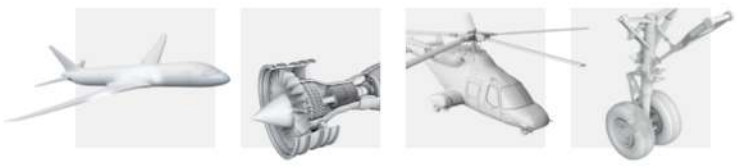
AUBERT&DUVAL

SUSTAINABLE SOLUTIONS FOR AEROSPACE HIGH INTEGRITY COMPONENTS

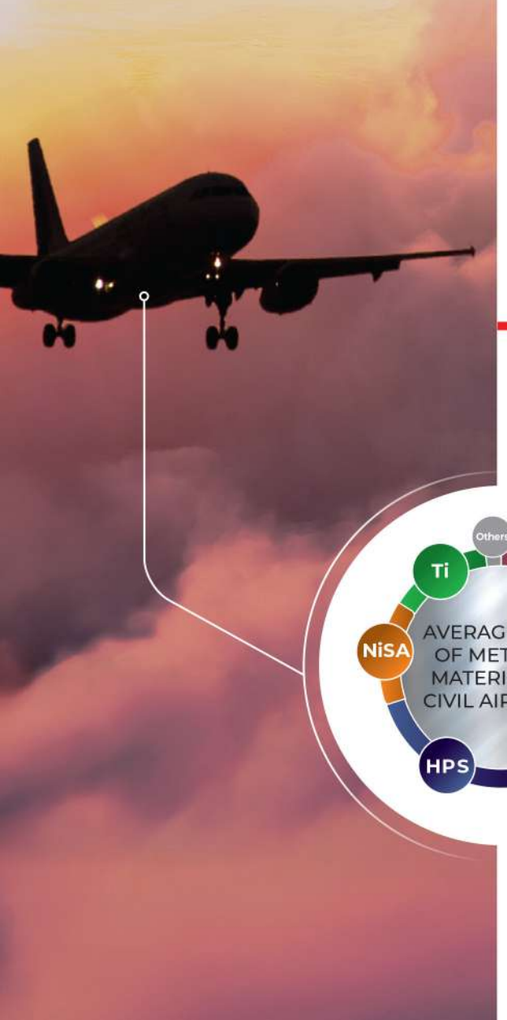


www.aubertduval.com

AUBERT & DUVAL

integrated from nose to tail

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, A320NEO, A330NEO, A350 XWB, A400M; Boeing 737MAX, 787, 777X; Embraer E2 family; Dassault Falcon, Rafale; COMAC C919...

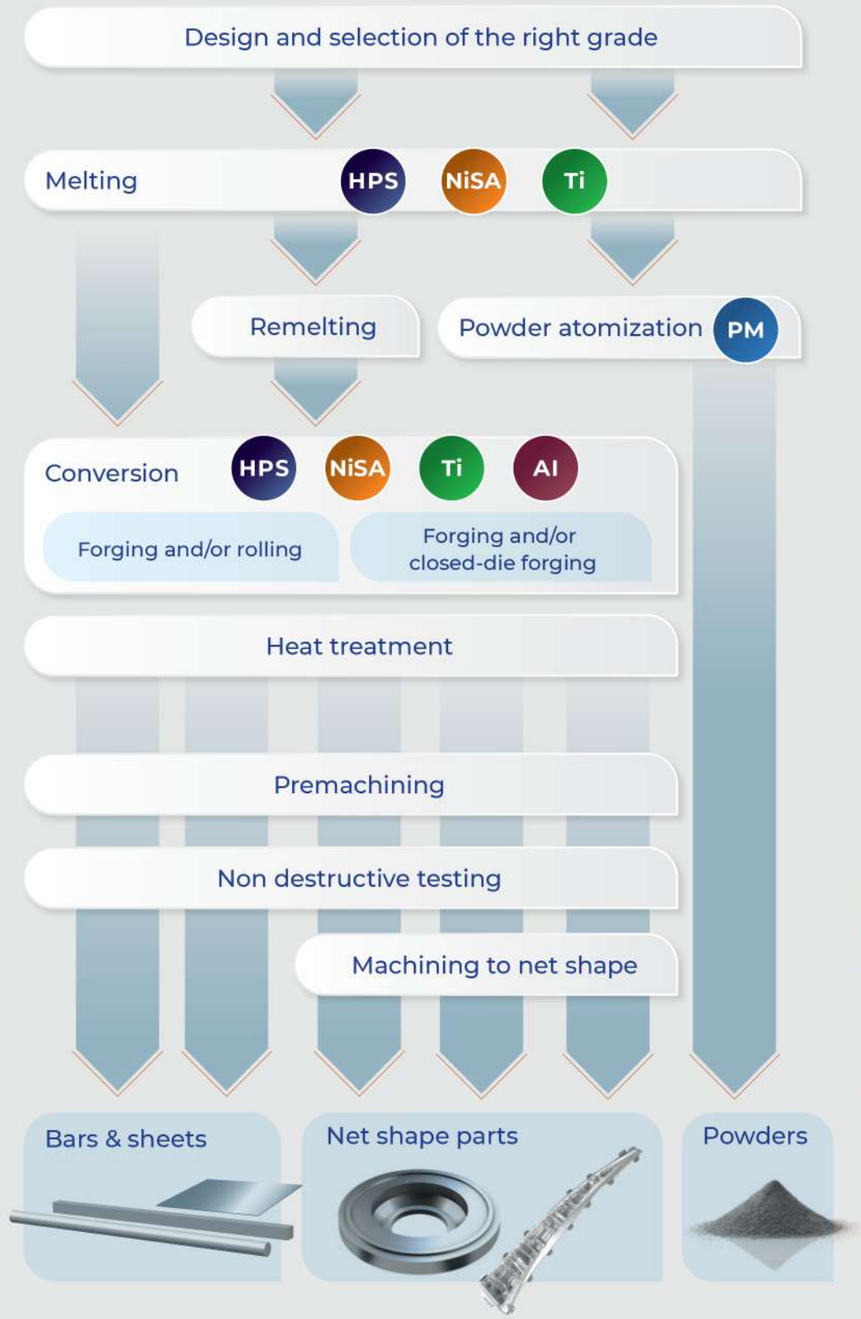


Solutions for tomorrow challenges

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.

