SAFETY FIRST?

ARE WE REALLY EMBRACING BEST AVAILABLE SAFEST TECHNOLOGY?

By Derek Park | Oil & Gas IQ

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a division of IQPC

Across the world the oil and gas industry makes great claims to have embraced 'Best Available and Safest Technology' (BAST).

In this e-book, Derek Park follows up some of the responses to his article 'Never Say Never Again' which looked at the lessons learned from major incidents. He also looks at some technology which challenges convention in pursuit of better solutions in the most crucial areas of well construction.

Never Say Never Again?

At the end of last year I published an article, **'Never Say Never Again'**, looking at the history of offshore disasters, and what the industry had learned from them. One conclusion was that we had done a good job at learning the 'technical' lessons but done less well at learning the 'human factor' lessons, which I attempted to deal with in '**Everything Will Be Alright, Won't It?'**

There was an overwhelming and largely positive response to the article, but some people did point out that there is still a way to go on the exploitation of best technology. This is particularly true in the area of well construction where we still remain a long way short of routinely using BAST.

I decided to look in more detail at the Macondo and Montara incidents, and see how far we had come in the adoption of best technology, with particular regard to mechanical equipment.

In their findings of March 2011 the Deepwater Horizon Study Group (DHSG) said:

> *'Major step change improvements that consistently utilize the BAST are required by industry and government to enable high hazard offshore exploration and production operations to develop acceptable risks and benefits. Future development of these important public resources require an advanced high-competency, collaborative, industrial-governmental-institutional enterprise based on use of high reliability technical, organization, management, governance, and institutional systems.'*

> *'There are important needs to make design, process, equipment and materials upgrades that will enable consistent realization of BAST in these operations including those in blowout prevention and emergency response systems, well design and construction (e.g., cement and cementing processes), well drilling and completion systems, and oil spill containment and recovery'.*

> *'Recommendation 1 – Develop and maintain an effective Technology Delivery System (TDS) that will unite industry and government collaboration in exploration for and development of high hazard environment hydrocarbon resources in reliable and sustainable ways.'*

PART I - Where We Need To Improve

Without doubt there were plenty of human failings at Montara and Macondo. Both incidents would have been avoided if someone had taken decisive action at crucial moments, but the fact is that they didn't. When people fail to act then we all we have left is the kit; the mechanical strength and integrity of the equipment either saves the situation or we fail.

So was 'Best Available and Safest Technology' evident at Macondo and Montara? More importantly, has BAST become universal in the two and a half years since these incidents?

The answer to these questions is no; surprising to some in light of the public outcry and the government and industry promises following the disasters.

As offshore production moves into more challenging areas, with deeper water and higher pressures and temperatures, the integrity of the equipment becomes increasingly important.

In June 2010, immediately after Macondo, Energy Point Research in Houston published their analysis of customer satisfaction surveys conducted over the previous five years. The summary of the research was that:

> *'The oil and gas industry's ability to locate hydrocarbons in deepwater locations has outpaced the industry's technical ability to extract them'*
>
> *'The category of subsea equipment has rated among the lowest in meeting the expectations of industry customers …'*
>
> *'Industry-wide survey data suggest that oilfield customers have been significantly less satisfied with the equipment and materials available for subsea and deepwater projects than for land- and surface-based applications ….. In fact, the subsea equipment category has consistently received the lowest overall customer satisfaction ratings. This category includes blow-out preventers, risers and flexible joints, wellheads and trees, as well as umbilicals, controls, manifolds and flowlines.'*

'... analysis cites that remotely operated vehicles (ROVs) have received the highest long-term customer ratings in the subsea categories ... it seems the equipment used to deal with problems on the sea floor is more highly regarded than the categories of products used to prevent troubles in the first place,'

Earlier this year BP EVP Bernard Looney, referring to 'new play' fields in the Gulf of Mexico, Kaskida and Tiber, said:

'Each of these fields has accessible hydrocarbons today, but each also has resources that lie beyond our industry's current limit of 15,000 psi and 275° F.'

'BP is working to increase its offshore exploration and production capabilities .... Making this vision a reality will require unprecedented collaboration across and outside of the industry involving not only operators, vendors, and contractors but also academics and regulators .... This will be necessary to define codes and standards for the design, operation, and reliability of the new technology.'

The main findings of Macondo and Montara are well documented and fairly well understood. What is less certain is that these findings have been interpreted correctly to discover what needs to be done to prevent recurrence, and how this in turn has translated to the adoption of best technology.

PART II - What Happened At Montara?

