Si Se Puede

Si Se Puede Foundation
STEM Center

NURC

The Si Se Puede Foundation proudly presents the 2024 National Underwater Robotics Challenge:

CAVERN CHAOS

June 14 - 16 2024
ASU Polytechnic Campus Pool

Rules:

Register:

www.NURC.us

Sponsored By

BlueRobotics

ASU

Microchip

StateFarm

NXP

Boeing

National Underwater Robotics Challenge
General Rules, Mission Specifics, and Mission Theme
Cavern Chaos!

Competition Information

Who may enter?

Basically, anyone! Grade school teams, homeschool teams, high school teams, college teams, adult teams, family teams, corporations, basically anybody is welcome to enter. There are four categories for awards:

1. Pre-high school
2. High school
3. College
4. Adult/corporate teams

What is NURC?

The **National Underwater Robotics Challenge** is an underwater, tethered robotics competition that takes place in a swimming pool. Each team gets 20 minutes to attempt to complete a series of tasks with their ROV, or Remotely Operated Vehicle, using the video feed as their only source of information from the pool.

When?

June 14-16, 2024

Where?

Arizona State University Polytechnic Campus, Sun Devil Fitness Center, 7332 E. Sun Devil Mall, Mesa, AZ 85212. It will take place at the pool at the student rec center. Check out Logistics page on website:https://www.nurc.us/logistics

Why?

The purpose is to create another STEM competition in Arizona for students across the state and the nation. It is also an attempt to help make Arizona a focal point for STEM competitions. The Si Se Puede Foundation wants to get as many students excited about STEM as possible. They see the competitions as a way to stimulate the youth of today to become the STEM workforce of tomorrow.

How much is the entry fee?

The entry fee to compete in NURC 2024 is $200 per team. To register, and find details on payment, please visit our website at:

https://www.nurc.us/register

The entry fee covers:

- Up to ten 2024 NURC T-Shirts per team
- Awards ceremony / banquet
- Live webcast

National Underwater Robotics Challenge
General Rules, Mission Specifics, and Mission Theme
Cavern Chaos!

Basic Rules

ROV Materials:

You are able to use whatever materials you wish to use, keeping in mind that you will be in water and that we will be using the pool at ASU, so make sure you use materials that will not damage the pool or contaminate the water in any way. This will be verified during tech inspection.

ROV Dimensions:

There are no size restrictions for your ROV, however, keep in mind that people must be able to handle the ROV both in water and in air. Also keep in mind that some mission elements may dictate a size limit in order to interact with them.

ROV Weight:

There is a limit to the weight allowed for an ROV for the competition. Since students and divers need to handle the ROVs, a 100lbs limit will be enforced.

ROV Power:

There is a voltage limit of up to 50 Volts DC (nominal battery voltage). There must also be an ROV system breaker that limits the ROV power to 1000W (***The maximum power of the ROV will be calculated as the nominal battery voltage X the current rating of the main breaker.***) This cannot be an auto resetting breaker. It must require manual reset. A kill switch to cut power to the ROV must be demonstrated to pass inspection. It is highly recommended that there are fuses within your ROV circuitry to protect your ROV. All of this will be verified through tech inspection. The ROV must get all its power from batteries only. A wall outlet connection or other AC power will not be allowed.

ROV KIts:

It is not required that a kit be purchased, although it is highly encouraged for beginners. We have put together a kit you may choose to purchase as a starting point. It is up to you. You are free to build your ROV any way you wish.

We have a deal with Blue Robotics where registered NURC participants will receive a 15% discount from purchases. Once you have entered, we will send you a 15% discount code.

For details on NURC kits, please visit https://www.nurc.us/nurc-rov-kit

Pit Area:

Each team will get one 6-foot-long table. There will also be one power strip for computer or monitor use only. No construction may take place at the pit. All construction must take place in the work area adjacent to the pit. Safety glasses are not required in the pit.

Work Area:

Each team will be required to work on materials in the designated work area, which will be shared by all teams. All sawing, soldering, gluing, cutting or any other type of construction will only be allowed in this work area. Safety glasses are required in this area. Only light work is

allowed at your pit.

Battery Charging:

Each team will be required to charge their batteries in the designated charging area. There will be no other place to charge batteries. If your batteries are embedded in the ROV and cannot be easily removed, then you must leave your ROV in the charging area to charge your batteries.

Competition Setup:

Each team will have a 30 minute time slot total. This time slot will be divided into a 5 minute setup period, a 20 minute mission period, and a 5 minute breakdown period. Your control center with laptops and monitors must go through our power strip with GFCI circuit protection. There will be one 6-foot-long table. The tether management person is the only person who can look into the pool. They are not allowed to talk to the rest of the team about anything they see in the water regarding their ROV or mission props.