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 corrosionresistance with light weight.

Al — Aluminum alloys

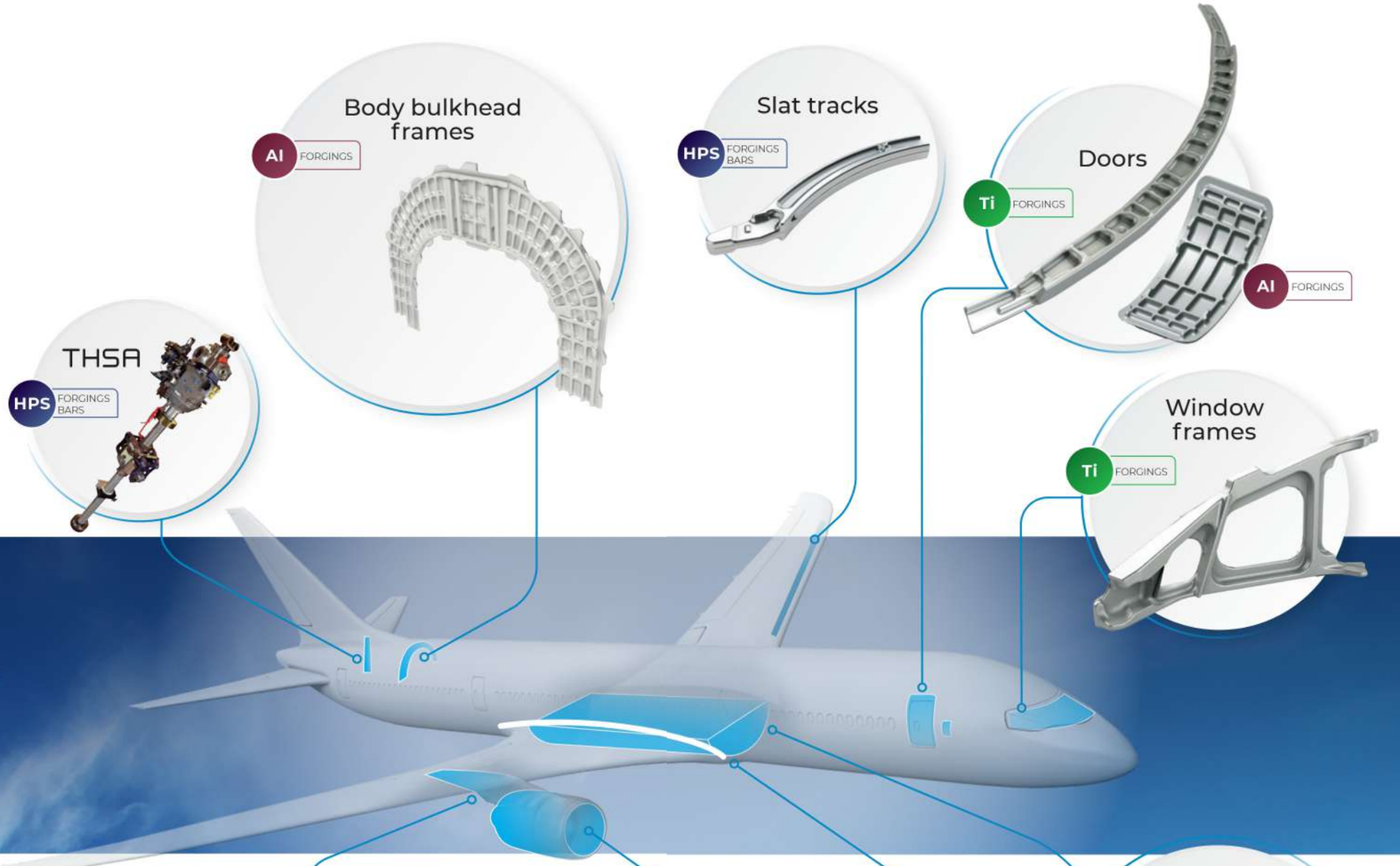
Slightly alloyed aluminum, widely used in aircraft.

PM — Metal powders

Steels, superalloys and titanium powders for additive manufacturing and aerospace 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.



THSA

HPS FORGINGS BARS

Body bulkhead frames

AI FORGINGS

Slat tracks

HPS FORGINGS BARS

Doors

Ti FORGINGS

AI FORGINGS

Window frames

Ti FORGINGS

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

HPS FORGINGS

Ti FORGINGS

At Aubert & Duval, we manufacture most of the parts for engine pylons such as spars and beams.

