Panel No. 2: What new design requirements are needed to provide assurance that BOPs will cut and seal effectively under foreseeable operating conditions?

Moderator: *Richard Sears, Visiting Scientist, Stanford*

- *Roger McCarthy, National Academy of Engineering*
- *Bryce Levett, Director, Risk Management Solutions, North America, Det Norske Veritas*
- *Frank Gallander, Chairman of API RP 53, Chevron*
- *Chuck Chauviere, General Manager Drilling, GE Oil and Gas*

Doug Morris, BSEE Director of Offshore Regulatory Programs

I'm Doug Morris: I'm going to tee up the next forum, next panel. We have assembled a team of experts to discuss BOP design requirements. The question for the panel is: what new design requirements are needed to provide assurance that BOPs will cut and seal effectively under foreseeable operating conditions. The moderator for this session is Richard Sears. Mr. Sears is well qualified to lead this discussion. He's a consulting professor at Stanford University where he teaches courses in energy systems, technology, and economics. He led exploration and development projects for Royal Dutch Shell for more than 32 years before retiring in 2009. He served as a senior science and engineering advisor to the national commission on BP Deepwater Horizon. He's currently a member of DOI's Ocean Energy Safety Advisory Committee OESC). He holds a bachelor's in physics and masters in geophysics, both from Stanford University. Thank you. Richard, it's all yours.

Moderator: Richard Sears, Visiting Scientist, Stanford

This is going to be an important session too, I think, set lot of the framework for the discussions on the day and the panel that we have is really well qualified to do this.

I'll introduce them as each gets up to speak. Just as an overall introductory comment, I thought the first panel was -- did a great job of bringing us up on post-Macondo what some of the key learnings were, what some of the revelations were when that accident happened. To me one of the most important post-Macondo learnings from industry regulators all involved is that the unthinkable actually could and did happen. And that the systems that were thought to be robust and reliable turned out not to be. On many levels, not just mechanical, but people as well. So the BOP bing an intergral part, key part of this is an important place to focus for this day and to look at the systems and how the BOP's can be better designed and work better in the future.

The first speaker for this panel is Bryce Levitt, he will give us a nice overview on systems safety and where the BOP is in that system. Bryce has 25 years' experience in the oil and gas industry with a number of companies. His current position is Director of

Risk Management Solutions for D.N.V. North America and works on risk management consulting for the oil and gas industry. So, Bryce.

Bryce Levett, Director, Risk Management Solutions, North America, Det Norske Veritas

Thank you, Richard. Good morning, everyone. To set the stage I really want to talk in terms of barriers, and this is just a simple diagram to familiarize everyone else. This is really to echo on what Director Watson said when you talk about safety at all times. We need to think about this equipment being a barrier that needs to be there all the time, not just when an inspector comes out.

The way we think of barriers, we have a hazard which can be present which can escalate into a top event, if you will, which is at the center, and then on the left-hand side there's a number of different causes which could cause that hazard to become the top event; however there are barriers in place to eliminate that from happening. If the top event does occur, then you can continue to escalate into certain types of consequences. There could be a number of different consequences you can escalate into. And again there are barriers in place to control just how bad those consequences get.

In terms of talking about a BOP, we usually paint the picture the hazard being we have hydrocarbons in the formation, that's why we have BOP's. The threat is there. It could escalate to a loss of containment, which is what we saw. Threats could come in the form of shallow gas when the BOP isn't in place. It could come in the form of unexpected high pressures, but there are barriers in place to prevent that from turning into a top event, which becomes the loss of containment, or a blowout.

On the right-hand side, these events can escalate into a number of different things. You could have a gas release. You could you have uncontrolled well flow. You could eventually have explosions, fire, loss of life, sinking of rigs, etc. Again there are barriers specifically in place that are meant to stop that from escalating to that point after the event has occurred.

In terms of talking about new regulations for BOP's, we think it's extremely important to understand what exactly are we talking about in a role for a BOP. In its traditional role, we look on the right-hand side and we think about primary well control being the mud, cement, drilling riser, casing, etc. And then backing it up is the secondary well control, which we call the Blowout Preventer. It's also perceived as the secondary well control backup to a primary well control which is the main means by which you prevent loss of containment. In this particular role, and this echoes a lot with what Dr. Hunter was saying in terms of its functionality, what are the requirements in this particular role?

