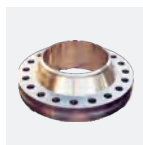


AUBERT&DUVAL



# HIGH PERFORMANCE MATERIALS FOR NUCLEAR INDUSTRY



[www.aubertduval.com](http://www.aubertduval.com)

AUBERT & DUVAL

# Your partner to energize your success



## Main materials

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

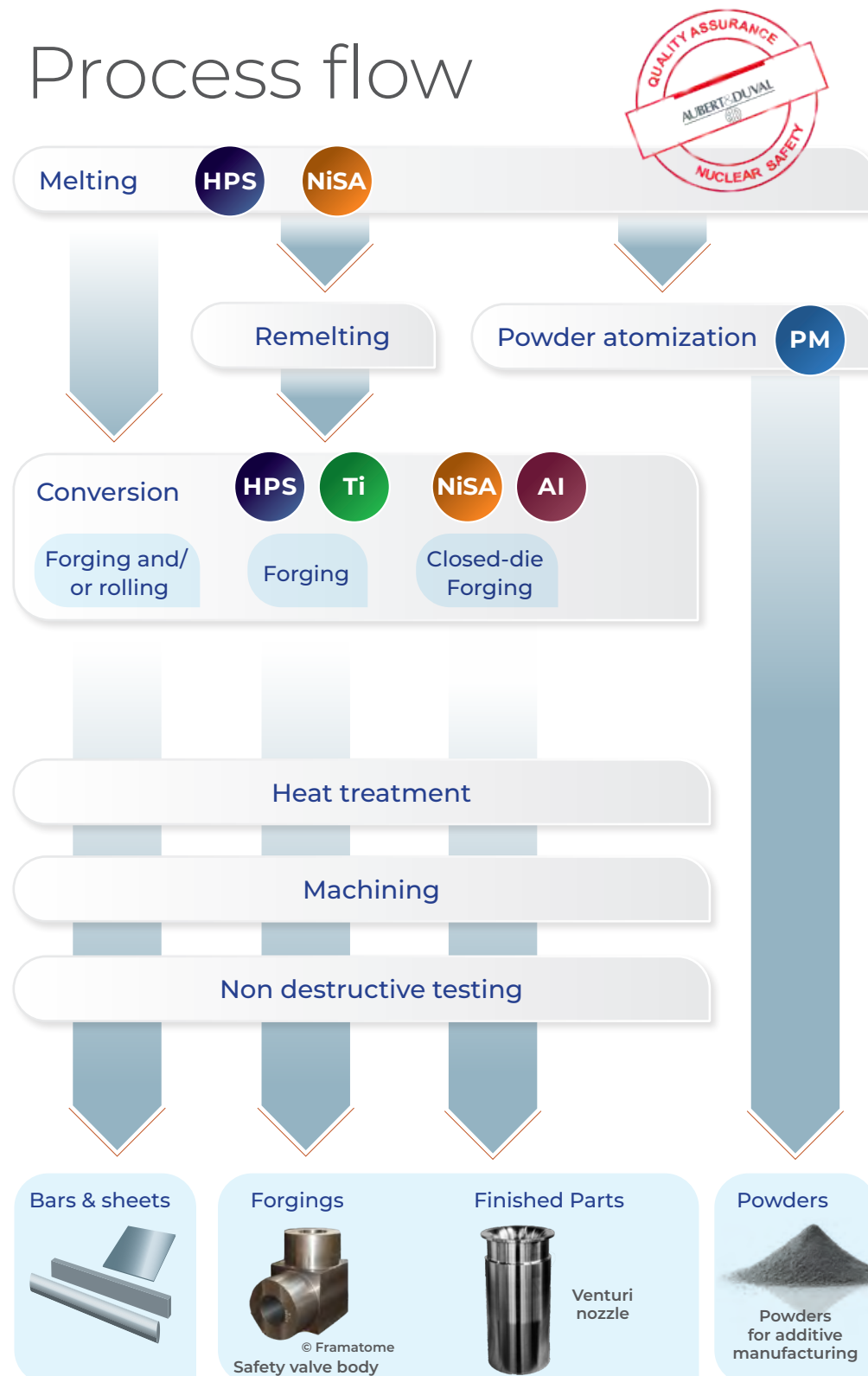
**NiSA** Nickel-based superalloys  
Materials keeping high surface integrity while withstanding severe mechanical stress in a high temperature and corrosive environment.

