



# Barnes Aerospace Overview

This presentation does not contain information subject to United States export control regulation under the International Traffic in Arms Regulations or the Export Administration Regulations. The presentation and the contents herein are Barnes Aerospace proprietary and shall be held in confidence. Further distribution or publication without Barnes Aerospace's permission is expressly prohibited.

# Our Mission

Our mission is to be the best performing supplier for the manufacture and repair of aerospace propulsion system components, across the full life-cycle, to create unmatched value for our customers, employees, and stakeholders.



*OEM Component Manufacture*



*MRO Component Repair*



# How We Deliver

We drive ourselves to meet the challenges of our customers and partners through capacity, capability, and culture



## *Engineering Excellence*

On-site engineering specialism with group support to drive best practice, behaviour and process development



## *Employee Engagement*

Driving employee engagement, ownership, accountability and process discipline to exceed customer expectations and corporate goals



## *Investment*

Targeted investment in talent, capability and capacity to deliver reliability and value to our customers and partners

# Focused Centers of Excellence Capabilities

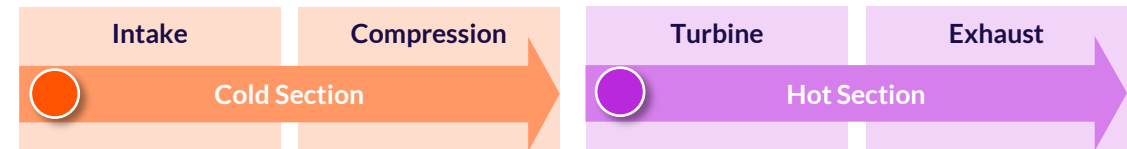
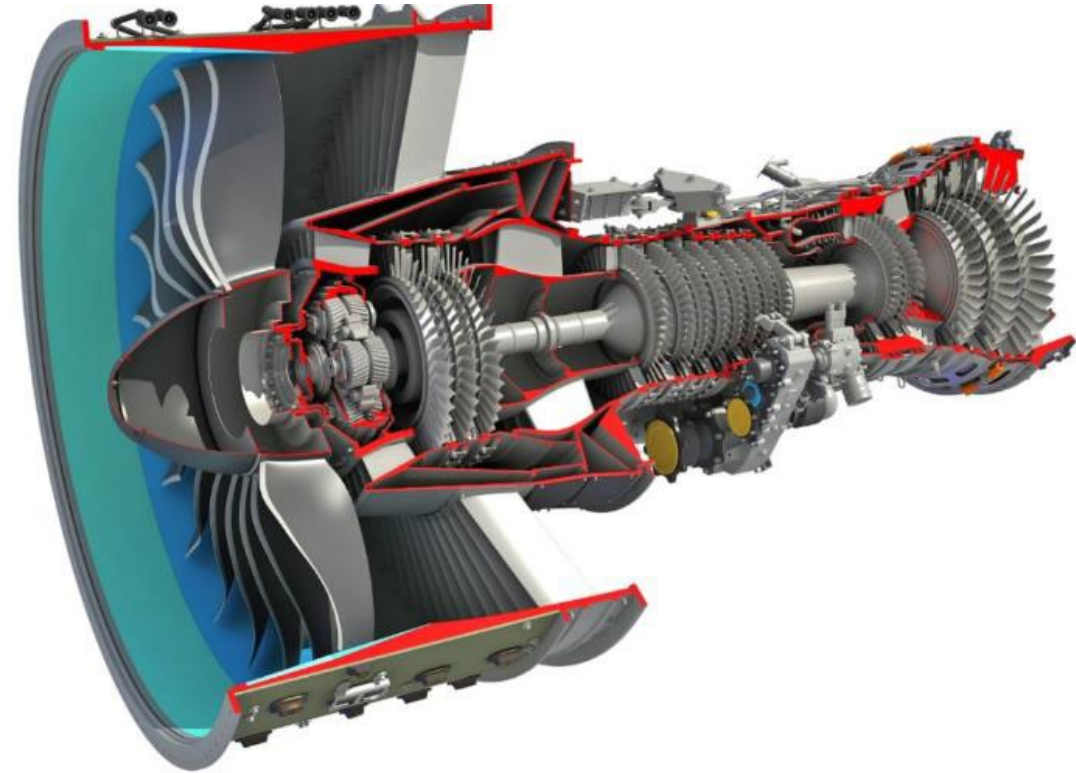


## OEM Component Manufacturing

Complex Housings & Cases	●	●
Rotating Components	●	●
Rings & Flanges	●	●
Complex Machined Fabrications	●	●
Complex Formed Sheet Fabrications	●	●
Engine Segments & Flow Path Hardware		●
Metal Leading Edge Components	●	
Airfoils – Turbine & Compressor	●	●
Formed Exhaust Components		●
Formed Nacelle Components	✈	
Formed Airframe Components	✈	
Electro-Mechanical Assembly		●

## MRO Component Repair

Turbine Honeycomb Seals		●
Stators, Shrouds & Segments	●	●
Rotating Components	●	●
Engine Cases (Medium/Large)	●	●












# A Global Aerospace Footprint

Over 1.5m sq. ft. of dedicated OEM and MRO footprint across North America, Europe, and Asia






## North America – 7 Sites



Windsor & East Granby OEM, CT USA		218 Employees 221k sq. ft
Warren Michigan USA	 	114 Employees 130k sq. ft
Ogden Utah, USA		180 Employees 173k sq. ft
Lansing Michigan USA		156 Employees 85k sq. ft
West Chester Ohio, USA	 	282 Employees 102k sq. ft
East Granby MRO Connecticut, USA		93 Employees 81k sq. ft
East Hartford Connecticut, USA		79 Employees 110k sq. ft.





## Europe – 5 Sites



Rzeszów Rzeszow, PL		399 Employees 77k sq. ft
Newton Abbot Devon, UK		352 Employees 230k sq. ft
Motherwell Lanarkshire, UK		78 Employees 63k sq. ft
Burnley Lancashire, UK		33 Employees 50k sq. ft
BA Technologies Kalisz & Tajęcina, PL		157 Employees 31k sq. ft

## Asia – 3 Sites



Singapore Singapore	 	512 Employees 262k sq. ft
Malaysia Malaysia		67 Employees 54k sq. ft.
Taoyuan Taiwan		225 Employees 83k sq. ft

