FUEL SYSTEMS

PURPOSE OF A FUEL SYSTEM

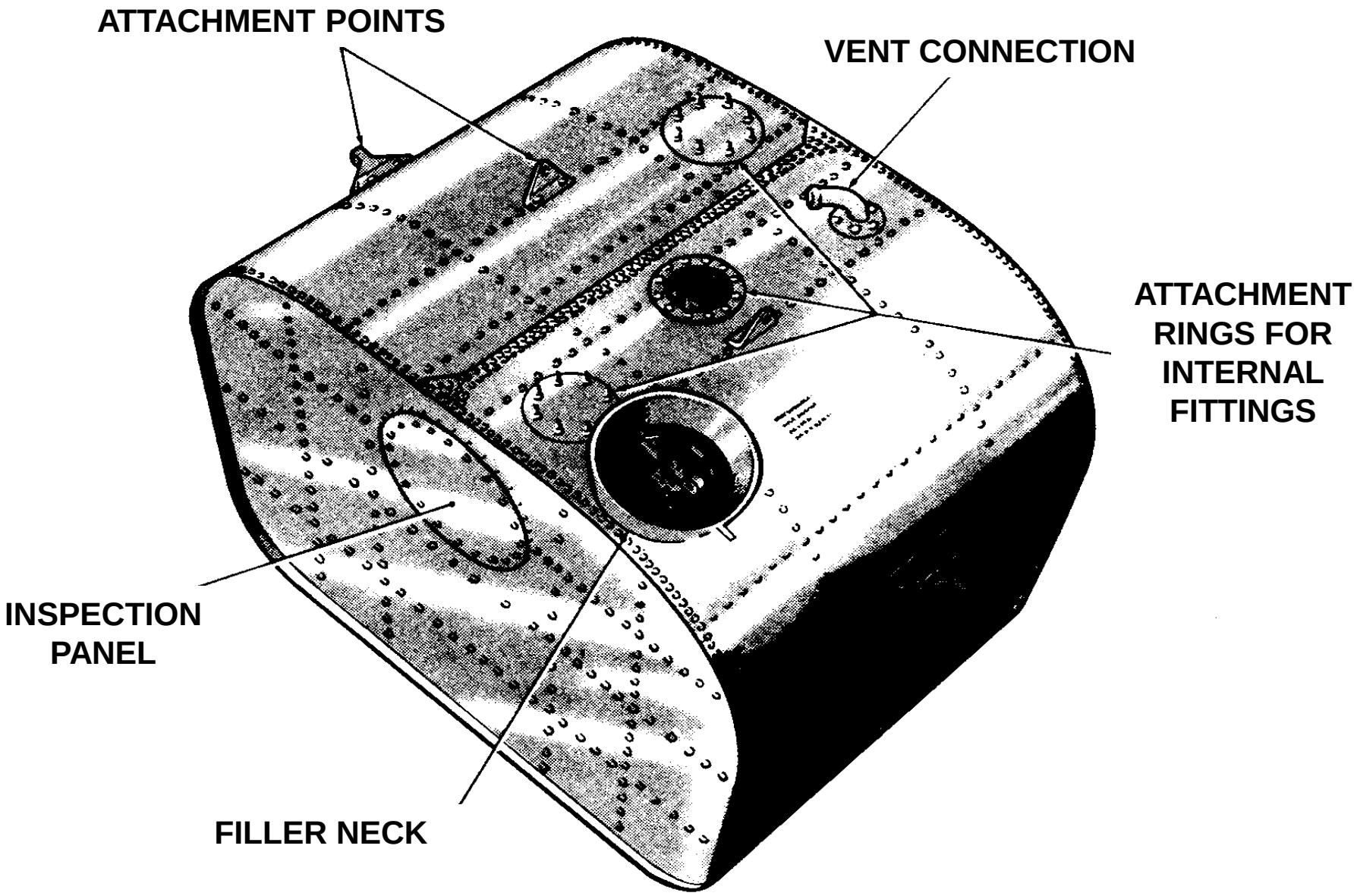
The purpose of an aircraft fuel system is to supply the main aircraft engines with sufficient fuel at a given pressure under all operating conditions

TYPES OF FUEL

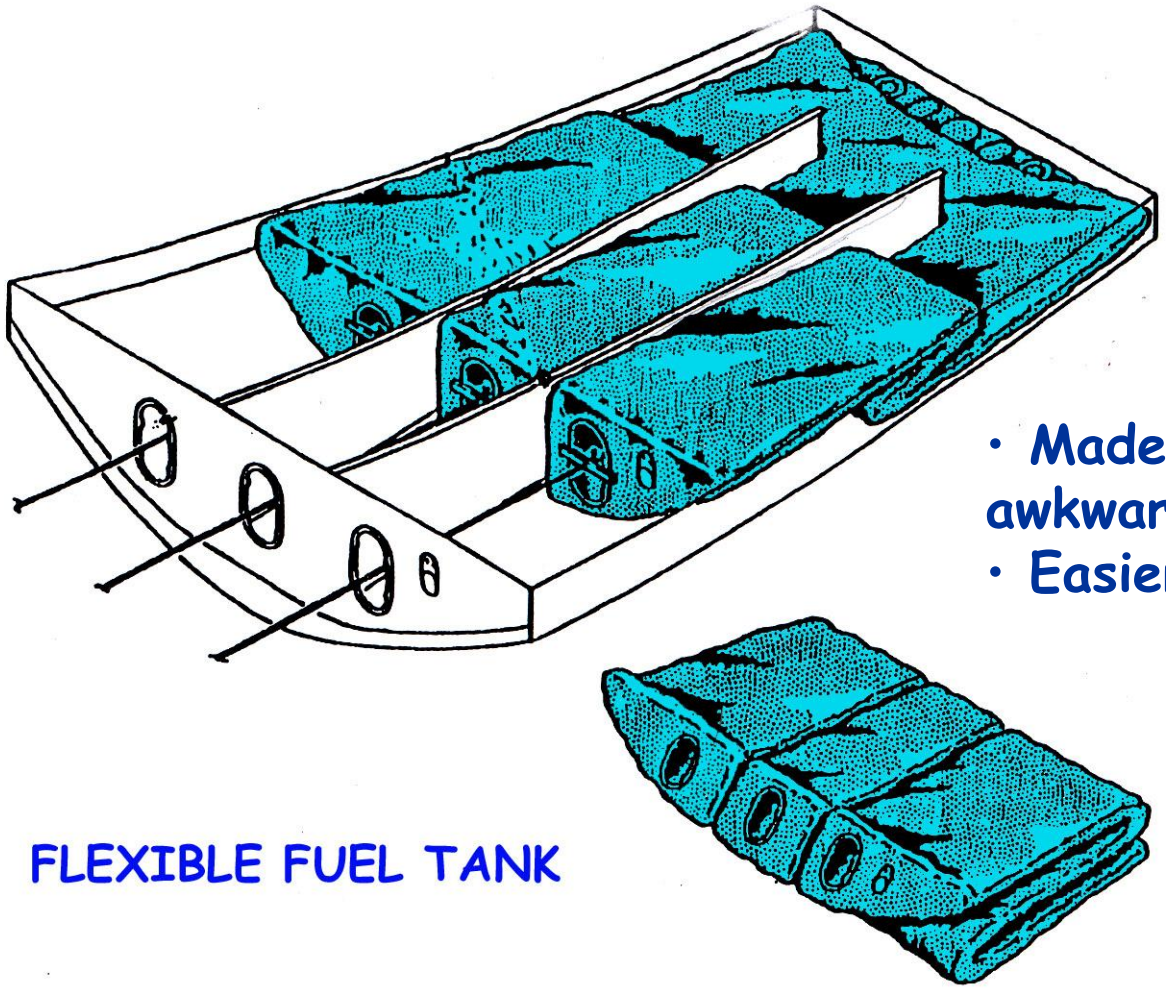
FUEL	AVTUR	AVTAG	AVCAT
Alt.name	Jet A JetA1 (fsii) JP 8	Jet B W/cut JP 4	JP 5 Naval Aviation
Flash point	42°C	18°C	64°C
Waxing point **	-40°C A -47°C A1	-60°C	-50°C
S.G.	0.78-0.82	0.76	0.86

- Fuel is straw in colour
- ** Do not allow temperature of fuel to fall below 5°C above waxing point (high-level operations - temperature taken in end wing tank)
- fsii = fuel system icing inhibitor

