Mission #3 – TOW TANK

Oil & gas exploration and production in the North Atlantic: Hibernia platform
The Atlantic Ocean has contributed significantly to the development and economy of the countries around it. Besides its major transatlantic transportation and communication routes and rich fishing resources, the Atlantic offers abundant petroleum deposits in the sedimentary rocks of the continental shelves.

The North Atlantic continental shelf is particularly rich in petroleum. Total oil production from North Atlantic fields is about 6 million barrels per day (mbls/day), or roughly 7.5% of the global demand (total world oil consumption is ~84 mbls/day). Currently there are three countries with oil-producing platforms in the North Atlantic – the United Kingdom, Norway and Canada.

Discovered in 1979, the Hibernia oil field is located in 80 meters of water 315km east/southeast (46˚45'N, 48˚47'W) of St. John's, Newfoundland, Canada. The field is found within the Jeanne d'Arc Basin, which underlies the northeast portion of the Grand Banks of the North Atlantic. The Hibernia field consists of two principal reservoirs of early Cretaceous age – the Hibernia and Ben Nevis-Avalon reservoirs, which are located at 3,700 and 2,400 meters, respectively, beneath the seafloor. At the time of its discovery, Hibernia was the 5th largest field ever discovered in Canada and jointly owned by ExxonMobil Canada, Chevron Canada Resources, Petro-Canada, Canada Hibernia Holding Corporation, Murphy Oil, and Norsk Hydro.

Hibernia oil production platform

The Hibernia drilling platform was towed to the oil field and positioned on the ocean floor in June of 1997 and began producing oil in November of that same year. The Hibernia platform stands 224 meters high, which is half the height of New York's Empire

State Building (449 meters) and 33 meters taller than the Calgary Tower (191 meters). The platform has three separate components: Topsides, Gravity Base Structure (GBS), and Offshore Loading System (OLS).

The Topsides facilities accommodate all drilling, producing, and utility equipment on the platform and provide living quarters for a crew of approximately 185 people. The Topsides structure is supported by the GBS, which is a massive concrete pedestal that sits on the ocean floor. It is specially designed to withstand the impact of sea ice and icebergs to allow for year-round production. The GBS is 111 meters high and includes an 85-meter high chamber that has storage capacity of 1.3 million barrels of crude oil. Oil is transferred from the platform to shuttle tankers via the OLS. The OLS consists of subsea pipelines, a sub-surface buoy, and loading hoses.

Currently the Hibernia platform has the capability of producing more than 200,000 barrels of crude oil per day, which it ships to refineries in Canada, the U.S., and other countries depending on the demand. The platform could support additional production, if new reservoirs were discovered.

And this is where your mission begins.

Note: The remainder of this scenario is fictional. While the events could potentially take place, they have not.

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Months of exploration have yielded a new reservoir. After much analysis, Hibernia owners have determined that the platform can support the production of the 50,000-100,000 barrels of oil expected per day from this new source. However, because the reservoir is some distance from the existing platform, rather than drill from the platform, Hibernia must drill into this new supply using subsea wells. Once the subsea well is completed, a pipeline will be laid to transport the oil to the Hibernia platform.

After drilling the new well, the next step is to prepare the wellhead for delivery of a Christmas tree. A Christmas tree is an assembly of valves, spools, and fittings that prevents the release of oil or gas from the oil well into the environment. The tree also directs and controls the flow of oil from the well; when the well is ready, valves are opened and oil is allowed to flow through a pipeline that leads to the Hibernia platform.

The Hibernia platform is supported by an ROV, which Hibernia leases from a company in the UK. The ROV was used initially to install equipment and conduct subsea inspections of the platform structure. Although the ROV will continue to be used for inspections, it's also been made available to other offshore operators. The vehicle is currently on a three-month loan and not available to prepare the wellhead for the timely delivery and installation of the Christmas tree. And in the offshore oil and gas business, time is money.

Your team has been called in by Hibernia to prepare the wellhead.

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 20 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 being touched by a team member at the launch station before the mission performance period ends. Teams must install the gasket in the wellhead and replace the protective cover before attempting the hot stab operation. ROVs do NOT need to return to the surface during the mission performance period.

Task: Install a gasket in the wellhead and inject corrosion prohibiter into the wellhead's protective cover.