Nacelle parts

AI FORGINGS

Wing box parts

AI FORGINGS

Ti FORGINGS

Wing mount parts

AI FORGINGS

Main materials

HPS High performance steels

Aubert & Duval grade	Common name
819AW	E35NCD16H
819B	35NCD16
CX13VDW	AMS 5719
FDMA	30NiCrMo16
Marval®13X	PH13-8Mo
Marval®18	Maraging 250
Marval®X12	AMS 5928
Marval®X12H	AMS 5935
MLX®17	AMS 5937
MLX®19	AMS 5955
MY19	Maraging 300
NC310YW	AMS 6499
NC40MW	4330
NC40SW	300M
X15U5W	15-5PH
X17U4	17-4PH

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

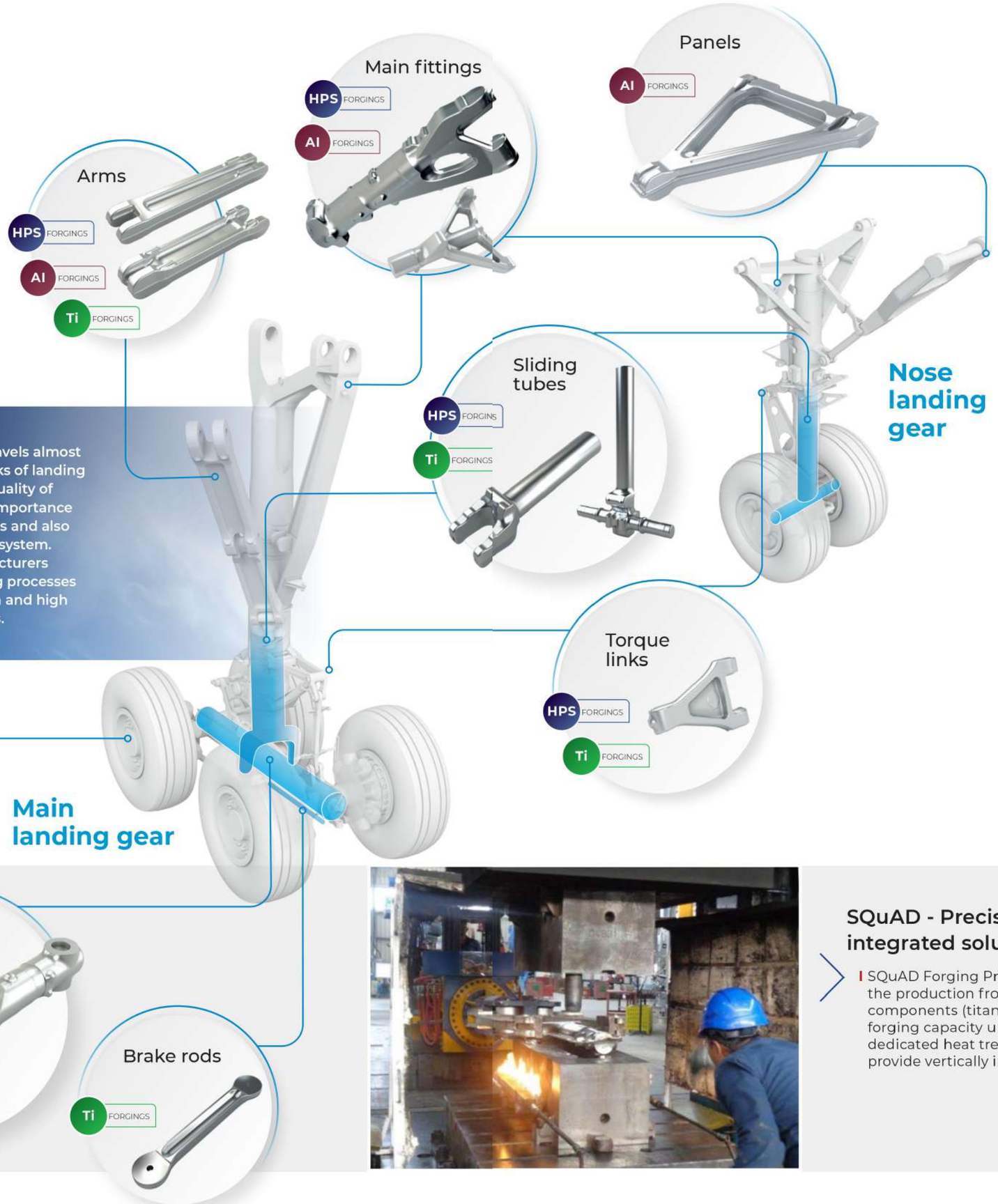
- TA6V
- TA6V ELI
- Ti6242

Main data

Closed-die forging parts:
- From 500 g (1 lb) to 15 T (33 klbs)
- Up to 8 m (314 in)

Selecting the most appropriate material

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 theses 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.



Main materials

HPS High performance steels

Aubert & Duval grade	Common name
819AW	E35NCD16H
819B	35NCD16
FADHW	E16NiCrMo13
GKH®YW	AMS 6481
Marval®13X	PH13-8Mo
MLX®17	AMS 5937
MLX®19	AMS 5955
NC40MW	4330
NC40SW	300M
X15U5W	15-5PH

