauging system supplies quantity data to the flight compartment and refuel/defuel panel for display. Fuel quantity may also be checked on the ground by use of the magnetic dipsticks.

Each wing tank includes a surge bay and a collector bay. The left tank supplies fuel to the left engine and the optional Auxiliary Power Unit (APU). The right tank supplies fuel to the right engine. A vent system keeps the air pressure in the fuel tanks between structural limits.

Fuel can be transferred between the tanks for lateral balancing or for fuel management. A single point pressure refuel/defuel system shares selected common components with the fuel transfer system. Gravity refueling may also be done through two overwing fuel filler points.

12.9.3 Controls and Indications - Fuel



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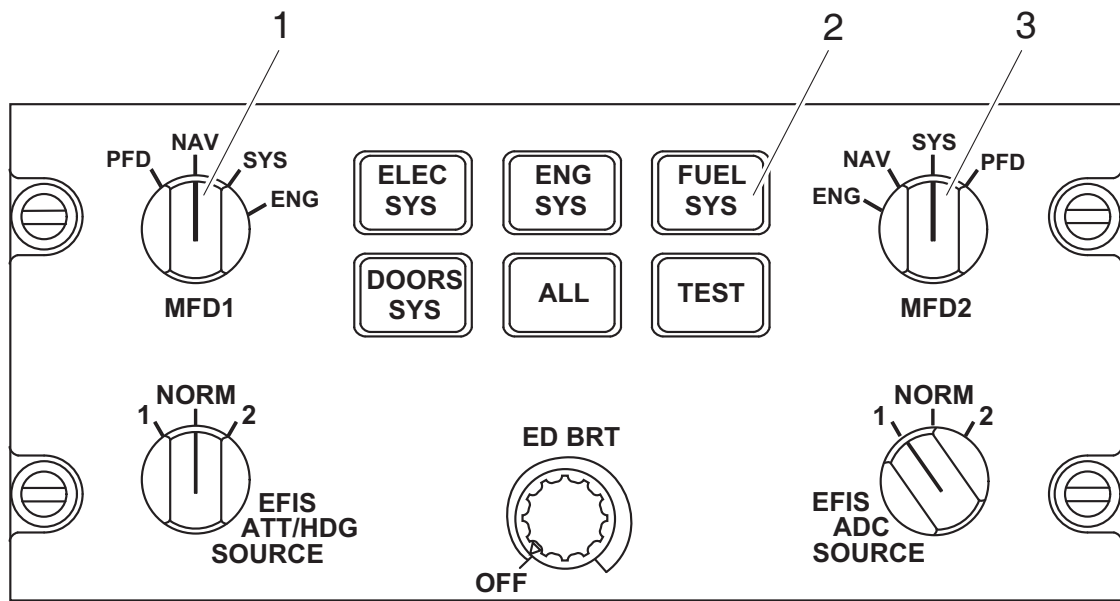
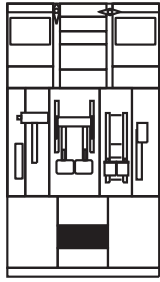


Figure 12.9-1 Engine and System Integrated Displays Control Panel (ESCP)

ESCP CALLOUTS PERTAINING TO FUEL ITEMS

1. MFD 1 REVISION SELECTOR (4 position, rotary action)

TURN - selectable positions are PFD, NAV, SYS, ENG

- ESCP provides the pilot with the ability to select any page on the MFD1 and to control the EIS reversion after display failures

2. FUEL SYS PUSHBUTTON (momentary action)

PUSH - provides a display of the fuel system page on the MFD (upper area) with MFD 1 or MFD 2 set at SYS

- there is no action with another push

PUSH AND HOLD - (with both MFDs not set to SYS)

- fuel system page shown on the Engine Display (ED)
- ED images are shown again when the pushbutton is released

3. MFD 2 REVISION SELECTOR (4 position, rotary action)

- same as MFD1 selector except selects pages on MFD2

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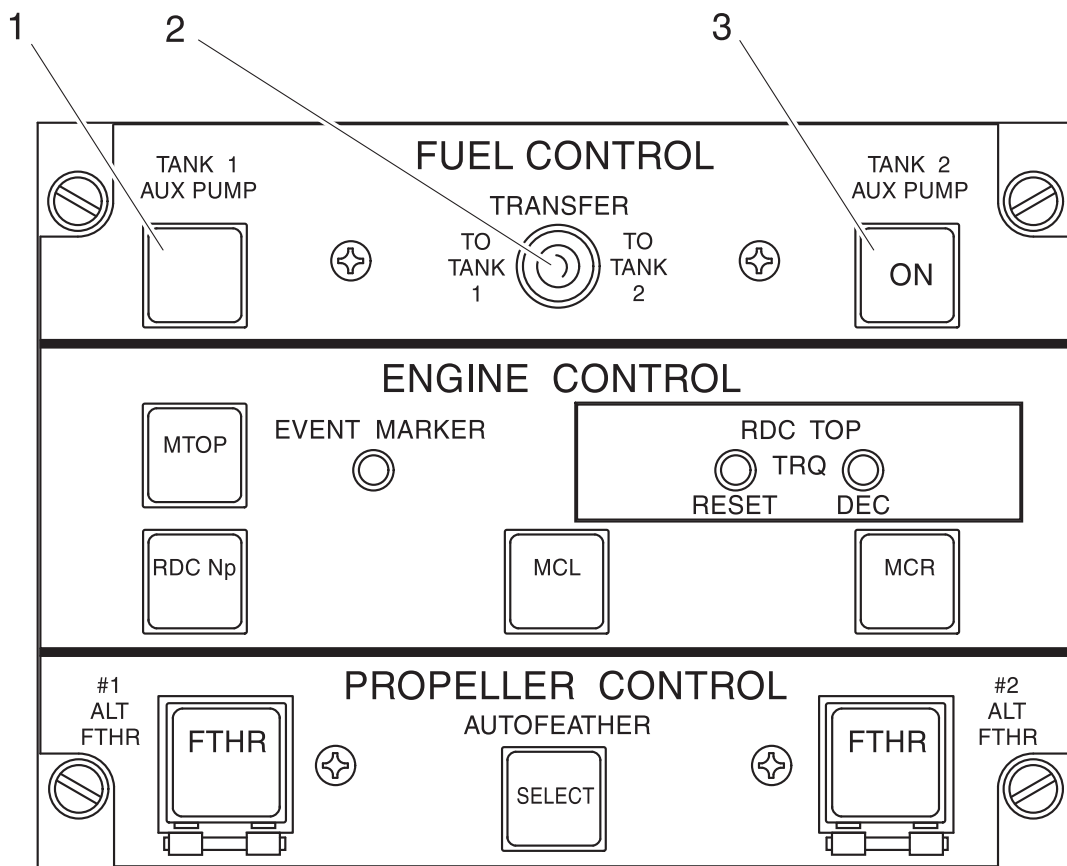
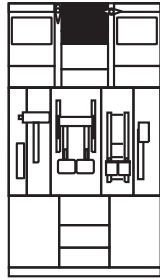


Figure 12.9-2 Fuel Control Panel

FUEL CONTROL PANEL CALLOUTS

1. TANK 1 AUX PUMP SWITCHLIGHT (alternate action)

PUSH - ON segment (green)

- activates auxiliary fuel pump in left collector bay

PUSH - ON segment (out)

- deactivates auxiliary fuel pump in left collector bay

ON segment (green) without pushing

- auxiliary fuel pump has been activated by the fuel transfer system (TANK 1 to TANK 2)

2. FUEL TRANSFER SWITCH (three position, lever latched)

TO TANK 1 - activates transfer system to transfer fuel from tank No. 2 to tank No. 1

CENTER - transfer system deactivated

TO TANK 2 - activates transfer system to transfer fuel from tank No. 1 to tank No. 2

3. TANK 2 AUX PUMP SWITCHLIGHT (alternate action)

- same as TANK 1 AUX PUMP switchlight, except auxiliary pump in No. 2 collector bay

ON segment (green) without pushing

- auxiliary fuel pump has been activated by the fuel transfer system (TANK 2 to TANK 1)

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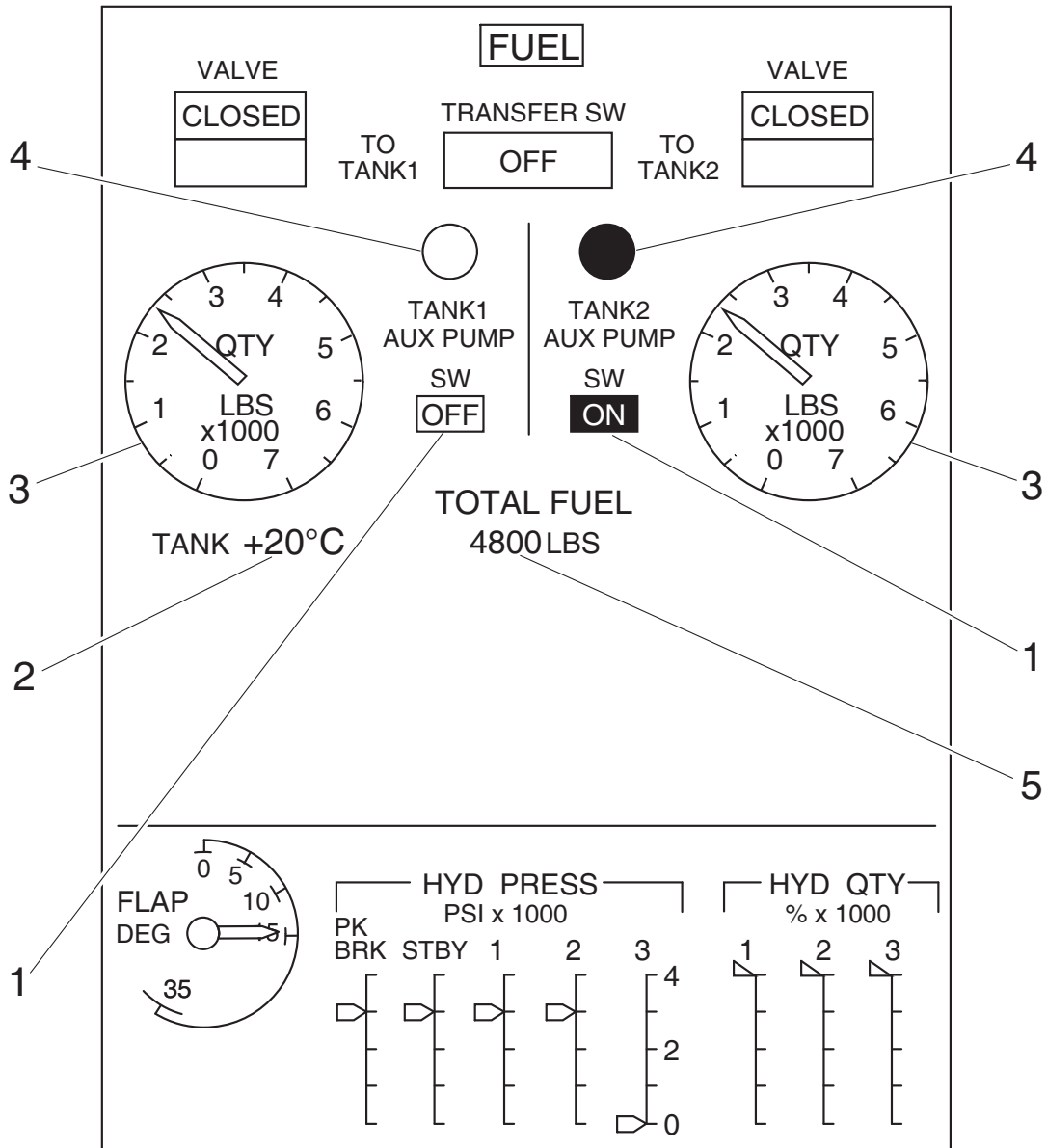
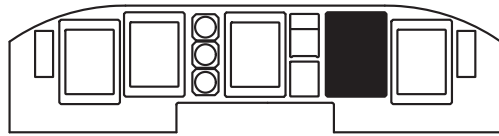


