RANGER PROP BUILDING INSTRUCTIONS & PHOTOS

Science under the ice

Ice sheet

At the international competition, the science under the ice product demonstration will take place under an actual sheet of ice. At regional competitions, the ice is simulated by 8 ft x 4 ft ½-inch foam sheeting (Home Depot part #703990 [in store only], model#320811). To construct the ice sheet, attach the foam sheeting to a framework of 1 ¼-inch PVC pipe. The pipe framework stabilizes the ice sheet and also keeps the algae samples in the product demonstration area.

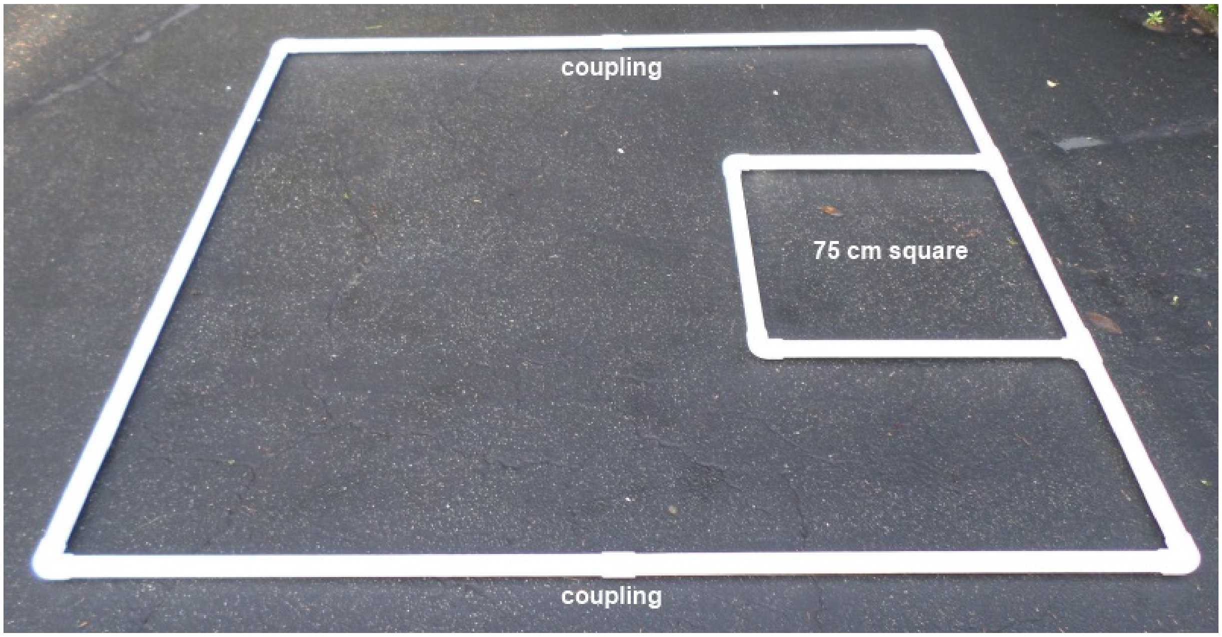
To construct the framework for the ice sheet:

1. Cut four 75 cm lengths of 1 ¼-inch PVC pipe. Attach a 1 ¼-inch 90° elbow to both ends of one 75 cm length of pipe. Insert another 75 cm pipe into each open end of the 90° elbows. Attach the middle opening of a 1 ¼-inch PVC tee to the other end of the pipes. Insert the final 75 cm section of pipe into the side openings of a PVC tees to make a square with inner dimensions of 75 cm x 75 cm. This square will serve as the launch area that the ROV must go through.
2. Cut two additional lengths of ¼-inch PVC pipe approximately 75 to 90 cm. Insert these pipes into the remaining side openings of the PVC tees. The overall length of these combined pipes should be approximately 2.5 meters (less than the 8 ft length of the foam sheet). Attach a 90° elbow to the end of each length of pipe.
3. Cut two 1.25 meter sections of 1 ¼-inch PVC pipe. Insert them into the openings of the two 90° elbows. Attach a 1 ¼-inch PVC coupling to the end of each pipe. Cut two more 1.25 meter sections of pipe and install them into the ends of the coupling. Attach a 90° elbow to the end of each pipe.

Design note: Combining each 1.25 meter section with a coupling allows the ice sheet to be taken apart in the middle. This allows for much easier movement and transportation of the ice sheet. If this is not a factor for your company, you may cut a 2.5 meter to 2.6 meter length of PVC instead of two 1.25 meter lengths of pipe joined by a coupling.

4. Measure the overall length of the combined PVC pipe that consists of the 75 cm section and two 75 cm to 90 cm sections of pipe. Cut a length of pipe equal to the length of the three combined pipes. Complete the square / rectangle by inserting this length of pipe into the open ends of the two 90° elbows.

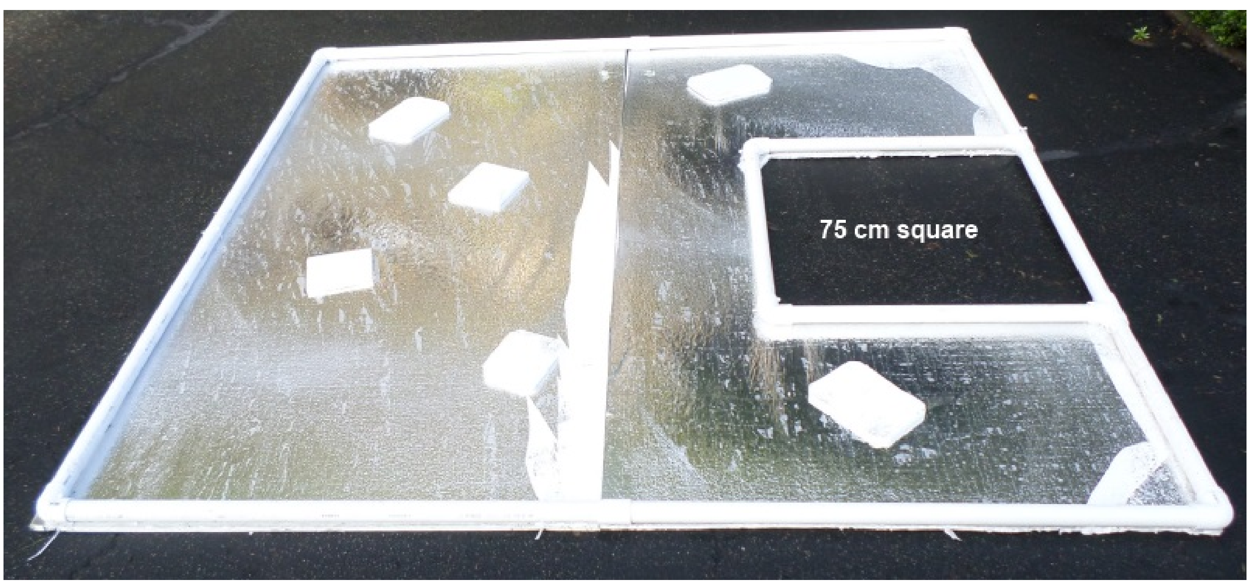
At this point you should have a square or rectangle of 1 ¼-inch PVC pipe approximately 2.6 meters by 2.6 meters. The exact dimensions of the ice sheet are not important, provided the overall dimensions are smaller than two 8 ft x 4 ft foam sheets.



RANGER prop build photo #1: 1 ¼-inch PVC framework for the ice sheet.

5. Use two 8 ft x 4 ft ½-inch thick foam sheets to completely cover the PVC framework. Use 11-inch cable ties to secure the foam sheet to the framework. Use a knife or box cutter to remove the 75 cm x 75 cm square section of foam for the vehicle to launch through. Also remove any excess foam from outside of the PVC framework.

The excess foam is used to create contours on the underside of the ice sheet. Cut or break the extra foam into random shapes approximately 10 to 20 cm in size. Use glue or epoxy to secure these shapes to the bottom side of the ice sheet (the bottom side is the side with the PVC framework).



RANGER prop build photo #2: Upside down ice sheet showing framework with foam sheet attached. Note the extra foam used a bottom contours.

Algae sample

Ping pong balls will be used to simulate algae on the underside of the ice sheet. These ping pong balls will be positioned inside the 1 ¼-inch PVC framework of the ice sheet. Check local sporting goods stores or big box stores (Walmart, Target, etc.) for ping pong balls. See RANGER Product Demonstration Photos.

Sea urchin

Sea urchins will be simulated by 4-inch O-balls. Check local toy stores for O-balls. See RANGER Product Demonstration Photos.

Sea star

Sea stars are constructed from ½-inch PVC pipe and ½-inch fittings. To construct a sea star:

1. Cut six 3 cm lengths of PVC pipe. Insert four of the 3 cm lengths of pipe into each opening of a ½-inch PVC cross.
2. Attach the middle opening of a PVC tee to one of the 3 cm lengths of pipe on the cross. Insert the remaining two 3 cm lengths of PVC pipe into the side openings of the PVC tee.
3. Attach a 90^{o} elbow to each of the 3 cm lengths of pipe on the side openings of the PVC tee. Attach a ½-inch coupling to the 3 cm length of pipe on the cross opposite the PVC tee. Attach a 45^{o} elbow to remaining two 3 cm lengths of pipe on the PVC cross. Align the elbows to simulate a star pattern.

RANGER prop build photo #3: A sea star.

The sea stars are painted different colors to represent different species. See the [RANGER Sea Star Identification Handbook]() for color schemes of sea stars.

Certain sea star species have longer arms. Cut five 5 cm lengths of PVC pipe. Insert them into the five open ends of the PVC fittings.

Passive acoustic sensor
The base of the passive acoustic sensor is constructed out of ½-inch PVC pipe. A 3-inch length of pipe (ABS or PVC) floats above the base. A wire runs from the base of the passive acoustic sensor to the surface, side of the pool. To construct the passive acoustic sensor:

1. Cut a 7 cm length of ½-inch PVC pipe. Attach the side opening of a PVC tee to each end of the 7 cm length of PVC pipe.
2. Cut four 3 cm lengths of ½-inch PVC pipe. Insert two of the 3 cm lengths of pipe into the other side openings of the two PVC tees. Attach a 90^o elbow to the end of each 3 cm length of pipe. Insert the other two 3 cm lengths of PVC pipe into the remaining openings of the 90^o elbow. Attach the middle opening of a PVC tee to the other end of each 3 cm length of pipe.

This makes two of the "legs" of the passive acoustic sensor. Repeat steps 1 and 2 to make a second set of legs.

3. Cut two 4 cm lengths of ½-inch PVC pipe. Insert these two 4 cm lengths into the openings of a 90^o PVC elbow. Attach the middle opening of a PVC tee to the ends of the 4 cm lengths of pipe.
4. Cut four 3 cm lengths of ½-inch PVC pipe. Insert the four 3 cm lengths of pipe into the four side openings on the two PVC tees. Rotate the two PVC tees so they are parallel to each other.
5. Attach the two middle openings on the 'legs' (step 1 and 2) to the 3 cm lengths of pipe. Attach the two middle openings on the other 'legs' too the other 3 cm lengths of pipe.
6. Orient the base of the passive acoustic sensor so all four 'legs' are down and the 90^o elbow sticks up in the middle. Drill a hole in the middle elbow to release any air trapped in the base.

To construct the flotation:

1. Cut a 25 cm length of 3-inch ABS or PVC pipe. Drill six 3/8-inch holes into the pipe, four holes at one end, two holes at the other end. The four holes at one end should be approximately 1.5 cm from the end of the pipe. The two holes at the other end should be 1 cm from the end.
2. Insert a 3-inch knock out cap (Home Depot model #39102, internet #100122751, Store SKU #508260) into the end of the 25 cm length of 3-inch pipe with four holes. Secure the knockout cap with glue or screws. The end with the knock out cap is the top of the sensor.
3. Cut a 30 cm length of 1/8-inch nylon and polypropylene rope (Home Depot model #65225, Internet #202957449, Store SKU #140287). Loop the rope under the top most 90^o elbow on the base of the sensor. Insert the ends of the 30 cm rope into the two holes on the bottom of the 25 cm length of pipe. Insert the rope from the outside of the pipe to the inside.
4. Tie an overhand knot to secure the end of the rope inside the pipe.