Tech Inspection:

Technical inspection of your ROV will be done by NURC staff and all requests from NURC staff must be adhered to. If your ROV does not pass tech inspection, it cannot practice or compete. You will get a tech inspection sticker when you are cleared for practice and competition.

Video UpLink:

You must be able to provide a live video stream from your ROV to the NURC officials as well as for your own ROV operation needs. This extra video feed will be used for a live broadcast that will go out over the internet. This can be an analog signal that is split, or it can be a duplicate screen HDMI output from your laptop. For analog signals, we will provide a signal splitter.

Team Journal Paper:

Each team must submit a journal paper. The paper must use size 12 font. It must not exceed 20 pages, including references. The journal paper must be submitted one week prior to the competition through email. The actual date of submission will be announced and the email address will be made available to you through email communication and website announcements. A rubric for what should be in your journal paper will be made available after you register for the competition.

Team Poster:

Each team must submit a technical poster of their ROV for review. The poster size can be anything you want, but it must be on display at your pit area at all times during the competition. The poster is due at the time of the competition. A PDF version of your poster should also be provided for Judges to review and to post on the NURC website.

Poster Rubric:

- Team name and school or group affiliation
- Diagram or drawing of your ROV
- Labels for all your ROV components or identifying special features
- Presentation is clean, organized and easy to read

Team Website:

Each team must have a website showcasing their team and ROV. The website is due by the time of the competition. Your team website will be made public through the NURC website. A rubric for what should be on your website will be made available after you register for the competition.

Team Oral Presentation:

Each team must make a technical oral presentation to a panel of judges. You may use anything you want as far as props or media to show the judges, but you must provide all the materials for these yourself. Each team will get a maximum of 30 minutes for the presentation time slot. This includes set up and break down. A projector will be provided if needed, with an HDMI interface.

Qualifying:

A qualification process will be used to rank each team and used to assign time slots for each team's mission. Qualification runs will be open to teams all day on Saturday. There is no limit to how many qualification runs a team can make.

Each qualification run will require the team's ROV, starting above the surface of the water, to dive to a depth of 9 feet to retrieve a diving ring. Each run is timed from when the ROV breaks the surface of the water to when the diving ring is in the hand of a team member on the pool deck. Ranking will be ordered by the fastest qualification time recorded for each team. During mission time frame selection, the top qualified team will have first pick for their desired time slot, followed by the second top qualified team, etc. Available time slots will begin at 8pm Saturday night and run until 2 am Sunday morning, with each mission starting at half hour increments. This will allow for 12 missions, but we will extend if we need more time.

Cavern Chaos!
Mission Specific Section

Mission Theme:

It all started off as a normal day. At 6:00 am, the alarm went off and Dr. Linda Bravo woke up to start a new day working at the Black Peak Geothermal Power Plant near Chignik, Alaska. She had an appointment to meet Colonel Benjamin Tanaka at 7:00 am to guide her down through the caverns to the primary substation to check on the new equipment that had just been installed in this one-of-a-kind experimental geothermal power plant.

In 2018, geothermal scientists discovered a series of very interesting caverns along the slopes of the Black Peak Volcano that faced Chignik Bay. What made these caverns so interesting is that they led to a section where the cave was extremely close to a source of volcanic heat. The ocean is also very close to this heat source and the sea water could be pumped into this hot zone to produce steam to run generators.

The Black Peak Geothermal Power Plant was even more unique in that new technology would be introduced that increased the output power of the plant. This was going to be a hybrid plant that used nuclear power as its second source of energy. The two sources of power, geothermal and nuclear, would provide Alaska with a huge source of power with little to no carbon footprint. Due to climate change, Alaska is experiencing huge growth since many people are now relocating to live in a cooler climate. This power plant would fill that need.

Today the power plant is in the final stages of construction and inspections need to be made for clearances so the plant can get online and begin producing power. Dr. Bravo met Colonel Tanaka at the entrance to the cave at 7:00 am sharp. The cavern was a natural cave when first discovered but has been re-engineered to make it easier for people to go through. The substation is located in the part of the cave where the heat source of the volcano is closest. This is about ¼ mile of the way in. Even though re-engineered, the cave is still somewhat dangerous. Since the Colonel is an experienced spelunker, he is required by the Black Peak Power Company to escort all personnel through the cave.

Just a couple of minutes after the duo ventured into the cave, disaster struck! The cave began to shake violently and pieces of the roof and walls began flinging all around them. Colonel Tanaka grabbed Dr. Bravo by the arm and pulled her in the direction of a side cavern that appeared to be more stable due to its smaller size. He kept running and pulling Dr. Bravo into the direction of the smaller cavern until he reached the end. There they both huddled together until the shaking stopped. This took about 30 seconds.