Figure 12.9-3 MFD2 Fuel Page - Quantity Indications

MULTI FUNCTION DISPLAY (MFD) FUEL PAGE CALLOUTS

1. AUXILIARY FUEL PUMPS SWITCH ANNUNCIATOR

OFF segment (white text surrounded by a white box)

- the respective TANK 1 or TANK 2 AUX PUMP switchlight is not in the depressed position

ON segment (reverse video, black text on green background)

- the respective TANK 1 or TANK 2 AUX PUMP switchlight is in the depressed position
- white dashes replace the text (without a box), when no data is available

2. DIGITAL DISPLAY OF FUEL TANK TEMPERATURE

(digital value and TANK segment in white, °C segment in blue)

- indicates temperature in left collector bay with a ± sign
- if using JET B/JP-4 and TANK temperature is more than 35°C, maximum altitude is 20.000 ft
- indicates from -99 to +99 in 1° increments
- digits are replaced by white dashes when the data is not valid

3. ANALOG DISPLAY OF FUEL QUANTITY

- gives an analog readout of fuel quantity in the left and right tanks

QTY segment (white)

KGx1000 segment (cyan)

Scale and digit segments (white)

- scale marks and digits are removed when the parameter is not valid

Pointer segment (white) - normal

Pointer segment (yellow) - during an imbalance condition

- removed when the parameter is not valid

4. TANK AUXILIARY PUMP PRESSURE STATUS INDICATOR

Circle segment (white outline with black fill) - low or no pressure

Circle segment (white outline with green fill) - normal pressure

5. DIGITAL DISPLAY OF TOTAL FUEL QUANTITY

(digital value and TOTAL FUEL in white, KG segment in blue)

- total fuel quantity given in KG
- indicates from 0 to 15000 in 5 KG increments
- digits are replaced by white dashes when the data is not valid

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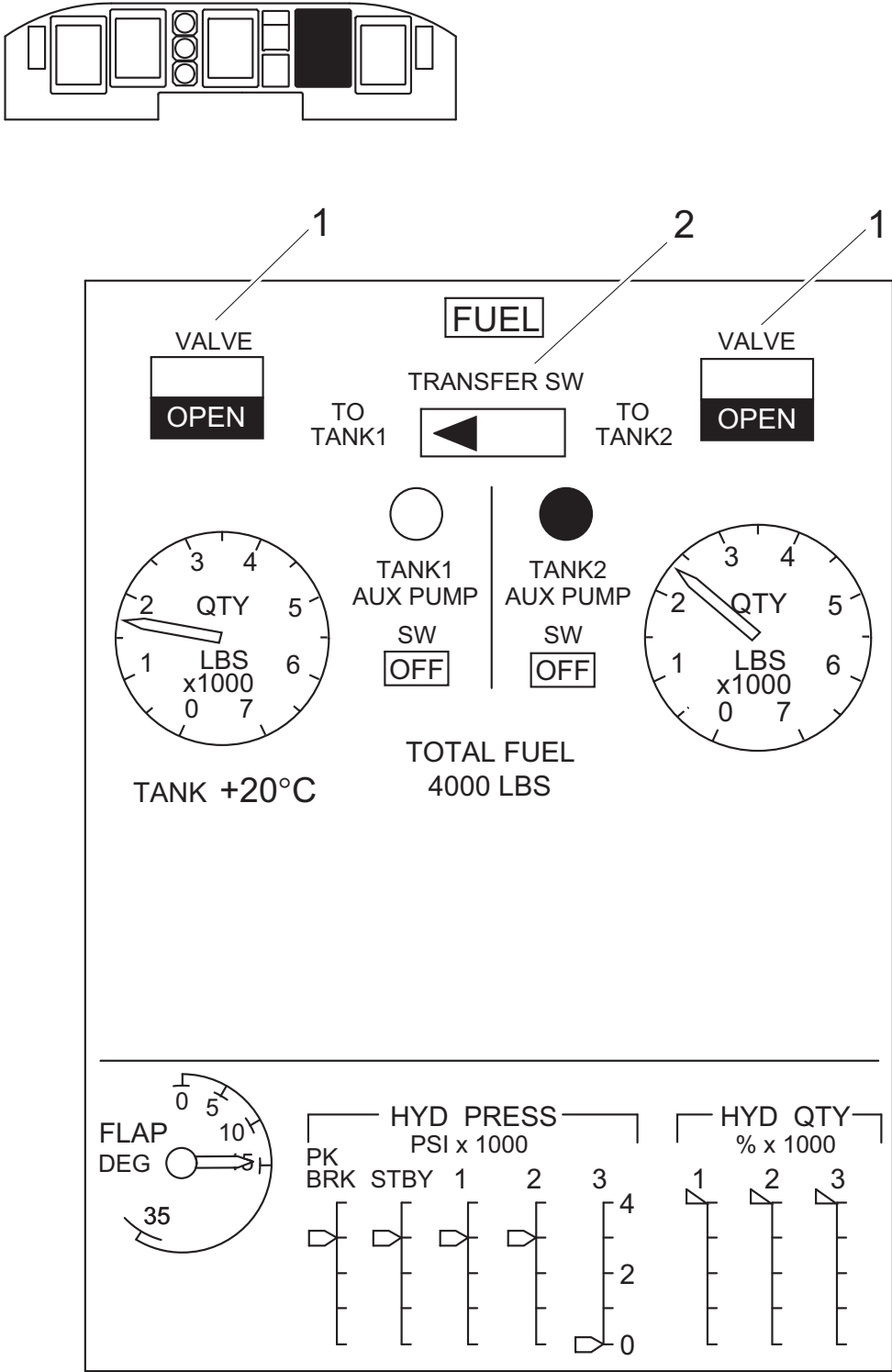


Figure 12.9-4 MFD Fuel Page - Transfer Indications

MULTI FUNCTION DISPLAY (MFD) FUEL PAGE CALLOUTS

1. FUEL SHUTOFF VALVE ANNUNCIATOR

- indicates shutoff valve state in response to a crew transfer request

VALVE segment (white)

CLOSED segment (white in upper white outline rectangle)

- indicates fuel transfer valve is closed

OPEN segment (reverse video, black text on green in lower rectangle)

- indicates fuel transfer valve is open

- when the valve is neither fully closed nor fully open (typical case during valve transition), nothing is displayed

- three white dashes are displayed instead of the CLOSED and OPEN indication when no data is available

2. FUEL TRANSFER SWITCH INDICATION

- indicates the position of the FUEL TRANSFER switch on the FUEL CONTROL panel

TRANSFER SW segment (white)

TO TANK 1 and **TO TANK 2** segment (white)

Triangle segment (white in white outline rectangle)

- pointing towards the left indicates that a transfer is active from right to left

- pointing towards the right indicates that a transfer is active from left to right

- in case of inconsistency (transfer fault towards both sides), both triangles are displayed as the data is received

- three white dashes are displayed when no data is available

OFF segment (white in white outline rectangle)

- indicates no fuel transfer is requested

Dash8 - Q400 - Fuel

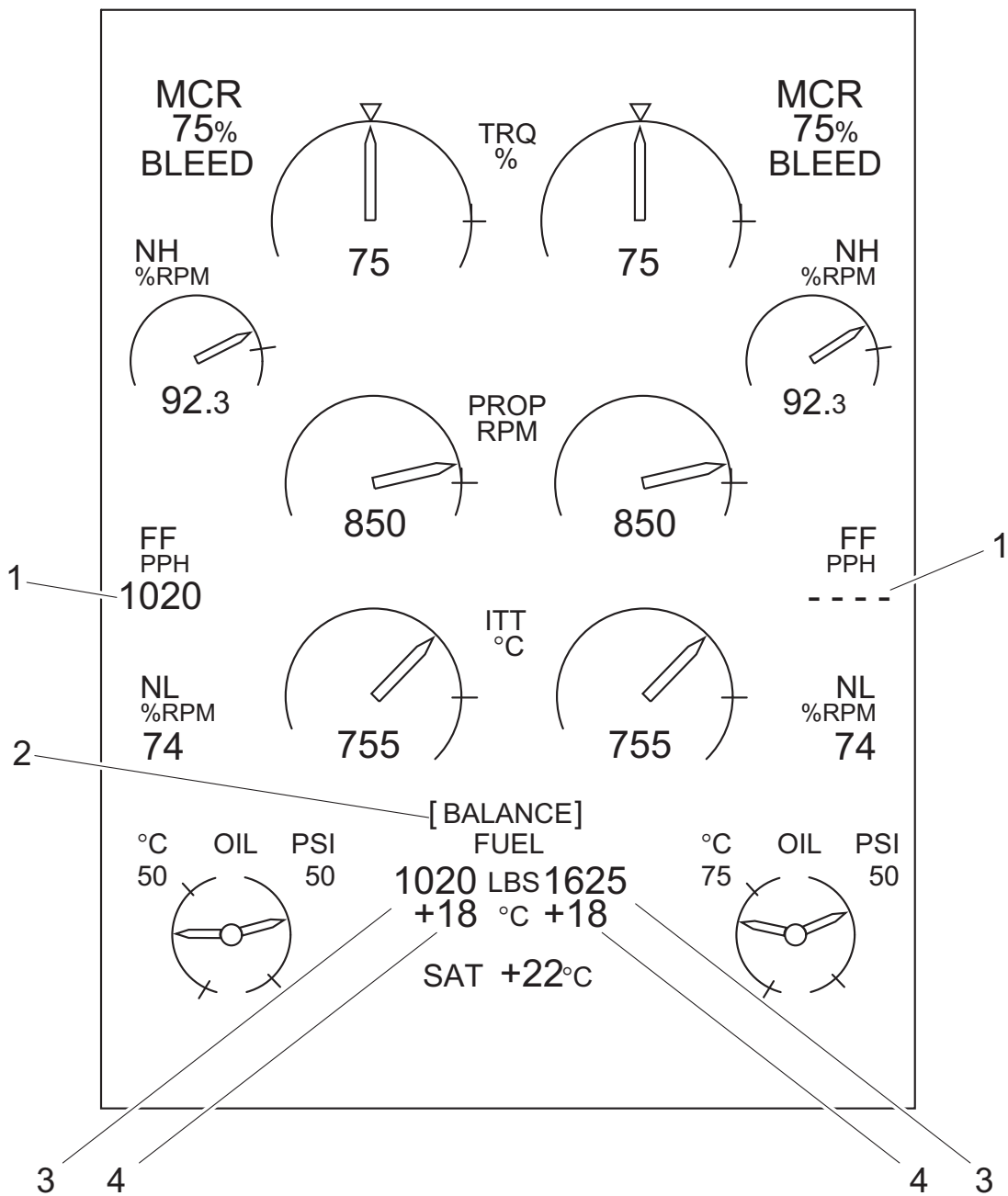
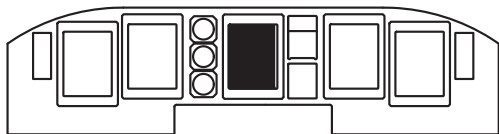


