

**Advanced Manufacturing
Research Centre**



AMRC Castings
Capability directory



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AMRC Castings develops new castings technologies and provides advanced manufacturing capabilities and expertise to the castings industry.

Conducting research into materials and casting processes, for aerospace and other high-value manufacturing sectors, allows AMRC Castings to help our industrial and academic partners improve their global competitiveness. Our unique un-biased position ensures that this can be done for the benefit of the castings industry and the sectors in which castings are, or could be used.

Having developed extensive expertise in melting, casting and processing a wide range of alloys including reactive metals and the vacuum melting of super alloys; AMRC Castings can offer expert advice on casting design, shell systems, melting, feeding and gating, casting methodologies and processing castings; made from a range of vacuum and air melted metals.

Our research is steered by the work we do in partnership with our global members, highlighting areas that will lead to funded projects and can deliver real benefits to original equipment manufacturers and their supply chains.

Our research and development projects fall into two categories:

Funded projects

Innovative projects carried out on behalf of the AMRC partners, with results presented to all partners. These projects are usually funded by outside agencies such as the Technology Strategy Board, European Framework Program, or other external body, and may involve collaboration with external research and industrial partners.

Bespoke projects

Specific projects can be commissioned from individual partners. The partner invests directly in the research and has exclusive access to the outputs of the project.

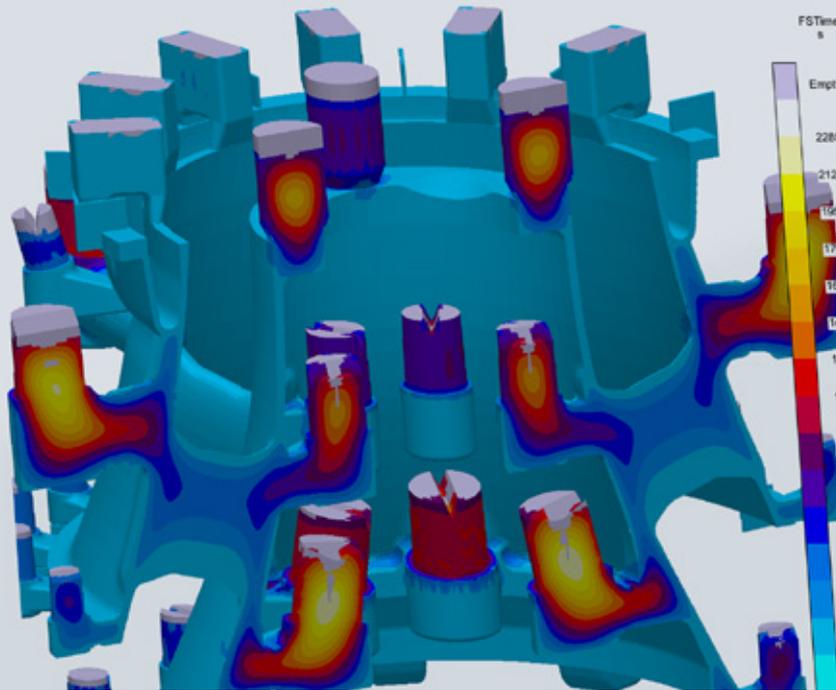
AMRC Castings is part of the University of Sheffield Advanced Manufacturing Research Centre (AMRC).

If you have any enquiries about research projects or our capabilities, please contact:

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AMRC Castings uses two highly sophisticated software programmes to simulate casting manufacture.

Design engineers use these software programmes to simulate fluid flow, solidification of the metal in the mould and predict any associated defects; optimising designs and facilitating the production process of components.

AMRC Castings has considerable experience in simultaneous engineering and by means of electronic data interchange, working on projects for companies around the world.

MAGMASOFT®

We use the following MAGMASOFT® design modules:

- Standard casting
- Iron casting
- Stress
- High pressure die casting
- Low pressure die casting
- Specialised process - rollover and tilt
- Specialised process - investment casting

ProCAST Simulation Suite

We use ProCAST simulation suite with one seat with the standard module, including the capabilities to create Titanium datasets.

MAGMASOFT® and ProCAST allows AMRC Castings to design castings and the method of production, covering most casting processes including sand moulding, investment shell, gravity die casting, high and low pressure die casting and some of the more specialised processes listed above, in most alloys ranging from iron, steel and aluminium through to Titanium.

