PTFE-Faced Hydrodynamic Bearings

Michell Bearings

About Us

As the inventor of the hydrodynamic bearing over 100 years ago, we have continued to innovate and develop our products to meet the changing needs of the industry.

Our in-house design engineers work alongside our specialist manufacturing teams in the UK and India to provide you with high quality, innovative hydrodynamic white metal and PTFE lined bearings serving a range of industrial, commercial marine and naval markets.

In order to support critical applications in industries where products are required to meet stringent specifications and perform in demanding environments, we have developed a range of unique performance software tailored to our products. This provides more accurate and reliable performance predictions than with any other commercially available software. Results from the software, which are backed up by years of product research and development testing, give you the peace of mind and confidence in our ability to deliver safe and reliable bearing solutions.

Our product range includes:

- Vertical Guide Bearings (V)
- Advanced Vertical Thrust and Guide Bearings (AV)
- Large Vertical Thrust and Guide Bearings (LV)
- Thrust Bearings for marine applications
- Industrial Horizontal Bearings (IH)
- Heavy Duty Thrust Bearings (HD)
- Marine Propeller Shaft Bearings (MA & MT)
- Self-aligning Pedestal Bearings (NSA)
- Omega Thrust Rings
- Omega Equalised Thrust Rings
- Journal Pad Units
- Special designs to individual customer specification

Quality

- The quality system operated at Michell Bearings for design and support of our products is approved to BS EN ISO 9001:2015
- Our management system has been certified to the health, safety and environmental standard BS EN ISO 14001:2015
- Michell Bearings also complies with the occupational health and safety standard BS OHSAS 18001:2007.

Michell Bearings' original, unfilled (white) PTFE installation, at a pumped storage hydro power station in the UK, which has been operational since 1996. The bearing life is already in excess of four times more than the whitemetal pads that were originally fitted.

Overview

Michell Bearings' development of the PTFE bearing began in the mid 1990s when investigative test work established that the material could operate without undue wear and at specific loads, significantly higher than that of whitemetal (or babbitt) bearings, without high pressure oil injection.

Polytetrafluoroethylene (PTFE) bearing technology has been in existence for a number of years. When initially developed to overcome problems experienced in large, heavily loaded, hydro-generator thrust bearings, the benefits of using PTFE within hydrodynamic bearings were discovered. PTFE bearings offer the option of eliminating the high pressure oil injection system on a whitemetal (or babbitt) bearing, used to provide shaft lift during start and stop.

The ability of the material to operate safely at minimal oil film thicknesses, allows for a higher specific load capacity than is normally associated with whitemetal. Initially development activity concentrated on large thrust pad sizes used in hydrogenerator applications whereby advantages of PTFE could improve the reliability of problematic machines. Today PTFE is often specified as first choice for hydro applications and has been shown to have clear advantages for small pad applications in more standardised reversing pump applications.

A large PTFE hydro thrust pad

A Commitment to Continued Development

Working in collaboration with world-leaders in tribology has enabled our research team to create a detailed mathematical model of operational heat transfer and the thermoelastic deformation of PTFE pads. Our purpose-built test rigs are used to verify theoretical predictions and allow both production-ready and prototype designs to be tested up to and beyond their operational limits. This testing has enabled the introduction of carbon-based filled PTFE pads, which are superior in terms of wear and creep resistance.

Construction

Our PTFE bearings are similar in construction and operation to whitemetal (or babbitt) pads, except that the whitemetal layer is replaced by a composite layer of compressed copper wire and PTFE.

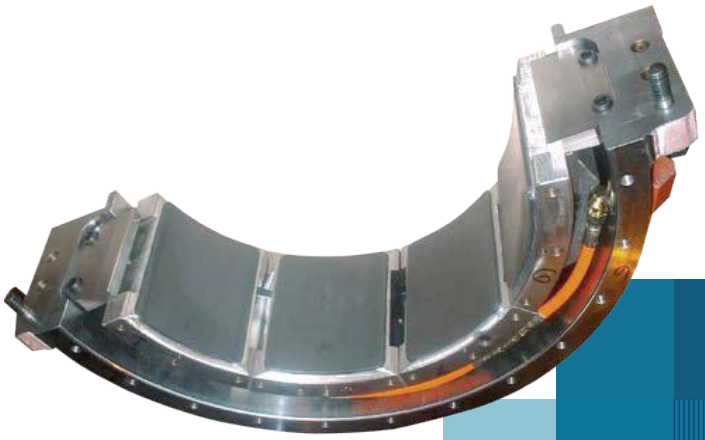
The chemical inertness of PTFE presents difficulties when bonding to metal surfaces, and its increased expansion coefficient means that simple adhesive bonding with the steel pad would be insufficiently strong to withstand the operational loads induced by thermal growth. To ensure a robust and reliable bond, we attach the PTFE onto a close-knitted copper wire mesh which forms a mechanical bond. The copper mesh is then soldered to the steel backing pad to form a metallurgical bond. The critical manufacturing process times, pressures and temperatures are digitally controlled so that every pad meets our exacting standards and quality is never compromised.