Figure 12.9-5 ED Fuel Parameters

ED CALLOUTS PERTAINING TO FUEL ITEMS

1. FUEL FLOW INDICATOR

(FF and digital value in white, PPH or KG/H in blue)

- indicates from 0 to 9990 in 10 PPH or 5 KG/H increments
- digits are replaced by white dashes when the data is not valid

2. [BALANCE] MESSAGE (yellow, flashings)

- indicates a fuel imbalance condition is detected by the left or right Fuel Gauging Computer (FGC1 or FGC2)

3. LEFT/RIGHT FUEL TANK QUANTITY DIGITAL VALUE

(Digital value white, yellow if imbalance, KG in blue)

- total fuel quantity given in KG
- indicates from 0 to 9990 in 5 KG increments
- digits are replaced by white dashes when the data is not valid

4. LEFT/RIGHT FUEL INLET TEMPERATURE DIGITAL VALUE

(Digital value in white, yellow, or red, °C segment in blue)

- indicates temperature of the fuel with a \pm sign, after it has passed through the Fuel Oil Heat Exchanger (FOHE)
- indicates from -99 to +99 in 1° increments
- digits are normally displayed in white
- digits will turn yellow if the temperature is below 0°C
- digits will turn red if the temperature is above 71°C
- digits are replaced by white dashes when the data is not valid
- continuous operation with fuel heater outlet temperature below 0°C or above 71°C is prohibited.

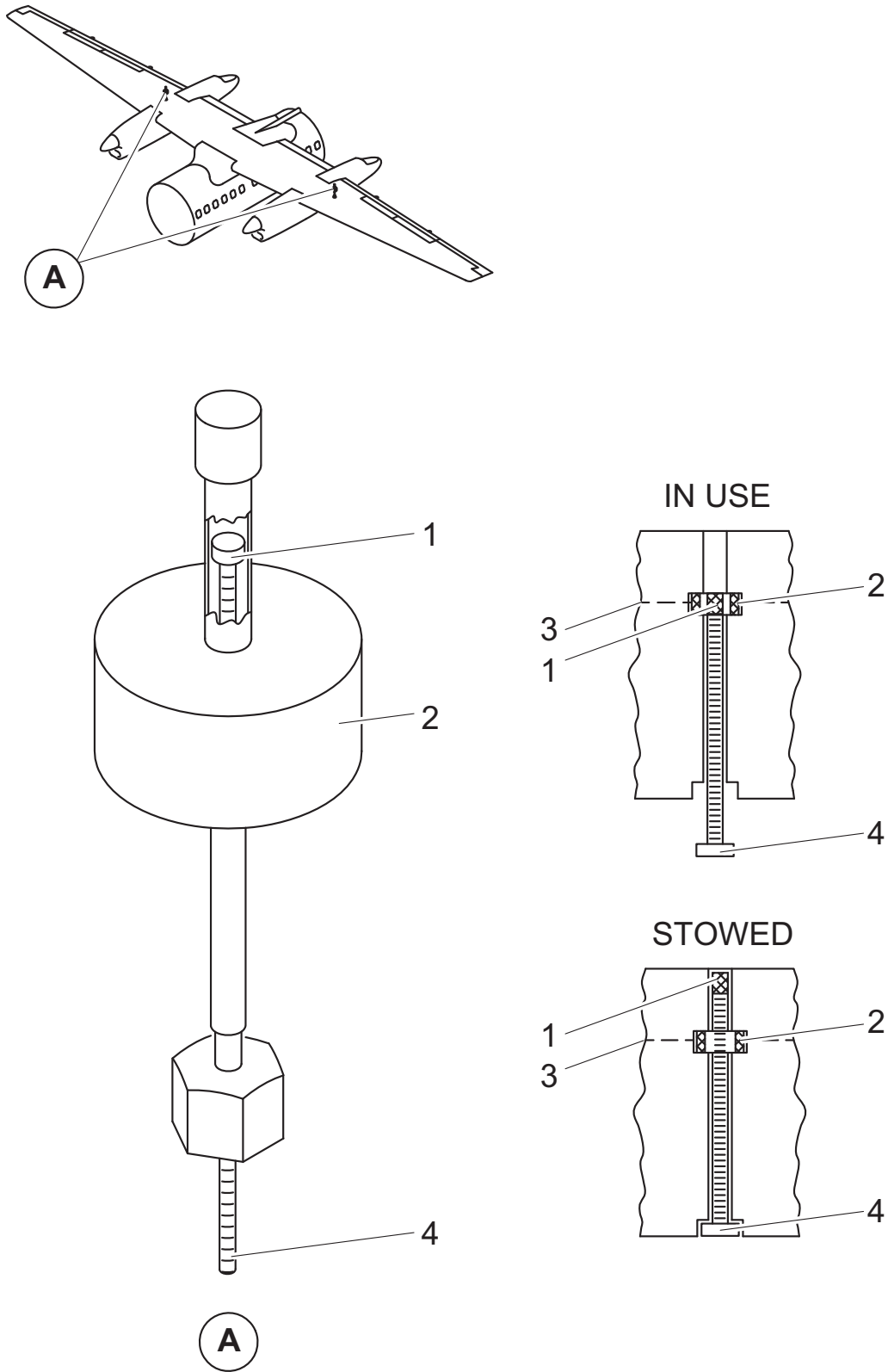


Figure 12.9-6 Magnastick Operation Locator

MAGNETIC DIPSTICK CALLOUTS AND OPERATION

1.MAGNATIC DISPSTICK MAGNET

2.FLOAT MAGNET

3.FUEL LEVEL IN MAIN TANK

4. CALIBRATED MAGNETIC DIPSTICK

- the magnetic dipsticks give an alternate means to measure the fuel quantity when the aircraft is on the ground
- the magnetic dipstick is accessed at the bottom of the wing
- when the rod is released, it moves slowly down until the rod magnet is attracted by the float magnet
- the fuel quantity is shown in US gallons or in liters
- the reading will indicate full whenever the tank is more than 700 U.S. Gal (2700 L)
- the reading will indicate empty whenever the tank is less than 100 U.S. Gal (400 L)

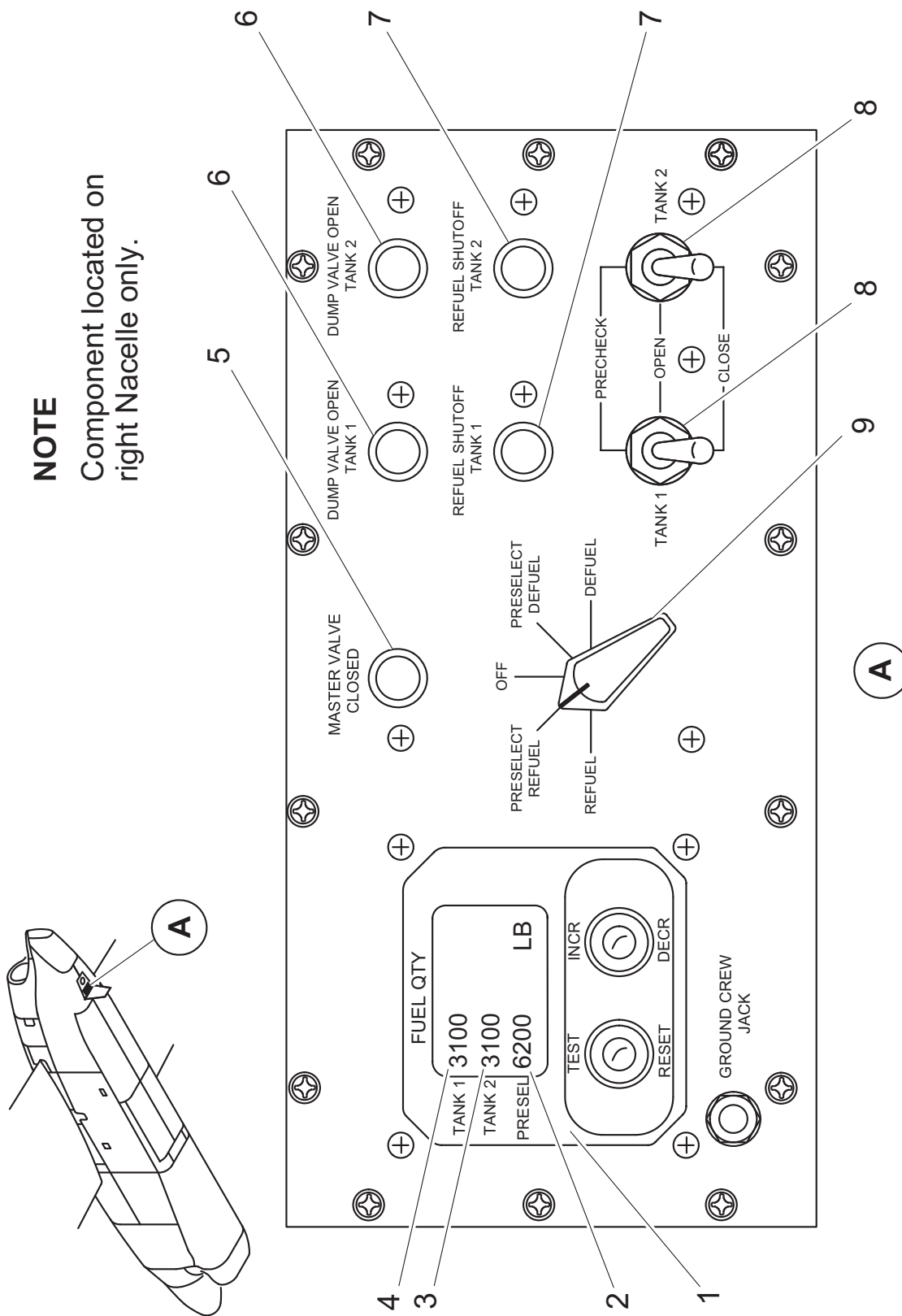


Figure 12.9-7 Refuel/Defuel Panel (1 of 2)

REFUEL/DEFUEL PANEL CALLOUTS

1. REFUEL/DEFUEL INDICATOR (RDI)

2. PRESELECTED FUEL QUANTITY

- desired amount of fuel for processing a refueling or defueling operation, as set by the INCR/DECR switch

3. TANK 2 ACTUAL FUEL QUANTITY

4. TANK 1 ACTUAL FUEL QUANTITY

5. MASTER VALVE INDICATOR LIGHT (amber)

- master refuel/defuel valve is closed
- turning selector switch from OFF will open the valve and light will go off

6. TANK 1/TANK 2 DUMP VALVE LIGHT (amber)

- vent/dump valve related tank is open

7. TANK 1/TANK 2 REFUEL SHUTOFF VALVE LIGHT (white)

- level control shutoff valve is closed (i.e. no fuel is flowing into related tank)

**8. TANK 1/2 LEVEL CONTROL SHUTOFF VALVE SWITCHES
(three position spring loaded away from PRECHECK, toggle switch)**

PRECHECK - simulates full fuel signal to the High Level Control Unit (HLCU) stopping refueling of related tank

OPEN - opens related Refuel/Defuel/Transfer shutoff valve for refueling or defueling

CLOSE - closes related Refuel/Defuel/Transfer shutoff valve to stop fuel flow

9. REFUEL/DEFUEL SELECTOR SWITCH (5 position)

REFUEL or **DEFUEL** - manual refueling or defueling continues until the selected switch is set to OFF, the HLCU detects a full tank, or the level control shutoff valve switches are placed in the CLOSE position

PRESELECT REFUEL or **DEFUEL** - refuel/defuel operation stops automatically, when the preselected levels are reached

OFF - power removed from the refuel/defuel control panel

NOTE
Component located on
right Nacelle only.