For one thing it has to be functional for the well conditions. So it has to be able to handle the pressure and the temperature and whatever you happen to have in the well bore at the time. What kind of pipe, what size diameter, etc.

And how do you make sure that something like this works. Well, you have to have verification and testing. A panel later on we'll be talking about that very subject. It has to work on demand. It sits there for a long time doing absolutely nothing for the most part, and that's kind of what you hope that you never have to really use it, but when you need it, you need it to work on demand. That means we have to have monitoring of it, give it a constant monitoring system so we know what its health is. We have to understand what state it's in. Again, Dr. Hunter was saying the questions we couldn't answer. Is it closed? Is it opened? Is it locked? We didn't know. We have to have a way of verifying what that state is. It has to be activated when needed. This goes back to what Assistant Secretary Smith was saying. There is a person involved in all of this. And there are human elements to the use of this. People have to know when to use this at the right time. That includes being able to monitor the well much better so you know when is the right time to do this. And the Sperry Sun data, as you saw, was quite confusing.

Lastly there has to be a continuous learning process on this as well. Which means that we need to come up with a robust system by which we register not only the failures, which we typically see, we need to register the near misses and we need to register the successes. When does this work when we ask it to work? That was a success. Let's start a database on all of this, if you will, so we can collect this information and understand. Just exactly how successful are we with the use of BOP's.

Now, if we then move over to the right-hand side of the bow tie, we can also talk about the BOP playing a role over there. So the top event has already occurred, now we are expecting the BOP to act as a barrier to basically prevent escalation to a much larger unwanted consequence. But we would argue this is no longer blowout prevention, because typically we talk about barriers on the left side as being preventive, and on the right side as being mitigated.

So we would argue that it is now called a Blowout Arrester. It now has to stop or arrest the blowout, not prevent it. It's too late now. The blowout has occurred. Now you want it to take a completely different role. In this case requirements change. So again we have pressure and temperature. We have the question, what's in the well? Now we have flow. Now we potentially have a well flowing through the BOP stack and the demands that it function there. But again it's verification and testing that's needed to prove this is what it's going to do. It still has to work on demand. It still has to be monitoring, verification of state, activation when needed.

The question mark comes up on human elements. As we saw in the Macondo, suddenly the human element goes away, especially when disaster takes place at the surface. You can no longer potentially rely on humans being there to intervene and use that BOP in that situation. So you have to consider that. And you have to start thinking about automated functions at this point as well -- really what is needed to make this work if there are no human beings there to push a button and say activate it.

And lastly, after action, learning. This is adding on to what we have already said in the previous discussion. What we are suggesting here is to start thinking about black box recording. I think we all wish we had a black box that we could have retrieved where we could easily pull up and figure out what exactly happened, what buttons were pushed, all those sorts of things. We need to start thinking about black box reporting in terms of after action events occurred.

So to summarize what we are saying in terms of new requirements that are needed, you have to think of it in two separate roles. You have to think of it as a blowout preventer. You have to think of it as a blowout arrester. This role needs to clearly be defined. You have to answer the question -- where do we want to sit in the bow tie in order to define the requirements? And then novel design functions; novel designs require functional specification, not prescription. This is really echoing what Dr. Hunter said about defining what -- not how. You need to define what you want something to do not how you expect it to do it. And we add further that, given the fact that we are asking for this to be usable in all foreseeable operating conditions, let's define what that is.

It has to be based upon a holistic risk assessment and asking the question what are the foreseeable operating conditions in which this equipment has to function; and establish performance. Don't restrict what the solution could be. Let the manufacturing companies and everyone else come up with a solution to meet that performance!

Then we move on to control systems. Again this is where Deputy Assistant Secretary Smith had said it’s about people interpreting things. This is very important when you think about how you design control systems. You have to consider what human beings are capable of interpreting and the decisions they make. Therefore we feel you have to establish what the potential human limitations are in this whole circumstance and then start incorporating automatic functions. Don't go designing a control system before you realize what people are capable of doing. And it has to be able to address all of the conditions that are there, especially an automated system. It has to know what is the condition in the well. What is the condition of the equipment? What is the condition of all the inventories you have if you require mud? Do you have the mud? Has the mud disappeared? Will automated systems know that? Will they try to do things or not?

Then a black box again to record all the important information. Very similar to what the aviation industry has demanded. Design requirements, they will only set the minimums. They will not set the maximums. Designs can be much better than the minimums and it should be set up in such a way you allow for continuous improvement.

