

Ready for New Challenges!

...BUT BUILDING ON EXPERIENCE.



With Trelleborg Aerospace into the last frontier



Rocket Engines



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Rockets and Launchers



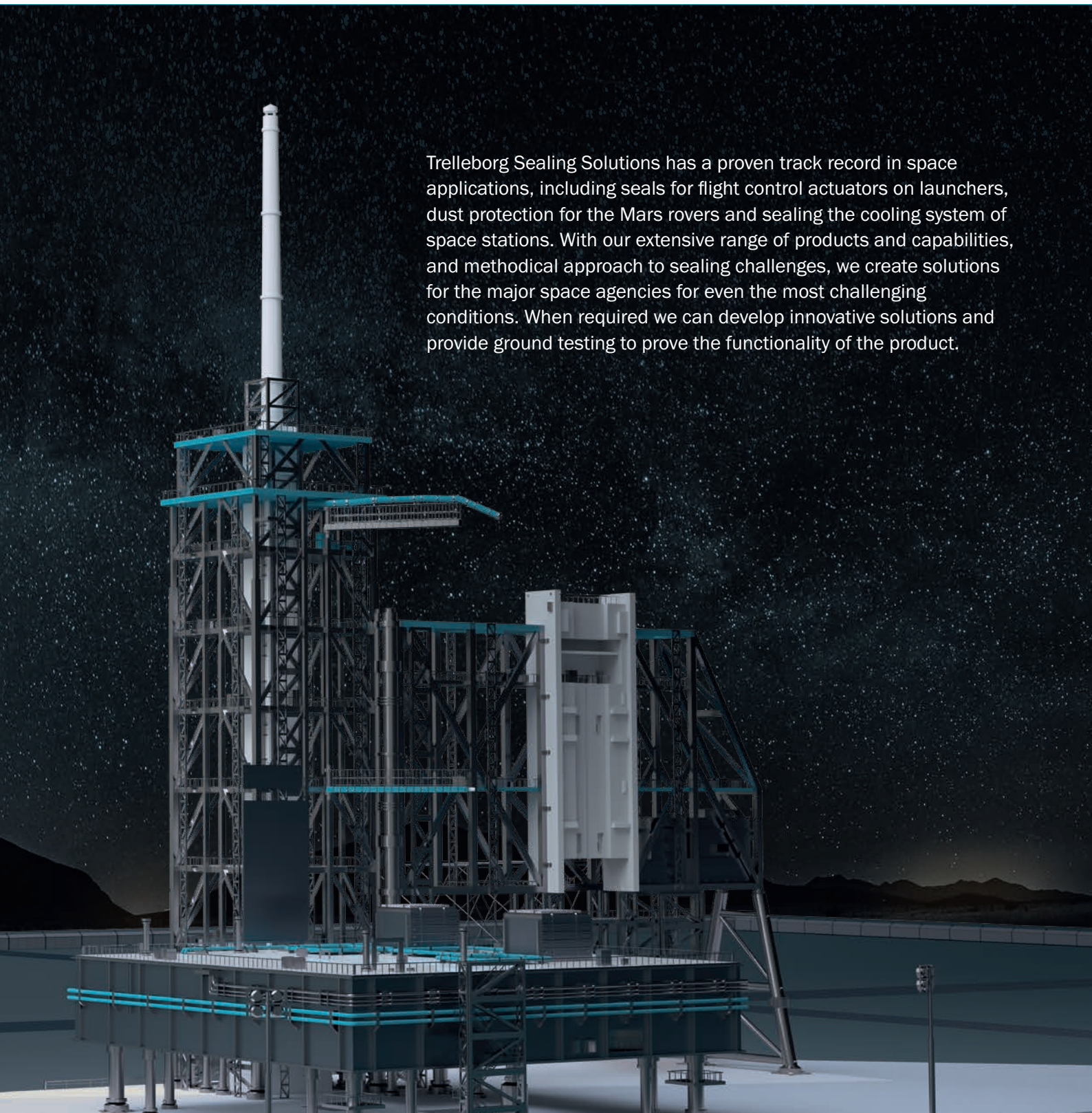
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Satellites & Payloads



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Trelleborg Sealing Solutions has a proven track record in space applications, including seals for flight control actuators on launchers, dust protection for the Mars rovers and sealing the cooling system of space stations. With our extensive range of products and capabilities, and methodical approach to sealing challenges, we create solutions for the major space agencies for even the most challenging conditions. When required we can develop innovative solutions and provide ground testing to prove the functionality of the product.



