

# FUEL

## GENERAL

The Sovereign utilizes a wet wing with fuel divided into two separate tanks by a fuel rib in the center of the wing (BL 0.00). Normal operation supplies fuel to the engine from its respective integral wing tank. Each wing tank holds approximately 837 U.S. gallons for a total airplane capacity of 1,674 gallons of usable fuel (approximately 11,223 pounds). Crossfeed capability is incorporated, and when selected enables both engines to receive fuel from a single tank. A single-point pressure refueling receptacle is located on the right side of the fuselage, forward of the wing. It permits simultaneous servicing of both sides of the fuel system. Refer to the Maintenance Manual, Chapter 12 for fuel servicing procedures.

System operation is fully automatic throughout the normal flight profile. Fuel system control and monitoring is available through the Fuel BOOST switches, CROSSFEED knob, fuel quantity and flow indicators, and EICAS information that will warn of abnormal system operation. A low fuel level warning system functions independently of the normal fuel quantity indicating system.

Normal operation of the fuel system allows each engine to receive fuel from its respective wing tank. APU fuel is supplied from the right fuel system.

During engine start the electric fuel boost pumps are automatically turned on to provide engine start fuel until sufficient engine RPM is achieved for the engine driven fuel pumps to provide high pressure flow to the primary ejector pump. The electric boost pumps will then automatically shut down with the annunciator switch in the NORM position.

During APU starting, the right fuel boost pump automatically turns on. If the APU is running independently, the right fuel boost pump will remain on. If the right engine is running and supplying motive flow pressure, the fuel boost pump will automatically shutoff after an APU start.

## WING FUEL TANKS

Fuel for each tank is contained between the fore and aft spars, and from the center point of the wing (BL 0.00) outboard to the wing tip (CWS 338.25) with necessary deviations in the wheel well area. Fuel flows freely inboard across the ribs through lightening holes and stringer cutouts, but is restricted from flowing outboard by flapper valves located on three different wing ribs.

An integral engine feed hopper contains the Primary Ejector and Electric Auxiliary Boost Pumps. It is sealed except for vent openings at the top in order to maintain a full hopper under low fuel conditions. Flapper valves allow for gravity fuel flow from the upper hopper down through the Negative G-deck into the Negative G-tank, where the Primary Ejector Pump and Electric Auxiliary Boost Pump inlets are located.

The vent surge tank is located in the most outboard bay of the wing tank. It is physically isolated from, but interconnected to the main tank. It serves to collect fuel that flows outboard through the vent system and to provide additional expansion space. Flapper valves located in the outboard wing allow for fuel in the vent surge tank to be returned to the main tank.

## **DRAIN VALVES**

Six wing tank drains are installed for inspection of fuel for contaminants. Four drains are located in the center of the wing and the remaining two are located at the outside of each wheel well.

## **VENT SYSTEM**

The left and right wing fuel tanks have separate vent systems that serve to vent the fuel tanks during flight maneuvers and single-point refueling/defueling operations. A normally open vent float valve mounted on the inboard side of the surge tank wing rib acts as the primary vent during refueling and defueling.

### **CLIMB VENT LINE**

A climb vent line is installed to provide fuel tank venting in a steep climb and/or wing low flight condition. It also provides additional wing tank venting during portions of the refuel/defuel operations. This vent line terminates in a climb vent standpipe near the upper wing skin within the vent surge tank.

### **VENT SURGE TANKS**

The surge tank, which functions as a fuel collector, is vented to the atmosphere through a flush, non-icing, NACA scoop. This vent scoop is connected to the vent surge tank with an open-ended standpipe located at a high point of the surge tank to prevent fuel from siphoning or spilling overboard.

## **RELIEF VALVES**

Each wing tank incorporates a relief valve, which prevents excessive positive or negative tank pressures during single point refueling or if the normal vent system fails, closes, or is blocked. Pressure relief is set to occur when internal tank pressure reaches +6.0 PSIG or -.7 PSIG.

## ENGINE FUEL SUPPLY COMPONENTS

The wing tank structure allows fuel to gravity flow freely through holes and cutouts to the wing root. The integral engine feed hopper contains fuel supply components (ejector pumps, boost pumps, etc.) and is located near each wing root.

