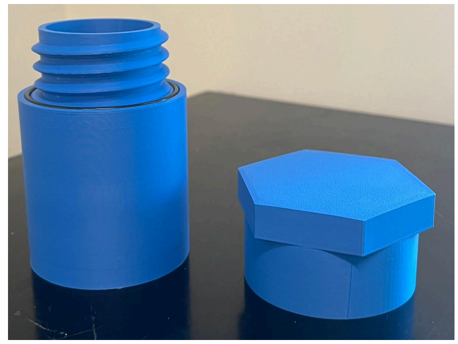
ENTS NODE ENCLOSURE INSTRUCTION MANUAL

Paragraph about the fact that there are three options, each with tradeoffs. Users will pick the best option for them (based on cost and time available) and then follow the instruction manual to put together the enclosure.

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1. Picking your Enclosure Type

The first step is to decide which enclosure to assemble.

Table 1: Comparing Properties of different enclosures.

	ML-70F	3D Printed	PVC
Cost	$49	$32	$37
Working Time	15 minutes	15 minutes	30 minutes
Idle Time	0 hours	20 hours	2.5 hours
Tool Requirements	Power Drill, Phillips Screwdriver	3D Printer	PVC Cement, Power Drill, Saw
Concerns	Cost, Size	Waterproofing, Reproducibility	Size, Scalability

Below is the Manufacturing & Assembly guide for the 3D Printed and PVC enclosures.

2. Manufacturing & Assembly

2.1. PVC Option

2.1.1. Overall Design

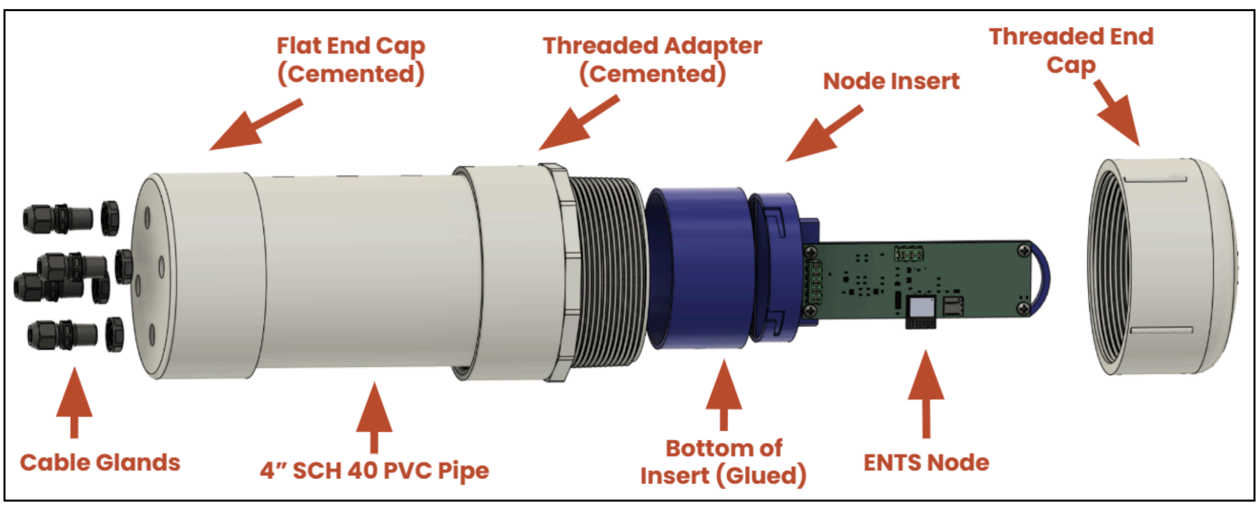

Figure XX: PVC Enclosure Component Diagram

2.1.2. Acquiring Materials

All components used for manufacturing a PVC enclosure may be procured from external suppliers. Standard schedule (SCH) 40 pipe is used. The required materials include:

Table 2: PVC Design Materials

Material	Procurement Link	Cost
PVC Pipe (4 in. x 2 ft SCH 40) *enough to make 3 enclosures	Home Depot	$17.86
Male Adapter (4 in. SCH 40 PVC)	Home Depot	$10.84
Threaded End Cap (4 in. SCH 40 PVC)	Home Depot	$14.96
Female Socket End Cap (4 in. SCH DWV PVC)	Grainger	$25.86
PVC Primer and Cement (multi-use)	Home Depot	$10.94
Teflon Tape (¾ in., multi-use)	Amazon	$7.59

* Cable glands will also need to be acquired and are outlined in Section 2.2.3 below.