Landers & Rovers



Human Space Flight – Interiors & Life Support Systems



Human Space Flight Suits

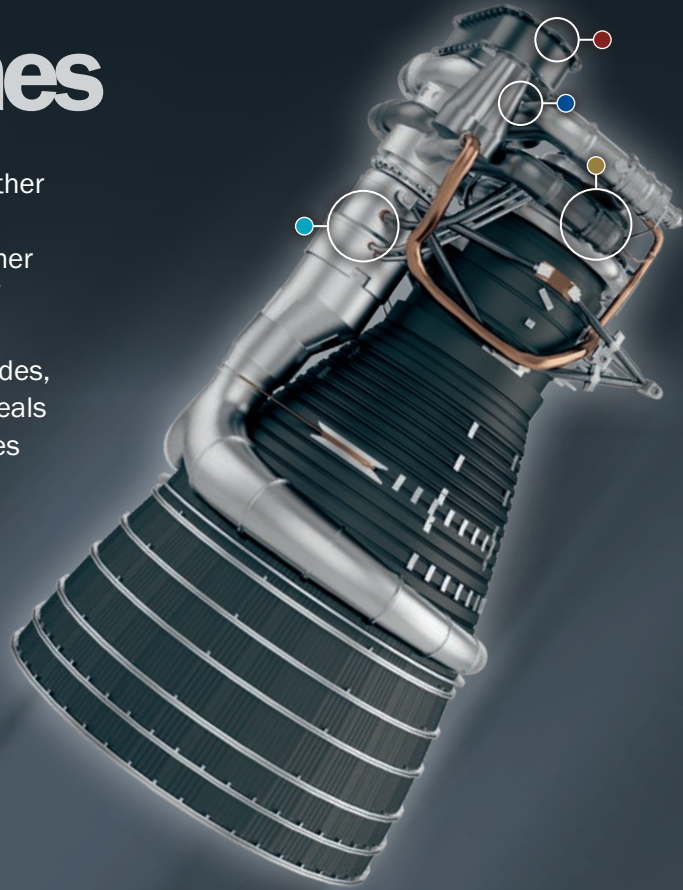


Ground Support Equipment



Rocket Engines

Challenging the performance of seals and other components to the limit, rocket engines are always demanding for designers using polymer materials. However, the right combination of materials and shielding polymers have been successfully sealing rocket engines for decades, typically in turbo pumps and valves; metal seals like Wills Rings® can be used at temperatures beyond the capabilities of polymers.



● Wills Rings® Metal Seals

Metal seals are commonly used in exhaust components for the engines and cryogenic applications throughout the rocket's fuel system. Metal seals can resist temperatures up to 1,550 °F/845 °C and pressures up to 145,000 psi/ 1,000 MPa.



● Isolast® O-Rings

FFKM-based Isolast® materials have high chemical resistance and a temperature working range up to 572 °F/300 °C.



● High-Speed Variseal® PDR Rotary Seals

High-speed rotary seals from Trelleborg Aerospace have been used in demanding applications such as cryo-pumps for many years, with rotational speeds of up to 131 ft/s/40 m/s.



● Turcon® Variseal® Cryogenic Seals

Trelleborg Aerospace has extensive experience in cryogenic space applications including sealing solutions liquid oxygen, liquid nitrogen, liquid natural gas and other media. PTFE-based spring-energized seals provide excellent performance with the low outgassing properties critical in space applications and resist cryogenic temperatures up to 500 °F/260 °C. They can be used statically and dynamically.



Hydraulic and Mechanical Actuation Sealing Systems

Trelleborg Aerospace has long provided reliable sealing systems for both hydraulic and mechanical actuation systems for space and commercial applications. The Turcon® VL II Seal is widely used in places where zero leakage is required both for static and dynamic situations.

Typical sealing challenges of a heavy-lift space launch rocket

Combustion chamber pressure of **1,595 psi/ 11 MPa**

These pumps deliver up to **123 gallons/s/ 560 liters/s** of liquid hydrogen at a pressure of **2,466 psi/ 17 MPa**

The liquid hydrogen unit operates at **34,000 rpm** and comprises a two-stage centrifugal pump driven by a **12-MW**, two-stage turbine.

