FORCEBEYOND

SUPERALLOY CASTING

Inconel 718, Inconel 625 & Vacuum Precision Casting

A Technical Guide to VIM, HIP, Alloy Selection, Near-Net-Shape Manufacturing, and Quality Control

Scope
This guide consolidates the technical claims and capability descriptions currently presented on ForceBeyond's Superalloy Casting, Inconel Vacuum Precision Casting, Inconel 718 Casting, and Inconel 625 Casting pages. The document keeps ForceBeyond-specific claims attributed to the company rather than expanding them into unsupported guarantees.

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1. Executive Summary

ForceBeyond presents superalloy casting as a precision manufacturing capability for demanding aerospace, power-generation, nuclear, marine, chemical-processing, oil-and-gas, automotive, and space applications. The current website connects the broader Superalloy Casting capability with a dedicated Inconel Vacuum Precision Casting process and material-specific Inconel 718 and Inconel 625 casting capabilities.

The current pages emphasize co-owned foundries in the USA, South Korea, and Taiwan; Vacuum Induction Melting (VIM); Lost Wax / vacuum investment casting; near-net-shape production; Hot Isostatic Pressing (HIPing); NDT; material traceability; and integration with 5-axis CNC machining.

Capability Layer	What the Current ForceBeyond Pages Emphasize
Superalloy Casting	Broad portfolio, complex geometries, NDT, material traceability, quality systems, global foundry network.
Inconel Vacuum Precision Casting	Vacuum investment casting, VIM, near-net-shape precision, process control, and Inconel alloy expertise.
Inconel 718 Casting	High-strength / high-temperature applications, VIM, HIPing, stated casting size and tolerance capability.
Inconel 625 Casting	Corrosion-resistant applications, VIM, HIPing, nuclear/marine/chemical applications, and material-specific inspection.

Important reading note
Numerical values, standards, capabilities, and application statements in this guide are presented as ForceBeyond website claims. They should be verified against the current drawing, purchase specification, material specification, customer requirements, and qualification documentation before production.

2. Superalloy Casting Capability

The current Superalloy Casting hub identifies nickel-based superalloys, cobalt-based superalloys, titanium, and specialty steels as part of the broader material portfolio. It specifically lists Inconel 718, 625, 713C, 738, Mar-M-247, Hastelloy X, Haynes 25 (L605), Stellite alloys, Ti-6Al-4V, and 17-4 PH.

Material Family	Materials Listed on Superalloy Casting Page
Nickel-based superalloys	Inconel 718, 625, 713C, 738, Mar-M-247; Hastelloy X
Cobalt-based superalloys	Haynes 25 (L605); various Stellite alloys
Titanium & specialty steels	Ti-6Al-4V; 17-4 PH

Benefits Identified on the Superalloy Casting Page

- High-temperature performance and retention of mechanical properties at elevated temperature.
- Corrosion and oxidation resistance for harsh environments.
- Mechanical strength for high-stress applications.
- Fatigue and creep resistance.
- Design flexibility for complex geometries.
- Dimensional stability under demanding operating conditions.
- Tailored alloy compositions for specific performance requirements.
- Wear resistance and long service life.

3. Inconel Vacuum Precision Casting

ForceBeyond describes its Inconel Vacuum Precision Casting capability as high-performance vacuum investment casting supported by co-owned foundries in the United States, South Korea, and Taiwan. The page states that all facilities utilize VIM technology and emphasizes direct operational oversight, supply-chain redundancy, and near-net-shape precision.

Primary Inconel Grades Listed

Alloy	Key Characteristics Stated	Typical Components Listed
Inconel 718	Exceptional yield, tensile, and creep-rupture properties up to 1300°F	Turbine blades, rocket engine parts, high-strength bolts
Inconel 625	Superior fatigue strength; resistance to pitting and crevice corrosion	Marine exhaust systems, chemical processing, fuel manifolds
Inconel 713C	Resistance to thermal fatigue and oxidation at high temperatures	Turbocharger wheels, gas-turbine hot-section components
Inconel X-750	Resistance to chemical corrosion and oxidation with high tensile strength	Pressure vessels, heat exchangers, rocket thrust chambers

Process Elements Listed

- Vacuum Induction Melting (VIM) to prevent oxidation of reactive elements such as aluminum and titanium.
- Robotic shelling for consistent ceramic shell thickness on complex, thin-walled geometries.
- Controlled thermal processing and in-house heat treatment.
- 100% material traceability.
- Level I & II X-ray, Fluorescent Penetrant Inspection (FPI), and tensile testing.

4. Inconel 718 Casting

The dedicated Inconel 718 page describes ForceBeyond as a supplier of mission-critical Inconel 718 castings for aerospace, space exploration, and power generation. It identifies VIM, co-owned facilities in the USA, South Korea, and Taiwan, and a casting capability up to 32 inches with weights from 0.02 to 220 pounds.

