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Oil Spill Insights from a Retired Manager of an Offshore Underwater Service Company

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This is a guest post from Oil Drum commenter shelburn, who is a retired manager for an offshore underwater service company.

I have been reading the various reports from the media for the last few days and am distressed by the amount of misinformation that is being provided to the public. In response, I have put together some rough calculations and have tried to develop analogies that are understandable to laymen regarding what has happened and what is/can be done.

I have some relevant background, as I was in the offshore industry, primarily in the underwater service side for many years, so I am familiar with diving and ROV operations. I have also been involved in designing and building an oil capture and recovery dome (actually a pyramid) in much shallower water. I also was involved in the Exxon Valdez cleanup and environmental surveys, several years after that incident, among other things.

I'm not a downhole expert, so I'll leave that side to Rockman and others with the necessary training and experience.

The Leaks:

There is every indication that the Blowout Preventer (BOP) was activated and at least partially worked. There is a good probability that the "leak" is inside the BOP. As the oil leaks through the BOP, it then finds its way through the damaged riser and drill pipe, where it will exit from any open end or damaged area.

Therefore trying to repair the leaks in the riser does not decrease the flow, but it can reduce the number of places where oil must be captured--which is why they capped the end of the leaking drill pipe. If a company tried to stop all the leaks coming from the riser, it would probably be like trying to repair a rotten garden hose. Every time the company stopped one leak, another one would appear. The task is to try to reduce the leaks to one, or to a couple in the same area, so the containment dome can be put over them and the oil recovered while waiting for the relief wells to "kill" the well.

Every deepwater work class Remotely Operated Vehicle (ROV) carries sector scan sonar. Sonar can pick up oil leaks that the naked eye cannot see. The picture of oil bubbles painted on a sonar screen looks like fireworks going off.

There was an ROV survey of the BOP and riser within hours after the rig sank. At that time,

there was no indication of any oil leakage from the BOP, and everyone breathed an extremely large, and extremely premature, sigh of relief.

Estimates made about leakage are primarily done from aerial surveys and satellite photos These are notoriously inaccurate, as is clearly stated in the USCG manual on reporting oil spills. The gravity and thickness of the oil, temperature, weather, currents, time, weathering of the oil and other factors all have a major impact on the size of a slick from a given amount of oil.

For example, if you are on a lake in very still water and pour a gallon--not a barrel, a gallon--of gasoline over the side, in a matter of minutes you can have a slick covering a square mile. If you want to try this, pick a cool day as on a warm day the gasoline will evaporate before the slick finishes forming. Also, the Coast Guard would be most unhappy if it knew you were attempting this experiment.

If you do the same with heavy crude similar to what was involved in the Exxon Valdez spill, it will probably take a few hundred barrels to cover that same square mile. Over a long enough time period, though, the type of oil involved in the Exxon Valdez spill will end up covering an area many times larger, and will take months to dissipate in the absence of heavy weather. The sweet crude involved in this spill is somewhere in between.

It was sometime during the night after the sinking that oil leaks started appearing from buckles and holes in the riser. This was stated to be about 1,000 barrels per day. I would read that to mean the leak was between 250 and 3,000 barrels per day (bpd). And a 5,000 bpd leak is probably between 2,000 and 10,000 bpd. Until there is some way to measure the flow--like running it through a pipeline or into a tank--it is impossible to have any accurate measurement of the leakage.

Factoid: If you assume that there is over 5,000 psi of downhole pressure at the BOP--and everything I have heard indicates it is probably substantially higher than that--then a 1/4 inch diameter hole is large enough to “leak” 5,000 barrels a day. That “leak” would probably cut off your arm if you passed it in front of it.

There is almost certainly sand in the oil. As that sand passes the leaking portion of the BOP, it acts as an extremely high pressure sand blaster, eroding the area around the leak and enlarging the hole. So there is a perfectly rational explanation why the leak would escalate from 1,000 bpd to 5,000 bpd to whatever it is now.

Nobody was lying about the volume or covering up. The leak was, and is, getting worse.

How much is 1,000 bpd? It works out to 30 gallons per minute, about the output from 3 garden hoses running wide open, or about enough to fill a smallish backyard swimming pool in 24 hours.

Weather

I’m not an oil spill expert, so I won’t address the clean up much except to mention the effect weather has on it.

For actually recovering the oil, calm weather is the best. It only takes about 3 or 4 foot waves to greatly impede skimming operations and render inflatable booms ineffective.

Unfortunately, the first week of the spill had enough bad weather that recovery operations were slowed and actually stopped for a few days. This week things have been much better, and a lot of

oil, but certainly not all, has been recovered before it reached land.

