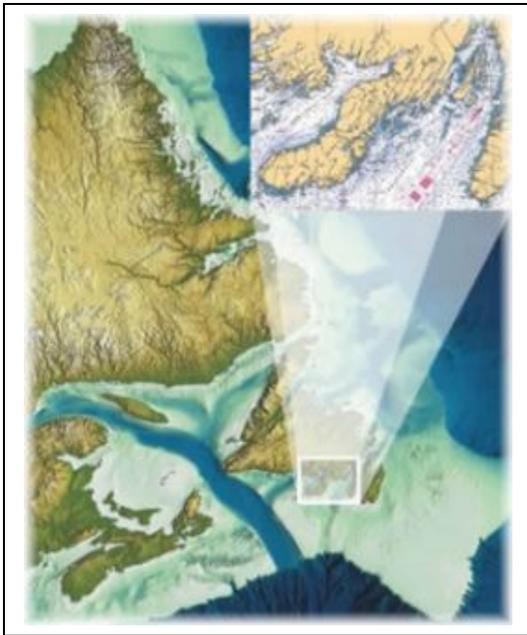


Mission #1 – FLUME TANK

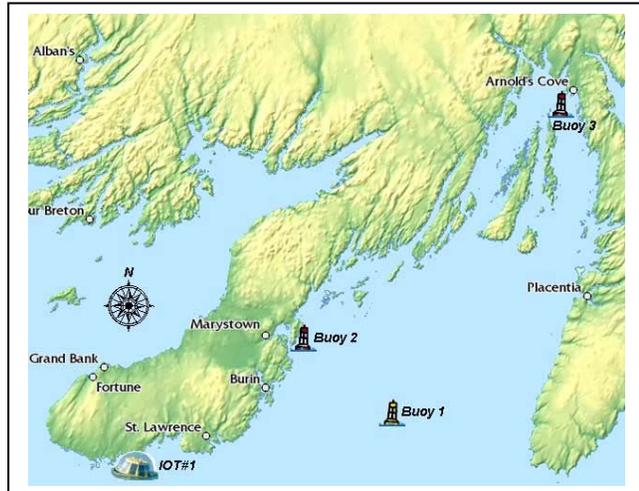
Ocean observing in polar seas: The SmartBay Project in Placentia Bay

As part of its Oceans Action Plan, the Canadian Government is supporting a number of projects that help it to better understand, protect, manage, and utilize Canada's ocean resources. One such project is the Canadian Centre for Marine Communications' (CCMC) Placentia Bay Demonstration Project or "SmartBay" ocean observing system.

Located on the south coast of Newfoundland, Placentia Bay is one of the most environmentally and economically important bodies of waters of Canada's 243,792 km of coastline. The bay is home to 27 species of fish and more than 50 species of birds. Fifteen species of marine mammals, such as humpback whales and harbor seals, are also found there. Recreational and commercial fishing boats ply Placentia Bay's waters, gathering catch or heading out to the rich fishing grounds of the Grand Banks. Oil field support vessels cruise back and forth into Placentia Harbor, ferrying supplies to and from production platforms. Oil transport tankers and other large merchant vessels enter and exit the bay, shipping goods to and receiving goods from all corners of the globe. Small communities dot the fringes, depending on the nearby waters for their livelihood.



Placentia Bay, Newfoundland



The SmartBay buoy locations

The goal of SmartBay is to monitor the marine ecosystem and improve weather forecasting for the Placentia Bay area. SmartBay will eventually link several buoys along the Newfoundland coastline, providing fishermen, vessel operators, tourism companies, weather forecasters, recreational users, and local communities with near real-time access to oceanographic and water quality data.

With the support of the Canadian Coast Guard's buoy tender the *CCGS George R. Pearkes*, the first buoy was launched in Placentia Bay in August of 2006. The buoy is

positioned at the mouth of Placentia Bay (46°59'N, 54° 41'W) in a water depth of about 230 meters. The buoy is equipped with instruments that measure a variety of atmospheric and oceanographic conditions including wind speed and direction; air temperature; humidity; dew point; barometric pressure; water temperature; salinity; current speed and direction; and wave height, direction, and period. This data, along with weather and sea-state forecasts generated from it, is currently accessible in real time on the SmartBay web site at www.smartbay.ca.