There in the dark, Dr. Bravo and Colonel Tanaka held each other tight while coughing and trying to reorient themselves. Suddenly the emergency lights came on. Colonel Takana quickly grabbed his radio and sent out a message. “Mayday! Mayday! Tanaka here with Dr. Bravo at the end of side Tunnel 4!” The cave started shaking again and the emergency lights went out. The two held on to each tight once more. The shaking didn’t last as long this time, but the emergency lights never came back on.

After what seemed like an eternity, Colonel Tanaka and Dr. Bravo let loose of each other and Colonel Tanaka turned on a flashlight. What they saw gave them chills. They were trapped at one end of the tunnel which then sloped downward into dark water. The patch of dry tunnel left where they stood was less than 6 feet square.

After a brief discussion with each other about what they should do, Colonel Takana explained that he wanted to see how far he could go into the flooded end. He removed his shoes and socks and walked into the water with his flashlight and then gently dove under. Dr. Bravo was left in total darkness for what seemed like a minute or two. She then saw a light returning in the water. Colonel Tanaka popped out of the water with a distressed expression and what looked like burns on his face and body. He came back onto the only dry patch of land holding his hands over his eyes. He explained that while the tunnel did not seem blocked, the water was very hot. They were essentially trapped.

A few minutes later Colonel Tanaka was able to remove his hands from covering his eyes and they were bloodshot. He then explained to Dr. Bravo that all they could do now was wait and hope that they get rescued somehow. Even though he told her this, he knew that the possibility of them being rescued was very slim to none.

At the David Gallo ROV Institute: Location Falmouth, Massachusetts

You and your team get alerts on your phones that a situation has occurred in Alaska that needs your team to mount a rescue! You are all gathered in the mission briefing room and Commander Preston is going over what your team needs to do.

“At approximately 7:10 am this morning at the Black Peak Geothermal Power Plant located near Chignik, Alaska, an earthquake measuring 6.8 on the Richter scale struck and lasted about 30 seconds. It was followed by a second smaller quake lasting a shorter duration measuring 3.3 on the Richter scale.”

The commander continued, “Two Black Peak employees were in the caverns when the earthquake occurred and they managed to get out a distress call between the two quakes. It is believed that they are alive and are trapped at the end side of Tunnel 4. It has been determined by observers and preliminary rescue efforts that the majority of the cave is now flooded and that the volcanic heat source is preventing divers from going into the flooded cavern to find their way to the two trapped personnel.”

The commander now turned on the overhead projector to go over the rescue plan. “This mission is a complicated one because there are many things that have to be taken care of and it is not clear what the conditions will be when we get to the locations of the tasks to be performed. The mission is as follows:

1. Turn on secondary backup emergency lights by flipping the lever.
2. Measure the temperature of the volcanic heated water to see how long the ROV can stand the temperature without damage.
3. Pass through heated water to get a special heat-resistant air supply hose and communication tether to the people trapped in Tunnel 4.
4. Place a demolition device to open a path for rescue divers to get to Dr. Bravo and Colonel Tanaka.
5. When the device detonates the ROV must be 15 feet away.
6. Remove debris from the new opening to allow divers to come through to get to the people trapped inside. Must remove at least one piece of the three debris to allow divers to pass through.