The propellants are delivered by **two independent turbopumps**

The ARIANE 5 – Vulcain engine delivers **1140 kN** thrust in vacuum and has a specific impulse of **432 sec**

- The single-stage liquid oxygen turbopump operates at **13,400 rpm** and delivers **38,9 gallons/177liters per second** of propellant at **1,855 psi/13 MPa** when the engine is running at 3.7 MW.
- The liquid hydrogen enters the propulsion chamber via an annular distributor. Most of this flow is routed through channels integrated in the double-walled structure of the combustion chamber and throat assembly.
- The nozzle is cooled by a hydrogen flow routed through **460 spirally welded inconel tubes**, ending at the bottom rim of the main nozzle.
- The turbopumps, gas generator and combustion chamber ignitions are started by **pyrotechnic cartridges**.

The Vulcain engine is **9.8 ft/3 m high**, 5.8 ft/1.76 m in diameter and weighs 3,717 lbs/ 1686 kg



Rockets and Launchers

Trelleborg Sealing Solutions supplies sealing systems for traditional hydraulic systems and actuators found on the larger launchers and also for hot or cold gas systems. As re-usable space exploration vehicles become commonplace, the need for reliable sealing systems for actuators and dampers is increasing.



● Composites

Trelleborg Aerospace continuous fiber-reinforced thermoplastics are used for structural parts, shafts and pressure vessels, EFI shielding, bearings and other applications. Thermoplastic and thermoset materials are available; PEEK is the most commonly used. We use patented production technology with in-situ consolidation, eliminating autoclaving processing.



● Thermoplastics

Trelleborg Aerospace thermoplastics are used for structural components such as shrouds, bearings, brackets and similar application saving valuable weight compared to metal components. Thermoplastic and thermoset materials are available, with PEEK the most commonly used, but other polymers are available.



● Sealing Joints and Couplings

O-rings and customized elastomer seals made from high-performance materials such as Isolast can cope with the aggressive environments and wide temperature range of fuel lines and couplings during the launch phases.

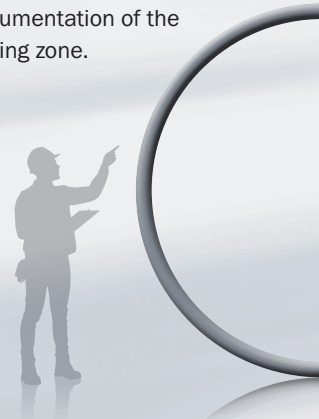


● Thrust Vector Actuation

Spacecraft may use thrust vectoring actuators or flight control fins on the body of the vehicle. Trelleborg Aerospace spring energized Variseal® products provide reliable sealing for the cold or hot gas ejected at high speed to provide the necessary momentum to change the trajectory of the rocket.

