Presented by

Zidan REN

Flight Operations Engineer

Operationwith minimum fuel

AIRBUS

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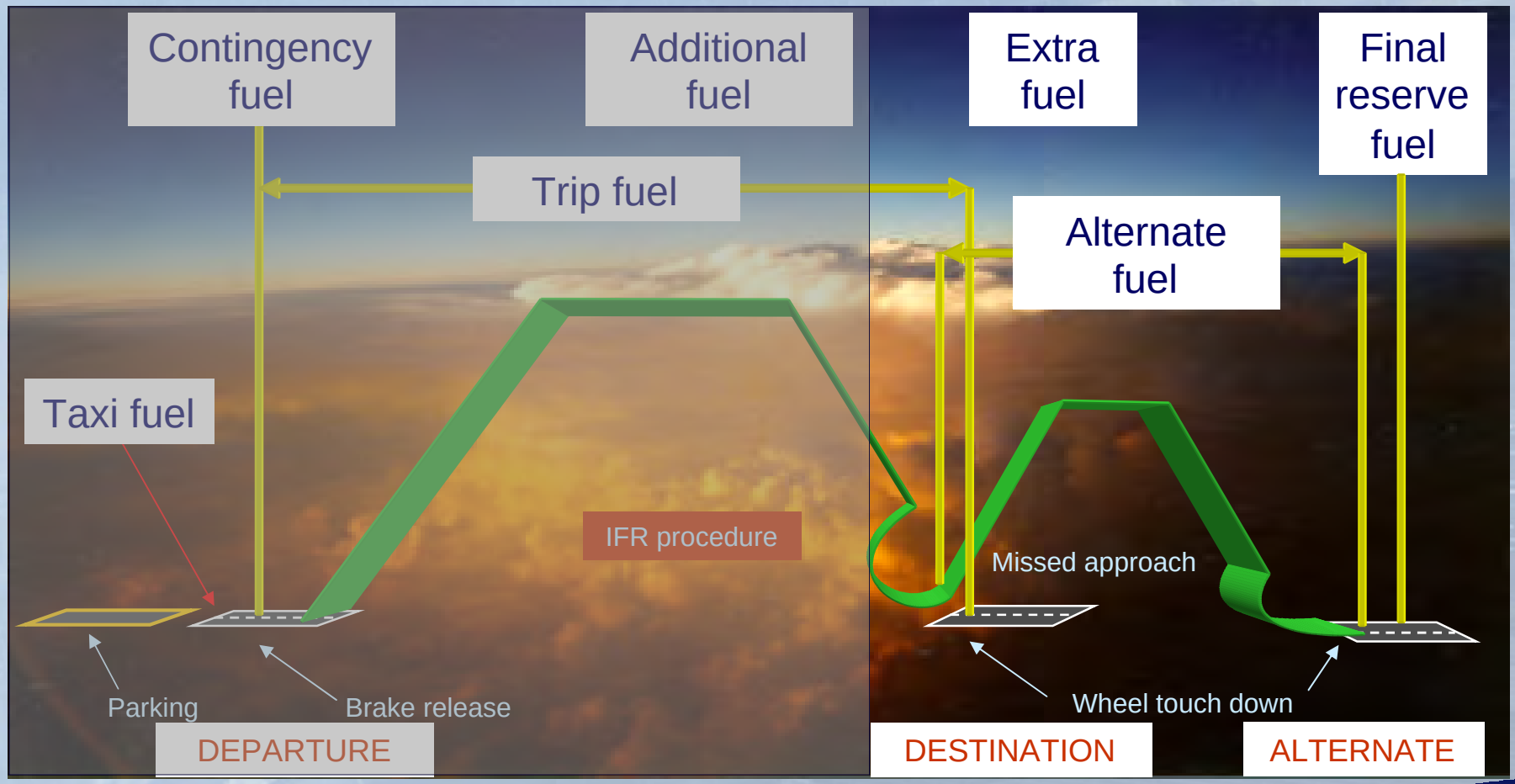
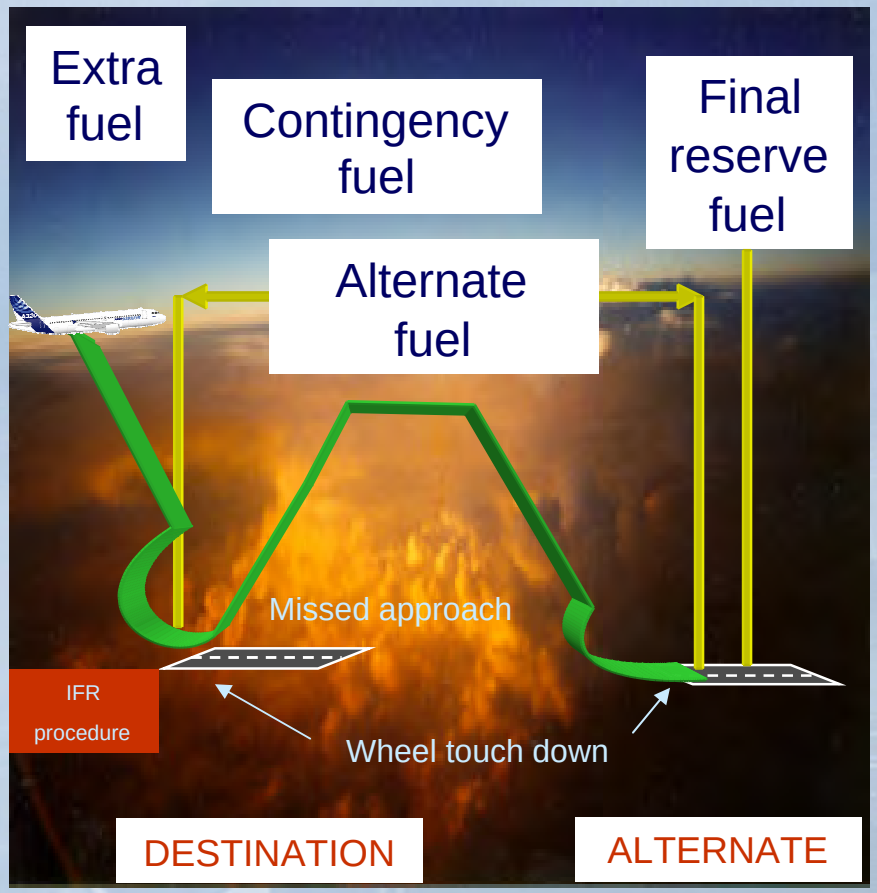
FUEL POLICY: Minimum Fuel at TakeOff

