RANGER PROP BUILDING INSTRUCTIONS & PHOTOS

Companies should be aware that tolerances in lengths of cut pipe and length of pipe inserted into joints can change the overall dimensions of product demonstration tasks. Except where noted, companies should expect tolerances in all product demonstration props, and should build their ROVs and tools accordingly. In no case should the dimensions given in this document for a product demonstration prop be used to calibrate a measuring device.

Home Depot part numbers are given for certain construction items. However, some Home Depot stores may not carry the listed items. If the local Home Depot does not carry the part in question, MATE recommends checking other local hardware stores or online sources, such as those listed below, for the required component.

http://www.pvcfittingsonline.com/
http://pvcpipesupplies.com/pvc-fittings/schedule-40-pvc-fittings/

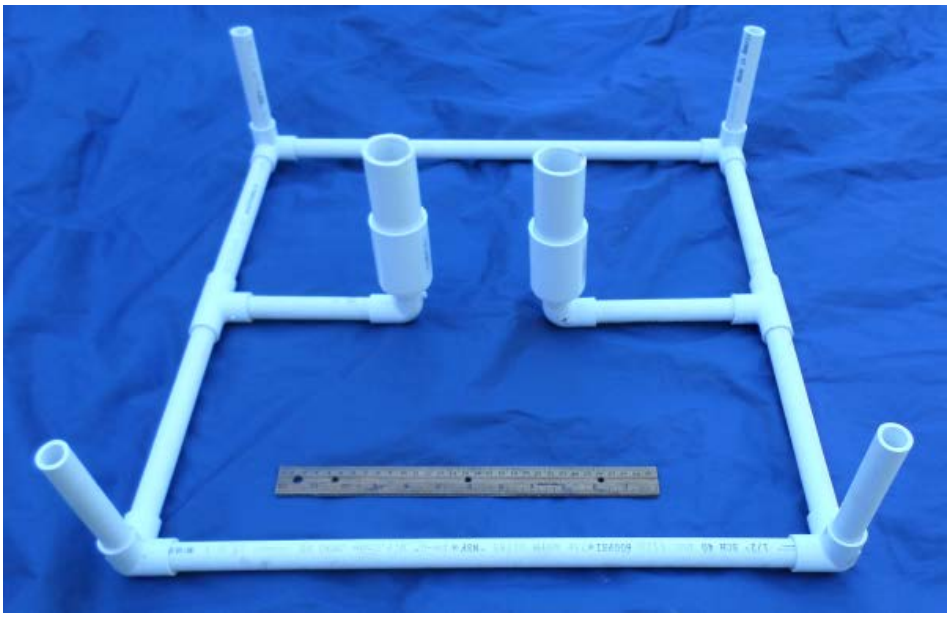
TASK 1: COMMERCE: HYPERLOOP CONSTRUCTION

Baseplate
The baseplate is constructed from ½-inch PVC pipe. To construct the baseplate:

1. Cut two 48 cm lengths of PVC pipe and four 22.2 cm lengths of PVC pipe. Insert two of the 22.2 cm lengths of pipe into the side openings of a tee. Insert the other two 22.2 cm lengths of pipe into the side openings of another tee. With the tee between them, the two 22.2 cm lengths of pipe should be 48 cm in overall length.
2. Attach a ½-inch sideout (corner piece) to the ends of the 48 cm lengths of PVC pipe to form a square. Orient all the sideouts so their remaining openings face upwards. Orient the two tees so they are horizontal, the middle opening parallel to the bottom of the pool.
3. Cut four 12 cm lengths and two 15 cm lengths of ½-inch PVC pipe. Insert four of the 12 cm lengths of pipe into the remaining openings of the four sideouts at the corners of the baseplate.

RANGER product demonstration build photo #1: The baseplate framework.

4. Insert the two 15 cm lengths of pipe into the middle openings of the two tees. Attach a 90° elbow to the other end of each 15 cm length of pipe. Twist the elbows so the open end faces upwards.
5. Cut two 3.5 cm lengths of ½-inch PVC pipe. Insert these 3.5 cm lengths of pipe into the open ends of each 90° elbow. Attach a 1 ¼-inch to ½-inch reducer bushing (Home Depot model# C437-166, Internet# 100345986, Store SKU# 294268) to the end of each 3.5 cm length of pipe. Attach a 1 ¼-inch PVC coupling to the other end of each reducer bushing.
6. Cut two 10 cm lengths of 1 ¼-inch PVC pipe. Insert the lengths of pipe into the 1 ¼-inch couplings.



RANGER product demonstration build photo #2: The baseplate.

The measurements of the baseplate must be very precise. They must match the measurements of the frame (see below) exactly. The distance between the corners of the baseplate, measured from the exact center of the ½-inch PVC pipe, should be 52 cm. Cut and adjust the lengths of the pipe to these precise measurements.

Use 3/8-inch rebar (actual rebar, not the simulated rebar below) inside the ½-inch pipe to weigh down the baseplate.

Rebar

The rebar will be simulated by ½-inch PVC. Four lengths of rebar will be available; only two need to be inserted into the baseplate. To construct the rebar:

1. Cut four 15 cm lengths of ½-inch PVC pipe. Attach a tee to one end of each 15 cm length of pipe.

RANGER product demonstration build photo #3: Rebar.

Elevator

The elevator will be constructed from a 5-gallon bucket lid. Four 1-inch end caps with 1-inch pipe inserted will hold the four lengths of simulated rebar to be used in the construction. To construct the elevator:

1. Screw four 1-inch end caps into the bottom side of a 5-gallon bucket lid.
2. Cut four 8 cm lengths of 1-inch PVC pipe. Insert the 8 cm lengths of pipe into the four end caps attached to the bucket lid.

Use a dive or other weight to weigh down the bucket lid. Insert the four pieces of simulated rebar into the 1-inch pipe.

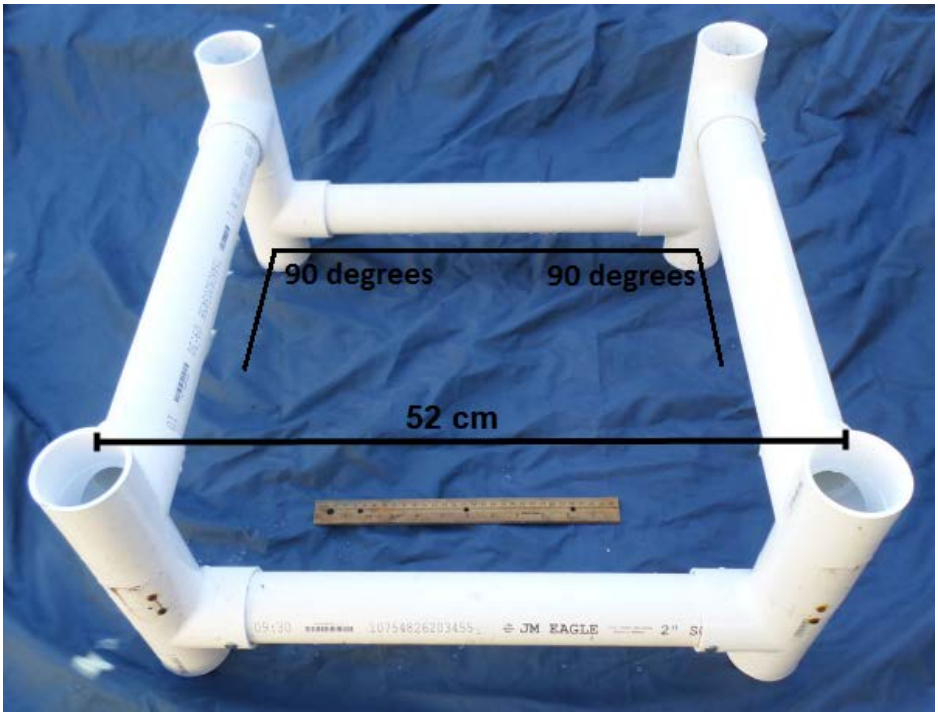
RANGER product demonstration build photo #4: The elevator.

RANGER product demonstration build photo #5: Four lengths of rebar installed on the elevator.

