**MATERIALS**

**Plastic Fantastic**
Injection-molded engineered plastics take the place of traditional materials

**COMPOSITES**

**Light as Air**
Composites are key to reducing weight and increasing fuel efficiency in aircraft

**ROTARY SEALS**

**In a Spin**
HiSpin® rotary seals for critical helicopter applications
In a Spin

HiSpin® rotary seals for critical helicopter applications.

Plastic Fantastic

Injection-molded engineered plastics are taking the place of traditional materials.

Light as Air

Composites are key to reducing weight and increasing fuel efficiency in aircraft.
<table>
<thead>
<tr>
<th></th>
<th>CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>04</td>
<td>Experience our Capabilities</td>
</tr>
</tbody>
</table>
| 06 | A Full Service  
Three new services transform a manufacturing facility into a full-service aerospace provider. |
| 10 | Sealing Solutions for Aircraft Interiors  
See where Trelleborg products contribute to performance and safety. |
| 12 | INTERVIEW  
Focusing on Aerospace  
A reorganized business structure for faster response and closer relationships. |
| 15 | A Good Flight Ahead  
The latest products for the next generation of aircraft. |
| 28 | Digital Update  
Tools and resources for the aerospace engineer. |
| 30 | MEETING REQUIREMENTS  
Vane Seals  
A new solution completely eliminates leak paths in actuators. |
| 33 | Fire Seals Test Lab  
A state-of-the-art facility to speed up development time and reduce costs. |
| 34 | AIRCRAFT ENGINES  
Sealing Solutions for Engines  
Learn where Trelleborg engineering improves engine performance. |
Trelleborg Sealing Solutions is expanding its manufacturing capabilities at its facility in Condé, France to fabricate proprietary elastomer parts, commonly used in flight control, actuation and landing gear applications.

Danielle Durand, the General Manager of the Trelleborg Sealing Solutions facility in Condé, says: “We are excited to offer enhanced production capabilities. Our European customers will benefit from reduced response time, since we will no longer have to ship seals from our manufacturing site in the U.S.”

The new facility has state-of-the-art production equipment for elastomer molding and a full suite of approvals from all relevant aircraft primes and OEMs.
Flying whales to boost production

On 15 April 2019, a giant whale lifted off into the skies over Toulouse. After five and a half hours in the air, the aircraft finished its maiden flight. The second plane of the BelugaXL family, BelugaXL 2, will enter service ahead of its predecessor BelugaXL. It will begin to carry wings from Airbus Broughton in North Wales to European assembly lines.

Two wings are better than one
To be more precise, the flying giant can carry two A350 XWB wings at once. This is thanks to its huge dimensions: over 63 meters long and an impressive body diameter of 8.8 meters. This huge space allows the BelugaXL 2 to carry up to six metric tons more cargo than the current Beluga ST, which can only carry one wing of the A350 aircraft.

This advantage will help Airbus in speeding up their transport from Broughton to the final assembly line in Toulouse, France. Airbus plans to build a total of six BelugaXL aircraft by 2023. The family of flying whales is growing bigger and bigger. This is exciting news for all aviation geeks and plane spotters across the globe. Keep your eyes open for the flying giants.

Japan flies entire Dreamliner family

Did you know that ANA (All Nippon Airways) was the original launch customer of the 787 Dreamliner? And recently Boeing delivered the first of three 787-10 airplanes ordered by ANA. With this milestone delivery, Japan’s ANA has become the first air carrier in Asia to operate the entire Boeing Dreamliner family.

The 787-10 is the 67th Dreamliner to join ANA’s fleet, which is the world’s largest consisting of 36 787-8 and 30 787-9 aircraft. The newest family member is set to operate on ANA’s popular Tokyo-Singapore route.

Fun Facts

AEROSPACE
A Full Service
The Trelleborg Sealing Solutions Aerospace facility in Cadley Hill, England, is enhancing its service portfolio. The addition of three new services transforms Cadley Hill into a full-service provider for aerospace customers.

By Meghan Cloud Braungar

THE TRELLEBORG SEALING SOLUTIONS FACILITY in Cadley Hill is a leading manufacturer and supplier of precision aerospace components, specializing in airframe and aircraft engine seals. Aerospace sealing experts work closely with customers to design and produce the optimum solution to meet individual needs.

Director of Global Operations Airframe Seals, Richard Furlong, explains: “Customer service is important to us. We value close partnerships with our customers and strive to continually enhance our capabilities to best support these relationships.”

Continuously developing engineering capabilities

“We know that two factors are crucial to meet the growing needs of our customers; the continuous development of engineering capabilities, methods and techniques, and the ability to rapidly serve and develop new products.” Richard continues, “Customers are not just looking for a supplier of seals, but rather a partner with the capabilities to jointly design, manufacture and provide innovative engineered aerospace components.”
Demand for advanced composite products is growing due to the benefits they offer over other materials, such as metals. Advantages include lighter weight, inherent flame resistance, excellent impact resistance and low moisture absorption.

As they are increasingly used in critical applications, advanced composite products must offer reliable performance and engineering properties. Therefore, reducing variability in the layup process of Prepreg material is crucial.
MATERIALS TEST HOUSE (MTH) & QUALIFICATION LABORATORY

The team at the manufacturing site in Cadley Hill, England is designing and implementing a new dedicated facility to bring all qualification testing in-house. The MTH & Qualification Laboratory will be accredited to ISO17025 and serve as a test facility and design engineering research lab for both internal and external customers.

