Qualification of Phosphoric Acid Anodizing Structural bonding application on Aluminium

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1 – Context : CAA Unsealed replacement

- **CAA Unsealed** concerned by European environmental regulation REACh as contains Hexavalent chromium (Cr6+).

- At Airbus Helicopters, CAA unsealed is used on Aluminium Alloys for structural Bonding applications.

- Substitute : **Phosphoric Sulfuric Anodising (PSA)**, an electrolycal treatment, without Cr6+.

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**Airframe applications**

**Etching Step**

**CAA unsealed**

**PSA**

**Blade applications**

**Degreasing Step**

**REACH**

**non compliant**

**Cr6+ free bath**
2 – Technical requirements and qualification approach

**Tests Performed**
- **Morphology** Thickness, pore size, visual aspect
- **Bonding performances** Shear tests, Peel test, Fatigue
- **Corrosion resistance** Salt Spray test, Bondline corrosion
- **Paint adhesion** acc. to ISO 2409

**Substrates**
- 2024 T3 bare, 2024 T3 clad, 2618 T6, 5086 H111, 6061 T6, 7075 T6 clad, 7175 T735

**Bonding Systems**
- 4 bonding systems tested that are representatives of Airbus Helicopters configurations

**Introduction of ROBUSTNESS Tests**

**Serial (2016)**

**Technological Demonstrators (2015)**

**Coupons on Industrial Scale (2015)**

**Coupons on Laboratory Scale (2013-2014)**

**Screening (2011-2012)**
3- Tests on coupons at Laboratory scale

**Goal**
To perform different tests at lab scale in order to find the good nominal range with parameters that satisfy the AH technical requirements on different aluminum alloys.

**Visual aspect and morphology**

- PSA oxyde layer is porous and has thickness lower than thickness of CAA unsealed layer.
- Thickness depends on Aluminium Alloys treated.
- PSA oxyde layer is visible to the naked eye.
3- Tests on coupons at Laboratory scale

**Goal**
To perform different tests at lab scale in order to find the good nominal range with parameters that satisfy the AH technical requirements on different aluminum alloys

**Bonding performances on PSA**

Shear tests on Alu 2024 T3 / Alu 2024 T3 treated with CAA unsealed or PSA and bonded with 5 different bonding systems (EN2243-1)

**Conclusion**: PSA at least equivalent to CAA unsealed
4- Tests on coupons at Industrial scale

**Goal**
To perform different tests at industrial scale to verify reproducibility and compliance of results within the qualified parameters.

**Bonding performances on PSA**

Realization of Dry/Wet Peeling test: test conditions following EN 2243-2. However, for the last 50% of the bondline length, injection of a wet agent on the disbonding location of the test coupon. This test reveals increase of sensitivity of the surface treatment.
4- Tests on coupons at Industrial scale

**Goal**
To perform different tests at industrial scale to verify reproducibility and compliance of results within the qualified parameters.

**Bonding performances on PSA**

![Graph showing bonding performances on PSA]

**Conclusions**: Results are compliant and reproducible at industrial scale
5- Tests on coupons at Industrial scale – Robustness tests

**Goal**
To perform different tests at industrial scale **out of the qualified limits** in order to verify influence of these parameters on bonding performances.

- **To identify Key-Characteristics of the process**
  Influences chosen from lessons learnt of Airbus Operations qualification and recurrent non-conformity on CAA unsealed

- **Exemple of Peeling tests results on the influence of open-time**
  Open-time: time between end of last rinsing after PSA and bonding primer application (first layer).

Influence of Open time: end of Surface treatment and primer application - Dry/Wet peeling

Influence of Open time: end of Surface treatment and primer application - Dry peeling

**Water based bonding primer**

**Solvent based bonding primer**

Mean force (N/25mm)

- 2h
- 4h
- 8h

Dry | Wet
6- Tests on technological demonstrators

Goal
To perform treatment of parts in serial conditions, with realization of tests.

- **Morphology**
  Thickness, pore size, PSA layer Homogeneity
- **Bonding performances**
  Peel tests on follow-up coupons
- **Paint adhesion**
  acc. to ISO 2409
- **Robustness**
  Influence of non compliant installation of part on production line
- **Successful test on part**

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Conclusions

• Equivalence of PSA to CAA unsealed demonstrated for bonding applications

• New step through qualification process: Robustness qualification
  ✓ Realization of mechanical tests out-of-the qualified limits at industrial scale
  ✓ Key characteristics of PSA process identified
  ✓ Involvement of Production workshops during this step

• Thanks to Robustness qualification, production workshop has a first experience of the process before serial treatments:
  ✓ Very positive returns from the two internal production workshops of Airbus Helicopters following serial introduction of PSA.
  ✓ Following step is to implement PSA the supply chain.
Thank you for your attention

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