

	FUEL		1.28.10	P 1
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GENERAL

DESCRIPTION

The fuel system :

- Stores fuel.
- Controls and monitors the correct quantity of fuel.
- Supplies fuel to the engines and the Auxiliary Power Unit (APU).
- Controls the transfer of fuel to maintain the Center of Gravity (CG) within limits.
- Maintains fuel in the outer tanks for wing bending relief.
- Allows fuel jettison for rapid weight reduction.
- Controls refueling and defueling.

TANKS

Fuel is stored in the :

- Wings
- Center section
- Trimmable Horizontal Stabilizer (THS).

DESCRIPTION

Each wing has two inner and one outer tank. Each inner tank contains a collector cell that:

- Maintains a fuel reservoir for the fuel booster pumps, and provides negative 'g' protection to feed the engines.
- Is maintained full and contains about 1000 kg (2200 lbs) of fuel.

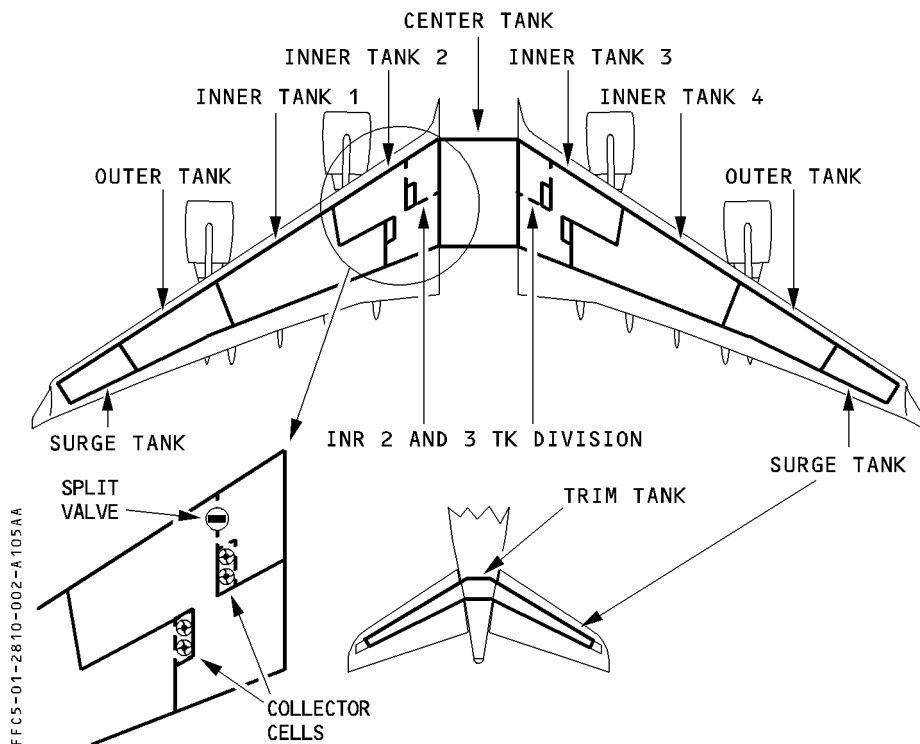
Inner tanks 2 and 3 can be divided into two parts via a SPLIT valve. If tank damage is suspected (i.e. FQI data is lost, or there is a rapid FQI decrease following an engine failure), the SPLIT valve can be manually switched to ON by using the dedicated pushbutton on the overhead panel. When switched to ON, the fuel of the aft inner tank part is moved to the forward part which contains the collector cell.

On the right side of the THS trim tank, and in each wing outboard of the outer tank, there is a vent surge tank.

After refueling to maximum tank capacity, fuel can expand by 2 % (20°C temperature increase) without spillage.

There is an overpressure protector in each wing surge tank, in the trim surge tank, and between the center and inner tanks 2 and 3.

TANK ARRANGEMENT



USABLE FUEL							
		OUTER TANKS (each)	INNER TANKS 1 and 4 (each)	INNER TANKS 2 and 3 (each)	CENTER TANK	TRIM TANK	TOTAL
VOLUME	(liters)	6360	25840	33280	55980	8238	195178
	(US gallons)	1769	6822	8785	14779	2175	51526
WEIGHT *	(KG)	4993	20284	26125	43944	6467	153215
	(LB)	11010	44726	57606	96897	14256	337837

* Fuel specific gravity : 0.785 kg/l or 6.551 lbs/US Gal.

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FUEL CONTROL AND MONITORING SYSTEM (FCMS)

GENERAL

Two Fuel Data Concentrators (FDC) provide the FCMCs with the tank data.

The FDC provide the FCMCs with :

- Fuel volume data.
- Fuel density data.
- Fuel electrical characteristics data.
- Fuel temperature data.

The fuel system is controlled by two Fuel Control and Monitoring Computers (FCMC).

The FCMCs :

- Measure the fuel quantity and indicate it on the ECAM.
- Calculate the aircraft's Gross Weight and Center of gravity, based on the Zero Fuel Weight and the CG entered by the crew.
- Control transfer of fuel to the inner tanks for engine feed.
- Control transfers of fuel for CG control.

Magnetic level indicators are fitted in the lower surfaces of the center and wing tanks to allow the manual measurement of each tank's fuel quantity.

FUEL QUANTITY INDICATION AND LEVEL SENSING

FUEL QUANTITY INDICATION

One FCMC is active and the other is on standby.

Each FCMC calculates the fuel quantity by using the :

- FDC fuel volume data from the FQI probes.
- FDC fuel density data from the densitometers.
- FDC fuel temperature data.
- Horizontal Stabilizer angle.
- Aircraft attitude.
- FDC fuel electrical characteristic data from the compensators.

The calculated fuel quantity is indicated on both the ECAM and the refuel control panel.