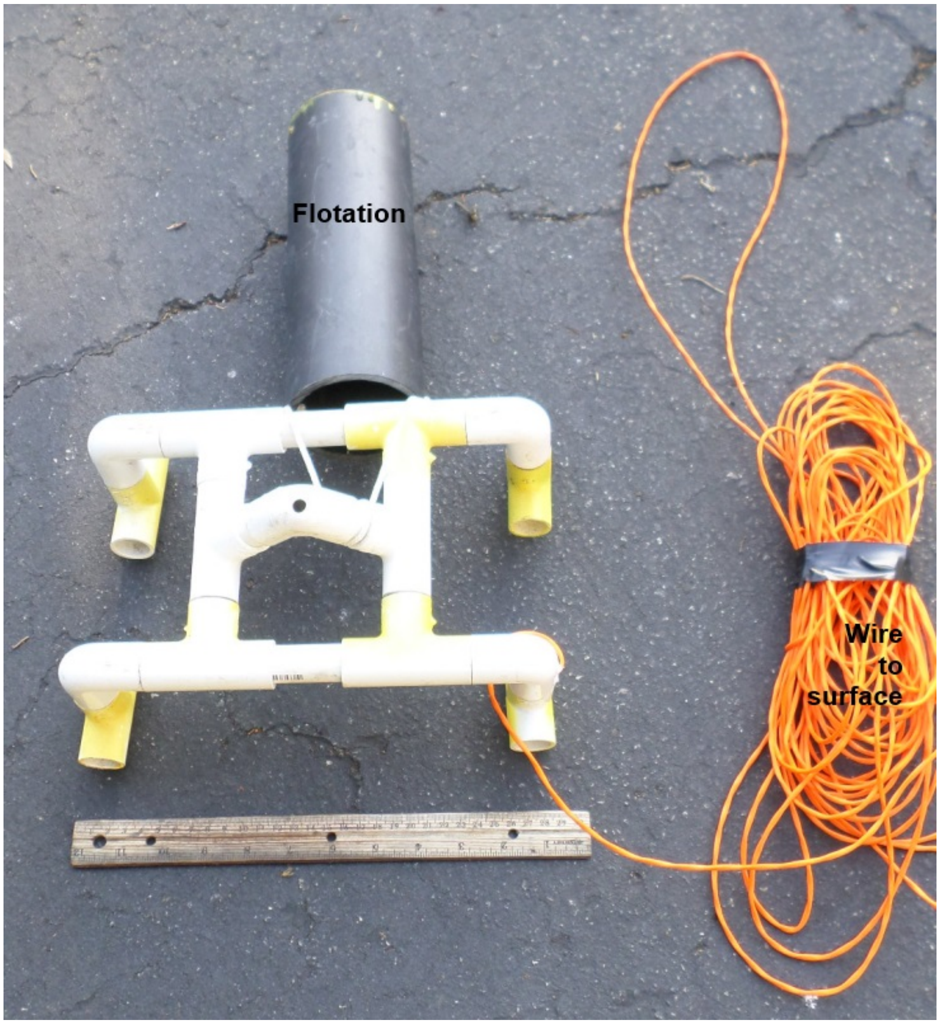
5. Insert flotation into the top of the 25 cm length of pipe. There should be enough flotation to make the pipe positively buoyant and float above the base structure, but should not lift the base off the bottom.
6. Attach weights to the base to provide sufficient negative buoyancy.

The passive acoustic sensor should weigh less than 20 Newtons in an EGADS solution of water (SG 1.025).

A 15 meter length of double stranded 16-18 gauge wire will connect the passive acoustic sensor to the surface. No electricity will run through the wire. The top end of the wire will be tied to the leg of table at the mission station. To connect the wire to the passive acoustic sensor:

1. Drill a ¼-inch hole into the side opening of one of the four tees making up the "legs" of the passive acoustic sensor. Insert the end of the wire into this hole. Tie an overhand knot to secure the wire inside the sensor.

The designated area to deploy the passive acoustic sensor is a 50 cm x 50 cm square constructed out of ½-inch PVC. Cut four 48 cm length of ½-inch PVC pipe and connect them with 90^{o} elbows. Rebar inside the ½-inch pipe can be used to weight the designated area.

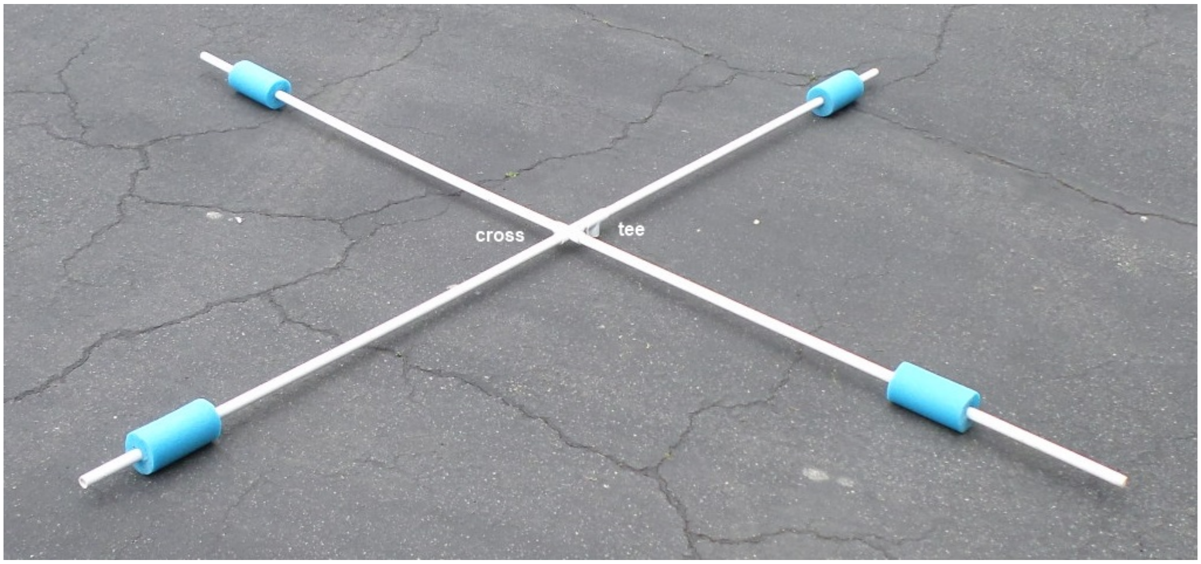


RANGER prop build photo #4: The passive acoustic sensor.

Iceberg

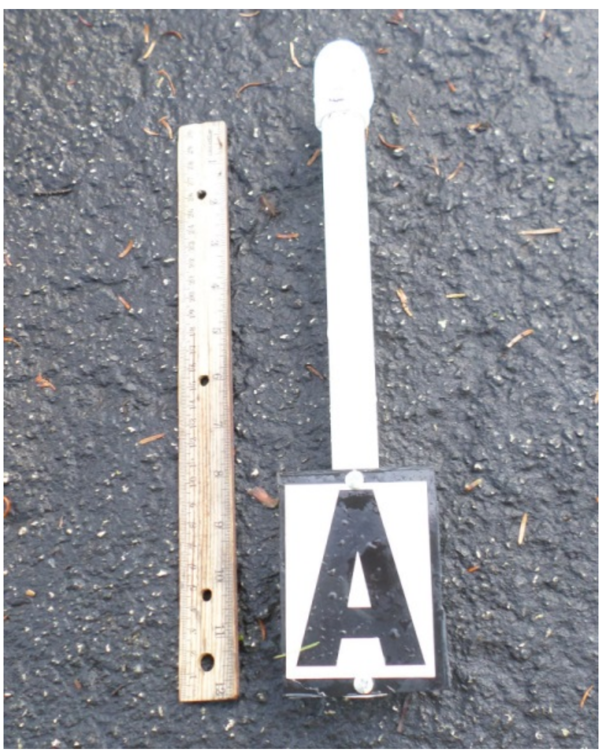
The iceberg is simulated with ½-inch PVC pipe. At the international competition, the iceberg is positioned underneath the sheet of ice. At regional competitions the iceberg is simulated by ½-inch foam sheeting or bubble wrap above the ½-inch PVC framework. To construct the framework:

1. Cut three identical lengths of ½-inch PVC pipe, between the lengths of 0.75 cm and 1.75 cm. Cut another length of PVC pipe 7.2 cm shorter than the other three. Attach the side opening of a PVC tee to one end of the shorter length of pipe. Cut a 3 cm length of ½-inch PVC pipe and insert it into the other side opening of the PVC tee. You should now have four identical lengths of PVC pipe, one of which has a tee at one end.
2. Insert the other end of the 3 cm length of PVC pipe into one side of a ½-inch PVC cross. Insert the other three lengths of pipe into the other openings of the PVC cross. Attach a 90^{o} elbow to each end of the four lengths of pipe.



RANGER prop build photo #5: Top construction for the iceberg with light blue flotation

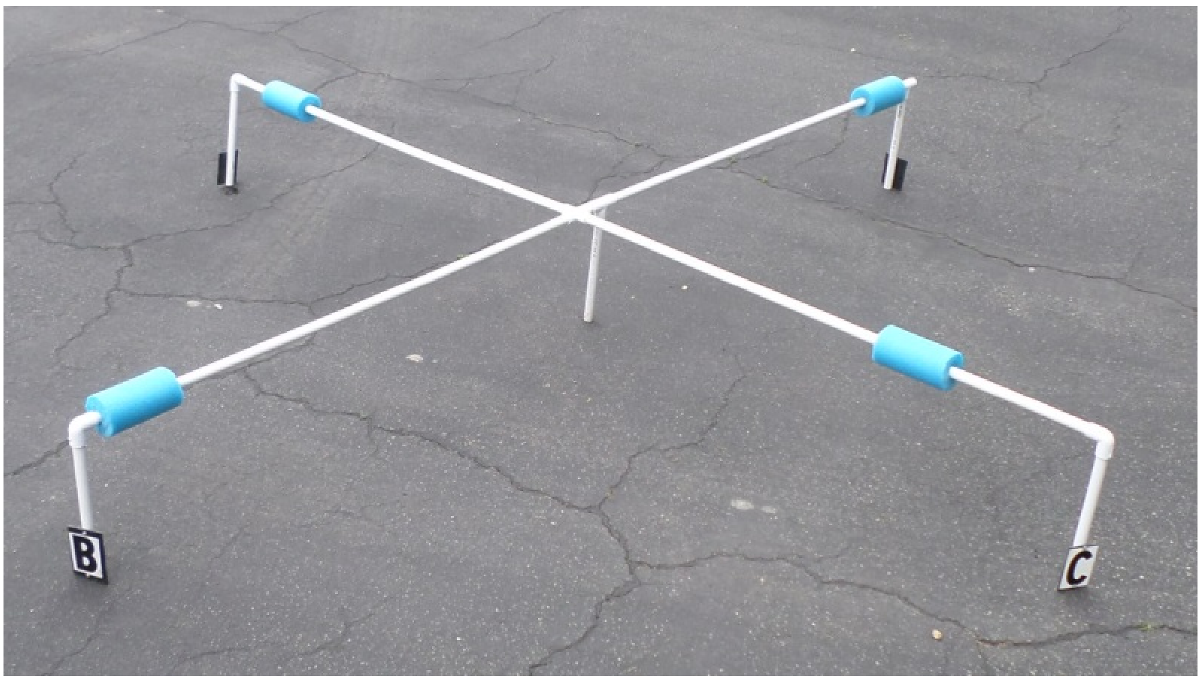
3. Cut four 30 cm lengths of PVC pipe. Insert these pipes into the four 90^{o} elbows at the perimeter of the iceberg.
4. Cut four 10 cm x 7 cm rectangles out of 1/8-inch black ABS sheeting. Attach 3-inch lettering (Home Depot model #847015, Internet #202982489, Store SKU#881277) to the flat, smooth side of the ABS sheet. The 3-inch letters should be A, B, C and D. Screw the ABS sheets to the bottom ends of the 30 cm lengths of pipe. Position the letters so they are right side up and facing away from the center of the iceberg.



RANGER prop build photo #6: Lettering on perimeter of iceberg.

A longer length of pipe descends from the middle of the iceberg. This length of pipe is the keel of the iceberg. Companies must measure the length of the keel to determine the keel depth of the iceberg. To construct the keel of the iceberg:

5. Cut a length of pipe for the maximum keel depth of the iceberg. The length of this pipe should be approximately 1/3 to 3/4 of the depth of the pool at the mission station. Insert this pipe into the middle opening of the PVC tee near the center of the iceberg.



RANGER prop build photo #7: Iceberg with lettering. Note that the keel length of PVC at the center of the iceberg has been shortened for photo.

