



## The BP Deepwater Oil Spill - Why Top Kill May Have Failed and Monday Open Thread

Posted by [Heading Out](#) on May 31, 2010 - 7:30am

Topic: [Environment/Sustainability](#)

Tags: [bp](#), [deepwater horizon](#), [lmp](#), [oil spill](#), [original](#), [top kill](#) [list all tags]

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*Note: this is the same prose from last night's post of 6p or so, just with a new comment thread this morning. Enjoy.*

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But while waiting for that, and for the [Lower Marine Riser Package](#) (LMRP), I thought I would spend a few paragraphs discussing why Top Kill may have failed as a substitute for my tech talk tonight; you can find that under the fold by clicking "there's more."

(The [last post has a very technical discussion of LMRP](#), check that out there and in the comments.)

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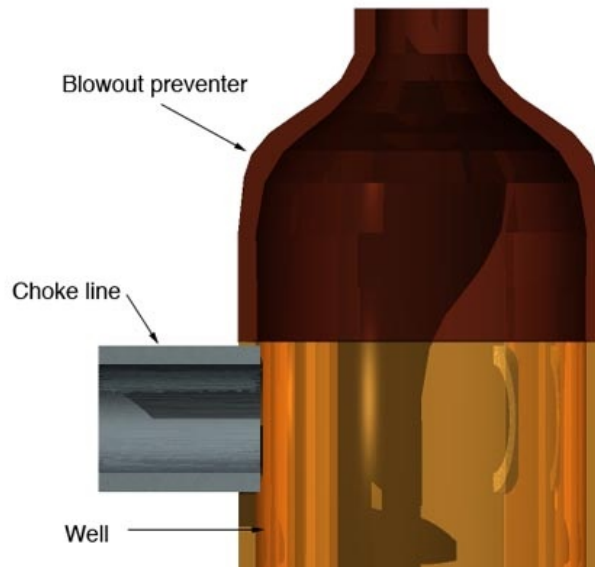
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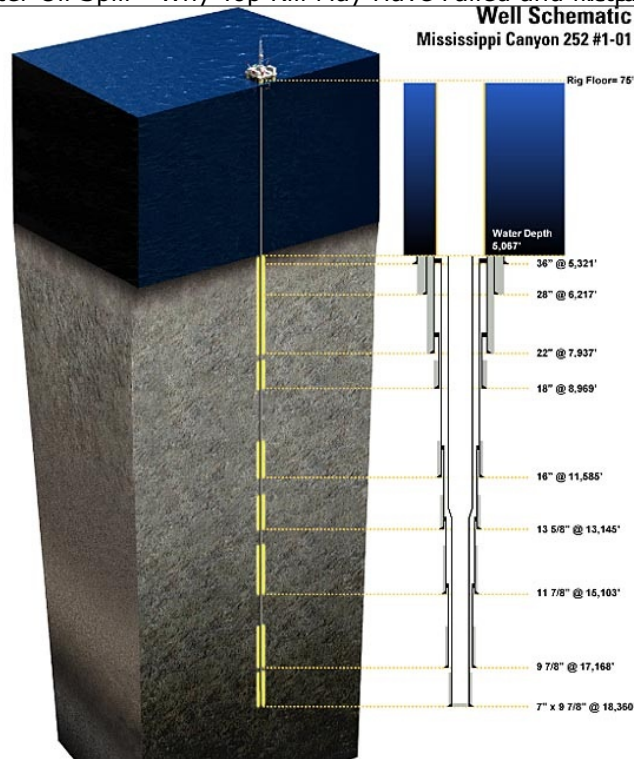
In a couple of earlier posts I wrote about how it was necessary to fill the gaps that ran through the Blow-Out Preventer (BOP) either with [spheres and triangles](#) or [with wire](#) (string would act similarly). To refresh your memory, in the initial simpler analysis, I had put up a simple sketch of the BOP and well, to show how the blocking particles were injected.



*Simple approximation of the situation*

Now, unfortunately that diagram left a significant part out, and that is that there are three sets of pipes leading down into the well. These are the well outer casing, which, surrounded by a layer of cement, holds the BOP in place. Then there is the production casing, which had just been set to the full depth of the well. And then there is the drill pipe that, at the time of the incident, extended down 8,367 ft from the platform, or roughly 3,367 ft below the BOP. That drill pipe (DP) had previously been used to locate the production casing at the bottom of the well, and itself now rode inside that production casing. In most normal operations it is closed at the bottom by a drill bit, but (and I'll come back to this later), it had just finished the cementing of the production casing into position, and once it detached from that and was being pulled from the well, it was an open pipe all the way up to the rig floor. And in that condition, it could be used for other things. By pulling mud out of the DP and transferring it to the mud pits (or standoff vessel), the level in the riser would fall and be replaced by seawater flowing in at the top. Unfortunately this also lowered the weight of mud in the well, and that is what caused the oil and gas to flow into the well.