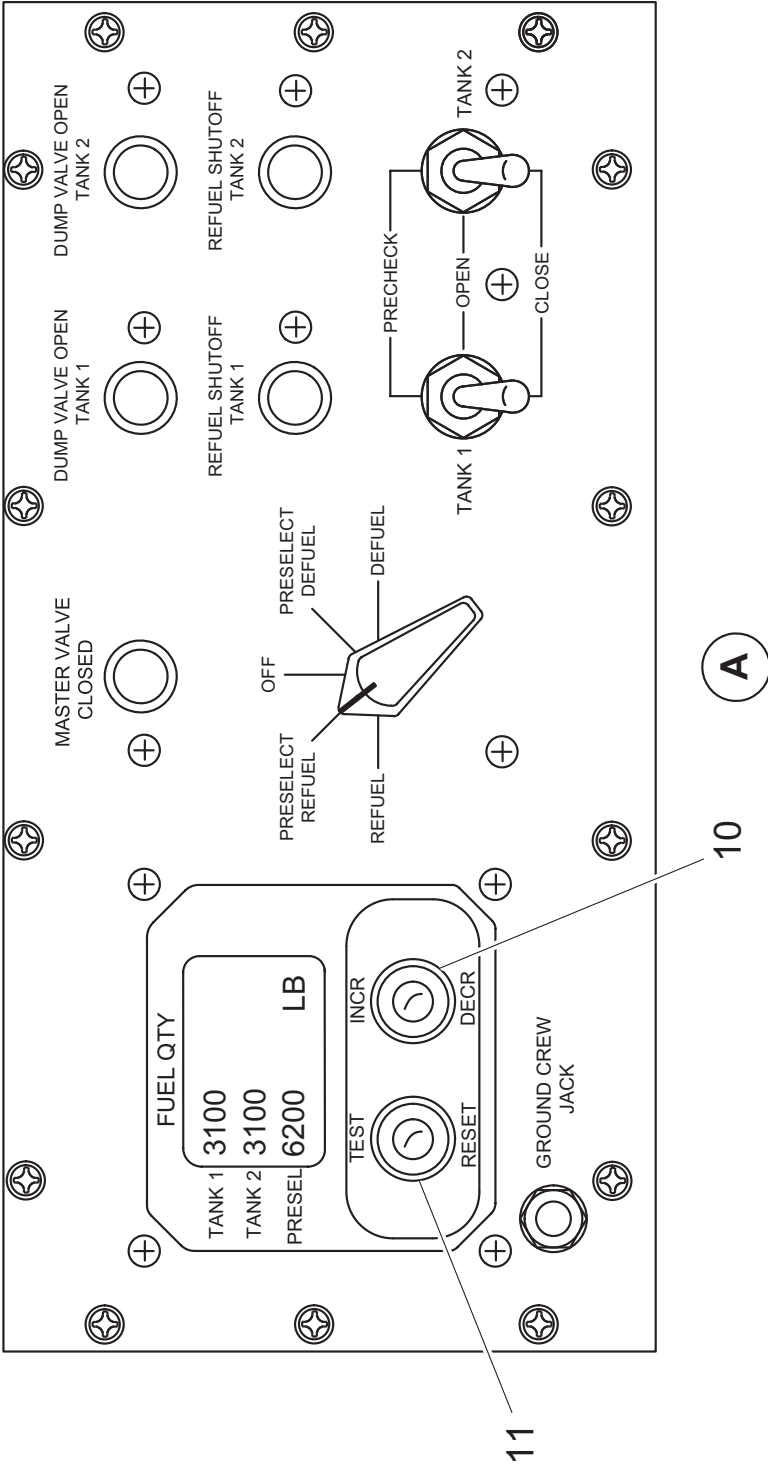
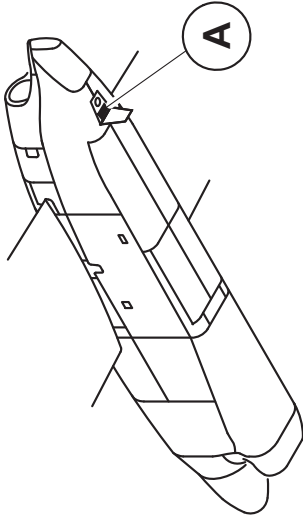


Figure 12.9-8 Refuel/Defuel Panel (2 of 2)

REFUEL/DEFUEL PANEL CALLOUTS (cont'd)

10. INCR/DECR SWITCH (three position, spring loaded to center)

- used to set the desired amount of fuel for processing a refueling or defueling operation
- | **INCR** or **DECR** - the current PRESEL display value on the RDI will increase/decrease by 10 kg
- | - this is repeated 10 times after which the current PRESEL display will increase/decrease by 100 kg
- indicates from 0 5800 kg
- the displayed preselect value will never rise above the total fuel quantity when the refuel mode status indicates a defuel operation is in progress
- the displayed preselect value will never fall below the total fuel quantity when the refuel mode status indicates a refuel operation is in progress
- four seconds after the INCR/DECR switch is stable at the neutral position, the automatic refuel/defuel function will start
- if refueling/defueling is in process and the INCR/DECR switch is moved out of its neutral position, the refuel/defuel operation will stop and will restart four seconds after the INCR/DECR switch activity is stopped

11. TEST/RESET SWITCH (three position, spring loaded to center)

TEST - starts display test

- displays a checkerboard pattern for 2 ± 1 seconds, followed by an inverse checkerboard pattern for 2 ± 1 seconds and finally, followed by all segments turned off for 2 ± 1 seconds

RESET - for maintenance purposes

- selecting RESET during refueling/defueling will cause the operation to stop and ABORT will be displayed in the PRESEL window. The PRESEL value will then display the current total fuel quantity. To restart refueling/defueling, the PRESEL value will have to be increase or decrease using the INCR/DECR switch

12.9.4 Fuel - Indications

Fuel quantity and temperature data is shown in white on the Engine Display (ED) and the Fuel Page of the Multi Function Display (MFD). White dashes replace the digits or simulated dials if the data is not valid or not available.

A Fuel Quantity Computer (FQC) uses nine capacitance type fuel probes in each tank to determine the total fuel quantity. The fuel quantity of each tank is shown in digital form on the bottom center of the Engine Display (ED). The Fuel Page of the Multi Function Display (MFD) also shows the fuel quantity of each tank on two simulated analog dials and below that the total fuel quantity in digital form. The fuel quantity can be shown in kilograms (KG). The fuel flow for each engine is shown in digital form on the ED in units of KG/H.

The fuel temperature (°C) in the left collector tank is shown in digital form on the MFD Fuel Page, just below the left fuel quantity dial. The engine inlet temperature of the fuel after it has passed through the Fuel/Oil Heat Exchanger (FOHE) for the left and right engines is shown in digital form on the bottom of the ED, just below the related fuel tank quantity. The digits are shown in white with a ± sign, and change to yellow or red if the temperature is not in the preset range. A °C unit is shown between the two inlet temperatures.

The fuel quantity of each tank is also shown on the refuel/defuel panel located at the back underside of the right nacelle. One magnetic dipstick on the underside of each tank can also be used on the ground to give an independent mechanical indication of the fuel quantity in liters or U.S. gallons. The magnetic dipstick is a calibrated rod with a magnet attached to the top. It moves within a tube that extends vertically from the bottom of the fuel tank. A float moves up and down on the outside surface of this tube to match the fuel level in the tank. The float contains a magnet that is attracted to the magnet on the magnetic dipstick, holding the dipstick at that level.