TYPICAL INTERNAL RIGID FIUEL TANK



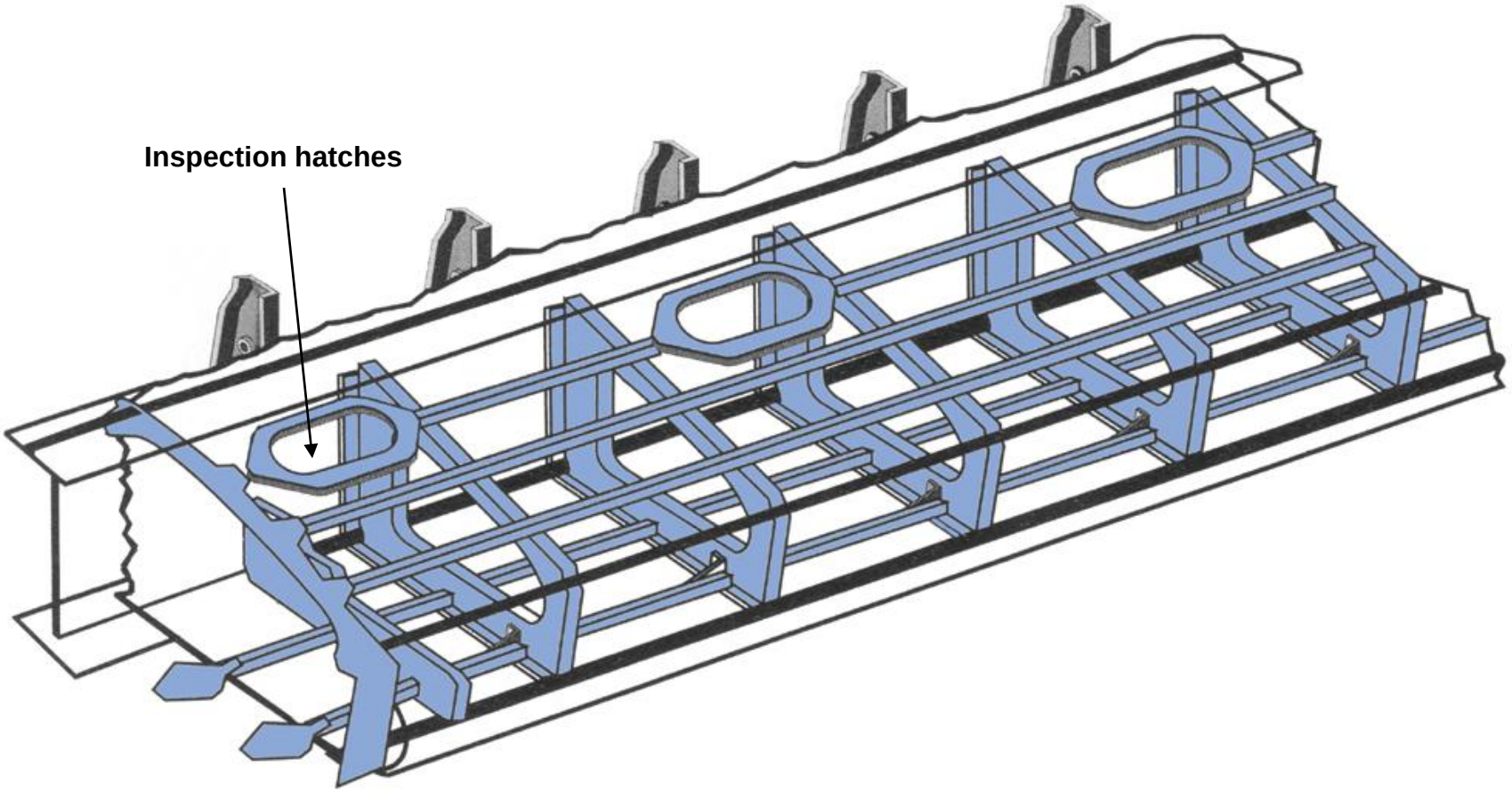
FLEXIBLE FUEL TANK



FLEXIBLE FUEL TANK

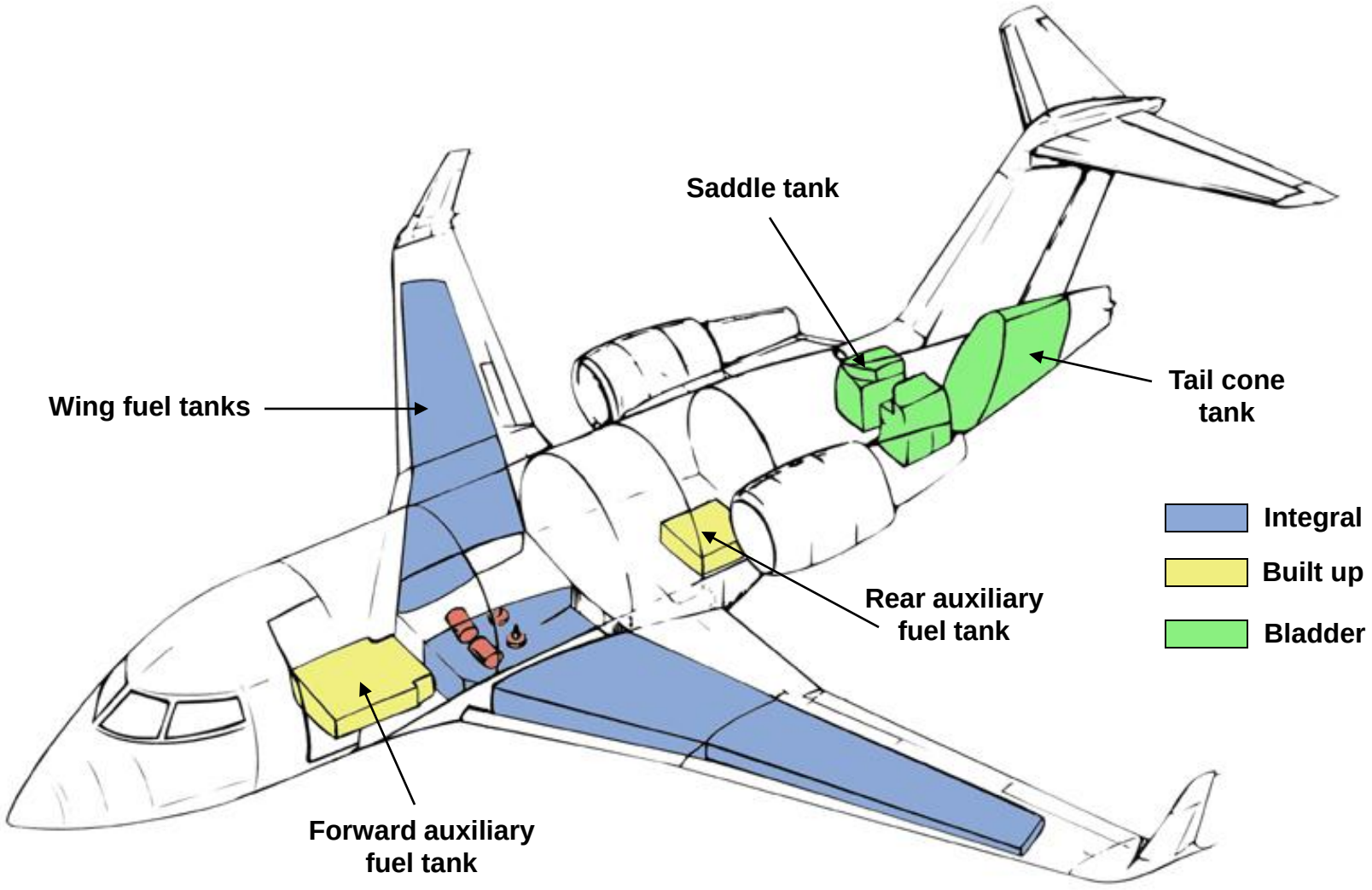
- Made of rubber; used in awkward locations
- Easier maintenance

INTEGRAL FUEL TANK



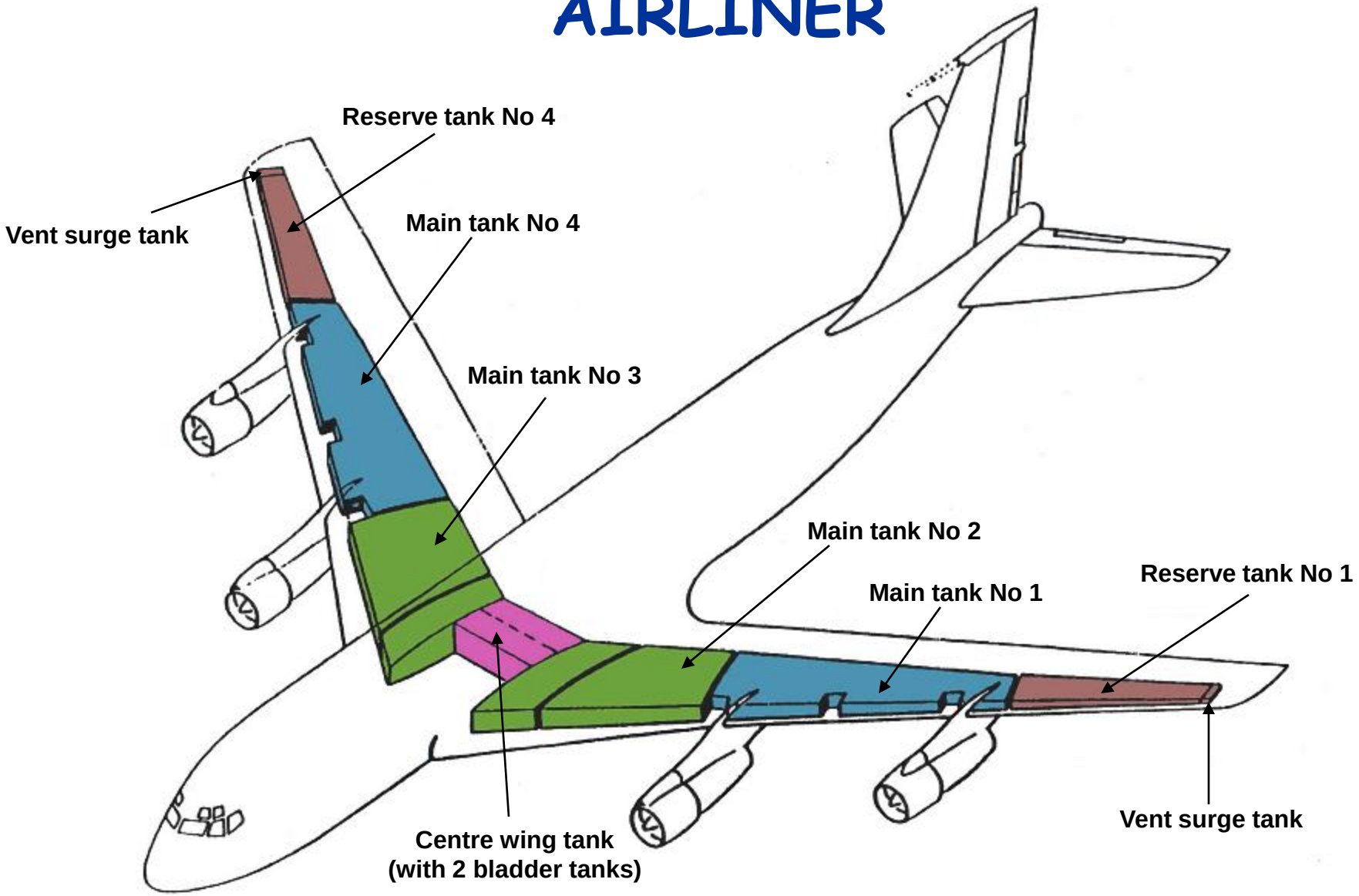
- Save weight and efficiently utilise space
- Maintenance may be difficult

ILLUSTRATION OF 3 TANK TYPES

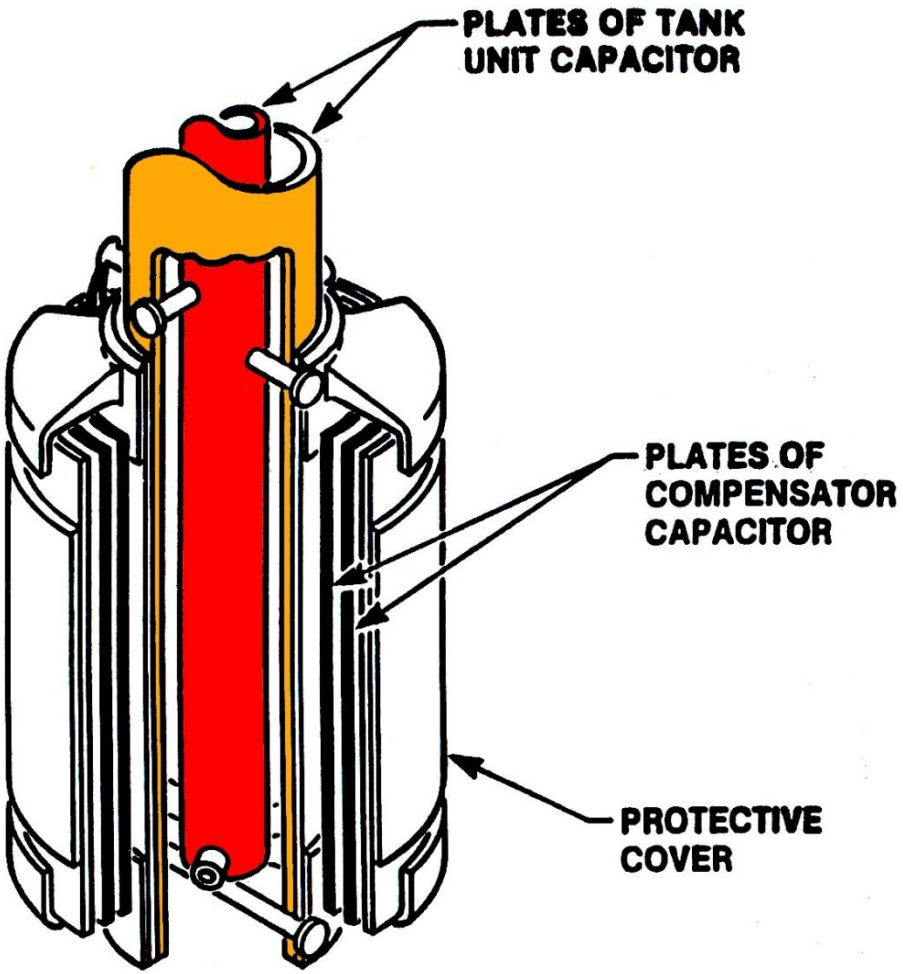


Disadvantage of built-up, rigid type is that it adds significant weight to the aircraft

FUEL TANK INSTALATION ON JET AIRLINER

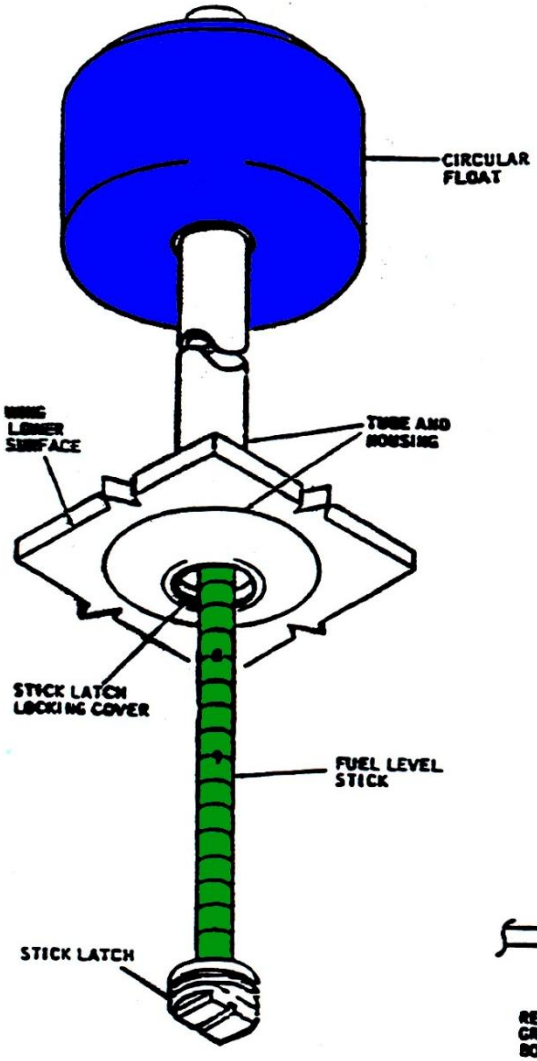


CAPACITOR TYPE FUEL GAUGE

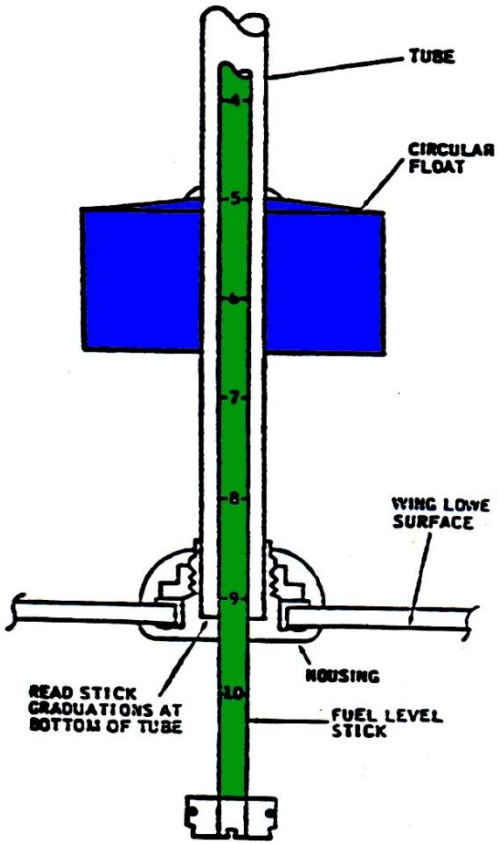


- Two capacitor plates supplied with ac at fixed voltage/frequency
- Plate dielectric either fuel or air and the ratio determines the current flow in the gauging circuit
- Current flow determines gauge reading
- Each tank contains many tank (gauging) units

