Nautilus Drydocks SubDriver

Overview, Operation and Maintenance

Last revised February 2022

Modular Control System for Powering and Controlling RC Submarines

SubDriver Overview:

Acknowledgements:

This product is the result of decades of RC submarine building experience, those decades hard-earned by not only myself, but by those who came before me. I want to acknowledge these people first and foremost, as without their pioneering work, this product would never have come into being.

In particular, I want to recognize David Merriman III, whose tireless work bringing his line of watertight cylinders to market forever changed the RC submarine hobby for the better.

Cylinder Overview:

The Nautilus Drydocks SubDriver product line has been designed to incorporate maximum flexibility and ease of assembly, maintenance and upgrade.

Check out the overview video on my YouTube channel here : https://youtu.be/tKFcJ0XL5Zc

- **250 Series SubDriver Features:**
  - Coming soon!

- **300 Series SubDriver Features:**
  - 3" diameter electronics and battery compartments
  - Options for either a 3" or 3.75" diameter ballast tank
  - High strength polycarbonate tubing
  - High strength white plastic bulkheads
  - Low friction cup-style linkage seals with easy maintenance and replacement
  - True linear linkage motion for decreased friction and increased power
  - Four full-sized servos and linkage outputs, two forward and two aft
  - Single or dual brushless motor power
  - Twin high capacity air pumps
  - Capability for either SNORT or SAS ballast (hybrid dynamic or full static diving)
  - Optional snorkel valve with NO mechanical moving parts for the highest reliability (used in SAS only)
  - Optional gas backup sub-system (note that option includes installation and testing)
  - Air ballast means the FULL capacity of the ballast tank is utilized, unlike pressure ballast systems
  - Compartment lengths can easily be re-sized to suit nearly any boat of adequate beam

Every Nautilus Drydocks cylinder ships fully assembled and tested for linkage and motor actuation as well as cylinder watertight integrity. Each one is certified prior to shipping. Some final installation of components such as radio gear, pitch controller, failsafe, remote switches, etc will be required on behalf of the builder.

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How Do I Know How Big To Make My Ballast Tank?

The job of a ballast tank is to lift out of the water everything that needs to be above the water. A submarine can dive, surface and otherwise operate perfectly fine with no ballast tank whatsoever. It will, however, be unable to bring any superstructure up out of the water for surfaced operations. In order to do that, the sub needs to get lighter, and submarines do this by replacing water from their ballast tank with air.

So, how do you know how much air you need?

Assuming that the density of the materials your submarine is made out of is primarily plastic or fiberglass, we are close enough to water density that calculations can ignore these small differences. With that being the case, calculations are much simpler.

If your boat is split at the waterline (as many WW2 fleetboats are, for example), then you can simply weigh the upper hull. This is the weight of water that needs to be purged in order for you to get to surfaced waterline (plus an additional "fudge factor" for safety).

If your boat is not split at the waterline, you're going to need to take a best guess as to the weight of the upper hull. For example, if your hull is split at the midline, weigh the upper hull and take approximately 40% of that weight as the surfaced portion (or whatever portion you determine would be closest).

300 Series SubDriver ballast capacity per inch:

- 3 inch ballast tank diameter:
  - 6.5 cubic inches per inch of tank
  - 3.6 fluid oz per inch (106.5g)
- 3.75 inch ballast tank diameter:
  - 10.3cubic inches per inch of tank
  - 5.7 fluid oz per inch (168.5g)

Example #1:

If your upper hull weighs 20oz, we add 10% and round up, getting 22oz. We now need to allocate enough ballast tank to take on 33oz of water. Each section of 3" ballast tank in the 300 Series SubDriver can hold approximately 3.6oz of water. We need 22, so that divided by 3.6 nets us a length of 6.1". Rounding off and 6" is what we'd get.

Example #2:

If your upper hull weighs in at 3lbs (must be a big, heavy boat!), then we are talking about 48oz. Adding 10% nets us 52.8, or 53oz if we round up. With this being a bigger boat, we have the room for the 3.75" diameter tank. 53oz of required ballast divided by 5.7oz/inch nets us a ballast tank length of 9.3", or 9 inches if we round.

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Static Versus Quasi-Static Diving

The SubDriver can be configured in two variations, those being *SNORT* (quasi-static diving) and *SAS* (full static diving). There are advantages and disadvantages to each system.

Configure for SNORT: All SubDrivers come pre-configured in this setup.

This is the recommended setup and the one that I implement on almost ALL of my builds. It is the safest and most reliable setup for your submarine and in no way detracts from the operational enjoyment of driving your submarine.