Use ½-inch foam sheeting or bubble wrap to create the top of the iceberg. Cut the foam or bubble wrap to the approximate dimensions of the ½-inch framework. Attach the foam or bubble wrap with cable ties to secure it to the PVC framework of the iceberg.

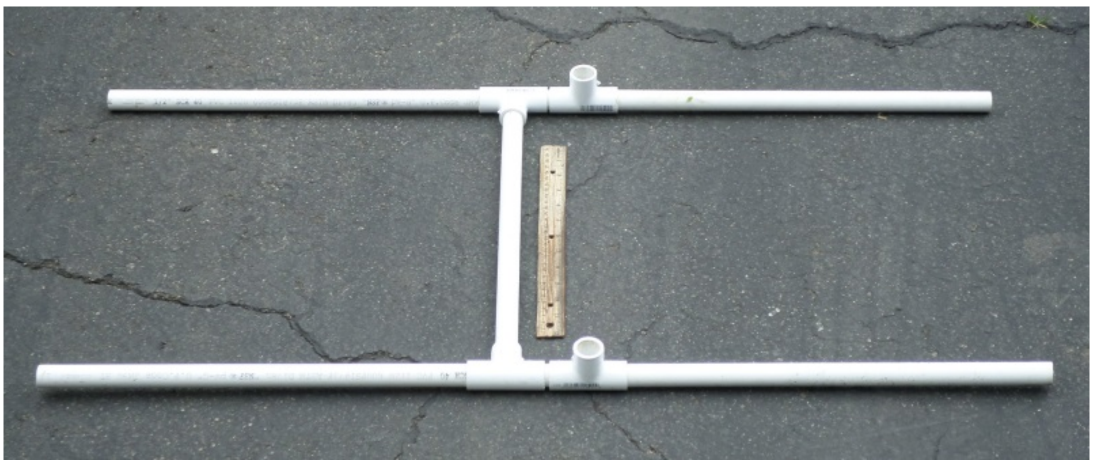
Subsea pipeline inspection & repair

Pipeline
The pipeline is constructed out of 2 sizes of PVC pipe. 1 ½-inch inch PVC pipe painted gray is used for the pipeline that companies must simulate cutting, lifting, and installing the flange. ½-inch pipe is used for the remainder of the pipeline. Corrosion is simulated by a brown circle, less than 2 cm in diameter.

Stands

Four stands hold the 1 ½-inch pipeline off the seafloor. The two middle stands are constructed from ½-inch PVC pipe and 2-inch tees. The outer two stands are constructed from ½-inch PVC pipe, 1 ½-inch pipe and 2-inch tees. To construct the stands:

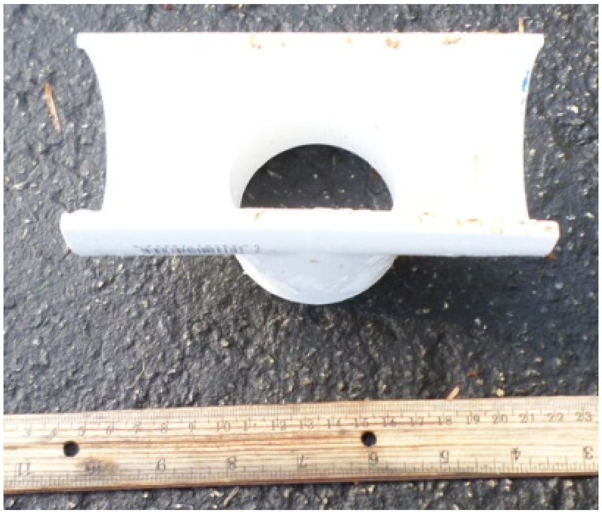
1. Cut two 3 cm length of ½-inch PVC pipe. Attach the side opening of a ½-inch PVC tee (four tees total) to each end of the two 3 cm length of PVC pipe.
2. Cut five 40 cm lengths of ½-inch PVC tee. Insert one 40 cm length of PVC pipe into the middle openings of two of the tees connected by the 3 cm length of pipe. Insert the other four lengths of 40 cm PVC pipe into the four remaining side openings of the PVC tees. Align the two remaining middle openings of the PVC tees so they point up.
3. Repeat build steps 1 and 2 until you have four stands.



RANGER prop build photo #8: Base of oil pipeline stand.

4. Cut four 30 cm lengths of ½-inch PVC pipe. Insert one 30 cm length of pipe into each of the upwards facing middle opening of a PVC tees on one of the stands. Attach a 2-inch to ½-inch reducer bushing (Home Depot model # C437-247, Internet # 100343810, store SKU # 744724) to the top of each 30 cm length of pipe on the stand.
5. Cut a 2-inch PVC in half lengthwise, bisecting through the side openings. Attach the middle opening of each cut 2-inch PVC tee to the 2-inch to ½-inch reducer bushing. Align the 2-inch cut PVC tees so they are parallel.
6. Repeat these two steps to make a second stand.

These two stands are the inner two stands of the oil pipeline.

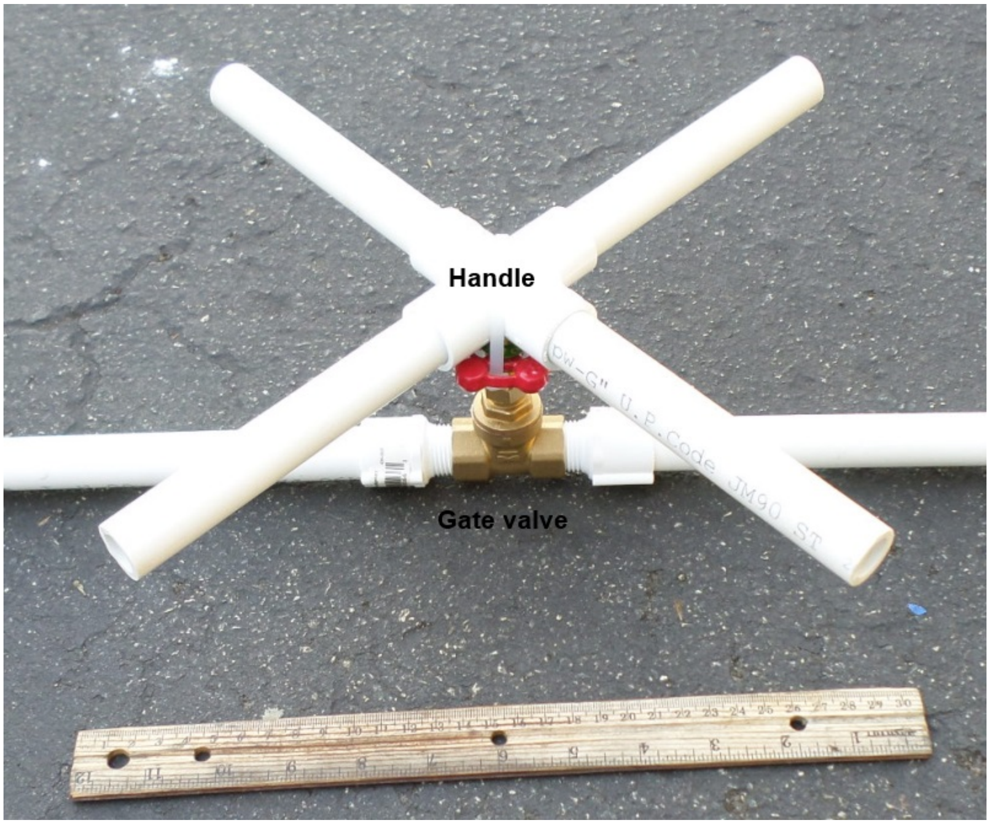


RANGER prop build photo #9: 2-inch tee cut in half lengthwise.

RANGER prop build photo #10: A completed inner stand.

The outer two stands are slightly different in their construction, but use the same base structure as the inner stands. The base structures were completed in steps #1 through #3 above. The first outer stand has the valve and handle that companies must turn to simulate shutting off the flow of oil through the pipeline. To construct the valve and handle:

1. Insert two ½-inch male adapters into both ends of a ½-inch gate valve (Home Depot model # 100-403NL, Internet # 202250434, Store SKU # 867855).
2. Drill a ½-inch hole in the center of one side of a ½-inch PVC cross. Place this cross on top of the handle of a ½-inch gate valve. The drill hole should slip over the nut at the center of the gate valve. Use two cable ties to tightly secure the cross onto the top handle of the gate valve.
3. Cut four 15 cm lengths of ½-inch PVC pipe. Insert these four lengths of pipe into the four openings of the cross.

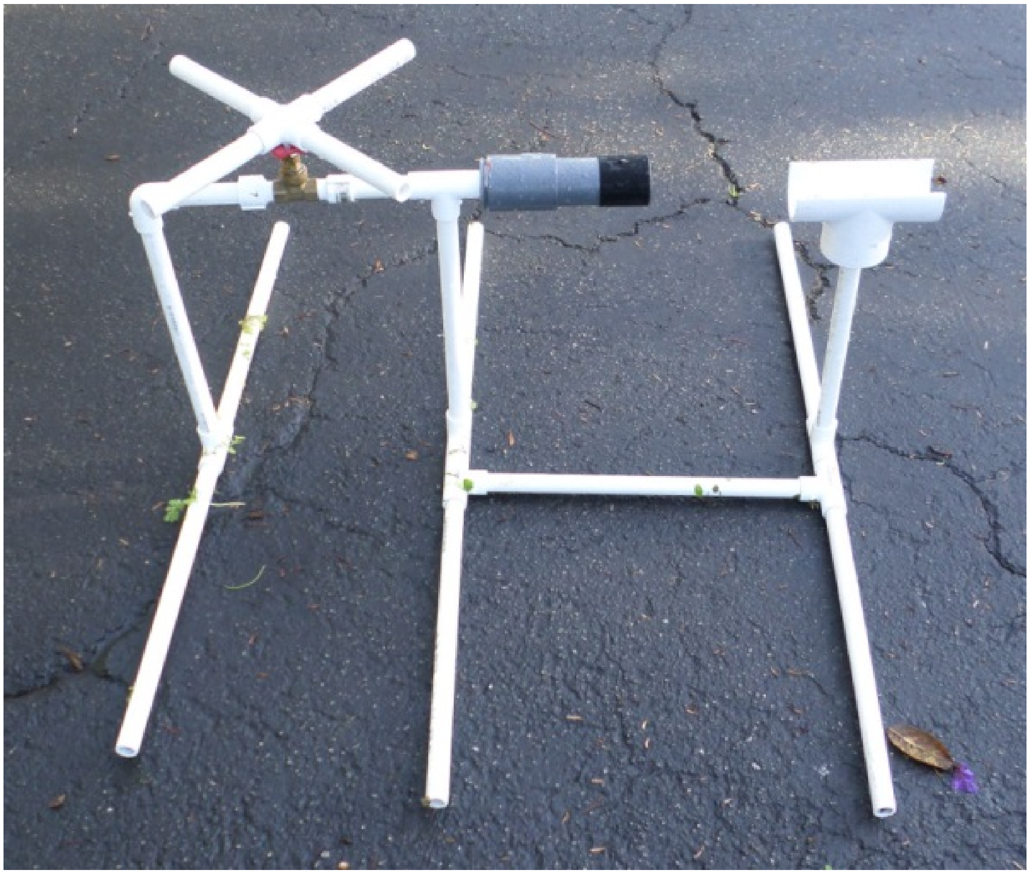


RANGER prop build photo #11: Gate valve with handle extensions.

