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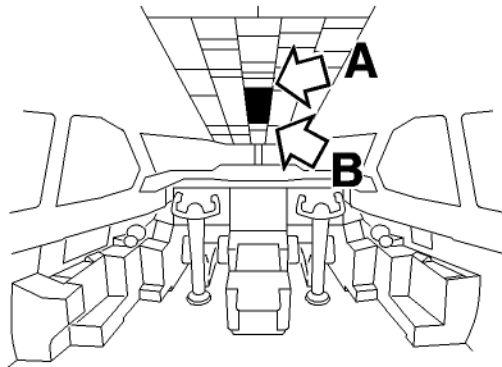
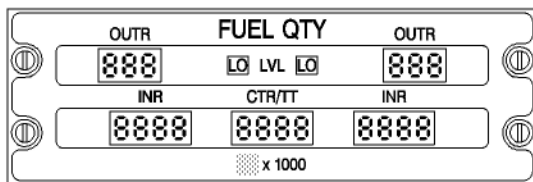
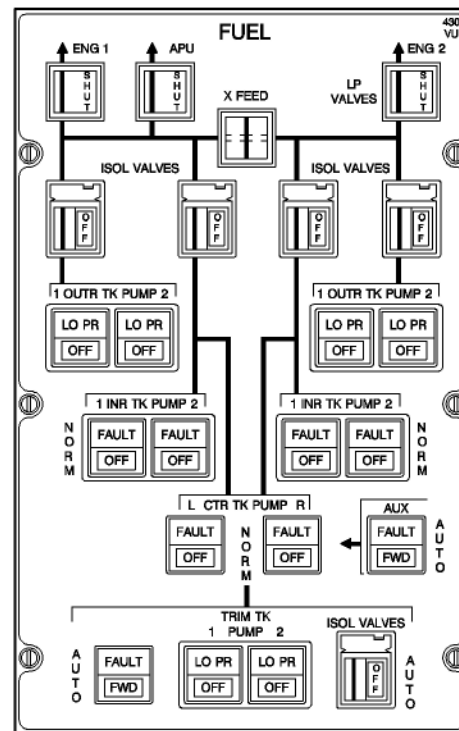
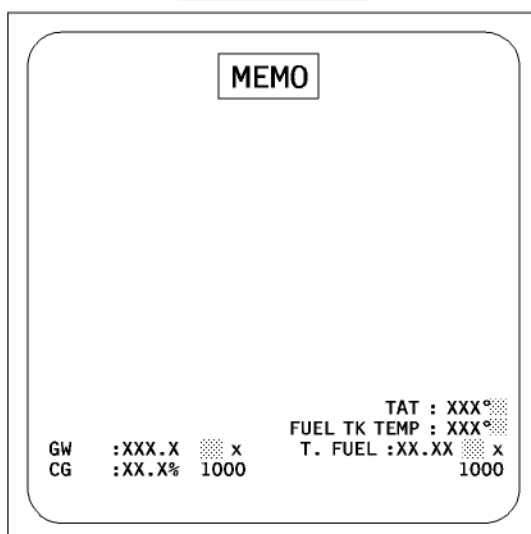
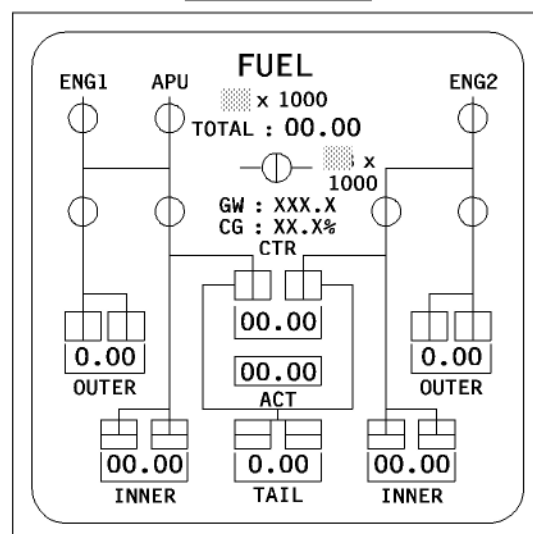
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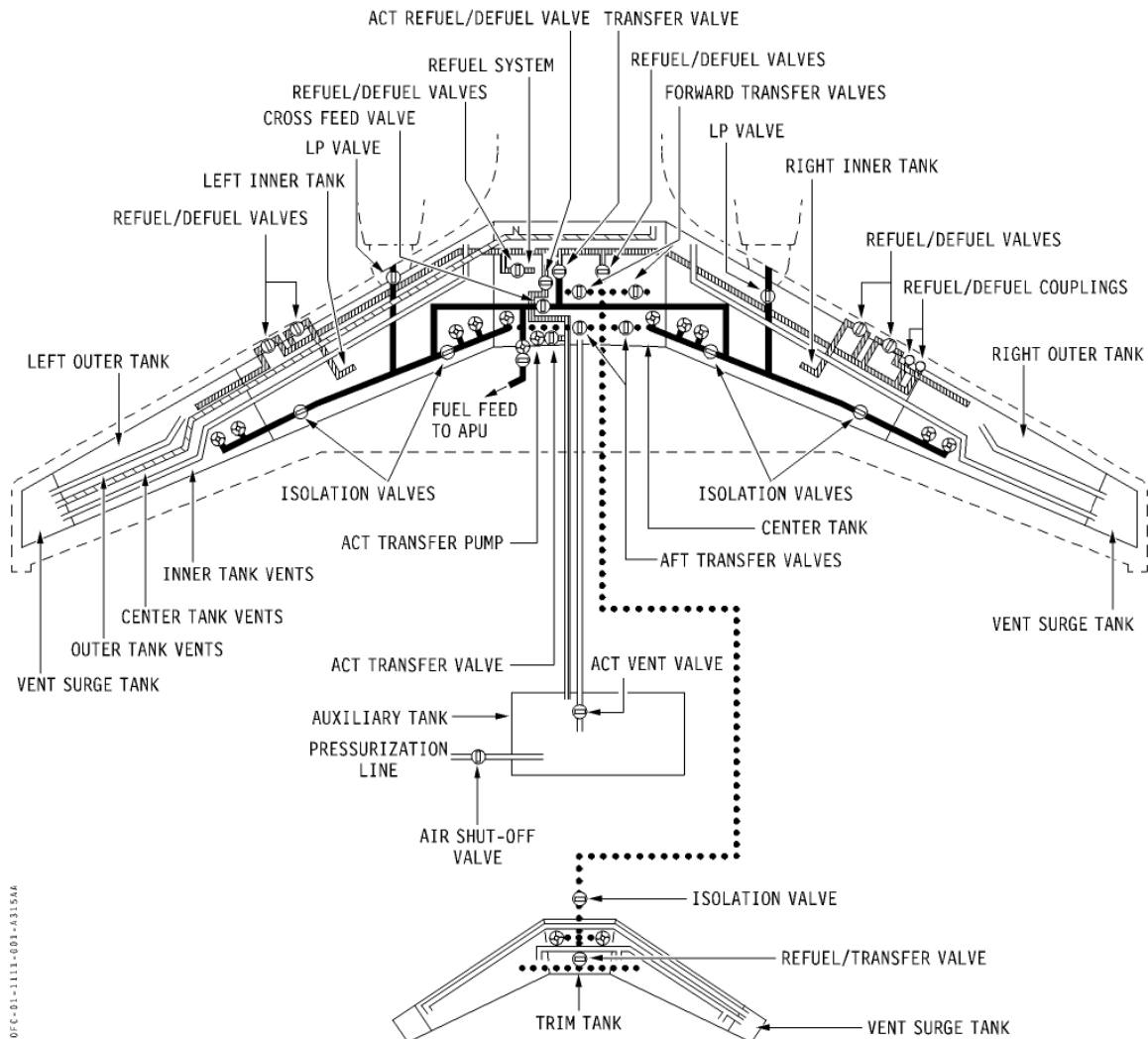

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Fuel System
**General Information,
Operational Description**

- The fuel system includes:
 - Five wing tanks with two fuel pumps per tank, and a tank vent system,
 - An Auxiliary Center Tank located in the forward end of cargo compartment,
 - A tail trim tank fitted with two transfer pumps,
 - An automatic fuel feed system for engines and APU,
 - A Fuel Quantity Indicating (FQI) System with a dedicated indicator and ECAM system display,
 - A pressure Refuel/Defuel system, and associated system controls and indicators.
- All fuel is stored in :
 - two outer and two inner wing tanks,
 - one center tank
 - one Auxiliary Center Tank
 - and one tail Trim tank.
- The wing tanks supply the engine on their respective side. The center tank supplies both engines simultaneously.
APU fuel is supplied from the left side of the crossfeed manifold.
- The engines and APU may be crossfed from any tank.
- Wing loading and Center of Gravity considerations, require fuel to be used in the following order :
 - center tank, then
 - inner tanks, then
 - from outer tanks.
- The fuel feed sequence is automatically controlled by a Fuel Autofeed system.
- Manual control of the fuel feed sequence is possible.
- Low pressure fuel supply to the engines and APU may be cut off by three electrically controlled fuel fire shutoff valves (one for each engine and the APU). These valves close when their respective Fire handle is pulled.
- Supply from the outer (OUTR TK) or inner (INR TK) / center (CTR TK) tanks may also be shut off by electrically controlled Isolation valves (ISOL VALVES guarded pushbutton switches).
- Refueling and defueling is possible using :
 - External power supply, or
 - APU power, or
 - Battery power only.
- Fuel transfers between wing and center tank are possible on ground only (the TRANSfer VALVE control switch is located on the REFUEL DEFUEL panel).

