The image features two white wind turbines standing in a turbulent ocean. The sky is a deep, clear blue, and the water is dark with white, frothy waves crashing against the base of the turbines. The overall scene conveys a sense of harsh, high-stress environment. The text is overlaid on the right side of the image.

**Whitford coatings  
for renewable  
energy in harsh  
environments**

**W**hitford manufactures the largest, most complete line of high-performance fluoropolymer coatings in the world. These coatings are used in countless applications including marine and wind energy, chemical processing, petrochemical, offshore oil and gas, industrial, high-temperature, decorative, aerospace, automotive, reprographics, etc.

In addition, Whitford has manufacturing and sales offices in every major market of the world to supply and assist customers.

But size is not what differentiates Whitford from its competitors: It's our commitment to research and development. Whitford spends a greater percentage of sales on research and development than any competitor.

We often formulate coatings to solve a customer's specific problem. And we provide unsurpassed worldwide technical support for our products.

### **Xylan® coatings withstand harsh environments**

Xylan fluoropolymer coatings are typically blends of high-performance resins and lubricants. These thin films, designed for offshore wind, tidal power and wave energy-generation devices, offer a variety of benefits, including reduced friction/wear, uniform control of torque-tension, resistance to galling, nonstick, non-wetting, electrical, chemical and abrasion resistance, and enhanced corrosion resistance (rust, galvanic and crevice).



Xylan has been used successfully in the offshore oil and gas industry for over 40 years. It is specified for many applications in subsea, splash and atmospheric zones. It is perfect for use on most metals and some engineered composites.

All Xylan coatings may be applied to a multitude of parts and components. The selection of a particular coating depends on the application and the problems it must solve (wear, heat, corrosion, etc.).

These coating systems enable products to perform to high standards set by many industrial specifications.



### **Key features of Xylan coatings**

- Uniform coefficient of friction.
- Reliable, consistent makeup torque.
- High corrosion resistance.
- Chemically inert/non-toxic.
- Colour identification.
- Low dielectric constant.
- Wide operating temperature ratings  
-425°F/-255°C to +550°F/+290°C.
- Non-wetting.
- Excellent nonstick/release.



*It's far easier (and faster) to replace an old fastener with a simple wrench than by cutting it with a blowtorch because the nut and bolt have corroded together. Xylan coatings make the difference.*



## Uniform coefficient of friction

Xylan coatings are engineered with PTFE for lubrication, which allows precise uniform makeup torque, important in high dynamic- and static-stress situations.



The lubricity of Xylan coatings (with a coefficient of friction as low as 0.055) makes removal of nuts and bolts easy. Components can be removed even after years of use in the field.

Available in many colours, Xylan can be used to identify the size and alloys of parts to allow

*Xylan allows for precise, uniform makeup torque, and permits easy break-out torque when fasteners need changing.*

the loads to be matched according to the size and application, ensuring the proper tension and pre-loading of

parts. Another advantage: tightness remains constant throughout the time in the field, so there is no need for periodic retightening at additional cost to maintain safety.

### Benefits of easy removal with Xylan

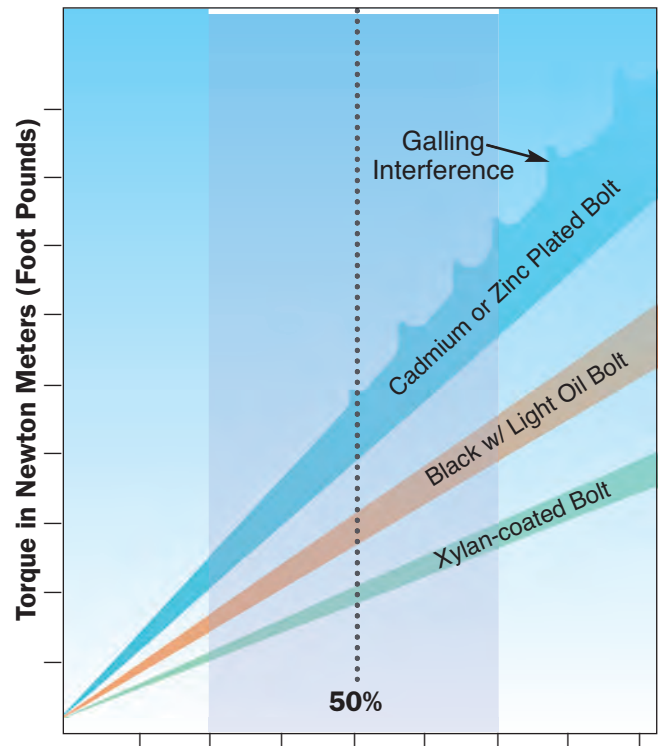
- Improved maintenance control.
- Reduced operating costs.
- Reduction of damage to parts.
- Increased service life.
- Consistent fastener breakout.

