Reference to Figure 92 CFM 56–5 System General

ATA 71..80 ENGINE SYSTEMS

73–10 ENGINE FUEL

Fuel Pump

The fuel pump and HMU are mounted as a unit. The fuel pump drive system consists of the centrifugal type LP stage pump (max. 174 psi) and the gear-type HP stage pump(max. 1000 psi).

Fuel Filter

The fuel filter consists of a disposable filter cartridge and a pressure relief valve. The filter cartridge is installed in a cavity on the pump body. In case of a clogged filter, a pressure relief valve bypasses the fuel to the HP stage.

Main Oil Fuel Heat Exchanger

The heat exchanger is a tubular design consisting of a removeable core, a ousing and a cover. Maintenance practices If there is contamination in the fuel, both the servo fuel heater and main oil/fuel exchanger must be replaced.

Fuel Filter Diff Pressure Switch

The fuel filter differential pressure switch is located on the fan case. The switch sends a fuel filter clog signal and indication is provided on the lower ECAM display.

Hydro Mechanical Unit (HMU)

The HMU receives electrical signals from the ECU (**E**lectronic **C**ontrol **U**nit) and converts these electrical input signals through torque motors/servo valves into engine fuel flow and hydraulic signals to various external systems. Fuel is used as hydraulic media.

The HMU provides metered fluel flow for combustion, a fuel shut-off function, fuel pressure calibration and power source to various engine fuel equipment.

It also provides mechanical N2 overspeed protection.

No Maintenance adjustments (Eg. Idle,Part Power Etc.) can be performed at the HMU!

Fuel Metering Valve(FMV)

The FMV is hydraulically driven through a torque motor/ servo valve by the ECU. At engine shutdown the Metering valve is completly closed.

High Pressure Fuel Shut-Off Valve(HPSOV)

The solenoid controlled valve valve shuts off fuel flow to the engine commanded by the master switch.

The HP fuel shut off valve opens if:

- command to open from the ENG/MASTER switch (solenoid de-energized)
- engine rotation speed above 15 percent N2 and fuel flow requested by ECU.

It has to be noted that the HP fuel shut off valve shut off signal by the master switch also closes the LP fuel valve.

79–00 ENGINE OIL

Oil Quantity Transmitter

The oil quantity transmitter is located in the oil tank.The oil quantity transmitter probe (tube portion) is a capacitor formed by two concentric tubes.

Lubrication Unit

The lubrication unit has a single housing containing:

- Five positive displacement pumps(Gear Type, one oil supply and 4 scavenge pumps).
- Six filters(one oil supply filter, 4 chip detectors and scavenge pump filters).
- One relief valve(305 psi, on supply discharge side).
- Two clogging indicators(CFM 56–5A :one for the oil supply filter and one for the main scavenge filter).
- Two bypass valves (one for the oil supply filter and one for the main scavenge filter).

Chip Detectors

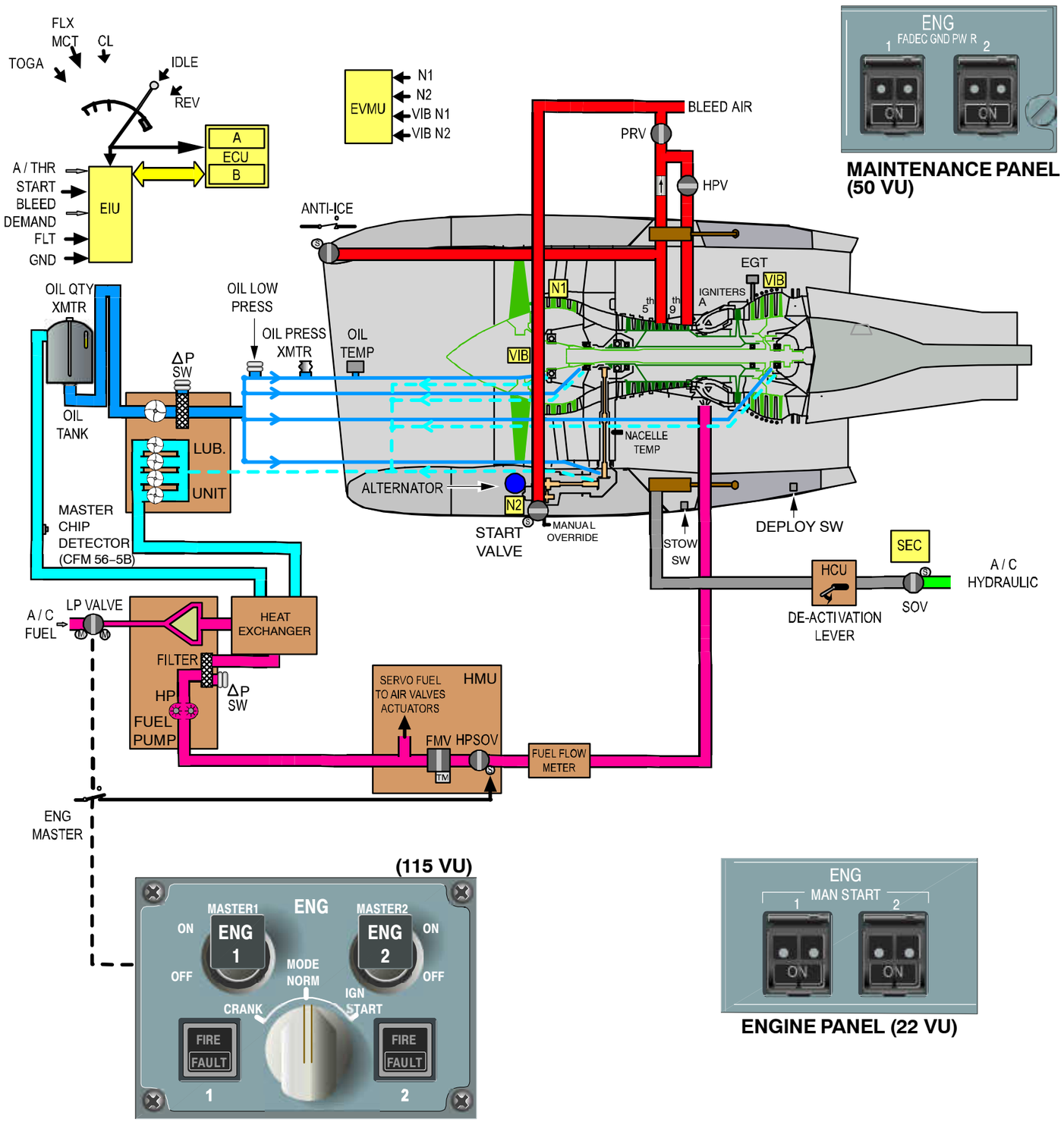
The oil from the engine bearings, accessory and transfer gearbox is scavenged by 4 pumps protected by a strainer equipped with a magnetic chip detector.

