GEA Tianjin / 中国民航大学中欧航空工程师学院

Presented by

Vincent de LABORDERIE
Airbus

# OTHER SYSTEMS

## SUMMARY


- DISPLAYS
- ENGINES
- FUEL SYSTEM
- HYDRAULIC SYSTEM
- LANDING GEAR WHEELS

## SUMMARY


- **DISPLAYS**
- **ENGINES**
  - **Way of working**
  - **Displays**
  - **Starting procedure**
  - **Take off phase**
  - **Reverse**
- **FUEL SYSTEM**
- **HYDRAULIC SYSTEM**
- **LANDING GEAR WHEELS**



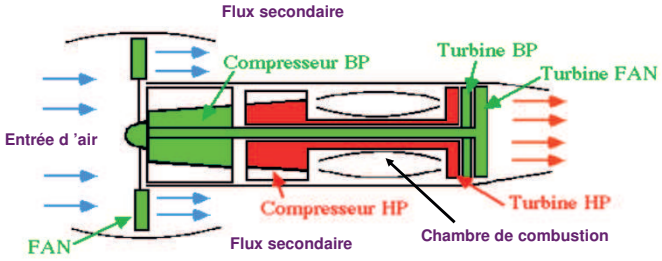



## Rôle des moteurs

- **Fournit la poussée à l'avion.**
- **Participe au freinage de l'avion**
- **Fournit la puissance mécanique aux :**
  - **Accessoires moteurs**
  - **Accessoires avion**
- **Fournit de l'air pressurisé pour réaliser la pressurisation et la climatisation de la cabine.**

## Fonctionnement du moteur

**Le réacteur double flux**




**La poussée est le produit :**

- **de la quantité d'air Q qui traverse le moteur,**
- **par la variation DV de la vitesse de celle-ci entre l'entrée et la sortie.**

**20-30% Propulsion par réaction**

**70-80% Propulsion par le FAN (flux secondaire)**





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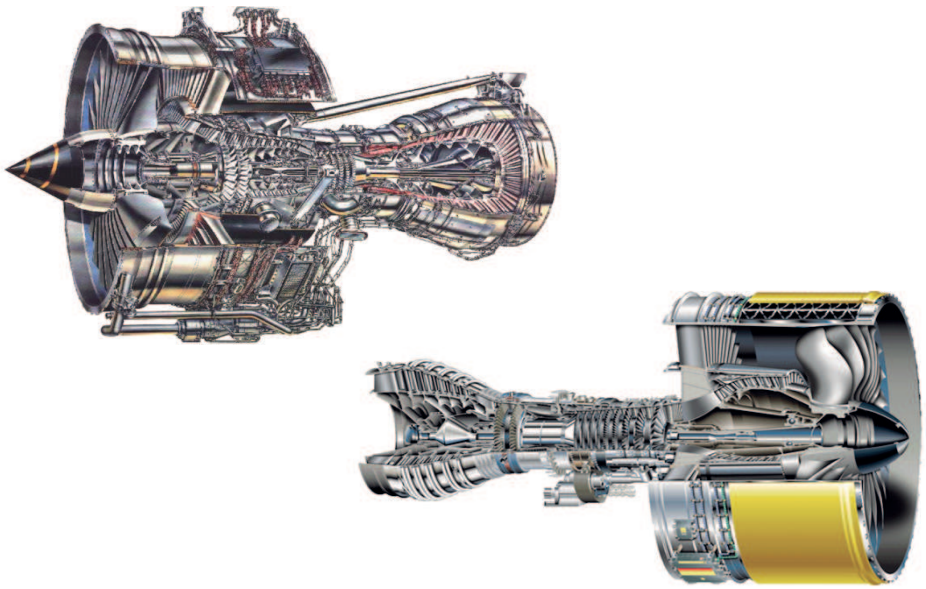
## Rolls-Royce – Trent 900 / Engine Alliance - GP7200







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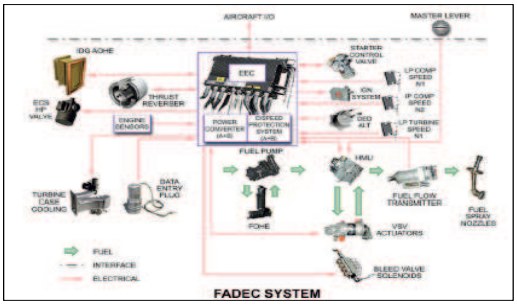
## Engine Control System Integration

### The FADEC System

### (Full Authority Digital Engine Control)

- **One main computer per Engine: Strict independence to be demonstrated from Throttles to Engines**
- **Input: manual (Throttles) or Automatic (Auto-THRust System)**
- **Several dedicated electrical peripherals:**
  - Sensors (pressure, temperature)
  - Actuators (Torque-motors, solenoids)
  - Dedicated Power supply
  - Harnesses and connectors
- **Several Pneumatic or Hydro mechanical peripherals:**
  - Fuel metering unit (HMU or FMU)
  - control valves or vanes
  - Starter air valve



FADEC SYSTEM





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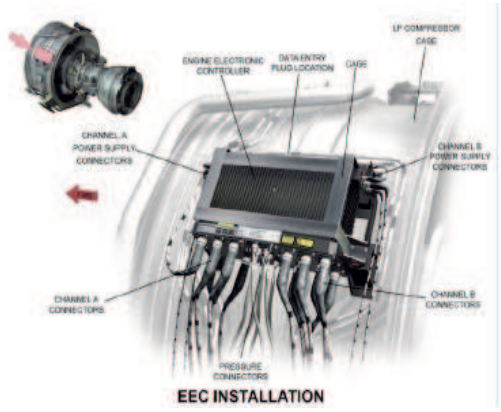
## Engine Control System Integration

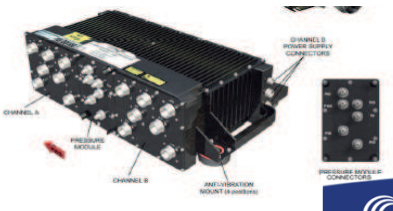
- **Few major specificities:**
  - **Overheat,**
  - **Engine Condition and Health Monitoring….**



EEC INSTALLATION

### Fire & overheat aspects

•Computer installed on engine







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## ACUTE

### Les différents paramètres d'affichage

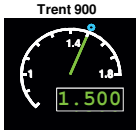
-Pour la famille moteur(CFM,GE,…) le paramètre de vitesse de rotation du moteur est N1(vitesse du FAN).

GP7200


N1 montré sur l' E/WD sous une forme numérique

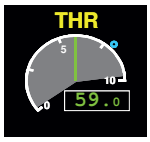
-Pour la famille moteur (RR,PW,IAE,…) le paramètre de vitesse de rotation du moteur est EPR (le taux entre la pression d entrée moteur et la pression de sortie de turbine).

Trent 900




EPR montré sur un SD ou un E/WD

- Le système ACUTE indique directement le pourcentage de poussée moteur.




