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BP's Deepwater Horizon - Static Top Kill vs. Bottom Kill: Weighing the Risks - and Open Thread

Posted by aeberman on July 30, 2010 - 10:45am
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Tags: deepwater horizon, oil spill, william semple [list all tags]

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A permanent solution to the BP Macondo blowout in the Gulf of Mexico may be achieved soon but there are risks. Admiral Thad Allen announced on Monday, July 26 that a static top kill would be attempted on August 2. The schedule may be accelerated to July 31 or August 1 according to an announcement today (July 29). The sealing cap has successfully stopped the flow of oil and gas from the well and the pressure continues to build slowly. Temperature at the wellhead has not increased, and seeps near the well are mostly nitrogen and biogenic methane unrelated to leakage. BP Senior Vice President Kent Wells' technical update on July 21 explained these findings and showed how the well will be killed.

There are risks involved in both the top and bottom kill procedures. The purpose of this post is to describe those risks. There are two risks associated with the static top kill. First, it may not work at all and second, it may rupture the casing by pumping heavy mud under pressure ("bull heading").

Kent Wells described the static top kill as a process of continuously pumping mud into the well until the oil is pushed into the reservoir. This is clearly erroneous and must be a simplification designed for the general public. What will more probably take place is a practice called "bleed and lubricate". Heavy mud is pumped into the well through the choke and kill lines on the blowout preventer (BOP) and allowed to sink to the bottom of the well. Hopefully, the mud will retard the flow so that some of the pressure can be bled off by producing oil to the surface for a short period. Then, more heavy mud will be pumped into the well, and the process repeated as necessary until the well contains enough mud to kill the well.

The first problem with stopping the flow from the top is that it has to be an annular kill: the flow was coming up the annulus outside the production casing. This is a very narrow space so mud will have to pumped at high pressure to achieve entry. It will initially be working against a full column of gas and oil and the shut-in pressure at the well head. On the positive side, if produced sand has accumulated in the annulus, the operation may not have to contend with the full force of the reservoir pressure in addition to these obstacles. On the negative side, the well head seals might prevent or restrict downward flow, or the pumping pressure could rupture the 22-inch casing, or reach a pressure high enough to call off the operation.

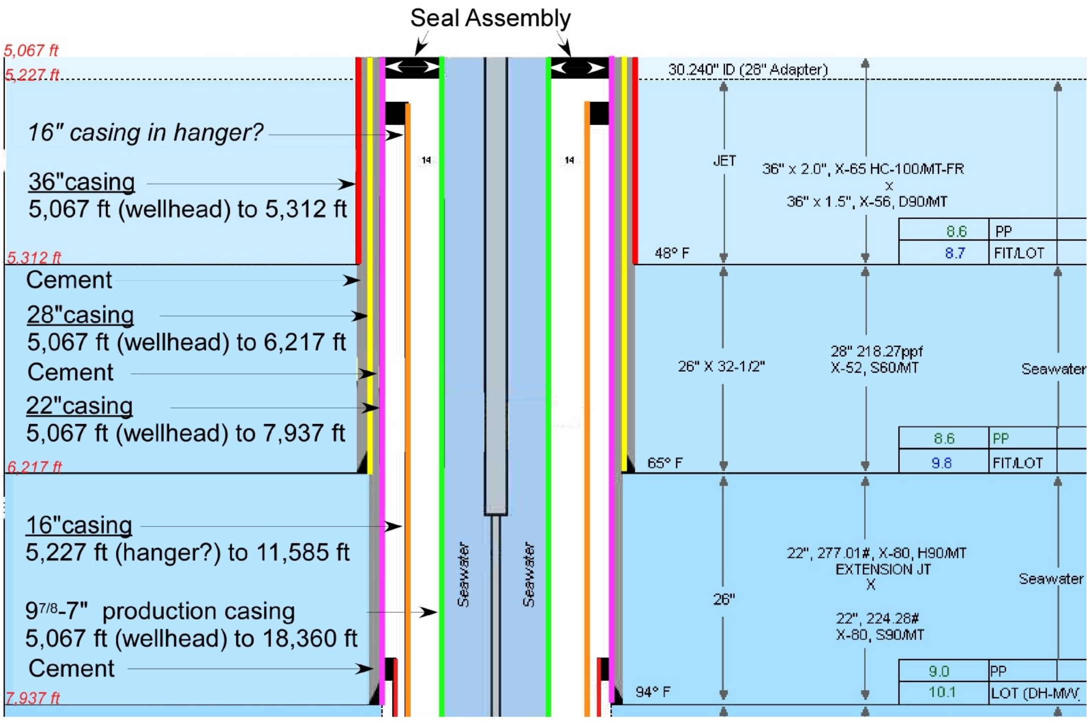

Figure 1a. Upper portion of Department of Energy well configuration diagram.
Modified from http://www.energy.gov/open/documents/3.1_Item_2_Macondo_Well_07_Jun_1900.pdf