Fuel System
**General Information,
Schematics**
LEGEND:

- ⊕ FUEL PUMP
- ⊖ VALVE
- VENT SYSTEM
- REFUEL SYSTEM
- ... TRANSFER SYSTEM
- FUEL FEED SYSTEM



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Fuel System
**Fuel Tanks,
Operational Description**
GENERAL

- The tanks are baffled to minimize fuel movement in the tank.
- Water drain valves are provided to remove accumulated water from the tanks.
- Extra volume in each tank allows some thermal fuel expansion to occur without causing fuel spillage.
- A water drain / scavenge system in the outer tanks, the inner tanks, the Additional Center tanks and trim tank enables water to be drawn into the engine feed system and consumed.
- A temperature sensor is located in the outer left fuel tank. The fuel tank temperature is displayed on the ECAM MEMO page (Refer to ECAM chapter, section - MEMO page).

TANK CAPACITY

USABLE FUEL								
		OUTR	INR	CTR	TRIM	ACT1	ACT 2	TOTAL
Volume	I	3,700	13,950	19,640	6,150	7,200	7,200	75,490
	US Gal	978	3,685	5,189	1,625	1,902	1,902	19,944
Weight-kg (0,8 kg/l)		2,960	11,160	15,712	4,920	5,760	5,760	60,392
Weight-lbs (6,68 lbs/US Gal)		6,525	24,605	34,642	10,848	12,698	12,698	133,146

Fuel System
**Fuel Tanks,
Operational Description**
VENT / SURGE SYSTEM

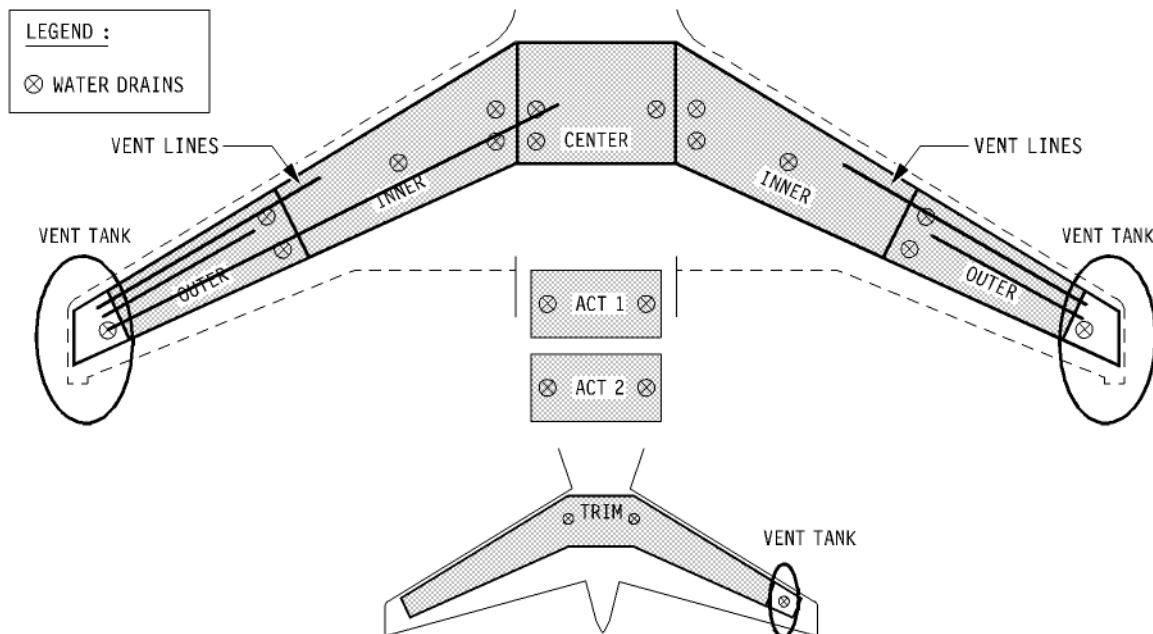
- A Vent/surge tank is located at the tip of each wing, and at the RH tip of the horizontal stabilizer.
- The volume of each wing vent tank is 190 liters (50 U.S. Gal.).

The volume of the tail vent is 120 liters (32 U.S. Gal.).

- The vent system prevents tank overpressure during refueling.
- The vent tanks provide additional thermal expansion space for fuel from the main tanks.
 - Each inner and outer tank is connected to the vent tank located in its respective wing.
 - The center tank is connected to the left wing vent tank.
 - Each Additional Center Tank vents into the center tank.
 - The trim tank vents into its own vent tank.

- In flight, these tanks are pressurized by ram air through flush NACA intake scoops on the underside of the wings.
 - This provides positive differential air pressure in the tanks whatever the aircraft attitude.
- Fuel in the vent surge tank siphons back to the associated inner wing tank when the fuel level in this tank drops.
- The vent tank will overflow overboard if it becomes full.
- Additional overpressure protection for each inner, center and vent surge tank is provided in the form of carbon safety discs which rupture if the tank becomes :
 - overpressurized (for example during climb or refueling),
 - or underpressurized (for example during descent).

Note : Fuel loss is limited should this occur.



Fuel System**Engines and APU Fuel Feed,
Operational Description****GENERAL**

- Each main fuel tank is fitted with two electrical fuel booster pumps (TK PUMPS).
- From the fuel tanks, fuel is supplied through four isolation valves (ISOL VALVES) to the left and right sides of the fuel crossfeed line.
- Four non-return valves between the ISOL VALVES and the fuel feed line prevent reverse flow of fuel from the fuel feed line to the tanks.
- The usual fuel feed sequence starts from the CTR TK, followed by the INR TK, and finally by the OUTR TK but the fuel feed sequence may be manually controlled, as required.

FUEL PUMPS

- Any one pump can supply one engine at maximum thrust.
- The INR and CTR TK pump pressure is higher than the OUTR TK pump pressure to ensure that the CTR TK and INR TK supply fuel before the OUTR TK.

Note : At high altitude, if using hot JP4 (JET B), CTR TK pump delivery pressure may momentarily drop below OUTR TK pump pressure, leading to a decrease in outer tank quantity.

- CTR and INR TK pumps operation is automatically controlled by the Fuel Autofeed.
- OUTR TK pumps operation is only manual: When an OUTR TK pump's pushbutton switch is pressed in, the associated pump operates continuously.

ISOLATION VALVES

- Four electrical ISOL VALVES can be used to shut off fuel supply from their respective fuel tank(s).

ISOL VALVES are manually controlled by guarded pushbutton switches on the overhead panel.

- OUTER TANK ISOL VALVES :

Closing an outer tank ISOL VALVE isolates the associated OUTR TK from the fuel feed line.

- INR TK ISOL VALVES:

The L INR TK pump, or the R INR TK pump can be isolated from the fuel feed line by closing the associated ISOL VALVE.

Note : The CTR TK cannot be isolated by itself.

CROSSFEED VALVE

- An electrical fuel crossfeed valve separates or connects the left and right sides of the fuel crossfeed line.
- For redundancy, the crossfeed valve is operated by two motors.
- Opening the crossfeed valve allows an engine or the APU to be supplied from the opposite side of the fuel crossfeed line.

**LOW PRESSURE (LP) FUEL/FIRE
SHUTOFF VALVES**

- Pulling an ENG or APU's FIRE handle (or an APU FIRE auto-shutdown) electrically closes the associated fuel LP VALVE to shut off the fuel supply to the respective engine or to the APU's.
- The three fuel LP VALVES are located in each engines pylon and in the APU fuel supply line.
- Each engine fuel LP VALVE is operated by two motors.

The APU LP VALVE is operated by only one motor.

Fuel System
**Engines and APU Fuel Feed,
Operational Description**
FUEL AUTOFEED MODE

- The fuel Autofeed mode automatically controls the INR TK and CTR TK PUMPS in accordance with the automatic fuel feed sequence.

Activation:

- To activate the Autofeed mode, at least one PUMP pushbutton switch for each INR TK and CTR TK must be pressed into the NORM position.

Automatic fuel feed sequence

- If the CTR TK contains fuel, the CTR TK PUMPS are activated, and the INR TK PUMPS are stopped.
- At first engine start, the CTR TK is feeding during 3 minutes (if not empty), then the INR TKs are feeding.
- After take-off, at slat retraction, CTR TK feeds again until the fuel level uncovers the calibration sensor (approximately 1000 kg/2200 lbs fuel remaining).
- 30 seconds after the CTR TK calibration sensor is dry, the CTR TK PUMPS are stopped and the INR TK PUMPS are activated.
 - If the fuel level in the CTR TK reaches again the calibration sensor level (for example as a result of forward fuel transfer from the Trim Tank), the INR TK PUMPS stop and the CTR TK PUMPS are re-activated.
 - This process is repeated until the fuel quantity in either INR TK reaches the low level sensor.
- 3 minutes after reaching the INR TK low level, INR TK PUMPS are stopped and CTR TK is feeding.
- 30 seconds after the CTR TK low level is reached, the CTR TK PUMPS are stopped.
- With all CTR TK PUMPS and INR TK PUMPS stopped the OTR TKs supply fuel to the engines.

- If during descent, CTR TK is feeding (following forward fuel transfer from TRIM TK), 3 minutes after slats extension CTR TK pumps are stopped and fuel feed is transferred to :
 - INR TKs, if not empty,
 - OTR TKs, if INR TK are empty.

This fuel feed configuration is maintained until engine shutdown.

- Once Autofeed mode is activated, Autofeed mode remains active as long as at least one INR TK PUMP in any INR TK and one CTR TK PUMP remains selected (i.e. pushbutton switch in NORM position).

Note : This enables to apply the FUEL X FEED IN FLIGHT procedure (for example, for fuel balancing or in case of single engine operation) without deactivating the Fuel Autofeed mode.

Deactivation:

- The fuel Autofeed mode can be deactivated by :
 - selecting all four INR TK PUMP pushbutton switches OFF,
 - or
 - selecting both CTR TK PUMP pushbutton switches OFF.