Saving time
“In the past, qualification testing required by our customers was outsourced. This led to a significant loss in lead time,” Richard explains. “In an effort to streamline our design and production lifecycle, we are developing a full in-house qualification testing suite.”

The MTH & Qualification Laboratory will offer a full range of testing capabilities. These tests are invaluable in ensuring that newly developed designs and products meet the demands of aircraft applications. Tests include: endurance, load deflection, product lifecycle, pressure, temperature and material resistance to chemicals. During these tests, airframe seals must withstand a range of typical environmental working conditions, which the seals are subjected to during daily operation in the aircraft’s airframe.

Controlled environment
To ensure the highest quality advanced composite products for aerospace applications, Trelleborg Sealing Solutions Aerospace at Cadley Hill has invested in a composite manufacturing cleanroom. With this new facility, airborne particulate, air temperature and humidity can be controlled during the manufacturing process, thereby guaranteeing optimum quality composite material.

The new cleanroom is Class 100,000 and designed to support advanced composite manufacturing and product expansion for the aerospace industry. It is equipped with specialized layup workbenches and Prepreg cutting equipment.

Number One
With these additional capabilities, the Cadley Hill site is the first Trelleborg facility approved for composite fabrication by the National Aerospace and Defense Contractors Accreditation Program (NADCAP).
Trelleborg Sealing Solutions has pioneered the development of innovative aerospace solutions for decades. From airframes to engines and actuators to landing gear, Trelleborg products can be found improving performance and ensuring safety in nearly every part of a plane.

Using cutting-edge manufacturing techniques and supported by the material expertise of Trelleborg Group, our solutions for aircraft cabin interiors include:

- Sealing profiles for cabin interiors and seats
- Bearings and wear pads for overhead bins and chairs
- Diaphragms for air-conditioning systems
- Galley interior sealing profiles
- Seals with global and regional regulatory approvals
- Seals for sanitation and drains
- All seals approved to international smoke and toxicity standards

Features

- Custom parts and standard O-Rings
- O-Rings with FDA approval
- Compatible with both clean and waste water
Extruded profiles to suit customer requirements.

**Features**
- Custom and standard profiles
- Delivered as standard lengths or cut-to-size
- Colors to match cabin designs

**Aeroflex “Bulb” Type**

**Cabin Air Conditioning Diaphragms**

**Features**
- Designed to customer specifications
- Fabric-reinforced for high flexibility and high fatigue strength

**Aeroflex “Blade” Type Seal**

**Features**
- Custom and standard profiles
- Delivered as standard lengths or cut-to-size

**Bearings for Overhead Bins**

**Features**
- Unique Trelleborg Sealing Solutions design, to customer specifications
- Low-friction and wear
- No lubrication required
- Noiseless
Focusing on Aerospace

Trelleborg Sealing Solutions is the number one supplier of seals to the aerospace industry globally. We’ve always had a focus on our customers but to serve them even better, we’ve reorganized our Aerospace Business structure.

IN THE NEW STRUCTURE the aerospace activities will be concentrated in a fully integrated Trelleborg Sealing Solutions Business Unit, which will include aerospace dedicated manufacturing facilities in the U.S., Europe and China.

We had a chat with Jürgen Bosch, who was appointed President Trelleborg Sealing Solutions Aerospace effective January 1. He gave his take on the newly established Business Unit.

ITG: Good morning Jürgen! Congratulations on your appointment as President Trelleborg Sealing Solutions Aerospace at Trelleborg Sealing Solutions. This is big news. In your opinion, what are the main benefits this new organization offers our customers?

Jürgen: Thank you! At Trelleborg Sealing Solutions, we are continually working on, and succeeding in, exceeding our customers’ expectations. Though we were effective in serving our customers in the previous aerospace structure, the reorganization will bring us even closer to our customers, particularly on the manufacturing side. The combination of our vast engineering know-how and our world class manufacturing expertise is one of the strengths that makes us unique. That means a total focus on aerospace with even faster responses and direct access from the manufacturing facility to the customer.

ITG: How will Trelleborg Sealing Solutions Aerospace meet the growing demand for parts and components of its aerospace customers?
Jürgen: Over the past few years, with our customers and their needs in mind, we’ve been heavily investing not only in capacity build-up, but even more in new innovations to enhance the capabilities of our manufacturing facilities. For example, at our Northborough site, we now offer a full range of fire proof and fire resistance testing. Advanced in-house testing capabilities allow us to significantly streamline our processes and reduce time to market.

Similar investments are being made at other sites: we are building a new Materials Test House & Qualification Laboratory at our facility in Cadley Hill, England, and we are expanding our elastomer seal production capabilities in Condé, France, to better serve European customers.

In Asia, we have been gradually expanding our engineering and manufacturing capacity, to support both our traditional customers, as well as the emerging Aerospace industry.

Additional investments are already in the planning stage. Our top consideration for any new investment is how it benefits our customers.

ITG: Composite products are a hot topic in the aerospace industry due to the benefits they offer over other materials, particularly metals. What capabilities does Trelleborg Sealing Solutions offer in this field?

