Polymer Solutions for Space

REVOLUTIONIZING EXPLORATION WITH CUTTING-EDGE TECHNOLOGY

With Trelleborg Aerospace into the last frontier

Rocket Engines p. 4

Rockets & Launchers p. 6

Satellites & Payloads p. 7

We have a proven track record in space applications, including seals for flight control actuators on launchers, dust protection for Mars rovers and sealing components for the space station cooling systems. 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

p. 8

Human Spaceflight – Interiors & Life Support Systems

p. 9

Spacesuits

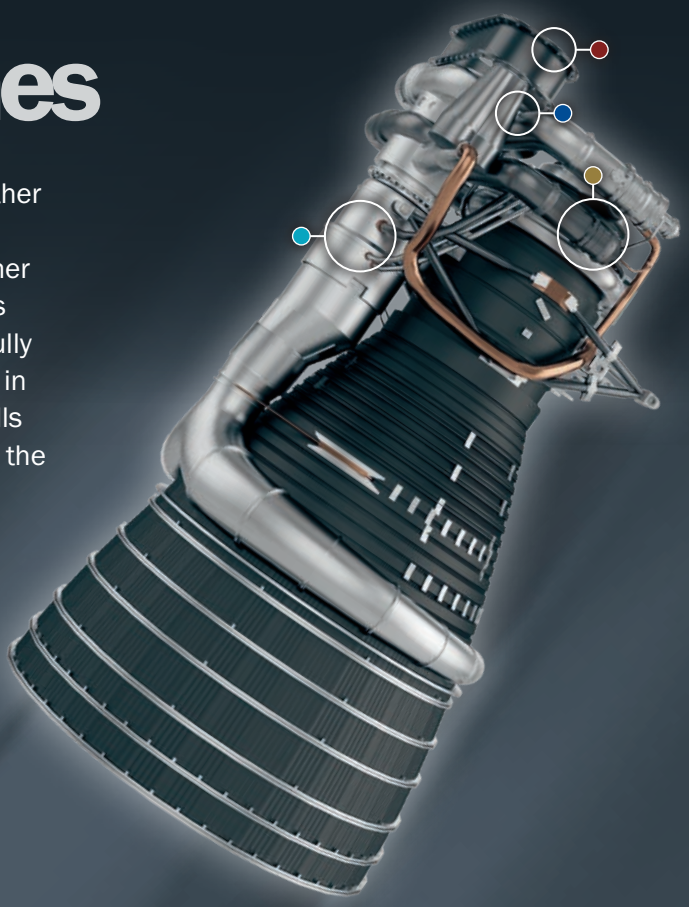
p. 10

Ground Support Equipment

p. 11

Rocket Engines

Challenging the performance of seals and other components to the limit, rocket engines are always demanding for designers using polymer materials. 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 are suitable for use in temperatures up to +1,550 °F/+845 °C and under pressures up to 145,000 psi/1,000 MPa.

Isolast® O-Rings

Perfluoroelastomer (FFKM)-based Isolast® materials demonstrate wide-ranging chemical compatibility and are suitable for temperatures up to +572 °F/+300 °C.

High-Speed Variseal® PDR Rotary Seals

High-speed rotary seals are used in demanding applications such as cryo-pumps and can be used in environments with rotational speeds of up to 131 ft/s/40 m/s.

Turcon® Variseal® Cryogenic Seals

We have extensive experience in cryogenic space applications including sealing solutions for liquid oxygen, liquid nitrogen, liquid natural gas and other media. Polytetrafluoroethylene (PTFE)-based spring-energized seals provide excellent performance with the low outgassing properties critical in space applications and are suitable for temperatures ranging from cryogenic up to +500 °F/+260 °C. They demonstrate effective performance in static and dynamic applications.

Hydraulic and Mechanical Actuation Sealing Systems

We offer reliable sealing systems for both hydraulic and mechanical actuation systems for space and commercial applications. Turcon® VL Seal® II is widely used in static and dynamic applications where zero leakage is vital.

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 rocket 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/177 liters per second** of propellant at **1,855 psi/13 MPa** when the engine is running at 3.7 MW.
- 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 hydrogen flowing through **460 spirally welded iconel tubes**, ending at the bottom rim of the main nozzle.
- The turbopumps, gas generator and combustion chamber ignitions are started by **pyrotechnic cartridges**.

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

Rockets & Launchers

We develop and supply sealing components 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.

Advanced Composite Products

Our continuous fiber-reinforced thermoplastics are used for structural parts, shafts and pressure vessels, Electromagnetic Interference (EMI) shielding, bearings and other applications. Thermoplastic and thermoset materials are available; polyether ether ketone (PEEK) is the most commonly used. We use patented production technology with in-situ consolidation, eliminating the autoclaving process.