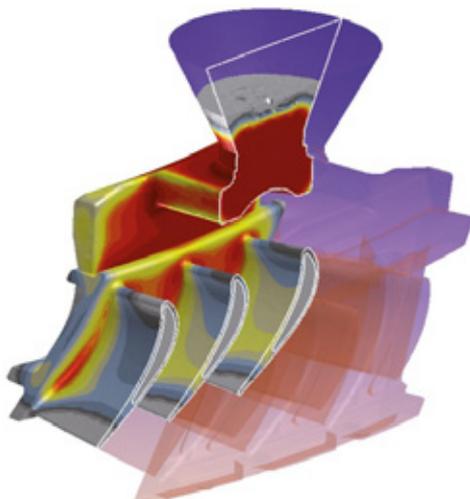
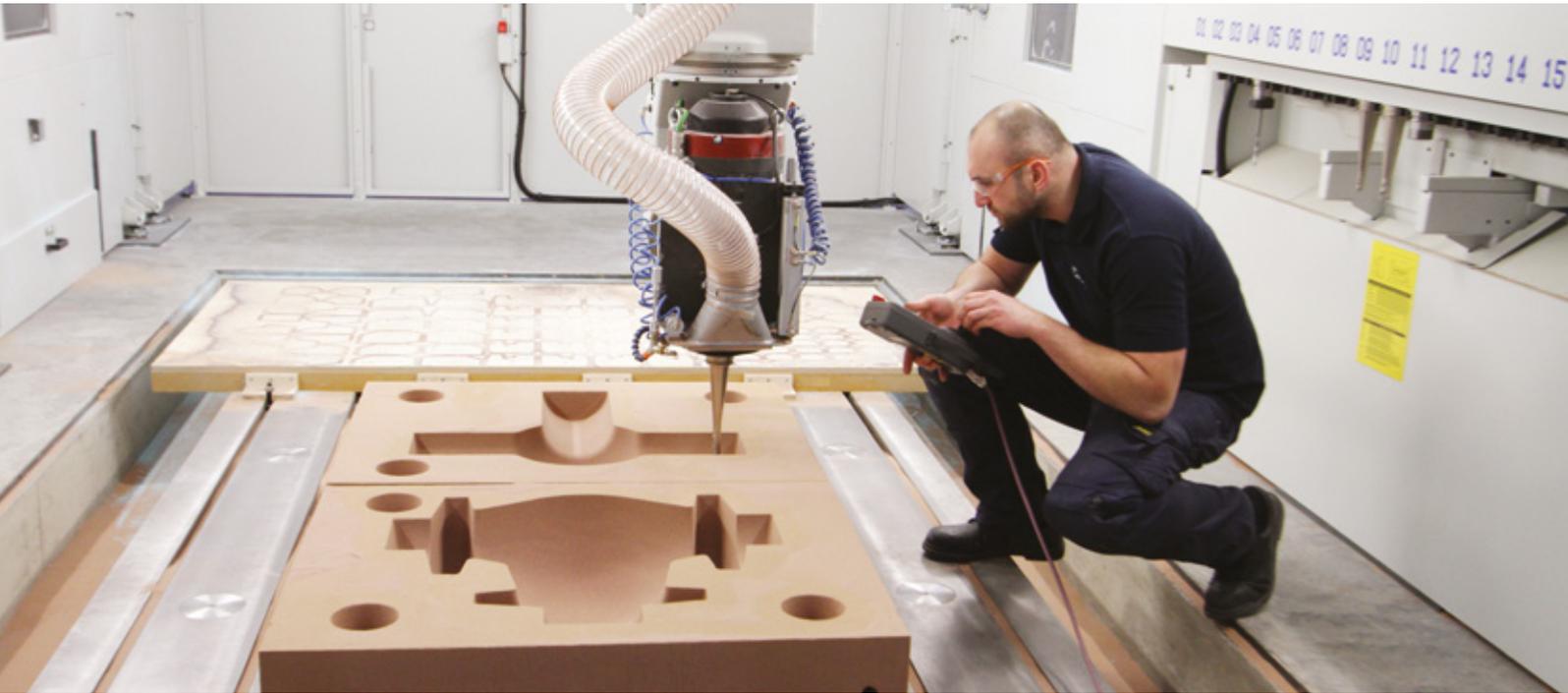


Image: Europea Microfusioni Aerospaziali & ESI Group



CMS Poseidon

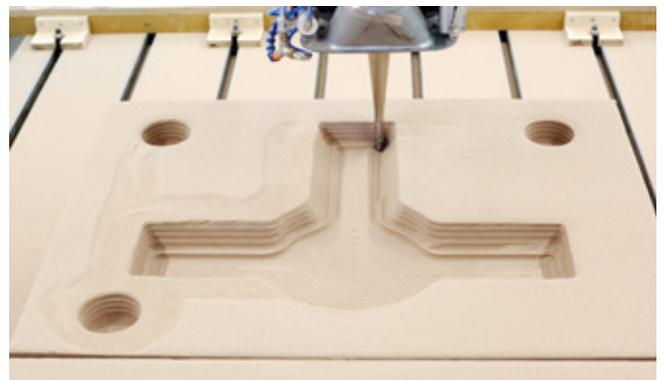
Five-axis CNC machine with Fanuc 31i A5 Full digital technology control.

Applications and research

Machining of large-scale investment casting patterns and creating and machining sand moulds.

Machining of conventional patterns and tooling for sand moulding in materials such as timber, model board and high-density extruded polystyrene.

Working envelope:	2600mm x 4000mm x 2000mm
X axis:	2500mm
Y axis:	2600mm
Z axis:	1300mm
B axis rotation:	$\pm 110^\circ$
C axis rotation:	$\pm 270^\circ$
Maximum spindle power:	28kW
Maximum spindle speed:	24000rpm
Tool magazine capacity:	16



3D Systems Ipro 8000 Stereolithography ALM QuickCast™

Used for producing plastic and composite components with precise surface quality and dimensional accuracy.

Build working envelope:	650mm x 750mm x 550mm
Build capacity:	414l
Layer thickness:	Minimum 0.05mm to maximum 0.15mm
Maximum part drawing speed:	Border spot 3.5m/sec (150ips) Large hatch spot 25m/sec (1000ips)



3D Systems SLA™ 7000 solid imaging system

Suited to foundries and design facilities, the SLA 7000 provides industrial-strength solid imaging performance and is used to manufacture prototypes, tooling, master patterns for castings and limited production runs.