Al Aluminum alloys

- 7010
- 7175

Ti Titanium alloys

- TA6V
- Ti1023
- Ti5553

Main data

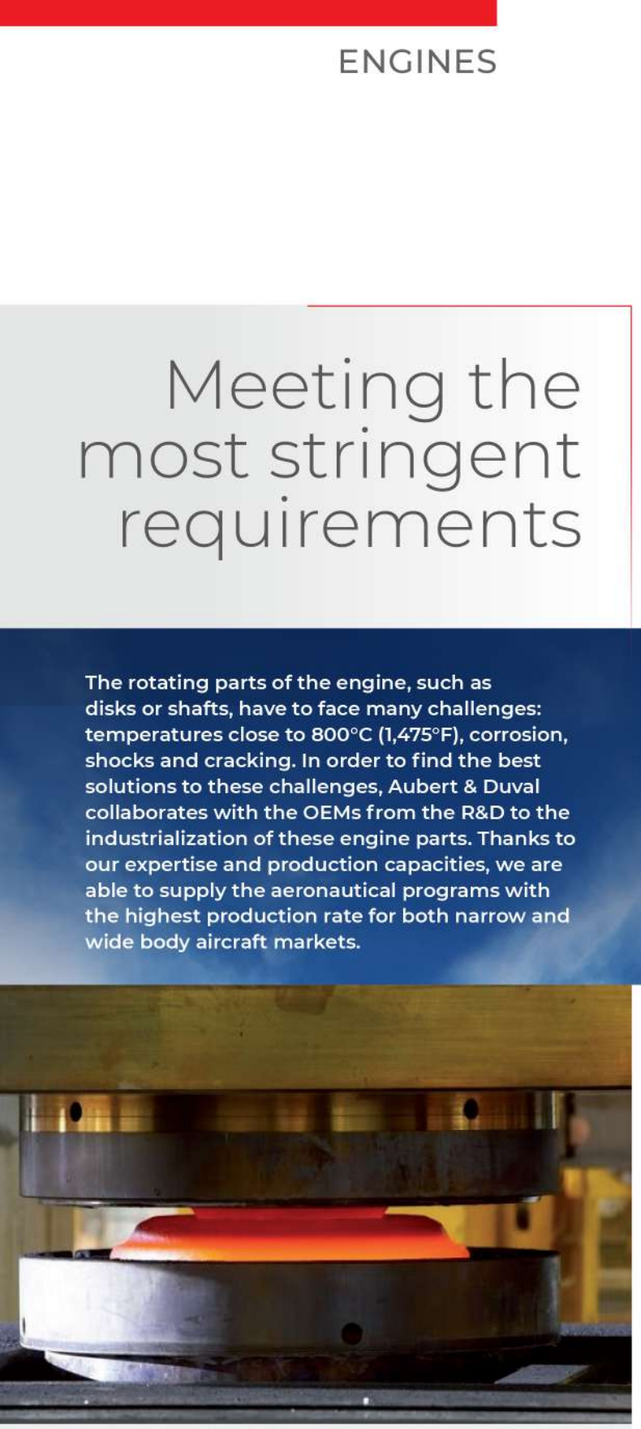
Closed-die forging parts:
- From 500 g (1 lb) to 15 T (33 klbs)
- Up to 8 m (314 in)

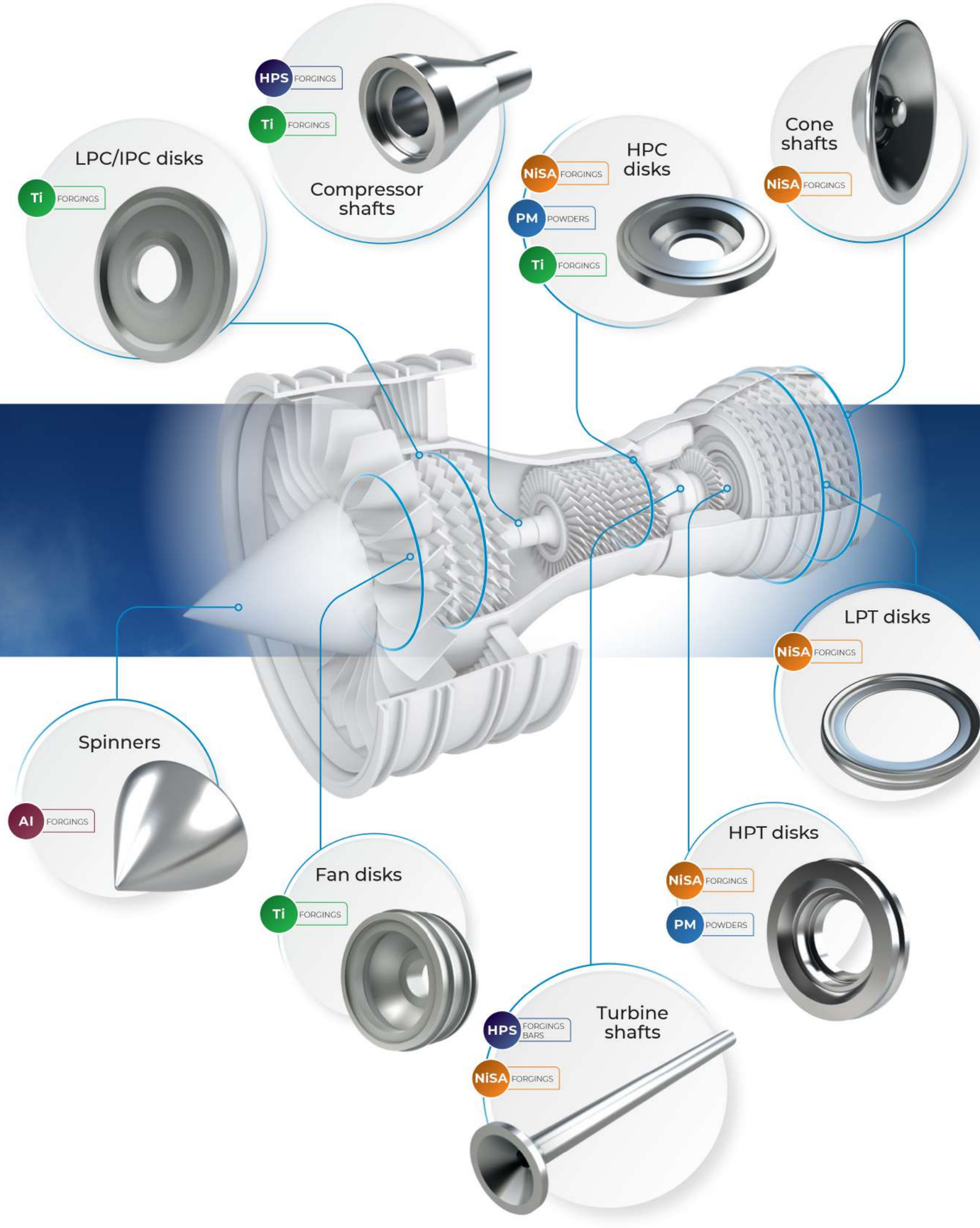
SQuAD - Precision forging integrated solution in India

