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UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF LOUISIANA

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IN RE: OIL SPILL BY THE OIL RIG *DEEPWATER HORIZON* IN THE GULF OF MEXICO ON APRIL 20, 2010 CIVIL	Docket No. MDL-2179 Section "J" New Orleans, LA Friday, October 18, 2013

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IN RE: THE COMPLAINT AND PETITION OF TRITON ASSET LEASING GmbH, ET AL	Docket No. 10-CV-2771 Section "J"

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UNITED STATES OF AMERICA V. BP EXPLORATION & PRODUCTION, INC., ET AL	Docket No. 10-CV-4536 Section "J"

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DAY 12, MORNING SESSION
TRANSCRIPT OF NON-JURY TRIAL PROCEEDINGS
HEARD BEFORE THE HONORABLE CARL J. BARBIER
UNITED STATES DISTRICT JUDGE

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PROCEEDINGS

(FRIDAY, OCTOBER 18, 2013)

(MORNING SESSION)

(OPEN COURT.)

THE COURT: Good morning, everyone. Please be seated. All right. Do we have any preliminary matters to take up?

MR. BENSON: I don't believe so, your Honor.

THE COURT: All right. I think this is pretty much irrelevant at this point, but I'll announce it anyway. Times: The United States has used 20 hours and 50 minutes; they have 24:10 remaining. And BP and Anadarko have used 25 hours and 33 minutes; they have 19 hours and 27 remaining. So quite obviously we'll end up with surplus time; which proves my point. I've been telling Judge Shushan all along that she gave y'all too much time. Next time I'll take her number and cut it in half, we'll probably come out with the right number.

All right. Ready to proceed? You're still under oath, sir.

THE WITNESS: Yes, sir.

THE COURT: Go ahead.

MR. BENSON: Thank you, your Honor.

CONTINUED CROSS-EXAMINATION

BY MR. BENSON:

Q. Dr. Johnson, good morning. Tom Benson for the United States

continuing your cross-examination.
A. Good morning.
Q. If we could have Demonstrative 21266, please.
MR. BENSON: This is a cured version of 21266 that we changed in order, I think, to cure the objection. I don't know if that suffices.
MR. REGAN: Yes, that was the objection. Thank you for curing it.
MR. BENSON: Thank you, Mr. Regan.
BY MR. BENSON:
Q. Dr. Johnson, we were talking yesterday about how we've got a drill pipe within a production casing, correct?
A. That's correct, yes.
Q. And that's what you modelled in Maximus?
A. That's correct, yes.
Q. And what we've done here is just set forth the area of the true geometry and the Maximus geometry, and let's walk through that. The drill pipe, the inner diameter is known and it's pretty simple to calculate the cross-sectional area for the drill pipe, right, you get about 18 square inches?
A. Yes, that's correct.
Q. And in your Maximus model, you used a hydraulic diameter to reflect the production casing geometry, right?
A. No. We used the hydraulic diameter to reflect the geometry of the annulus, so the area of the annulus and the wetted perimeter of

that annulus; so that's the outer surface of the drill pipe and the inner surface of the production casing.

Q. So what we're talking about, just so we're on the same page, we're talking about an annulus here, because they're different annuli in the system, we're talking about the space between the outside of the drill pipe and the inside of the production casing, correct?

A. Yes, that's what the annulus is, yes; and of course, the surfaces of that annulus take into account as well.

Q. And so the hydraulic diameter you used to calculate that annulus is the difference between the inner diameter of the production casing and the outer diameter of the drill pipe, correct?

A. Yes, that's correct. That's how it comes out. The actual equation is four times the area of the annulus divided by the wetted perimeter. But when you do the arithmetic, you find that it comes out to the difference in the two diameters, yes.

THE COURT: So you're basically excluding or deducting the inside diameter of the drill pipe?

THE WITNESS: No. What we're doing is, there's a standard formula that's used throughout the industry and can be found in many textbooks for working out hydraulic diameter for any non-circular cross-section, so non-circular pipe. And that is four times the cross-sectional area of that non-circular pipe divided by this wetted perimeter that I was referring to, which is the surface over which the fluid is traveling. And when you do that calculation for this annulus geometry, it just happens to come out as the difference in the diameters between the inside of the production casing and the outside of the drill pipe.

THE COURT: So is that another way of saying what I said that you're effectively deducting the inside diameter of the drill pipe?

THE WITNESS: Well, the -- small difference, but the outside diameter of the drill pipe, yes, from the inside diameter of the production casing.

THE COURT: Does that in any way assume that there was no flow through the drill pipe?

THE WITNESS: Oh, no, no, no. This is just to obtain a hydraulic diameter to represent the annulus space, both the cross-sectional area of it and the wetted perimeter. So it's a far more hydraulically restrictive flow path than would be described purely by the cross-section.

THE COURT: Because you have two round pipes, in essence, one inside the other?

THE WITNESS: That's correct, yes.

THE COURT: And of course, they each have -- well, in the annulus you have an inside surface?

THE WITNESS: That's correct.

THE COURT: But with the drill pipe, you have inside and outside surfaces, which adds some friction or something I suppose, right?

THE WITNESS: Yeah. The friction --

THE COURT: Is that what you're trying to take out of the equation, so to speak, to come up with this model?

THE WITNESS: No, we're not trying to take it out of the equation. What we're talking about here is modeling the annulus space, which has the cross-section area and the two wetted surfaces, so the outside of the drill pipe and the inside of the casing.

But then a side to that, we model the drill pipe as a pipe, as a normal pipe of the area that you see there with the diameter that you see of 4.778 inches.

