Meeting the Challenge of Environmental Regulations in Europe and North America

ASETS Conference
New Orleans, La, USA
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8 February 2011
Meeting the Challenge of Environmental Regulations in Europe and North America
• THE SAFRAN GROUP
• AERONAUTIC DRIVERS
• CADMIUM REPLACEMENT
• CHROMIUM VI REPLACEMENT
• MAGNESIUM PROTECTIONS
• ReaCH
Revenues: 10,329 million euros

Operating income: 798 million euros

Net income – Group share: 256 million euros
Safran worldwide

Canada

United States

Mexico

Colombia

Brazil

Uruguay

Europe

Morocco

South Africa

United Arab Emirates

Japan

China

India

Malaysia

Singapore

Australia

Design office

Industrial site

HQ

Office

Services

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AEROSPACE ENGINES (2)

- **HM7B™**
  - Thrust: 22,000 lb

- **Vulcain®2**
  - Thrust: 297,000 lb

- **Vinci®**
  - (Under development)

- **Ariane 5**

- **HTE**
- Fan blades, booster and Fadec on GEnx engine
- Landing gear
- Wheels and carbon brakes
- Electric brake actuation controller (EBAC)
- Wiring
- Integrated landing and braking system
- Main landing gear
- Wheels and carbon brakes
- Fuselage and engine pylon wiring
- Components for onboard information system and flight control system
Launch vehicle

ARIANE

- Vulcain main stage engine
- HM7B upper stage engine
- Solid booster motors, via Europropulsion
Research & environment

INNOVATION: AT THE HEART OF THE GROUP’S PRODUCTS

Technologies - architectures - processes

- Electrically-actuated A380 thrust reverser
- Electrically-actuated carbon brake
- A380 ventilation
- Hemispherical resonating gyro
- Thermal imager
- 3D RTM fan blade
- Félin integrated equipment suite
- Mica missile seeker
- CMC nozzle and combustor
- 3D composite strut for B787 landing gear
- Complex simulations
- Biometric recognition

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R&D investment: **1.2 billion euros in 2008**, equal to 12% of revenues, with about 60% self-financed by the Group

**R&D calls on about 20% of the Group’s workforce:** 450 doctoral scientists and over 100 doctoral candidates work at Safran

**> 400 patents filed per year**, on average: **1th** highest in Aerospace in France (source: INPI 2009)
DRIVERS (1) FLEET GROWTH

**Needs 2006-2026**

- **twin aisle:** 7,170 units
- **Single aisle:** 14,430 units
- **Regional jet:** 6,530 units
- **Regional turbo:** 1,520 units

**AIRCRAFTS**

- 30-80: 1,666
- 91-112: 2,753
- 113-135: 966
- 136-162: 3,353
- 163-182: 5,444
- 183-212: 3,436
- 213-275: 1,463
- 276-325: 2,216
- 326-375: 1,329
- >380: 854
- 381-500: 1,307

**20-year demand for 24,951 aircraft**

- **16,977** single aisles
- **6,245** twin aisles
- **1,729** very large aircraft

*Market value of $3.1 trillion*
DRIVERS (2) CUSTOMER PROJECTS

- Airbus
- Boeing
- Dassault Aviation
- Bombardier Aerospace
- General Electric
- Eurocopter
- Comac
- Embraer
- Rolls-Royce
- Sukhoi
- Mitsubishi
- Safran Aerospace • Defence • Security
REACH

REGISTRATION , EVALUATION and AUTORISATION of CHEMICALS

RoHS

RESTRICTION OF USE on HAZARDOUS SUBSTANCES (electronic and electrical equipments)
OUTLINE

• THE SAFRAN GROUP

• AERONAUTIC DRIVERS

• CADMIUM REPLACEMENT

• CHROMIUM VI REPLACEMENT

• MAGNESIUM PROTECTIONS

• ReaCH
CADMIUM REPLACEMENT Requirements

<table>
<thead>
<tr>
<th>E(V)/ENH</th>
<th>Alloy</th>
<th>Solution Potential (V)</th>
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</thead>
<tbody>
<tr>
<td>Pt/Pt²⁺</td>
<td>+ 1,20</td>
<td></td>
</tr>
<tr>
<td>Cu/Cu²⁺</td>
<td>+ 0,34</td>
<td></td>
</tr>
<tr>
<td>H₂/H⁺</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ni/Ni²⁺</td>
<td>- 0,25</td>
<td></td>
</tr>
<tr>
<td>Fe/Fe²⁺</td>
<td>- 0,44</td>
<td></td>
</tr>
<tr>
<td>Zn/Zn²⁺</td>
<td>- 0,76</td>
<td></td>
</tr>
<tr>
<td>Al/Al³⁺</td>
<td>- 1,67</td>
<td></td>
</tr>
</tbody>
</table>