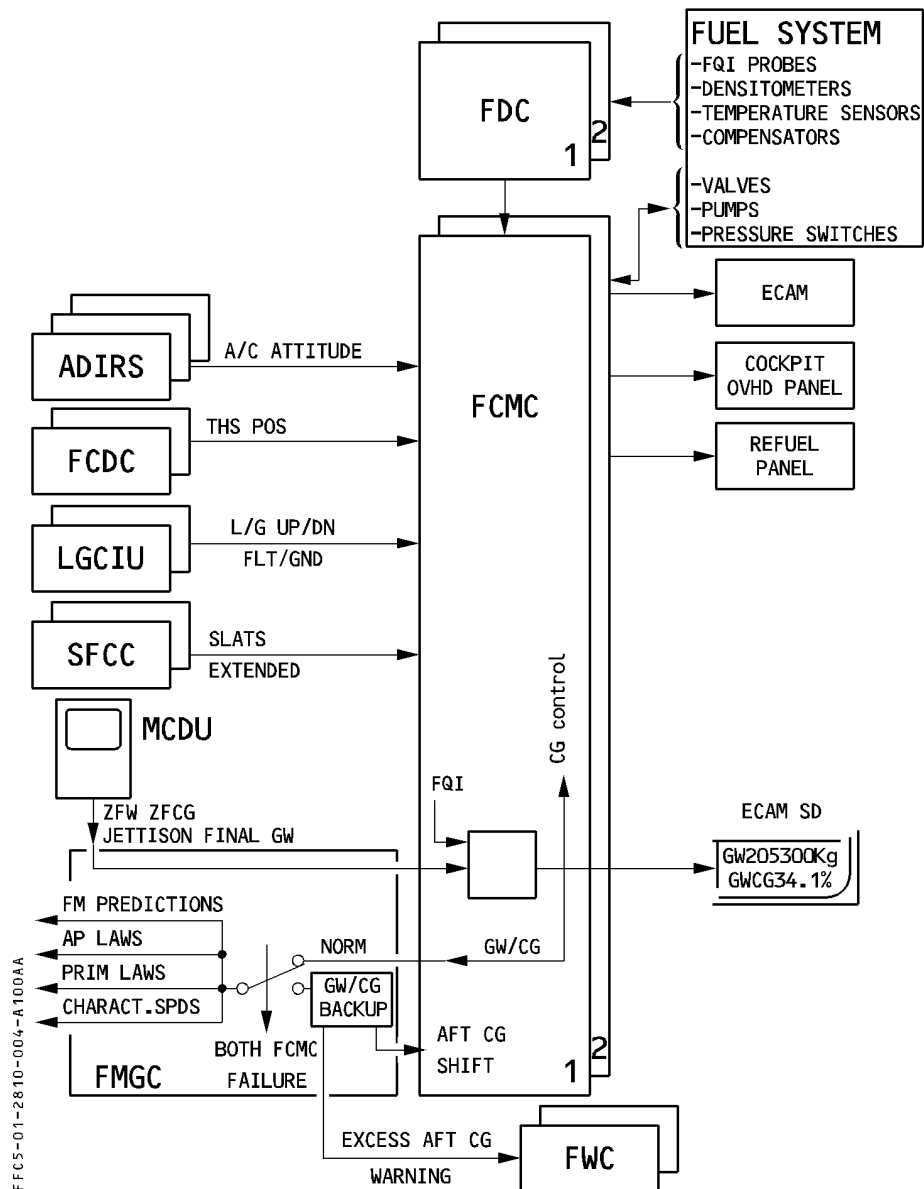
FUEL LEVEL SENSING

The FCMC receives the fuel level sensing data from the FQI probes via the FDCs, to :

- Trigger the low level warnings for the inner tanks,
- Trigger overflow warnings for the surge tanks,
- Initiate the high level shut-off during refueling, or ground transfers for all tanks.

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ARCHITECTURE



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ENGINE FEED

GENERAL

The main fuel pump system supplies fuel from each inner tank to its corresponding engine. In each inner tank there is one collector cell. Each collector cell contains two fuel pumps, one main and one standby. When closed, the crossfeed valves separate the system into four parts, and their associated fuel pumps supply the engines. When open, the crossfeed valves allow any pump to supply any engine.

MAIN COMPONENTS

INNER TANK PUMPS

During normal operation, all main pumps run.

If a main pump fails, or is switched off, then the standby pump of that inner tank runs. With the crossfeed valves open, one pump is capable of supplying all four engines in cruise.

CROSSFEED VALVES

A X-FEED valve is associated with each engine. It connects the engine and its associated pumps to the X-FEED line. This enables any pump to supply any engine. All X-FEED valves automatically open in electrical emergency configuration.

ENGINE LP VALVE

The flow of fuel to an engine can be stopped by closing its respective low pressure (LP) valve via the :

- Engine master switch, or the
- ENG FIRE pushbutton.

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FUEL FEED WITH ALL ENGINES FLAME OUT (ELEC EMER CONFIG)

