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**METALS FOR THE AEROSPACE INDUSTRY 2008**  
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**JAMES F. KING**  
**TRENDS IN THE ALUMINIUM INDUSTRY**  
**IMPLICATIONS FOR METAL SUPPLY**

**JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY**

***“Intelligence is never too dear”***

***Sir Francis Walsingham (1530-1590)***  
***Secretary of State to***  
***Queen Elizabeth I of England***

***“If we knew what it was we were  
doing, it would not be called  
research, would it ?***

***Albert Einstein (1879-1955)***

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- ***Aerospace and Aluminium***
- ***Metal Requirements and China***
- ***Costs of Production***
- ***Structural Issues and Conclusions***

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### Aluminium by End Use (capacity in million tonnes)

| <i>Item</i>         | <i>m.t.</i> | <i>%</i> |
|---------------------|-------------|----------|
| Transport           | 13.73       | 26.7%    |
| aerospace           | 1.18        | 2.3%     |
| automotive          | 10.12       | 19.7%    |
| Construction        | 11.63       | 22.6%    |
| Electrical          | 6.83        | 13.3%    |
| Packaging           | 6.59        | 12.8%    |
| Other               | 12.68       | 24.6%    |
| Total semi-finished | 51.45       | 100.0%   |

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### **AEROSPACE AND ALUMINIUM**

- ***Aerospace is a high-profile sector within the aluminium industry, but***
  - ***it is only a small part of total aluminium consumption – less than 3% by volume.***
- ***Construction, automotive, electrical and packaging are the driving force for the aluminium industry, particularly in the developing countries.***

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### Aluminium Industry and Aerospace

(capacity in million tonnes)

| <i>Item</i>         | <i>m.t.</i> | <i>%</i> |
|---------------------|-------------|----------|
| Plate               | 1.19        |          |
| aerospace           | 0.55        | 45.9%    |
| Sheet               | 20.32       |          |
| aerospace           | 0.20        | 1.0%     |
| Extrusions          | 15.54       |          |
| aerospace           | 0.26        | 1.7%     |
| Forgings            | 0.31        |          |
| aerospace           | 0.13        | 42.5%    |
| Total semi-finished | 51.45       |          |
| aerospace           | 1.18        | 2.3%     |

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### **AEROSPACE AND ALUMINIUM**

- ***Aerospace is very important in some products – particularly plate and forgings,***
  - ***and therefore for some producers that specialise in those products.***
- ***Even for the largest aerospace producers, this sector is a small part of their business, at 9-10% of volume for aluminium products.***

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### Aluminium for Aerospace - Top Companies, 2007 (million tonnes)

| <i>Company</i>     | <i>Aero<br/>m.t.</i> | <i>share of<br/>aero</i> | <i>Total<br/>m.t.</i> | <i>aero<br/>share</i> |
|--------------------|----------------------|--------------------------|-----------------------|-----------------------|
| Alcoa              | 488                  | 41.4%                    | 5134                  | 9.5%                  |
| Rio Tinto Alcan    | 138                  | 11.7%                    | 1648                  | 8.4%                  |
| Chalco             | 70                   | 6.0%                     | 1027                  | 6.9%                  |
| Aleris             | 70                   | 5.9%                     | 1163                  | 6.0%                  |
| Hindalco Novelis   | 44                   | 3.8%                     | 3212                  | 1.4%                  |
| Kaiser             | 44                   | 3.7%                     | 518                   | 8.5%                  |
| Others             | 324                  | 27.5%                    | 38747                 | 0.8%                  |
| <b>Total</b>       | <b>1180</b>          | <b>100.0%</b>            | <b>51449</b>          | <b>2.3%</b>           |
| <b>Total Top 6</b> | <b>855</b>           | <b>72.5%</b>             | <b>12702</b>          | <b>6.7%</b>           |

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### **AEROSPACE AND ALUMINIUM**

- ***Within individual products concentration is high:***
- ***A few producers dominate supply, particularly in rolled products.***
- ***Concentration in rolled products has increased – a concern for consumers ?***

**JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY**

**Aluminium Plate - Top Companies, 2007**  
(000 tonnes)

| <i>Total</i>       |             |              | <i>Aerospace</i>   |             |              |
|--------------------|-------------|--------------|--------------------|-------------|--------------|
| <i>Company</i>     | <i>m.t.</i> | <i>%</i>     | <i>Company</i>     | <i>m.t.</i> | <i>%</i>     |
| Alcoa              | 448         | 37.5%        | Alcoa              | 260         | 47.4%        |
| Rio Tinto Alcan    | 152         | 12.8%        | Rio Tinto Alcan    | 73          | 13.3%        |
| Aleris             | 96          | 8.1%         | Aleris             | 60          | 10.9%        |
| Chalco             | 67          | 5.6%         | Chalco             | 44          | 8.0%         |
| Hindalco Novelis   | 62          | 5.2%         | Kaiser             | 20          | 3.6%         |
| Hydro Aluminium    | 41          | 3.4%         | Hindalco Novelis   | 19          | 3.5%         |
| Others             | 327         | 27.4%        | Others             | 73          | 13.4%        |
| <b>Total</b>       | <b>1193</b> | <b>100%</b>  | <b>Total</b>       | <b>548</b>  | <b>100%</b>  |
| <b>Total Top 6</b> | <b>866</b>  | <b>72.6%</b> | <b>Total Top 6</b> | <b>474</b>  | <b>86.6%</b> |

**JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY**

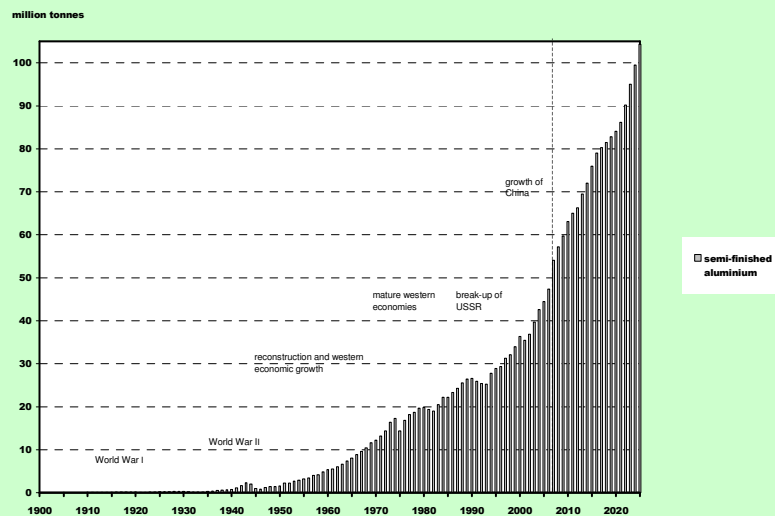
**Aluminium Extrusions - Top Companies, 2007**  
(000 tonnes)

| <i>Total</i>        |              |              | <i>Aerospace</i>   |             |              |
|---------------------|--------------|--------------|--------------------|-------------|--------------|
| <i>Company</i>      | <i>m.t.</i>  | <i>%</i>     | <i>Company</i>     | <i>m.t.</i> | <i>%</i>     |
| Alcoa               | 3255         | 20.9%        | Alcoa              | 94          | 35.6%        |
| Hydro Aluminium     | 2955         | 19.0%        | Chalco             | 21          | 7.8%         |
| Sun Capital Partner | 1261         | 8.1%         | Rio Tinto Alcan    | 16          | 6.1%         |
| Elkem               | 883          | 5.7%         | Menziken           | 14          | 5.4%         |
| YKK                 | 797          | 5.1%         | Hydro Aluminium    | 11          | 4.1%         |
| Rio Tinto Alcan     | 674          | 4.3%         | Creuzet            | 11          | 4.0%         |
| Others              | 5713         | 36.8%        | Others             | 97          | 36.8%        |
| <b>Total</b>        | <b>15537</b> | <b>100%</b>  | <b>Total</b>       | <b>264</b>  | <b>100%</b>  |
| <b>Total Top 6</b>  | <b>9824</b>  | <b>63.2%</b> | <b>Total Top 6</b> | <b>167</b>  | <b>63.2%</b> |

## AEROSPACE AND ALUMINIUM

- ***In extrusions there are hundreds of suppliers, but***
  - ***relatively few in hard alloys.***
  