### Legend

OEM Component Manufacture



MRO Component Repair



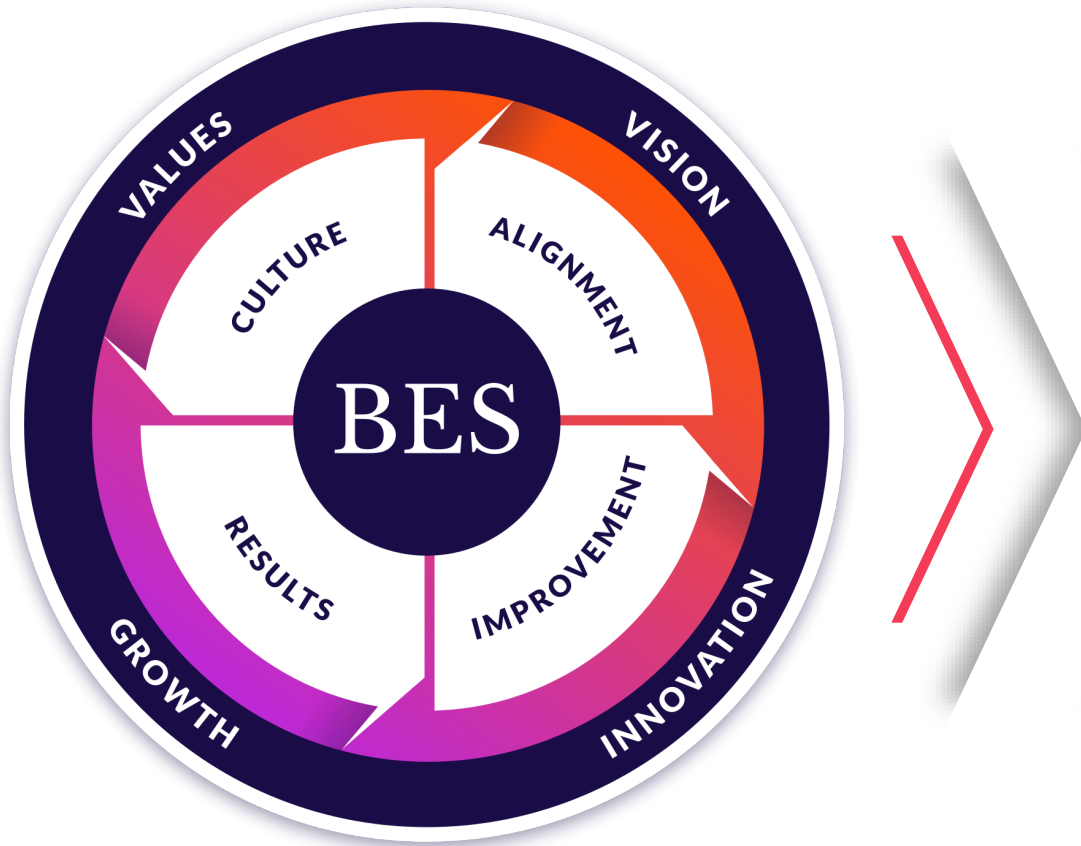


# Why Barnes Aerospace



- Proven long-term partner with our customers by providing solutions, developing creative deal structures, and investing on strategic programs.
- Customer first mindset supports Concurrent Engineering activities to improve performance, delivering quality and manufacturability with reduced administrative burden
- Investing in our businesses, adding new technology and footprint to support customer growth
- Demonstrated ability to invest/expand to support new growth programs for both component manufacturing and repair
- Innovation – focused on bringing new ideas/approaches to our customers

# Barnes Enterprise System



## Barnes Enterprise System Overview

- Promotes culture of employee engagement and empowerment reflecting strong corporate values
- Drives alignment across organization around common purpose and vision

## Disciplined Operating System

- Site monthly review
- Strategic business unit review
- Segment review

## Robust Operational Excellence Processes

- Operational planning – level loading
- Value stream mindset
- Capacity management
- Manufacturing floor execution

## Creating Value through Execution

- Customer performance metrics (OTD and quality)
- Productivity

**Building a Foundation of Excellence, Empowerment, & Competitiveness**



# OEM Component Manufacturing Overview

## Core Capabilities

- Precision multi-axis machining & grinding
- Non-conventional machining
- Complex fabrications & assemblies
- Hot-forming & Super-plastic forming
- Specialist Airfoil milling & grinding
- Vertically integrated special processes
- NDT & inspection
- Robust NPI process & concurrent engineering capabilities
- Tool design & manufacture
- ISO/AS9100 & Nadcap

## Product Families

### Machined Components



### Fabricated Components



*End Product Applications*

Engine

Nacelle

Airframe

# OEM Component Manufacturing: Machining



Fan & Inlet Cases



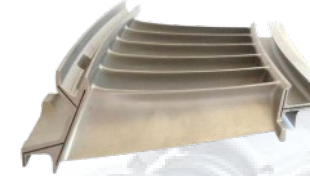
Compressor Cases



Turbine Center Frames



Turbine Blades & NGVs



Turbine & Exhaust Cases



Static Rings & Seals



Engine Housings



Turbine Support Case



Flow Path Fairings



Rotating Air Seals



Bearing Hubs & Housings



Compressor Airfoils



Diffusers & Combustor Cases



Hangers, Segments & Shrouds



Spools & Spinners



# OEM Component Manufacturing: Fabrication



Fan Blade Metal Leading Edge



Exhaust Assembly



Core Fairing



Inlet Bulkhead



Door Threshold



Wing Splice



Vent Tube



Nacelle Waffle



Pylon Fairing



Air Cooling Manifold



Support Structures



Splitter Fairing



# OEM Component Manufacturing Facilities

## Complex Machined & Fabricated Components & Assemblies

### East Granby OEM, CT



- 3, 4, & 5 Axis Machining & Turning
- 5 Axis Grinding
- EDM: Sinker, Wire, Hole
- Welding & Heat Treatment
- Mechanical Assembly
- CNC Turning – Horizontal & Vertical
- CNC Milling – 3, 4 & 5 Axis
- TIG, Plasma & Resistance Welding
- Robotic & Multi-Axis Auto Welding
- Sinker EDM
- NDT: FPI, X-Ray & Pressure Testing

*Flow Path Fairings*



*Complex Housings & Cases*



- Compressor Cases
- Combustor Cases
- Turbine Cases
- Exhaust Cases

*Machined Fabricated Components*



*High Complexity Fabs & Assemblies*



- Diffusers
- Fan Frames & Inlets
- Fabricated Structures
- TECs & TCFs

### Singapore



- Milling, Turning, Grinding (HEDG, VIPER, Creep Feed)
- 3, 4 & 5 Axis Machining
- EDM, Wire Cut, Fast Hole Drill and Spark Erosion Grinding
- Brazing and Sintering; Laser Welding
- Air Flow Testing

*Machined Case Assemblies*



*Flow Path Fairings*



*Turbine Hangers*



*Rings, Seals & Segments*





# OEM Component Manufacturing Facilities

## Complex Machined & Fabricated Components & Assemblies

### Warren, MI



- 3, 4 & 5 Axis Machining
- 4 Axis, Die Sinker & Fast Hole EDM
- Welding (CNC, EB, TIG, Gas Shield Arc)
- Vacuum Heat Treatment & Brazing
- Plasma & Thermal Spray Booths
- HVOF, Flame Spray, Chem Etch
- NDT: Balancing, FPI, X-Ray

#### *Complex Fabrications*



- Turbine Support Cases
- Diffusers
- Frames & Fabricated Cases
- Bearing Housings

