SPACE INDUSTRY METALLURGICAL SOLUTIONS

www.aubertduval.com
A&D has been selected on major space programs for its unique combination of metallurgical expertise and know-how along with world-class melting and forging tools. This unique industrial set-up enables us to offer highly reliable and secure metallurgical solutions for the most complex, lighter, large-scaled, critical and cryogenic applications. Thanks to this positioning, Aubert & Duval is supporting the development of the most ambitious projects: space stations, heavy or reusable launchers, spacecrafts as well as all satellite sizes.

A unique combination to help realize your ambitions

- Passionate teams driven by metallurgical innovation and industrial challenges.
- R&T and co-engineering culture with unrivalled simulation capabilities.
- A unique integrated solution of world-class tools from melting to closed-die forging.
- Multi-material expertise: special steels, superalloys, titanium, aluminum (forging only).
- A multi-certified player able to support customers’ needs on all markets (aeronautics, defense, nuclear): ISO 9001/EN 9100, ISO 14001, OHSA 18001, NADCAP, AQAP2110, TAA experienced (US market), Fully Authorized Economic Operator (AEO).

Melting
Melting furnaces (EAF, AOD, VOD) up to 60 tons
Vacuum Induction Melting (VIM) up to 20 tons
Titanium Plasma Arc Melting furnace (PAM-CHR)
Remelting furnaces (ESR, VAR) up to 30 tons

Powder metallurgy
Gas atomization (Air, VIM)

Forging
Open-die forging presses from 1,200 to 10,000 tons
Closed-die forging presses from 4,500 to 65,000 tons

Rolling mill
7-200 mm diameter bars

Heat treatment
Solution and ageing furnaces
Horizontal and vertical quenching equipment

Testing
Immersion UT up to 13 tons (28,000 lbs)
Automated contact UT up to 20 tons

- The 65kt closed-die forging press: a world-class tool for the manufacturing of complex, large, thick and seamless parts.

AUBERT & DUVAL
The Space industry supplier of choice

Main materials

**HPS**
High performance steels
- A range of alloyed steels with tightly controlled characteristics, offering optimum value for customers.

**NiSA**
Nickel-based superalloys
- A range of alloyed materials with specific resistance to very high temperatures and corrosion, the majority component being nickel.

**Ti**
Titanium alloys
- Pure or alloyed titanium, combining mechanical properties and corrosion-resistance with light weight.

**Al**
Aluminum alloys
- Slightly alloyed aluminum, widely used in aircraft.

**PM**
Metal powders
- Steels, superalloys and titanium powders for additive manufacturing and aero rotating parts.

Process flow

**Melting**
**HPS**
**NiSA**
**Ti**

**Remelting**
**Powder atomization**
**PM**

**Conversion**

**HPS**
**NiSA**
**Ti**
**Al**

**Forging and/or rolling**
**Open-die forging and/or Closed-die forging**

**Heat treatment**

**Machining**

**Non-destructive testing**

**Bars**
**Rotating and static parts**
**Powders**
**Parts and Bars**

**Main materials**

- **Aluminum alloys**
  - A2000 series
  - A7000 series
  - 5083
  - 6061
  - Aluminum-Lithium

- **Titanium alloys**
  - TA6V
  - Ti6Al4V ELI
  - Ti 2.3
  - Ti 2.3

- **Nickel-based superalloys**
  - AD730®
  - NY276
  - PER3
  - PER625
  - PER718
  - X5H

- **High performance steels**
  - B19B
  - CKH™
  - MSNIL
  - Manaf®
  - ML340
  - MX17
  - MLX19
  - MODAC
  - SCV®
  - X15SW
  - X6RA
  - XD5N®
  - XDBD
  - XN26T

**Main sizes**

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>Diameter (inches)</th>
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<td>Ø 15 - 500</td>
<td>Ø 0.6 - 20</td>
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**Surface conditions**

- Black
- Peeled
- Ground
- Others

**Heat treatment conditions**

- Annealed
- Heat solution treated
- Heat treated
- Aged

**Innovation**

- We continuously develop new processes and grades to help face the challenges of the space industry.

- **ML340**
  - Fully innovative nickel-based superalloy withstandng higher temperatures (750 °C / 1,382 °F) while reserving strength, creep and fatigue resistance at a competitive cost.

- **AD730®**
  - Duplex hardening grade specifically adapted for high temperature turbine shafts (450°C/840°F), requiring 2230 MPa/323 Ksi resistance. Benefits: weight savings, improved engine efficiency & gas consumption.

- **Aluminum-Lithium alloys**
  - Allowing weight gain up to 4% with static properties equivalent or higher than 7000/7050 & improved fatigue and rigidity properties over 10%.

**Co-engineering**

- Simulation of complex, large, thick and seamless parts
- Leading expertise in residual stress optimization and control of stress relief
- Allows parts to be machined without constraints
- Allows you to eliminate the roughing and straightening steps
- Metallurgical know-how to obtain best mechanical properties (LH2, High T°…)
- Co-design & input weight reduction

**Example of residual stress after quenching**

**Example of residual stress elimination after cold-work**

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**Launchers:** Ariane, Vega ESA programs; PSLV Indian program;

**Stations:** ISS & Axiom programs;

**Spacecrafts:** Orion & Cygnus programs;

**Satellites:** very large range of programs from LEO to GEOSAT tanks...

**And you tomorrow!**
Over the years, Aubert & Duval has acquired a deep and thorough knowledge in the design and optimization of metal powders in order to meet customers’ most stringent requirements, particularly for air industry and space applications. We support space equipment manufacturers in achieving success in powder development for series production in their additive manufacturing.

Our research centers and development teams are dedicated to developing new alloys and optimizing powder characteristics to achieve the best material performance and processability for all additive manufacturing technologies.

The performance of our powders at the heart of your additive manufacturing success

Thanks to our long-standing experience serving the space industry, we can offer tailored metal powder, including design of the chemical and mechanical properties, in accordance with space requirements.

We help our customers in the definition of metal powder specifications in order to develop suitable solutions for space applications for propulsion and structural parts for use at higher temperature and for higher trust & weight savings.
The information and the data presented herein are typical or average values and are not a guarantee of maximum or minimum values. Applications specifically suggested for materials described herein are made solely for the purpose of illustration to enable the reader to make their own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes. Aubert & Duval's liability shall not extend, under any circumstances, to the choice of the Product and its consequences.