The air/oil mixtures are passed through the chip detectors and the scavenge filters, and then to the specific scavenge pump.

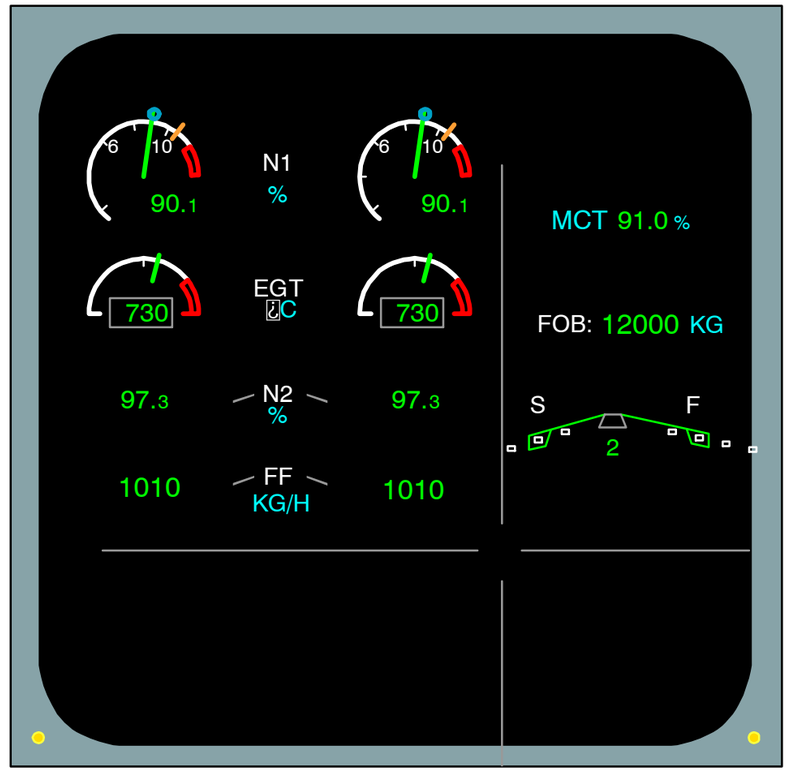
On CFM 56–5B versions a master chip detector gives a activation signal for an electrical pop-out.

Oil system sensors

Oil filter differerential pressure, low oil pressure, oil pressure value and oil temperature is monitored by signals from dedicated sensors and switches.

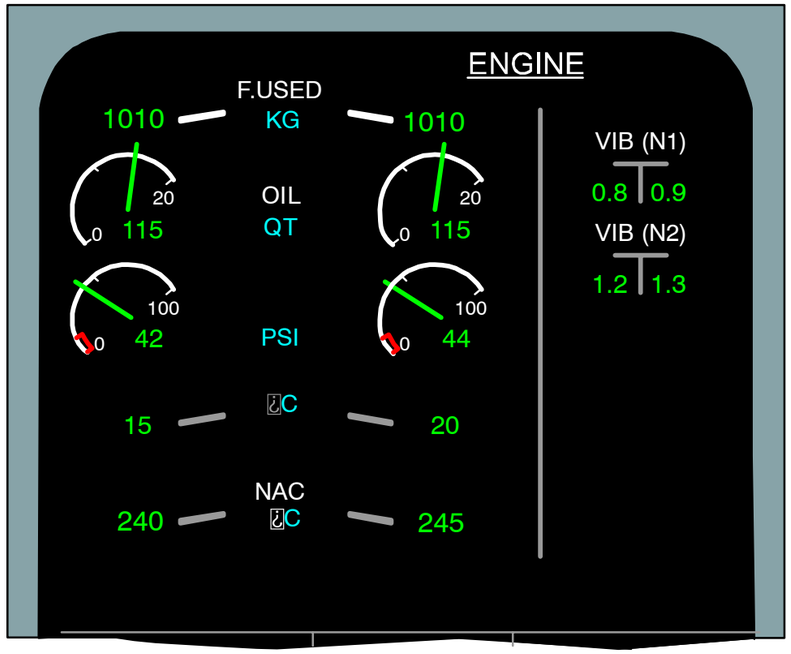


MAINTENANCE PANEL (50 VU)



(115 VU)

ENGINE PANEL (22 VU)



Reference to Figure 93 CFM 56–5 Fuel System

ATA 73 ENGINE FUEL & CONTROL

73–10 DISTRIBUTION

Fuel Return Valve

The purpose of the fuel return valve is to return fuel flow to the tank. The return fuel flow is controlled at the IDG oil cooler outlet by:

- the engine oil temperature (signal from TEO)
- the fuel temperature

Shut Off Function

The fuel return valve has a shutoff function when the engine is shutdown (solenoid de–energized) from the ENG/MASTER control switch.

The signal transits through the Arinc bus and ECU and overrides the engine ”oil in” temperature command.

In case of high fuel flow conditions the electrical open signal is overrided by a hydraulic signal from the HMU and the shutoff valve is closed. A ”close” command from the HMU interrupts both fuel flows to the aircraft. Dhe fuel return valve controls 2 flow levels:

- The first level (300 kg/h) is controlled by the engine ”oil in” temperature when the temperature is higher than 93 deg C.
- The V1 solenoid valve is energized by the electronic control unit (ECU).
- The second level (which adds approximately 300 kg/h to the first flow level) is controlled by the IDG oil cooler ”fuel out” temperature when higher than130 deg C (269 deg F).
- The V2 thermostatic valve is controlled by the ”fuel out” temperature.