#### *Critical Machined & Assembled Cases*



- Fan Cases
- Combustor Cases
- Rings & Flanges

### West Chester, OH



- Cold Forming
- 3, 4, & 5 Axis Machining & Turning
- 2 & 5 Axis Laser Cutting
- Welding, Brazing, Heat Treatment
- Laser Welding
- Mechanical Assembly

#### *Fabricated Engine Manifolds*



#### *Ducted Assemblies*



#### *Fabricated Assemblies*



### Malaysia



- 3- & 4- Axis Milling & Turning
- Surface Grinding
- Broaching
- Wire Cut
- Shot Peening
- Progressive Stamping & Roll Forming
- TIG Welding

#### *Shrouds*



#### *Lever Arms*



#### *Bell Cranks*



#### *Nozzle Lock Pins*



#### *Support Links*



# OEM Component Manufacturing Facilities

## Complex Machined Components & Level 1 Fabrications with Integrated Special Processes

### Rzeszów



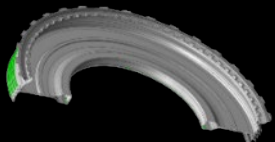
- Up to 5 Axis CNC Lathes
- 3 & 4 Axis CNC Horizontal Mills
- 3, 4 & 5 Axis CNC Vertical Mills (with Turning Capability & Live Tools)
- ID / OD Grinding
- TIG & Auto Welding
- EDM Wire, Sink & Fast Hole
- Balancing, Pressure Testing, Assy & NDT

#### *Critical Cases & Housings*



- Bearing Housings
- Fan, Inlet & Compressor Cases
- Combustor & Turbine Cases
- C-Sump & Oil Scoop
- Fabricated Seals / Frames

#### *Rotating & Static Components*



- Rotating Air Seals
- Rings & Flanges
- Welded Pressure Seals

### Technologies



- Heat Treatment
- Brazing in Vacuum (incl. Honeycomb)
- Plasma Spray Coatings
- Inorganic & Organic Paint Coatings
- Chrome Free Coating
- HVOF Spray
- Shot Peen, Paint Stripping & Met Lab

#### *Compressor & Rotating Components*



- Compressor Rotors
- Variable Guide Vanes
- Shafts
- Couplings

#### *Static & Ancillary Components*



- Cases & Frames
- Seals, Shrouds, Rings
- Fuel, Oil & Pump Hardware



# OEM Component Manufacturing Facilities

## Sheet Metal Formed Components with Complex Machining & Fabrication

### Ogden, UT



- Hot & Super Plastic Forming (large)
- Cold & Hot Expanding
- 3, 4, & 5 Axis Machining & Turning
- Welding, Brazing, Heat Treatment
- Metal & Composite Assembly
- Chemical Cleaning & Etching

#### *Nacelle/Exhaust Components*



#### *Fairings & Complex Fabricated Assemblies*



#### *Hot Form/SPF Components*



### Lansing, MI



- Hot & Super Plastic Forming
- 3, 4, & 5 Axis Machining & Turning
- Welding Brazing, Heat Treatment
- Metal & Composite Assembly
- Chemical Cleaning & Etching
- Additive Manufacturing
- Laser Welding

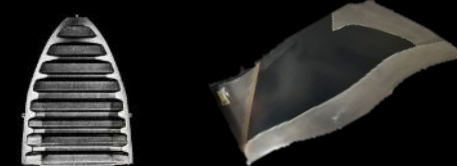
#### *Complex Fabricated Assemblies*



#### *Hot Form/SPF Components*



#### *Fan Blade Metal Leading/Trailing Edges*



# OEM Component Manufacturing Facilities

## High Volume Airfoil Production

### Newton Abbot



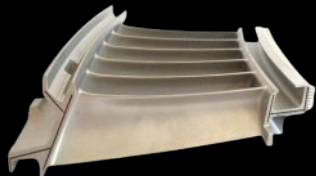
- 5 Axis Capable Vertical Milling
- CNC Lathes, Mill Turn
- Radial Interpolation Grinding
- Laser Weld & EDM
- Vacuum Brazing & Vapor Phase Aluminizing Coatings
- Robotic Deburr & Airfoil Polishing

#### Compressor Airfoils



- LPC & HPC Rotors
- Stator & Variable Vanes
- Compressor Blisks
- Additive Mfg. Airfoil Finishing

#### Turbine Airfoils



- LPT Rotors
- Nozzle Guide Vanes

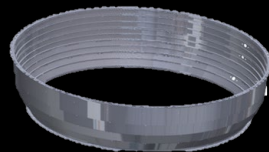
## Engineering Led Complex Parts

### Motherwell



- CNC Turning & Milling
- ID/OD Grinding
- EDM
- Wire Cut
- FPI, MPI & Pressure Testing
- L&LV Product Management

#### Stationary Components



- Static Seals
- Shrouds & Segments
- Rings & Flanges
- Compressor & Turbine Cases

#### Rotating Components



- Rotor Spools
- Spinners
- Rotating Seals
- Nose Cones & Stub Shafts

## Launch System Assemblies

### Burnley



- Incoming Inspection
- Welding
- Critical Mechanical & Electrical Assemblies
- New Build & Assembly Testing
- Repair & Refurbishment
- Assembly size range up to 5 m

#### Launch Systems



- Land Launch
- Sub Launch
- Deck Launch



# MRO Component Repair Overview

## Core Capabilities

- Cases & Frames, Bearing Housings
- Complex Fabrications
- Rotating Parts
- Shrouds, Vanes & Honeycomb Seals
- Repair Development & Tool Design
  - Source Demonstration
  - Book Repair
- Coatings, Heat Treatment, EB Welding
- Grinding, Milling, Turning, EDM
- Fluoride Ion Cleaning (FIC), Chemical Clean
- FAA/EASA/CAAC approvals
- ISO/AS9100 & Nadcap

## Product Families

*High Pressure Turbine Shrouds*



*HP Compressor*



*Turbine Support Case*



*LPT Honeycomb Seals*



*HPC Split Case*



*Rotor Shaft*



*Stator Segments*



*Drum Rotor*



*Spool*



# MRO Component Repair Product Capabilities



## Seals, Rings & Flanges

- CF6 Vent Seals
- PW4000, CFM56, V2500 OAS
- V2500 Static Seals
- CFM56 HPC H/C Seals
- V2500 Rear Static Seals
- V2500 Annulus Filler
- CF6, CFM56 Rotating & Stationary Seals
- CFM56 HPT Air Impingement Manifold
- Trent 1000, 7000, XWB H/C Seals & Segments
- Trent 700, 900 H/C Seals & Segments
- CFM56 HPT CDP Seal
- CFM56 HPT Seal Segments
- CFM56 Rotating Air Seal
- CFM56 Stationary Air Seal
- LEAP 1A/C & 1B Seals
- Trent 1000, 7000, XWB H/C Seals & Segments
- Trent 700, 900 H/C Seals & Segments
- PW4000 Air Seals
- F110 Front/Rear Air Seal
- PW2000 HPC Air Seal
- F118 Air Seal
- AE3007 Vane Rings
- PW100 LP Housing Seal
- PW900 HP Seals
- F414 Pressure Balance Seal