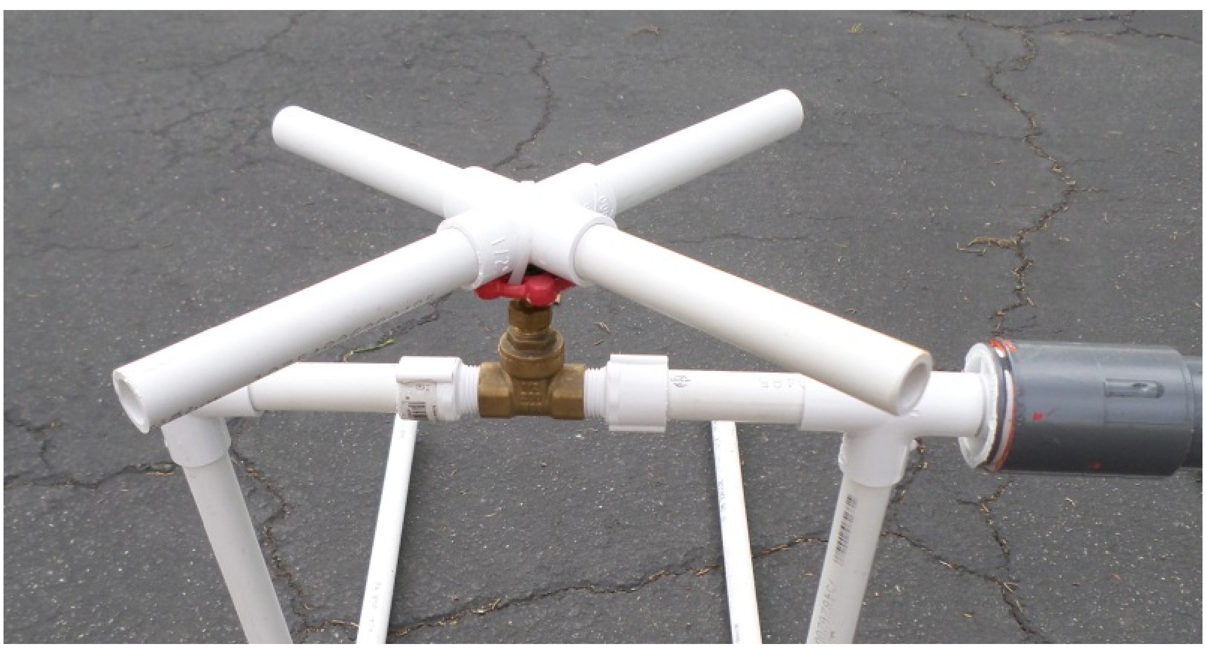
The gate valve and handle are attached to one of the out stands on the pipeline structure. Use one of the base stands constructed earlier. To complete the construction:

4. Cut a 30 cm length of ½-inch PVC pipe. Insert this 30 cm length of pipe into one of the upwards facing middle openings of a PVC tees on one of the stands. Cut a 32 cm length of pipe. Insert this 32 cm length of pipe into the other upwards facing middle opening of a PVC tee on one of the stands.
5. Attach a 2-inch to ½-inch reducer bushing (Home Depot model # C437-247, Internet # 100343810, store SKU # 744724) to the top of the 30 cm length of pipe on the stand. Cut a 2-inch PVC in half lengthwise, bisecting through the side openings. Attach the middle opening of the cut 2-inch PVC tee to the 2-inch to ½-inch reducer bushing.

6. Attach the middle opening of a ½-inch PVC tee to the top of the 32 cm length of pipe. Align the tee so the two side openings are parallel to the cut side openings of the 2-inch tee on the other side of the stand.
7. Cut a 10 cm length and a 4 cm length of ½-inch PVC pipe. Insert the 4 cm length of pipe into the side opening of the tee facing the 2-inch tee on the other side of the stand. Insert the 10 cm length of pipe into the other side opening of the PVC tee; the one furthest from the cut 2-inch tee.
8. Attach a 1 ½-inch to ½-inch PVC reducer bushing (Home Depot model # PVC021081400HD, Internet # 203851132, store SKU # 744917) to the 4 cm length of PVC pipe. Attach a 1 ½-inch PVC coupling to the reducer bushing.
9. Cut a 10 cm to 15 cm length of 1 ½-inch PVC pipe. Insert this pipe into the 1 ½-inch coupling. Paint the coupling and length of 1 ½-inch PVC pipe gray.
10. Attach one of the male adapters on either side of the ½-inch gate valve to the end of the 10 cm length of ½-inch PVC pipe. Twist the male adapter – pipe connection until the gate valve handle is straight above the pipeline.
11. Cut another 10 cm length of PVC pipe and insert it into the other male adapter on the other side of the gate valve. Attach a ½-inch 90^{o} elbow to the other end of the 10 cm length of pipe. Cut a 32 cm length of pipe. Insert the 32 cm length of pipe into the other opening of the 90^{o} elbow. Align the elbow so the 32 cm length of pipe drops to the seafloor.
12. Cut two 40 cm lengths of ½-inch PVC pipe. Insert these lengths into the side openings of a ½-inch PVC tee. Attach the middle opening of the PVC tee to the 32 cm length of pipe descending from the gate valve.



RANGER prop build photo #12: Outer stand with valve handle on end. Note the gray 1 ½-inch pipe.



RANGER prop build photo #13: Stand with valve and handle.

The other outer stand will hold the 1 ½-inch PVC pipe and have a pipe pressure gauge that companies must read. This stand will use the base structure constructed previously. To complete the construction:

1. Cut a 30 cm length of ½-inch PVC pipe. Insert this 30 cm length of pipe into one of the upwards facing middle openings of a PVC tees on one of the stands. Cut a 32 cm length of pipe. Insert this 32 cm length of pipe into the other upwards facing middle opening of a PVC tee on one of the stands.
2. Attach a 2-inch to ½-inch reducer bushing (Home Depot model # C437-247, Internet # 100343810, store SKU # 744724) to the top of the 30 cm length of pipe on the stand. Cut a 2-inch PVC in half lengthwise, bisecting through the side openings. Attach the middle opening of the cut 2-inch PVC tee to the 2-inch to ½-inch reducer bushing.
3. Attach the middle opening of a ½-inch PVC tee to the top of the 32 cm length of pipe. Align the tee so the two side openings are parallel to the cut side openings of the 2-inch tee on the other side of the stand.
4. Cut a 30 cm length and a 4 cm length of ½-inch PVC pipe. Insert the 4 cm length of pipe into the side opening of the tee facing the 2-inch tee on the other side of the stand. Insert the 30 cm length of pipe into the other side opening of the PVC tee; the one furthest from the cut 2-inch tee.
5. Attach a 1 ½-inch to ½-inch PVC reducer bushing (Home Depot model # PVC021081400HD, Internet # 203851132, store SKU # 744917) to the 4 cm length of PVC pipe. Attach a 1 ½-inch PVC coupling to the reducer bushing.
6. Cut a 10 cm to 15 cm length of 1 ½-inch PVC pipe. Insert this pipe into the 1 ½-inch coupling. Paint the coupling and length of 1 ½-inch PVC pipe gray.
7. Attach the side opening of a ½-inch PVC tee to the end of the 30 cm length of PVC pipe. Cut a 32 cm length of PVC pipe. Insert this 32 cm length of PVC pipe into the middle opening of the PVC tee. Align the tee so the 32 cm length of pipe drops to the seafloor.
8. Cut two 40 cm lengths of ½-inch PVC pipe. Insert these lengths into the side openings of a ½-inch PVC tee. Attach the middle opening of the PVC tee to the 32 cm length of pipe descending from the PVC tee.
9. Cut a 30 cm length of ½-inch PVC pipe. Insert this 30 cm length of pipe into the remaining side opening of the PVC tee (step 7).

A pipeline pressure gauge goes on the end of the 30 cm length of pipe. An alternative to using a real pressure gauge is to use a fake pressure gauge. 2-inch lettering, a zero, may be used as a substitution for the real pressure gauge. To construct the real pressure gauge:

1. Attach a pressure gauge into the middle opening of the tee at the end of the 30 cm length of pipe. Rotate the gauge so the reading is facing away from the oil well.

RANGER prop build photo #14: Outer stand with pressure gauge on end.

RANGER prop build photo #15: Close up of pressure gauge.

RANGER prop build photo #16: Four completed stands in a line.

Pipeline sections

The pipeline sections are constructed from three variable lengths of 1 ½-inch PVC pipe. These lengths of pipe will sit on the four stands. To construct the sections of pipeline:

1. Cut three lengths of 1 ½-inch PVC pipe between 75 cm and 175 cm. The three sections of pipe should be of three different lengths.
2. Paint the pipe gray.
3. Cut eight 16 cm x 5 cm lengths of industrial strength Velcro hooks. Attach six of the Velcro hooks around both ends of each length of 1 ½-inch pipe. Attach the other two Velcro hooks around the 1 ½-inch pipe on the outer stands of the pipeline. Note that 16 cm of Velcro is just enough to go around the outer circumference of the 1 ½-inch PVC pipe.
4. Drill a 3/8-inch hole through the 1 ½-inch PVC pipe. The center of these holes should be 2.5 cm from the end of each pipe. These holes are drilled through the Velcro as well. The drill holes on one end of the variable length of pipe should be parallel with the drill holes on the other end of the pipe. The drill holes on the 1 ½-inch pipe on the outer stands should be parallel to the ground. Make sure the holes are smooth from any burrs or excess melted Velcro.
5. Attach a #310 U-bolt (Home Depot model #806826, internet # 204273753, Store SKU # 117996) across the middle of the pipe as a grab point.

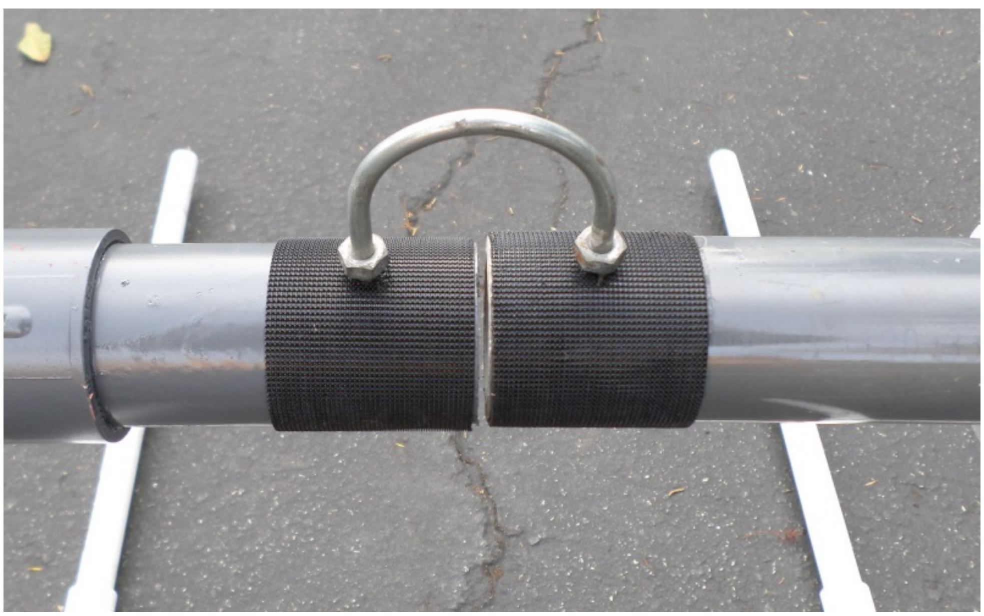
RANGER prop build photo #17: Pipeline section with grab point

Position the four stands along the pool bottom so that all six cut 2-inch PVC tees are parallel. The 1 ½-inch PVC pipe sections on each of the outer stands should be parallel with the cut PVC tees as well.

1. Take one variable length of pipeline and set it into the cut 2-inch tees on an outer stand and an inner stand. Bring the end of cut pipeline flush with the 1 ½-inch pipeline on the outer stand. Align the drill holes so they are parallel to the sea floor.

2. Insert a #310 U-bolt through the drill holes to secure the two sections of pipeline together. The #310 U-bolts are the pins that must be pulled out to simulate cutting of the pipe.

RANGER prop build photo #18: One section of pipeline on outer and inner stand.



RANGER prop build photo #19: Close up of a #310 U-bolt through both ends of pipe

3. Install a second section of variable length pipeline and set it into the cut 2-inch tees of the two inner stands. Note that you may need to adjust the distance between the various stands to match the length of the cut 1 ½-inch pipeline. Align the drill holes on both pipes so they are parallel to the ground.

4. Insert another #310 U-bolt through the drill holes to secure the two sections of pipeline together.
5. Install the third section of variable length pipeline and set it into the cut 2-inch tees of the inner and remaining outer stand. Align the drill holes on both pipes so they are parallel to the ground.
6. Insert another #310 U-bolt through the drill holes to secure the two sections of pipeline together. Adjust the outer stand so the end of the variable length pipe is flush with the 1 ½-inch pipe secured to the outer stand.
7. Insert a #310 U-bolt through the drill holes to secure the two section of pipeline together.

Design note: Once the pipeline is set up and all pipes are aligned properly, use small set screws to secure the ½-inch pipeline in the stands so it does not move or rotate.

Design note: Water, simulating oil, will not actually be flowing through the pipeline.

Design note: Use weights on the base of the stands to keep the pipeline from moving.

RANGER prop build photo #20: The entire pipeline assembly.