SQuAD Forging Private Ltd. (JV with Aequs) 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 (Billet conversion, 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...).

Main materials

HPS — High performance steels

Aubert & Duval grade	Common name
GH4W	E40CrMoV12
Marval®18	Maraging 250
ML1014	GE1014
ML340	X23NiCoCrMoAl13-6-3
X13VDW	X12CrNiMoV12
X17U4	17-4PH
XN26TW	A286

Al — Aluminum alloys

- 2618
- 7050

Ti — Titanium alloys

- TA6V
- Ti17
- Ti6242
- Ti6246

NiSA — Nickel-based superalloys

Aubert & Duval grade	Common name
AD730®	-
PER3	Waspaloy
PER718	Inco718
PER72	Udimet720
PER901	Inco901
René 65	-
Gatorized Waspaloy	-

PM — Metal powders

- Superalloy powders for aero engine rotating parts.

Main data

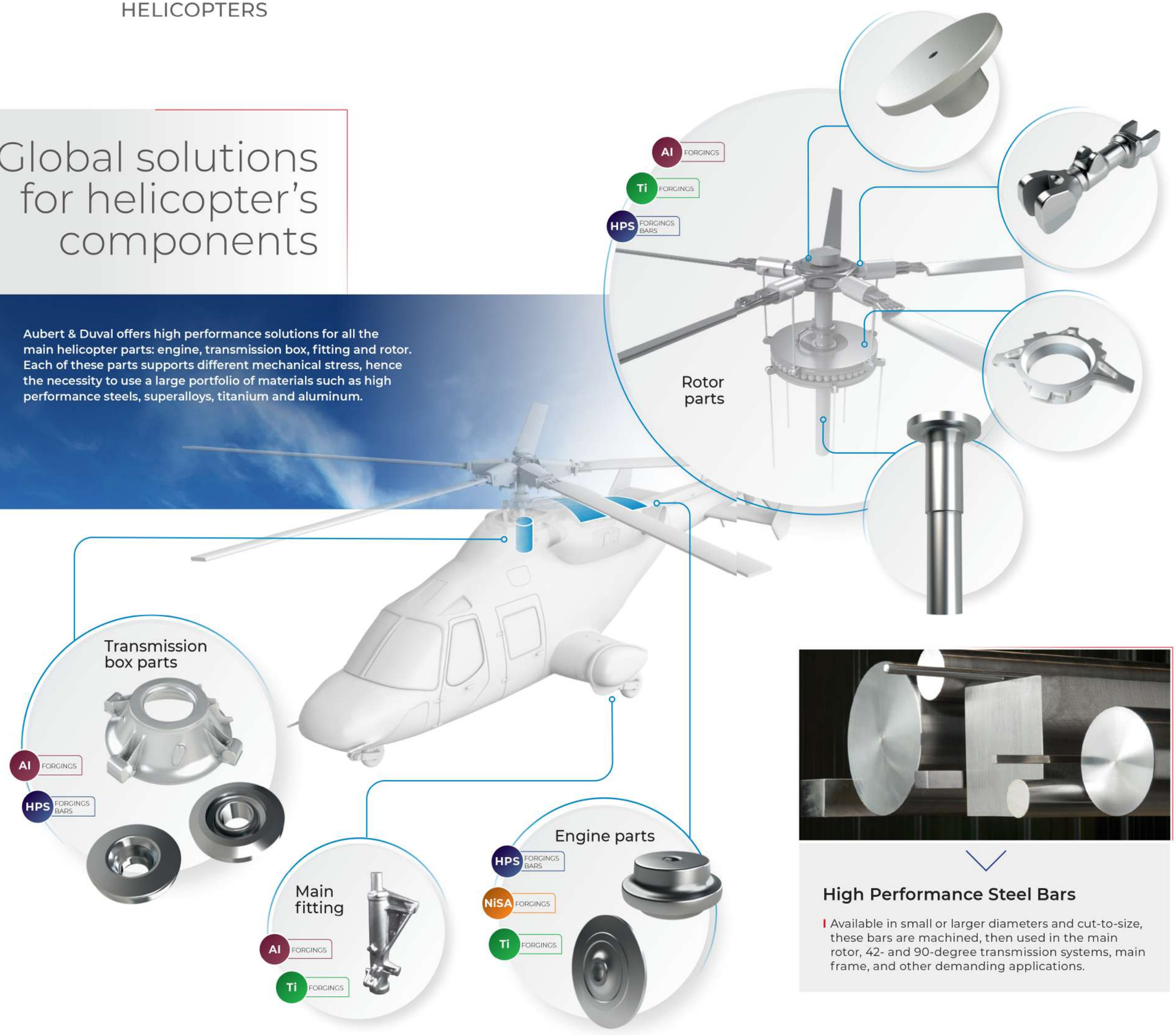
Closed-die forging parts:
- From 20 kgs (44 lbs) to 20 T (44 klbs)

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

Max length for shafts:
- 4 m (157 in)

Global solutions for helicopter's components

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.

