AEM 617

Fuel Systems
part 3

Excellent Source: Aircraft Fuel Systems, Langton (editor) et. al. , AIAA
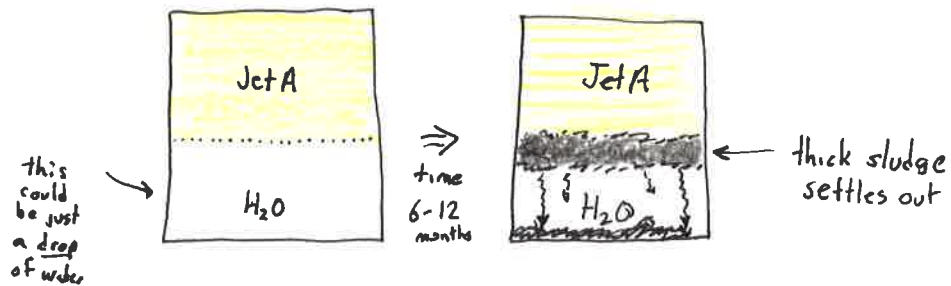
G450 source: code 7700.com   (strongly rec')

B737 source: www. b737.org .uk

Microbial Growth in Diesel and related fuels (Jp8, JetA)   aka: Diesel Bug

Fungus, and Yeasts live (and thrive) at the diesel/water interface.
(Bacteria)

this could be just a drop of water →

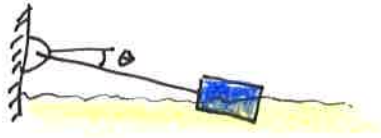Jet A / H₂O   ⇒ time 6-12 months   Jet A / H₂O   ← thick sludge settles out

The primary culprit is a fungus *Cladosporum resinae* which metabolizes the carbon (and sulfur?) in the fuel. The fungus creates a biofilm to ~~moist~~ trap more water and increase the interface region. The growth also creates acid that dissolve into the fuel (MIC = Microbially Induced Corrosion).

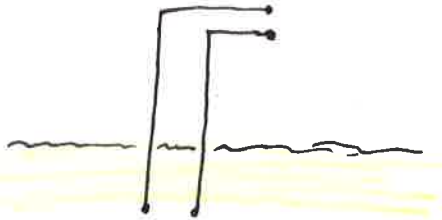Growth requires water. Growth is vigorous at 75°F to 95°F.

- Clogs fuel systems (injector nozzles!)
- ~~Trapps~~ Traps H_2O filters
- Pervasive and ubiquitous
- Multiple species (dozens)
- Corrosion
- Misleading fuel gauges (esp. capacitance types b/c H_2O)
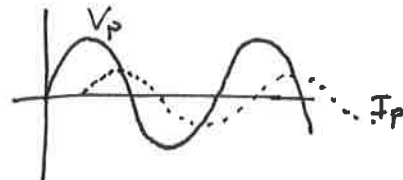- Biocide treatment.

Fuel Probes.

Floats:

Capacitance:

$=$

Input sine wave voltage

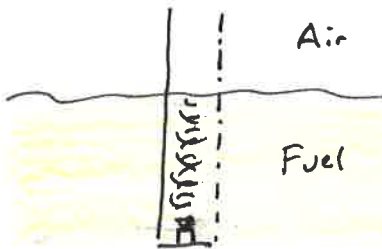$$I_p = \frac{V_p}{R} \quad \text{but } R \text{ is complex}$$

$$I_p = V_p \, 2\pi f C$$

high voltage best
(in a fuel tank!)

Amplitude and phase change indicates capacitance
which is a function of fuel height.

Ultrasonic

Air

Fuel

Measure time of flight to determine fuel height

Float Stick

read the # here

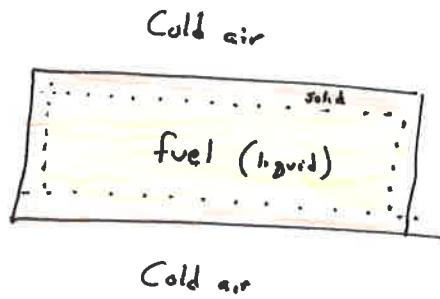Can be pushed flush for flight.

737

6 in each wing tank
4 in center tank

D1 nozzle
NATO spec.

Wax Buildup

When exposed to low temperatures, the jet fuel can "freeze" on the surface.

