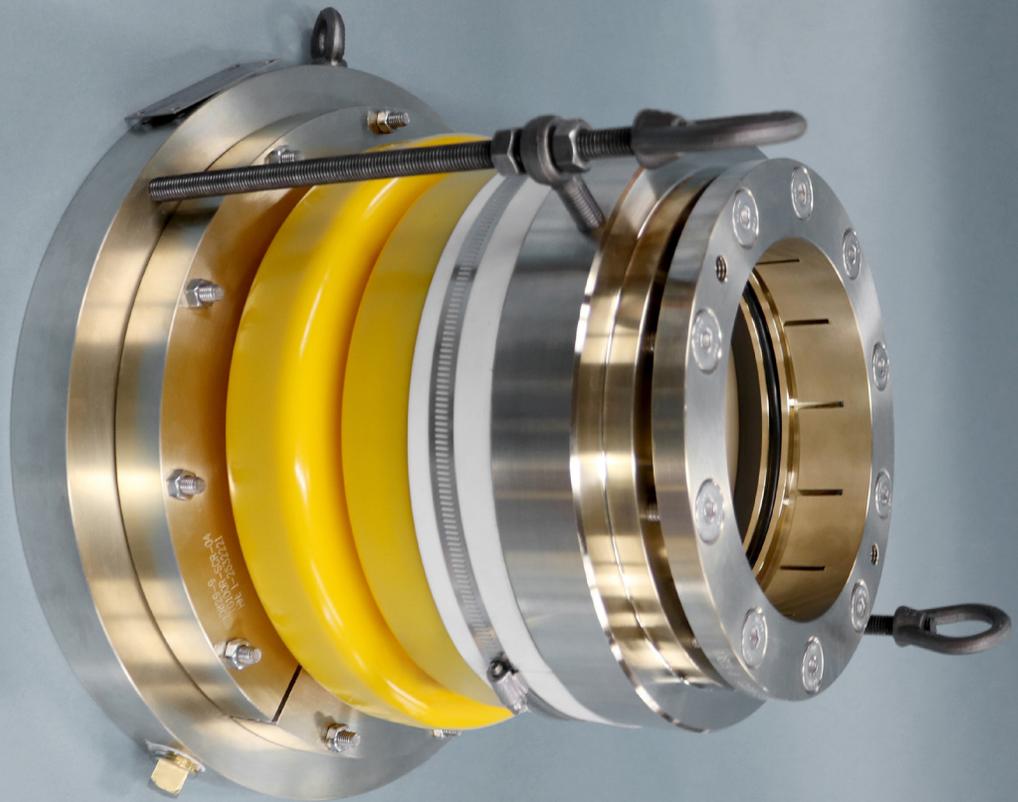


TG100r Seal

Installation & Operation Manual



THORDON
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1.0 TG100r SEAL GENERAL DESCRIPTION

The TG100r is a water-lubricated mechanical face seal preventing water leakage into the vessel located at the stationary bulkhead of the machinery space/water interface. The stationary face and rotary face of the TG100r are made out of high strength, abrasive resistant Silicon Carbide specifically selected to operate in highly abrasive water and still last the life of the vessel. With the introduction of the TG100r, workboat operators eliminate the maintenance hassles and shaft wear commonly experienced with stuffing box packing. A Safe Return to Port (SRTP) inflatable safety seal allows the vessel to return to the nearest port with low water leakage rates should the primary seal ever become damaged.

2.0 TG100r SEAL TYPICAL FACTORY SHIPMENT

Standard Parts:

- Qty.1 – Rotating subassembly with rotary face
- Qty.1 – Gasket, inflatable seal and mounting ring assembly.
- Qty.1 – Elastomeric bellows, split clamp ring and stationary face assembly.
- Qty.1 – Rotating ring, rotary face and wedge ring assembly.
- Qty.1 – Inflatable seal air control panel.
- Qty.1 – Installation toolkit.

Spare Parts Included:

- Qty.2 – Hex socket flat head cap screws to fit wedge ring.
- Qty.2 – Nyloc hex nuts and washers to fit split clamp ring.

Optional Parts:

- Adaptor plate and gasket.
A special adapter plate and gasket may be required for certain installations to match the bulkhead bolt pattern.
- Emergency repair kit for vessel in water repair.
Kit includes split stationary and rotary faces and O-rings (cord to be bonded).
- Dry dock repair kit for vessel out of water repair (shaft withdrawal).
Kit includes solid stationary and rotary faces, O-rings and rotor cushion gasket.

Items by Others (not supplied by Thordon):

- Hex socket head cap screws to fasten the mounting ring to the bulkhead.
- Lubricant, use water-based lubricant or soap & water solution.
- Isopropyl alcohol.
- Thread adhesive, use Loctite® 243 or equivalent.
- RTV silicone rubber sealant, use Work Zone® 100% Silicone Sealant or equivalent.
- Gasket sealant and dressing, use Permatex® gasket sealant and dressing or equivalent.
- Piping, hoses, fittings, valves.

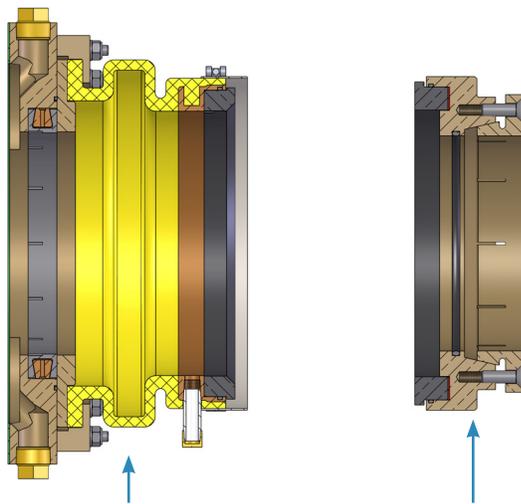


Figure 1: Stationary Seal Subassembly Rotating Subassembly

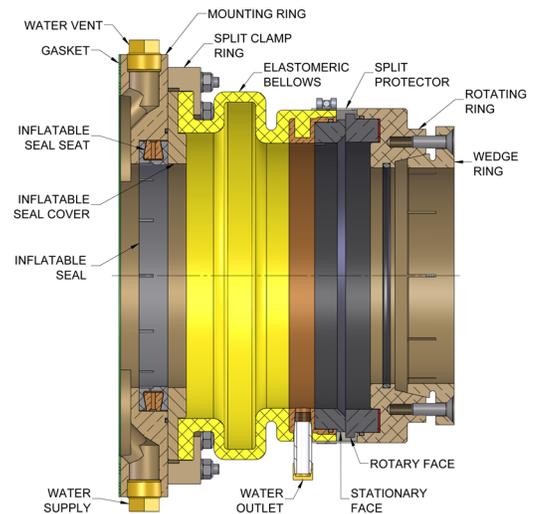


Figure 2: TG100r Seal Components and Water Ports

3.0 TG100r SEAL APPLICATION & SPECIFIED USAGE

The TG100r is designed to seal between a vessel's rotating propeller shaft and stationary bulkhead preventing water leakage into the vessel. Any other, or additional usage, shall be considered as "not specified". The "specified use" designation implies following the installation, operating and maintenance procedures described in this manual. Usage not in accordance with these procedures shall result in the loss of all warranty rights.