Paramètres communs d'affichage sur l' E/WD indicateur de poussée

THR = Thrust (poussée)

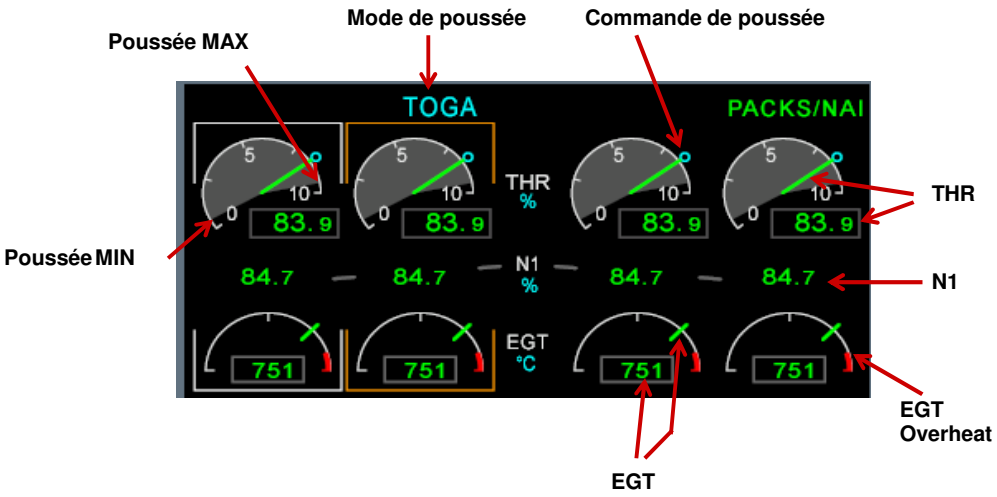
Moteur RR

Moteur EA

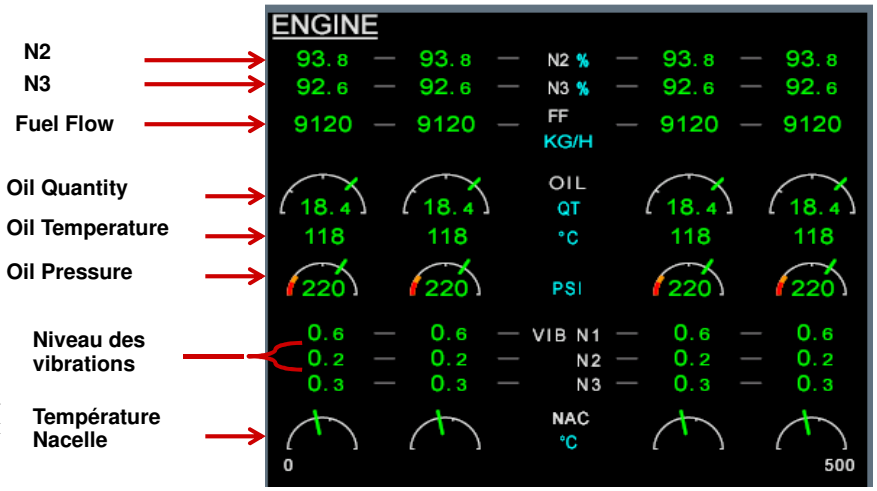




## Pages ED – Généralité



## Pages SEN – Généralité




Moteur RR

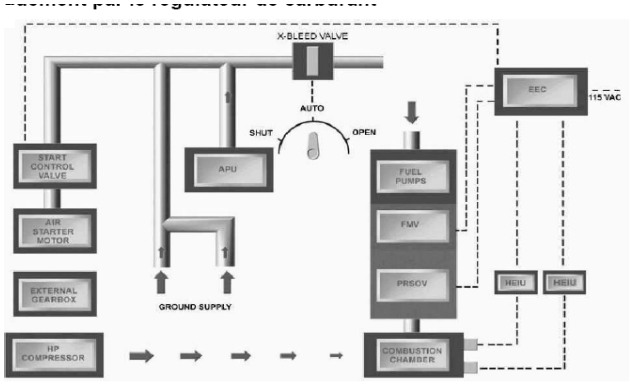




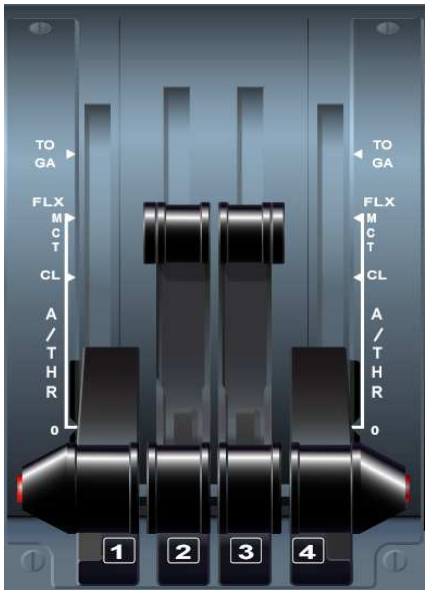
## Démarrage – Principe

**Le démarrage consiste à :**

- **Accélérer le rotor HP pour avoir un débit d'air suffisant**
- **Injecter le carburant dans la chambre de combustion en mettant sous tension les allumeurs**
- **Laisser le moteur accélérer jusqu'au régime IDLE. Le débit de carburant est automatiquement géré par l'EEC**



## Manette de commande de poussée








## Décollage – Phases

**Les limitations de poussées sont définies au travers du FMS et de la position manette :**

**Décollage**

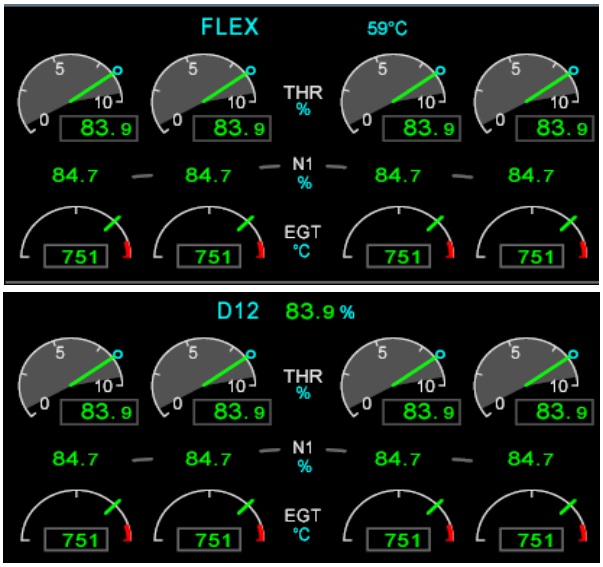
- **TOGA : plein gaz**
- **Flex : une température est saisie au FMS. Cette température permet de limiter la poussée moteur (économie)**
- **Derated TakeOff : un pourcentage est saisie au FMS. Il correspond à un pourcentage de réduction de la poussée max (ex D04 : réduction de 4%**
- **MCT : Poussée maximale continue (pas d'effet avion en cas de perte moteur)**