$\uparrow$ wax

Cold air

fuel (liquid)

Cold air

The fuel tank is a source of thermal mass.

- Cool hydraulic systems.
- Cool electronic systems

Fuel Density

Jet A has varying density b/c refiners.

Fuel burn in lbs per hour. Capacity is gallons.

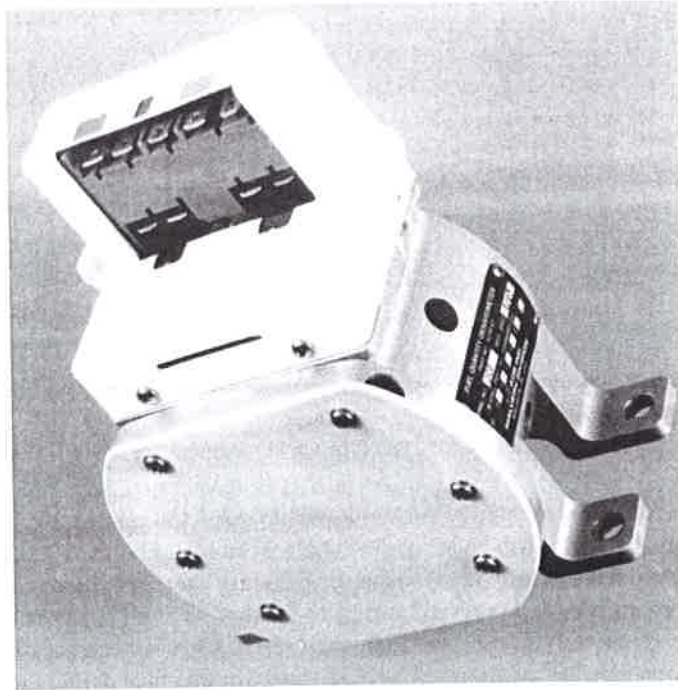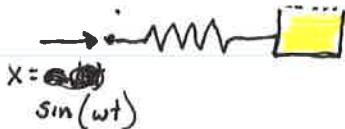How can the pilot/plane convert or know the relationship between lbs and gallons?

Figure 12.31 Fuel densitometer (courtesy of GE Aviation formerly Smiths Aerospace).

Densitometer vibrates a known volume of fuel to give a derived mass of fuel
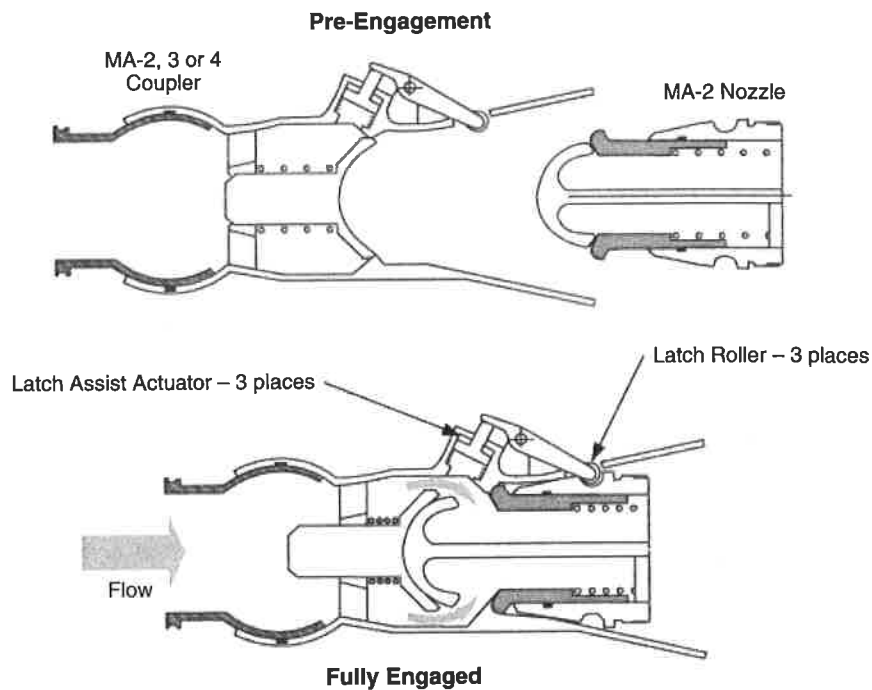

$x = a \sin(\omega t)$

The resulting force during vibration gives mass.