PTFE Journal Bearings

Using similar proven manufacturing techniques to those used for thrust pads, we are able to bond the PTFE/copper composite to a curved journal bearing surface. This ensures that the required bond strengths are maintained and the PTFE's properties are not affected.

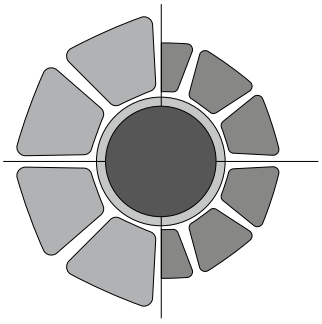
Extensive testing of up to 85m/s (280 ft/s) sliding speed have shown that our PTFE journal pads are capable of delivering the significant operational benefits associated with our PTFE thrust bearings.

Building on our pedigree in hydrodynamic bearing design and manufacture dating back to 1920, we have optimised the PTFE manufacturing processes and continue to expand applications for PTFE thrust and journal bearings. This continues the bearing innovation tradition that our founder, A.G.M. Michell, began with the invention of the tilting pad bearing in 1905.



450mm (18") diameter journal pads for a thrust block test rig

Technical Advantages



Same scale plan drawings of identically loaded whitemetal and PTFE bearings

Increased Load Carrying Capacity

Testing has shown that our manufactured PTFE thrust pads have a load carrying capacity significantly higher than that of whitemetal.

Smaller and Lighter Bearings

The smaller pad surface area of a PTFE bearing can result in reduced overall bearing dimensions when compared to whitemetal. The reductions in thrust collar diameter and outer casing dimensions can result in weight savings of typically 20%. When combined with our expertise in the design and manufacture of compact, self-contained designs, even greater weight savings can be achieved.

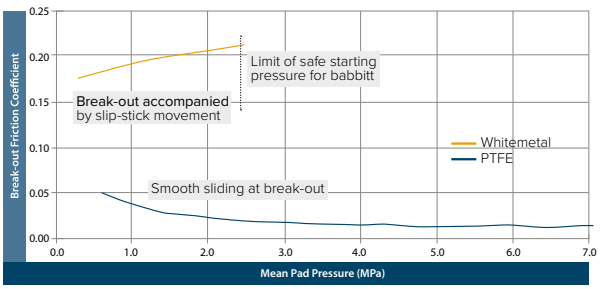
When PTFE is used in our Advanced Vertical (AV) and Large Vertical (LV) product ranges, the bearing can usually be supplied as one frame size smaller than the whitemetal equivalent.

Reduced Power Losses

The smaller bearing working surface area significantly reduces power losses from oil shear, in which savings are typically 20% to 30% when compared to a whitemetal bearing operating under the same conditions.

Superior Friction and Wear Characteristics

PTFE's renowned low-friction properties prove valuable when the hydrodynamic oil lift, used during start and stop, cannot be generated. Static coefficients of friction are around 0.05 and below. Uniquely, PTFE's coefficient of friction reduces as pad pressure increases, giving PTFE-faced bearings distinct advantages for high-load start-ups (see graph below). Furthermore, there is no requirement for dwell time before restart.



Comparison of break-out friction of whitemetal (babbitt) and PTFE

Complete Elimination of High Pressure (HP) Oil Injection

The low friction and low wear characteristics of a PTFE bearing mean that it is not necessary to provide high pressure (HP) jacking. Unlike whitemetal, PTFE has much higher load limits for starting and stopping and it is also possible to operate the machine at much lower speeds before braking systems are employed. HP jacking can be installed in PTFE pads if specified by the customer.

Highly "Forgiving" Material

PTFE is capable of plastic deformation on a localised scale, whilst maintaining the overall pad profile necessary to maintain the hydrodynamic film. With a modulus of elasticity of just 0.2% that of whitemetal, the material is therefore highly compliant. This provides a greater ability to accommodate overloads, transient effects, and misalignment resulting in a very resilient material with long life.

Ideal Material for Problematic Whitemetal Applications

The 'forgiving' nature of PTFE has enabled us to successfully retrofit PTFE thrust pads in a number of units which previously suffered repeated failures with whitemetal.