MANUAL (ON-GROUND) FUEL GAUGING



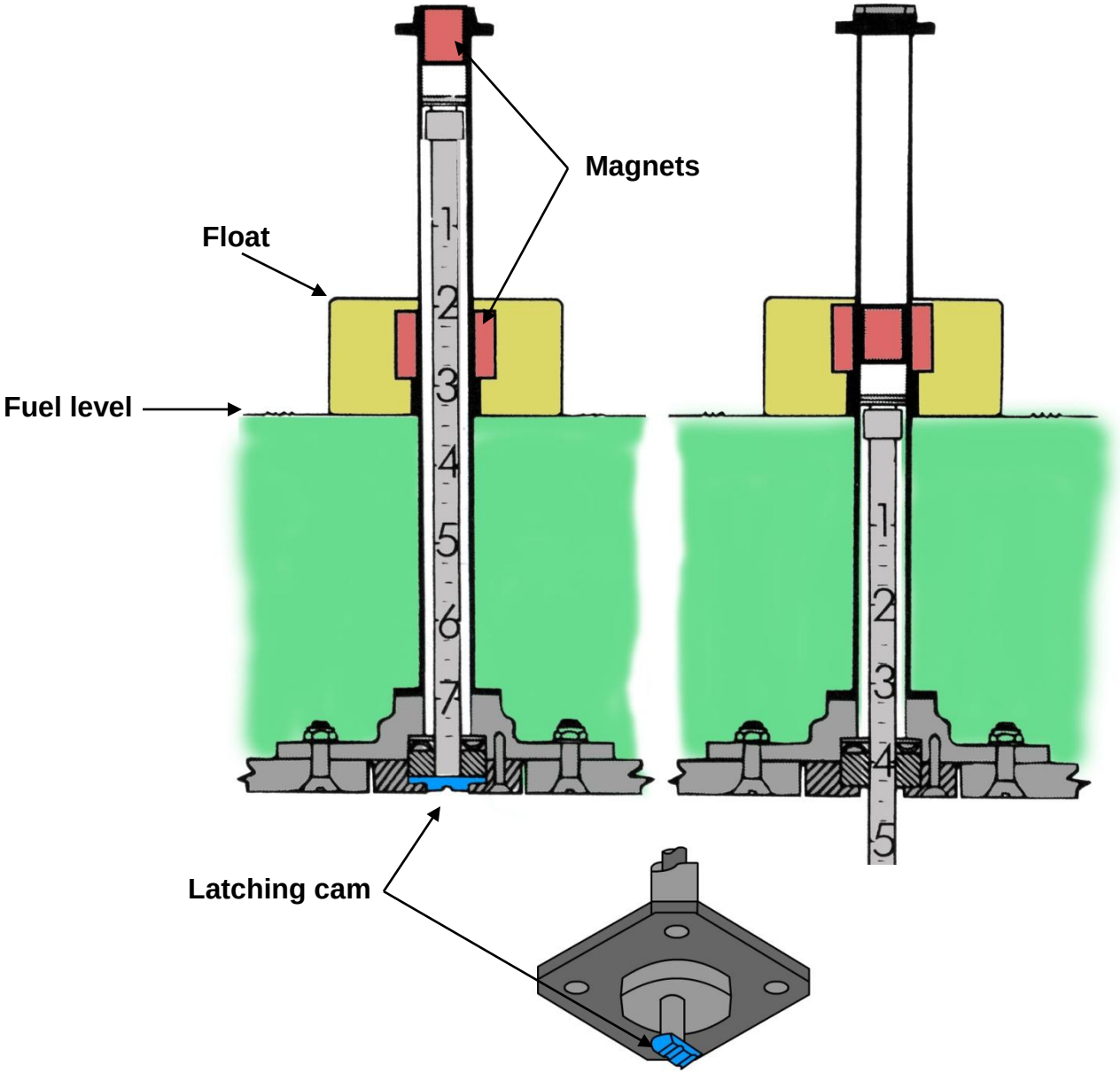
Magnetic Float Level Indicator (MFLI)



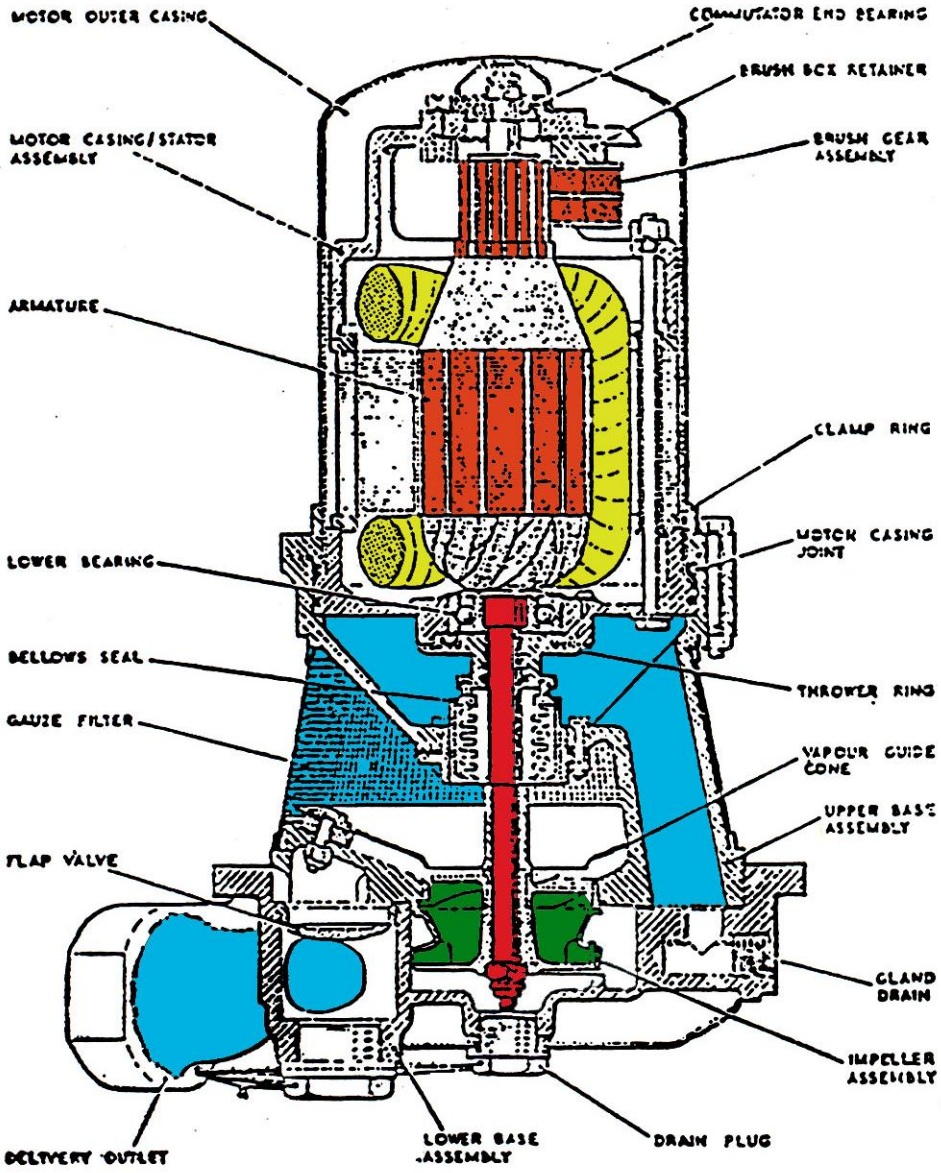
Other methods are:

- Dip-stick; inserted from top of tank
- Drip-stick; as for MFLI but gauge has a hole in the top that will allow fuel to drip through the stick when it is level with the fuel surface

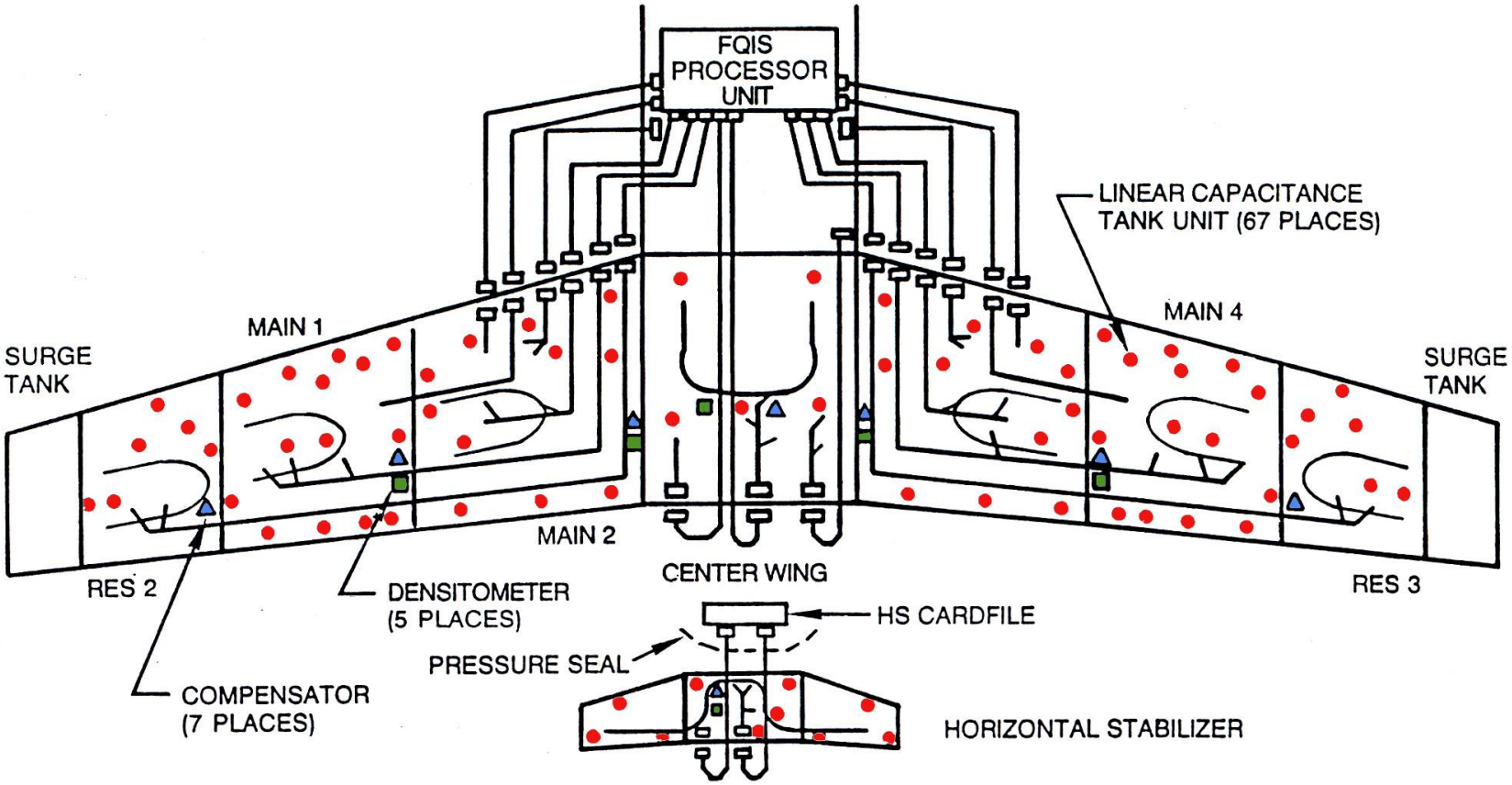
MAGNETIC FLOAT LEVEL INDICATOR



FUEL PUMP



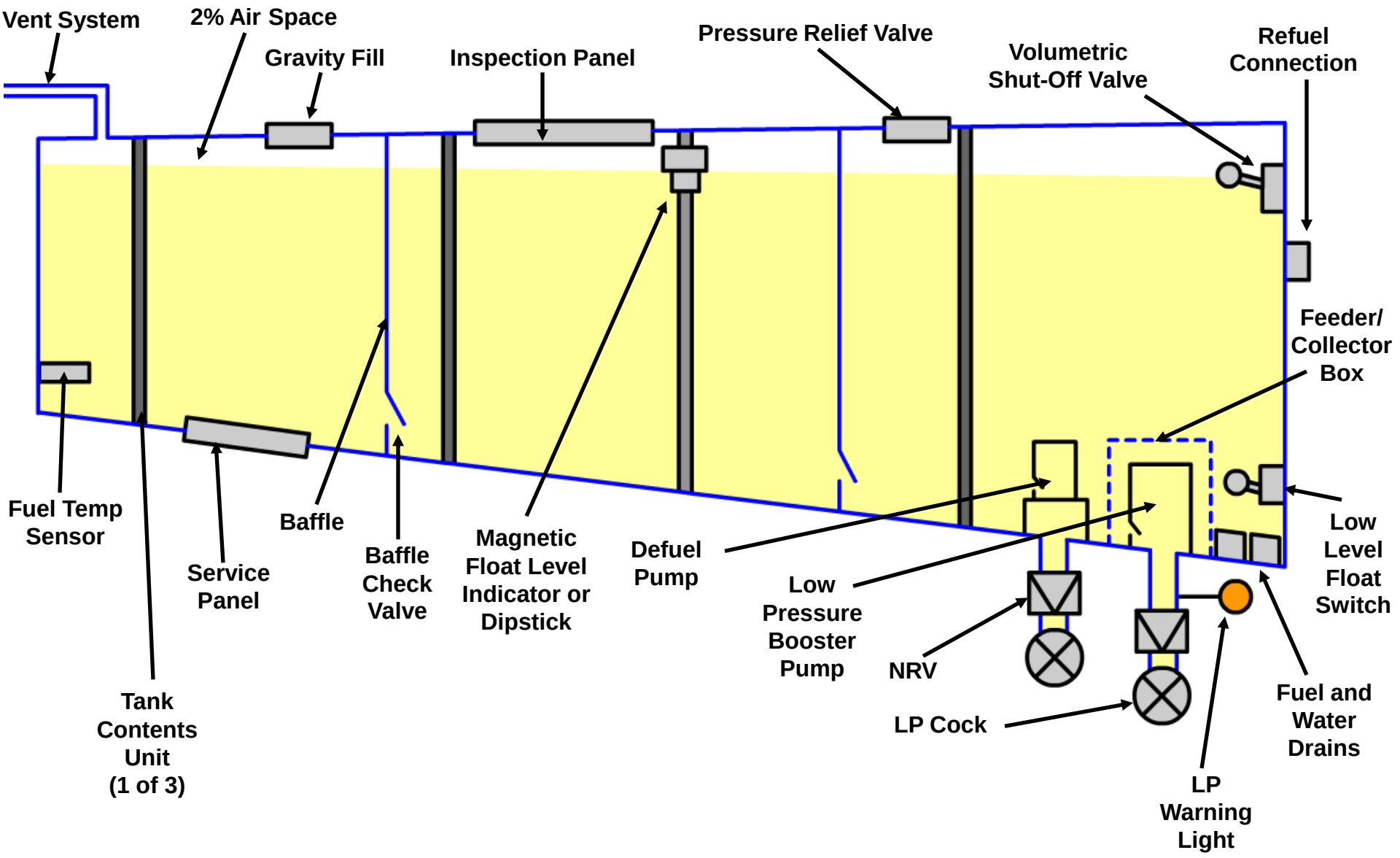
- LP centrifugal pump
- Ac electric motor 115/200v, 400 Hz, 3ϕ switched by dc
- Fuel cooled
- Pressure 25-50 psi
- High flow rate capability