THE COURT: You do them separately as two different calculations?

THE WITNESS: No, they're done simultaneously as a network, and it's very important to solve it as a network and that's what we do.

So we have a flow coming up the production casing and then that flow splits between the drill pipe and the annulus and the physics of the pressure drop across those two flow paths, and what's going on in the two flow paths in terms of flow rates dictates how much is going up the two flow paths.

THE COURT: But bottom line is, your model, in your opinion, accounts for the flow path, the flow through both the annulus and the drill pipe?

THE WITNESS: Oh, yes, sir; yes, it does.
THE COURT: Go ahead, Mr. Benson.
MR. BENSON: Thank you, your Honor.
BY MR. BENSON:
Q. The hydraulic diameter you calculate for this portion of this system in your drill pipe high case with a 9 7/8-inch case and a 5 1/2-inch pipe, the hydraulic diameter is 3.125 inches, correct?
A. Yes, correct, that's the hydraulic diameter.
Q. And that gets you an area in your model for the annular space in the production casing of a little bit less than eight square inches, correct?
A. Yes, that's correct.
Q. And now, if we were to look at the actual cross-sectional area in the production casing annulus as it exists in real life, it would be more like 35 square inches, right?
A. That's correct, yes. But do remember that we need to account for the perimeter, the wetted perimeter, the wetted surfaces of this as well because they're what's making this a very hydraulically restrictive flow path.
Q. And to do the calculation to get that 35 square inches, you would take the area of the entire production casing and then subtract the area of the drill pipe, right?
A. Yes, that's correct.
Q. So in your Maximus modeling, your cross-sectional area for the annular space in the production casing is about four-and-a-half

times less than it is in the actual geometry, correct?
A. For the cross-sectional area of the hydraulic diameter is about, yeah, four-and-a-half times less than the actual cross-sectional area of the annulus. But that's the purpose of that is, what we're doing is we're maintaining the same pressure drop/flow rate relationship between those two flow paths, and we're maintaining the same cross-sectional area to wetted perimeter ratio between those two flow paths, too. And that's the important thing. That's how we do it.
Q. Let me just make sure we're clear on the area part. In reality, the cross-sectional area of the production casing annular space is about twice as big as the area of the drill pipe, correct?
A. Sorry, could you repeat that?
Q. Sure. In reality, the annular space in the production casing of almost 35 square inches is about twice as big as the cross-sectional area of the drill pipe?
A. Yes, roughly, yes.
Q. And in Maximus, it's the other way around, the drill pipe in Maximus has twice as big a cross-sectional area -- more than twice as big a cross-sensational area than the annular twice, right?
A. It's not just in Maximus, that's the way we do it. That's the way we represent a non-circular geometry where we've got additional wetted perimeter, and that additional wetted perimeter is giving additional drag on the fluids which is causing additional pressure drop; and that needs to be taken account of in the calculation of

the pressure drop across that annulus, the pressure drop of that annulus. And if we didn't do that, we would get the wrong split of flow between the drill pipe and the annulus.

Q. You would agree you have a different area in your model than exists in reality, right?

A. Yes, by necessity, yes.

Q. And it's by a factor of about four-and-a-half?

A. Yes, by necessity to take account of the -- to respect that pressure drop/flow rate relationship. Because what we're interested in here is getting the right pressure drop across that drill pipe annulus combination so that we can get the right pressure drop pressure at the bottom of the drill pipe, and then we can get the right pressure at the bottom of the well. And it's that pressure that dictates the back pressure on the reservoir. And that's all important to get the right flow rate out of the reservoir, and that's the number we're interested in.

Q. Can we have Demonstrative 22201, please. Dr. Johnson, while we're waiting to get that up. You will agree that the mass flow rate is generally equal to the density times velocity times flowing area, right?

A. Yes.

Q. And the Court heard about that yesterday. So if you have an incorrect area, either your velocity is going to be wrong or your flow rate is going to be wrong, right?

A. No. That's not correct. We have a velocity that is consistent with the correct pressure drop/flow rate relationship for that hydraulic diameter related to the actual geometry of the annulus, so that's what we're respecting here. We've got to respect that relationship and keep that relationship correct.

So we're not trying to find the velocity, that's not what we're interested in. What we're interested in is the pressure drop across that annulus and drill pipe and, therefore, the split in flow between those two flow paths. And that's what we've got to make sure we get right, and that's how we do with hydraulic diameter.

Q. So if I'm understanding you right, when you use a hydraulic diameter, you're not necessarily going to have the right velocity for the system, correct?

A. It's the velocity to do with that hydraulic diameter that respects that pressure drop/flow rate relationship.

Q. So again, that would be a different velocity than exists in the actual system?

A. In that annulus, yes, yes; but the mass flow rate into those flow paths is the correct mass flow rate. I mean, the equation you've got there, that is true. It's really a single phase condition; we're talking about multiphase conditions here where we have more than one velocity and more than one density. But, yes, generally that's true.

