AVT-373 Research Specialist Meeting on "Emerging Technologies for Proactive Corrosion Maintenance"

Replacement of chromated protections on aluminum structural parts at Dassault-Aviation

Joy ROMAN, Dassault Aviation, France

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DASSAULT AVIATION

Summary

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2. Introduction
3. Chromated protection substitutions on aluminum structural parts
4. Process for qualification
5. Focus on specific applications
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6. Maintenance impacts
7. Conclusion

1. Dassault Aviation presentation

- +12400 employees, more than 9000 based in France
- 75% of our aircraft produced over the past 50 years have been exported
- Over 8000 aircraft delivered worldwide since 1945
- Customers in more than 80 countries
- 90% of revenues export-related
- 27% of revenues generated by the Falcon range

1. Dassault Aviation presentation

Dual technologies in the service of customer needs


Falcon 2000S


Falcon 10X


Falcon 6X


Falcon 2000LXS


Falcon 7X


Falcon 900LX


Falcon 8X


Falcon Archange

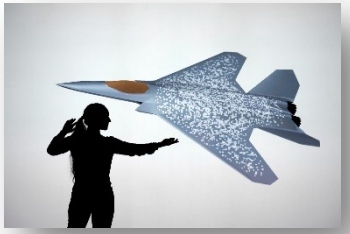

Falcon 2000 MRA/MSA


Falcon Albatros


Rafale


nEUROn

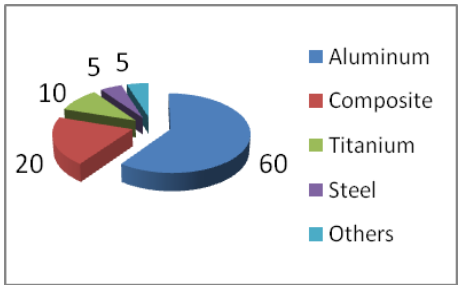

MALE Eurodrone


New Generation Fighter (NGF)

A common design office

→ **Same protection but maintenance quite different**

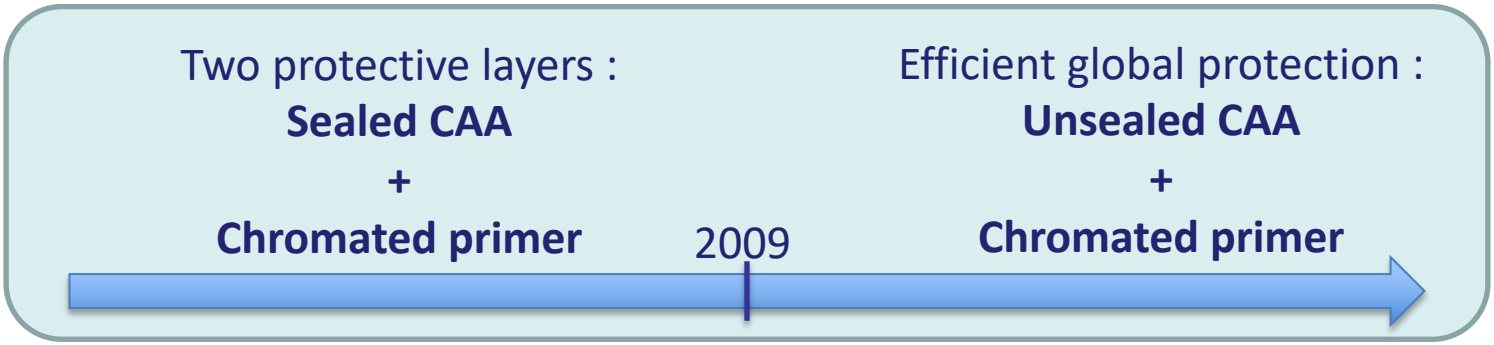
2. Introduction



Treatments on aluminum Rafale parts :