EMER GEN POWERED BY THE RAT

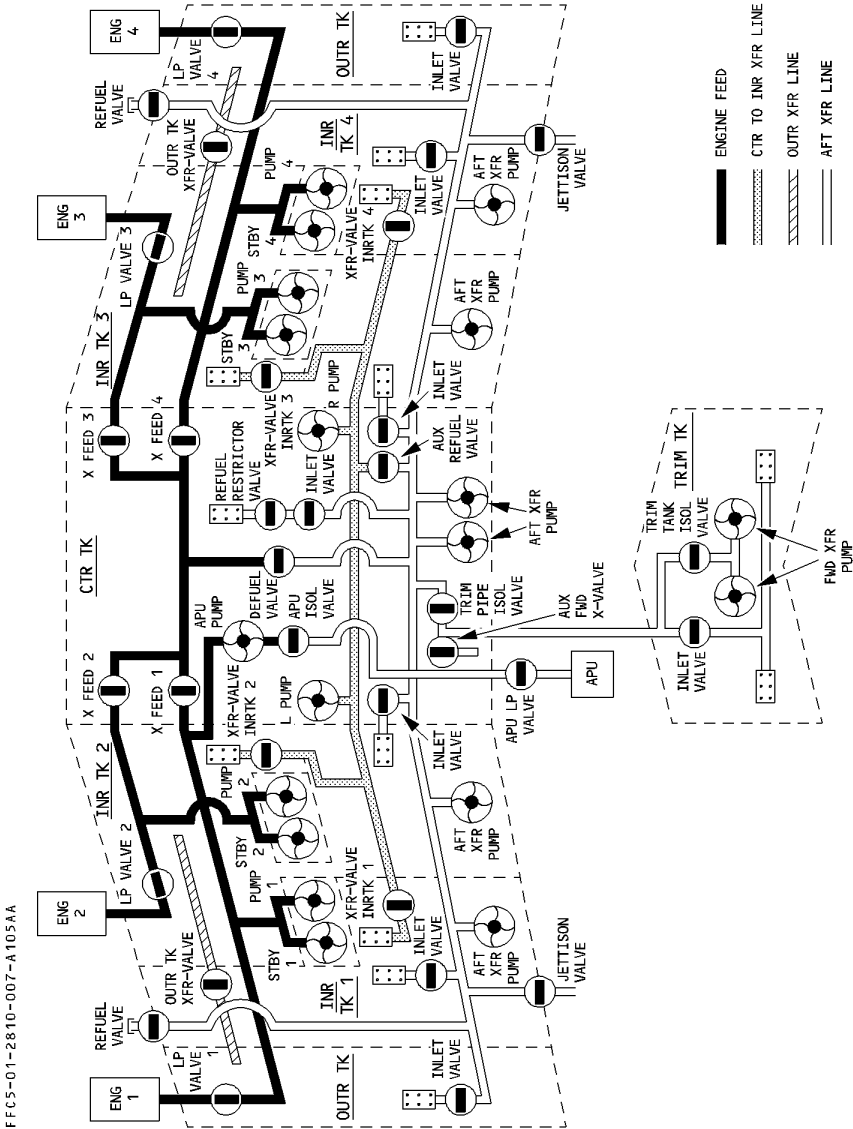
- All X-FEED valves automatically open.
- Only the MAIN pump 2 remains powered.
- If pump 2 fails, or is selected OFF, MAIN pump 3 will automatically replace it.
- When the speed decreases below 260 knots, or when LAND RECOVERY is selected ON, all MAIN and STBY pumps are lost and the engines are fed by gravity.

FLIGHT ON BATTERIES

- All MAIN and STBY pumps are lost.

ENGINE FEED

FOR INFO



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FUEL FEED SEQUENCE

NORMAL OPERATION

Fuel is always fed to the engines from the inner tanks.

The fuel transfer sequence is as follows :

1. Center tank fuel transfers to all inner tanks, until center tank fuel quantity reaches 17000 kg (37520 lbs).
2. Center tank fuel transfers to inner tanks 1 and 4, to maintain full quantity.
3. Center tank fuel transfers to all inner tanks, once inner tanks 2 and 3 are balanced with inner tanks 1 and 4.
4. Each inner tank empties down to 4000 kg (8830 lbs).
5. Trim tank fuel transfers to the inner tanks.
6. Each inner tank empties down to 2000 kg (4415 lbs).
7. Outer tank fuel transfers to the inner tanks.

AUTOMATIC FUEL TRANSFERS

CENTER TO INNER TANK TRANSFER

The center tank pumps run continuously whenever there is fuel in the center tank. Each inner tank transfer valve controls the transfer by cycling its inner tank contents between full and approximately 1000 kg (2200 lbs) below full. When the center tank is empty, both center tank pumps stop, and all inner tank inlet valves close.

OUTER TO INNER TANK TRANSFER

The outer tank fuel is transferred to the inner tanks by gravity. The outer tank transfer valves, and the outer and inner tanks inlet valves, control the transfer by cycling the associated inner tanks contents between 2000 kg (4415 lbs) and 2500 kg (5518 lbs). When each outer tank has been empty for five minutes, its outer tank transfer valve and the outer and inner inlet valves close.

TRIM TANK TRANSFER

Refer to CG control.

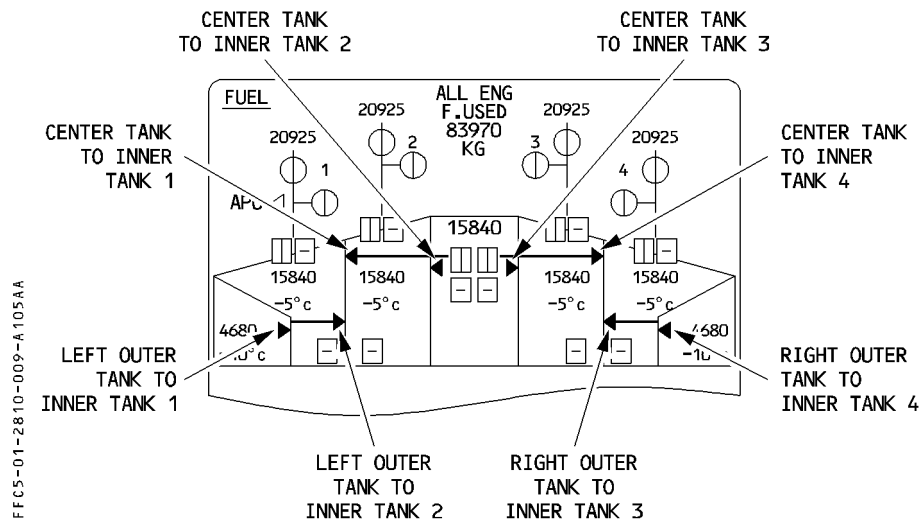
ROTOR BURST TRANSFERS

The FCMC enters the rotor burst mode, if both split valves are selected and one engine LP valve is shut. If an inboard engine rotor burst occurs, all automatic transfers directed to the inner tanks are into inner tanks 1 and 4 only.

If an outboard engine rotor burst occurs, all automatic transfers, directed to the inner tanks, are into inner tanks 2 and 3 only.