Build working envelope:	508mm x 508mm x 600mm
Build capacity:	253.6l
Layer thickness:	0.0254mm
Maximum part drawing speed:	Border spot 2.54m/sec (140ips) Hatch spot 9.52m/sec (525ips)



3D Systems SLA™ 3500 solid imaging system

Suited to foundries and design facilities, the SLA 3500 provides industrial-strength solid imaging performance and is used to manufacture prototypes, patterns for casting and moulding, pre-production tooling and limited production runs.

Build working envelope:	350mm x 350mm x 400mm
Build capacity:	99.3l
Layer thickness:	0.05mm
Maximum part drawing speed:	2.54m/sec



Teubert Precision Pattern Mould Machine TPV 150/150

Siemens S7-300 PLC controlled horizontal polystyrene pattern moulding machine with a four stage venturi fill system, steam moulding, immersion tool cooling and automatic disassembly.

Applications and research

Used for research into large investment casting patterns and lost-foam, near-net shape and high-integrity casting processes.

Working envelope:	1500mm x 1500mm
Tool size:	750mm x 750mm x 200mm to 1500mm x 1500mm x 600mm
Tool weight:	700kg
Working pressure:	1.5 bar



Pattern making, 3D printing and moulding

Used for product and process development and the prove-out of high volume manufacturing techniques prior to tooling procurement.

Due to the ability of the technology to print very complex replica patterns, it enables the creation of cast parts not possible using conventional moulding techniques and FAST-MAKE of flight quality components for full-rate use and titanium aluminium, iron and steel castings.

Ex-One S15 digital mould and core making system

Suited to foundries and design facilities, the S15 manufactures complex moulds and cores directly from CAD files. It provides a high mould accuracy, does not require support structures and there is no post-processing required.

Maximum build volume:	1500mm x 750mm x 750mm
Build speed:	14-20mm/hr or 15,000cm ³ /hr
Manufacturing time for complete a 700mm high mould:	Approximately two days



Ex-One S-Max+™ Phenolic

Used to print highly complex sand cores and moulds suitable for high-temperature and challenging casting. Two large job boxes, used in conjunction with an automatic microwave to stove the moulds once they have been printed allow faster manufacturing times.

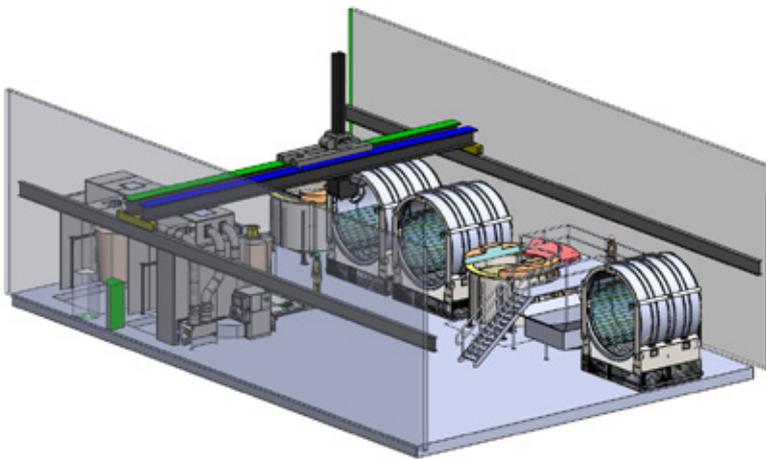
Maximum build volume:	1800mm x 1000mm x 600mm
Build speed:	60–85 l/h



VA TECH Heavy Payload Shell Handling System (HPSHP)

The HPSHP is engaged in large-scale ceramic shell manufacture, suitable for titanium and steel castings. The HPSHP has an automated coating application system and independently controlled twin drying cells capable of operating at variable - but controllable - temperature and humidity for optimum drying parameters.

Maximum shell weight capacity:	2500kg
Maximum shell envelope:	2000mm x 2500mm (d x l)
Additional features:	1 x Primary slurry flow-coater Intermediate slurry tank: 3200mm x 1300mm (diameter x depth) Back-up slurry tank: 3200mm x 1800mm (diameter x depth) 3 x sand rainfall sanders for Primary, Intermediate and Back- up stuccos: 4000mm diameter



KEA Automated Robotic Shelling System

The modular KEA automated robotic shelling system is used for manufacture of ceramic shells for titanium and steel castings. The system has a two position manual load and unload station and employs a 6-axis M9020/360 robotic arm for the coating process.

Two slurry tanks:	1450mm x 1400mm (diameter x depth)
Two rainfall sanders:	2150mm x 1700mm (diameter x depth)
Maximum part weight:	250kg
Maximum envelope:	1200mm x 1200mm (diameter x depth)



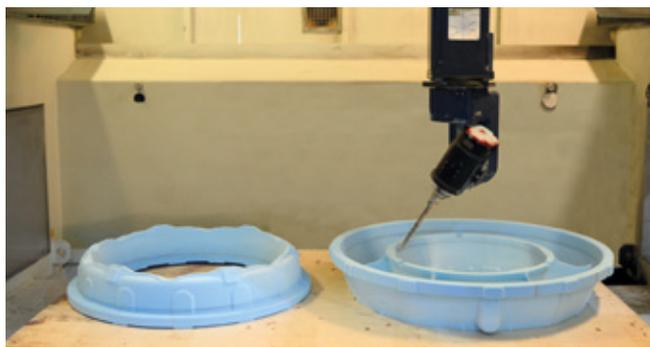


CMS Antares 2615 PX5

Rigid five-axis CNC milling and machining centre.

