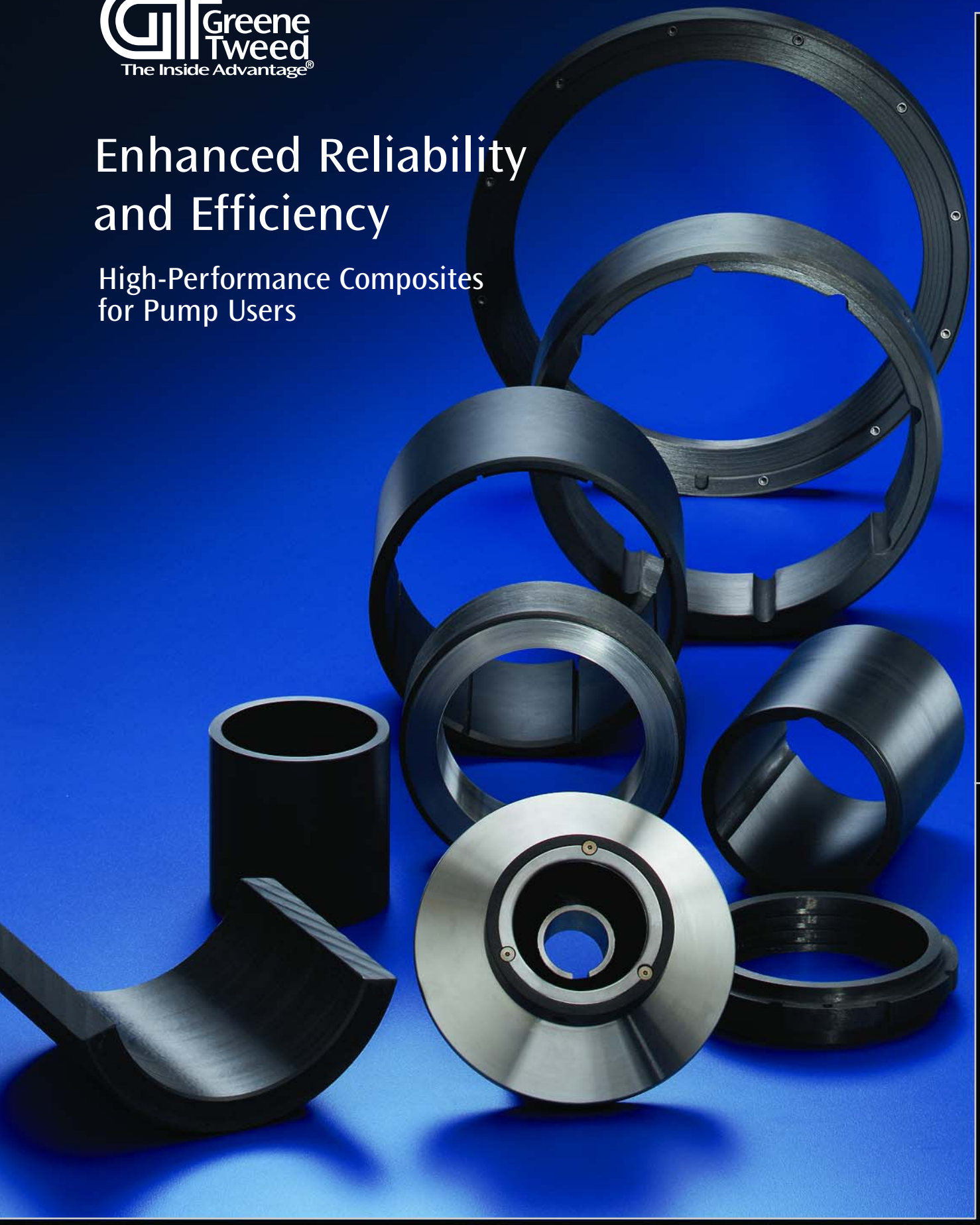
Greene Tweed
The Inside Advantage®

Enhanced Reliability and Efficiency

High-Performance Composites for Pump Users



High-Performance Composites

CUSTOMER FOCUS

Always on the forefront of technology, we at Greene, Tweed work with our customers to provide reliable, efficient answers to their application needs. As a world-class leader in the design and manufacture of high-performance materials and customized-engineered components, we leverage our expertise in a variety of markets and products to give our customers the most innovative and cost-effective solutions to their demanding applications.