Frame

The frame is constructed from 2-inch PVC pipe and fittings. Chains and ropes will connect to the frame and will allow the frame to be lowered down and manipulated from the surface, side of the pool. To construct the frame:

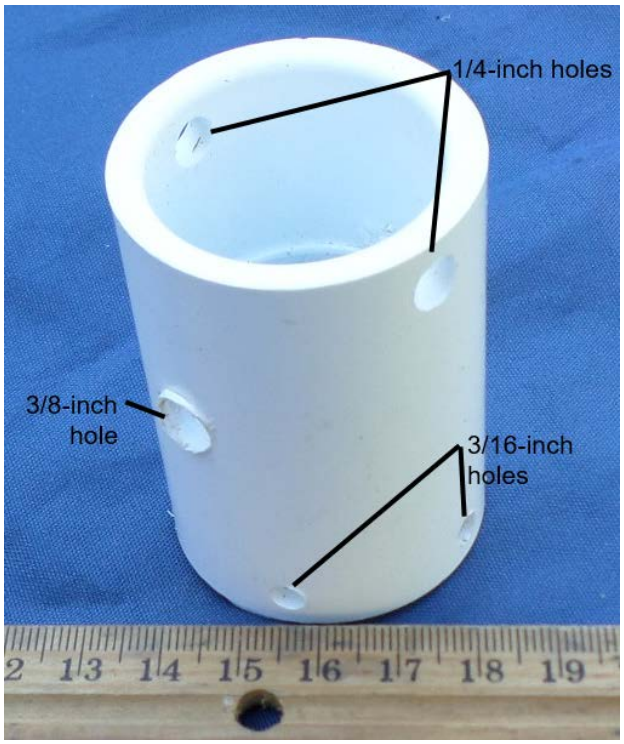
1. Cut four 7 cm lengths of 2-inch PVC pipe. Attach the side opening of a tee to each end of the 7 cm lengths of pipe, eight tees total. Twist the tees so that the middle openings of the two tees attached to each 7 cm length of pipe are perpendicular to one another. Use a framing square, T-square or other tool to confirm the angle between the two middle openings is 90^{o}.
2. Cut four 45 cm lengths of 2-inch PVC pipe. Insert the 45 cm lengths of pipe into the middle openings of the eight tees, creating a square.



RANGER product demonstration build photo #6: The frame.

The measurements of the frame must be very precise. They must match the measurements of the baseplate (see above) exactly. The distance between the corners of the frame, measured from the exact center of the 2-inch PVC tees, should be 52 cm. Cut and adjust the lengths of the pipe to these precise measurements. The MATE Center recommends verifying that the frame fits over the baseplate, with the center of the 2-inch tees matching the 12 cm long ½-inch pipes at the corners of the baseplate and that the angles of the frame are all 90°. Once the frame is properly aligned, insert screws into the frame at every tee/pipe connection to keep it from twisting out of alignment.

3. Drill four 3/16-holes at 90° angles around one end of a 1-inch PVC coupling. These four holes should be within 5 mm of the edge of the coupling. Drill two ¼-inch holes across from each other at the other end of the 1-inch coupling. Drill two 3/8-inch holes through opposite sides of the middle of 1-inch coupling.



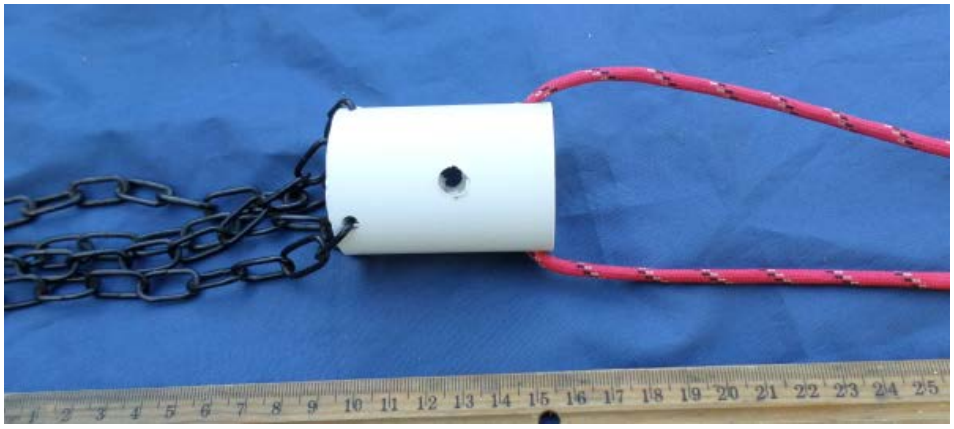
RANGER product demonstration build photo #7: The coupling with holes drilled. Two 3/16-inch holes and one 3/8-inch hole are not seen in this view.

4. Cut four 1.5 meter lengths of #100 black chain (Home Depot model# 810016, internet# 204640736, Store SKU# 444895). Use pliers to open up the chain link at one end of the 1.5 meter length of chain. Insert this open link through one of the four 3/6-inch holes at one end of the coupling.

RANGER product demonstration build photo #8: Opened chain link and the opened chain link through the coupling.

5. Once the link is inserted through the hole, use the pliers to close the link of the chain.

6. Repeat this process for the other three chains, inserting the open links into the other three 3/16-inch holes around the coupling. Close up each link after inserting it through the hole.
7. Cut a length of 1/8-inch nylon-poly blend rope (Home Depot model# 12715, Internet #203602865, Store SKU# 498533) equal to 2.5 times the depth of the pool. Insert this rope through the two ¼-inch holes at the other end of the 1-inch coupling.



RANGER product demonstration build photo #9: Rope and chains through the coupling.

8. Drill a 5/8-inch hole in the inside edge of the four 2-inch tees on the top of the frame. These holes should be approximately 3 cm from the top edge of the tees.

RANGER product demonstration build photo #10: Hole in the inside top of the frame.

9. Insert one of the four chains through each of the 5/8-inch holes, running the chain from inside the 2-inch tee, through the hole, and out towards the middle of the frame.
10. Bring all four loose ends of the chain and insert them inside the 1-inch coupling. Insert a galvanized steel tent stake (Amazon: https://www.amazon.com/10-Piece-Galvanized-Steel-Tent-Pegs/dp/B003TMPCT0/ref=sr_1_7?s=outdoor-recreation&ie=UTF8&qid=1477946450&sr=1-

7&keywords=tent+stakes) through one 3/8-inch hole drilled into the middle of the coupling, through the final link of all four loose ends of the chain, and out the other 3/8-inch hole drilled in the opposite side of the coupling.

RANGER product demonstration build photo #11: Chain through hole in the frame.

RANGER product demonstration build photo #12: Tent stake.

RANGER product demonstration build photo #13: All four chains held in place in the coupling.

RANGER product demonstration build photo #14: The frame.

Hose

The hose for pouring concrete will be constructed from at least 3.5 meters of garden hose. A hose to PVC adapter will be attached to the end of the hose. A #310 U-bolt attached to a 1-inch PVC cross will provide a grab-point for the end of the hose. To construct the hose for pouring concrete:

1. Drill two ¼-inch holes 5.8 cm apart in the center of a 1-inch cross. Install a #310 U-bolt (Home Depot model# 806826, Internet# 204273753, Store SKU# 117996) into the middle of a 1-inch PVC cross. The U-bolt will go into two opposite openings of the PVC cross.
2. Insert a 1-inch to ½-inch PVC reducer bushing into one of the openings of the cross that does not have the U-bolt.
3. Cut a 3.5 cm length of ½-inch PVC pipe. Insert this pipe into the reducer bushing. Attach a ½-inch to ¾-inch hose fitting to the other end of this 3.5 cm length of pipe. Use a ½-inch x ¾-inch MHT fitting (Home Depot model#53362, Internet #202257137, Store SKU #685822) or a ½-inch x ¾-inch FHT fitting (Home Depot model #53368, Internet #100373244, Store SKU #879288). The type of hose fitting will depend on the end of the hose that will be attached.

4. Insert the hose into the hose adapter.

RANGER product demonstration build photo #15: The PVC end of the hose for pouring cement and the hose attached to the PVC end.

Positioning Beacons

The positioning beacons will be constructed from 1 ¼-inch PVC couplings. Two strips of industrial strength Velcro will be attached each coupling. To construct the positioning beacons:

1. Cut two 5 cm by 2 cm rectangles of industrial strength Velcro hooks.
2. Attach the Velcro hook strips to opposite sides of the coupling.

RANGER product demonstration build photo #16: Positioning beacon.

TASK 2: ENTERTAINMENT: LIGHT AND WATER SHOW MAINTENANCE

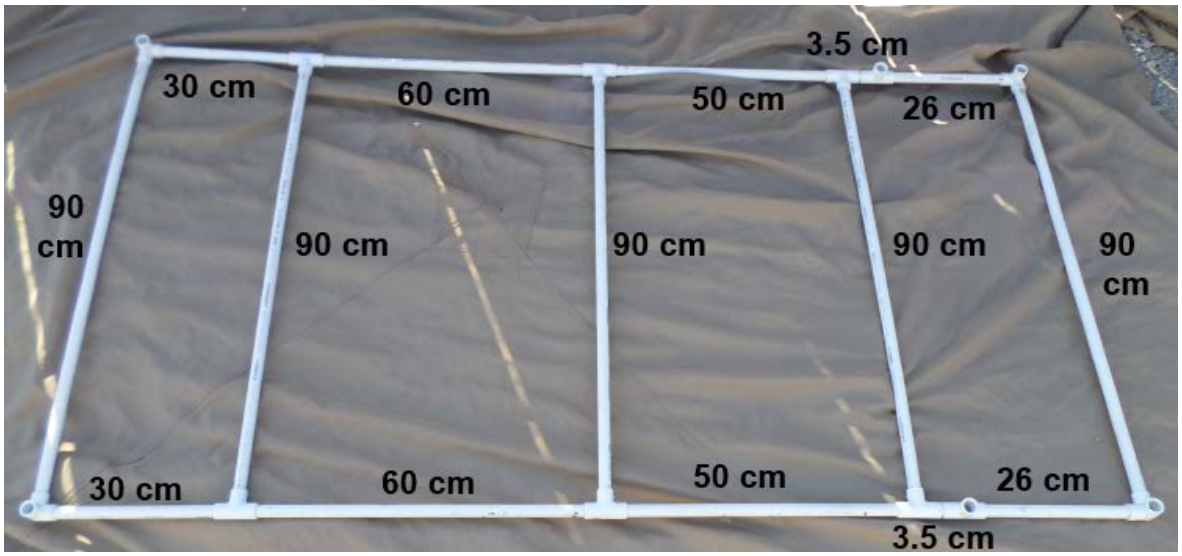
Standard Platform

The standard platform will be used in pool venues that are 2 meters, or deeper, in depth. Contact your regional coordinator to determine whether the regional will use the standard platform or the shallow water platform (see below prop building instructions for the shallow water platform).