Wing tank fuel is constantly transferred to the engine feed hopper by three scavenge ejector pumps. Each engine is supplied with fuel primarily by the motive-flow primary ejector pump and by the auxiliary electric fuel boost pump located in the feed hopper. The three scavenge ejector pumps are located forward, center, and aft of the inboard wing. The forward scavenge pump provides fuel flow to the engine hopper in descent flight attitudes, the center pump for cruise attitudes, and the aft pump for climb flight attitudes. The scavenge ejector pumps makes sure the engine feed hopper maintains a constant level of fuel for supply to the engine in all flight attitudes. The scavenge ejector and engine feed hopper gravity flapper valve inlets protect the feed hopper and engines from contaminants using large area wire mesh screens.

### EJECTOR PUMP

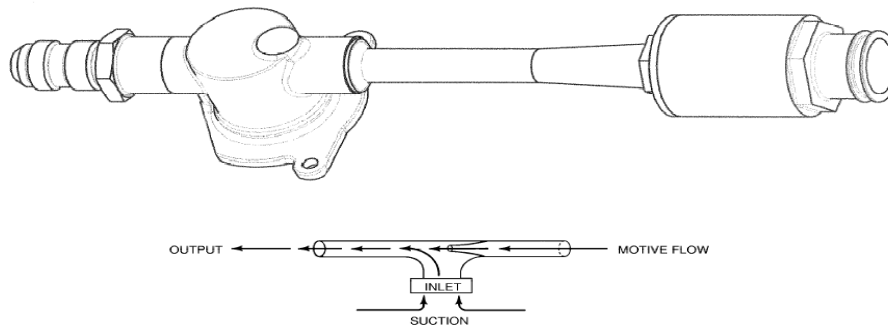


Figure 2-7

In normal operation each engine receives fuel from the corresponding wing tank. For engine start and low fuel pressure conditions the electric boost pump supplies fuel to the engine. High-pressure fuel from the engine driven fuel pump provides motive flow for use of the primary ejector pump to supply fuel to the engine during normal operation. The electric boost pump is energized during crossfeed operations.

A fuel pressure-sensing switch is located in the engine nacelle and provides for automatic electric boost pump operation. In the event that fuel pressure drops to between 8.5 and 9.0 PSIG, the pressure switch becomes active and turns on the electric boost pump for the respective engine. This switch will deactivate the boost pump once fuel pressure reaches approximately 10.8 PSIG and is increasing. The pilot is notified of fuel boost pump operation with an amber FUEL BOOST PUMP ON L or R CAS message.

Each fuel supply line (left engine and right engine) also contains a firewall shutoff valve. These valves are located behind the rear spar in an access panel area, and are actuated by the fire tray annunciator/switches.

## CROSSFEED OPERATION

Either engine can be provided with fuel from the opposite wing tank. To initiate crossfeed operations, position the CROSSFEED knob, located on the lower left of the cockpit instrument panel, to either the left (L TANK) or right (R TANK) position and verify that the fuel boost pump annunciator switches located directly above the crossfeed control are illuminated in the NORM position. In the L TANK \ R ENG position, both engines receive fuel from the left wing tank. If the fuel CROSSFEED selector knob is turned to the R TANK / L ENG position fuel is supplied to both engines from the right wing tank.

When fuel crossfeed is selected, the corresponding electric fuel boost pump is energized and the crossfeed valve receives power and opens. Three seconds later, the motive-flow valve on the engine receiving crossfeed fuel is closed.

In order to terminate crossfeed operation, the fuel CROSSFEED sector knob is placed in the OFF position. The following sequence of events is performed once the CROSSFEED select knob is turned to the OFF position:

- 1) The motive-flow valve is opened.
- 2) After three seconds the crossfeed valve is closed and the respective electric boost pump is shut off.

## SINGLE-POINT REFUEL/DEFUEL SYSTEM

### GENERAL

The single-point refueling system is used to pressure refuel and defuel the left and right wing tanks from a single refuel/defuel adapter. This adapter is found just forward of the wing fairing on the right hand side of the fuselage. Normal system operation is by fuel level and positive (refuel) or negative (defuel) pressure. A system precheck is incorporated to test the high level automatic shutoff prior to fueling completion.