All cylinders come pre-configured in this setup. The boat should be ballasted slightly positively when the ballast tank is completely filled with water. A tiny bit of forward movement, a small addition of downward angle on the dive planes, and your submarine slips under the surface, fully capable of diving to any depth desired.

To surface, simply put rise on the planes until the sail emerges, kick on the ballast air pump, and the cylinder evacuates the water via air pulled from the surface until the boat rises to full surfaced waterline.

- When the model is at periscope depth or higher, air comes into the cylinder via a mast or periscope mounted high in the sail. If the pump is accidentally kicked on while the model is fully submerged, no harm is done. Rather than air, the pumps simply pull water from the intake and blow it into the ballast tanks, resulting in no difference in model buoyancy.
- Air travels to the pumps via a flexible rubber hose which enters the bottom of the ballast tank and is then connected to the pump intakes via a split hose fitting. This setup allows for parallel air flow, effectively doubling the volume of air that a single pump would be able to produce, and also creates redundancy and increased safety margin.
- Air is pumped through the air pumps and is then expelled out the outlets. These outlets disperse the air into the ballast tank, displacing water and causing the model to surface.

  PROS: The boat is always positively buoyant and will always resurface in case of problems or loss of location. Simplified setup. Lower chance of water leaks into dry compartments of the cylinder.

  CONS: Some degree of forward movement and plane input is required to stay submerged

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Configure for SAS (Semi-Aspirated System):

SubDrivers must be re-plumbed for air intake and the snorkel valve fitted.

In this configuration, the boat can be ballasted neutrally or even negatively so that it can submerge *statically* (no forward movement required). In my opinion, this is really just a trick to show the guy next to you at the pond or pool. Real submarines never submerge statically unless they are missile boats setting up to launch weapons.

- When submerged, the air pumps are turned on. Air from the dry compartments of the cylinder is drawn into the pump intakes and is expelled into the ballast tank, causing a net increase in buoyancy. The submarine surfaces.
- Once the snorkel valve breaches the surface, air is allowed through the valve and comes into the cylinder, equalizing air pressure in the entire system. This valve allows air to travel into the pumps, but not water.

  Note that when the pumps pull air into the ballast tank, a partial vacuum is created in the dry compartments of the cylinder. Having a complete seal of all cylinder compartments is vital for safe operation.

  Once a surface operation is initialized, you MUST completely surface the boat and allow the cylinder to equalize the pressure. Failure to do so will result in the pumps being unable to overcome the vacuum and result in a lack of ability to create positive buoyancy

- The surface air is expelled into the ballast tank, displacing water and causing the model to rise to its full surfaced waterline.

PROS: Full static diving and the ability to "hover" at depth

CONS: Increased complexity, increased cost, increased chance of leaks as the air intake line leads directly to the dry compartment of the submarine instead of cycling directly through the pump.

At the end of the day, you need to determine how you think you'll operate your submarine. If you're just starting out, I HIGHLY recommend the SNORT setup for reliability and simplicity.

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Emergency Gas Backup System

The Nautilus Drydocks gas backup system is based off of the system engineered by David Merriman and allows for increased safety margin when operating your submarine. It consists of a copper pressure vessel designed to house liquid gas (air brush propellant or equivalent), and a Schraeder (tire) valve that is mounted to the pump bulkhead, actuated by the ballast vent servo linkage.

In practical application, you set up your transmitter in such a manner that standard blow (air pump only) does not depress the valve. The 2IS ballast switch that is pre-installed in your cylinder will engage the pump after approximately 40% throw in that direction. In case of loss of signal (automatically enacted via a Battery and Link Monitor failsafe electronic module or similar failsafe) or other need to immediately surface the boat, the linkage is thrown to the extreme end of travel, depressing the valve and blowing liquid gas into the ballast chamber, displacing water and causing the model to surface.

Installation of Gas Backup System

If you are installing the gas backup system after you received your cylinder, installation is a fairly straightforward procedure:

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1. Remove the 3 stainless bolts on the pump side of the ballast tank
2. Carefully twist and pull the connection between the polycarbonate tube and the pump bulkhead apart. The clear wire conduit inside will also pull loose.
3. Press the gas valve into the receptacle in the pump bulkhead until the flange is flush with the side. The valve stem should protrude past the mounting receptacle by about ⅛”.
4. Using a servo tester or by powering up your cylinder, test the adjustment of the gas backup arm (the one closest to the pump bulkhead). At full throw in the “blow” direction, the linkage arm should fully depress the valve stem of the gas backup, but not “bottom out” in doing so, which could damage the servo and linkages.
5. Put a generous bead of clear silicone RTV around the perimeter of both the wire conduit and the pump bulkhead flange.
6. Re-assemble the wire conduit and ballast tube into the pump bulkhead. Twist the ballast tube until the holes in the tube and the pump bulkhead are aligned.
7. Put a squeeze of silicone into the holes for the stainless bolts and re-install the bolts.
8. Wipe any excess silicone from the perimeter of the ballast tube using a clean, soft rag.
9. Allow the silicone to cure for 24 hours, then test the cylinder in a tub or pool to ensure that the seam between ballast tube and pump bulkhead is air tight.