The most effective spill cleanup is a violent storm. Mother Nature is much more successful than man at taking care of herself. In Alaska, we found areas prone to heavy storms were essentially clean after one winter, while protected bays and inlets still have oil deposits more than 20 years later.

A number of years ago, a small tanker with a full load of fuel broke up on the Scottish coast during a North Sea winter storm. Heroic efforts by the British Coast Guard and the salvage tug crew saved most of the crew members, but the tanker was completely destroyed, and all the cargo spilled. There was a great fear of massive environmental consequences. But after the storm abated, there was almost no sign of the oil. The power of the storm had effectively dispersed all the oil and cleaned the rock beaches and cliffs.

Obviously the answer is to recover the oil before it reaches land, but a large storm that pushed the oil out to sea and broke it up would be beneficial. That is unlikely to happen at this time of year. It is much more likely any storm would push the oil onshore and would not be violent enough to disperse it.

Remotely Operated Vehicles (ROVs)

The ROV videos available on YouTube and other sites have been edited or cropped to remove some of the company information and data that is normally visible on the screen. Also, the picture quality is severely degraded from what the operators (BP and all the others) are seeing. But they do give a bit of insight as to what the pilots are seeing and the quality of visibility. So far the ones I've seen do not show much detail about the leaks, except for the end of a piece of drill pipe which has been capped.

Incidentally, BP will almost certainly be watching all the ROV video in real time and high definition in their war room in Houston, surrounded by people from the MMS and the USCG.

Twenty years ago a typical ROV spent about as much time on deck being repaired as it did in the water. Today anything less than about 98% to 99% "uptime" is considered substandard. I would be surprised if the ROVs come to the surface except to change tool packages, or if the vessel has to leave location. At that depth, it takes about 3 hours to make a round trip from the work site to the deck and back down.

All the ROVs onsite are considered large work class ROVs. They are at least 150 and often over 200 horsepower. They have multiple thrusters that give them accurate positional control in three dimensions plus pitch and yaw. They carry two strong manipulator arms, color sector scan sonar, several high definition color video cameras, and an incredible multiplexed data system. They have jet pumps that can move vast quantities of mud, wire rope cutters, grinders and cutting systems. Besides the ROVs, BP has access to numerous tool packages that can repair pipelines, clean platform members, etc.

All the deepwater BOP stacks and other equipment are specially designed to interface with ROVs as they operate WAY past the depth any diver can go.

There are some reasonably good short videos of ROVs at www.oceaneering.com. Go the section on ROVs.

The "Dome"

Let's talk about the dome a little. It would appear from the photos that the dome is designed to be large enough to encase the BOP. It has mud mats 16 feet off the bottom, so obviously the idea is to let it sink into the mud which will stabilize the dome and keep it in place.