Return Fuel Temperature Limitation.

The fuel return valve mixes:

- a cold fuel flow (from the engine LP fuel pump) with
- the hot fuel flow (calibrated to maintain a temperature of 214 deg F(100 deg C) in the return line. The mix is as follows:
  - Fuel out temp. below 130 deg C˚
  - 200 kg/h cold flow with 300 kg/h hot flow.
  - Fuel out temp. above 130 deg C˚
  - 400 kg/h cold flow with 600 kg/h hot flow.

A signal from the ENG/MASTER control switch to FADEC permits to override the V1 opening signal if:

- Engine oil temperature is higher than 93 deg C during take off or climb or specific operating conditions.
- A hydraulic signal from the HP fuel shutoff valve closes the V1 valve at engine shutdown.

In Flight only!

The FLSCU (**F**uel **L**evel **S**ensing **C**ontrol **U**nit) sends also FRV Inhibition signal to the ECU, if:

- Fuel Tank Temp. high
- Low Fuel Level in the Tanks
- Fuel in Surge Tank
- Gravity Feed.

Fuel Flow Transmitter

The purpose of the fuel flow transmitter is to provide the ECU with information, for indicating purposes, on the weight of fuel used for combustion. The fuel flow transmitter consists of an aluminium body with a cylindrical bore containing a rotating measuring device, which generates electronic pulses proportional to the fuel flow

Servo Fuel Heater

The servo fuel heater raises the temperature. This prevents ice from entering the control servos inside the HMU (**H**ydro **M**echanical **U**nit).

IDG Fuel Cooled Oil Cooler

The purpose of the cooler assembly is to cool oil coming from the Integrated Drive Generator (IDG). The heat generated is transfered to the fuel coming from the HMU and returning to the oil/fuel heat exchanger.

HMU INTERNAL COMPONENTS(NOT SHOWN)

Overspeed Governor

The overspeed governor is of the fly ball type. It is designed to prevent the engine from exceeding a steady state speed in excess of 106.3% N2.

A pressure switch sends a signal to the ECU if the overspeed governor fails when the engine is started (OVSPD Protection fail)

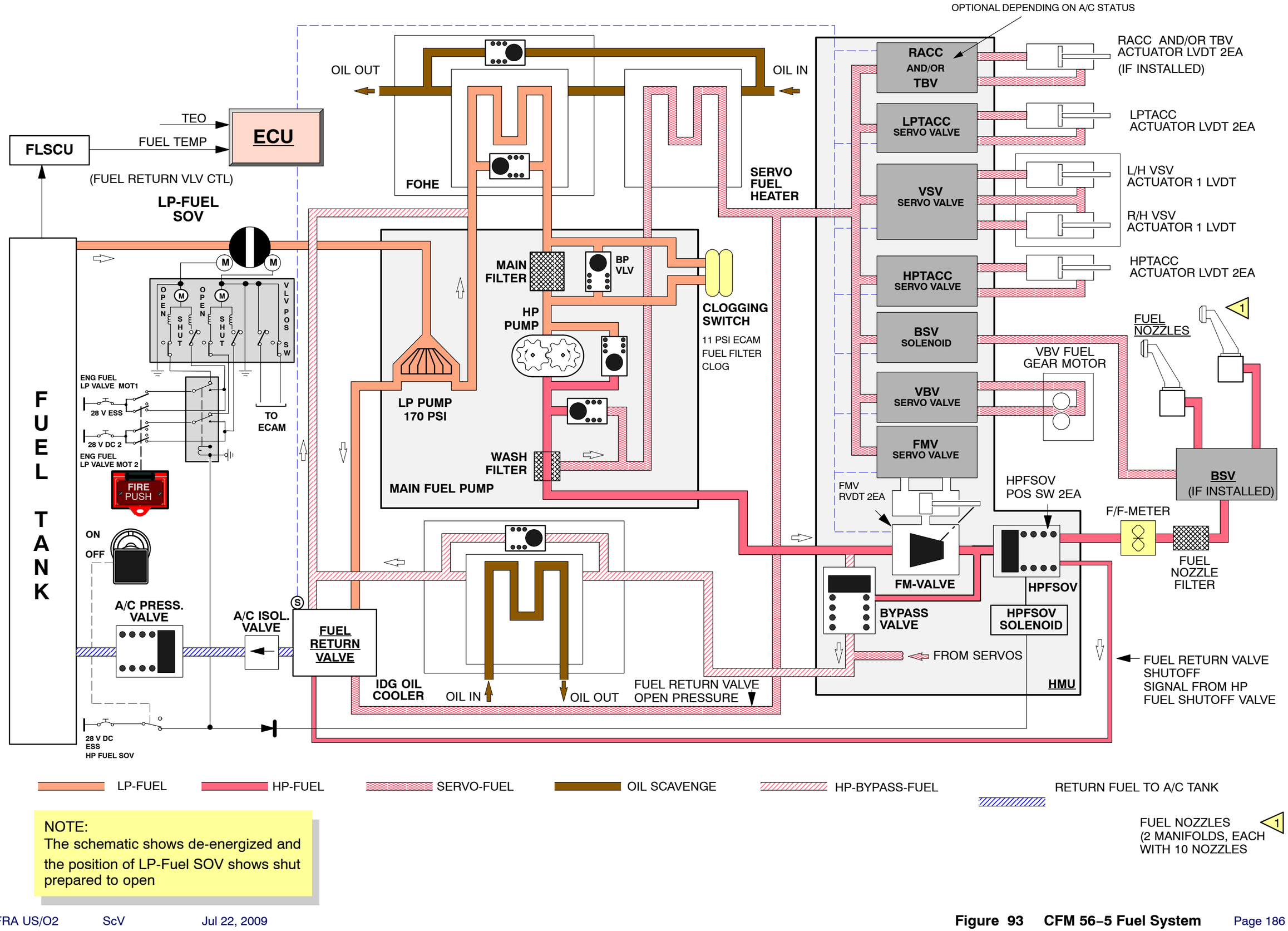
Delta P Valve

A differential pressure regulating valve maintains a constant pressure drop across the metering valve. As a result, fuel flow varies proportionally with metering valve position.