At Greene, Tweed we listen to what our customers have to say. Our expertise in thermoplastic composites builds upon the success of our Arlon® thermoplastic materials. With our in-house design and manufacturing processes, we help customers enhance the performance of their products, increase efficiencies and revenues, and reduce downtime. Greene, Tweed's **WR**® composite materials, constructed into high-performance, extremely reliable wear components, are replacing metal in critical applications. **WR**'s outstanding wear and friction properties, excellent chemical resistance, and nongalling and nonseizing properties create ideal wear rings, bushings and bearings for centrifugal pumps.

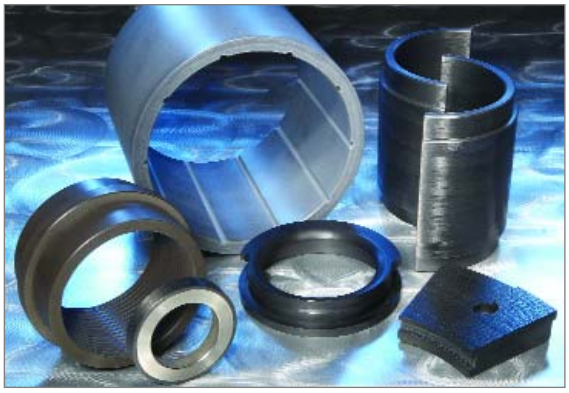
SUPERIOR PRODUCT PERFORMANCE

WR components, made from carbon-fiber reinforced thermoplastic material, provide enhanced performance and reliability not possible with metallic wear parts.

In fact, proper utilization of **WR** materials enables pumps to operate safely at clearances that are approximately half of what the API (American Petrochemical Institute) recommends for metal wear rings.

Tighter wear ring clearances reduce pump interstage leakage and recirculation. Cutting pump internal recirculation and interstage leakage increases pump efficiency. The recently released API 610 specification, ninth edition, recognizes this available improvement and lists polymer-based composites, such as Greene, Tweed's **WR** materials, as an acceptable option for replacing metal wear materials to improve pump performance in appropriate applications.

Overhung pumps suffer premature seal and bearing failure due to shaft deflection. Radial bearings fail due to the strain created by deflection, while seal faces wear and separate due to high vibration.



Reducing the running clearances of throttle bushings and wear rings with our **WR** products can eliminate these problems. Because **WR** has nongalling and nonseizing properties, it will not damage mating metal parts in these critical applications.

WR composites provide a low coefficient of friction to ensure long wear life, a ductile quality to absorb shock/vibration and high strength to withstand upset conditions.

Best practices dictate the reduction of clearances in vertical elements to minimize the effects of side load, hydraulic-related shaft whip and vibration. The proper application of Greene, Tweed's **WR** materials helps pump users operate successfully at these reduced clearances and realize significant performance advantages, e.g., reduced vibration and improved energy efficiency.

The pressure differential through the rings and bushings in a horizontal pump helps to center the rotating element during normal operating conditions. However, metal-to-metal contact can occur during suction loss, cavitation, start up or other upset conditions, resulting in galling or even catastrophic seizing of metallic pump parts. **WR** pump parts provide the strength of metal combined with nongalling and nonseizing characteristics to handle conditions that could otherwise result in catastrophic failure.

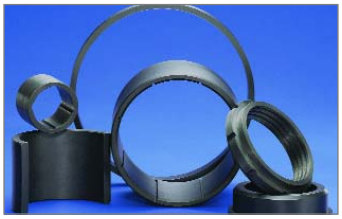
Additionally, metal-to-metal contact is a potentially dangerous situation that not only can severely damage equipment but possibly contaminate the environment with process media due to leakage. The nongall/nonseize nature of **WR** material minimizes damage to metal parts, reduces repair time and costs, and helps avoid potential adverse safety and environmental impact.

Customer satisfaction and value-added service is our focus at Greene, Tweed. To help our customers get the best payback from their systems, we have created an on-line tool to calculate the efficiency improvements available from the use of our **WR®** materials as a replacement of traditional metal wear components. Visit us at www.gtweed.com to use this interactive web-based efficiency calculating tool.

WR materials manufactured by Greene, Tweed solve challenging system requirements. Greene, Tweed's engineering expertise and advanced products offer superior performance and chemical compatibility, enabling us to provide our customers with solutions that improve process reliability, increase efficiency and outlast our competition. We have developed several different wear-resistant materials designed to optimize each customer's individual application.

