

**THORDON**

THORDON BEARINGS INC.



**Marine Renewable Energy  
Bearing Applications  
Product Manual**





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**Note:** *The information contained in this document is offered as part of our service to customers. Thordon Bearings reserves the right to revise any information or specifications included in this document without prior notice.*

## COMPANY PROFILE

Thordon Bearings Inc., a member of the Thomson-Gordon Group of Burlington, Ontario, Canada, designs and manufactures a complete range of high performance, environmentally-friendly bearings and bearing systems. Recognized internationally for superior performance, Thordon solutions and products are specified extensively in marine, offshore, pump, hydro-turbine and many other industrial applications in over 70 countries throughout the world.

Utilizing proprietary polymers developed and manufactured by Thordon as the bearing surface, Thordon bearing solutions deliver high reliability and long wear life, particularly in tough, abrasive operating conditions. This high level of product performance results in decreased life cycle costs and increased mean time between failures for Thordon's customers. A team of experienced, in-house application design engineers provides innovative bearing system designs to meet or exceed each customer's technical requirements. Thordon products and services are available worldwide through local distributors whose factory-trained specialists consult with customers from the establishment of bearing system specifications to ensuring the product is correctly installed and commissioned in the field.

Since the turn of the century, Thordon Bearings' parent company, the Thomson-Gordon Group, a fourth generation family-owned business, has recognized the importance of providing industry with superior products, precision manufacturing and solid application engineering support. Thordon Bearings' own engineering and quality focus has earned worldwide recognition from its many customers. Quality procedures are certified to ISO 9001:2000 Quality System requirements.

Thordon bearings, and bearing systems, are the proven, cost-effective, environmentally-friendly, solution for rigorous and demanding journal bearing applications.

## WHAT WE DESIGN AND MANUFACTURE

### Thordon XL Propeller Shaft Bearings



Installed on U.S. Coast Guard icebreakers since 1983. Shaft diameter = 922 mm (36.3")

### Thordon SXL Main Turbine Shaft Bearings



Installed in 2 turbines at Spaulding Power Station, Pacific Gas & Electric, California, U.S.A.; 2011, 2012

### Thordon COMPAC Propeller Shaft Bearings



Installed on 4 Disney Cruise Lines cruise ships: 1998, 1999, 2011 and 2012

### Thordon SXL Rudder Bearings



Installed on *Emma Maersk* containership. Shaft diameter = 1100 mm (43.3")

## WHAT WE DESIGN AND MANUFACTURE

### Thordon SXL Stern Roller Bearings



Installed on over 80 Anchor Handling Tug Supply vessels, worldwide

### Thordon SXL Turret Bearing Pads



Installed on FPSO *Firanze* owned by Saipem in 2010. Shaft diameter = 4466 mm (175")

### Thordon SXL Propeller Shaft Bearings



Installed on 3 U.S. Navy nuclear submarines SSN *Seawolf* Class since 1996

### Thordon Composite Cutterhead Intermediate Ladder Bearing



Installed on dredger, *D'Artagnan*, owned by DEME Group in 2005. Shaft diameter = 900 mm (35.4")

## SECTION C

### PRODUCT AND CONFIGURATIONS

Thordon has developed two types of polymer bearings and several grades that allow selection of the optimal bearing for your unique application.

#### **Elastomeric Bearings**

Thordon Bearings introduced a proprietary, elastomeric, synthetic polymer alloy more than 30 years ago originally for use as a sleeve bearing for vertical pump applications. The unique polymer structure yields basic properties more in line with those you could expect from a very high performance rubber if one existed. However, Thordon is harder - yet elastomeric, tough and resilient in nature, self-lubricating with a much lower coefficient of friction and able to accommodate much higher specific pressures than rubber.

Thordon elastomeric bearing grades are not reinforced with layers of woven fabric, rather, it is a fully homogenous product with all properties consistent throughout the entire wall thickness of the bearing. Compared to other non-metallics such as thermoset laminates, Thordon is somewhat softer and more compliant. As a result, under slight misalignment conditions where edge loading is created, Thordon is able to deform slightly, allowing the load to be distributed over a larger area. The localized pressure on the bearing edge is significantly reduced. Due to its elastomeric nature, Thordon is also able to withstand higher degrees of vibration and shock loading without incurring permanent deformation or damage. Thordon offers three elastomeric grades and two configurations

Continuous research over the years has resulted in development of four different bearing-grade elastomer products - XL, SXL, HPSXL and GM2401. This allows selection of an optimum solution based on matching product characteristics to the specific application requirements.

#### **ThorPlas Thermoplastic Bearings**

ThorPlas is a proprietary, engineered thermoplastic bearing product developed by Thordon Bearings. While the Thordon range of high performance elastomeric bearing products clearly offer superior performance in the applications in which they can be specified, there are technical limits, such as maximum temperatures and pressures beyond which they cannot be used.

To address these limits, Thordon Bearings has created ThorPlas, which significantly expands the range of applications where Thordon bearings can be specified, while still maintaining many of the recognized Thordon performance advantages.

## PRODUCT AND CONFIGURATIONS (cont'd.)

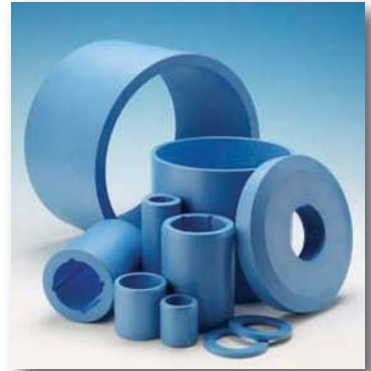
When compared to the Thordon elastomer-based products, ThorPlas offers:

- Increased strength and rigidity allowing maximum dynamic working pressures up to 31 MPa (4500 psi) in a full-form tubular configuration
- Improved ability to operate at elevated temperatures up to 80°C (176°F) in water
- Improved chemical resistance in all major chemical categories
- Enhanced wear life in non-abrasive environments

## THORDON GRADES

### ThorPlas (Blue)

- Thermoplastic material developed by Thordon specifically as a homogeneous high pressure bearing
- Maximum dynamic working pressure to 31.0 MPa (4500 psi)
- Very low wear in non-abrasive environments
- Reasonable abrasion resistance - less than Thordon elastomeric grades, but better than bronze, epoxy phenolics and many other non-metallic bearing materials



### Thordon SXL (Off White)

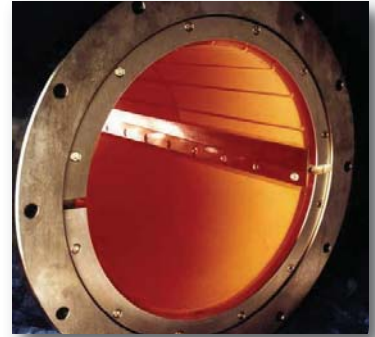
- Maximum dynamic working pressure to 10.0 MPa (1450 psi) in limited motion
- Lower coefficient of friction (typically 0.10-0.20) than XL
- Higher dry PV (Pressure Velocity) rating than XL
- Higher resistance to abrasion than XL in wet applications; good abrasion resistance operating dry
- Dry start-up capability as a vertical pump bearing
- High resistance to shock loading and vibration



## THORDON GRADES (cont'd.)

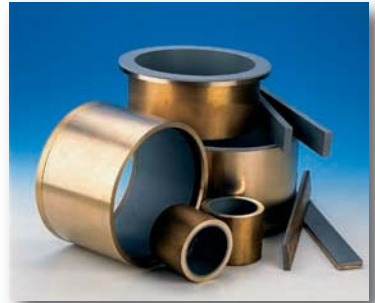
### Thordon COMPAC

- A high performance grade of Thordon that is used in open water lubricated propeller shaft bearing systems
- Specially formulated with a low coefficient of friction to reduce startup friction and eliminate stick-slip, COMPAC's unique configuration is designed to promote early formation of a hydrodynamic film at lower shaft rpm.
- COMPAC's design properties are effectively similar to SXL.



### Thordon HPSXL (Grey)

- Designed for higher pressure applications, as the bearing component in HPSXL TRAXL bearings (HPSXL bonded in a metallic shell)
- Maximum dynamic working pressure to 15.0 MPa (2175 psi) in limited motion
- HPSXL TRAXL has maximum dynamic working pressure to 55.0 MPa (8000 psi) in limited motion
- Lowest coefficient of friction (typically 0.06 - 0.12)
- Moderately abrasion resistant (lower abrasion resistance than XL or SXL)
- High resistance to shock loading and vibration



### Thordon XL (Black)

- Maximum dynamic working pressure to 5.5 MPa (800 psi) in limited motion
- Low coefficient of friction (typically 0.20-0.25)
- High resistance to abrasion in dry applications
- High resistance to shock loading and vibration



## THORDON GRADES (cont'd.)

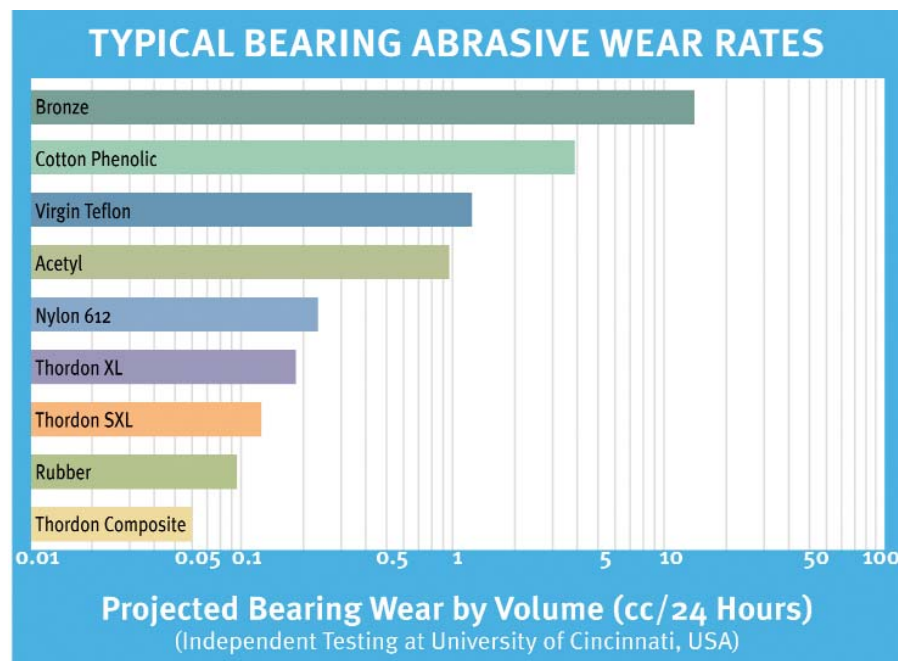
### Thordon GM2401/Composite (Yellow Shell, Black Wear Surface is GM2401)

- Bearing formulated specifically for use in very abrasive environments
- Used in rotating applications in abrasive water conditions such as pump and dredge bearings
- Outstanding abrasion resistance - two or more times that of rubber
- Significantly lower coefficient of friction than rubber
- Higher resilience and stiffness than rubber



### Thorseal

- High performance elastomer lip (cup) seal for use in water
- Highly abrasion resistant - use as a seal to exclude abrasives from limited motion bearings
- Suitable for pressures from 0 to 100.0 MPa (0 - 15,000 psi)
- Recommended for reciprocating linear or limited motion rotary applications
- Very tough - cut and tear resistant
- Low friction - self-lubricating
- Available in a variety of configurations depending on application