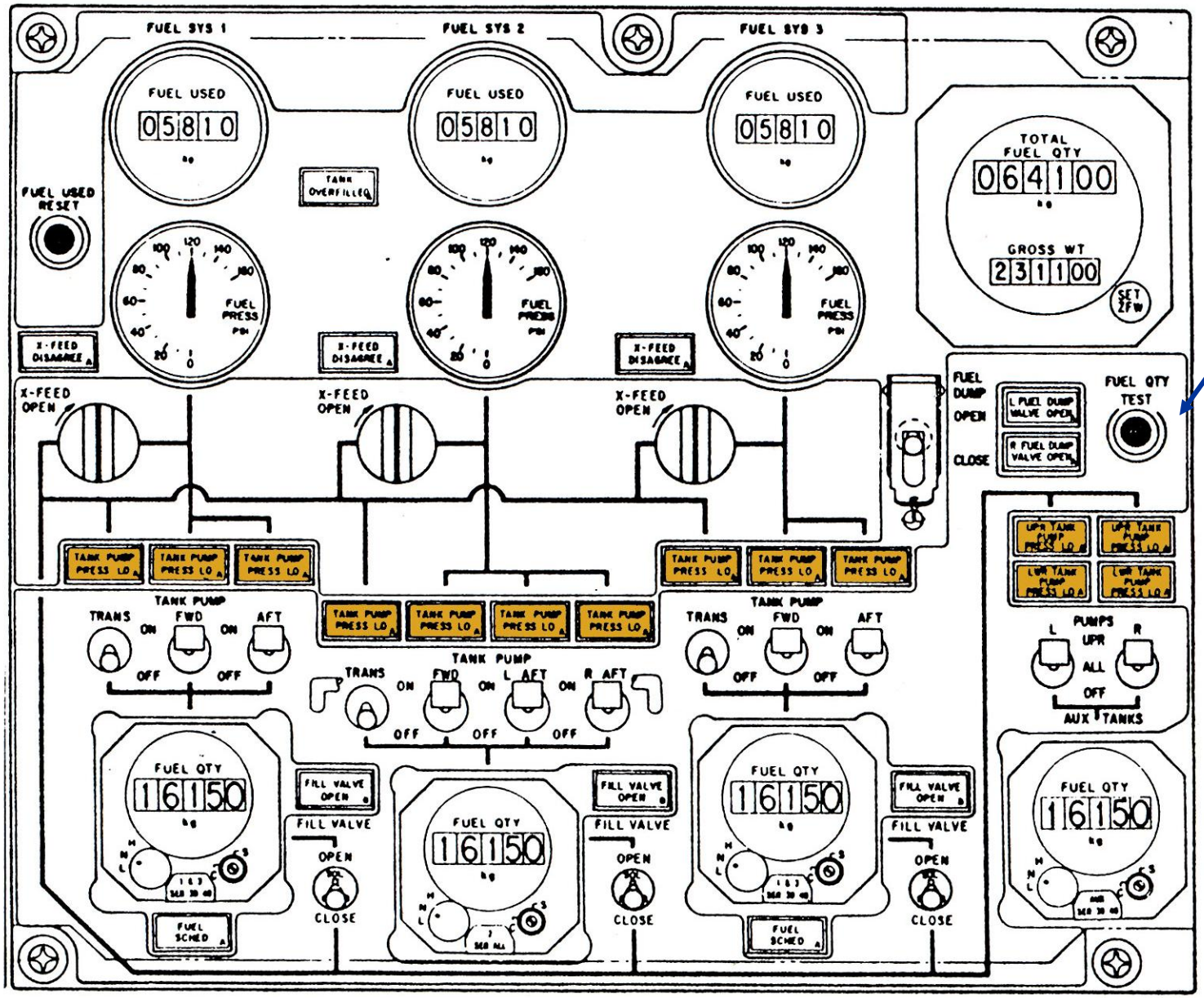


FUEL QUANTITY INDICATING SYSTEM COMPONENTS

- Failures - must draw attention of user
  - single sensor failure has no effect
  - system failure arranged so that indications slowly fall to zero (pilot not given false over-reading)
- Test button drives gauges towards zero; must be seen to return to original indication on release (more modern systems have a BITE that indicates 88888 on test)