### SINGLE-POINT REFUELING

Single-point refueling is accomplished by the connection of refueling equipment to the refuel/defuel adapter and applying positive pressure for refueling. Each wing tank receives fuel through a common manifold to each tank's fuel shutoff valve. Fuel pressure opens the spring-loaded shutoff valves and delivers most of the fuel to the wing tanks with a small amount bypassed to the high level pilot valve. A float-operated needle valve will seat and close the pilot flow once the fuel level reaches the high level pilot valve; this builds pressure on the backside of the fuel shutoff diaphragm. The resulting force imbalance closes the shutoff valve and fuel flow is stopped to prevent an over fill of the respective tank. If one tank has already received a full load of fuel, the remaining tank will continue to receive fuel until it receives a full load of fuel.

The wings can be refueled together or independently. The opening of a precheck valve of the respective wing prevents refueling of a wing. This causes precheck flow to be sent directly to the high-level pilot valve causing the float operated needle valve to close and shutoff fuel flow to the wing as in a full fuel condition.

### **SINGLE-POINT DEFUELING**

Single-point defueling is accomplished using the same refuel/defuel adapter and applying negative fuel pressure to the fuel tanks. Fuel level and the negative pressure from the defueling equipment control defueling. Opening of the respective precheck valve and applying negative pressure through the refuel/defuel adapter accomplish the defueling operation of one or both tanks. A check valve in the precheck line to the high level pilot valve closes allowing the defuel actuation port of the defueling valve to see negative pressure. This negative pressure releases the float in the defuel valve and unseats the needle valve. When the needle valve is unseated negative fuel pressure is applied to the backside of the diaphragm opening the defuel valve poppet and defueling begins. As one wing tank empties first, the float drops, causing that wing's defuel valve to close, but allows the wing tank with fuel remaining to complete the defueling process.

### **FUEL FLOW INDICATORS**

A fuel flow transmitter in the fuel inlet at the engine measures fuel flow rate. Fuel flow is presented in pounds per hour in the FUEL portion of the EICAS.

### **FUEL QUANTITY INDICATORS**

The Fuel Quantity System measures the amount of fuel onboard. The quantity is displayed in the FUEL portion on the EICAS display. Fuel quantity information is provided to the EICAS by a compensated capacitance gaging system consisting of 7 probes for each wing tank and a dual channel signal conditioner. Each wing fuel tank has an independent channel for fuel quantity measurement.

Each probe has an integrated electronic module that converts the capacitance of the fuel probe to a current signal. This module regulates a current signal supplied by the signal conditioner. The regulated electrical signal is then returned to the signal conditioner as a function of the wing tank fuel level. When probe #1 in either tank is fully covered with fuel it will act as a fuel density compensator. When this probe is not fully covered, reversion to a default density value occurs. Individual fuel probes return a modulated current between 0.5mA for a dry probe to 5.0mA for a completely immersed probe. The signal conditioner processes the output signals from all the probes in the tank to provide a total fuel quantity indication.

The signal conditioner is a microprocessor-based unit with a left and right channel corresponding to the respective wing tank. These channels are electrically isolated but perform identical functions. Each channel of the signal conditioner supplies an ARINC 429 signal to the airplane system for display of fuel quantity on the EICAS. The EICAS will display three amber dashes in the digital readout for an invalid fuel quantity value or a probe failure in either tank.