The standard platform framework will be constructed of ½-inch PVC pipe. A corrugated plastic sheet will cover the top and one side of the platform framework. To construct the standard platform framework:

1. Cut five 90 cm lengths, two 60 cm lengths, two 50 cm lengths, two 30 cm lengths, two 26 cm lengths, and two 3.5 cm lengths of ½-inch PVC pipe.
2. Take a 30 cm length and attach the side opening of a PVC tee to one end. Insert a 60 cm length of PVC pipe into the other side opening of the PVC tee. Attach the side opening of another PVC tee to the other end of the 60 cm length of pipe. Insert a 50 cm length of pipe into the other side opening of the PVC tee. Attach the side opening of another PVC tee to the other end of the 50 cm length of pipe. Insert a 3.5 cm length of pipe into the other side opening of the PVC tee. Attach the side opening of another PVC tee to the other end of the 3.5 cm length of pipe. Turn this tee perpendicular to the other tees. Insert a 26 cm length of pipe into the other side opening of the PVC tee.
3. Attach a ½-inch sideout (3-way) to the 30 cm pipe on one end of the combined segments of pipe. Attach a different ½-inch sideout to the 26 cm pipe on the other end of the combined segments of pipe.
4. Repeat steps two and three, making a second combined section of pipe. The sections should contain: a sideout, 30 cm pipe, tee, 60 cm pipe, tee, 50 cm pipe, tee, 3.5 cm pipe, tee, 26 cm pipe, sideout.
5. Use the five 90 cm lengths of pipe to connect the combined sections of pipe. Two of the 90 cm lengths go into the two sideouts on either end. The other three 90 cm lengths go into the tees between the 30 cm length and the 60 cm length, the tee between 60 cm length and 50 cm length, and the tee between the 50 cm length and the 3.5 cm length.

This will make one sidewall of the platform.



RANGER product demonstration build photo #17: Sidewall of the standard platform.

6. Repeat steps 1 through 5 to make a second sidewall of the platform.
7. Cut four 115 cm lengths and four 56 cm lengths of ½-inch PVC pipe.
8. Line up the two sidewalls of the platform so the 60 cm lengths and 50 cm lengths are across from each other (symmetrical). Use the four 115 cm lengths of pipe to join the two sidewalls at the corners, inserting the 115 cm lengths of pipe into the sideouts at each corner.
9. Insert two 56 cm lengths of pipe into the side openings of a ½-inch PVC tee. This should make a combined length of approximately 115 cm. Repeat this with the other two 56 cm lengths of pipe and a second tee.
10. Insert these combined 115 cm lengths of pipe into the remaining middle openings of the tees. These tees should be located between the 3.5 cm and the 26 cm lengths of PVC pipe.

RANGER product demonstration build photo #18: Framework of the standard platform.

Shallow Water Platform

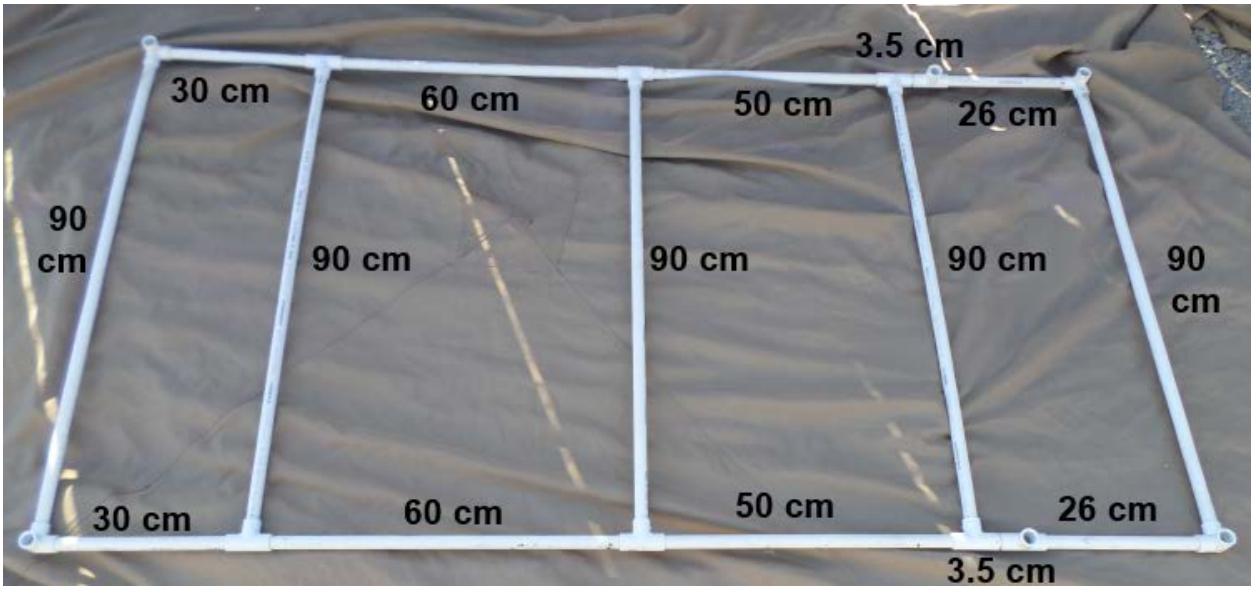
The shallow water platform will be used in pool venues that are less than 2 meters deep. Contact your regional coordinator to determine whether the regional will use the shallow water platform or the standard platform.

The shallow water platform framework will be constructed of ½-inch PVC pipe. There will be an upper section and a lower section. A corrugated plastic sheet will cover the top of the upper and lower sections. The side wall between the upper and lower sections will be covered with corrugated plastic as well. To construct the shallow water platform framework:

1. Cut five 90 cm lengths, two 60 cm lengths, two 50 cm lengths, two 30 cm lengths, two 26 cm lengths, and two 3.5 cm lengths of ½-inch PVC pipe.
2. Take a 30 cm length and attach the side opening of a PVC tee to one end. Insert a 60 cm length of PVC pipe into the other side opening of the PVC tee. Attach the side opening of another PVC tee to the other end of the 60 cm length of pipe. Insert a 50 cm length of pipe into the other side opening of the PVC tee. Attach the side opening of another PVC tee to the other end of the 50 cm length of pipe. Insert a 3.5 cm length of pipe into the other side opening of the PVC tee. Attach the side opening of another PVC tee to the other end of the 3.5 cm length of pipe. Turn this tee perpendicular to the other tees. Insert a 26 cm length of pipe into the other side opening of the PVC tee.
3. Attach a ½-inch sideout (3-way) to the 30 cm pipe on one end of the combined segments of pipe. Attach a different ½-inch sideout to the 26 cm pipe on the other end of the combined segments of pipe.

4. Repeat steps two and three, making a second combined section of pipe. The sections should contain: a sideout, 30 cm pipe, tee, 60 cm pipe, tee, 50 cm pipe, tee, 3.5 cm pipe, tee, 26 cm pipe, sideout.
5. Use the five 90 cm lengths of pipe to connect the combined sections of pipe. Two of the 90 cm lengths go into the two sideouts on either end. The other three 90 cm lengths go into the tees between the 30 cm and the 60 cm lengths of pipe, the tee between 60 cm and 50 cm lengths of pipe, and the tee between the 50 cm and the 3.5 cm lengths of pipe.

This will make one sidewall of the platform.



RANGER product demonstration build photo #19: Sidewall of the shallow water platform.

6. Repeat steps 1 through 5 to make a second sidewall of the platform.
7. Cut four 115 cm lengths and four 56 cm lengths of ½-inch PVC pipe.
8. Line up the two sidewalls of the platform so the 60 cm lengths and 50 cm lengths are across from each other (symmetrical). Use the four 115 cm lengths of pipe to join the two sidewalls at the corners, inserting the 115 cm lengths of pipe into the sideouts at each corner.
9. Insert two 56 cm lengths of pipe into the side openings of a ½-inch PVC tee. This should make a combined length of approximately 115 cm. Repeat this with the other two 56 cm lengths of pipe and a second tee.
10. Insert these combined 115 cm lengths of pipe into the remaining middle openings of the tees. These tees should be located between the 3.5 cm and the 26 cm lengths of PVC pipe.

RANGER product demonstration build photo #20: Framework of the shallow water platform.