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ECAM INDICATION



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MANUAL FUEL TRANSFERS

CENTER TO INNER TANK TRANSFER

Transfer from the center to inner tanks can be manually selected with the CTR TK TO INR XFR pushbutton. When selected MAN, the inner tank inlet valves are opened and the CTR TK pumps run.

The CTR TK pumps must be selected OFF, when the :

- Inner tanks are full, to manually prevent inner tank overflow.
- Center tank is empty.

Note : 1. When the fuel quantity of each inner tank is below 14000 kg (30890 lbs), all center tank fuel can be transferred without any risk of overflow.

2. When the CTR TK TO INR XFR pushbutton is pressed, aft transfer is inhibited.

OUTER TO INNER TANK TRANSFER

Transfer from the outer to inner tanks can be manually selected with the OUTR TK XFR pushbutton. When selected ON, the outer tank fuel transfer valves, and the inner and outer inlet valves are opened.

CG CONTROL – TRIM TANK TRANSFER

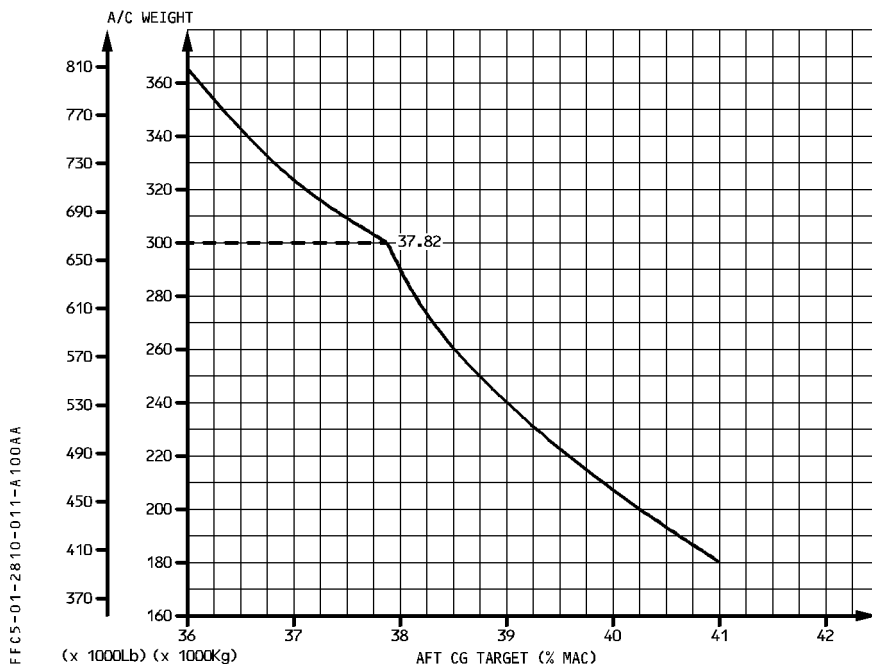
GENERAL

The trim tank transfer system controls the aircraft's Center of Gravity (CG).

- The system either transfers fuel to the trim tank (aft transfer), or from the trim tank (forward transfer).
- This movement of fuel changes the aircraft's CG.
- When the aircraft is in cruise, the system optimizes the CG position to increase fuel economy by reducing drag.
- Normal operation is automatic, but the crew can manually select a forward fuel transfer.
- The Fuel Control and Monitoring Computer (FCMC) calculates the aircraft's CG and compares it to a target value. (This target depends on the aircraft's actual weight. See AFT CG Target Graph below).
- Based on this calculation, the FCMC determines the quantity of fuel to be moved aft or forward in flight.

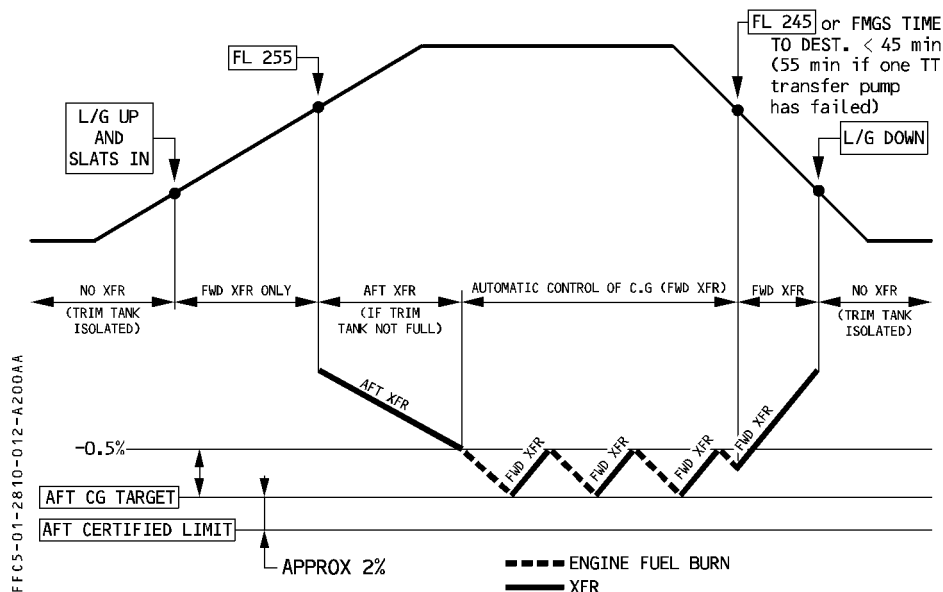
AFT CG TARGET

FOR INFO



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NORMAL OPERATION



Automatic CG control :

- Begins during climb to FL 255.
- Ends at descent to FL 245, or when the FMGS time to destination is less than 45 minutes (or less than 55 minutes with only one trim tank forward transfer pump in operation).