**Montée :**

**CLB : puissance géré par le FMS (Automanette)**

**Derated Climb : DCLB 1 à 5 géré par le FMS**

## Décollage – Display



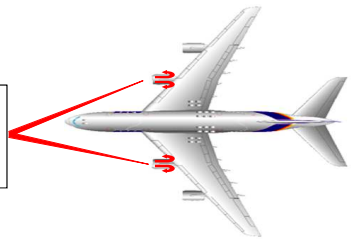


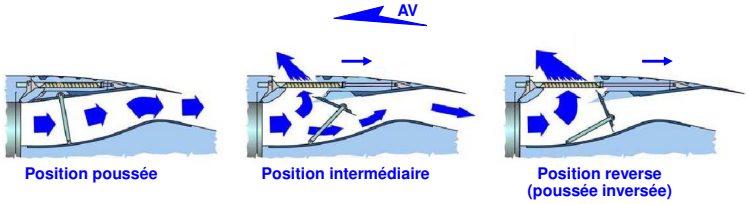



## Fonctionnement Moteur - Reverse

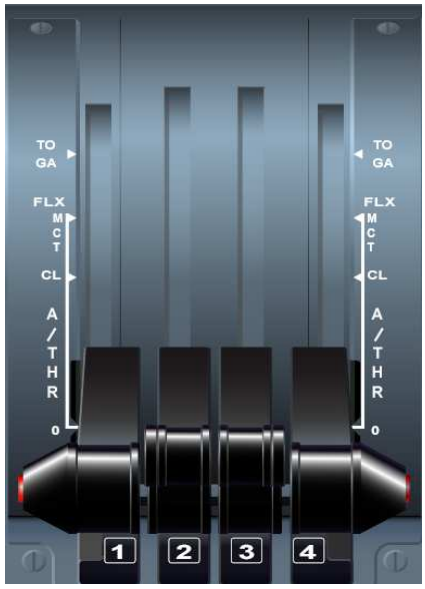
### L'inverseur à porte

Seuls les moteurs internes N° 2 et N°3 sont équipés de reverse (A380)





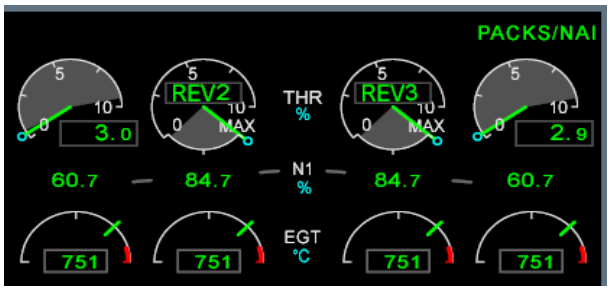
## Reverse – Commandes








## Reverse – Display



## SUMMARY

- DISPLAYS
- ENGINES
- **FUEL SYSTEM**
  - **Architecture**
  - **Tanks**
  - **Transfer**
  - **Displays**
  - **Refuel**
  - **Jettison**
- HYDRAULIC SYSTEM
- LANDING GEAR WHEELS





## FUEL SYSTEM FUNCTIONS

The fuel system **stores** fuel, **monitors** the quantity of fuel in each tank and controls **fuel transfers**, in order to:

- **Supply fuel** to the engines and to the APU
- Maintain the **center of gravity** within limits
- **Alleviate** structural loads
- Control **refuelling** and **defuelling**
- Enable **fuel jettison** when necessary

## FUEL SYSTEM ARCHITECTURE

**The fuel system is composed by:**

- **2 FQMS** / **4 CPIOM** (2 for each FQMS):
  - *FQMS1* : CPIOM F1 (COMmand partition) and CPIOM F3 (MONitoring partition)
  - *FQMS2* : CPIOM F2 (COMmand partition) and CPIOM F4 (MONitoring partition)
  - Master/Slave control
- **2 FQDC (Fuel Quantity Data Concentrator)**
  - each FQDC has a TSP (Tank Signal Processor) and an AGP (Auxiliary Gauging Processor)
- **ICP**
- **IRP (Integrated Refuel Panel)**
- **Pumps and Valves**
- **Probes and sensors**
- **11 fuel tanks ( + optional center tank)**

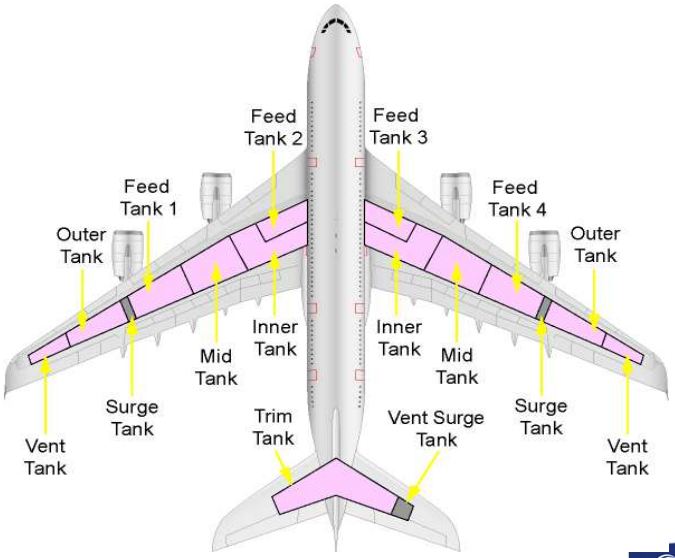




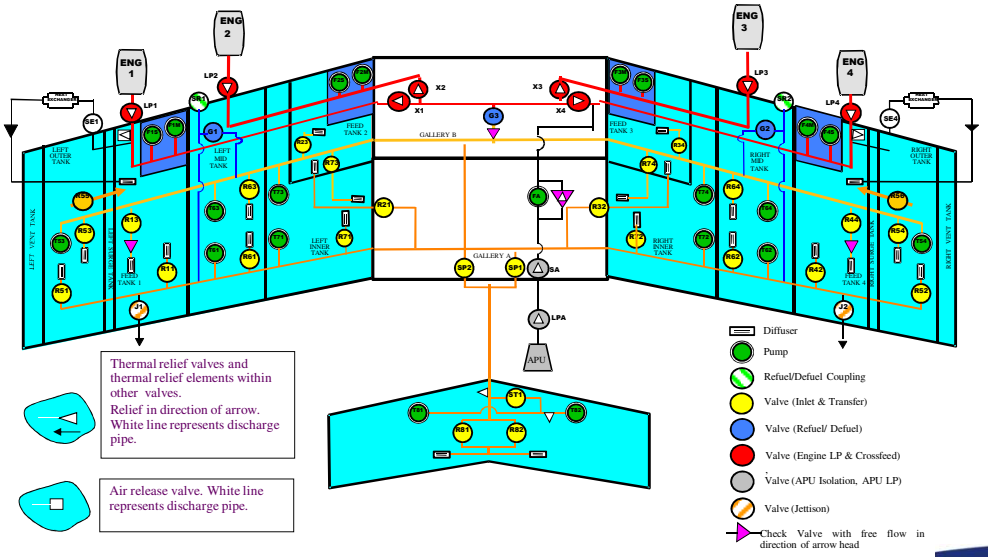
## FUEL SYSTEM TANKS ARRANGMENTS

**Each feed tank:**

- Provides fuel directly to the engines and the APU
- Receives fuel from all of the transfer tanks (inner, mid, outer, and trim tanks)
- Contains a **collector cell** that has a fuel capacity of approximately 1 000 kg to keep the fuel pumps immersed.