Flange

The flange is constructed from an ABS 3-inch to 2-inch reducer bushing (Home Depot model #C58012FHD32, Internet #100343802, store SKU # 188301). Holes are drilled through the walls of the flange. Bolts inserted through these holes will secure the flange to the end of the pipeline. To construct the flange:

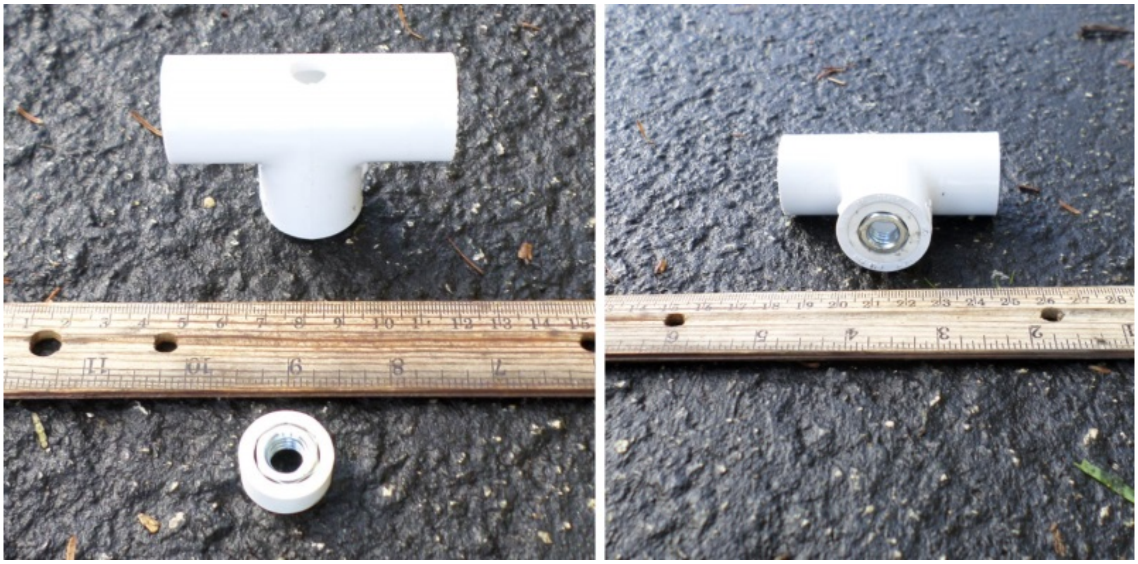
1. Drill six 5/8-inch holes through the side wall of the flange at 60^o angles around the 360^o circumference. These holes should go all the way through the wall, from the outside to the middle of the reducer bushing.

RANGER prop build photo #21: ABS flange with holes drilled through the side wall.

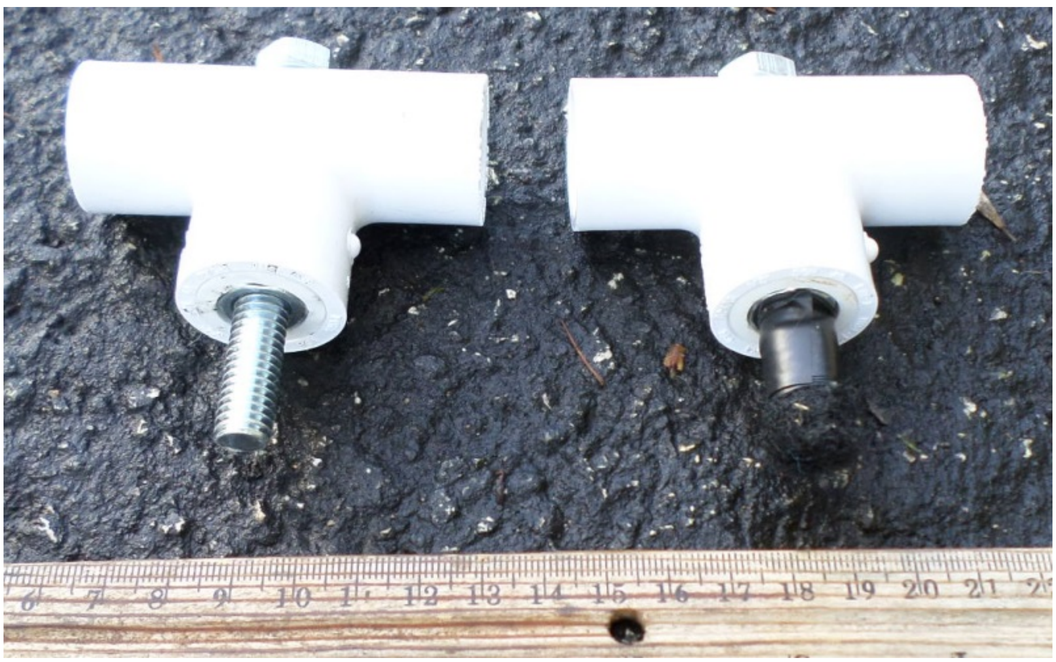
Bolts

The bolts are constructed from 3-inch long 3/8-inch x 16 thread bolts through a ½-inch PVC tee, which serves as a holder for the bolts. Velcro loops around the end of the bolt will secure the bolt to the Velcro hooks on the end of the pipeline sections. To construct a bolt:

1. Drill a 3/8-inch hole through the center of the middle opening of a PVC tee.
2. Cut a 1 cm long length of ½-inch PVC pipe. Use a hammer to force a 3/-inch nut inside the 1 cm length of PVC pipe. Insert the 1 cm length of pipe into the middle opening of the PVC tee.
3. Push a 3-inch long 3/8-inch bolt through the hole in the tee and screw it into the nut inserted into the middle opening of the tee. The bolt should extend approximately 2.5 cm beyond the middle opening of the tee.
4. Cut a 5 cm x 1 cm rectangle of Velcro loops. Attach the middle of the Velcro loop rectangle to the end of the 3/8-inch bolt. Secure the 2 cm Velcro on either side of the middle of the rectangle to the sides of the bolts. Wrap plastic tape tightly around the ends of the Velcro loop rectangle to secure it to the end of the bolt.



RANGER prop build photo #22: PVC base of the bolt with 3/8-inch nut inserted.



RANGER prop build photo #23: Completed bolt without Velcro. Completed bolt with Velcro.

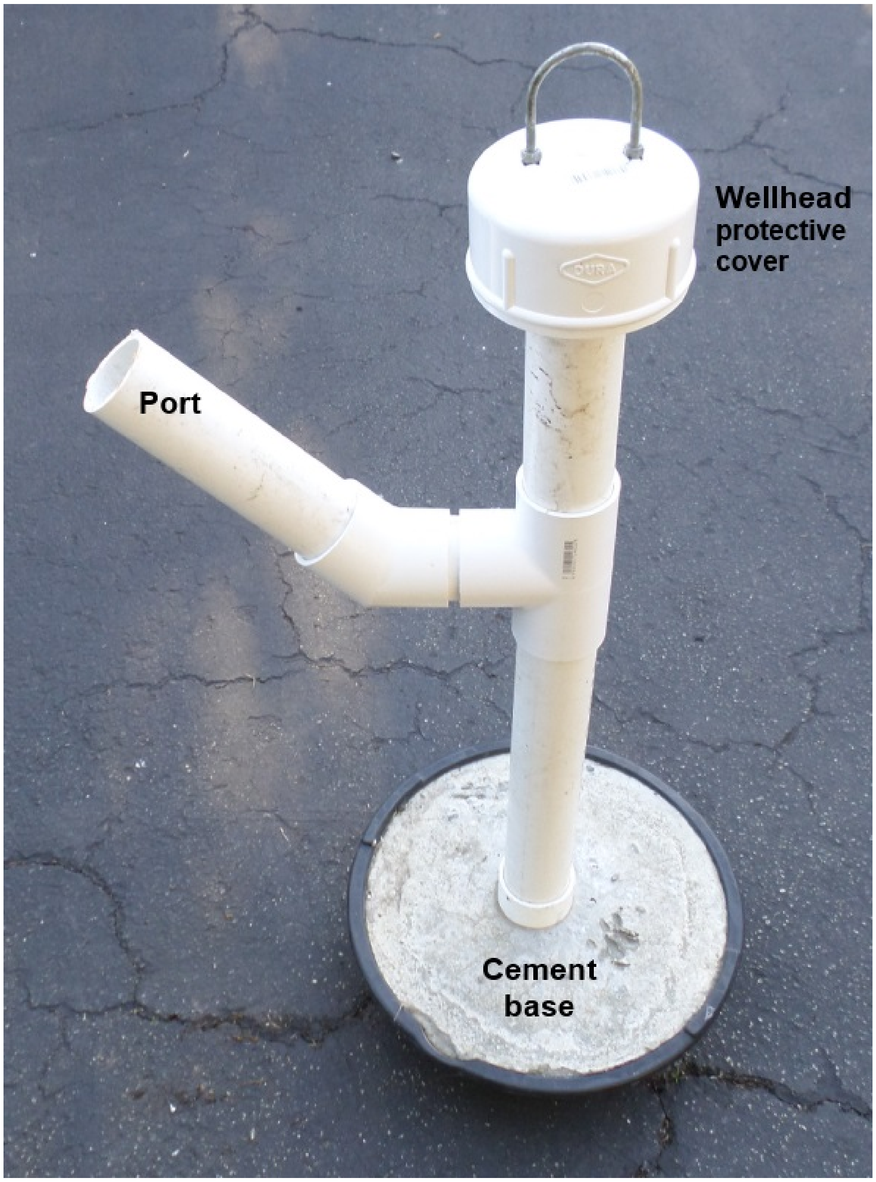
Wellhead

The wellhead is constructed from 2-inch PVC pipe and joints set into a cement base. To construct the cement base, fill a 40 cm oil pan with cement. Before the cement dries, set a 2-inch PVC coupling into the cement. For the wellhead, the coupling should be set halfway into the cement and at a 90^{o} angle from the sea floor. Let the cement dry after inserting the coupling.

RANGER prop build photo #24: Cement base of the wellhead.

To construct the wellhead:

1. Cut a 40 cm length of 2-inch PVC pipe. Insert this 40 cm length of PVC pipe into the 2-inch coupling set into the dried cement base. Attach a side opening of a 2-inch PVC tee to the other end of the 40 cm length of PVC pipe.
2. Cut a 20 cm length of 2-inch PVC pipe. Insert this 20 cm length of pipe into the other side opening of the 2-inch PVC tee. Attach a 2-inch to 3-inch adapter (Home Depot model # 02950H, internet # 205002023, Store SKU # 232521) to the other end of this 20 cm length of pipe.
3. Cut an 8 cm length of 2-inch PVC pipe. Insert the 8 cm length of pipe into the middle opening of the 2-inch PVC tee. Attach a 2-inch 45^{o} elbow to the other end of the 8 cm length of PVC pipe.
4. Cut a 20 cm length of pipe. Insert this 20 cm length of pipe into the remaining opening of the 45^{o} elbow. Align the elbow and 20 cm length of pipe so it rising at a 45^{o} angle from the sea floor.

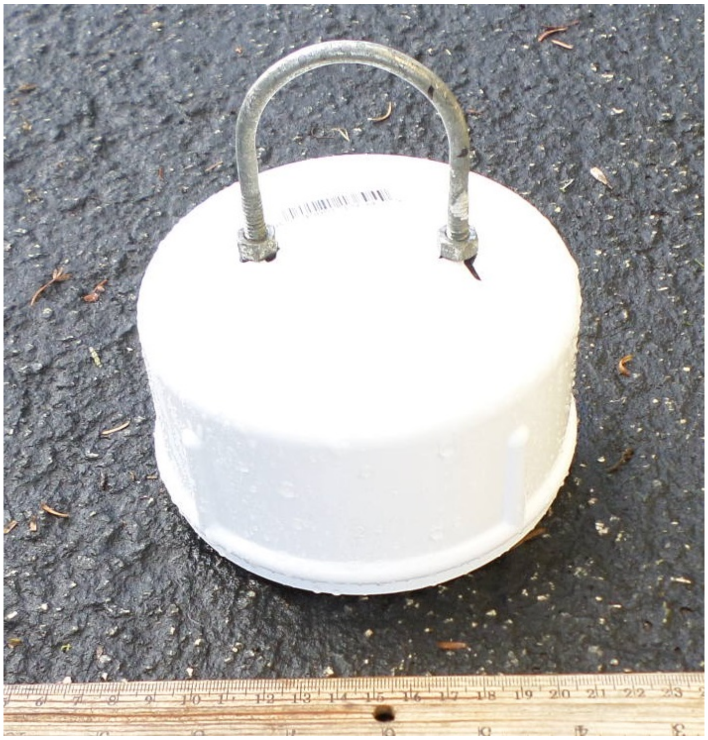


RANGER prop build photo #25: Completed wellhead.