2.1.3. Cable Gland Setup

Depending on your individual use case there are many possible cable gland configurations that can be used. For each cable gland there needs to be a hole drilled for installation. Each hole needs to be drilled in the female socket end cap to a prescribed diameter. Specific cable glands depending on the cables being used should be picked out from Section 3.2.. Optionally each cable gland can be sealed with aquarium silicone sealant around its interface with the enclosure for additional protection. See Section 3.2 for more cable gland information.

2.1.4. Cutting to Size

While cutting the PVC pipe to length, it is important to follow proper safety precautions for operating any equipment. It is recommended to use a power-driven saw to cut the PVC pipe, but hand saws are also a viable option. The PVC pipe should be cut to a length of 8 in. After cutting the pipe, it is recommended to cut or sand off any protruding plastic from the area that was cut, as to not interfere with the cementing required later on.

2.1.5. Assembly

Once all materials are procured and any modifications of materials conducted, assembly may begin. PVC primer will need to be applied to the inside of the female socket end cap and end of the PVC pipe. After around 10 seconds, PVC cement should be applied to both coated regions and joined together immediately. Following this, PVC primer and cement will need to be applied to the inside of the PVC male adapter and other end of the cut PVC pipe, then joined immediately. It is recommended to allow for the PVC cement to cure in a well ventilated area to avoid inhaling any fumes. 😶‍🌫️

Application of teflon tape is crucial to the functionality of this enclosure. Using the ¾ in. teflon tape previously procured, proper installation requires for teflon tape to make clockwise revolutions around the threads of the PVC male adapter in an overlapping manner. It is necessary to apply between 4 to 5 layers of overlapped teflon tape throughout the entire length of the PVC male adapter threads.

2.1.6. Node Insert (Optional)

See Section 3.2 for more information.

2.1.7. Deployment

After all of these steps have been completed your enclosure is ready for outdoor deployment!