# FUEL SYSTEM PUMPS & VALVES








# FUEL SYSTEM TRANSFER MANAGEMENT

Transfers ensure:

- **fuel feeding** to engines
- **longitudinal balance** of the aircraft
- **lateral balance** of the aircraft
- aircraft **CG position control** as long as possible
- **load alleviation** for aircraft structure

Two galleries (FWD and AFT) pass through all wing tanks (inner, mid, outer, and feed tanks) to enable fuel transfers.
Each wing transfer tank has one or two transfer pumps, each connected to one of the two galleries.

In normal operation:

- The FWD gallery is for fuel transfers between the wing tanks
- The AFT gallery is for fuel transfers between the trim tank and the wing tanks via the trim pipe

## FUEL SYSTEM TRANSFER TYPES

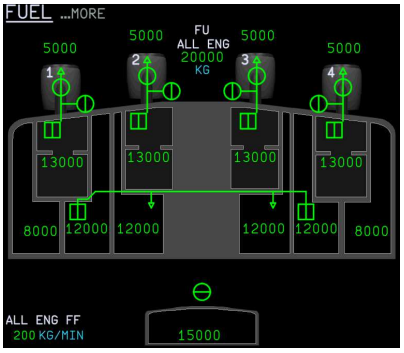
There are several categories of transfers:

- **automatic/manual**: the pilot select a manual transfer when the FQMS is failed
- **by pump/by gravity**: gravity transfer when the pump transfer is failed
- **automatic ground transfer**: used when the CG target is not reached on ground (<25min)
- **load alleviation transfer**: used to alleviate structural loads on the aircraft
- **CG transfers**: used to control the aircraft center of gravity

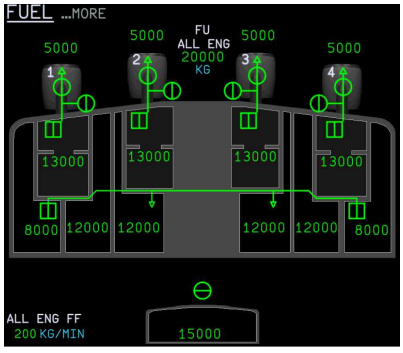




## FUEL SYSTEM FUEL PAGE




**Auto ground transfer**




**Load alleviation transfer**

# FUEL SYSTEM REFUELLING OPERATIONS

In normal operations, refuelling is performed under full control of the FQMS. This automatic refuel can be initiated from the external refuel panel or from the cockpit.

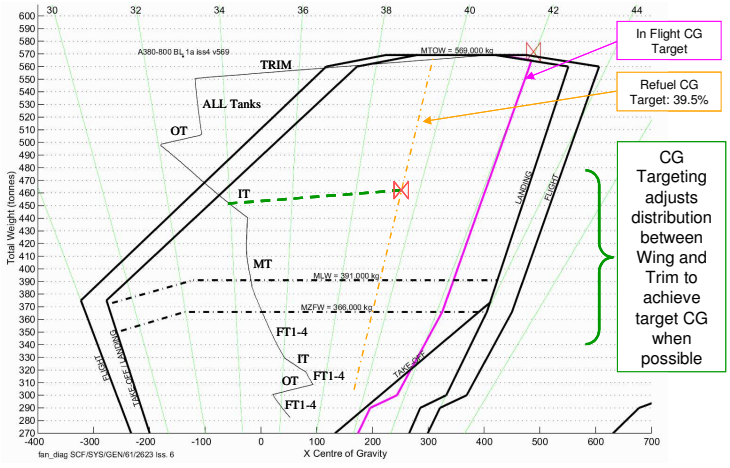
Manual refuel is also possible from the external refuel panel if necessary (e.g failure case). In this case, refuelling is controlled by an operator, via the FQMS.





# FUEL SYSTEM REFUELLING OPERATIONS – CG TARGETING

The figure shows the contribution made by each tank to the Refuel vector, assuming default ZFW and ZFCG, for the dynamic targeting distribution. With the exception of the outer tanks, the wing tanks tend to move the CG forward which biases the vector to the left of the envelope. The trim tank moves the CG aft thus allowing the target CG to be achieved



## FUEL SYSTEM JETTISON

- Used for fast weight reduction of the aircraft
- Automatically controlled once selected by the crew (2 P/B: ARMED and ACTIVE)
- Fuel in the engine feed tanks is not jettisoned
- 2 jettison valves
- All aft pumps pressurise the aft gallery
- Jettison rate: 150 t/h
- Max time: 1h

Jettison operation is terminated :

- **Automatically**, when the crew pre-selected final jettison gross weight is reached or when all the transfer tanks are detected empty.
- **Manually**, by de-selection of one of the 'Arm' and 'Active' push buttons on the OHP to the OFF position





## SUMMARY

- DISPLAYS
- ENGINES
- FUEL SYSTEM
- **HYDRAULIC SYSTEM**
  - **Components**
  - **Displays**
  - **Cooling System**
- LANDING GEAR WHEELS

## Hydraulic Power System Presentation

**Hydraulic power system comprises:**

- A main hydraulic power generation
- a backup hydraulic power generation supplied by electrical power,
- an auxiliary hydraulic power generation

**Basic functions of Hydraulic System :**

- All required flight control maneuvers (ATA 27)
- Retraction / Extension of Slats / Flaps (ATA 27)
- Retraction / Extension of Landing Gears and associated Doors (ATA 32)
- Wheel Brake Operation (ATA 32)
- Nose Wheel and Body Gear Operation (ATA 32)
- Cargo doors operation (ATA 52)
- Retraction of RAT on ground (ATA 24)





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## Hydraulic Power System Presentation

**• A380 hydraulic power is generated by two fully independent hydraulic circuits coded Green and Yellow :**

- The two circuits operates simultaneously,
- There is no possible fluid transfer between them
- Normal pressure of 5000 PSI

**•The Green and Yellow circuits are symmetrically installed on A/C :**

- The Green circuit generation is located in the LH Engines and Pylons
- The Yellow circuit generation is located in the RH Engines and Pylons

**•For each circuit :**

- The main hydraulic power is generated by 4 Engine Driven Pumps (2 EDP per Engine)
- The auxiliary hydraulic power is generated by 2 Electrical Motor Pumps (2 EMP per Outer Pylon)

**•The 2 EMPs of a circuit run in parallel and supply hydraulic power on ground only. EMPs are inhibited when at least one engine is started (N3 > 50%) and can not be used in flight.**





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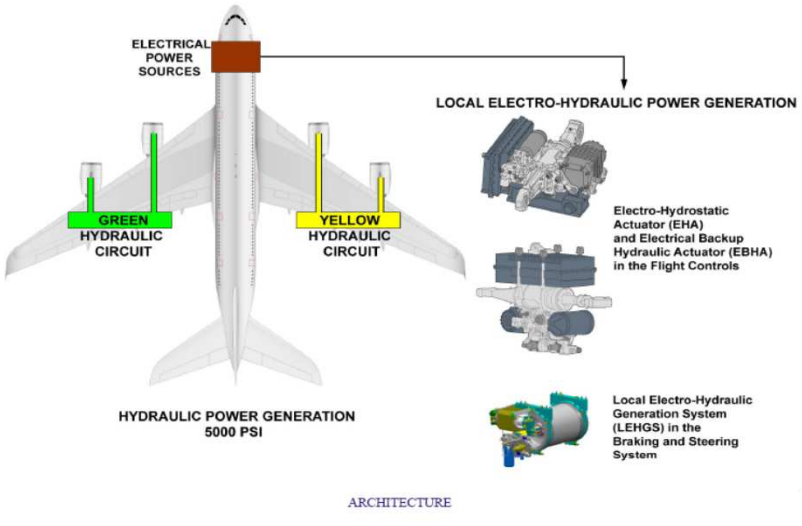
## Hydraulic Power System Presentation