→ 90% in unsealed Chromic Acid Anodize (CAA) + Chromated Primer

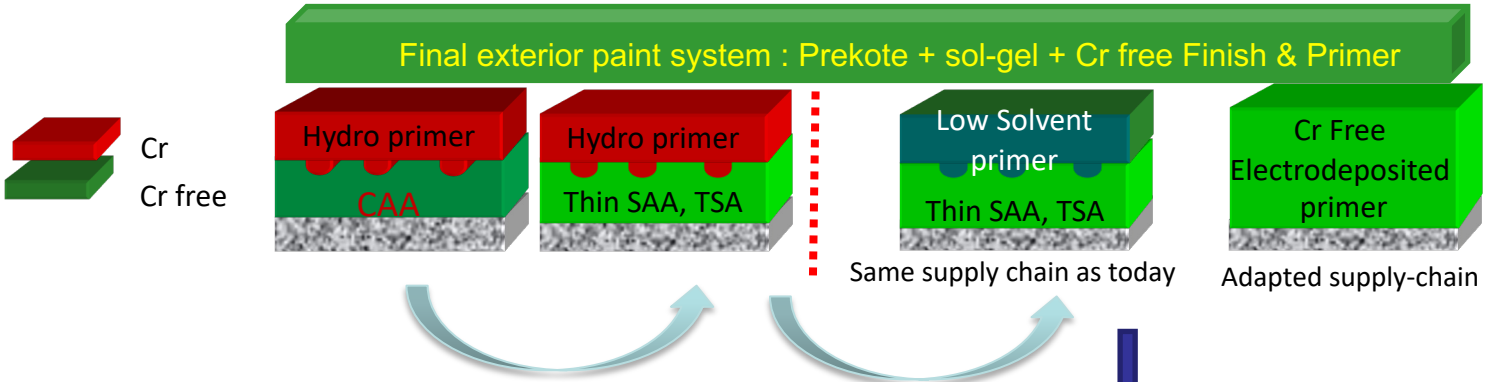
→ Other treatment (like sealed CAA) for parts with specific design or function



Objective : replacement of chromated protections on aluminum structural parts to respect REACh regulation

3. Chromated protection substitutions on aluminum structural parts

Substitution in several steps :



2 types of substitute will coexist :
- **Spraying processes**
- **Anodic Electrocoat = Ecoat = Anaphoresis**

Primer for structural parts - Main challenge :

- Replace several functionalities : corrosion inhibition, fluid compatibilities, biocide …
- Elementary tests not representative enough, testing according to specification doesn't give confidence on performances in service
- Must be compatible with worldwide supply chain → fully opened to cooperation

4. Risk reduction process for qualification

- R&D to support all changes (need to understand)
- Adapted specification based on in-service corrosion environment monitoring
- Accelerated Lab tests (to be improved)
- Natural exposure on representative assemblies
- Field experiments on aircraft

→ All qualifications based on no regression

Other points to take into account for chromate free substitutions :

- Supply chain compatibility → Key = collaborative approach
  - IAEG (International Aeronautic Environmental Group)
  - Airbus, Boeing, Embraer, Bombardier, Gulfstream, tiers 1, supply chain… → common specifications
  - USA/France MoD corrosion exchange (AFRL, NAVAIR)
  - NATO seminar, SURFAIR …
  - Airbus, GIFAS (French aerospace industries)
  - European Defense Agency collaborative research
- REACh regulation (Authorizations)

4. Process for qualification

➢ Accelerated lab testing

- **Elementary tests :**

	CF primer	Ecoat	Chromated primer
Wet Adhesion	Pass	Pass	Pass
Fluid resistance	Pass	Pass	Pass
Galvanic Corrosion	Pass	Pass	Pass
Filiform Corrosion	+++	+++	+
Salt Spray	Corrosion in scratches – No propagation	Corrosion in scratches – No propagation	Scratches remain bright
Cycling (humid/wet)	Pass	Pass	Pass
Fatigue	Pass	+	Pass

Salt Spray tests suggest a regression for chrome free solutions but in real environment passivation is fast enough to reprotect defects.
We choose to give priority : adhesion and impermeability vs inhibition/leaching

- **Work done on more efficient tests : Combined ageing, ACET, Fuel tank … but not totally mature**

→ **All accelerated lab tests give us confidence in unsealed Thin SAA/TSA + Chrome Free primer systems and Ecoat, but they are not sufficient**