Sealing Joints and Couplings

O-Rings and custom elastomer seals made from high-performance materials such as Isolast® are suitable for aggressive environments and wide temperature range found in fuel lines and couplings during the launch phases.

Variseal®

Some spacecraft use thrust vectoring actuators or flight control fins on the body of the vehicle. Our spring-energized Variseal® products offer reliable sealing for cold or hot gases, which are ejected at high speed to provide the necessary momentum to change rocket trajectory.

Thermoplastic Parts

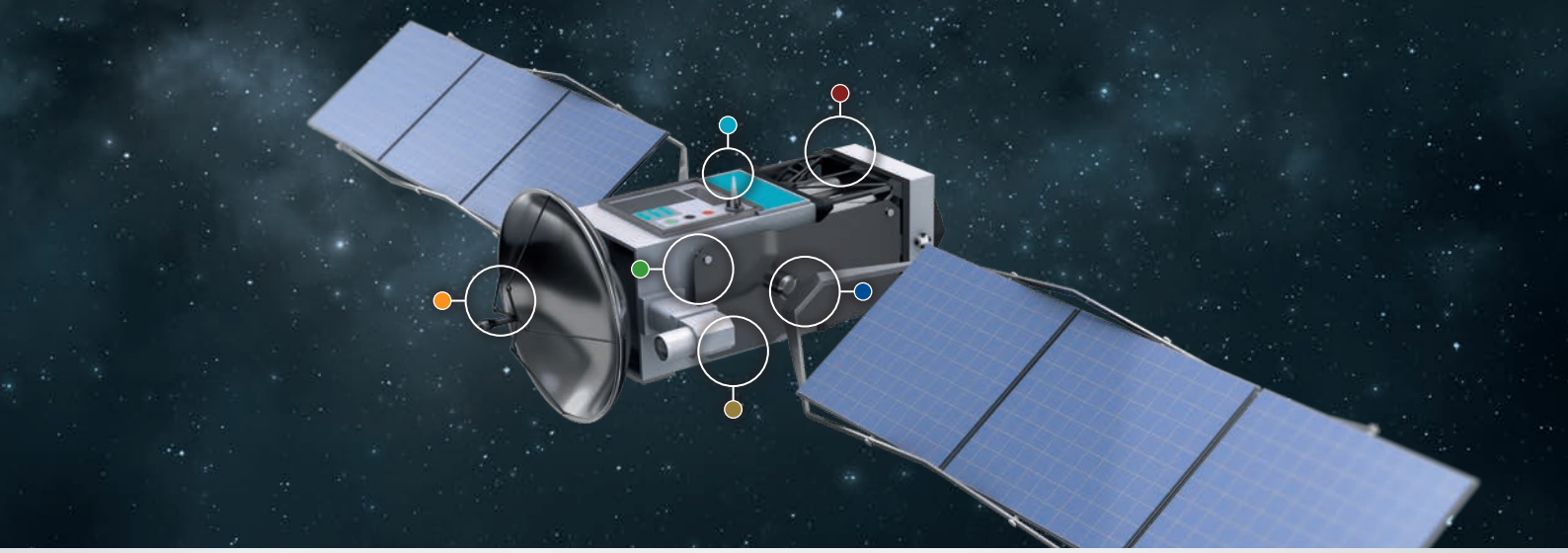
Our thermoplastics are used for structural components such as shrouds, bearings, brackets and similar applications offering significant weight savings compared to metal components. We offer a wide range of thermoplastic and thermoset materials and other polymers, PEEK being the most commonly used.

Large-Diameter Seals

Our production facilities 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 energy 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, polymer specification for satellite and payload applications is critical. Elastomers do not provide reliable long-term solutions as they 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.



Advanced Composite Products

Continuous fiber-reinforced thermoplastics are used extensively in satellites. Carbon fiber reinforced PEEK materials are most common and thermoset materials are also available. Our patented production technology with in-situ consolidation eliminates the autoclaving process.

Will Rings® Metal Seals

Metal seals are ideal for cryogenic applications and environments exceeding the temperature and pressure limitations of polymer-based materials. We offer Wills Rings® in numerous standard and custom geometries.

Slydring® Bearings

Not requiring lubrication, Slydring® bearings and bushings are commonly used in satellite components with rotary or linear motion. Produced in low-outgassing materials such as PTFE and other high-performance polymers, bearings absorb transverse loads while meeting the rigorous requirements of satellite applications. Small diameter bearings save weight and provide lubrication-free service for years.

Turcon® Variseal® Spring-Energized Seals

With low outgassing properties, PTFE spring-energized seals are suitable for static and dynamic applications with temperatures from -436°F/ -200°C to +500 °F/+260 °C. We offer a standardized low-temperature range, which is specially cleaned according to IEST-STD-CC1246 for use with oxygen and in space applications.