- Note :**
1. The trim pipe isolation valve and the trim tank isolation valve are closed during takeoff and landing. It is possible to reopen them, when the landing gear is up and the slats are retracted (or when the MODE SEL switch is set at REFUEL on the REFUEL panel).
 2. If the FMGC detects a CG that is too far aft, then the target will automatically be moved forward by 2 %. The CG target may be moved forward by 2% three times, before the "FUEL FE/FCMC CG DISAGREE" warning is triggered. The target also moves forward 2 %, in the case of FQI data degradation, or if ZFCG/ZFW have not been entered or need to be reinitialized via the MCDU.
 3. The above-mentioned CG target alterations should be added together.

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AFT FUEL TRANSFER

In flight, the FCMC only starts an AFT fuel transfer, when all of the following conditions are met :

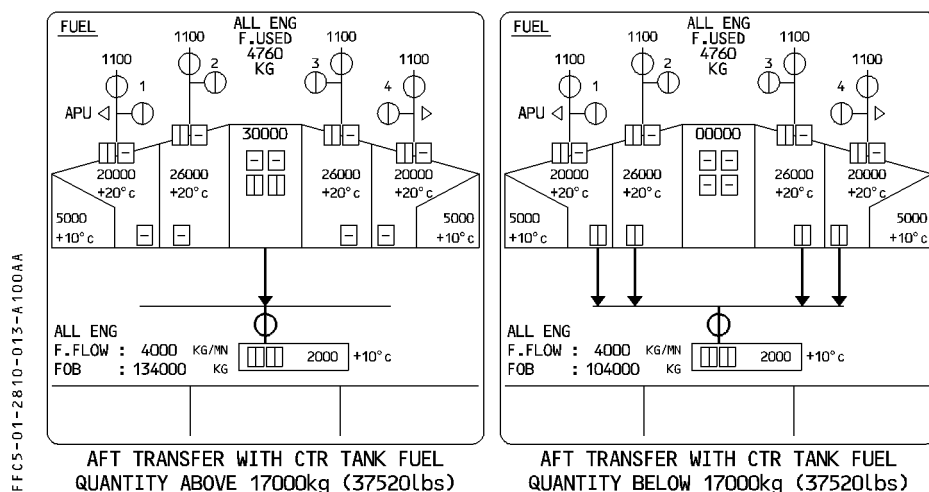
- Landing gear is retracted.
- Slats are retracted.
- Trim tank is not full.
- Inner tank's fuel quantity is above 6250 kg (13733 lbs).
- Aircraft is above FL 255.
- Aircraft CG is not on target.

Normally, only one aft fuel transfer occurs per flight. However, if the CG in cruise is ahead of the target by more than 2 %, and the trim tank quantity is below 3000 kg (6620 lbs), an additional aft transfer will occur. An aft transfer terminates, when the :

- Computed CG = Target CG - 0.5 %, or
- Trim tank high level is reached, or
- Inner tank's fuel quantity reaches 6000 kg (13228 lbs), or
- T TK XFR pushbutton is selected FWD, or
- Jettison is selected, or
- Fuel transfer from the outer tanks to the inner tanks is manually selected.

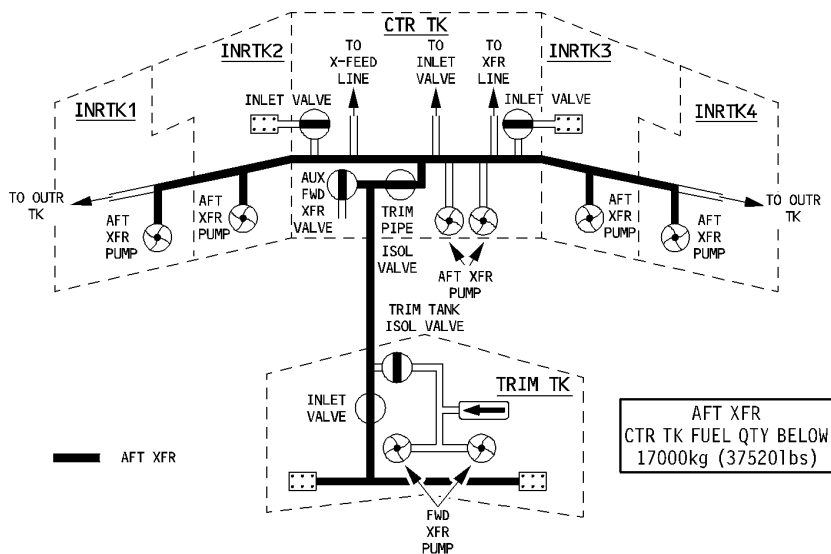
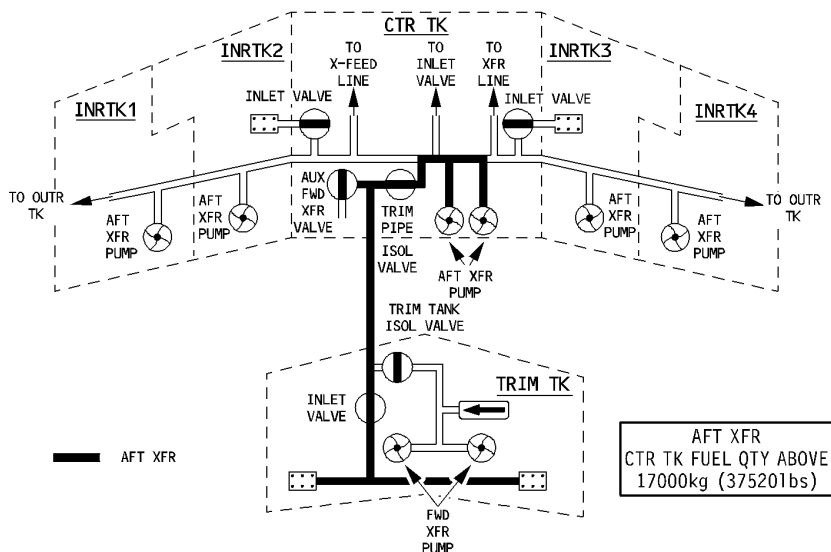
Fuel for trim tank aft transfer is provided by the center tank, when it contains more than 17000 kg (37520 lbs) of fuel, or by the inner tanks when the center tank contains less than 17000 kg (37520 lbs) of fuel. If, during the transfer, the total fuel quantity in inner tank 1 and 4 is different by more than 2000 kg (4400 lbs) to the total fuel quantity in inner tank 2 and 3, the transfer from the lighter pair of tanks will stop until fuel balance is restored.