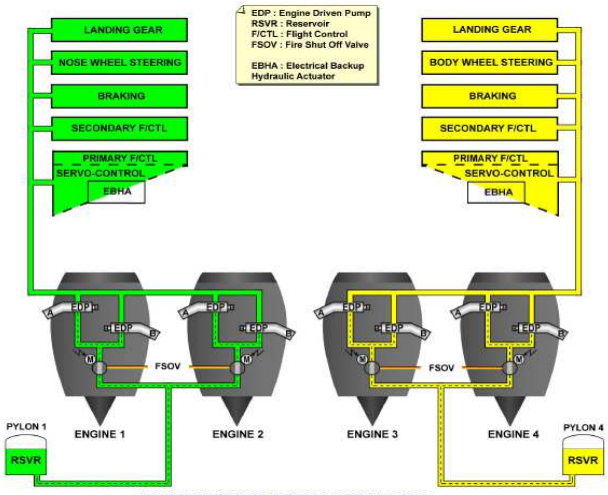



ARCHITECTURE



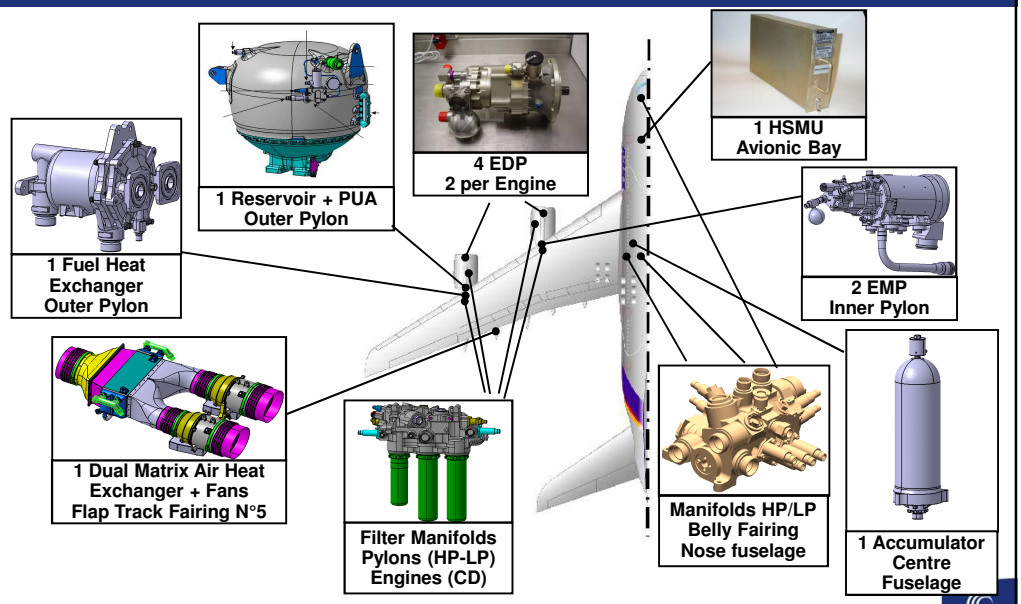


## Hydraulic Power System Presentation




HYDRAULIC POWER SYSTEM ARCHITECTURE

## Hydraulic Power System COMPONENTS





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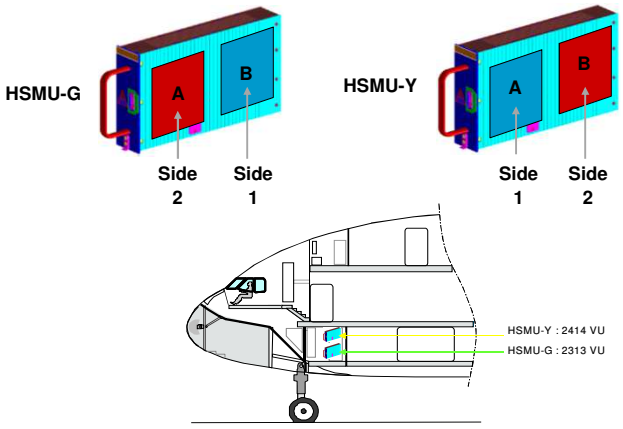
## Hydraulic Power System HSMU

- Hydraulic Circuits Control and Monitoring are dispatched into 2 Units
- Each Unit is dedicated to one Hydraulic Circuit *(NEW)*
- Each Unit is interchangeable (same P/N)
- Each Unit is made of 2 Boards (Channel A / B)
- Each Board is dedicated to an Electrical Route (Side 1 / Side 2)





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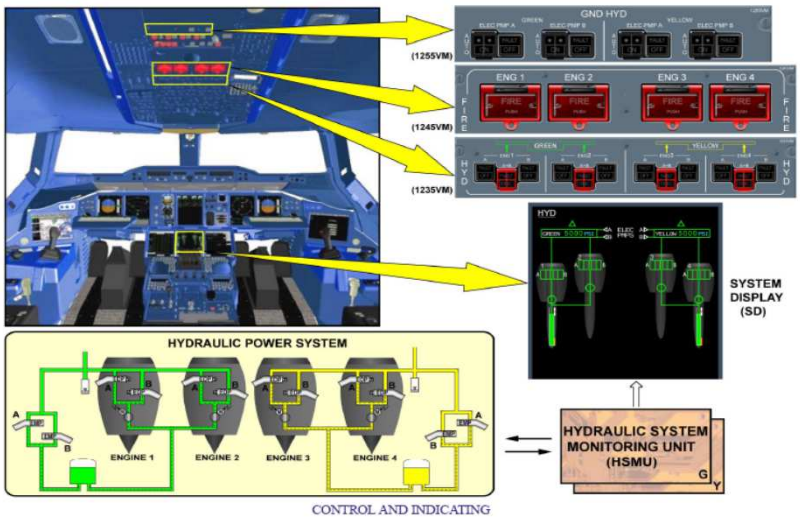
## Hydraulic Power System Interface