The shallow water platform has an additional lower platform level at 10 cm above the pool bottom. This additional platform level will be attached to the 120 cm wide end, adjacent to the 26 cm lengths of PVC pipe on the side wall. To construct the additional lower platform level:

1. Remove the 90 cm length of vertical pipe in the sideout that is adjacent to the 26 cm length of pipe.
2. Cut a 5 cm length of pipe from the 90 cm length of pipe removed from the platform framework. Insert this 5 cm length of pipe into the sideout on the bottom of the platform. Attach the side opening of a ½-inch tee to the other end of this 5 cm length of pipe. Cut another 3 cm from the now 85 cm length of pipe, and discard. Insert the 82 cm length of pipe (90 cm minus 5 cm minus 3 cm) into the other side opening of the tee, and insert the top end into the sideout at the top of the framework.
3. Repeat steps 1 and 2 for the 90 cm vertical length of pipe on the sidewall of the shallow water platform.
4. Cut two 115 cm length of ½-inch PVC pipe, four 50 cm lengths of ½-inch PVC pipe, and two 5 cm lengths of ½-inch PVC pipe.
5. Insert two 50 cm lengths of pipe into the side openings of a ½-inch tee. Insert the other two 50 cm lengths of pipe into the side openings of another tee. This should make two 103 cm lengths of pipe with a tee in the middle. Insert these combined 103 cm length of pipes into the tees inserted into the 90 cm vertical pipes (step 2). Rotate the two tees so the middle openings of each tee face each other. Insert one of the two 115 cm lengths of PVC pipe into the middle openings of these two tees.

6. Attach a 90° elbow to the end of each 103 cm combined length of pipe. Insert a 5 cm length of pipe into the open end of each 90° elbow. Attach another 90° elbow to the other end of each 5 cm length of pipe. Rotate the two elbows so the remaining openings face each other. Insert the 115 cm length of PVC pipe into the two remaining openings of the two 90° elbows.

RANGER product demonstration build photo #21: Framework of the shallow water platform.

Locking Mechanism:
The locking mechanism will be located inside the platform framework. The locking mechanism will be constructed from a 1-inch PVC cross that rests on ½-inch PVC. The locking mechanism will be located approximately 40 cm up the vertical PVC pipe inside the platform framework.

1. Cut a 45 cm length, a 35 cm length, a 12 cm length, two 5.5 cm lengths, and four 2.5 cm lengths of PVC pipe.
2. Insert the 35 cm length of pipe into the middle opening of the tee (56 cm length, tee, 56 cm length) on the bottom crosspiece of the framework. Attach a PVC cross to the topside other end of the 35 cm length of pipe. Insert a 3.5 cm length of PVC pipe into the opening of the cross opposite of the 35 cm length. Attach a ½-inch PVC coupling to the other end of the 3.5 cm length of pipe. Insert another 3.5 cm length of pipe into the other end of the coupling. Attach another coupling to the other end of this 3.5 cm pipe.
3. Insert the remaining two 3.5 cm lengths of pipe into the two remaining side openings of the ½-inch cross. Attach a 90° elbow to the other end of each 3.5 cm length of pipe. Insert the two 5.5 cm lengths of pipe into the open ends of the two 90° elbows.
4. Twist the cross so it is perpendicular to the sidewalls of the framework, parallel to the closest back wall of the platform framework. Twist the two 90° elbows so they angle about 20 degrees back towards the back wall of the platform framework (see photo #5).

RANGER product demonstration build photo #22: Locking mechanism internal, front and side view.

5. Install a 1-inch PVC cross over the two ½-inch couplings. It should fit over the couplings with the bottom opening resting against the ½-inch tee. Insert a 1-inch to ½-inch reducer bushing into a side opening of the 1-inch PVC cross. Insert the 12 cm length of ½-inch pipe into the reducer bushing.

The 1-inch PVC cross should rotate 180° around the ½-inch couplings. The 5.5 cm lengths of pipe attached to the 90° elbows act as backstops to the rotation. Adjust the angle of the two 90° elbows as needed to create the stopping point for the 12 cm pipe at opposite ends of the 180° rotation.

6. Insert the 45 cm length of pipe into the open end of the ½-inch coupling. The top end of this 45 cm length of pipe should fit into the middle opening of the tee at the top of the platform framework.

RANGER product demonstration build photo #23: Locking mechanism; locked (left) and unlocked (right).

Corrugated Plastic Sheeting

The standard platform framework and the upper section of the shallow water framework, should be approximately 1.8 meters long, 1.2 meters wide, and 1 meter tall. Cut a 1.8 meter by 1.2 meter rectangle of corrugated plastic sheeting. Use screws to attach this sheeting onto the top side of the platform framework. Cut a 1.2 meter by 0.9 meter rectangle of corrugated plastic sheeting. Use screws to attach this sheeting onto the back wall of the platform, the side closest to the locking mechanism.

For the shallow water platform, cut an additional rectangle of corrugated plastic that is 1 meter by 1.2 meters. Use screws to attach this sheeting onto the top side of the lower section of the shallow water platform.

RANGER product demonstration build photo #24: Standard platform.

RANGER product demonstration build photo #25: Shallow water platform.

Use screws to hold the platform framework together and to secure the corrugated plastic to the frame.

Power Cable Connector

The cable connector will be constructed from 1-inch PVC pipe. A screw hook and a screw eye act as grab points for the cable connector. 2 meters of wire are attached to the power cable connector. To construct the power cable connector:

1. Cut a 16 cm length of 1-inch PVC pipe. Insert it into one opening of a 1-inch PVC cross.
2. Cut an 8 cm length of 1-inch PVC pipe. Insert it into the opposite opening of a 1-inch PVC cross. Attach a 1-inch end cap to the other end of this 8 cm length of PVC pipe.
3. Drill a 3/16 hole in the center of PVC end cap. Twist a #6 screw eye (Home Depot part # 803682, internet #204273860, Store SKU #727432) into the center hole until all but 1 to 3 mm of threads are inside the plastic of the end cap. The eye should be horizontal, parallel to the side openings of the central PVC cross.
4. Drill a 1/8-inch hole half way between the center of the end cap and the bottom edge of the end cap. Cut a 2 meter length of 18-gauge red/black power wire. Insert one end of this wire into this hole and tie an overhand knot in the wire to secure it inside the end cap. Tie the other end of the 2 meters of wire to a dive or other weight. This weight should be placed approximately 1 meter from the power cable connecter in the power port.
5. Screw a #8 screw hook (Home Depot part #803272, internet #204273853, Store SKU #727320) into the top center of the 1-inch plus. Insert the screw hook until all but 1 to 3 millimeters of thread are visible. Twist the screw hook until the top end faces the back of the cable connector, the 1-inch end cap.

RANGER product demonstration build photo #26: The cable connector.

Design note: The RANGER power cable connector is the 2016 ESP cable connector. The 8 meters of rope has been replaced with 2 meters of wire.

Power Port

The port is constructed from a 20 cm length of 2-inch PVC. This 20 cm length of PVC pipe is attached to the ½-inch platform framework. To construct the power port:

1. Cut a 20 cm length of 2-inch PVC pipe. Attach a 2-inch coupling to one end of the pipe. Insert a 2-inch to ½-inch reducer bushing (Home Depot model# C437-247, Internet #100343801, Store SKU# 744724) into the coupling.

RANGER product demonstration build photo #27: The power port.

Attach the port to the bottom corner of the platform, into the 30 cm length of PVC pipe. To attach the port:

1. Remove the 30 cm length of pipe on the bottom corner of the framework. Cut a 3.5 cm length from this 30 cm of pipe. Insert the 3.5 cm length of pipe into the side opening of a ½-inch tee. Insert the remaining 26.5 cm of pipe into the other side opening of the tee. Use a ruler to measure the overall length. Cut the 26.5 cm pipe down until the entire length is 30 cm. Return this 30 cm length of pipe, now with a tee at one end, into the bottom corner of the framework. The tee should be adjacent to the sideout at the corner.
2. Cut a 3.5 cm length of pipe and insert it into the middle opening of the tee. Rotate the tee so it sticks up at a 45^{o} angle. Attach a 45^{o} elbow to the other end of the 3.5 cm length of pipe.
3. Cut another 3.5 cm length of pipe and insert it into the open end of the 45^{o} elbow. Twist the elbow so the pipe is parallel to the bottom of the pool. Attach the 2-inch to ½-inch reducer bushing (part of the power port) onto the end of the 3.5 cm length of pipe. The power port should be parallel to the bottom of the pool and just above the bottom of the pool.

RANGER product demonstration build photo #28: The power port attached to the platform.