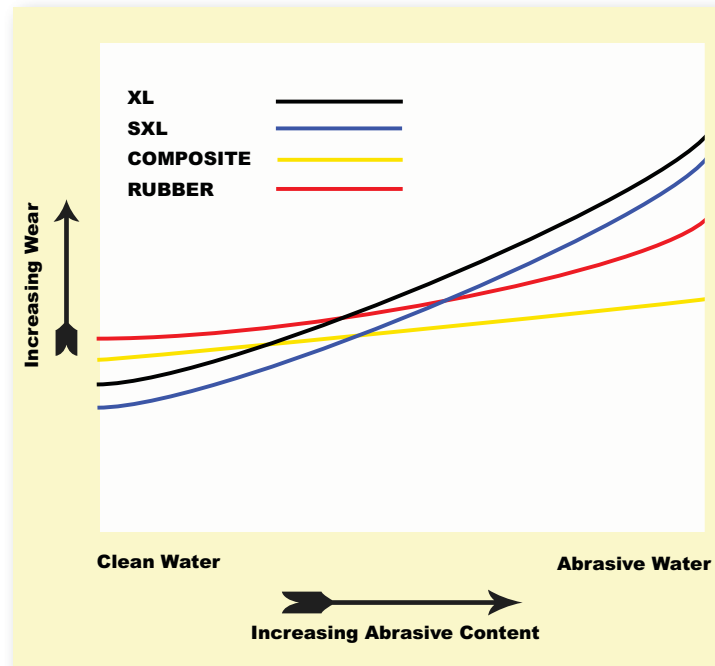
## GENERAL MATERIAL SELECTION GUIDE FOR VARIOUS APPLICATION PARAMETERS

Lubrication / Operating Pressure	Recommended Thordon Grades	
	★★★★★	★★★★
<b>Dry (sealed or minimal abrasives)</b>		
0-10 MPa (0-1450 psi)	SXL	ThorPlas
10-15 MPa (1450-2175 psi)	ThorPlas	HPSXL
15-31 MPa (2175-4500 psi)	ThorPlas	HPSXL TRAXL
31-55 MPa (4500-8000 psi)	HPSXL TRAXL	
<b>Dry (abrasives present)</b>		
0-5.5 MPa (0-800 psi)	SXL	ThorPlas
5.5-10 MPa (800-1450 psi)	SXL	ThorPlas
10-15 MPa (1450-2175 psi)	HPSXL	ThorPlas
15-31 MPa (2175-4500 psi)	ThorPlas	
<b>Wet (sealed or minimal abrasives)</b>		
0-10 MPa (0-1450 psi)	SXL	ThorPlas
10-15 MPa (1450-2175 psi)	ThorPlas	HPSXL
15-31 MPa (2175-4500 psi)	ThorPlas	HPSXL TRAXL
31-55 MPa (4500-8000 psi)	HPSXL TRAXL	
<b>Wet (abrasives present)</b>		
0-3 MPa (0-500 psi)	GM2401	SXL
3-10 MPa (500-1450 psi)	SXL	ThorPlas
10-15 MPa (1450-2175 psi)	HPSXL	ThorPlas
15-31 MPa (2175-4500 psi)	ThorPlas	

*Note: The maximum pressures given for the various products are based on maximum dynamic working pressures for intermittent, limited motion. For applications involving continuous rotary motion, PV limits of the materials will significantly reduce the maximum allowable pressures stated above.*

**This is a general guide for technical reference only. Critical applications that are close to pressure or temperature limits, or subjected to non-standard environments should be reviewed and approved by Thordon Bearings.**

## TYPICAL BEARING WEAR RATE VS. WATER ABRASIVE CONTENT



## DESIGN AND INSTALLATION CONSIDERATIONS

Before choosing a Thordon grade for an application, the following criteria must be considered:

- Speeds (rpm)
- Type of lubrication
- Pressures
- Amount of abrasives
- Degree of impact loading
- Ambient temperatures (maximum/minimum)
- Special ambient conditions (e.g. intermittent exposure to high temperature steam cleaning)
- Thordon has produced a Bearing Sizing Calculation computer program to assist designers in the calculations required to correctly size Thordon bearings (see sample above)
- **Thordon engineers can help in designing bearing solutions and drawings can be provided**

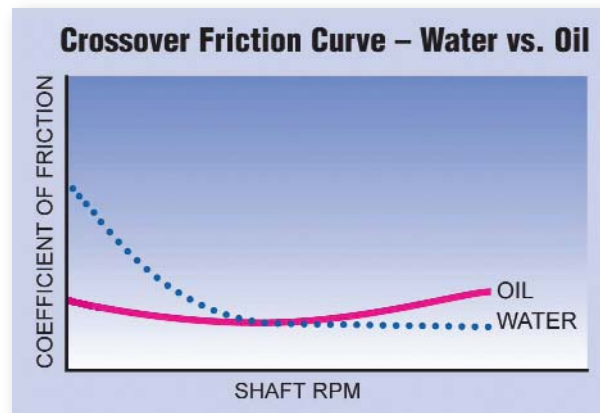
## THORDON BEARING SOLUTIONS OFFER DEVICE DEVELOPERS THESE BENEFITS

### Zero Pollution Risk

Thordon bearings eliminate oil and grease from the underwater assemblies, as the lubricant is sea or river water. There are no seals, no grease or oil systems, and no worry of seawater ingress which could contaminate or damage conventional oil/metal or rolling element bearings. Thordon water lubricated bearings will ensure that there will be no environmental violations resulting from oil leakage.

### Lower Friction Than Oil

For horizontal applications, Thordon COMPAC bearings have been designed to reduce running friction and improve low speed hydrodynamic film development. The lower (loaded) portion of the COMPAC bearing is smooth and the upper half is designed with water grooves for lubrication and cooling. Although start-up friction is initially higher, at rated shaft speeds drag on the rotating shaft resulting from the viscosity of the lubricating fluid is lower with water than with oil, resulting in potential fuel savings.



### Extensive References

Thordon bearing systems are extensively used in many marine propulsion, hydro-turbine and offshore applications. Designers, shipyards, shipowners and utility companies have chosen Thordon for its pollution-free simplicity and proven reliability. A partial list of a diverse selection of references is on page 25.

## TECHNICAL SUPPORT

Thordon Bearings recognizes the importance of superior products, precision manufacturing and application engineering support. Thordon Bearings in-house engineers work closely with customers to provide innovative bearing system designs that meet or exceed the technical requirements of the application. Full engineering drawings are generated as necessary. Thordon has many years of experience with applications in severe marine environments and offers technical support during machining and installation.

Geared to provide quick response to customer needs, Thordon Bearings understands the importance of quick delivery and reduced downtime. Standard size bearings are stocked at the factory and by Thordon distributors around the world. Special sizes or designs can be machined to the exact requirements of the customer and delivered quickly throughout the world.



## THORDON BEARING SIZING CALCULATION PROGRAM

The Thordon Bearing Sizing Calculation Program is provided to assist designers in the calculations required to correctly size Thordon bearings. The program input parameters include shaft RPM, interference or bond fit, type of lubrication, type of service, load on bearing, etc. Output parameters include machined bearing sizes and tolerances, amount of interference, bore closure amount, min. installed clearance, running clearance, etc. An example of the Thordon Bearing Sizing Calculation Program output is attached.

Designed to operate on a PC (personal computer), the software operates in the Windows operating system. The program is in a color, menu-based format so that entries can be made with a minimum of effort. Outputs can be printed and inputs can be saved to a file. Contact Thordon or your distributor to obtain a copy of the program or visit our website at [www.ThordonBearings.com](http://www.ThordonBearings.com).

## SAMPLE OUTPUT

### Thordon Bearings Sizing Calculation Program

No: 901302EN41 V 2006.2  
 Printed Date: 15/02/2012

THORDON BEARINGS INC.  
 3225 Mainway Drive, Burlington, Ontario, Canada L7M 1A6  
 Tel: 905-335-1440 Fax: 905-335-0209, www.thordonbearings.com

### General Information

Thordon Distributor:	
Customer:	Thordon Bearings Head Office
Project Reference:	Pivot Bearing
Calculated By:	Thordon Engineering
Checked By:	
Comments:	Ocean Energy Device
Drawing Number:	
MRP Number:	

### Results

**== ATTENTION ==**

**Means of axial retention required.  
 Amount of interference increased to increase bearing retention.**

	Designed at 21 °C	Machined at 21 °C
Machined Bearing Inside Diameter:	504.47	504.47 mm (For reference)
Machined Bearing Outside Diameter:	553.14	553.14 mm +0.25, -0.00
Calculated Machined Bearing Length:	744.72	744.72 mm +0.00, -1.0
Bearing Wall Thickness:	24.34	24.34 mm +0.00, -0.13
Amount Of Interference:	3.14 mm	
Bore Closure Factor:	1.072	
Bore Closure Amount:	3.50 mm	
Minimum Installed Diametrical Clearance:	0.97 mm	
Diametric Running Clearance:	0.55 mm	
Diametric Thermal Expansion:	0.11 mm	
Diametric Absorption Allowance:	0.31 mm	
Axial Thermal Expansion:	1.53 mm	
Axial Absorption Allowance:	3.75 mm	
Outside Diameter After Dry Ice Cooling:	548.09 mm	
Outside Diameter After Nitrogen Cooling:	541.93 mm	

### Input Data

Dimension Scale:	Metric
Temperature Scale:	Celsius
Maximum Operating Temperature:	30 °C
Minimum Operating Temperature:	0 °C
Machine Shop Ambient Temperature:	21 °C
Maximum Shaft Diameter:	500.00 mm
Maximum Housing Diameter:	550.00 mm
Minimum Housing Diameter:	550.00 mm
Housing Length:	750.00 mm
Type of Lubrication:	Water
Grade of Thordon Used:	SXL
Type of Service:	Ind. Oscillating Rotation
Type of Installation:	Interference Freeze Fit
Load on Bearing:	0 kg
Shaft RPM:	0

## APPLICATIONS

### **Turbine Main Bearings (Vertical or Horizontal) Recommended Grades: SXL and GM2401**

Thordon Bearings recommends two bearing grades for use in water-lubricated turbine main bearings. Thordon SXL offers the lowest coefficient of friction, superior adhesive wear performance and good resistance to wear resulting from third particle abrasion. GM2401 is specially formulated to provide optimal wear resistance in abrasive-laden water conditions, routinely outwearing rubber bearings by a factor of two or more, in conventional hydro-turbine bearings, yet still exhibiting a lower coefficient of friction compared to rubber.



Thordon can be specified as an upgrade for rubber or other non-metallic bearings in existing water-lubricated bearing systems or designed as an alternative to sealed rolling element bearings.



Thordon main shaft bearings can be supplied factory-bonded into split bearing housings, or interference fit into cylindrical housings. Thordon bearings can also be custom designed to fit many other configurations, depending on customer requirements.

### **Pivot, Linkage and Operating Mechanism Bearings Recommended Grades: HPSXL, HPSXL TRAXL and ThorPlas**

Thordon HPSXL TRAXL bearings are suitable for use in linkage or pivot bearing systems. HPSXL TRAXL achieved a top level overall rating in the U.S. Army Corps of Engineers Powertech simulation tests for low speed operating linkage bearings.



Thordon ThorPlas is also well suited for pivot and linkage bearing applications. An engineered thermoplastic, ThorPlas can be installed as a full-form product and does not require a bronze shell that HPSXL requires to meet the specific pressure requirements of this application. Also successfully tested by Powertech, ThorPlas demonstrated very low wear and acceptable friction levels. Where there is a preference for a full form bearing, ThorPlas is the clear choice for performance and value.



Both HPSXL and ThorPlas are easily machined and can be supplied either finished to final sizes provided by the customer, or with overbuild to facilitate line boring after installation to correct the misalignment and dimensional inconsistencies often encountered during turbine rehabilitation. Wiper seals can often be fit directly within the bearing to reduce abrasive entry into the bearing area.