- *JAR OPS 1.255 & FAR 121.645*

  The minimum fuel quantity (Q) calculated for flight planning is defined as follows:



FUEL POLICY: Minimum Fuel in flight



In minimum fuel operation:
FOB near destination

No Extra fuel

≈

Alternate fuel + Contingency fuel + Final reserve

- Low for close Alternate
- Low for small trip
- JAR FAR

FOB NEAR DESTINATION CLOSE TO THE FINAL RESERVE FUEL

FUEL POLICY: Minimum Fuel at Landing

- JAR-OPS 1.375, the Final Reserve Fuel should remain at landing (alternate or destination):

  Fuel required to fly for a period of 30 minutes at 1500 feet AGL, at holding speed in ISA conditions.

- FAR 121 does not provide fuel management rules: Operators usually adopt the following rules in their operating manual: The minimum quantity of remaining fuel at landing (alternate or destination) is usually equivalent to the final reserve:

  Fuel quantity necessary to fly for a period of 30 to 45 minutes at 1.500 feet AGL at holding speed in ISA conditions.

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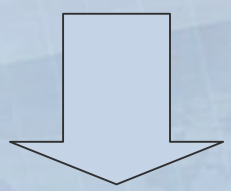
Minimum fuel alert on ECAM

- For all A320/A330/A340 (except for A340-200/300)

FUEL L + R WING (INR) TK LO LVL

≈

30 mn holding at 1500ft AGL at green dot speed in clean configuration



FUEL L + R WING (INR) TK LO LVL ≈ FINAL RESERVE FUEL

Minimum fuel alert on ECAM

FUEL L + R WING (INR) TK LO LVL caution threshold may vary:

- **Fuel density**

△=115kg

LIMITED VARIATION

ρ =0.77 kg/l ρ =0.83 kg/l

- **Aircraft pitch**

Pitch up

Pitch down

- **Aircraft acceleration/deceleration**

LIMITED VARIATION

Fuel system design

- **Aircraft roll**

LIMITED VARIATION

RELY on ECAM

Minimum fuel alert on ECAM

- Low level sensors locations/numbers are:

A318/A319/A320/A321 | A330/A340-200/-300 | A340-500/-600

Low Level Sensors

Threshold is based on fuel volume

Density

✓Low fuel level is based on low level sensors

✓Located at a fixed position, they indicate whether they are wet or dry

low level sensor must be dry

Pitch

✓Located towards the forward and aft of the inner tanks

Confirmation time: 30 seconds

Acceleration
Deceleration

Minimum fuel alert on ECAM

- Low level sensors locations/numbers are:

A318/A319/A320/A321	**A330/A340-200/-300**	A340-500/-600

Low Level Sensors

Threshold is based on fuel volume

Density

- ✓Low fuel level is based on low level sensors
- ✓Located at a fixed position, they indicate whether they are wet or dry

All low level sensors must be dry

Pitch

- ✓Located towards the forward and aft of the inner tanks

Confirmation time: 60 seconds

Acceleration
Deceleration

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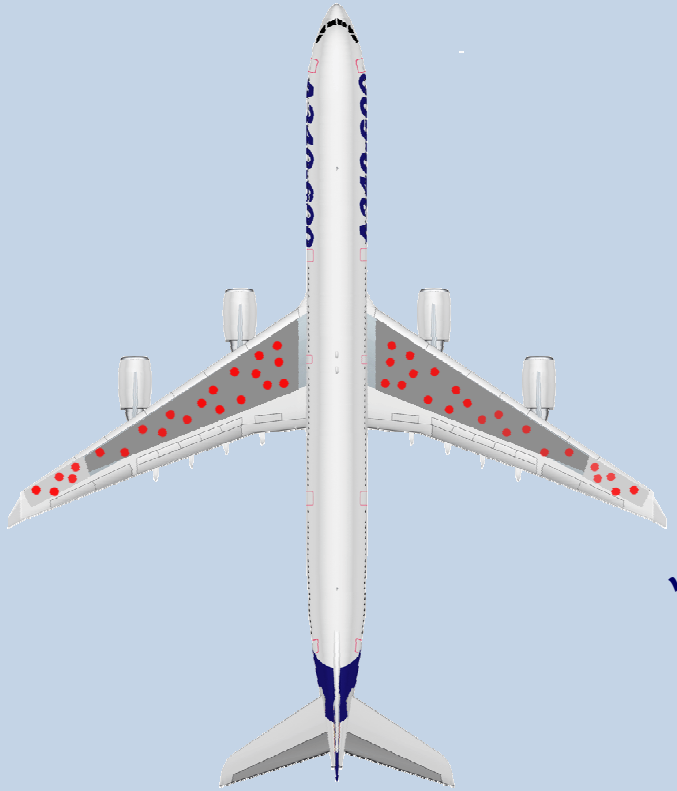
Minimum fuel alert on ECAM

- Low level sensors locations/numbers are:

A318/A319/A320/A321	A330/A340-200/-300	**A340-500/-600**



37 Fuel probes in inner tanks (per wing) and
16 Fuel probes in the outer tank (per wing)

Threshold is based on fuel volume

Density

✓Low fuel level is based on probe capacitances

✓Fuel probes measure changes in capacitance relative to fuel tank volume

Fuel probes are used

Pitch

✓ Fuel probes positioned at numerous locations within the tank

Confirmation time: 60 seconds

Acceleration
Deceleration

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Operationwith minimum fuel alert on ECAM