FUEL SYSTEM LAYOUT

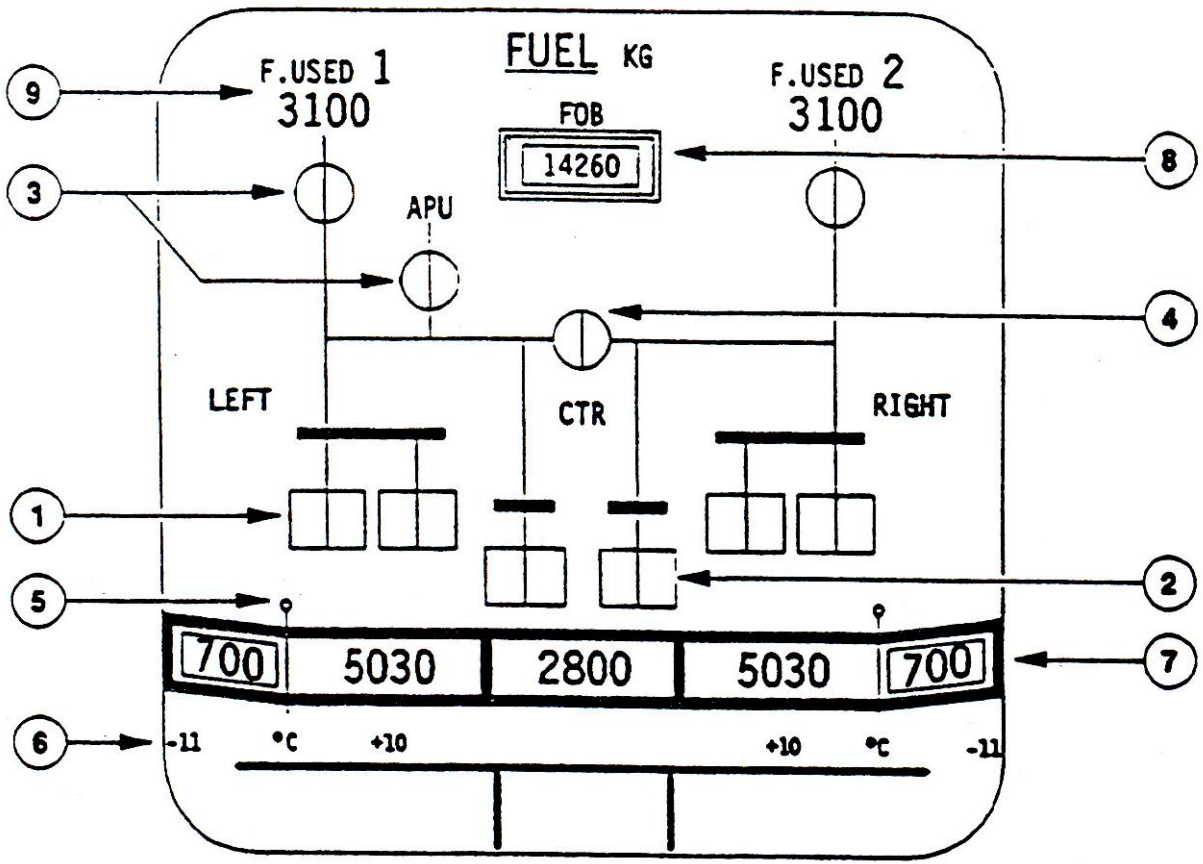




Motors counters back to a lower value

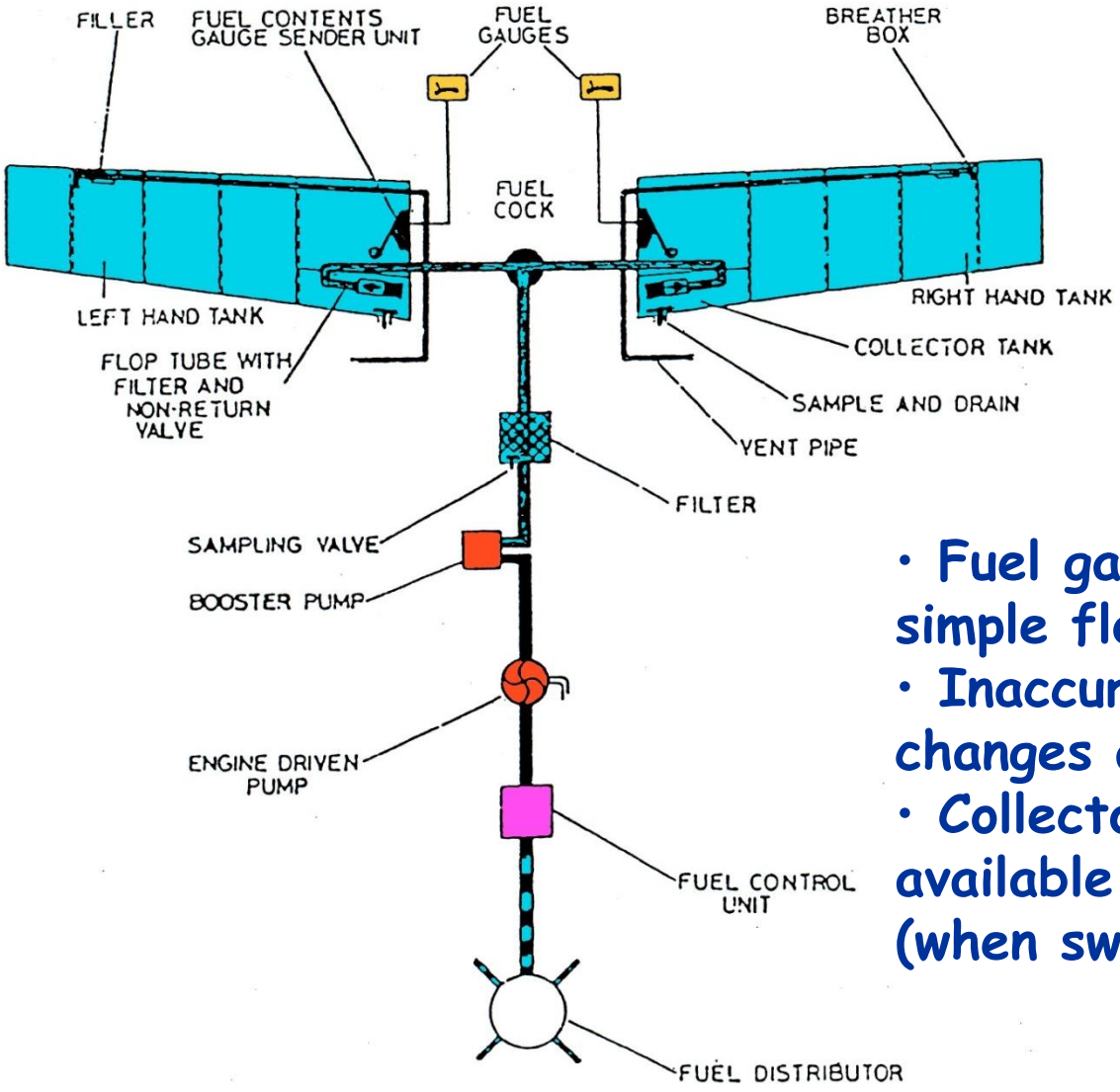
TESTING GAUGES - FUEL PANEL

ECAM (AIRBUS) FUEL DISPLAY



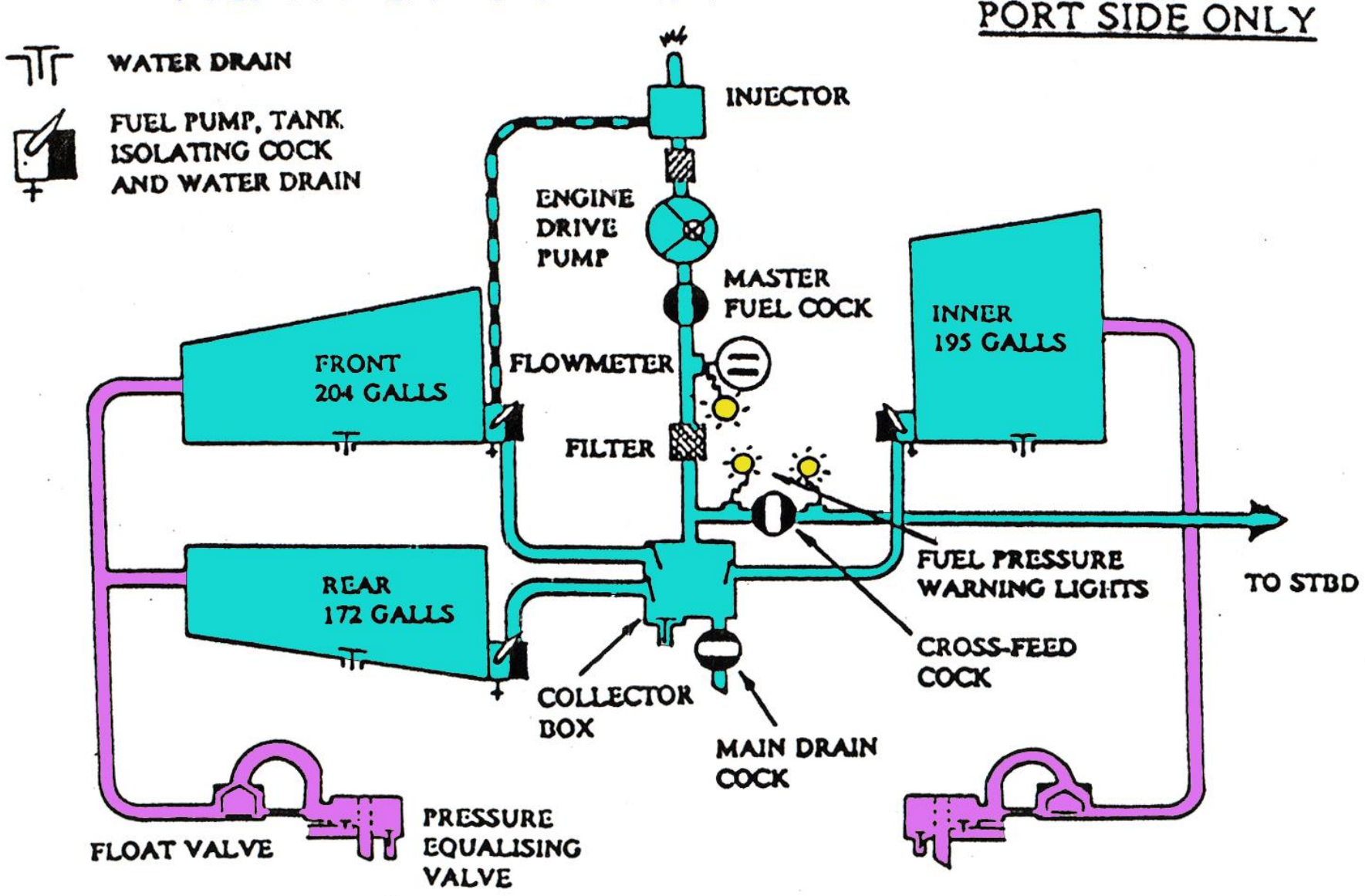
1 - Wing tank BP indication
2 - Centre tank BP indication
3 - Engine fuel shut off valve
4 - Cross feed valve
6 - Fuel tank temperatures
7 - Tank contents (kg)
8 - Fuel on board (kg)
9 - Fuel used (by engine)

LIGHT AIRCRAFT FUEL SYSTEM



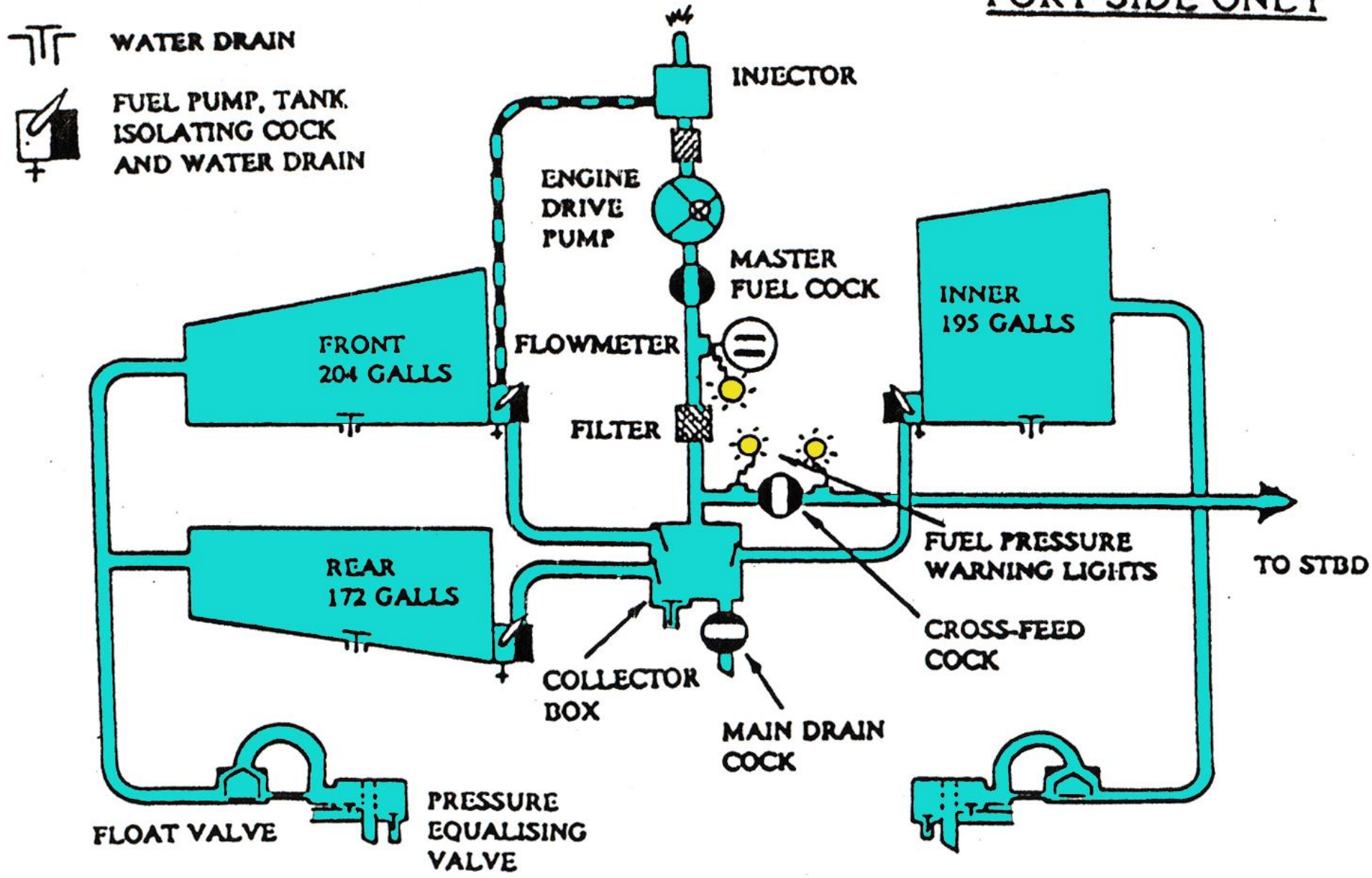
- Fuel gauging system uses simple float units
- Inaccurate when aircraft changes attitude
- Collector tank ensures fuel available to engine at all times (when switching between tanks)