Valve

The valve is located on the same corner of the platform framework. The valve is constructed from a ½-inch gate valve. A ½-inch cross with 20 cm lengths of pipe serve as a handle to turn the valve. To construct the valve:

1. Attach a ½-inch male adapter into both ends of a ½-inch brass gate valve (Home Depot Model# 170-2-12-EB, Internet# 205816192, Store SKU# 867855). Use zip ties to secure a ½-inch PVC cross onto the valve handle; use 2 or 3 zip ties to secure the cross tightly.
2. Cut four 20 cm lengths of ½-inch PVC pipe. Insert them into the four openings of the PVC cross. Paint one of the 20 cm lengths of pipe red, or other bright color. This will aid in determining whether the valve has been turned 1080^{o} (3 times around).
3. Remove the vertical, 90 cm length of pipe in the same corner where the power port is attached (see power port, above).
4. Cut 40 cm from the 90 cm length of pipe removed from the framework. Attach one of the male adapters on the end of the gate valve to one end of the 40 cm of pipe. Insert the remaining 60 cm of pipe into the male adapter on the other side of the gate valve. Cut this 60 cm pipe so the total length (40 cm, gate valve, 60 cm pipe) is 90 cm.
5. Insert this 90 cm combined pipe back into the sideouts where the 90 cm pipe was removed. The 40 cm length of pipe can go either on the top end or bottom end of the 90 cm length. Rotate the valve so the handle (PVC cross) is outside of the platform.

RANGER product demonstration build photo #29: The valve.

RANGER product demonstration build photo #30: The valve on the platform

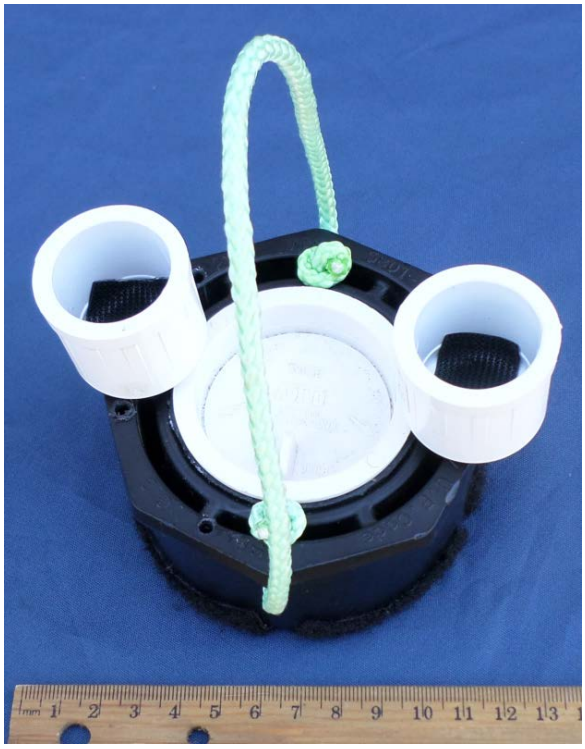
Fountain

The fountain (old and new) is constructed from an ABS 3-inch to 2-inch reducer bushing (Home Depot model #C58012FHD32, Internet #100343802, store SKU # 188301). It has two ½-inch PVC end caps screwed into the top side. To construct the fountain:

1. Cut a 2 cm length of 2-inch PVC pipe. Insert the 2 cm length of pipe into the 2 cm opening on the reducer bushing.
2. Insert a 2-inch knockout cap (Home Depot model #39101, Internet #100137732, Store SKU #508257) into the 2-inch pipe.
3. Use a screw to secure a ½-inch PVC end cap to the outside of the top edge of the 3-inch to 2-inch ABS reducer bushing. The screw should go straight down into the side wall of the bushing. Repeat this one more time (two end caps total) at opposite sides of the bushing.
4. Cut a 40 cm length of 1/8-inch polypropylene rope (Home Depot part #72402, internet #205804755, Store SKU #402816). Drill two 3/16-inch holes through the top side wall of the wellhead cap on opposite sides. Push the 40 cm length of rope through both 3/16-inch holes. Tie an overhand knot on the ends of each rope to secure the rope to the wellhead cap.

Design note: The fountain for the 2017 task is almost identical to the wellhead cap from the 2016 product demonstration tasks. The 2017 fountains do not require the Velcro add-ons required for the wellhead cap. However, the Velcro does not affect the task in any way and may be included. If you wish to add the Velcro:

1. Cut two 1.8 cm x 1.8 cm squares of Velcro hooks. Adhere the sticky side of the Velcro to the inside bottom surface of the two end caps, over the screw heads holding them in place.
2. Cut four 5 cm x 3 cm lengths of Velcro loops. Attach them around the bottom, angled end of the 3-inch to 2-inch reducer bushing.



RANGER product demonstration build photo #31: The fountain.

A small piece of flotation can be added to the top of the rope to keep it upright in the water.

A small washer or other weight can be added inside the 2-inch knockout cap to provide additional weight if necessary.

RANGER product demonstration build photo #32: 1-inch end cap holder for fountain.

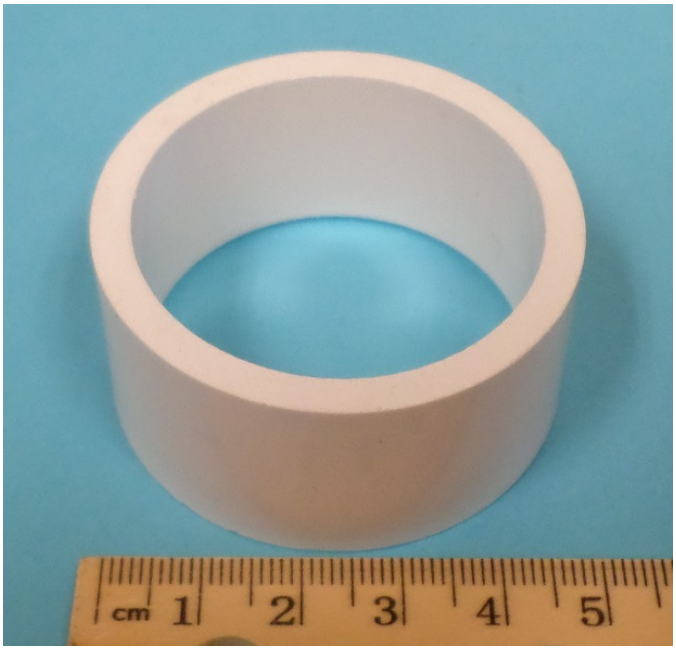
RANGER product demonstration build photo #33: The fountain on the platform.

TASK 3: HEALTH: ENVIRONMENTAL CLEANUP

Clams

The clams are constructed from 2 to 3 cm lengths of 1 ½-inch pipe or 2 to 3 cm lengths of 1 ¼-inch couplings. To construct the clams:

1. Cut 25 or more 2 to 3 cm lengths of 1 ½-inch pipe or 1 ¼-inch couplings.

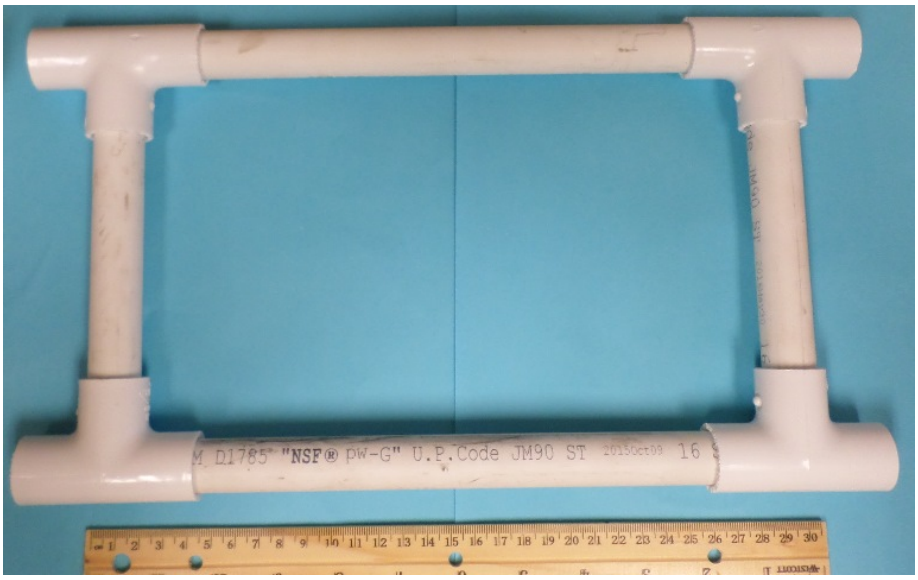


RANGER product demonstration build photo #34: One clam.

Clam Bed:

The 25 (or more) clams will be piled in a small clam bed constructed from ½-inch PVC pipe. The clam bed will be 33 cm by 20 cm. To construct the clam bed:

1. Cut two 24 cm lengths and two 13.5 cm lengths of ½-inch PVC pipe. Attach a side opening of a ½-inch PVC tee to each end of the 24 cm lengths of pipe, four tees in all. Insert the two 13.5 cm lengths of pipe into the middle openings of the four tees, creating a rectangle 33 cm in length and 20 cm wide.
2. Pile 25 or more clams randomly into the bed.



RANGER product demonstration build photo #35: Clam bed.

RANGER product demonstration build photo #36: Clam bed with 28 clams.

Sediment

The sediment sample will be simulated by agar. The "recipe" used to create the microbial mat is 2 teaspoons of agar per 550 mL of water. A few drops of food coloring can be used as well. The agar will be contained in a 16 oz., 550 ml, red plastic cup (check grocery and other stores). To make agar:

1. Using a cooking pot or other container that can be heated, soak the agar in water for 10 to 15 minutes.

2. Bring the water to a gentle boil and simmer while stirring until the agar dissolves completely. To completely dissolve the agar takes about 5 minutes for powder, 10 to 15 minutes for flakes.
3. Let the agar cool in the pot for about 5 minutes, and then pour the agar mixture into a 16 oz cup. Fill the 550 ml cup completely.
4. Cut a 2 cm x 2 cm square of Velcro hooks. Once the agar has cooled, attach this Velcro square to the bottom of the cup.