Jürgen: In the past few years, increasing our capabilities in the area of composite products has been a big focus. Not only do we offer in-house engineering expertise for composites, but also state-of-the-art R&D and manufacturing capabilities. Our new Composite Cleanroom in Cadley Hill, England, for example, supports the production of highest quality composite material, ideal for use in critical applications.

In addition, we recently acquired Automated Dynamics, a specialist in advanced composite products. This new facility in Albany, New York, U.S., makes composite parts using both the traditional autoclave process and the innovative Out Of Autoclave (OOA) process for continuous-fiber thermoplastic components, which offers more efficient production and are even lighter in weight.
ITG: Trelleborg Sealing Solutions Aerospace is the undisputed market leader in sealing systems for aircraft hydraulics, but what other strengths does Trelleborg offer to the aerospace industry?

Jürgen: Good question! Seals are not just used in hydraulics, but they can be found almost everywhere on aircraft. We offer sealing solutions for jet engines and interior applications, like air conditioning systems, overhead bins and fluid water and waste management. And, in my opinion, our most visually impressive products are our airframe seals. Contributing to aerodynamic efficiency and reduced fuel burn, these can be found throughout the aircraft body, wings, windows, and doors.

In addition, we’ve recently developed a new line of high-speed rotary seals. Our HiSpin® products are designed to ensure maximum performance at high rotational speeds and HiSpin® PDR RT is ideal for use in gearbox applications on helicopters.

But our strengths and expertise don’t just include our products. Our engineers and sealing experts, as well as the services we offer our customers, is where our primary strengths lie. Our experts work closely with customers in joint partnerships to develop solutions to meet the customers’ needs. I like to call this hand-in-hand engineering.

ITG: One final question on a very different topic: what role do you think social media plays in the future for communication with customers?

Jürgen: Social media has huge potential to enhance communication with customers. Not only is it an effective tool to raise awareness among customers and potential customers for our business, products and capabilities. But, social selling is also a powerful mechanism to improve communication between our engineers and customers.

Rather than promoting our business at a company level, social media enables increased personal contact on a more informal level. At Trelleborg Sealing Solutions, we have a number of expert social sellers and we’ve seen the real benefits social media can offer.

ITG: Thank you Jürgen for your insight! It was great having the opportunity to speak with you about the new Trelleborg Sealing Solutions Aerospace business, the role of the customer and your vision for the future.

Jürgen: My pleasure!

AN UNRIVALLED HISTORY OF PRODUCT AND SERVICE

Trelleborg Sealing Solutions has a history that goes back over 60 years in the aerospace industry. Dowty, Palmer-Chenard, Shamban, Coorstek, Automated Dynamics, Airframe Seals and Impervia are all brands within the Trelleborg Sealing Solutions portfolio. Our products are used in almost every major aircraft program and are commonly specified by leading aircraft manufacturers and original equipment manufacturers on a wide range of critical applications. Products include airframes and sealing solutions for engines, flight controls, actuation systems, landing gear, wheels and brakes.

For further information go to https://www.tss.trelleborg.com/aero
A Good Flight Ahead

Trelleborg Sealing Solutions Aerospace is the leading supplier of sealing systems to the aerospace industry. To continue to serve our customers effectively, it's vital that we continuously evolve our range of seals for aircraft inline with the latest demands from our customers. Here is a round up of some recent additions to our offerings.

By Donna Guinivan

IN SHORT

1. HiSpin® meets demand for seal integrity at high rotational speeds
2. The Square Ring gives optimum contact in cold temperature applications
3. AFP makes using light weight composites more cost effective
HiSpin® HIGH SPEED ROTARY SEALS

Boosting performance at high rotary speeds
Our new family of HiSpin® seals has been developed to meet the ever-growing demand to provide seal integrity at increasingly higher rotational speeds for aerospace applications:

- **HiSpin® PDR RT** optimizes the performance of rotary wing aircraft gearboxes by ensuring essential lubrication and simultaneously preventing leakage at high speeds.

- **HiSpin® HS40**, with outstanding low friction capabilities, has been designed to withstand the demanding conditions of high-speed electric aerospace applications.

Read In a Spin on page 18 to learn more about our innovative HiSpin® seals.

TURIEL® SQUARE RING

A square option for the cold
Trelleborg Sealing Solutions has developed a range of square elastomeric seals for use in cold temperature applications in landing gear and other static sealing applications that are exposed to thermal extremes. All are suitable for use in sealing grooves complying to the AS5857 standard for aerospace static seal glands.

Preventing leakage
Brian Bowen, the Trelleborg Sealing Solutions landing gear seal specialist, says: “Due to long-term exposure of seals to low temperatures during long flights and a high degree of deflection of hardware, there have been instances where aircraft landing gear has developed leakage from static seals. Our new Turel® Square Ring seals are highly squeezed radially and have an optimum sealing contact footprint to eliminate potential leakage. This is combined with high precision manufacturing processes that maintain very tight tolerances, contributing to enhanced low temperature performance.”

In addition to landing gear, the Turel® Square Ring can also be used in other low temperature applications such as aircraft spoilers, hydraulic transfer tubes and valve end caps, as well as in drones that typically fly at high altitudes for prolonged periods of time.