ECAM INDICATION



AFT FUEL TRANSFER

FOR INFO



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AUTOMATIC FORWARD FUEL TRANSFER

The FCMC sends a forward fuel transfer signal, if one of the following conditions are met:

- The calculated CG = Target stops when the computed CG = the target CG - 0.5 %.
- The fuel contents of one of the four inner tanks decreases to 4000 kg (8830 lbs).
- The FMGS sends a time-to-destination signal, below the threshold, or the aircraft descends below FL 245. In this case, transfer is continuous but is controlled by the inner tank high levels to prevent overflow.
- The jettison system is set to the open position.
- In electrical emergency configuration.
- The fuel quantity in the trim tank is greater than 3000 kg (6620 lbs) and the manual out to inner transfer is selected.

If the center tank contains fuel, the forward transfer is into the center tank.

If the center tank is empty, or in electrical emergency configuration, the forward transfer is into the inner tanks. If during transfer to the inner tanks, the total fuel quantity of inner tanks 1 and 4 differs by more than 500 kg (1100 lbs) from the total quantity of inner tanks 2 and 3, then the transfer to the heavier pair of tanks will stop until fuel balance is restored. The trim tank transfer pump operates as long as there is fuel in the trim tank.

In the event of trim tank pumps failure, forward transfer is by gravity, through the trim tank non-return valve.

Note : *The running trim tank forward transfer pump has no effect on the aft transfer, since the TRIM TK ISOL VALVE is normally closed during this transfer.*

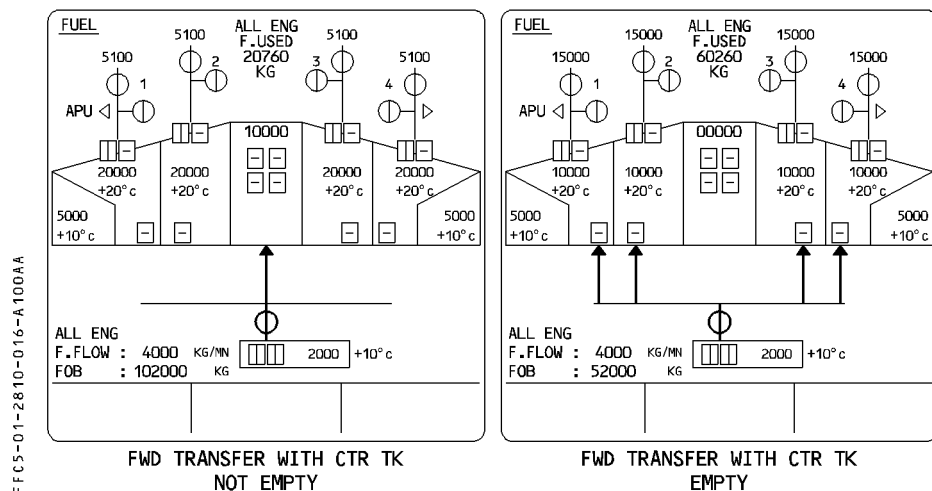
CENTER TANK EMPTY

- Fuel is transferred from the trim tank to the inner tanks.
- If an inner tank reaches the high level, the related inlet valve closes to prevent tank overflow.
- It reopens when the inner tank quantity reaches 1000 kg (2210 lbs) below high level.

CENTER TANK NOT EMPTY

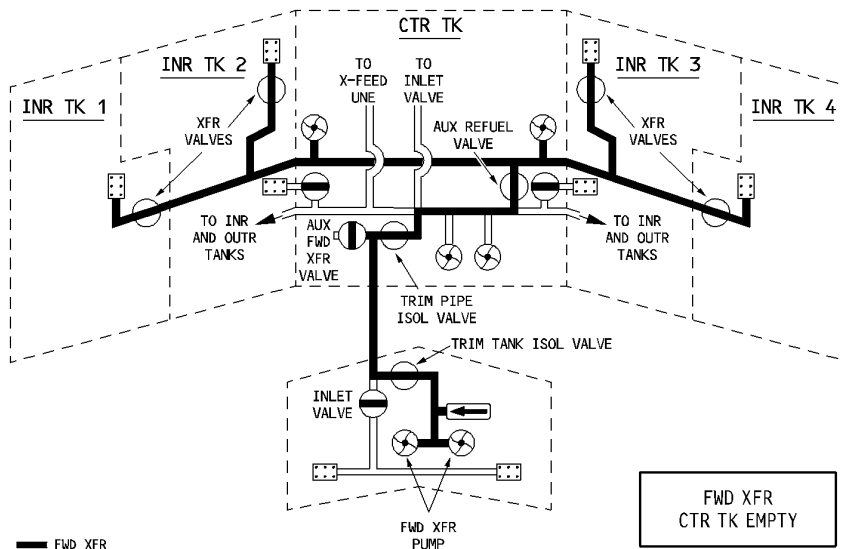
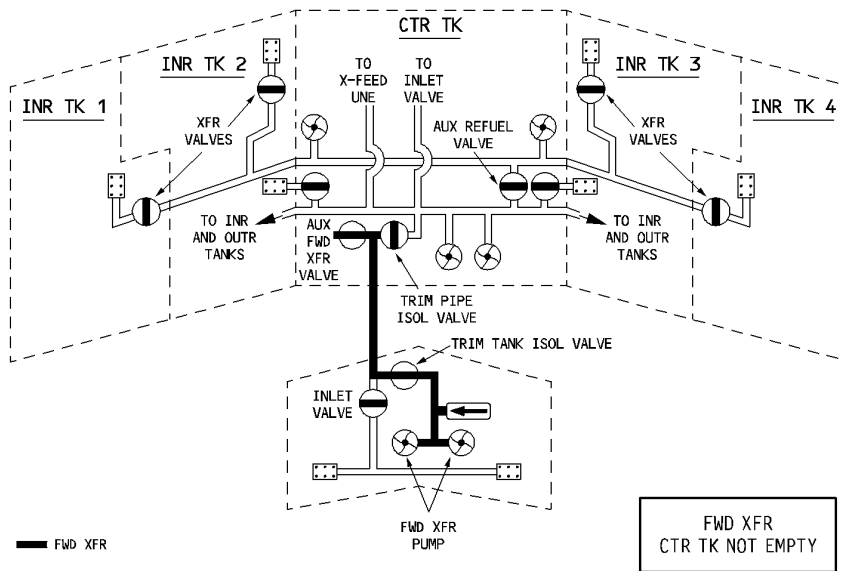
- Fuel is transferred from the trim tank to the center tank.