HP Fuel Shut Off Position Switches

Two switches monitor the position of the HPFSOV.

If the two switches sense an open valve the ECU will not command the Fuel Metering Valve to close.



NOTE:
The schematic shows de-energized and the position of LP-Fuel SOV shows shut prepared to open

Reference to Figure 94 CFM FADEC-General

73–21 FADEC

Full Authority Digital Engine Control (FADEC)

The FADEC consists of the Engine Control Unit (ECU), Hydromachanical Unit(HMU) and its peripheral components and sensors used for control and monitoring.

Engine Control Unit (ECU)

The ECU consists of two channels(A and B) which are permanently operational. In case of failure on one channel, the sytem switches automatically to the other. During engine start the ECU is supplied with 28 VDC by the A/C network then by its own generator, mounted on the accessory gearbox, when N2 reaches ~12%.

The ECU gets informations from various sensors for FADEC. Pressure informations are taken from different engine stations and routed via sense lines to sensors within the ECU.

P0 Sensor

The PO air pressure is measured through a vent plug, installed on the ECU shear plate. This value is used by the ECU, in case of lost signals from the Air Data Computer(ADC).

T25 SENSOR

The T25 sensor is located at 5:45 o□clock upstream of variable bleed (VBV) in fan frame. The sensor measures the air temperature downstream of the booster.

T12 Sensor

The T12 sensor is made to measure the engine intake air temperature. It is installed on the air inlet cowl at the 1:00 o'clock position.

PS 12 Sensor

Three static pressure ports are mounted on the forward section of the fan inlet case, at the 12, 4 and 8 o'clock positions. A pneumatic line runs around the upper portion of the fan inlet case, collecting and averaging the pressures.

PS3 HP Compressor Discharge Pressure

This static pressure pick–up is located on the combustion case, at the 9o'clock position, between two fuel nozzles.

TCASE Sensor

This sensor measures the HPT shroud ring temperature.

T3 HP Compressor Discharge Temp Sensor

The T3 sensor is a thermocouple which is installed at the 12 o'clock position on the combustion case, just behind the fuel nozzles.

PS13, P25 and T5

These sensors are part of the optional monitoring kit, available upon customer request. If the kit is not required, the ports are blanked off on the ECU shear plate.

76–00 ENGINE CONTROL

ThrottleCcontrol System

The throttle control system consist of:

- the throttle control levers, linked to mechanical rods
- the throttle control artificial feel unit (Mecanical Box), where friction and detent force can be adjusted
- the thrust control unit, which sends position signals via resolvers to the ECU and via potentiometers to the flight control system.

The design of the throttle control is based upon a fixed throttle concept. This means that the throttle control levers are not servo motorized.

77–00 ENGINE INDICATING

N1 Speed Sensor

The N1 speed sensor is installed on the fan frame strut at the 5:00 o'clock position.This sensor is an induction type tachometer.

3 independent sensing elements send signals to the ECU(Chan A+B) and the Engine Vibration Monitoring Unit(EVMU).

N2 Speed Sensor

The N2 speed sensor detects the rotational speed of the HP rotor assembly.It is installed at 6:30 o'clock on the accessory gearbox (AGB) rear face.

3 independent sensing elements send signals to the ECU(Chan A+B) and the Engine Vibration Monitoring Unit(EVMU).

Exhaust Gas Temperature (EGT) Sensors

9 thermocouple probes (chromel/alumel) are located in the T495 plane of Low Pressure Turbine (LPT) stage 2 nozzle assembly. They send average signals via junction boxes to the ECU.

HPTACC: HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTOL
LPTACC: LOW PRESSURE TURBINE ACTIVE CLEARANCE CONTOL
TBV: TRANSIENT BLEED VALVE
TLA: THROTTLE LEVER ANGLE
VBV: VARIABLE BLEED VALVES
VSV: VARIABLE STATOR VANES
BSV: BURNER STAGING VALVE