The question becomes: what's the best available technology? What's the safest? And when should it be adopted? What sort of grandfathering do we have to think about? At the time of the Macondo Well, there were solutions to shearing that covered the entire board. But it just wasn't necessarily in place. And lastly, it should address its relationship to all these other barriers that we talk about.

Moderator: Richard Sears, Visiting Scientist, Stanford

The second speaker in this section is -- this panel is Dr. Roger McCarthy. Roger has a long, long career in both this industry and others and in the investigation and understanding of complex mechanical systems and their safe operation and design. Within the oil and gas industry, he's been involved in the investigation of several incidents, including the explosion and fire on Piper Alpha, the grounding of the Exxon Valdez, and many others. He's a consulting -- independent consulting engineer and was also a member of the committee for the National Academy of Engineering and the National Research Council investigating the Deepwater Horizon. With that I'd like to introduce Roger McCarthy.

Roger McCarthy, National Academy of Engineering

Thank you for that kind introduction. Briefly many of the speakers have touched on really the important points of this. So I will just try and emphasize where I think some nuance is important.

First the new design requirement should at least address our past known failures. I appreciate Director Watson's comment that we don't want to fight the last war, but remember we lost the last war. So if we fight that war again, let's at least win that one. We didn't win it last time. So at a minimum we should be able to anticipate with our current design regulations and incorporate in them all the history we have paid so dearly for by not being prepared for the last disasters.

And obviously the what we learned in the investigation of the well system, which many people have touched on and Deputy Director Smith did an excellent job of going through, is obviously there were significant deficiencies in the design process of the BOP itself. And obviously and most importantly the BOP system was neither designed nor tested under the conditions it was going to encounter.

I think Secretary Hayes hit it right on the head when he said it's got to cut and seal anything in front of it. I would add a caveat to his remark and say it's got to cut and seal anything in front of it when all hell is breaking loose. And there is the tough part. I think as Mr. Smith touched on earlier, these are very stressful conditions when you have a disaster, especially when you are trying to recapture a well. Obviously because of the flaws of the particular blind shear rams, it was not able to shear a set of pipes in compression dramatically below its shearing capacity. Obviously, I love the term that Dr. Hunter used, shear certain, which I had not heard before, I'll remember that one.

You know them quotes I put under the most demanding conditions to be expected, that is not an original line from me, I will get to the author shortly. In terms of philosophy of design requirements, Mr. Levitt and I are on the same page here. We firmly believe the design requirements should be performance-based and not prescriptive. Obviously prescriptive regulations are inherently limiting in terms of the technology and innovation. Of course they often lag the technology because it's tough to change a prescriptive regulation. They are slow to update.

They are always slow to update. As the conditions the regulations are supposed to address change, again the regulations aren't likely to pick up. As I mentioned earlier, they've got to address at least the times we failed. It would be nice to win the next war, but at least make sure we can win the last ones we lost.

But the real key to any new design regulation is testing. I once had a colleague -- in fact, Dr. John Shine, who invented maraging steel--, who once remarked that one test is worth 1,000 expert opinions. And that is a good dictum. If these things are going to be expected to work under conditions where all hell is breaking loose, they have to be tested in conditions that simulate all hell breaking loose. I recognize, and we at the Academy, recognize that's neither cheap nor easy. But neither is cleaning up five billion barrels of oil. The consequences of not doing these tests under very difficult conditions, have got to be weighed against failing to operate under very difficult conditions.

Now, this -- in the immortal words of Yogi Berra, is deja vu all over again. This study done by West Engineering, done for MMS in 2002, was "Can a given rig BOP shear the pipe in a given drilling program under the most demanding conditions to be expected?" Now this is 10 years ago these words were uttered. Of course they concluded, 10 years ago, that the limited data set from the last generation, grim picture. Those are not my words. Those were words provided to MMS 10 years ago by a contractor asked to look at this specific topic.

Even more recently we have had studies of BOP reliability that I believe have been flawed because of the inclusion of hours and hours and hours and activations under the most benign conditions. Sure they are great for the eye wash and reliability number but they do nothing about what the performance is going to be under the really difficult conditions. Hours of use data are not the way to go here.