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

**Al** Aluminum alloys  
For specific applications combining resistance with light weight.

**PM** Metal powders  
Metal Powders (steels, superalloys) for additive manufacturing.

## Process flow



## Equipment

- MELTING**  
Melting furnaces (EAF, AOD, LF) up to 60 tons  
Vacuum Induction Melting (VIM) up to 20 tons  
Remelting furnaces (ESR, VAR) up to 30 tons  
Powder atomization (VIM, Gas) up to 1 ton
- FORGING**  
Open-die forging presses from 1,500 to 5,000 tons  
Closed-die forging presses from 4,500 to 65,000 tons
- ROLLING MILL**  
20-200 mm diameter bars
- HEAT TREATMENT**  
Solution and ageing furnaces  
Horizontal and vertical quenching equipment
- TESTING**  
Immersion UT up to 13 tons  
Automated contact UT up to 20 tons

For almost 60 years Aubert & Duval has been a key partner for the development of forged and rolled products, especially those customized for the nuclear market. With full vertical integration from melting, to remelting, hot converting and machining (rough machining through to near-net-shape parts), Aubert & Duval offers wide-ranging cutting edge capabilities for nuclear applications.

Aubert & Duval has also put in place over many decades dedicated skills to co-design re-engineered metallurgical solutions with its clients.

Aubert & Duval processes nickel-base alloys, high-performance steels, aluminum and titanium alloys.

Aubert & Duval melting capacities allow extra low cobalt achievement:

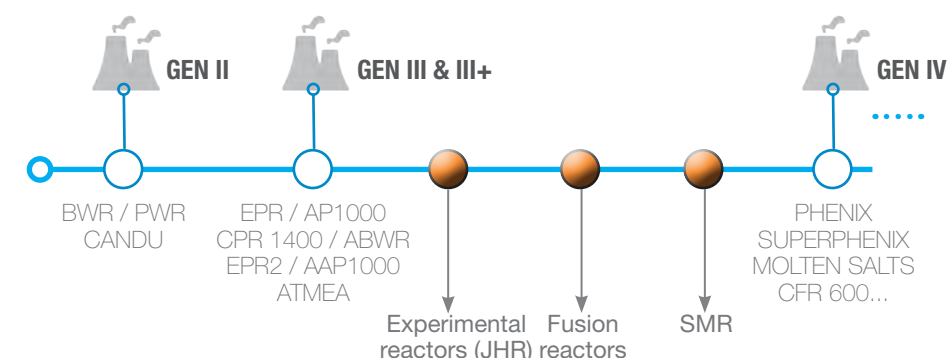
- nickel-base alloys (<150ppm)
- high performance steels (<300ppm)

Vertically integrated from the melting of ingots and atomization of powders to forging or rolling, Aubert & Duval produces:

- Bars and flats in special steels, superalloys, titanium
- Forged parts in steels, superalloys, aluminum, titanium
- Steel and superalloy powders for Additive Manufacturing

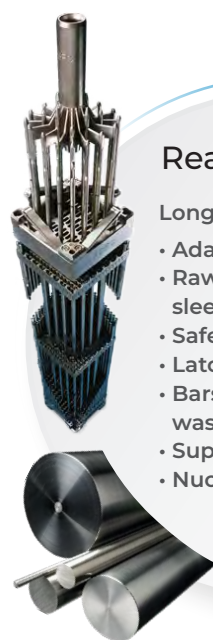
Our products are mainly used in Primary Circuit equipment. We work with our customers on metallurgical solutions for the next generations of reactors (GenIV, Small Modular Reactors, research reactors).

## Supplying for all generations of nuclear power



# HIGH PERFORMANCE ALLOYS FOR CRITICAL NUCLEAR APPLICATIONS

Combining metallurgical expertise, outstanding industrial capabilities and high manufacturing skill, Aubert & Duval is involved at each stage of primary circuit, i.e. nuclear reactor, steam generator, pressurizer, primary pump and connecting pipes. Whether working on homogenous structure of open-die forged massive parts (up to 25 tons), or wrought advanced materials with an ultra-low cobalt content, Aubert & Duval has the ambition of being a recognized manufacturer and supplier of safe, competitive nuclear solutions to help its customers meet global energy challenges.