Applications and research

Aluminium mould and pattern machining, machining of nonferrous metals, model making (board), and machining of carbon fibre, fibreglass, composite or EPS foam materials.



Working envelope:	2600mm x 1500mm x 850mm
Operating speed:	120m/min
Melt power supply:	2200kVA
X axis:	2600mm
Y axis:	1500mm
Z axis:	1200mm
B axis:	+/- 120°
C axis:	+/- 270°
Maximum spindle speed:	24,000rpm
Additional features:	Eight-place tool changing rack. Equipped with linear motors on its X and Y axes. ATC head. Liquid cooled. HSK63F connection.



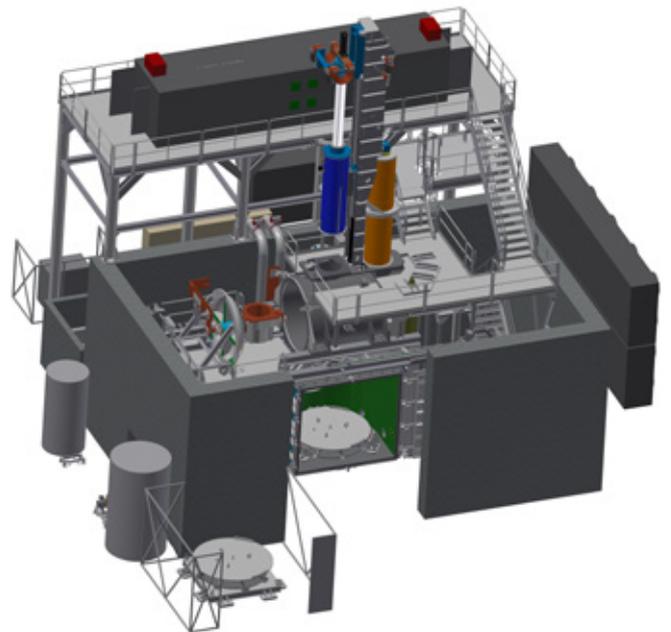
Titanium casting facility

The biggest furnace in Western Europe for casting titanium aerospace components. Helping UK companies break into the market for large-scale titanium aerospace engine and structural components.

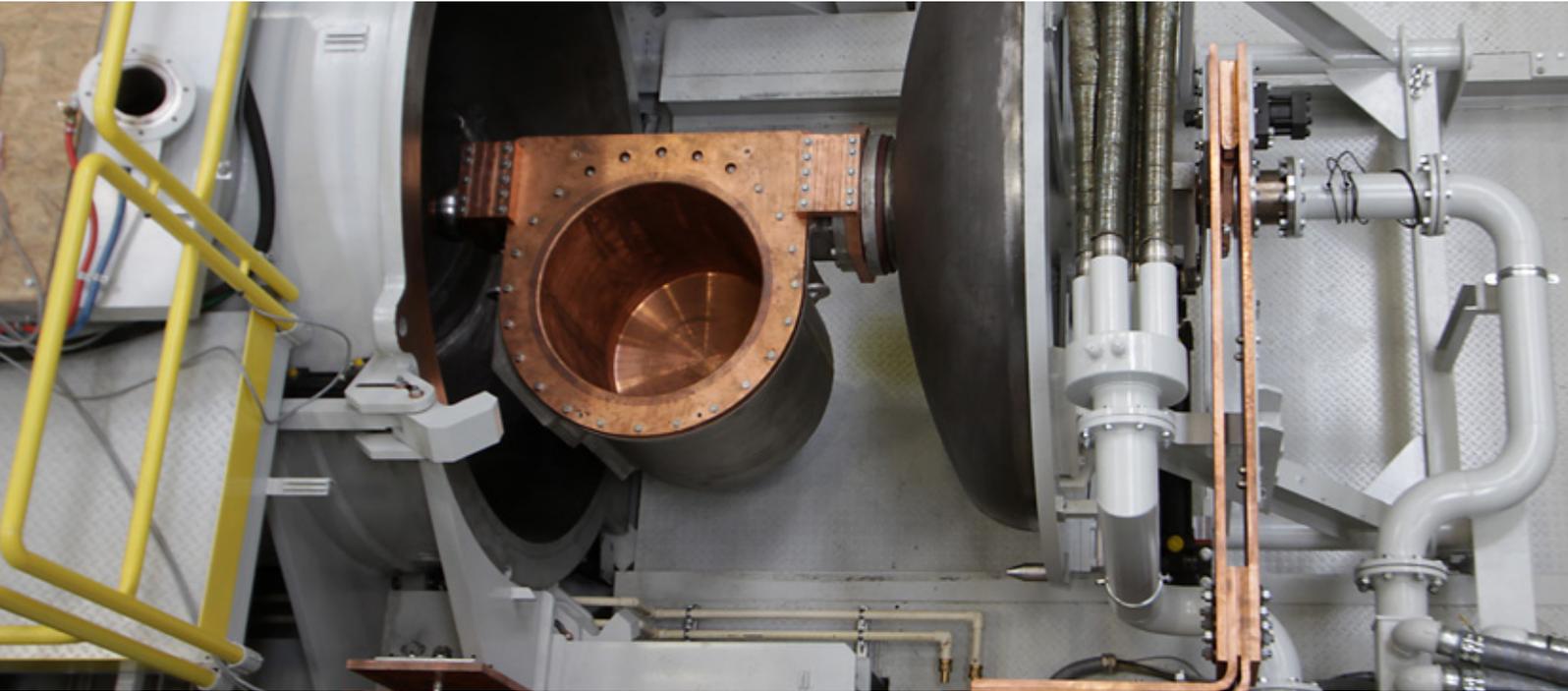
AMRC Castings launched its unique titanium casting facility at the end of 2016. Centred around a Retech Consumable Electrode Casting Furnace, it is the biggest furnace in Western Europe for casting components.