Aerial Refueling

Probe + Drogue (NAVY)

- a conical entrance to guide the nozzle into the coupler;
- a poppet that is opened by the MA-2 nozzle;
- an internal pressure regulation and receiver aircraft surge protection device (for MA-3 and MA-4 couplers only); the MA-3 has one such device while the MA-4 has two for system redundancy;
- roller latches (3) that engage a groove in the MA-2 nozzle body;
- internal fuel pressure actuated pistons that assist holding of the nozzle when engaged.

These features are illustrated in Figure 6.27.

Pre-Engagement

MA-2, 3 or 4 Coupler

MA-2 Nozzle

Latch Roller – 3 places

Latch Assist Actuator – 3 places

Flow

Fully Engaged

Figure 6.27   Probe and drogue nozzle and coupler.

Boom + Receptacle (Air Force)

Pre-Engagement

Boom Nozzle

Receptacle

To Latch/Unlatch
Cylinder

Nozzle Latch

Flow

Fully Engaged

Figure 6.25 Illustration of engagement features of nozzle and receptacle.
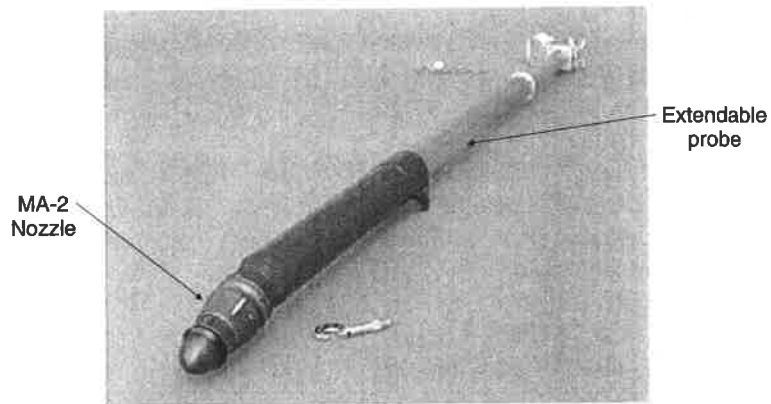
Extendable
probe

MA-2
Nozzle

Figure 6.26 Extendable refueling probe with MA-2 nozzle (courtesy of Parker Aerospace).
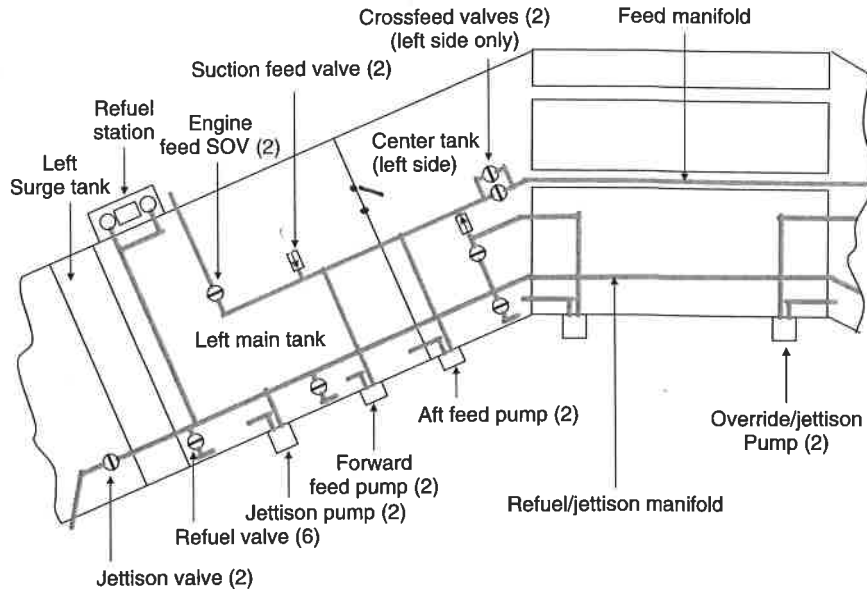
Boeing 777 fuel system

Twin jet transport.

Crossfeed valves (2)
(left side only)

Feed manifold

Suction feed valve (2)

Refuel station

Engine feed SOV (2)

Center tank (left side)

Left Surge tank

Left main tank

Aft feed pump (2)

Override/jettison Pump (2)

Forward feed pump (2)

Jettison pump (2)

Refuel valve (6)

Refuel/jettison manifold

Jettison valve (2)

Figure 12.23   Fluid mechanical schematic.