The Montara well failed because of poor cementation of the 9⅝'' casing resulting in a 'wet shoe'. However, the overall management and construction of the well was so poor that what should have been a controllable incident lead to a blowout and 6,000 km² of spilled crude.

The enquiry found major management failings not only in the cement operation but also in the selection and use of well components. Questions were also asked about the effectiveness of the Australian regulatory regime.

The Montara wells were batch drilled and temporarily abandoned to await tie back and completion. The problem well was left underbalanced with a wet shoe and no cement plug. An untested 9⅝" pressure containing anti-corrosion cap (PCCC) was the only barrier in the well. When the *West Atlas* rig returned to complete the well it was discovered that the 13⅜" PCCC, intended to be a secondary barrier, had never been installed and the threads of the 13⅜" casing had corroded. The 9⅝" PCCC had to be removed to clean these threads. The design of the PCCC did not allow testing to check for pressure build up prior to removal nor was the BOP fitted. When 9⅝" PCCC was removed the well was effectively open because of the poor integrity of the cement and the underbalanced fluid column.

The Montara Commission of Enquiry stated:

> *'If a secondary tested barrier had been in place, such as a cement plug, an RTTS packer, or if the 9⅝'' PCCC had been removed through a BOP, the blowout is unlikely to have occurred.'*

The manufacturer of the PCCC also told the Enquiry:

> *'…the PCCC may contain pressure upon installation…it is not intended as a barrier against an uncontrolled release of hydrocarbons … and (the manufacturer) has not designed and is not aware of a test that could verify the internal pressure containing capability…'*

The Enquiry also makes recommendations concerning the placement and removal of well barriers for example:

> *'Licensees should be subject to an express obligation to inform regulators of the proposed removal of a barrier, even if they consider that well integrity is not thereby compromised'.*

Surely as an industry we should be doing all we can to avoid this kind of regulation? But not by lobbying and attempting to brow beat regulators, but rather by doing all we can to incorporate best available technology and practice into our operations, wherever in the world we operate. The enquiry also recommended that:

> *'Secondary barriers (including PCCCs) should only be installed, tested, and removed with a BOP in place unless a documented risk assessment indicates that well control can be maintained at all times.'*

> *'Wells should be re-entered with a BOP in place unless a documented risk assessment indicates that well control can be maintained at all times.'*

> *'Any equipment (including PCCCs) used as, or to install, a barrier should be manufactured for that purpose and be generally recognised as fit for purpose'*

So we should ask ourselves:

- Are PCCC's available that can be removed through a BOP?
- Are PCCC's available that could act as a classified barrier against uncontrolled release of hydrocarbons?
- Are PCCC's available that allow testing for contained pressure prior to removal?
- Are systems available which lock down and seal casings during temporary abandonment?

PART III - What Happened At Macondo?

Macondo followed just eight months after Montara, and there were startling similarities between the two incidents. The BOEMRE enquiry found that BP failed to perform the production casing cement job in accordance with industry accepted recommendations and that as a result of this there was flow through the shoe track.

The enquiry also found a lack of clear authority and reporting lines as well as negligible management of change. They highlighted the decision to set a casing lock down sleeve which meant the cement plug had to be set deeper than planned, and also the decision to set the plug in sea water, which meant that mud had to be displaced to that depth.

> *'BP's decision to include the setting of a lock-down sleeve (a piece of equipment that connects and holds the production casing to the wellhead during production) as part of the temporary abandonment procedure increased the risks associated with subsequent operations, including the displacement of mud, the negative test sequence and the setting of the surface plug.'*

> *'engineers …. developed temporary abandonment procedures (different from the MMS-approved procedure) for the Macondo well that included the following steps: performing a positive pressure test; displacing mud in the well from 8,367 feet to the wellhead;*

performing a negative pressure test; 35 setting a 300-foot cement plug in the well approximately 3,300 feet below the sea floor and setting a lock-down sleeve to lock the final casing into place ……… engineers changed the order of these steps several times in the days before the temporary abandonment.'

It is unusual to use a rig such as *Deepwater Horizon* to install a lockdown sleeve, this being more typically done by smaller completion rigs. To compound this, none of the BP personnel on board the rig at the time had any prior experience of setting a lock down sleeve. Here was an organisation coming to the end of a job and struggling to cope with changes of plan so late in the proceedings.