Wellhead protective cover

The wellhead protective cover is constructed from a 4-inch PVC end cap. A #310 U-bolt (Home Depot model #806826, internet # 204273753, Store SKU # 117996) acts as a lifting point for the protective cover. To construct the wellhead protective cover:

1. Drill two ¼-inch holes approximately 5.7 cm apart on the top of a 4-inch PVC end cap. These holes should each be 2.85 cm from the center of the end cap.
2. Insert a #310 U-bolt into these holes. Use nuts to secure the U-bolt to the end cap. The top of the U-bolt should be 5 cm above the top of the PVC end cap.



RANGER prop build photo #26: Wellhead protective cap.

Gasket

The gasket is constructed from a cut section of 2-inch coupling (or other joint) and covered in plastic tool dip (Dip: Home Depot model #11603-6, Internet #202196703, Store SKU #882666 or Spray: Home Depot model #11203-6, Internet #100131010, Store SKU # 602575). To construct the gasket:

1. Cut a 2 cm length from a 2-inch coupling (or other 2-inch PVC joint).
2. Drill two 3/16-inch holes on opposite sides of the 2 cm length of cut pipe, approximately 5 mm from one end.
3. Use plastic tool dip to completely cover the cut section of the 2-inch coupling. Multiple coats can be used. The holes may need to be re-drilled once the plastic coating has dried.
4. Cut a 25 cm length of 1/8-inch rope. Insert one end of the 20 cm length of rope through one of the holes drilled through the gasket. The rope should go from the outside to the inside of the gasket. Tie an overhand knot to secure the rope to the gasket. Insert the other end of the rope through the other hole and secure it with an overhand knot.

The gasket will weigh less than 5 Newtons in water.

RANGER prop build photo #27: Gasket

Hot stab

The hot stab is constructed from 1-inch PVC pipe and a ½-inch PVC pipe handle. To construct the hot stab:

1. Paint a 1-inch coupling red.
2. Cut a 28 cm length of 1-inch PVC pipe. Attach the red 1-inch PVC coupling to on end of this 28 cm length of pipe. Insert a 1-inch to ½-inch reducer bushing (Home Depot model #021080700, Internet # 203811579, store SKU # 610380) into the other end of the 1-inch PVC coupling. Screw a ½-inch male adapter into the reducer bushing.
3. Cut a 3 cm length of ½-inch PVC pipe. Insert this 4 cm length of PVC pipe into the male adapter. Attach the middle opening of a ½-inch PVC tee to the other end of the 4 cm length of pipe.
4. Cut two 8 cm lengths of ½-inch PVC pipe. Insert these 8 cm lengths of pipe into the side openings of the PVC tee.

RANGER prop build photo #28: The hot stab

Offshore oil field production & maintenance

Leg of platform

The leg of the platform is constructed from 2-inch PVC pipe and couplings set into a cement base. To construct the cement base, fill a 40 cm oil pan with cement. Before the cement dries, set a 2-inch PVC coupling halfway into the cement and at a 90^{o} angle from the sea floor. Let the cement dry after inserting the coupling.

RANGER prop build photo #29: The cement base of the leg.

The four test points and common ground for the leg of the platform are inserted into 2-inch PVC couplings.

Cut a 22 cm length of ¾-inch galvanized hanger strap (Home Depot model # 339232, Internet # 100167964, Store SKU # 502072). The 22 cm length should be just long enough to wrap around a 2-inch PVC coupling. Drill a 3/16-inch hole along the center of a 2-inch PVC coupling, approximately 40 cm from each end. Put a 10-24 nut on the end of a 1-inch long 10-24 bolt. Screw the nut all the way down to the head. Insert the bolt through the hole closest to one end of the 22-cm length of galvanized hanger strap. Insert the 10-24 bolt through the hole drilled into the 2-inch coupling. Use another 10-24 nut on the inside of the coupling to secure the bolt tightly through the coupling.

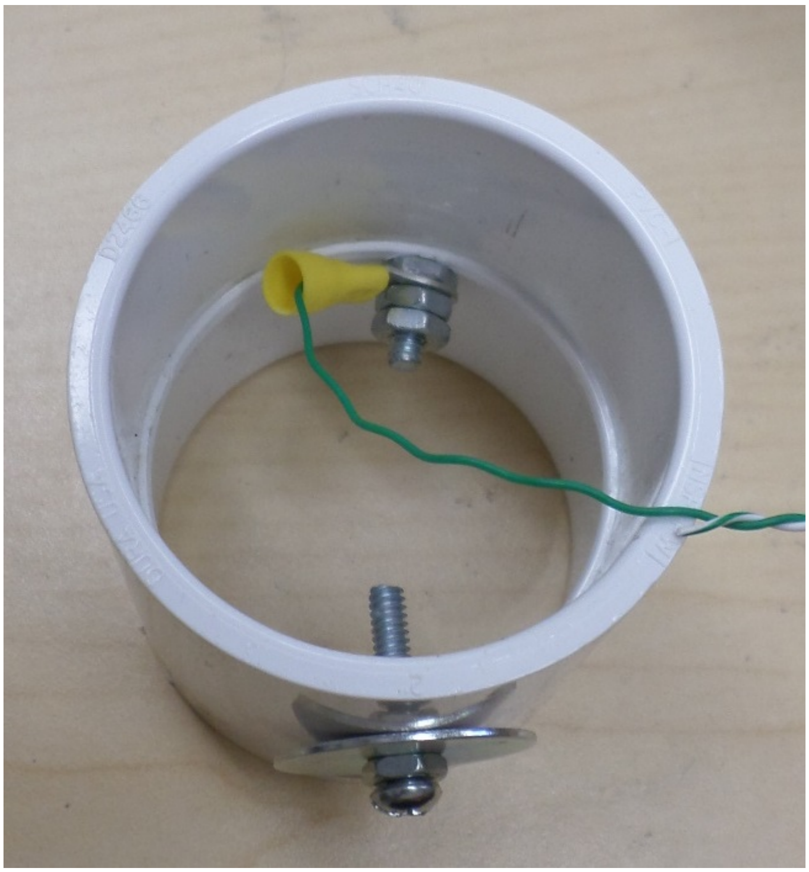
Pull the 22 cm length of galvanized hanger strap tightly around the center circumference of the 2-inch coupling. The two edges of the hanger strap should just overlap. Drill another 3/16-inch hole through the end hole on the adjoining end of the hanger strap and through the PVC coupling underneath. Use another 1-inch 10-24 bolt to secure the end of the hanger strap to the PVC coupling.

RANGER prop build photo #30: Galvanized hanger strap around middle of 2-inch PVC coupling.

Further secure the galvanized hanger strap with a third 10-24 bolt on opposite side of the 2-inch coupling. Use a 10-24 nut on both sides of the PVC. The nut on the outside provides additional spacing for the head of the screw.

One of the bolts in this 2-inch coupling must be connected by a wire to the surface. This will provide a common ground for the test points. Cut a 12 meter length of CAT5 cable (8 strands of 24-gauge wire inside). The length of the wire should be sufficient to reach from the leg of the platform, positioned in the underwater product demonstration area, to a surface switch box controller that will allow the test points to be switched on and off. If you are operating in a deeper or shallower pool, you may need to adjust the length of the CAT5 cable. The four test points and the common ground will each use a one of the 24-gauge wires inside of the cable. The remaining three wires will not be used.

Choose a wire for the common ground. Strip 2 cm from the end of the wire and fold the wire over to provide additional wire thickness 1 cm long. Attach a ring terminal over the end of the wire. Use a crimper to secure the terminal to wire. Attach the ring terminal over one of the 10-24 bolts on the inside of the 2-inch PVC coupling. Secure the ring terminal to the bolt with two 10-24 nuts.



RANGER prop build photo #31: Ring terminal attached to the 10-24 bolt inside the 2-inch coupling.

Each of the four test points can be activated by a single pole, single throw (SPST) switch. Two test points are located above the common ground, while two test points are located below the common ground. Drill two 3/16-inch holes on opposite sides of another 2-inch PVC coupling. These holes should be in the middle of the coupling, approximately 4 cm from either end. Screw a 10-24 nut onto a 1-inch 10-24 bolt. Add a 1 ¼-inch x ¼-inch Fender washer to the bolt. Insert the bolt through the hole so the fender washer is on the outside of the coupling. Use a 10-24 nut on the inside of the coupling to secure the bolt tightly in place. Repeat the process with another 10-24 bolt for the hold on the opposite side of the coupling.

RANGER prop build photo #32: Test point A.

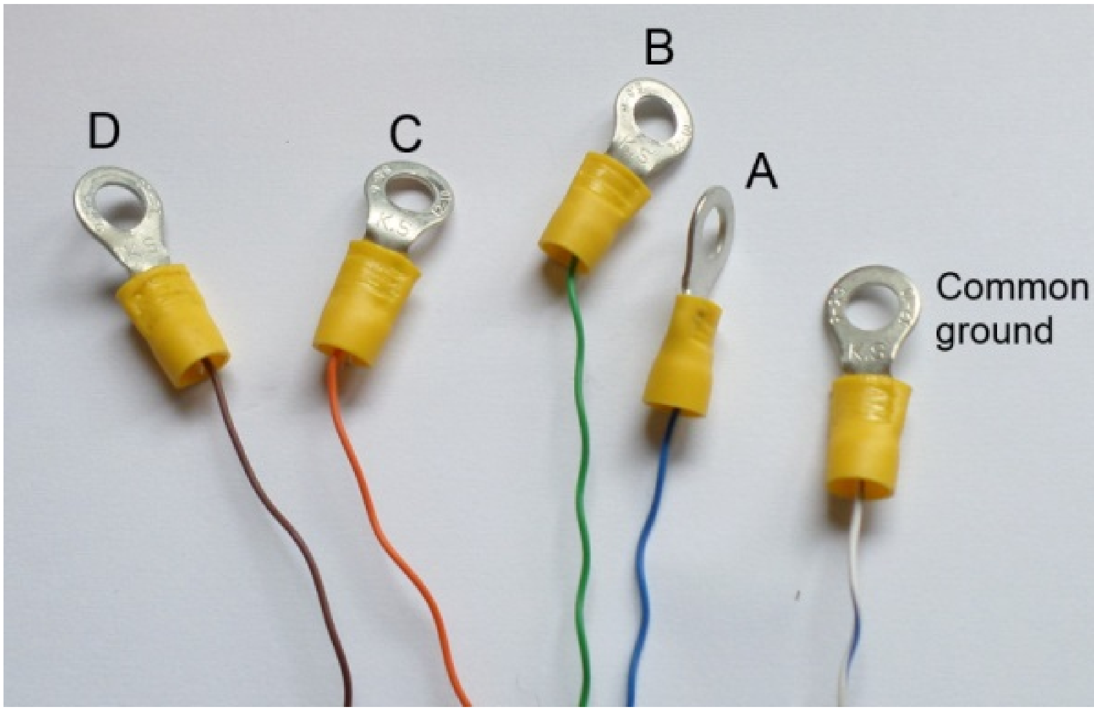
Repeat the entire process on another 2-inch coupling. Drill two more holes and insert two more bolts with fender washers and nuts. The leg of the platform is constructed out of three 2-inch PVC couplings. One has the common ground, two have test points.

Cut two 6 cm lengths of 2-inch PVC pipe. Insert one 6 cm length of pipe into one end of a 2-inch coupling with test points on it. Insert the other 6 cm length of pipe into one end of the other 2-inch coupling with test points on it. Attach the two couplings with the test points on them to either size of the coupling with the common ground. Note that you will need to slide one test point coupling over the 12 meters of CAT5 cable in order to secure it in place.

RANGER prop build photo #33: Three 2-inch couplings with a common ground in the center and two test points on either side of the common ground. Note Test point C is on back side of pipe.