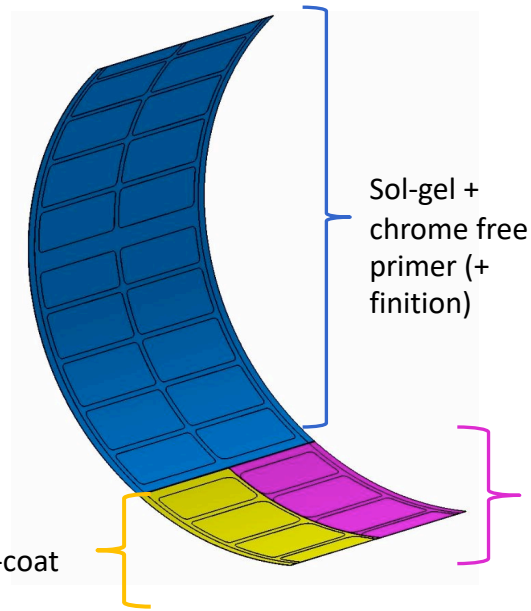
4. Process for qualification

➢ Natural exposure on representative assemblies

Sea exposure of representative panels : 3 years exposition at ICB (Institut de la corrosion Brest)

New chrome free protections

Chromated protections (reference)



Fasteners lines protected with chrome free primer on demonstrator

4. Process for qualification

➢ Field tests

ATL2 : experiments on 10 aircraft. External areas parts.

Evaluated systems :

- for production: unsealed thin SAA + PPG CA 7049 or CA7521 + external top coat
- for maintenance: Pickling + Sol gel + PPG CA 7049 or CA7521 + external top coat

→ After 5 years : no corrosion, no erosion

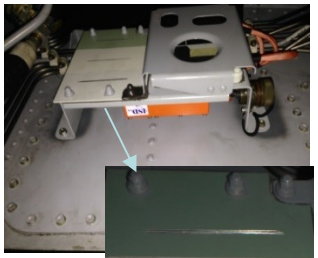
Rafale : experiments on 5 aircraft.

Access doors parts.

Evaluated systems :

- for production: unsealed thin SAA + PPG CA7521 or Ecoat + external top coat
- for maintenance: Pickling + Sol gel + PPG CA7521 + external top coat

→ After 5 years : no corrosion, no erosion



After 3 years : no corrosion salts in scribes on chromated and all unchromated primers

4. Process for qualification

For painted parts general case : unsealed CAA + chromated primer on 2000, 7000, 5000 and AS7G06 aluminum alloys could be replaced by :

- **Unsealed Thin SAA or TSA + chrome free primer 7521**
- **Ecoat**

→ Industrial implementation in progress except for very limited areas
(example : lower fuel tank area, In field experiments still in progress)

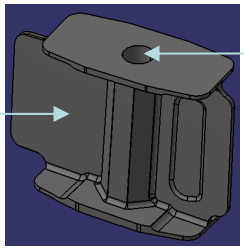
But a direct one for one, non Chromated for Chromated material substitution is not always possible !

5. Focus on specific applications

➢ Parts with singularities

Parts specificity : Critical structural parts (2000 or 7000 Aluminum alloys) treated in semi-sealed CAA + chromated primer with unpainted and exposed areas (closed tolerances bores)

On external surface :
Semi-sealed CAA + paint



In bore : Semi sealed CAA unpainted for functional purpose

Objective: Find protection system that combine no regression performance for adhesion paint and corrosion resistance

Possibilities of substitution :

- **Unsealed Thin SAA or TSA (+ paint on external surface)**
- **Unsealed Thin SAA or TSA + temporary protection in bores (+ paint on external surface)**
- **Unsealed Thin SAA or TSA + CrIII primer or Ecoat (included in bores)**