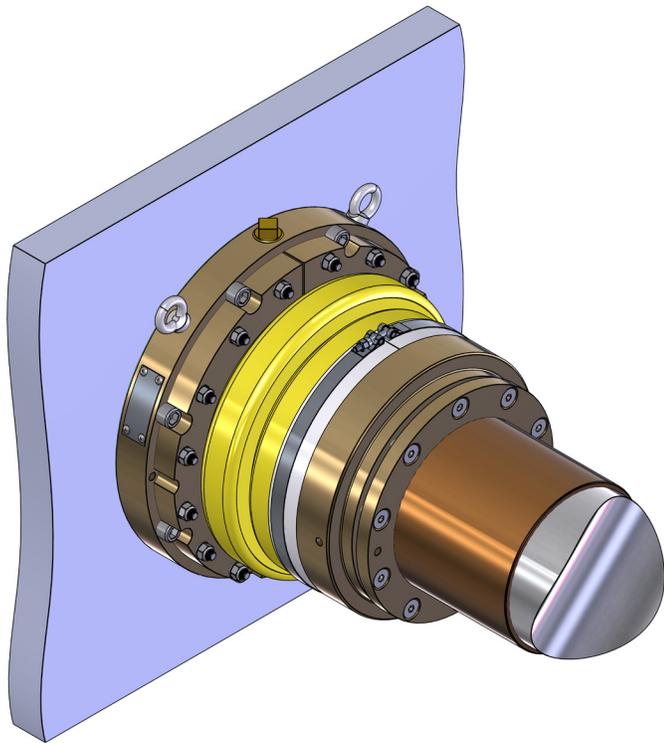


Figure 3: Typical Installation

4.0 TG100r SEAL TYPICAL INSTALLATION CONFIGURATION

The TG100r is fabricated in eight nominal sizes, from #01 to #08, per Table 1.

The TG100r is typically supplied PARTIALLY finished. The mounting ring holes must be drilled & milled by others and the gasket holes must be drilled or punched by others to match the bulkhead bolt pattern..