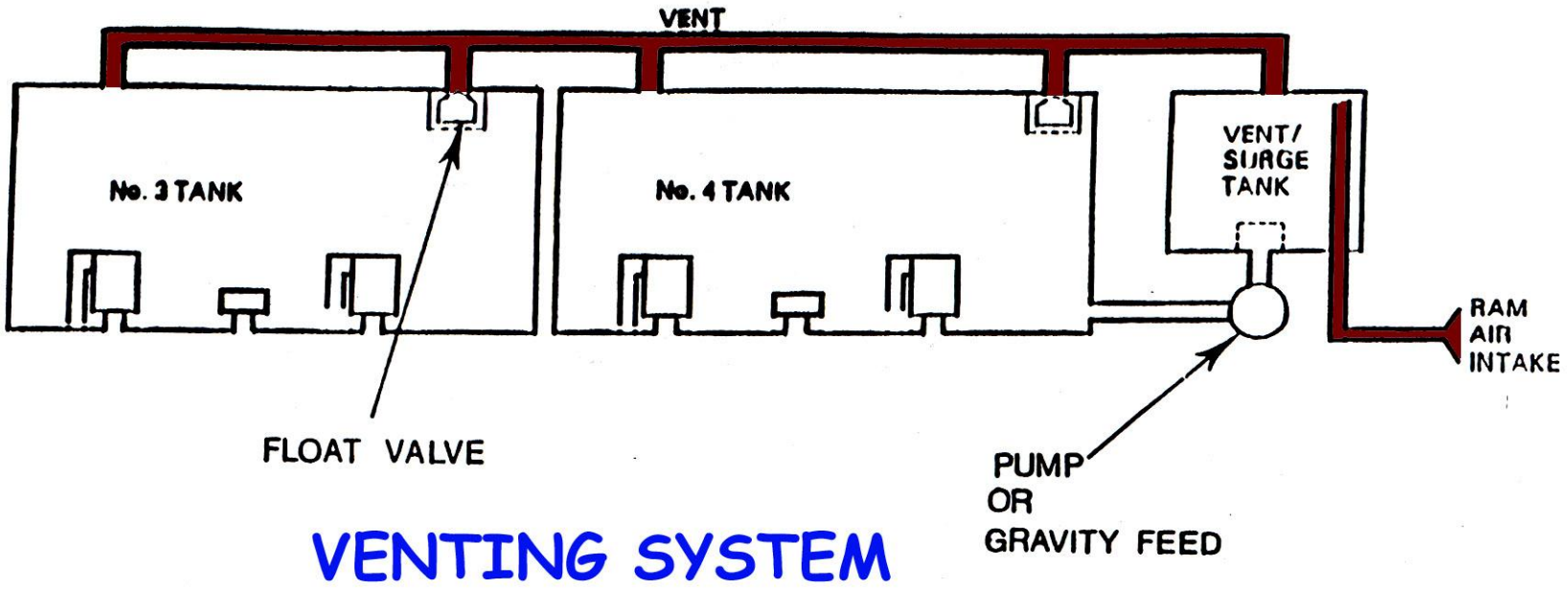
FUEL SYSTEM - LIGHT TWIN



FUEL SYSTEM - LIGHT TWIN

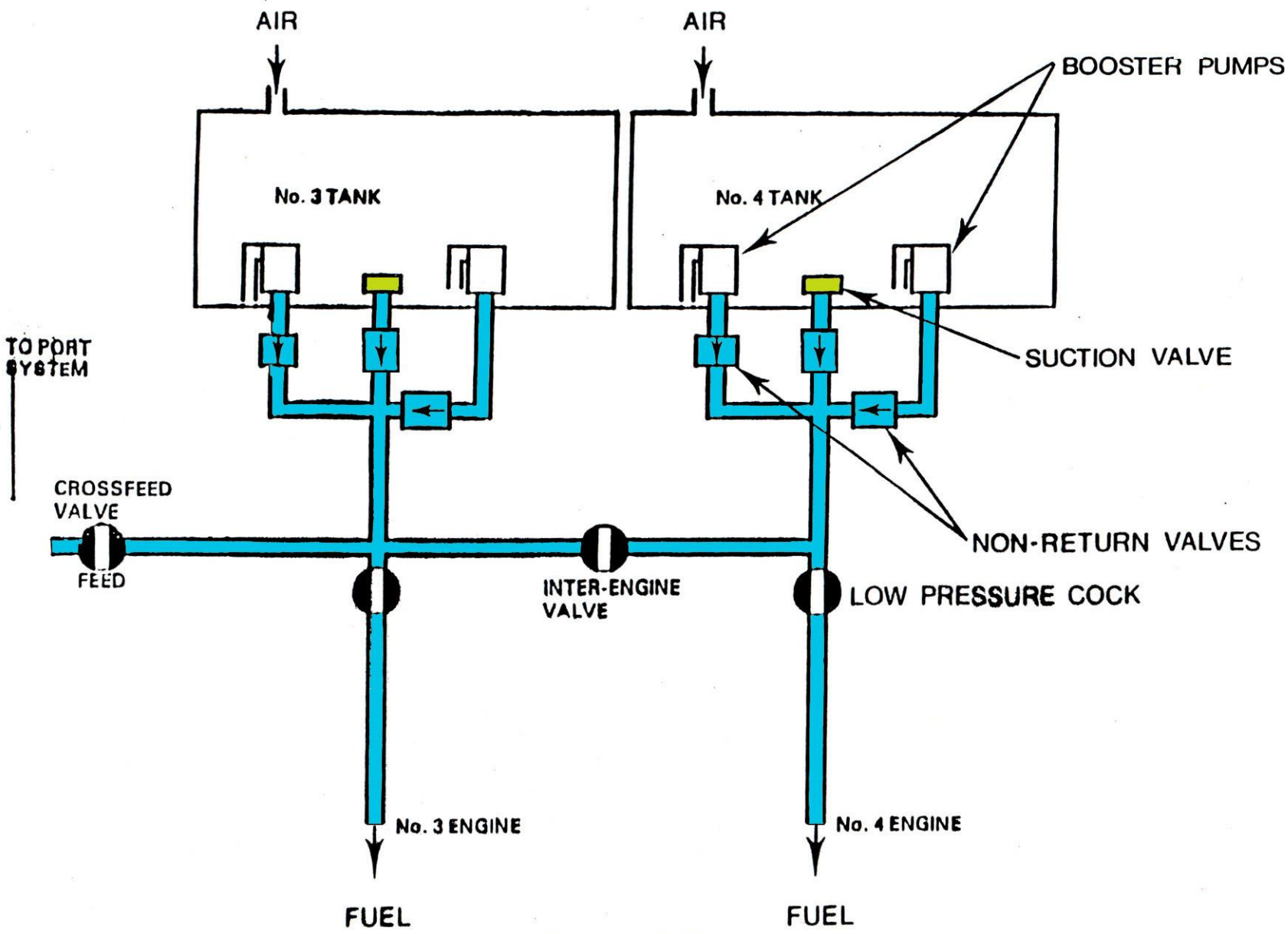
PORT SIDE ONLY





VENTING SYSTEM

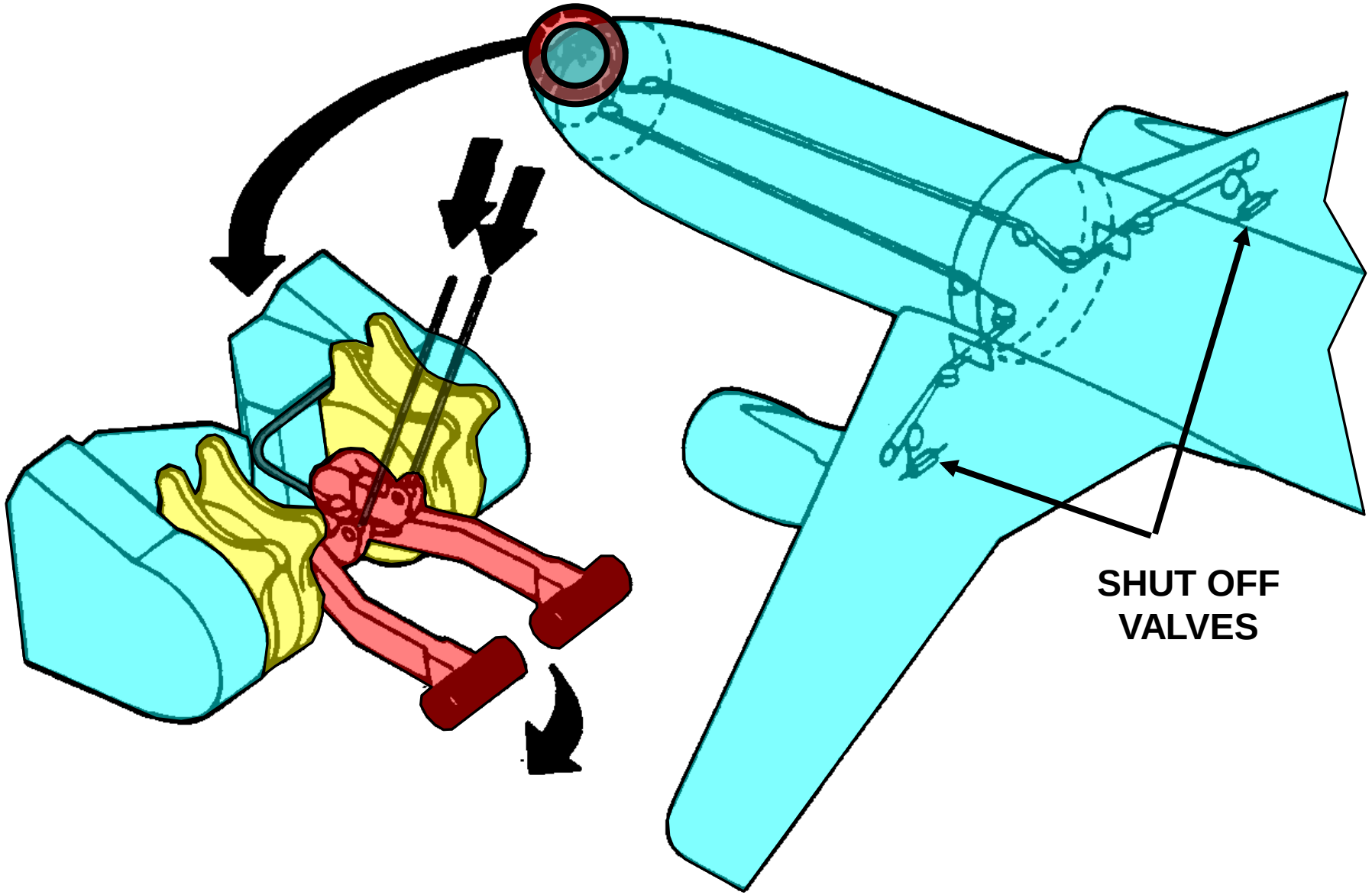
- To prevent pressure build-up (+ve or -ve) in tanks
  - allows air to escape during refuelling
  - allows air to enter during fuel usage
- Vent surge tank collects droplets of fuel from the vent air and, hence, reduces losses from vent system by returning this fuel to tanks
  - Ram air intake gives slight +ve pressure in tanks and helps reduce vaporisation (boiling-off) at high level

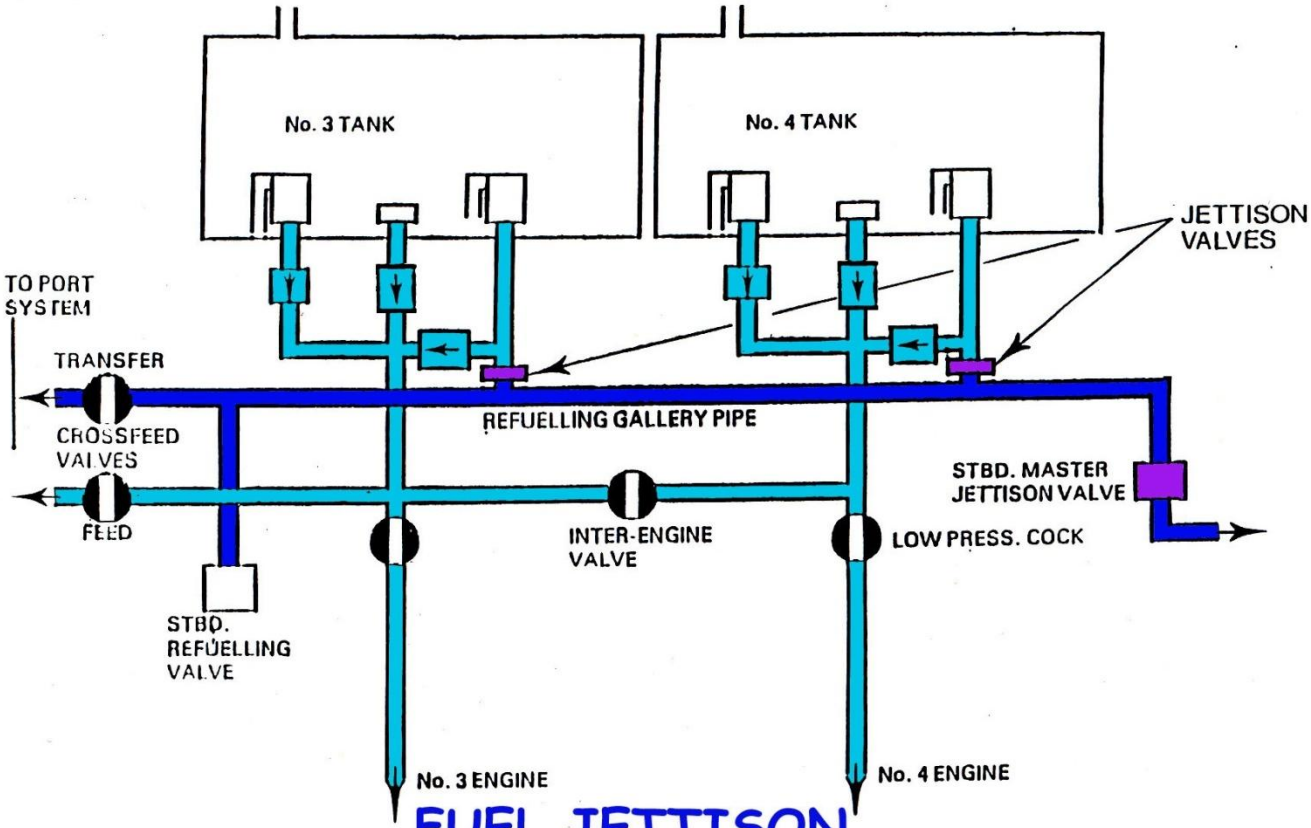


FUEL FEED

- Designed so that any engine can be fed by any tank

LP SHUT OFF VALVE





FUEL JETTISON

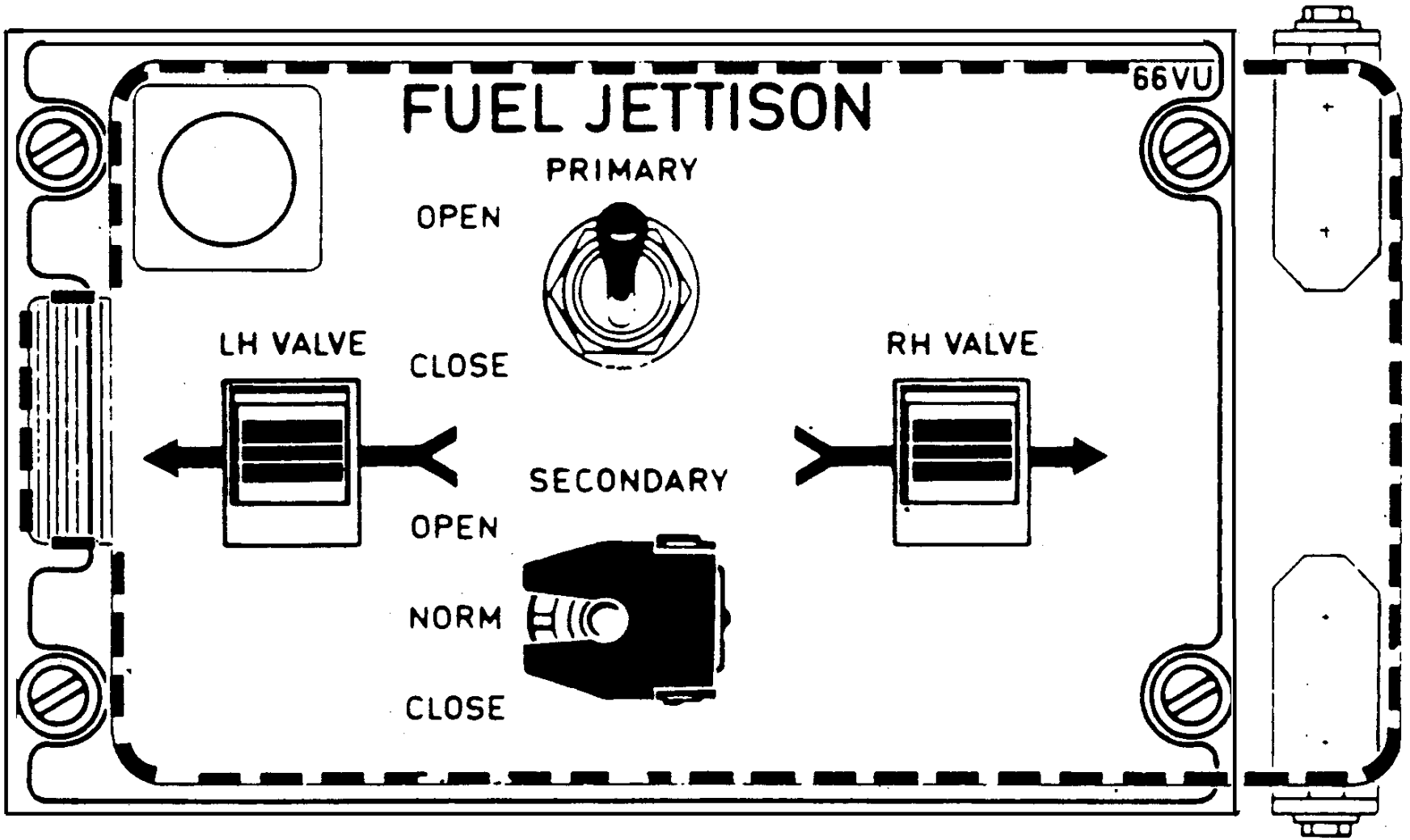
- JAR says that after fuel jettison must be able to climb to 10 000' and fly at range speed for 45 minutes
- Aircraft should be able to achieve maximum landing mass from maximum take-off mass in 15 minutes
- Dump rates are typically 3-4 tonnes/minute
- Some systems can be overridden to jettison down to unusable fuel (normally jettison is halted by low-level float switch to keep JAR minima)

