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A380 Landing Gear and Systems

Lecture for RAeS, DGLR, VDI and HAW Hamburg

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Description of Landing Gears and Associated Systems
– Development of Gears Layout
– Highlight new functions and technologies
– Overview of Systems Architectures and Equipment
The A380

- The A380 is a completely new, very high capacity, very long range commercial transport aircraft, powered by 4 RR Trent 900 or Engine Alliance GP7200 engines
- Standard A380-800 accommodates 555 Passengers in three-class long-range arrangement
- MTOW 569 tonnes, MLW 391 tonnes
- First flight 27 April 2005
- Entry into service Oct 2007, with Singapore Airlines
- Delivery schedule for 2008: 13 A/C to Singapore, Qantas and Emirates
A380 Landing Gear Systems – An Overview
Major Components and Systems

- ATA Chapter 32 Landing Gear Systems
- Gears
  - Nose Landing Gear (2 Wheels)
  - Body Landing Gear x2 (Bogie Type, 6 Wheels - 4 Braked)
  - Wing Landing Gear x2 (Bogie Type, 4 Wheels - 4 Braked)
- Extension/Retraction System
- Braking Control System
- Steering Control System
  - Nose Wheel Steering
  - Body Wheel Steering
- Wheels, Tyres and Brakes (16 Braked Wheels)
- Monitoring Systems
  - Tyre Pressure Indication System
  - Brake Temperature Monitoring System
  - Oleo Pressure Monitoring System
A380 Landing Gear & Systems – An Overview
Evolution of Main Landing Gear Configuration

A380 Landing Gear Configuration
Starting Point – 38 Alternatives
First Down Selection:

2 Family Concepts for the gear and airframe

Classical Bay

Longitudinal Bay
A380 Landing Gear & Systems – An Overview
Evolution of Main Landing Gear Configuration

Second Down Selection:
- Family Concept Selected
- Kinematic Options traded

Bay concept selected
Kinematic options
Baseline configuration
Main Gear Group:
Installation in Wing & Fuselage
A380 Landing Gear Systems – An Overview
Evolution of Gears Configuration

• Landing Gear Configuration – Basic Requirements
  ‣ one concept philosophy for all aircraft variants
  ‣ each variant capable of optimization
  ‣ concept capable of development to significantly higher design weights
  ‣ ACNs no worse than existing large aircraft
  ‣ Nose gear to be compatible with towbarless towing

• Manoeuvring on ICAO code E and FAA group V airports
  ‣ 45m wide runways and 23m taxiways
  ‣ U-turn on 60m wide runway possible

• Capable of growth beyond current a/c definitions
  ‣ 2 wheel or 4 wheel CLG installation possible
A380 Landing Gear Systems – An Overview
Wing Landing Gear
A380 Landing Gear & Systems – An Overview

Body Landing Gear
A380 Landing Gear & Systems – An Overview
Nose Landing Gear

Nose Wheel Steering (NWS):
- Towing Angle is +/- 60°
- Hydraulic Steering Angle is +/- 70°
- Mechanical Stop Angle is +/- 75°
High Strength Steel (300M), except:

- **Titanium**
- **Aluminium**

A380 Landing Gear & Systems – An Overview

Landing Gear Structure

Weight / Cost / Size / Timescale Trade-offs
A380 Landing Gear Systems – An Overview
Gears Retraction Animation
Honeywell Wheel & Brake:

**Braked Wheel**
- Deep Cavity A-Frame
- 2014-T6 Aluminium Alloy
- 23 inch rim size
- 11 Vent Holes
- 11 Drive keys
- 22 Iconel Tie Bolts
- Segmented Heat-shield
- Stainless Steel Axle Sleeve

**Non-Braked Wheel**
- Symmetric A-Frame

**Brake**
- 5 Rotor Carbenix® 4000 heat-sink
- 1.59inch wear pin
- 23 spline titanium torque tube
- Aluminium 7050 piston housing
- 6 x Ø1.805" pistons (split-ball adjuster)
- Integral Lug and steel torque pin

**Bridgestone Tyre**
- 1400x530 R23 40PR Lightweight Radial
A380 Landing Gear Systems – An Overview
Nose Wheel and Tyre

• Honeywell Wheel

• Wheel
  • Symmetric A-Frame
  • 2014-T6 Aluminium Alloy
  • 22 inch rim size
  • Iconel Tie Bolts
  • Light-weight Aluminium Axle Sleeve

• Bridgestone Tyre
  • 1270x455 R22 32PR Lightweight Radial
A380 Landing Gear Systems – An Overview
Power Systems Architecture