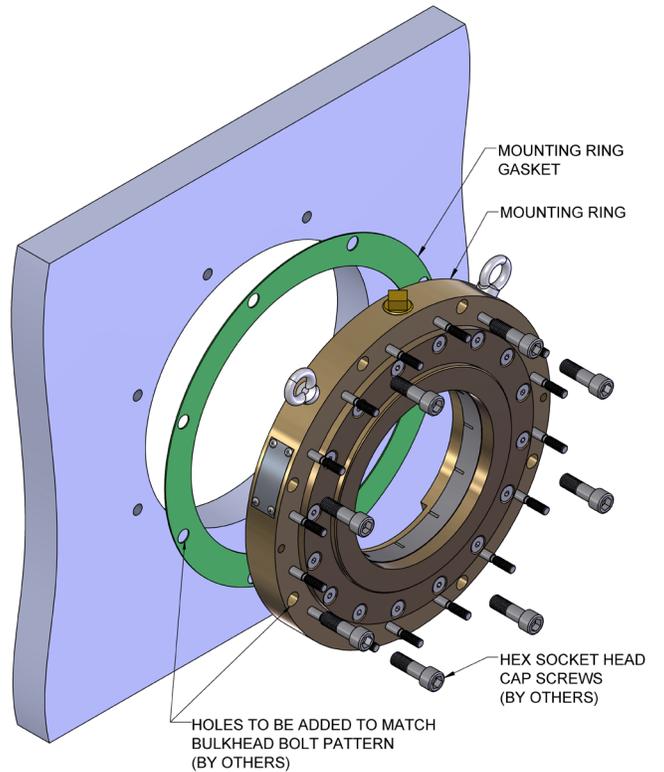


Figure 4: Mounting Ring and Gasket Drilling

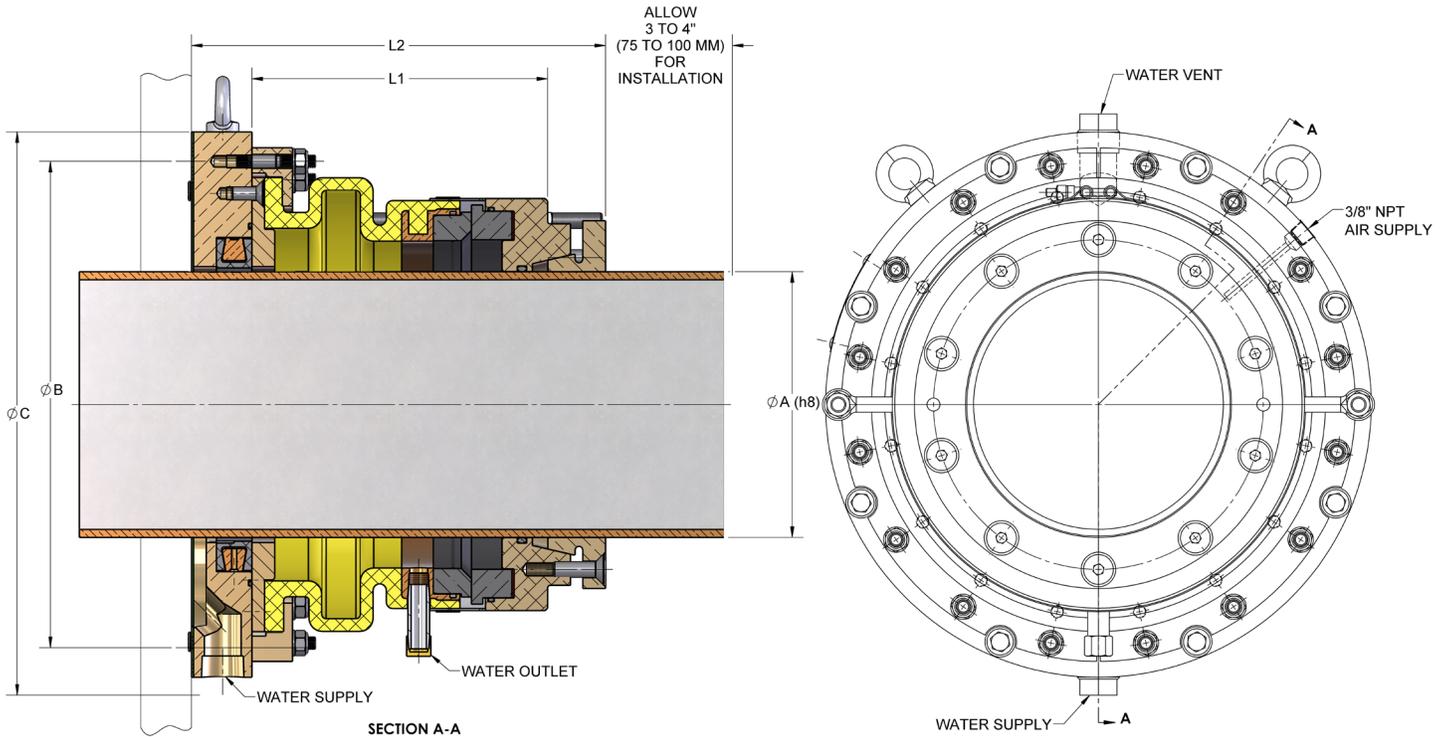


Figure 5: Sizing Dimensions and Connection Ports of Standard TG100r Seals

TG100r Seal - Sizing Dimensions Table

Seal Size	Seal Nominal Range	Shaft Diameter Range A				Installation Height L1				Installed Length L2		Mounting Ring OD C		Mounting BCD Range B				Bolt Size
		inch (+/-0.002)		mm (h8)		inch		mm		inch	mm	inch	mm	inch		mm		
Size #	inch	min	max	min	max	comp	free	comp	free	inch	mm	inch	mm	min	max	min	max	DIN912 A4-70
01	4.000	3.375	4.625	85.73	117.48	7.894	8.209	200.50	208.50	10.827	275.00	11.811	300.00	9.134	11.024	232.00	280.00	8 x M12
02	4.750	4.626	5.750	117.50	146.05	7.894	8.209	200.50	208.50	10.827	275.00	12.992	330.00	10.157	12.205	258.00	310.00	8 x M12
03	5.875	5.751	6.875	146.08	174.63	8.071	8.386	205.00	213.00	11.004	279.50	14.173	360.00	11.654	13.386	296.00	340.00	8 x M12
04	7.000	6.876	8.000	174.65	203.20	8.268	8.583	210.00	218.00	11.201	284.50	15.748	400.00	13.150	14.764	334.00	375.00	8 x M16
05	8.250	8.001	9.000	203.23	228.60	8.740	9.173	222.00	233.00	12.362	314.00	16.929	430.00	15.118	15.945	384.00	405.00	8 x M16
06	9.250	9.001	10.000	228.63	254.00	8.740	9.173	222.00	233.00	12.362	314.00	18.110	460.00	16.378	17.126	416.00	435.00	8 x M16
07	10.250	10.001	11.000	254.03	279.40	9.173	9.606	233.00	244.00	13.071	332.00	19.685	500.00	17.165	18.701	436.00	475.00	8 x M16
08	11.250	11.001	12.000	279.43	304.80	9.173	9.606	233.00	244.00	13.071	332.00	20.866	530.00	18.346	19.882	466.00	505.00	8 x M16

Contact Thordon for custom and new build mounting BCD (B)

Table 1: Sizing Dimensions

5.0 TG100r SEAL TYPICAL INSTALLATION

The TG100r mounting ring and gasket are supplied partially finished without the bulkhead bolt pattern drilled.

These items must be drilled to suit the vessel's bulkhead bolt pattern.

The TG100r rotating assembly and wedge ring are supplied to suit the shaft diameter.

After drilling and/or milling the mounting ring and gasket, the seal is ready to be fitted. For fitting, please follow procedures listed below.

Step 1:

Preparing the Equipment

- Disconnect coupling and partially withdrawal shaft prior to seal fitting. Ensure bulkhead and shaft/liner are thoroughly cleaned.
- Inspect bulkhead surface and shaft/liner to ensure they are free from rust, burrs, grit, pits or scratches. Break all sharp corners on shaft/liner steps over which O-rings must pass or seal against with a lead-on chamfer. Finish shaft/liner to $< 63 \mu\text{in}$ ($< 1.6 \mu\text{m}$).
- Successful operation and life of the seal is dependent on acceptable equipment alignment. If dimensions exceed the values shown in table 2 correct the equipment before proceeding.

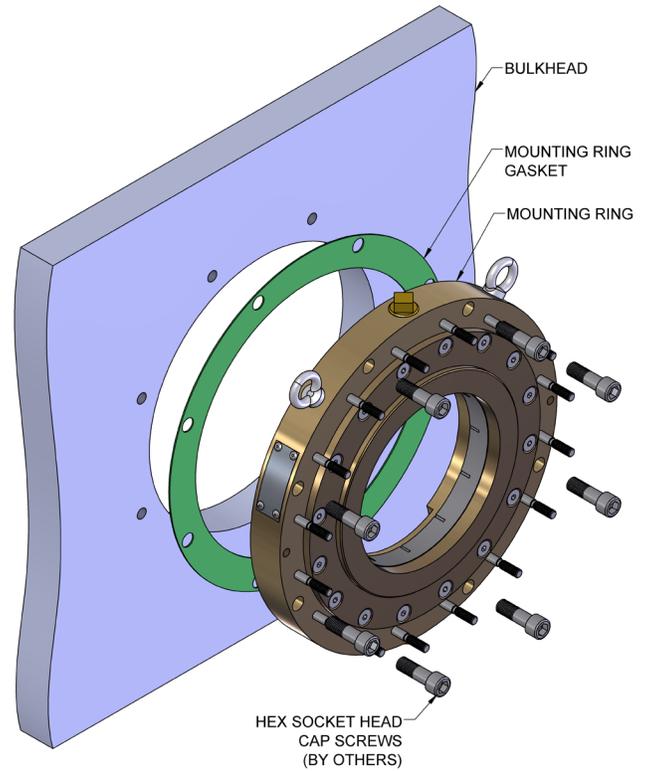
Seal Size	Shaft Diameter Range A				Shaft Out of Roundness FIM		Shaft Radial Runout FIM		Shaft Axial End Play		Bulkhead Squareness to Shaft FIM		Bulkhead Concentricity to Shaft FIM	
	inch		mm		inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
Size #	min	max	min	max										
01 to 04	3.375	8.000	85.73	203.20	< 0.002	< 0.05	< 0.040	< 1.0	+/-0.118	+/-3	< 0.020	< 0.5	< 0.040	< 1.0
05 to 08	8.001	12.000	203.23	304.80	< 0.002	< 0.05	< 0.060	< 1.5	+/-0.118	+/-3	< 0.040	< 1.0	< 0.060	< 1.5

Table 2: Allowable Equipment Dimension & Alignment

Step 2:

Gasket, Inflatable Seal & Mounting Ring Fitting

- Sling mounting ring using lifting eye bolts near 11 o'clock and 1 o'clock.
- Apply gasket sealant to dress gasket on both sides. This will help fit gasket and address any bulkhead surface defects.
- Fit gasket to bulkhead, align clearance holes with tapped holes in bulkhead.
- Lift and suspend mounting ring to bulkhead, align clearance holes with tapped holes in bulkhead, align water ports near 6 o'clock and 12 o'clock, align installation rod tapped holes near 3 o'clock and 9 o'clock.
- Fit mounting ring to bulkhead with hex socket head cap screws and thread adhesive. Tighten hex socket head cap screws by hand while ensuring the mounting ring is centered on the bulkhead.
- Tighten hex socket head cap screws with a torque wrench, diametrically opposed pattern, uniform 1/4 turn increments.
- Repeat process until no screw turns at full tightening torque. Do not over tighten as this may distort the mounting ring resulting in seal leakage. Torque per table 3.