The new series of Turel® Square Ring is available in all the Turel® materials and can be combined with Turcon® PTFE-based Back-up Rings.

WHAT IS A ROTARY WING AIRCRAFT?

A rotary-wing aircraft is a heavier-than-air flying machine that uses lift generated by rotary wings or rotor blades that revolve around a mast 1. The most commonly known rotary wing aircraft is the helicopter.

1 https://en.wikipedia.org/wiki/Rotorcraft

HiSpin® PDR RT is ideal for rotary wing aircraft
COMPOSITE TECHNOLOGY

Unique composites
Automated Fiber Placement (AFP) expertise has been added to the Trelleborg Sealing Solutions portfolio after Trelleborg Group acquired U.S. company, Automated Dynamics.

Aerospace moving to composite use
Rob Langone, General Manager of Trelleborg Sealing Solutions in Albany, New York in the U.S., previously Automated Dynamics, said: “We’ve been manufacturing thermoplastics for decades, focusing on continually improving the process. Historically, the aerospace industry has favored thermoset products, but we’re seeing a migration towards thermoplastic composites. This is because thermoplastic composites offer many advantages over their thermoset counterparts, including inherent flame retardancy, high degrees of impact toughness, low moisture absorption, and the ability to be stored at room temperature indefinitely.”

The thermoplastic composite process involves an AFP machine and proprietary software to gauge heat and pressure as raw materials are laid down layer-by-layer. Little time is needed to produce a fully consolidated laminate, and any post-processing steps such as autoclave curing are eliminated. As this is a true Out-of-Autoclave (OOA) process for continuous-fiber thermoplastic components, it has proven to be 30 percent more cost effective when compared with existing production methods.

Commercial production is almost here
As the industry works to find ways to take advantage of thermoplastic composite materials, developers believe this process is on pace to become the chosen manufacturing method for the next generation of aircraft components. Commercial production of thermoplastic composite parts is now closer than ever to the mainstream.

“We’ve been manufacturing thermoplastics for decades, focusing on continually improving the process.”

ROB LANGONE, General Manager of Trelleborg Sealing Solutions in Albany, New York, U.S.

Want to know more about the Trelleborg Sealing Solutions aerospace range?
If you’re involved in design and engineering of components for aircraft, find out what Trelleborg Sealing Solutions has to offer by visiting www.tss.trelleborg.com/aero
HiSpin®
PDR RT

HiSpin®
HS40
Efficiency is key for aerospace applications. That’s why, we endeavor to make the seals that are an integral part of these ever better and it is what we have achieved with the HiSpin® PDR RT and HiSpin® HS40 rotary seals.

**HiSpin® PDR RT gets rotary wing aircraft in the right gear**

Chris Cox, Senior Product Engineer at the Trelleborg Sealing Solutions manufacturing facility in Bridgwater, England, said: “Our customers wanted us to design a seal that would provide an even better performance at very high speeds, specifically for rotary wing aircraft. That meant engineering a seal that outperforms anything comparable. Ensuring that essential lubrication is maintained and preventing any leakage presented major challenges, but with the new HiSpin® PDR RT rotary seal we were able to overcome them.”

**Overcoming a paradox**

Efficient lubrication on the one hand, and a dry shaft on the other were needed. That might sound like a paradox, especially for a single component, but it is ensured by a unique design of the sealing lip in the HiSpin® PDR RT. Withstanding extremely high speeds at high temperatures with minimum friction and minimum power loss, it maintains lubrication within the gearbox while keeping the shaft dry.

The superior high-speed sealing capability of the HiSpin® PDR RT, not only matches the needs for high speed rotary seals in helicopter gearboxes but also provides a longer lifetime for the gearbox assembly, resulting in a better service life for the helicopter and ultimately it increased safety.
Higher rotational speeds
Running in dry, moist or lubricated environments, HiSpin® PDR RT meets an ever growing demand for seal integrity at increasingly higher rotational speeds. Its excellent sealing characteristics allow continuous use at speeds of up to 60 meters per second.

The combination of a unique material, an innovative manufacturing process and specialized sealing lip design, reduces friction by up to 75 percent when compared to traditional PTFE seals. This leads to a significant reduction in power consumption, heat generation and wear on both the seal itself and its mating surface.

Outstanding test results
The design of the HiSpin® PDR RT has been optimized so it can run on a range of surface finishes and coatings, including ceramics. In in-house tests, the seal has undergone more than 20,000 hours of endurance testing, with this pioneering design operating at 3,500 hours leak free.

FEATURES AND BENEFITS
• Capable of operational surface speeds up to 60 m/s (195 ft/s) and beyond
• Bi-directional sealing capability
• Compact design reduces assembly space requirement
• Wide temperature range, from -60 °C to +200 °C (-75°F to +390°F)
• Ability to handle pressure
• Excellent sealing performance with and without lubrication
• Extremely low friction and heat development
• Wide media compatibility
• Negligible shaft wear
• Design optimized for durability and long service life
Electric in the Skies
The development of “more electric aircraft” holds huge potential and at the same time many challenges for aerospace systems and their sealing solutions. To meet these new demands, HiSpin® HS40 represents a ground breaking design for eMobility applications.

Tested under extreme conditions, HiSpin® HS40 offers superior cost-effective performance and reliability. Its outstanding low friction capabilities meet the demanding conditions of high-speed electric aerospace applications, such as electric hoists and electro mechanical actuators.