Note: The consistency of agar may vary with type of agar used and other factors. The agar sample should be solid, but easy to penetrate to retrieve samples. Modify the agar recipe as needed to get the consistency desired.

The cup containing the solidified agar is nested within a second plastic cup that has been secured to a sheet of plastic. The sheet of plastic, in turn, is weighted and set on the bottom of the pool.

5. Cut a 30 cm x 15 cm rectangle of corrugated plastic.
6. Cut a 2 cm x 5 cm square of Velcro hooks. Attach this Velcro square to the inside bottom of a 550 ml, (16 oz.) red plastic cup.
7. Position the cup in the center of the corrugated plastic square. Use two small screws (1/2-inch sheet metal screws) to attach the plastic cup to the center of the corrugated plastic. The heads of the screws should be inside of the plastic cup and penetrate down through the Velcro square, securing it to the cup, through the cup and through the corrugated plastic sheet.

RANGER build photo #37: Top view of empty agar cup holder

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RANGER build photo #38: Side view of empty agar cup holder.

RANGER build photo #39: Full agar cup sitting next to empty agar cup holder.

RANGER build photo #40: Full agar cup nestled into agar cup holder.

Plastic cups containing agar can be fitted into the holding cup for each product demonstration run. After a mission run, used agar containers can be easily removed and discarded. Use dive weights, bricks or other heavy objects to secure the corrugated plastic container to the pool bottom.

Each product demonstration station will have two plastic cups containing agar.

Cap

The cap is constructed from the lid of a Rubbermaid Roughneck plastic tote. The lid is 60 cm by 40 cm wide. A 1-inch PVC handle will be a lift point for the lid. To construct the lid:

1. Cut a 15 cm length and two 4 cm lengths of 1-inch PVC pipe. Attach a 1-inch 90^{o} elbow to each end of the pipe. Insert a 4 cm length of pipe into the other ends of the two 90^{o} elbows. Attach a 1-inch coupling to the other end of each 4 cm length of pipe. Insert a 1-inch to ½-inch reducer bushing into the other end of each coupling.
2. Cut two 3.5 cm lengths of ½-inch PVC pipe. Insert these two 3.5 cm lengths of pipe into the two reducer bushings.
3. Cut two 2.2 cm diameter holes in the Rubbermaid lid, 20 cm apart. These holes should be just large enough so the ½-inch PVC pipe fits through them. Push the two 3.5 cm lengths of ½-inch pipe through these holes.
4. Attach a 2-inch to ½-inch reducer bushing to the end of the 3.5 cm lengths of pipe that protrudes though the plastic lid.

Push the reducer bushings tightly against the plastic of the lid. The reducer bushings provide area to secure the handle to the lid.

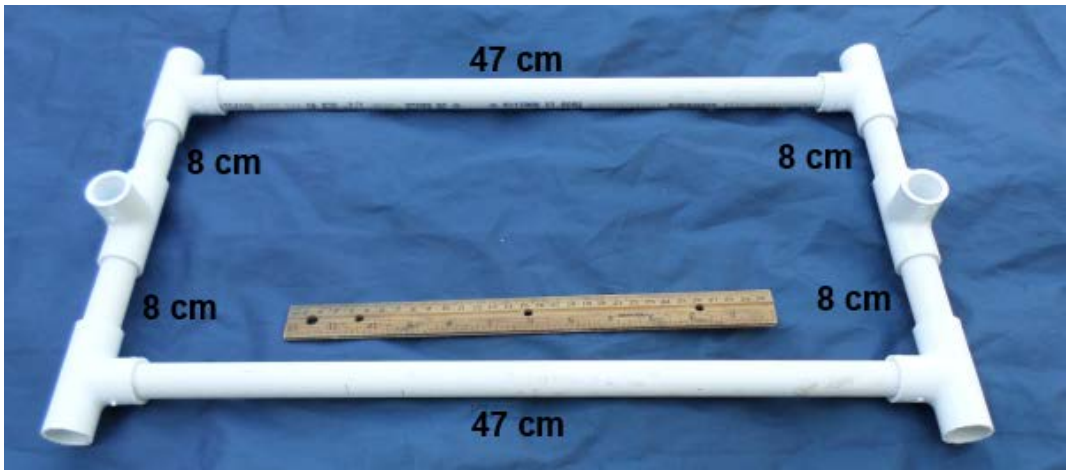
RANGER build photo #41: Cap with 1-inch PVC handle.

TASK 4: SAFETY: RISK MITIGATION

Containers

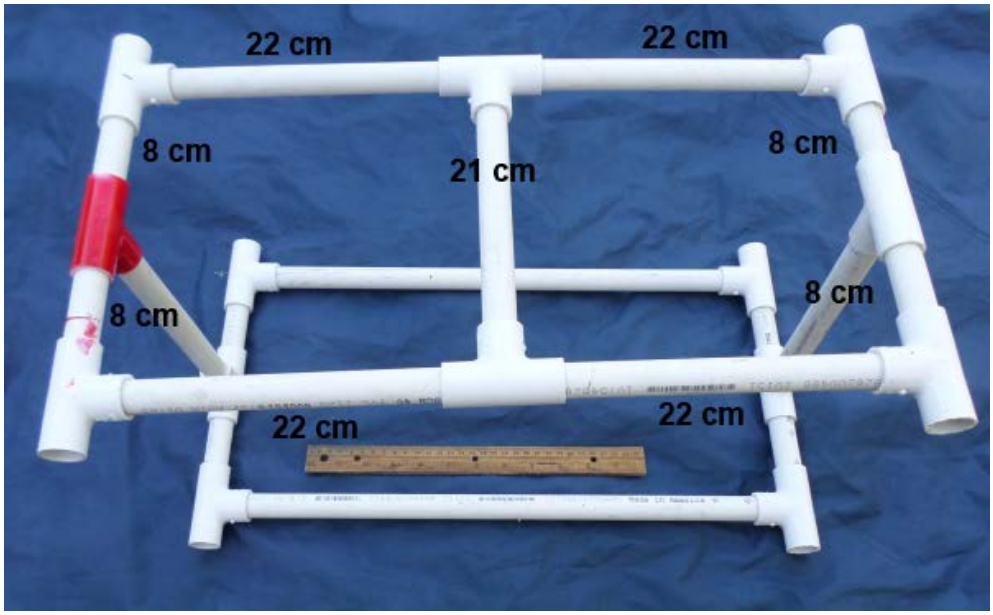
The four containers will be constructed from ½-inch PVC pipe. A #310 U-bolt at the top will be used to attach the buoy and to designate the center of the container for distance and direction measurements. To construct the containers:

1. Cut two 47 cm lengths and four 8 cm lengths of 1/2-inch PVC pipe.
2. Attach the middle opening of a PVC tee to each end of the 47 cm lengths of pipe, four tees total. Insert two of the 8 cm lengths of pipe into the side openings of a ½-inch tee. Insert the other two 8 cm lengths of pipe into the side openings of a second PVC tee.
3. Insert the other ends of each 8 cm lengths of pipe into one of the side openings of the PVC tees attached to each 47 cm length of pipe. This should make a rectangle approximately 50 cm x 30 cm. Rotate the middle openings of the two tees between the 8 cm lengths of pipe to face upwards.



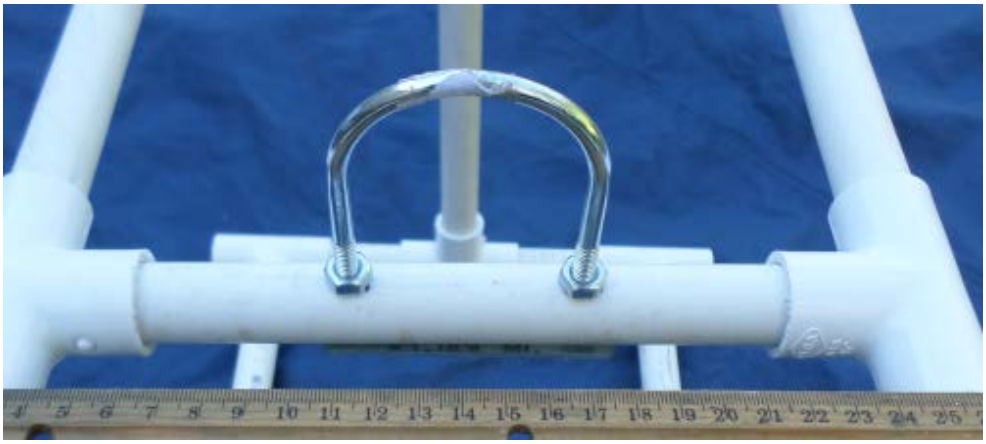
RANGER build photo #42: Bottom framework of a container.