Q. And we talked to Dr. Zaldivar about this yesterday, and he said this would be true for multiphase conditions as long as you take an

average velocity; is that right?
A. You could take a mixture velocity, yes, and you could take a mixture density.
Q. If you have the wrong velocity, you're, in turn, going to have the wrong flow regimes for different parts of the system, right?
A. You have flow regimes consistent with that velocity which are consistent with the pressure drop/flow rate relationship, and that, as I say, I'll repeat it, that's what we need to respect here. We need to get the correct pressure drop/flow rate relationship to make sure we get the correct split of mass flow between those two flow paths. And that's what we've done here. It's a standard way of doing it.
Q. Now, you testified yesterday, I believe, that flow regimes -- differences in flow regimes are one of the critical differences between how Maximus modelled this system and how Dr. Griffiths modelled this system, correct?
A. That's correct, yes.
Q. And flow regimes are, in turn, dictated by the density and the velocity of the fluid, right?
A. Yes. They're dictated by many things and density and velocity of the fluid are two of them, yes.
Q. And so if you don't have the correct velocity, your flow regimes are going to be different, right?
A. They're going to be consistent in that flow path with what we need to respect that pressure flow rate relationship, and that's

the all important thing here. We're interested in that pressure drop across the annulus, that's the all important thing.
Q. Now, you said yesterday that the goal of using an industry model is to track the physics of the system, right?
A. That's correct, yes.
Q. But here you're not tracking the physics, are you, because you don't have the right area and you don't have the right velocity?
A. No. What we're doing is using a standard method that we've used many times before that you could find in many, many textbooks, that has been proven empirically as well, that can be used to take account of the non-circular cross-section, so an annulus in this case.
And so what we're doing is tracking physics, but it's the physics consistent with that pressure flow rate relationship that we've got to respect for that annulus.
Q. The hydraulic diameter concept is just an approximation, right, that folks have used over time to try to approximate physics in a one dimensional model, right?
A. Yes, it's an approximation, yes. It's what you need to do in the absence of doing CFD or such thing as that.
Q. And you didn't do CFD, computational fluid dynamics modeling here, did you?
A. No, I don't think that was necessary for this comparison.
Q. Let me ask you a question about some of the modeling that BP has done and you've looked at. Are you aware of BP modeling that

shows higher flow rates in the production casing than in the drill pipe?
A. No, I am not aware of that.
Q. Could we have TREX 41026, please. If we stay on this front page for a minute. You've seen this document before, right, Dr. Johnson?
A. I have, yes.
Q. And this is Appendix W. It's Mr. Emilsen's report that was an Appendix to the Bly Report. And Mr. Emilsen came and testified in the Phase One trial based, in part, on this work. And you relied on this report, in part, in developing your opinions in this case, correct?
A. Yes, I did, I relied on this to infer a PI at the time of the blowout.
Q. And Mr. Emilsen performed modeling with the industry standard model known as OLGA-Well-Kill, correct?
A. Yes, that's correct, yes.
Q. And that's a hydraulic model designed specifically for blowout situations, right?
A. I believe so, yes.
Q. And as part of his work, Mr. Emilsen studied the blowout potential for the Macondo well, didn't he?
A. Blowout potential. What do you mean by "blowout potential," sir?
Q. If we could have, let's see, the first callout 41026.29 and

30.1.US. If we look at the top of the page, Mr. Emilsen says here, "Estimation of the well's flowing potential is important for the determination of the events leading up to the explosion." Do you see that, Dr. Johnson?
A. I do, yes.
Q. And he describes here Table 3.4 and 3.5 showing the distribution of the flow between the drill pipe and the riser for the scenario of flow through the production casing. It's a little confusing when he says, "riser" here, he is referring to the annular space. Do you recall that?
A. Yes, I do remember, vaguely remember some of the confusion like that, yes.
Q. If you see Tables 3.4 and 3.5, in both cases, he shows greater flow up the riser, which is, as we just talked about, the production casing annular space, as compared to the drill pipe. And in each case, he shows more than twice as much flow in the production casing as the drill pipe, correct?
A. Yes, it does appear so, yes.
Q. And in your modeling, you show more flow up the drill pipe than up the production casing, correct?
A. That's correct, yes.
Q. And did you look at any modeling that BP did during the response about how flow would go between the production casing and the drill pipe?
A. No, I didn't look at the model during the response, no.

Q. Let me turn to one last point about the Maximus modeling that you did. One of the things you did in this case was to make a conversion of PT-B pressures to bottom hole pressures, right?
A. Yes, we did a separate piece of work from most of the rest that we've been discussing, yes, to do that.
Q. But you used the same Maximus model, right?
A. We used a very similar Maximus model. It was a flow rate specified model instead of a pressure specified model. That means that in the pressure specified one, which we've been using for the comparison with Dr. Griffiths' work -- with one part of Dr. Griffiths' work should I say, we used -- we had a pressure at the reservoir and pressure at PT-B. A flow rate specified model means we had a pressure at the top and we were specifying the flow rate up, so we were calculating the pressure at the bottom.
Q. In the type of modeling you're talking about here, a flow rate specified model, you need the correct flow rate if you're going to get the correct bottom hole pressure, right?
A. Yes, you do, yes.
Q. And that's information that you provided to Dr. Gringarten as part of his work in this case, right?
A. Which part, sir?
Q. The bottom hole pressure.
A. We provided bottom hole pressures, that's what we were doing, yes. We didn't know who we were providing it to at the time, but, yes, that's what we did.