Seal Size	Shaft Diameter Range A				Bolt Size		Torque	
	inch		mm		DIN912 A4-70	Hex Key mm	Ft-lb	N-m
	min	max	min	max				
01 to 03	3.375	6.875	85.73	174.63	8 x M12	10	36	49
04 to 08	6.876	12.000	174.65	304.80	8 x M16	14	90	121

Table 3: Bulkhead Bolt Torque

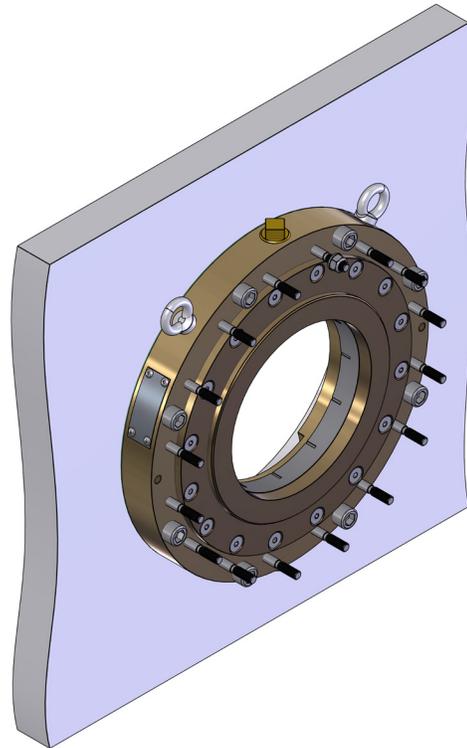


Figure 6: Inflatable Seal and Mounting Ring Fitting

Step 3:

Elastomeric Bellows, Stationary Face & Split Clamp Ring Fitting

- Remove hose clamp and split protector from elastomeric bellows.
- Apply RTV silicone rubber sealant between inflatable seal cover and elastomeric bellows flange.
- Lift and suspend elastomeric bellows and split clamp ring onto mounting ring studs, align water port near 6 o'clock, align split clamp ring joints near 12 o'clock and 6 o'clock. Take care stationary face is not damaged when handling.
- Fit split clamp ring to mounting ring studs using nyloc hex nuts. Tighten nyloc hex nuts with a wrench.
- Tighten hex nuts with a torque wrench, diametrically opposed pattern, uniform 1/4 turn increments. Ensure metal to metal contact between split clamp ring and mounting ring.

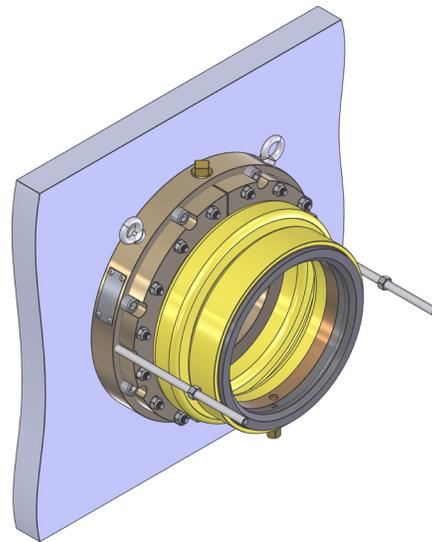
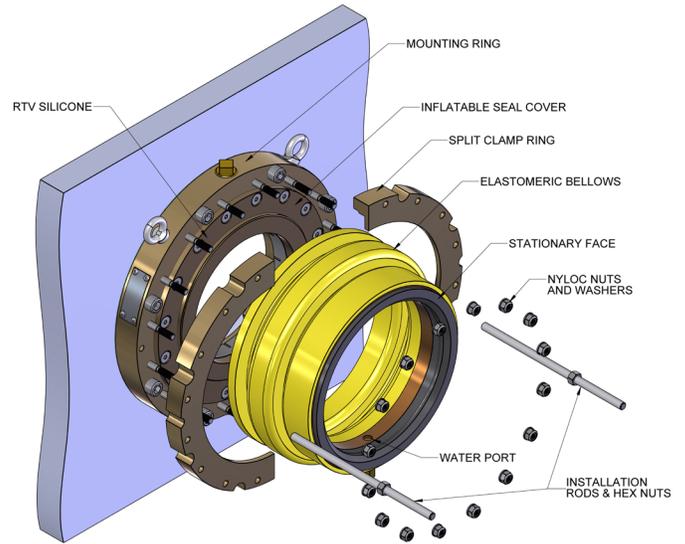


Figure 7: Elastomeric Bellows, Stationary Face and Split Clamp Ring Fitting

Seal Size	Shaft Diameter Range A				Bolt Size		Torque	
	inch		mm		DIN912 A4-70	Hex Key mm	Ft-lb	N-m
01 to 04	min	max	min	max	M8	13	10	14
05 to 08	8.001	12.000	203.23	304.80	M10	17	21	28

Table 4: Split Clamp Ring Hex Nut Torque

- Fit hex nuts half way along installation rods.
- Fit installation rods with hex nuts to mounting ring. Tighten installation rods by hand.
- Tighten installation rods with wrench, 1/4 turn.

Step 4:

Insert the Shaft

- Slowly draw partially withdrawn shaft through stationary assembly. Leave a gap between shaft ends to allow for fitting rotating seal components.
- Ensure shaft does not contact inflatable seal or stationary face and remains centered at all times.

Step 5:

Rotating Ring, Rotating Face & Wedge Ring Fitting

- a. Apply lubricant from elastomeric bellows to end of shaft.
- b. Fit rotating ring to shaft, align two eye bolts with installation rods. Slide rotating ring along shaft by applying steady pressure to forward side. Leave a gap between rotating ring and elastomeric bellows. Take care rotary face is not damaged when handling, especially near shaft end.
- c. Fit wedge ring to shaft. Slide wedge ring along shaft. Leave a gap between wedge ring and rotating ring.

Step 6:

Fit the Shaft to Final Position

- a. Connect coupling.
- b. Shaft must be locked in final axial position before completing seal installation.

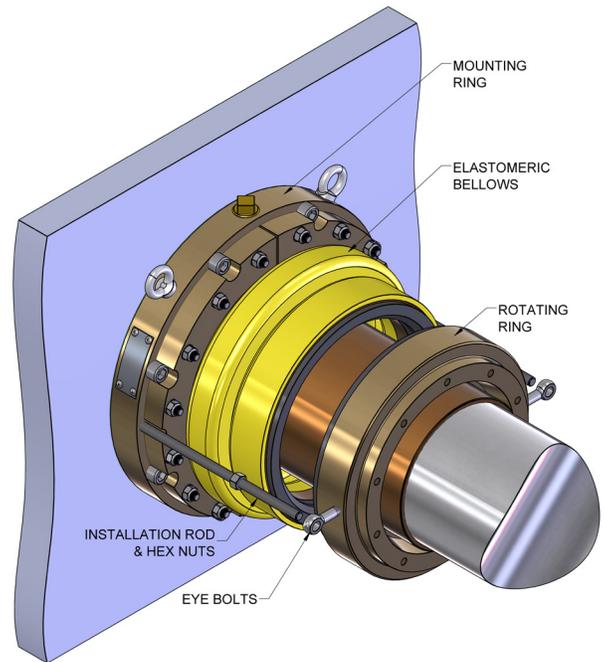


Figure 8: Rotating Ring & Rotating Face Fitting

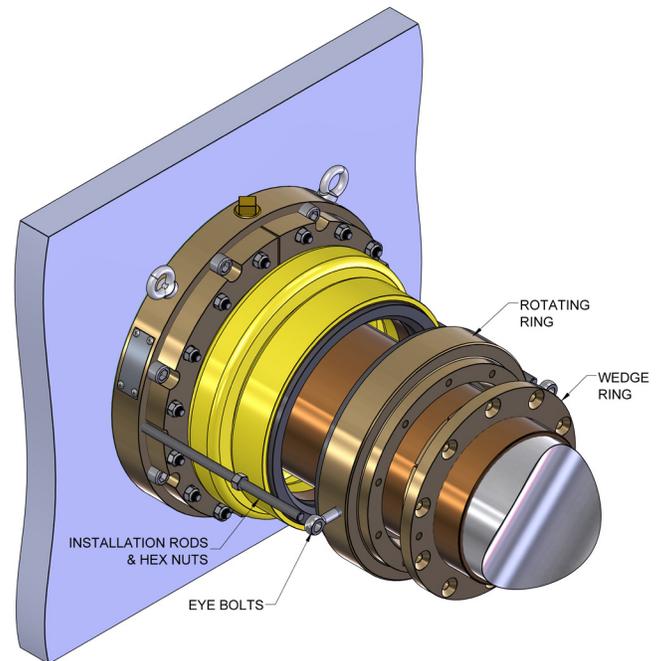


Figure 9: Wedge Ring Fitting

Step 7:

Setting the Seal Compression:

- Wipe stationary and rotating faces clean with isopropyl alcohol. Do not lubricate stationary and rotating faces with oil or other lubricant.
- Slide rotating ring along shaft, align eye bolts with installation rods.
- Slide rotating ring along shaft until stationary and rotating faces are lightly touching.
- Fit hex nuts to installation rods, tighten by hand until hex nuts touch eye bolts.
- Tighten hex nuts with a wrench, uniform 1/4 turn increments, to compress elastomeric bellows evenly per table 5.

Seal Size	Shaft Diameter Range A				Compress Bellows				Hex Nut Size	
	inch		mm		inch		mm		DIN933 A4-70	Hex A/F mm
	min	max	min	max	min	max	min	max		
01 to 04	3.375	10.000	85.73	254.00	0.250	0.375	6.35	9.53	M12	19
05 to 08	10.001	12.000	254.03	304.80	0.375	0.500	9.53	12.70	M16	24

Table 5: Seal Compression Settings

- Measure distance L1 from mounting ring to rotating ring.
- Adjust hex nuts with a wrench to ensure the measurements are within 0.031" (0.79 mm) of each other.
- Tighten hex nuts installed on threaded rods to lock axial position of rotating ring.

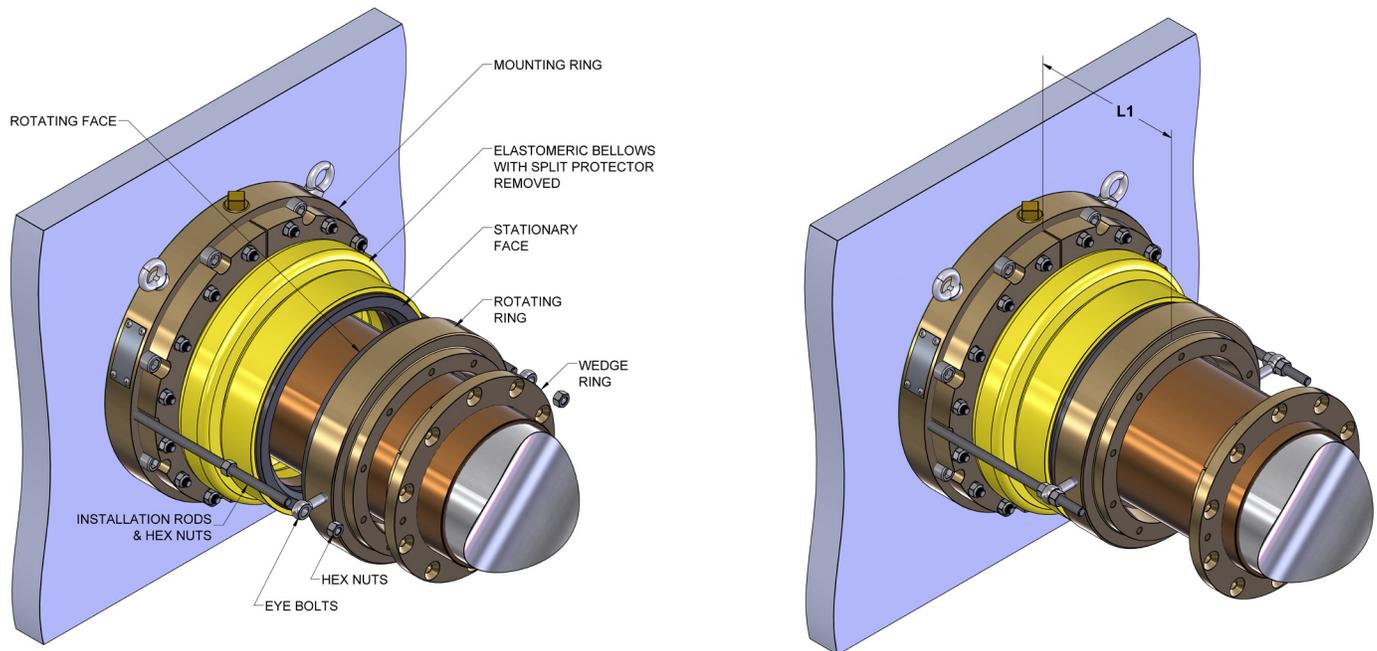
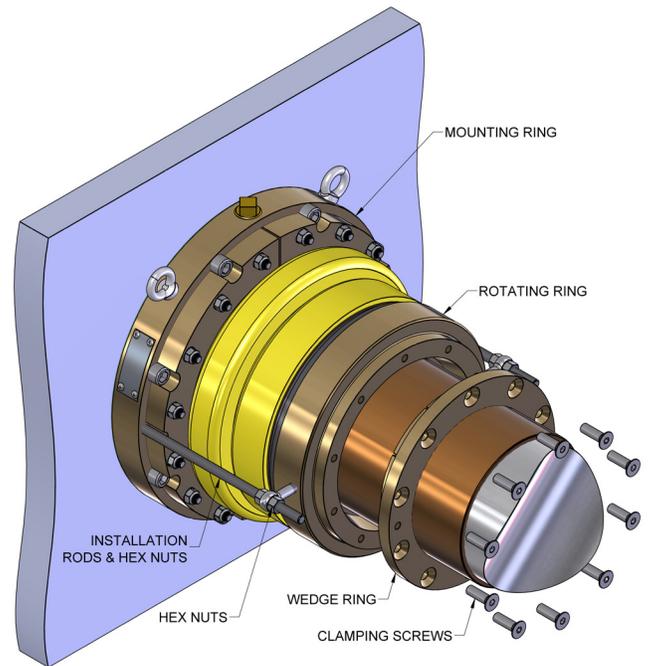


Figure 10: Rotating Ring and Rotating Face Final Fitting (Set Compression)

Step 8:

Wedge Ring Final Fitting

- Slide wedge ring along shaft to rotating ring, align clearance holes with tapped holes in rotating ring.
- Fit wedge ring to rotating ring with hex socket flat head cap screws and thread adhesive. Tighten hex socket flat head cap screws by hand while aligning wedge ring so that wedge ring and rotating ring are parallel to each other.
- Tighten hex socket flat head cap screws with a torque wrench, clockwise pattern, uniform 1/4 turn increments. Repeat the process until no screw turns at the full tightening torque. Do not over tighten as this may distort rotating ring resulting in seal leakage.
- Measure the gap between rotating ring and wedge ring at a minimum of four points at 90° to each other around the outside diameter to ensure even loading. Torque per table 6.