Center tank-left

Center tank-right

Left main wing tank

Right main wing tank

Left surge tank

Right surge tank

Float drain valves (6)

Float actuated Vent valve (2)

Re-settable Pressure relief valve

NACA scoop & flame arrestor
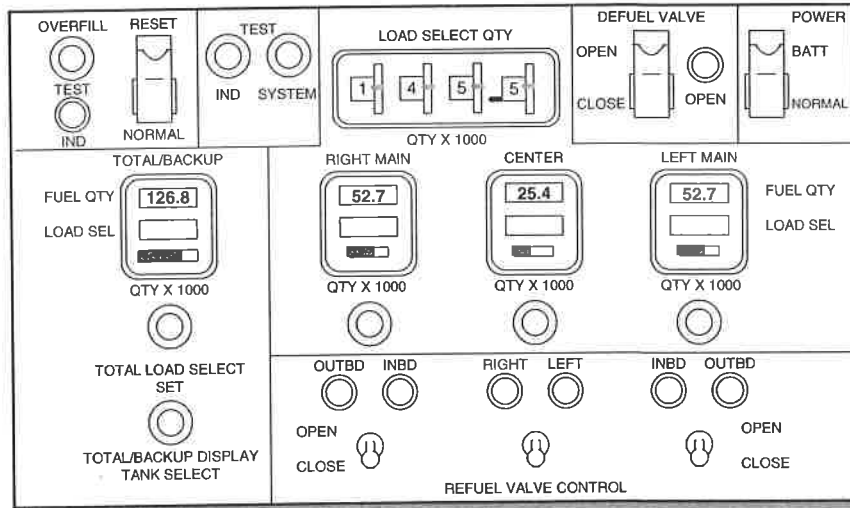
Figure 12.22   Vent system overview.