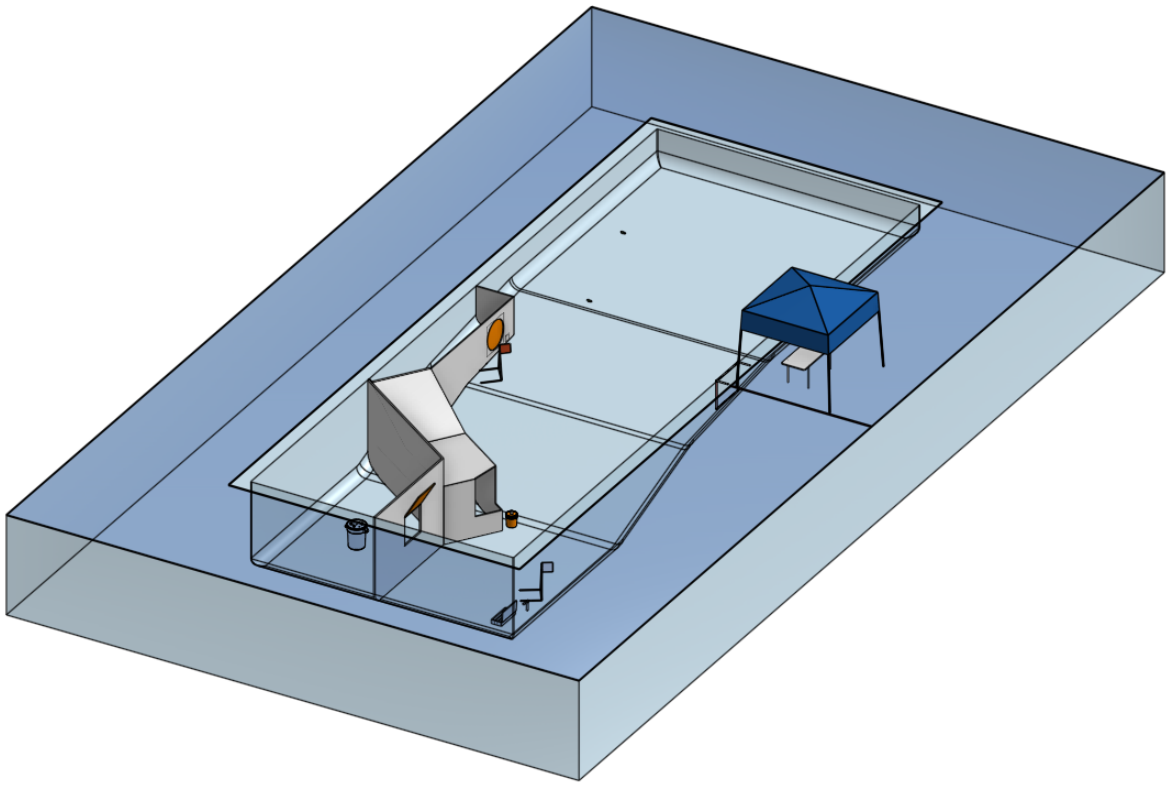
7. Measure the distance from the lead case containing radioactive fuel rods to the new opening made in the cave to rescue people trapped inside.
8. Go to the substation and turn off the nuclear reactor by flipping the lever.
9. Punch the 4-sequence combination lock to open the door to the reaction chamber. You will be given the combination to use.
10. Enter the reaction chamber and remove the three radioactive fuel rods.
11. Each rod must be taken outside and placed in the lead case and then close the case
12. Flip the next lever to activate lead case lift system.
13. Catch one, two, or three fish to test for radioactivity.

Some things to note:

- The ROV can only withstand the temperature of the heated water 15 seconds at a time. Staying in the heated water longer than that will kill the ROV. The tether is able to withstand the heat; the ROV is not.
- When detonating the demolition device, if the ROV is not 15 feet away, then the ROV is dead.

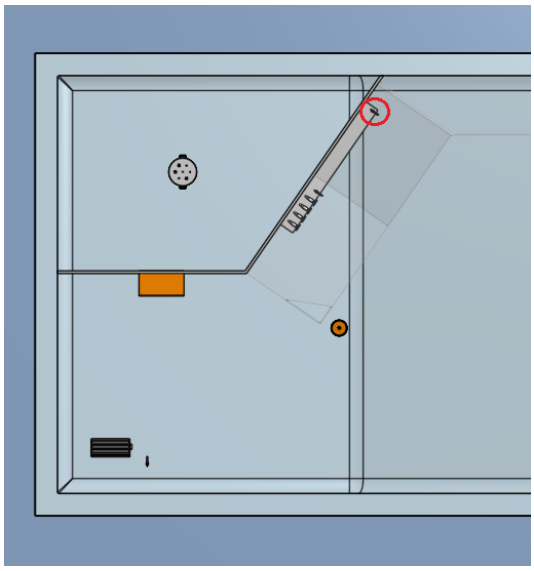
Pool setup

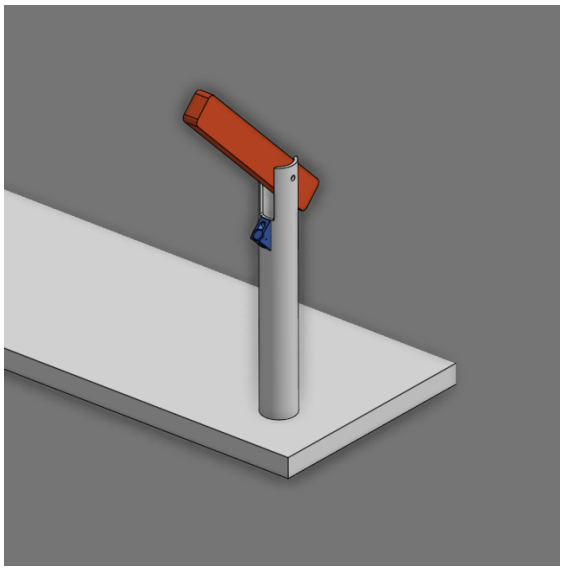
Field- Link to CAD file



Backup emergency lighting

There is a lever on the far side of the tunnel that can be accessed by going through the main tunnel opening. Turn on secondary backup emergency lights by flipping the lever to the down position. The lever requires ~2 lbs of force to move and is locked into the down position with magnets.