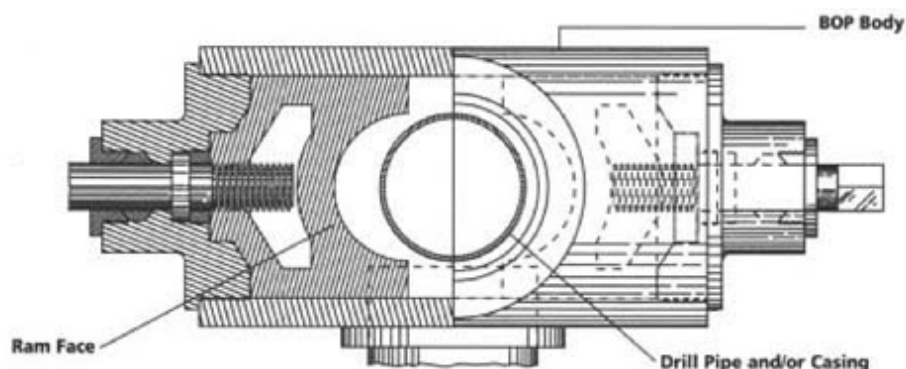
Outside of the DP is the casing and cement segments that make up the [outer lining of the well](#). The diagram presented in Congressional testimony, shows these various pipes, except for the central drill pipe.



*Casing and cement down the Deepwater well*

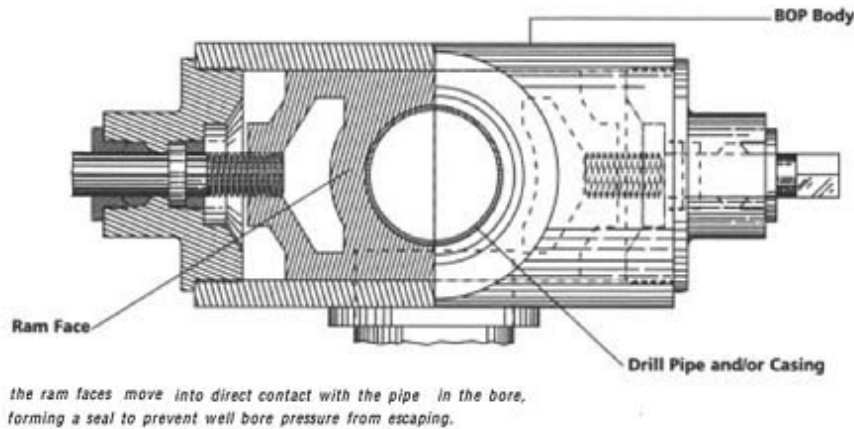
BP do not know, but believe that the oil is getting into the well through the cement wall at the bottom of the well, and probably rising up the well through the empty space (annulus) between the production casing and the outer lining of the well. However the oil and gas may have broken through the bottom of the cement plug and be rising up within the production casing, in which it is also rising through the DP once the oil reaches its lower end. It could also reach the bottom of the DP by flowing up the annulus then go down the production casing to the bottom of the DP and then back up into the BOP.

Most normal blowouts occur when the well is being drilled, and mud is flowing down, through the drill bit, and then back up the space (the annulus) between the DP and the rock wall. Thus, when there is a blowout, the oil and gas that flow into the well normally flow up this outer passage to the rig, and give the spectacular fountain of oil. The BOP was invented (by [Harry Cameron and Jim Abercrombie](#)) to stop that flow and to protect the crew at the surface. Because the flow is normally up the outside of the drill pipe, the initial BOP designs were rams that pushed seals across the flow path through the BOP, and sealed against the side of the DP.