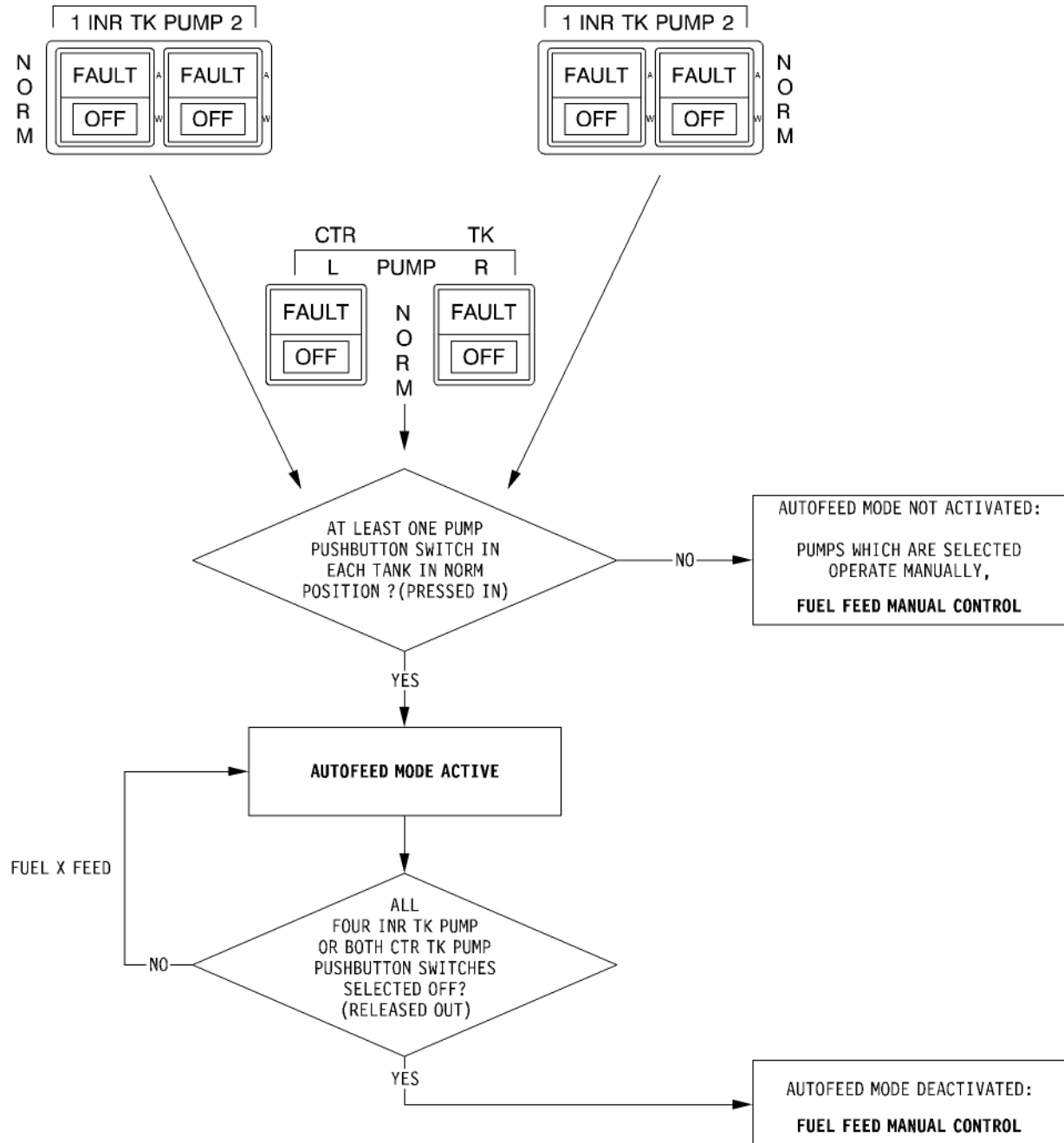
Note 1 : The OTR TK PUMPS are not controlled by the Autofeed mode, the OTR TK PUMPS constantly operate whenever their respective pushbutton switches are pressed in.

However the OTR TK PUMPS cannot supply fuel to the fuel feed line until CTR TK PUMPS and INR TK PUMPS pressure drops below 77 psi.

Note 2 : In Autofeed mode, the INR TK PUMPS and CTR TK PUMPS are not activated simultaneously.

FUEL FEED MANUAL CONTROL

- When the Autofeed mode is deactivated, fuel pump operation can be manually controlled, using the respective PUMP pushbutton switches, in accordance with the corresponding QRH (Quick Reference Handbook) procedure.

Fuel System
**Engines and APU Fuel Feed,
Operational Description**
FUEL AUTOFEED MODE ACTIVATION LOGIC


Fuel System
**Engines and APU Fuel Feed,
Operational Description**
FUEL AUTOFEED MODE FAULTS

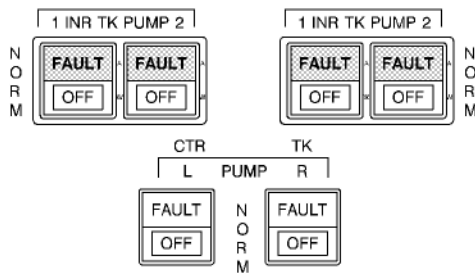
- If the Autofeed sequence does not operate correctly, an AUTO FUEL FEED FAULT is detected and PUMP FAULT lights illuminate on the overhead panel to indicate which pumps must be selected OFF in order to revert to the FUEL FEED MAN CTL mode.

• All four INR TK PUMP FAULT lights illuminate:

- If both CTR TK PUMPS are not running when commanded to run,

or

- If an INR TK PUMP is running when commanded to stop.



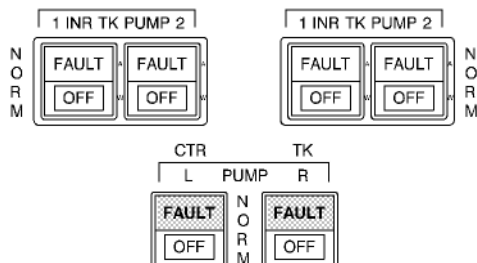
- Switching all four INR TK PUMPS to OFF deactivates the Autofeed mode and enables the CTR TK PUMPS to be operated manually.

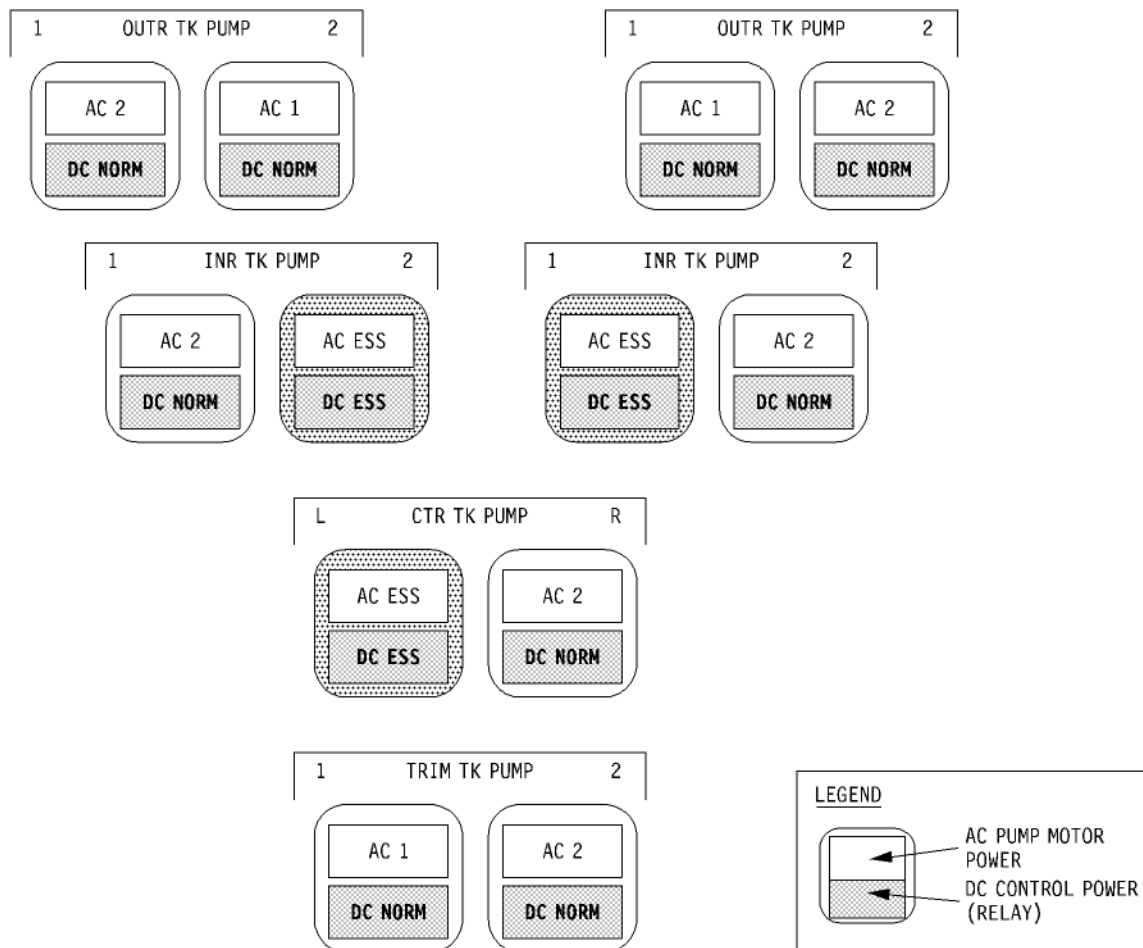
• Both CTR TK PUMP FAULT lights illuminate:

- If INR TK PUMPS are not running when commanded to run,

or

- If a CTR TK PUMP is still running when commanded to stop.



Fuel System
**Engines and APU Fuel Feed,
Operational Description**
FUEL PUMP POWER SUPPLY

AVIONICS SMOKE DRILL:

- If the SMOKE DRILL procedure is applied, the only pumps still supplied are the L INR TK PUMP 2, R INR TK PUMP 1 and L CTR TK PUMP (DC ESS and AC ESS remain supplied in the SMOKE DRILL configuration).

AC BUS FAILURE:

- The loss of one AC BUS does not affect fuel feed because at least one pump in each tank remains supplied, and Autofeed remains active.