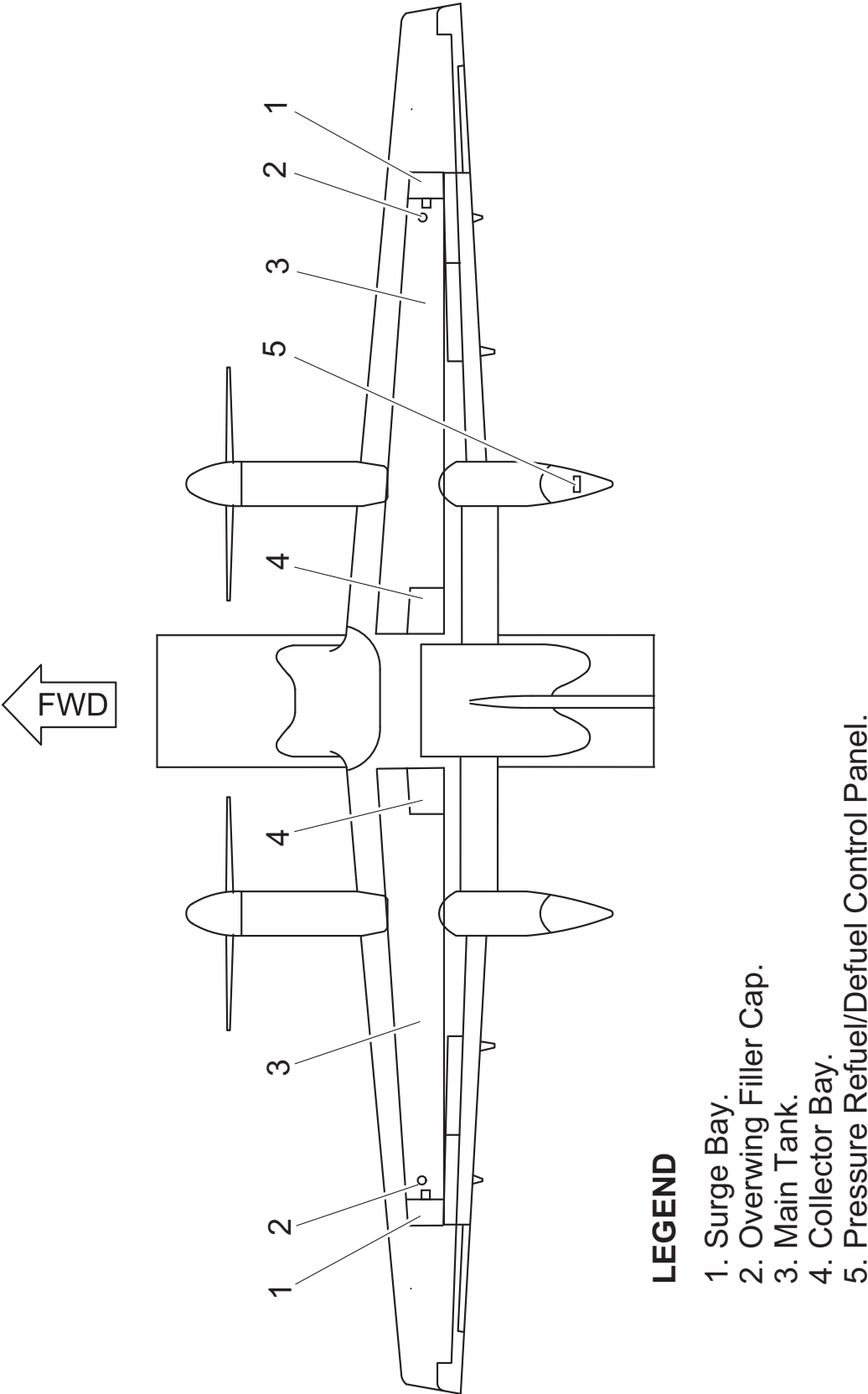


Figure 12.9-9 Fuel Tank Layout

12.9.5 Storage And Distribution

There are two integral (wet) wing tanks that extend laterally from the fuselage to the rib just inboard of the ailerons (Figure 12.9-9). Each wing tank is divided into three sections:

- Surge bay
- Main tank
- Collector bay

The surge bay is located between the two ribs inboard of the aileron. The main tank extends from the surge bay to the fuselage and collector bay. The collector bay is located at the inboard and aft part of the wing tank. Fuel is contained in the main tanks and the collector bays.

Total usable fuel from the tanks is 5,318 kg. The maximum lateral imbalance permitted between tanks is 272 kg. Water drain valves in the low points of the surge bays, main tanks, and collector bays are located on the underside of the wings.

The surge bay is used for main tank venting and fuel recovery. Two outboard float vent valves and one inboard vent line, control the pressure between the related surge bay and main tank (Figure 12.9-10). The two float vent valves, located near the top of the tank, open and close depending on the fuel level in the main tank. Each surge bay is vented through integral stand-pipes to two separate NACA vents on the bottom of the wings. During flight, any fuel that may spill into the surge bay, is returned to the tank by the reduced pressure in the main tank, as fuel is used.

The collector bay supplies engine fuel regardless of aircraft attitude. Fuel tank scavenging takes place using scavenge ejector pumps in each tank which draw fuel from tank low points, to keep the collector bay full. A primary ejector pump in the collector bay then provides a constant low-pressure fuel supply to the engine. High-pressure motive flow is used to operate the scavenge and primary ejector pumps.

Flapper check valves are located at the base of each collector bay, and select ribs. They ensure gravity fed fuel flow into the collector bay if the scavenge flow is not sufficient.

The related #1 TANK or #2 TANK FUEL LOW caution light will come on if:

- park brake is off
- related collector bay level drops below approximately 150 kg.
- related engine is operating.

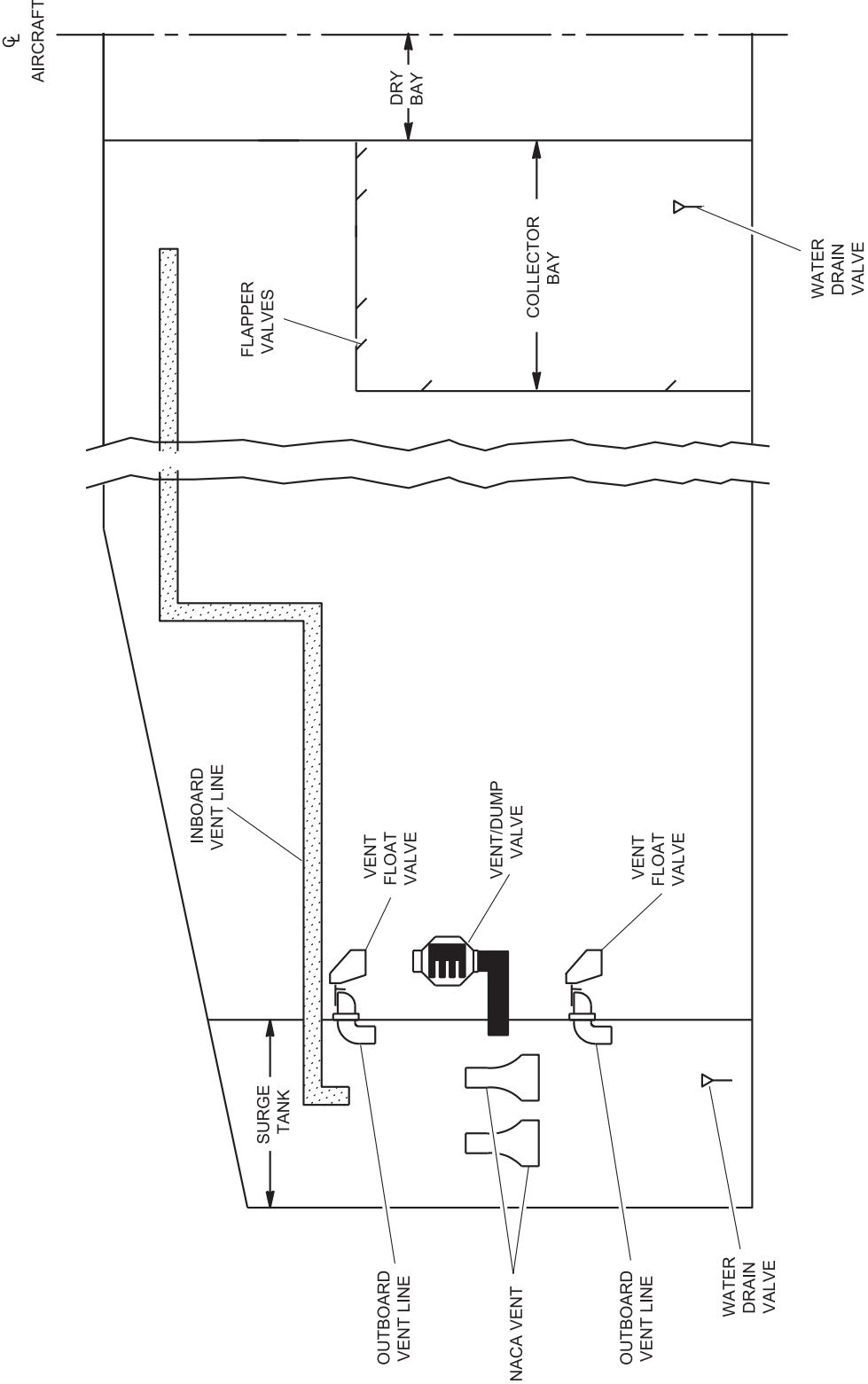


Figure 12.9-10 Fuel Tank Venting

12.9.6 Engine Fuel Feed

Fuel to each engine is fed from the collector tank, from a primary ejector pump or an AC driven auxiliary pump, and delivered to the engine driven pump (Figure 12.9-11). If the engine driven pump inlet pressure drops below a preset limit, the related #1 or #2 ENG FUEL PRESS caution light comes on.

An AC (Variable Frequency) auxiliary pump in each collector bay serves as a back up source of fuel boost pressure for takeoff and landing, and in case the related primary ejector pump does not supply the necessary fuel pressure. Related TANK 1 or TANK 2 AUX PUMP switchlights on the FUEL CONTROL TRANSFER panel control the auxiliary pumps manually (Figure 12.9-12). A TANK 1 or TANK 2 AUX PUMP switch indicator on the MFD Fuel Page shows the position of the switchlight. When the pump is supplying sufficient boost pressure, the TANK 1 or TANK 2 AUX PUMP light on the Fuel Page will turn green, and the related ON switchlight segment turns green.

The engine feed shutoff valve closes when the related PULL FUEL/HYD OFF handle, on the Fire Protection Panel (FPP), is pulled (Figure 12.9-12). Advisory lights on the FPP show when the valve is open or closed.

The fuel is filtered and heated by Fuel Oil Heat Exchanger (FOHE) before entering the FMU. If the fuel filter becomes blocked, fuel bypasses the filter. The #1 or #2 FUEL FLTR BYPASS caution light will come on if a related bypass is impending.

