Sustainable solutions for aerospace high integrity components
The aeronautical industry is facing many challenges: reduction of fuel consumption, long distance flights, maintenance costs optimization. From these comes the necessity to work with our customers from conception to final delivery in order to choose the appropriate material and to optimize the design for all aircraft parts.

Founded in 1907, shortly after the first manned flight, Aubert & Duval has continuously participated in the development of the most challenging programs. Today, we partner with OEMs in both commercial and military markets to develop materials and parts for their newest regional, narrow and wide-body programs: Airbus A220 (CSeries), A320NEO, A330NEO, A350 XWB, A400M; Boeing 737MAX, 787, 777X; Embraer E2 family; Dassault Falcon, Rafale; COMAC C919…

Solutions for tomorrow challenges

Aubert & Duval is a recognized actor in high performance steels, superalloys, titanium and aluminum. We design and develop advanced metallurgical solutions in the form of closed and open-die forged parts, long products and metal powders for the most critical aircraft and helicopter parts in engines, airframe structures and landing gears. Our metallurgical and industrial expertise is based on a unique, fully integrated set of processes and facilities from steel and alloy-making through to machined parts.
Process flow

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.
Providing resistance at key locations

Today’s aircraft manufacturers have to meet two major requirements: maximum safety along with minimum surcharge reducing the fuel consumption. Aubert & Duval supports its clients throughout the critical fuselage and wing parts development and industrialization to ensure the perfect resistance and strength of narrow and wide body aircrafts even in the hardest flight conditions.

Large portfolio of presses

Our large portfolio of presses, ranging from 1,200T to 65,000T, allows us to deliver a full range of closed-die forged parts from all metallic materials.

Engine pylon parts

At Aubert & Duval, we manufacture most of the parts for engine pylons such as spars and beams.
### Closed-die forging parts:
- From 500 g (1 lb) to 15 T (33 klbs)
- Up to 8 m (314 in)

### Main materials

#### HPS (High performance steels)

<table>
<thead>
<tr>
<th>Aubert &amp; Duval grade</th>
<th>Common name</th>
</tr>
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#### AI (Aluminum alloys)

- 2214
- 2219
- 2618
- 6061
- 7010
- 7050
- 7175
- Airware®2050 [Al-Cu-Li]*

* Airware is a trademark owned by Constellium

#### Ti (Titanium alloys)

- TA6V
- TA6V ELI
- Ti6242

### Main data

- Nacelle parts
- Door frames
- Window frames
- Wing box parts
- Wing mount parts
- Slat tracks
- Window frames
- Door frames
- Wing box parts
- Nacelle parts
- Wing mount parts
An aircraft landing gear carries over 500 tons, travels almost 500,000 kilometers and absorbs the heavy shocks of landing during its whole life cycle. Material choice and quality of each landing gear part are therefore of utmost importance to meet these extremely stringent requirements and also to reduce the maintenance cost of landing gear system. Aubert & Duval works with landing gear manufacturers on design, simulation, 3D models and machining processes to ensure the optimal use of titanium, aluminum and high performance steels on critical landing gear parts.
SQuAD - Precision forging integrated solution in India

SQuAD Forging Private Ltd. (JV with Aequus) is dedicated to the production from small to medium-size closed-die forging components (titanium, aluminum and steel). Benefitting from its forging capacity up to its 10,000T hydraulic press together with dedicated heat treatment lines, SQUAD is the preferred partner to provide vertically integrated solutions for airframe structure parts.
Meeting the most stringent requirements

The rotating parts of the engine, such as disks or shafts, have to face many challenges: temperatures close to 800°C (1,475°F), corrosion, shocks and cracking. In order to find the best solutions to these challenges, Aubert & Duval collaborates with the OEMs from the R&D to the industrialization of these engine parts. Thanks to our expertise and production capacities, we are able to supply the aeronautical programs with the highest production rate for both narrow and wide body aircraft markets.

Transformation of high performance γ–γ' superalloys

We have a recognized and deep expertise in the transformation of γ–γ' nickel-based superalloys (closed-die forging and ring rolling...). Our process knowledge allows us to offer parts for the most demanding applications and performance requirements, as requested notably for critical engine discs (fatigue properties, high temperature resistance...).
### HPS
**High performance steels**

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### AI
**Aluminum alloys**

- 2618
- 7050

### Ti
**Titanium alloys**

- TA6V
- Ti17
- Ti6242

### NiSA
**Nickel-based superalloys**

<table>
<thead>
<tr>
<th>Aubert &amp; Duval grade</th>
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<td>Rene 65</td>
<td>-</td>
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<tr>
<td>-</td>
<td>Catorized Waspaloy</td>
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### PM
**Metal powders**

- Superalloy powders for aero engine rotating parts.