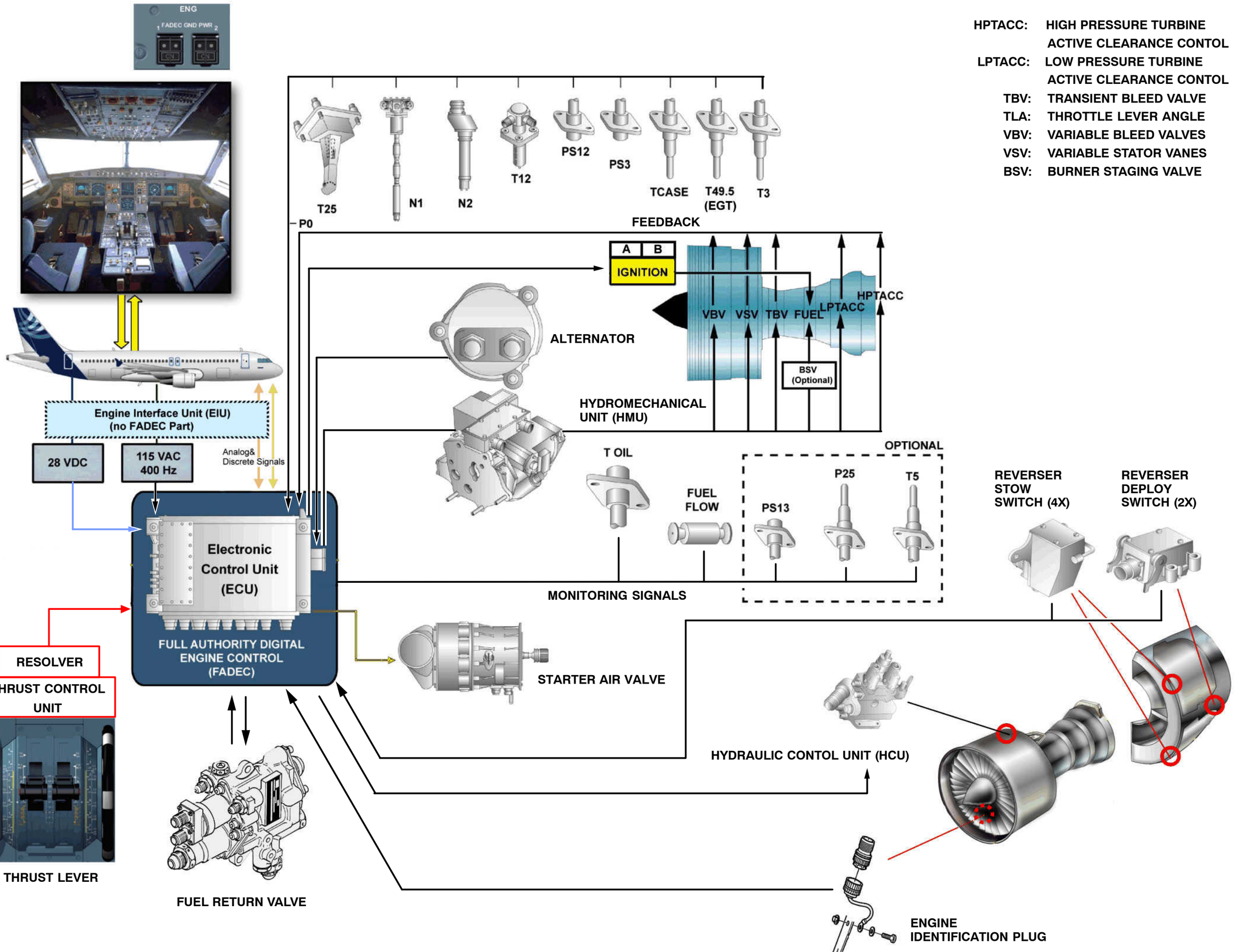
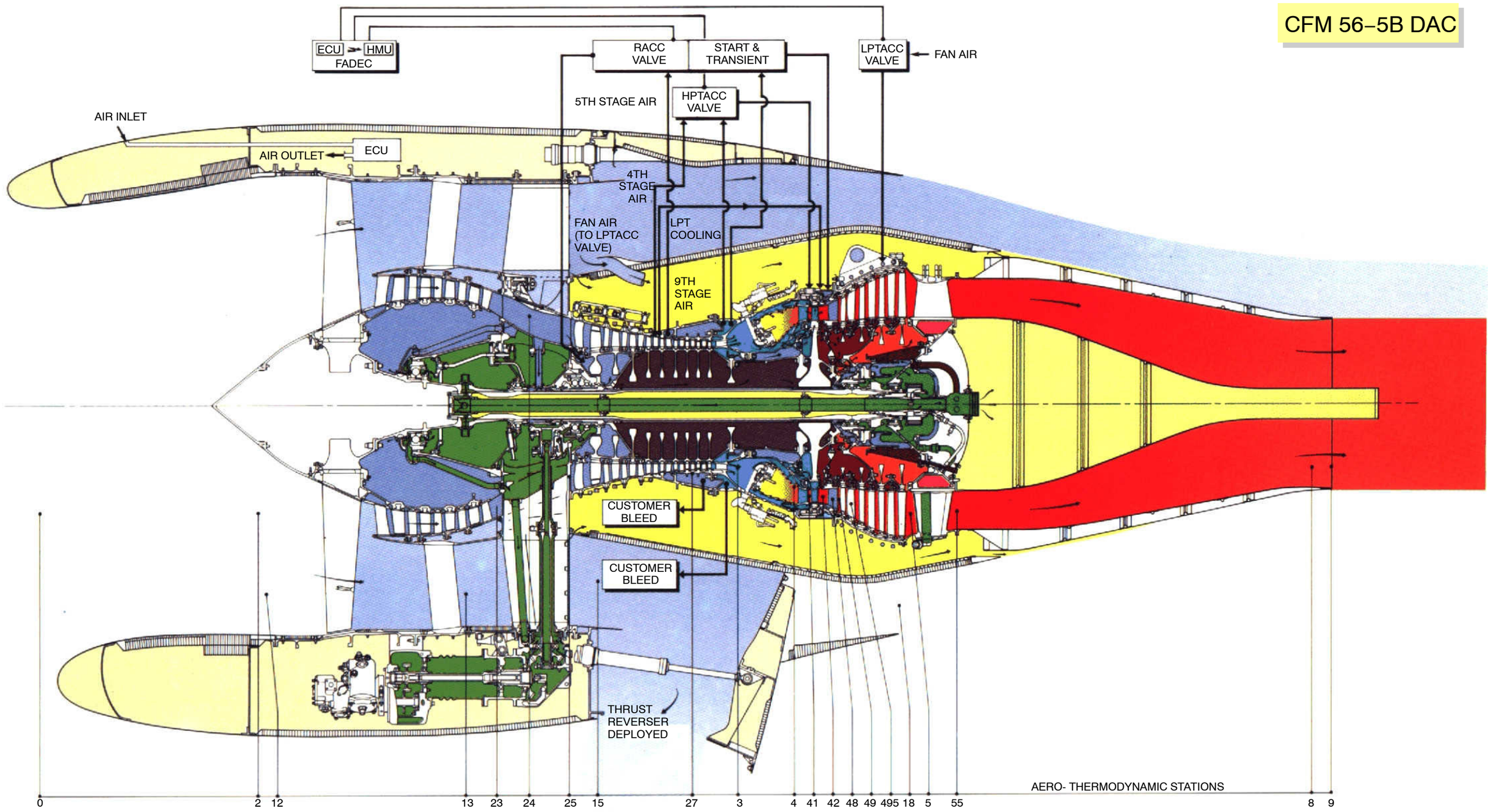