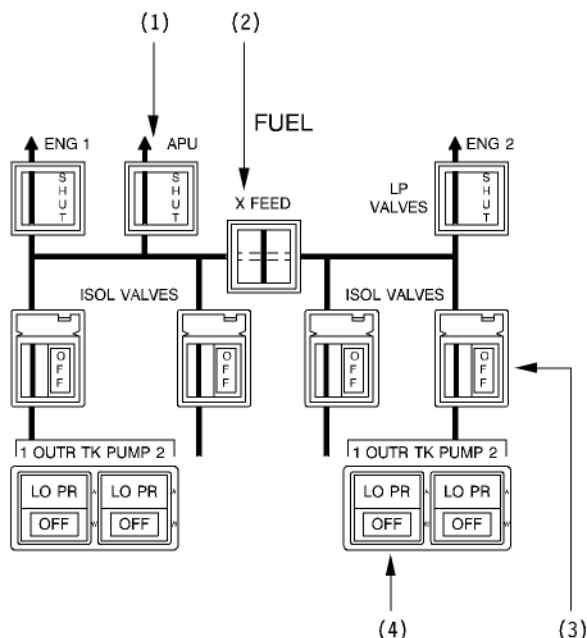
DC BUS FAILURE:

- The loss of DC NORM (ESS) BUS results in the loss of the associated pumps.
- If DC NORM (ESS) BUS is lost, the AC contactor opens and the associated fuel pumps are lost without indication on the pushbutton switches.

BATTERY ONLY :

- On BAT ONLY supply , all fuel pumps are lost. (3 phase AC power is required to operate the pump motor).

Fuel gravity feeding procedure must be applied.

Fuel System
**Engines and APU Fuel Feed,
Controls and Indicators**
FUEL PANEL (see Pull-out page)

(1) ENG 1, APU, ENG 2 LP VALVES Annunciators :

- The annunciators display the position of the associated FUEL LP VALVE (fire shutoff valve)
- **Green Flowbar illuminated**
 - Valve is open.
- **SHUT (Amber)**
 - Valve is closed (FIRE handle pulled).

(2) X FEED Valve pushbutton switch :

- Controls the position of the fuel crossfeed valve.
The pushbutton switch includes two green position indicating flowbars (in-line and cross-line).
- **Cross-line flowbar illuminated**
 - (Pushbutton switch released-out)
 - Valve is closed.
- **In-line flowbar illuminated.**
 - (Pushbutton switch pressed in)
 - Valve is open.

(3) ISOL VALVES pushbutton switches :

- These four guarded pushbutton switches control the position of the related tank ISOL VALVES.

Note : The inner tank ISOL VALVES also shut off fuel supply from the respective CTR TK PUMP'S.

- **Green Flowbar illuminated**
 - (Pushbutton switch pressed in)
 - Valve is open.

Note : The flowbar flashes when the valve position disagrees with the pushbutton switch selection (for example during valve transit).

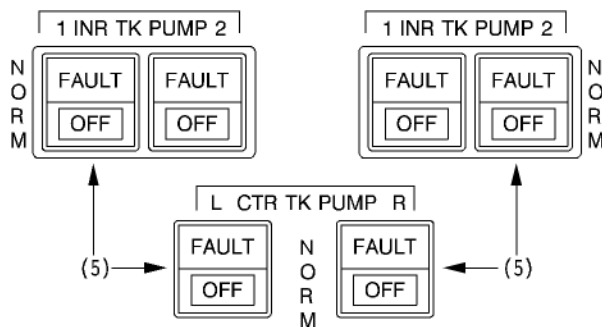
- **OFF (White : Pushbutton switch released out)**
 - Valve is closed.

(4) OUTR TK PUMP pushbutton switches :

- Each of the four pushbutton switches controls an OUTR TK PUMP
- **No light :** (Pushbutton switch pressed in)
 - Pump operates continuously.
 - Fuel is supplied from the outer tank only when inner and center tank pumps pressure drops.
- **LO PR (Amber : Pushbutton switch pressed in)**
 - Illuminates in case of pump low pressure due to pump failure or fuel starvation.

Note : The LO PR light is inhibited when the pump is switched OFF.

- **OFF (White : Pushbutton switch released out)**
 - Pump is deactivated.

Fuel System
**Engines and APU Fuel Feed,
Controls and Indicators**

**(5) INR TK/PUMP and CTR TK/PUMP
Pushbutton switches.**

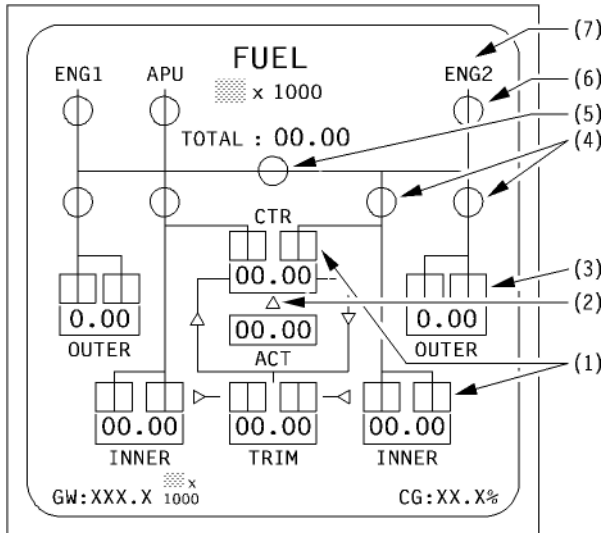
- These pushbutton switches control the selection of the FUEL FEED MANUAL CONTROL or FUEL AUTO FEED modes.
 - If at least one PUMP in each TK is selected to NORM, the FUEL AUTO FEED mode is activated.
 - If all four INR TK PUMPS or both CTR TK PUMPS are selected OFF, the FUEL AUTO FEED mode is de-activated (i.e. FUEL FEED MANUAL CONTROL is required).
 - **NORM (Pushbutton switch pressed in)**
 - In FUEL AUTO FEED mode, the pump operates according to the FUEL AUTO FEED mode logic.
 - In FUEL FEED MANUAL CONTROL mode, the pump operates continuously.
 - **FAULT (Amber: Pushbutton switch pressed in)**
 - The illumination of a single pump FAULT light indicates a pump low pressure.
 - The simultaneous illumination of both CTR TK PUMP FAULT lights, or of all four INR TK PUMP FAULT lights, indicates a failure of the FUEL AUTO FEED mode (refer to section Controls and Indicators– FUEL AUTO FEED SYSTEM FAULTS).
- Note :** The pump FAULT light is inhibited when the pushbutton switch is selected OFF.
- **OFF (White : Pushbutton switch released out)**
 - The pump does not operate.

Note 1 : When the INNER tank is emptying prior to change over to OUTER tank feed, the FAULT light of the outer pump of the INNER tank illuminates until the change over occurs. This indication does not signify a fault condition nor does it require any action.

Note 2 : When one of the two CTR TANK pumps is running the indication « CTR TANK FEEDING » is given on the ECAM MEMO page.

Note 3 : Switching from CTR to INR tanks feeding may occur prematurely during climb due to pitch angle.

Note 4 : If INNER tanks are empty before refueling and if only OUTER and INNER tanks are refuelled, INNER TK pumps will not start for 30s after pumps selected NORM. This indication does not signify a fault nor does it require any action.

Fuel System
**Engines and APU Fuel Feed,
ECAM**
SYSTEM DISPLAY

(1) -INNER (OR CENTER) TANK PUMP

- ☐ (G) : PUMP ON AND NORMAL FUEL PRESSURE
- ☐ (LO) (A) : PUMP ON AND LOW PRESSURE
- ☐ (A) : PUMP PUSHBUTTON SWITCH SELECTED OFF
- ☐ (G) : PUMP PUSHBUTTON SWITCH SELECTED ON, BUT PUMP NOT RUNNING

(2) -TRANSFER INDICATION FROM ACT TO CTR TANK

- ▲ (G) : AUTOMATIC OR MANUAL FWD TRANSFER
- △ (A) : TRANSFER FAULT OR NOT ALLOWED
- ▲ (A) : ACT PUSHBUTTON PRESSED IN (FWD POSITION) AND ACT TANK EMPTY

(3) -OUTER TANK PUMP

- ☐ (G) : PUMP ON AND NORMAL FUEL PRESSURE
- ☐ (LO) (A) : PUMP ON AND LOW PRESSURE
- ☐ (A) : PUMP OFF

(4) -INNER AND OUTER TANK ISOLATION VALVE

- ⊕ (G)-VALVE OPEN
- ⊕ (A)-VALVE OPEN WITHOUT FUEL PRESSURE
- ⊖ (A)-VALVE CLOSED

(5) -X-FEED VALVE

- ⊕ (G)-VALVE OPEN
- ⊕ (A)-VALVE OPEN WITHOUT FUEL PRESSURE
- ⊖ (G)-VALVE CLOSED

(6) -LP VALVE (FIRE VALVE)

- ⊕ (G)-VALVE OPEN
- ⊕ (A)-VALVE OPEN WITHOUT FUEL PRESSURE
- ⊖ (A)-VALVE CLOSED

(7) - ENG2(W)

- (A) WHEN NO FUEL PRESSURE

Note: Fuel feed lines are not displayed in case of DC NORM BUS OFF, but fuel feed system is not affected.