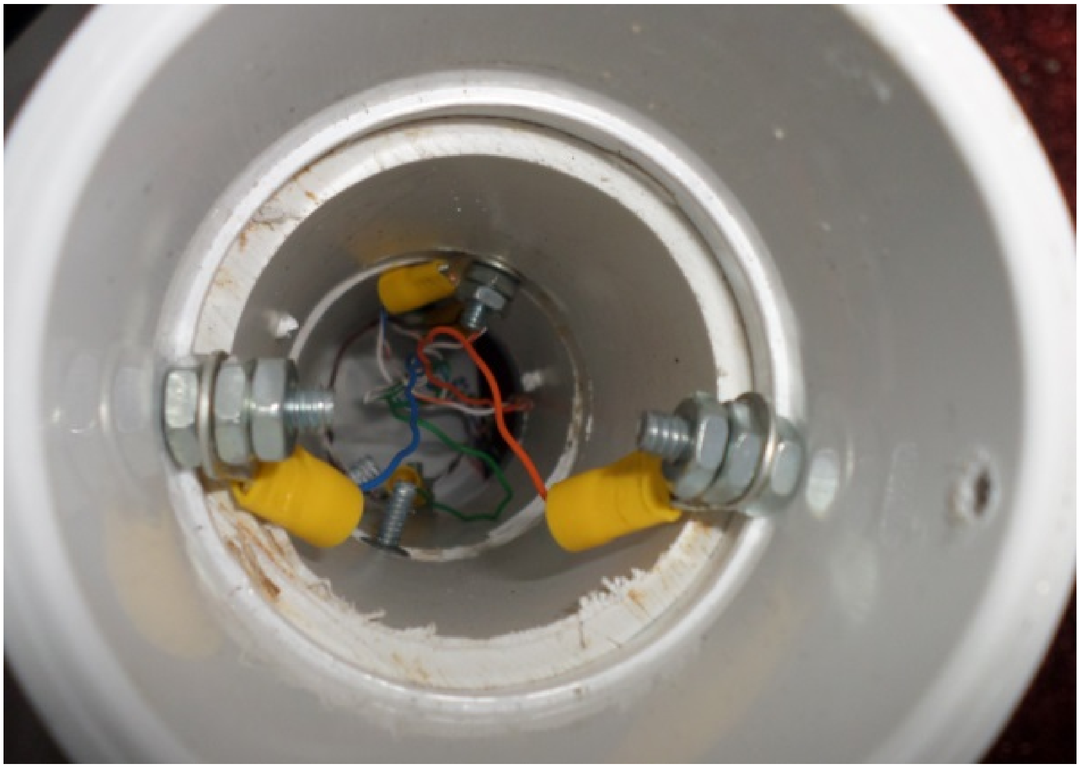
The four test points need to be connected by wire to the surface. Choose a wire for the each of the four test points. Strip 2 cm from the ends of each wire and fold them over to provide additional wire thickness 1 cm long. Attach a ring terminal over the end of the wire. Use a crimper to secure the terminal to the end of the wire. Repeat this for the remaining wires chosen to connect the test points. There should be four ring terminals and four 10-24 bolts comprising the test points. Attach the ring terminals over the four bolts of the four 10-24 bolts on the inside of the 2-inch PVC couplings. Use two 10-24 nuts to secure the ring terminals in place.

Label the four test points A, B, C and D.



RANGER prop build photo #34: Five wires with ring terminals.

Note: Blue & white is common ground. Blue is connected to test point A. Green is connected to test point B. Orange is connected to test point C. Brown is connected to test point D. Green & white, orange & white, and brown & white are not used. On the top side, blue is connected to the first switch, A. Green is connected to the second switch, B. Orange is connected to the third switch, C. Brown is connected to the fourth switch, D. The blue and white wire is connected to the black power wire that leads to battery negative.


RANGER prop build photo #35: Inside view of the three 2-inch couplings. One ring terminal to the common ground, four to test points, three wires not used. Test point A, the blue wire, is on the left. Test point C, the orange wire, is on the right.

Cut a 30 cm to 75 cm length of 2-inch PVC pipe. Drill a ½-inch hole five cm from one end of the pipe. Insert this 2-inch PVC pipe into the 2-inch coupling in the cement base. Position the pipe so the ½-inch hole is near the cement base. Insert the CAT5 cable into the top of the 2-inch PVC pipe and slide it out the ½-inch hole near the bottom. Note that it may be easier to do this when the length of pipe is not attached to the coupling set into the cement.

Attach the 2-inch coupling to the top of the 30 cm to 75 cm length of pipe. Reinsert the bottom of the pipe into the cement base if it was removed. Insert a 2-inch to ¾-inch reducer bushing (Home Depot model #02108, Internet # 203851181, store SKU # 907979) into the top most 2-inch coupling. Alternatively, cut another 6 cm length of 2-inch pipe, insert that into the top most coupling and attach a 2-inch end cap over the top. Drill holes in the end cap so water can escape.

This completes the underwater portion of the platform leg task.

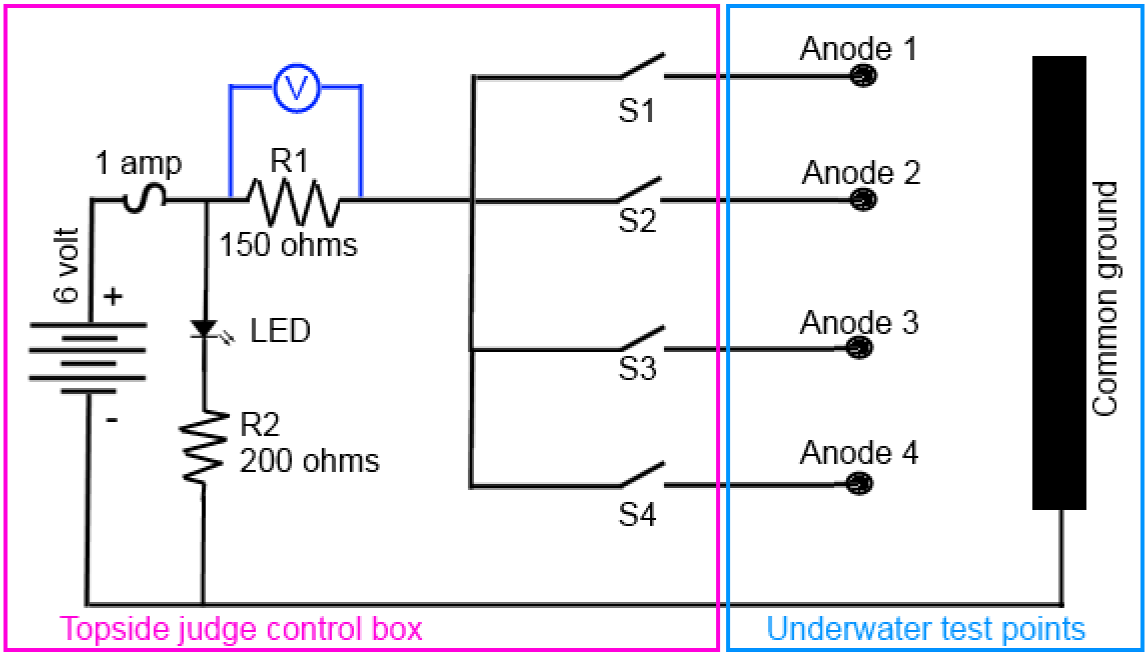
RANGER prop build photo #36: The leg of the platform.

Design note: 2-inch couplings, 2-inch PVC pipe and 2-inch to ¾-inch reducer bushings were used to construct bottles for the 2014 product demonstration (known as mission in 2014). Most of the PVC parts needed for the leg of the platform can be reused from these bottles.

Design note: If you are unable to find 10-24 nuts and bolts, any similar sized matching nut and bolt will work.

Top side switch box and power supply

A switchbox is used to turn the four test points on and off between product demonstration runs. Four labeled switches are mounted into a small electrical box. The mission station judge will operate the switchbox; companies will not be able to see the switchbox during their product demonstration.

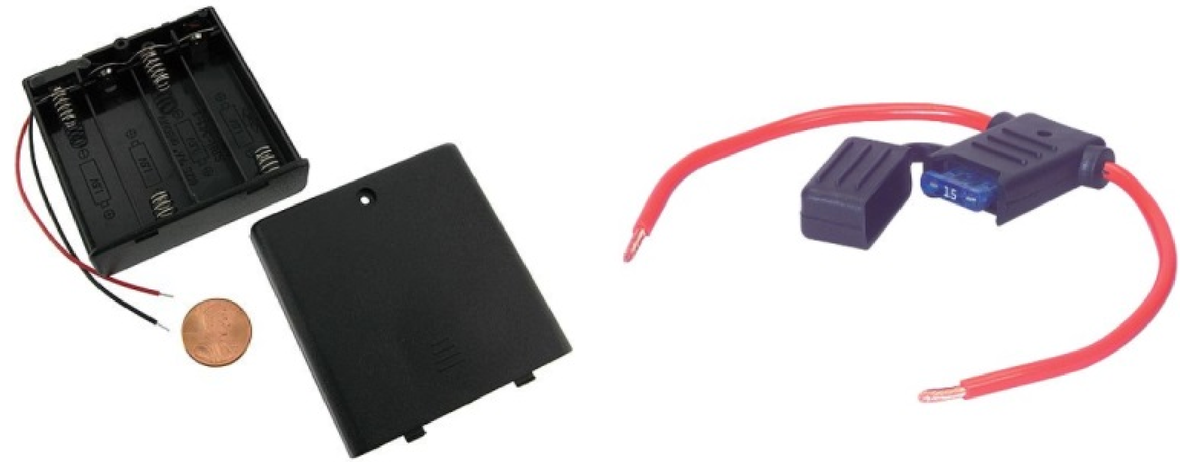


RANGER prop build photo #37: Electrical Schematic of the switchbox.

Note: The voltmeter shown in the above schematic is optional.

Any type of plastic box can be used to make the switchbox. To construct the switchbox:

1. Drill four ½-inch holes into the top of the control box. Insert one SPST switch (Home Depot model #GSW-11, Internet #100030219, store SKU #540315) into each hole and secure it with the nuts provided.
2. Cut four 10 cm lengths of 24 gauge wire. Strip 2 cm from each end. Bend the end back on themselves to double up the wire, 1 cm long. Attach a wire to the positive side of each of the four switches. Secure the wire by soldering or using the screw provided.
3. Cut a 15 cm length of 16 or 18 gauge red wire. Strip 1 cm from both ends. Use a wire nut to combine one end of the 15 cm length of red wire to the four wires attached to the four switches.
4. Drill two 1/4 inch holes in opposite sidewalls of the control box (the side with the 4 SPST switches is the top). Run the 15 cm length of red wire out of one of these holes. Tie an overhand knot in the wire to secure it inside the box and to provide strain relief. Solder a 150 ohm resistor to the stripped end of the wire.
5. Cut a 10 cm length of 16 or 18 gauge red wire. Solder one 10 cm length of red wire to the other end of the 150 ohm resistor. Attach a fuse holder to the other end of the 10 cm length of red wire. Insert a 1 amp fuse into fuse holder.
6. Solder the red positive wire from a 4 x AA battery holder (Amazon: http://www.amazon.com/4AA-Battery-Holder-Wires-Switch/dp/B003YD8DQ8, Home Depot model #7-CHG, Internet #204602828) to the other end of the fuse holder.



RANGER prop build photo #38: Battery holder and fuse.

7. Cut a 40 cm length of 16 or 18 gauge black wire. Run the black wire in one 1/8-inch hole and out the other 1/4 inch hole. Tie an overhand knot to secure the wire inside the box and provide strain relief. One side of the black wire will emerge out of the same hole as the red wire. Solder that side of the wire to the black wire on the battery holder.
8. Solder the other end of the black wire to the CAT5 wire that is attached to the common ground.
9. Label the switches A, B, C, and D. Connect the proper colored wires to each switch, switch A to test point A, switch B to test point B, etc. Solder or use the screws to secure the wires to the switches.

An LED can be installed into the circuit to verify that power is connected. This LED should always be on when the batteries are connected. Install an LED and 200 ohm resistor into the circuit as shown in the wiring diagram.

The volt meter in the system is optional.

RANGER prop build photo #39: Top side switchbox with four SPST switches.

Connect the proper colored wire to each switch. Using the color choices from the wiring on the leg (see above), the blue wire from the tether attaches to test point A, the green wire from the tether attaches to test point B, the orange wire from the tether attaches to test point C, and the brown wire from the tether attaches to test point D. The blue & white wire from the tether attaches directly to the black wire leading to battery negative, it does not attach to the SPST switches.

Insert four AA batteries into the battery holder to provide 6 volts. When a switch is turned on, it should "activate" a test point. Use your sensor to evaluate each test point when the switch is on and when the switch is off. It is recommended that companies test their system in both the air and in the water.