Innovative design and materials
A unique hydrodynamic feature within the HiSpin® HS40 helps reduce frictional torque. Simultaneously, oil back-pumping leads to improved sealing performance without causing any damage to the shaft.

The seal is manufactured with our proprietary XLT high-performance fluoroelastomer (FKM). This material provides outstanding resistance to extreme engine conditions resulting from high motor speeds and aggressive synthetic fluids. Testing of the new generation of XLT compounds has proven that these low temperature FKM grades outperform and extend the temperature performance capability of traditional FKM materials.

FEATURES AND BENEFITS
- Works at high speeds up to 40 m/s (130 ft/s)
- Bi-directional sealing capability
- Compact design to reduce assembly space
- Wide temperature range, from -45 °C to +200 °C (-50°F to +390°F)
- Ability to handle run out
- Excellent sealing performance in different lubricated environments
- Exceptional low frictional torque
- Reduction of heat development
- Proven compatibility with various eMobility transmission and other aggressive fluids
- Negligible shaft wear
- Easy installation
- Cost effective
- Available in different outer diameter configurations, e.g. partially rubber covered
Light-weighting is a key objective for all aircraft manufacturers. Making a plane lighter reduces fuel use, lowering operator costs and the negative impact of flying on the environment. And this is where composites are coming into their own.

By Donna Guinivan

**FUEL IS THE NUMBER ONE EXPENSE** for airlines, so it’s no surprise that they are continually looking for ways to lighten the load.

A figure brought to the forefront by Norwegian economist Bharat P Bhatta’s proposed pay-as-you-weigh pricing model for passenger fares, is his estimate that a reduction of one kilogram of weight could result in a fuel saving of 3,000 US dollars per year.

**Innovative ways to lower weight**

Maybe not going the whole hog of charging passengers depending on their weight, carriers have resorted to ever more inventive ways of lowering aircraft weight. These have included American Airlines serving one less olive in its inflight salads, British Airways lighter inflight magazine and Virgin Atlantic’s radical rethink of economy meals.*

---

* https://core.ac.uk/download/pdf/52064257.pdf
https://www.effective-design.org.uk/sites/default/files/6-4-1%20Virgin%20Atlantic%20Airways.pdf

In this model, upper and lower bearings of a landing gear shock absorber have been replaced with Orkot® composite bearings.
All of these measures add up to lower operator costs, less fuel and a reduction in CO₂ emissions. As effective as these in-cabin changes may be, potentially greater savings can be made in the fundamental design of the plane. One option for this is a shift from metal components to composites.

**Composite bearings**
Trelleborg Sealing Solutions has a focus on composites at its facility in Albany New York in U.S. as well as in Rotherham, England, where the unique Orkot® material is manufactured.

“Traditionally, Orkot® has been used in bearings for ships and hydropower plants,” says Brian Bowen, who is heading up a project to transfer this proven technology to aerospace applications. “Metal bearings feature in the landing gear shock absorbers of planes and if these can be successfully replaced with composite bearings instead, a huge potential saving can be made by operators through light-weighting.”

**Not just lighter in weight**
Replacing a steel/ bronze bearing with a composite bearing saves weight due to the specific density of the materials used. The specific density of steel is eight grams per centimeter cubed and bronze is 8.75. Polymer bearings have a specific density of just 1.25 grams per centimeter cubed; a typical saving of 7.5 in volume per unit.

“Composite bearings have other advantages too,” continues Brian. “Friction is low, running dry or lubricated, and constant. There’s no surface coating to wear off, and when running dry, there’s no maintenance.

“The composite bearings are easier to fit than metal ones and their flexible base material spreads load more effectively, allowing a larger contact area. They also have no edge loading, are impact resistant and oversized repair parts require no tooling. All in all the composite bearing is a promising alternative to metal ones.”

**Eliminating metallic wear particles**
A less obvious but important additional benefit of composite bearings, that has been identified by Trelleborg Sealing Solutions, is the exclusion of metallic particles from the hydraulic system.

Brian explains: “We’ve observed that customers who use metallic bearing shells have an increased risk of metallic wear particles in the shock absorber hydraulic fluid. Over time these metallic wear particles can scratch the counter surfaces of the shock absorber slider, and more critically, can damage the soft polymer seals. If the dynamic seal caps become scratched, then this can lead to a reduction in the service life of the shock absorber. Composite bearings do not generate such abrasive wear particles, extending the life of seals and the system itself.”

However, despite all these benefits, the biggest advantage of the composite bearing remains its lighter weight. To prove this Trelleborg Sealing Solutions undertook tests to verify the potential weight saving from switching from metal to composite bearings.
Huge savings per year
“The total saving from just the replacement of the bearings in the landing gear shock absorbers is 20 kilograms per plane. If we go back to Bharat P Bhatia’s estimated fuel saving of 3,000 US dollars per year per kilo, that equates to 60,000 US dollars per year per plane.

“And the shock absorber bearings are not the only application we’re looking at for Orkot®. There are also the LG pin bearings, landing gear actuation bushings, door hinges and cargo handling rollers and wear pads,” concludes Brian.