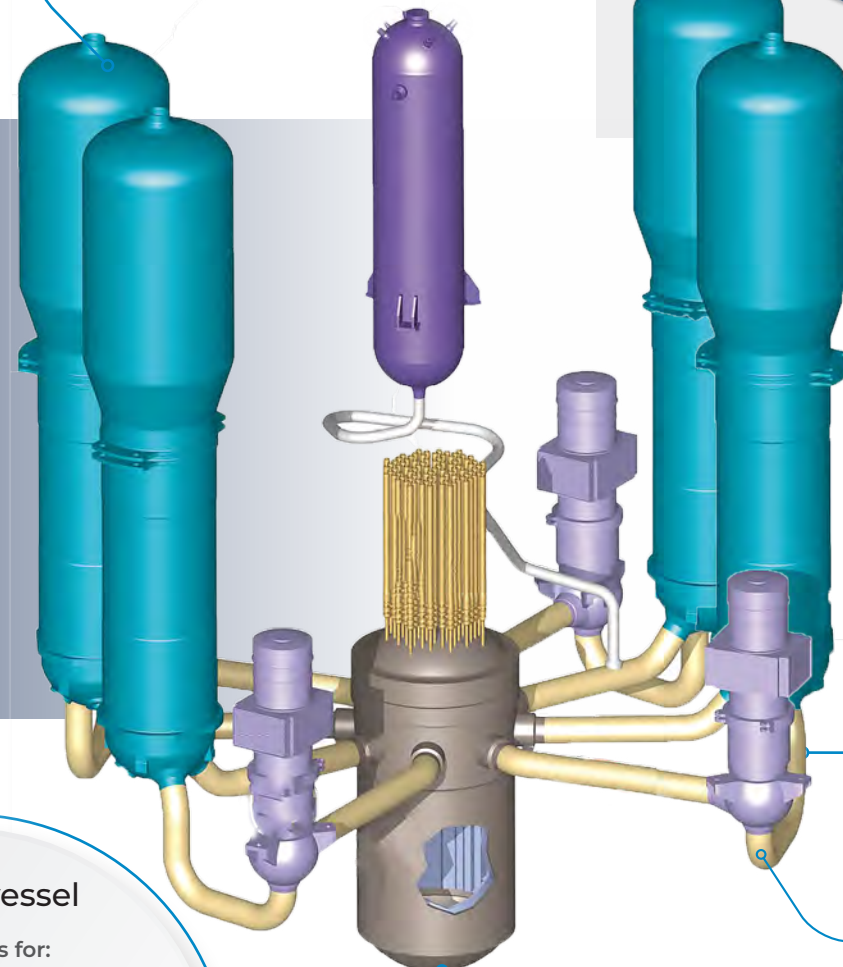
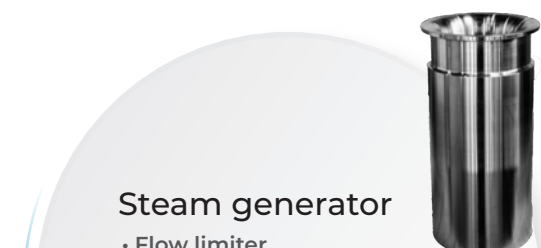


## Reactor vessel

- Long products for:
- Adaptator flanges
  - Raw material for adaptator sleeves
  - Safe end nozzles
  - Latch housing for CRDM
  - Bars for bolts, nuts and washers
  - Support blocks
  - Nuclear fuel assemblies

## Steam generator

- Flow limiter
- Bars for tubes
- Divider plate
- Nozzles and manways
- Safe end nozzles
- Safe valve bodies
- Support blocks