- ***Some large producers of extrusions are not significant in hard alloys or products for aerospace.***

### Aluminium, 1900-2025



**METAL REQUIREMENTS AND CHINA**

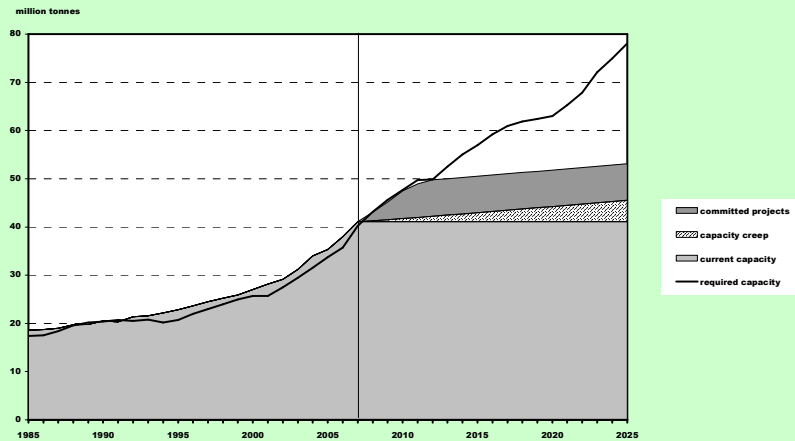
- **Continuous long-term growth. Stagnation in the 1980's. Fast growth in the 1990's, accelerating under the impact of China: Recent growth in world consumption:**

|             |              |
|-------------|--------------|
| <b>2003</b> | <b>9.1%</b>  |
| <b>2004</b> | <b>5.7%</b>  |
| <b>2005</b> | <b>6.7%</b>  |
| <b>2006</b> | <b>7.9%</b>  |
| <b>2007</b> | <b>11.7%</b> |

**Primary Aluminium: Supply/Demand Balance**  
(million tonnes)

| <b>Item</b>                | <b>2007</b> | <b>2010</b> | <b>2025</b> |
|----------------------------|-------------|-------------|-------------|
| Consumption                | 38.30       | 44.94       | 74.41       |
| Stock change               | -0.07       | 0.36        | -0.24       |
| Production                 | 38.23       | 45.31       | 74.17       |
| Required capacity at 95%   | 40.24       | 47.69       | 78.07       |
| Committed capacity + creep | 41.09       | 47.48       | 53.14       |
| Surplus capacity           | 0.85        | -0.21       | -24.94      |

**Aluminium: Capacity Requirement to 2025**



**METAL REQUIREMENTS AND CHINA**

- **Large future requirements for new smelting capacity to meet demand – new projects required after 2010.**
- **Problems are:**
  - **electricity availability and cost at a time of energy shortage**
  - **high capital costs for new capacity**
  - **high-risk locations for investment ?**

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### Primary Aluminium: Major Producing Countries (million tonnes)

| <i>Country</i>           | <i>1985</i>           | <i>2007</i>            | <i>2025</i>            |
|--------------------------|-----------------------|------------------------|------------------------|
| China                    | 0.50                  | 12.61                  | 23.12                  |
| CIS                      | 3.25                  | 4.53                   | 8.47                   |
| Canada                   | 1.28                  | 3.08                   | 4.88                   |
| USA                      | 3.50                  | 2.56                   | 3.29                   |
| Australia                | 0.85                  | 1.96                   | 3.26                   |
| Brazil                   | 0.55                  | 1.65                   | 2.56                   |
| Others                   | 6.63                  | 11.83                  | 28.59                  |
| <b>World</b>             | <b>16.57</b>          | <b>38.23</b>           | <b>74.17</b>           |
| <b>Total Top 6 share</b> | <b>9.93<br/>60.0%</b> | <b>26.39<br/>69.0%</b> | <b>45.58<br/>61.5%</b> |

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### **METAL REQUIREMENTS AND CHINA**

- **China is now by far the world's largest producer of primary aluminium.**
- **Chinese requirements for metal are forecast to rise strongly into the long term.**
- **The extent to which Chinese production can match this demand is crucial to the pattern of future world supply.**

**JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY**

**Primary Aluminium: CIS and China**  
*(million tonnes)*

| <i>Item</i>                 | <i>2007</i> | <i>2010</i> | <i>2025</i> |
|-----------------------------|-------------|-------------|-------------|
| <b><u>CIS countries</u></b> |             |             |             |
| Consumption                 | 1348        | 1617        | 4011        |
| Production                  | 4532        | 5247        | 8469        |
| net exports                 | 3184        | 3630        | 4458        |
| <b><u>China</u></b>         |             |             |             |
| Consumption                 | 11706       | 15751       | 28818       |
| Production                  | 12607       | 15370       | 23119       |
| net exports                 | 901         | -381        | -5699       |

**JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY**

***COSTS OF PRODUCTION – PRIMARY METAL***

- ***Production costs at primary aluminium smelters are at all-time high levels in dollar terms.***
- ***Costs at marginal smelters are in the range of \$3000 per tonne.***
- ***Because of the size of its industry, costs at Chinese smelters are now very important.***

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### Primary Aluminium: Cost Structure of Smelting (*\$ per tonne of cold remelt ingot, FOB smelter, 2008 Q1*)

| <i>Item</i>                    | <i>World</i> | <i>Marginal</i> |              |
|--------------------------------|--------------|-----------------|--------------|
|                                |              | <i>USA</i>      | <i>China</i> |
| Raw Materials                  | 1062         | 1131            | 1383         |
| Energy                         | 475          | 881             | 774          |
| Labour + administration        | 198          | 383             | 62           |
| Other operating costs          | 123          | 138             | 110          |
| Operating costs                | 1858         | 2534            | 2329         |
| Total costs, cold metal        | 2105         | 2792            | 2603         |
| Total costs + profit           | 2248         | 2908            | 2742         |
| <u>Major single cost items</u> |              |                 |              |
| Alumina                        | 794          | 790             | 1131         |
| Electricity                    | 418          | 830             | 702          |
| LME 3-months metal price       | 2655         | 2655            | 2655         |

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### ***COSTS OF PRODUCTION – PRIMARY METAL***

- ***Prices required by new smelter projects in areas of low production costs, using alumina from integrated operations also in low-cost areas, are about \$2550.***
- ***Not long ago this figure was \$1600.***

***COSTS OF PRODUCTION – PRIMARY METAL***

- ***Chinese integrated production remains competitive in comparison with the best locations for raw materials and smelting.***
- ***Operating costs up to smelting are not better than other producers, but low capital costs are a major.***

***COSTS OF PRODUCTION – PRODUCTS***

- ***Aerospace products such as heat-treated plate and extrusions are high-cost products.***
- ***Primary metal is a major part of the cost, but other cost factors are more important than for other rolled and extruded products.***

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### Aluminium Plate : Cost Structure

(\$ per tonne of 6061 heat treated plate, FOB mill, 2008 Q1)

| <i>Item</i>              | <i>USA</i> | <i>Europe</i> | <i>China</i> |
|--------------------------|------------|---------------|--------------|
| Primary ingot + scrap    | 2960       | 2957          | 2886         |
| Other Raw Materials      | 222        | 257           | 266          |
| Energy                   | 336        | 470           | 319          |
| Labour + administration  | 1071       | 1661          | 596          |
| Other operating costs    | 49         | 38            | 42           |
| Operating costs          | 4638       | 5383          | 4110         |
| Total costs              | 4787       | 5579          | 4233         |
| LME 3-months metal price | 2655       | 2655          | 2655         |

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### ***COSTS OF PRODUCTION – PRODUCTS***

- ***Chinese production costs for rolled and extruded products are significantly lower***
- ***They offer a potential major advantage, more than enough to offset transport costs.***

**STRUCTURAL ISSUES AND CONCLUSIONS**

- **The structure of metal supply has changed greatly in the past 20 years.**
- **Concentration in primary metal supply has remained similar – the top 6 companies holding about 50% of capacity, despite the huge growth of China, but**