The investment was backed by the Aerospace Technology Institute and the UK's High Value Manufacturing Catapult and is designed to enable UK companies to break into global markets for large-scale titanium aerospace engine and structural components weighing up to 500kg.

The development of the facility is one of AMRC Castings' most ambitious research initiatives yet. Allowing the group to demonstrate the enhancements made to reactive alloy and large scale ceramic shell capabilities; producing castings that are up to 2m in diameter and 2.5m long – sized for the largest aero engine intercases.



Melting – Vacuum Arc Remelting



Retech Consumable Electrode Casting Furnace

Single piece crucible furnace with three interchangeable bodies capable of producing titanium for castings weighing up to 500kg and 2000mm in diameter and 2500mm in length.

Applications and research

For the research and melting of titanium.

Maximum melt weight of Ti6Al4V:	250kg, 500kg and 1000kg
Maximum mould dimensions:	2500mm x 2500mm x 2500mm
Melt power supply:	2200kVA



For multi-purpose melting of a range of reactive and other alloys.

ALD ISP10E/CC

Cold crucible induction melting with a single-chamber furnace and centrifugal casting unit.

Applications and research

Used for the melting of reactive metals (e.g. titanium and zirconium).

Maximum melt weight of Ti6Al4V:	30kg
Maximum mould dimensions (diameter x height):	1200mm x 600mm
Melt power supply:	600kW



ALD Leicomelt 26TP

Cold crucible induction melting with a single-chamber furnace and centrifugal casting unit.

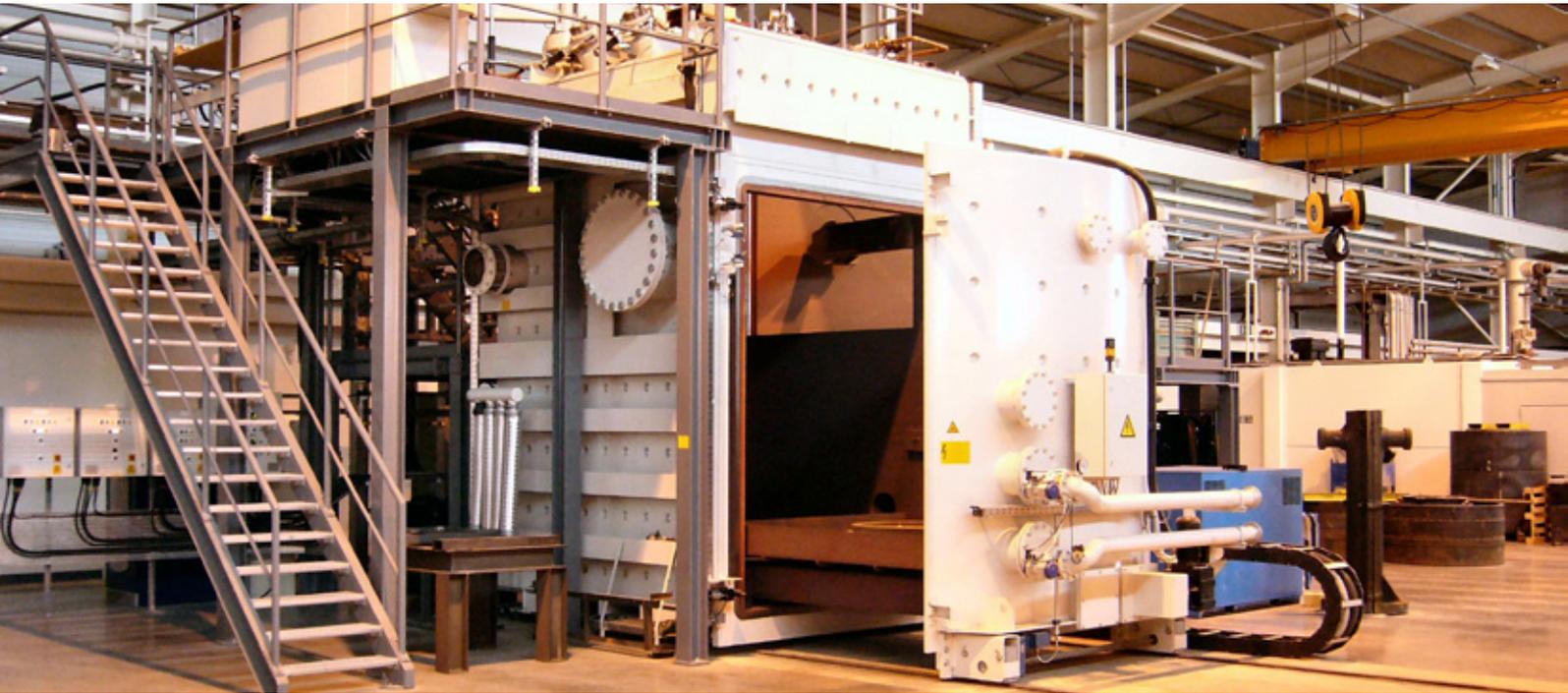
Applications and research

Used for the melting of reactive metals (e.g. titanium and zirconium).