Seal Size	Shaft Diameter Range A				Bolt Size		Torque	
	inch		mm		DIN912 A4-70	Hex Key mm	Ft-lb	N-m
01 to 02	3.375	5.750	85.73	146.05	M10	6	21	28
03 to 08	5.751	12.000	146.08	304.80	M12	8	36	49

Table 6: Wedge Ring Cap Screw Torque

- Remove hex nuts from installation rods. Remove installation rods from mounting ring. Store items in the installation tool kit for future use.
- Fit split protector and hose clamp to elastomeric bellows stationary assembly. Ensure there is clearance .039" (1 mm) between split protector and rotating ring.

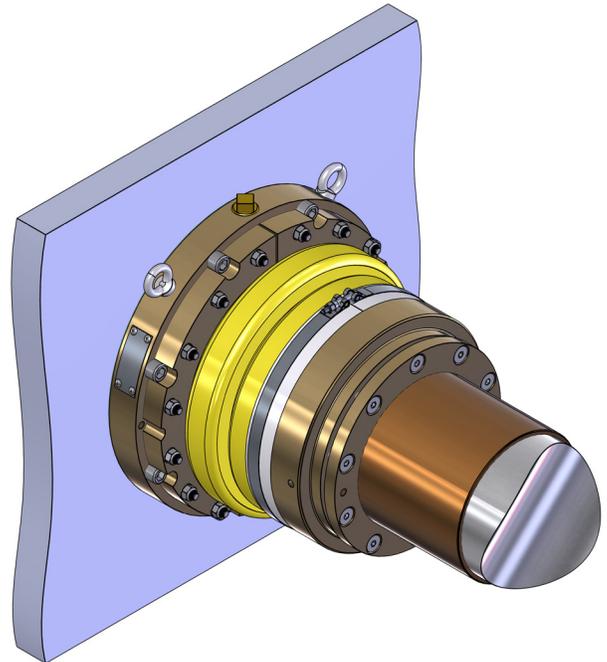


Figure 11: Wedge Ring Final Fitting

Step 9:

Fit Water Pipe and / or Water Hose

Water must be available for the TG100r to ensure optimum performance and life when operating at elevated temperatures or in harsh environments. The mounting ring has a water supply port located at 6 o'clock and a water vent port located at 12 o'clock. The elastomeric bellows has a water outlet port located at 6 o'clock.

The water connection can be made at the mounting ring water supply port using hard pipe allowing water to flow from the hull mounted scoop, sea chest, or pump through a flow sight gauge to the seal and the stern tube bearings. If the water connection is made at the elastomeric bellows water outlet port the connection must be done using appropriate hose to allow the seal components to move axially. Care should be taken to prevent scuffing of the hoses. Hoses should not have any contact with other pipes, hoses or machinery parts. For Classed vessels, the hose material must meet the Class Society's requirements.

The minimum required water flow for the seal and the stern tube bearing is shown in table 7.

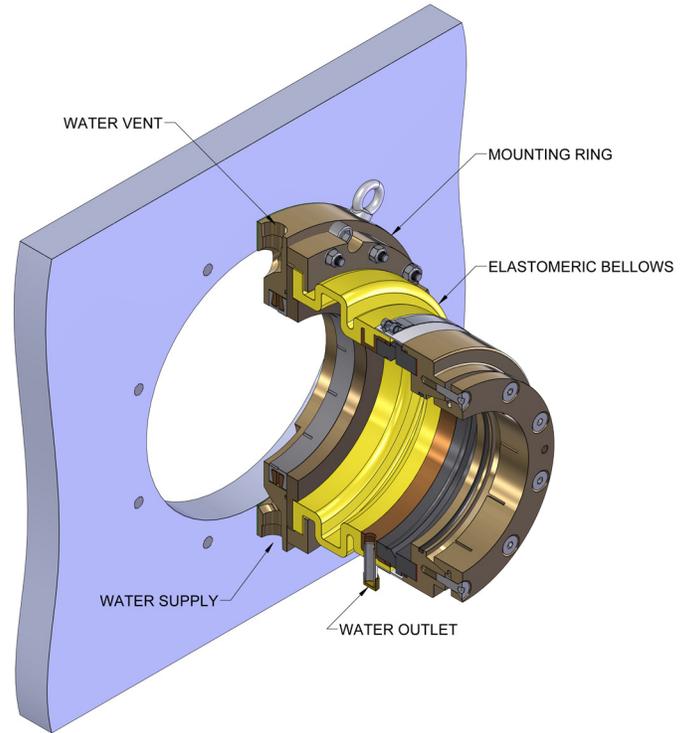


Figure 12: Rotating Ring Water Supply and Water Vent Ports

Seal Size	Seal Nominal Range	Shaft Diameter Range A				Water Flow Rate Seal & Bearings	
		inch		mm		GPM	LPM
Size #	inch	min	max	min	max	min	min
01	4.000	3.375	4.625	85.73	117.48	4.5	17
02	4.750	4.626	5.750	117.50	146.05	5.5	21
03	5.875	5.751	6.875	146.08	174.63	6.5	25
04	7.000	6.876	8.000	174.65	203.20	8.0	30
05	8.250	8.001	9.000	203.23	228.60	9.0	34
06	9.250	9.001	10.000	228.63	254.00	10.0	38
07	10.250	10.001	11.000	254.03	279.40	11.0	42
08	11.250	11.001	12.000	279.43	304.80	12.0	45

Table 7: Minimum Water Flow Rate

There are two typical water connection arrangements for the TG100r:

ARRANGEMENT #1 WATER INTO THE MOUNTING RING PORT

Arrangement #1 can be used in operations in warm waters above 95°F (35°C).

- Connect the mounting ring water vent port at 12 o'clock to a high point above the vessel water line.
- Connect the water line from the hull inlet scoop, sea chest or water pump through a water flow sight gauge to the mounting ring water supply port at 6 o'clock.
- If a water pump is used, and it is not self-priming, ensure that the water pump is located below the level of the water source. Always ensure the water delivered to the seal is as cold as possible, DO NOT use water that has been used for engine cooling.

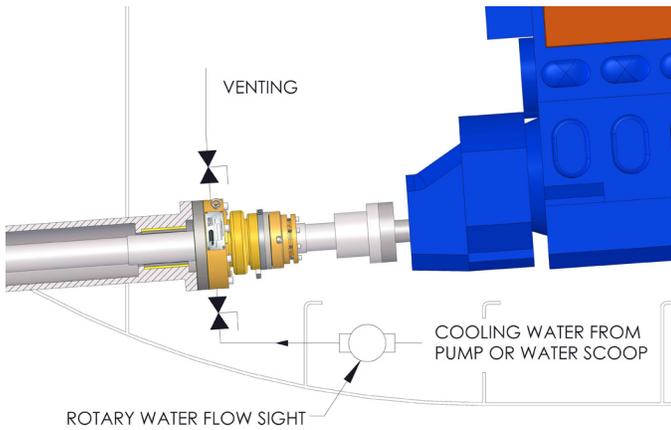


Figure 13: Arrangement #1 Water into the Mounting Ring Port

ATTENTION:

- If a single water pump is used to provide water to multiple seals, ensure the water flow to each seal is equal.
- Ensure the water pump can deliver enough head pressure to compensate for the vessel's draught and piping losses. If required, contact Thordon to size the water pump for your installation.
- If your vessel operates in dirty or abrasive waters and the water quality is a concern, please contact Thordon for information about a Thordon Water Quality Package for your vessel.