FUEL DUMPING

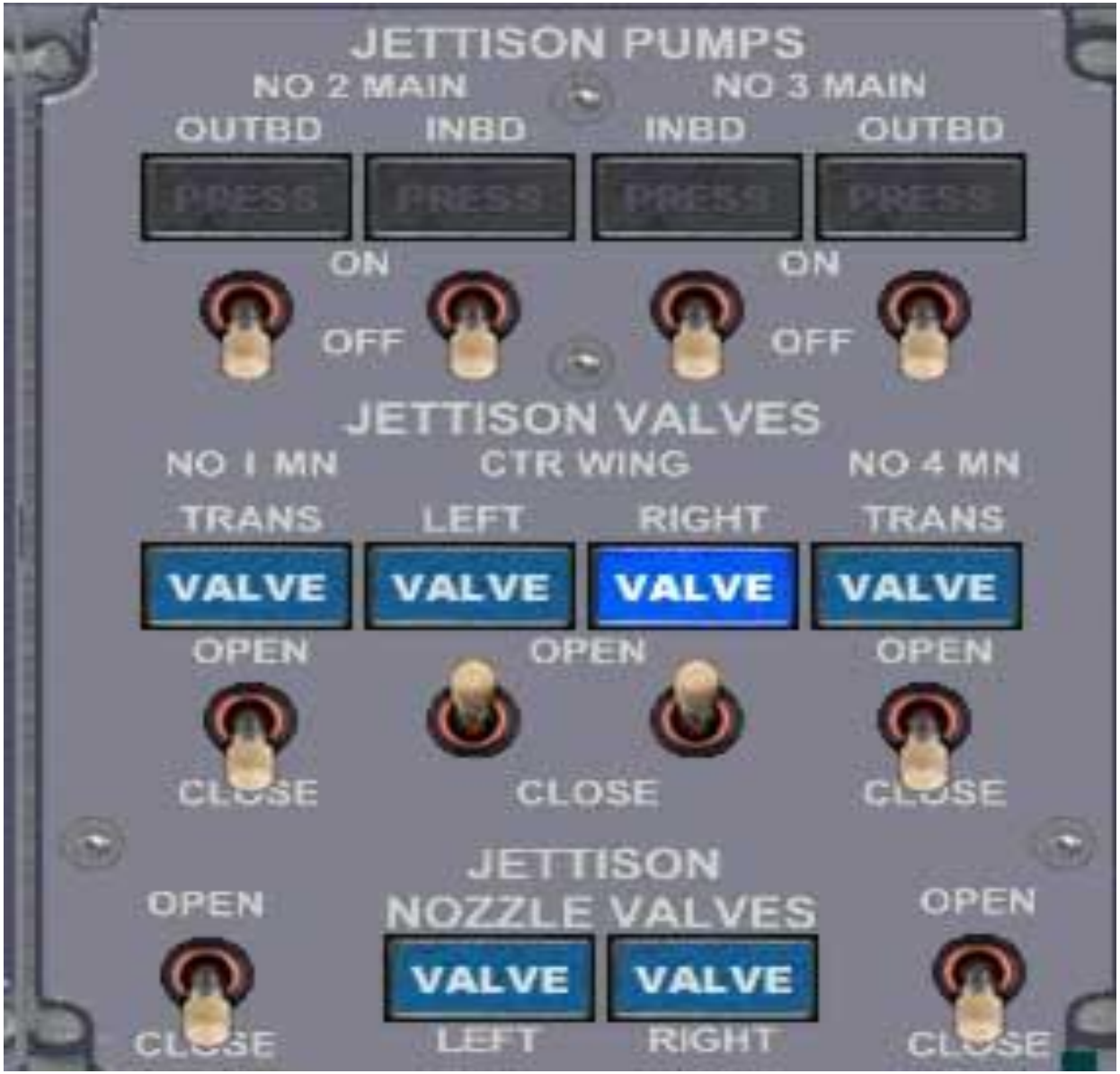
If time permits:

- Inform air traffic control
- Avoid areas of static/cloud
- Do not fly in circles or turn down wind
- Be at a safe altitude and speed
- Clean aircraft configuration
- No smoking
- Non-essential electrical equipment - off
- No HF radios on
- Use a designated dumping area
- Ensure positive fuel feed to the engines

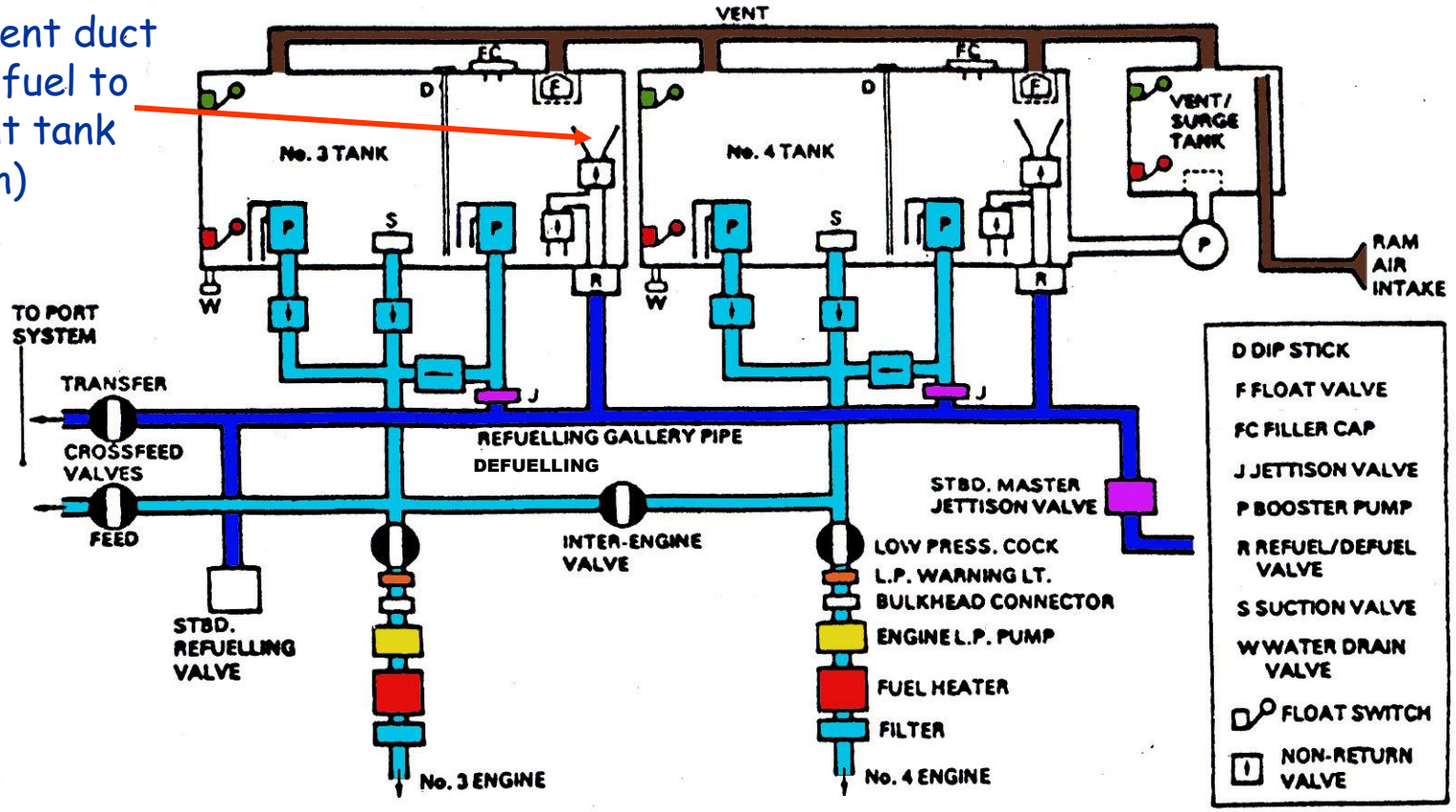
JETTISON VALVE



JETTISON CONTROL PANEL



Divergent duct (slows fuel to prevent tank erosion)



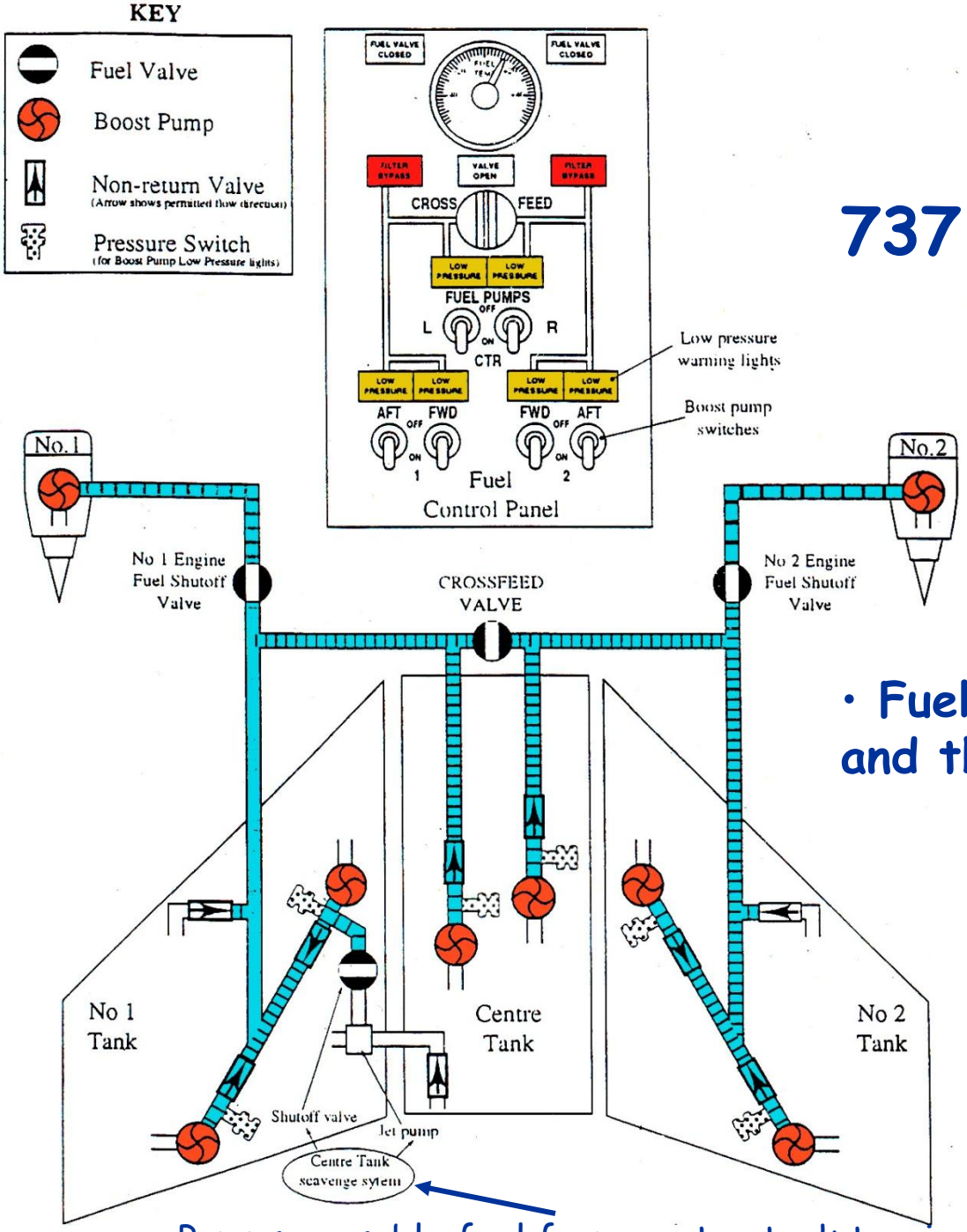
MULTI-ENGINED AIRCRAFT FUEL SYSTEM

- Refuel at about 50psi from bowser or underground fuel tank
- Defuel at about 11psi