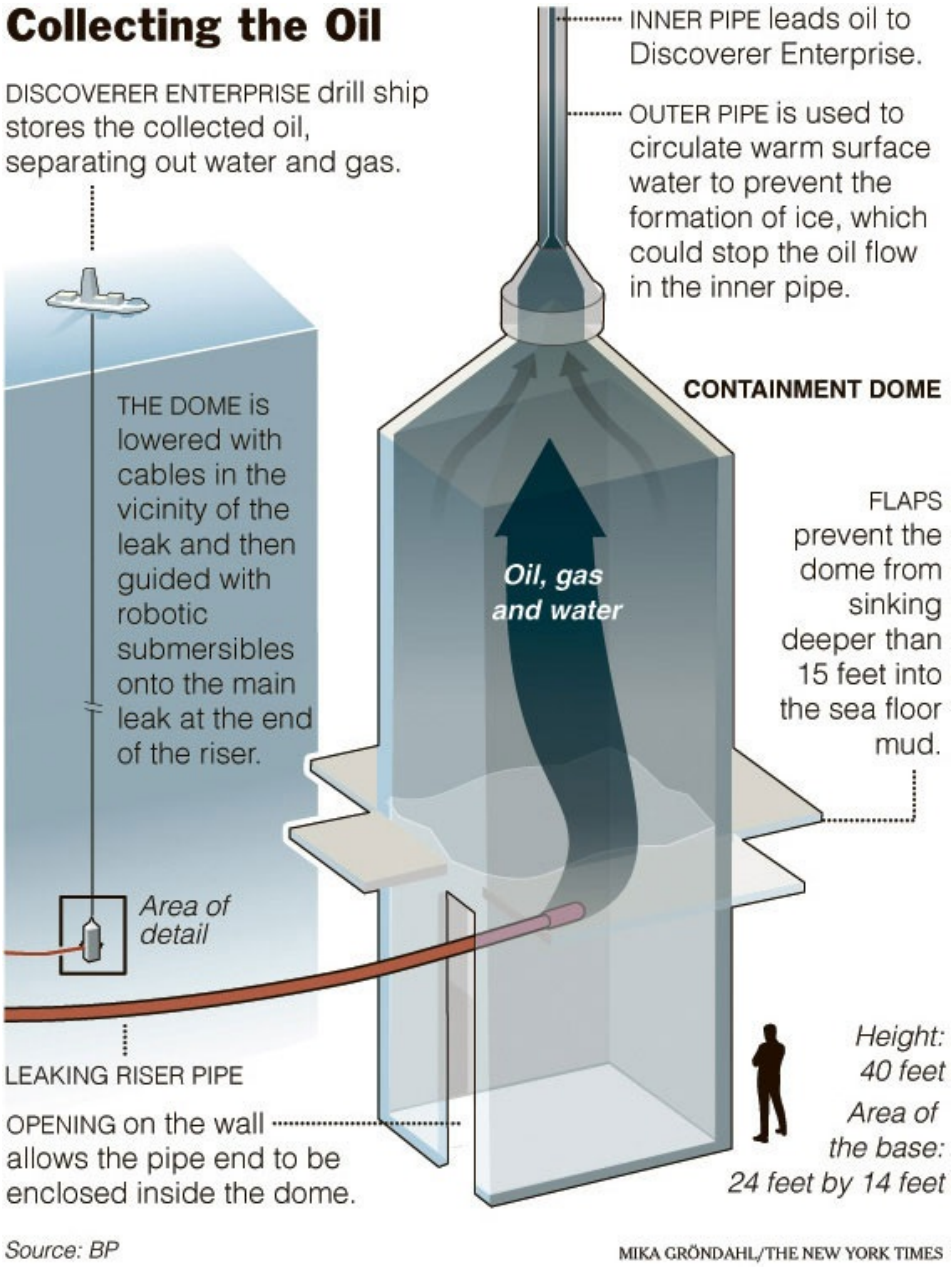

Image from a recent New York Times article

The dome should act as a primary oil/water separator and minimize the amount of water going up the drill string. But even better, if I understand the plan correctly, the leak will probably be above the oil/water interface (water will not entirely fill the dome), which means if the dome system is working smoothly, the oil leaking from the riser will never come in contact with the water before it heads up the drill string.

The dome has to be open to the sea water near the bottom, so the pressure will equalize. If the dome were to seal tightly to the seabed, any negative pressure created by the oil rising in the drill string would suck the surrounding mud sea bed right up into the drill string (this is the principal behind suction anchors for drill rigs), and possibly collapse the containment vessel.

I assume the way they will control the system will to be to monitor the level of the oil/water interface inside the dome and throttle the flow at top of the drill string to keep the oil/water interface at a set level.

It is to be connected to the Discoverer Enterprise with a 6-7/8" drill string. Based on some rough estimates I made, if a person assumes the specific gravity of the oil is 0.89, the specific gravity of sea water is 1.026, the depth is 5,000 feet (actually this is of little importance in calculating the maximum flow), and a freeboard of 33 feet to reach the drill ship deck piping, it should be possible to get about 24,000 bpd on the ship using the natural buoyancy of the oil alone. Most of my numbers, especially the specific gravity of the oil, are conservative, so the maximum throughput could be greater, maybe much greater.

If the drill string is filled with oil, the static pressure is entirely dependent on the specific gravity of the oil and the actual water depth. Roughly, if the specific gravity is 0.80, then the pressure at the water surface would be about 500 psi; if the specific gravity of the oil is 0.90, the pressure would be just under 300 psi.

In real life any entrained gas will make a major difference. If the drill string was entirely filled with gas, the static pressure at the surface would be over 2,200 psi. And as soon as you start mixed flow, you get into undefined territory unless you know the exact percentage of gas mixed in the oil.

Entrained gas in the leaking oil will greatly change the flow dynamics, as the gas will expand approximately 150 times going up the drill string and act as a giant airlift. The problem then won't be getting the oil up the drill string; it will be throttling back the flow onboard the drillship. Luckily, a deepwater drillship will have the proper equipment to handle this.

The expanding gas also has a substantial cooling effect, enough to freeze the water entrained in the stream. So the design of the drill string has been modified to include a warm water jacket and a methanol (antifreeze) injection system.

They have a potentially dangerous situation separating the oil, gas and water, but since the Discoverer Enterprise has processing equipment on board they should be able to handle that safely. The Enterprise also has dual draw works and drill floor, so they are equipped to handle a second drill string to another dome if needed.