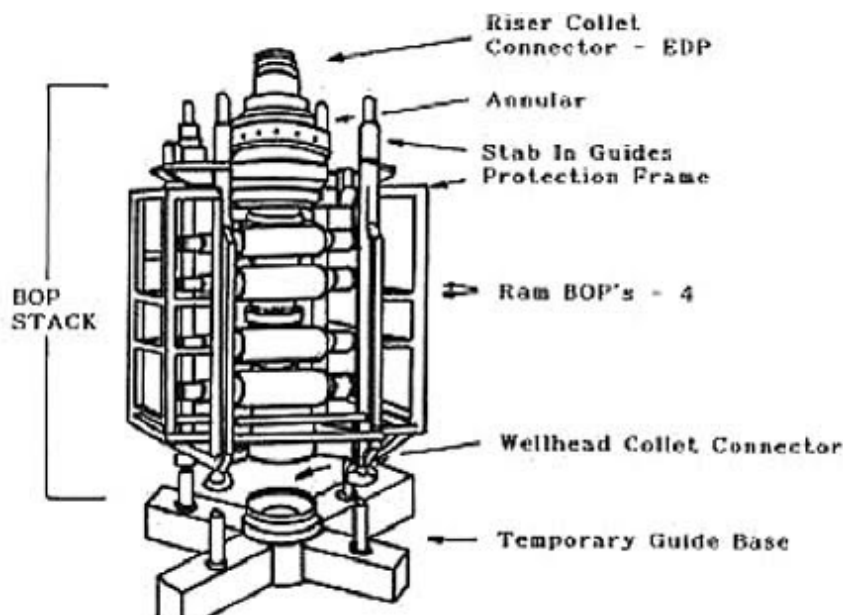
*MO BOP in the fully open position. The ram faces are retracted back, away from the pipe in the bore.*

*BOP open allowing flow through the annulus ([ASME](#))*



*BOP closed against the pipe, sealing the annulus ([ASME](#))*

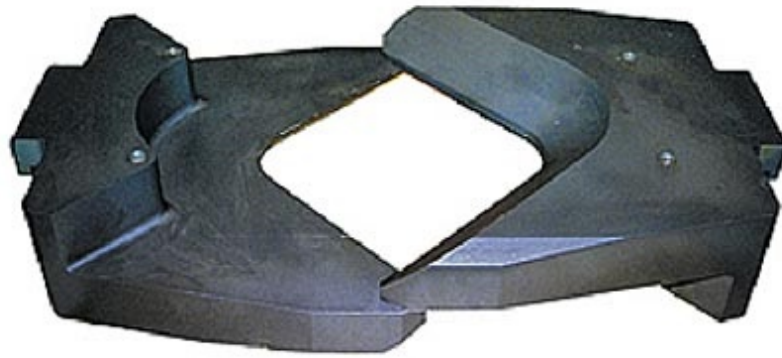
A BOP could have two of these mounted so that one sealed to the production casing in the well, and one to the drill pipe, but if underwater then the production casing is tied back to the Wellhead Collet Connector, and then the only tube running through the BOP will be the DP, to which they will seal.



*BOP connection to casing at the seabed ([PCCI report for MMS](#))*

The problem that this leaves, in the current situation, is that the pipe that runs through these two seals is open at the bottom to the oil flow. So how can the flow through this be stopped?

The answer is to mount a top ram set that has a set of shear cutting blades on it, that will cut through the pipe and seal the full face of the well.

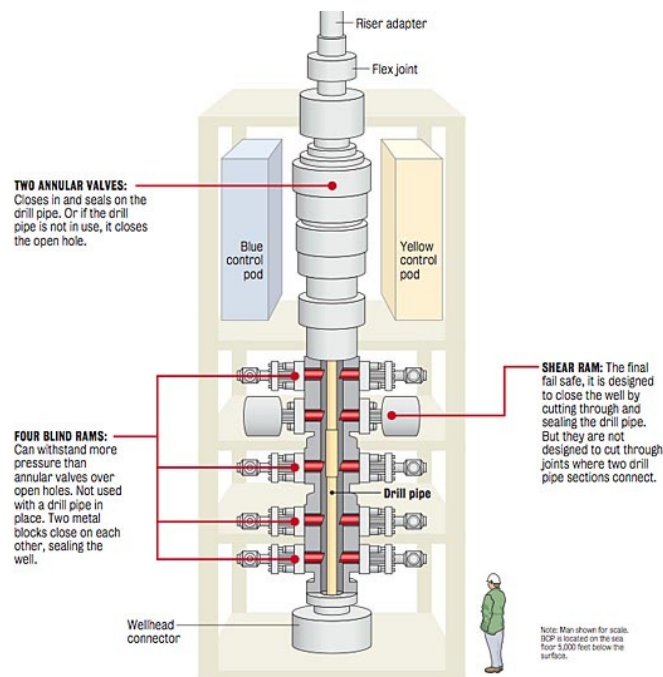


*Shear blades to cut through the DP and seal the well ([Varco](#))*

The DP should shear, but would be held in place by the grip of the annular sealing rams below.