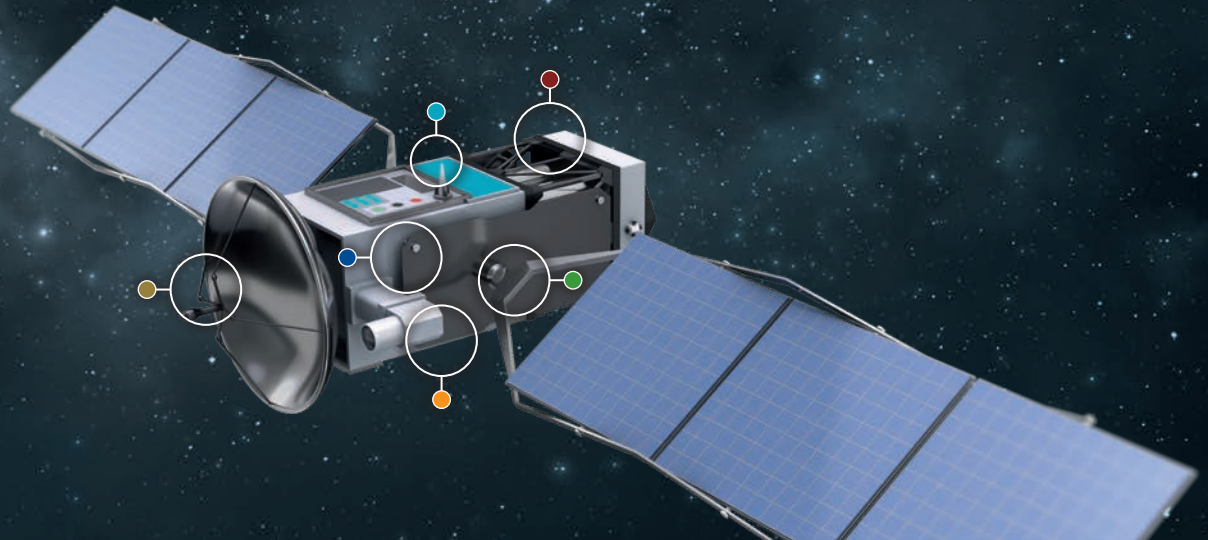
● Large-Diameter Seals

Trelleborg Aerospace production facilities regularly supply both spring-energized seals and O-rings from one to three meters in diameter and can manufacture larger sizes. A special welding technique developed for the oil and gas industry secures complete documentation of the material properties in the welding zone.



Satellites & Payloads

Due to their required longevity and exposure to the hostile space environment, the choice of polymers for satellite and payload applications is critical. Elastomers do not provide reliable long-term solutions as they generally degrade rapidly in this harsh environment. Fluoropolymers are significantly more resistant to irradiation and temperature variations and can retain functionality after decades of space travel. They also have low outgassing properties, an important characteristic where highly sensitive measuring equipment is used.



● Composites

Continuous fiber-reinforced thermoplastics are used extensively in satellites. Carbon fiber reinforced PEEK materials are most common and thermoset materials are also available. Trelleborg Aerospace uses patented production technology with in-situ consolidation, eliminating autoclaving processing.



● EMI/RFI Shielding

RFI shielding is critical to many satellite applications. Trelleborg Aerospace offers a full range of products meeting MIL-DTL-83528, including custom geometries.



● HiMod® Thermoplastics

Numerous thermoplastic polymers are used in space applications, including polyimide, PTFE, PCTFE, PEEK, polyimide imide, polyetherimide. They are used for structural components, bushings, electrical connectors and insulation, thermal insulation, and other applications.



● Turcon® Variseal® Spring Energized Seals

Spring-energized seals are made from PTFE and other polymer materials with low outgassing properties. PTFE materials can also be used from cryogenic temperatures up to 500 °F/260 °C. PTFE spring-energized seals can be used statically and dynamically at temperatures down to -436 °F/-200 °C. We offer a standardized low-temperature range IEST-STD-CC1246 cleaned for oxygen use.



● Will Rings® Metal Seals

Metal seals can be used in cryogenic applications as well as applications exceeding the temperature and pressure limitations of polymer-based materials. Trelleborg Aerospace offers Wills Rings® in numerous standard and custom geometries.