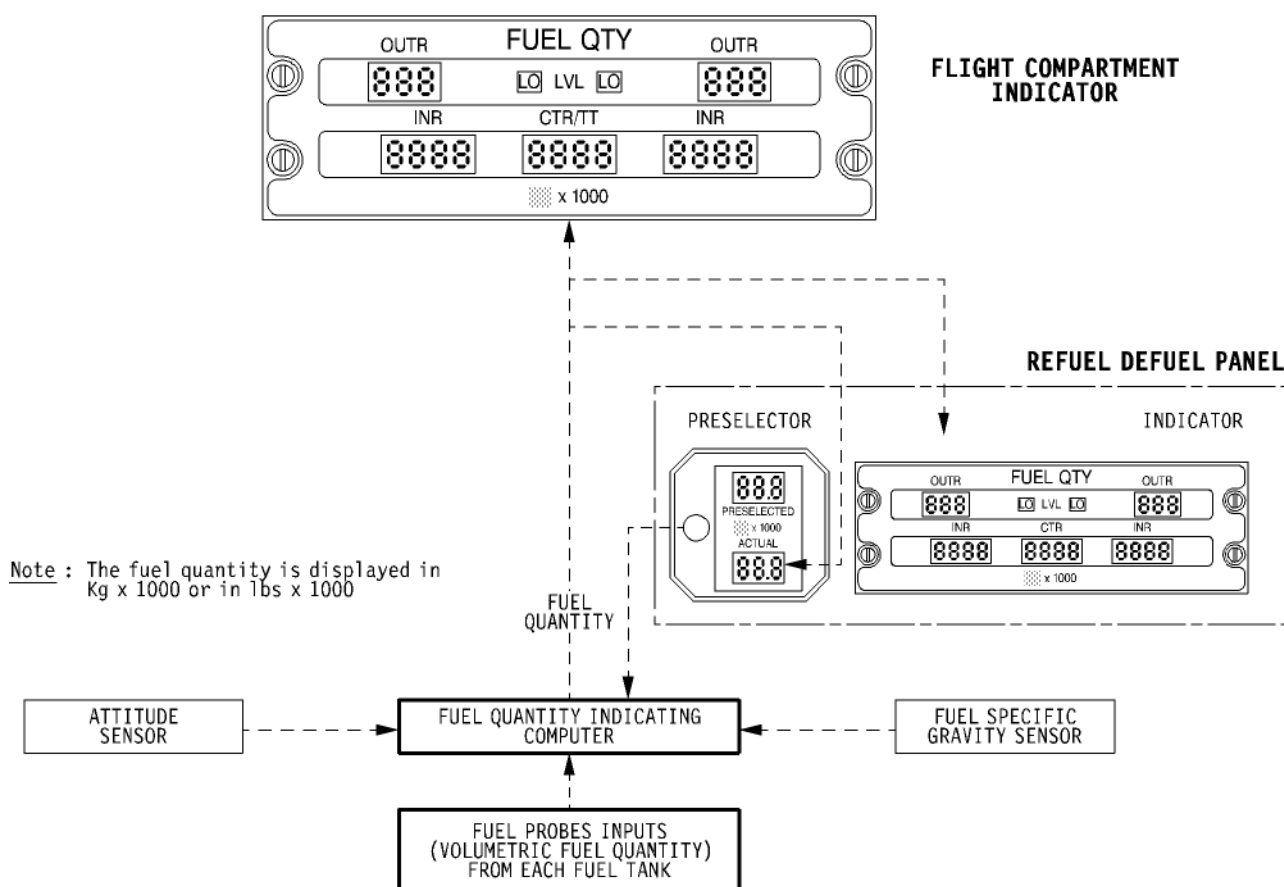
Fuel System
**Quantity Indicating,
Operational Description**
GENERAL

- Each tank has several fuel quantity probes.
- Volumetric fuel quantity information from tank probes is processed by a Fuel Quantity Indicating (FQI) computer, and adjusted using data from :
 - A fuel specific gravity sensor, (called a Cadensicon), which samples fuel during refueling to provide the specific gravity (SG),
 - An attitude sensor which provides pitch attitude and bank angles, and
 - A compensator probe in each tank which senses the dielectric characteristic of the fuel in the tank.
- Calculated tank fuel quantities are displayed on ECAM Fuel Page, on the FUEL QTY indicators on the overhead panel and on the REFUEL DEFUEL panel.

- The CTR/TT value is the sum of the Center and Trim Tank fuel quantity.

Note : When installed, the Additional Center Tanks fuel quantities are added to the CTR/TT value.

- T. FUEL (Kg x 1000 (lbs x 1000) total fuel) indication is always presented at the bottom right side of the ECAM MEMO page.
- This fuel quantity information is also used during refueling to close the refuel valves when a preselected fuel quantity is reached.
- Magnetic fuel quantity indicators are installed in the bottom of each fuel tank to provide manual back-up for measuring tank fuel quantity on the ground (for example when there is no electrical power on the aircraft or when the FQI of a tank has failed).



Fuel System
**Quantity Indicating,
Controls and Indicators**
FUEL QTY INDICATOR (See PULL-OUT PAGE)
(1) OTR, INR, and CTR/TT Tank FUEL QTY Indicators :

- The FUEL QTY Indicator (FQI) displays the calculated fuel quantity in each tank (Ibs x 1000 or kg x 1000) to within ± 10 kg (Ibs) per tank.

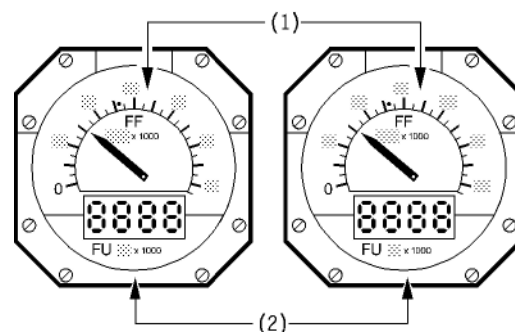
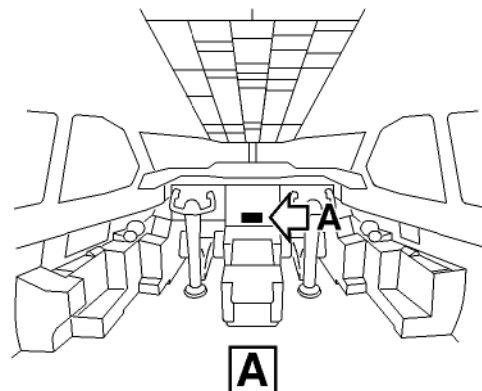
The CTR/TT display indicates the sum of the CTR TK, TT and Auxiliary Center Tank (when installed) fuel quantities.

- A dash (-) is displayed instead of the last digit of each indicator if :
 - a probe compensator fails,
 - the fuel specific gravity sensor fails,
 - the attitude sensor fails,
 - the pitch attitude exceeds 15° for at least 4 minutes.
- The dash indicates that the quantity indication accuracy is degraded to within ± 100 kg (Ibs) of the associated tank capacity.
- In case of failure of the fuel specific gravity sensor, the code LA (Lower Accuracy) is displayed during the annunciator light test.

(2) OTR Tank LO LVL Warning Lights :

- The LO LVL light illuminates red, with ECAM activation, when the fuel remaining in the associated OTR TK is between 800 kg (1800 Ib) and 1000 kg (2250 Ib).

Note: During pitch attitude changes, or if decelerating, the LO LVL lights may illuminate at a higher fuel quantity.

FF/FU INDICATORS


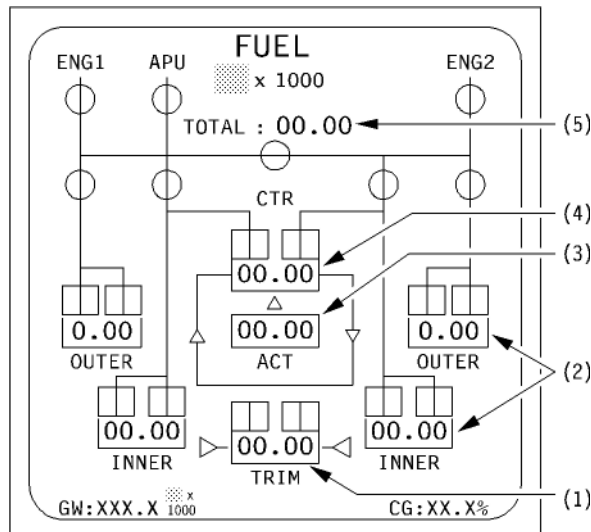
- A fuel Flow (FF) / Fuel Used (FU) indicator is provided for each engine.

(1) FF indication :

- The engine fuel flow is indicated by a pointer. The scale is graduated in thousands of kg/h (Ibs/h).

(2) FU Counter :

- The total Fuel Used by the engine is digitally indicated in thousands of kg (Ibs).
- The FU indication is reset to 0 when the engine is started, on the ground only, when start valve opens.

Fuel System
**Quantity Indicating,
ECAM**
SYSTEM DISPLAY


(1) **TRIM tank fuel quantity (G)**

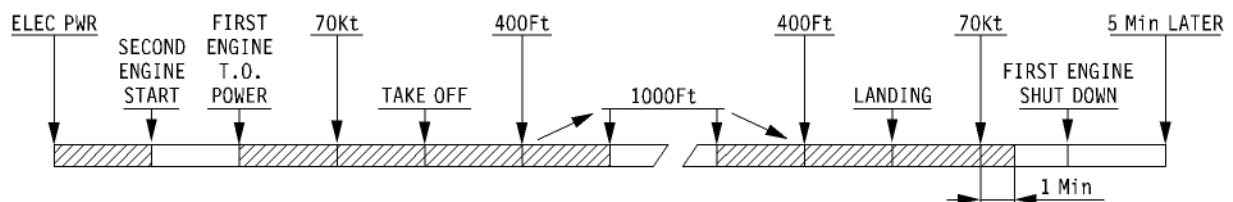
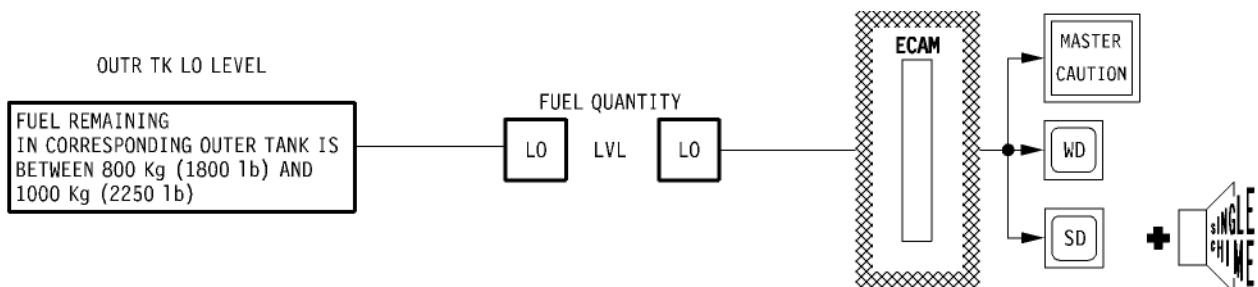
(2) **OUTER and INNER tank fuel quantity (G)**

- When fuel imbalance between the wing tanks exceeds 3000 kg (6700 lbs), the fuel quantity indications on the heavy side flash.