## Thrust Bearings/Washers Recommended Grade: SXL

Thordon SXL thrust washers can carry axial loading in low speed applications without grease or oil. The polymer's inherent resilience and low coefficient of friction ensures smooth operation with no stick slip at very low speeds.

Water lubricated fluid film thrust bearings can also be designed for higher speed applications, taking into account expected loads and speeds.



## Spherical Bearings Recommended Grades: ThorPlas or HPSXL TRAXL

ThorPlas is a good bearing choice for spherical bearing applications, where the application requires self-aligning characteristics. In this type of application, the bearings can operate wet or dry depending on load and operating speed. A split bearing design allows for easy installation and replacement to maintain tight clearances.



Where bearing pressure may exceed 31 MPa, metal backed HPSXL TRAXL spherical bearings can also be used up to a maximum bearing pressure of 55 MPa.

## Wear Pads

**Recommended Grades: SXL and HPSXL**

Thordon SXL and HPSXL wear pads offer smooth, grease-free operation and high abrasion resistance between mating components operating at low speeds in wet or dry applications. Usually supplied molded to size complete with stainless steel inserts for mechanical fastening, Thordon wear pads can also be bonded in position using a Thordon-approved adhesive.



## Pump Bearings

**Recommended Grades: SXL, XL, GM2401 and ThorPlas**

Non-polluting Thordon water-lubricated pump bearings offer dry-start capabilities, long wear life, low friction and superior resistance to abrasive wear. Available in four grades, Thordon pump bearings can be selected to optimize specific performance requirements. From Thordon Composite for highly abrasion resistant bottom bowl bearings to Thordon SXL for dry-start upper bearings to ThorPlas for higher temperature applications, Thordon pump bearings outperform rubber bearings by a factor of two or more in abrasive conditions. Not limited by shelf life or a range of standard production sizes, Thordon pump bearings facilitate quick turn-around and reduced maintenance inventories. Costly sleeve or shaft replacement can often be avoided by machining a pre-grooved Thordon tube to the exact non-standard dimensions required.

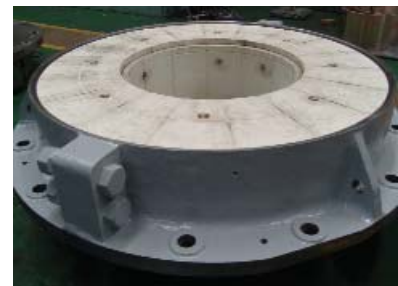


A separate Pump Bearing Product Manual is available.

## Yaw Bearing Systems

**Recommended Grades: SXL**

Based on extensive experience with rudder bearing systems for large commercial and naval vessels, Thordon can design complete yaw bearing systems for submerged operation, carrying both axial and radial forces using Thordon SXL.



## **Pillow Block Assemblies**

**Recommended Grade: SXL or Composite**

Easily servicable and self-contained water lubricated pillow block assemblies can be designed and supplied by Thordon using either SXL or Composite material as the bearing surface. Thrust rings can also be fitted to these assemblies to provide for positive axial location of rotatin equipment.



## **Servo-Motor and Other Hydraulic Sealing Applications**

**Recommended Grade: Thorseal**

In servo-motor and other hydraulic sealing applications, high performance, tough, Thorseal lip self-lubricating polymer lip seals offer positive sealing up to 100 MPa (15,000 psi). Thorseals provide long wear life with no need for periodic adjustments; resist tearing and extrusion; and as a result of their internal lubricants, operate with less drag and reduced cylinder wear. Thorseals are not only available in a wide range of standard sizes but can also be quickly machined to custom size requirements up to 1.5m (60") in diameter.



## **Seals for Pivot Bearings, Operating Mechanism and other Limited Motion Bearings**

**Recommended Grade: Thorseal**

To prevent contamination of wicket gate, or other hard-to-reach bearings by abrasive laden waters; or operating mechanism bearings by corrosion residue or other contaminants, seals are recommended. High quality Thorseal lip seals are formulated from a tough, high-strength polymer impregnated with internal lubricants and are supplied as an integral part of the bearing design.



## **Turbine Blade Hub Seals** **Recommended Grade: Thorseal**

Taking advantage of tough, long-wearing Thorseal polymer lip seals, an enhanced sealing design has been developed for adjustable pitch blade hubs. Essentially, two specially designed Thorseal single ring U-cup seals are locked together to function as a monolithic double-acting seal and fitted back to back in the blade shaft stuffing box. The outer seal lip prevents ingress of water into the hub contaminating the lubricating oil and the inner seal prevents oil from leaking out of the hub into the environment. This design is easy to install, resists distortion during blade re-positioning and the modified lip design insures positive sealing under conditions of significantly more blade droop than conventional packing. Shaft wear is reduced due to the friction and wear reducing additives in the polymer and the seals can be supplied split for easy in-situ replacement.



Thordon Offshore Applications

Thordon SXL Lower Turret Bearing Pads for Exmar Offshore FPSO “Farwah” for C137B Field off the Coast of Libya

# Novel turret design speeds Libyan vessel construction

TotalFinaElf’s FPSO-based development plans for its CPTL 137B field offshore Libya moved ahead recently with the completion by London Marine Consultants of the loadout and transport of an innovative external turret mooring system for the field’s FPSO.

The turret was designed and fabricated under an EPC contract, London-based LMC’s first, from Doris Engineering, as part of the construction of the offshore facilities at the field, a concept built around the FPSO and a process platform, known as BD1.

Specifically designed for single lift, minimal hook-up installation onto the FPSO hull – aimed at ‘significantly reducing the interface issues’ associated

with conventional internal turret systems, while allowing vessel fabrication to proceed in parallel – the turret will be lifted and connected to the hull in the Fene yard of Spain’s Izar which is providing the FPSO hull. Doris is supplying process facilities for the vessel.

To be installed in 83m of water in a 3x3 configuration off Libya, the newbuild FPSO has been designed with a 900,000 barrels storage capacity and will go into service early next year.

‘The turret design is novel in its external use of a twin bearing column type structure, which is more frequently used in conventional internal turret/moonpool systems, but has been modified to provide rigid cantilever structures at

top and bottom, connected by an outer shaft structure to minimise relative deflections,’ explains LMC director Jon Dunstan.

The outer shaft of the turret protects the inner shaft, which connects to the chain table and the nine 5in mooring chains. Once on-line at the field, the structure will take a 10in production line from BD1, located 3km away, and pass three 6.6kV power umbilicals from FPSO to power the platform.

The equipment is protected by an upper deck mounted housing structure that has been ‘rigorously designed’ to resist possible greenwater loading, which can result from the design significant wave height of 9m.



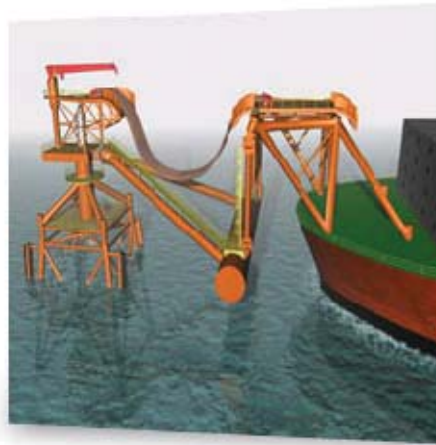
FPSO Farwah equipped with Thordon SXL turret bearing pads



### Thordon Offshore Applications

#### Thordon HPSXL TRAXL Bearings for Tower Yoke U-Joint Assembly for FMC SOFEC ESSO Chad Development FPSO

In the SOFEC design (shown below) a fixed tower brings crude oil from the ocean floor to the FPSO. The oil is then transferred to the ship by the pipes shown on the top of the unit. Thordon HPSXL TRAXL bearings are in the cylinder shaped unit between the ship and the fixed tower. The cylinder is a hinge to allow relative movement between the ship and the fixed tower. When the unit is installed the cylinder is filled with water to make it very heavy. When the distance between the ship and the tower changes, due to weather or tides, the cylinder is lifted. The lifted weight of the cylinder then acts as a restoring force trying to maintain the correct distance between the ship and the tower.



*HPSXL TRAXL bearings*




*SOFEC ESSO Chad Development FPSO*

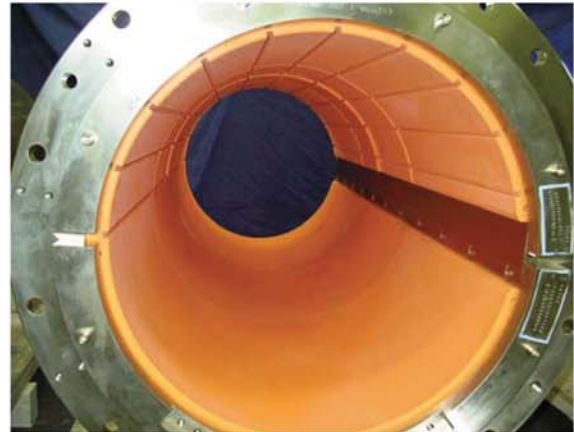
# PRINCESS CRUISES CONTINUES TO INSTALL WATER LUBRICATED PROPELLER SHAFT BEARINGS

Princess Cruises has specified Thordon water lubricated COMPAC propeller shaft bearing systems for two new GRAND Class cruise ships (Hull No.'s 6131 and 6132) being built at Fincantieri Cantieri Navali Italiani SpA for 2007 and 2008 delivery. There is an option for a third bearing system for a follow-on ship.

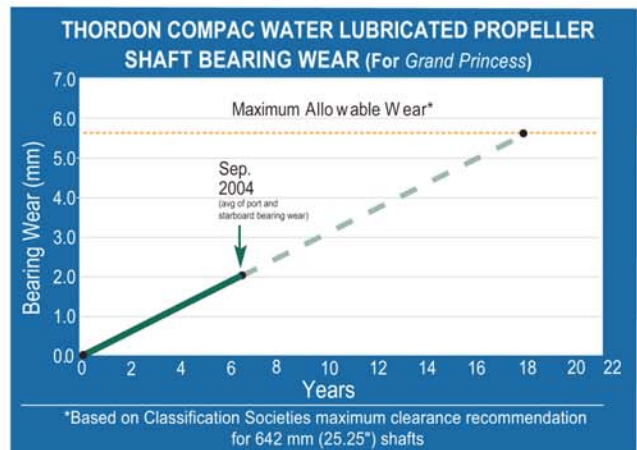
Princess Cruises, part of Carnival Corporation, currently has seven vessels fitted with water lubricated COMPAC bearings after the first installation in 1998 on *Grand Princess*. "The water lubricated bearings from Thordon have been problem free," says Richard Vie, Vice President Newbuildings for Carnival Corporation. "Based on bearing wear data, we are not expecting to replace the bearings more than once in the life of the vessel, or perhaps not at all."

Thordon Bearings is supplying its unique COMPAC Single Key Design Bearings for the 116,000 GRT twin screw newbuild vessel. The tapered Single Key Design allows the bearings to be easily withdrawn from the bronze carrier, inspected and re-installed with the shaft still in place. The COMPAC elastomeric polymer alloy bearings for the 642 mm (25 in.) diameter propeller shafts are designed to promote hydrodynamic operation at low shaft speeds and provide long wear life. A flow of seawater will be provided to the bearings for efficient cooling and lubrication in this pollution free propeller shaft bearing system.

By completely eliminating oil from the stern tube and struts, Thordon's COMPAC system ensures there is no risk of pollution or subsequent environmental violations that could result from stern tube oil leakage, however small. There are currently over 380 Commercial and Naval vessels that are equipped with Thordon COMPAC water lubricated propeller shaft bearings plus many more on order. 