- Nota : sealed Thin SAA or TSA not considered mainly because of paint adhesion

5. Focus on specific applications

➢ Parts with singularities

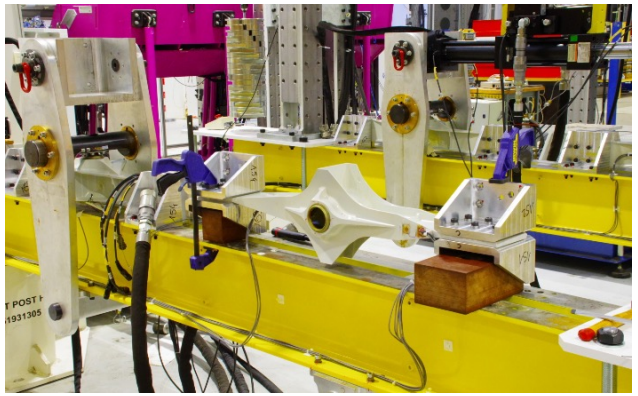
Qualification tests :

Specifics tests on parts, aiming to replicate actual in-sercice protection damage, were developed to evaluate and qualify effectiveness of chrome-free alternatives

Techno trials :

Dynamic friction and corrosion

Scale 1 trials:



Dynamic friction

5. Focus on specific applications

➢ **Parts with singularities**

Results : not a single solution meets all requirements

Two solutions have been qualified:

- **If no dynamic friction between parts : Ecoat on the complete part**
  → thickness has to be taken into account in design
- **If friction between parts : Unsealed Thin SAA + CrIII post-treatment (touch up) + temporary protection**

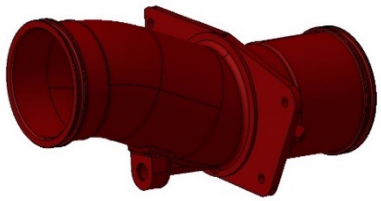
→ Industrial implementation in progress

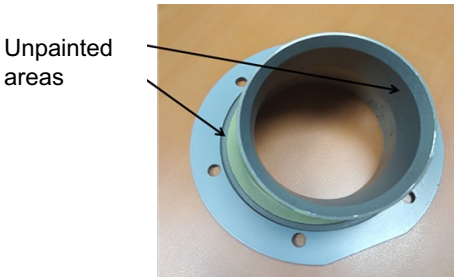
5. Focus on specific applications

➢ Circuit parts

Parts specificity :

Circuit parts in 2000 or 7000 Aluminum alloys treated in sealed CAA + chromated primer with unpainted and exposed areas like seal grooves





Objective: **Find protection compatible with functional areas**

Possibilities of substitution for local currently unpainted areas :

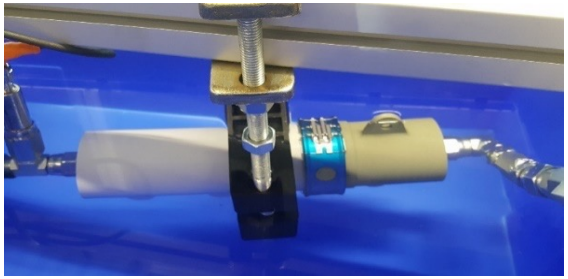
- **Unsealed anodize → not enough corrosion protection**
- **Spray paint → not compatible with tolerances**
- **Sealed SAA → less corrosion inhibition effectiveness compared to sealed CAA + primer adhesion concern**
- **Ecoat → better solution, compatible with tolerances (thickness reliability)**

5. Focus on specific applications

➢ Circuit parts

We choose to treat all areas included specific functional areas like seal grooves

Qualification tests : To validate new design with painted seal grooves we develop and realize airtightness tests



Results :

- **Samples in Ecoat, included in seal grooves, passed all tests → qualification OK**
- **Ecoat also provided industrial production improvement**

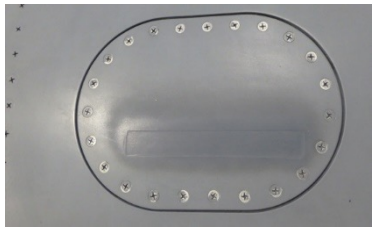
→ Industrial implementation in progress

6. Maintenance Impacts

Objective: not increase the maintenance cost with new chromate-free paint system

→ Dassault validated through risk reduction process only one repair paint system compatible with old and new protections: sol-gel + CA7521