No Catastrophic Failure Mechanism

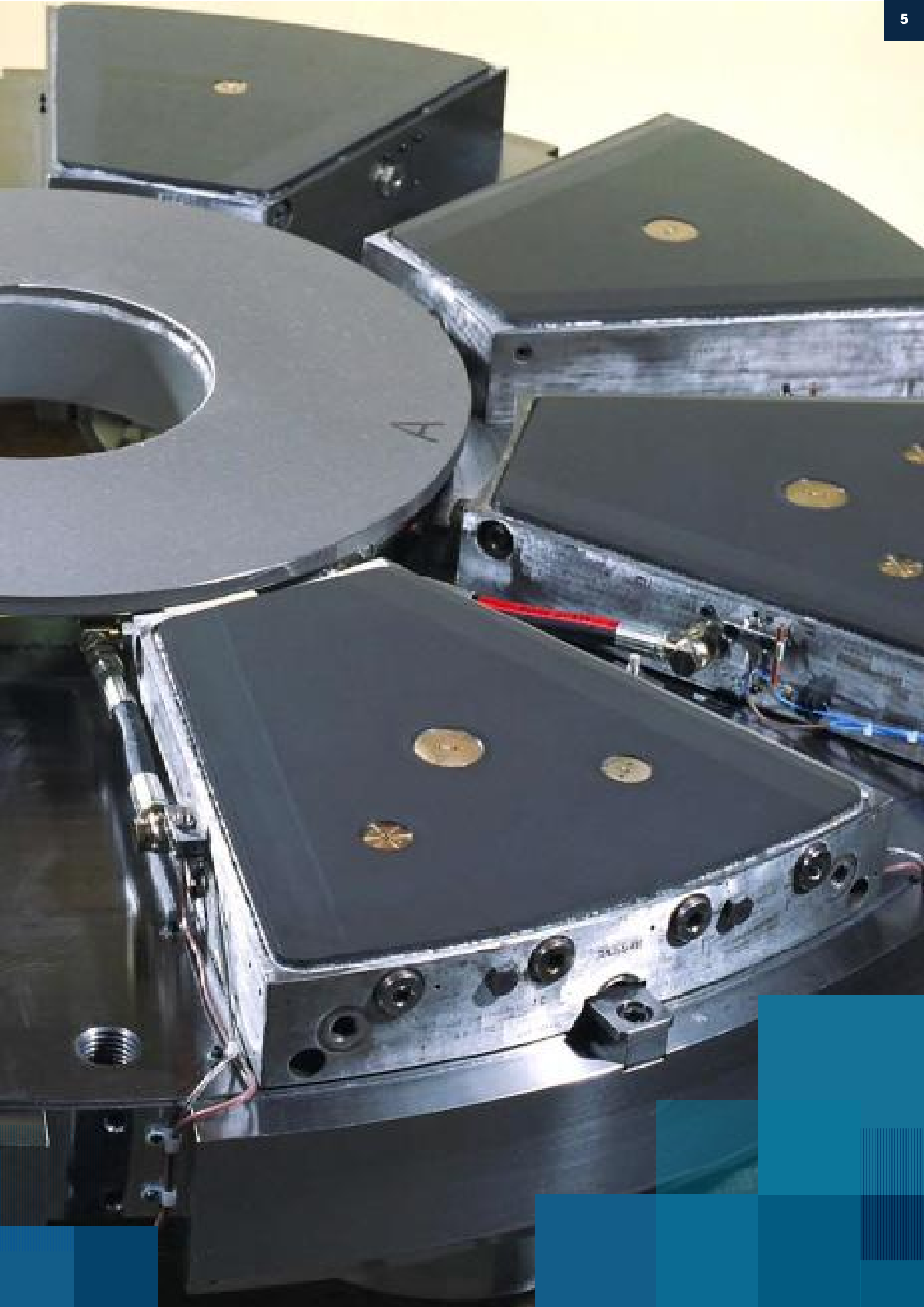
From extreme overload testing in our purpose-built test rig, to the microscopic analysis of the PTFE surface, we have identified that PTFE bearing pads do not exhibit the catastrophic failure modes associated with whitemetal pads. This allows the continued operation and controlled shut-down of machinery. PTFE bearings can therefore protect the equipment from mechanical damage such as runner scorings, which are commonly associated with whitemetal.

Sacrificial Material

The relative softness of PTFE ensures that it will act sacrificially in the event of any debris entering the lube oil system. Operational experience shows that PTFE has a greater capacity than whitemetal to continue operating even with damage to the pad face. In some instances, foreign bodies can embed into the PTFE surface without causing damage that would otherwise lead to the failure of whitemetal bearings.

Thermal and Electrical Insulation

With a thermal conductivity of just 0.6% that of whitemetal, PTFE pads exhibit a significant reduction in thermal 'crowning' of the pad surface, ensuring that more of the surface can be used to support the loads applied to the bearing. The fact that some grades of PTFE are electrical insulators, means that a combined PTFE thrust and journal bearing can provide complete electrical insulation of the shaft, from the entire bearing. This eliminates the risk of electrical erosion from circulating shaft currents, without any requirement for separate electrical insulation.



