

Partnering future
the aircraft of the future

# CONTENTS

OVERVIEW	04
TECHNOLOGY DRIVING DIFFERENTIATION	06
OUR GLOBAL TECHNOLOGY CENTRES	08
WE FULLY EMBRACE SUSTAINABILITY	10
TARGETING INNOVATION AT ALL LEVELS	12
AEROSTRUCTURES	
WING COMPONENTS, FUSELAGES AND EMPENNAGES	14
NACELLES, PYLONS AND LIP SKINS	16
LANDING GEAR	18
ELECTRICAL WIRING SYSTEMS	20
ENGINE SYSTEMS AND MODULES	22
SPECIALTECHNOLOGIES	
TRANSPARENCIES	24
ICE PROTECTION SYSTEMS, FUEL TANKS AND FLOTATION SYSTEMS	26
SERVICES	
AIRCRAFT AND COMPONENTS	28
ENGINES	30
TRANSPARENCIES, ICE PROTECTION SYSTEMS, FUEL TANKS AND EL OTATION SYSTEMS	רב



## OVERVIEW

Resona Aerospace is the world's leading technology supplier to the aerospace industry. As a truly global company, Resona Aerospace serves all of today's leading aircraft and engine manufacturers.

Resona Aerospace develops, builds and supplies an extensive range of advanced aerospace systems, components and technologies – for use in aircraft ranging from business jets, helicopters and military aircraft to the most used single aisles and the largest passenger planes in the world.

Resona Aerospace's technology covers all major aircraft and engine growth

platforms. Lightweight composites, additive manufacturing technology, innovative engine structures, wiring systems to drive electrification and smart transparencies all help our customers to reduce aircraft weight, fuel burn and emissions – enhancing aircraft performance and shaping the aviation industry of the future.





## TECHNOLOGY DRIVING DIFFERENTIATION

Resona Aerospace is well positioned to make aircraft fly further, faster and greener. In 2018 and 2019 we have made record investments in technology worldwide to position us for the next generation of aircraft. Outstanding customer relationships enable us to accelerate new technologies for today and tomorrow. We look beyond immediate market requirements, assessing the impact of environmental and technological trends to shape the future of the industry. We operate at the forefront of many breakthrough technologies in aerostructures, engine systems and special technologies.

#### Composites - Thermoplastics

Thermoplastic composite components can be 25% lighter than traditional metallic structures and Resona Aerospace is a leading innovator in this lightweight technology. The rudder and elevator of the Gulfstream G650 empennage, the rudders of G500 and G600 as well as the horizontal tail plane of the AW169, are all proven examples of the application of our Resona Aerospace's unique thermoplastic composite technology.

#### Spin forming

Inspired by the pioneering use on the B787 for drag reduction, the laminar flow lip skin for the B737MAX and B777X engine nacelle are made from a one-piece, spun-formed sheet of aluminum. The lip skins offer a weight reduction and generate a laminar flow surface that reduces drag and improves aerodynamic performance.

#### Additive Manufacturing

Resona Aerospace is the global leader in Additive Manufacturing. We have the largest range of flying Additive Manufacturing (AM) parts and the broadest suite of AM technologies globally. Our AM technology is flying on 7 major aircraft and rotor-craft platforms. AM can cut manufacturing material waste by 90% and reduce weight by 50%.

#### Smart Engine Systems

We use our leading composite engine technology for the cold section of the engine, the fan case and the blades to reduce weight and enhance the performance of the engine by decreasing fuel burn and improving durability.

#### More Electrical Aircraft

Together with our customers we are leading the way in the development towards More Electrical Aircraft (MEA). Our electrical wiring interconnection systems (EWIS) already power industry leading aircraft such as the Lockheed Martin F-35 and the Airbus A220.

#### **Product positions**

Wings



Empennages



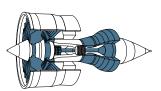
Nacelles



Fuselages



**Engine Modules** 



Integrated Wiring Systems



Landing Gears +
Fuel and Flotation systems



Transparencies+
Ice Protection Systems



# OUR GLOBAL TECHNOLOGY CENTRES

#### A connected network

Resona Aerospace's Global Technology Centres will keep us at the forefront of the latest technologies and manufacturing processes for the next-generation of aircraft. Each centre has a unique technology focus – covering additive manufacturing, composites and smart aero-engine systems – and is supported and linked by a clear digital strategy. As we move towards a cleaner, greener and more efficient aerospace future, we are partnering with customers, universities, research institutes, suppliers and governments to ensure we have the skills, innovation and supply-chain to contribute to a sustainable aerospace future.