Inconel 718 Item	Current Website Statement
Material	Inconel 718 / UNS N07718
Melting route	Vacuum Induction Melting (VIM)
Casting size	Up to 32 inches
Casting weight	0.02–220 lb
Typical tolerance	ISO 8062 CT7 to CT5 / VDG P690 D1 to D2
Temperature statement	Creep-rupture strength up to 1300°F (700°C)
Process / post-processing	Vacuum casting and HIPing
Rapid prototyping	3D-printed wax patterns are stated for rapid prototypes

718 Mechanical Properties Stated on the Site

Property	Typical Cast & Aged Value
Tensile strength	125,000 psi (860 MPa)
Yield strength	110,000 psi (760 MPa)

Elongation	5–10%

The 718 page also identifies AS9100 requirements and describes HIPing as a method used to eliminate internal microporosity. The page lists radiographic testing, FPI, spectrographic analysis, and mechanical testing as part of its quality approach.

5. Inconel 625 Casting

The dedicated Inconel 625 page positions 625 around corrosion resistance in aggressive thermal and corrosive environments. It specifically highlights nuclear/SMR, subsea oil and gas, advanced chemical processing, marine/subsea, and aerospace applications.

Inconel 625 Item	Current Website Statement
Material	Inconel 625 / UNS N06625
Referenced standards	AMS 5581; ASTM B443
Tensile strength, cast & annealed	120,000–150,000 psi (827–1034 MPa)
Yield strength, 0.2% offset	60,000–95,000 psi (414–655 MPa)
Density	0.305 lb/in^3 (8.44 g/cm^3)
Melting range	2350–2460°F (1290–1350°C)
Temperature statement	Tensile and fatigue properties stated from cryogenic temperatures up to 1800°F (982°C)
Casting size / weight	Up to 32 inches and 220 lb

625 Corrosion and Application Positioning

- Resistance to pitting and crevice corrosion.
- Resistance to chloride-ion stress-corrosion cracking.
- Positioned for seawater and acidic environments.
- Applications include primary reactor cooling loops, fuel-element spacers, waste-management hardware, seawater piping, subsea connectors, chemical-processing equipment, and aerospace exhaust/fuel-manifold components.

The 625 page also identifies VIM, HIPing, X-ray/radiography, corrosion testing, positive material identification, and FPI as part of the stated quality and processing approach.

6. Inconel 718 vs. Inconel 625: Material Screening

Factor	Inconel 718	Inconel 625
Primary ForceBeyond positioning	High-temperature mechanical strength and creep-rupture performance	Corrosion resistance and environmental resilience
Key environments emphasized	Aerospace, space, power generation, gas-turbine / cryogenic applications	Nuclear/SMR, marine/subsea, chemical processing, aerospace
UNS	N07718	N06625
Material standard examples on dedicated pages	AMS 5383; ASTM B637	AMS 5581; ASTM B443
Casting size / weight stated	Up to 32 in; 0.02–220 lb	Up to 32 in; up to 220 lb

Selection rule
The current ForceBeyond pages frame 718 as the choice when high-temperature mechanical strength and creep performance are primary concerns, while 625 is framed around corrosion and oxidation resistance in aggressive environments. This is a website-based screening distinction, not a substitute for formal materials selection.

7. HIPing and Internal Microporosity

ForceBeyond's current casting pages identify Hot Isostatic Pressing (HIPing) as an important post-processing operation for mission-critical castings. The company describes HIPing as applying high pressure and temperature simultaneously to eliminate or heal internal voids and microporosity and states that it is used to increase density.

- On the Superalloy Casting hub, HIPing is positioned as an advanced post-processing operation for internal microporosity.
- The 718 page links HIPing with internal microporosity control for mission-critical parts.
- The 625 page identifies HIPing for safety-critical nuclear/SMR applications.
- The exact HIP cycle is not specified in these web pages and therefore is not prescribed in this guide.

Do not over-interpret the claim
The website uses strong commercial language such as '100% density' and 'zero-defect.' This white paper preserves those as ForceBeyond claims rather than presenting them as an independently verified universal result.

8. Quality Assurance and NDT

Inspection / Control	Current ForceBeyond Website Description
X-Ray / Radiography	Detect internal microporosity, inclusions, or shrinkage in cast components.
Fluorescent Penetrant Inspection (FPI)	Detect surface-breaking cracks and porosity.
Ultrasonic Testing (UT)	Listed on the Superalloy Casting hub for internal inspection.
Spectrographic / chemical analysis	Verify alloy composition / positive material identification.
Tensile testing	Listed on the Inconel Vacuum Precision Casting page and material-specific pages.
CMM dimensional audit	Listed on the Superalloy Casting hub for complex geometries.
Material traceability	The site states 100% material traceability.
Quality systems	AS9100 and ISO 9001 are stated on the Superalloy Casting hub.

Material-specific inspection requirements differ by alloy and application. For example, the Inconel 625 page additionally identifies ASTM G28 corrosion testing and ASTM E192 / ASTM E1030 radiography.

9. Casting vs. Forging

ForceBeyond presents casting and forging as complementary manufacturing routes. The Superalloy Casting page identifies casting as advantageous for complex internal geometries, while the Superalloy Forging page positions forging for components where grain refinement, structural density, and fatigue performance are more important.