Weight saving per aircraft
Large Aircraft Main Landing Gear Shock Absorber Dynamic (Upper and Lower) Bearings

<table>
<thead>
<tr>
<th>BEARING MATERIAL:</th>
<th>PE/PEEK</th>
<th>BEARING DENSITY:</th>
<th>1.25 g/cm²</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>BEARING MATERIAL:</th>
<th>BRONZE</th>
<th>BEARING DENSITY:</th>
<th>8.75 g/cm²</th>
</tr>
</thead>
</table>

20 Kg (45 lbs) weight saving per aircraft
= 60,000 USD Fuel saving per year per plane

A350 LANDING GEAR QUALIFIED
To support our customers in proving seals for critical applications, Trelleborg Sealing Solutions invested in the world’s most powerful test bench for hydraulic rod seals. This unique facility allows testing to be carried out that has previously never been possible and was utilized to qualify the seals for the landing gear of the Airbus A350. The sealing system has successfully passed 20,000 full landing cycles plus additional tests for ice scraping and water spraying.

FACTS ABOUT
The world’s most powerful test bench for hydraulic rod seals

- **Location:** Trelleborg’s research and development center in Stuttgart, Germany
- **Weight:** 18 ton / Power: 260 kW
- **Type:** Floating-mount rod seal test bench
- **Test capabilities:** Long-term endurance and development tests for complete sealing configurations in a single test construction.

**Simulation capabilities:** Patterns of movements and pressure patterns in sinus waves, trapezoidal forms and freely modeled patterns. Replicates the pressure between the primary and secondary seals and can simulate different atmospheric temperatures between -60 °C and +90 °C/ -76 °F and +194 °F.

**Aerospace test capabilities:** Check parameters such as braking or lateral forces on landing gear and simulate life-like knocking caused by uneven runways.

**Size capabilities:** Seals 100 and 400 millimeters/ 4 to 16 inches in diameter

**Speed capabilities:** Up to 1 meter/ 3.3 feet per second

**Frequency capabilities:** Can generate up to 10 Hz

**Novel feature:** The Lateral force cylinder is mounted at the bottom of the bench that is capable of exerting forces of up to 225 kN, it can place permanent radial loads on the seals, or, depending on the stroke, exert dynamic loads.

**Results:** Can be fully documented, allowing customers to provide their clients with proof of performance related to prescribed parameters.

**Installation:** Specially constructed so that vibrations can be isolated from the surrounding building.

**Sustainability:** Set up in a separate room so that energy otherwise lost through emissions can be used in an environmentally friendly manner to reheat the building.
Plastic Fantastic

They may be injection molded plastic but that does not mean they are weak. Bringing lighter weight and impact resistance to metal applications, engineered plastics are likely to be increasingly taking the place of traditional materials.
THE AEROSPACE INDUSTRY is continuing to evolve and there is a long-term trend toward using more engineered injection molded and machined parts in aircraft. According to Stratistics MRC the global aerospace plastics market accounted for 12.32 billion USD in 2017 and is predicted to reach 26.79 billion USD by 2026; an annual growth rate of 9%.*

The same report points to the main drivers as a rise in the number of aircraft manufactured, increasing demand for lightweight components and growing demand for plastics in several aerospace applications. However, the high cost of fabrication and a limited range of material options are hampering the market.

To counter that limitation, injection molding represents an effective and efficient option for production of plastic components. Sometimes thought of as weak, the latest plastic innovations in terms of materials and processes, mean that even structural metal parts can be replaced with injection molded alternatives.

“There are numerous advantages associated with ultra, high performance, and engineered polymers,” says Tim Miller, Technical Manager at Trelleborg Sealing Solutions. “These advantages include lighter weight, inherent flame resistance, excellent impact resistance, and low moisture absorption. More and more traditionally metal parts are being replaced with plastics and this trend will continue as the industry looks for lighter weight and more cost-effective solutions.

“A focus on material technology and processes to make production of plastic parts ever more effective, will no doubt contribute to spurring the market along.”

Injection molding is the ideal process to produce complex aircraft components such as this outlet guide vane fairing.

**TORLON® MOLDING CAPABILITIES**

The Trelleborg Sealing Solutions manufacturing facility in Denver, Colorado, U.S., is certified as an injection molder for ultra-high performance Torlon® polyamide-imide (PAI) polymer.

The site is one of a few locations globally that is certified to injection mold parts from Torlon® PAI.

By adding Torlon® to our aerospace material portfolio we are able to support a wider range of applications in the industry. The properties of the Torlon® material make it ideally suited to high-heat, load bearing applications, such as in engines, where reliable performance over time is critical.

**TIM MILLER, Technical Manager at Trelleborg Sealing Solutions**

“There are numerous advantages associated with ultra, high performance, and engineered polymers.”
Simplify your Engineering – New & Improved O-Ring Calculator

To better support your engineering needs, we’ve completely overhauled our renowned O-Ring Calculator. One of our most popular tools, since its release in 2014, it boasts over 9,000 average sessions per month.

The O-Ring Calculator offers engineers and professionals a quick and easy way to calculate O-Ring dimensions and the appropriate housing layout in accordance with the international O-Ring standard ISO 3601. By simply entering installation specifications for an application, it recommends O-Ring sizes, housing layout and corresponding part numbers.