A second buoy was launched in November of 2006; a third buoy is scheduled for deployment in the New Year. Once operational, these buoys will collect data on a number of water quality parameters, including salinity; sea surface temperature; dissolved oxygen; chlorophyll; turbidity; current speed and direction; wind speed and direction; air temperature; barometric pressure; and relative humidity.

The CCMC's Bill Carter is the project manager for SmartBay. In addition to overseeing deployment, he and his crew are responsible for buoy maintenance and repair. As long as the weather cooperates, Bill and his crew can quickly repair any damage, ensuring uninterrupted delivery of data to those who depend on it.

And this is where your mission begins.

They said it was the storm of the century, as all the storms seem to be these days. But there was no denying that this one was a whopper. A southerly gale formed from the vise-like movements of two intense weather systems. One, the remnant of a hurricane that earlier ravaged Puerto Rico and the Florida Panhandle; the other, a low pressure system located over the Canadian Maritime Provinces. The systems joined forces just south of Halifax, Nova Scotia, tracked along the west coast of Newfoundland, and formed a tempest with hurricane-force winds and 13-meter waves. For the inbound foreign fishing trawler *Ocean Queen*, sturdy as she was, it was all she could do just to make safe haven in Placentia Bay.

The seas in Placentia Bay were like a horse gone loco, unpredictable yet beautiful in its fury. The skipper of the *Queen* was making a run northeast up the bay towards Placentia Harbor. There they might be able to tuck into one of the "quiet" coves, drop a hook, and lick their wounds. He had been to sea for most of his life, but this storm was bigger than he could ever remember. All of the radios and radar had been wiped out; the compass swung wildly in its gimbals as the deckhand tried his best to keep the *Queen* on course. The real danger, however, came from broaching. The mountainous waves would come under the stern, lifting it high into the air. The propeller would rise clear out of the wave and start to race. The rudder, losing her grip on the water, would dangle uselessly in the air for a second before gravity pulled it back under. That one second was enough for the wheelsman to lose steerage as the *Queen* bucked broadside to the waves. The fight for control of the ship left the crew exhausted, but they dared not give up. To do so would be certain death in the frigid bay waters.

Suddenly a panicked shout came from the crew serving as lookout on the bridge wing. He was pointing straight at the bow. The skipper caught a glimpse of bright yellow just as the bow rose and it disappeared. In his mind he asked himself, was it a lifeboat? That thought was quickly replaced by the mind-numbing crunch of steel on steel followed by a scrapping sound that traveled down the side of the hull towards the prop. Whump! The beating of his heart pounded in his ears; he knew this was serious trouble. The *Queen* had lost a blade, and the rudder was not responding to the helm. He looked aft to see what appeared to be a yellow navigation buoy floating away from him. Yes, he remembered the weather buoy from the nautical chart. He had the misfortune to hit it; if he only had such luck with the lottery. At least it wasn't a lifeboat as he had first imagined. His relief was short lived as the *Queen* careened broadside to the seas, tossing him across the wheelhouse. The danger of capsizing was real. A lesser man would have given up, but he was a captain, responsible for the safety of his ship and crew. He wasn't going to let a "small" thing like a busted rudder and prop in the middle of a tempest keep him from bringing his ship into port. He mustered all his strength and self-confidence and began to give orders that would, eventually, save them all.

The next day Bill Carter, the Canadian Centre for Marine Communications' SmartBay project manager, was working in the shore-side facility used as a base station for buoys deployed in Placentia Bay as part of the SmartBay project. The weather advisories had gone out to mariners that the hurricane was losing its strength. The worst was over. But Bill had lost contact with SmartBay buoy 1 located at the mouth of the bay. The initial iridium satellite feed showing GPS position indicated that the buoy was off station and drifting; however, the feed was lost shortly thereafter and now the status of the buoy was uncertain. The buoy was designed to withstand the worst that wind and seas could throw at it; it was virtually unsinkable in its design, so he reasoned that it still should be drifting somewhere. Perhaps the radio modem was damaged during the storm? They would head out to check on it and repair any damage as soon as it calmed down enough.