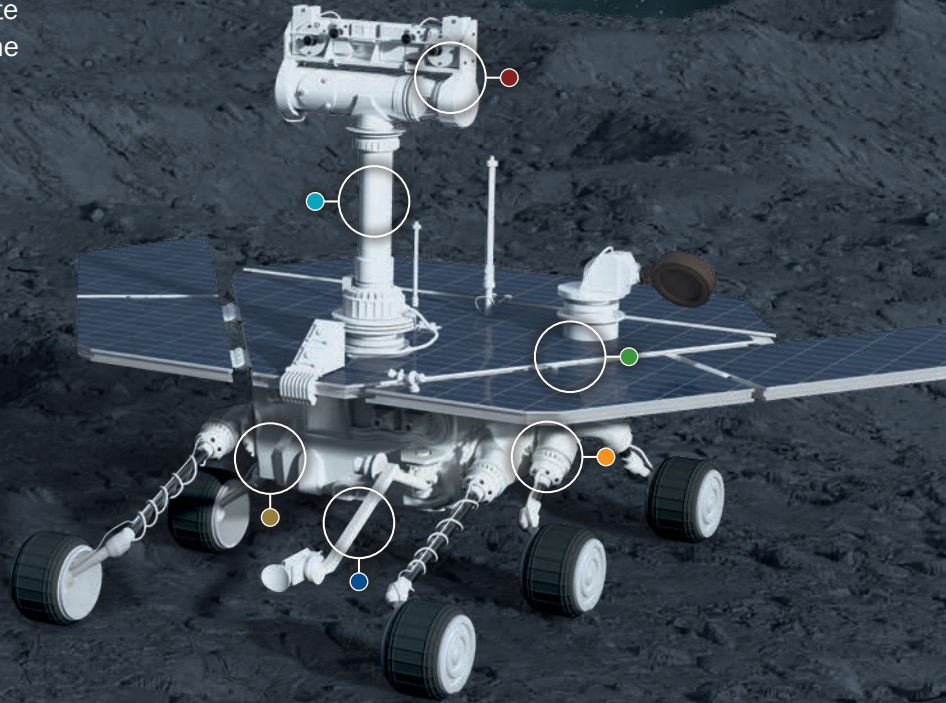
● Slydring® Bearings

Slydring® bearings and bushings are commonly used in satellite components with rotary or linear motion as they do not require lubrication. Low-outgassing materials such as PTFE are used to absorb transverse loading while also meeting the rigorous requirements of satellite applications. Small diameter bearings can be made of high-performance polymers to save weight and provide lubrication-free service for years.

Landers & Rovers

With Trelleborg Aerospace seals already on the Moon and on Mars, we can demonstrate the experience required to meet the extreme sealing needs of landers and rovers.

Seals need to perform not only at the final destination but be robust against the challenges of transit. Trelleborg Aerospace works closely with customers to create sealing solutions that maintain critical characteristics like friction performance and structural integrity throughout a mission.



● Composites

Continuous fiber-reinforced thermoplastics are used extensively on these vehicles. Carbon fiber reinforced PEEK materials are most common; thermoset materials are also available. Trelleborg Aerospace uses patented production technology with in-situ consolidation, eliminating autoclaving processing.



● Slydring® Bearings

Slydring® bearings and bushings are commonly used as rover and lander components with rotary or linear motion. Low-outgassing materials such as PTFE are used to absorb transverse loading while also meeting the rigorous requirements of vehicle applications.



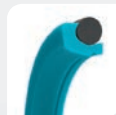
● HiMod® Thermoplastics

Numerous thermoplastic polymers are used in rover and lander applications, including polyimide, PTFE, PCTFE, PEEK, polyimide imide, polyetherimide and others. They form structural components, bushings, electrical connectors and insulation, thermal insulation and other applications.



● Turcon® Variseal® W Spring Energized Seals

Spring-energized seals are made from PTFE materials with the low outgassing properties essential for use in space exploration and Turcon® Variseal® W is made from PTFE compounds with almost zero outgassing. These materials can be used from cryogenic temperatures up to 500 °F/ 260 °C. The W spring offers low friction and moderate load on the seal jacket, ensuring the seal keeps its integrity for extremely long periods under difficult conditions.



● Landing Gear and Actuators

With years of experience in commercial aviation landing gear, Trelleborg Aerospace excels in this sector. Our experts can specify sealing systems for any size actuator or landing gear operating in all types of environments.

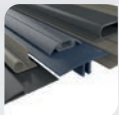


● EMI/RFI Shielding

EMI/RFI shielding is critical to many vehicle applications. Trelleborg Aerospace offers a full range of products meeting MIL-DTL-83528 including custom geometries.

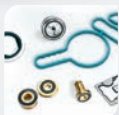
Human Space Flight – Interiors & Life Support Systems

Trelleborg Aerospace draws on its many years' experience in sealing solutions for aircraft interiors to meet the often-similar challenges of space craft, offering a full range already approved for use in oxygen and water systems. We also have polymer materials approved for smoke and toxicity regulations in aircraft cabins. We have approved color matching capabilities at several of our facilities to meet customers' aesthetic requirements for branding of interior polymer parts.



● Extruded Materials

Trelleborg Aerospace offers a full range of extruded thermoplastic and elastomer materials, typically meeting smoke and toxicity requirements for human environments.



● Molded Parts for Environmental Control/ Comfort Systems (ECS)

Our solutions for vital on-board ECS functions including HVAC, wastewater and other applications are made from NSF- and FDA-compliant molded parts.



● Thermoplastic components

Injection-molded thermoplastic materials are used extensively in crew capsules for various components. They are typically structural or decorative and must meet smoke and toxicity requirements.