ARRANGEMENT #2 WATER OUT OF THE ELASTOMERIC BELLOWS PORT

Arrangement #2 can be used for operations in dirty, abrasive waters such as rivers and coastal estuaries. This arrangement provides continuous water flow and agitation through the seal internals preventing accumulation of mud or other debris.

- Connect the mounting ring water vent port at 12 o'clock to a high point vent above the vessel water line.
- Connect the water line from the hull inlet scoop to the stern tube water port. Connect the elastomeric bellows water outlet port at 6 o'clock using appropriate hose through a water flow sight gauge to a scoop with low pressure. Care should be taken to prevent scuffing of the hoses. Hoses should not have any contact with other pipes, hoses or machinery parts. For Classed vessels, the hose material must meet the Class Society's requirements.
- The mounting ring port at 6 o'clock should remain plugged or may be used to inject clean water into the stern tube bearings and seal during routine maintenance.

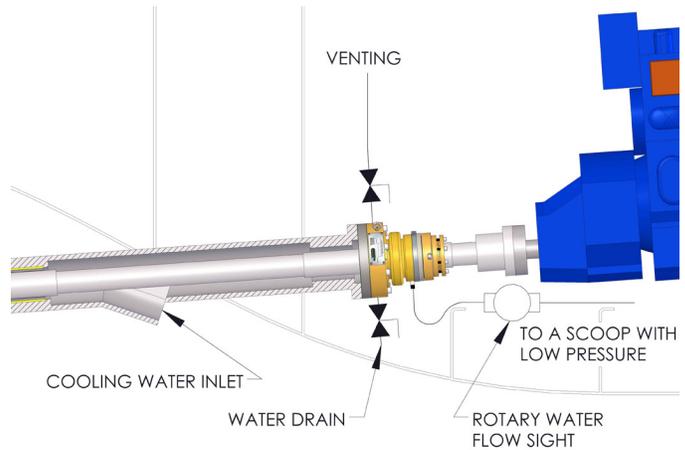


Figure 14: Arrangement #2, Water out of the Elastomeric Bellows Port

Step 10:

Fit Compressed Air Supply to the Air Control Panel and Inflatable Seal

The TG100r includes an air control panel to regulate compressed air from the vessel to operate the inflatable seal. The required minimum pressure is 120 psi (0.8 MPa), max air pressure is 150 psi (1.0 MPa). The regulator with built in pressure gauge is pre-assembled on a mounting panel, with valves that can be operated independently, to achieve the pressure for inflatable seal operation.

- a. Connect vessel compressed air supply through shut-off valve (not supplied by Thordon) to regulator compressed air inlet port.
- b. Connect compressed air supply valve port with hose (not supplied by Thordon) to an isolation valve (not supplied by Thordon) at the mounting ring compressed air port. Typical compressed air supply circuitry is presented in the compressed air piping diagram shown in the appendix. Care should be taken to prevent scuffing of the hoses. Hoses should not have any contact with other pipes, hoses or machinery parts. For Classed vessels, the hose material must meet the Class Society's requirements.
- c. Ensure inflatable seal is operating by fully deploying, and then fully retracting inflatable seal. Instructions on how to operate inflatable seal panel are presented in the compressed air piping diagram in the appendix.
- d. For vessels with multiple seals, the vessel's compressed air supply can be split to feed two or more compressed air control panels. Ensure the required minimum compressed air pressure is 120 psi (0.8 MPa) at each panel to allow independent inflatable seal operation.

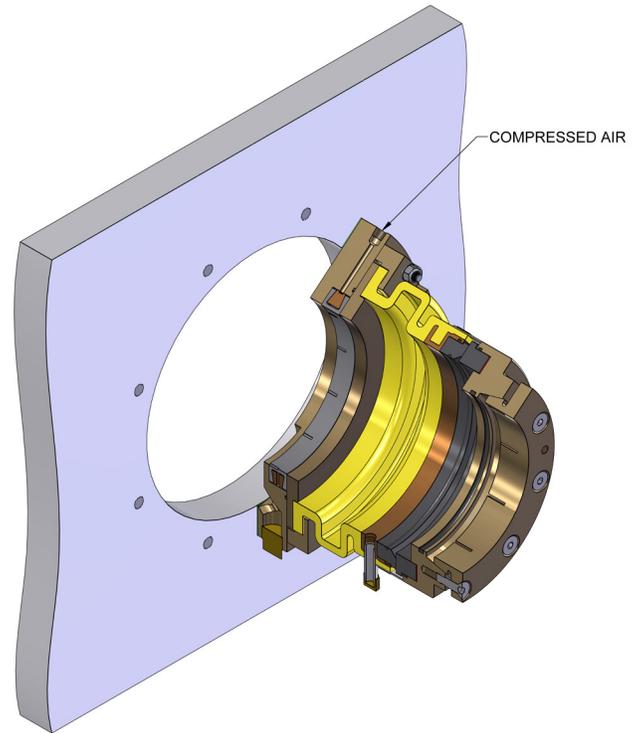


Figure 15: Inflatable Seal

6.0 FINAL CHECKS BEFORE VESSEL IS LAUNCHED (VESSEL IS IN DRY DOCK)

Do these final checks before the vessel is launched:

- a. Check all fasteners are tight.
- b. Check all water connections are tight and metal plugs or caps are installed and tight.
- c. Check air connection is tight and air control panel has been properly piped.
- d. Complete the Warranty Registration Card enclosed in the seal crate and forward to Thordon Bearings.

7.0 SEAL OPERATION AFTER VESSEL IS LAUNCHED (VESSEL IS IN WATER)

Do these checks once the vessel has been launched:

- a. With the vessel shaft not turning, visually check the seal for leakage. Observe if any leakage occurs at stationary and rotary faces. If there is water leaking, the stationary and rotary faces may need to be cleaned and/or the elastomeric bellows compression may need to be set again. Deploy inflatable seal and shut off water supply to the seal.

See APPENDIX for inflatable seal instructions.

- b. With the vessel shaft turning, running in steady state, check the temperature of the stationary face every hour for a period of 6 hours. For access to the stationary and rotary faces, remove the hose clamp and split protector from the elastomeric bellows. The temperature of the stationary face should be approximately 11 to 14°F (6 to 8°C) above the water inlet temperature. If the seal temperature is higher than specified, the elastomeric bellows compression may need to be set again. Deploy inflatable seal and shut off water supply to the seal.

See APPENDIX for inflatable seal instructions

- c. With the vessel shaft turning, maneuvering forward and reverse, observe if there is any vibration at the elastomeric bellows. If there is visible vibration, the elastomeric bellows compression may need to be set again. Ensure the distance from the mounting ring to the rotating face holder is consistent. Measure the distance between the mounting ring and the rotating ring at a minimum of four points at 90° to each other around the outside diameter to ensure even loading. Deploy inflatable seal and shut off water supply to the seal.

See APPENDIX for inflatable seal instructions.

- d. Fit split protector and hose clamp to elastomeric bellows stationary assembly. Ensure there is clearance .039" (1 mm) between split protector and rotating ring.
- e. During operation, periodic inspection of the seal should be carried out.