A knock disturbed his thoughts about the logistics of getting a repair crew out on the bay. The deeply etched face of a fisherman flashed a wry grin. "G'day boy, this one yours?"

The sea-worn hand pointed out to the harbor where a fishing boat was tied alongside a yellow buoy. Bill's jaw dropped, how in the world...? "My boys found it drifting around the bay this morning. Thought you'd like it back."

Later that day the story came out how the *Queen*, now safely tied up in Placentia Harbor, had collided with the buoy. The captain and his crew had managed to jury-rig a rudder, saving her from sure peril. She was later seen by a passing ship and reported to the Canadian Coast Guard, who towed it into port.

While he was relieved to hear that the crew and their livelihood, the *Queen*, were safe and sound, Bill now faced his own "hurricane." Bill's problem was how to get the buoy moored and back on station as quickly as possible. To order up a new anchor and

mooring chain would take time – and money. He knew that if he could only retrieve the anchor and mooring chain, the Coast Guard buoy tender *CCGS George R. Pearkes* could easily repair any damage, reattach the buoy, and redeploy it.

But how to get the chain and anchor, which combined weigh ~3,600kg, to the buoy tender? At 230m in frigid waters and a current kicked up by the storm, it pushed the limits for a diver to safely attach a lift line. What about an ROV? The ROV could bring down a messenger line, thread it through the anchor ring, and bring it back up to the ship. From there Bill and his crew could attach successive heavier lines to the messenger line and pull them through the anchor ring using the ship's winch. The last line would be a strong, yet flexible, wire rope that would either pass through the ring and back up to the ship or connect directly to the ring with a special shackle called a toggle that his crew would fabricate. They could decide what strategy to use once the ROV was able to observe the situation. Regardless, first they needed the critical messenger line threaded through the anchor ring. Then using the ship's winch, the anchor and its mooring chain could be hauled up to the surface.

Yes, it could be done, but he needed an ROV – and he needed it now. Who had such a machine capable of doing this job?

MISSION TASKS – EXPLORER & RANGER

Teams will get one attempt at the mission task. The time allotted to complete the mission (i.e., the mission performance period) is 15 minutes, plus 5 minutes to set up your system and 5 minutes to demobilize your equipment and exit the control shack.

Teams will receive a time bonus for successfully completing the mission, returning their ROVs to the surface, and touching the side of the flume tank by the control shack before the mission performance period ends. ROVs do NOT need to return to the surface during the mission performance period.

Task: Thread a messenger line through the buoy anchor ring and return the messenger line to the surface.

Your mission is to thread a messenger line through the buoy's anchor ring and return it to the surface. In this scenario, the messenger line serves as the mechanism to thread other, heavier lines through the anchor ring. Eventually a line capable of lifting the anchor and mooring chain will be threaded through the ring, allowing the anchor and chain to be retrieved to the surface.

The mission task involves:

- **Transporting the messenger line to the buoy anchor.**
- **Threading the messenger line through the buoy anchor ring.**
- **Returning the messenger line to the surface.**

Note: Teams are required to provide their own messenger line. See the **MISSION PROP SPECIFICATIONS** below for further details about the messenger line.

At the start of the mission, one team member at the control shack must hold one end of the messenger line in his or her hands. This same team member is responsible for paying out the line to the ROV as it transports the other end of the messenger line to the buoy anchor and threads it through the anchor ring. **Your ROV can only thread the messenger line through the anchor ring and not around or through the links of the mooring chain.** Once the end of the line is threaded through the anchor ring, your ROV must return it to the surface. Once the line is at the surface, a team member must retrieve it from the ROV. Your mission is successfully completed when one team member holds the two ends of the messenger line in his or her hands.

Note: Once this team member has the two ends, your team is neither required to attach heavier and heavier lines to your messenger line nor required to attempt to haul the anchor and the mooring chain to the surface. (Bill and his crew are responsible for that.)