## Fan, Inlet & Compressor Cases

- V2500 HPC Rear Outer Case
- CFM56 HPC Front/Rear Stator Case
- PW4000 HPC Inner Rear Case
- Trent 700 & 800 HPC OGV Case
- Trent 700 & 1000 Compressor Intermediate Case
- RB211 HPC OGV Case
- LM2500 Rear Compressor Case
- Siemens A65 IPC & Intermediate Case
- GG8 Intermediate Case
- PW100 Front & Rear Inlet Case
- PW300, PW500, JT8, F117 Fan Case
- PW100 Inter Compressor Case
- J85 Compressor Case

## Rotating Parts

- CF6 Fan Rotor Spool
- CF6 LPT Disk Stg 1-5
- Trent 700, 900 Stub Shafts
- Trent 700 HPT Disk
- PW4000 HPC & LPT Disks
- PW4000 HPC Rear Shaft
- RB211 HPC & LPT Rotor Disks
- RB211 HPC Rotor Shaft
- RB211 HPT/IPT/LPT Bearing Inner Race
- RB211 Stub Shaft
- LM6000 Fan Rotor Spool
- F110 Stub & Rear Shafts
- Siemens A65 Stub & Compressor Shafts
- Siemens A65 LPC Rotor Disk
- PW2000 HPC Drum Rotor Disk Assy
- F414 Compressor Blisk
- GE90 Rotating Oil Seal
- F118 Stub Shaft
- F404 Fan Disk
- PW800 Shaft

## Stators & Shrouds

- PW4000, CF6, PW2000, V2500 HPC & LPC Stators
- PW4000 Ring Case Stators
- PT6 Stators
- PW4000, CF6, CFM56, V2500 VVIS
- CF6 H/C Shroud Segments
- CF6, CF34, GE90, GENx LPT Shrouds
- CFM56 Compressor Stator Shrouds

- CFM56 Compressor Stator Shrouds
- CFM56 Fan OGV
- CFM56, CF34 HPT Shrouds
- CF6, GE90, GENx HPT Shrouds
- LM2500, LM6000, LMS100 HPT Shroud
- AE1107, AE2100 Blade Tracks
- PT6 PT & CT Shrouds

## Airfoils

- GE90 HPT & Fan Blade Retainers
- Trent 1000, 7000, XWB HPC Airfoils Stg 1-6
- Trent 700, 800, 900, RB211 HPC Airfoils Stg 1-6
- CFM56 LPT Blades Stg 1-5
- AE1107 HPT/LPT Vanes
- GE Frame 7 HPT Vanes & Nozzles

## Housings & Frames

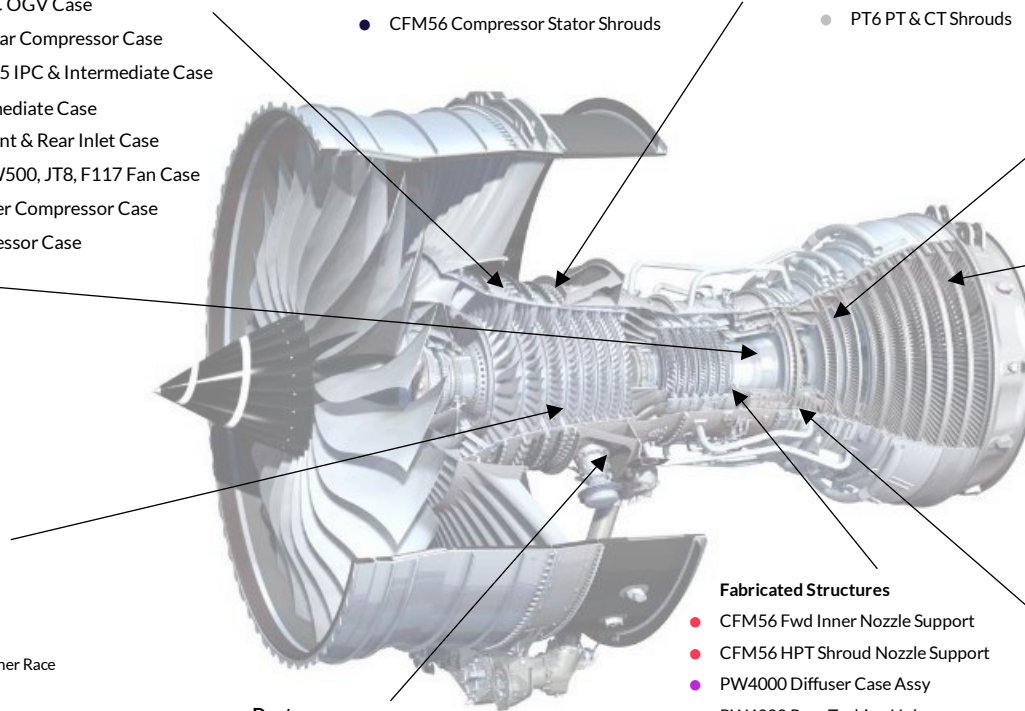
- CFM56 LPT Rear Frame
- CFM56 Bearing Support
- LEAP 1A/C & 1B HPC Cases
- CF6 Turbine Mid Frame
- CF6 Compressor Rear Frame
- Siemens A65 HPT/IPT Bearing Support Assy
- F119 Hub Seal Assy
- GG8 #4 Bearing Housing
- GG8 #6, #7, #8/9 Bearing Support
- LM2500 Turbine Mid Frame
- GG8 Tobi Duct
- PT6 Stator & Shroud Housings
- PW100 Support Housings
- PW600 Impeller Housing
- JT8 PT Stator Housing
- JT15 LP Housing
- HT15 Impeller Housing
- APS2300 Combustor Housing
- APS2300 Exhaust Housing
- AE1107 Rear Turbine Bearing
- AE2100 Air Inlet Housing
- AE2100 Center Sump

## Fabricated Structures

- CFM56 Fwd Inner Nozzle Support
- CFM56 HPT Shroud Nozzle Support
- PW4000 Diffuser Case Assy
- PW4000 Rear Turbine Hub
- GG8 Diffuser
- FT4 Burner Case
- PW100 Diffuser Assy
- PW150 GG Diffuser
- AE2100 Diffuser Case
- PW200 Turbine Exhaust Nozzle
- PW300 Turbine Disk Nozzle
- APS2300, APS2600 Turbine Nozzle

## Ducts

- V2500 LPC Bleed Duct
- V2500 Bleed Valve
- V2500 Duct Support Segment
- CFM56 Compressor Rotor Air Duct
- PT6 Exhaust Duct
- PW100, PW900 Turbine Exhaust Duct
- JT8 Fan Duct Liner Segments
- JT8 Inner Duct Segments