(3) **ACT (Additional Center Tank) fuel quantity (G)**

(4) **CTR tank fuel quantity (G).**

(5) **TOTAL fuel quantity (G)**

FAULT
**WARNING LOGIC
LOCAL WARNING LIGHTS**
ECAM WARNING


Fuel System**Refuel/Defuel System,
Operational Description****GENERAL**

- Refueling and defueling is controlled from a REFUEL DEFUEL panel located on the lower right side of the fuselage near the air conditioning pack outlet.
- Two standard REFUEL DEFUEL couplings are mounted under the right wing, outboard of the engine.
- The REFUEL DEFUEL VALVES are electrically commanded and they open by fuel muscle pressure.
 - REFUEL DEFUEL VALVES have mechanical controls to allow them to be manually opened if electrical power is not available.

Note : At parking it is recommended to set all fuel pumps to OFF except L INR TK PUMP 2 if fuel remains in INR TK and APU is used.

AUTOMATIC PRESSURE REFUELING

- A fuel quantity preselector on the REFUEL DEFUEL panel is used to preset the desired fuel load.
- The required fuel load is distributed with the following priority : outer, inner, then center and trim tanks.
- The automatic refueling sequence simultaneously refuel all tank requiring fuel (based on above refuel priority).
- Tank refueling is automatically stopped by the FQI when the preset quantity is reached.
- As a backup of the automatic system, refueling may be manually controlled by placing each tank's REFUEL DEFUEL VALVES switch to OPEN or SHUT as required.
- Complete main tanks refueling takes approximately 25 minutes depending on refuel pressure. (Maximum fuel pressure is 50 PSI)

- Each tank has a high level sensor which closes the tank's REFUEL DEFUEL VALVE when the fuel level reaches the sensor.
- The center tank has a pressure relief valve which automatically opens when the REFUEL DEFUEL panel door is open. This valve allows excess center tank fuel to overflow into the right inner tank if the center tank overfills.
- If this valve is not open, it is not possible to refuel or defuel the center tank.

ALTERNATE GRAVITY REFUELING

- The individual wing tanks may also be gravity refueled by removing fuel caps on top of the wings.
- To refuel the center tank in this manner, the fuel transfer procedure must be applied.

Fuel System**Refuel/Defuel System,
Operational Description****FUEL TRANSFER**

- Fuel transfer between main tanks is possible on the ground only.
 - On the REFUEL DEFUEL panel :
 - The TRANSF VALVE guarded toggle switch must be in the OPEN position.
 - The REFUEL DEFUEL VALVES guarded toggle switches of all tanks except the receiving tank must be in the SHUT position.
 - The REFUEL DEFUEL VALVES guarded toggle switch of any receiving tank must be in the OPEN position.
 - The supplying TK PUMP's must be operating.
- Fuel is pumped from the supplying tank into the fuel crossfeed line.
- From the crossfeed line, fuel goes through the TRANSF VALVE into the refuel/defuel line.
- From the refuel/defuel line, fuel enters the receiving tank through the associated REFUEL VALVE.

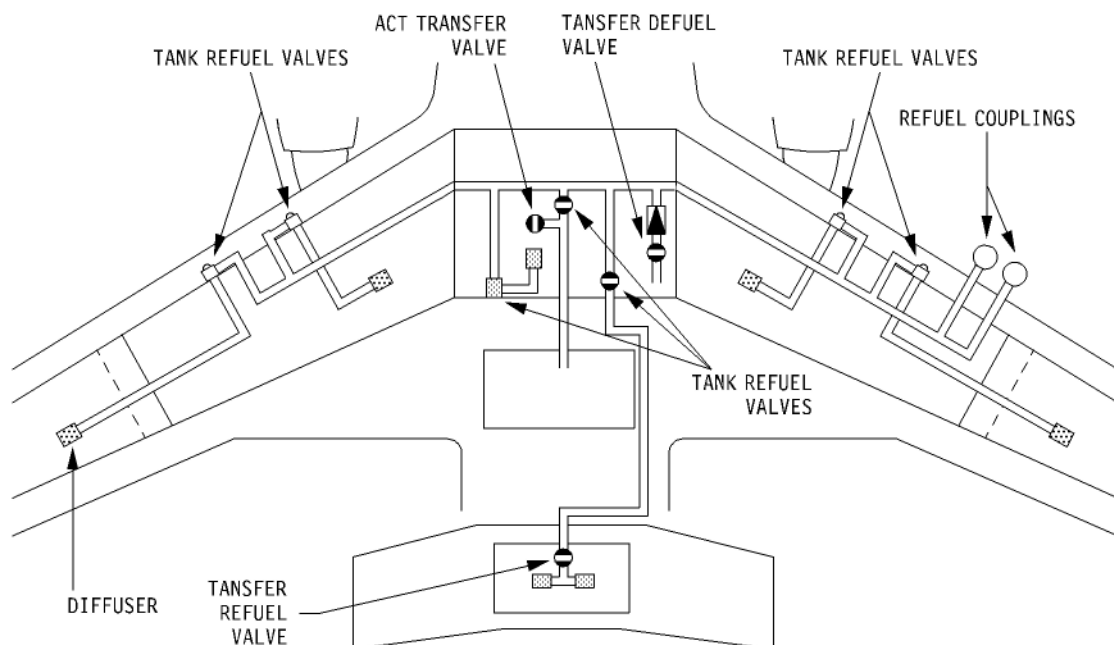
Fuel System
**Refuel/Defuel System,
Operational Description**
DEFUELING

- Defueling can be performed by use of the fuel TK PUMP's with the TRANSF VALVE open and / or by suction applied at the REFUEL DEFUEL couplings.

POWER SUPPLY FOR REFUELING/DEFUELING

- When the REFUEL DEFUEL panel door is open, refueling electrical power can be obtained from three sources :
 - APU GEN or EXT PWR ON.
 - Aircraft not powered but :
 - . EXT PWR plugged (AVAIL but not ON), and
 - . MAINT BUS switch ON.
 - Aircraft not powered but :
 - . REFUEL DEFUEL panel PWR SUPPLY switch in the BAT position.

Note : The aircraft Battery 7 supplies the DC Fueling Bus only (not the DC ESS BUS) and supplies the AC Fueling Bus through the Emergency Inverter.



Fuel System
**CG Control System,
Operational Description**
GENERAL

- The Trim tank system is installed in order to :
 - Increase the fuel tank capacity.
 - Decrease the fuel consumption by reducing drag during cruise, by maintaining the aircraft Center of Gravity (CG) close to the certified aft limit.
- To maintain the CG target, fuel is transferred aft from the Center or Inner tanks to the Trim tank, or forward from the Trim tank to the Center tank.
 - Aft transfer is controlled by the Center of Gravity Control Computer (CGCC).
 - Forward transfer is controlled by the CGCC, or can be manually selected on the fuel panel.
- An independent monitoring of the CG is provided by the FWC, and is based on the THS position.
It signals to the CGCC if the CG is too far aft and provides ECAM warnings.

CGCC FUNCTIONS

The CGCC has three main functions.

- The CGCC computes the aircraft CG and Gross Weight (GW) which are displayed on the ECAM.
The CG and GW calculation is based on :
 - Zero Fuel CG (ZFCG) and Zero Fuel Weight (ZFW) entered by the crew on the FMS CDU.
 - Fuel quantity in each tank provided by the FQI.
 - Aircraft pitch angle provided by the IRS.
- Monitoring the aircraft CG and maintaining the CG target.
- Controlling fuel transfer to and from the Trim tank in order to maintain the CG target.
This function is only active if at least one TRIM TK PUMP pushbutton switch is selected ON, and the MODE selector is in the AUTO position.

CGCC MODES

The CGCC has three modes of operation.

Normal Mode

- The CG control is fully automatic and maintains the CG close to the target.

Alternate Mode

- CG control is fully automatic, but fuel aft transfers are stopped.
- Fuel in the Trim tank will automatically be transferred forward in steps.
- An ECAM status message is displayed : FUEL TRIM TANK AFT XFR NOT AVAIL
- No crew action is required.

Fault Mode

- The automatic CG control is lost, and crew must manually transfer the Trim tank fuel forward.
- An ECAM caution is displayed :

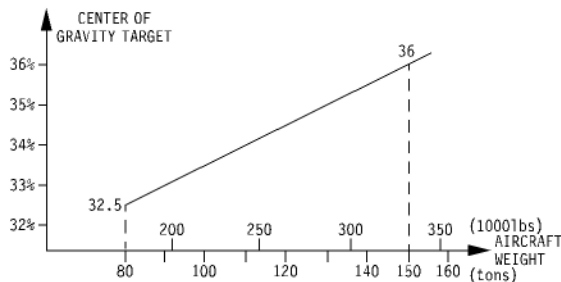
FUEL TRIM TANK SYS FAULT

PROC TRIM TANK SYS FAULT

- The crew must apply the TRIM TK SYS FAULT QRH procedure.

Fuel System
**CG Control System,
Operational Description**
CG TARGET

- The CG target (computed by the CGCC) depends on the aircraft Gross Weight, as illustrated hereafter :



- The CG target is shifted forward in the following cases :
 - Degraded FQI accuracy (1.5 % more forward).
 - Aft CG condition detected by the FWC independent aft CG monitor (CG beyond 39.8 %).
 - At the first occurrence, the CG target is shifted 1.5 % forward.
 - At the second occurrence, the CG target is shifted forward a further 2.3 %.