Scoring – 60 points (no partial points will be given)

- 20 points – transport the messenger line to the buoy anchor.
- 20 points – thread the line through the anchor ring so that it threads completely through the anchor ring and remains threaded through once your ROV has released it.
- 20 points – return the line to the surface under the control of your ROV so that one team member at the surface control shack holds both ends of the messenger line in his or her hands.

Time bonus

Teams will receive 1 point for every minute and 0.01 point for every second under 15 minutes remaining. Your mission performance period ends when your ROV has successfully threaded the line through the anchor ring, returned the line to the surface, and one team member holds the two ends of the messenger line in his or her hands. Time bonus points will be awarded accordingly.

MISSION PROP SPECIFICATIONS

The buoy's anchor is simulated by a black plastic oil pan filled with cement. The oil pan is 40cm in diameter and 10cm tall. Cemented in the center of the anchor is a 3.5-inch U-bolt (0.5-inch thickness), called the anchor ring, that extends approximately 9 cm (internal measurement) above the cement surface.

A length of 3/16-inch blu-krome chain attached to the U-bolt simulates the mooring chain. The chain is attached to the U-bolt by a 1/4-inch shackle. A 1 meter length of chain is attached to the anchor ring.

The U-bolt, chain, and shackle were purchased at Orchard Supply Hardware. The part #s are:

Chain: 208-1578

U-bolt: 657-3521

Shackle: 115-3071

Teams MUST provide their own messenger line and are responsible for determining the length of line needed to reach from the control shack to the anchor, through the anchor ring, and back to the control shack. Teams are also responsible for determining the type of line and mechanisms they will use to complete this mission.

Note: A photo of the buoy anchor is included at the end of this document. Assemblies and drawings of the buoy anchor were created in SolidWorks and are also included at the end of this document.

ENVIRONMENTAL CONDITIONS

An ocean current called the North Atlantic Drift along with winds called the westerlies push ocean water into Placentia Bay. The currents in the bay generally flow inward on the eastern side and outward on the western side of the bay. However, given the recent storm conditions, the wind from the southwest is exceptionally strong; the currents stretch across the mouth of the bay and are not insignificant at depth.

Your team should prepare to operate your ROV in the simulated environmental conditions described in the **Operating Environments – Flume Tank** section of the **Design & Building Specifications and Competition Rules** document. Note that while the mission is the same, EXPLORER and RANGER class teams will face different environmental conditions.