Q. And you used the same approximation for hydraulic diameter that we just talked about in the bottom hole pressure modeling that you did for Dr. Gringarten, correct?
A. Yes, yes.
Q. Now, you talked a lot in your direct about hydraulic models like Maximus that are used in the industry. Do you recall that?
A. Yes, that's correct.
Q. And over the course of this trial, the Court has also heard about programs like PROSPER and OLGA, and you would agree that those are also industry standard models for flow analysis, right?
A. Yes, they are, yes.
Q. And you would also agree that it can be appropriate to use a custom model rather than a commercial model to do flow rate analysis, correct?
A. Yes, I think you can use a custom model. We've got something very complex here that we need to model correctly, and starting from a validated industry standard model is a better thing to do. But if someone did a very detailed custom model then, yeah, that would be acceptable.
Q. And you've done custom models yourself, haven't you?
A. Yes, I've done a lot of detailed custom models, yes.
Q. And you've used them in your own consulting in the oil and gas industry, right?
A. I have, yes.
Q. You talked about you had your own company called Whitewood for

about 11 years, right?
A. That's correct, yes.
Q. And that's what you did when you were at Whitewood, you used custom models for the oil and gas industry, right?
A. Yes, correct, that's a lot of what I did, yes, yes.
Q. And that included spreadsheet models, right?
A. Yeah, there were some very, very detailed spreadsheet models of thermal hydraulics, yes.
Q. And, in fact, isn't Maximus the only commercially available flow software that you've ever used?
A. No, no.
Q. You've never personally used OLGA, have you?
A. I do tinker with OLGA, let's say, but I have a team of consultants who run OLGA for me; so I lead a lot of work with the transient OLGA software, but I am past doing hands-on work with things like that.
Q. You don't personally run OLGA yourself, right?
A. I don't, no.
Q. And you started using Maximus in 2010 when you joined FEESA, correct?
A. Yes, that's correct.
Q. Let's turn to your testimony about productivity index over time, you talked about that yesterday. Let's start with the productivity index trend that Dr. Griffiths calculated.
You're not disputing, are you, that he had a reasonable

PI for the shut-in time period, right?
A. His PI was in the sort of range of PIs that I've seen for the capping stack period.
Q. And let's turn to the hypothetical PI trends that you used yesterday. First of all, you're not offering an opinion, are you, on what the correct PI trend is over the 86 days?
A. No, that's correct. I think there's a huge uncertainty over that and I think I made that point in my direct yesterday.
Q. And when you developed your expert report and set forth the two PI trends that are in there, that was simply based on information you were asked to assume by counsel, right?
A. I -- yes, that's right. And brief discussion with Dr. Zaldivar just before I submitted my report.
Q. And that brief discussion with Dr. Zaldivar came after you did the work setting forth your PI trends, right?
A. Yes, yes, you're referring to Path B, I think, there, probably, yes.
Q. Yes.
A. Yes.
Q. So when you developed your opinions, you didn't know why those trends would make any sense, right?
A. No. And as I've said, as I say in my report, there are many, many more trends that could be postulated. There's -- those are two examples of trends that could exist. And we're not saying those are exactly the right trends, but that's the whole point,

there's huge uncertainty around that what path is.
Q. I believe on your direct you stated that you used Mr. Emilsen's work from Appendix W that we were just looking at as a starting point for your PI trends, correct?
A. Yes, that's correct.
Q. But you would agree that Mr. Emilsen's work only looked at what the productivity index was before the blowout, right?
A. Leading up to the blowout, yeah. I mean, his last point was, if arguably, at the point of blowout after some of the rams had been closed, yes.
Q. You would agree that Dr. Emilsen's work doesn't tell us anything about how the productivity index changed over time from 2149 on 20 April until the well was shut-in, correct?
A. Yes, that's correct.
Q. And you mentioned Dr. Zaldivar a minute ago and one of your PI path references Dr. Zaldivar's work. Let me make sure I understand this. For Dr. Zaldivar to reach the estimate that he testified about in Court, that requires a PI of approximately 10 standard barrels per psi, correct?
A. Yes, that's using Dr. Griffiths' method and my recreation of Dr. Griffiths' method to calculate the flow rate, and that required a PI of about 10, yes.
Q. And that's for the period of May 13th to May 20th, right?
A. Yes, yes.
Q. Now, let's turn to the PI that BP was using internally from the

first days of the spill. Are you aware of evidence that BP was modeling a PI of 50 from the outset?
A. I've seen numbers of 50, yes. And they were based on information they had at the time, I guess.
Q. If we could have TREX 10483, please. If we could just callout the header of that e-mail. So this is an e-mail from William Burch on April 22nd, 2010, and Mr. Birch worked for Wild Well Control, right?
A. I don't know.
Q. BP hired Wild Well to do modeling after the blowout, and so this is dated just two days after the well exploded. If we could have the first callout, please.
MR. REGAN: Your Honor, I just object to the testimony from the podium here about what the documents are. I don't object to him asking questions, but we're hearing a lot of testimony about evidence at this point.
THE COURT: Well, this is cross-examination. I think the phrasing of the question was okay. Overrule the objection.
BY MR. BENSON:
Q. If we can have callout one from that page or if you could just highlight the middle. Sorry.
If we can start from, "Here's what's known at the moment from an R/G group perspective," about halfway down. Perfect. Do you see this, Dr. Johnson? The first line is, "Here's what's known at the moment from an R/G group perspective." Do you see that?

A. I do, yes.
Q. And then if we go down about seven bullets it says, "PI equals 50 barrels per day per psi and possibly 55 barrels per day per psi." Do you see that?
A. I see that, yes.
Q. And you didn't see this document, BP didn't share this document with you in developing your opinions?
A. I don't believe I've seen that document before, no.
Q. TREX 10658.1.1.US. This is an e-mail on May 2nd from Tim Lockett to Yun Wang. And Dr. Lockett says, "From our telephone discussion, the following items need to be addressed to improve the OLGA well model." And one of those items is, "inflow PI set at 50 bbl/d/psi." And he says, (not done yet, set at 10)." Do you see that?
A. I do see that, yes.
Q. Did BP share this e-mail with you in developing your opinions?
A. I don't -- I might have seen that e-mail, I forget. I've reviewed a lot of documents. But this is all during the response, of course, when they didn't know an awful lot of what was going on. So they were basing their PI assumptions on probably a fully exposed reservoir instead of the partly expected reservoir as we believe it was at the beginning of the incident.
Q. You would agree that from the beginning of the incident, BP was using a PI of 50 in its modeling?
A. Yes, it appears to be. And that's consistent with the end PI,

of course. But as I say that's based on the assumption of a fully expected reservoir which people now believe wasn't the case. I don't know what Tim Lockett would say now if you asked him that question.