● Window/Door Seals

Trelleborg Aerospace has a full range of fabric-reinforced door and window seals that meet spacecraft requirements.



● Variseal® H

Due to the aggressive media used by many spacecraft cooling systems Turcon® Variseal® and Isolast® products are ideal. These products also function for prolonged periods in space without losing their sealing capabilities.



● EMI/RFI Shielding Components

Shielding from harmful electromagnetic radiation is critical to protect communications and other systems aboard spacecraft. Trelleborg Aerospace offers a full range of products meeting MIL-DTL-83528 including custom geometries.



DID YOU KNOW?

Not all equipment is designed for scientific research or to control and support life on the vehicle. Exercise equipment helps the astronauts to stay fit and virtual reality technology enables them to train in beautiful surroundings or have a 3D video call with family members on earth.

Human Space Flight Suits

Seal, damp & protect is Trelleborg's mantra, and nothing better describes our approach to products used in space suits. Our components for astronauts' space suits exceed all the unique requirements of human space travel, ensuring the equipment's functionality and safety.



● Rotary Joints

Varilip® PDR seals are ideal for rotary joints where low friction is essential. They require no lubrication and have no outgassing or stick slip. Classified as having unlimited lifetimes, the seals are suitable for storage over long periods.



● Molded Parts for Environmental Control/ Comfort Systems

ECS systems provide vital functions onboard the spacecraft and in space suits. Trelleborg Aerospace provides solutions for HVAC, wastewater and other applications. Our molded-part product range includes NSF and FDA compliant materials.



● Thermoplastic Components

Injection molded thermoplastic materials are used extensively in crew capsules. These materials are typically structural or decorative in nature and must meet smoke and toxicity requirements.



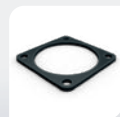
● Visor Seals

Custom-molded visor seals designed using FEA modelling offer low handling forces and efficient sealing.



● Turcon® Variseal® H

Turcon® Variseal® and PDR seals are used extensively in life support systems for their inherent non-toxic properties, low friction and compatibility with the fluids and gasses in space applications. Turcon® Variseal® and PDR seals also feature almost unlimited design freedom for custom parts.