## Achieving uniform torque

Fluoropolymer coatings have the lowest coefficient of friction of all known fastener coatings, which requires that makeup torque specification be adjusted to compensate.

Many factors affect the determination of the ideal torque value to achieve recommended clamping loads (K-factor). The coefficient of

## Torque to Load Schematic for Bolts



Load as a Percent of Minimum Yield Strength\*

friction (CoF) is only one. The K- (or nut) factor varies, since it is the net effect of many variables such as type of fastener, thread, thread angle, type of pretreatment, etc. It would be inappropriate for Whitford to offer K-factor information when Xylan is only one of the many variables involved. The same lot of Xylan 1424 applied to different types of fasteners can result in a reduction of makeup torque from 30 all the way to 70 percent. Note: Makeup torque will not vary on fasteners of the same size and make.

Every bolted joint is unique, and the optimum tightening torque should be determined for each by careful testing. A properly tightened bolt is stretched so that it acts like a rigid spring, pulling the mating surfaces together. Whitford recommends a direct-tension (load-cell) study for every size and type of fastener you are using; routine practice in the construction industry.

Another option is to use Fastorq's Boltcalc software. Fastorq, of Houston, Texas, has performed this direct-tension study on many types of fasteners with many types of coatings, including Xylan. They have put this information in a program called Boltcalc, which is available

\* Tensile load data, F.J. Allen, Jr., Consulting Petroleum Engineer, April, 1973.

for purchase ([fastorq.com/products/boltcalc.cfm](http://fastorq.com/products/boltcalc.cfm)). We also recommend that you use direct-tension-indicating washers (DTIs) on random connections to double-check the theoretical values.

## Physical/chemical properties

Corrosion comes in many forms: atmospheric, galvanic, chemical, fretting, salt-fog, etc.

Stainless steel needs oxygen to provide an oxide layer that inhibits corrosion. So it would not be fair to compare Xylan to stainless steel in an ASTM B-117 salt-fog test when the end use is buried in hot soil. Of course stainless steel will outperform Xylan in the salt-fog test, although Xylan will outperform stainless steel when buried in hot soil.

In coastal environments, stainless steel is susceptible to chloride-induced stress-corrosion cracking (chemical corrosion). Xylan-coated carbon-steel bolts are not affected by chlorides.

Stainless-steel fasteners also gall and seize. It is common knowledge that stainless-steel fasteners need to be retorqued after 24 hours due to galling, losing up to 40% of their clamping force. But Xylan-coated carbon-steel fasteners reach the required clamp load on the first makeup.

When stainless steel is combined with dissimilar metals, galvanic corrosion can result. Xylan-coated carbon steel in combination with any alloy does not lead to galvanic corrosion.

Perhaps the most striking difference of all is that stainless-steel fasteners can cost twice as much as Xylan-coated carbon-steel fasteners.

## Long-term corrosion resistance

Corrosion is a serious issue in marine energy devices, since corrosion damage can be costly. Important parts and equipment must be protected from corrosion.

Xylan protects against different types of corrosion, including red rust, galvanic and crevice corrosion.

### Red-rust corrosion

Carbon-steel components coated with Xylan over a zinc pretreatment typically provide corrosion resistance almost equal to that of stainless steel. Such coated components last as long as 10,000 hours in ASTM B-117 salt-fog tests, with less than 15% red rust.