Q. And the PI that we're seeing here of 50 that BP was using from the start, that's higher than the PI Dr. Griffiths had at the end of the period, right?

A. Yes. It's consistent with many of the PIs that various people have calculated at the end of the period, of the capping stack period, yes.

Q. And the PI that BP is using at the beginning of the spill is five times higher than the PI that you used as a starting point assumption, correct?

A. Yeah. I think the starting point assumption of 10 from Mr. Emilsen's work is later information and more reliable information than the various assumptions. I don't know what they were assuming at the time and I don't know what they were doing this for. Of course, during the response, they were wanting to shut the well down, and so if they wanted to shut the well down, they would have needed a conservative estimate of what the flow rate was to judge how they were going to pump mud, what junk shot they were going to use, and what other methods they were going use to shut the well down.

That was what they were trying to do at that time, I assume. So I can well imagine they would have made a worst case

assumption on what the PI would have been and assume that the reservoir was probably fully exposed so that they got a conservative flow rate.
Q. You're just speculating here, right, Dr. Johnson?
A. Well, yes, I am. But I am thinking, well, what would I do if I was trying to shut this well down? And I would want to know a conservative number. So I don't know what exactly what they were doing, I haven't studied their work, the things that were going on the in response; but, you know, that's consistent with what I'd probably do anyway.
Q. Did you ever talk to Dr. Lockett about what he meant in this e-mail?
A. No, no.
Q. Did you ever talk to Dr. Lockett or any BP employees during your expert work in this case?
A. Not about anything to do with this, no.
Q. Let's turn to the PT-B data before May 8th for a moment. Now, you testified on direct about the potential BOP pressure trends that could have existed before May 8th, but like the PI trend, you can't say what the correct BOP pressure trend was from the time of the blowout to May 8th, right?
A. Yeah, thank you for pointing that out. There's huge uncertainty in that trend, and this is the point we're making. All of these inputs have huge uncertainty, and that makes the outputs very, very uncertain and gives a very wide range of possible

discharges to the sea.

So, yeah, you're quite right, we had a data point at 8700 psi at the time of the beginning of the incident, at the time of the blowout, and there are various assumptions you can make about the interpolation between that point and May the 8th, and this just highlights the whole uncertainty and many of the inputs.

Q. You mentioned the 8700 point is the one data point that you relied on. Again, that data point came from before the blowout, correct?

A. That data point was basically from the last Sperry Sun drill pipe pressure reading, so at the time of the explosion basically.

Q. But it was before the explosion, right?

A. Well, I assumed it was at the time of the explosion because there was no more data from that point on.

Q. You're saying you don't know whether it was before the explosion or after the explosion?

A. Well, for the purpose of what we're doing here, it actually really doesn't matter too much. We know that rams were closed before it, so -- and you can see in the pressure trend that the pressure went up in a couple of steps up to 8700 psi due to the closure of the rams. And that's what's important for this thermal hydraulic analysis and various other hydraulic analysis that's being done. I mean, the explosion isn't a feature in any of that, any of the work we've done.

Q. You said yesterday and you say in your report that your

hypothesized trend from 8700 straight line down to the May 8th value was adopted by U.S. expert Dr. Pooladi-Darvish; isn't that right?
A. It was, yes, I think we put up a plot from his report that showed that.
Q. You've seen in his report he specifically says he did not adopt that value, right?
A. Well, he did adopt the value. It's in his report.
Q. Let's have TREX 11653.28.1.US. This is from Dr. Pooladi-Darvish's report. He says, "This scenario is an extreme," and those are his italics, "case because the way I have model the BOP restriction at the time of blowout leads to zero flow on April 20th, 2010. The evidence is otherwise." You read that in his report, right?
A. Yes, I did, yes. I don't think he is saying anything inconsistent with what I am saying. I'd agree with him that it could be an extreme case. We've -- the assumption of a linear interpolation between those two points is probably not the exact path. And as I say, there's great uncertainty and there are many paths we could take between those two points.
And this is the whole point of what I am saying in my report that there is wide ranges of input uncertainty that give wide ranges of output uncertainty, and that's the problem with this whole case. So, no, I don't think that's inconsistent with what I am saying.

Q. Well, you're talking about wide ranges of uncertainty here, but you picked the highest possible pressure trend starting at the 8700, right?
A. It's a real data point, yes.
Q. 8700 is essentially a shut-in pressure, right?
A. Yes, it's probably close to a shut-in pressure. It's difficult to say depending on assumptions of how much gas was in the well and things like that.
Q. But it can't be a higher pressure than that?
A. Like I say, it depends how much gas is in the well. If you've got a lot of gas in the well, then that would create a lower gravitational pressure drop in the well. So for -- if the flow rate is low -- and let's assume the flow rate is low at that point in time -- then what is effectively a near shut-in pressure, you could have a high one if there's a lot of gas in the well because of that difference in head.
Q. Do you recall in your deposition telling me that the 8700 was essentially a shut-in pressure and you couldn't have a higher pressure than that?
A. I think I discussed in my deposition what I've just mentioned about, if you've got gas in the well. And I think I discussed about closing in two closed-in tubing head pressures. We had a discussion about that, and if you've got a gas filled well, then you'll get a higher closed-in tube in pressure than if you've got an oil-filled well, so I think we had a discussion of that in the

deposition if I remember right.