## FUEL SYSTEM ANNUNCIATIONS

ANNUNCIATOR	COLOR	DESCRIPTION
FUEL QTY VALUE DISPLAY	Green/Amber	Fuel Quantity Display changes from nominal green to amber dashes if there is a failure within the fuel quantity system for that side. Fuel quantity digits for each wing tank indication will turn amber at less than 500 pounds remaining and the total fuel quantity digits will turn amber at less than 1000 pounds remaining.
FUEL TEMP VALUE DISPLAY	White/Amber	Fuel temperature is displayed in white. Amber dashes are displayed when the value is invalid.
FUEL LEVEL LOW L-R	Amber	The CAS message is displayed if the respective low fuel level switch float remains in down position >90 sec indicating that the usable fuel quantity is <500 lbs. Also, if the low fuel condition is not present (float up) for >90 sec then both the respective annunciator disappears.
FUEL PRESSURE LOW L-R	Amber	The CAS message is displayed when the respective fuel system has low-pressure and the engine has not been commanded to shut down or has not failed. This annunciator should not be observed because its delay ought to suffice to permit the boost pump to turn on and restore normal pressure.
FUEL FW SHUTOFF L-R	Cyan	The CAS message is displayed only if FW shutoff valve is both commanded closed (for fire) and is closed.
FUEL FW S/O IN TRANSIT L-R	Amber	The CAS message is displayed when FW Shutoff Valve is neither open nor closed for more than 2 seconds.
FUEL BOOST PUMP ON L-R	Cyan/ Amber	The CAS message is displayed amber if the respective boost pump is energized while the respective fuel system has low pressure. Activation for low pressure is delayed 1/4 second. The CAS message is displayed cyan if the respective boost pump is commanded on without low fuel pressure.
FUEL MOTIVE VLV FAIL L-R	Amber	The L CAS message is triggered when R tank to L engine cross feed is selected and motive pressure fails to drop after 10 seconds. A corresponding symmetrical case exists for R Motive valve fail.
FUEL CROSS FEED	Cyan/ Amber	The CAS message is displayed if the fuel cross feed valve is open. Color is cyan if tank with most fuel transfers to opposite engine, or amber if tank with least fuel transfers to opposite engine. Color changes from cyan to amber if feeding tank is <sup>3</sup> 60 lbs under the weight of opposite tank, and resets to cyan if feeding tank is < 60 lbs under the weight of the opposite tank.
FUEL CROSS FEED TRANSIT	Amber	Fuel cross feed Valve is neither open nor closed for more than 2 seconds.