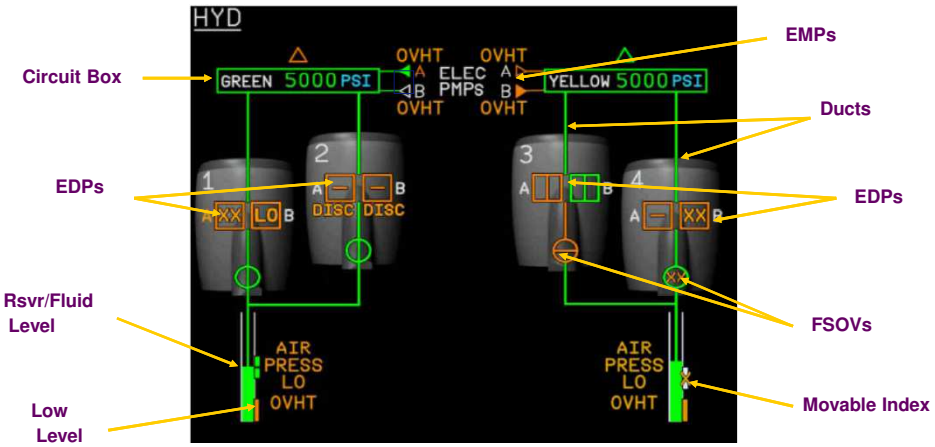






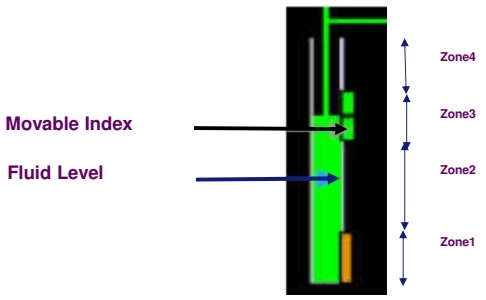

## Hydraulic Power System - SD Page

**This schematic is available by selecting the HYD button using the ECAM Control Panel (ECP).**
**This page is not representative of a real configuration.**



## Hydraulic Power System – ECAM Page

**Monitoring quantity of Hydraulic fluid into reservoir (Res Qty = 70 L).**
**Two indications of fluids quantity transmitted by HSMU (Channel B):**
**- Fluid Level (based on qty)**
**- Movable Index (based on T°C and Xfr with ATA32/27)**
**Segregation by CDS (different zone for visibility and accuracy) :**

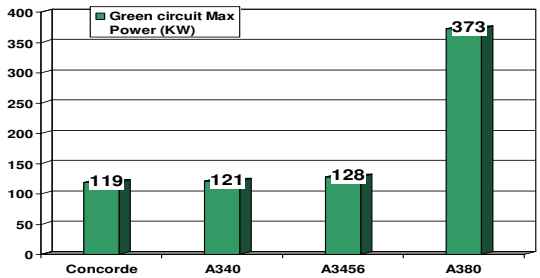







## Hydraulic Power System – Cooling System

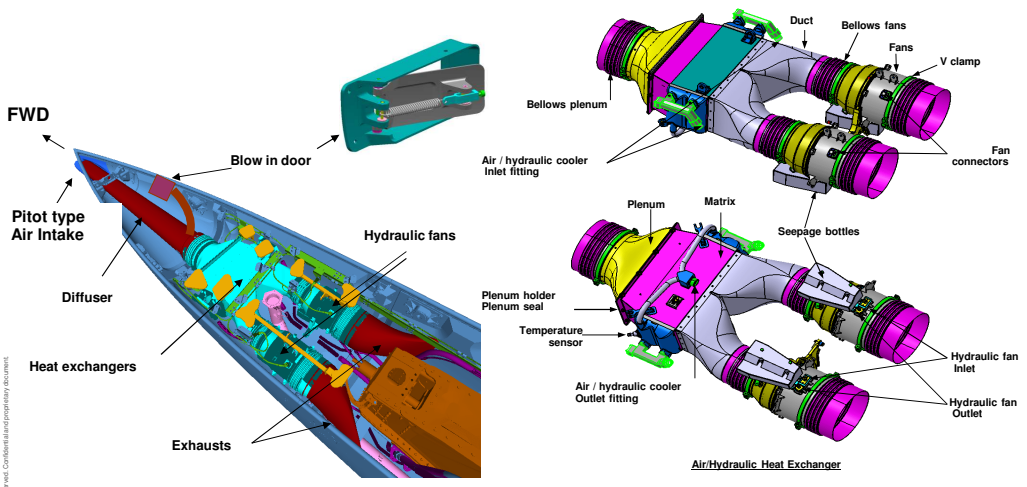
**Why an hydraulic cooling system on A380 ?**
- **A380 Green (Y) Power = 3 x A3456 Green Power**




***Thermal Balance at circuit level (Take Off)*:**

| | |
|---|---|
| 4 EDP heat rejection | 4 x 10.75 kW= 43 kW |
| Internal leakage | 10 kW |
| Natural cooling (pipes) | -25 kW |
| | 28 kW |
| => Need for Heat exchangers : | 2 x 15 kW |

## Hydraulic Power System – **Air/Hyd Heat Exchanger**




Air/Hydraulic Heat Exchanger





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## SUMMARY

- DISPLAYS
- ENGINES
- FUEL SYSTEM
- HYDRAULIC SYSTEM
- **LANDING GEAR WHEELS**
  - ➢Landing Gear Extension & Retraction System
  - ➢Braking Control System
  - ➢Wheel Steering Control System
  - ➢Landing Gear Monitoring System





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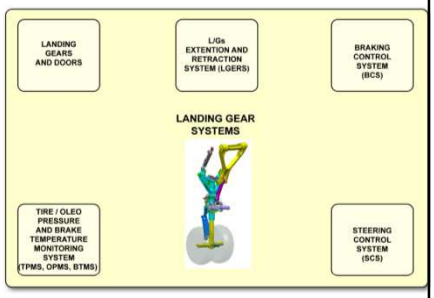
## Landing Gear System

- **Landing Gear System Presentation**

- **Landing Gear Sub-Systems**
  - **Landing Gear Extension & Retractation system**
  - **Braking Control System**
  - **Wheel Steering Control System**
  - **Landing Gear Monitoring System**
    - Brake Temperature Monitoring System
    - Tire Pressure Monitoring System
    - Oleo Pressure Monitoring System



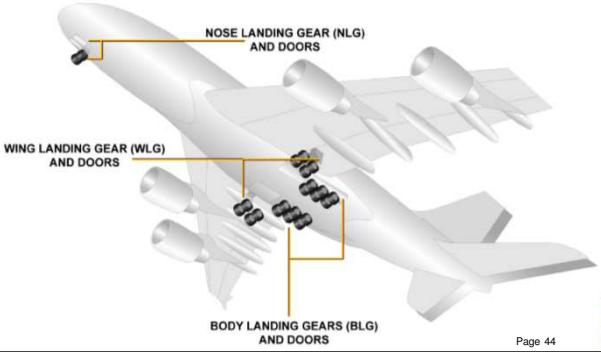





## Landing Gear System presentation

- **The A380 has :**
  - **1 nose Landing Gear (NLG) and related doors**
  - **2 Wing Landing Gears (WLG) and related doors**
  - **2 Body Landing Gears (BLG) and related doors**

- **Gears and doors are hydraulically operated**



## Landing Gear System presentation

**WHEELS**

| | |
|---|---|
| 2 NOSE WHEELS | 8 BRAKED WHEELS IN BLG |
| 20 MAIN WHEELS | 8 BRAKED WHEELS IN WLG |
| 16 BRAKED WHEELS | NLG NOT BRAKED |