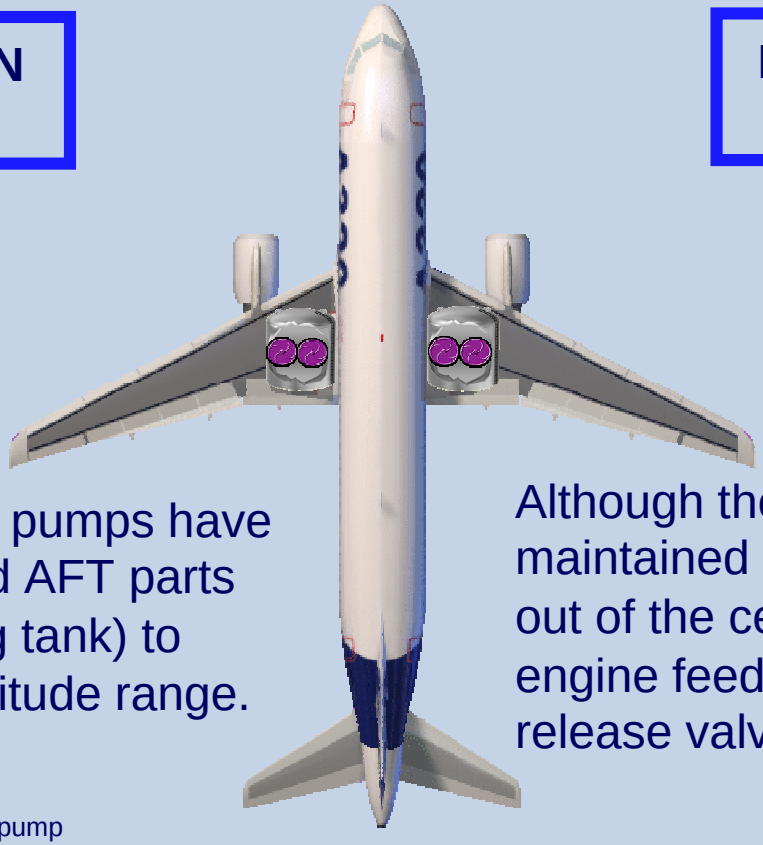
FUEL L + R WING (INR) TK LO LVL is triggered

A318/A319/A320/A321

A330/A340

NO RESTRICITION IN PITCH

NO RESTRICTION IN G LOAD



The engine feed fuel pumps have 2 pick-ups (FWD and AFT parts of the engine feeding tank) to cater for the pitch attitude range.

Although the collector cells are not maintained full, the flow of the fuel out of the cell is restricted and engine feed lines contain an air release valve.

Collector cell Engine feed pump

Operationwith minimum fuel alert on ECAM

FUEL L + R WING (INR) TK LO LVL is triggered

A318/A319/A320/A321

NO RESTRICTION IN PITCH

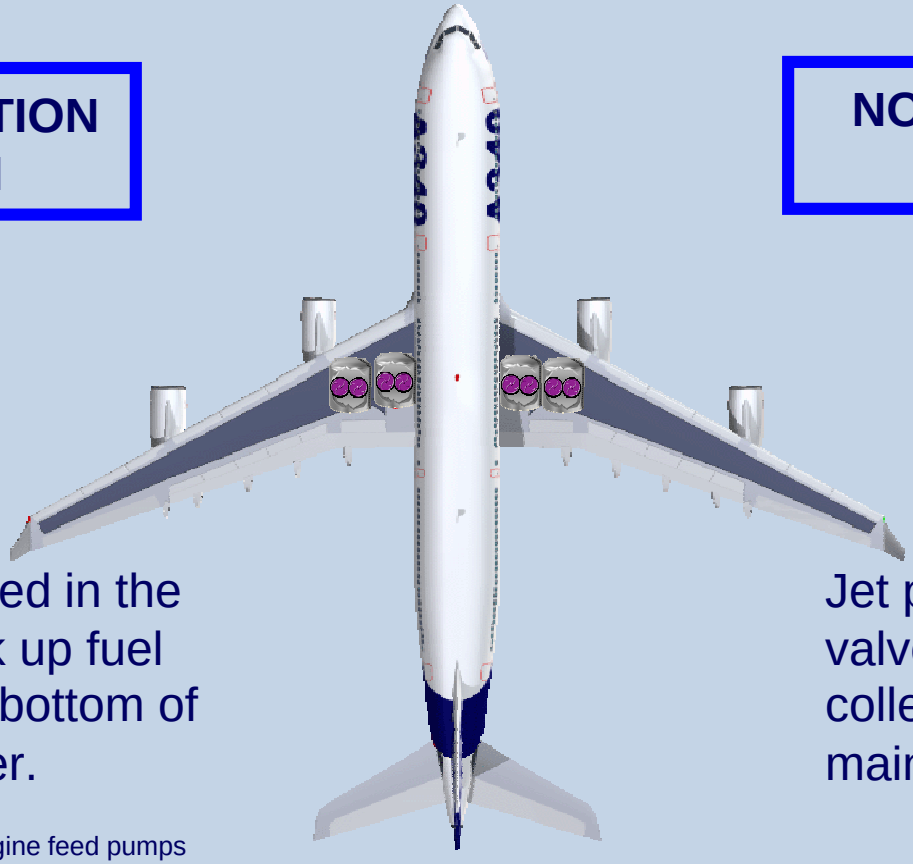
The pumps located in the collector cell pick up fuel directly from the bottom of the pump canister.