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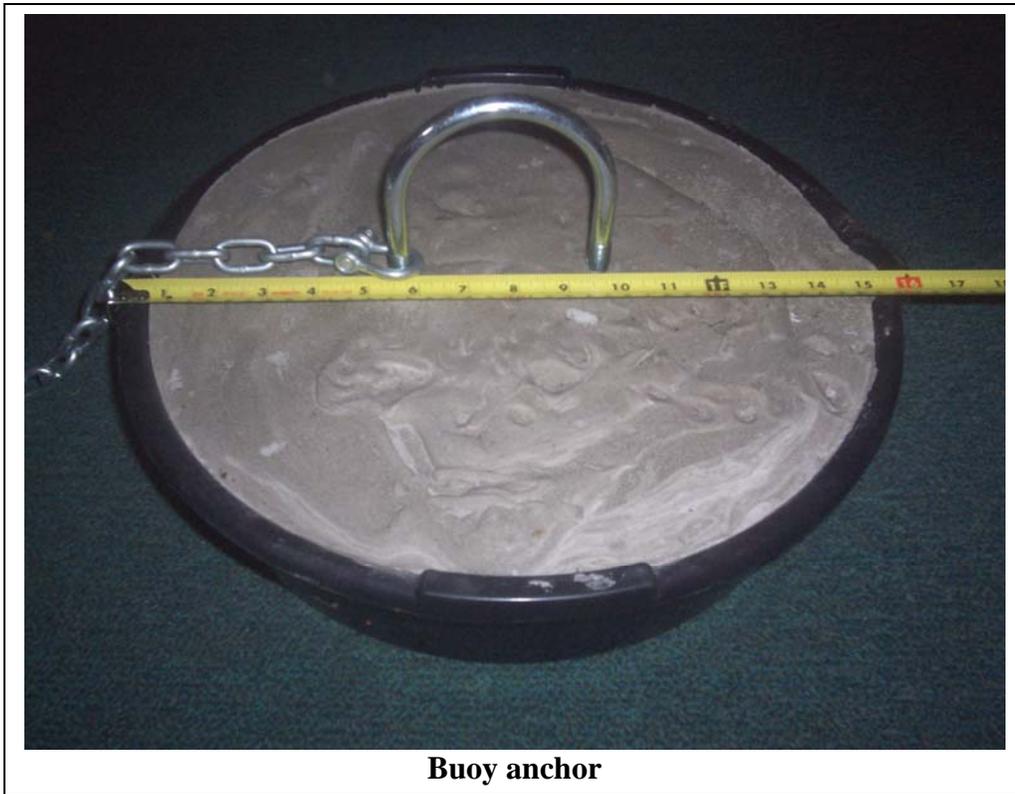
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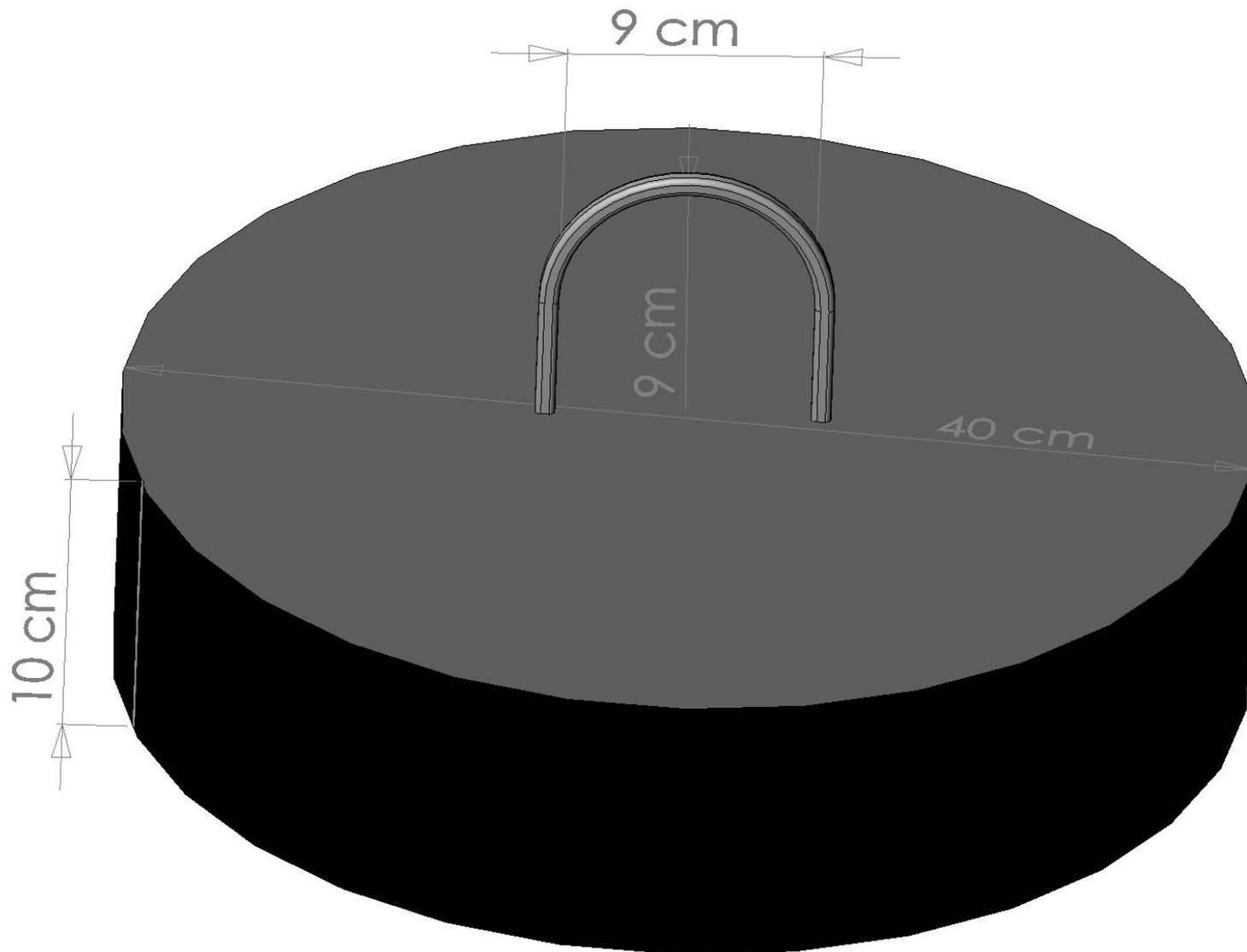
Placentia Bay