## Combustor & Turbine Cases

- Trent 1000, 7000 CRIC
- CFM56 LPT Case
- CFM56 Combustion Case
- Trent 700 Combustion Outer Case
- GENx Combustion Case
- LEAP 1A/C & 1B Bearing Support
- PW4000 LPT Case Assy & Hub
- PW4000 Diffuser Cases
- PW4000, Trent 800 Turbine Exhaust Case
- F100 Turbine Case
- Siemens A65 LPT Case
- Siemens A65 Inner Combustor Case
- RB211 Inner Combustor Case
- Trent 500, 800, 900 Combustion Case
- F119 Turbine Exhaust Case
- GE90 LPT Case
- GG8 Turbine Exhaust Case
- PT8 Power Turbine Inlet Case
- PW100, PW150 Turbine Support Case
- PW200, PW545 Turbine Support Case
- PT6, PW100, PW300 GG Case
- PW100 LP Turbine Case
- PW100 Turbine Interstage Case
- APS2300 Turbine Exhaust Case

Key	
●	Taoyuan
●	Singapore
●	East Granby
●	West Chester
●	Warren



# MRO Component Repair Facilities

## Shroud & Vane Repairs

### Taoyuan, Taiwan



- Stators
- Honeycomb Segments
- Variable Vane Inner Shrouds
- HPC Rotating & Static Seals
- Annulus Fillers
- LPC Stators / Seals
- PW4000, PW2000, F117
- V2500
- PT6
- CF34, CFM56-5B & -7B
- CF6, GEnx, GE90
- Trent 700-900
- Trent 1000, 7000 & XWB

*Compressor Stator Segment*



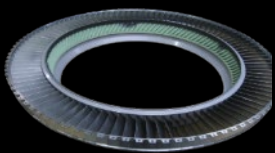
*Rotating Air Seal*



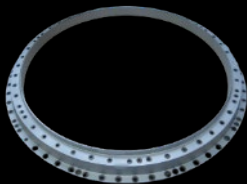
*Annulus Filler*



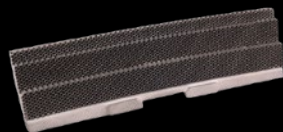
*Compressor Stator*



*Abradable Seal*



*Outer Air Seal*



*Honeycomb Seal Carrier*



## Casing, Knife Edge Seal & Honeycomb Repairs

### Singapore



- Cases
- Rotating Parts
- Honeycomb Seals
- Shrouds
- CFM56 (All Models)
- GEnx
- LEAP 1A/C & 1B
- Trent 700 & 800
- Trent XWB, 1000 & 7000
- PW4000

*Rotating Air Seal*



*Combustion Case*



*HPC Front Stator Case*



*Outer Air Seal*



*LPT Case*



*HPC Rear Stator Case*



# MRO Component Repair Facilities

## Shroud & Vane Repairs

### West Chester, OH

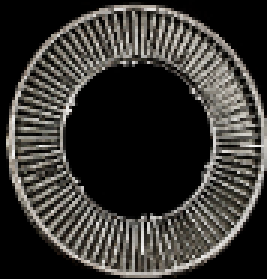


- High Pressure Turbine Shrouds
- Low Pressure Turbine Vane Rings
- Inner/Outer Transition Liners
- CFM56
- CF6, GEnx, GP7200
- CF34
- LM2500, LM5000, LM6000
- LMS100

*High Pressure Turbine Shrouds*



*Low Pressure Turbine Vane Rings*



## Cases, Frames & Rotating Parts

### East Granby, CT \*



- Cases/Frames
- Diffusers
- Rotating Parts
- Bearing Housings
- CF6, GE90
- F110, F404, F414
- Trent XWB, 1000, 700/900, RB211
- F100, F117, F119
- LM2500, GG8, Siemens ADGT

*Diffuser Case*



*Combustor Case*



*Front Case*



*Drum Rotor*



*Stub Shaft*



*Rotor Shaft*



\* 2 Business Units

## Engine Cases & Fabrications

### Warren, MI



- Turbine Exhaust Cases
- Turbine Support Cases
- Gas Generators
- Shroud & Stator Housings
- PW100, PW150
- PW200
- PT6
- PW300, PW500, PW600
- F414
- AE Family

*Turbine Support Case*

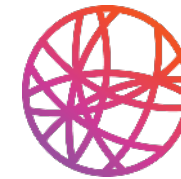


*Gas Generator Case*





# OEM Component Manufacturing Businesses



**BARNES**<sup>™</sup>  
AEROSPACE

# Connecticut OEM Ops – East Granby, CT



## Critical Machined & Fabricated Cases & Frames

- Established in the 1950's as an independent manufacturing facility focused on critical component machining and fabrication for military aero-engines
- Capability to produce very high complexity parts typically manufactured within OEM facilities

39 Bradley Park  
Road, East  
Granby CT,  
06026, USA

### Floorspace

84k sq. ft

### Employees

218

### Capabilities

- CNC Turning – Horizontal & Vertical
- CNC Milling – 3, 4 & 5 Axis
- TIG, Plasma & Resistance Welding
- Robotic & Multi-Axis Auto Welding
- Sink EDM
- Chem Etch
- CMM & Pressure Testing
- FPI & X-Ray
- Dedicated Component Repair Cell

### Customer Approvals



### Industry Certifications

- Nadcap Approved Processes: NDT, Welding, Non Conventional Machining, Chemical Processing
- ISO 9001, AS9100

### Complex Housings & Cases



- Compressor Cases
- Combustor Cases
- Turbine Cases
- Exhaust Cases

### High Complexity Fabs & Assemblies



- Diffusers
- Fan Frames & Inlets
- Fabricated Structures
- TECs & TCFs

## Complex Machined Components including Turbine Center Frames

- Established in 2004 with West Chester OEM lever arms transfer, as lower cost alternative to US manufacturing operations
- Transformed in recent years from High Mix Low Volume to focused, growth engine programs for GE, delivering results for the business through strong business execution

65 Changi North Crescent,  
499633,  
Singapore

Floorspace

157k sq. ft

Employees

268

### Capabilities

- Milling, Turning, Grinding
- 3, 4 & 5 Axis Machining
- EDM, Wire Cut, Hole Popper & Spark Erosion Grinding
- HEDG, VIPER & Creep Feed Grinding
- Laser Welding; Brazing & Sintering
- Nickel Plating
- Shot Peening
- Progressive Stamping
- Air Flow Testing

### Customer Approvals



### Industry Certifications

- Nadcap Approved Processes: : Non Conventional Machining, NDT, Heat Treat, Welding, Chemical Processing, Surface Enhancement
- ISO 9001, AS9100

### Turbine Center Frame



### Fairings



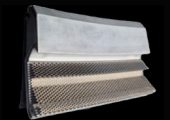
### Rings



### Turbine Hangers



### Turbine Seal Segments



### Honeycomb Seals



## High Mix, Low Volume Manufacturing Facility Aligned with Singapore Site

- Established in 2018 for RSP manufacturing transfer from Singapore OEM
- Commenced next phase of growth : Non-RSP manufacturing (lower value add) from Singapore OEM (Leap Shrouds and Honeycomb Seals) and West Chester OEM (various)