When asked about the timing of the lock down sleeve operation one contractor told the enquiry

'…when you get to that point, everybody goes to the mind-set that we're through, this job is done'

The Panel also found:

'No evidence that BP assessed the risks associated with its decision to set the lock-down sleeve. This decision increased the risk associated with subsequent procedures, including the setting of the surface plug, the displacement, and the negative test sequence.

In all likelihood, had the lockdown sleeve been set at a later time, the surface plug would not have been set as deep; the surface plug would have been set sooner; and displacement would not have resulted in a lower pressure differential in the well.'

As we now know, the crew displaced the mud but never got to the point of setting the lock-down sleeve. The well blew out and then the BOP failed. Eleven men died.

Many organisations are faced with similar circumstances particularly when there are frequent crew and shift changes. People become pre-occupied and distracted by unfamiliar operations and late changes of plan.

Two ways of easing the burden on hard pressed managers and crews is to make sure that the equipment is as intrinsically safe as it possibly can be and that any avoidable activities are eliminated.

Casing Lock Down

BOEMRE's comments about the lock down sleeve are worthy of further consideration. They criticised BP for the decision to save time by using *Deepwater Horizon* to set the sleeve, but there is no doubt that having the sleeve set and the casing locked down would have improved the overall integrity of the well.

Whilst the primary cause of the blowout was found to be the failure of the shoe track cement, there also were questions at the time (and during the later kill operation) about the casing seal and the annulus cement. A locked down casing would have provided a further secure barrier against these other potential problems and perhaps even more importantly would have prevented an unnecessary distraction at critical times.

About a month after the blowout, three attempts were made to kill the well. These were unsuccessful. BP's analysis of why the top kill failed explained that pressures caused by the initial blowout could have ruptured discs in the 16'' casing and that mud pumped during the kill could have escaped to the formation rather being forced down the well.

Irrespective of whether this theory turned out to be correct, fear of a flow path from the production casing to the formation via the 16'' casing, and subsequent danger of 'broach or underground blowout' resulted in a two month delay in further attempts to cap the well. Oil continued to gush into the Gulf and the focus shifted to collection and containment whilst waiting for completion of a relief well.

Had the production casing been locked down and the seal known to be fit for purpose, there would at least have been more confidence in further well kill attempts. The spectre of the unlocked casing looms over not only the causes of the blowout but also over the subsequent attempts to control it.

In its report to the US President, the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling said:

'Before the Macondo blowout, a lockdown sleeve was not generally considered a safety mechanism or barrier to flow prior to the production phase of the well….'

'Based on the Macondo event, and given early concerns that upward forces during the blowout had approached or exceeded the force needed to lift the production casing up out of its seat in the wellhead, the Commission believes operators should consider installing a lockdown sleeve or other device to lock the casing hanger in place as part of drilling operations (or, at the very least, at the outset of temporary abandonment).'

And in the 'Drilling Safety Rule' issued in September 2010, BOEMRE specified the need for

> *'Ensuring proper installation, sealing and locking of the casing or liner'*

So as we continue our quest for Best Available and Safest Technology we can add to our list of questions,

- Is there a system that ensures casings are always locked down?
- Is there a system that allows casings to be locked without the risky (and time consuming) need to set lock down sleeves?
- Is there more reliable casing seal available which performs fully as soon as the casing is set and gives more confidence during well construction and throughout the life of the well and beyond?

PART IV - So Is Better and Safer Technology Available?

Montara used a slip and seal type wellhead for both the drilling and tieback operations. This hundred-year-old technology requires removal of the BOPs each time casing is set.

In tieback operations, a slip and seal wellhead requires the removal of the BOPs after the Pressure Containing Corrosion Caps (PCCC) barrier has been removed, leaving the system a long way short of BAST.

Compared to the system used on Montara, much safer wellhead and mudline technologies have long been available, Adjustable wellheads, as commonly used in the North Sea, and more sophisticated mudline hangers allow casing strings and temporary PCCCs to be installed with the BOPs in place, and all at no additional cost to the operator. Indeed, time savings are a feature of this safer technology and this begs the question

If the industry really is committed to BAST, why is such readily available equipment not routinely specified throughout the industry?

For twenty five years, equipment has been available from the UK which incorporates wellhead adjustment alongside a unique mudline hanger PCCC system. It features a single dual seal temporary abandonment cap, which instantly seals and locks the production casing hanger in the intermediate casing strings whilst leaving free the tieback profile for the intermediate casing riser.

This means that BOPs can remain in place not only whilst drilling, but also during the critical temporary abandonment operations. Once installed, the temporary cap can be fully tested from above (avoiding the risk of test pressure on the casing annulus cement) and hence providing a mechanical barrier across the intermediate annulus, as is the requirement on subsea wells.