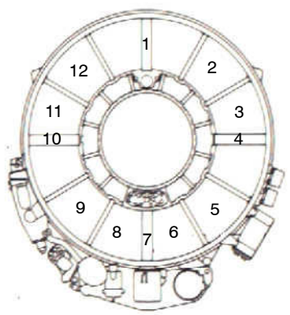
Figure 94 CFM FADEC-General

Reference to Figure 95 Engine Air General		**STAGE NUMBERING CFM56-5B**	
STAGES:	**COMPONENT.**	**STAGE NUMBER:**	**NOTES:**
1	FAN	1	FAN AIR USED FOR ACC
1 2 3 4	LOW PRESSURE COMPRESSOR (BOOSTER)	2 3 4 5	 VBV
1 2 3 4 5 6 7 8 9	HIGH PRESSURE COMPRESSOR	1 2 3 4 5 6 7 8 9	**(IGV)** **VSV** **VSV** **VSC** HPTACC A/I CUSTOMMER BLEED CUSTOMER BLEED; MUSCLE PRESS A/I, START BLEED, HPTACC
	COMBUSTION CHAMBER		20 FUEL NOZZLES, 2 IGNITOR PLUGS
1	**HIGH PRESSURE TURBINE**	1	ACC COOLING OF HPT SHROUD SUP-PORT STRUCTURE
1 2 3 4	**LOW PRESSURE TURBINE**	1 2 3 4	ACC COOLING OF LPT EXTERNAL CASE (ALL STAGE)
	EXHAUST NOZZLE		

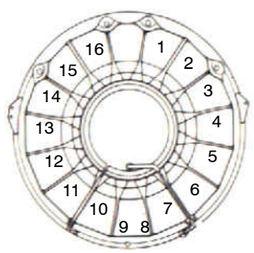
AERODYNAMIC STATION	STATION LOCATION	STATION USED FOR:
0	AMBIENT	**P0** = Ambient Static Pressure used for FADEC.
10	INTAKE/ENG: INLET INTERFACE	
12	FAN INLET	**T12** = Fan (Booster Inlet Temp.) used for FADEC. **PS12** = Fan (Booster) Inlet Press. (PT2) used for FADEC.
13	FAN EXIT	**PS13** = Static Pressure of Fan Bypass Air Flow used for Monitoring.
25	L.P. COMPRESSOR (BOOSTER) EXIT	**T25** = High Pressure Compressor Inlet Temp. (CIT) used for FADEC.**P25** = High Pressure Compressor Inlet Press.used for Monitoring
30	H.P. COMPRESSOR EXIT	**T3** = High Pressure Compressor Dis-charge Temp. (CDT) used for FADEC. **PS3** = Compressor Discharge Pressure (CDP) used for FADEC
40	COMBUSTION SECTION EXIT	
42	H.P. TURBINE EXIT	**T case** = HPT Shroud Support Temper-ature used for HPT Active Clearance Control
49	L.P. TURBINE STAGE 2 INLET	**T49.5** = Exhaust Gas Temp. (EGT) used for Cockpit Indication.
50	EXHAUST	**T5** = Total Temp. Turbine Rear Frame Plane used for Monitoring.

CFM 56-5B DAC





FAN FRAME (AFT LOOKING FWD)



TURBINE FRAME (AFT LOOKING FWD)

AIRFLOW LEGEND

- INLET
- FAN DISCHARGE
- BOOSTER DISCHARGE AND SUMP PRESSURIZATION
- BOOSTER DISCHARGE BLEED FOR HPC-HPT-LPT COOLING
- COMPRESSOR DISCHARGE
- HPT CLEARANCE CONTROL
- CORE COMPARTMENT VENTILATION
- FAN MID-SHAFT AIR CAVITY
- CENTER VENT DISCHARGE
- SUMP VENT
- HPT-LPT INTERFACE
- AFT LPT ROTOR COOLING
- VENT/DRAIN TUBE
- COMBUSTION GAS
- LPT FRAME HUB COOLING

ENGINE STATION IDENTIFICATION

0 FREE STREAM AMBIENT CONDITIONS	23 BOOSTER DISCHARGE
2 FAN INLET FROM FRAME HUB SECTION	24 BOOSTER VARIABLE BLEED VALVE DISCHARGE
3 HP COMPRESSOR DISCHARGE	25 HP COMPRESSOR INLET
4 COMBUSSOR DISCHARGE	27 HP COMPRESSOR 5TH STG. BLEED EXT. STATION
5 LOW PRESSURE TURBINE DISCHARGE	41 HP TURBINE ROTOR INLET
8 PRIMARY EXHAUST NOZZLE THROAT	42 HP TURBINE DISCHARGE
9 PRIMARY EXHAUST NOZZLE DISCHARGE	48 LOW PRESSURE TURBINE INLET
12 FAN INLET FROM FLANGE TIP SECTION	49 LOW PRESSURE TURBUNE ROTOR INLET
13 FAN OGV DISCHARGE	55 LP TURBINE FRAME EXIT
15 FAN FRAME DISCHARGE	495 EXHAUST GAS TEMPERATURE MEASURING PLANE
18 BYPASS EXHAUST NOZZLE THROAT	

Figure 95 Engine Air General

Reference to Figure 96 Oil System Schematic CFM56–5A1

ATA 79 ENGINE OIL (CFM56–5A1)

79–00 ENGINE OIL GENERAL

Oil Tank Pressurization and Venting

In normal operation, the tank is pressurized by the air included in the scavenge oil. The pressurizing air in the tank is up to 0.8 bar above the external pressure. The oil-in tube port discharges tangentially into a cavity connected with the tank vent and directing the air/oil mixture to a static air/oil separator. During engine shut down, the pressurizing air is vented overboard, thus enabling the oil level to be checked five minutes after engine shut down by opening the gravity filler cap or by looking at the cockpit indication. The tank is vented to the forward sump through the transfer gearbox and radial drive shaft housing. Thus, oil tank pressure is adequate to provide pressurization of the supply pump inlet.

When engine N2 RPM increases from idle to take–of the quantity of oil in the tank may decrease to between 6 US Quarts (5.7 liters) and 8 US Quarts (7.6 liters) due to gulping effect.

Anti Siphon System

The supply lines from the oil tank to supply the pump has an antisiphon device to prevent the drainage of the lube tank into the gearboxes and sumps when the engine is shut down for extended periods.