The corrosion-protection properties of Xylan coating systems greatly reduce breakout torque, enabling users to remove the fasteners without causing damage to parts.

### Galvanic corrosion

Galvanic corrosion is an electrochemical process in which one metal corrodes preferentially to another when both metals are in electrical contact and connected by an electrolyte.

Typically, galvanic corrosion occurs when stainless-steel fasteners are used with ductile iron. Xylan coatings have a dielectric strength from 500-1200 volts per mil, which inhibits galvanic corrosion.

Xylan coatings, particularly the formulations made with PTFE, offer a simple solution to the problem. Xylan insulates one metal from the other, shielding them from compounds such as salts, acids, bases.

### Crevice corrosion

Crevice corrosion occurs in confined spaces such as gaps and contact areas between parts, under gaskets or seals, inside cracks and seams, etc.

Xylan's ability to withstand the harsh environmental conditions in offshore wind, wave and tidal applications makes it a perfect partner for the marine renewables sector.



*Red rust makes removal of nuts difficult at best.*

## Offshore energy

Given the urgent demand for clean renewable energy and the enormous potential of this source, the European Commission has supported ocean energy research and development for many years. In fact, since 1988, the EU has funded more than 40 projects on renewable energy. These projects include offshore wind (most promoted in the EU), tidal and wave power.

### Offshore wind power

Offshore wind farms (already in excess of 1600 turbines in the EU) have the advantage of more frequent and powerful winds than those found in land-based installations, and of course have less negative visual impact on the landscape. But, there are considerably higher construction costs. Furthermore, offshore sites pose problems in terms of accessibility for routine maintenance issues.



*Xylan industrial coatings drive down "life-operating" costs.*

Xylan coatings, used in many areas of the structure, help drive down the "life-operating" costs by reducing maintenance over the 25-year life span typically demanded.

### Tidal power

Tidal power is a form of hydropower that converts the energy of tides into useful forms of power — mainly electricity. The earth's gravitational pull creates tidal streams, and any constriction of these streams causes high-velocity

tidal flows, perfect for energy generation. Although not yet widely used, tidal power has significant potential in this area. One obvious advantage: tides are predictable, while wind and solar energy are weather-dependent.

Xylan coatings are an integral part of many renewable energy structures, from turbines to test sites. Among sources of renewable energy, tidal power has traditionally suffered from relatively high costs and limited availability of sites with sufficiently high tidal ranges or flow velocities. Corrosion (both galvanic and red-rust) is a key concern with spiral, single or multi-blade devices on floating, surface or sub-surface piled foundation components.

Xylan inhibits this corrosion. In addition, the stresses placed on turbine blades on a root-fastener connection are significant. Xylan delivers benefits in terms of torque-tension certainty and limits "backing off".

### Wave power

This occurs when wind causes water to move near the sea surface. The height and time between successive peaks of the waves determine the amount of energy that can be generated. Offshore wave converters are designed for deep sites, while shoreline and near-shore systems are modified for shallower water. Power-generating devices are usually floating, and the splash zone is where the most demanding corrosive conditions are experienced.

Another system uses underwater equipment on the sea bed close to the coast. Waves that pass across the top of the unit cause a piston to move. This movement pumps the sea water and drives the generators on land.



*Wave turbines benefit from Xylan coatings.*



Xylan provides excellent corrosion resistance for metallic components in these hostile environments. In addition, Xylan is a dry lubricant, ideal for fail-safe applications such as storm valves.

## The coating options

### 1000 series general-purpose coatings

1014 and 1070 were the first Xylan fastener coatings, introduced in the mid-1970s and still going strong. They provide outstanding lubrication for predictable makeup and break-out torque, and they have outstanding chemical resistance.

Another advantage: They tolerate temperatures from  $-425^{\circ}\text{F}/-255^{\circ}\text{C}$  to  $+550^{\circ}\text{F}/+290^{\circ}\text{C}$  continuously. Xylan 1070 has added corrosion inhibitors.

