



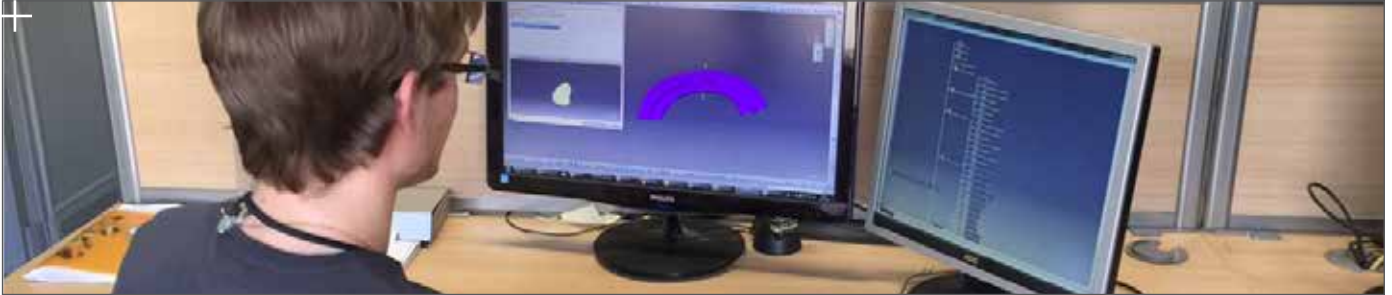
# FERRY CAPITAIN

## CAST TOOLING FOR AEROSPACE PROCESSES

INVAR & REFRACTORY STEEL MATERIALS



## MECHANICAL DESIGN ENGINEERING



**FERRY CAPTAIN's** development engineers, in partnership with our customers' design departments, utilize finite elements analysis (FEA) software to achieve optimized mechanical stress profiles within the cast tooling designs used in the manufacture of aerospace components.

Catia V5 - FEMAP V11 - NASTRAN V10 - TOP SOLID - NOVA FLOW - NOVA CAST

## CASTING GEOMETRY OPTIMIZATION

Decades of **FERRY CAPTAIN** experience in the production of large, complex castings for a wide range of critical applications in the nuclear, naval, offshore and hydro industries, to cite just a few, is also being applied to full benefit in the aerospace sector.

By simulating the mold filling and casting solidification processes, our foundry engineers are able to ensure that sound cast tooling is produced right the first time, without the need for expensive and time consuming prototype trials.

Through the combination of mechanical design optimization and casting process simulation, the end result is a cast tooling product that may offer distinct cost and performance advantages when compared to fabricated alternatives.

- + Cast tooling from 300 Kg to 50 tons
- + Convert fabricated tooling to single pieces castings
- + With fabricated or cast egg-crates
- + Complex shape
- + Parts of varied sizes
- + Thin wall castings for improved heat transfer



