Recent Advances and Future Electrical Landing Gear Systems

ICAS Workshop – Cape town

02 / 09 / 2013
AGENDA

1. Historic Hydraulic Landing Gear Systems and move toward more electric

2. Recent advances on EHA technology for Steering and Extension/Retraction Systems (example of the nose landing gear)

3. Recent advances on EMA technology for Landing Gear Systems:
   - Braking System
   - Extension/Retraction System
   - Steering System

4. The future of Electrical Landing Gears
Historic Landing Gear Systems
Since apparition of centralized Hydraulic System on A/C in the 30’s, Landing Gears have been actuated with hydraulic power.

The progress made on electrical technology permitted use of electrically powered LGS for back-up modes.

- **3H**
  - 737 / A320
  - A330 / 777
  - A/C systems with hydraulic power

- **2H2E**
  - A380 / 787
  - KC390 / JSF
  - Mixt power for A/C systems
  - EHA as back-up: Steering, Braking, EMA for braking

- **3E**
  - Electrical power only for A/C systems
  - A30X/737RS ?
  - Autonomous EHA or EMA for all landing gear systems: Steering, Braking, Extension / Retraction

No more centralized hydraulic power available on A/C.

- **90’**
- **2000**
- **2020**
- **2025**
Recent advances on EHA technology for steering and Extension/Retraction Systems
EHA TECHNOLOGY ALREADY IN SERVICE

Technology certified on A380 for back-up modes

- Braking/Steering: LEHGS (Local Electro-Hydraulic Generation System)
- MBD responsible for the whole system
  - The Motor Pump is pressure controlled, filling a reservoir (constant speed / sense of rotation)
  - The reservoir provides the hydraulic supply to braking or steering control valves (DDV, EHSV) in case of failure of the normal mode

Motor Pump Sub-Assembly
System EHA demonstration completed on real NLG
(Steering + Extension / Retraction of LG & doors)
EHA (Electro-Hydrostatic Actuation) : already certified technology on back-up modes.

Objective is to make EHA technology reliable enough for normal mode application during A/C full life

→ Extensive studies have been made on Pumps Geometry, Material, Treatments:
  - Life potential of pumps already doubled, final goal is to meet 150 000 FH endurance
  - Robustness to fluid pollution will be demonstrated
Recent advances on EMA technology for Braking System
ELECTRICAL BRAKING SYSTEM
DEMONSTRATION ON A/C

⇒ EABS A340 ELECTRIC BRAKE
  ▪ Braking System Qualification (EMA, EBC, adapted BSCU)
  ▪ Economical assessment: weight, maintenance
  ▪ Flight tests in 2008: Performance Validation

⇒ BOEING 787 DREAMLINER
  ▪ Large project management for Electric Technology
  ▪ Technical optimization (incl. Power consumption)
  ▪ Maturity and Robustness demonstration
  ▪ Specification, conception & qualification tests
  ▪ DO160 / DO254 / DO178 Certification
  ▪ EIS on 787-8 since August 2012
ELECTRICAL BRAKING SYSTEM
EMA TECHNOLOGY

Technology Assessment

- System weight to be slightly higher in Electric than in Hydraulic (depending on the A/C size)
- Reliability will remain lower at equipment level
- Better availability is reached at system level
  - LRU health monitoring
  - Very high dispatch based on architecture design and reconfiguration capability
- Eased installation and maintenance (plug & play system)
  - Decrease of the A/C assembly cost and of the maintenance costs
- Braking performances are comparable in Electric and in Hydraulic
Recent advances on EMA technology for Extension/Retraction System
Direct Drive Duplex Actuator for E/R

**Mains characteristics / Schematics**
- Dual screw → jam tolerant
- Direct Drive on normal path
- High torque / Low speed motor
- Electromagnetic damping in emergency

**Fully duplex configuration lead to overweight actuators – need to find alternative solution**
Simplex Jam Tolerant Actuator for E/R

**Mains characteristics:**
- Simplex mechanical transmission
- Jam tolerant in extension
- Hydraulic passive damping / Wet actuator
- LG architecture optimized to permit unlock and retract from single EMA

**Achievements:**
- Low weight EMA Prototype available
- Component level tests:
  - Rollerscrew/axial bearing over temperature
  - Electric motor
- Actuator level test:
  - Normal and Emergency mode
- System level tests on real LG expected end-2013
03.3

Recent advances on EMA technology for Steering System
FIRST TRIAL – FULLY REDUDANT STEERING EMA

WHEEL GEAR
CLUTCH
REDUCER
ANGULAR SENSOR
MOTORS
WORM SCREW
HOUSING
SECOND TRIAL - PROMISING CONCEPT TESTS FROM COMPONENT TO REAL LANDING GEAR

- Tests successfully completed:
  - Components tested separately:
    - Motor (dedicate loading rig)
    - Harmonic Drive (over Temperature)
    - Torque limiter (Static / Dynamic tests)
  - Actuator tested on real landing gear:
    - Full load / speed spectrum
    - Full actuator characterisation and good model correlation
    - Cold Temperature test campaign

- Next step is to address weight optimisation and realistic test for shimmy and flat tire landing
The future of Electrical Landing Gears
THE FUTURE OF ELECTRICAL LANDING GEARS

1. Completion of robustness demonstration of EHA technology & Entry Into Service for LG Systems in normal mode

2. Cumulate experience in service for Electrical Braking System & Optimize next generation architecture

3. Qualify/Certify the new Electrical Green Taxiing function for Short Range aircraft application

4. Mature Simplex Extension / Retraction EMA to compete with EHA weight for all electric aircraft application

5. Demonstrate weight effective steering EMA solution compliant with Shimmy and Flat tire landing requirements