Features:

- ISO quick search - makes O-Ring and housing recommendations based on single diameter measurements
- O-Ring Search – search for O-Rings in accordance with various national and international standards
- Calculates compression force - enables you to estimate mechanical stress on the housing counterparts
- O-Ring part number - based on your calculations, the O-Ring Calculator provides you with a part number and link to the part in the e-Catalog
- CAD Files – upon completing calculations you’ll receive a quick link to relevant drawings
- Save results directly to your Trelleborg Sealing Solutions member account – just log-in to access your calculations
- Share your projects with colleagues – you can send your calculations to colleagues, either directly to their member account or via email

Try the O-Ring Calculator now! You will find the O-Ring Calculator on www.tss.trelleborg.com by going to Design Support & Engineering Tools under "Tools & Resources."
Mobile Apps

To support design engineers, we offer an innovative range of tools and services for mobile devices. Just search for “Trelleborg” in the iTunes App Store or Google Play. All apps are available free of charge.

Aerospace Groove selector
This app covers three of the most important SAE aerospace groove standards for hydraulic systems, AS4716 Rev B, AS5857 Rev A and AS6235 Rev A. You can easily find groove sizes and determine if grooves are suitable for a dynamic and/or static seal. Available in metric and inch, based on standard dash numbers.

ISO Fits & Tolerances
Aimed to assist engineers, this app supports the calculation of ISO fits. Just enter the nominal diameter of the bore or shaft and select tolerance classes. The app then provides the complete ISO fits definition with all relevant values including the type of fit. Tolerances are shown for the most commonly used ISO tolerance classes and convenient graphs illustrate these classes by bore and shaft. Results based on the DIN ISO 286 System of Limits and Fits.

Converter – Universal Conversion
Trelleborg’s Unit and Hardness Converter is an easy-to-use conversion tool covering a comprehensive list of units. Simply select the dimension, choose the units you are working with and enter the value for conversion to get the numbers you need. The converter covers over 300 engineering and scientific conversion units in 32 categories.

Hardness conversions are based on material table type offering quick conversion between different hardness scales. Bonus features include currency and time zone conversions, running pace calculator and percentage calculator.

Fluid Mechanics Calculator
This Fluid Mechanics Calculator is designed to support fluid thinkers. The app covers a wide variety of topics in the field of fluid mechanics and serves as a reference for the analysis, design, maintenance and operation of fluid related systems.

You can stop memorizing hundreds of equations! This app includes over 130 formulas and over 360 calculations for different fluid mechanics equations, including those used in civil, structural and mechanical engineering.
When a customer requested completely leak-free operation within an aerospace actuator, Trelleborg utilized an innovative new production method to deliver a high-tech vane seal.

By Jan Sklucki

**ROTARY VANE ACTUATORS (RVA)** aid in controlling aircraft wing flaps, anti-roll suspension systems on premium cars and machine tools, and operate with rotating and oscillating motions. Generally, actuators are designed with one or two vanes, but versions are available with three or more.

In a two vane rotary actuator, a rotor replaces the piston, which operates within linear hydraulic cylinders, with two vanes attached. When fluid pressure is applied to two of the four working chambers that turn the actuator, it requires sealing to ensure reliable performance.

The vanes allow more power from a smaller envelope, but even small amounts of fluid leakage creates inefficiency and power loss.

**Continual development**

Over the years, Trelleborg Sealing Solutions has been looking at more efficient and cost effective vane seal designs, increasing efficiency and performance with each step.

“From milling to stamping, we’ve had successes with creating seals of different shapes and materials to meet our customers’ demanding requirements,” says Steve James, Aerospace Product Engineering Manager at Trelleborg Sealing Solutions.

An aerospace customer involved with commercial aircraft approached Trelleborg Sealing Solutions looking to create a completely leak-free seal to further improve performance and meet environmental requirements.
Removing the leak path
Traditional vane seals feature an inherent leak path. “The corner actuator seal has been the weak link in the chain, and the industry has been looking for a way to eliminate it for 25 years, with substantial research time dedicated to a solution. After a great deal of development and testing, including designs with springs and trying to tighten the corner’s geometry, we’ve developed a new seal to completely eliminate the corner actuators – and hence removed the leak path entirely,” says Steve.

Using a patented process, a PTFE and bonded elastomer is bent into a geometry to consolidate multiple sealing functions into a single highly engineered part, enabling three-dimensional sealing.

Decades of experience
“It’s the result of decades of experience in sealing, not just in aerospace, but in all industries. Few companies have the combined resources: the material technology, the worldwide engineering expertise and the manufacturing capabilities,” ends Steve.

As actuators have developed, manufacturers are looking for better internal performance. The vane seals offer this and more. They can keep up with the requirements of newer, smaller actuators that deliver ten times the power and meet the latest safety guidelines on the market.

VANE SEALS – FEATURES AND BENEFITS:

- **Customizable non-circular shapes**
  High-efficiency, ultra-tight designs for enhanced leakage performance and low hysteresis

- **Streamlined designs**
  Advanced low-friction solutions
  Requires fewer assembled components, reducing weight and complexity while providing easier installation

- **Space optimization**
  Reduced size to meet today's demands for slimmer profiles

- **High wear resistance**
  Provides longer service life and reduced maintenance costs

- **Unique manufacturing techniques**
  Include 3D printing, stamping and milling processes

- **Extreme performance**
  Capable of operating under high pressure, within a wide temperature range and at high speeds up to 15 meters / 49 feet per second

FIND OUT MORE
Learn more about Vane Seals at: www.tss.trelleborg.com/literature
AS PART OF ITS CONTINUED SUPPORT for its aerospace customers and focus on research and development, Trelleborg Sealing Solutions expanded its fire seals R&D and qualification testing capability with the addition of a new state of the art fire test lab.