### 1400 series coatings

The 1400 series does not have quite the wide temperature range of the 1000 series, although it has nearly three times the corrosion resistance applied over any given pretreatment. Xylan 1400 series coatings can be made in any colour, including white. They also have better chemical resistance to bases than the 1000 series. Xylan 1400 series reaches complete cure at  $400^{\circ}\text{F}/205^{\circ}\text{C}$ , ideal for most coating operations. Xylan 1400 series coatings work best for one-time installations, where the fastener will be coated, installed, and left alone.

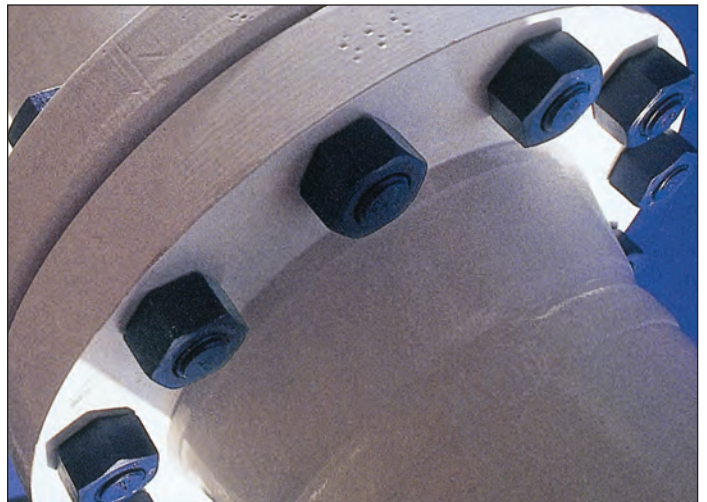
### 142X series coatings

Xylan 1424 and 1427 are the environmentally friendlier combination of the 1000 and 1400 series coatings, the best of both. Xylan 142X coatings have all the chemical resistance of the 1400 series with the lubricant levels of the 1000 series products. However, the 142X series products do not have the wide temperature range, performing best between  $-40^{\circ}\text{F}/-40^{\circ}\text{C}$  to  $+350^{\circ}\text{F}/+175^{\circ}\text{C}$ .

All Whitford coatings require that the surface be properly prepared to remove any



*Large bolts and washers become corroded when conventional marine paints are used.*



*Large bolts and washers are protected when coated with Xylan.*

oils and contaminants through processes such as grit-blasting and/or phosphating.

## Applying Xylan coatings

The techniques for applying Xylan depend on the shape and dimensions of the component, the number of components, the desired transfer efficiency, the application rate and the type of carrier used (water or solvent).

**Spraying** is the most versatile and widely used application technique, either conventional, HVLP (High-Volume Low-Pressure), airless, pressure pot or electrostatic. Any spray gun used for fluoropolymer coatings will provide a uniform film.

**Bulk techniques** are the most economical methods of applying coatings to smaller or

irregularly shaped pieces, typically known as “dip/spin” or “barrel/tumble”.

**Dip/Spin:** This process involves dipping parts in a basket into a can filled with coating, then partially removing and spinning the basket to throw off the excess liquid, which is recovered. Baking between coats cures the coating onto the parts.

All Xylan coatings must be cured at a specific temperature to provide maximum performance. Always refer to the Product Data Sheets (PDS) when applying.