The ECAM STATUS message CG TARGET SHIFTED FWD is displayed.

Note : If degraded FQI accuracy occurs and an aft CG condition is detected, CG target shifts are added.

C.G. CONTROL

When the slats are retracted after take-off, the TRIM TK ISOL VALVE automatically opens to allow fuel transfers to and from the trim tank.

In climb below FL 205

No aft transfer will occur, forward transfer will occur if the CG moves beyond the aft target due to fuel burn.

Flight above FL 205

- Automatic aft and forward transfers will be controlled by the CGCC in order to maintain the C.G. within 0.5 % forward of the C.G. target.
- If for any reason, the C.G. goes aft of the target by more than 0.1%, then a fast forward transfer is initiated, terminating when the C.G. is 0.5 % forward of the target. Normal C.G. control is then resumed.
- If the CG target cannot initially be reached due to a full trim tank, C.G. control is interrupted and resumed automatically once the C.G. target is reached by fuel consumption.
- Aft transfer is from either the center tank or inner tanks, depending on which is feeding according to the fuel auto feed control system. With inner tanks feeding, aft transfer is stopped when the fuel quantity in one inner tank is below 500 kg (1100 lb).
- Once the inner tanks are empty, the C.G. target is no longer maintained and the CGCC controls forward transfers to maintain the center tank between 500 kg (1100 lb) and 1000 kg (2200 lb) until the trim tank is empty.

Descent below FL 200

- When descending below FL 200, the CGCC initiates a fast forward transfer in order to empty the trim tank. If the forward C.G. limit is reached, or center tank becomes full, forward transfer is suspended.
- When the landing gear is down, the TRIM TK ISOL VALVE will automatically close and to prevent any further fuel transfer.

Note : If the whole flight is performed below FL 205, there will be no automatic C.G. control except to ensure the C.G. does not go beyond the C. G. target. In this case the crew must check the trim tank quantity prior to descent and select TRIM TK MODE to FWD to manually transfer the trim tank fuel forward prior to landing. It is permitted to land with up to 2000 kg (4400 lb) in the trim tank.

Fuel System
**CG Control System,
Operational Description**
FUEL TRANSFER SYSTEM

- The trim tank transfer pipe connects the trim tank to the engine feed gallery and refuel gallery.
- At the trim tank the pipe is isolated by the TRIM TK ISOL VALVE.
- This valve is automatically controlled :
 - On ground, it will be closed, except when the refuel panel is powered.
 - In flight the TRIM TK ISOL VALVE opens at SLATS retraction and closes again at landing gear extension. The TRIM TK ISOL VALVE will also open whenever TRIM TK MODE is selected FWD.
- The TRIM TK ISOL VALVE can also be manually selected closed, using its guarded pushbutton switch. The manual selection of the TRIM TK ISOL VALVE should not be used in flight.

Aft Transfer

- Fuel is supplied from the center or inner tanks, dependent on the autofeed control system.
- The transfer is controlled by the CGCC through two AFT TRANSFER VALVES which will be opened separately by the CGCC if inner tank fuel imbalance is more than 200 kg (440 lbs).
- Manual aft transfer is not possible.
- Aft transfer rate is approx 150 kg/min (330 lbs/min).

Forward Transfer

- FWD transfer is only possible from trim tank to center tank.
- The CGCC activates the trim tank pumps and opens the FORWARD TRANSFER VALVE (plus the AUXILIARY FORWARD TRANSFER VALVE for fast forward transfer).

- If this automatic mode is not available, fuel can be manually transferred forward, by selecting FWD on the TRIM TK MODE pushbutton switch.

In this case, the trim tank pumps are activated and the FORWARD TRANSFER VALVE and the UXILIARY FORWARD TRANSFER VALVE open (fast forward transfer).

- FWD mode must be deselected and trim tank pumps turned off once the trim tank is empty.

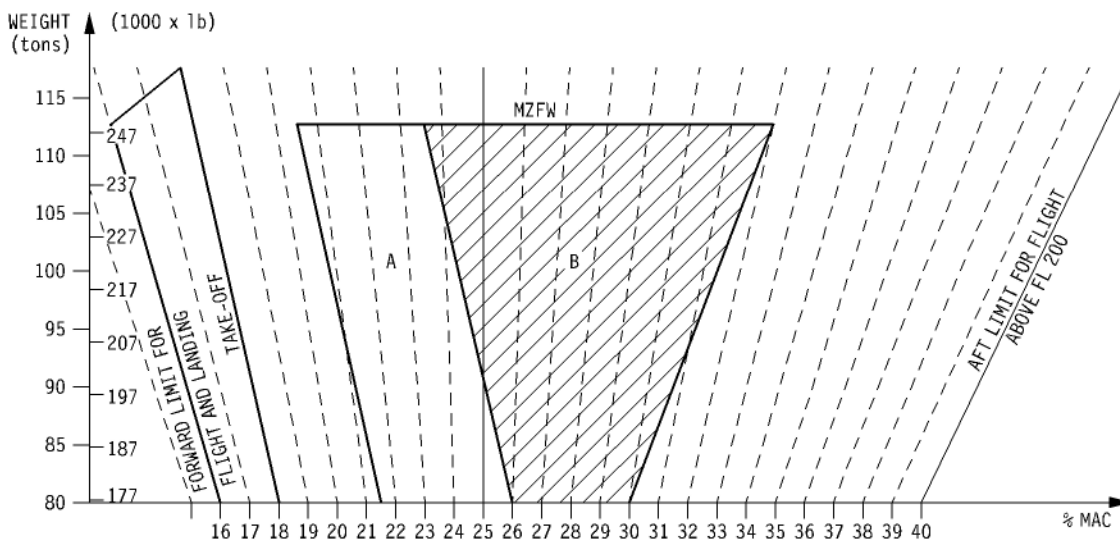
- Forward transfer can also be performed by gravity.

Transfer Rates

TRANSFER	TRANSFER RATE
AFT	150 kg/min (330 lb/min)
Automatic FWD	120 kg/min (265 lb/min)
Fast FWD	450 kg/min (990 lb/min)
Manual FWD	450 kg/min (990 lb/min)
Gravity FWD in cruise	100 kg/min (220 lb/min)
Gravity FWD in descent	125 kg/min (275 lb/min)

Fuel System
**CG Control System,
Operational Description**
FORWARD TRANSFER FUNCTIONS

FAILURE	ZFCG in Zone A	ZFCG in Zone B
TYPE 1	Two-step fuel transfer : - 3 tons (6 600 lb) transferred from TRIM TK to CTR TK - Remaining TRIM TK fuel is transferred as soon as Inner tank pumps are running.	One step transfer : - Whole TRIM TK fuel is transferred to CTR TK as soon as failure is detected.
TYPE 2	Two-step fuel transfer : - When CTR TK fuel decreases below 12.4 tons (27 300 lb), 3 tons (6 600 lb) are transferred from TRIM TK to CTR TK. - Remaining TRIM TK fuel is transferred as soon as INR TK PUMPS are running.	Multiple-step transfer : - First transfer is initiated as soon as failure is detected. - When CTR TK fuel quantity increases above 15.4 tons (34 000 lb), transfer is stopped. - When CTR TK fuel quantity decreases below 14.4 tons (31 700 lb), transfer is resumed until fuel quantity in CTR TK reaches 15.4 tons (34 000 lb). - The process is repeated until TRIM TK is empty.

ZFCG Zones:

TYPICAL GRAPH

Fuel System**CG Control System,
Operational Description****CGCC ALTERNATE MODE**

- Some failures causes the CGCC to enter in alternate mode.
- This mode only controls the forward transfer to ensure that the CG is maintained within safe limits, and to prevent a CTR tank overfilling.
- In case of FQI failure, the alternate mode initiates a **normal forward transfer** (Type 1 failures).
- With the following failures, the alternate mode initiates a **fast forward transfer** (Type 2 failures) :
 - Refuel transfer valve fails to open or to close,
 - FWD transfer control valve fails to open or to close,
 - FWD auxiliary transfer valve fails to open or to close,
 - One aft transfer valve fails to open or to close,
 - Both Trim tank pumps fail.
 - Independent aft CG warning system fails,
 - Independent aft CG warning not available (landing gear down, or slats extended above FL 200),
 - Both ADC fail.

Note 1 : The message :

**FUEL TRIM TANK AFT XFR NOT A VAIL
is displayed on the left ECAM CRT.**

Note 2 : Fuel is automatically transferred forward from the Trim tank in steps. No crew action is required.

Fuel System
**CG Control System,
Operational Description**
CGCC FAULT MODE

- The following failures cause the CGCC to enter the **FAULT mode** :
 - CGCC internal failure,
 - CG moves aft of the CG target by more than 0.3 % above FL 205,
 - Alternate mode type 2 failure and FQI failure simultaneously,
 - No forward transfer, when transfer commanded by the CGCC,
 - Selection of both TRIM TK PUMPS OFF or TRIM TK MODE in the FWD position during alternate mode,
 - No initial ZFW or ZFCG.
- Automatic C.G. control is lost, and the flight crew must follow the TRIM TANK SYS FAULT procedure.
- If the fuel transfer is not confirmed (Trim tank quantity not decreasing) TRIM TANK UNUSABLE procedure must be applied.