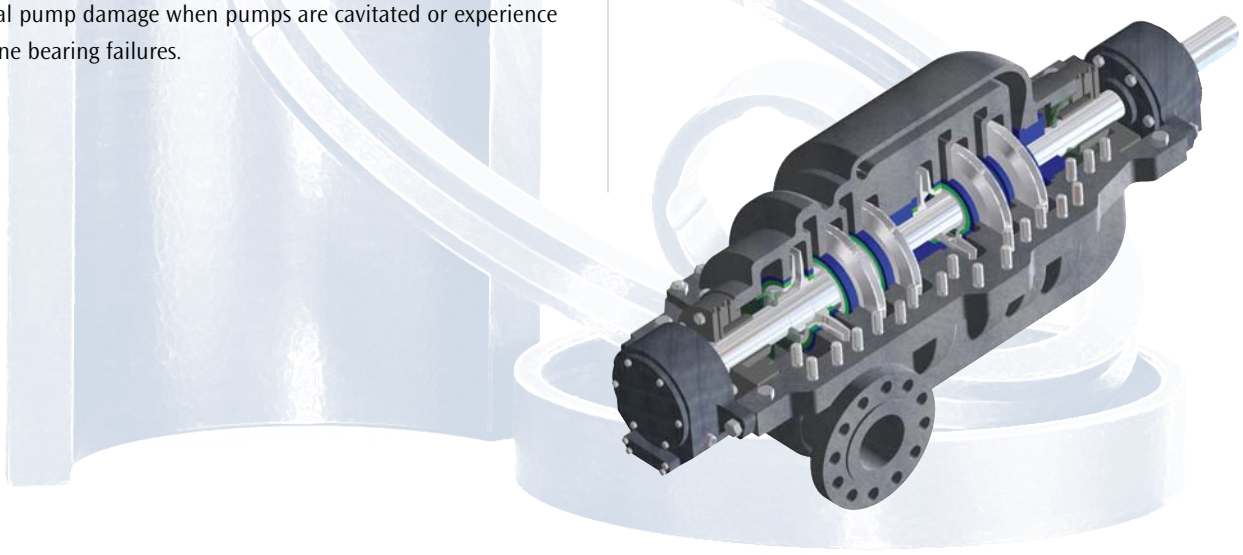
WR®300

WR300 is an engineered carbon-reinforced PEEK™ (polyetheretherketone) that meets the nonmetallic wear part material description of the API 610 specification, ninth edition. **WR300** provides enhanced strength, stability and heat dissipation properties beyond other thermoplastic compounds due to its use of a long carbon-fiber fill. **WR300**'s low coefficient of friction and thermal expansion characteristics make it ideal for bushings, bearings and wear rings in centrifugal pump designs. Because **WR300** has excellent heat dissipation properties and chemical resistance as well as nongalling and nonseizing properties, it excels in boiler feed, condensate, cooling tower, propane, butane, butadiene and other low specific gravity media with poor lubricating properties. These benefits enable the pump user to increase pump efficiency by running tighter wear ring clearances while decreasing potential pump damage when pumps are cavitated or experience down-line bearing failures.



WR®525

Greene, Tweed's **WR525** thermoplastic material consists of continuous carbon fiber in a PEEK matrix. **WR525** meets the nonmetallic wear part material description of the API 610 specification, ninth edition. This revolutionary fiber placement technology produces a material ideally suited to replace metallic, carbon and graphite wear components. **WR525**'s phenomenal strength, unique thermal expansion characteristics and excellent wear properties deliver maximized rotor stability, pump efficiency and improved MTBF (Mean Time Between Failure). **WR525** provides excellent chemical resistance, nongalling and nonseizing properties, impact resistance, and thermal shock and hydrolysis resistance. **WR525** works well in media such as butane, propane, boiler feed water and ethylene. Because of the benefits **WR525** delivers, it is ideal in applications ranging from diffuser bearings and line shaft bearings to case wear rings and throttle bushings. In addition, unlike most nonmetallic materials, **WR525** is ideal for use as parts in tension such as impeller wear rings.