West Engineering, this is again their graphic, used with permission, indicating the results of their testing 10 years ago. Now, if we didn't listen then, we have to make sure not to repeat that question now. So I hate to disagree with my moderator, Professor Sears, but I don't think, certainly I was not, under the impression these things were robust and reliable.

This was my picture of the reliability of BOP's. To my knowledge if someone did testing to contradict this, I didn't see it. That doesn't mean it wasn't done, but I'm not aware of it. I don't think there was a perception. I think the greater perception, and this is me personally, was we are never going to need them anyway, so why spend a lot of money making them even more expensive? In point of fact, the unthinkable did happen and now it's very thinkable.

Obviously we have to revisit the worst engineering conditions. Those West Engineering tests we just saw in that graphic were static. No dynamics considered. They were conducted on drill strings centered in the BSR [Blind Shear Ram] and in tension. They were conducted under ambient conditions corrected for pressure. I'm not critical of the correction. Yet a 50% failure rate under these conditions was observed. Now, if we do the test and they tell us we got a problem and we walk away from it, we are going to have a problem again.

Obviously under the new regulations, any test failure or we have talked a lot about monitoring, but monitoring has to have consequences, if it's going to mean anything. If situational monitoring the BOP indicates that piece of hardware is unavailable or has a problem, drilling has to stop. That will do wonders in and of itself for the reliability, trust me.

Now, more recently the API RP-53 has presented it to then BOP GIP study and, note the date of this presentation september 13, this is four months after Macondo. If you look down at the BSR [Blind Shear Ram], we have an equipment probability of success, that's not my graphic, that's theirs, 99.5%? Come on.

Now, at the time West did its tests, it was unaware of any regulatory requirements that the BOP must be capable of shearing a pipe in front of it. Obviously that needs to be cured. Obviously there's been no reducudancy, one BSR, one shuttle valve, cables independently. Obviously the biggest single short coming is pipes and compression. Not to mention not being able to handle all sorts of pipes that may be in front of it.

And as previous speakers have identified, a perfectly designed BOP can be useless if operators don't understand or know where to use it. And they can't be expected under high stress situations to make a complex decision, and it should be added that, remember the Macondo well if you believe 50,000 barrels a day, is a 3.4 gigawatt power line. Yet the crew sat there for seven minutes before they punched the button and let

3.4 gigawatts assault their vessel. Now, think about the design requirement if any of these designs have to take 3.4 gigawatts of insult for seven minutes before the activation is given. That is a terrible design problem. I think we have to get rid of that 3.4 gigawatt requirement. So the expert systems have to be there to help people out to do what's required.

If you looked at the Transocean procedure in place at the time, I'm not critical of this per se, but this is what they were supposed to do in the middle of an emergency. Obviously for the reasons that people indicated they didn't know the condition of the valves, solenoids, the flow velocity, as many have identified, the fact there were faults in the BOP system didn't cause drilling operations to cease. Obviously most of the current shear rams will not seal if the pipe is in compression today. Learning about tubes or pipes in suppression and not sealing of BOP's is not new news. We've now heard that for 10 years.

The recommendations here are just those in the N.A.E. report and you can read them for yourself. The lesson we have to take away is obviously the systems that failed on the BOP that day made the difference between what should have been just a kick instead of an horrendous national accident. And in the immortal words of Santayana, if we don't remember this past, we are condemned to repeat it. Thank you.

Moderator: Richard Sears, Visiting Scientist, Stanford

The next speaker in this panel is Frank Gallendar. This is a nice transition because in the first two speakers, we've seen a lot of what should be done. And the next two speakers, are going to talk about what is being done. Frank has a long career, 36 years in this industry. 31 years with Chevron. He's currently Intervention Consultant for Chevron upstream, involved in oil and gas drilling and completion operations. And he's very significantly right now chairman of API Standard 53 and is going to talk to us about API Recommended Practice 53.

Frank Gallander, Chairman of API RP 53, Chevron

Thank you, Mr. Sears. I thank the director for hosting this and giving us the opportunity to be here today. I'd like to give you an update on where we are with RP 53 and where we plan to be going ahead in the next couple months.

The standard is the industry document, guidance document I should say, for the operation and maintenance of drilling BOP equipment. Post-Macondo when we took on the task, we looked at the old document, the RP-53 as it was written and there were 21 sections in it. We looked at the 21 sections and we knew that there were other documents out there that existed that this was in direct conflict with. So we went through the document and did kind of a clean cut on what was covered in other documentation that did not require to be addressed in an operations and maintenancetype guidance document. So we took those out. We narrowed it down to seven sections. The first five sections, common to both, surface and subsea BOP, it's common to both. So there's no big difference.