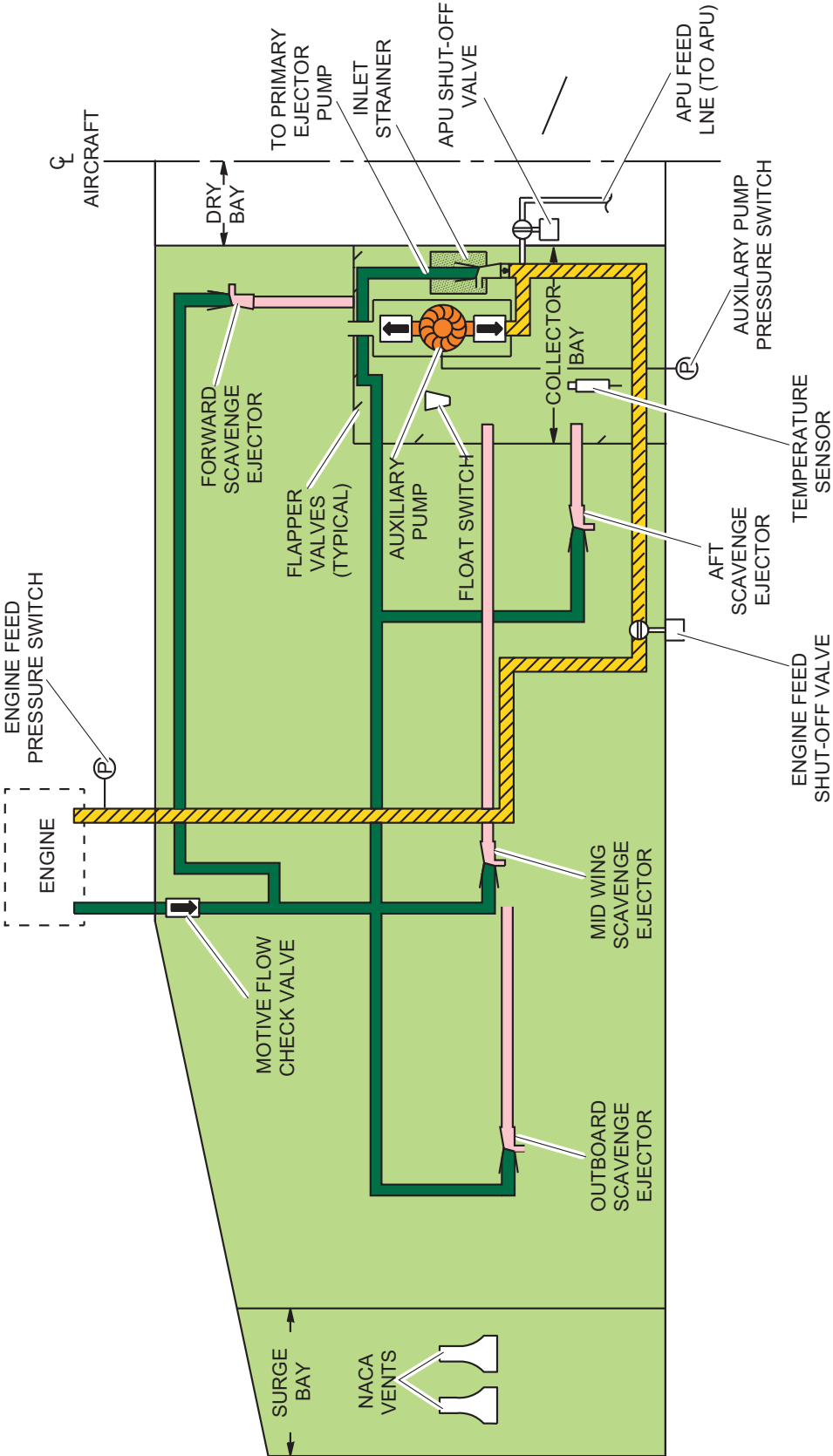


Figure 12.9-11 Engine Fuel Feed Schematic

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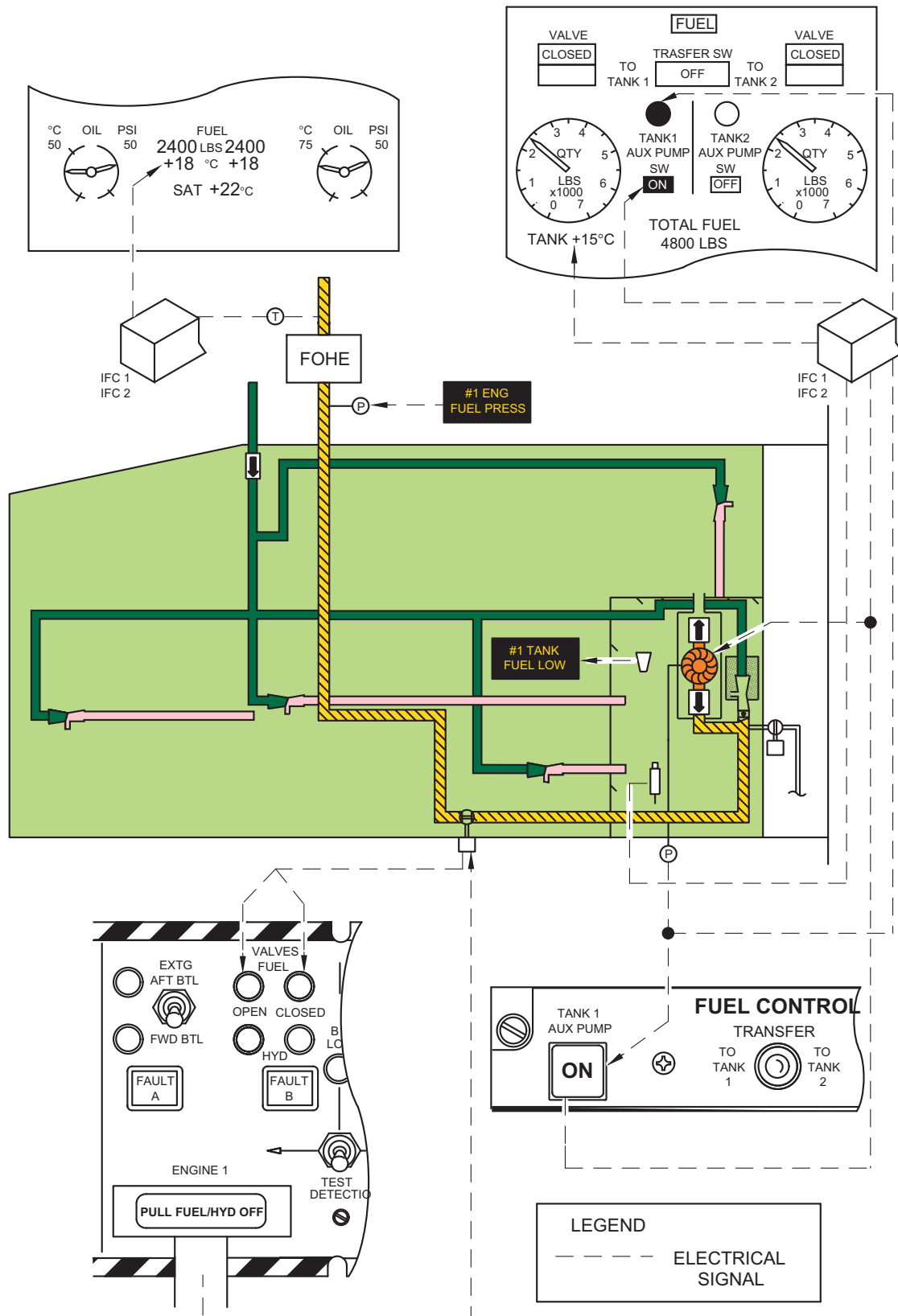


Figure 12.9-12 Engine Fuel Feed Operation

Dash8 - Q400 - Fuel

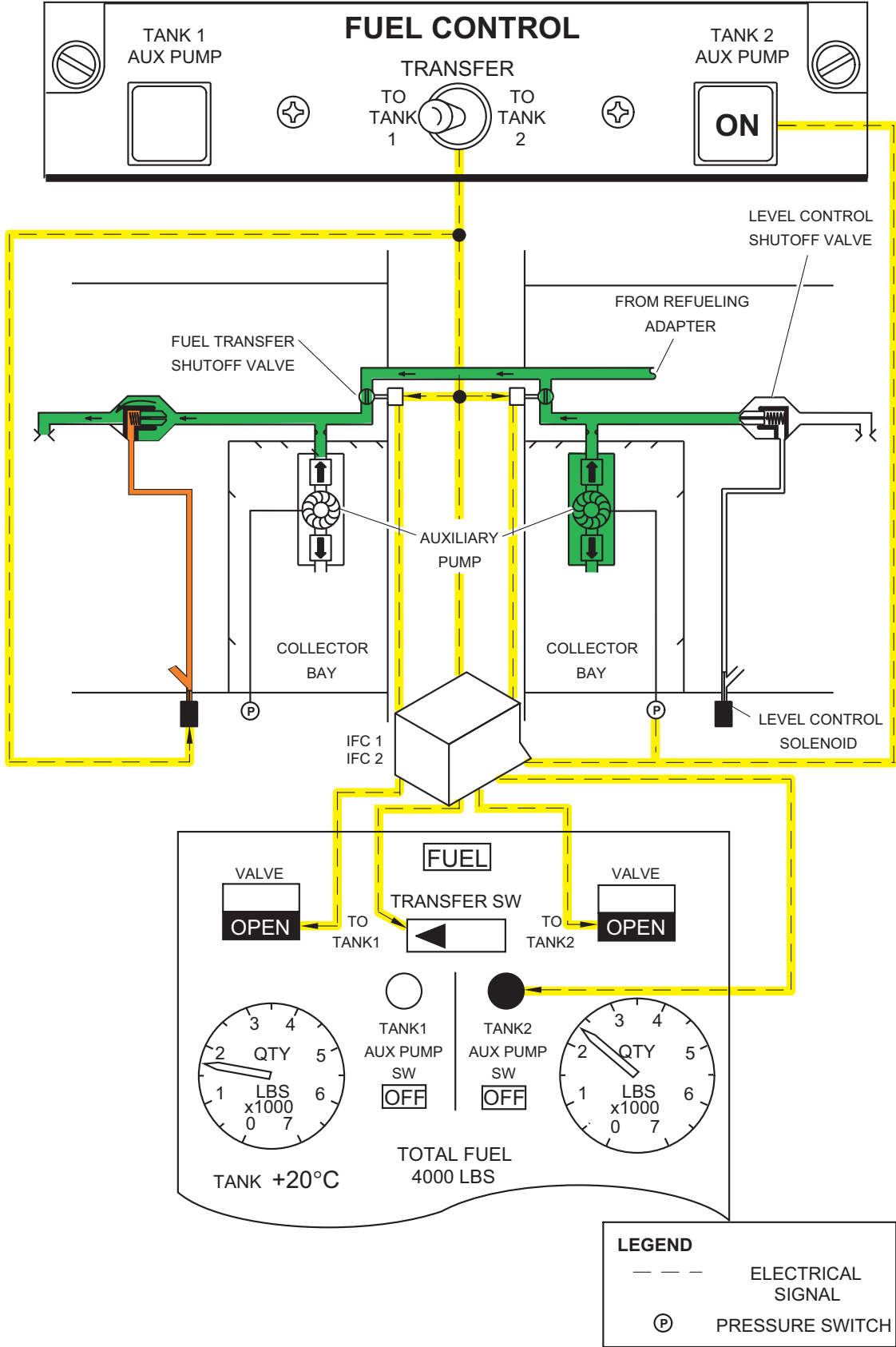


Figure 12.9-13 Fuel Transfer Schematic

12.9.7 Fuel Transfer

Fuel can be transferred from one tank to the other to correct fuel imbalances or for fuel management. If the Fuel Quantity Computer (FQC) detects a fuel imbalance of more than 272 kg, a yellow [BALANCE] message flashes just above the FUEL legend of the ED. The message will flash until the imbalance is corrected. An imbalance condition will also be shown on the Fuel Page by the analog quantity dials changing to solid yellow.

A TRANSFER switch on the FUEL CONTROL TRANSFER panel controls the fuel transfer system (Figure 12.9-13). When the TRANSFER switch is selected, the auxiliary pump in the donor tank operates automatically to pump fuel to the receiver tank. A signal from the operating pump causes the related ON switchlight segment to turn green. Electrically operated fuel transfer shut-off valves open for fuel transfer and close when the transfer is stopped. Fuel transfer indications are also shown on the MFD Fuel Page. Once selected, fuel transfer will continue until deselected by the flight crew or until a high-level sensor in the wing tank which is receiving fuel detects an overfill condition, which automatically halts fuel transfer. Fuel cannot be transferred if the FUELING ON caution light is on. The FUELING ON caution light is on if the refuel/defuel access door is open.