**Primary Aluminium - Top Companies, 1985-2007**  
(million tonnes)

| <b>Company</b>     | <b>1985</b>  |              | <b>2007</b>        |              |              |
|--------------------|--------------|--------------|--------------------|--------------|--------------|
|                    | <b>m.t.</b>  | <b>%</b>     | <b>Company</b>     | <b>m.t.</b>  | <b>%</b>     |
| Russia - state     | 2.59         | 14.1%        | Alcoa              | 4.85         | 11.8%        |
| Alcoa              | 1.91         | 10.4%        | UC Rusal           | 4.54         | 11.0%        |
| Alcan              | 1.84         | 10.0%        | Rio Tinto Alcan    | 4.12         | 10.0%        |
| Reynolds           | 0.78         | 4.2%         | Chalco             | 3.35         | 8.1%         |
| Pechiney           | 0.86         | 4.7%         | Hydro Aluminium    | 1.82         | 4.4%         |
| Kaiser             | 0.74         | 4.0%         | BHP Billiton       | 1.48         | 3.6%         |
| Others             | 9.69         | 52.6%        | Others             | 20.94        | 51.0%        |
| <b>Total</b>       | <b>18.40</b> | <b>100%</b>  |                    | <b>41.09</b> | <b>100%</b>  |
| <b>Total Top 6</b> | <b>8.72</b>  | <b>47.4%</b> | <b>Total Top 6</b> | <b>20.15</b> | <b>49.0%</b> |

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### Aluminium CR Coil - Top Companies, 1985-2007 (million tonnes)

| 1985               |              |              | 2007               |              |              |
|--------------------|--------------|--------------|--------------------|--------------|--------------|
| Company            | m.t.         | %            | Company            | m.t.         | %            |
| Alcan              | 1.76         | 13.9%        | Alcoa              | 3.26         | 16.0%        |
| Alcoa              | 1.44         | 11.4%        | Birla Novelis      | 2.96         | 14.5%        |
| Russia - state     | 1.32         | 10.4%        | Hydro Aluminium    | 1.26         | 6.2%         |
| Reynolds           | 0.97         | 7.7%         | Rio Tinto          | 0.88         | 4.3%         |
| Kaiser             | 0.64         | 5.1%         | Aleris             | 0.80         | 3.9%         |
| Alusuisse          | 0.61         | 4.8%         | Chalco             | 0.67         | 3.3%         |
| Others             | 5.92         | 46.8%        | Others             | 10.49        | 51.6%        |
| <b>Total</b>       | <b>12.66</b> | <b>100%</b>  |                    | <b>20.32</b> | <b>100%</b>  |
| <b>Total Top 6</b> | <b>6.74</b>  | <b>53.2%</b> | <b>Total Top 6</b> | <b>9.82</b>  | <b>48.4%</b> |

## JAMES F. KING: TRENDS IN THE ALUMINIUM INDUSTRY

### **STRUCTURAL ISSUES AND CONCLUSIONS**

- ***Metal supply is now less integrated, as major companies try to focus on their best assets, so***
  - ***some major suppliers of rolled products and extrusions have little or no metal production.***
  
- ***This will mean:***

**STRUCTURAL ISSUES AND CONCLUSIONS**

- ***The full impact of changes to LME market prices for primary metal will be passed forward to aerospace products.***
- ***Producers will not be willing or able to price aerospace products in relation to their internal production costs***

**STRUCTURAL ISSUES AND CONCLUSIONS**

- ***Competition is increasing in the aluminium smelting and semi-fabricating industry, with a long-term threat from producers in China. This will mean:***
- ***Producers will be less willing or able to spend on R&D for aerospace products in the hope of high margins in the future, but***

**STRUCTURAL ISSUES AND CONCLUSIONS**

- ***More producers will seek niche markets such as aerospace to avoid low-margins for “commodity” for aluminium products.***
- ***Aluminium will always be available for the aerospace industry, which will remain a preferred market, but***
  - ***the aerospace industry must expect to pay the full market price for the products, and***

**STRUCTURAL ISSUES AND CONCLUSIONS**

- ***the aerospace industry may need to encourage and accept new suppliers, and***
- ***the aerospace industry may need to assist with the development of aluminium products to meet its needs – the major aluminium producers may no longer do it for them.***

***THANK YOU FOR THE INVITATION  
AND FOR YOUR ATTENTION***

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