Maximum melt weight of Ti6Al4V:	90kg
Maximum mould dimensions (diameter x height):	1450mm x 750mm
Melt power supply:	1000kW



Melting – Vacuum induction melting



ALD ISP10E/CC

Vacuum induction melting furnace.

Applications and research

Used for melting super alloys such as niobium, as well as nickel or cobalt base alloys.

Crucible capacity (nickel base alloy):	48-90kg
Maximum mould dimensions (diameter x height):	700mm x 800mm
Melt power supply:	180kW

ALD VIM-IC40E

Static single-chamber vacuum induction melting furnace.

Applications and research

For the melting of Inconel, nickel or cobalt based alloys, vacuum melted super alloys and high strength steels for production of large components.

Maximum cast weight (nickel base alloy):	500kg
Maximum mould (diameter x height):	2000mm x 2000mm
Standard melt power supply:	350kW
Typical operation vacuum:	8×10^{-2} mbar



Inductotherm Induction Furnaces

Coreless induction melting (air) for alloys such as CA6NM, CF8C, CD4MCu, Duplex and Super Duplex ASTM890-4A, 5A, and 6A, 17-4 PH, High Chrome Iron, Monel, Hastelloy and AB2.

Utilising its Dual-Trak system, both furnaces can be used simultaneously with a power sharing capability, ensuring very close control over composition and temperature when melting the combined weight of 2800kg.

Melt capacity:

Furnace A: 0.6t
Furnace B: 2.2t
Total of 2.8t based on steel density



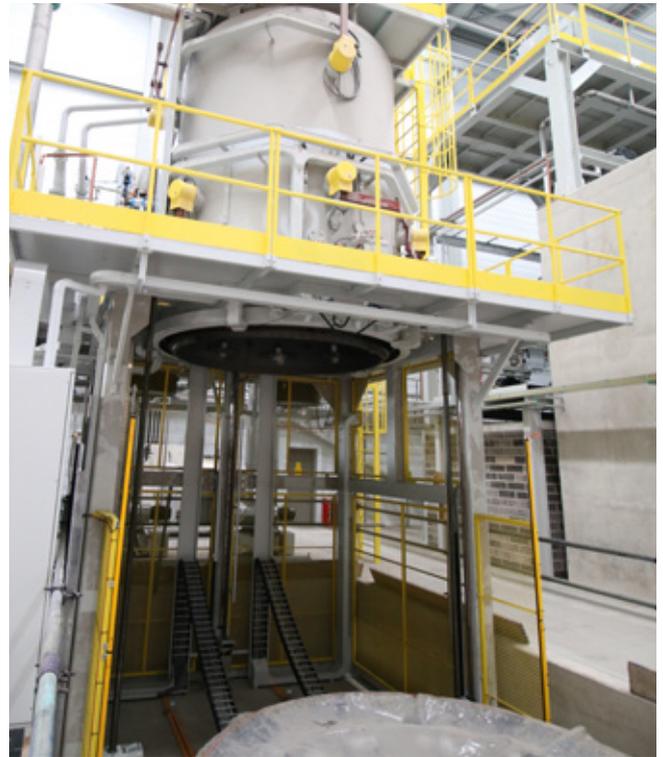
TAV TPVH-SE 200/250

Vertical bottom loading vacuum heat treatment furnace.

Applications and research

Used for the controlled treatment of large scale castings.

Graphite chamber heating zone (diameter x height):	2000mm x 2500mm
Heating zones:	4 independently controlled
Heat treatment cycles under high vacuum or inert gas partial pressures:	1×10^{-4} mbar
Controlled cooling:	Up to 6 bar quenching with inert gas



Seco Warwick 10.0VPT-4056/60N

A NADCAP approved vacuum heat treatment furnace, which can also be used for partial pressure and controlled atmosphere heat treatment cycles.

Low pressure carburizing and partial pressure hydriding. Quenching rates during cycles are variable up to 10 Bar abs. with the cooling media being either Argon or Nitrogen.

Applications and research

Used for the processing of aerospace or quality commercial products, development of material properties through heat treatment trials.

Operating temperature:	Up to 1300°C
Operating vacuum:	10-5 mbar
Working volume:	1000mm x 1000mm x 1500mm
Additional features:	Graphite hot zone, AMS2750 Rev E compliant



Pacific Kiln New Generation Flashfire Dewax System

Ceramic shell burnout furnace with clean emission control for removal of wax, polystyrene and rapid pattern materials.



NG-FFDWS-5484836

Applications and research

Used for shell firing and de-waxing.