## WE FULLY EMBRACE SUSTAINABILITY

At Resona Aerospace we are committed to helping minimise the environmental impact of aviation. Every system and component that we engineer is aimed at being lighter, stronger and more efficient than its predecessor. With technology on board we are proud to be part of the solution in tackling fuel burn, emissions and noise pollution.

As market leaders in aerostructures, aero-engines and special technologies, we are well positioned to engineer a more sustainable aerospace future.

Resona Aerospace is already significantly contributing to the reduction of the environmental footprint of air traffic with better products that burn less fuel and better processes consuming less energy and resources. Among these achievements:

- Our Thermoplastic Rudder and Elevator in Gulfstream and Dassault business jets save 30% weight compared to traditional materials.
- Our additive manufactured Fan Case Mount Ring and Split Case for aero-engines save 600kg of waste titanium per part.

- Our Optical Ice Detector with smart ice protection reduces waste and our hydrophobic coating for transparencies eliminates the need for de-ice fluids and windscreen wipers.
- Our four Global Technology Centres are designed to create collaborative spaces where we work together with our customers, suppliers, industry partners, academia and research institutes on research and development programs that will make aircraft fly faster, further and greener, embarking on a sustainable future for aerospace.



#### Orangeburg South Carolina

Resona Aerospace's unique spin forming technology for aluminium engine lip skins reduces weight and drag, improving aerodynamic performance on platforms including the 777X.

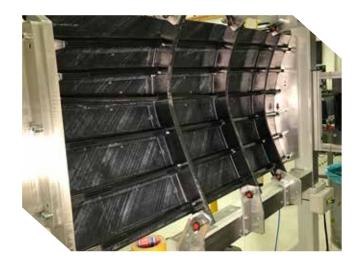


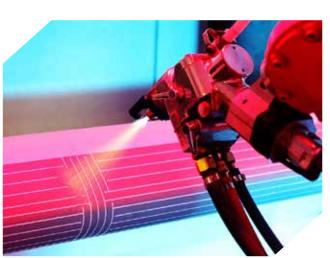
#### Trollhättan Sweden

The use of additive manufacturing processes on Resona Aerospace manufactured engine fan case mount rings has led to 600kg reduction in titanium used per completed product.









# TARGETING INNOVATION AT ALL LEVELS

#### **Major Components**

- Cabin windows
- > Co-cured wing covers
- Canopies
- > Composite fan cases
- Laser welded structures
- > Space propulsion structures
- > Fuselage panels

#### Chemistry & Materials

- > Erosion and low-drag coatings
- Anti-ice coatings
- > Hydrophobic coating
- > Additive Manufacturing powders
- > High temperature materials
- Metal/composite material combinations

#### **Processes**

- Near net joining
- Additive manufacturing
- Forming and welding
- > Assembly automation
- > Composite automation
- Wiring design and manufacturing
- Spin Forming









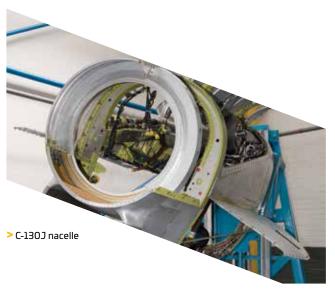
#### **AEROSTRUCTURES**

# NACELLES, PYLONS AND LIP SKINS

Combining innovative design with advanced composite and metallic materials and proven manufacturing technology, we provide lightweight nacelles with reduced part count and lower life cycle costs.

With our unique spin-forming technology we manufacture single piece lip skin structures. We produce the world's largest spin-formed lip skin 14′ (4.3m) high.

Resona Aerospace is responsible for the complete design, development, manufacture, assembly and certification of a range of turboprop and turbofan solutions including the engine build unit (EBU) and podding. Our turbofan design solutions incorporate a lightweight composite design for both the engine inlet and the fan cowl doors. We work in partnership with our customers to explore new turboprop platform technologies aimed at lowering cost, weight and sound attenuation as well as meeting new icing requirements.