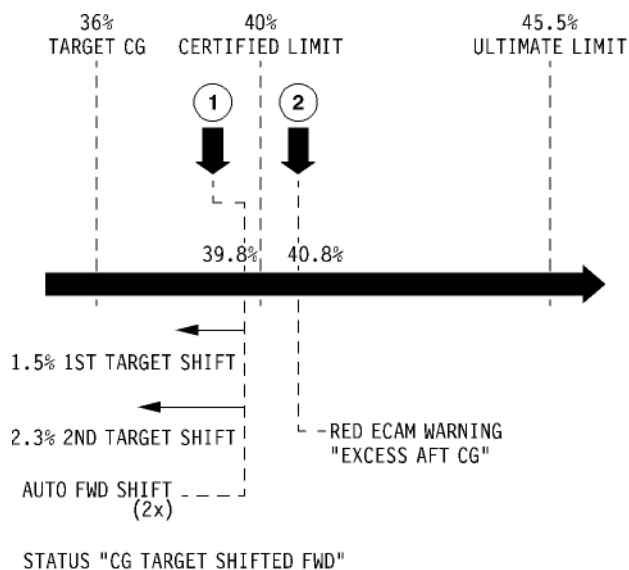
MANUAL MODE

- The CGCC can be overridden by selecting manually FWD transfer on the MODE pushbutton switch.
- A fast forward transfer is initiated regardless of CGCC commands and of the CTR TK high levels signals.
- The CGCC automatic functions can be resumed if AUTO is selected again on the MODE pushbutton switch.

INDEPENDENT AFT C.G. MONITOR

- In order to cover cases of undetected failures of the CGCC, an independent monitoring of the C.G. is performed by the FWC.
- The monitor computes the CG position from the Trimmable Horizontal Stabilizer position, for a given Mach number and thrust setting.
- If an error is detected, the aft C.G. monitor is considered inoperative.

- The aft C.G. monitor is also considered inoperative if the landing gear or the slats are extended above FL 200.
- The aft C.G. warning is inhibited when the speed brakes are extended.
- If the aft C.G. monitor is inoperative a signal is sent to the CGCC, which will enter Alternate mode.
- The independent aft CG monitor has two alert thresholds as shown in the following graph :


(1) AFT C.G. : 39.8 %

- In this condition, the FWC sends a signal to the CGCC in order to move the CG target 1.5 % more forward by a normal forward transfer.
- If an aft C.G. condition is detected a second time during the flight, the FWC sends a signal to the CGCC in order to move the CG target a further 2.3 % forward by a fast forward transfer.

Note : The ECAM status CG TARGET SHIFTED FWD is displayed.

(2) EXCESS AFT CG : 40.8 %

- In this case, the flight crew must follow the EXCESS AFT CG procedure.

Note : The red ECAM warning EXCESS AFT CG is displayed.

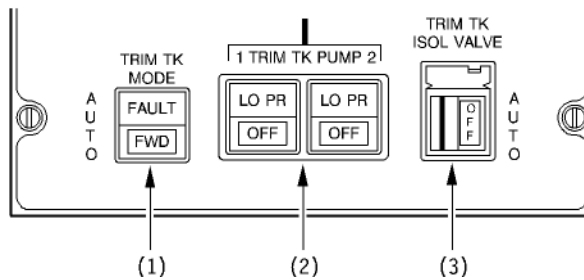
Fuel System**CG Control System,
Operational Description****ZFW AND ZFCG MONITORING**

- On ground, the CGCC monitors the ZFW and the ZFCG received from the FMS.
- An ECAM caution is generated in the following cases :
 - If the difference between values received from FMS 1 and FMS 2 exceed a certain tolerance (in case of FMS independent operation).
 - If only one FMS is operative, the CGCC accepts the first entry of the ZFW but the next change in ZFW or ZFCG will lead to the display of ZFW or ZFCG DISAGREE message (as there is no possibility of cross check with the other FMS).

Note : The ECAM message is :

**FUEL ZFW or ZFCG DISAGREE PROC
TRIM TK SYS INIT**

- The flight crew must follow the TRIM TK SYS INIT procedure.
- If there is still a discrepancy, the CG control system should not be used and Trim tank pumps selected OFF.

Fuel System
**CG Control System,
Controls and Indicators**

(1) TRIM TK MODE Pushbutton Switch

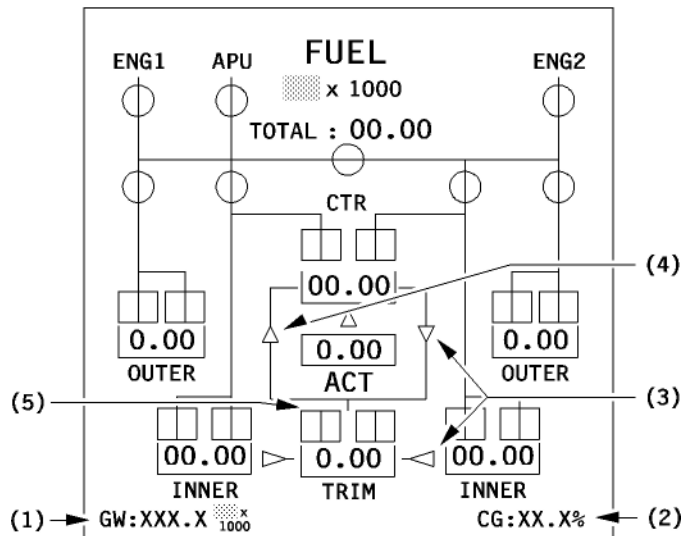
- **AUTO :**
- In flight, CG is automatically controlled by the CGCC (provided one TRIM TK PUMP at least is selected and the TRIM TK ISOL VALVE pushbutton switch is selected to AUTO).
- **FAULT light (Amber) :**
- Illuminates when :
 - The CGCC detects a TRIM TK system fault.
 - EXCESS AFT CG warning occurs.
 - TRIM TK ISOL VALVE is not open with landing gear up and slats retracted.
 - TRIM TK PUMPS 1+2 LO PR and TRIM TK not empty, for more than 40 sec.
- **FWD (white) :**
- When the pushbutton switch is pressed the FWD light illuminates white.
- Fuel is transferred forward, provided that the TRIM TK ISOL VALVE pushbutton switch is selected to AUTO.
- Both the Forward Transfer Valve and Auxiliary Forward Transfer Valve open.
- TRIM TK PUMPS (if selected) are activated, otherwise the transfer is performed will be by gravity.

(2) TRIM TK PUMP 1 (or 2) Pushbutton Switch

- **Normal position**
- The TRIM TK PUMPS are activated according to the CGCC logic or if the TRIM TK MODE pushbutton switch is selected FWD.
- CGCC control is enabled if at least one TRIM TK PUMP is selected.
- **LO PR**
- Illuminates amber if a low pressure is detected at the pump outlet.
- **OFF**
- The light illuminates white.
- The TRIM TK PUMP is deactivated.
- If both TRIM TK PUMPs are selected OFF, the CGCC control is disabled.
- No Automatic Transfers will occur, CGCC monitoring and warnings are still available.
- Manual FWD Transfer is available.

(3) TRIM TK ISOL VALVE Pushbutton Switch

- **AUTO :**
- The valve is open or shut (OFF) depending on its logic.
- **Flow bar (green)**
- In line when the valve is open.
- Flashing during valve transit.
- **OFF**
- The light illuminates white.
- The valve is closed.

Fuel System
**CG Control System,
ECAM**

(1) Gross weight indication (Green)

In KG x 1000

(2) CG indication (Green)

- Green when CG is between 18.5 % and 39.5 %,
- Amber if CG exceeds 40 % or is more forward than 18 %.

**(3) Transfer indication from CTR or INR tank
to TRIM tank**

▼ (G): AFT transfer

▽ (A): AFT transfer FAULT or not allowed

**(4) Transfer indication from TRIM tank
to CTR tank**

△ (W): No transfer (FAULT or alternate mode)

▲ (G): FWD transfer

△ (A): FWD transfer FAULT

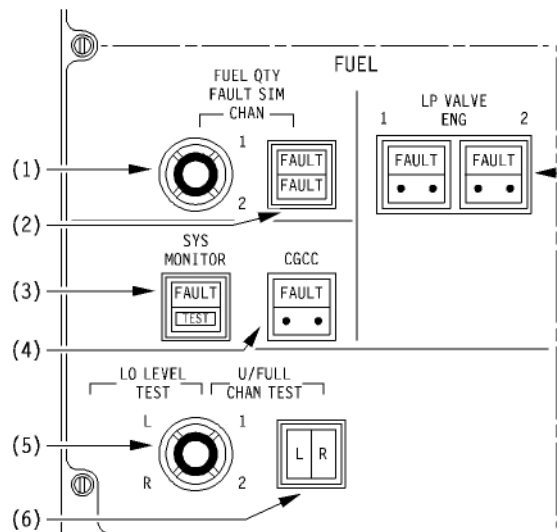
(5) TRIM tank pumps

□ (G): pump ON and normal fuel pressure

LO (A): pump ON and LOW pressure

□ (A): pump selected OFF

□ (G): pump selected NORM but not running.

Fuel System
**Maintenance Panel,
Controls and Indicators**
A. FUEL QTY

(1) FUEL QUANTITY FAULT SIM Selector

- **UP**
 - A failure is simulated in the channel 1 of the FQI.
- **Neutral**
 - No failure simulated.
- **DOWN**
 - A failure is simulated in the channel 2 of the FQI.

(2) FAULT SIM Indicator

- Each FAULT light illuminates when a failure is detected in the corresponding channel of the FQI.

(3) SYS MONITOR Pushbutton Switch

- **Normal (pushbutton switch released-out)**
 - No test performed.
- **TEST (pushbutton switch depressed-in)**
 - The light illuminates white. FUEL QTY indicator displays a code indicating the detected failure.

- **FAULT**

- The light illuminates white if a failure is detected by the incorporated BITE.

(4) CGCC FAULT light

- Illuminates white if a CGCC fault is detected.

(5) LO LVL and U/FULL CHAN TEST Selector
(7) • UP

- LH LO LVL sensor and U/FULL channel 1 sensors are tested.

- **Neutral**

- No sensor tested.

- **DOWN**

- RH LO LVL sensor and U/FULL channel 2 sensors are tested.

(6) U/FULL CHAN TEST Light (if installed)

- L (or R) light illuminates when the test of the LH (or RH) sensor of the selected channel is positive, or when the respective OUTER TK fuel quantity is below 2000 kg (4400 lbs).

(7) LP VALVE ENG 1 (2) FAULT Light

- Illuminates in case of failure of one of the two contactors of the corresponding FIRE HANDLE.