Main materials

HPS High performance steels

Aubert & Duval grade	Common name
819AW	E35NCD16H
CX13VDW	AMS 5719
FDC®	AMS 6493
FND®	AMS 6495
GKH®YW	AMS 6481
GKP®YW	AMS 6497 - 6498
MARVAL®X12	AMS 5928
MLX®17	AMS 5937
MLX®19	AMS 5955
X15U5W	15-5PH
X17U4	17-4PH

Al Aluminum alloys

- 7175
- Airware®2050 (Al-Cu-Li)*

* Airware is a trademark owned by Constellium

Ti Titanium alloys

- TA6V
- Ti1023

NiSA Nickel-based superalloys

Aubert & Duval grade	Common name
AD730®	-
PER72	Udimet720
PER718	Inco718

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)

Setting the bars at their highest

Our customers transform our bars

Structure

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.

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.

ROUND BARS
20 ≤ Ø ≤ 500 mm

FLAT BARS
on request

SQUARE BARS
on request

SHEETS
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, GKHW®, FNDW®,** 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, 50NILYW, GKHYW®, CX13VDW, XD15NW®...)** enables the improvement of many behaviors such as **fatigue resistance, surface hardness, temperature resistance, compressive stress profile** and **corrosion resistance** (if requested).

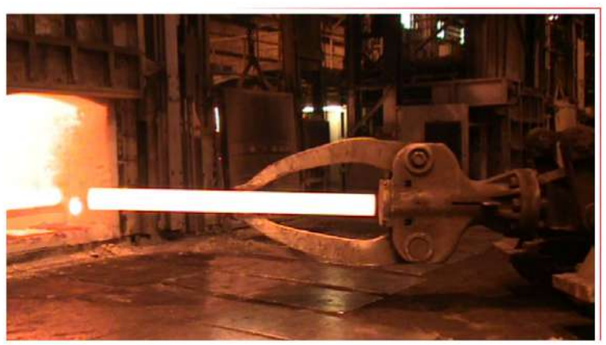
We're also constantly developing new solutions to meet new gearing and/or bearing function needs for critical applications such as gear-driven turbofans.

For transmission market, Aubert & Duval is also constantly developing new solutions to meet new gearing and/or bearing function needs for critical applications such as gear-driven turbofans.

Landing gear

MLX®19

This stainless precipitation hardening steels shows a strength of 1900 MPa (276 Ksi), and simultaneously keeps an excellent resistance to stress-corrosion cracking.
By its stainless performance, MLX®19 permits to eliminate the need for cadmium plating and to lighten the maintenance. It saves costs and is a most environmentally friendly solution.



Main materials

HPS High performance steels

	Aubert & Duval grade	Common name
Steels	50NiLYW	AMS 6278
	819B	35NiCrMo16
	FADC	9310
	FADHW	E16NiCrMo13
	FDG®	AMS 6493
	FND®W	-
	GH4	40CrMoV12
	GKH®YW	AMS 6481
	GKP®YW	AMS 6497 - 6498
	MARVAL®18	MARAGING 250
	ML18PQ	MARAGING 250
	ML340	X23NiCoCrMoAl13-6-3
	NC310YW	AMS6499
	NC40SW	300M
	RA50YW	M50
	SCV®	15CDV6
Stainless Steels	APX®	431
	APX®4	-
	CX13VDW	AMS 5719
	MARVAL®X12	AMS 5928
	MARVAL®X12H	AMS5935
	Marval®13X	PH13-8Mo
	MLX®17	AMS 5937
	MLX®19	AMS 5955
	MLX®465	AMS 5936
	X13VD	JETHETE M152
	X15U5W	15-5PH
	X17U4	17-4PH
	XD15NW®	AMS 5925
	XDBD	440C
	XN26TW	A286

NiSA Nickel-based superalloys

Aubert & Duval grade	Common name
AD730®	-
PER3	Waspaloy
PER625	Inco625
PER718	Inco718
PER72	Udimet720
PER75	Nimonic75
XSH	KC20WN