TEMPERATUR ENGINE OIL (TEO)

This sensor is used for the IDG cooling system control (Fuel return). The oil temperature is sensed by a dual resistor unit. The unit consists of a sealed, wire-wound resistance element (Chromel/alumel). This element causes a linear change in the DC resistance when exposed to a temperature change. Temperature measurement range: -70 deg. C to 300 deg. C. Both signals (channel A and B) are routed to the ECU.

Low Oil Pressure Switch

The low oil pressure switch is located on the lubrication unit outlet line. Actuation of the low pressure switch is at:

- 16 PSID increasing pressure
- 13 PSID plus or minus 1 decreasing pressure

Oil Pressure Transmitter

The oil pressure transmitter is located on the lubrication unit outlet line.

- Pressure range: 0 to100PSID.

Oil Temperature Sensor

The oil temperature sensor is located on the oil pressure filter downstream of the pressure pump.The oil temperature is sensed by a dual resistor unit.

Oil Filter Differential Pressure Switch

The oil differential pressure switch is located on a bracket on the engine above the scavenge filter. Lines are routed to the switch from bosses on the scavenge filter. Actuation of the differential pressure switch is at:

25.5 plus or minus 1 PSID increasing pressure 22 PSID decreasing pressure.

Minimum Oil QTY on ground(ECAM INDICATION)

Before engine start:

11 quarts + estimated consumption (0,3qts/h)

Engine at idle:

5 quarts + estimated consumption (0,3qts/h)

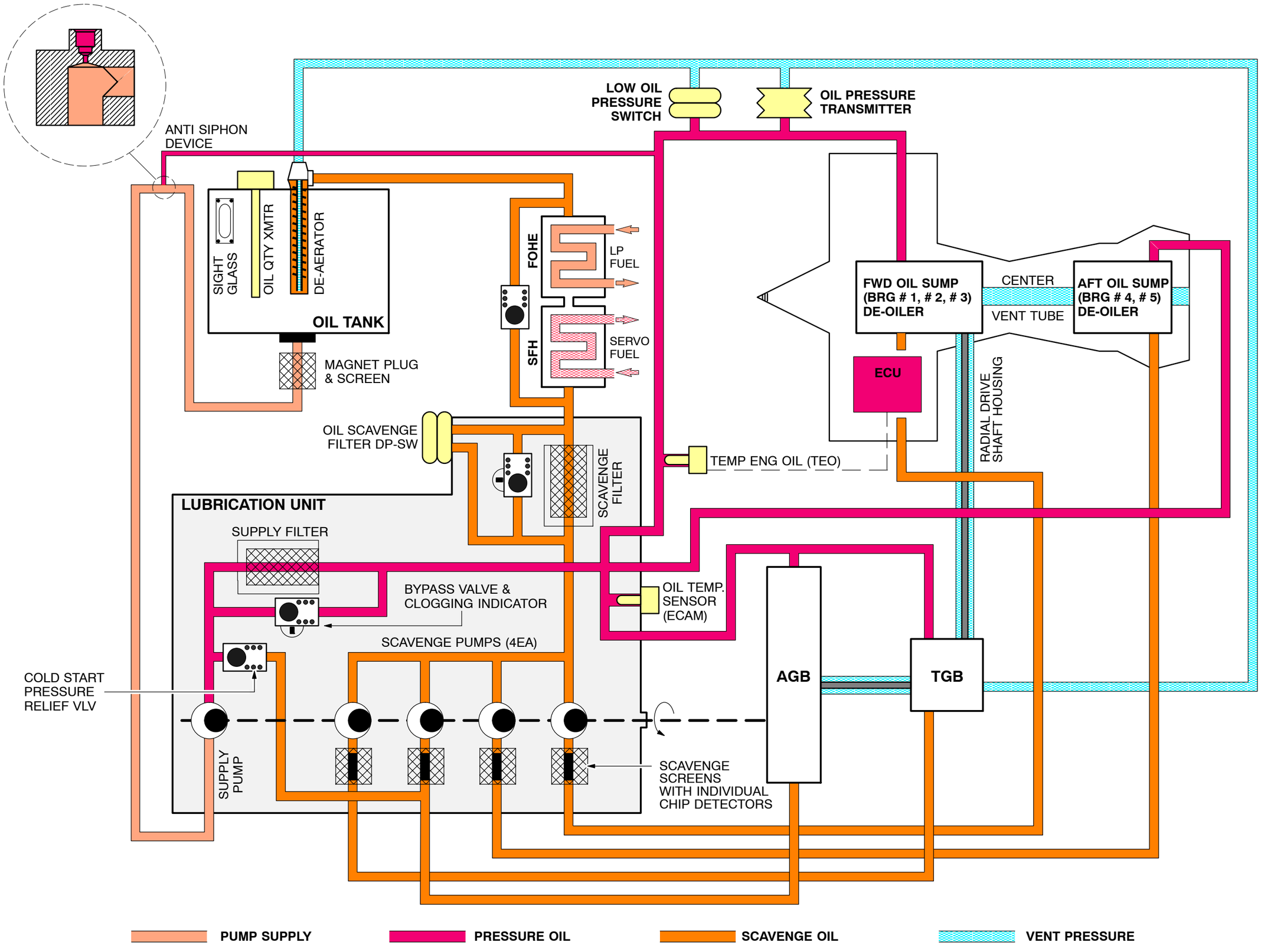


Figure 96 Oil System Schematic CFM56–5A1

Reference to Figure 97 Oil System Schematic CFM56–5B

ATA 79 ENGINE OIL (CFM56–5B)

79–00 ENGINE OIL GENERAL

Lubrication Unit

It is installed on the left hand side of the AGB front face.

Externally, the lubrication unit has:

- a suction port (from the oil tank).
- four scavenge ports (aft & fwd sumps, TGB, AGB).
- four scavenge screen plugs.
- an oil out port (to master chip detector).
- a main oil supply filter.
- a back–up filter.
- pads for the oil temperature sensor and the oil differential pressure switch.