## Primary Pumps

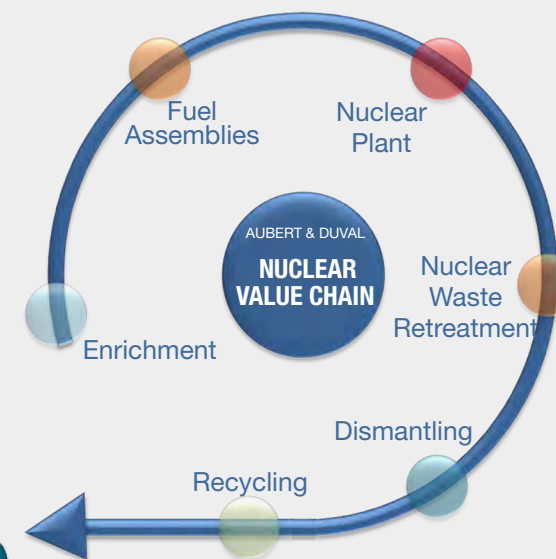
- Seal housing
- Pump shaft
- Thermal barrier
- Disc for flywheel
- Motor shaft
- Main flange
- Diffuser flange

## Connectors

- Safety valve bodies
- Surge line tubes
- Severe accident valve bodies



AUBERT & DUVAL:  
supplier for conventional  
and emerging technologies



## Main materials

### HPS

#### High performance steels

| A&D grade | Common name                  | Normes/Références             |
|-----------|------------------------------|-------------------------------|
| 16/18MND5 | 16/18MnNiMo5                 | SA 508 Gr 3/RCCM-M2119        |
| P355      | P355                         | 1.0571/NF EN 10222-4          |
| MOC2      | 42CrMo4                      | 1.7225/RCC-M5110              |
| MOCV2     | 42CrMoV4-6                   | 1.7711/RCC-M 5110             |
| 25NCD8-05 | 25NiCrMo8-05                 | RCC-M2132                     |
| 20NCD14   | 20NiCrMo14-07                | SA 508 Gr 4N Class 1/         |
| NC40M1    | 40NiCrMo7.03                 | AISI 4340 / RCC-M2312         |
| NC40M4    | 40NiCrMoV7.03                | AISI 4340/RCC-M2311-RCC-M2312 |
| SC2109    | X2CrNi 18-10                 | AISI 304L                     |
| SC2118    | X2CrNiMoNb 17-12-2           | AISI 316L                     |
| SC2283    | X10CrNiMoTi 15-15            | 15-15 Ti                      |
| X18PA     | X5CrNiTi 18-10               | AISI 321                      |
| X18NBZ    | X6CrNiNb18-11                | AISI 347                      |
| X13MA     | X12Cr13                      | AISI 410                      |
| X13BC     | X6Cr13                       | AISI 405                      |
| X17U4     | X5CrNiCuNb 17.4              | 1.4542                        |
| APX®4     | X5CrNiCu16.5.1               | 1.4418                        |
| XN26TW    | X6NiCrTiMoVB25-15-2          | A286 (Low Co)                 |
| AFA       | (alumina-forming austenitic) | In progress                   |

### NiSA

#### Nickel-based superalloys

| Aubert & Duval grade | Common name        |
|----------------------|--------------------|
| NY690                | ALLOY 690          |
| NY600                | ALLOY 600          |
| NY800                | ALLOY 800          |
| PER20N               | ALLOY X750         |
| SC8006W              | ALLOY 718 (Low Co) |
| PER625               | ALLOY 625          |

### Ti

#### Titanium alloys

| Aubert & Duval grade | Common name     |
|----------------------|-----------------|
| TiCp                 | Ti ASTM Grade 2 |
| TA6V                 | Ti ASTM Grade 5 |

### PM

#### Metal powders for AM

- 316L
- Ni625
- Ni718

Other grades on demand.