The Section 6 is assigned specifically to surface BOP and control systems and how you maintain and operate them. Section 7 goes more in-depth in the subsea side of it. We also took the opportunity to incorporate some of the effects of negative pressure on subsequent BOP's. We had never done that before. This was an opportunity to look at it so we incorporated those into the document. We identify condition-based maintenance as an alternative to schedule-based maintenance. Previously all the A.P.I. documents, specifically 53, really focus on scheduled-based maintenance. We looked at it and said, well, there's an opportunity here because we are looking at differences in technology, differences in equipment. So we threw in the opportunity for a person to select whether it's going to be condition-based or schedule-based, included additional verbiage, language on competency, training, procedures and such. And most importantly, in my view, was the change from the RP to the standard. There is more greater emphasis between the equipment manufacturers and the equipment owners, as exhibited in the annex that gives direct instructions on the communications route for the manufacturer and equipment owner.

There's some prescriptive points in the document, specifically the drawdown test, which refers back to specification 16-d and that's for the design, manufacturing, and testing of BOP control systems. In the verbiage you notice there are specific requirements that you have to perform and results from the test.

One of the other things we did is we looked at all the various A.P.I. documents and we looked at how others in industry were using a BOP and how it was identified. So we regrouped and said: ok, first of all let's define what a BOP is. We looked at all the documents, pulled it together. We came up this definition of a BOP and subsequently after going through the other documents, we resorted back to saying let's explain what a BOP isn't. So looking at other documents, we defined: a BOP is not a gate valve. It's not a work over control package. It's not a subsea shut-in device, it's not a well control component (that's for RP 16-S-T which is specifically to operations). That's what they refer to their well control system as opposed to a BOP. Intervention control packages, diverters, rotating heads, circulating devices, cap and stacks, etc. So we kind of broke that apart to say if you are going to build a BOP, this is what it's got to mean. This is how you are going to operate it and this is how you will maintain it.

Additionally we took into consideration the RP 96, which is the guiding document for the design and construction of deepwater subsea wells. The definition that they had developed would also play a part in the way that we used our document. So we took MASP [Maximum Anticipated Surface Pressure] and put it in as a design load that represents the maximum pressure that may occur at the surface during well construction or production. Additionally, as part of the subsea well, you have to look at the MAWHP [Maximum Anticipated Wellhead Preassure] and the definition there is the highest pressure predicted to be encountered at the wellhead in a subsea well. This number can be identified in each whole section as well as the full breadth of the well.

During the write of the document we continued checking over our shoulder at other A.P.I. documents and other committee discussions that were going on to try to have some level of consistency in the messages that we were writing and the documents we were producing.

There's one new additional definition that comes into play and this is the Maximum Speculative Wellhead Shear Pressure [MSWSP], which I think kind of meets some of the discussions that we have seen so far, and that is the expected pressure at the wellhead for a given hole section, a specific shear pressure requirement, specific operating piston design, the drill pipe material specifications, to achieve shearing at MASP, MAWHP, or whatever other limiting design pressure for the well.

In addition there's other points that's included in this section in surface and subsea, that give you more discussion points and considerations pertaining to dealing with MEWSP. Earlier on in the discussions we knew that we were going to get into some areas where we would agree to disagree and move on. To address that, we had to prioritize two items that would be our governing words. So of the two words we came up with; we all agree that when we came to an impasse, life, and the environment will take precedence. Everything else in discussion followed. So those two would help us get past an impasse.

We have been to the tables for testing, including the frequency and acceptance criteria. And we also used the clarification of the use of fire retardant or gas permeating hoses for control systems, which is 16-d, or 16-c, which is choke and kill systems. So in this case lines for hydrocarbons can be introduced, and permewate through the line structure, they are required to meet Spec16-c fire testing requirements.

Those lines that are incapable of getting hydrocarbons introduced are not required to meet the fire requirements of 16-c. We put that specific language in there because once again it is -- we didn't see this prescriptive as much as trying to be clear in the intent of what we wanted to document. Additional testing requirements we put in, just one example of it, is the -- we added the riser recall system which we haven't done in the past but now included into it and there are others as well.