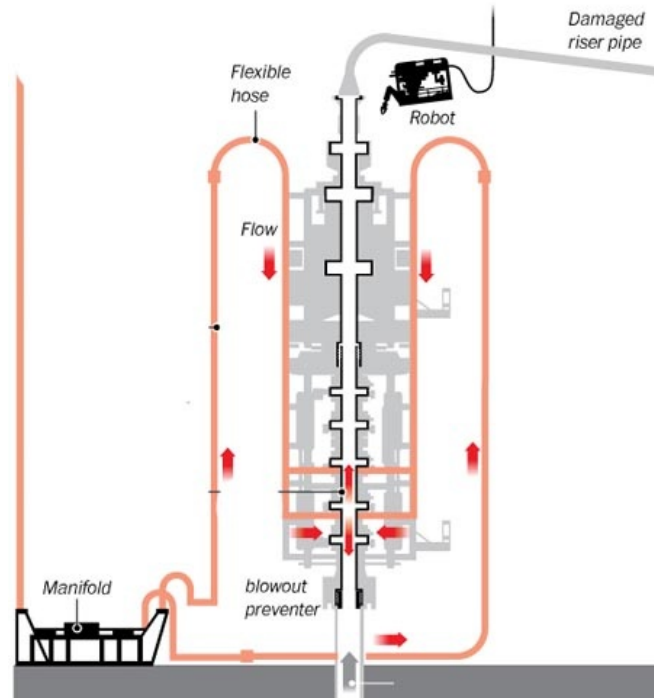
In this case it seems to be recognized that for some reason this shear event did not totally succeed. Thus the pipe was not totally severed and the two shear plates did not fully move over one another to complete the seal.

Now this is where the problem arises, because, in part, that pipe is still open at its lower end. If the leak is around the outside of the pipe, through a gap that has generated between the pipe and the annular seals, then the use of the junk shot to fill the cracks and gaps could conventionally have worked. But the configuration of the rams on the Deepwater Horizon had changed from the initial simpler configuration to add seals for occasions where the drill pipe was not in place.



*Ram layout on the BOP ([Times Picayune](#))*

And the "junk" is being injected at the bottom of this stack.



*Section through the BOP, showing the anticipated mud flow path (initially from BP)*

If the leak is coming up through the remnants of the drill pipe then life is complicated. It can't all be coming up through an undamaged pipe alone, since it was the far open end of that which was successfully closed at the beginning of the remedial steps, but if it is coming through the pipe and leaking out at the shear rams into the annulus that feeds into the riser, and out to the sea, then putting sealing particles into the bottom of the BOP to seal the cracks could have sealed some of the leakage around the DP trapped in the shears, but not that flowing through the shears in the remaining pipe section.

The reason that it can't is that the access to that flow is occurring 3,367 ft below the riser, and there is no easy way to get the sealing particles down that far. If they are mixed with mud and pushed down the well to that level and then released they have a different problem. The hope when they were released into the well was that the flow of the current would be enough to carry them up to the cracks that they could seal. But if they have to be carried down to the zone where the oil remains, then their density may be sufficiently high that they get into the flow without enough speed to lift them up into the BOP, instead it will cause them to sink to the bottom of the well.

The materials that BP tried included [materials that might float](#) on the surface, and might not be dense enough.

Those materials, including fibrous pieces of rope and chunks of rubber, were supposed to force more of the mud down the wellbore, but ultimately it did not work.

Rubber has a specific gravity of [0.91](#) and rope varies from [0.9 to 1.4](#). But remember that at that depth any buoyancy from air entrainment would be lost.

In other circumstances it might have worked, If they could have dropped the DP out of the shears

UPDATE: Thinking about this a little more, I had two more thoughts. The first is that once the LMRP preparation cuts off the riser and the bent drill pipe, then the full weight of the pipe below the shears may come onto the section in the shear jaws at the moment, pulling them further out of alignment and increasing the flows. It could also cause the pipe to drop out of the jaws, pulled out by the underlying weight, and hopefully not distorting them too much so that in the best of worlds they could then be cranked shut.

One could also, once the bent riser and pipe had been cut, go in down the pipe bit that extends up, go down past the annular seals with an abrasive jet lance (most of the flow is around the DP as we have established above) and cut it off, right above the shears. Then partially open the shears, drop the pipe out, and close them again. If they move all the way closed, without the obstruction, then the well may be sealed.



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