AUTOMATIC TOP-OFF UNIT

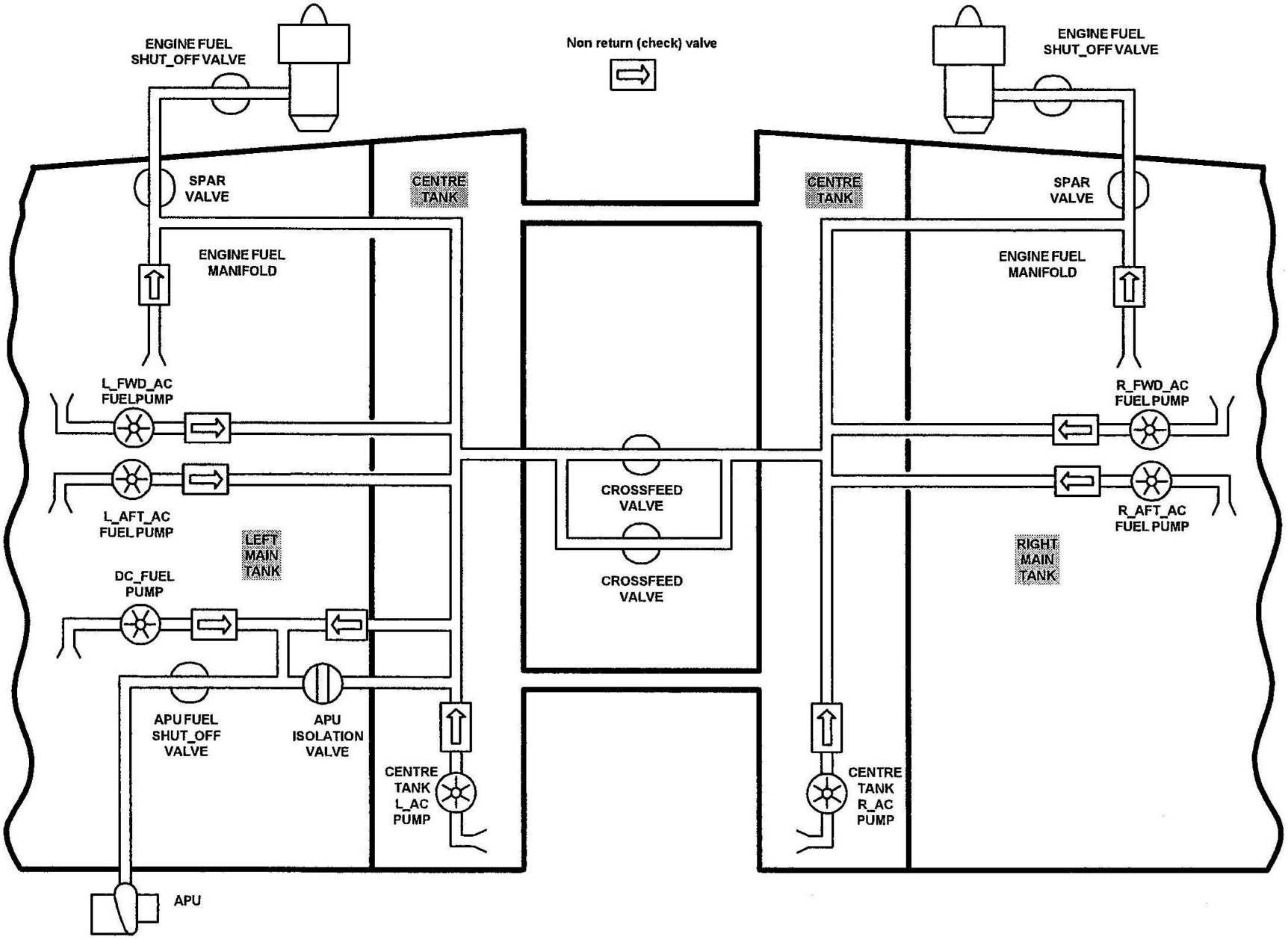
- Some (main) fuel tanks are fitted with an 'Automatic top-off unit'
- This unit consists of a float valve set at a pre-determined level that initiates feed from an auxiliary or subsidiary tank
- The feed may be either a gravity or pump feed and will maintain the main tank at the pre-set level

737 FUEL SYSTEM

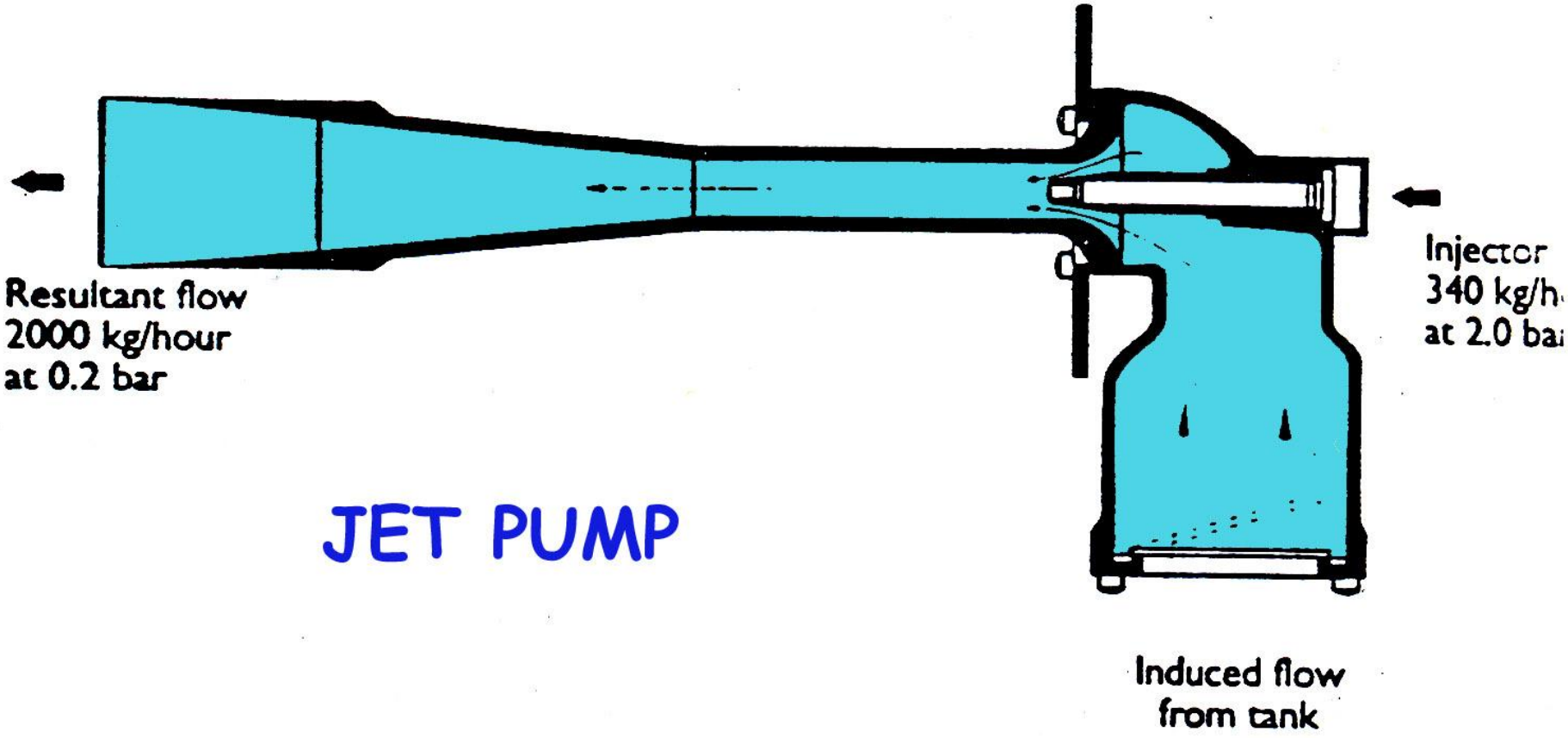


- Fuel feeds from centre tank and then from wing tanks

Pumps unusable fuel from centre tank to wing tank

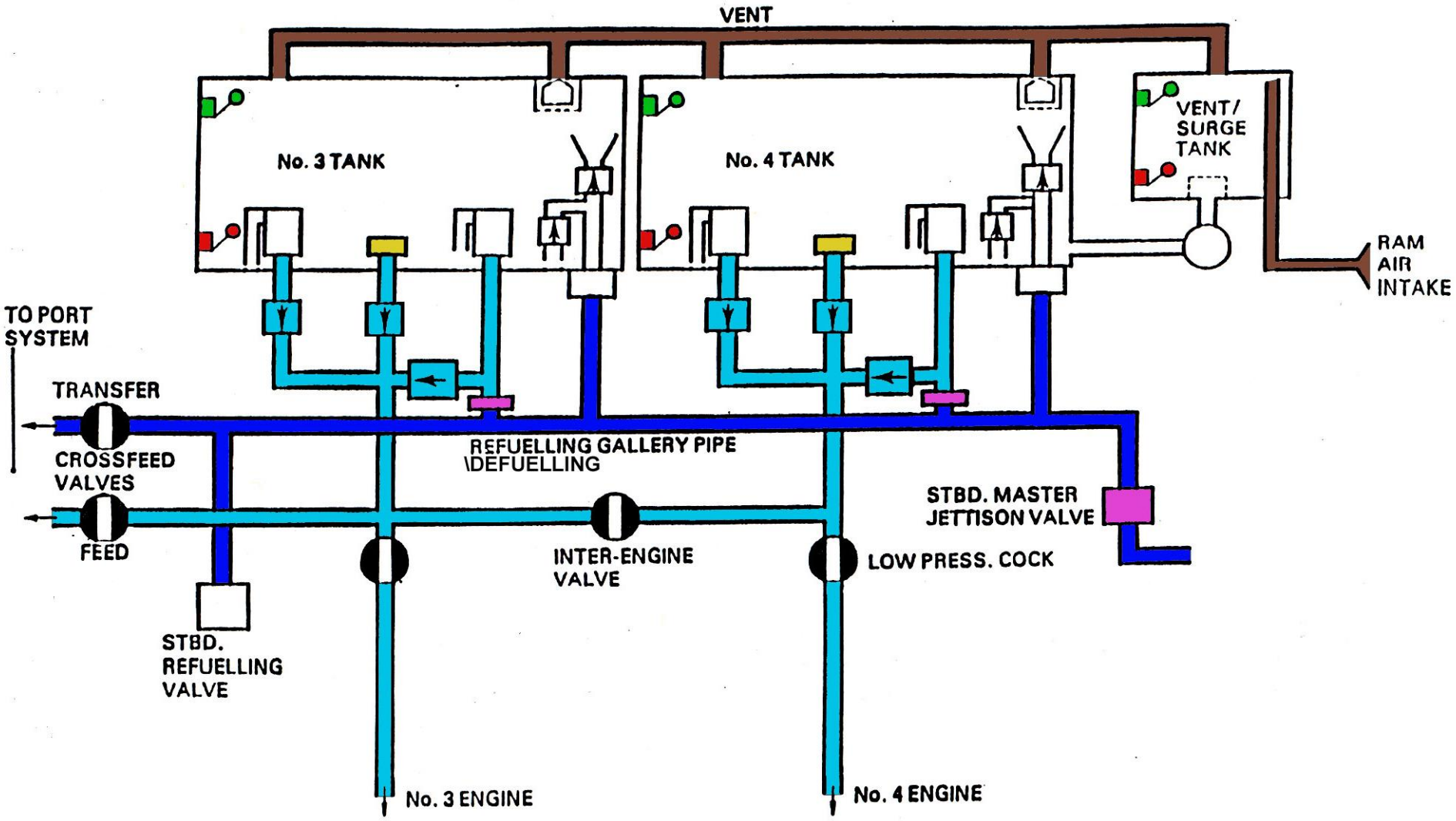


sample fuel system



JET PUMP

- Fuel pump in wing tank pumps fuel through injector
- This creates a low pressure area that draws fuel from the centre tank into the wing tank until the centre tank empty



REFUELLING/DEFUELLING SYSTEM

FUELLING ZONES

Fuelling zones should be established before fuelling commences. These zones should be regarded as extending at least 6 metres (20 feet) radially from the filling and venting points on the aircraft and fuelling equipment. Within this zone, smoking, use of naked lights and operation of switches which are not of the approved pattern should be forbidden.

1. Unless fuelling takes place in a designated a no smoking area 'no smoking' signs should be displayed not less than 15 metres (50 feet) from the fuelling equipment and a/c tank vents
2. APUs which have an exhaust discharge into the zone should, if required during fuelling, be started before filler caps are removed. If APU stops, it should not be restarted until refuelling has ceased.
3. GPUs should be located as far as practical from a/c should not be connected/disconnected during fuelling.
4. Fir extinguishers should be located so as to be readily accessible and preferably be of the CO_2 and/or BCF types.

PRECAUTIONS PRIOR TO FUELLING

The aircraft should be connected to an effective earthing point and to the fuelling equipment. This is always achieved through the undercarriage.

When overwing fuelling, the nozzle of the hose should be bonded to the aircraft structure before removing the tank filler cap. When fuelling from hand-operated equipment, including pumping from cans or drums, similar precautions should be taken to bond equipment, hoses, nozzles and containers. If funnels are used, they too should be bonded to the nozzle or can and to the aircraft. If a chamois leather filter is used, the funnel and all metal parts securing the leather should be included in the bonding circuit.

When pressure fuelling, the fuel tank pressure relief valves should,if possible, be checked for correct operation and the bonding lead on the nozzle should be connected to the receptacle, located adjacent to the fuelling point, before connecting the nozzle.

SPECIAL PRECAUTIONS

Aircraft should not be fuelled within 30 metres (100 feet) of radar equipment, under test or in use, in aircraft or ground installations.

When any part of an aircraft landing gear appears overheated, the fire service should be called and fuelling should not take place until heat has dissipated.

Extreme caution should be exercised when fuelling during electrical storms. Fuelling should be suspended during severe electrical disturbances in the vicinity of the aerodrome.

The use of photographic flash bulbs and electronic flash equipment should not be permitted.

PRECAUTIONS DURING FUEL TRANSFER

When overwing fuelling, the amount of fuel required should be determined and the quantity of fuel delivered should be regulated so that no overflow occurs. Fuel should not be splashed or allowed to run down the aircraft structure.

When pressure fuelling, any levelling devices between tanks should be operated as required; the correct fuelling sequence of operations is essential to avoid damage to tanks.

PRECAUTIONS AFTER FUELLING

When transfer of fuel is completed, the bonding wires should not be removed until the filler caps have been refitted or the pressure fuelling hose disconnected.