



# Towards chrome free protection systems on aircraft

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HIGHER TOGETHER™



# Overview



- Introduction
- Substitution of Cr<sup>VI</sup> for painted aluminium parts
- Feedback on substitution
- Conclusion

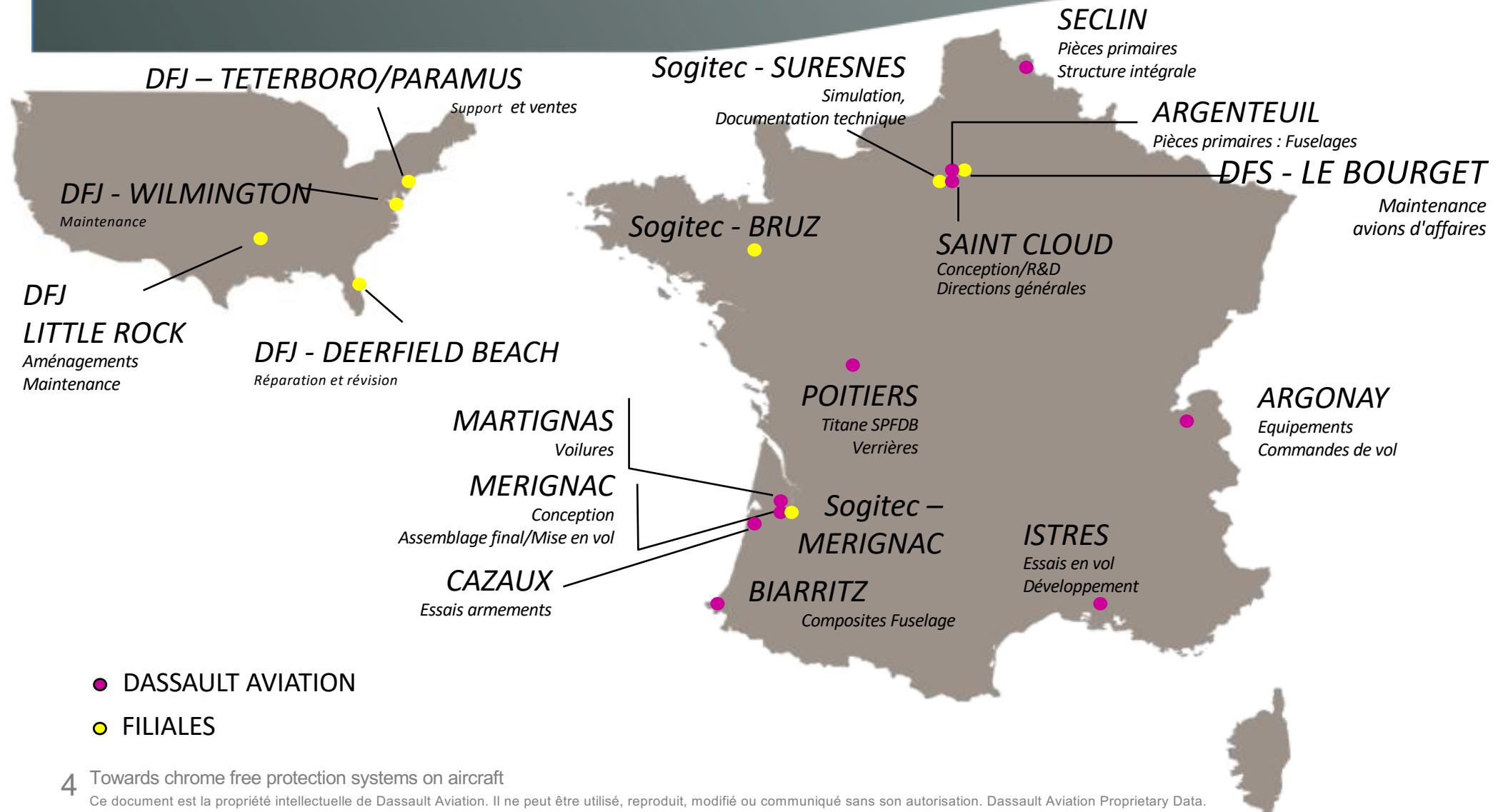
# Presentation



- ❖ Dassault family owned company
- ❖ More than **8000 employees**
- ❖ Annual revenue in 2018 : 5,2 billion euros (78% export)
- ❖ More than 100 prototypes
- ❖ Over 7000 aircraft produced
- ❖ Customers in more than 80 countries