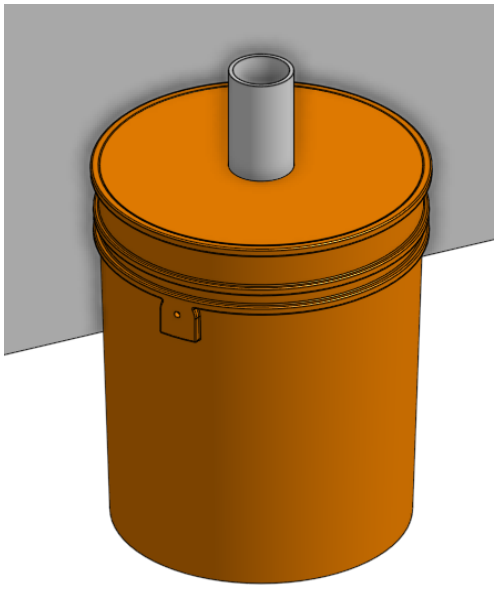




Measure volcanic vent temperature

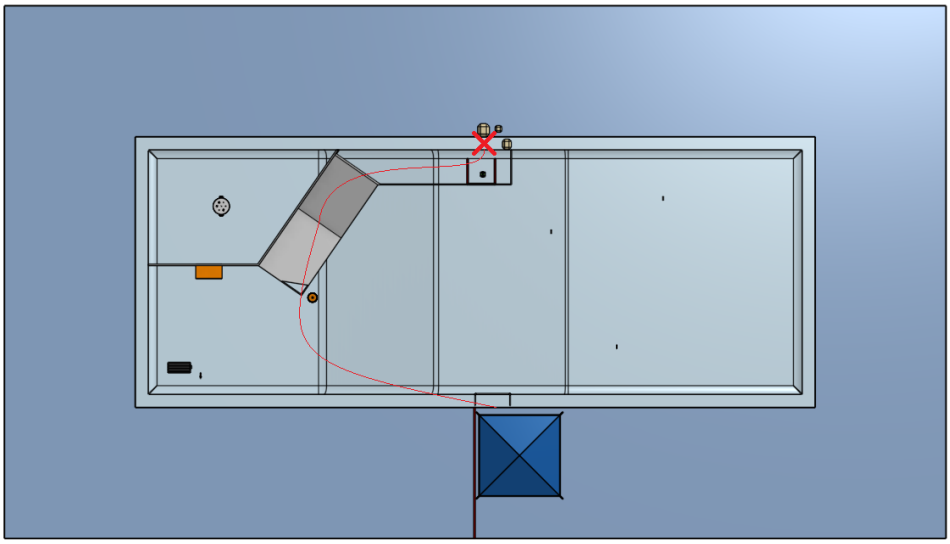
The volcanic vent will be illuminated and emitting a bubble stream. The inside diameter of the vent is 2”. To get an accurate measurement of the vent temperature, measure the bottom of the vent, which is approximately 6” below the top of the vent opening. Points for this task are scaled by accuracy of measurement of the local water using the following formula:

Vent Points = 50 - (| Actual temperature (ºC) - Measured temperature (ºC) | * 10)



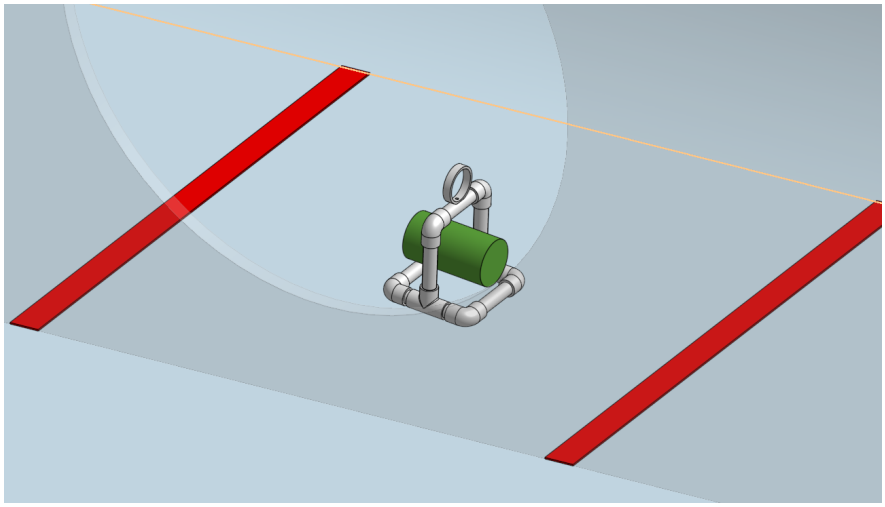
Deliver air supply hose

Pass through heated water to get a special heat-resistant air supply hose and communication tether to the people trapped in Tunnel 4. The hose itself is neutrally buoyant and the end of the hose is 0.5” in diameter. When the hose is delivered to the survivors, they will detach it from the ROV.