### Al

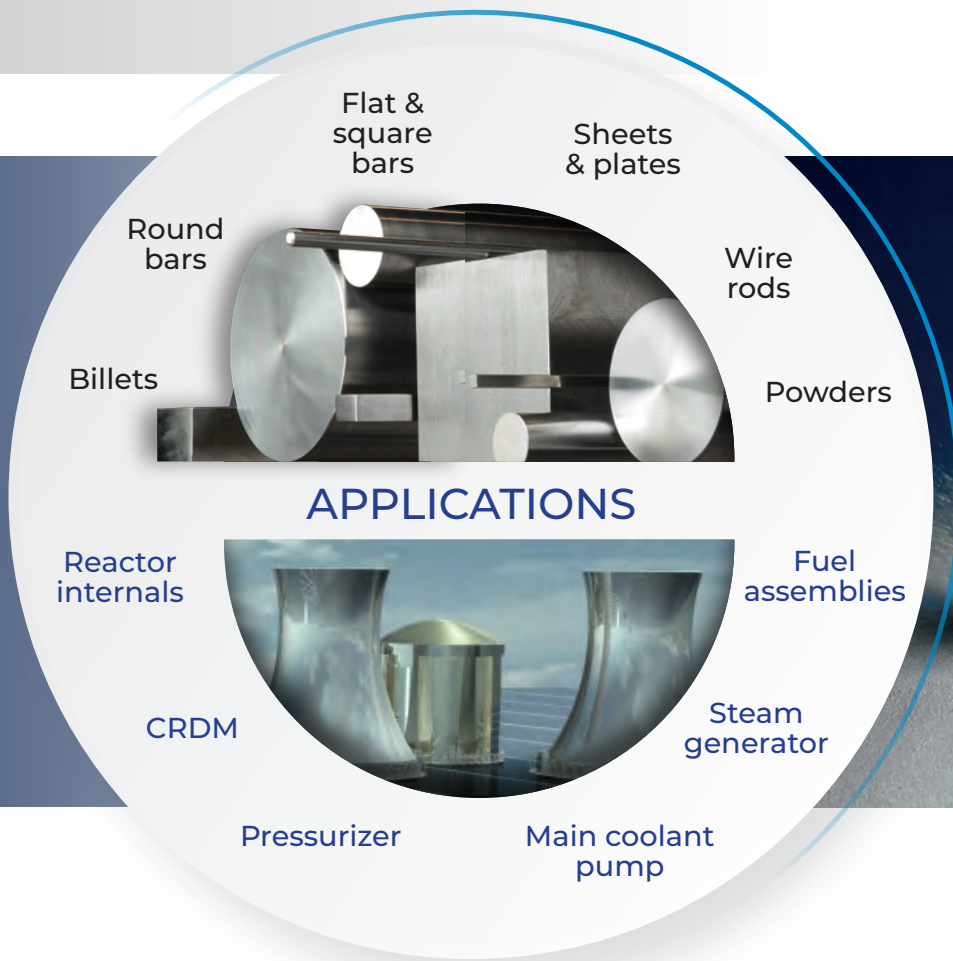
#### Aluminum alloys

- AL6061

# A complete offer of bars, plates, sheets and powders for Nuclear Power generation applications

Aubert & Duval follows the most stringent requirements in terms of grade composition, material integrity, dimension tolerances, quality documentation and quality control.

Aubert & Duval operates to RCC-M, RCC-MR, RCC-MRx, as well as to ASME code and many customer certifications.

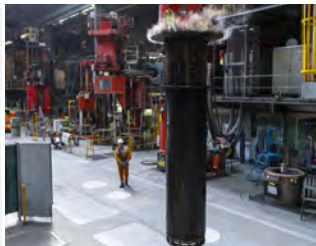


## Bars, Sheets & Plates

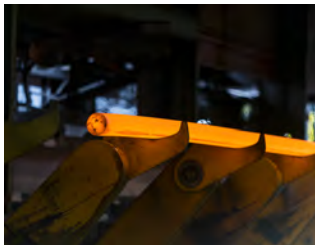
### Main sizes

|                    | mm                    | inches          |
|--------------------|-----------------------|-----------------|
| Round Bars         | Ø 20-450              | Ø 0.79-18       |
| Flat & Square Bars | T ≤ 450               | T ≤ 18          |
| Sheets             | length ≤ 2000         | ≤ 79            |
|                    | width ≤ 1000          | ≤ 39            |
|                    | thickness 10 ≤ T ≤ 20 | 0.79 ≤ T ≤ 0.39 |
| Plates             | length ≤ 6000         | ≤ 236           |
|                    | width ≤ 4000          | ≤ 157           |
|                    | thickness ≤ 150       | ≤ 5.9           |

### Main Processes



Melting / Remelting



Rolling



Forging



Heat treating

## Powders for Additive Manufacturing

### Particle size distribution

Laser Beam Melting: • 10-53 or 15-63 µm  
Electron beam Melting: • 45-106 µm  
Direct Energy Deposition: • 45-90 µm or 45-106 µm



Atomizing

### Chemical conditions

- Low Cobalt grades
- Custom-made compositions
- Ingots EAF+Refining, VIM-ESR/ VAR