Your mission is to install a gasket in the wellhead. This seal will help to ensure a good connection between the wellhead and the Christmas tree. Once the wellhead's protective cover has been replaced, your mission is to inject corrosion prohibiter (to protect the gasket and the wellhead) into the wellhead using a hot stab.

A hot stab is a tool used to transfer fluid (typically hydraulic fluid) to another tool or piece of subsea equipment. For example, a hot stab can be connected to an ROV's hydraulic pressure unit (HPU) then used to hydraulically activate a torque tool for opening and closing valves on a Christmas tree. In this scenario, the hot stab is connected to a reservoir of corrosion prohibiter located on your ROV.

Note: The hot stab will be provided. You are NOT required to include a reservoir (or simulation of one) on your ROV. See the **MISSION PROP SPECIFICATIONS** below for further details about the hot stab operation.

The mission task involves:

- **Transporting the gasket to the wellhead.**
- **Removing the wellhead's protective cover.**
- **Installing the gasket into the wellhead.**
- **Replacing the wellhead's protective cover.**
- **Transporting the hot stab to the wellhead.**
- **Inserting the hot stab into the port on the wellhead.**
- **Removing the hot stab from port on the wellhead.**
- **Returning the hot stab to the surface.**

There will be only one wellhead in each mission area. The wellhead will be placed on a platform submerged to 2.8 meters depth. Your team will have to locate this wellhead and remove its protective cover before installing the gasket. Once removed, the protective cover can be placed on the bottom of the platform or it can remain attached to your ROV while the gasket is being installed. The protective cover can be replaced only after the gasket has been installed. The cover must fit completely over the wellhead and remain on the wellhead once your ROV releases it.

The hot stab will be connected to your ROV by a line. The line simulates the line that allows for delivery of the corrosion prohibiter to the wellhead. Your team is responsible for attaching this line to your ROV; it must be attached during the 5-minute set-up period. Attaching the line to your ROV will simulate connecting it to the reservoir of corrosion prohibiter; you are NOT required to include a reservoir (or simulation of one) on your ROV. **The hot stab can neither dangle freely by its line as you transport it to the mission area nor dangle freely by its line as you return it to the surface.** Once the hot stab is inserted into the port, the mission control officials will need to confirm a successful insertion before your ROV removes the hot stab from the port. Your team does not have to physically touch the hot stab once it reaches the surface; however, the mission control officials must confirm that your ROV is indeed in control of the hot stab (and the hot stab is not dangling by its line) when it reaches the surface.

Scoring – 80 points (no partial points will be given)

- 10 points – transport the gasket from the surface to the wellhead under the control of your ROV.
- 10 points – remove the wellhead's protective cover so that it is completely separated from the wellhead.
- 10 points – install the gasket so that it fits completely into the wellhead and remains there once your ROV has released it.
- 10 points – replace the wellhead's protective cover so that it fits completely on the wellhead and remains there once your ROV has released it.
- 10 points – transport the hot stab from the surface to the wellhead under the control of your ROV and so that its line is and remains attached to your ROV.
- 10 points – insert the hot stab into the port on the wellhead so that it remains within the port once your ROV has released it and until mission control officials confirm it is a successful insertion.
- 10 points – remove the hot stab from the port on the wellhead.
- 10 points – return the hot stab to the surface under the control of your ROV. The hot stab cannot dangle on its line below your ROV and its line must remain attached to your ROV.

Time bonus

Teams will receive 1 point for every minute and 0.01 point for every second under 20 minutes remaining. Your mission performance period ends when your ROV has successfully completed the mission task, returned to the surface in control of the hot stab connector and under its own power, and a team member at the launch station has physically touched the vehicle. Time bonus points will be awarded accordingly.

MISSION PROP SPECIFICATIONS

The wellhead is simulated by a length of 2-inch PVC pipe and a 2-inch PVC T topped off by a 2-inch to 3-inch PVC pipe increaser. The internal diameter of the 3-inch PVC increaser is 8.8cm. The bottom of the wellhead is a 2-inch PVC adapter cemented into an oil pan 40cm in diameter and 10cm tall. This anchors the wellhead to the bottom. The

top of the wellhead (sans cover) is between 0.4m and 0.75m above the bottom of the platform.

