Advances in Production of the Largest Military Aerospace Monolithic Titanium Forgings

Eric Roegner
President, Alcoa Forgings and Extrusions
October 4th and 5th International Titanium Association (ITA) Military Aerospace Panel
## Alcoa at a Glance

- Founded in 1888
- 200+ locations
- 31 countries
- $18.4 billion 2009 revenue
- 10 times safer workplace than US average
- Award-winning sustainability leadership
- 120 years of aluminum technical leadership

### Number of Employees (2009)

<table>
<thead>
<tr>
<th>Region</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>23,000</td>
</tr>
<tr>
<td>Other Americas</td>
<td>19,000</td>
</tr>
<tr>
<td>Europe</td>
<td>10,000</td>
</tr>
<tr>
<td>Pacific</td>
<td>7,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>59,000</strong></td>
</tr>
</tbody>
</table>
## Operations

<table>
<thead>
<tr>
<th>Upstream (41%)</th>
<th>Midstream (33%)</th>
<th>Downstream (26%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bauxite mining</strong></td>
<td><strong>Aluminum Sheet &amp; Plate</strong></td>
<td><strong>Fastening Systems</strong></td>
</tr>
<tr>
<td><strong>Alumina refining</strong></td>
<td><strong>Aluminum Can Stock</strong></td>
<td><strong>Super-alloy castings</strong></td>
</tr>
<tr>
<td><strong>Aluminum smelting</strong></td>
<td></td>
<td><strong>Wheel &amp; Transportation</strong></td>
</tr>
<tr>
<td><strong>Aluminum recycling</strong></td>
<td></td>
<td><strong>Building &amp; Construction</strong></td>
</tr>
</tbody>
</table>

- **Upstream** - $7.5bn
- **Midstream** - $6.1bn
- **Downstream** - $4.8bn

### Primary Operations
- Primary Aluminum
- Transportation
- Packaging
- Building/Construction
- Aerospace
- Industrial
- Oil & Gas
- Consumer Electronics
Alcoa Forgings and Extrusions Key Markets

- **Aerospace**
  - 65%
- **Defense**
  - 11%
- **Automotive**
  - 10%
- **Industrial**
  - 13%
- **Oil & Gas**
  - 1%

2009 Data

**Key Markets**

- **Automotive**
- **Industrial**
- **Oil and Gas**
- **Aerospace**
- **Ground Defense**

**Category**

- **Commercial & Defense**
- **Risers**
- **Combat & Tactical Vehicles**
Alcoa Forgings and Extrusions is a Global Organization

2400 employees - 9 plants - 4 countries

Alcoa Forgings and Extrusions Locations
Alcoa has a rich history of producing large titanium forgings for the military and commercial industry over the past several decades.
In 2005, Alcoa began production JSF bulkheads in 7085.

CTOL variant of the “496” bulkhead had to be titanium:
- One of the largest dual sided die forging ever produced
- Proven monolithic design capabilities in previous forgings
- Excellent current engineering relationship with OEM, machine shops, and material suppliers to co-develop the single piece concept

CTOL Bulkhead Materials

7085-T7452

Ti-6-4 Eli

CTOL 496 Titanium Bulkhead
This monumental forging was able to be produced start to finish within 28 weeks:

- Large hydraulic press capability
- Advanced segmented forging design and simulation
- Integrated titanium supply, partnerships and processing
- Controlled thermal processing and modeling technologies
Development of the JSF CTOL Bulkhead
Alcoa Large Hydraulic Press Capability

50,000 ton press in Cleveland

Press Rebuild on Track to be Complete EOY 2011

35,000 ton press in Cleveland

**Part Size:**
354 in. L – 120 in. W – 65 in. height
30,000 pounds weight

**Plan View:** 24,000 square inches

**Markets:**
Al. structural parts
Land based turbine parts (Nickel-based super alloys)
Ti structural parts
Monolithic structures
Development of the JSF CTOL Bulkhead
Integrated Titanium Supply & Processing

Entire Material Flow Path Through Forging is Fully Integrated with Partners for Fast Lead Times
Development of the JSF CTOL Bulkhead Thermal Processing and Modeling Technologies

- Proper “beta-anneal” must be assured within such large structures
  - Careful process control and design must be established
  - Proper pre-machine configuration and racking
  - Proper beta anneal cycle modeling

- Alcoa worked closely with the machine shop, OEM, Air Force, and Navy to assure proper development of the thermal cycles

Thermal Modeling Utilized To Develop Proper Beta Anneal Cycle Based on Geometry
Based on the Alcoa Advantages, the CTOL 496 bulkhead was produced in 28 Weeks

Alcoa’s success on the CTOL 496 bulkheads led to Alcoa next producing the largest CV titanium forgings (CV 496 even bigger)

Alcoa is a proven industry leader in the design, development, and manufacturer of large monolithic titanium structures
Alcoa Forgings is committed to:

- Our customers
- Our people
- Our community
- Our environment
- Our suppliers

Thank You for Your Time