# Implementations



# Aircraft



## Civil business jets



FALCON 900LX



FALCON 7X (5950 nm)



FALCON 8X (6450 nm)



FALCON 2000S / 2000LXS



FALCON 6X (5500 nm)

## Military aircraft



RAFALE



Coast guard



SCAF



nEURON

# Spatial Activities

Since 1962, Dassault Aviation apply his technical competences in different fields of Aerospace :

- Aerospace vehicles
- Pyrotechnics
- Telemetry

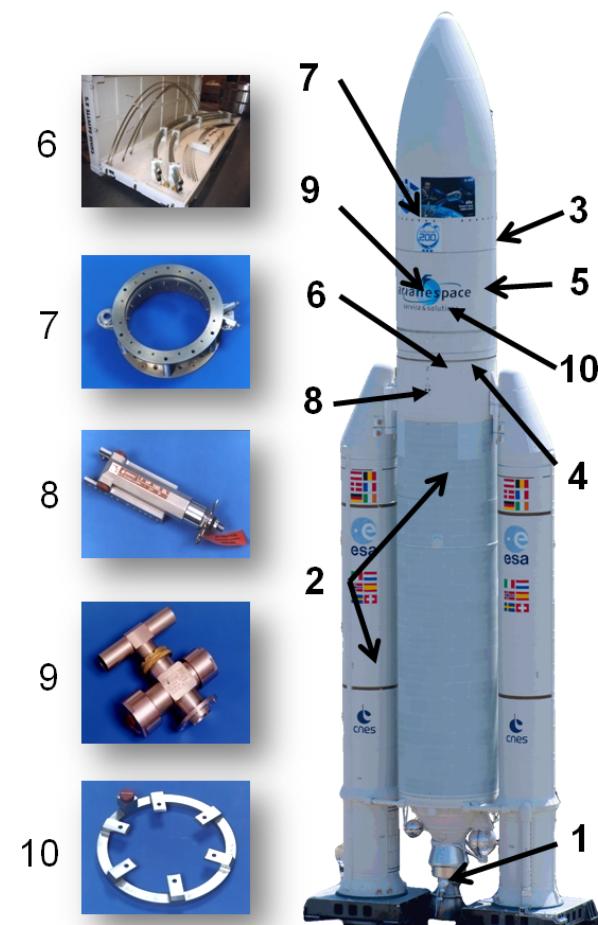
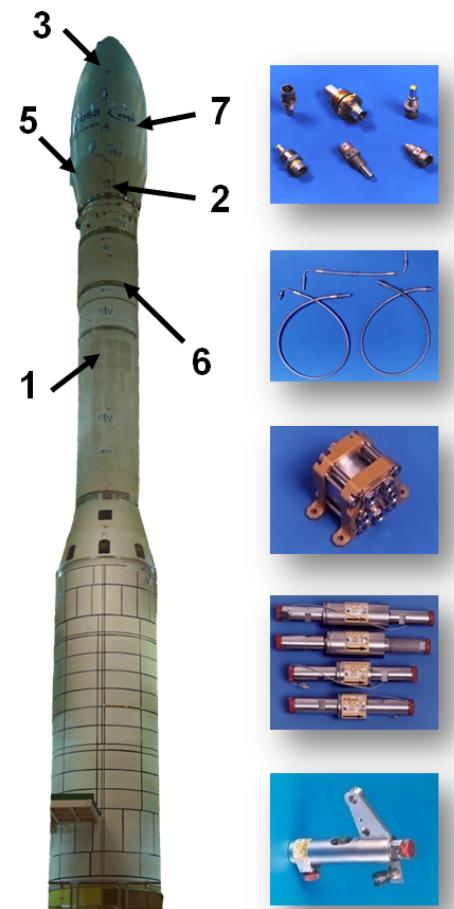
## 1962 – 2012 : 50 ans d'Espace