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Maintenance and Upkeep

Properly maintained, your cylinder should last for many years of continuous use. Included with your kit are spare seals, which will be the components most likely to fail over time.

Recommended maintenance tasks are very straightforward:

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1. Prior to each run, thoroughly check the cylinder for evidence of cracks, distortion or damage.
2. After your charged batteries are installed, fully tighten the knurled nuts, ensuring not to overtighten. “Finger tight” is what you’re aiming for, even if you use an allen wrench.
3. Put a drop of silicone oil at the base of each linkage seal and cycle the servos to spread the lubricant over the shaft and seals. Since you have it out, put another drop at the base of each control surface shaft where it enters the bushing in your hull. Add another at the interfaces of drive shaft and thrust and reverse thrust bearings.
4. Submerge your cylinder in a tub or pool, unplug the testing hose and then blow gently into the cylinder. You should be able to put significant pressure into the cylinder without air bubbles being evident. If leaks are found, ensure that they are addressed prior to installing the cylinder in your boat.
5. After each run, check the inside of the tubing for evidence of condensation or water ingress. Slight condensation or one or two drops of water are normal. Any more than that will require re-testing in the test tank/pool in order to identify and address the leak.
6. Flush your brushless motor(s) with water displacing oil, such as WD-40 to prolong life and stop any corrosion from taking hold. Putting a wadded up towel under the motor will ensure that excess oil does not get onto your model and damage your paint finish.
7. Open both the motor and battery compartments, even if no evidence of water ingress is found. Even a few drops unnoticed can corrode sensitive electronics. Leave the cylinder open for at least 24hrs to fully dry. You can also add a small package of desiccant (found in dry goods or electronics packaging) and keep it in your cylinder at all times to help with moisture, particularly if you are running in humid climates
8. Charge your battery fully to proper storage voltage.
9. Re-assemble your cylinder and store in a cool, dry and safe location.

