Minimizing risk through improved safety features: How to choose technologies

In 2011, the BEAR team was asked to provide forensic engineering and economics analysis on BP's Deepwater Horizon well blowout in the Gulf of Mexico in 2010. One piece of the analysis consisted of evaluating the possibility of a stand-by blowout preventer, that might have shortened the time and amount of uncontrolled release of oil and hence lessened the damages cause by the well blowout. A straight forward cost/benefit analysis was performed.

If one follows Lord Justice Asquith's legal definition of SFAIRP or ALARP, which states that "the quantum of risk is placed on one scale and the sacrifice involved ….. on the other" it is obvious that the duration of a blowout carry a different cost. Furthermore it is important, in statistical terms, to distinguish between dependent and independent events. [1] Blowout events are clearly dependent events in statistical terms. In the first instance, there is a historical learning curve to prevent blowouts. Past events, industry conferences, improved technologies have led to fewer blowouts between 1992 and 2006 compared to the period between 1971 and 1991. Second, the main principle of ALARP is the cost of marginal risk reduction. Each technology in risk management has a different probability of success. If the risk management portfolio lacks a particular technology, it affects the outcome of other available technologies. In the specific instance of BP's blowout on April 20th, 2010, the absence of two technologies, advanced BOB and a BOP standby, immediately led decision makers towards the most expensive mitigation technology, that of drilling a relieve well.

When assigning risk mitigation measures, each technology needs to be evaluated in terms of cost. Drilling a relief well for 59 days automatically puts the blowout duration above the 28 day range. Having alternative standby technologies, such as a BOP could have shortened the duration of the blowout, and hence the cost of the blowout. Using an advanced BOP double shear ram could have further mitigated the damages.

The proper risk analysis for deepwater blowout mitigation strategies is as follows:

Control Strategies	Cost of Technology	Duration of Blowout	Cost of Damages
A. Advanced BOP	$ 2.85 Million	1 -14 day	$ 1 Billion
B. BOP standby	$ 50 + Million $ 12.3 annually	15-27 days	$1-30 Billion

If not A and not B, or

[1] The probability of rolling a dice with an outcome of 6, is one in six. Rolling the dice a second time yields the same probability. Statistically these are independent events. In contrast, in a Lotto, the probability that the number 7 is chosen is one in 49 (assuming the Lotto has 49 numbers). Once 7 is chosen, the probability of picking the number 7 again is 0, as in that instance, 7 is already eliminated. And, the probability of picking a 21, is one in 48, as there are one less numbers to pick from.

If A and B fails then

C. Relieve Well Note the cost of a relief well is the marginal cost of additional damages when A and B are not present or fail.

Burch maintains that the only risk analysis necessary is that of designing, building and maintaining a capping stack, his Option 1.[2] He erroneously assumes that the cost of damages is the same weather there is a readily available capping stack or not, when in fact the costs are vastly different.

Burch assumes the cost of a capping stack to be $50 million, with an annual operating cost for standby of $9 million. He amortizes the capping stack over 30 years at 5% which yields an annual cost of $3.2 million. He puts the annual cost of a standby capping stack at $12.3 million.

Clearly the interest rate used has some influence on the yearly cost of a standby capping stack. At 4% it is $2.9 million, at 3% it is $2.4 million.[3] Also, Burch assumes that a standby capping stack is for BP only when the resources can easily be shared among several deepwater oil exploration outfits. Sharing the resources makes a standby solution immediately viable. The following matrix shows the breakeven points between cost of all technologies and damages.

Table 1 shows blowout durations of < 14 days, 14 + days and 28+ days. For the case of a blowout lasting < 14 day the use of an advanced double shearing ram BOP lowers the probability of a blowout event to 4.72E-05. The additional cost of a double shearing ram is $2,85 million, with an annual cost of $ 184,000. A blowout cost of less than $1 Billion justifies the use of this technology. The annualized cost of a standby capping stack, using Burch's calculations is $12.3 Million. This additional cost is justified if the expected cost of a blowout is in excess of $30 Billion for a blowout event that lasts 14 + days.

The successful deployment of a standby capping stack might take more than 14 days, and at some time after that, if the estimates of cost of damages exceed $75 Billion, a relief well is drilled. These two technologies are not mutually exclusive, but the cost of deployment of these clearly show, that a standby capping stack has, potentially big advantages over not having one at all. The exclusive reliance of drilling a relief well increase the cost of damages significantly.

Table 2 shows the cost of drilling a relief well, using the marginal cost of damages. These do not include the additional cost of actually drilling the well. The actual costs of this technology option far exceed any other mitigating technology costs.

[2] Burch p. 34

[3] Using an online amortization calculator

Table 1: Blowout Duration and Cost of Prevention

	Blowout Duration		
	< 14 days	14+ days	28+ days
Subsea Blowout Frequency based on SINTEF 2010 Blowout Database		7.05E-004	
Probability Duration > Specified Days	0.75	0.15	0.1
Ratio of Advanced BOP non-acoutic (2 shearing, sealing rams) to single BSR BOP	0.089		
Calc'd Blowout Freq in number of wells drilled per blowout	21170	9456	14184
Probability of Blowout Expenditure per well drilled	4.72E-05	1.06E-04	7.05E-05
Freq per year assuming BP drills four wells/yr	1.89E-04	4.23E-04	2.82E-04
	Expected Annual Cost (millions)		
Blowout Cost (Billions)			
1	$0.2	$0.4	$0.3
2.5	$0.5	$1.1	$0.7
5		$2.1	$1.4
10		$4.2	$2.8
15		$6.3	$4.2
20		$8.5	$5.6
25		$10.6	$7.1
30		$12.7	$8.5
35			$9.9
40			$11.3
45			$12.7
Advanced BOP $2.85 Million at 5%, 30 year amortization	$0.18		
Capping Stack Annual Cost (millions) based on 5% int, 30 yr amortization	$12.30		

Table 2: Cost of Drilling a Relief Well

Drilling a Relief Well when Technology A and/or B are not in place			
Marginal Cost above 30 Billion	**Expected Annual Cost (millions)**		
5			$1.4
10			$2.8
15			$4.2
20			$5.6
25			$7.1
30			$8.5
35			$9.9
40			$11.3
45	**Breakeven point**	**$75 Billion**	$12.7

This analysis revealed, that a stand-by blowout preventer was not only feasible, but moreover economically desirable.