No. 18, Jalan  
Teknologi 1/1,  
Johor,  
Malaysia

Floorspace

54k sq. ft

Employees

67

### Capabilities

- 3- & 4- Axis Milling
- Turning
- Surface Grinding
- Broaching
- Wire Cut
- Swiss Lathe
- Shot Peening
- Progressive Stamping
- Roll Forming
- TIG Welding

### Customer Approvals



### Industry Certifications

- Nadcap Approved Processes: Non Conventional Machining, NDT, Welding, Chemical Processing, Surface Enhancement
- ISO 9001, AS9100

### *Retainer Clips*



### *Shrouds*



### *Lever Arms*



### *Nozzle Lock Pins*



### *Bell Cranks*



### *Support Links*



## Complex Fabrication Capability Combined with Vertically Integrated Special Processes

- Established in the 1940's as a manufacturing facility focused on sheet metal, it combined these capabilities in welding and joining with hard alloy machining in the 1980s to become a leading supplier of complex Cases and aero-engine Fabrications
- Key core competencies include Turbine Support Cases and Gas Generator Cases

25250 Easy  
Street, Warren,  
MI, 48089,  
USA

Floorspace

130k sq. ft

Employees

114

### Capabilities

- 3, 4 & 5 Axis Machining
- 4 Axis, Die Sinker & Fast Hole EDM
- Welding (CNC, EB, TIG, Gas Shield Arc)
- Vacuum Heat Treatment & Brazing
- Plasma & Thermal Spray Booths
- HVOF & Flame Spray
- Chem Etch & Pressure Testing
- Balancing
- FPI, X-Ray & Metallurgical Inspection

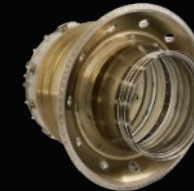
### Customer Approvals



### Industry Certifications

- Nadcap Approved Processes: NDT, Coatings, Heat Treatment, Welding, Non Conventional Machining
- ISO 9001, AS9100

### Complex Fabrications



- Turbine Support Cases
- Diffusers
- Frames & Fabricated Cases
- Bearing Housings

### Critical Machined & Assembled Cases



- Fan Cases
- Combustor Cases
- Rings & Flanges





## Specialist Formed & Machined Components for Aero-Engine & Aerostructure Applications

- Highly specialized capability in the forming of aerospace grade alloys with a focus on large scale parts supporting the wider engine and aircraft supply chains
- Augmenting forming technologies with traditional machining and fabrication to provide full component manufacturing solutions for complex parts, on high volume applications

1025 Depot  
Drive, Ogden, UT,  
84404,  
USA

Floorspace

173k sq. ft

Employees

180

### Capabilities

- Hot & Superplastic Forming (large)
- Cold & Hot Expanding
- 3, 4, & 5 Axis Machining & VTL
- 5 Axis Laser Cutting
- TIG, Semi-Automatic & Resistance Welding
- Vacuum Braze & Heat Treat
- Sand Blasting
- Mechanical Assembly, Chemical Cleaning & Etching

### Customer Approvals



### Industry Certifications

- Nadcap Approved Processes: Welding, Non Conventional Machining, Heat Treat, Materials Testing, Chemical Processing, NDT
- ISO 9001, AS9100

### *Nacelle & Engine Components*



### *Engine Exhaust Details & Assemblies*





## Specialist Formed & Machined Components for Aero-Engine & Aerostructure Applications

- Highly specialized capability in the forming of aerospace grade alloys for aero-engine, nacelle and aerostructure components
- Augmenting forming technologies with traditional machining and fabrication to provide full component manufacturing solutions for complex parts, on high volume applications

5300 Aurelius  
Road, Lansing,  
MI, 48911,  
USA

Floorspace

85k sq. ft

Employees

156

### Capabilities

- Hot & Superplastic Forming (small-med)
- 3, 4, & 5 Axis Milling
- 5 Axis Laser Cutting
- TIG, Laser & Resistance Welding
- Vacuum Braze & Heat Treat
- Sand Blasting
- Mechanical Assembly
- Chemical Cleaning & Etching

### Customer Approvals



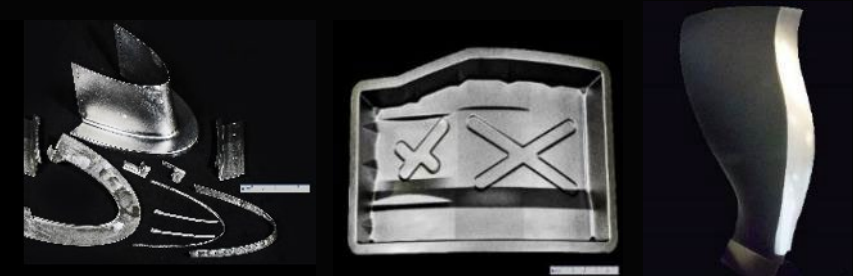
### Industry Certifications

- Nadcap Approved Processes: Welding, Non Conventional Machining, Heat Treat, Materials Testing, Chemical Processing, NDT
- ISO 9001, AS9100

### Complex Assemblies



### Detail Fabrication





## Complex Aero-Engine Fabrications including Combustion Components, Manifolds & Honeycomb Shrouds

- The West Chester Site has been within Barnes Aerospace for over 20 years specializing in the production of complex fabricated aero-engine components
- Utilizing a full range of machining and welding technologies; together with Honeycomb brazing to deliver critical aero-engine fabrications

9826 Crescent  
Park Drive, West  
Chester, OH,  
45069, USA

Floorspace

102k sq. ft

Employees

156

### Capabilities

- Cold Forming
- 3, 4, & 5 Axis Machining
- 2 & 5 Axis Laser Cutting
- TIG & Resistance Welding
- Vacuum Braze & Heat Treat
- Spark Erosion Grinding
- Shot Peening
- Customer Self Release

### Customer Approvals



### Industry Certifications

- Nadcap Approved Processes: Welding, Non Conventional Machining, Heat Treat, NDT
- ISO 9001, AS9100

### Complex Fabrications & Assemblies



## High Volume, Vertically Integrated, Compressor & Turbine Airfoils

- Established in the 1940s by a member of Frank Whittle's Power Jet team, Newton Abbot was one of the earliest innovators of CNC and robotic technologies for Airfoil manufacture
- Focusing on complex, machined, Compressor Airfoils; together with LPT Airfoils benefitting from cellular, automated manufacture combined with integrated Technologies