ECAM INDICATION



AUTOMATIC FORWARD FUEL TRANSFER

FOR INFO



FFCS-01-2810-017-A200AA

	FUEL		1.28.10	P 19
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APU FEED

The APU is either fed by any main or standby pump, or by the APU pump. The APU pump is deactivated, if any main or standby pump is running, since the pressure supplied by these pumps is sufficient to operate the APU.

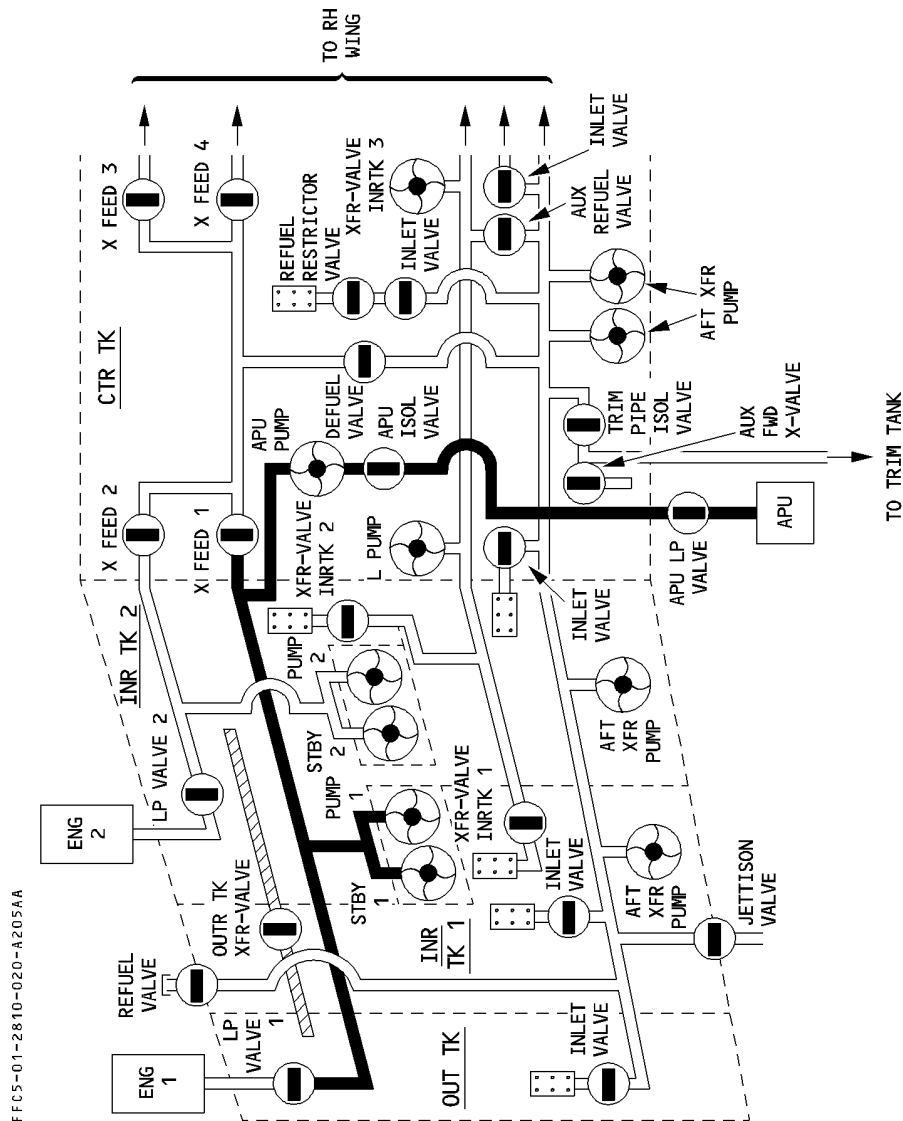
The APU feed pump starts to operate, if :

- The APU master switch is ON.
- The fuel pressure is too low for correct APU operation.
- The FCMS does not detect a fuel line damage.

Note : *The APU is normally fed from inner tank 1. If the APU is running for a prolonged period of time, inner tank 1 will deplete.*

APU FEED

FOR INFO

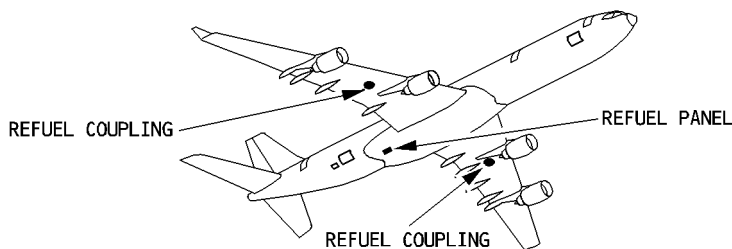


REFUELING - DEFUELING

Two double refuel couplings are installed under the wings. These couplings allow refueling from both the right and left sides of the aircraft.

A refuel panel is located on the fuselage side, beneath the right wing.