“Our testing includes fire proof and fire resistance testing, meaning we can do nearly every test required for aerospace product qualification testing in-house, and work closely with customers to develop a testing regime that is right for them,” says Quinn Collett, General Manager - Airframe for Trelleborg Sealing Solutions Aerospace.

Testing is vital for aerospace applications
From concept to full qualification, testing plays a vital part in speeding up development time and reducing costs. Many sealing suppliers make use of 3rd party testing laboratories, which can be costly and add extra time into the development cycle.

“With products like fire seals, which can require iterative development, especially when product performance is being optimized, multiple testing intervals can be carried out throughout development. If it fails, it goes back to the drawing board and testing must occur again. By keeping all fire testing in house, we’re able to dramatically reduce that schedule,” says Quinn. “And with the new equipment we can extend our behind-the-scenes work on evolving fire seal technology, which we’ve been doing for over 50 years.”

Examples of the types of testing regimes performed are ISO 2685 and AC20-135. ISO 2685 test subjects the seal to vibrations, flames and intense heats of +1,100 °C / +2,000 °F for 15 minutes, while being studied for predetermined failure modes such as flame penetration or other customer-specified failure modes. “The testing conditions can be modified to take into account additional factors customers may be interested in, such as compression loading, air flow or pressurization,” says Quinn.

A whole package of testing
Seals used within aerospace applications often require other testing procedures, other than fire testing, which is where Trelleborg Sealing Solutions can really excel with its full suite of testing capabilities.

“Fire seals may require cycle load testing or fluid compatibility testing too. With other seal providers typically involving external testing laboratories, the qualification procedure could be very lengthy, but with our inhouse facilities, we can significantly reduce that. We really are a one-stop-shop, and with our design and engineering facilities we can move very quickly through design, testing, qualification and iteration,” finishes Quinn.

MORE INFORMATION
Check out our video illustrating the fire test capabilities. Go to the films section of www.tss.trelleborg.com.
Trelleborg offers a wide product range suitable for use in and around aircraft engines. From thrust reverser door seals to VBV door seals, complexity, size and design depend heavily on the application. Typical requirements include fire resistance, media resistance, operation within a wide temperature range and long lasting flexibility.

**Sealing Solutions for Engines**

Isolast® perfluoroelastomer material and AeroXLT™ (low temperature fluoroelastomers) can be molded to any shape and work under extreme temperatures.

**Blade Seals**

Fan blade seals are located at the base of the fan blades and close the gap between the blade and the filler platform efficiently to improve the airflow through the engine to reduce fuel consumption.

**Specialty Elastomers**

Isolast® perfluoroelastomer material and AeroXLT™ (low temperature fluoroelastomers) can be molded to any shape and work under extreme temperatures.
Flexible Hosing
Allows connected tubing to expand and move during the engine’s working cycle. Reinforced layers provide a service life that matches other engine components.

Duct Seals
Flexible joints allow bleed air from the engine into auxiliary systems like cabin heating and deicing, even at high deflections during strong air turbulence.

Bleed Air (KISS) Seals
Designed to handle the hot engine bleed air, these seals tolerate the air used in deicing and cabin heating, up to temperatures of +300 °C / +572 °F. As part of the qualification, these seals must withstand the flow of hot engine air during the whole aircraft’s service life.

Himod™ Engineered Plastic Components
A wide range of highly advanced plastic materials are designed to have a high temperature capability up to +260 °C / +500 °F with low friction and high bearing load capacity. Compared to metal bearings, the advantages include vibration damping, lower weight, and soft wear particles that do not interfere with seal function.

VBV Door Seals
Trelleborg Sealing Solutions has the expertise to develop complex solutions, such as these Variable Bleed Valve (VBV) door seals that contribute significantly to the improved fuel economy of next generation engines.

Thrust Reverser Seals
Fire resistant seals on the thrust reverser doors withstand extreme temperatures and high airflows due to fabric reinforcement in exposed areas.
Boost the performance of your rotary wing aircraft now

Seals to Optimize Performance at High Rotary Speeds

Increasing efficiency, ensuring safety and extending service life are key in the development of innovative high-speed aerospace applications. Our new HiSpin® HS40 and HiSpin® PDR RT seals, specifically designed to perform at high rotational speeds, are the perfect match for cutting-edge solutions.

Find out more at: www.tss.trelleborg.com/accelerate

Americas – Airframe +1 303 469 1357, Distribution & Engineering +1 260 749 9631
East +1 610 828 3209, West +1 310 371 1025
Canada +1 514 284 5415, Government Group +1 260 748 5709
Europe – North (UK, Eire, Poland and Nordic Countries) +44 (0) 121 744 1221
South & West (Continental Europe and Middle East) +33 (0) 1 30 86 56 00
Asia Pacific – China +86 (0) 21 6145 1830, Singapore +65 6 577 1778