• **Hydraulic architecture:**
  - 5000 psi
  - 2 A/C circuit (Green & Yellow)
  - Segregation Between Green and Yellow:
    - BLGs ATA32 function on Yellow circuit only
    - WLGs & NLG ATA32 function on Green circuit only
  - All hydraulic back-up functions ensured by local hydraulic generation system (LEHGS) owned by the function system

• **Electrical Architecture:**
  - AC : 115V Variable frequency
  - DC: 28V with no power transients
    - 2 segregated Normal DC : DC1 & DC2
    - 1 Emergency DC : DC essential
    - 1 DC Service Bus
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Local Hydraulic Power Generation System

- Redundancy of hydraulic power for Braking and Nose Wheel Steering provided by LEHGS

- Features:
  - Re-pressurises the HP accumulators to 350 bar throughout the flight
  - Low pressure reservoir with LVDT for level sensing and visual indicator
  - Electric motor-pump
  - Incorporates health monitoring (fluid and motor temperature sensing, filter clog detection)
1) **Normal ATA32 functions controlled by shared avionics units for all systems**
   - Core Processor Input Output Module (Integrated Modular Avionics)
     - CPIOM-G (IMA): All ATA32 System functions
       - Control functions and indication management
       - Central monitoring functions (BITE)
       - Main interfaces to other A/C systems
   - Remote Data Concentrator
     - Landing Gear RDCs: Extension/Retraction (LGERS) and Monitoring (LGMS)
       - Specific Systems sensors Acquisitions
       - Ext/Ret Valves and Actuators second order control
       - Local monitoring
     - Interface RDCs: Braking and Steering (BSCS)
       - A/SKID and pressure control loop function
       - Specific Systems sensors Acquisitions
       - Local monitoring

2) **Emergency ATA32 functions controlled by specific analogue units, independent of IMA and AFDX avionics technology**
   - Brake Control: Emergency Brake Control (EBCU)
   - Ext/Ret Free Fall: Free-Fall Control (FFCM)
Oleo pressure is monitored simultaneously on all landing gear shock absorbers and any warning is passed on to the Flight Warning System.

- Prevents departure with mis-serviced Landing Gear
- Accurate Check - performed once per flight, after gear extension
- Gross Check - continuous monitoring
- Combined Pressure and Temperature sensor mounted on each Shock Absorber

OPMS is designed to:

- Provide a warning when one or more L/G oleo pressure is outside defined limits.
- Provide a warning when there is an OPMS equipment failure.
- Provide L/G oleo pressure status to the flight and maintenance crew.
- Provide other aircraft systems with L/G oleo pressure status & equipment information via AFDX.
- **OPMS removes the need for carrying out pre-flight oleo pressure checks by the maintenance crew.**
A380 Landing Gear Systems – An Overview
Brake Temperature Monitoring System

BTMS (Brake Temperature Monitoring System):

- Prevents take-off with a hot brake
- Prevent landing gear retraction with a hot brake
- Monitors for residual braking due to a dragging brake

Equipment:
- Brake Temperature Compensation Module
- Brake Temperature Sensor located next to the brake heat pack.
Tyre pressures are monitored simultaneously on all wheels and any warning is passed on to the Flight Warning System.

TPIS is designed to:

Provide other aircraft systems with tyre pressures & equipment status information.
Provide tyre pressure information to the flight and maintenance crew.
Provide an alert when the pressure in one or more tyres is outside defined limits.
Provide an alert when the differential pressure between any two tyres on the same axle differs by an amount beyond defined limits.

TPIS can be used to carry out daily tyre pressure checks.
Depending on the flight phase, a warning will be triggered if a tyre pressure is detected below a given percentage of the nominal tyre pressure (for 5 seconds continuously).

Likewise, a warning will be triggered if a differential pressure above a given percentage is detected across tyres on the same axle (measured from the tyre with the higher pressure).

A ‘TYRE PRESS LO’ message will be displayed on the E/WD if a Low or Differential tyre pressure condition is triggered.
A380 Landing Gear Systems – An Overview
Steering Control System

Steering is mainly effected on the NLG Wheel Pair by classic push-pull design (Nose Wheel Steering)

Aft Axle of BLG is steerable to ensure better manoeuvrability for small radius turn (Body Wheel Steering)
A380 Landing Gear Systems – An Overview
Steering Control System Architecture
NORMAL / ALTN BRAKING

- Body Landing Gear (BLG) & Wing Landing Gear (WLG) attached to separate hydraulic systems
  - BLG – Yellow, WLG – Green
  - Single Cavity Brakes
  - Servo Valve per Wheel Pair
- LEHGS (Local electro-hydraulic generation supply)
  - Electric motor driven pump supply Alternate hydraulics

AUTO-BRAKE

- Autobrake function available in Normal & Alternate Braking mode
- Comfortable & symmetric disconnect
- Provision for Brake to Vacate function
  - Adapts deceleration rates to runway exits
The Braking System architecture is divided into three groups linked to the three wheel groups:

- WLG (8 wheel braked)
- BLG (8 wheel braked - aft axle wheels not braked)
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Brake Control System Architecture

AFDX

Side 1
- COM1
- MON3
- COM2
- MON4

Side 2
- ARINC 429 links
- RDC1
- RDC3
- RDC2

A/C Green Hydraulics
WLG LEHGS

A/C Yellow Hydraulics
BLG LEHGS

EBCU
### A380 Landing Gear Systems – An Overview
### Brake Control System – Braking Modes

**Braking Modes available per wheel group.**

<table>
<thead>
<tr>
<th>BRAKING</th>
<th>HYDRAULICS</th>
<th>CONTROL UNIT</th>
<th>ACTIVATION</th>
<th>FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMAL</td>
<td>• <strong>YELLOW</strong> – BLG • <strong>GREEN</strong> – WLG</td>
<td>IMA</td>
<td>• AUTOBRAKE • PEDALS</td>
<td>• ANTI-SKID • PEDALS • AUTOBRAKE</td>
</tr>
<tr>
<td>ALTERNATE (WITH ANTI-SKID)</td>
<td>• <strong>LEHGS</strong> + ACCU</td>
<td>IMA</td>
<td>• AUTOBRAKE • PEDALS</td>
<td>• ANTI-SKID • PEDALS • AUTOBRAKE</td>
</tr>
<tr>
<td>ALTERNATE EMERGENCY</td>
<td>• <strong>LEHGS</strong> + ACCU</td>
<td>IMA</td>
<td>• PEDALS</td>
<td>• NO ANTI-SKID • PEDALS with limited pressure</td>
</tr>
<tr>
<td>EMERGENCY (Same as above, but with EBCU control)</td>
<td>• <strong>LEHGS</strong> + ACCU Or • ACCU</td>
<td>EBCU</td>
<td>• PEDALS</td>
<td>• NO ANTI-SKID • PEDALS with limited pressure</td>
</tr>
<tr>
<td>ULTIMATE</td>
<td>• <strong>LEHGS</strong> + ACCU Or • ACCU</td>
<td>EBCU</td>
<td>• PARK SWITCH ONLY</td>
<td>• BRAKING ON ALL WHEELS</td>
</tr>
<tr>
<td>PARK</td>
<td>• <strong>NORMAL</strong> Or • <strong>LEHGS</strong> + ACCU</td>
<td>-</td>
<td>• PARK SWITCH ONLY</td>
<td>• BRAKING ON BLG ONLY</td>
</tr>
</tbody>
</table>
The Landing Gear Extension and Retraction System is made up of three sub-systems:

The Normal System:

Landing Gear Control and Indication System (LGCIS) Side 1 and 2, implemented in IMA
Nose and Wing Landing Gear and Doors - Green Hydraulic System
Body Landing Gear and Doors - Yellow Hydraulic System

An Independent Freefall System for Emergency operation

Independent of IMA
Dedicated uplock electrical actuators and valves
Uses dissimilar technologies where possible to avoid common-mode failures
Uses different wiring routes

An Auxiliary Ground Door Opening System

Allows on-ground access to each landing gear bay for maintenance purposes
Electrically operated and controlled from GDO Panels
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Extension/Retraction System Equipment

- Vent Valve
- Landing Gear Selector Valve
- Dual Valve Actuator
- Door By-Pass Valve
- Cut-Out Valve
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Extension/Retraction System Equipment

NLG Door Uplock

Emergency Unlock Actuator
Normal Unlock Actuator

Wing Landing Gear Uplock
System operation is from a Control Panel, which is accessible from outside the aircraft and located near the operated door(s). There is a Control Panel for:

- NLG (both doors)
- L WLG (one door)
- R WLG (one door)
- L BLG (outer door only)
- R BLG (outer door only)

Operation of system commands isolation of the Gear Door Actuator via a By-Pass Valve and release of the Door Uplock via the Side B EUA, allowing it open by gravity.
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Cockpit Controls and Indications

- Landing Gear Emergency Extension Switches
- Brake Pedal Transmitters
- Parking Brake Selector
- Independent Landing Gear Position Lights
- Landing Mode Rotary Selector Switch
- Brake Pressure Triple Gauge
- Anti-Skid selector switch
- Systems Display (Wheel Page)
- Landing Gear Selector
- Steering Tiller
- Emergency BPTU (Emergency Braking)
- Normal BPTU (Normal and Alternate Braking)
- Transmitters
- Anti-Skid selector switch
- Wheel Page Parking Brake Selector
- Brake Pedal Transmitters
- Landing Gear Emergency Extension Switches
- Systems Display (Wheel Page)
A380 Landing Gear & Systems – An Overview
Flight Test Highlights