During the subsequent completion phase, the well can be tied back and the wellhead installed without disturbing either PCCC seals, and once the BOP is reinstalled, pressure in the well bore and annulus can be separately monitored and bled off prior to the removal of the cap.

The single plug arrangement also means that the production and intermediate casings remain locked down during temporary abandonment when the mudline hanger effectively becomes a wellhead. The critical tie back threads can also be cleaned out without removing the plug.

If we are committed to using Best Available and Safest Technology why was such a system, a quarter of a century after its introduction, not in use at Montara and why is it still not used routinely on similar operations throughout the world?

Despite the remoteness of the East Timor Sea, Australia is scarcely a frontier province and boasts some of the best and most experienced engineers in the business. So why did this situation develop when economic and practical alternatives were available?

The criticism of the Australian regulators was clearly justified, but as an industry we shouldn't hide behind regulators. We should do right, not because a regulator says so, but because it is morally right and makes good business sense. Engineers should be bound by the BAST code just as doctors were once beholden to the Hippocratic Oath.

Much of the industry focus has shifted to deepwater subsea wellheads where remotely installed annular seals are used and where, following the Macondo incident, the regulators now demand that casing hangers are locked down, as is the case of on all surface wellhead applications.

Despite the availability of tried and tested systems, which were first adopted and still mainly used in the North Sea, it remains the case that in other areas of the world, mudline casing hangers continue to be left unsecured when wells are temporarily abandoned.

If anything, the world should be more concerned about the conditions of these wells, which are drilled in much shallower waters, which tend to be located much closer to our shore lines, and where intervention is made more difficult under active blowout conditions.

We saw from Macondo how the design of casing hanger seals and the process of locking them down may have had a big influence, not only on the cause of the blowout, but on the subsequent efforts at control. It is obviously essential that casing hangers which seal in the wellhead bore are locked down as soon as the casing is cemented.

Clearly BP's preference to not lock down their production casing hanger during the drilling cycle was driven by a compelling reason. A casual survey of drilling managers will show that many operating companies have been following the same practice ever since subsea wellheads were introduced 40 years ago. Some equipment suppliers even go so far as to recommend the removal of lock rings from subsea casing hangers because they are inconvenient. They tend to malfunction during installation, and when it comes to removing casing to side-track, subsea locking devices are hard if not impossible to reverse.

Once again a better design for casing hangers has been around for some considerable time. A new technology based on friction grip has been used for more than ten years on jack up drilling operations. At the heart of this system is a high performance metal to metal friction grip seal for casing hangers. This innovative design, uses external compression to squeeze an outer tubular so that it grips and seals on an inner tubular by metal to metal contact.

The design replaces the conventional casing slips or landing shoulders and obviates annular seals. It also allows casings not only to be run and set through BOPs but also sets and locks the casing seal immediately after cementation. The hanger can also be gripped and sealed many times over, even in remote applications.

The technology works within the elastic range of materials, which means that casing hangers can be unlocked, perhaps for tensioning, and relocked any number of times. The metal to metal seal is held completely rigid and cannot be compromised by differential expansion of tubulars as the well pressurises and warms up.

The seal area remains perfectly concentric and so does not need any resilient seal materials to accommodate different casings on different centre lines. Perhaps best of all it completely eliminates the lockdown ring with all its attendant risks.

Friction grip technology for jack-up operations has been around for many years and if utilised in conjunction with the right mudline system design would have prevented the Montara incident.

It is true that had the existing technology been used properly the incident would have been less likely, but in any event the technology used on Montara was far from best available and safest, particularly with regard to BOP removal and the use of temporary abandonment plugs.

In respect of the Macondo incident it is the case that the friction grip method of engineering had not yet been developed for subsea applications, although I understand that efforts are under way.

A new subsea wellhead technology is under development which cannot be installed without locking casing hangers down and sealing the casing annulus.

The system eliminates the lockdown sleeve and provides multiple metal to metal seals across the casing annuli, which are held rigid with a gripping capacity that exceeds any force anticipated in a well, even under blowout conditions.

Additionally the new system has the goal of providing annulus pressure monitoring, bleed-off, and remedial repair capabilities to deal with sustained casing pressure (SCP).

Only time will tell if these efforts will result in a system which can provide economic and operational benefits, but more importantly I hope that the 'intrinsic safety' potential of this innovation in wellhead engineering will find its way into the system at a faster pace than has been the case for jack-up operations.