8.0 APPENDIX: SUPPLEMENTARY FIGURES

TG100r SEAL PERPENDICULARITY & RUNOUT REQUIREMENTS

The standard requirements on perpendicularity and runout for bulkhead/stern tube flange or adaptor plate are shown below:

Note: The acceptable out-of-round tolerance for the propeller shaft is less than 0.05mm (0.002").

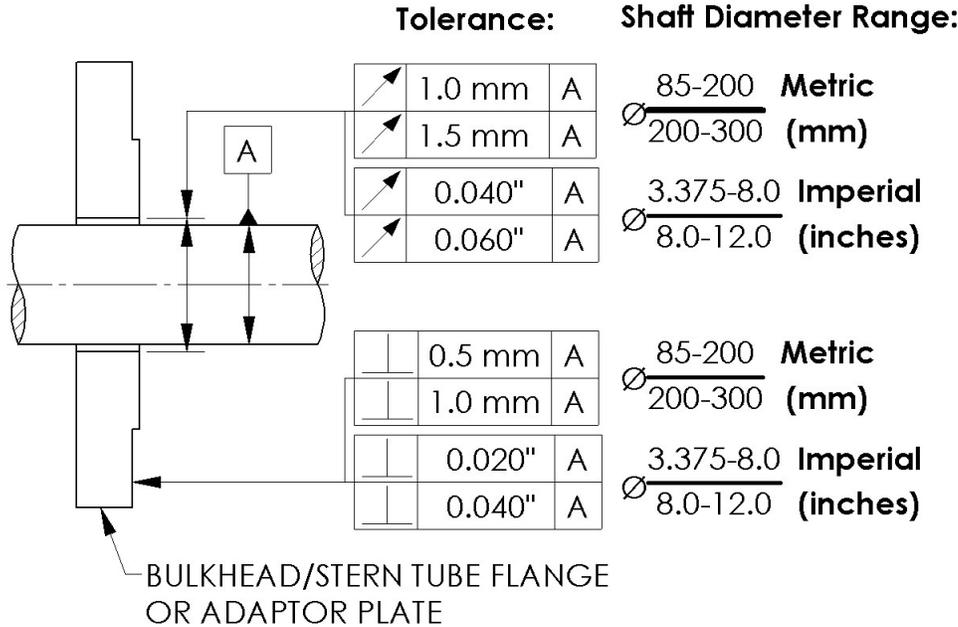


Figure 16: TG100r Seal - Perpendicularity and Runout tolerances

TG100r SEAL RECOMMENDED INSTALLATION TORQUE (N-m)

All Thordon-supplied fasteners are Grade A4-70, with a tensile strength of 700 MPa (101,500 lb/in²).

The recommended torque for installation of TG100r Seals are listed below; set your torque wrench to the closer value:

Bolt Size	M8	M10	M12	M16	M20
Torque (N-m)	14	28.5	49	121	237
Torque (in-lbs)	125	250			
Torque (ft-lbs)	10	21	36	90	175

Table 8: Recommended Installation Torque

Note: Metric Torque values are given in Newton-meters (N-m). Imperial Torque values are given in foot-pounds (ft-lbs) for all sizes and in inch-pounds (in-lbs) for bolt sizes up to M10. All Torque values are shown for "lubricated torque" as Loctite® threadlocking compound (or equivalent) shall be applied at bolt installation.

TG100r Seal – Typical Air Piping Diagram

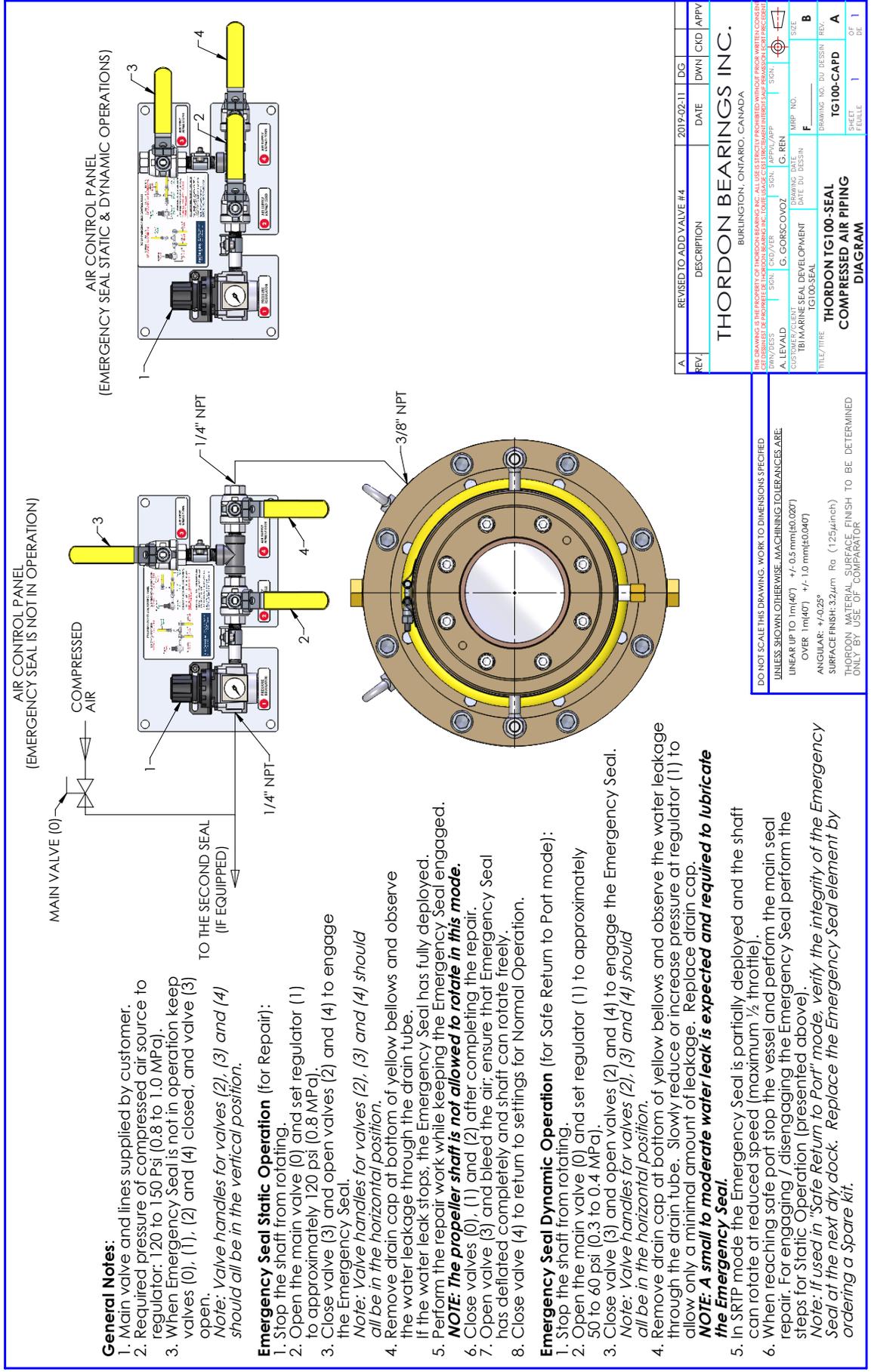


Figure 17: Typical Compressed Air Piping Diagram for one Seal

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