4. Cut four 22 cm lengths of ½-inch PVC pipe. Insert two 22 cm lengths into the side openings of a PVC tee to make a combined 47 cm length of pipe. Repeat steps 1 through 3 to make a second half of the container framework, using these combined 47 cm lengths of pipe.
5. Cut a 21 cm length of pipe and insert it into the middle openings on the two tees in the center of each combined 47 cm length of pipe.
6. Remove one of the PVC tees between two 8 cm lengths of pipe on this second half of the framework and paint it red. When the paint has dried, return the tee to its position.
7. Cut two 24 cm lengths of ½-inch pipe. Insert these two 24 cm lengths of pipe into the middle openings of the two tees between the 8 cm lengths of pipe. This will make a container 50 cm x 30 cm x 30 cm.



RANGER build photo #43: Framework of a container.

8. Drill two ¼-inch holes 5.8 cm apart in the center of the 21 cm length of PVC pipe across the top center of the container. Insert a #310 U-bolt through these two ¼-inch drill holes. Use the ¼-inch – 20 nuts to secure the U-bolt in the top center of the container.

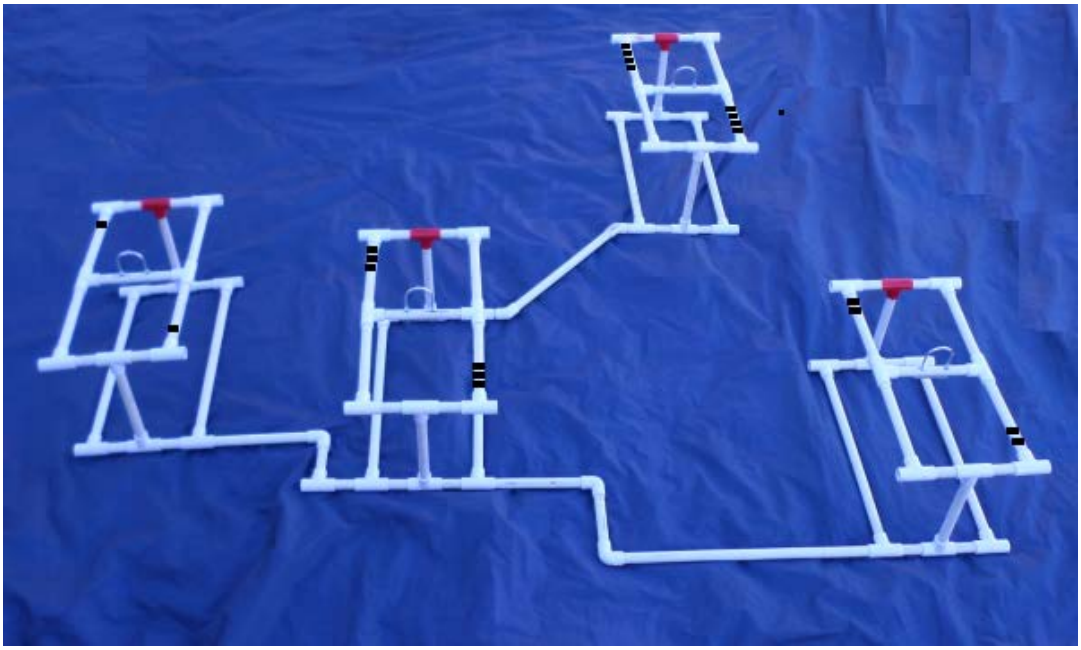


RANGER build photo #44: U-bolt installed at the top, center of the container.

RANGER build photo #45: A cargo container.

Repeat steps 1 through 8 to construct four total containers. Mark two opposite upper corners on opposite sides of the container with strips of tape. These marks will designate the four different containers.

Design note: The four containers should be positioned at constant distances and directions from each other. MATE recommends using ½-inch PVC pipes to connect the four containers and keep them from moving. Cut the PVC on the bottom framework of the container and add a tee. Use variable lengths of pipe and elbows to hold the four containers in a spatial arrangement that keeps the distances and directions between the containers constant.



RANGER build photo #46: Four cargo containers.

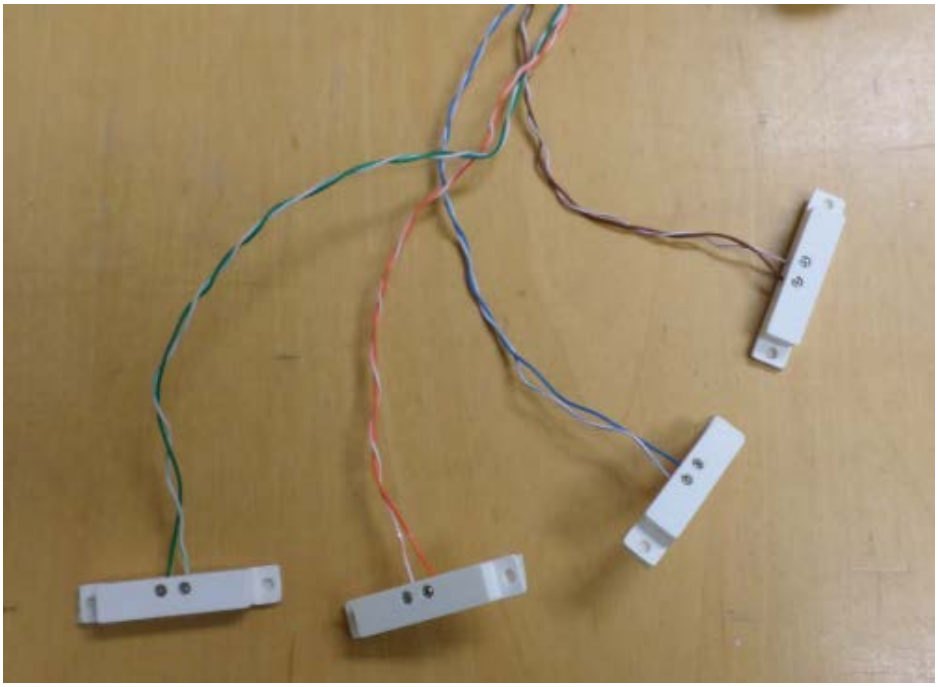
RFID and indicator

The RFID will be constructed from a magnetic reed switch (N-O). A magnetic reed switch (N-O) is a switch that is normally open, but closes and completes the circuit when in the presence of a magnet. Magnetic reed switches will be located on the four containers; the indicators for each switch will be located on the surface, side of the pool. The indicators will respond (buzz and light) when the switch is closed. To construct the RFID magnetic reed switches:

1. Cut a 15 meter length of CAT5 wire (8 strands inside). Strip away 2.5 meters of the plastic sheathing on the CAT5 cable. Strip 1 cm from the end of each of the 8 strands of wire in the CAT5 cable.
2. Attach a magnetic reed switch to each colored pair of wires, one switch to orange and orange/white, one switch to green and green/white, one switch to blue and blue/white, one switch to brown and brown/white. The MATE Center will use the magnetic reed switch located

here https://www.amazon.com/dp/B0011W4YNK?smid=A29PFSLE3D9XFX&th=1, but any magnetic reed switch will work.

3. Insert one of the colored wire pairs into each of the terminal ports on the magnetic reed switch and tighten the screw to secure the wires into the switch. Repeat for the other colored wire pairs using a different magnetic reed switch.
4. Secure a magnetic reed switch to the top of each container on the red colored PVC tee. The magnetic reed switch should be parallel with the long axis of the red colored PVC tee. To protect the CAT5 wires, consider running them through the ½-inch pipe at the top of the container and emerge through the pipe at the bottom corner of the container.
5. Use hot glue or epoxy to waterproof the connection where the wires attach to the magnetic reed switch.



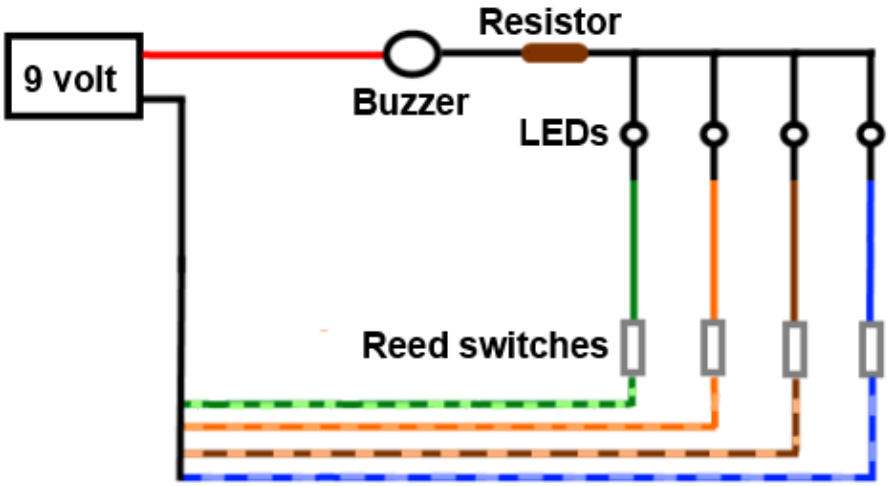
RANGER build photo #47: Four magnetic reed switches on the CAT5 cable.

RANGER build photo #48: Magnetic reed switch mounted on container.