# Space Activities : Pyrotechnie for European launchers



## Vega and Ariane 5



7 Towards chrome free protection systems on aircraft

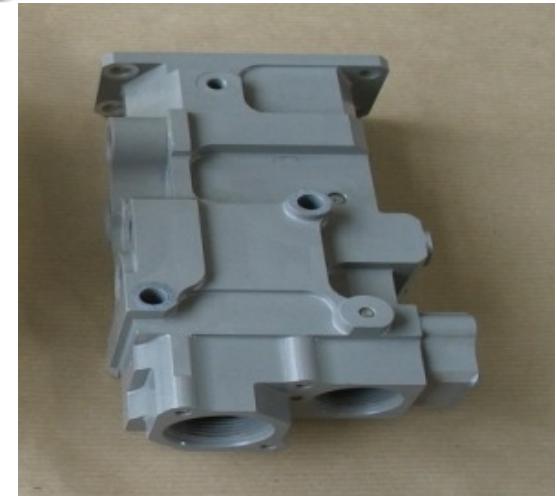
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# Substitution of Cr<sup>VI</sup>: Process and products impacted



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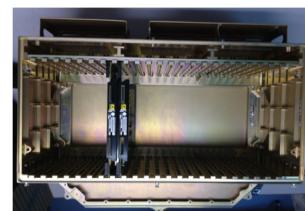
Unsealed CAA + chromated Primer



Sealed CAA



Hard chrome plating



Chromic conversion



Stainless steel  
Passivation

# Substitution of Cr<sup>VI</sup> : Focus on painted structural part protection



**Unsealed CAA + chromated Primer**

Reach Reglementation :

2014

2015

2016

2017

21 sept 2017

22 jan 2019

2018

2019

**CAA**

**Chromated primer**

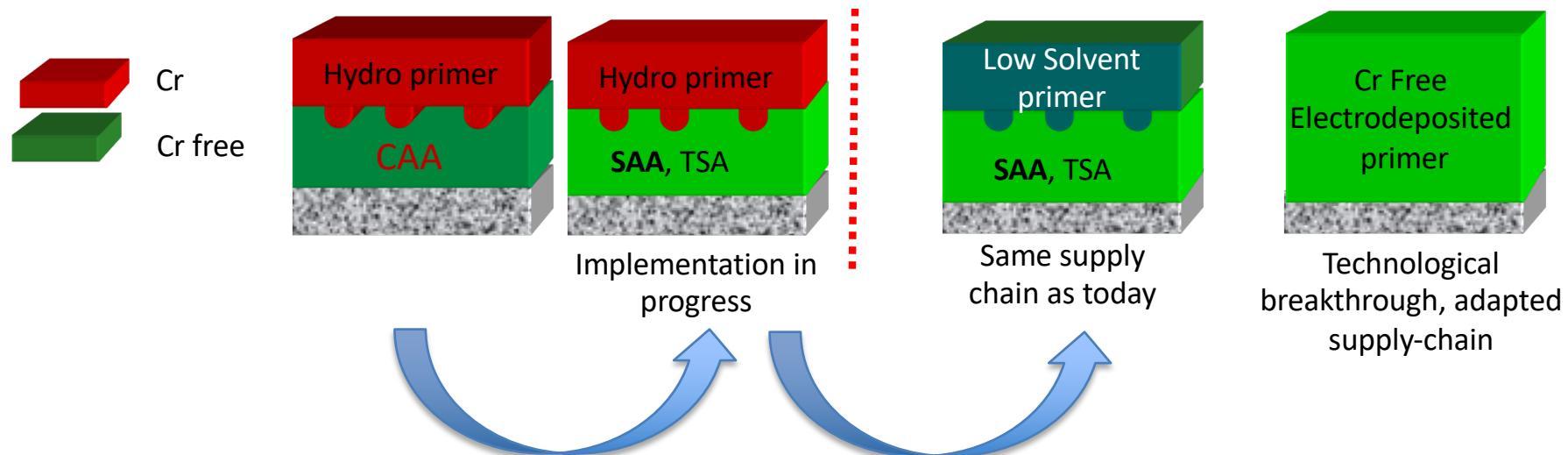
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# Substitution choices for painted Aluminium parts