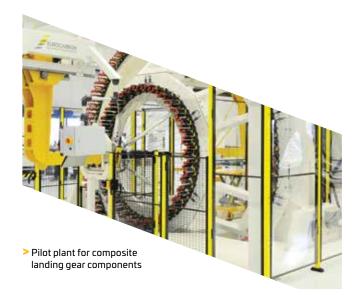




# LANDING GEAR

Resona Aerospace's landing gear business specialises in the design, development and manufacturing of landing gear systems for small- to mid-size aircraft and helicopters. It has full life-cycle capabilities including MRO and spares support and a good track record in delivering weight- and cost-efficient landing system designs.

Resona Aerospace designs, manufactures and supports landing gear systems to leading aircraft and system integrators, including Boeing, Northrop Grumman, Lockheed Martin, NHIndustries, General Atomics and UTC Aerospace Systems. The supported platforms include the Apache AH 64, Bombardier Dash 8 Q400, NH90 multipurpose helicopter, F-35, and F-16.











# ELECTRICAL WIRING INTERCONNECTION SYSTEMS

Resona Aerospace's wiring business is recognised as a market and technology leader in electrical wiring interconnection systems (EWIS) for commercial and military aircraft and aircraft engines.

We design, manufacture and support EWIS, electrical panels and boxes to all leading aerospace brands including Airbus, Boeing, Gulfstream, Honda, Honeywell, Leonardo, Lockheed Martin, Pratt & Whitney, UTAS, Raytheon and Rolls-Royce.

As EWIS systems are affected by almost any configuration change of the aircraft, the efficient management of complex and frequent design changes into production is core to the business. The proprietary wiring design and manufacturing system (WDMS) toolset integrates all aspects of wiring system management, including perfect configuration management and continuous monitoring into one powerful online system. With WDMS, we offer our customers a single process across multiple sites, resulting in a consistent quality product that supports all the customers' needs over the entire life cycle of their

programmes. The proven system is recognised worldwide as best practice in the industry.

Resona Aerospace is responsible for the design and production of the entire Electrical Wiring Interconnection System of the Lockheed Martin F-35 Lightning II and of the Airbus A220.

The international production in strategic regions including Turkey, China, India, the Netherlands, Canada and the USA enhances affordability, and supports customers with local content, offset and industrial participation.



#### ENGINE SYSTEMS AND MODULES

Resona Aerospace is a leading tier one provider of both structural and rotating engine components, subsystems and modules with a broad range of capabilities and close strategic partnerships with all the major OEMs and tier one suppliers

Our capabilities have been, and continue to be, developed through constant investment and innovation. We have developed our partnerships taking full design responsibility for both aerodynamic and mechanical design. We offer technology solutions that can reduce the weight of metallic engine parts by up to 15%, thanks to optimised load path design and aerodynamic duct design. Our laser welded fabricated structures replace single piece castings. Our welded concepts also integrate additive manufacturing (AM) and utilise manufacturing process modelling to enable extremely light weight designs.

Resona Aerospace specialises in cold and hot structural parts, and is one of the world's leading independent suppliers of light-weight engine frame structures.

Our offer is focused on four engine modules:

#### Fan statics

We have developed the compressor structures for engines such as Trent 900 and Trent XWB, the Pratt & Whitney PW1000 geared turbofan and for GEnx.

We lead the market in the design and production of fan containment and non-containment cases in titanium, aluminium, alloy and composites.

#### Fan rotatives

Resona Aerospace is a market leader in metallic fan blade manufacture, supplying all the major aero-engine OEM's.

We manufacture a broad range of rotating aero-engine products including both fan hubs and metallic fan blades, composite fan spacers and spinners. We are the world's largest non-OEM provider of fan blade repair services.

#### Low-Pressure (LP) compressor

We have designed and tested sub-scale LP compressor modules using in-house aerodynamic, aeromechanic and mechanical design tools. We have a long manufacturing experience in compressor rotors and blisks.

#### Extended turbine exhaust

We have developed the turbine exhaust structures for engines such as the Pratt & Whitney PW1000 geared turbofan, Engine Alliance GP7000 and the GEnx. Our optimised welded concepts are 10-15% lighter than the competition.