Composite mold - Invar

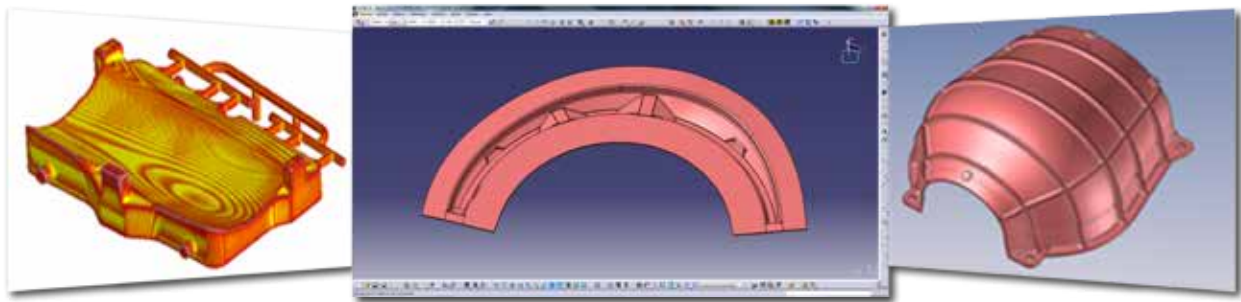


Acoustic panel tool  
Ferrynox N36 - 13t -  $\varnothing$ 3,5m



Rotor blade mold  
Ferrynox A36  
8m long

➤ *Casting simulation & FEA to optimize tooling designs*



➤ *FASTFORM molding process used to produce tooling castings without a pattern*

## PATTERNLESS MOLDING TECHNIQUE

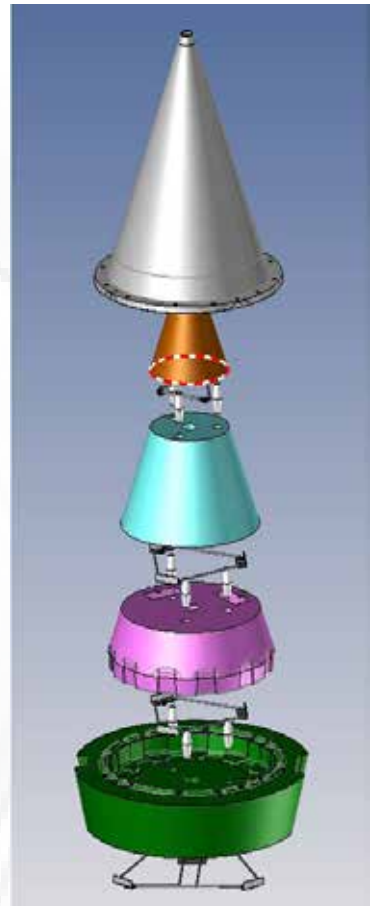
**FERRY CAPITAIN** utilizes a state-of-the-art mold manufacturing technique to produce castings without the need of expensive patterns and core boxes requiring multiple weeks of fabrication. It also allows for the production of complex casting geometries that may not otherwise be possible using traditional pattern molding techniques.

The FastForm process starts with a 3-D model of the cast component to be manufactured. The model is then transformed into multiple individual mold components, which are then machined from blocks of sintered casting sand using a custom 5-axis machining center.

The individually-machined mold components are assembled to produce the overall casting mold. Considering that a mold may be comprised of an unlimited number of subcomponents, there is no dimensional limit to the size of part that may be produced using this technique.

Castings from a few hundred kilograms to over 50 tons in unit weight can be produced using this method.

The use of the FastForm technique results in parts with high dimensional stability and consistency, very good as-cast surface finish, and limited excess surface stock material that is typical with pattern use due to draft and shrinkage allowances.



- + No pattern required
- + Unlimited size range
- + Precise mold geometry
- + Near net shape
- + Reduced lead-times

Mold assembly



Core cowl - Ferrynox N36 - 700 Kg



FASTFORM view



➤ Superior casting alloys covering a full range of operating conditions

## PROPRIETARY MATERIALS

**FERRY CAPITAIN**, with a continued emphasis on material and process development, has established, and continues to expand upon, its proprietary range of Ferrynox alloys for use in all types of aerospace tooling applications : Hot Forming (HF), Superplastic Forming (SPF), Diffusion Bonding (DB), and Composite Curing.

The production of low thermal expansion alloys and high temperature refractory alloys is enhanced through the use of a 15-ton capacity AOD converter, resulting in materials with low levels of residual elements and superior mechanical properties.



### + Forming Alloys:

	Working temperature	Creep Strength			
		Rupture (Mpa)		1% elongation (MPa)	
		100 h	1000 h	1000 h	10 000 h
Ferrynox 25 HF die applications	700° C	100	80	/	65
Ferrynox 37 SPF & DB processes	925° C	32	24	19	/
Ferrynox 52S SPF & DB processes	950/980° C	33	24	19	/