We took into consideration the joint task force equipment recommendations that came to us post-Macondo . The ROV interface standardization has been adopted. It's now an industry standard. We also adopted the minimum functions that are going to be required to hold the ROV interface configuration. We also included requirements for 20, 25, and 30 k systems and defined BOP classification with regard to well-control equipment with some relationship given to the pressure.

And again we considered all the past JIP and other JTF recommendations that came to API. They passed them on to us for inclusion in the document. The last document we received 281 comments, approximately 40% of those were technical in nature. We have addressed those. We have had the last meeting for the task group on May 18, last Friday, with the intent of going through and resolving all the comments from the second ballot. Our intent now is to go out in June with another ballot for review -- a two week session. So that will happen in June. And hopefully we will have a summer document come out that's finalized and hopefully issued by early fall. That's the intent and that's where we are at right now. I'll turn it over to Richard.

Moderator: Richard Sears, Visiting Scientist, Stanford

Thank you, Frank.

The fourth speaker this morning in this panel is Chuck Chauviere. Chuck is General Manager of Drilling for General Electric Oil and Gas. He has a long career in the industry with equipment manufacturers. So this is a way to bring this panel around and ground us in the real world of actually building these systems that have to operate in the ways that have been described so far. Chuck, currently with GE Oil and Gas, previously with Hydril and Cameron, and brings that experience and the perspectives of GE to this discussion. Thank you.

Chuck Chauviere, General Manager Drilling, GE Oil and Gas

Thank you very much. So as a manufacturer, we are borne by many challenges on what to do and how to do it. So being part of this panel, it's an interesting challenge that we all face. So in stepping through some of these things I am going to step back a little bit, sort of give an overall view, but then I'm also going to give some examples of what a healthy industry does which I believe we have, where we share information back and forth, and to the point of many of the speakers, where we provide those learnings and we embed those back as part of a journey, a long design journey.

Being part of a company that has been in the BOP business for 80 years, we recognize as we move from land to offshore, to subsea to deep water, this is an evolutionary process. Now, any of the things we are looking at right now aren't extraordinarily revolutionary, but we need to recognize there's a way to roll those out. I'm going to show you some things and then we'll step through it.

Now, this is, as we talked about, what this panel is trying to accomplish, and one of the things I wanted to highlight up here is, for instance, this concept of cut and seal. I want to make sure as we are talking about giving these design parameters to engineers. We have lots of engineers in here. Engineers say: “what do you want?” and then they want to go do it. So we need to be careful that if we put phrases like cut and seal, they are going to go try and accomplish it by cutting and sealing. I'm here to say “tell them what you want” which is to “stop it.” Whatever it is, you want to stop it. Now, if that requires it to be cut and sealed in the same cavity, so be it. If you cut in one and seal in the other I don't think anybody in this group is really affected by that, you just want it to happen.

That's one of the things I wanted to highlight, this is the concept of *foreseeable*. As we get all the information and we get the forensic knowledge, I think that's very valuable as an OEM [Oringal Equipment Manufacturer] because those are things we can respond and react to -- this concept of foreseeable. We use phrases like any and all. That's not something that we can convert to tangible action. I think we all recognize what the challenge is, but we just need to make sure we are working through that so that we are using reasonable thought processes around this entire ecosystem that we work in.

The ecosystem that we are in, we recognize, we have a very diverse crowd. We have many different stakeholders. This isn't something that’s trying to identify all those stakeholders, but we recognize from the regulations, the regulatory bodies, the individuals that do things, the equipment provider, the users, and the information that you use.

This is a large ecosystem that we are working in and it's something that we need to continue to collaborate on, because let's -- I think the majority of us know – we’re not talking about thousands of these things. There aren't thousands of deep water drilling systems out there. They are in the hundreds. So we recognize it has to be a collaborative approach. We can't put the burden on any one organization or set of groups to do this. This is something that is going to take many, many people and bodies to work on, because we recognize from the aspect of developing technology, this is our license to operate, for all of us. So if it's our license to operate, then we need to do it appropriately. To the point of some of the other speakers, this is for -- for a global activity. These are mobile offshore drilling units. They don't just sit in the Gulf of Mexico, they move around the world. So we recognize, we need to satisfy many, many stakeholders and regions.