The protective cover for the wellhead is constructed of a 4-inch PVC drain cap with a 2 x 2 11/16-inch U-bolt. The U-bolt is centered in the top of the drain cap, and extends 5.1 cm (internal measurement) above the top surface of the end cap. The internal diameter of the U-bolt is 2 inches. The internal diameter of the PVC drain cap is 11.4cm.

Note: A drain cap is different from an end cap. A drain cap has a flat top, whereas an end cap has a curved top. Check the drainage pipe section of your local hardware store.

The gasket is simulated by a tub drain gasket made of rubber. The outer diameter of this gasket is 7.2cm; the inner diameter is 4.7cm. Attached to the gasket by #6 x ½ self-tapping screws is 20cm of 1/8-inch diamond braid polypropylene rope. The rope is slightly rigid and slightly negatively buoyant; it will hold its shape above the gasket. The rope serves as the "handle" by which your ROV can transport the gasket and install it into the wellhead. The gasket, including the rope, weighs less than 1N in fresh water.

The port for the hot stab is located on the wellhead at a 45 degree angle. When the wellhead cover is in place, the port is approximately 3cm below the wellhead cover. The port is simulated by a 2-inch length of PVC that connects to the wellhead's 2-inch PVC T. A 2-inch PVC 45 degree elbow is connected to this 2-inch length to give the port the proper orientation. A 12cm length of 2-inch PVC pipe connected to the 45 degree elbow simulates the port opening. The opening is 5.08cm (2 inches); the depth of the port is 18.5cm.

The hot stab is simulated by an insert T ½-inch threaded, a ½ inch x ¾ inch male adapter, and a 20cm length of ¾-inch PVC pipe. Two meters of 1/8-inch diamond braid polypropylene rope is attached to the insert T. This line is used to connect the hot stab to your ROV. The hot stab, not including the polypropylene rope, weighs 1N in fresh water.

Attaching the line to your ROV will simulate connecting it to a reservoir of corrosion prohibiter; you do not need to simulate a reservoir on your ROV. The line must be attached to the frame or other structural component (e.g., ballast tanks, electronics can) of your vehicle. The line must remain attached for the duration of the mission performance period.

Parts for the wellhead and hot stab were purchased at Orchard Supply Hardware. The part #s are:

½ inch insert T, threaded:	419-6028
½ inch x ¾ inch PVC male adapter:	000-1305
1/8 inch Diamond Braid Polypro rope:	650-7677
2 inch to 3 inch PVC pipe increaser	144-6681
Tub drain gasket	268-4686
4 inch drain cap	771-3415
2 x 2 11/16 inch U-bolt	932-5507

Note: Photos of the wellhead, wellhead cover, gasket, hot stab, and hot stab port are included at the end of this document. Assemblies and drawings of the wellhead cover, gasket, and hot stab were created in SolidWorks and are also included at the end of this document.

LAUNCH & RECOVERY SPECIFICATIONS

Teams must be able to carry and maneuver their vehicle over this wall and to the launch station during their 5 minute set up period.

Teams will launch their vehicles from a 5-foot x 10-foot platform located at the edge of the tow tank. Teams will access the launch station using a small stairway that leads from the deck of the tow tank, up and over the wall of the tow tank, and down to the platform. From the deck of the tow tank to the top of the wall is 54 inches. Teams must be able to carry and maneuver their vehicles up the stairway, over the wall of the tank, and down the stairway to the launch station during the 5 minute set-up period.

Pilots will control the vehicle from the deck of the tow tank, facing the wall. The tether handlers will be located on the launch station. The launch station will be secured approximately 1 foot above water level to avoid waves. (See photos inserted at the end of the **Design & Building Specifications and Competition Rules** document.)

ENVIRONMENTAL CONDITIONS

The North Atlantic is known for its harsh environmental conditions. In winter, temperatures can dip as low as –8˚ Celsius and wind speeds average 37 km per hour. Wave heights between 10 and 15 meters are commonly recorded. The Guinness World Book of Records calls the Grand Banks the foggiest place on earth. Sea ice and icebergs are realistic hazards, as the tragic voyage of the *RMS Titanic* can attest.

Your team should prepare to operate your ROV in the simulated environmental conditions described in the **Operating Environments – TOW 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.