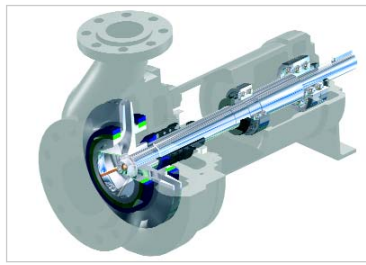


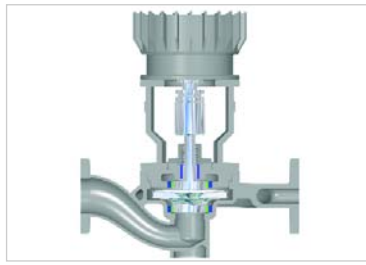
AR®

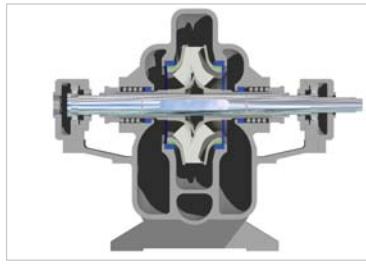
Abrasives such as sand and coke fines have long been a problem for pump users. Abrasives cause clearances on line shaft bearings and bowl wear rings to open up too soon, reducing pump efficiency, increasing vibrations and leading to premature pump failure. Greene, Tweed's **AR®** line of proprietary thermoplastic composites delivers excellent abrasion and chemical resistance. Because of its dry run ability, impact resistance and machining ease, **AR** materials are perfect replacements for rubber, bronze and silicon carbide in extreme applications. AR1* is rated from ambient to 120°F (49°C), while ARHT is rated from -100°F to 250°F (-73°C to 121°C).

**For applications outside the suggested temperature range please contact GT engineering for further design assistance.*

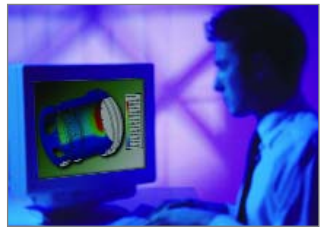
Our products in action







Note: All sections in blue and green show placement of Greene, Tweed's products



Customer focus

EFFECTIVE GLOBALLY—RESPONSIVE LOCALLY

At Greene, Tweed we work to find the optimum solutions for our customers. The global reach of Greene, Tweed combined with our local support capabilities extends to our customers the advantages and resources of a world-class organization. We pride ourselves on hiring and developing highly trained and technically skilled employees and giving them room to think and create.

Greene, Tweed's experienced engineers and local field personnel work closely with end users, pump repair facilities and OEMs around the world to find the best possible WR® design for each unique customer application. Our experts use comprehensive design software and FEA (Finite Element Analysis) to ensure the best possible equipment performance and maximum return on investment for our customers.

With fully qualified engineering, sales and support personnel located throughout the Americas, Europe and Asia, Greene, Tweed delivers innovative solutions to individual customer challenges on a global scale. This consistent high level of skill and experience creates a unique customer relationship. Our success is based on providing products and services that make our customers successful. We are committed to providing local service and technical expertise to help our customers thrive.

To learn more about what the Inside Advantage can offer you, visit us at www.gtweed.com.

TYPICAL PROPERTIES, (ASTM METHODS)					
	WR®300	WR®525 Parallel to Fiber	WR®525 Perpendicular to Fiber	AR®HT	AR®1
Color	Black	Black	Black	Gray	Brown
Specific Gravity	1.43 (D792)	1.63 (D792)	1.63 (D792)	1.63 (D792)	2.00 (D1457)
Hardness, Shore D, (Points)	93 (D2240)	98 (D2240)	98 (D2240)	80 (D2240)	65 (D2240)
Upper Temperature Limit, °F (°C)	275°F (135°C)	525°F (273°C)	525°F (273°C)	250°F (121°C)	105°F (40°C)
Compressive Strength, psi	29,300 (D695)	197,000 (D695)	N/A	9,800 (D695)	2,700 (D695)
Elongation @ Break, %	1.88 (D638)	1.5 (D3039)	0.9 (D3039)	2.2 (D638)	300 (D1457)
Flexural Modulus, psi	1,580,000 (D790)	18,100,000 (D790)	1,300,000 (D790)	495,000 (D790)	157,000 (D790)
Flexural Strength, psi	30,700 (D790)	290,000 (D790)	20,000 (D790)	8,700 (D790)	2,790 (D790)
Poisson's Ratio		0.301 (D3039)	0.011 (D3039)		
Tensile Modulus, psi	1,570,000 (D638)	20,000,000 (D3039)	1,500,000 (D3039)	460,000 (D638)	165,000 (D638)
Tensile Strength @ Break, psi	19,400 (D638)	300,000 (D3039)	12,500 (D3039)	5,100 (D638)	2,270 (D4745)
Water Absorption (ambient), %	<0.10	<0.10	<0.10	<0.10	<0.10

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