Ti Titanium alloys

TA6V
TA6V Eli

A fully integrated titanium solution

ROUND BARS
Ø 82 - 800mm

FLAT BARS
Thickness 60mm

SQUARE BARS
From 63,5mm

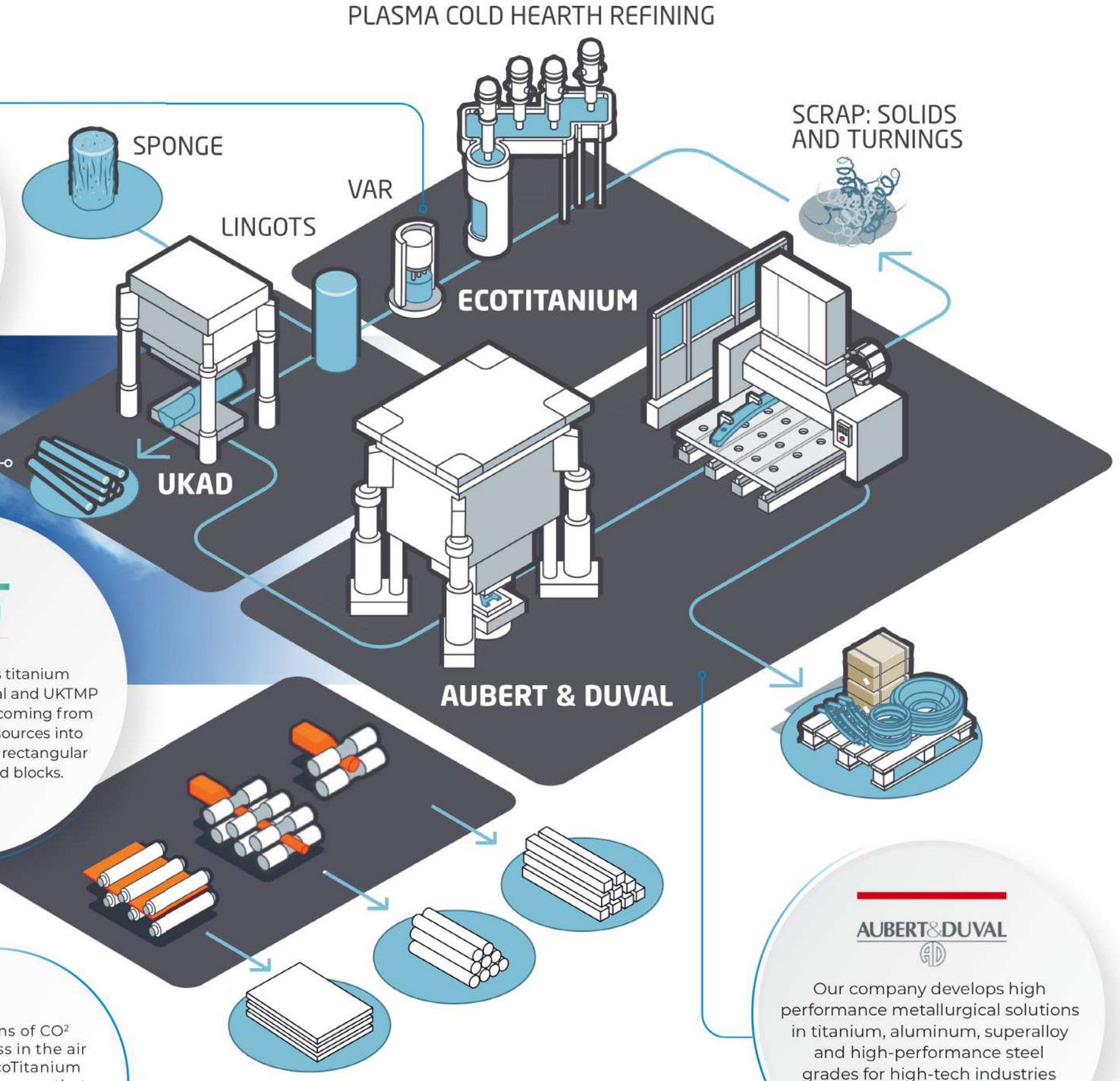
SHEETS & PLATES
from 1,6 mm to 100mm

EcoTitanium

Created by UKAD, ADEME and Credit Agricole Centre France to manufacture high quality titanium ingots using titanium scrap as feedstock (minimum content 80%).

UKAD

Created by world-class titanium specialists - Aubert & Duval and UKTMP - UKAD converts ingotes coming from EcoTitanium and other sources into forged billets, round and rectangular bars, plates and forged blocks.



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**
- **High quality standards of the aerospace industry**

100,000 tons of CO^2 emissions less in the air thanks to EcoTitanium innovative process that consumes 4 times less than primary melting route using Titanium sponge.

AUBERT&DUVAL

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,...)

Meeting the greatest of AM challenges

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**
- **Technical support**
- **Flexible service**