EMI / Radio Frequency Interference (RFI) Shielding Components

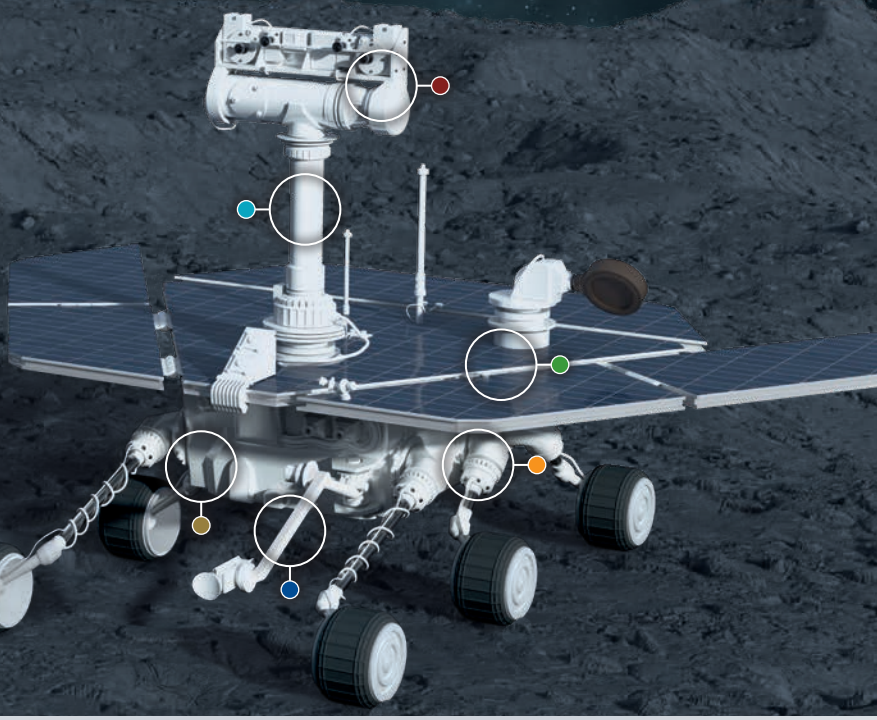
RFI shielding is critical to many satellite applications. We offer a full range of products meeting MIL-DTL-83528, including custom geometries.

HiMod® Thermoplastic Parts

Numerous thermoplastic polymers are used in space applications, including polyimide, PTFE, Polytetrafluorethen (PCTFE), PEEK, polyimide imide and polyetherimide. We manufacture these materials into structural components, bushings, electrical connectors and insulation, thermal insulation and more.

Landers & Rovers

With seals already on the Moon and Mars, we offer 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. We work closely with customers to create sealing solutions that maintain critical characteristics like friction performance and structural integrity throughout a mission.



Advanced Composite Products

Continuous fiber-reinforced thermoplastic parts are found in numerous places on these vehicles. PEEK is the most commonly used polymer base material, but other thermoset materials are available. We use 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 loads while also meeting the rigorous requirements of vehicle applications.

HiMod® Thermoplastic Parts

Numerous thermoplastic polymers are used in rover and lander applications, including polyimide, PTFE, PCTFE, PEEK, polyimide imide and polyetherimide. 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 PFTE 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.

Seals for Landing Gear and Actuators

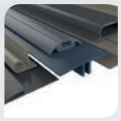
With years of experience in commercial aviation landing gear, our experts can specify sealing systems for any size actuator or landing gear operating in all types of environments.

EMI/RFI Shielding Components

EMI/RFI shielding is critical to many vehicle applications. Our full range of products, including custom geometries, complies with MIL-DTL-83528.

Human Spaceflight – 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 spacecraft, 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 Parts

We offer a full range of extruded thermoplastic and elastomer parts, which, when required, meet smoke and toxicity requirements.

Molded Parts for Environmental Control/ Comfort Systems (ECS)

Our solutions for vital onboard 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 for various components in crew capsules. They typically perform structural or decorative functions and must meet smoke and toxicity requirements.

Window and Door Seals

We have a full range of fabric-reinforced door and window seals that meet spacecraft requirements.

Turcon® Variseal® H

Spacecraft cooling systems frequently contain aggressive media. Our Turcon® Variseal® are ideal in these environments. They 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. We offer a full range of products, including custom geometries, which are compliant with MIL-DTL-83528.

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 stay fit and virtual reality technology enables them to train in beautiful surroundings or have a 3D video call with family members on earth.

Spacesuits

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

Varilip® PDF

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.

Thermoplastic Components

Injection-molded thermoplastic components are used in spacesuits due to their low weight and dermatological properties. These materials typically perform structural or decorative functions and must meet smoke and toxicity requirements.