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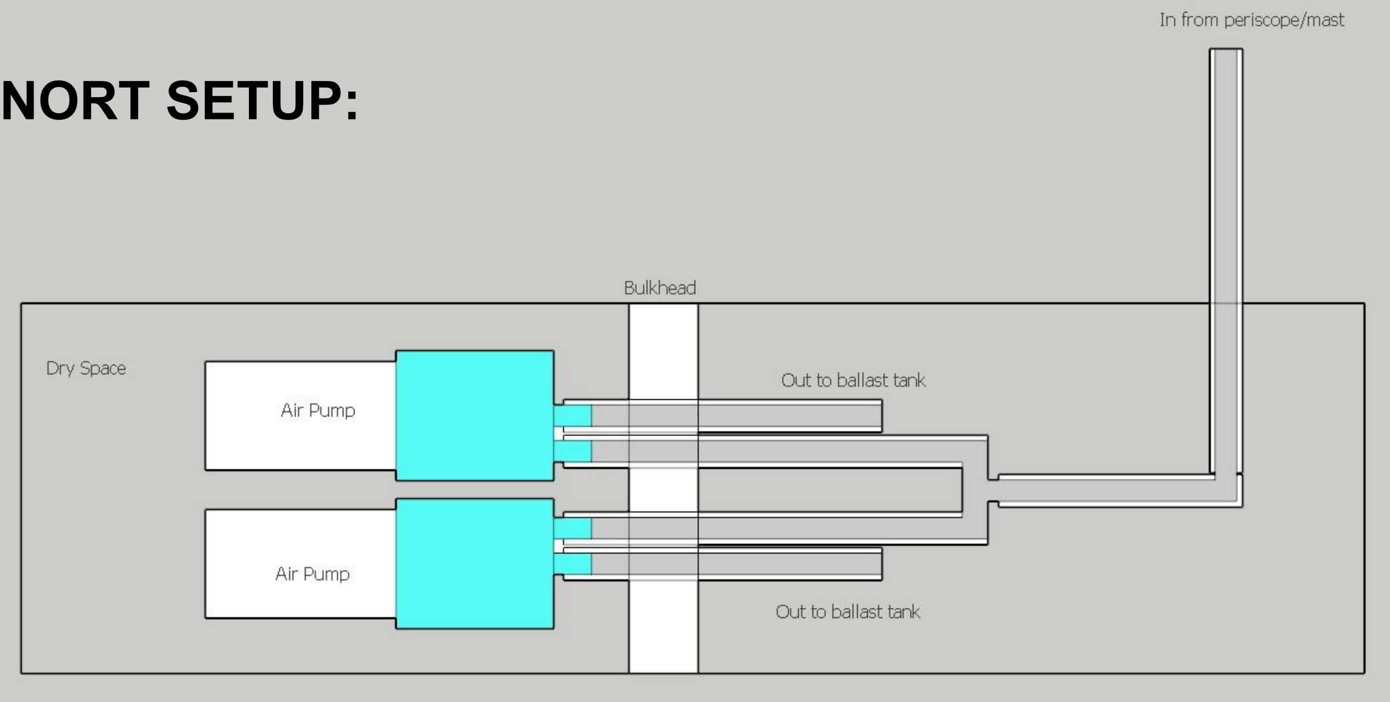
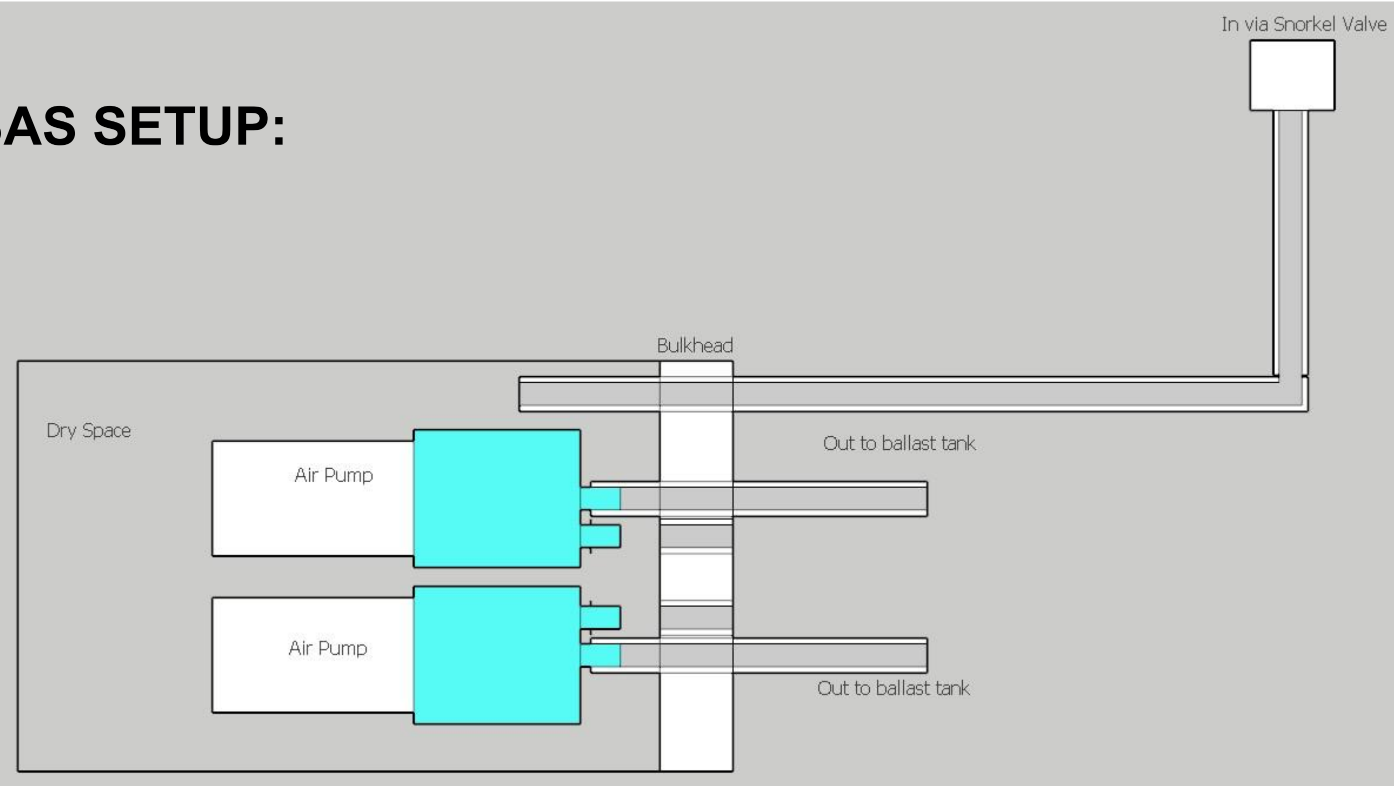
SNORT SETUP:



SAS SETUP:



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