Demolition device

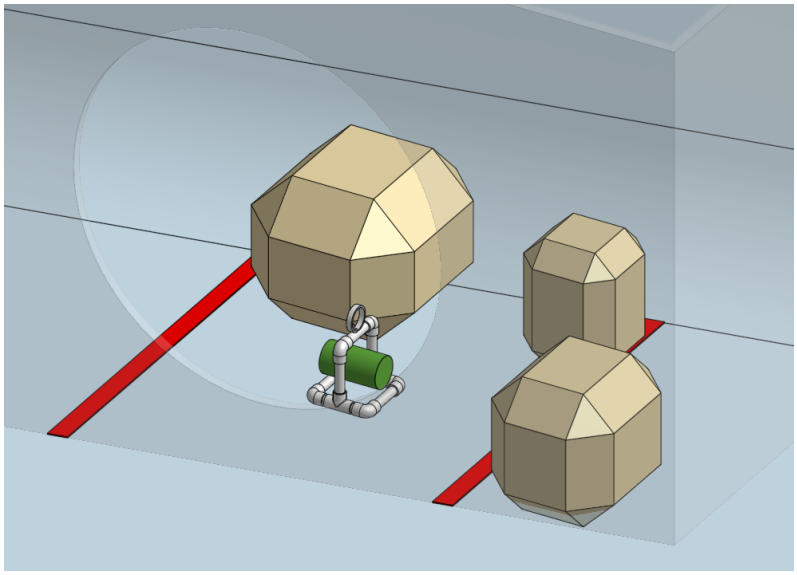
Place a demolition device to open a path for rescue divers to get to Dr. Bravo and Colonel Tanaka. A marked area on the floor of the tunnel shows the target zone for placement. The device will have a countdown timer set at 120 seconds*. When the device detonates the ROV must be 15 feet away or the mission will end. A correctly placed and detonated device will create a 36” diameter circular opening in the tunnel wall and deposit debris on the pool floor near the opening. The demolition device has a 2” PVC ring to facilitate handling and weighs approximately 1 lb underwater.



*Detonation timer is approximate, subject to adjustment at event

Debris

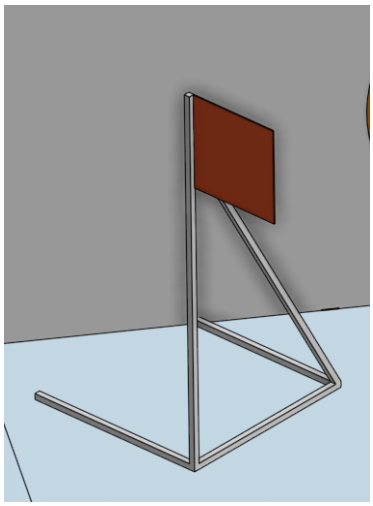
Remove debris from the new opening to allow divers to come through to get to the people trapped inside. The pieces of debris will each weigh ~1 lb underwater, but are somewhat bulky. A piece of debris is considered to be removed if it has been pushed away from the tunnel opening and out of the demolition zone indicated on the pool floor. At least one piece of debris must be removed in order for the divers to access the people trapped in Tunnel 4.

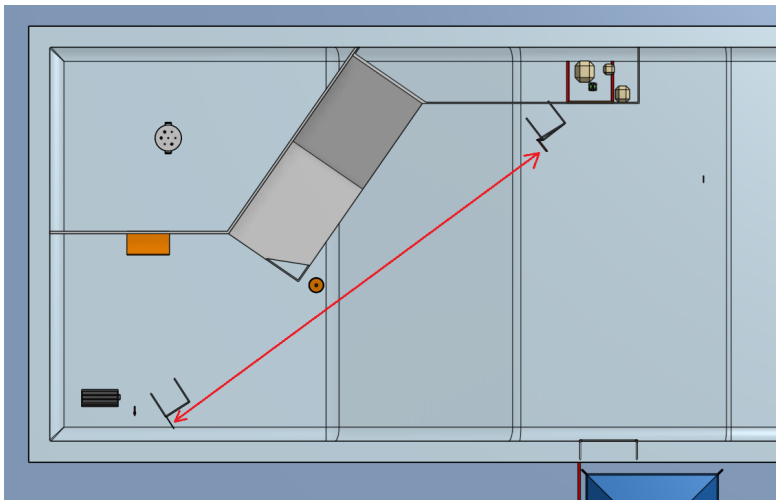


Distance measurement

Two distance targets are placed on the pool floor, one near the new tunnel opening and one near the fuel rod container. Each target consists of a 12” x 12” PVC plate. An accurate measurement of the distance between these two plates will yield the most points, according to the following equation:

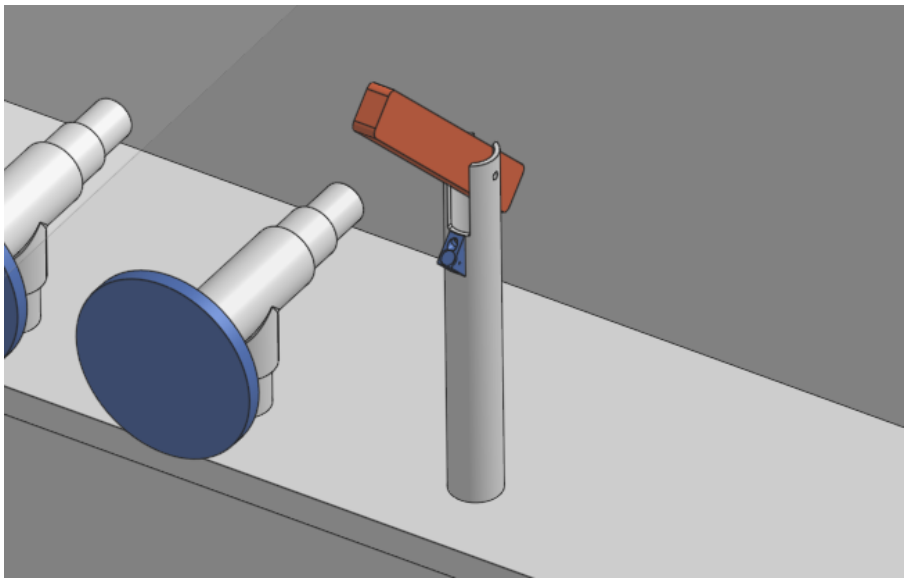
Distance Points = 75 - (| Actual value (in.) - Measured value (In.) | * 3)





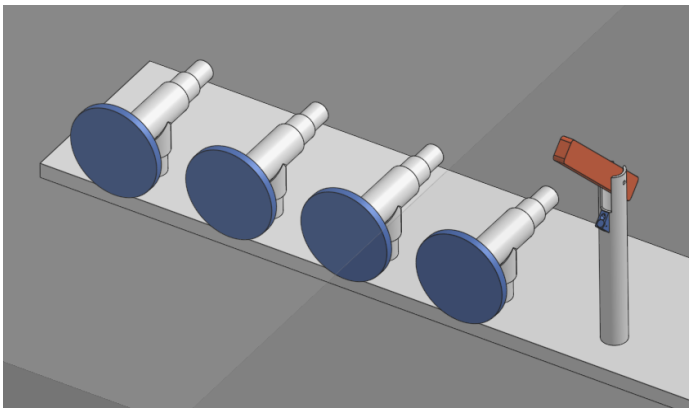
Turn off reactor

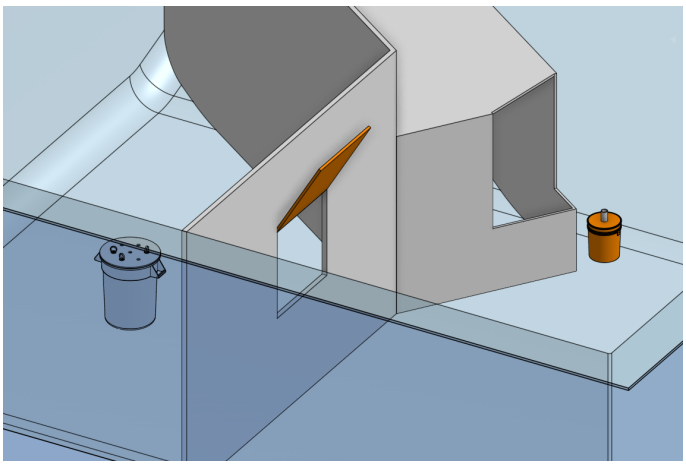
Turn off the nuclear reactor by flipping the lever in the substation to the down position.