Q. If we could have page 344 of Dr. Johnson's deposition. Starting at line seven, and going through line 13, please. The question was, "I think you said earlier that 8700 was essentially a shut-in pressure for PT-B, correct?" Your answer was, "Essentially at that point in time, yeah." And then I asked, "And there can't be a higher pressure than the shut-in pressure, right?" And you said, "Correct, yes."

A. I don't think that's inconsistent with what I've just said. It is essentially a shut-in pressure. I mean, there may have been small flow at that time. And it is true you can't have a higher pressure than a shut-in pressure, but what I've just said is you could have a higher pressure potentially than an 8700 number if you've got a gas-filled well. So I don't think that's inconsistent with what I just said.

Q. In reality, you didn't have a gas-filled well at the time, the well was full of mud and seawater?

A. Yes. Well, we know that gas went to the surface, so I assume there was some gas in there; but we have, you know, a good data point there that should have been used in the analysis of the U.S. experts to assess their uncertainty ranges.

Q. Let's look at the data that we did have before the blowout. If we could have TREX 41026.57.1.US. We're going to be going back to Mr. Emilsen's report, and this is where you got your 8700, right?

A. Yes -- no, the 8700 came from Sperry Sun data which he used as

well. And I calculated the 8700 based on the assumption of seawater in the drill pipe and the assumption of mud in the annulus around the drill pipe, and calculated the head differences to arrive at 8700 at the bottom of the BOP.
Q. And here Mr. Emilsen is modeling pressure at the BOP based on the Sperry Sun data, correct?
A. Yes, correct.
Q. And so we see, as you've talked about, at the time of the blowout, at about 2149, it's over 8000, right?
A. Correct.
Q. And if you go back about three minutes -- use my pointer -- you go back about three minutes, you are between 3000 and 4000 psi, correct?
A. Yes, yes.
Q. And if you go back another hour or more, the pressure trend stays in that 3000 to 4000 range, right?
A. Before rams were shut, yes.
Q. And you can't say, sitting here today, that the line you drew from 8700 to the May 8th value is anymore likely than a flat line from 4,000 psi to the May 8th value, can you?
A. Well, your argument there is that the pressure before the rams were shut is much lower. That's kind of self-evident. I don't quite understand what you're getting at there.
Q. My question is simply this, Dr. Johnson, let me say it again. You can't say that the line you drew from 8700 down to the May 8th

value is anymore likely than a line from 4000 to the May 8th value?
A. Yes, I can.
Q. Okay. Can we have page 355 from Dr. Johnson's deposition. Dr. Johnson's deposition, starting at line 16 going through the rest of the page. My question is: "Well, can you say that the line from 8700 to May 8th is anymore accurate than the line from, say, 4000 to May 8th?" And your answer was, "It's one of the lines that could be assumed, but we need to test out that range of uncertainty because we have uncertainty there."
MR. REGAN: Your Honor, I just object to that as improper impeachment. I don't think that's an inconsistent statement at all.
THE COURT: It's really not. I sustain the objection.
BY MR. BENSON:
Q. Let's turn to erosion for a minute, Dr. Johnson. You haven't done anything to quantify how any of the changes in the system that you talked about yesterday affected the flow rate, have you?
A. Only in the comparisons that you saw used in Dr. Griffiths' method and using the Maximus modeling in one case.
Q. So you're saying the Maximus modeling that you did test out changes in the system over time?
A. Yeah, the Maximus modeling was used for testing out the changes of -- effectively the changes of K well. So assuming -- taking away that assumption of everything being constant in the well for 86 days and assuming that you've got multiphase flow and the

effects of those multiphase flow -- that multiphase flow, then that's what the Maximus modeling did, that was that part of it.

Also, we did the comparisons that you heard about in my direct, and you can read about in my report, which look at the effect of those PT-B -- different PT-B assumptions that we've just been discussing, and also the effect of the different PI assumptions that we've been discussing. So for purposes of comparison and demonstration of the effect of input uncertainties, then, yes, I did do some quantification, but it was only for comparison purposes.

Q. I'm sorry, let me clarify my question a little bit.

A. Sure.

Q. Let me give you an example. You talked about when the drill pipe detached and when it fell. You said you're not quite sure when it happened. You didn't do anything to quantify how when the drill pipe fell or when the drill pipe detached would effect the flow rate at that time, did you?

A. Well, we did the drill pipe high, drill pipe low case, but our aim wasn't to specifically try and find out when the drill pipe detached and dropped. That is something that is subject to enormous uncertainty. And this is the point again. And, you know, you're highlighting the uncertainty again.

So for purposes of comparison, we did an exercise where we calculated cumulative release for those different input uncertainty assumptions, changes in input uncertainty assumptions,

but we weren't doing it for the purpose of producing a quantification.
Q. You can't opine, can you, on which elements of the BOP were the biggest restrictions to flow?
A. Well, it's uncertain like I say.
Q. As a general matter, you would agree that erosion will occur more rapidly at the beginning of a process and then slow down, right?
A. All else being equal, erosion will be faster at the beginning; but as we know from this Macondo case, that all else isn't equal, many things are changing throughout time.
Q. And erosion depends on the velocity in that area, right?
A. That's one of the factors, yes.
Q. And if you have an orifice, for instance, as that orifice grows, the velocity is going to decrease, correct?
A. Like I say, hypothetical case, all else being equal, that is true; but as I say, not all else isn't equal in the Macondo case because there are many things changing through time.
Q. Now, you agree with Dr. Griffiths that the physical evidence shows that the drill pipe was eroded at the upper annular within 36 hours, right?
A. We know the drill pipe eroded through at the upper annular because it was found -- that section of drill pipe was found in the kinked riser. It could have only got there before or at the time when the riser fell and kinked. So that is good evidence of that