**TYRES**

NLG 1270 X 425 R22

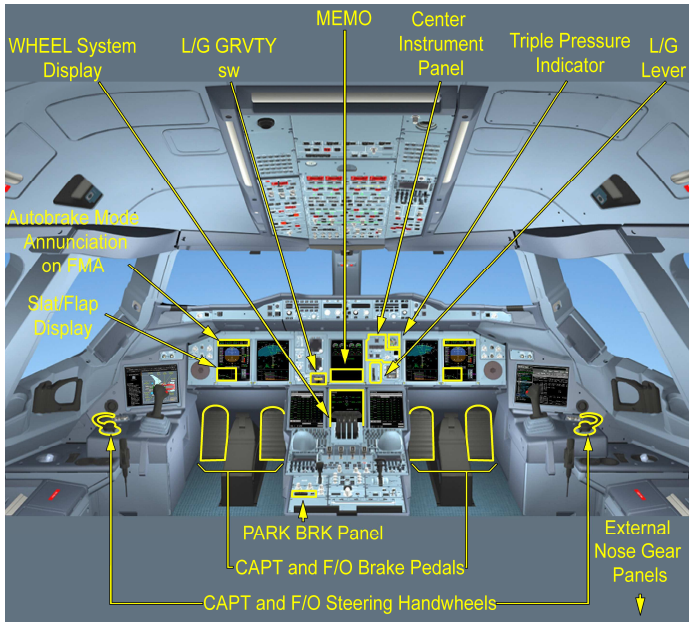
MICHELIN 1400 X 530 R 23 } BLG & WLG

BRIDGESTONE 1400 X 530 R 23





## Landing Gear System - CONTROLS & INDICATORS



# Landing Gear System - CONTROLS & INDICATORS

**Steering Handwheel**

**Center Instrument Panel**

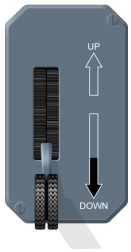

**Triple Pressure Indicator**




**L/G GRVTY sw**


**Brake Pedals**

**L/G Lever**



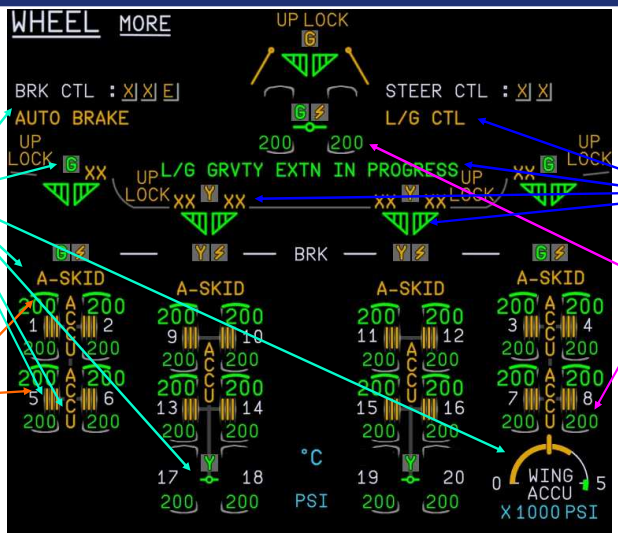

**PARK BRK Panel**






# Landing Gear System presentation - ECAM PAGES

**WHEEL Page with 16 brakes**




BCS SCS

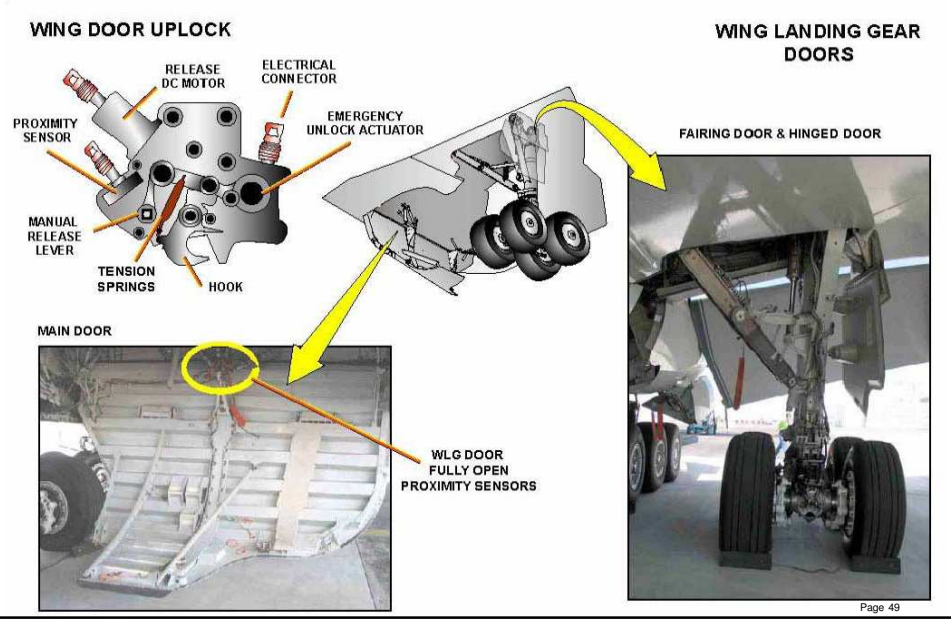
LGERS

TPMS

BTMS

BCS-SCS: Brake Control System – Steering Control System
LGERS : Landing Gear Extension Retraction System
BTMS : Brake Temperature Monitoring System
TPMS : Tire Pressure Monitoring System (optional)

## Landing Gear System - EXTENSION & RETRACTION SYSTEM



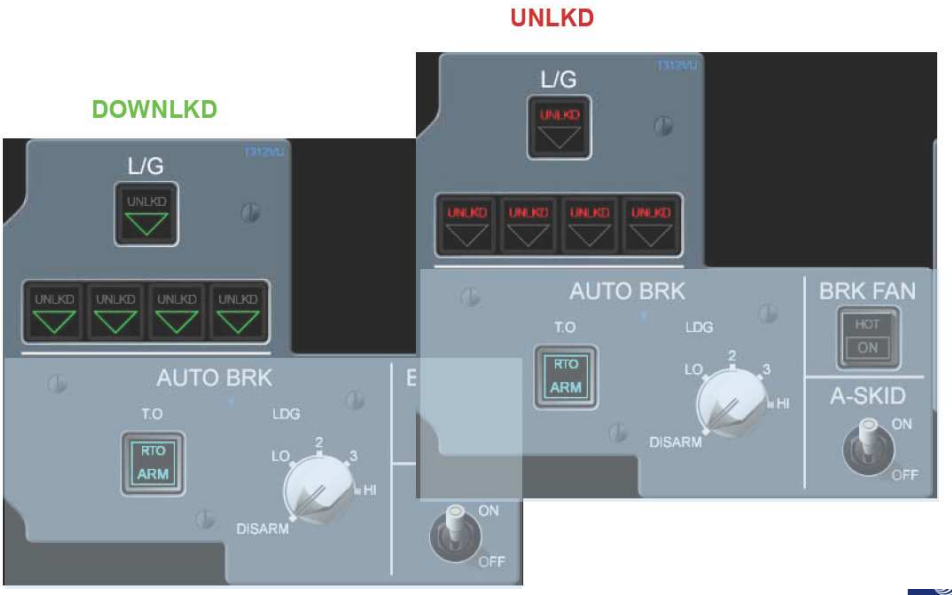





## Landing Gear System - EXTENSION & RETRACTION SYSTEM

- **The landing gear has <u>3 modes</u> of operation :**
  - **Normal operation, through the landing gear lever : *normal extension & retraction system,***
  - **Emergency operation (in case normal mode is unavailable) : *free fall extension system***
  - **Ground door operation (maintenance access) : *Ground Door Opening System (GDO).***