2.2. 3D Printed Option

2.2.1. Overall Design

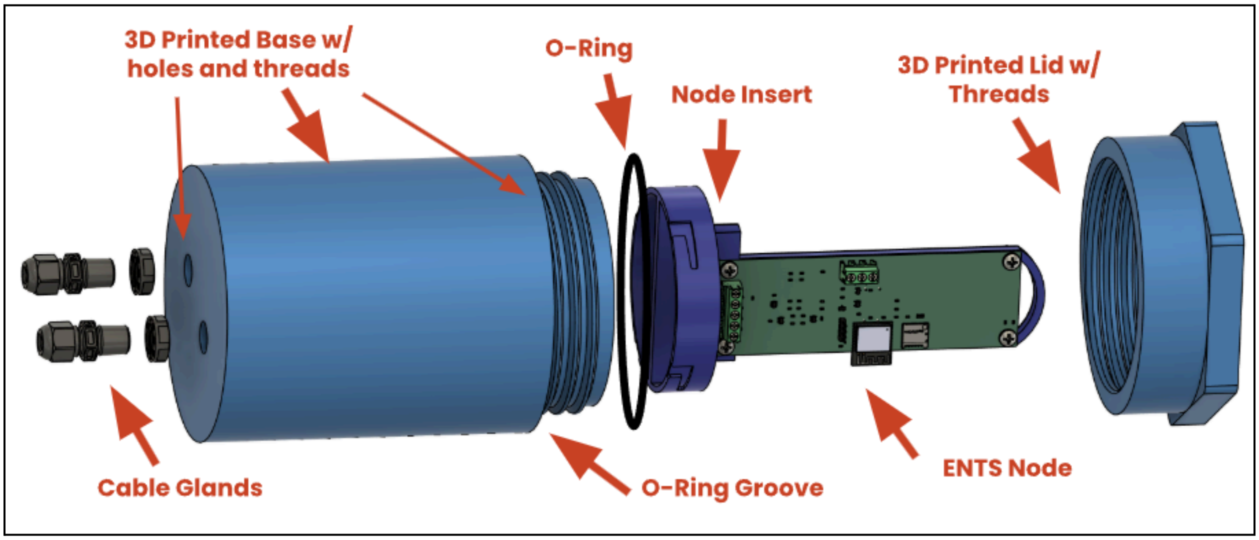

Figure XX: 3D Print Enclosure Component Diagram

2.2.2. O-Ring & Cable Gland Holes Configuration

The enclosure was designed for a 115 mm ID Buna-N O-Ring. O-Ring sizes can be modified with the 3D print parameters specified in Section 2.23. Other O-Ring sizes can be procured here.

Cable glands can be used with cables according to the cable range listed in table XX. Make sure to adjust 3D print holes to reflect sensor cable configuration used. 3D print holes should be the correct 3D print hole diameter size listed below. As a rule of thumb, if the clearance hole diameter is not listed on the technical data sheet, add 0.6 mm to the outer diameter of the threads. This worked well for our team over the course of this project. See Section 3.1 for details on procuring and selecting cable glands.

2.2.3. Preparing 3D Print

The Enclosure was designed using Autodesk Fusion 360 CAD software and has also been provided as an Autodesk Fusion Archive File (*.f3z) for easy customization, in addition to the STL files. The enclosure is composed of two components: the lid and the base.

User parameters were used to define key dimensions of any potential enclosure design. These parameters are in centimeters and include:

- BoxOpening: the circular opening of the enclosure's base
- BaseHeight_ExcludingThreads: the height of the base excluding the threads, from the bottom of the base to the start of the threads
- ThreadHeight: height of the base's threads and the lid's thread cavity

- LidHeight: total height of lid
- CableGlandHoleDia: clearance hole diameter for cable gland
- O_RingID: inner diameter of O-Ring

2.2.4. Printing Enclosure and Node Insert

With newly selected user parameters you are ready to start printing.
See Section 3.2 on Node Insert.

2.2.5. Insert Cable Glands

Once you have an enclosure printed the next step is installing cable glands. Simply thread the gland through the holes configured at the bottom and seal with a locknut on the other end. At the interface of the cable gland and the 3D printed surface you can add some additional aquarium silicone sealant for additional protection. See figure XX below for a sample final result.

Figure XX: Sample cable glands after installation.

2.2.6. Sealant

We recommend using one of the following silicone sealants seen below:

509 Aquarium ASI Silicone Sealant

This sealant is thick and is harder to apply but has performed well in all of our tests. Might want to dilute for easier application. This sealant takes about 24 hours to cure and should be applied over all surfaces of the enclosure.

ECOFLEX Ceramic Quick Coat

This sealant is spray-on and easier to apply but weaker than the aquarium sealant above. Make sure to apply multiple generous coats on all surfaces of your 3D print and let it cure for 2 hours.

2.2.7. Deployment

After all of these steps have been completed your enclosure is ready for outdoor deployment!

3. Common Components

3.1. Cable Gland Options

Table 3: Cable gland comparison

Cable Gland	WISKA ¼" NPT	TE Connectivity M12 1.5	Polycase CG-30
Cable Diameter Range	3-7 mm	3-6.5 mm	0.115-0.25" to 0.865-1.26"
Thread Length	15 mm	15 mm	0.32"
3D Print Hole Diameter	14.138 mm	12.6 mm	0.473"
Locknuts	¼" NPT Locknut	M12 1.5 Locknut	Included

3.2. Node Insert