particular part eroded in that 36 hours.
Q. Let's talk about Top Kill for a moment. During Top Kill, BP pumped mud, they pumped junk, they pumped all kinds of stuff into the well, right?
A. Correct, yes.
Q. And after Top Kill was over, BP vice-president Paul Tooms concluded that Top Kill had not significantly changed the flow rate, correct?
A. I do remember seeing an e-mail where he concluded that, yes.
Q. Can we have TREX 5066.1.1.US, please. And this is just -- the header of that, it's from Paul Tooms to a number of people, including and Andy Inglis, Kent Wells, James Dupree, Mark Mazella, a number of people the Court has heard from already.
If we could have .3.US. And Here is what Mr. Tooms said. He said, "Attached is a chart showing BOP pressure over time. A number of points can be taken from the graphs, including pressures below and across the BOP with the test rams closed are broadly the same now as they were prior to Top Kill. This suggests that the overall flow rates have not changed much, unless there's some unexplained mechanism in the well." It goes on, "The pressure drop across the BOP has been relatively consistent, and it can be inferred that the drill pipe is present and that flow through it has remained relatively unchanged." Do you see that?
A. I do, yeah. There's a number of points I would like to make on that. One --

08:55:38 Q. Well, if I can cut you off, Dr. Johnson. Mr. Regan can ask you about whatever points you want to make about this.

08:55:45 MR. REGAN: I would respectfully ask that you not cut the witness off.

08:55:48 THE COURT: He can explain his answer.

08:55:50 THE WITNESS: Thank you, your Honor. My first point is he qualifies his statement there with "unless there is some unexplained mechanism in the well." And we have many unexplained mechanisms in the well.

08:56:05 He also is -- the data he is using here is data that's read from various instruments. It's not logged data as such. And I think at some point -- I don't know if it's in this e-mail or in a related piece of text to this e-mail -- he or someone else associated with it talks about the fact that these points are measured. And if you look to a slightly different point in time, you might get a slightly different answer to the pressure.

08:56:34 Also, a third point I would like to make is I've looked at the pressure data through Top Kill and there is a change. Now, maybe Paul Tooms didn't have that pressure data available to him at the time when he wrote this e-mail. I don't know. I haven't spoken to the man. And there is a pressure change before and after Top Kill. There is evidence of things like mud flowing down the well, there are many things going on like that.

08:57:02 Q. You didn't take the opportunity to talk to Paul Tooms and ask him what he meant, ask him if he changed his mind?

A. I don't know Paul Tooms.
Q. Let's talk briefly about the pressure data that Dr. Griffiths used. First, you don't have any objection to the reservoir pressure values that Dr. Griffiths used in his analysis, do you?
A. The starting reservoir pressure is the reservoir pressure that everyone tends to be taking of 11,850. And he uses a number of different end reservoir pressures in his expert report, I think he's got 10,050 in there, and 10,090 in there, and I think he's got 10,310 in there as well, so he's got a number of ending pressures, so I might take a little bit of issue with that.
Q. There's nothing in your expert report that criticizes Dr. Griffiths' reservoir pressures, is there?
A. I think only the points I've just made.
Q. Let's talk about BOP pressure. You haven't done your own analysis of what the appropriate correction would be for the BOP -- I'm sorry, for PT-B?
A. I did look at PT-B correction. I looked at the BP correction for the 26th of May Top Kill period, Top Kill 1, where they found a correction to PT-B of 966 at that point in time, and that seemed an appropriate correction given the data that they got. But that doesn't say anything about the correction outside of that period. Of course, it could have been different, probably was different. And that's just, again, another uncertainty in the whole issue.
Q. You're not offering an opinion about what the appropriate correction was on those days other than May 26th, correct?

A. No, I only looked at the May 26th data.
Q. And you haven't done anything to assess how uncertainty in PT-B data affected Dr. Griffiths' results, have you?
A. No, I didn't look at the uncertainty of the PT-B data and the effect on Dr. Griffiths' results.
Q. Now, you're aware at the time of Top Kill there were also pressures measured from the gauges PT-C and PT-K, correct?
A. Yes, correct.
Q. And did you -- you considered those pressure gauges reliable, right?
A. I think if memory serves me right, one of them had an offset, the other one didn't.
Q. Last topic, Dr. Johnson. You talked a lot yesterday about changes in the system over time. You talked yesterday and we visited a little bit today about how your hypothetical trends or how the PI might have changed over time and how PT-B pressure might have changed over time before May 8th, and you also testified yesterday that if you combine your assumed PT-B trend and your PI trend for Path B, then Dr. Griffiths' flow rate would be just $3.4 million barrels, right?
A. Yes, using Dr. Griffiths' method, that's the number I got, yes.
Q. Talking about changes in the system, you would agree that the biggest change that happened in the system came on April 20th, right?
A. There was an explosion on April 20th, unfortunately, yes.