Substitution in several steps :

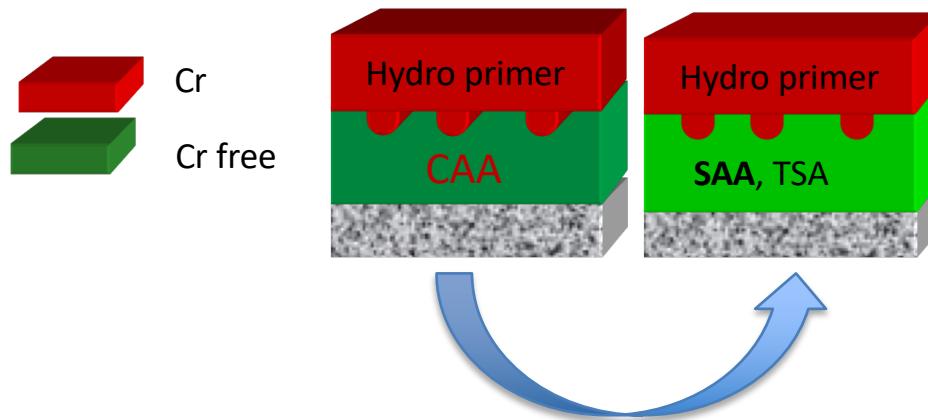


# Timing challenge – De-risking process



- R&D to support all changes (need to understand)
- Accelerated Lab testing (to be improved)
- Natural exposure on representative assemblies
- Field experiments
  - + Real in-service corrosive environment monitoring
- 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
- Authorizations (REACH)

# Unsealed CAA Substitution



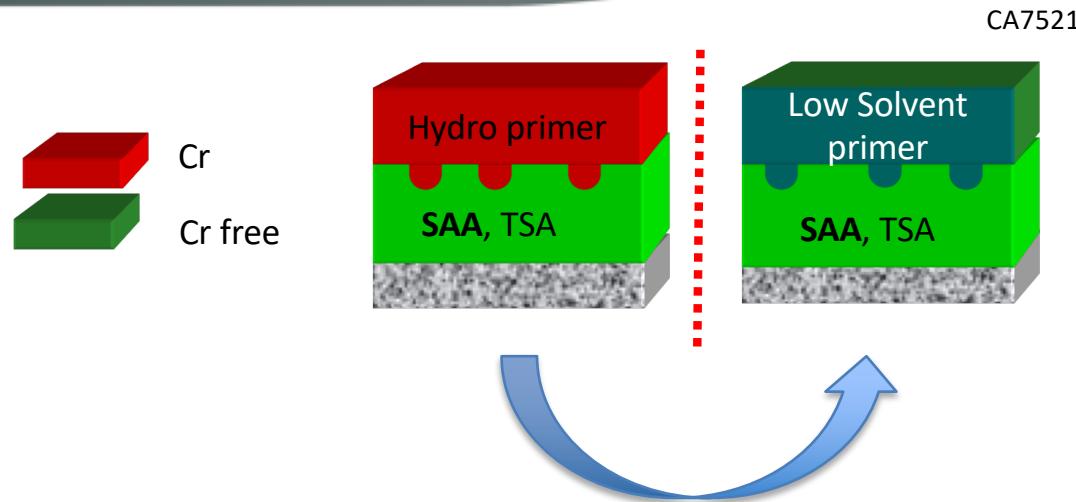
Only Accelerated lab tests necessary for this step because :