### Main data

- **Closed-die forging parts:**
  - From 20 kgs (44 lbs) to 20 T (44 klbs)

- **Max diameter for disks:**
  - 1,400 mm (55 in)

- **Max length for shafts:**
  - 4 m (157 in)
Aubert & Duval offers high performance solutions for all the main helicopter parts: engine, transmission box, fitting and rotor. Each of these parts supports different mechanical stress, hence the necessity to use a large portfolio of materials such as high performance steels, superalloys, titanium and aluminum.
High Performance Steel Bars

Available in small or larger diameters and cut-to-size, these bars are machined, then used in the main rotor, 42- and 90-degree transmission systems, main frame, and other demanding applications.
Aircraft manufacturers have to increase the aircraft parts’ properties to ensure maximum safety and also to reduce their maintenance costs. Aubert & Duval provides a wide range of high performance steels, with ideal characteristics, usable for the most critical structural parts. Furthermore, our maraging stainless steel grades such as Marval® X12/Marval®X12H and MLX®17/MLX®19, exhibit a high stress corrosion cracking (SCC) resistance and are the best solution to replace Titanium alloys.

**Structure**

**WIRE**  
5,5 ≤ Ø ≤ 20 mm

**ROUND BARS**  
10 ≤ Ø ≤ 500 mm

**FLAT BARS**  
on request

**SQUARE BARS**  
on request

**Transmission**

The transmission’s parts are exposed to different impacts such as contact and structure fatigue or corrosion, hence the necessity to be resistant and tough. Our bars are used for both, motion and power transmission systems:

**Power**

High power density and reliability are two main requirements that gears and shafts have to meet. Thanks to excellent properties of our grades such as FADHW, GKH®, FND®, our customers can optimize their own use conditions such as bending and pitting performances, surface distress and also corrosion resistance (if requested).

**Motion**

Assuming that the main failure mode is surface distress, improving the reliability of bearings is a pivotal requirement. Depending on the conditions of use, our large product portfolio (RA50YW, GKYW®, CX13VDW, XDI5NW...) enables the improvement of many behaviors such as fatigue resistance, surface hardness, temperature resistance, compressive stress profile and corrosion resistance (if requested).
Engine

Thanks to our long standing expertise in melting and remelting, we deliver mill products with perfect micro-cleanliness ensuring the high temperature and fatigue resistance of different engine parts. We offer a portfolio of:

- High Performance Steels and especially ML340, the highest resistant duplex hardened maraging steel (2200 MPa), used for shaft applications.
- Ni-based Superalloys such as AD730®, offering higher temperature resistance (750°C/1382°F) and lower cobalt content.

Fasteners

Thousands of fasteners used in aircraft construction have to meet different requirements to ensure maximum safety.

We propose a large portfolio of high performance steels, superalloys and titanium materials (the latter in development) which can be used for both aircraft airframe and engine fasteners. Our portfolio of products such as bars or coils permit answer to our customers’ requirements for fastener applications:

- Homogeneous properties
- High mechanical performance
- High temperature resistance if needed

Main materials

<table>
<thead>
<tr>
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SHEETS
0.8 ≤ thk ≤ 100 mm

thk = thickness

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<tr>
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<tr>
<td>TA6V Eli</td>
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</table>
Thanks to its fully integrated Titanium solution, Aubert & Duval is present throughout the entire Titanium value chain:

- Circular economy from raw material through melting ingots and forging materials to recycling titanium scrap into new titanium ingots of aerospace quality.
- A simplified and controlled supply chain from ore to finished parts.
- Support our customers in the growing titanium demand.
- Two different sources of supply for titanium ingots: produced from sponge or recycling.
- Titanium offer conforming to the high quality standards of the aerospace industry.

100,000 tons of CO₂ emissions less in the air thanks to EcoTitanium innovative process that consumes 4 times less than primary melting route using Titanium sponge.