Working envelope:	1400mm x 3400mm x 1200mm
Maximum load size:	2000mm x 2000mm x 2590mm
Operating temperature:	600 to 1200°C
Main burner output:	2,000,000 BTU/H
Afterburner output:	2,100,000 BTU/H
Gas requirement:	4,100,000 BTU/H
Electricity supply:	415vac 30amp 50hrz
Additional features:	Five mould capacity located on 610mm x 560mm centres

NG-FFDWS-548483-DB

Applications and research

Used for the burning-out of moulds and curing-out of shells. Shell firing and de-waxing.

Working envelope:	1219mm x 1219mm x 914mm
Maximum load size:	1219mm x 1219mm x 914mm
Operating temperature:	700 to 1150°C
Main burner output:	1,000,000 BTU/H
Afterburner output:	2,100,000 BTU/H
Gas requirement:	3,100,000 BTU/H
Electricity supply:	415vac 30amp 50hrz
Additional features:	Five mould capacity located on 355mm x 355mm centres



Climaivent Down Draft Extraction System

The state of the art fettling booth and arc gouging system is comprised of three parts and is a custom design for ferrous castings. The system allows full flexibility over casting shapes and sizes with a geometric capability of up to 2m³ and is integrated with our bespoke shop floor data collection system.

Applications and research

The system is associated to processing and welding upgrading of castings or materials.

Arc gouging / welding cell

The facility can be used for thermal processing in the form of arc air cutting / gouging or to increase welding capacity by doubling as a welding cell for large components.

Size: 3000mm x 3000mm x 2500mm (w x d x h)

Fettling Booth Solution with downdraught extraction

Consists of two 2400mm x 900mm (w x d) work benches with an internal strip curtain. Extraction is provided by 4 x LW22P Wet Collector units which will create a velocity of 0.7m/s at the face of the bench. The facility is flexible to be used as two large or four smaller processing stations.

Large fettling booth with local extraction

Open fronted booth with internal strip curtain and two fabricated benches.

Size: 3000mm x 3000mm x 2500mm (w x d x h)

Tantek Re Soak Furnace

For the heat treatment of ferrous castings up to a maximum temperature of 1200°C, with water quench facility.

Internal Dimensions: (w x d x h)	1550mm x 1550mm x 1550mm
External Dimensions: (w x d x h)	4200mm x 2800mm x 4000mm
Utility Requirements	
Gas supply:	50 mbar natural gas
Electricity supply:	415 volts 3 phase
Air supply:	100 PSI compressed air.



Nabertherm W8100

For annealing or hardening of large-scale cast components, outside loading with transfer system for quicker turnaround time between process cycles. The doubled-walled housing with rear ventilation provides low shell temperatures and heating from five sides provides even temperature distributions.

Maximum temperature:	1280°C
Working volume:	8070l
Internal Dimensions (w x d x h):	1600mm x 3600mm x 1400mm
External Dimensions (w x d x h):	2270mm x 4400mm x 2590mm
Power supply:	390kW



Titanium Fettling Booths

Two booths for the fettling of non-ferrous materials, enabling the processing of titanium castings approximately 2500mm x 2500mm. Constructed from 14g (2mm) galvanised mild steel panels of fully bolted construction.

Applications and research

The fettling and fine finishing of titanium castings.



Booth size (w x d x h):	3000mm x 2500mm x 2000mm
Internal components:	1400mm x 800mm 'collapsible' workbench on either side of the partition designed to support a casting of 200kg
Air requirement:	Requires an air volume of 16,000cfm (27,200m ³ /hr) based on a face velocity of 200fpm (1m/sec)

Inert Gas Welding Chamber

This self-contained welding cell is fully NADCAP compliant and can accommodate a component in a controlled atmosphere, with a smaller twin chamber system for more efficient processing.

The system is specifically designed for use with Argon, with Oxygen monitoring and a full cleaning and drying system to prepare the components.

It supplies a TIG welding capability with both AC and DC current and independent amplitude/amperage control for both the tungsten and workpiece.



Maximum working envelope:	1200mm x 1200mm x 1200mm
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Titanium Fluorescent Dye Penetrant Inspection System

The system is predominately used for the inspection of titanium parts to Aerospace Standards and is fully NADCAP compliant.

Comprised of a post-emulsified water-based fluorescent inspection method with a pre-inspection heated detergent cleaning, rinsing and drying system for de-greasing parts prior to processing.

Applications and research

For the inspection of titanium components.

In-Line Fluorescent System

Maximum part size:	1m ³ through all stages, as well as multiple small parts in batches.
Maximum part weight:	87kg
Utility Requirements	
Air supply:	100 P.S.I
Water supply:	Mains pressure
Electricity supply:	400v



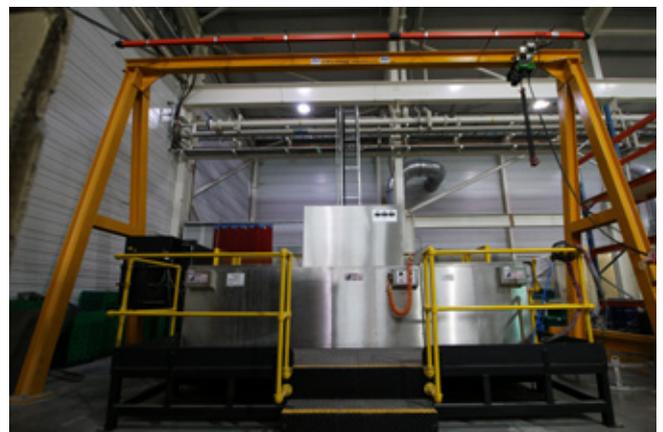
Independent Fluorescent System

Maximum part size:	Up to 1m ³
Maximum part weight:	Up to 125kg through all stages
Utility Requirements	
Air supply:	100 P.S.I
Water supply:	Mains pressure
Electricity supply:	400v



Pre-Cleaning System

Maximum part size:	Up to 1m ³
Maximum part weight:	Up to 250kg through all stages
Utility Requirements	
Air supply:	100 P.S.I
Water supply:	Mains pressure
Electricity supply:	400v





XYZ ProTURN 425 Gap Bed CNC Lathe

With CNC Lathe for proof and finishing applications with ProtoTRAK SLX Control and windows operating system.