Outer 20 ft of 777 were originally designed to fold.
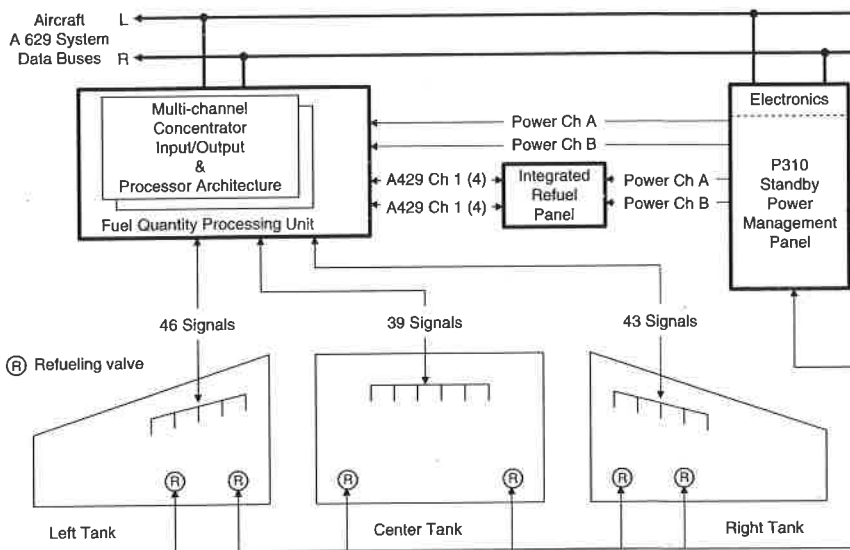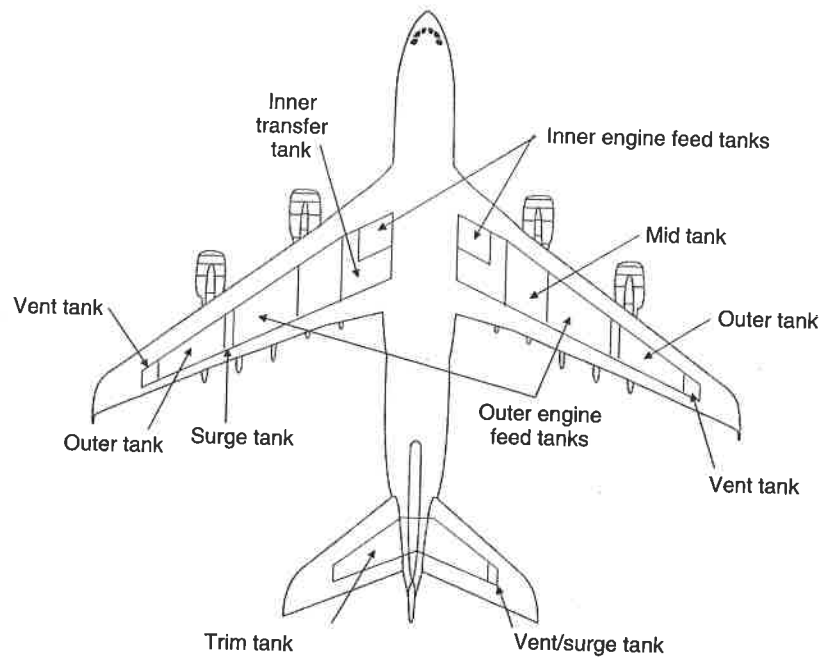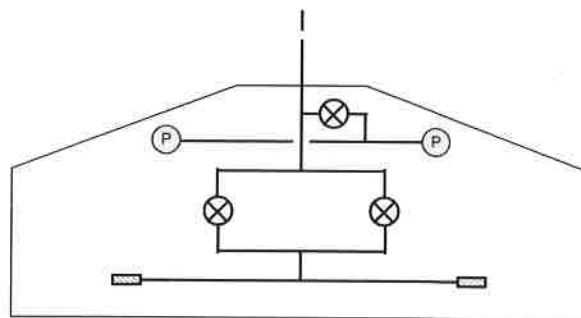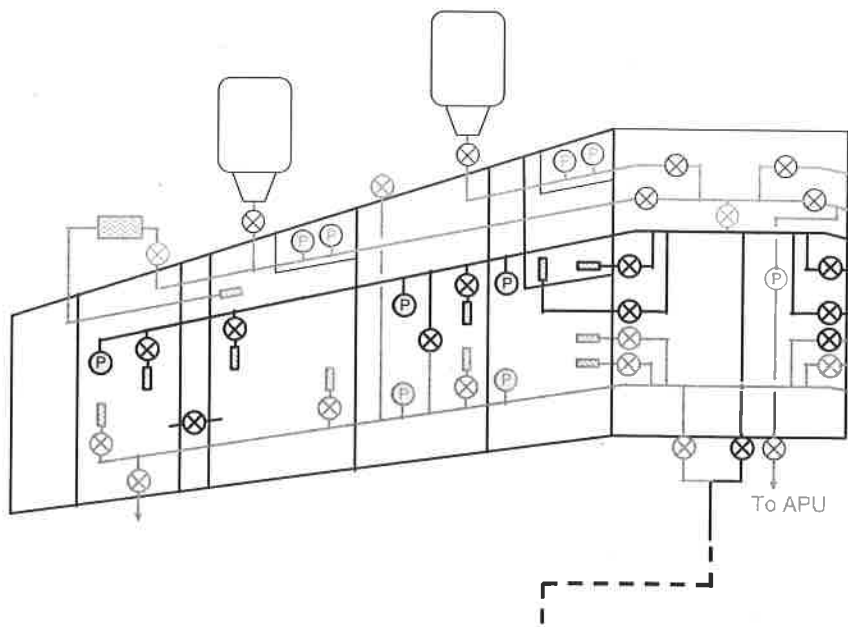
Figure 12.25 Integrated refuel panel.

Figure 12.19 Fuel gauging and management system overview.