Now, I put this one up here just to get everybody sort of calibrated to the complex dynamics that happen below the ocean. We are focusing just on this element over here. This is a BOP system on a horizontal tree. So this is after all drilling is done that the system shows up. So let's make sure when we are talking about what passes through it, what it has to do what, are the multitude of possibilities that we address all these things and that we don't just get so myopic in our views.

There are many challenges out there. As part of the design as we are looking at this, pressures are getting greater. As it gets deeper, the external pressures get greater, the internal pressures get greater, we even get negative pressures internal to the system. There are many challenges we need to work through. Temperatures; we hear things, high temperature wells, different initiatives are in place for that. This affects metallurgy, it affects fatigue, it affects the elastomer. We have to make sure we do elaborate on what this needs to look like from going completely cold at sea floor conditions to completely whatever the hot is. And hot's an interesting dynamic in this industry.

This is my best graphic I found forces. Look, we have compression, we have tension that have been talked about. You have bending. You have torsion. These things are under unbelievable loads. When you think about the loads they see, you have got to include all of those things. These design parameters are important to the industry and we respond to them as they are given to us.

Now, this is the other thing about what are the environmental test datas. When you talk about testing under internal flows and what those flows may or may not look like, and exactly how you replicate and model those flows, this is a big deal. Again, external conditions and internal conditions that we need to work through and that is a challenge for the industry. The industry has done testing under certain types of conditions but in this all hell breaks loose scenario, we’ve got some work in front of us, so we need to work on that.

Finally, the speed decision making. This is something that we continue to talk about, which is how does this work? We also have the speed of technology and adoption, grandfathering those other things, but the speed and accuracy of the data to enable this, we are still dependent -- and we talked about an individual knowing when to push the EDS. That is critically important to us. As we have talked about, there are many factors that impact that. Hopefully, for those of you working it, you know what a typical EDS sequence does and why it exists the way it exists.

Again, we are just talking about tools of the trade. These are tools of the trade that are used by people with procedures with control processes in place, and we recognize there are different tools for different applications, and you have to know what the tool is capable of doing when you are using the tool. That being said, there are multiple tools that we use in the industry. We had the example of the annular Blowout Preventer, which has different functions that it serves. And we have also been focusing on the blind ram, specifically the shearing element of it.

Quickly moving through this, just an example of things where you say it is very factual that people want the right thing. This is just the evolution of air bags and seat belts in the automotive industry. We're talking about how do you short cycle this and bring something to market really quick, which means we have to do something unique in the industry.

This is a things where I've tried to show the concept of " we have worked on," based on the learnings we have on the field. Hopefully, this will run.

This is things that you can do with the equipment. I will talk to read a little bit but this is about how you can utilize the assets best in the field. As we got feedback from the industry, we realized that you need to have equipment that was very usable in many different applications. This is a little bit of a containment or a response scenario. This is between an LMRP [Lower Marine Riser Package] and the BOP Stack. This just shows an example of a disconnect, leaving a stack behind and then coming in with a different vessel with an interchangeable Lower Marine Riser Package that you can bring along side to engage that system.

Hopefully, you get the concept that the industry is providing solutions that will enable us for this license to operate. Now, quickly, we talked about data. This is an ROV data display package. This is for a stack that has no power, no controls, where you can see the temperature, position of the rams, and you can get a variety of that information without having any surface control. So again, this is technology that we have out there.

The last video I will show you, and this is very germane to cut and seal. This year, we showed you this, I will talk to the video, and then I promise I will be done. What you're going to see -- this is going to be a shear test we have done, and this on a pipe that is in a buckled situation. A number of conditions that we will show on this which you can read and then I will highlight this short video.

So what you're looking at, this is a pipe and then we are going to begin to buckle the pipe. The pipe is now hard over to the side and we are going to engage the new shear blades we have that fit in existing cavities. The system is hard over, the pipe collects into the shear plane, you will see it bring it over. At that point, it brings it in. Now this is an offset in compression shear. So it is showing the industry responds to forensic information that is given to us. This is something that we need to continue to encourage and engage in the industry as part of these committees, and we understand that we play globally; this was a requirement for a different operator to shear in a region. This is shearing an actual tool joint. This used to be considered unshearable, but with this new device, we are able to cut and seal tool joints. It's not everything that we can cut and seal, but we're improving the capabilities of the equipment are. I apologize for running over. Thank you all.