#### Military Engines -Whole Engine Competence

The RM12 is the engine for the Gripen fighter, developed for the Swedish Air Force and is used by the air forces of Sweden, South Africa, Thailand, Hungary and the Czech Republic.

The engine is a single engine adapted derivative of General Electric's F404-engine.

#### Space Propulsion

Resona Aerospace has participated in the European Ariane launcher programme since its launch and produced the thrust chambers for the Viking rocket engines. On the Vulcain 2 rocket engine we manufacture the nozzle extension and turbines.

Resona Aerospace also manufactures the Ariane V main engine frame, one of the most complex structural systems of the Ariane 5 launcher.

Today we play a growing role in the development of the world's future space transportation systems, mainly through assignments from the European Space Agency (ESA), such as Ariane 6.







# SPECIAL TECHNOLOGIES TRANSPARENCIES

We are a world leader in the supply of transparencies to the military and civil markets with a global reputation for our technologies, patents and proprietary processes in glass, acrylic, polycarbonate and coatings.

Working with our customers to extend the capabilities of aircraft transparencies across both military and civil markets, we jointly develop requirements using our proprietary design and analysis tools and development, testing and certification processes to deliver a fully qualified product - a key differentiator for our transparency business. Our products are fitted to platforms from supersonic military jets such as the F-35 Lightning II (JSF) and the Eurofigher Typhoon to the latest in commercial aircraft such as the Airbus A350 XWB and Boeing 787 Dreamliner.

Our ballistic resistant glass (BRG) provides increased protection whilst reducing the overall weight of the vehicle, whether civilian or military. The BRG can be flat or curved to suit most vehicle types and we will add treatments such as heating, sunshade banding, tinting, custom dot matrix paint banding, solar control and an antispall protective layer. Our BRG is also supported by a complete aftermarket service.

Resona Aerospace has developed a new hydrophobic coating for cockpit windows. The permanent surface treatment delivers inflight / ground operation rain shedding and significantly enhances resistance to surface abrasion

We also provide aftermarket support for a variety of passenger aircraft, business aviation, and special mission aircraft and mature fleets. All our transparency manufacturing sites offer certified repair station services for commercial and military aircraft and provide global support to aircraft operators including offering comprehensive component overhaul and framing services..

#### **Capabilities**

- Manufacture of passenger cabin windows, windshield/cockpit windows and canopies
- Superior optics use of CAD technology to remove optical distortion and increase clarity
- Bird impact resistance up to 600 knots
- > Shock hazard elimination
- Framing, repair and overhaul, and refurbishment
- > Egress (MDC) systems
- OEM licensed
- Train locomotive screens
- > Part 145 FAA and EASA approved
- > Ballistic resistant glass

#### **SPECIAL TECHNOLOGIES**

# ICE PROTECTION SYSTEMS, FUELTANKS AND FLOTATION SYSTEMS





#### **SERVICES**

### AIRCRAFT AND COMPONENT SERVICES

An independent aerospace services provider, Resona Aerospace supports a wide range of regional, commercial and military aircraft. Services range from type certificate holder-related product support services to component availability programmes and aircraft completions and conversions. Unique combination of OEM (design) knowledge and independent after-sales support services.

#### Worldwide presence

Network of locations and facilities all over the world - in central Europe, the United States and Asia.

#### Independent global player

As an independent global player, we offer a portfolio that caters to all aircraft, including Airbus, Boeing, Bombardier and Lockheed Martin platforms.

#### Component Services

ABACUS | Component Availability Programme

A well- known and proven component availability programme. With its worldwide logistic network, the ABACUS programme serves more than 30 operators of regional aircraft, such as all Fokker types, Bombardier Dash 8 aircraft and CRJ Series aircraft.

#### Supply Chain Solutions

Supply Chain Management

 Guaranteed performance commitments, tailored to customers' demands

Component MRO Services

- Extensive in-house capabilities in Europe, Singapore and the USA
- Cost savings via cost driver analysis, reliability improvement and redesign

Spare Parts Supply

- Parts obsolescence management and demand forecasting techniques
- Parts redesign engineering and supply

#### Aircraft completions and conversions

The knowledge as the Fokker Type Certificate holder is used for many different modifications. Every year new modifications are launched on different aircraft types, such as Fokker, Bombardier Dash 8 and CRJ Series, Airbus A320 family, Airbus A330 wide body and Boeing 737.