Angled Wellhead

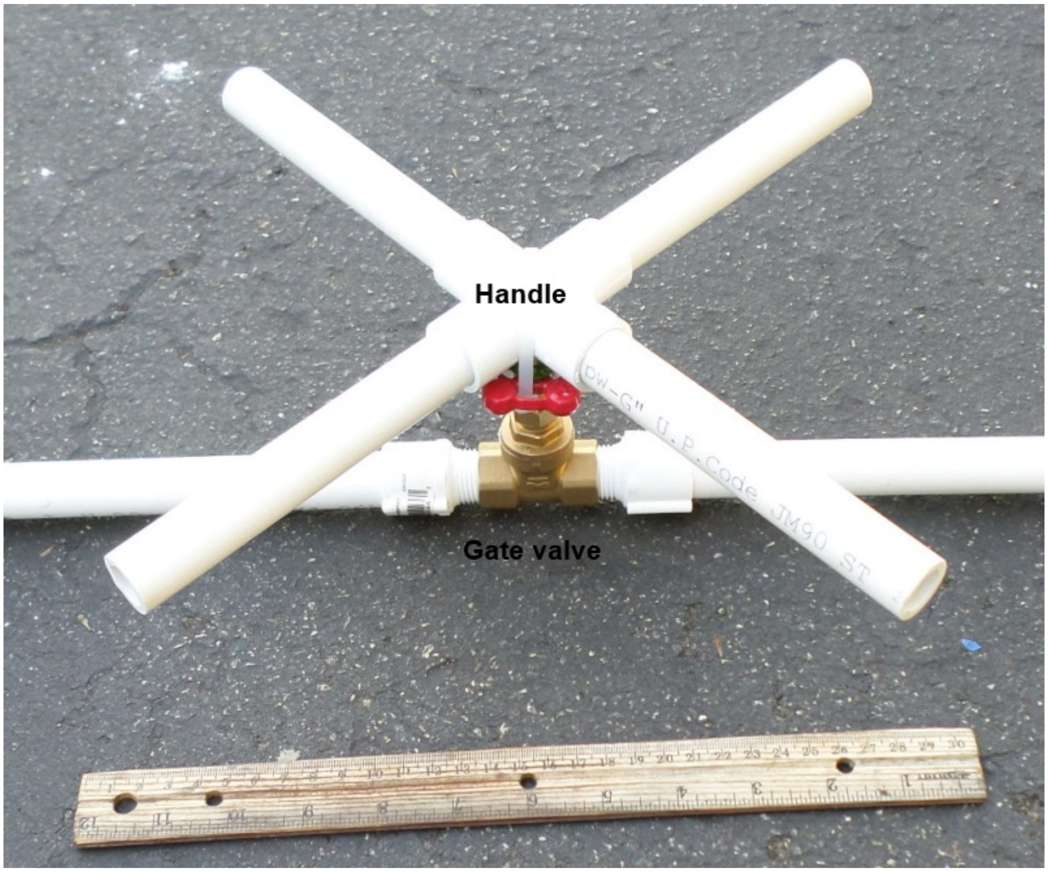
The wellhead is constructed from 2-inch PVC pipe and couplings set into a cement base. To construct the cement base, fill a 40 cm oil pan with cement. Before the cement dries, set a 2-inch PVC coupling into cement at an angle between 60^{o} and 85^{o} from the sea floor. To construct the rest of the angled wellhead:

1. Cut a length of 2-inch PVC pipe between 60 cm and 125 cm. Insert this length of pipe into the 2-inch coupling when the cement has dried.


RANGER prop build photo #40: Cement base of angled wellhead.
See RANGER Product Demonstration Photos for photos of the completed angled wellhead.

Pipeline pathways
The pipeline pathway has six valves and four outlets. Each valve is labeled with a 2-inch gold on black numbering. The four outlets are labeled with 3-inch lettering. Companies must move water through the pipeline pathway by moving water into the input of the pipeline pathway, which is a 2-inch coupling. The pipeline pathway and location of the six valves will vary. To construct the valves:

1. Insert two ½-inch male adapters into both ends of a ½-inch gate valve (Home Depot model # 100-403NL, Internet # 202250434, Store SKU # 867855).
2. Drill a ½-inch hole in the center of one side of a ½-inch PVC cross. Place this cross on top of the handle of a ½-inch gate valve. The drill hole should slip over the nut at the center of the gate valve. Use two cable ties to tightly secure the cross onto the top handle of the gate valve.
3. Cut four 15 cm lengths of ½-inch PVC pipe. Insert these four lengths of pipe into the four openings of the cross.
4. Cut an 8 cm x 5 cm rectangle of black ABS sheeting. Adhere the 2-inch gold on black numbering (Home Depot model #842268, Internet #100183234, Store SKU #135795) to the smooth side of the plastic rectangle.
5. Repeat until all six valves are complete, and there are six labels, 1, 2, 3, 4, 5, and 6.



RANGER prop build photo #41: Gate valve with handle extensions.

6. Secure the numbering to the pipe at the base of the valve so it can be seen from above.

Companies must move water through the pipeline from the input, through the open valves, and out the proper outlet. The input is constructed from a 1 ½-inch coupling that is reduced to ½-inch PVC pipe. To construct the input:

1. Insert a 1 ½-inch to ½-inch reducer bushing (Home Depot model # PVC021081400HD, Internet # 203851132, store SKU # 744917) into the 1 ½-inch opening on the other reducer bushing.
2. Cut a 20 cm length of ½-inch PVC pipe. Insert the 20 cm length of pipe into the ½-inch opening in the 1 ½-inch to ½-inch reducer bushing. Attach a ½-inch 90^o elbow to the other end of the 20 cm length of pipe.
3. Cut a 15 cm length of ½-inch PVC pipe. Insert this pipe into the open end of the 90^o elbow. Attach another 90^o elbow to the other end of the 15 cm length of pipe.

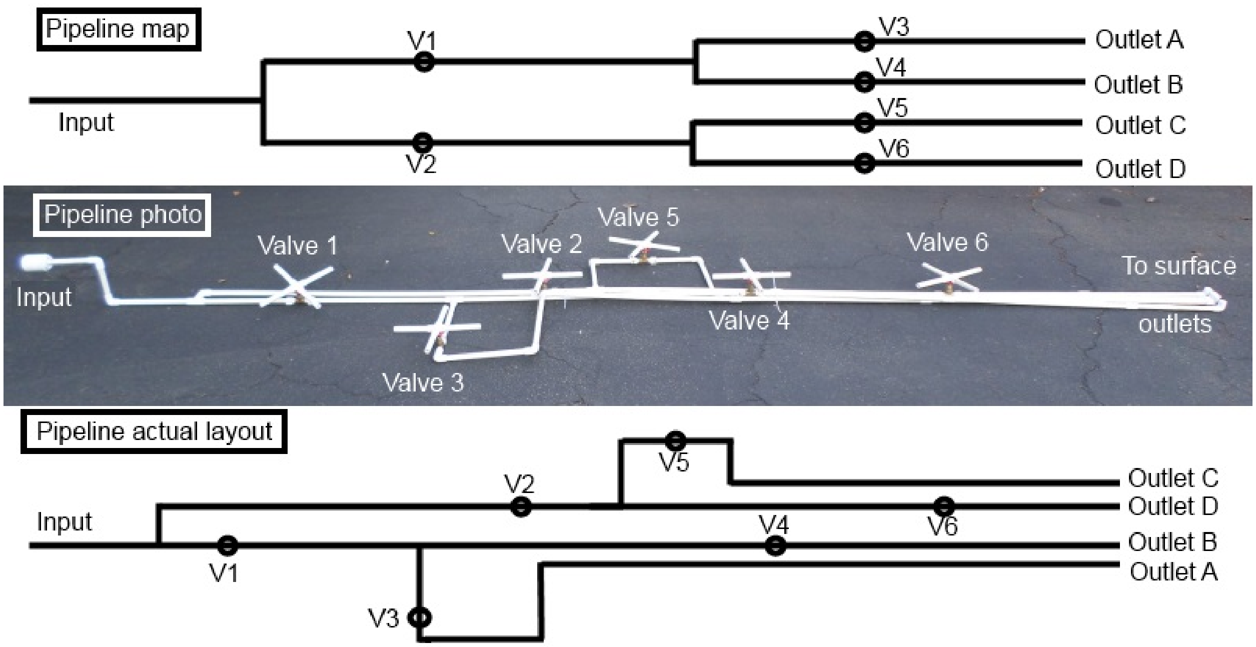
The other end of the 90^o elbow will attach to the pipe of the pipeline pathway. The 15 cm length of pipe will hold the input coupling approximately 18 cm (additional length from the two PVC elbows on either end of the 15 cm pipe) above the bottom of the pool. Note that companies should not assume the 1 ½-inch input coupling will be exactly 18 cm off the pool bottom. Companies should be prepared for any height between 10 cm and 40 cm.

RANGER prop build photo #42: 2-inch coupling that is the input to the pipeline pathway.

The pipeline can be vary in its size and the locations of the valves. For a basic idea on constructing the pipeline pathway:

1. The pipeline should be built with one ½-inch pipe that attaches to the 90° elbow at the end of the input coupling.
2. A tee should be used to split this one input pipeline into two pipeline pathways. Place a valve in each of the two pathways. Label the two valves #1 and #2.
3. Each valve should have a length of ½-inch pipe on the outlet side of it. Two valves means two pipes.
4. Attach a tee to the end of each of the two pipes, splitting each pipe into two additional pipes (4 total). Place a valve in each of the four pathways. The valves coming from valve #1 should be labeled valve #3 and valve #4. The valves coming from valve #2 should be labeled valve #5 and valve #6.
5. Each valve (#3, #4, #5, and #6) should have a length of ½-inch pipe on the outlet side of it. Attach 90° elbows to the ends of the ½-inch pipe. Use additional ½-inch pipe to bring the four pipelines together at least 40 cm beyond the final valve. All four pipeline pathways should be parallel to each other.
6. Attach a 90° elbows on the end of each of the 4 pipeline pathways. Twist the elbows so the open ends face upwards.
7. Insert four lengths of ½-inch PVC pipe into the elbows. The lengths of these pipes should be from the bottom of the pool to the surface of the pool.

Notes: Place the valves far enough apart so they do not interfere with each other when being rotated.



RANGER prop build photo #43: A diagram of the pipeline map given to the company (top), the actual pipeline with 6 valves (middle) and a diagram of the actual layout of the pipe (bottom).

The four pathways are separated so the proper outlet can be easily seen by the mission station judge. The four outlet pathways are labeled with 3-inch black on white lettering (Home Depot model #847015, Internet #202982489, Store SKU#881277). To construct the four outlets.

1. Cut four 10 cm x 7 cm rectangles out of 1/8-inch black ABS sheeting. Attach 3-inch lettering to the flat, smooth side of the ABS sheeting. The 3-inch letters should be A, B, C and D.
2. Cut two 15 cm lengths of ½-inch PVC pipe and attach a 90^o elbow to both sides of each 15 cm length of pipe (4 elbows total). Attach the open end of one elbow to the pipeline coming up from the bottom that represents outlet B. Twist the 90^o elbow on the other end of this 15 cm length of pipe so it is facing up.
3. Attach an open end of one elbow on the other 15 cm length of pipe to the pipeline coming up from the bottom that represents outlet C. Twist the 90^o elbow on the other end of this 15 cm length of pipe so it is facing up.
4. Position the two 15 cm lengths of pipe so they point away from each other.
5. Cut two 45 cm lengths of ½-inch PVC pipe and attach a 90^o elbow to both sides of each 45 cm length of pipe (4 elbows total). Attach the open end of one elbow to the pipeline coming up from the bottom that represents outlet A. Twist the 90^o elbow on the other end of this 45 cm length of pipe so it is facing up.
6. Attach an open end of one elbow on the other 45 cm length of pipe to the pipeline coming up from the bottom that represents outlet D. Twist the 90^o elbow on the other end of this 45 cm length of pipe so it is facing up.

7. Position the two 45 cm lengths of pipe so they point away from each other. Outlet A should be parallel to (and 30 cm longer than) outlet B. Outlet D should be parallel to (and 30 cm longer than) outlet C.
8. Cut four 15 cm lengths of ½-inch PVC pipe. Insert them into the four openings, A, B, C and D. Label each outlet with the proper letter. Secure the lettering to each 15 cm length of pipe.

RANGER prop build photo #44: Outlet positions.

Use flotation to hold and stabilize the four outlets just above the water level.