Figure 2-8

# FUEL SYSTEM CONTROL PANEL

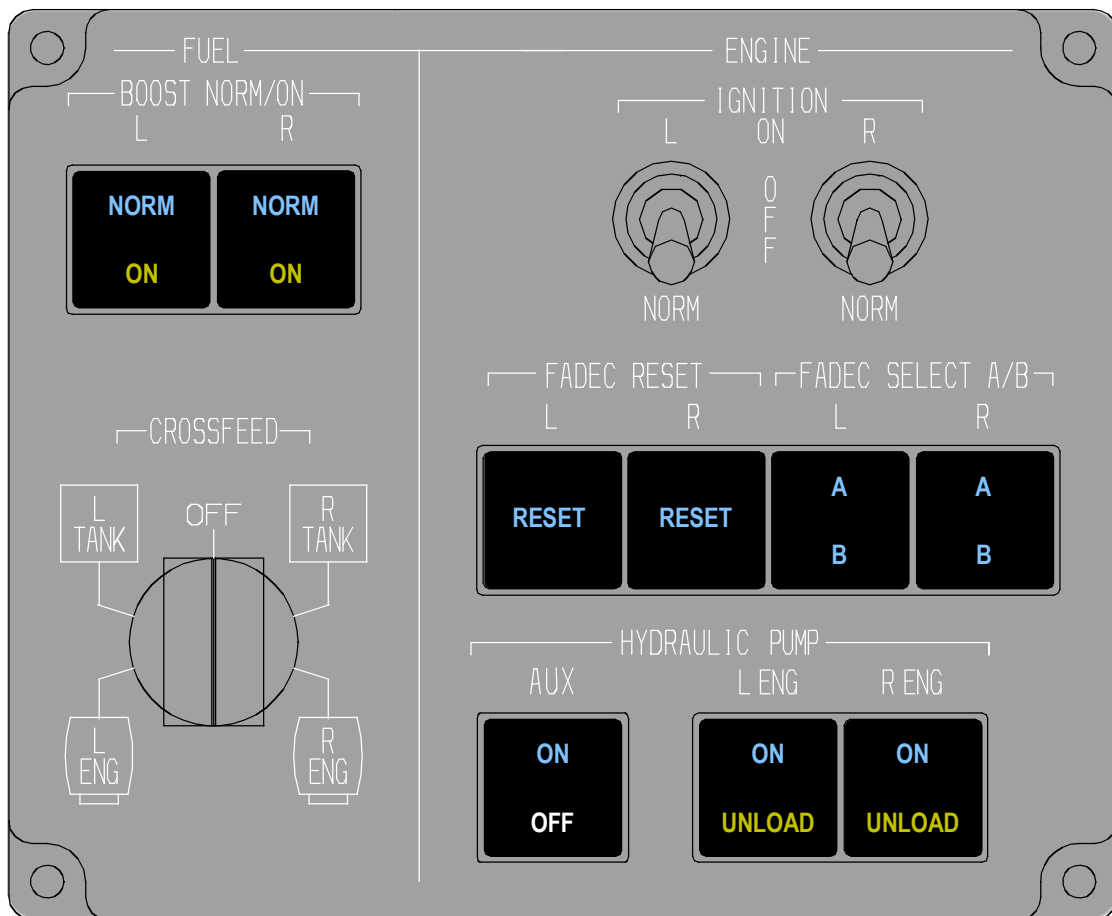
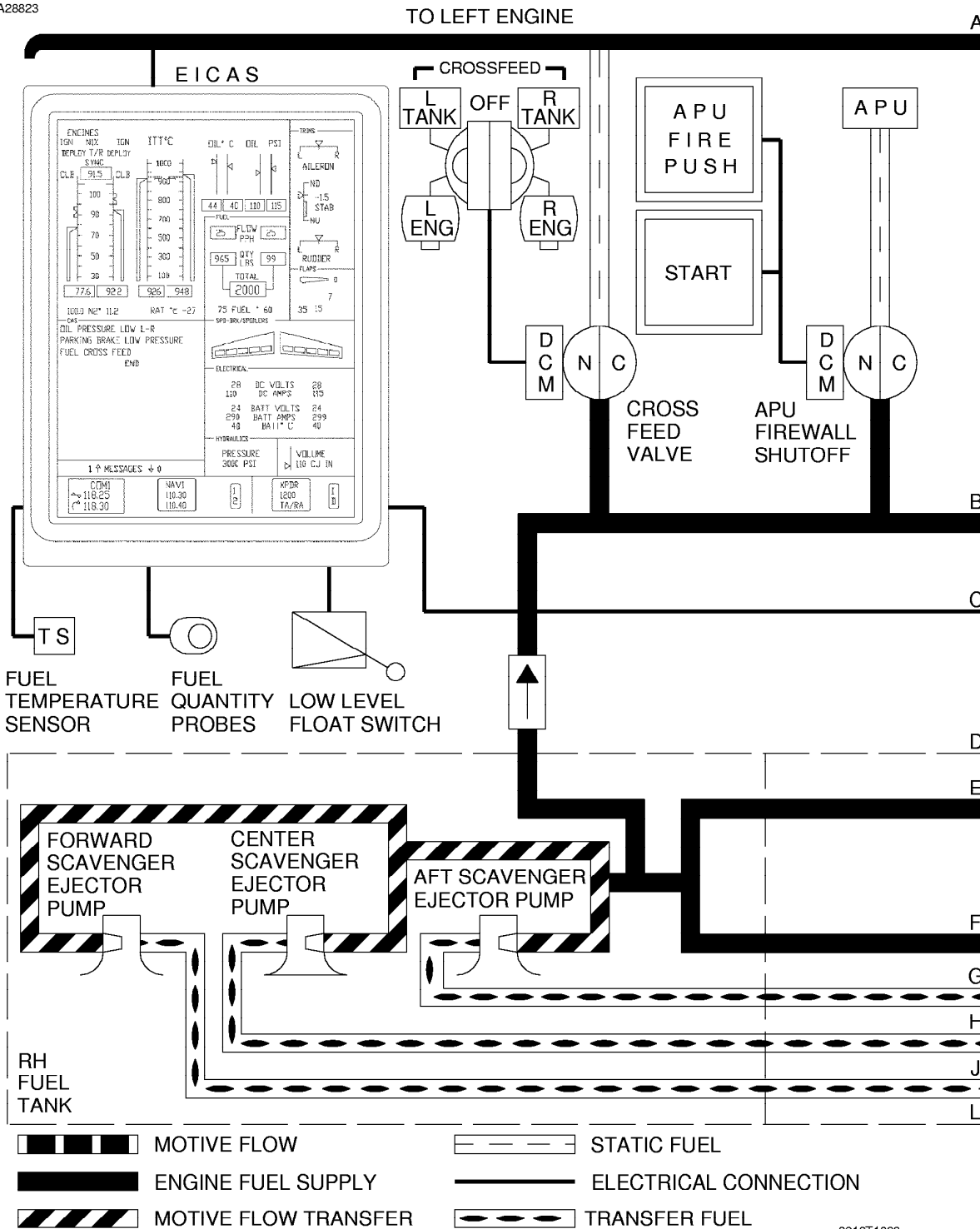