The Politics

This is obviously a disaster. It is quite possible that a human error or series of errors, coupled with possible equipment failure, are to blame.

Does BP have culpability because of trying to move too fast? At over $500 a minute, they certainly have the incentive to move fast. We don't know - yet.

Is Transocean to blame for some sort of negligence in not properly monitoring the mud return or some other aspect of cementing process? We don't know - yet.

Was Halliburton's cement job faulty? We don't know - yet.

Did Cameron International's BOP fail due to manufacturing or design fault? We don't know - yet.

Is a combination of one or more of the above? Quite possibly, but we don't know - yet.

There are unsubstantiated reports that the kick registered over 30,000 psi. If the BOP stack saw that kind of pressure, it could be a important factor, both in determining what happened and how to prevent it from happening again.

For those who are appalled that BP had no contingency plans in case of a spill, perhaps you think the skimmer vessels, the miles and miles of inflatable boom, and the couple hundred trained oil spill control personnel that you see on TV just materialized out of thin air. In fact, they have been on standby for a couple decades. They train, work on small spills, and prepare for disaster. As Rockman says: think of them as a fire department, paid for by the oil companies, under requirements of the US government.

For those who are appalled by the lack of government response, consider that the US Coast Guard was underway in minutes after the blow out, and their spill response personnel (as well as the teams and equipment from the oil industry) were already onsite, standing by, before the rig sank.

For a week after the initial incident, from the blowout April 20 until April 28, things weren't going well. The BOP was still leaking, and the weather was slowing recovery operations, but it is fair to say that the incident was reasonably "under control". There was no need for Obama to get directly involved, mobilize the Dept of Defense, etc.

On April 29, everything started falling apart--a true worst case scenario. That morning, it was obvious the leakage from the BOP had increased dramatically. Even worse, the weather changed and strong offshore winds start moving the oil directly toward some of the most sensitive barrier islands in Louisiana. Not only did the wind change direction, but by evening, it also increased to the point it effectively shut down all skimming and recovery operations and most boom deployments.

The media, which had had only superficial coverage up to this point, got heavily involved and disseminated a great deal of technical information that was just plain incorrect.

There is a certainly an expectation that someone may be to blame for the uncontrolled blow out with its loss of life, and potential for extreme environmental and economic damage. But, it is my opinion, with some understanding of the complexities and technical and operational challenges involved, that both the oil industry and the government operational people have responded to the incident quickly and professionally. I wish I could say the same for the media, the politicians and the bloggers.

The only operation after the blow out that I might question was the decision to keep pumping water into the rig. I wonder whether it might have been better to let it float, assuming it didn't sink due to a hole in a pontoon, and let the oil burn. But with the rig's engines and thrusters dead, the only thing holding it in position was the riser, so the potential for it to further damage the BOP probably played into that decision. It is always easy to "Monday morning quarterback," especially if a person doesn't understand the technical or operational problems. Fortunately, some of the best and most experienced people in the world are working this problem.

BP has stated they will pay for the cleanup and environmental damage (as required by law), and will pay any legitimate claims for economic damage. This is a reasonable requirement. During the Exxon Valdez disaster, we saw numerous outlandish claims from "fishermen" who couldn't tell you the difference between the bow and the stern and "landowners" and "tourist industry people"

who had never been to Alaska until after the spill.

There is a lot of press about a $75 million cap on BP's liability. This has been taken out of context, as it does not apply to the cleanup or environmental damage--there BP's liability is unlimited. The $75 million is in reference to economic damage, and BP has stated they will not hide behind that limit. Time will tell, but for now I am taking them at their word.

I'm sure this will require some effort on the part of people filing claims. For instance, if you are a charter boat owner or fisherman, I expect BP will require you to submit business records proving you are really in that business, and substantiate the amount of business you had before and after the event. It is fair and reasonable for BP to protect themselves from scams, just as it is fair and reasonable that those who have been economically damaged by this event be given realistic compensation.

I have a much greater problem understanding why the 200+ lawyers currently meeting to decide how to split up the pie should be entitled to the hundreds of millions of dollars in fees they will eventually receive.

We are lucky that this happened to one of the very few companies in the world that has the financial resources to pay the billions of dollars this will cost. This spill is in some ways similar to the Exxon Valdez spill, where Exxon, despite their overwhelming arrogance, did pay all the costs of the cleanup, even while they fought paying many of the economic damage claims I considered valid and tried to avoid all of the punitive damages.

If either spill had happened to a foreign tanker firm or an independent oil company, the taxpayers would have ended up paying for the entire cleanup bill. The people economically affected would have been out of luck, and the companies involved would have already declared bankruptcy.

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