Shaldon Road,  
Newton Abbot,  
Devon,  
TQ12 4SQ, UK

Floorspace

230k sq. ft

Employees

352

### Capabilities

- Over 120 5 Axis Capable Vertical Milling Machines
- CNC Lathes
- Mill Turn
- Robotic Deburr & Airfoil Polishing
- Radial Interpolation Grinding
- Laser Weld & EDM
- Vacuum Brazing & Vapor Phase Aluminizing
- Shot Peen, Superfinish & Balancing
- Auto Blade Paint Line

### Customer Approvals



**Rolls-Royce**



**SAFRAN**

**Solar Turbines**

A Caterpillar Company

**Avio Aero**

A GE Aviation Business

**SIEMENS**



### Industry Certifications

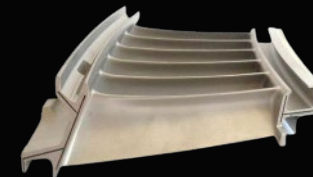
- Nadcap Approved Processes: NDT, Coatings, Heat Treatment, Welding, Non Conventional Machining, Chemical Processing, Surface Enhancement
- ISO 9001, AS9100

### Compressor Airfoils



- LPC & HPC Rotors
- Stator & Variable Vanes
- Compressor Blisks
- Additive Manufacturing Airfoil Finishing

### Turbine Airfoils



- LPT Rotors
- Nozzle Guide Vanes

## Engineering Capability for Rapid NPI on Complex Products

- Skilled engineering team supporting volume production parts alongside challenging Legacy & Low Volume and critical customer NPI execution
- Looking to develop its future capability range into a wider range of complex Cases and rotating parts including Rotor Spools

Logans Road,  
Motherwell,  
ML1 3NP,  
UK

Floorspace

63k sq. ft

Employees

78

### Capabilities

- CNC Turning & Milling
- ID/OD Grinding
- EDM
- Wire Cut
- FPI & MPI
- Pressure Testing
- Assembly

### Customer Approvals



Rolls-Royce



SIEMENS

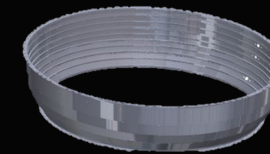


Avio Aero  
A GE Aviation Business

### Industry Certifications

- Nadcap Approved Processes: NDT, Non Conventional Machining
- ISO 9001, AS9100

### Stationary Components



- Static Seals
- Shrouds & Segments
- Rings & Flanges
- Compressor & Turbine Cases

### Rotating Components



- Rotor Spools
- Spinners
- Rotating Seals
- Nose Cones & Stub Shafts

## Volume Manufacturing in the Heart of the Polish Aviation Region

- Established in 2007 as a direct OEM manufacturing facility, Rzeszów has developed as part of the worldwide recognized Central European aerospace cluster in the region
- Looking to develop its future capability range into rotating, life limited, parts and fabrication technologies to support its core market of engine Housings

Przemysłowa  
9/B, 35-105  
Rzeszów,  
Poland

Floorspace

77k sq. ft

Employees

399

### Capabilities

- Up to 5 Axis CNC Lathes
- 3 & 4 Axis CNC Horizontal Mills
- 3, 4 & 5 Axis CNC Vertical Mills (with Turning Capability & Live Tools)
- ID / OD Grinding
- TIG & Auto Welding
- EDM Wire, Sink & Fast Hole
- Balancing & Assembly
- Pressure Testing & NDT
- Special Processes via Barnes Technologies

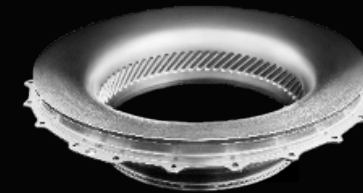
### Customer Approvals



### Industry Certifications

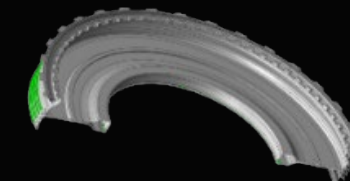
- Nadcap Approved Processes: Welding, NDT Non Conventional Machining as a Special Process
- ISO 9001, AS9100

### Critical Cases & Housings



- Bearing Housings
- Fan, Inlet & Compressor Cases
- Combustor & Turbine Cases
- C-Sump & Oil Scoop
- Fabricated Seals / Frames

### Rotating & Static Components



- Rotating Air Seals
- Rings & Flanges
- Welded Pressure Seals



## High Performance Treatments & Coatings

- From two facilities within Poland, Barnes Aerospace Technologies is a specialist provider of high-performance treatments and coatings for aero-engine components.
- We directly work with aero-engine OEM's and Tier 1's as well as their supply chain partners. We also support component manufacturing capabilities across Barnes Aerospace

Elektryczna 8,  
62-800,  
Kalisz,  
Poland

Floorspace

31k sq. ft

Employees

157

### Capabilities

- Heat Treatment
- Brazing in Vacuum (incl. Honeycomb Brazing)
- Plasma Spray Coatings
- Inorganic & Organic Paint Coatings
- Chrome Free Coating to REACH Compliance
- HVOF Spray Coatings incl. Coating Grinding
- Shot Peen, Paint Stripping & Met Lab

### Customer Approvals



### Industry Certifications

- Nadcap Approved Processes: Heat Treatment (incl. Brazing), Coating (incl. Thermal Spray Coatings)
- ISO 9001, AS9100

### *Compressor & Rotating Components*



- Compressor Rotors
- Variable Guide Vanes
- Shafts
- Couplings

### *Static & Ancillary Components*



- Cases & Frames
- Seals, Shrouds, Rings
- Fuel, Oil & Pump Hardware



## Launch System Assemblies for Land, Sub & Deck Missiles

- Burnley have specialized in the build, test and delivery of critical military launch systems for over 30 years
- On site capability for both mechanical and electrical assembly dovetails with complex, cross border supply chain management to deliver complete systems and assemblies

Widow Hill Road,  
Burnley,  
BB10 2TG,  
UK

Floorspace

50k sq. ft

Employees

33

### Capabilities

- Incoming Inspection
- Welding
- Mechanical Assembly
- Electrical Assembly
- Testing
- Paint & Coatings

### Customer Approvals



### Industry Certifications

- Nadcap Approved Processes: NDT, Welding
- Boeing & US Government Approvals
- ISO 9001, AS9100

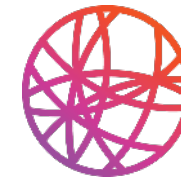
### Launch Systems



- Land Launch
- Sub Launch
- Deck Launch



# MRO Component Repair Businesses



**BARNES**<sup>™</sup>  
AEROSPACE

## High Volume Honeycomb, Segment & Seal Component Repairs with Sub 25 Day TAT

- A dedicated repair facility established in 1996 to cater for Repairs on High Pressure Compressor Stators & Shrouds on PW2000 and PW4000 engine programs
- Establishing itself as a world class facility with fast turn times and Gold performance standards for over a decade. Capability has extended across the global aircraft fleet