Moderator: Richard Sears, Visiting Scientist, Stanford

Thank you, jeff. [applause]

We have a few minutes for questions from the audience. There are a couple of microphones, if anybody has questions for the panel. Raise your hand and one of the microphones will come to you.

Questions and Answers

Audience

Holly Hopkins, API. Frank, could you clear up the slide that was in Mr. McCarthy's presentation, changes in 53 that have been made in response to that? Would you like to clarify the JIP [Joint Industry Project] slide that was in Mr. McCarthy's presentation, including the improvements in 53 that have been made to address that?

Frank Gallander, Chairman of API RP 53, Chevron

The presentation that Dr. McCarthy showed was a presentation we gave to Director Bromwich in September. That is when Bromwich was still director at the time. That was just an update to him as to what have we been doing, what was going on. Another part of the study, part of the discussion was about going back to work, so we left it as -- the studies are done and had been completed prior to the Macondo incident.

I wanted to ask Dr. McCarthy, the intent of the slide that you showed about the West and the one from the director that I gave, what was the intent of your discussion point?

Roger McCarthy, National Academy of Engineering

The point I was trying to make clear, I guess I didn’t make clear, was the industry had plenty of warnings about the problems of shearing, even pipe they were designed for, under very benign conditions set forth by West. Yet somehow, for reasons I don’t understand, instead of concentrating -- which I think West did properly at the time -- on actual testing of shearing in conditions, somehow the industry started to look at, “OK, how many hours were they out there, how many times were they activated and how many times they worked?”

That makes a great reliability but it does not tell us anything about when all hell breaks loose. I was contrasting those different approaches. When West did the test, they failed. When you add that operational hours, nothing is going on, you can get some high reliability numbers that tell you nothing about your emergency performance.

I would invite you to have some further discussions about this offline, if you have the opportunity.

Moderator: Richard Sears, Visiting Scientist, Stanford

I think there is another question.

Audience:

Director of Innovation for Transocean. I appreciate the panelists for providing the framework and context for these discussions. One thing that I think we all agree is performance. We need to make this new regulatory framework based on performance. That brings me to the point of metrics. We need somehow before defining what are the regulatory for the new base, what are the metrics we need to pursue? One that we really don't have something to propose yet, but I think we need to put the brains on is, how to eliminate the issue of the 'man in the middle' control? We have a very complex control system, yet, we are relying on that button. And how you model [inaudible] that button can be pushed in that case of panic or chaos. What do you think we need to be arguing and discussing?

Bryce Levett, Director, Risk Management Solutions, North America, Det Norske Veritas

I will speak first. I think the most important thing -- [inaudible] what we need to establish first is what exactly do we want the performance to be? I think that is still an issue that needs to be discussed and agreed upon. Again, it becomes a matter of what side of the bow tie do we expect this to work on. As Roger was mentioning, when you talk about the situation where all hell breaks loose, there are a lot of us in the industry that understand emergency disconnect was not necessarily thought of as something you needed to do for all hell breaks loose at the wellhead. It was all hell breaks loose at the surface when the rig decides it wants to go somewhere else and you no longer are connected to the well. It was intended to be a way to safely shut the well in. The expectation was, we still have primary well control in place but we were about to lose our connection and we need to make sure we are secure. Now we are talking about a completely different circumstance.

First of all, let's agree, what do we want this to do? If we do not think a BOP is capable of being developed to a point where it can handle all hell breaks loose, let's come up with a different innovation that will handle all hell breaks loose, and figure out how all that is added together. That, to me, is the foremost nad primary challenge, to define what the performance needs to be, and then we can decide what metrics we want to have for that performance.

Roger McCarthy, National Academy of Engineering

I think Chuck made a great point. You know at the end of the day, engineers to design BOP's have to be given specific performance metrics. We can only talk in generalities for so long. That is why this is an important topic at a design requirements conference. Because when you're talking about a design requirement, that will set forth the testing requirements that it has to pass to be a certified design. These generalities we have been talking about today have to be translated into specific pressures, flows, temperatures.

I do not mean to minimize the technical challenge of the process, but it can be done, and it needs to be done, because the consequences of not doing it are just too great. We have the challenge ahead of us, no question, and we have to come up with standardized tests that will replicate the lost war, which we lost.

Moderator: Richard Sears, Visiting Scientist, Stanford

Thank you, everybody. That brings this panel to a close. If you have additional questions, I am sure that they will be back later in the day. Try to be back in your seats in 10 minutes or so.