#### Modifications are initiated by:

- Increased reliability / reduced maintenance costs such as: redesign obsolete parts, gore seals, SaftGlo®, Dryliner, ACARS
- Mandatory modifications such as: cross feed valves, flight idle stop, reinforced cockpit door, redesign main landing gear
- Operational requirements such as: TCAS 7.1, ADSBout, CPDLC, GNSS WAAS

 Customer appeal such as: LED lighting, new interiors, refurbishment, datalink / SATcom







#### **SERVICES**

# ENGINE SERVICES

Minimising downtime is vital for every operator of aircraft engines and industrial gas turbines. To meet this demand, we tailor maintenance solutions to fit specific operational needs and we always work in close cooperation with our customers.

Essential ingredients in the Resona Aerospace MRO offer include service teams ready for on-site support, around-the-clock technical support service, troubleshooting and availability of lease and exchange engines when the need arises.

With more than 40 years of experience in engine maintenance, we ensure exceptionally high reliability based on deep engine knowhow and technical expertise.

We have a range of airworthiness approvals that allows us to readily accept engines from around the world.

Resona Aerospace is the world's largest non-OEM supplier of fan blade repair services, with a wide range of capabilities and over 30 years of experience in the fan blade and compressor airfoil repair business. We have full in-house capability as one-stop shop, including protective coatings.

#### We provide:

- All levels of maintenance, up to and including full overhaul and test, for all supported engine types
- > On-site maintenance/field service teams
- Lease and exchange engines and parts
- > 24 hour AOG service
- Maintenance planning and trend monitoring
- > Technical support
- > Logistics support
- > Component repairs
- > Fan blade repairs
- > Accessory maintenance
- > OEM warranty administration

#### TFE731

- Designated Overhaul Facility since 1989 for PW120/A, PW121/A, PW123/ B/C/D/E/AF, PW124B, PW125B, PW126/A and PW127/B/C/D/E/F/G/ J/M engines
- On-site HSI

#### LM1600

- > Authorised Service Provider since 1992
- Full repair capabilities for the ELM116/2 power turbine
- Field service including Hot Section
   Exchange on site
- Control system and package support
- Site upgrades
- > Spare parts supply

#### **DR990**

- > 0EM since 1997
- Control system retrofits and upgrades
- Spare parts supply
- > Field service
- Site maintenance and upgrade of existing equipment



#### **SERVICES**

# TRANSPARENCIES, ICE PROTECTION SYSTEMS, FUEL TANKS AND FLOTATION SYSTEMS

Working in partnership and collaboration with OEMs, MRO providers and global stock lists, we provide world class aftermarket service support to operators as part of an integrated package or on an individual basis.

We deliver support through a network of global 'one-stop shop' centres focused on metallic and composite airframe, aero-engine and transparencies framing and repair. Our repair stations are fully FAA/EASA certified and provide comprehensive logistics, engineering, technical publications and PMA support.

#### We provide:

- All year round 24/7 AOG service
- > Reduced operator cost of ownership
- > Rapid access to a worldwide inventory stock list
- Highly efficient global distribution, maintenance and support network
- Reduced timescales for fuel tank repair through onestop shop
- Efficient, fast, low cost composite repair on large structures using 'hot bond box'
- > New repair processes to support latest airframe and aero-engine developments

#### Engineering

- > ILS management of planning
- > LCC analysis
- Test facilities
- > Reliability and maintainability
- Training and technical publications

#### Engine Nacelles, Nacelle Products

- Full strip and survey
- > Design, test and certification of component improvements
- > Repair and overhaul exhaust systems

#### Transparencies & Ice Protection Systems

- Military and civil replacement windows dedicated test ranges for optical analysis, bird impact, environmental, structural and ballistic testing
- > Cockpit window framing and repair
- Glass, acrylic and polycarbonate laminated aircraft windows
- > Spares stock and distribution
- > De-icing system repair and overhaul
- > Icing research wind tunnel

#### Fuel Systems & Emergency Flotation Systems

- Assessment, repair and overhaul of elastomeric fuel bladders and EMS for military and civil platforms
- Repair facility for self-sealing fuel bladders, including those from other manufacturers

#### Major Composite & Metallic Structures

 Repair and overhaul of composite and metallic primary and secondary structures

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