Open reactor chamber door

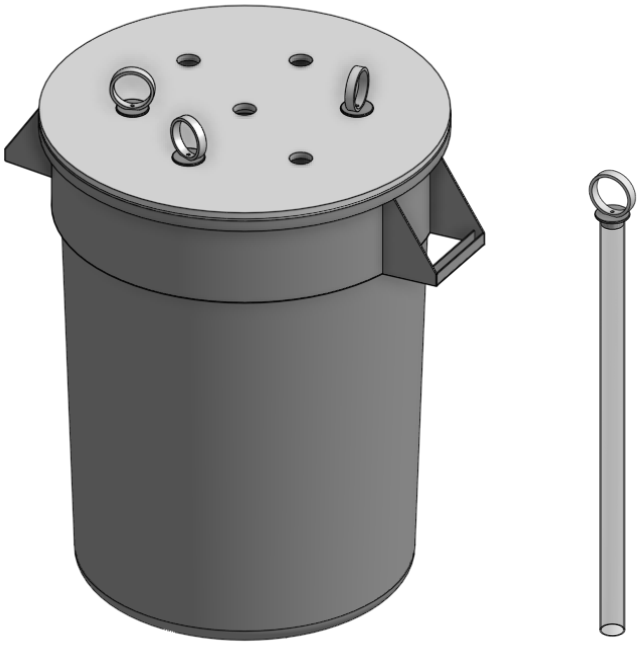
Punch the 4-sequence combination lock to open the door to the reaction chamber. Each button requires ~1 lb of force to push closed. The reactor door is 36” x 36” square opening.





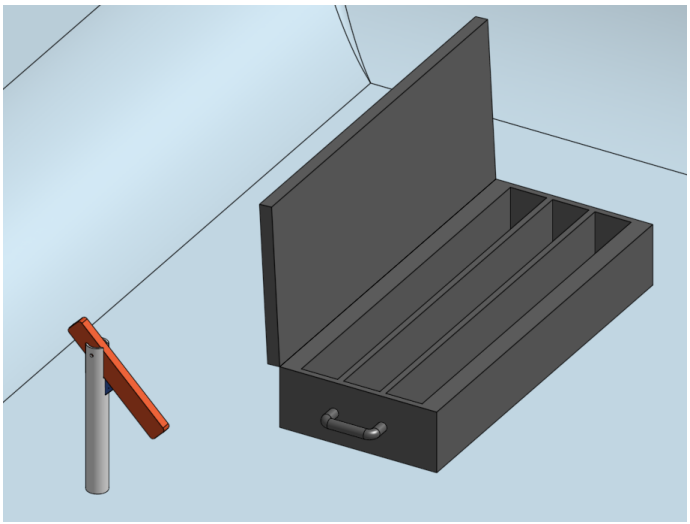
Remove fuel rods

Enter the reaction chamber and remove the three radioactive fuel rods. Each rod is approximately 1.25” in diameter and 24” long and constructed from polycarbonate with a weight in water of approximately 1 lb. Each fuel rod is equipped with a 2” inner diameter ring on top for handling.



Place fuel rods in lead case

Each rod must be taken outside of the reactor chamber and placed in the lead case. For full recovery, the lead case lid must then be closed. The case lid will be held closed with magnets.



Activate fuel rod recovery system

Flip the lever next to the lead case to activate the lift system. The lever will need to be pushed from the up position to the down position.

Catch fish for sampling

There will be three motorized fish swimming in the pool near the tunnel and reactor. The fish each measure ~5” long and will be actively swimming. They will be constrained to their starting positions with a length of fishing line and velcro. Recovering a fish to the surface for examination earns 25 mission points.

Mission End

A team may end their mission at any point during their 20 minute allotted mission time. If a team decides to end their mission before their time has expired, they will earn 3 points / minute of remaining mission time. The ROV must be out of the water before the mission may be ended.

Scoring:

There are a total of 550 points available during the mission portion of the competition, with an addition of 60 possible bonus points for ending the mission early:

Task	Points available
Turn on backup lights	10
Measure temperature	Maximum of 50
Deliver air hose to trapped people	60
Place a demolition device in target area before timer runs out	30
Remove debris (3 total)	15 each
Measure distance from fuel rod case to tunnel	Maximum of 75
Turn off nuclear reactor	10
Enter the 4-sequence combination to open chamber	45
Remove fuel rod from nuclear reactor chamber (3 total)	20 each
Place fuel rods in lead container and close lid (3 total)	25 each
Recover fuel rods in the lead container to surface (3 total)	5 each
Recover fish to surface (3 total)	25 each

In addition to scorable points, there are some actions that will deduct points from a team's mission score:

Penalty	Penalty Points
Requiring diver retrieval of ROV to surface	-20
Tether person pulling tether to retrieve ROV	-20
Exceeding mission time limit	-20/minute
ROV within 15 feet of demolition device during detonation	Mission ends

Total points in the competition

- Journal Paper 100 points
- Presentation 100 points
- Website 50 points
- Poster 25 points
- Video 25 points
- Mission 550 points

Total points **850 points**