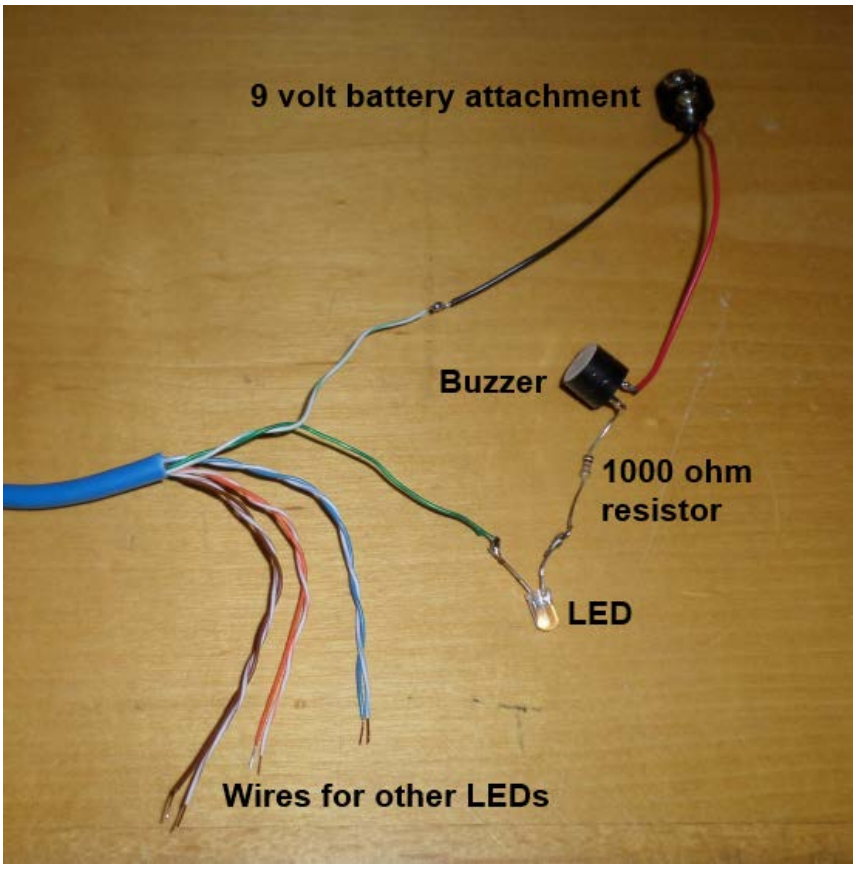
The MATE Center will use colored LEDs and buzzers as indicators, with a 1000 ohm resistor to protect the LED. The color of the LED indicator will identify the specific cargo container in the handbook. These indicators can be wired in series into a circuit, or incorporated into a circuit board specifically designed for this task. To wire the components into a series circuit:

6. Remove 8 cm to 10 cm of sheathing from the top end of the CAT 5 cable. Strip the ends of each of the colored wires in the CAT5 cable. Using one colored pair of wires, attach a 1000 ohm resistor, an LED, a buzzer https://www.amazon.com/uxcell-Terminals-Electronic-Continuous-Buzzer/dp/B00B0Q4KKO/ref=sr_1_3?ie=UTF8&qid=1476297215&sr=8-3&keywords=buzzer, and a power source (9-volt battery) in series.
7. Repeat step 6 for the other colored pairs of wire. Note that one power source can power all four circuits. Use different colored LEDs (red, green, white, one other color) for each different circuit. Alternatively, white LEDs can be colored with a marker to construct different colored LEDs.

Design note: You can use a single buzzer and resistor to decrease the number of components needed. Each colored pair of CAT5 wires will need its own different colored LED for identification of the container.

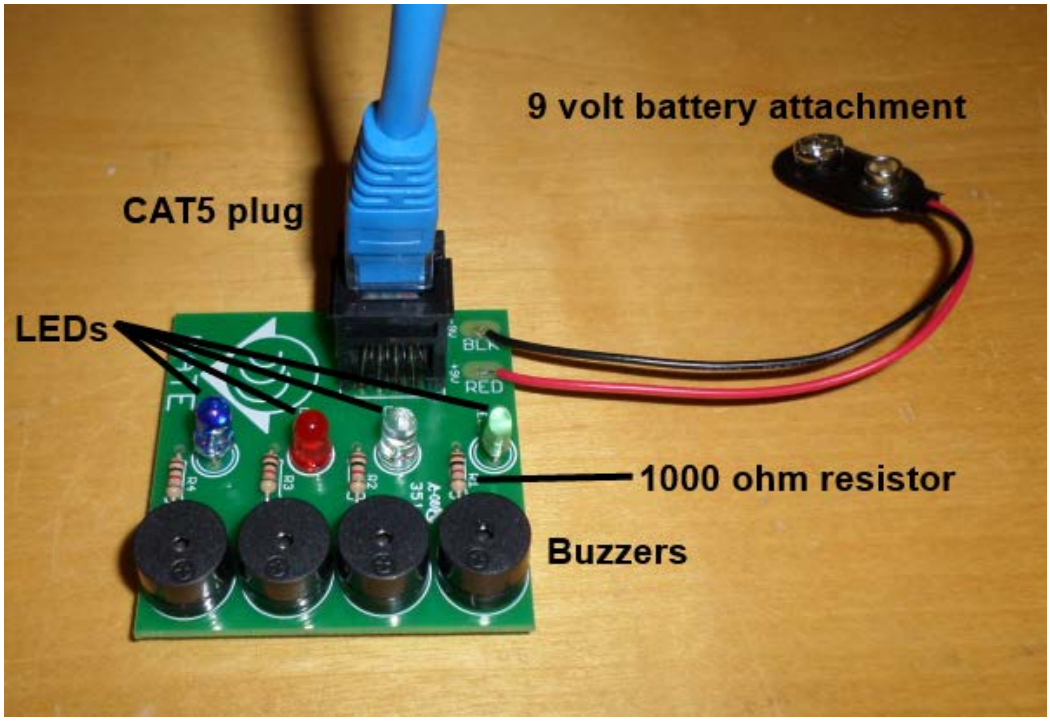


Circuit diagram for the four RANGER sensors with magnetic reed switches on the four containers with LED and buzzer indicators on the surface.



RANGER build photo #49: Resistor, LED, buzzer and power source wired in series.

Four resistors, four different colored LEDs, and four buzzers can also be wired into a printed circuit board. A plug for CAT5 wire and power leads are also incorporated into the board. RANGER class companies will see the circuit board at regionals and at the international competition.

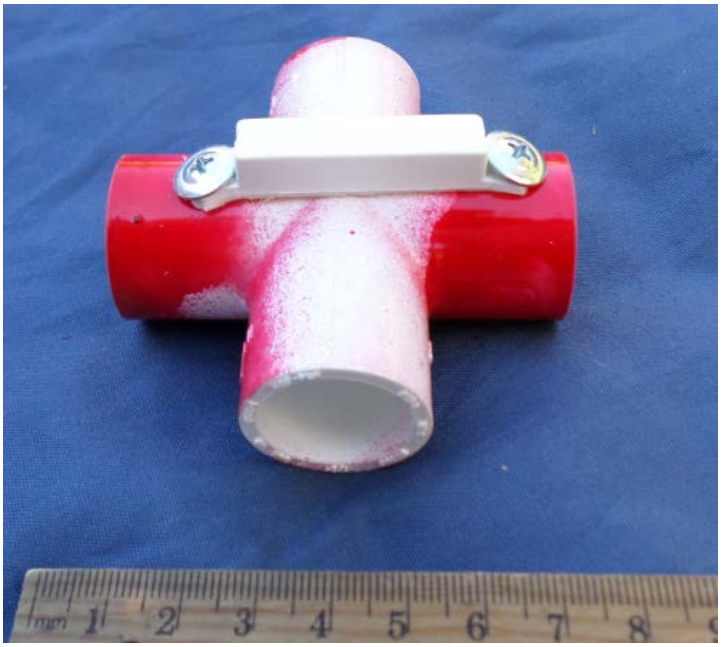


RANGER build photo #50: Resistors, LEDs, buzzers and power source mounted in circuit board.

RFID sensor

The RFID sensor will be constructed from a ½-inch PVC cross. A magnet will be attached to the bottom of the cross. Two opposite openings of the cross will be painted red. The magnet will be positioned parallel to the two red painted openings on the cross. To construct the RFID sensor:

1. Paint two opposite openings of a ½-inch PVC cross red.
2. Attach a magnet to the bottom of the cross. A magnet is included with the magnetic reed switch; see https://www.amazon.com/dp/B0011W4YNK?smid=A29PFSLE3D9XFX&th=1. This rectangular magnet should be parallel to the two red painted openings. Secure the magnet to the cross.



RANGER build photo #51: Magnet mounted on PVC cross. Note that the cross should be positioned with the magnet facing downwards to make the best connection to the upwards facing magnetic reed switch.

Note that alignment may be important for magnets and magnetic reed switches. The magnet and magnetic reed switch work best when the two are parallel to each other. The MATE Center recommends practicing with the magnets and magnetic reed switches to determine the best orientation to complete the circuit.