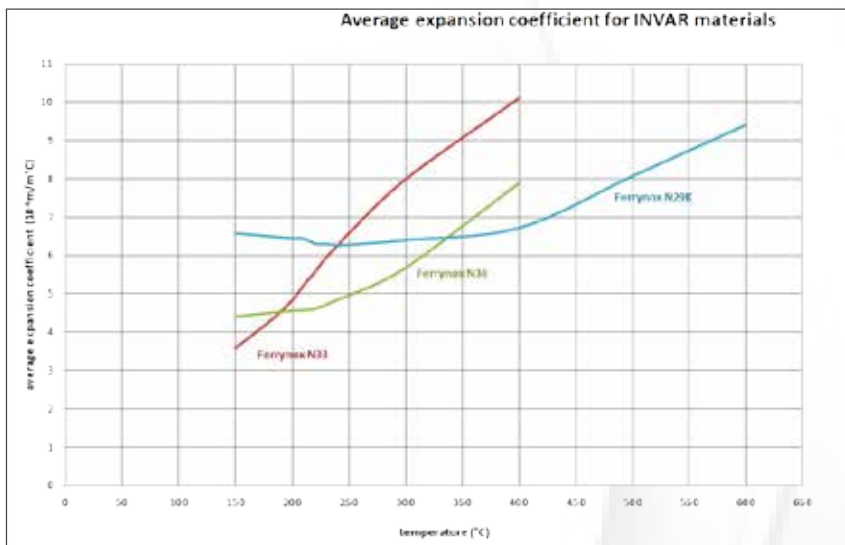
## MATERIALS R&D

Our metallurgical research & development team has at its exclusive disposal a 250 kg capacity pilot production furnace, used to develop and refine custom alloys, and to produce small scale sample components for testing and evaluation purposes.



+ Castable Invar® Equivalent Alloys:

	At room temperature			At high temperature			
	UTS (MPa)	0,2% YS (MPa)	E (%)	Temp.	UTS (MPa)	0,2% YS (MPa)	E (%)
<b>Ferrynox A36</b> Composite curing processes up to 180°C	390	220	45	180°C	290	120	28
<b>Ferrynox N33</b> Composite curing processes between 180°C to 250°C	430	270	17	180°C	340	140	20
<b>Ferrynox N36</b> Composite curing processes between 180°C to 250°C	420	260	18	300°C	330	110	24
<b>Ferrynox N29K (patented)</b> High temperature polyamide curing processes up to 450°C	450	280	20	400°C	320	140	25



Acoustic panel segment  
Ferrynox N33 - 4t



Tail mandrel tool - Ferrynox N36 - 3,5t



Cast egg-crates

➤ *Extensive in-house metallurgical testing capability for production & development work*

## ▶ METALLURGICAL LABORATORY

The ability to properly characterize a full range of key material properties is critical for aerospace tooling applications.

**FERRY CAPITAIN's** metallurgical laboratory is fully equipped to support both the development of custom-tailored alloys and the monitoring of on-going production. Chemical composition, micrography, creep resistance, thermal expansion and other mechanical properties are all determined using some of the latest technology available to the metal casting industry.



### SPECTROMETER

#### SPECTROLAB M11

- + Hybrid optical system
- + Fe and Ni matrices
- + 30 elements (trace to 10 ppm)

### MICROSCOPE

#### NIKON ECLIPSE MA 200

- + 1000x magnification
- + Camera and image analysis software



### DILATOMETER

#### UNITHERM 1161

- + High temperature vertical dilatometer
- + Ambient to 1650°C
- + Vacuum and inert atmospheres
- + For Coefficient of Thermal Expansion (CTE) measurement

### CREEP TESTER

#### TCN 30

- + 1200 °C operating range
- + 20 KN capacity

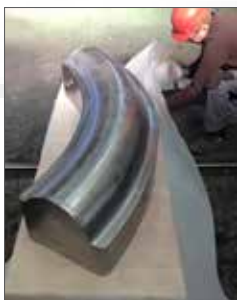


➤ *Full range of machining & large dimension inspection means*

## FINISH-MACHINING CAPABILITY

**FERRY CAPITAIN**, with over 200 modern machine tools installed within its facilities, capable of handling parts from 1m to 16m in length or diameter, and unit weights from a few hundred kilograms to 450 tons, supplies the majority of the parts it produces in a finish-machined condition.

From a multitude of 5-axis CNC milling machines, aerospace tooling components requiring tight-tolerance, countoured -surface machining are produced with exacting precision.



*HF Tool*



*Satellite interface - 2,5t*



*SPF mold*

+ As-cast, rough-machined, & finish-machined tooling

+ Large finish-machining capability



*Engine lip - SPF tool - Ferrynox 37 - 6t*



*Fan - Ferrynox N36 - 740Kg*

## Large Dimension Inspection



*Leitz 3D*

The dimensional inspection of large, heavy, complex-geometry components is facilitated through the use of our Leitz 3-D co-ordinate measuring machine (CMM).

Measuring envelope : 5,4 m x 7,5 m x 3,8 m

Table capacity: 70 tons



A Groupe CIF Company



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