1. Zn
2. Zn-Co
3. AA 5083
4. Cd
5. Zn-Ni
6. Mild Steel
7. Sn
8. Ni

Galvanic properties

Hydrogen embrittlement

Thicknesses

Corrosion resistance

Coating engineering

Torque

Fricition

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CADMIUM REPLACEMENT (1) A wide range of parts

Of some mm to few meters length
CADMIUM REPLACEMENT (1) Zinc Nickel

- **Atotech**: Reflectalloy ZNA (listed on BAC 5680) + Cr³⁺ passivation
- **Mecaprotec**: «home-made» process (12-15%) + Cr³⁺ passivation
- **Coventya**: Performa 280.5 + Cr³⁺ passivation
- **SurTec**: SurTec 716 and 717 + Cr³⁺ passivation
- **McDermid**: Enviralloy Ni 12-15% + Cr³⁺ passivation
- **Enthone OMI**: Zincrolyte KCL-Ni III + Cr³⁺ passivation
- **Glomax**: Glovel 800 + Cr³⁺ or Cr-free (Zec-Coat 888) passivation

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CADMIUM REPLACEMENT(2) – Al coatings

Ion Vapour Deposition (TRL 9)

Electrolytic Al coating
CADMIUM REPLACEMENT(3) - MCAC

(TRL 9)
CADMIUM REPLACEMENT (4) – Lamellar zinc

(TRL 9)
CADMIUM REPLACEMENT(5) - New technologies

- Electrolyte: [EMIm]Cl/AlCl₃
- Electrolyte preparation in a glove box
- Electrolysis under argon

Zn/Sn alloy (20%Zn)
Electrolyte: CHCl + EG + Zn and Sn chlorides + EDTA

Al electrolysis with film (room atmosphere)

Bright Al coating on steel

- Sol Gel

- Ionic liquid processes Zn/Sn or AL
CHROMIC ACID ANODIZING REPLACEMENT (1)

• SULFOCHROMIC ETCHING REPLACEMENT (TRL 9)
  • Sulfo fluoro nitro ferric
  • Phospho sulfonic
  • Alkaline

• DICROMATE SEALING (TRL 1 - 4)
  • Molybdates salts
  • Electrolytic
  • Trivalent chromium
  • Rare earth salts
  • Sol Gel

Socomor Finishing Technologies
Henkel Technologies
Chemetall
Coventa
CHROMIC ACID ANODIZING REPLACEMENT (2)

- **SAA (TRL9)**
  Sulfuric acid anodizing  \( H_2SO_4 \text{ 160 to 240g/l} \)
  Low thickness applications

- **DSAA (TRL3)**
  Diluted sulfuric acid anodizing  \( H_2SO_4 > 50 \text{ g/l} \)

- **SBAA (TRL4)**
  Sulfo boric acid anodizing  \( >30 \text{ g/l} \)

- **TSA (TRL4)**
  Sulfo tartaric acid anodizing  \( > 34 \text{ g/l} \)
**TRIVALENT CHROMIUM**

- **SUITABLE ONLY TO 1000, 3000, 5000 and 6000 ALLOYS SERIES**

**+**
- Electrical conductivity, painting adhesion, fatigue

**-**
- Poor Corrosion on rich copper alloying aluminium alloys
- Color less
- Very Sensitive to Surface Preparation

TRL 4
Other followed tracks

- TRIVALENT CHROMIUM + TOP COAT

- TRIVALENT CHROMIUM + INHIBITORS

- OTHER CHEMISTRY BASED

- SOL GEL
NEW TECHNOLOGIES (5)

Plasma Electrolytic Oxydation on Aluminum alloys

Ceratronic (F)

(TRL 9) LIEBHERR AEROSPACE

MESSIER-BUGATTI
Airbus 320

LIEBHERR-AEROSPACE Toulouse 2004
Airbus A380
HARD CHROMIUM REPLACEMENT
HARD CHROMIUM REPLACEMENT (1)

H.V.O.F.