Complete part with repair solution on in-service ATL2

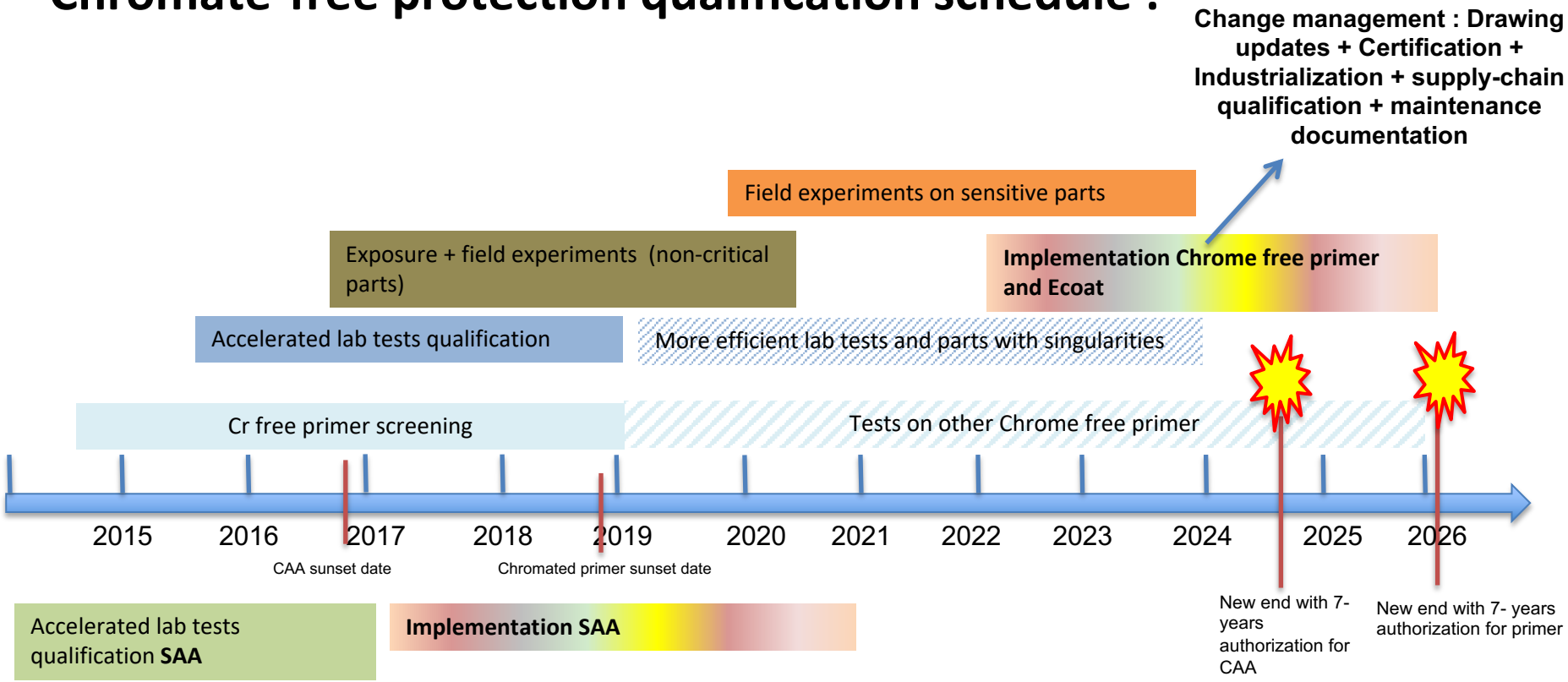


Local repair on in-service Rafale

This solution gives good technical performances but process conditions could be improved : polymerization time not always compatible with maintenance deadlines

7. Conclusion

Chromate-free protection qualification schedule :



7. Conclusion

- **Thanks to no regression regarding corrosion resistance observed during risk reduction process and particularly in field experiments, we are confident in our current choices of chromate-free systems.**

- **Dassault Aviation will be on time for chromated paint substitution before January 2026, but we are looking for a second chrome-free spray primer to secure supply chain.**

Thank you for your attention

Joy.Roman@dassault-aviation.com