**Seal Pressure Calculation:**

This pressure calculation assumes worst case scenario, boat fully submerged. This will be the pressure the rudder seals experience:

Volume of water displaced, V = 0.1295 m3

Average boat depth, h = 0.25 m

Density of water, ρ = 1030 kg/m3

Gravity, g = 9.81 m/s2

P = ρgh = 9.81\*1030\*0.5 = 5052 Pa

**Seal requirements:**

* Keep water out at a pressure of 5052 Pa
* Support a shaft rotating at 8 rpm (0.84 rad/s, 0.0067 m/s)

**Available sealing solutions:**

* Stuffing boxes
* [U-cup seals](https://www.hitechseals.com/products/u-cups.asp)
* Spring loaded rotary shaft seals
* Rod and buffer seals
* [Rotary O-rings](https://www.applerubber.com/seal-design-guide/seal-types-and-gland-design/rotary-seals/)

**Information for sealing:**

<https://www.reddit.com/r/engineering/comments/71j0qg/general_question_regarding_oring_seal_design/>

<https://www.reddit.com/r/AskEngineers/comments/ugvfs4/what_is_a_correct_way_to_choose_bearing_for/>

<https://www.reddit.com/r/MechanicalEngineering/comments/vm5ctv/seal_for_a_small_rotating_shaft_for_low_torque/>

<https://www.reddit.com/r/AskEngineers/comments/89bg5b/seal_on_a_rotating_shaft_without_lubricant/>

<https://www.parker.com/content/dam/Parker-com/Literature/Engineered-Polymer-Systems/5350.pdf>

<http://www.robotlife.com/2018/06/18/the-rudder/>

<https://www.reddit.com/r/AskEngineers/comments/ugvfs4/what_is_a_correct_way_to_choose_bearing_for/>

<https://robotics.stackexchange.com/questions/150/preventing-leaks-in-motor-shafts-for-underwater-bots>

<https://www.reddit.com/r/radiocontrol/comments/3csfxi/rc_submarine_drive_shaft/>

<https://www.youtube.com/watch?v=5FTqb8HWLAo>

https://www.reddit.com/r/RCSubmarines/comments/dy9zmi/rc\_submarine\_basics\_waterproof\_wtc\_penetrations/