References:

Atlantic Ocean
http://en.wikipedia.org/wiki/Atlantic_Ocean

Oil production
www.offshore-technology.com/projects/
www.gravmag.com/oil.html
www.ualberta.ca/~parkland/research/perspectives/CanadaFirst06OpEd.htm
http://crudemarketing.chevron.com/overview.asp?hibernia
www.neb-one.gc.ca/newsroom/Speeches/2005/GCCanadianOilUSMarketAOPL2005_05_25_e.htm

Hibernia
www.hibernia.ca

Christmas tree
http://en.wikipedia.org/wiki/Christmas_tree_(oil_well)

Wellhead

Wellhead without cover

Wellhead with cover

Wellhead cover

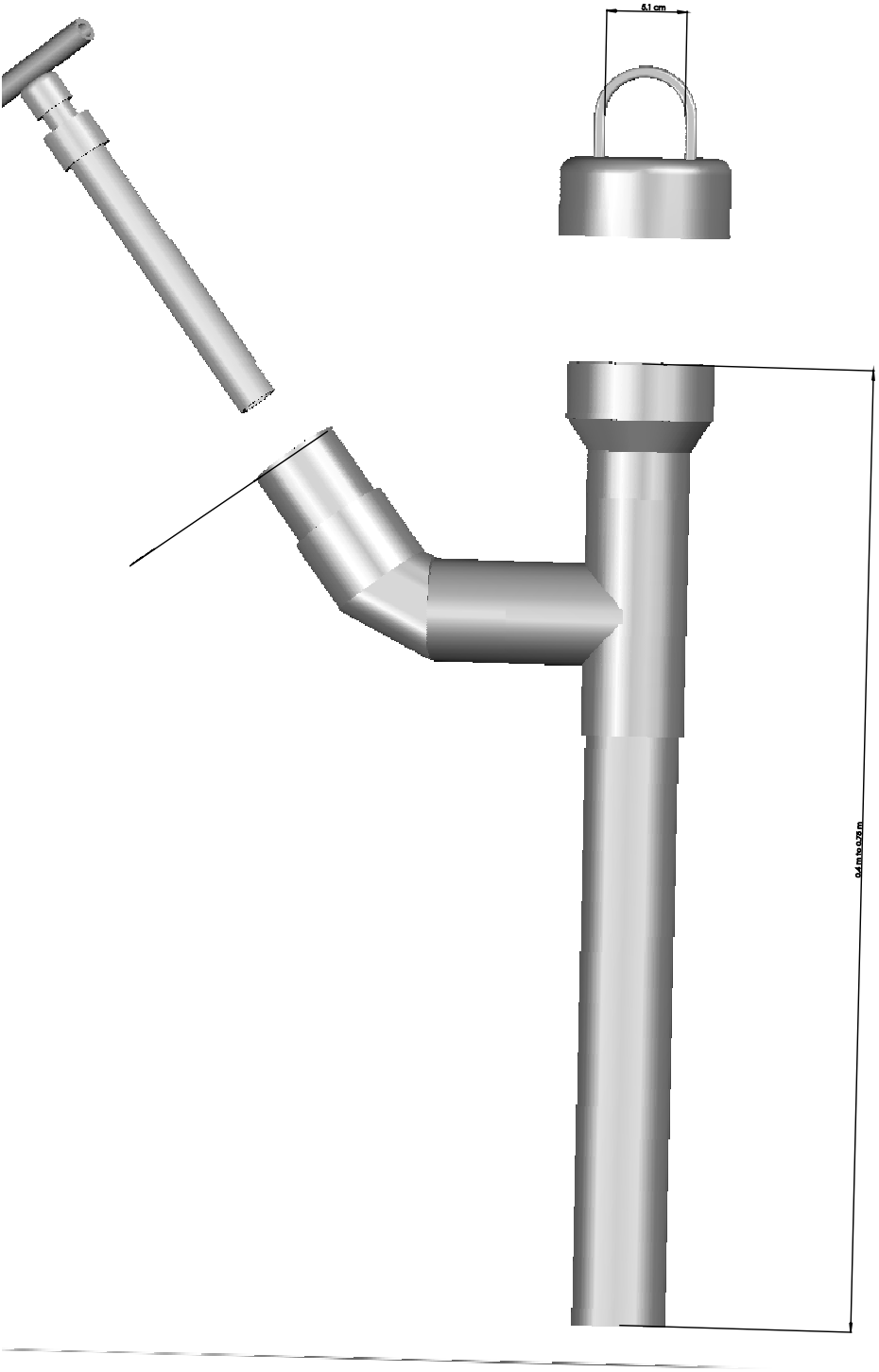
Gasket

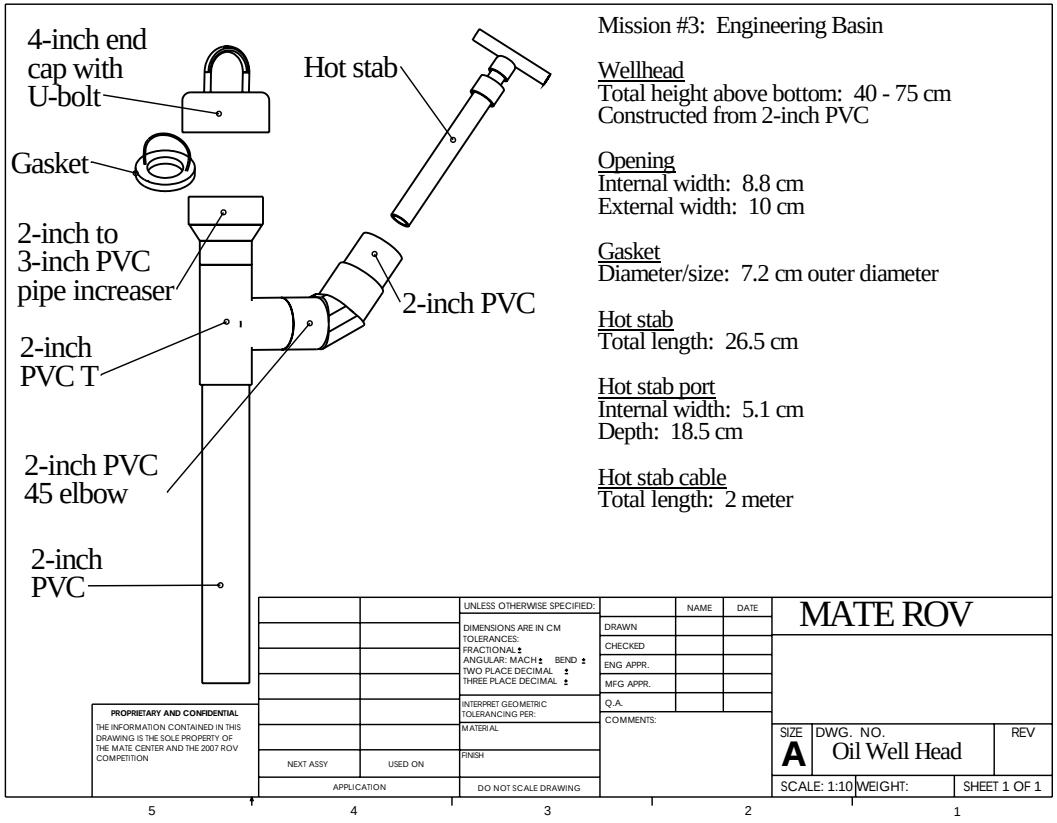
Gasket being inserted into well head

Hot stab

Hot stab inserted into port

Open port





Mission #3: Engineering Basin

Wellhead
Total height above bottom: 40 - 75 cm
Constructed from 2-inch PVC

Opening
Internal width: 8.8 cm
External width: 10 cm

Gasket
Diameter/size: 7.2 cm outer diameter

Hot stab
Total length: 26.5 cm

Hot stab port
Internal width: 5.1 cm
Depth: 18.5 cm

Hot stab cable
Total length: 2 meter

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN CM TOLERANCES: FRACTIONAL ± ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN		
			CHECKED		
			ENG APPR.		
			MFG APPR.		
			Q.A.		
		INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
		MATERIAL			
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

MATE ROV

SIZE	DWG. NO.	REV
A	Oil Well Head	
SCALE: 1:10	WEIGHT:	SHEET 1 OF 1

5 4 3 2 1