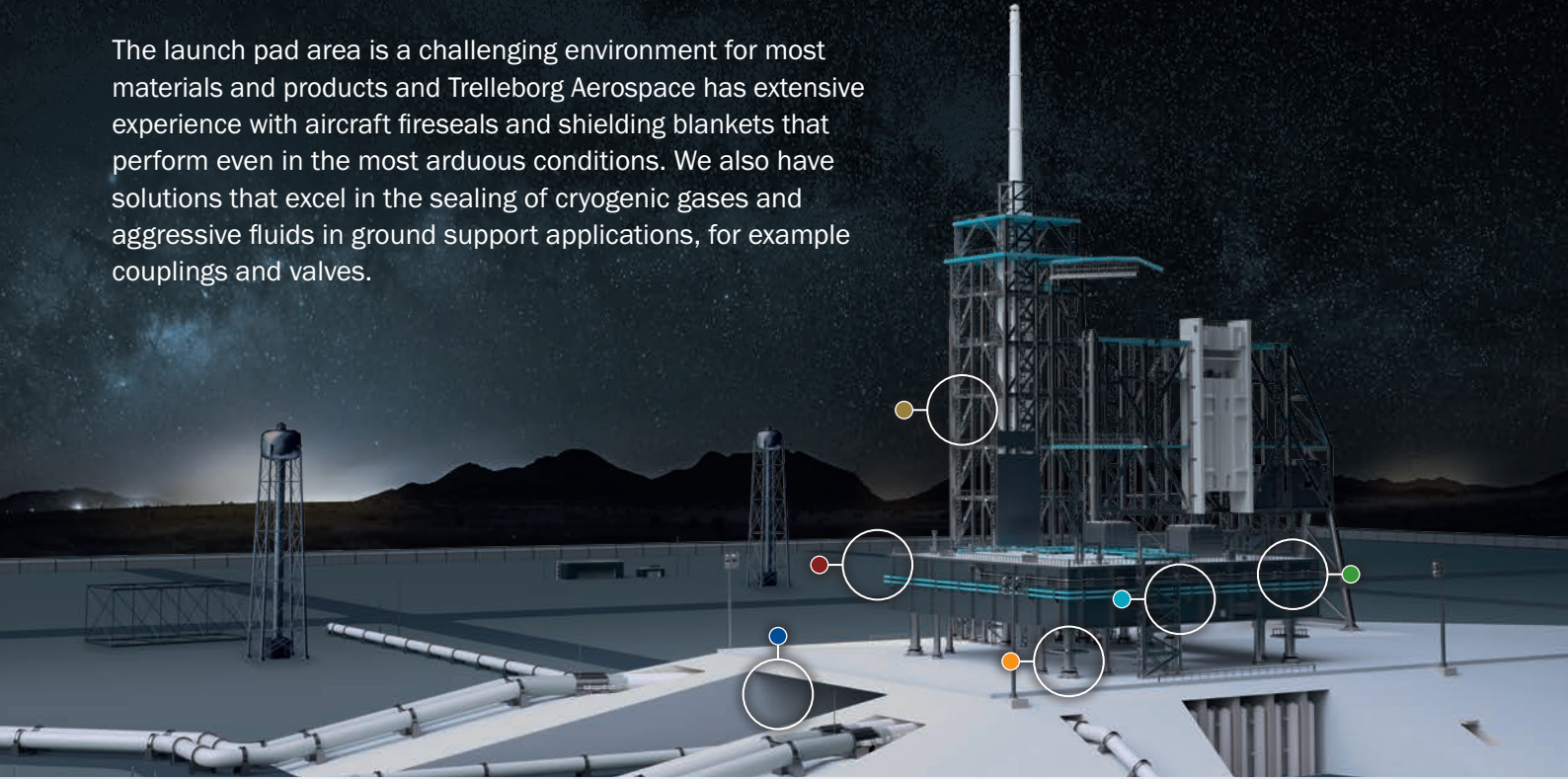


● EMI/RFI Shielding Components

Shielding from harmful electromagnetic radiation is critical to protect communications and other systems aboard spacecraft. Trelleborg Aerospace offers a full range of products meeting MIL-DTL-83528 including custom geometries.

Ground Support Equipment

The launch pad area is a challenging environment for most materials and products and Trelleborg Aerospace has extensive experience with aircraft fireseals and shielding blankets that perform even in the most arduous conditions. We also have solutions that excel in the sealing of cryogenic gases and aggressive fluids in ground support applications, for example couplings and valves.



● Gaskets and Plate Seals

Our components are fireproof for 15 minutes at 2,192 °F/1200 °C and withstand high vibration, making them ideal for connecting pipes and other equipment exposed to the tough environment of the launch pad.



● Variseal® Cryogenic Seals

Trelleborg Aerospace has extensive experience with cryogenic seals in space applications including liquid oxygen, liquid nitrogen, and liquid natural gas. PTFE-based spring-energized seals provide excellent sealing performance in the harsh environment of the launch platform.



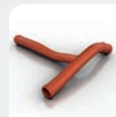
● Thermal Protection/ Flame Protection Blankets

Trelleborg Aerospace has developed elastomer-based flame-protection blankets to shield vital equipment from direct flame exposure.



● Thermoplastic Parts

Injection-molded thermoplastic components can be used to replace metal components, making ground support structures lighter and cheaper.



● Fire Seals

Usually manufactured from fabric-reinforced silicone to accommodate vibrations and movement in all directions, our Fire Seals are custom made products available in various configurations. They are stringently fire tested in-house to prove components can be classified as fireproof for 15 minutes at 2,192 °F/1200 °C.



● Diaphragms

Trelleborg Aerospace has extensive experience manufacturing elastomeric diaphragms both with and without fabric reinforcement. Inserts can be used to eliminate secondary operations.



DID YOU KNOW?

Did you know the water tower at the Kennedy Space Center holds up to 250 million gallons/1,135 million liters to cool down the ramps during launch?

Trelleborg is a world leader in engineered polymer solutions that seal, damp and protect critical applications in demanding environments. Its innovative solutions accelerate performance for customers in a sustainable way.

Trelleborg Sealing Solutions is a leading developer, manufacturer and supplier of precision seals, bearings and custom-molded polymer components. It focuses on meeting the most demanding needs of aerospace, automotive and general industrial customers with innovative solutions.

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