## Landing Gear System - Unlock Downlock Independant Indication





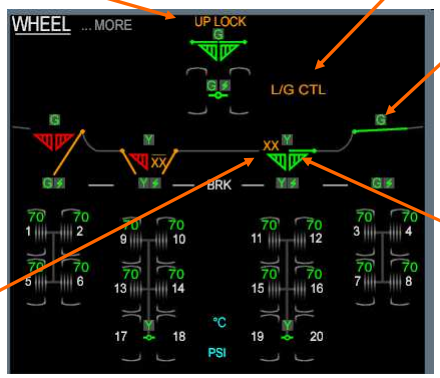



## Landing Gear System - EXTENSION & RETRACTION SYSTEM

Gear Uplock in locked position while downlock sensed

Display amber if LG NOT in selected position after transition timeout

Door uplocked




In normal condition Side 1 L Body Gear Dowlock indication

In normal condition Side 2 R Body Gear Dowlock indication

## Landing Gear System - BRAKING CONTROL SYSTEM

- To supply control to the 16 wheel brake units of the WLG & BLG.
- The brakes can be applied either manually (brakes pedals) or automatically via the autobrake. The brakes on the BLG can also be applied, as a parking brake.
- The braking system has 5 braking modes: Normal, Alternate, Emergency, Ultimate & the Parking brake.
- If there is a braking system failure, the system will automatically reconfigure to the appropriate mode, in order to optimize braking performance.





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## Landing Gear System - BRAKING CONTROL SYSTEM

The Braking System architecture is divided into 3 groups : WLG, left BLG & right BLG.

- WLG group :
  - 8 braked wheels,
  - Powered in Normal braking mode by the Green Hydraulic system,
  - Powered in the other braking modes by a dedicated Green Local Electro-Hydraulic Generation System (LEHGS),
  - Controlled by BCS function hosted in CPIOM, or by the Emergency Brake Control Unit (EBCU).
- Left hand BLG group & right hand BLG group :
  - 4 braked wheels (the 4th front wheel) for each,
  - Powered in Normal braking mode by the Yellow Hydraulic system,
  - Powered in the other braking modes by the Yellow LEHGS,
  - Controlled by BCS function hosted in CPIOM, or by EBCU
- Brakes indications & warning are supplied by the CPIOM through the ECAM.





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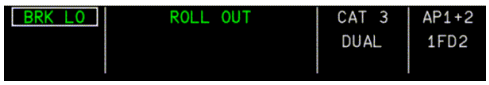
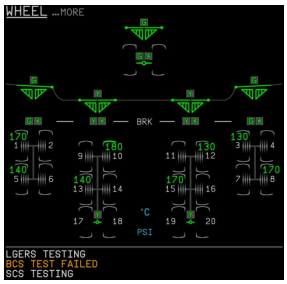
## Landing Gear System - BRAKING CONTROL SYSTEM

- **BCS interface with FMA zone**



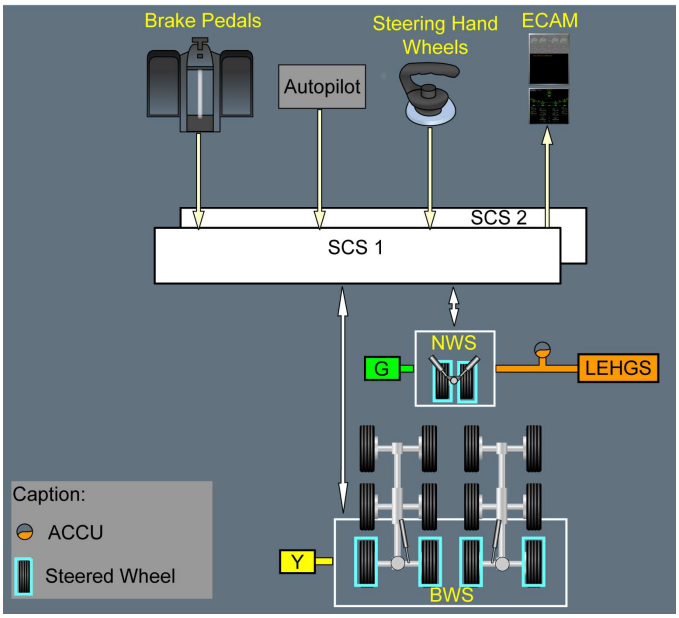

- **BCS – SCS interface with Safety Message (area below WHEEL Page)**








## Landing Gear System - WHEEL STEERING CONTROL SYSTEM



## Landing Gear System - WHEEL STEERING CONTROL SYSTEM

- **The steering system provides directional control of the aircraft on ground, allow towing, and combines:**
  - **Nose Wheel Steering (NWS)**
  - **Body Wheel Steering (BWS)**
- **The steering system has two redundant Steering Control Systems (SCS).**





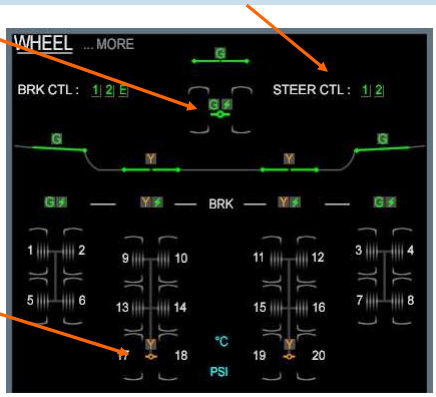
## Landing Gear System - WHEEL STEERING CONTROL SYSTEM

- **SCS Wheel Page**

**STEERING CONTROL indicates:**
- **SCS faulty side**
- **Activate side in green**

**Indication available on MORE page or when fault is detected**

**NWS in amber indicates :**
- **Normal & Alternate NWS faulty**
- **Data not valid**
- **SCS 1& 2 faulty**




**Left & Right BWS in amber indicates :**
- **Left OR Right BWS faulty OR lock faulty**
- **Data not valid**
- **SCS 1& 2 faulty**

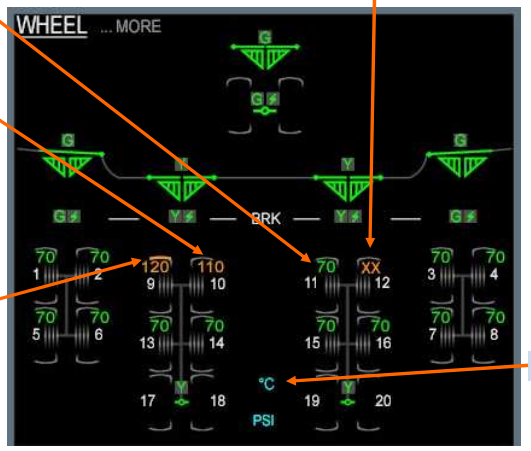
# Landing Gear System - MONITORING SYSTEM

**BTMS indicates:**
**-Brake temperature values for each brake (always display)**

**If data from BTMS invalid -> corresponding brake = XX in amber**

**High Temperature warning for each brake when applicable (amber)**

**Identification of highest brake temperature of all braked wheels**




**Brake T° unit**





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