COMPAC Propeller Shaft Bearing With Single Key Design



Star Princess Equipped With COMPAC Water Lubricated Propeller Shaft Bearings Since 2002

# ROLLS-ROYCE MARINE'S 17-YEAR TROUBLE-FREE HISTORY WITH THORDON BEARINGS

When Charles Rolls partnered with Henry Royce in 1906, they created a company that has remained on the leading-edge of industrial technology for almost a century. Rolls-Royce innovations make jets fly faster, cars run quieter, and ships move faster. They even built the engine that powered the first transatlantic flight. So it's no wonder that Rolls-Royce is careful when specifying components to be used in their systems. They have a reputation to protect.

"In the area of marine propulsion systems," says Roger Duwel, President of Duwel Tecno, Thordon Bearings distributor in Sweden, "no one in the world has a better name than Rolls-Royce. They take pride in that name and do everything they can to protect it."

Today, more than 20,000 commercial and 400 naval vessels use equipment developed at the Rolls-Royce Marine division. The company's product portfolio includes the most advanced systems available for the supply of power, propulsion and motion control.

## Selecting the best

Rolls-Royce has been using Thordon products for water lubricated stern tubes since 1987 and has been consistently impressed with the reliability and performance. "Thordon are a little more expensive than other bearings," says Jan Pahnke, Strategic Sourcing Specialist for Rolls-Royce Marine, "but they offer technical advantages that we feel are worth the extra money."

As Duwel puts it, "The folks at Rolls-Royce particularly appreciate the technical expertise." The knowledge base at Thordon Bearings goes well beyond bearing design and includes surrounding components and systems as well. "This is an important advantage for Rolls-Royce. They can send us shaft calculations, for

example, and we can add value with our comments and suggestions."

As the pioneers in water-lubricated bearing technology, Thordon has more than a quarter century experience in a full range of applications in commercial and naval vessels.

Thordon bearings are pollution free, highly resistant to abrasion, have low static and dynamic coefficients of friction, offer high resilience and impact resistance, and feature a long wear life.

"Thordon's track record in Rolls-Royce propulsion systems has been exceptional," says Duwel. "That's why they continue to specify Thordon in the systems they supply to their most important customers."

Here are just a few recent examples.

Thordon SXL water lubricated journal bearings are being used on waterjets from Rolls-Royce in a number of ships:

- YS2000 Visby Class 73 m Stealth Corvettes for the Swedish Navy - the first ships in the world to have fully developed stealth technology.



Swedish Navy YS2000 Visby Class Corvette

- A 210 ton carrying capacity ferry for Techno-Seaways of Japan. This vessel will be used to transport up to 700 passengers and cargo between Tokyo and the Ogasawara Islands.

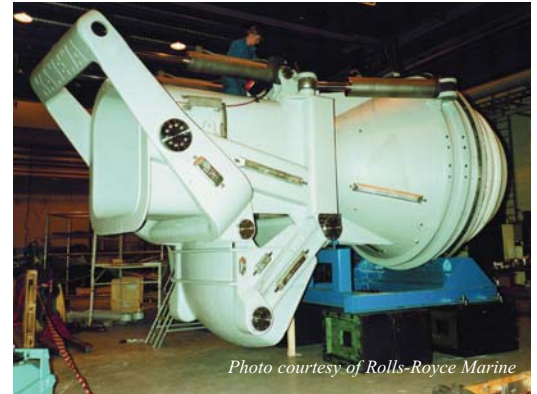


Photo courtesy of Rolls-Royce Marine

Very Large Waterjet

Thordon COMPAC is the pollution-free water lubricated propeller shaft bearing of choice for a number of new vessels featuring Rolls-Royce systems:

- KBV 201 & 202 class multi-purpose patrol ships for the Swedish Coast Guard. To meet the demanding operational criteria, the propulsion design concept was evaluated at the Rolls-Royce Hydrodynamic Research Centre in Kirstinehamn, Sweden.
- Thordon COMPAC has been used by Rolls-Royce on over 10 different Navies, primarily in the Far East.
- Three new multipurpose container vessels currently being built at the Bodewes Shipyard in The Netherlands.
- New large tugs for the Bharati Shipyard - the largest private shipbuilder in India.
- New pusher tugs currently under construction at EISA Shipyard in Brazil.

It all comes down to trust. "We have had a good track record with the bearings," says Pahnke. "And there have never been any problems working with either Thordon or Duwel Tecno."

Obviously, one great name deserves another. 

# COMPOSITE BECOMING THE BEARING OF CHOICE FOR CUTTERHEAD DREDGES



**Recently Built Jumbo Dredger, D'Artagnan, Owned By Société De Dragage International Of France Equipped With Thordon Composite Cutterhead Shaft Bearings And Intermediate Lineshaft Bearings**

Thordon Composite cutterhead shaft bearings have been recently installed or ordered on six cutter suction dredgers in Europe, China and the Middle East.

Thordon Composite is a tough two-component elastomeric polymer alloy bearing specifically formulated to provide superior wear life in very abrasive water conditions. Thordon Composite bearings operating in

combination with a hard stainless steel shaft or hard coated shaft liner such as Ni-Cr-B, routinely outwear rubber bearings by a factor of two or more, significantly reducing maintenance downtime and costs over the operating life of the dredge.

"Archirodon Dredging Construction (Overseas) Co. S.A, of United Arab Emirates has been using Thordon

Composite dredge bearings since 1999 and they have performed better than we expected", says Panos Zoglopitis, Mechanical Engineer for Archirodon Dredging Division. "These bearings last longer than rubber bearings. We have installed Thordon Composite on *CSD Pontos* and *CSD Aetos* and plan to continue using Thordon Composite bearings and staves."

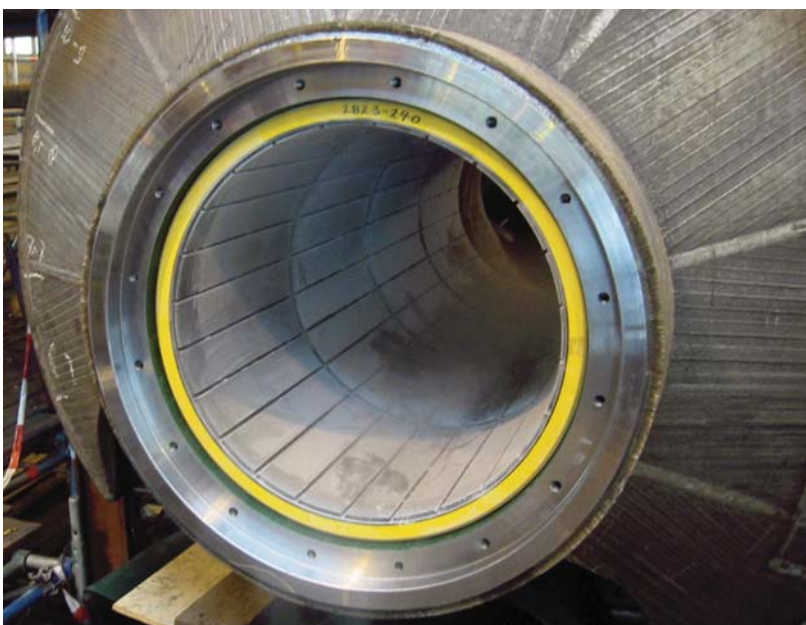
Other Cutter Suction Dredgers to be equipped or having had Thordon installed recently, include *Zeeland II*



**Thordon Composite Intermediate Lineshaft Bearing For CSD D'Artagnan**

owned by Van Oord Ship Management B.V., Netherlands, *Huta Sete 07* owned by Huta-Sete Marine Works Ltd., Saudi Arabia, *Jin Hang Jun 215* owned by Tianjin Waterway Bureau, China and *CSD 8060* owned by Jan de Nul of Belgium. National Marine Dredging Company of U.A.E has also been using Thordon Composite dredge bearings since 1996 with installations on five of their dredgers.

The recently built jumbo dredger, *D'Artagnan*, owned by S.D.I. S.A. (Société De Dragage International), France, also has water lubricated Thordon Composite intermediate lineshaft bearings installed in addition to the Composite cutterhead shaft bearings.



**Thordon Composite Cutterhead Shaft Bearing**

# COMPOSITE A KEY COMPONENT OF THE MOST ADVANCED DREDGER IN WORLD

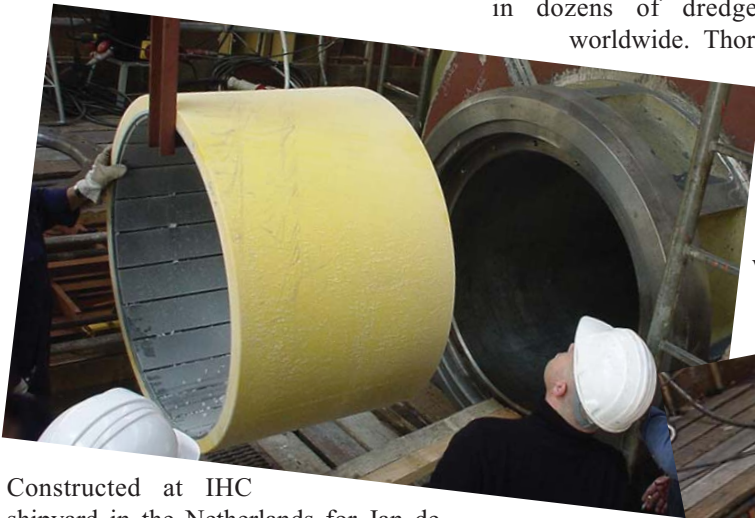
When Caesar conquered Egypt in 48 B.C., he used dredgers to clear the way for his ships into the Alexandra Harbour. No one knows for sure what these dredgers looked like or how they worked. We can speculate, however, that if the Roman engineers who built them could see into the future, they would be astonished by the size and power of the *J.F.J. de Nul*.

extreme underwater forces and unpredictable torque peaks. The *J.F.J. de Nul* needed a cutterhead bearing that not only performs well, but also has a long wear life in dirty, sandy water.”

Introduced in 1977, Thordon Composite was first installed as a cutterhead bearing on the dredger, *Gouda*. Since that time the product has been installed in dozens of dredger applications worldwide. Thordon Composite

*J.F.J. de Nul* was huge. So, to accommodate the need for both ease-of-maintenance and portability, the Thordon Composite bearing was engineered into five, 695 mm (27”) long bearing tube segments. Each was shipped to the construction location, placed in dry ice, then inserted one by one into the 1080 mm (42.4”)-cutterhead housing. “At installation, there was a 3 mm to 4 mm (0.1181” to 0.1574”) gap left between the frozen bearing segments so that as the bearings reached ambient temperature, they would have room to expand and fit in place,” says Butzelaar.

Although the overall size of the cutter bearing is the largest ever for a dredger,



performs reliably in highly loaded and abrasive laden water conditions - its wear life is



Thordon Composite bearing freeze-fit installation on *J.F.J. de Nul* cutterhead drive shaft

Constructed at IHC shipyard in the Netherlands for Jan de Nul of Belgium, the *J.F.J. de Nul* is the most advanced self-propelled cutter suction dredger ever built. Her 6,000kW cutter drive, 30% more powerful than cutters currently in use, is capable of dredging from a depth of 6.5 m to 35 m (21 ft. to 115 ft.). According to IHC, the vessel incorporates the latest advances into dredging systems, engineering, and materials technology.

typically twice that of rubber or more.

“Dredge vessels often work in remote locations, dredging new ports and waterways,” says Butzelaar. “They can often be hundreds of miles away from an airport or commercial port where a bearing can be replaced. That’s why reliability and long wear life is so crucial.”