TRIBALLOY 28.17.3 or 28.6.2
CERMETS WCCoCr 86.10.4
CERMETS Cr3C2 / 20NiCr
Nanocobalt phosphorus coating

Electroless Ni + (…)

Trivalent Chromium Process

Ionic liquids

Electrolyte: choline chloride + Cr III chloride + 20% water

Electrolysis:
25°C, 5A.dm⁻² (up)
40°C, 20A.dm⁻² (down)
HARD CHROMIUM REPLACEMENT (3)

Based on Martensitic CRES MLX 17/19 (Aubert&Duval)
Custom 465 (Carpenter)

Non chromate passivated processes

• Ionic implantation
• DLC coating
• Triboslide WS2 coating
Chromic Conversion Coating

Mordançage (F) / DOW 17 (US)
MAGNESIUM SURFACE TREATMENTS (2)

HAE Coating (Harry A. Evangelides patented 1952)

POTASSIUM PERMANGANATE, TRISODIUM PHOSPHATE, POTASSIUM AND ALUMINIUM HYDROXYDE

MAGOXID (G) –

Ceratronic Process (F)
MAGNESIUM SURFACE TREATMENTS (3)

Touch Up Process
MAGNESIUM SURFACE TREATMENTS (4)

- Alodine 160/161
- Anaphoretic coating (E-coating)

- What is and will be low VOC???
- “Lower” VOC products have been in use since early 90’s.
- All new programs require “lower” VOC.

- Water based / Cr6 free paints

- Cold Spray
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REACH: SCHEDULE and MILESTONES

- **Entry into effect of REACH**: June 1st, 2007
- **Pre-registration**: June 1st, 2008
- **Notification of the substances of very high concern in the articles**: Nov. 30th, 2008
- **Registration times**: June 1st, 2009
- **Annex XIV**: June 1st, 2007
- **Restrictions**: June 1st, 2007
- **Authorization**: June 1st, 2011
- **Communication of the substances of very high concern in the articles**: June 1st, 2018
- **Notification of the substances of very high concern in the articles**: June 1st, 2018
REACH Process (Registration, Evaluation, Authorization of Chemicals)

- **Step 1 was closed End of 2008**
  - 150 000 substances
- **Phase 1 by December 2010**
  - About 10 000 substances

1. **PRE-REGISTRATION**
   - Definition of Substances of Very High Concern (SVHC)
   - Authorisation
   - >0,1% weight

2. **3-PHASES REGISTRATION**
   - Technical file + Chemicals Safety Report

3. **EVALUATION**
   - Customers and EU to be notified

4. **AUTHORISATION RESTRICTION**
   - Step 1 was closed End of 2008
   - 150 000 substances
   - Phase 1 by December 2010
   - About 10 000 substances

About 10 000 substances
Step 1 was closed
End of 2008
150 000 substances
Phase 1 by December 2010
About 10 000 substances

Technical file + Chemicals Safety Report
Customers and EU to be notified

Definition of Substances of Very High Concern (SVHC)
Authorisation
>0,1% weight
SAFRAN Identified risks

SAFRAN put a Specific Group Project in place to manage the following Risks:

- **Risk 1 - Very short term obsolescences**
  - Due to the end of each step of the Registration processes

- **Risk 2 - Restriction of use**
  - Due to yearly release of SVHC

- **Risk 3: Chemicals traceability in articles**

- **Risk 4 : Monitoring the evolution of REACH Regulation**
EXAMPLE SAFRAN BUSINESS UNIT: REACH PROJECT

Objective 1
Ensure Registration

- Identification of short-term obsolescences

Objective 2
Manage Authorisations

- Identification of middle-term obsolescences

Objective 3
Substitution

Objective 4
Define Chemicals
Traceability tool for MD articles

- Chemical products:
  - Paint schemes
  - Mastics/Sealing Pdt
  - Alodine/Alochrom
  - …

- R&T Programs:
  - CADFREE
  - Nano-HVOF
  - Aluminium Surf. Treat.
  - …
Collaboration

- European REACH regulation shows us a path, we experience as you and we need to understand and to respect it.

- Safran is interested in pursuing more partnerships ......