Created by two world-class titanium specialists - Aubert & Duval and UKTMP.
- UKAD converts ingots coming from UKTMP and EcoTitanium into forged billets and bars.
Our company develops high performance metallurgical solutions in titanium, aluminum, superalloy and high-performance steel grades for high-tech industries (aerospace, energy, space, medical, defense,...)
With several decades of experience in powder metallurgy, Aubert & Duval has acquired a very thorough knowledge of design and optimization of metal powders and proposes a complete offer:

- Standard & customized compositions
- Tailored particle size distribution
- Packaging in plastic bottles or metallic containers
- Handling, HSE and storage
- Recommendations
- Flexible service

Thanks to our mindset for continuous improvement, aerospace standards and our collaborative approach in R&D, we build long-standing partnerships with the leading suppliers of critical aerospace parts.

Key benefits
- Melting in VIM furnace or with ESH technology
- N- or Ar-atomization
- High cleanliness level
- Highly spherical powder morphology
- Fully controlled oxygen and carbon levels
- Minimize satellites & internal porosities
- High stability and reproducibility
- Broad range of batch sizes

Quality and certifications
- EN 9100
- ISO 9001
- Aerospace customer accreditations
Main materials

**HPS** - High performance steels
- Aubert & Duval grade
  - 17-4PH
  - 316L

**NiSA** - Nickel-based superalloys
- Aubert & Duval grade
  - HX
  - Ni247
  - Ni625
  - Ni718
  - Ni738

**Ti** - Titanium alloys
- Ti6Al4V ELI

Powder sizes

- Laser Beam Melting: 10-53 or 15-63 μm
- Electron Beam Melting: 45-106 μm
- Direct Energy Deposition: 45-106 μm

Powders for AM Technology

Pearl® Micro metal powders are designed for the full range of additive manufacturing processes:

**Powder Bed**
- Laser Beam Melting
- Electron Beam Melting
- Binder jetting & sintering

**Blown Powder**
- Laser Metal Deposition
- Cold Spray

Locations:
- SWEDEN: Gas atomization
- FRANCE: VIM gas atomization + EIGA (R&D)
- SPAIN: VIM gas atomization
Creating value through innovation

- Innovative products & increased value of legacy products
- More sustainable processes to save material and costs
- Use 4.0 Revolution to boost our innovation
- Enhance high level of knowledge in metallurgy

Digitalization
- New Grades Design
- Heating furnaces & quenching processes (simulation/3D Modeling)
- Digitalization of conversion process
- Tools for properties, prediction or accelerated design

Material engineering
- High performance Corrosion Resistance Steels (MLX®17, MLX®465, MLX®19)
- New Steel grades for transmissions
- New γ-γ′ alloys forging (R65, AD730®)
- Near Net shape TA6V closed-die forging for structural parts

Scope of R&T Road Maps

Technologies for production
- DED (Wire Additive manufacturing) maturation and hybridation for TA6V structural parts
- Gas Atomization yields & productivity
- New Continuous Rolling Mill (LAMA)
- Optimization of aerospace grades, Melting & Conversion route

4% of our added economic value invested in R&D

432% of our added economic value invested in R&D
Aubert & Duval has developed specialist knowledge through its world-renowned support and technical assistance. The primary goal is to give you the best possible advice in selecting suitable materials and effective manufacturing processes and heat treatments.

Our technical support teams are composed of engineers and technicians who are highly trained and knowledgeable in state-of-the-art technology, and stimulated by current and future challenges in metallurgy.

digitAlloys data
To leverage data to its full potential, using artificial intelligence to:
- Deploy predictive maintenance
- Improve our processes
- Assist teams in their decision-making

digitAlloys manufacturing
To take advantage of a totally integrated industrial information system to optimize operations and supply chain, allowing for example:
- Documentation availability
- Production tracking
- KPI calculation and broadcast
- Short term planning optimization...

digitAlloys factory
To optimize our production process on the field, deploying technologies such as:
- 3D scan for automatic dimensional checks
- Robotic automation
- Automated Guided Vehicle (AGV)
- Traceability

digitAlloys experience
We use also the new technologies such as additive manufacturing, augmented reality or different web applications for different, more specific projects.

Building a reliable partnership
Aubert & Duval has developed specialist knowledge through its world-renowned support and technical assistance. The primary goal is to give you the best possible advice in selecting suitable materials and effective manufacturing processes and heat treatments.

Our technical support teams are composed of engineers and technicians who are highly trained and knowledgeable in state-of-the-art technology, and stimulated by current and future challenges in metallurgy.

Key benefits
- Knowledge of Aubert & Duval portfolio, technical advantages of our grades/processes
- Grades in-use properties
- Function analysis at customers (mechanical engineering)
- Translate design requirements into material solution (grade, process, properties)
- Build technical partnerships with customers
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 material described herein are made solely for the purpose of illustration to enable the reader to make his 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.