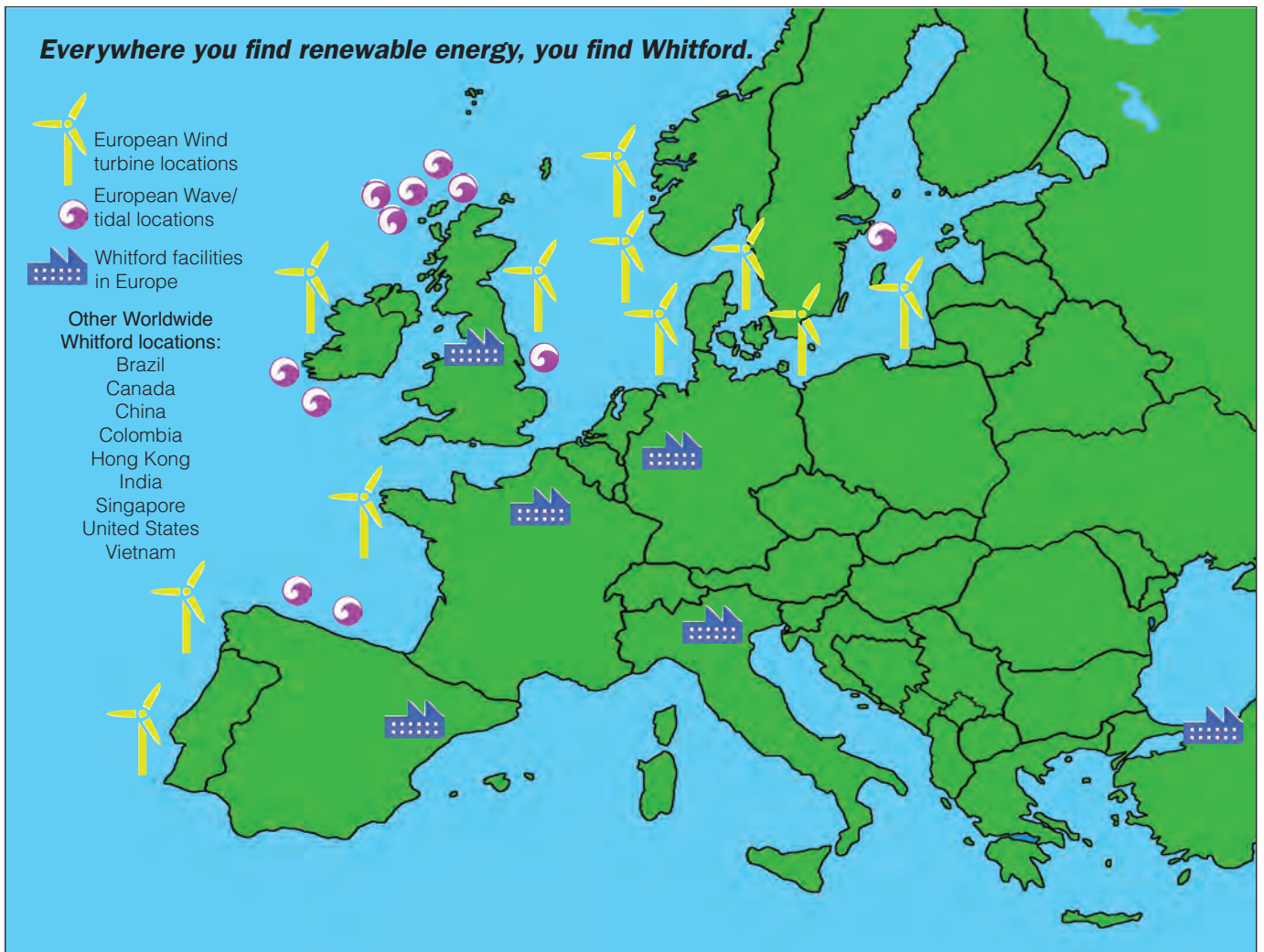
## QAC Program

Xylan coatings are applied by many custom coaters worldwide. To assure proper application to stud bolts in critical offshore markets, we created the Whitford Quality Approved Coater (QAC) Program.

The QAC is restricted to custom applicators who have completed a rigorous Whitford Training Course, have the proper equipment, maintain a formal quality program including audits and comply with rigid quality standards set by Whitford. Once in the program, the coater has access to in-depth training, application-line setup and equipment review.

To find the Quality Approved Coaters in your area, please contact your local Whitford representative, or Whitford directly at [sales@whitfordww.com](mailto:sales@whitfordww.com).

*Every member of the QAC displays the “Quality Approved Coater” plaque in his or her coating facility.*





**Whatever your coating problem,  
Whitford probably has  
the right product to solve it.  
If not, we will work  
closely with you to develop  
the coating that will.**

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### **How to contact Whitford**

Whitford manufactures in 8 countries with sales offices and agents in many more. For more information, please contact your Whitford representative or the nearest Whitford office (see our website: [whitfordww.com](http://whitfordww.com)) or [sales@whitfordww.com](mailto:sales@whitfordww.com).

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**Whitford**

*Where good ideas come to the surface*

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