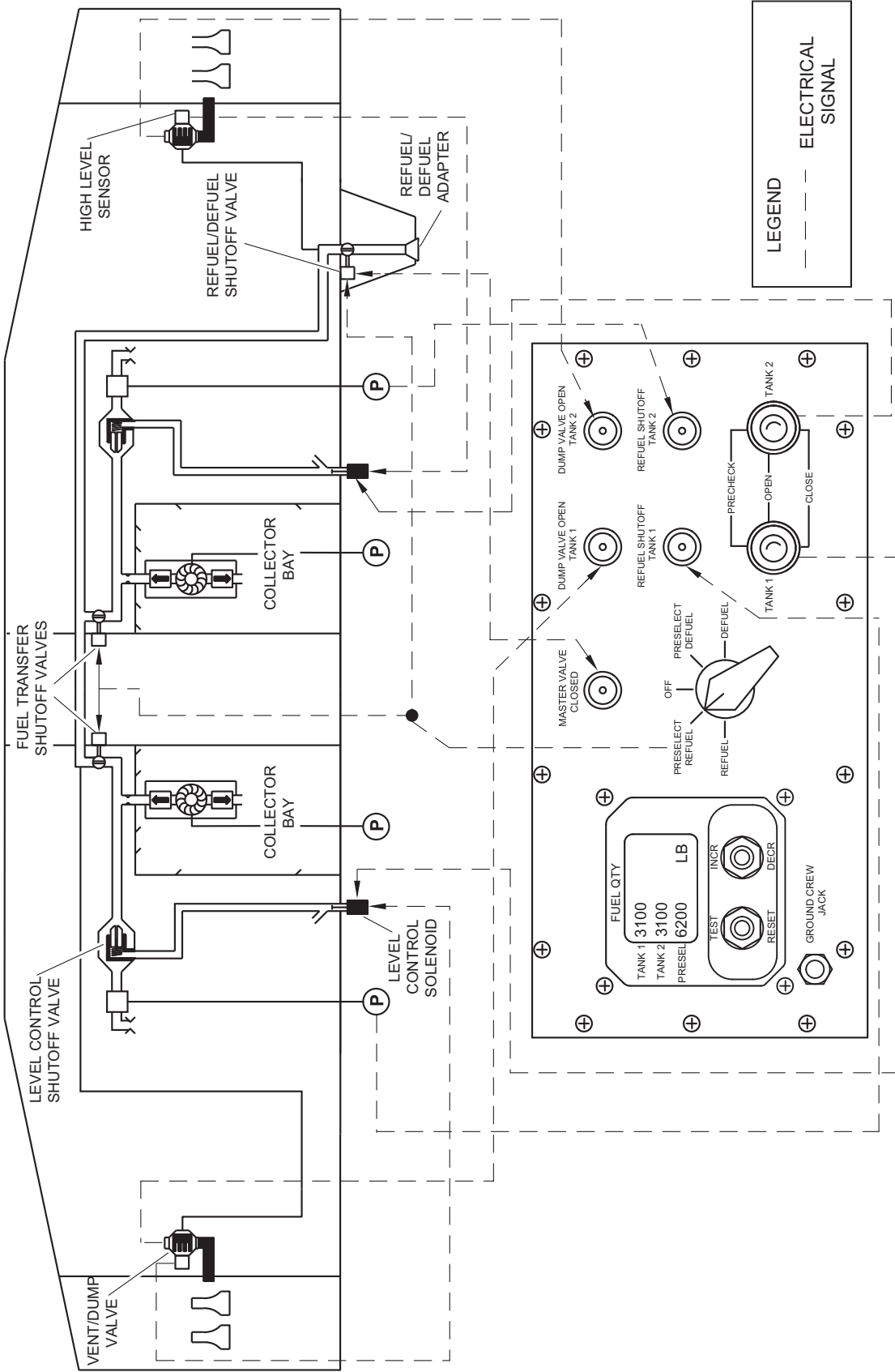


Figure 12.9-14 Refueling Schematic

12.9.8 Refueling

The refuel/defuel panel controls all refuel and defuel operations (Figure 12.9-14). Access to the panel is gained through a flush door on the rear underside of No. 2 nacelle. DC power must be available for refueling. The FUELING ON caution light will come on when the refuel/defuel door is open with electrical power supplied. Refueling can be accomplished either automatically (PRESELECT REFUEL), or manually (REFUEL).

When the rotary selector is turned to the PRESELECT REFUEL or REFUEL position, the MASTER VALVE CLOSED light goes out to show that the refuel/defuel shutoff valve is open (Figure 12.9-15,16). The refuel/defuel shutoff valve will close when the refuel/defuel door is closed, regardless of the rotary selector position. During pressure refueling, fuel pressure opens a vent/dump valve in each tank to vent the tanks through the surge bay. For automatic refueling, the desired quantity is selected adjacent the PRESEL display on the Refuel/Defuel Indicator (RDI), by using the INCR DECR toggle switch (Figure 12.9-17). When the selected quantity is reached, the level control shutoff valve automatically stops fuel flow to the related tank. The PRECHECK, OPEN, CLOSE switches must be set to OPEN for refueling.

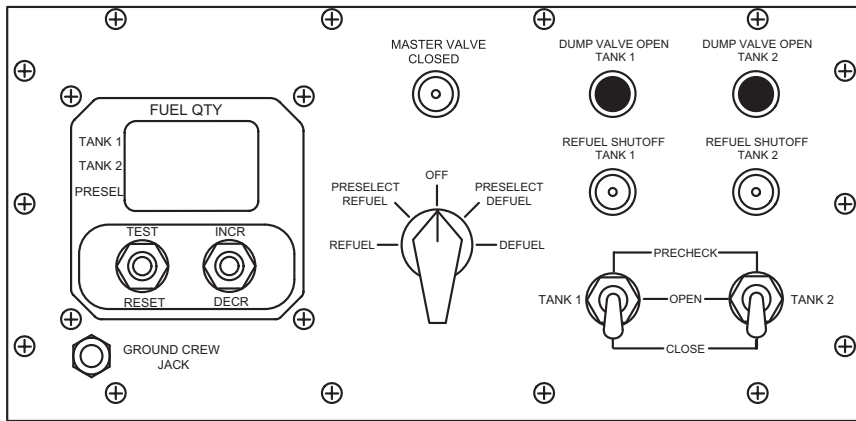
During manual refueling, the desired quantity in each tank is controlled by the PRECHECK, OPEN, CLOSE switches. The RDI will display the individual tank quantities. With the rotary selector turned to the REFUEL position, refueling continues until the PRECHECK, OPEN, CLOSE switches are in the CLOSE position, the selector switch is turned to the OFF position, or until the high level sensors sense a full tank condition.

When fueling is in progress, advisory lights on the refuel/defuel control panel indicate the position of the fuel control valves. The amber DUMP VALVE OPEN indicator light comes on when the related vent/dump valve opens. The vent/dump valve allows air to vent from the tank as it fills, and prevents damage should the tank overfill due to failure of both normal and backup shutoff features. In the latter case, fuel flows into the surge bay through the refuel vent valve and, if it reaches the height of the standpipes, is spilled overboard through the surge bay NACA vents.

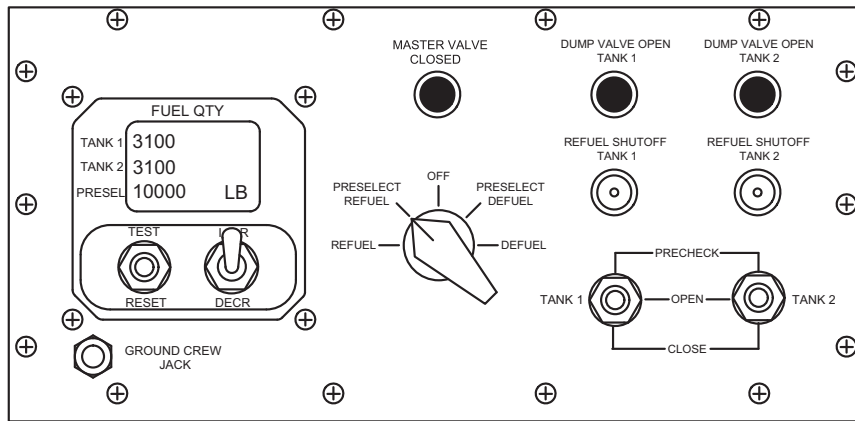
Two PRECHECK, OPEN, CLOSE switches test the automatic shutoff operation of the related high level control unit during refueling, ensuring operation of the overfill shut off system. With the switch in the PRECHECK position a full tank is simulated for the related tank, and the high level sensor shuts off refueling to that tank by closing the level control shut off valve. This causes the related amber REFUEL SHUTOFF light to turn on. Refueling restarts when the switch is released. If DC power is lost during refueling, refueling stops.

Gravity refueling can be done through the wing mounted gravity refuel adapter located on the top surface of the wing (Figure 12.9-18).

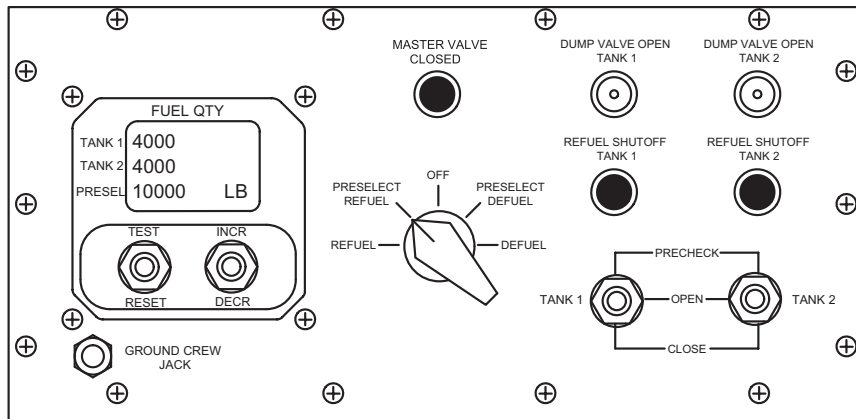
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INITIAL CONFIGURATION



PANEL SET TO INITIATE REFUELING



REFUELING IN PROGRESS

LEGEND



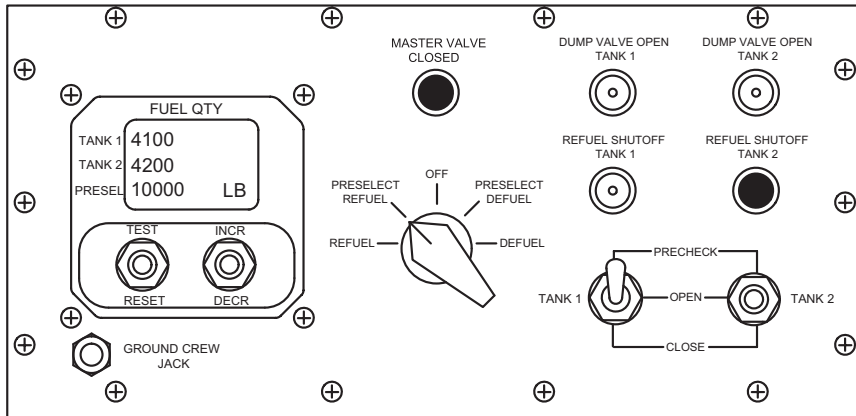
Light Off.