- CAA and SAA is based on the same technology (anodization)
- Aim of anodizing layer is to allowed good adhesion of primer
- Not complete transition to chrome free solutions (still chromated primer)

Examples of accelerated lab tests : adhesion, salt spray corrosion test, strain test...

→ Satisfactory results compared to CAA

# Chromated primer substitution



Primer for structural parts - Main challenge :

- Replace several functionalities : corrosion inhibition + 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 cooperations**

Three steps of de-risking process necessary to be more confident in new chrome free protection system



# Conventional elementary tests

## Limitations of lab tests

	CF primer	Chromated primer
Wet Adhesion	Pass	Pass
Fluid resistance	Pass	Pass
Galvanic Corrosion	+++	+ (leachable inhibitors increase conductivity of electrolyte)
Filiform Corrosion	+++	+ (id)
Salt Spray	Corrosion in scratches – No propagation	Scratches remain bright
Cycling (humid/wet)	+++	+ (leachable inhibitors increase conductivity of electrolyte)
Combined	Pass	Pass



Elementary tests required in Tech Spec are based on Chromated mechanisms.

→ No real Chrome Free candidate capable to be mimetic to Chromates

Salt Spray tests suggest a regression for chrome free primer but field tests show that in real environment passivation is fast enough to reprotect defects.



Field test experimentation

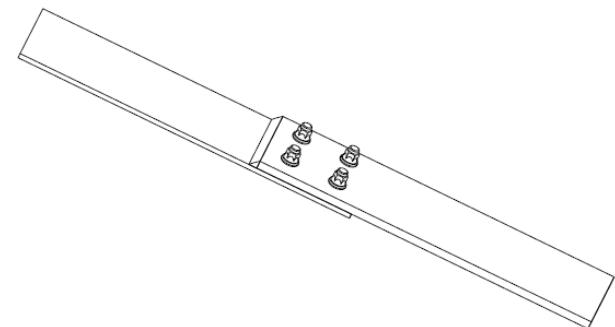
## Improved lab test



In-house combined ageing test for structure primer :

### Ageing cycle :

- Strain : Tension P/0.1P 100 000 cycles (N initiation in Al plate/2 )
- Environment - 20 times
  - 1 day NSS
  - 4 days [80% / 40°C]
  - 2 days cold -18°C ( 4°C/min )



### Other improved tests :

For example, Accelerated Cycling Electrochemical Test (ISO 17463) to compare system performances (representative corrosion pits contrary to salt spray)