Collector cell Engine feed pumps

A330/A340

NO RESTRICTION IN G LOAD

Jet pumps and clack valves ensure that the collector cells are maintained full.



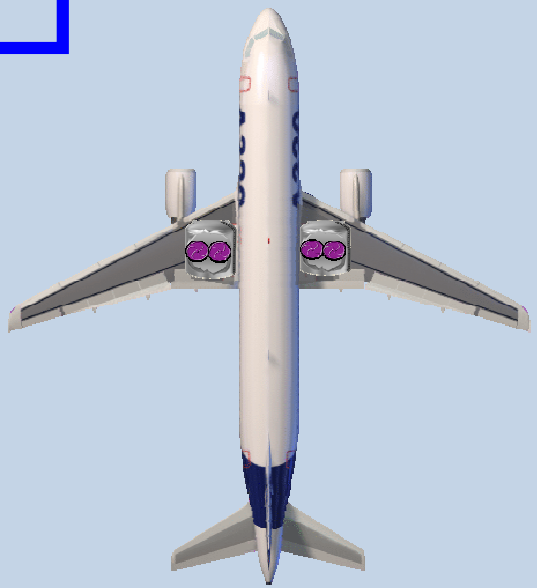
Operationwith minimum fuel alert on ECAM

FUEL L + R WING (INR) TK LO LVL is triggered

A318/A319/A320/A321

A330/A340

NO RESTRICTION IN ROLL



LO LVL sensors and engine feed fuel pumps are located in the same wing area: given the wing geometry, the pumps will still be filled with fuel even during bank manoeuvres.

Low Level Sensors

Collector cell

Engine feed pumps

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Operatorreports

- **FUEL L + R WING (INR) TK LO LVL** is sometimes triggered in approach
- Affect the Flight Crew workload during the approach phase
- When the auxiliary tanks are empty, some procedure lines are not always necessary
- A340-200/300 are prone to this caution

REVIEW OF THE A340-200/300A/C

- **FUEL L+R WING TK LO LVL** threshold higher than the rest of the fl

≈

50mn holding at 1500 ft AGL at green dot speed in clean c ration

Design Constraint

- To compensate for the **FUEL L+R WING TK LO LVL** threshold:
  - **LAND ASAP** delayed for 20 minutes:

Fuel remaining
≈
30 mn holding at 1500ft AGL
at green dot speed in clean configuration
≈
FINAL RESERVE FUEL

Similarity with the other FBW

REVIEW OF THE A340-200/300A/C

- To prevent applying all ECAM actions of **FUEL L+R WING TK LO LVL** (manage flight crew workload), anticipated **FUEL L+R WING TK LO LEVEL** paper procedure is proposed by A340-200/300 operators :

Apply the following procedure, at the flight crew's discretion, if the expected FOB at destination is 6 tons or less:

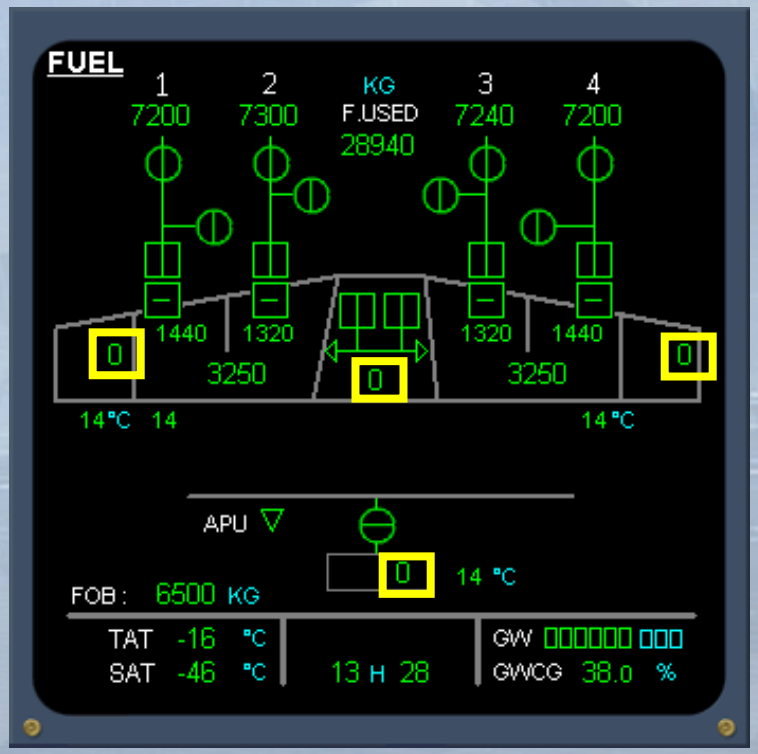
Just prior to descent, check on the Fuel SD page:

- CTR TANK . . . . . Check empty

- T TANK . . . . . Check empty

- OUTR TANK . . . . . Check empty

Note: If any of these tanks is not empty, the flight crew shall not continue with this procedure. Normal ECAM discipline applies.



REVIEW OF THE A340-200/300A/C

- If **FUEL L+R WING TK LO LVL** caution is triggered:

- WING PUMPS . . . . ON

-X FEED 1+2+3+4 . . . . ON

Note:

(1) Provided that the center, trim and outer tanks are empty, read the ECAM and clear it.

(1) A LAND ASAP will be displayed 20 minutes after the LO LVL warning.

✓ **FUEL L+R WING TK LO LVL** is inhibited below 800 feet AGL

ECAM Procedure

✓ Technically acceptable but not in accordance with the Airbus policy and the ECAM discipline

✓ Approval from the local authority may be required to provide such procedure

Paper Procedure

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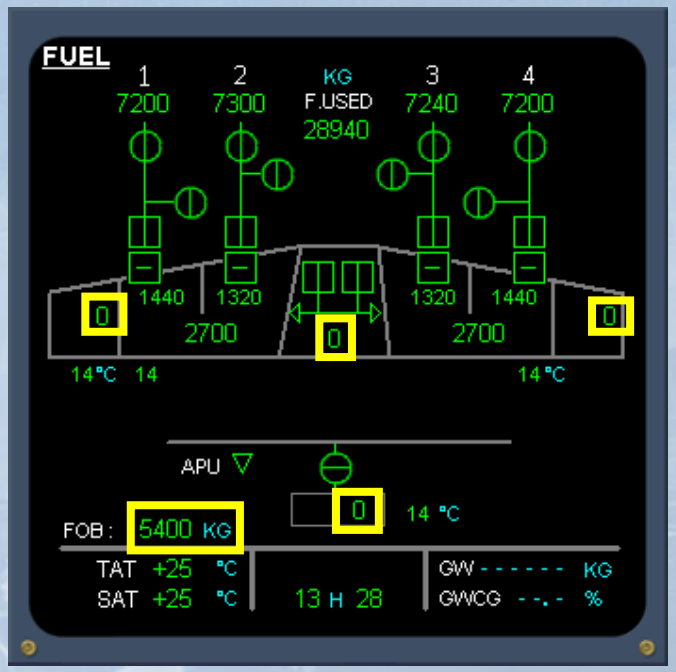
WAY FORWARD

- Conditioned the procedure line (for the auxiliary tanks) of the **FUEL L + R WING (INR) TK LO LVL**



20 minutes later

For A340-200/300

WAY FORWARD

- Subject to review before any changes are considered *(this includes a review of system safety cases)*

- Decision to implement such improvement:

…To be confirmed

For the A340-200/300

CONCLUSION

- In minimum fuel operation, Fuel On Board (FOB) near destination can be close to the Final Fuel Reserve.

- **FUEL L + R WING (INR) TK LO LVL** threshold is roughly similar to the Final Fuel Reserve quantity except for the A340-200/300.

- The A340-200/300 **FUEL L + R WING TK LO LVL** threshold is higher but:
  - LAND ASAP display is delayed
  - Review is in progress for a possible ECAM procedure change

- Rely on the **FUEL L + R WING (INR) TK LO LVL** caution as the threshold has limited variation.

- When **FUEL L + R WING (INR) TK LO LVL** is triggered there are no specific manoeuvre restrictions.

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