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Buoy anchor



Mission #1: Flume Tank

Buoy anchor

Diameter: 40 cm

Height: 10 cm

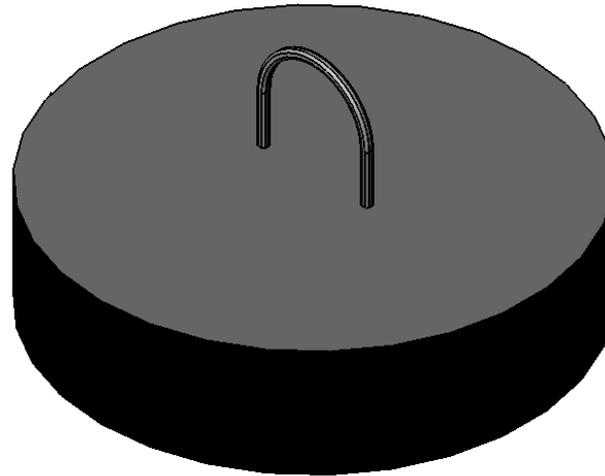
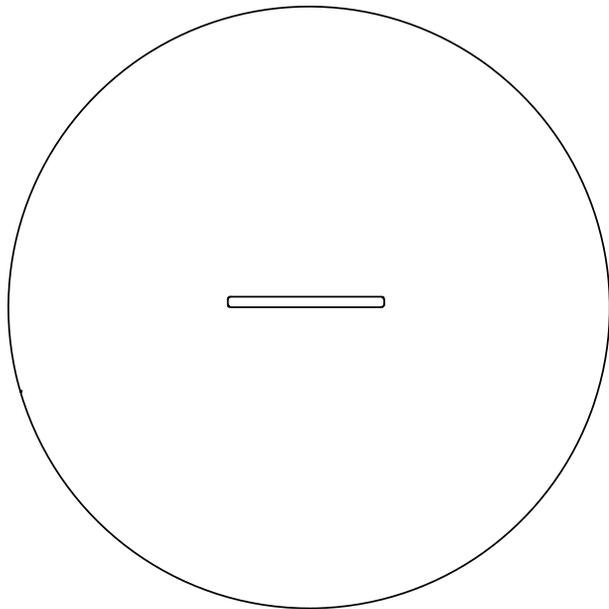
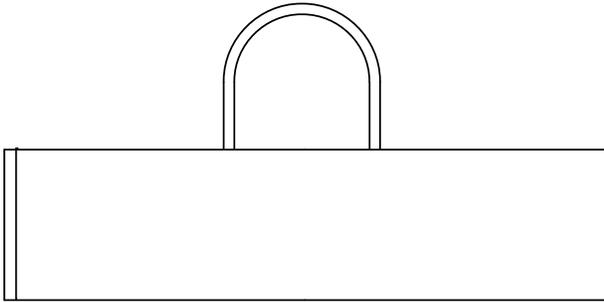
Weight: 15 kg

U-bolt

Size: 3.5 inch

Thickness: 0.5 inch

Height above anchor: 9 cm (internal)



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 THE INFORMATION CONTAINED IN THIS
 DRAWING IS THE PROPERTY OF
 THE MATE CENTER AND THE 2007 ROV
 COMPETITION.

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