These advances included specifying Thordon Composite as the bearing material for the 950 mm (37.4”) diameter cutterhead drive shaft.

each individual segment weighs a manageable 258 kg (570 lbs.). The smaller bearing tubes are easier to transport and, if necessary, easy to stow aboard the *J.F.J. de Nul*.

“Thordon was selected for a number of reasons,” says Marc Butzelaar, Sales Manager for Sandfirden Technics BV, a Netherlands-based company that, in addition to being a Thordon Distributor, specializes in engineered products for industrial and marine applications. “Dredging systems are exposed to

Portability is also an issue. Because dredgers can work in isolated areas around the globe, they must stow most of the materials they need for maintenance and repair onboard. At 958 mm (38”) ID x 1084 mm (42.7”) OD x 3475 mm (136.8”) long, the required size of the cutter bearing for the

Advanced materials like Thordon Composite are enabling dredge vessels to operate more productively with less down time. Sea trails for *J.F.J. de Nul* are planned to be completed by the end of November and handed over to Jan de Nul in the spring of 2004.

**THORDON IMPROVES HYDROELECTRIC EFFECIENCIES...**

Thordon non-metallic bearings are the recognized choice of hydroelectric power producers for long life, low friction bearing systems. These pollution-free bearings function well whether sealed and dry or immersed in water.


A testament to the durability and flexibility of Thordon bearings in hydroelectric applications is Mercer Construction Company, Inc. (MCC), an operations and maintenance company that does extensive municipal and third-party work. Since 1991, MCC has installed five Thordon bearings at hydroelectric plants throughout upstate New York.

"We have a consistent operating history with Thordon," says MCC's president, Dave Crandell. "We just hadn't gotten the service life we wanted out of the rubber turbine marine bearings that we were using. The Thordon bearings have reduced

our downtime and operating costs."

MCC has teamed up with Thordon Distributor Johnson Packings, to install Thordon bearings with shaft diameters ranging from 355mm to 900mm (14" to 36") and lengths up to 1820mm (72"), in both horizontal and vertical applications. A Thordon main guide bearing that was installed at Fourth Branch on the Mohawk River in 1991 performs as well today as it did nearly 10 years ago. In this horizontal application, it is important to maintain a water film in uniform surface contact, and rubber bearings that were formerly used wore out in three to four years. Crandell reports that the more durable Thordon bearing has already proven to last three times as long as any rubber bearing. In another application, a Thordon bearing has held up for more than seven years, while the grease-lubricated Babbitt bearings that were

formerly used only lasted about a year and a half each.

"With Thordon, we got a much longer service life and extended our dewatering schedule from one to three years," Crandell said. "These bearings are just more reliable." 

Thordon SXL Main Guide Bearing



## Commercial Seawater Lubricated Propeller Shaft Bearing References

Vessel Name	Vessel Type	Tonnes (DWT)	Ship Owner	Grade	Initial Install Date	Shipyard	Shaft Diameter (mm)
<i>Captain Kurbatskiy</i>	Ro-Ro	19,493	Azia Shipping Holding	XL	Feb -2006	China	1,050
<i>Polar Sea</i>	Ice Breaker		U.S. Coast Guard	XL	Jul -1983	Lockheed Shipbuilding, Seat U.S.A.	922
<i>Polar Star</i>	Ice Breaker		U.S. Coast Guard	XL	Jul -1984	Lockheed Shipbuilding Co. U.S.A.	914
<i>Gemmata</i>	LNG Tanker	72,740	Shell International (STASCO)	XL	Mar -2004	Mitsubishi Heavy Industries Japan	840
<i>Terry Fox</i>	Ice Breaker	7,100	Canadian Coast Guard	XL	Aug -1994	Halifax Shipyard Ltd. Canada	836
<i>50 let Pobedy</i>	Ice Breaker		Atomflot	XL	Jun -1993	Baltic Shipping Co. Russia	830
<i>Sovetskiy Soyuz</i>	Ice Breaker		Murmansk Ship Co.	XL	Aug -1997	Murmansk Shipyard Russia	830
<i>Arktika</i>	Ice Breaker		Murmansk Ship Co.	XL	Mar -1992	Murmansk Shipyard Russia	830
<i>Rossiya</i>	Ice Breaker		Murmansk Ship Co.	XL	Sep -1997	Murmansk Shipyard Russia	830
<i>Shasta</i>	Supply Vessel	19,940	U.S. Navy MSC	XL	Jul -2006	BAE U.S.A.	803
<i>Kiska</i>	Supply Vessel	19,940	U.S. Navy MSC	XL	Jun -2008	U.S.A.	803
<i>USNS Flint</i>	Supply Vessel	19,940	U.S. Navy MSC	XL	Aug -1996	Norshipco U.S.A.	803
<i>Yulgaok Yi I</i>	Destroyer		Korean Navy	XL	May -2010	Hyundai, Ulsan South Korea	760

## Commercial Seawater Lubricated Propeller Shaft Bearing References

Vessel Name	Vessel Type	Tonnes (DWT)	Ship Owner	Grade	Initial Install Date	Shipyard	Shaft Diameter (mm)
<i>Sejong the Great</i>	Destroyer		Korean Navy	XL	May -2007	Hyundai, Ulsan South Korea	760
<i>Alan Shepard</i>	Container/Dry Cargo	19,159	U.S. Navy MSC	COMPAC	Jun -2007	NASSCO U.S.A.	744
<i>Matthew C. Perry</i>	Container/Dry Cargo	16,000	U.S. Navy MSC	COMPAC	Aug -2009	NASSCO U.S.A.	744
<i>Richard E. Byrd</i>	Container/Dry Cargo	19,227	U.S. Navy MSC	COMPAC	Nov -2007	NASSCO U.S.A.	744
<i>Wally Schirra</i>	Container/Dry Cargo	16,000	U.S. Navy MSC	COMPAC	May -2009	NASSCO U.S.A.	744
<i>Charles Drew</i>	Container/Dry Cargo	16,000	U.S. Navy MSC	COMPAC	Jul -2010	NASSCO U.S.A.	744
<i>Lewis And Clark</i>	Container/Dry Cargo	18,973	U.S. Navy MSC	COMPAC	Mar -2006	NASSCO U.S.A.	744
<i>Carl Brashear</i>	Container/Dry Cargo	16,000	U.S. Navy MSC	COMPAC	Apr -2009	NASSCO U.S.A.	744
<i>Washington Chambers</i>	Container/Dry Cargo	16,000	U.S. Navy MSC	COMPAC	Feb -2010	NASSCO U.S.A.	744
<i>William McLean</i>	Container/Dry Cargo	16,000	U.S. Navy MSC	COMPAC	Feb -2010	NASSCO U.S.A.	744
<i>Sacagawea</i>	Container/Dry Cargo	19,000	U.S. Navy MSC	COMPAC	Feb -2007	NASSCO U.S.A.	744
<i>Robert E. Peary</i>	Container/Dry Cargo	16,000	U.S. Navy MSC	COMPAC	Jun -2008	NASSCO U.S.A.	744
<i>Amelia Earhart</i>	Container/Dry Cargo	16,000	U.S. Navy MSC	COMPAC	Nov -2008	NASSCO U.S.A.	744

## Thordon Turret Bearing References

Vessel Name	Tonnes (DWT)	Ship Owner	Owner Country	Application	Grade	Shaft Diameter (mm)	Install Date
<i>Petrojarl Banff</i>	20,800	Teekay Corp	Canada	Turret Bearings	SXL	8,710	Jul -1998
<i>Espoir Ivoirien</i>	132,500	Prosafe ASA	Norway	Turret Bearings	SXL TRAXL	8,500	Jan -2001
<i>FPSO Petrojarl Cidade de Itajai</i>	273,187	PETROBRAS	Brazil	Turret Bearings	SXL	8,320	Jul -2008
<i>Golar Frost</i>	79,984	OLT Offshore LNG Toscana SpA	Italy	Turret Bearings	SXL	5,050	Dec -2009
<i>FPSO Ningaloo Vision</i>	101,832	Prosafe SE	Singapore	Turret Bearings	SXL	4,930	Aug -2008
<i>FPSO Polvo</i>	247,131	Prosafe SE	Singapore	Turret Bearings	SXL	4,930	Aug -2006
<i>FPSO Umuroa</i>	119,990	Prosafe SE	Singapore	Turret Bearings	SXL	4,930	Aug -2006
<i>FPSO Firenze</i>	110,000	Saipem	Italy	Turret Bearings	SXL	4,466	Oct -2010
<i>Betatank II</i>	110,371	Saipem	Italy	Turret Bearings	SXL	4,456	Dec -2009
<i>Fanwah</i>	135,514	CMB SA	Belgium	Turret Bearings	SXL	4,120	Jan -2002
<i>Statoil - Lufeng</i>	101,832	Statoil - Lufeng	Norway	Turret Bearings	SXL	2,980	Jul -1996
<i>Ruby Princess</i>	140,905	PETROVIETNAM	Vietnam	Turret Bearings	SXL TRAXL	2,265	Jul -1998