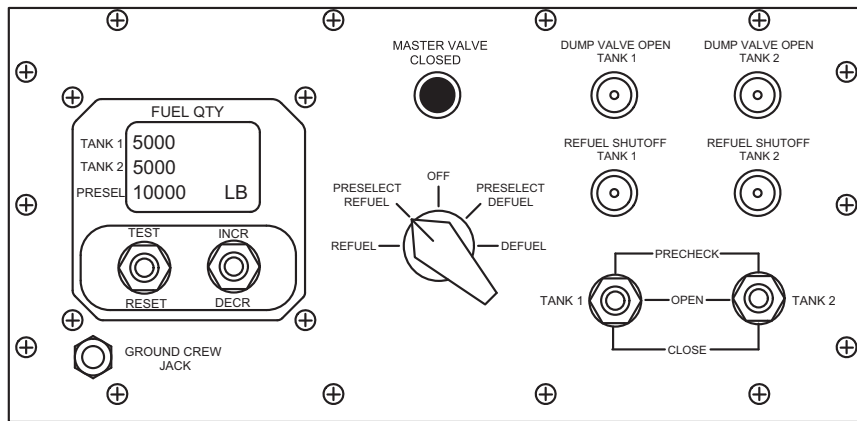
Light On.

Figure 12.9-15 Refueling Operation (1 of 2)

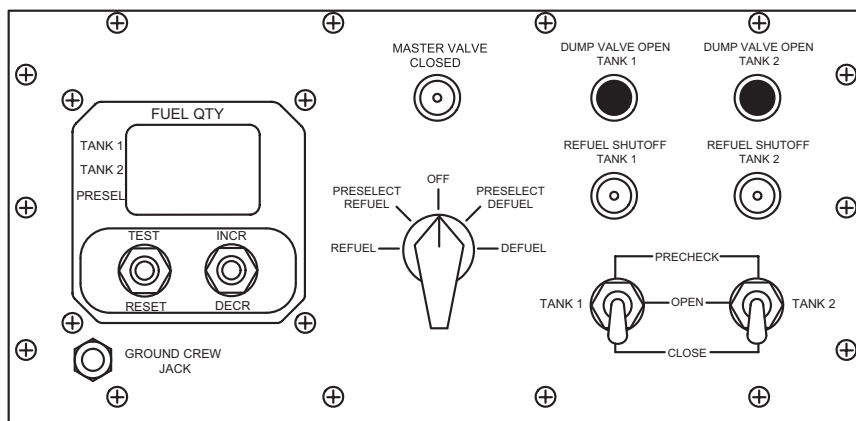
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PRE-CHECK TEST (No. 1 TANK) DURING REFUELING



TANKS FULL



REFUELING COMPLETE

Figure 12.9-16 Refueling Operation (2 of 2)

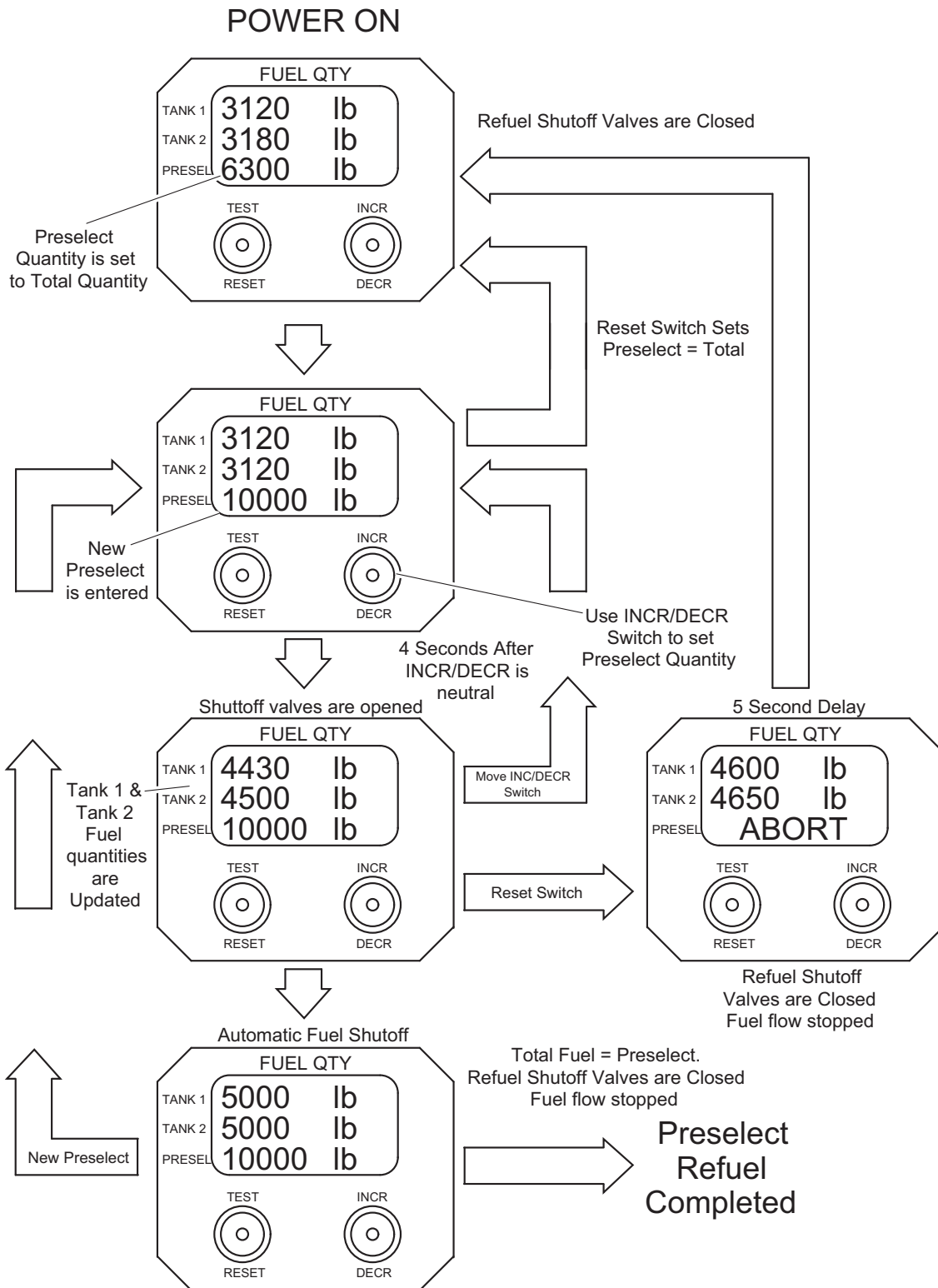


Figure 12.9-17 Refuel/Defuel Indicator Operation

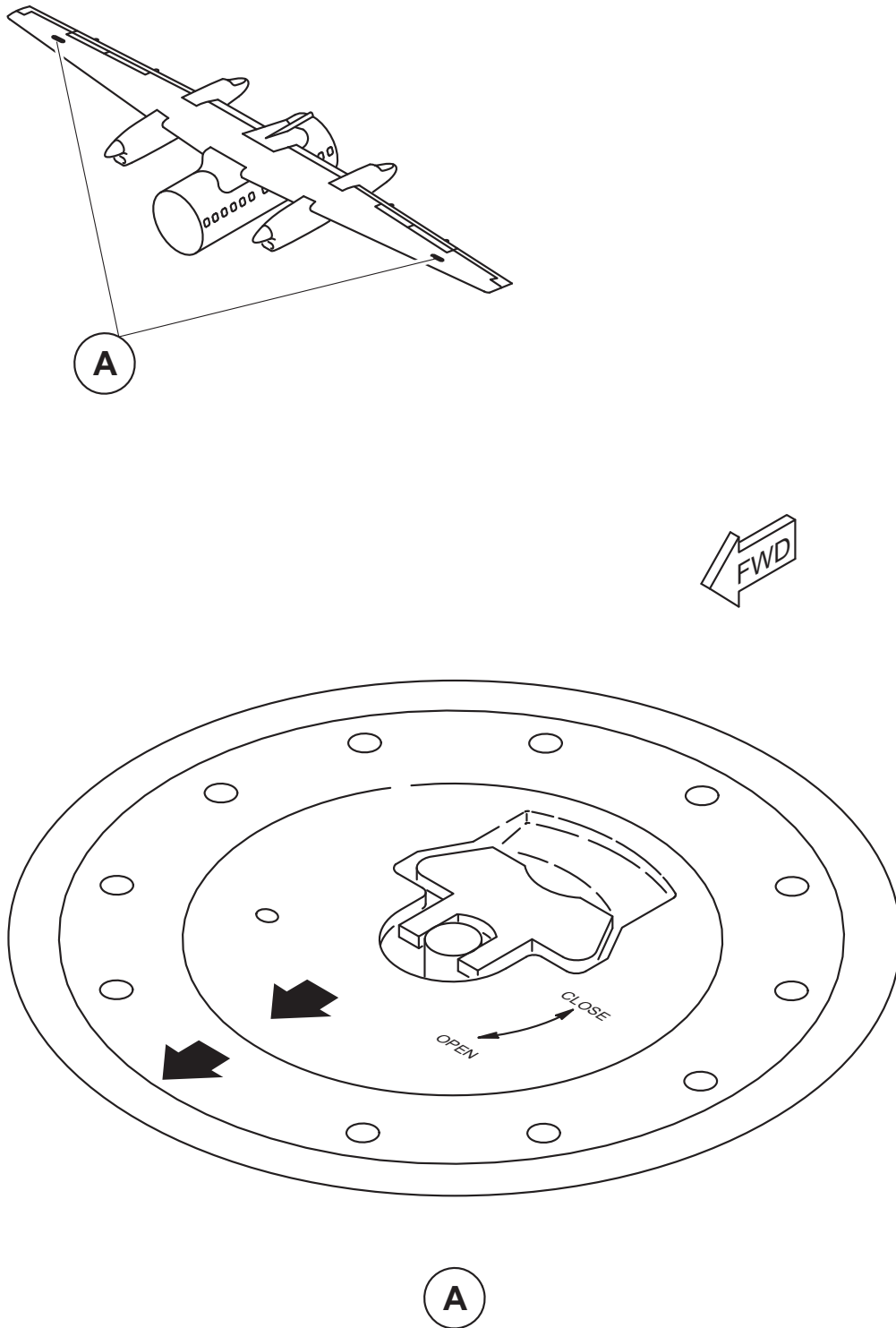


Figure 12.9-18 Overviewing Filler Cap

12.9.9 Defueling

When the rotary selector is turned to the PRESELECT DEFUEL position, the FGC closes the refuel/defuel valves to automatically stop defueling at the preset quantity. When the rotary selector is turned to the DEFUEL position, defueling continues until the selector switch is turned to the OFF position. If AC (variable frequency) power is available, the related auxiliary fuel pump operates to help the defueling process. Without an AC power source, suction defueling must be used. DC power is required for defueling regardless of AC power availability.

12.9.10 Limitations

The maximum refueling pressure is 50 psi, which gives a refueling flow rate of approximately 125 gallons per minute. A minimum of 20 psi refueling pressure is necessary for the system to operate properly.