Internally, it has 5 pumps driven by the AGB, through a single shaft. The lube unit is lubricated with supply pump outlet oil, which flows within the drive shaft. The AGB mounting pad has no carbon seal and the lube unit has an 0–ring for sealing purposes.

NOTE: Individual Chip Detectors are used for Trouble Shooting!

Main Supply And Backup Filter

In the supply circuit, downstream from the pressure pump, oil flows through the supply system which includes, first, the main oil supply filter.

A sensor, installed in between the upstream and downstream pressures of the supply filter, senses any rise in differential pressure due to filter clogging.

If the filter clogs, an electrical signal is sent to the aircraft systems for cockpit indication. A bypass valve, installed in parallel with the filter, opens when the differential pressure across the valve is greater than the spring load. The oil then flows through the back–up filter and goes to the pump outlet. The back–up filter is a metallic, washable filter. During normal operation, the oil flow, tapped at the main supply filter outlet, washes the back–up filter and goes back to the supply pump inlet, through a restrictor

Master Chip Detector

The MCD (**M**aster **C**hip **D**etector) collects magnetic particles suspended in the oil that flows from the common outlet of the four scavenge pumps, by means of two magnets on a probe immersed in the oil flow. It is installed on the lubrication unit and is connected to an oil contamination pop–out indicator, through the wiring harness. The probe is locked in position through a bayonet system. When a sufficient amount of particles are caught, the gap between the 2 magnets is bridged and the resistance between them drops. This electrical signal is then sent to the contamination pop–out indicator.

Magnetic Contamination Indicator

The magnetic contamination indicator works in conjunction with the MCD and its purpose is to provide maintenance personnel with a visual indication of oil circuit contamination. The indicator is an electro–mechanical device, located on the right hand side of the downstream fan case, just above the oil tank. When magnetic contamination in the oil occurs, an electronic circuit in the indicator detects a drop in resistance between the two magnets on the MCD probe. The electronic circuit then energizes a solenoid which triggers a red pop–out button, thus providing a visual indication. After maintenance action, the pop–out button must be manually reset. It has 2 electrical connectors

- One for the wiring harness connected to the MCD
- One for the harness connecting the indicator to the EIU.

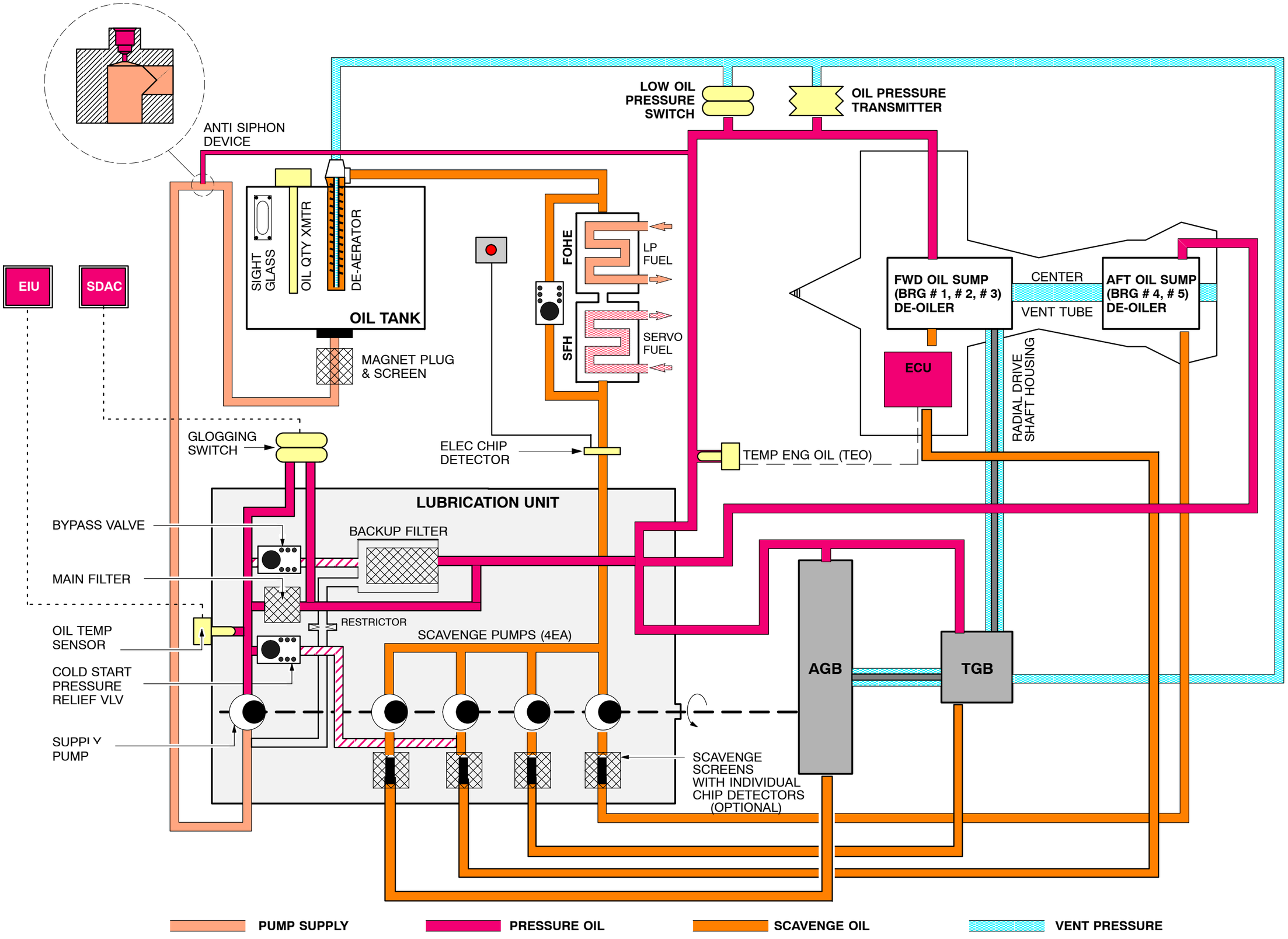


Figure 97 Oil System Schematic CFM56-5B