# Natural exposure on representative assemblies

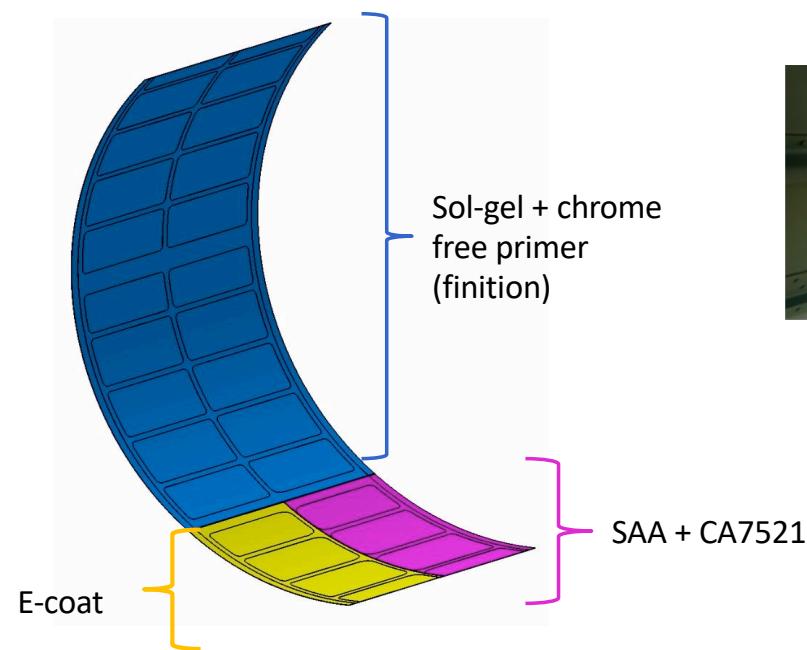
Sea exposure of representative panels

→ 3 years exposition at ICB (Institut de la corrosion Brest)



New chrome  
free  
protections

Chromated  
protections  
(reference)



Fasteners lines protected with  
CA7521 on demonstrator



# Field tests



System	Parts	CF alternatives tested	Statement
ATL2 10 A/C		Unsealed SAA + PPG CA7049, CA7521 CF primer Repair : Sol-gel B0202 + PPG CA7049, CA7521 CF primer or PPG CA7530 CF « wash-primer »	Still in progress, no corrosion after 5 years
Rafale 5 A/C	Access doors	Unsealed SAA + PPG CA7521 or Mapaero EPD3 CF primer Anaphoretic PPG Ecoating Repair : Sol-gel B0202 + CA7521 CF primer or PPG CA7530 CF « wash-primer »	In progress, no corrosion after 2,5 years
Falcon	Corrosion sensitive parts	Unsealed SAA + PPG CA7521	Implementation on aircraft in process (start march 2019)

# Field tests ATL 2



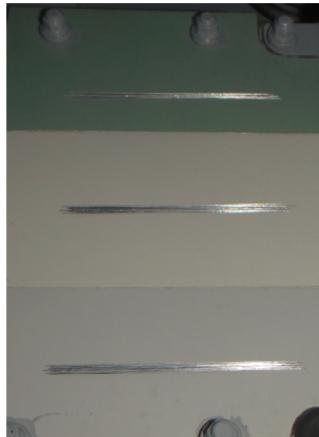
- 10A/C - Selection of exposed parts
- 2 Chromate free systems :
  - for production: concentrated SAA thin film + PPG CF primer CA 7049 , CA7521 + external top coat
  - for maintenance: on parts : Pickling +Sol gel + PPG CF primer CA 7049 , CA7521 + external top coat / for local touch-up : PPG CF “wash-primer” CA7530 + external top coat
- **5 years** → no corrosion, no erosion



# Field tests Rafale



- Parts : Chromate free systems including repair + external top coat on aerodynamic surfaces
- Monitoring to have a link between corrosion & environment parameters (**T°, RH, Pressure, water**)
- Samples with scribes to evaluate need of leaching
- **2,5 years** including few months on carriers → No corrosion initiation