Feature	Vacuum Investment Casting	Superalloy Forging
Complexity	High; complex internal geometries	Low to medium; simpler shapes

Grain structure	Cast structure	Refined / directed grain flow
Material waste	Minimal / near-net-shape	Higher; more machining may be required
Typical uses listed	Turbine vanes, housings, manifolds	Turbine disks, shafts, rings

10. Manufacturing Flow

1. Review the part drawing, material specification, service environment, and inspection requirements.
2. Select the alloy and casting route appropriate to the component.
3. Develop the Lost Wax / investment-casting process and ceramic shell.
4. Melt and pour the alloy using Vacuum Induction Melting (VIM).
5. Control casting and thermal-processing conditions.
6. Apply HIPing when required by the applicable program or specification.
7. Perform required NDT, material identification, and mechanical testing.
8. Perform dimensional inspection and secondary machining as required.
9. Complete material certification, traceability, and final documentation.

Only the process elements specifically described on the ForceBeyond pages are represented as ForceBeyond capabilities here; the sequence above is a consolidated workflow rather than a proprietary process specification.

11. Applications

Industry	Applications Stated Across Current Casting Pages
Aerospace & Defense	Propulsion systems, structural engine components, vane segments, turbine blades, exhaust systems, fuel manifolds
Power Generation	Industrial gas-turbine components, combustor components, heat exchangers
Nuclear / SMR	Primary reactor cooling loops, fuel-element spacers, waste-management hardware
Marine / Subsea	Marine exhaust systems, seawater piping, subsea cable connectors
Chemical Processing	Reaction vessels, heat exchangers, valves, piping, fittings, fuel manifolds
Oil & Gas	Subsea and high-corrosion components
Automotive	Turbocharger wheels and high-temperature engine components
Space Exploration	Cryogenic valves, high-pressure turbopumps, rocket-engine manifold hardware

12. Frequently Asked Engineering Questions

What is ForceBeyond's superalloy casting capability?

The current site describes precision casting for nickel-based superalloys, cobalt-based superalloys, titanium, and specialty steels, with VIM, NDT, traceability, and a global co-owned foundry network.

What is Inconel vacuum precision casting?

ForceBeyond describes it as high-performance vacuum investment casting supported by VIM and a co-owned foundry network in the USA, South Korea, and Taiwan.

Which Inconel grades are specifically listed for vacuum precision casting?

The dedicated page lists Inconel 718, 625, 713C, and X-750.

Why is VIM used?

ForceBeyond states that VIM helps prevent oxidation and control impurities / dissolved gases in the melt.

Can ForceBeyond cast thin-walled components?

Yes. The vacuum precision casting page specifically describes robotic shelling for complex, thin-walled geometries, and the Superalloy Casting hub describes near-net-shape complex geometries.

When should I consider Inconel 718?

The current 718 page emphasizes high-temperature strength, creep-rupture performance, and applications in aerospace, space, and power generation.

When should I consider Inconel 625?

The current 625 page emphasizes corrosion resistance, including pitting, crevice corrosion, and chloride-ion stress-corrosion cracking, especially for nuclear, marine/subsea, and chemical environments.

What is the stated 718 casting size?

Up to 32 inches, with casting weights from 0.02 to 220 pounds.

What is the stated 625 casting size?

Up to 32 inches and 220 pounds.

What inspection methods are listed?

X-ray/radiography, FPI, UT, spectrographic or chemical analysis, tensile testing, and dimensional inspection are listed across the relevant pages.

Does ForceBeyond integrate machining with casting?

The current Superalloy Casting and Superalloy Machining pages describe integration with in-house 5-axis CNC machining under the Tier-1.5 model.

13. Global Manufacturing and Tier-1.5 Integration

ForceBeyond's current casting pages describe co-owned production assets in the USA, South Korea, and Taiwan. The company positions the model as providing direct operational oversight and supply-chain redundancy.

- USA operations are described as supporting rapid prototyping, DFM engineering, and specialized production runs.
- South Korea is described as supporting high-precision power-generation and aerospace components.
- Taiwan is described as supporting scalable, high-capacity production.
- The Tier-1.5 model connects casting with specialized 5-axis CNC machining centers.

14. Technical References

The following ForceBeyond pages were used as the primary source set for this white paper. The document intentionally avoids adding numerical specifications or ForceBeyond-specific process claims that are not supported by these pages.

Superalloy Casting: https://www.forcebeyond.com/superalloy-casting/

Inconel Vacuum Precision Casting: https://www.forcebeyond.com/inconel-vacuum-precision-casting/

Inconel 718 Casting: https://www.forcebeyond.com/inconel-718-casting/

Inconel 625 Casting: https://www.forcebeyond.com/inconel-625-casting/

Superalloy Machining: https://www.forcebeyond.com/superalloy-machining/

Technical Disclaimer

This document is a general technical reference based on ForceBeyond's public website content available during preparation. It does not replace an applicable material specification, drawing, purchase specification, code, customer requirement, qualification plan, or engineering analysis. Casting size, weight, tolerance, mechanical properties, inspection requirements, HIP conditions, and service limits may vary by alloy, geometry, process qualification, and governing specification. Verify all requirements against the current controlled technical documentation before production or design release.