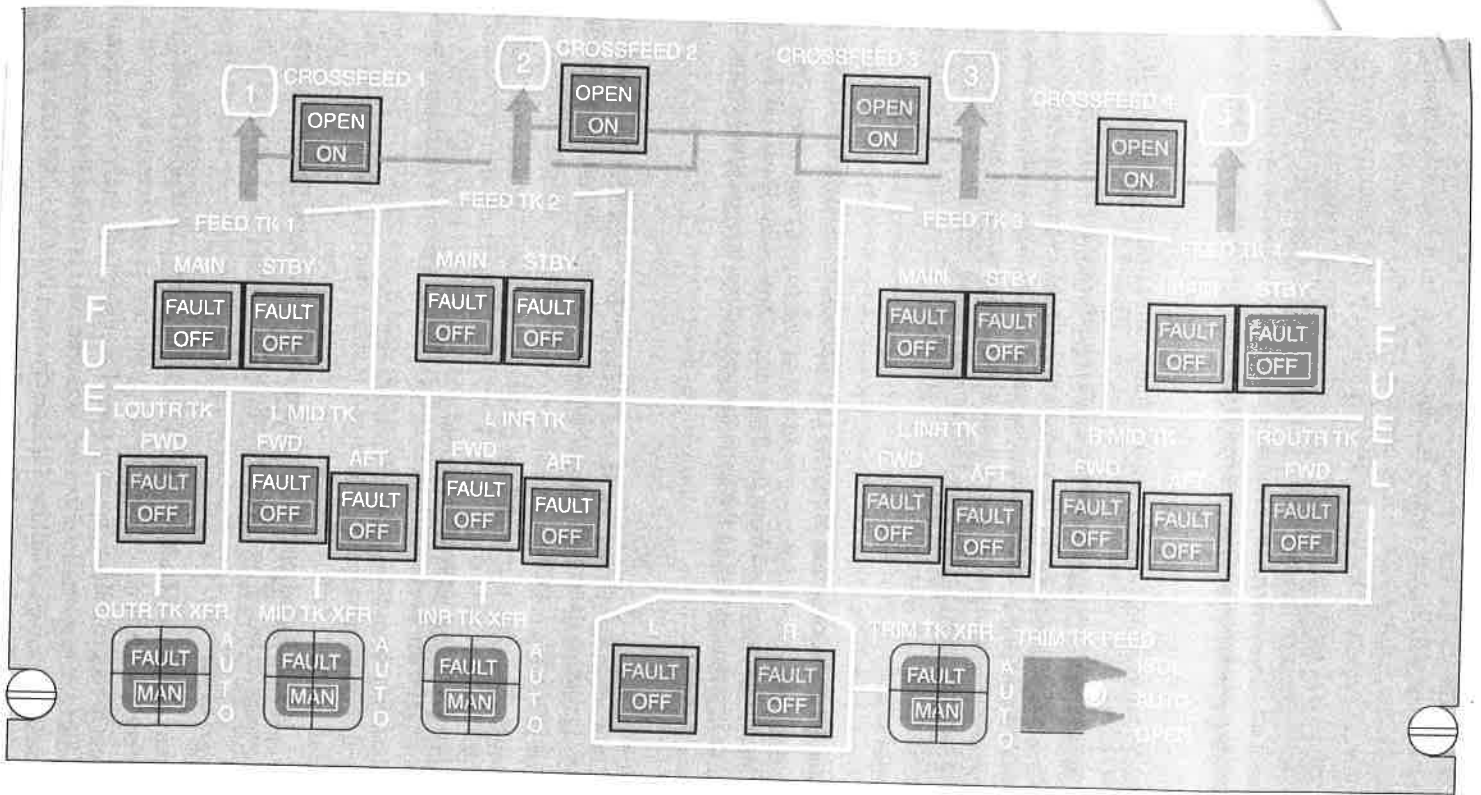# Airbus A380

Figure 12.33 A380-800 fuel tank arrangement.