EMI/RFI Shielding Components

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

Visor Seals

Custom-molded visor seals designed using Finite Element Analysis (FEA) modelling offer low handling forces and efficient sealing.

Molded Parts

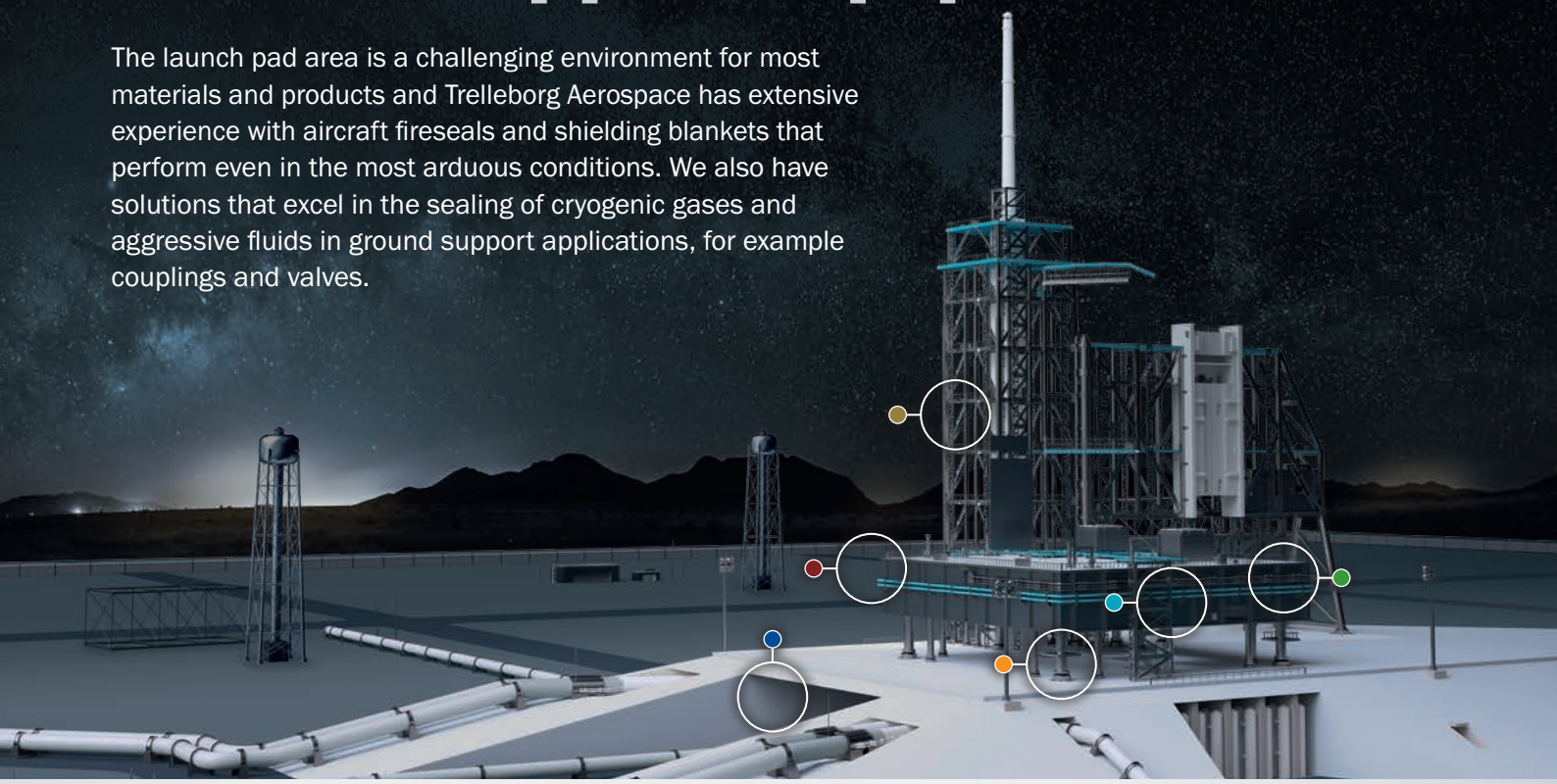
ECS provide vital functions onboard the spacecraft and in spacesuits. Our molded-part product range includes NSF- and FDA-compliant materials.

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.

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/+1,200 °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

We have 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

We have 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 more cost-effective.

Fire Seals

Usually manufactured from fabric-reinforced silicone to accommodate vibrations and movement in all directions, 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/+1,200 °C.

Diaphragms

We manufacture elastomeric diaphragms both with and without fabric reinforcement. Inserts can be used to eliminate secondary operations. Reinforced diagraphms offer a longer service life and ensure a consistent flow of fluid during refilling processes.

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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