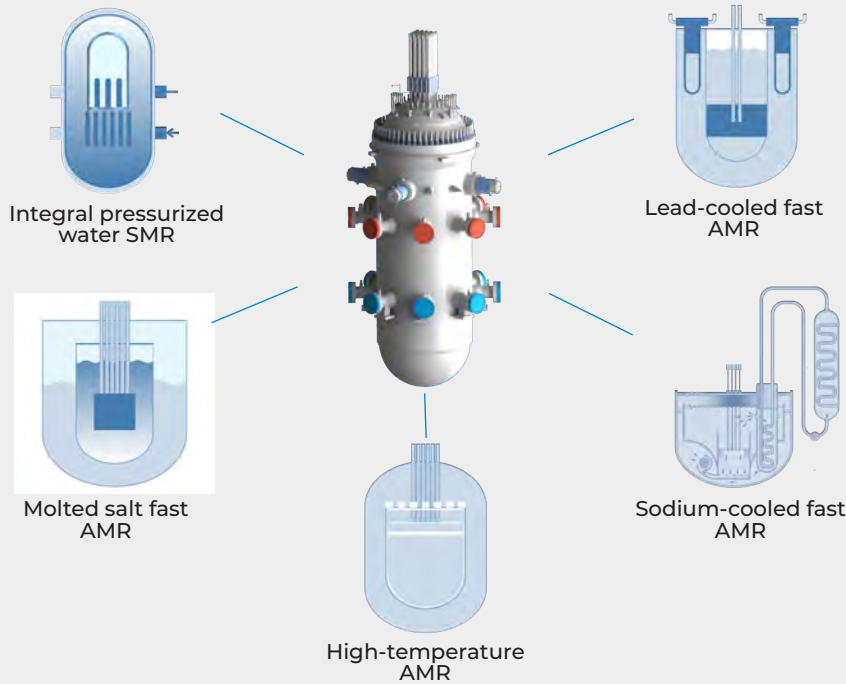
### CERTIFICATIONS AND SPECIFICATIONS

In addition to general certifications (ISO 9001, ISO 14001, ISO 18001, ISO 19443), our plant laboratories are ISO 17025 accredited by third parties.

## New generation of nuclear reactors (AMR, SMR, GEN IV...)

### Challenges:

|                             |                                                               |                                              |                                           |
|-----------------------------|---------------------------------------------------------------|----------------------------------------------|-------------------------------------------|
| HIGH TEMPERATURE RESISTANCE | ABILITY TO INNOVATE, PROVIDE ADEQUATE METALLURGICAL SOLUTIONS | CORROSION RESISTANCE IN EXTREME ENVIRONMENTS | COMPLIANCE WITH NUCLEAR QUALITY STANDARDS |
|-----------------------------|---------------------------------------------------------------|----------------------------------------------|-------------------------------------------|



### METALLURGICAL EXPERTISE FOR NEW GENERATIONS OF NUCLEAR REACTORS

- **15-15Ti** is an austenitic stainless steel with 15% Chromium, 15% Nickel doped with Titanium. It offers excellent corrosion resistance in molten salt, lead, and liquid sodium, and withstands irradiation swelling in fast neutron reactors. Aubert & Duval can produce and supply ingots, long products, and forgings from this grade.
- **Austenitic alumina-forming (AFA)** alloys are metallic materials stabilized primarily through adding nickel and aluminum. Aluminum plays a dual role: it helps maintain the austenitic phase at high temperatures and promotes the formation of a protective alumina (Al<sub>2</sub>O<sub>3</sub>) layer on the surface during oxidation. This oxide layer provides excellent resistance to high-temperature corrosion and oxidation, making these alloys ideal for harsh environment encountered in fourth generation nuclear reactors. A&D is developing an AFA-type grade for nuclear applications using artificial intelligence.

### HPS High performance steels

| A&D grade | Common name                  |
|-----------|------------------------------|
| SC2283    | 15-15-Ti                     |
| SC2104    | 316LN                        |
| AFA       | (alumina-forming austenitic) |

### NiSA Nickel-based superalloys

| Aubert & Duval grade | Common name |
|----------------------|-------------|
| NY690                | ALLOY 690   |
| PER625               | ALLOY 625   |

### PM Metal powders for AM



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