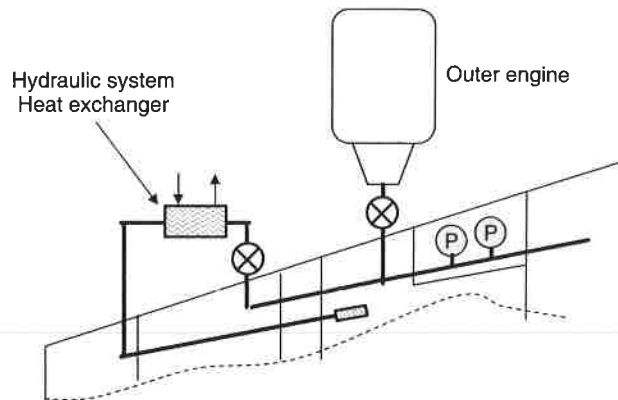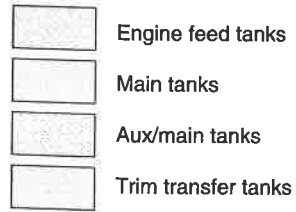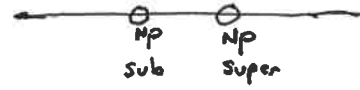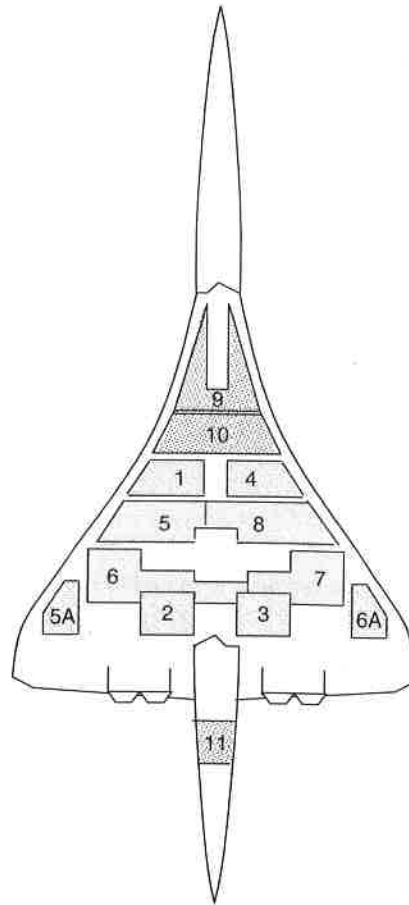**Figure 12.42** A380-800 Flight deck fuel panel (courtesy of Airbus).

Figure 12.38 Hydraulic system cooling.

Concorde

Tank	Capacity	
	lb	kg
1	9350	4240
2	10180	4620
3	10180	4620
4	9350	4240
5	16040	7240
6	25800	11700
7	16490	7480
8	28590	12970
9	24710	11210
10	26580	12060
11	23200	10520
5A	4950	2250
6A	4950	2250

Engine feed tanks
Main tanks
Aux/main tanks
Trim transfer tanks

Figure 12.45 Fuel tanks configuration and capacities (courtesy of Airbus Industrie).

Sub - Super Sonic
NP shift.

Super -> Subsonic
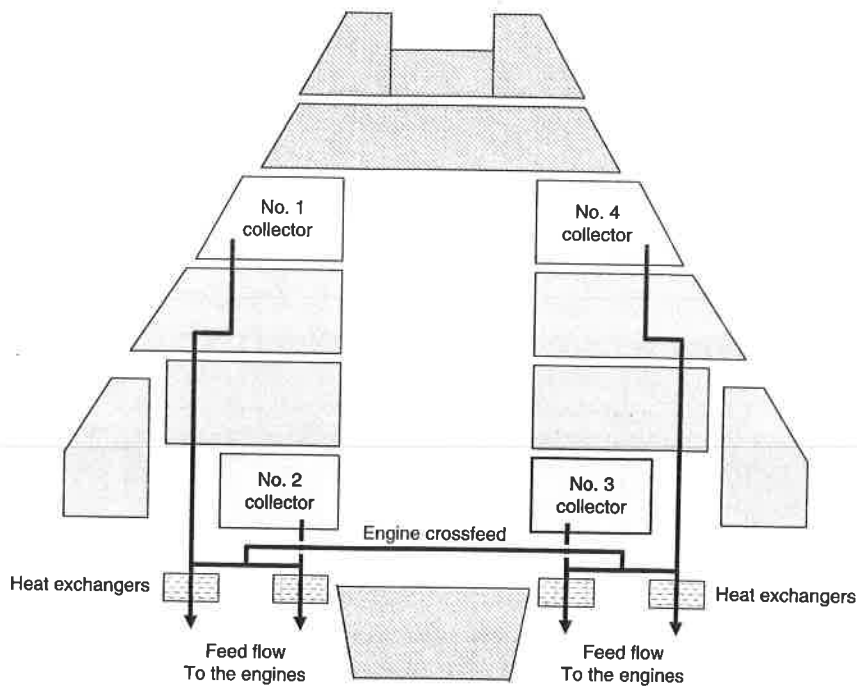shift is engine
failure.

Trim transfer fast

Legend:
- Main transfer
- Trim transfer
- Jettison

No. 1 collector
No. 4 collector
No. 2 collector
No. 3 collector

Engine crossfeed

Heat exchangers

Feed flow
To the engines

Feed flow
To the engines

Figure 12.50 Feed system schematic.