PART V - So Who Is Using Best and Safest Technology?

One would expect an industry publicly committed to safety to embrace the best of new technology, but it just doesn't happen that way.

Montara is absolute proof of that; systems which allow casings to be set through BOPs have been available for 25 years but were not used. Safer temporary abandonment equipment was also available and again did not come into play.

The industry just needs to do better; these comments are from the Montara enquiry:

> *'Decision-making about well control issues should be professionalised. Industry participants must recognise that decision-makers owe independent duties to the public, not just their employer or principal, in relation to well control.*
>
> *Risk management in the context of well control needs to be understood as an ethical/professional duty. Self-regulation contemplates self-regulation by the industry, not just by individual licensees and operators.'*

And we all know that it is not just Montara; such practice is still found in many parts of the world. It is unacceptable for companies to exploit the different world regulatory regimes and hide behind the skirts of tacit compliance.

Many credible incident reports have shown regulators struggling to keep up with the pack. This is hardly surprising as operators and service companies staff the best people, not least because of their ability to recruit and reward them.

With the experience of the last few years, one would have expected to find an industry determined to adopt best practice throughout the world. The message coming out in the aftermath of Macondo paints a different picture. Just after the blowout, at the ***U.S. Senate Committee*** on ***Energy and Natural Resources*** hearings, the CEO of Transocean (which operates in approximately 30 countries) was asked about the international regulatory regimes. He commented that:

> *'The regulatory regimes we operate in around the world vary from very minimal to quite stringent, I would characterize the U.S. as being closer to the end of quite stringent.'*

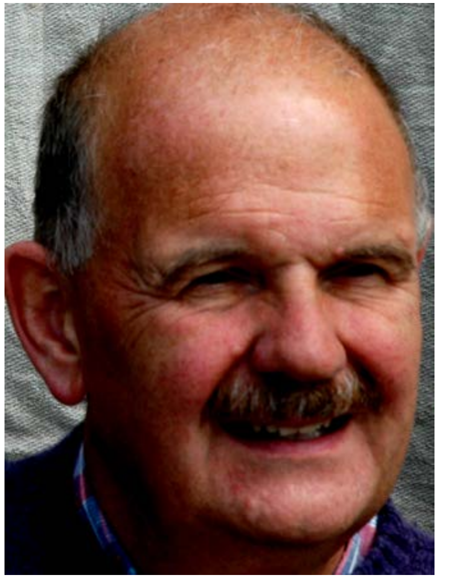
But crucially he went on to add:

> *'I think there are aspects of the regulatory regime in places like the U.K. and Norway that would be more stringent than the U.S.'*

Before Macondo, the U.S. fell short of European standards as there were no truly independent regulators and no requirement for a safety case, both statutory requirements in the UK post Piper Alpha.

The requirement to prepare and maintain a safety case puts a simple obligation on operators to do everything reasonable to avoid an incident. This effectively means introducing BAST to all operations as soon as practicable rather than hiding behind prescribed (and almost instantly out of date) standards and regulations.

This effectively eliminates the 'Titanic defence' of *'we didn't have enough lifeboats to save the all the passengers but we did have enough to meet the regulations!'* The adoption of such practice in Europe has led to a continual striving for better technology and a healthy growth in companies who invest in its development and use, there is no reason why this could not be replicated the world over.



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Derek Park has 35 years experience of operational and organisational management in the oil, process and utilities industries. A chartered mechanical engineer, he spent time as a construction and commissioning manager on major offshore projects and was later an OIM in the North Sea. He has also managed operations on major pipelines and at onshore petrochemical facilities. During this time he realised that whilst the actions of people are key to the performance of any organisation, this is often not fully appreciated by managers and management systems.

He is a creator and developer of effective organisations and is driven by a belief that too many people spend too much of their time working on things that simply make no difference. He works directly with front line staff and advocates a ‘bottom up’ approach to transformation, complementary to the usual structural techniques. He specialises in engaging people in the change process, recognising that sustainable cultural change can only happen when people are prepared to take personal responsibility for transformation process itself.

Derek now works as an independent consultant and you can learn more about him at www.OpsIntegrity.com

NEVER SAY NEVER AGAIN

Read the original report “Never Say Never Again”

Downloaded over 50,000 times since its publication in late 2011, the report has become required reading for HSE professionals in the Oil & Gas industry.

THE ORGANIC ORGANISATION

Read the follow up: “The Organic Organisation”

If Never Say Never was the “what”, “where” and “when”, then this piece is the remedy to the “how” and “why” disasters strike.

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