1, Industrial 3rd  
Road, Taoyuan  
Hsien,  
32853, Taiwan

Floorspace

83k sq. ft

Employees

225

### Capabilities

- CNC Machining
- TIG, Plasma & Resistance Welding
- Brazing & Heat Treatment
- Plasma & APS Coatings
- Flammable Coating & Dual Wire Arc Spray
- Honeycomb & Felt Metal Braze
- FPI & X-Ray

### Portfolio

- PW4000 & PW2000 / F117
- V2500 & PT6
- CF6, CF34, GEnx, GE90, CFM56-5B & -7B
- Trent 700-900, 1000-TEN, 7000 & XWB

### Approvals & Certifications

- FAA 145 (United States): #C50Y850N
- EASA (EU) & CAD (Hong Kong)\* Approvals
- Additional Airworthiness Approvals
- PWA, PWC, GE & RR Source Demonstrations

\* HK CAD Form One is accepted by CAAC based on JMM agreement



## Centre Of Excellence for Casing, Knife Edge Seal & Honeycomb Repairs

- Established in 1990 as sole Barnes Aerospace international site. Centre Of Excellence for Casing, Knife Edge Seal and Honeycomb repairs
- Provides vertically integrated Special Process capabilities (EB weld, advanced coatings, X-ray) to achieve customer TAT

21 Loyang Lane,  
508921,  
Singapore

Floorspace

101k sq. ft

Employees

193

### Capabilities

- Electron Beam Welding
- Auto TIG / Dabber Weld
- Advanced Coatings : Plasma Spray, HVOF, Vapor Aluminizing
- Waterjet Stripping
- Brazing
- Shot Peening
- Turning, Milling, Grinding
- Spark Erosion Grinding
- NDT : FPI, MPI & X-ray Inspection including NDT Level IIIs

### Portfolio

- CFM56 (All Models)
- LEAP 1A/C & 1B
- GENx
- Trent 700 & 800
- Trent XWB, 1000 & 7000
- PW2000, PW4000

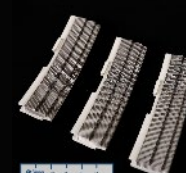
### Approvals & Certifications

- FAA 145 (United States): #ZWDY470L
- EASA (EU) & CAAC (China) Approvals
- Additional Airworthiness Approvals
- CFM & RR Source Demonstrations
- Nadcap Approved Processes

*Rotating Air Seal*



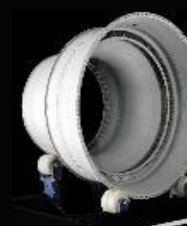
*Outer Air Seal HPC Rear Stator Case*



*HPC Front Stator Case*



*OGV Case*



*LPT Case*



*Combustion Case*



*HPT Forward Inner Nozzle*





## Honeycomb, Shrouds & Segments Repair Across Commercial & IGT Applications

- The West Chester Site has been within Barnes Aerospace for over 20 years with key capability in the repair of Honeycomb, Shrouds and Segment
- Supports high volume requirements across commercial CFM56, CF6 and CF34 platforms as well as IGT engines

9826 Crescent  
Park Drive, West  
Chester, OH,  
45069, USA

Floorspace

102k sq. ft

Employees

127

### Capabilities

- CNC Creep Feed Grinding
- CNC EDM incl. Fast Hole
- CNC Plasma Arc & Auto TIG Welding
- Vacuum Brazing
- Vapor Phase Coatings
- Chemical Stripping & Cleaning; Fluoride Ion Cleaning (FIC)
- CMM Inspection
- Fluorescent Penetrant Non-Destructive Testing
- Gas Path Repair Development

### Portfolio

- CFM56
- CF6, GEnx, GP7200
- CF34
- LM2500, LM5000, LM6000
- LMS100

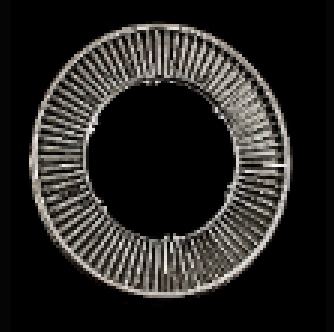
### Approvals & Certifications

- FAA 145 (United States): #KKWR148K
- EASA (EU) & CAAC (China) Approvals
- Additional Airworthiness Approvals
- GE & RR Source Demonstrations
- US Government Approved Repairs
- Nadcap Approved Processes

### High Pressure Turbine Shrouds



### Low Pressure Turbine Vane Rings



## Complex Cases & Rotating Parts Repair

- Highly capable specialized MRO component repair facility focused on both engine Cases and rotating parts, supporting aero-engine, military and IGT applications
- Weld and machine repairs are coupled with in-house coatings to manage quality and TAT

7 Connecticut S  
Dr, East Granby,  
CT, 06026,  
USA

Floorspace

86k sq. ft

Employees

93

### Capabilities

- CNC Turning, Milling, EDM
- EB Weld, CNC Plasma Arc Welding, Laser Clad Welding
- Automatic Tig Manual Welding
- CNC Robotic Water Jet Stripping
- Vacuum Brazing, Heat Treatment
- Plasma & Dual Wire Arc Coatings
- Chemical Stripping & Cleaning
- CNC Shot Peening
- Radiographic, FPI & Ultrasonic Non-Destructive Testing

### Portfolio

- CF6, GE90
- F110, F404, F414, LM2500
- Trent XWB, 1000, Trent 700, Trent 900, RB211-535
- F100, F117, F119
- GG8, FT4000, Siemens ADGT

### Approvals & Certifications

- FAA 145 (United States): #KC1R265K
- EASA (EU) & CAAC (China) Approvals
- Additional Airworthiness Approvals
- PW, GE & RR Source Demonstrations
- US Government Approved Repairs
- Nadcap Approved Processes

Diffuser Case



Front Case



Combustor Case



Drum Rotor



Rotor Shaft



Stub Shaft



## Complex Case Repairs including Source Demonstration Approved Schemes

- Over two decades experience as a supplier of complex Book & Source Demo repairs on critical Cases & Frames for the largest MRO facilities around the globe has given Warren a reputation for quality, service and unrivalled product knowledge
- Specialized repair capabilities for Turbine Support Cases and Gas Generator Cases

25250 Easy  
Street, Warren,  
MI, 48089,  
USA

Floorspace

130k sq. ft

Employees

117

### Capabilities

- 3, 4 & 5 Axis Machining
- 4 Axis, Die Sinker & Fast Hole EDM
- Welding (CNC, EB, TIG, Gas Shield Arc)
- Vacuum Heat Treatment & Brazing
- Plasma & Thermal Spray Booths
- HVOF, Flame Spray, Chem Etch & Pressure Testing
- Balancing, FPI, X-Ray & Metallurgical Inspection

### Portfolio

- PW100, PW150
- PW200
- PT6
- PW300, PW500, PW600
- F414
- AE Family

### Approvals & Certifications

- FAA 145 (United States): #QGIR458L
- EASA 145 (EU): #EASA.145.4484
- PWC & GE Source Demonstrations
- Nadcap Approved Processes

*Turbine  
Support  
Case*



*Gas  
Generator  
Case*