Figure 1a (based on a government document) shows that the upper part of the well bore is protected by three strings of casing (36-, 28-, and 22-inch) and cement down to 7,937 feet (measured depth below sea level). A fourth string of 16-inch casing extends nearly from the well head to where it is cemented at 11,585 feet, but it is apparently hung inside the 22-inch casing at 5,227 feet, leaving a gap of 160 feet. The 16-inch pipe has a burst rating approximately equal to the current shut-in pressure of 6,900 psi (80% of rating), but the 22-inch pipe does not meet this standard.

BP has said that the relief well DD3 plan will continue regardless of the success of the top kill operation. The main risk with a bottom kill is that it may take considerable time to accomplish. Because of the recent tropical storm, crews are just removing the storm packer today, and it will take time to re-enter and condition the hole before drilling resumes. BP estimate that the DD3 will intersect the Macondo well around August 10. Most efforts to intersect a blown-out wells require several attempts. The recent 2009 Montara blowout in the Timor Sea required four attempts that took a month after the relief well was near the blow out and cased. The bottom of the first Macondo relief well is currently located a few feet from the target at approximately 17,220 feet measured depth (based on Wells' update and shown in Figure 1b).

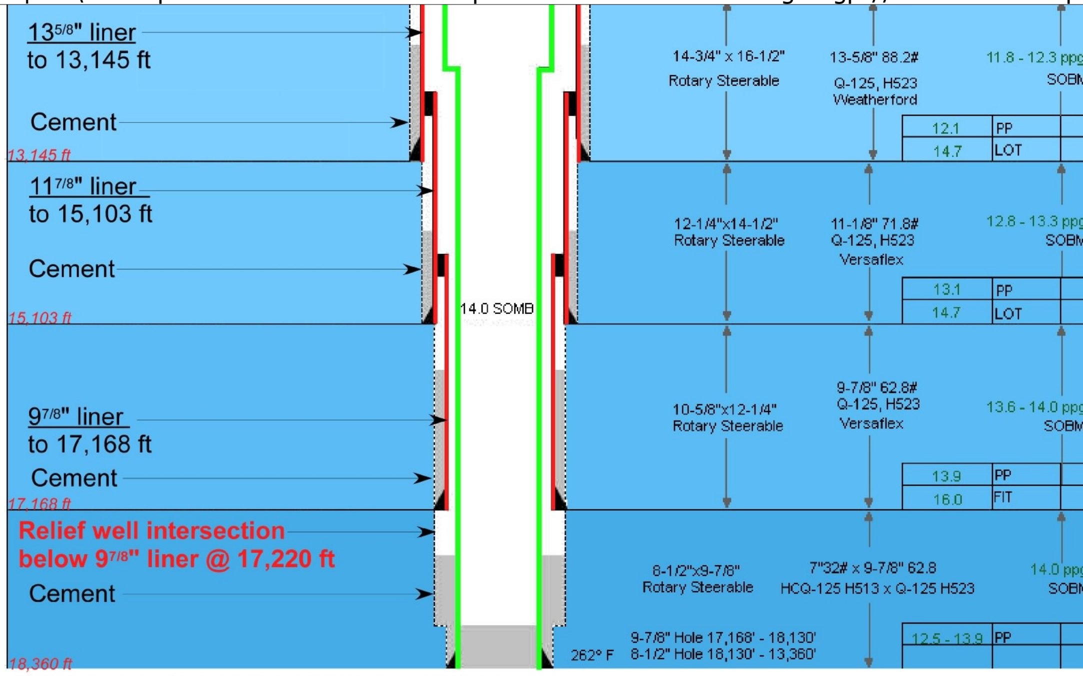

Figure 1b. Lower portion of Department of Energy well configuration diagram.
Modified from http://www.energy.gov/open/documents/3.1_Item_2_Macondo_Well_07_Jun_1900.pdf

The good news is that, in this case, the relief well does not, apparently, need to intersect the well exactly--it just needs to be close. Once the relief well penetrates the reservoir, enough mud can be pumped to hopefully overcome flowing pressure and kill the well. The bottom-kill option has the same annular flow path liabilities as the top kill, but it has the capacity to deliver higher flow rates directly to the reservoir. This approach will not cause significant pressuring near the well head and should not, therefore, pose a risk of rupturing the 22-inch casing.

The bottom kill option involves considerably less mechanical risk than the top kill, but time is the enemy, so the top kill makes sense. Maintaining the objectivity to abandon the operation rather than risk casing rupture will be critical.