## Thordon Offshore Stern Roller Bearing References

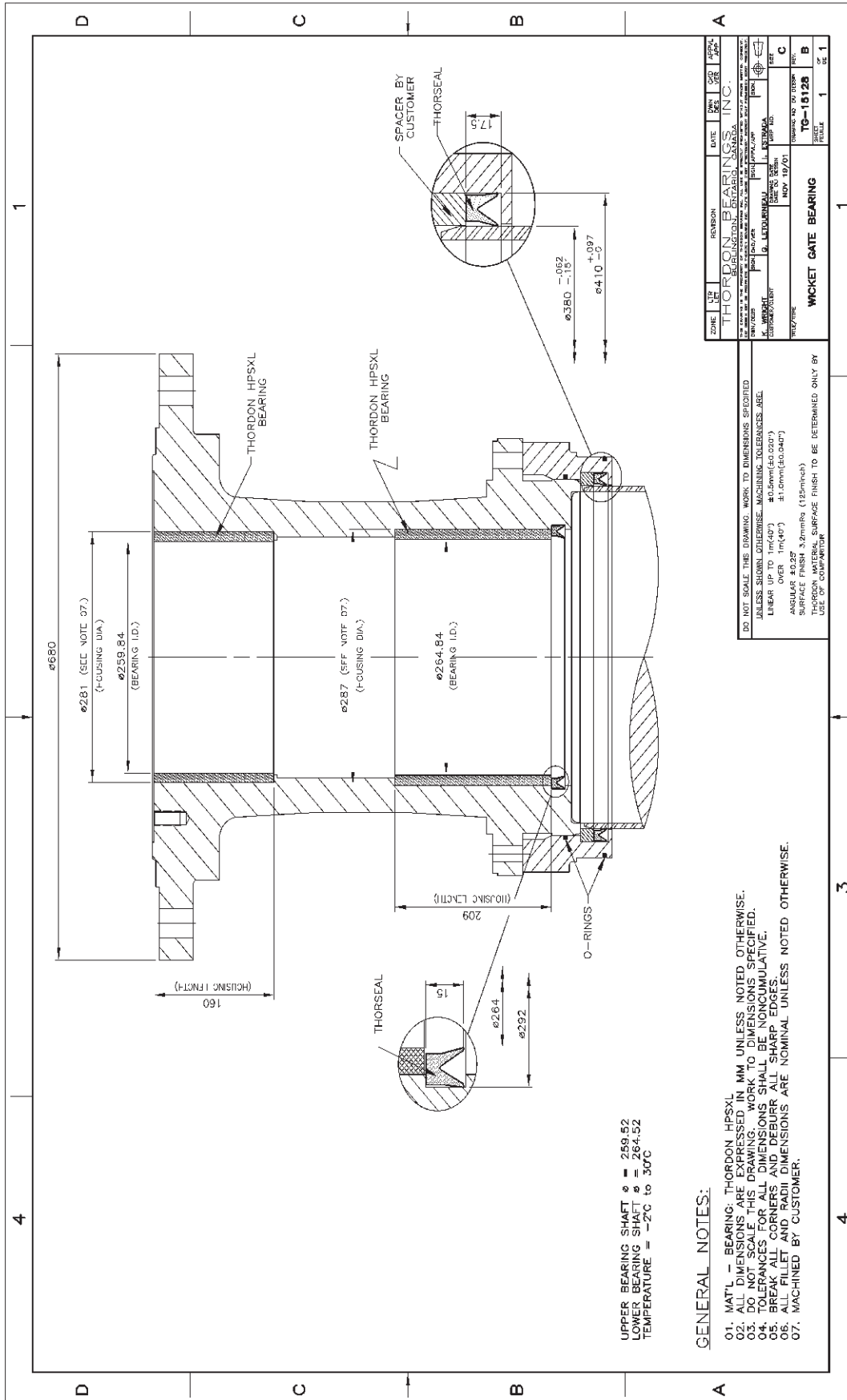
Vessel Name	Vessel Type	Tonnes (DWT)	Ship Owner	Shipyard	Application	Grade	Shaft Diameter (mm)	Install Date
Maersk Lancer	Anchor Handling Tug Supply (AHTS)		Moller AP Denmark	Volkswertf Stralsund Germany	Stern Roller Bearing	SXL	1,960	May -2010
Maersk Achiever	Anchor Handling Tug Supply (AHTS)	4,577	A.P. Moller Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,860	Dec -2002
Maersk Advancer	Anchor Handling Tug Supply (AHTS)	4,614	A.P. Moller Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,860	Feb -2003
Maersk Asserter	Anchor Handling Tug Supply (AHTS)	4,597	A.P. Moller Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,860	Jan -2003
Maersk Attender	Anchor Handling Tug Supply (AHTS)	5,010	A.P. Moller Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,860	Jan -2000
Maersk Winner	Anchor Handling Tug Supply (AHTS)	3,400	A.P. Moller Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,860	Jan -2003
Maersk Detector	Anchor Handling Tug Supply (AHTS)	4,028	Moller AP Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,825	Jun -2006
Maersk Dispatcher	Anchor Handling Tug Supply (AHTS)	4,028	Moller AP Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,825	Oct -2005
Maersk Lancer	Anchor Handling Tug Supply (AHTS)		Moller AP Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,825	May -2010
Maersk Laser	Anchor Handling Tug Supply (AHTS)		Moller AP Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,825	Jul -2010
Maersk Launcher	Anchor Handling Tug Supply (AHTS)		Moller AP Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,825	Jan -2010
Maersk Leader	Anchor Handling Tug Supply (AHTS)	4,028	Moller AP Denmark	Volkswertf Stralsund GmbH Germany	Stern Roller Bearing	SXL	1,825	Jul -2009

## Thordon Hydro Turbine - Main Guide Bearings

Thordon Grade	Company	Power/Dam Station	Country	Max. Head (M)	Shaft Diameter (mm)	Type of Turbine	Direction	MW	Initial Installation Date
SXL	LMZ	Krasnoyarskaya	Russia	124	2,390	Francis	Vertical	6000	Jun -2001
SXL	LMZ	Krasnoyarskaya	Russia	124	2,390	Francis	Vertical	6000	Jul -2002
SXL	LMZ	Krasnoyarskaya	Russia	124	2,390	Francis	Vertical	6000	Jun -2005
SXL	LMZ	Krasnoyarskaya	Russia	124	2,390	Francis	Vertical	6000	Jun -2006
SXL	LMZ	Krasnoyarskaya	Russia	124	2,390	Francis	Vertical	6000	Aug -2003
SXL	Hydro Engineering	Resita Power Station			1,992				Oct -2011
SXL	LMZ	Sayano-Shushenskaya	Russia		1,970		Vertical		Jan -2001
SXL	LMZ	Volga	Russia		1,520		Vertical		Mar -2004
SXL		Volzhskaya HPP			1,520				Sep -2004
SXL		Zeiskaya		80	1,420	Kaplan		225	Apr -2004
SXL		Kolymskaya		100	1,420	Kaplan		180	Nov -2004
SXL		Volzhskaya			1,100				Nov -2003
GM2401	LMZ	Narva Hydro Power Station	Russia	18	955	Kaplan	Vertical	40	Jun -2000

## Thordon ThorPlas Hydro Turbine Bearings

Application	Company	Power/Dam Station	Country	Max Head (M)	MW	Shaft Diameter (mm)	Type of Turbine	Direction	Initial Installation Date
Wicket Gate Bearings	Dongfang Electrical Machinery	Manwan	China		250	340	Francis		Feb -2006
Wicket Gate Bearings	Seattle City Light	Boundary Hydroelectric Plant	U.S.A.		1050	296	Francis	Vertical	Dec -2010
Wicket Gate Bearings		Boundary Hydro Electric Plant	U.S.A.			296			Dec -2010
Runner Blade Trunnion Bearings	Alabama Electric	Gantt Hydro, No. 4	U.S.A.		3	282	Kaplan		Sep -2004
Wicket Gate Bearings	Endesa	Pangué	Chile	99	460	280	Francis	Vertical	Mar -2008
Wicket Gate Bearings	Harbin Electric Machinery Co. Ltd.	Baishan Hydro Generating Station	China		1500	260	Francis		Jul -2005
Servomotor Bearing	Xcel Energy	Chippewa Falls	U.S.A.			229			Mar -2006
Operating Mechanism/Linkage Bearings	Exel Energy		U.S.A.			229			Mar -2006
Wicket Gate Bearings		Seitenoikea	Finland	35		220			Sep -2008
Wicket Gate Bearings	SMUD	Camino	U.S.A.	40	154	213	Pelton	Vertical	Oct -2010
Control Gate Unit		Stânca-Costesti Hydroelectrical Plant	Romania			180		Vertical	Sep -2011
Wicket Gate Bearings	Pacific Gas & Electric	Butt Valley	U.S.A.	28	40	172			Feb -2007
Butterfly Valves	GE Hydro		Sweden			170			Dec -2007
Wicket Gate Bearings		Vaduri Power Station	Romania		22	170	Kaplan		Feb -2010
Wicket Gate Bearings	Harbin Electric Machinery Co. Ltd.	Malutangll	China	380	135	160	Francis		Mar -2008
Connecting Rod Bushing	SMUD	SMUD-Fresh Pond Maint. Facility	U.S.A.			150			Dec -2008



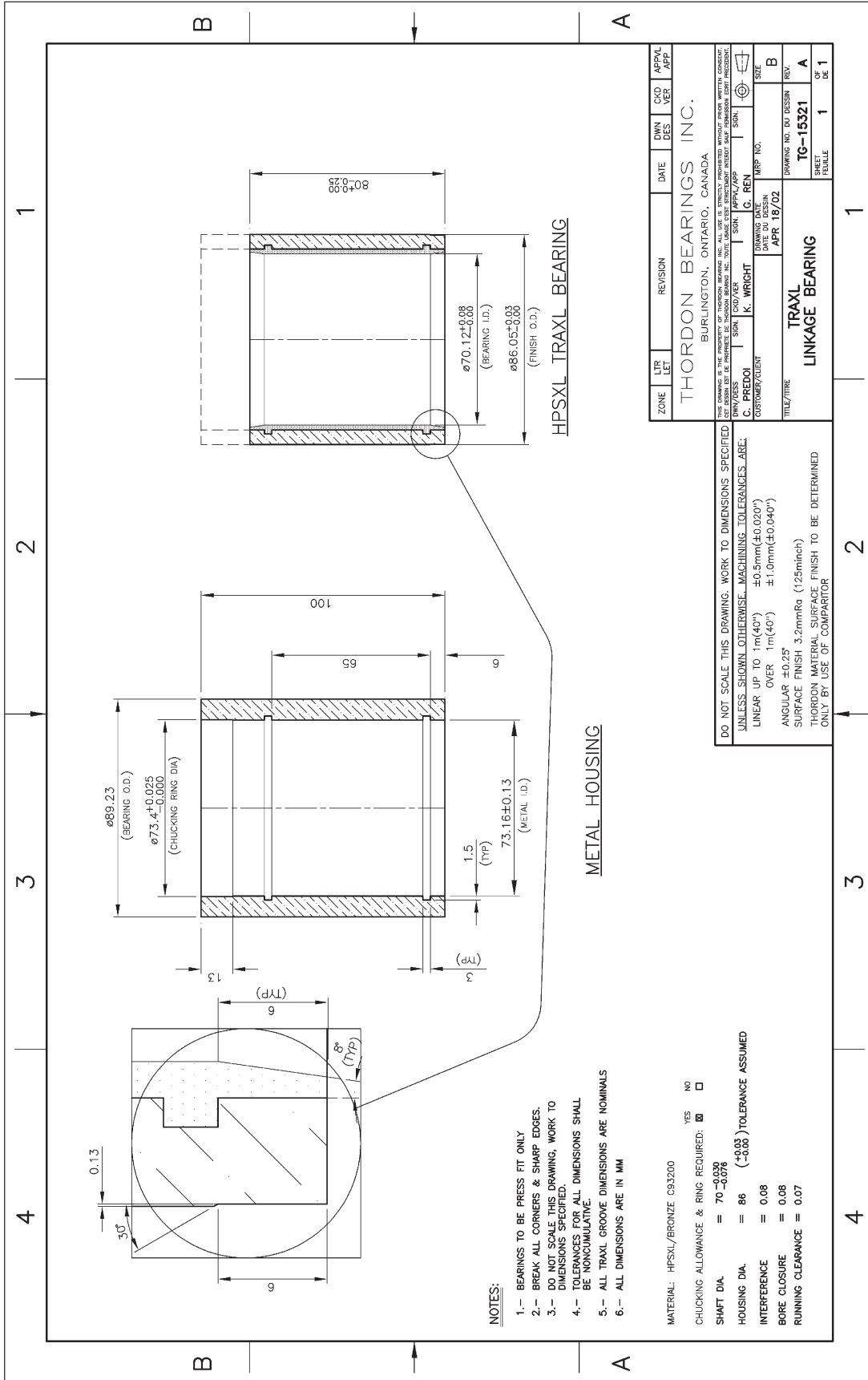
UPPER BEARING SHAFT  $\phi = 259.52$   
 LOWER BEARING SHAFT  $\phi = 264.52$   
 TEMPERATURE =  $-2^{\circ}\text{C}$  to  $30^{\circ}\text{C}$

**GENERAL NOTES:**

- 01. MAT'L - BEARING: THORDON HPSXL
- 02. ALL DIMENSIONS ARE EXPRESSED IN MM UNLESS NOTED OTHERWISE.
- 03. DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED.
- 04. TOLERANCES FOR ALL DIMENSIONS SHALL BE NONCUMULATIVE.
- 05. BREAK ALL CORNERS AND DEBURR ALL SHARP EDGES.
- 06. ALL FILLET AND RADIUS DIMENSIONS ARE NOMINAL UNLESS NOTED OTHERWISE.
- 07. MACHINED BY CUSTOMER.

DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED UNLESS SHOWN OTHERWISE. MACHINING TOLERANCES ARE:  
 LINEAR UP TO 1mm (40")  $\pm 0.025\text{mm} (\pm 0.001")$   
 LINEAR UP TO 1mm (40")  $\pm 0.050\text{mm} (\pm 0.002")$   
 ANGULAR 40.25°  $\pm 0.10\text{mm} (\pm 0.004")$   
 SURFACE FINISH 3.2mmRa (125-micro)  
 THORDON MATERIAL SURFACE FINISH TO BE DETERMINED ONLY BY USE OF COMPASSIONATOR

ZONE	REV	DATE	REVISION	DATE	REV	DESCRIPTION
<b>THORDON BEARINGS INC.</b> 1000 WILSON AVENUE, SUITE 100, WILSON, ONTARIO, CANADA TEL: (905) 709-1111 FAX: (905) 709-1112 WWW.THORDONBEARINGS.COM						
DESIGNED BY	DRW NO.	DATE	REVISED BY	REV NO.	DATE	DESCRIPTION
K. WRIGHT	1	NOV 19/01	G. LEONARDI	1	NOV 19/01	QUANTITY OF ORDER
CHECKED BY	APP'D BY					
<b>WCKET GATE BEARING</b>						<b>TG-18128</b> SHEET 1 OF 1



- NOTES:**
- 1.- BEARINGS TO BE PRESS FIT ONLY
  - 2.- BREAK ALL CORNERS & SHARP EDGES.
  - 3.- DO NOT SCALE THIS DRAWING, WORK TO DIMENSIONS SPECIFIED.
  - 4.- TOLERANCES FOR ALL DIMENSIONS SHALL BE NONCUMULATIVE.
  - 5.- ALL TRAXL GROOVE DIMENSIONS ARE NOMINALS
  - 6.- ALL DIMENSIONS ARE IN MM

MATERIAL: HPSXL/BRONZE C93200

CHUCKING ALLOWANCE & RING REQUIRED:	YES	NO
SHAFT DIA.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
HOUSING DIA.	<input type="checkbox"/>	<input checked="" type="checkbox"/>
INTERFERENCE	<input type="checkbox"/>	<input checked="" type="checkbox"/>
BORE CLOSURE	<input type="checkbox"/>	<input checked="" type="checkbox"/>
RUNNING CLEARANCE	<input type="checkbox"/>	<input checked="" type="checkbox"/>

**METAL HOUSING**

**HPSXL TRAXL BEARING**

DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED. UNLESS SHOWN OTHERWISE, MACHINING TOLERANCES ARE:  
 LINEAR UP TO 1m(40') ±0.5mm(±0.020")  
 OVER 1m(40') ±1.0mm(±0.040")  
 ANGULAR ±0.25'  
 SURFACE FINISH 3.2mmRa (125minch)  
 THORNDON MATERIAL SURFACE FINISH TO BE DETERMINED ONLY BY USE OF COMPARTOR

ZONE	LTR	REV	REVISION	DATE	DWN	DES	CHK	APP

THORNDON BEARINGS INC.  
 BURLINGTON, ONTARIO, CANADA

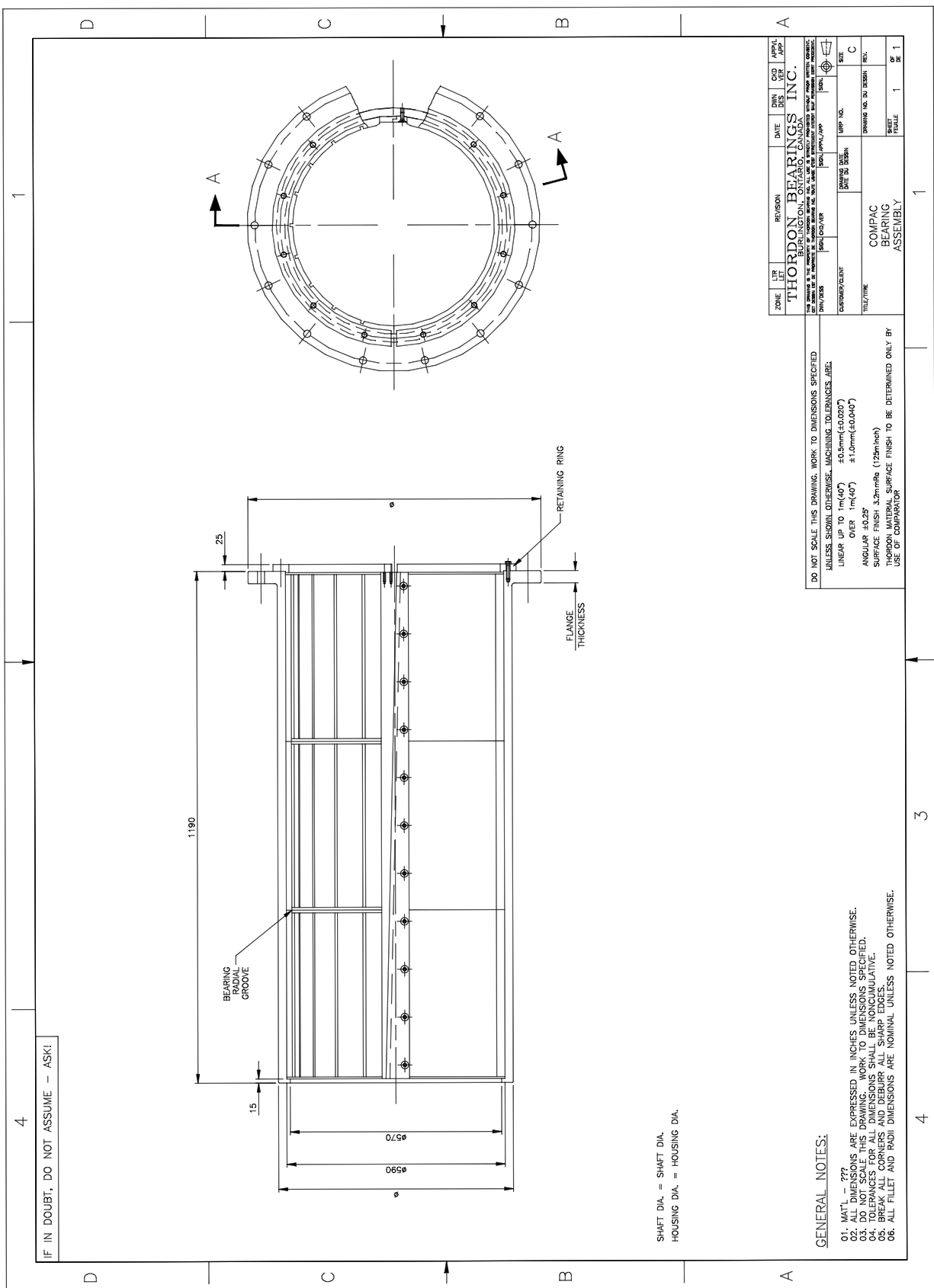
THIS DRAWING IS THE PROPERTY OF THORNDON BEARINGS INC. ALL USE IS STRICTLY PROHIBITED WITHOUT WRITTEN CONSENT. IT IS TO BE KEPT IN CONFIDENCE AND NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.

DRW/ISS	CHK	APP	DATE	MRP NO.	SIZE
C. PREDOI	K. WRIGHT		APR 18/02		B

CUSTOMER/CLIENT: G. REN

TITLE	THORNDON NO.	DWG DESGN	REV.
TRAXL LINKAGE BEARING	TG-15321		A

DATE: APR 18/02



IF IN DOUBT, DO NOT ASSUME - ASK!

SHAFT DIA. = SHAFT DIA.  
HOUSING DIA. = HOUSING DIA.

**GENERAL NOTES:**

- 01. MAT'L. = ??? ARE EXPRESSED IN INCHES, UNLESS NOTED OTHERWISE.
- 02. DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED.
- 03. DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED.
- 04. TOLERANCES FOR ALL DIMENSIONS SHALL BE NONCUMULATIVE.
- 05. BREAK ALL CORNERS AND DEBURR ALL SHARP EDGES.
- 06. ALL FILLET AND RADI DIMENSIONS ARE NOMINAL UNLESS NOTED OTHERWISE.

DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED  
UNLESS SHOWN OTHERWISE. MACHINING TOLERANCES ARE:  
LINEAR SURF. ±0.0075 (±0.0003)  
HOLE SURF. ±0.0075 (±0.0003)  
ANGULAR SURF. ±0.0075 (±0.0003)  
SURFACE FINISH: 3.2µm rms (125µin) root  
THROUGH MATERIAL SURFACE FINISH TO BE DETERMINED ONLY BY USE OF COMPACTOR