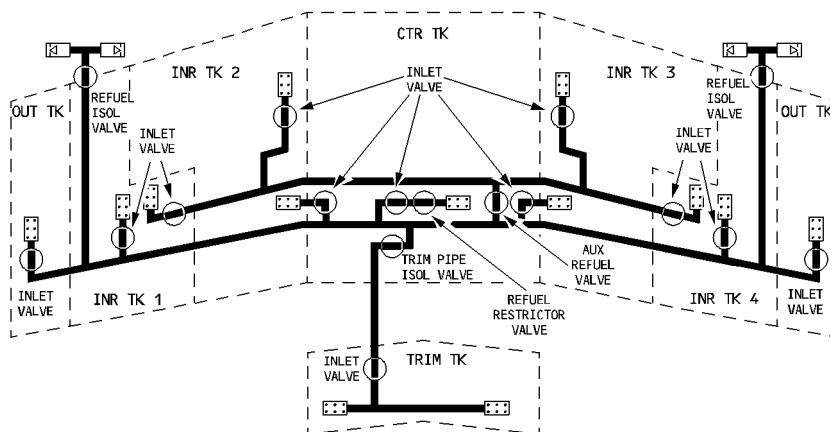
A gallery connects the refueling coupling to the fuel inlet valve of each tank.



From the cockpit, refueling can be controlled with the refuel pushbutton . Although manual control is possible, it is normally automatic when the required fuel load is set on the preselector. In addition, it is possible to refuel by battery power only.

Any tanks that require refueling start to be refueled simultaneously. Refuel valves automatically close either when the required quantity is reached, or when high level is detected.

Wing tank gravity refueling is achieved via overwing refueling points. If the FCMC is powered, transfer is possible from any tank to outer, inner, or center tanks. When four refuel hoses are used, refueling time at nominal pressure (50 psi) is approximately 34 minutes for all tanks.



JETTISON

The Jettison system :

- Makes it possible to jettison fuel in flight.
- Output rate is approximately 1600 kg (3520 lbs) per minute, excluding fuel burn.
- Is manually activated by two JETTISON pushbuttons, located on the overhead panel. Both pushbuttons must be pressed to select the jettison.

Fuel is simultaneously jettisoned from the trim, inner and the center tanks.

To accelerate the depletion of the center tank, the center to inner fuel transfer is automatically initiated.

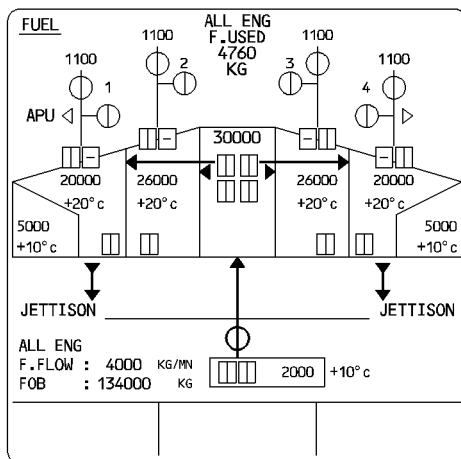
The outer tank fuel is transferred into inner tanks 2 and 3.

The crew starts the jettison operation and all AFT XFR pumps run.

The jettison operation continues, until one of the following occurs :

- The crew stops the operation.
- Either inner tank quantity reaches 4000 kg (8830 lbs) with fuel left in the outer on center tank.
- All inner AFT XFR pumps are uncovered, which corresponds to 3500 kg (7720 lbs) of fuel in each inner tank.
- The Fuel Control and Monitoring System (FCMS) stops the operation at the jettison grossweight preset on the FMGS MCDU.

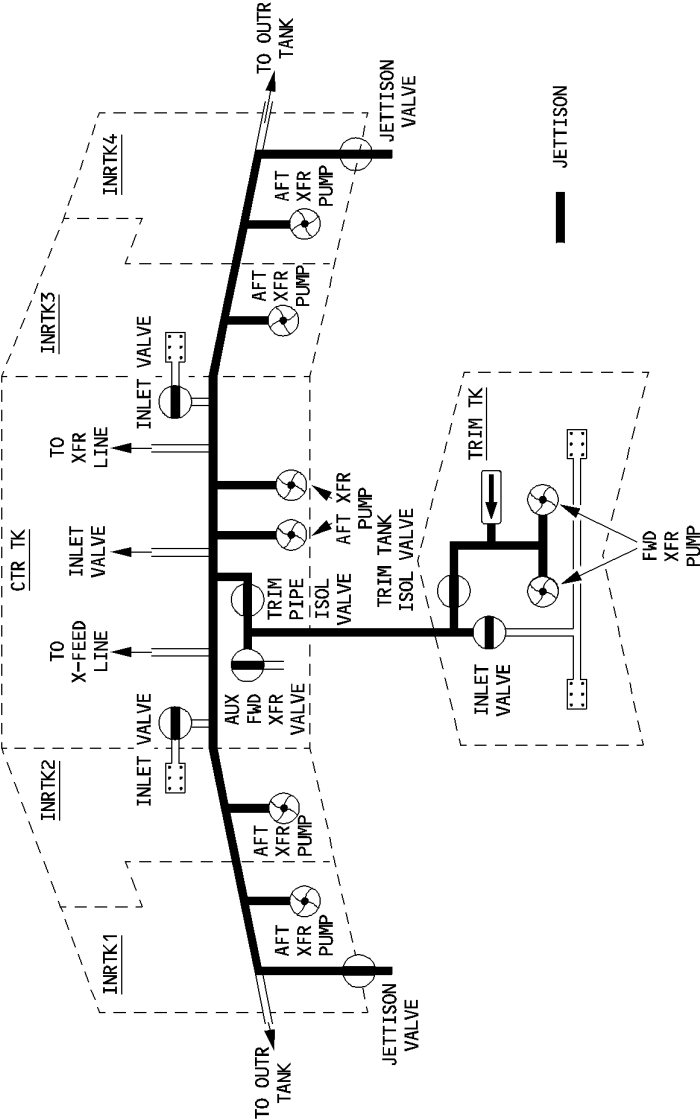
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JETTISON

FOR INFO





FUEL		1.28.10	P 24
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