Applications

Our PTFE thrust pads are installed across four continents, ranging from retrofits on existing hydro power generator units, to the innovative bearings supplied for a high-speed water jet catamaran.

Hydro Power Generation

PTFE faced bearings are ideally suited to the low-rpm, high-load conditions which are often required in hydro power generation applications.

As PTFE pads are smaller than equivalently loaded whitemetal pads, it is possible to retrofit PTFE into existing whitemetal thrust bearings, removing the HP jacking systems. This gives the operational benefits of PTFE, without other significant changes to the machine.

Problem Bearings

Uneven loading and transient loading conditions, whether as a result of a bearing operating outside of its design conditions or a specific construction problem, can in some cases be accommodated by retrofitting a PTFE-faced bearing.

In one project, at a pumped storage power station, three machines initially fitted with conventional whitemetal bearings were experiencing failures when the machines changed from generate to pump mode. It was discovered that uncontrolled collar deformation was causing the thrust load to be concentrated on the inner 50% of the pad faces, and the resulting local pressures were too high for the whitemetal to support. PTFE faces were retrofitted in place of the whitemetal, which meant that all three machines were able to operate immediately and have been operating since their conversion in 1999, even though the original collar deformation is still present.

Marine Thrust Blocks

The significant weight and size reductions achieved through utilising a new PTFE-faced bearing, compared to a whitemetal bearing, can be of particular value when designing marine propulsion systems. In 2002, we supplied the main propulsion thrust blocks with PTFE-faced bearings used on a large high-speed catamaran in Japan, powered by Rolls-Royce water jets, where space and weight were critical to the design. Our PTFE design provided a five tonne saving on the ship-set weight. We have also developed a full-sized submarine thrust block test rig with PTFE-faced thrust pads.

Cost Benefits

Using PTFE can reduce costs across the wider project as it allows for smaller shaft forgings, bearing housings, coolers and lubrication systems. Furthermore, using PTFE pads improves generator efficiency and means that there is no need for high pressure oil injection. The cost saving, from reduced power losses, on a 90MW generator set over a 30 year operational period, would typically be $0.5 million.

Self-Contained Pump Bearings

The reduction in power loss from using PTFE pads has enabled us to supply self-contained, fan cooled bearings for pump installations. This has reduced the power losses generated from larger whitemetal thrust pads, which would have typically required circulated oil systems or water-cooling. Our PTFE bearing, combined with our skills in the design and manufacture of complete bearings, eliminates the need for any other machinery manufacturer to provide auxiliary services.

A complete fan-cooled vertical bearing including PTFE thrust pads

Instrumentation

Our temperature probes are housed in metallic inserts, which penetrate through the PTFE copper layers, giving an accurate indication of the oil film temperature without any detrimental effect to the hydrodynamic film or pad strength. We house the temperature probes in this way as resistance temperature detectors (RTDs) would register a false reading when traditionally positioned in the back of the pad, as PTFE is a thermal insulator.

Hydrostatic High Pressure Oil Injection (Jacking)

A PTFE-faced thrust pad incorporating two RTDs and HP Jacking

PTFE-faced thrust pads can operate safely without hydrostatic high pressure oil injection systems, however there may be circumstances where it is desirable for hydrostatic jacking to be available. This could include trying to achieve extremely high starting torques, or the continuous rotation of the shaft at low (barring) speed is required for maintenance.

As part of our development programme, our PTFE-faced pads, fitted with the HP oil injection feature, have been extensively tested on a full size test rig and have been supplied for many project applications. The incorporation of the jacking feature is dependant on the customer's requirements.

Our Total Customer Support Model

Our Michell Bearings customer support model ensures that you will have peace of mind throughout the lifetime of the bearing solutions that we engineer.

We know that bearing failure is serious and downtime is expensive; so with this in mind, exacting maintenance and servicing is key. If the worst happens, speed of response is critical to ensure repair of existing parts, or availability of replacement and spare parts.

Our global network and 24 hour manufacturing capability ensures Michell Bearings can react quickly and efficiently to the requirements of our customers. We have the in-house technical expertise to undertake virtually any whitemetal bearing repair, whether on an original Michell Bearings product or any other manufacturer's product.

However, service is the key to preventing bearing failure. Our dedicated service team, all highly trained engineers, travel all over the world to carry out both installation and routine service work in both the marine and industrial sectors.

Michell Bearings offers tailored, structured maintenance programmes to ensure bearing reliability. Whether scheduled or unplanned our diagnostic and corrective maintenance is vital to the continued smooth running of your operations and the satisfaction of our customers.

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