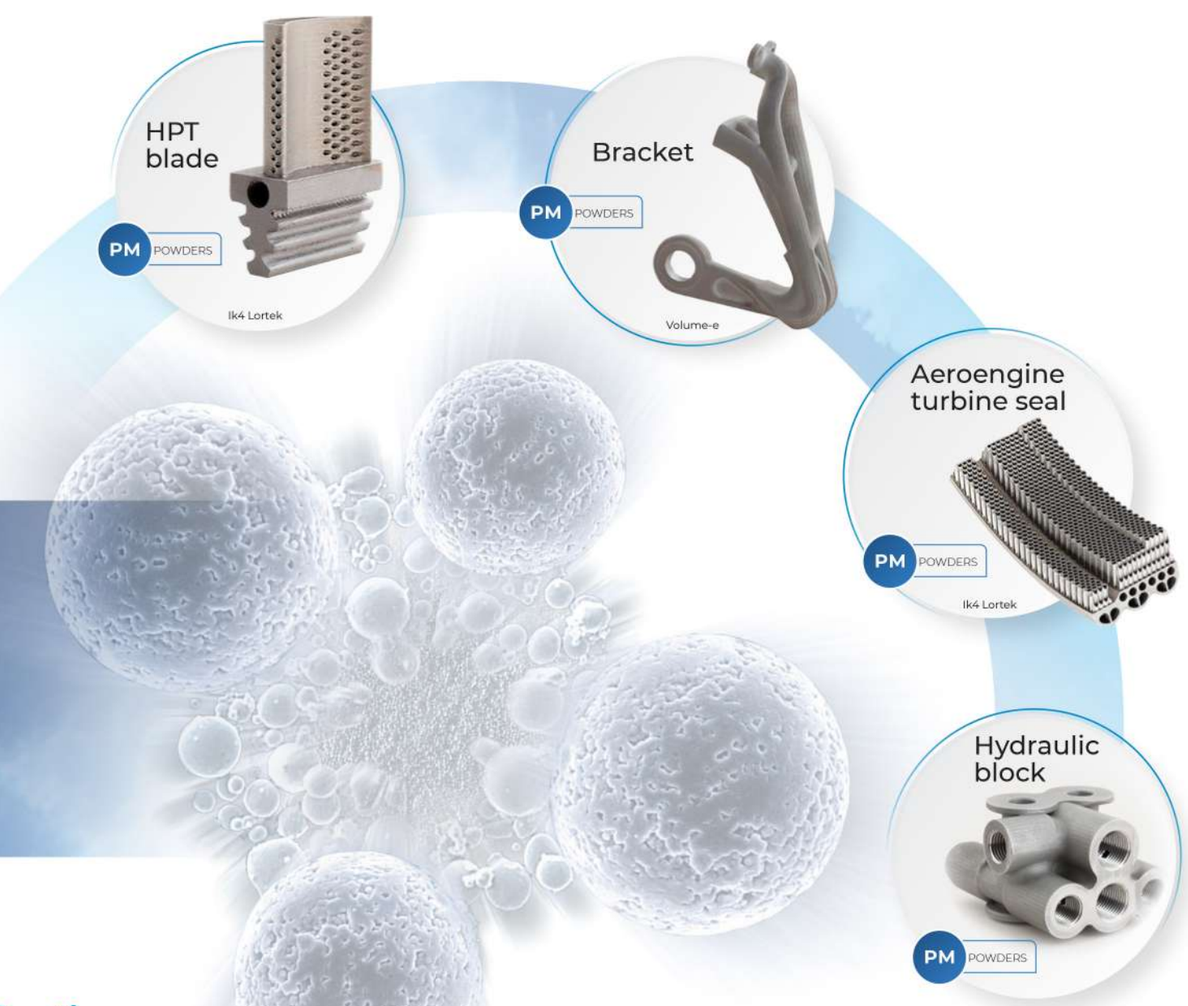
Thanks to our mindset for continuous improvement, aerospace standards and our collaborative approach in R&D, we build long-standing partnerships with the leading suppliers of critical aerospace parts.

Key features

- Melting in VIM furnace
- 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



Our production facilities

PM Main materials

NiSA Nickel-based superalloys

Aubert & Duval grade	New alloys
HX	ABD-900AM® [1]
Ni247	AD730®
Ni625	MHA3300® [2]
Ni718	
Ni738	

Ti Titanium alloys

- Ti6Al4V ELI[3]

[1] : in partnership with Alloyed
[2] : in partnership with Mitsubishi Heavy Industries
[3] : in partnership with Pyrogenesis

Powder sizes

Laser Beam Melting:
- 10-53 or 15-63 µm

Electron beam Melting:
- 45-106 µm

Direct Energy Deposition:
- 45-90 µm

Powders for AM Technology

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

Creating value through innovation

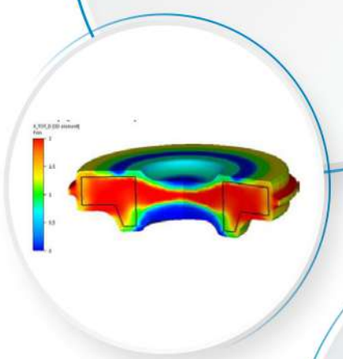
- Innovative products & increased value of legacy products
- More sustainable processes to save material and costs
- Use 4.0 Revolution to boost our innovation
- Enhance high level of knowledge in metallurgy

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

Scope of R&T Road Maps

Digitalization

- Heating furnaces & quenching processes (simulation/3D Modeling)
- Digitalization of conversion process
- Prediction modeling of residual stresses
- Tools for properties, prediction or accelerated design

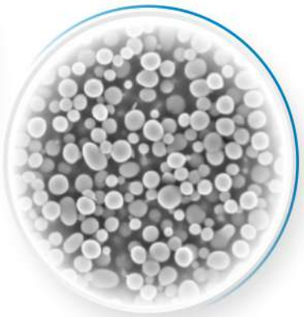


Technologies for production

- 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

Material engineering

- High Corrosion resistance PH steels (MLX®17, MLX®465, MLX®19)
- New Grades Design
- New Steel grades for transmissions
- New γ–γ' alloys forging (R65, AD730®)
- Near Net shape TA6V closed-die forging for structural parts



Manufacturing the future

Involved in the 4th industrial revolution and new emerging technologies, Aubert & Duval has set up a digital transformation plan, involving all factories and support functions.

This plan, named digitAlloys, covers 4 main areas:

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.

Technical support: driving customer success

The primary goal is to give you the best possible advice in selecting suitable materials and effective manufacturing processes and heat treatments.

Their expertise covers the final properties delivered by:

- Materials
- Part design
- Heat treatments or thermo-mechanical treatments
- Manufacturing programs
- Machining
- Or even final treatments for various materials.

Through a broad-ranging portfolio of specialist skills developed through strong, deep partnerships with customers, our technical support teams are able to help every customer, regardless of the application. They are also qualified to assist in innovative projects by solving problems and delivering the best metallurgical solutions.

As we are aware of each customer's requirements, we offer continuous, immediate and straightforward service.

AUBERT&DUVAL

Design by irweego www.irweego.com - Aubert & Duval - 06-2022
Photo credits: A. Chassin, Airbus, Shutterstock,
R. Seaman, SKF, THSA - Ratier Figeac

www.aubertduval.com