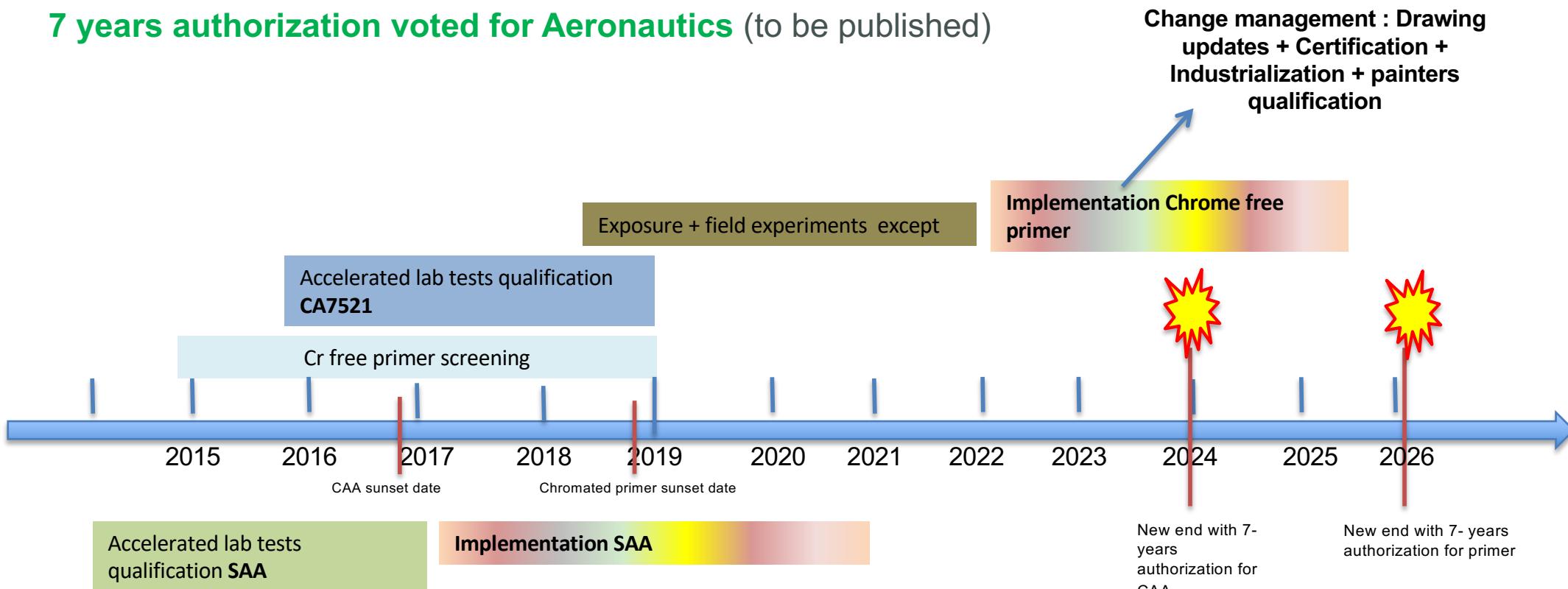
2,5 years in field exposure (landing bay)  
→ no corrosion salts in scribes on chromated and all unchromated primers → Passivation occurs !

# Timing challenge - CAA + Chromated primer substitution



Authorization Dossier CTAC and CCST :

**7 years authorization voted for Aeronautics** (to be published)



→ No need for new authorization request

Dassault Aviation is still working on other solutions :

- Recent qualification of unsealed TSA in equivalence of unsealed SAA
- Lab testing on other chrome free primers proposed by different coating companies
- Discussions/result exchanges with others OEM (Gifas, IAEG, etc)  
→ mutualized solutions
- Evaluation of different technology like E-coat (Accelerating lab tests and Field tests in progress)

# Feedback on substitution



Important not to minimize implementation time after qualification :

- ❖ Listing of particular parts
  - SAA + Chrome free primer solution cover 90% of painted aluminium parts
- ❖ Supply chain qualification
  - Difficulties when aerospace contractors choose different solutions
- ❖ Updating of definition
  - Longer if needed updated of drawing
- ❖ Updating of manufacturing documentation (manufacturing drawing, purchase order...)

# Conclusion



- One of the major risks for an airframer (decrease of corrosion durability)
- Need to understand mechanisms (R&D)
- Substitution of CrVI :
  - ❖ De-risking process :A horizontal flowchart showing three stages: a green arrow pointing right labeled "Accelerated lab tests", a red arrow pointing right labeled "Natural exposure", and a blue arrow pointing right labeled "Field tests".
  - ❖ Time for implementation must not be minimized
  - ❖ Collaborations mandatory to be compatible of the supply chain
- For chromated primer, Dassault Aviation should not go for further REACH authorization

Thank you for your  
attention