Applications and research

Proof and finish machining of impeller and diffuser castings.

Swing over bed:	430mm
Swing in gap:	700mm
Gap in front of face plate:	224mm
Swing over cross slide:	257mm
Distance between centres:	2000mm
Spindle bore:	80mm
Spindle nose:	D1-8 camlock
Spindle motor:	10hp variable speed
Maximum spindle speed:	2500rpm
Tailstock travel:	196mm
Tailstock taper:	5MT
Tailstock diameter:	75mm
Bed width:	370mm
Footprint (length x distance x height):	3350mm x 1500mm x 1560mm
Additional features:	Dickson quick change tool post and six holders for 25mm shank tooling. Air assist 'floating' tailstock.



XYZ 710 Vertical Machining Centre

Machining centre with Siemens 828D CNC control.

Applications and research

Used for proof and finish machining of castings.

Working envelope:	760mm x 430mm
X axis:	710mm
Y axis:	450mm
Z axis:	510mm
Maximum cutting feed rate:	20000mm/min
Maximum table load:	500kg
Positioning accuracy:	±0.005mm (repeatability ±0.003mm)
Maximum spindle speed:	8000rpm
Maximum spindle power:	15Kw
Tool magazine capacity:	24
Tool change time:	2.5secs
Maximum tool diameter:	90mm
Maximum tool length:	250mm
Maximum tool weight:	7Kgs

Metallographic Laboratory

Fitted with a suite of metallographic equipment for the preparation of specimens for macro and micro examination, the laboratory offers services such as specimen sectioning, grinding, polishing of hot or cold mounted specimens, chemical etching.



ELTRA CS 800 Carbon / Sulphur Analyser

Used for testing of carbon and sulphur content in metallic and non-metallic samples, allowing a wide range of inorganic materials to be analysed.

Precise and quick measurement for testing of carbon and Sulphur in inorganic samples.

Powerful 2.2kW induction furnace for temperatures above 2000°C



Hardness Suite

To characterise material hardness over a range of different materials using various hardness equipment, including Brinell, Vickers and Rockwell.



Microscopy Suite

A range of different microscopes including inverted, standard and stereoscope capabilities for the use of characterising material microstructures. Image Pro Premier software utilised to carry out calibrated measurements, e.g. inclusion counts, phase counting, grain size and linear measurements.

Microscopes are equipped with a powerful luminaire camera for capturing high resolution images and capable of taking both macro and micro images between 5x to 2000x.

As part of the wider AMRC group, AMRC Castings has the ability to access further facilities such as the ones owned by the Nuclear AMRC, visit: namrc.co.uk



Eltra Oxygen / Nitrogen / Hydrogen Analyzer ONH-2000 (Inert Gas)

To determine oxygen, nitrogen and hydrogen in inorganic samples via inert gas fusion in an impulse furnace with temperatures in excess of 3000°C.



Laboratory-scale Furnaces

Used to develop heat-treatment parameters to achieve specific material properties, thermal processing and preparation of laboratory samples.



Spectro Maxx-X

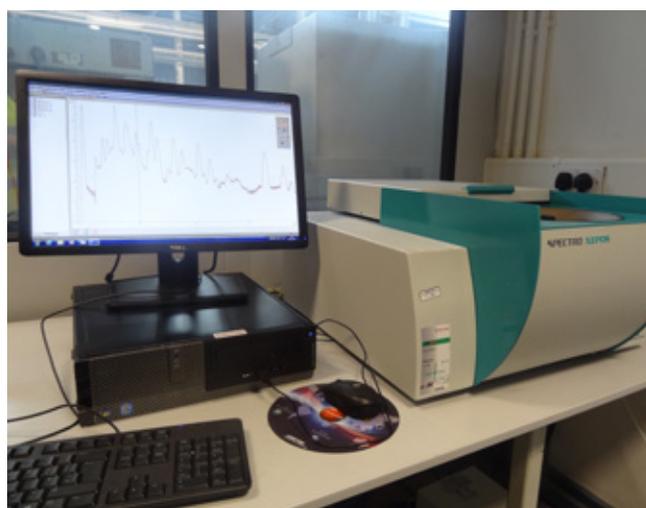
Optical emission spectrometer for chemical analysis of solid metal samples, including iron, nickel, copper, cobalt, aluminium, magnesium, titanium and zirconium based alloys.



XRF Spectro XEPOS

An elemental analyser ED-XRF spectrometer delivers high sensitivity and accuracy for a vast majority of elements and optimised for the analysis of medium to high atomic numbers.

The spectrometer can accommodate testing for 12 samples between 32mm and 40mm in diameter.





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CATAPULT
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