Figure 2-9

# FUEL SYSTEM SCHEMATIC

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Figure 2-10 (Sheet 1 of 2)

# FUEL SYSTEM SCHEMATIC

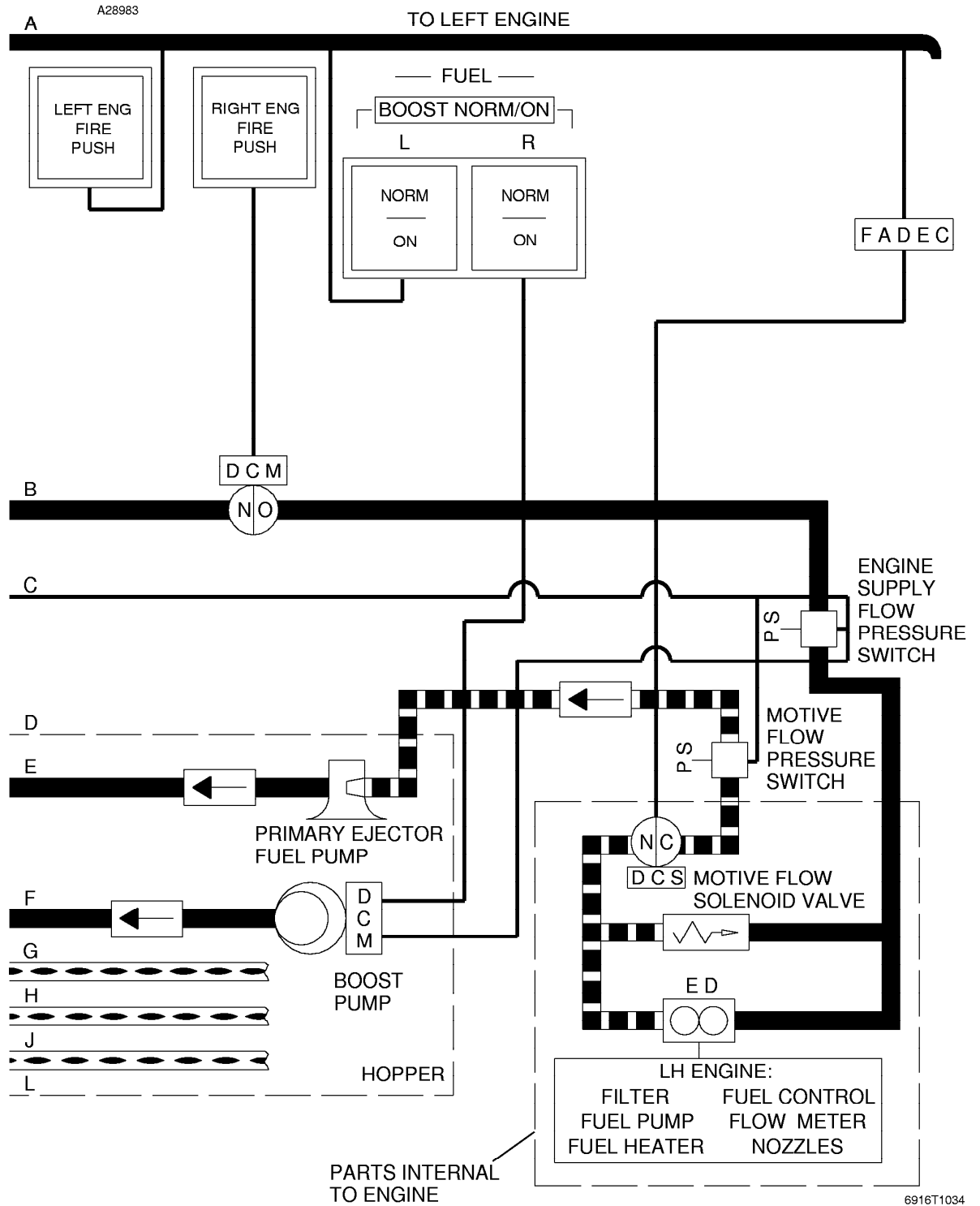


Figure 2-10 (Sheet 2)