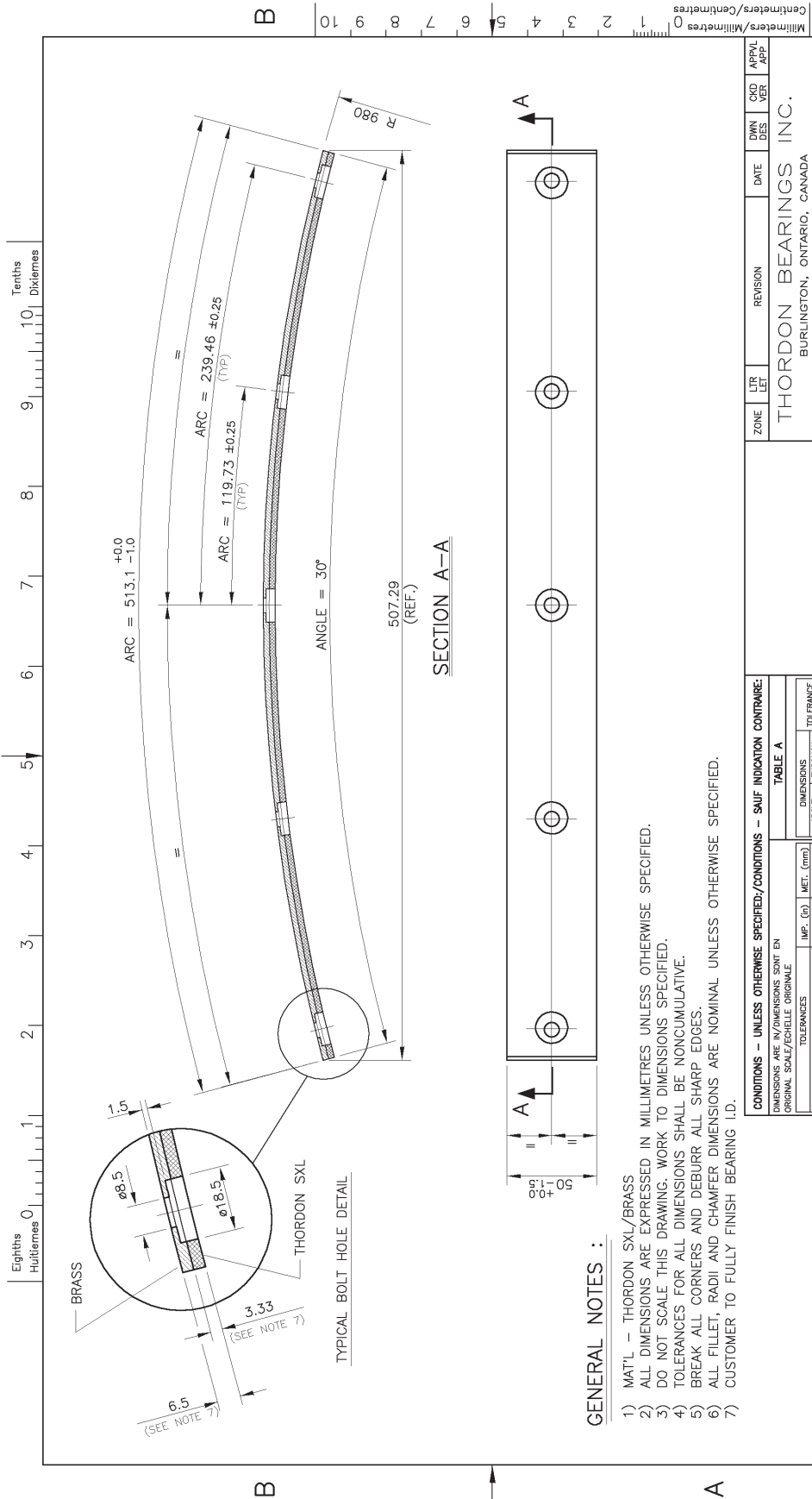
ZONE	LTR	REVISON	DATE	DWN	CHD	APP'AL

**THORNDON BEARINGS INC.**  
BURLINGTON, ONTARIO, CANADA

DRAWING NO.	REV.	DATE	BY	CHKD.
COMPAC BEARING ASSEMBLY	1			

4 1 1 3 4





SECTION A-A

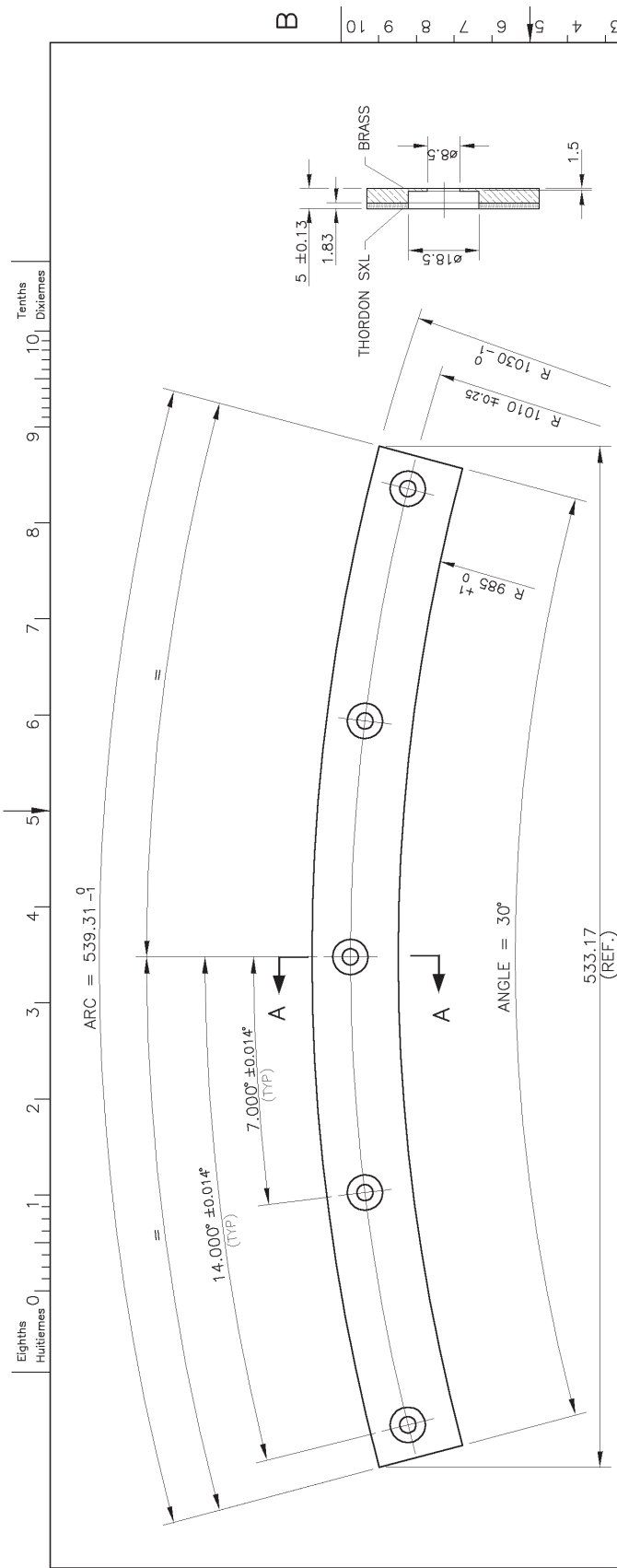
GENERAL NOTES :

- 1) MAT'L - THORDON SXL/BRASS
- 2) ALL DIMENSIONS ARE EXPRESSED IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
- 3) DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED.
- 4) TOLERANCES FOR ALL DIMENSIONS SHALL BE NONCUMULATIVE.
- 5) BREAK ALL CORNERS AND DEBURR ALL SHARP EDGES.
- 6) ALL FILLET, RADI AND CHAMFER DIMENSIONS ARE NOMINAL UNLESS OTHERWISE SPECIFIED.
- 7) CUSTOMER TO FULLY FINISH BEARING I.D.

CONDITIONS - UNLESS OTHERWISE SPECIFIED/CONDITIONS - SAUF INDICATION CONTRAIRE:		TABLE A	
DIMENSIONS ARE IN DIMENSIONS SONT EN ORIGINAL SCALE/ÉCHELLE ORIGINALE		DIMENSIONS SONT EN ÉCHELLE D'ORIGINE	
TOLERANCES	IMP. (in)	MET. (mm)	TABLE A
SURFACE FINISH/FINIS DE SURFACES	± 0.1	± 0.1	± 0.1
DECIMAL/DECIMALE - 1 PLACE (X.0)	± 0.015	± 0.015	± 0.3
DECIMAL/DECIMALE - 2 PLACES (X.00)	± 0.005	± 0.005	± 0.1
DECIMAL/DECIMALE - 3 PLACES (X.000)	± 0.001	± 0.001	± 0.03
FRACTIONAL	± 1/64	± 1/64	± 1.2
ANGULAR DECIMAL/ANGULAIRE DECIMALE	± 1/64	± 0.4	± 2
FLAME CUTTING, SHEARING, NIBBLING, PLASMA CUTTING, WATERJET CUTTING, FORMING AND WELDING	± 1/16	± 1.6	± 4
FORGEAGE ET Soudure AUTORENE			± 5

ZONE	LTR LET	REVISION	DATE	DWN DES	CKD VER	APPL APP
THORDON BEARINGS INC. BURLINGTON, ONTARIO, CANADA						
DWN/DESS	SKN/CRQ/VER	SKN/JAPPL/APP	SKN	SKN	SKN	SKN
CUSTOMER/CLIENT	DRAWING NO. DU DESSIN		DATE DU DESSIN	MRP NO.	DRAWING NO. DU DESSIN	
TITLE/TITRE	SKL VERTICAL WEAR PAD				TG-14145	
THIS IS NOT TO BE CONSIDERED AN APPROVED DRAWING UNLESS IT IS SIGNED BY THORDON BEARINGS INC. IN RED INK AND SEALED.			THIS IS NOT TO BE CONSIDERED UN APPROUVÉ SAUF SI IL EST SIGNÉ EN ROUGE PAR THORDON BEARINGS INC. EN ENCRE ROUGE ET SCELÉ.			

1 2 3 4



**GENERAL NOTES :**

- 1) MAT'L - THORDON SXL/BRASS
- 2) ALL DIMENSIONS ARE EXPRESSED IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
- 3) DO NOT SCALE THIS DRAWING. WORK TO DIMENSIONS SPECIFIED.
- 4) TOLERANCES FOR ALL DIMENSIONS SHALL BE NONCUMULATIVE.
- 5) BREAK ALL CORNERS AND DEBURR ALL SHARP EDGES.
- 6) ALL FILLET, RADII AND CHAMFER DIMENSIONS ARE NOMINAL UNLESS OTHERWISE SPECIFIED.

CONDITIONS - UNLESS OTHERWISE SPECIFIED/CONDITIONS - SAUF INDICATION CONTRAIRE:

DIMENSIONS ARE IN / DIMENSIONS SONT EN ORIGINAL SCALE / ÉCHELLE ORIGINALE	
TOLERANCES	IMP. (in)
SURFACE FINISH / FINIS DE SURFACES	150
DECIMAL / DECIMALE - 1 PLACE (x.0)	± 0.1
DECIMAL / DECIMALE - 2 PLACES (x.00)	± 0.005
DECIMAL / DECIMALE - 3 PLACES (x.000)	± 0.001
FRACTIONAL	± 1/64
ANGULAR DECIMAL / ANGULAIRE DECIMALE	± 1/64
ANGULAR FRACTIONAL / ANGULAIRE FRACTIONNAIRE	± 1/16
FLAME CUTTING, SHEARING, NEBULING, PLASMA CUTTING / COUPE AU TORCHON, DÉCOUPE À LA GÉOMÉTRIE, DÉCOUPE AU LASER	± 0.4
FORMING AND WELDING / MISE EN FORME, SOUDURE	± 1.6
FORGEAGE ET SOUDURE AUTOGÈNE	± 1.6

TABLE A	
DIMENSIONS / DIMENSIONS	TOLERANCE (mm)
6	± 0.1
30	± 0.2
100	± 0.3
300	± 0.4
1000	± 0.6
2000	± 1.0
4000	± 1.2
8000	± 1.6
12000	± 2.0
16000	± 2.5

THIS IS NOT TO BE CONSIDERED AN APPROVED DRAWING UNLESS IT IS SIGNED BY THORDON BEARINGS INC. IN RED INK AND SIGNED, SEALED AND STAMPED BY THORDON BEARINGS INC. EN ROUGE ROUGE ET SIGNÉ, SCÉLÉ ET STAMPÉ PAR THORDON BEARINGS INC. EN ROUGE ROUGE ET SIGNÉ.

ZONE	LTR	LET	REVISION	DATE	DWN	DES	APP
THORDON BEARINGS INC. BURLINGTON, ONTARIO, CANADA							
DWN/DESS	SIGN./CGR/VER	SIGN./APP/APP	SIGN./APP/APP	DATE OF DESIGN	DATE OF DESIGN	MRP NO.	SIZE
CUSTOMER/CLIENT				TITLE/TITRE		DRAWING NO. DU DESSIN	REV.
						10-14146	B
						SHEET	OF
						FEUILLE	DE

4 3 2 1

# CUSTOMER FOCUSED TO QUICKLY MEET YOUR NEEDS

## **Quick and Responsive Service**

It takes quality products to be globally successful in the marine bearing industry. It also takes great service to keep customers coming back.

Thordon Bearings Inc. is geared to respond quickly to new shipbuilding, repair and conversion projects. Thordon bearings arrive quickly, fit right and last!

## **Extensive Distribution Network**

Thordon Bearings has an extensive distribution network to supply our global customers. More than 70 distributors in 100 countries carry extensive inventories of Thordon's common bearing sizes which are backed by large regional and head office inventories. Non-standard requests are met with responsive design, quick machining and speedy delivery.

## **Application Engineering**

Thordon engineers work closely with customers to provide innovative bearing system designs and solutions. We offer in-house design, CAD and the proprietary Thordon Bearing Sizing Calculation Program to help correctly size our bearings.

Our decades of experience mean that we offer the right technical support during design, machining, installation and operation.

## **Manufacturing Quality**

Thordon Bearings Inc. is a family-owned company that operates a state-of-the-art polymer processing plant and new product development facilities in Burlington, Ontario, Canada.

We manufacture to ISO 9001:2008 Quality System requirements. Contact us for references of our installations.

## **High Performance Bearings and Shaftline Products; Industry-Leading Service**

Thordon Bearings is an industry leader in the design, manufacture, supply and installation of high performance marine bearings systems.

# THORDON

THORDON BEARINGS INC.

*A Thomson-Gordon Company - Innovating Since 1911*

ZERO POLLUTION | HIGH PERFORMANCE | BEARING SYSTEMS

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Tel: +1.905.335.1440 Fax: +1.905.335.4033

[www.ThordonBearings.com](http://www.ThordonBearings.com)