Q. There was an explosion, the top drive fell, and at that point, there was a clear path through the drill pipe, through the BOP and out into the Gulf, right?
A. There were changes going on throughout the whole of the 86 days, as far as I can see, and the problem is we have uncertainty -- and this is my whole point, we have uncertainty when those changes happened and the magnitude of those changes, and data like PT-B data doesn't tell us -- doesn't give us enough evidence to say what was happening there.
Q. So you're saying April 20th is just another day, another day of changes in 86 days of changes?
A. April 20th there were changes going on, no doubt; but there were changes going on everywhere else as well, so I am not quite sure what the point is you're making.
Q. You don't think there is a different order of magnitude in the changes happening on April 20th when there was an explosion and the top drive fell, as compared to any other day in the response?
A. I can't say there was an order of magnitude difference. How can you quantify the changes then to the changes elsewhere. You know, it's an uncertain thing, and this is the whole point, this is the whole point. You've got a great range of uncertainty about those inputs.
Q. You would agree, though, that on April 20th, the top drive fell and there was a clear path through the drill pipe to the Gulf?
MR. REGAN: Your Honor, I think we've been asked and

answered this about four times.

THE COURT: Okay. Overruled.

THE WITNESS: On April 20th -- if by top drive you mean traveling block fell, is that what you're talking about?

BY MR. BENSON:

Q. Right.

A. Yeah, the traveling block fell, and -- yes, it did. There was obviously hydrocarbons leaking to the *Deepwater Horizon* because we know that because there was an explosion.

But to quantify the changes then in relation to the changes -- to the point through the 86 days, I don't think it's possible to say -- it depends what changes you mean as well, what changes are you talking about, what quantities are you talking about? It's a very nebulous thing you're asking.

Q. Demonstrative D-22833, please. And, Dr. Johnson, I think you'll recognize this. We just put two of your curves on the same graph. In the red we have your PT-B pressure assumption for before May 8th, do you see that?

A. Yes, I do, yes.

Q. And in green, we have your Path B, PI trend assumption, right?

A. Yes, that's correct.

Q. And so based on this, you're hypothesizing that the PI after the explosion, after the traveling block fell was the same as the PI before the explosion, correct?

A. I'm saying that the -- this is an example of a PI trend that should have been considered by, in this particular case, Dr. Griffiths. But it's one example of a PI trend, so you could draw many, many PI trends, as I say, between those two points of ten and about 44.

So in this particular one, we have evidence from Dr. Zaldivar that there's a flow rate of about somewhere around 30 MBD at this point here, which in Dr. Griffiths' method implies a PI of 10. So all I've simply done is interpolated between those two points of the Emilsen number and the Dr. Zaldivar number. And now we could, of course, have all sorts of things going on in this trend. We could have it going down to start with and then up or up a bit and then down, who knows. And that's the whole point, this is very uncertain.

Q. But, Dr. Johnson, this is the PI trend that you chose to present and this is the PI trend that you rely on in saying that Dr. Griffiths' number could be as low as 3.4, correct?

A. Yes, this is an example of the PI trend, one of the possible PI trends.

Q. And for this trend, you say that the PI is the same after the explosion as it was before the explosion and it stays at that level for 30 days?

A. Yes, that's the assumption here.

Q. And for your PT-B trend you assume that it starts at the maximum shut-in pressure and then slowly declines over the course of 18 days to the May 8th value, correct?

A. For testing out the input uncertainties, that's the assumption here, yes.
Q. So in each case you're treating April 20th just like any other day, right, any other day in that trend?
A. Yes. Yes, to demonstrate the range of input uncertainty, we're treating it as the start of the incident, that is true.
Q. And based on those assumptions, the flow rate on the first day would just be a trickle, right?
A. It would be a small flow rate with that 8700 using Dr. Griffiths' method. I think if you look in my report, you will see a plot of flow rate trends over time using these assumptions, and it starts off at the very low flow rate of a couple hundred thousand barrels a day -- I'm sorry, a couple of hundred barrels a day at the time 0.
Q. You describe the first day flow in your report as close to 0, correct?
A. Yes. Like I say, it's close to 0, it's about 200 barrels a day or something like at that time.
MR. BENSON: Thank you, Dr. Johnson. I have no further questions.
THE WITNESS: Thank you.
THE COURT: Redirect.

REDIRECT EXAMINATION

BY MR. REGAN:
Q. Good morning, your Honor. Good morning, Dr. Johnson. Matt

Regan on behalf of BP and Anadarko, and I have Dr. Johnson on redirect.

Dr. Johnson, I would like to start with one of the documents that was shown to you, TREX 5066. If we could put that up, please. You were shown this document, Dr. Johnson, about 15 minutes ago. Do you recall seeing paragraphs one and two?

A. Yes, that's correct.

Q. I would like to show you paragraph three. Could you read the last sentence, or we can read the entire paragraph. What does Mr. Tooms say about trying to use the pressure information from Top Kill to reach and interpret trends?

A. Well, he says "Test rams would appear to be holding back pressure when they are closed," which is what we've kind of just been discussing, "which suggests that there is at least some flow past the pipe rams. This graph will be included in a more complete report on pressures and flow indications which will be issued shortly. However, I thought it useful to share this now as it can dispel certain myths that have taken root amongst the teams. Note that it might be tempting to try and interpret trends for individual parts of the graph - this is not advisable since there is quite a lot of noise in the readings and they are taken infrequently."

And I think this is the point I was trying to explain when Mr. Benson put that e-mail up.

Q. Thank you. Secondly, you were asked about the topic of

hydraulic diameter and asked about whether areas were appropriately modeling things in reality. And first, just to confirm, in your modeling of the drill pipe trends, you were modeling flow both in the drill pipe and the annulus, the area outside of the drill pipe, correct?
A. Yes, that's correct.
Q. Now, can you explain how in reality using hydraulic diameter actually respects what is happening in the physics of the system?
A. Sure. What we're aiming to do there is respect the cross-sectional area and perimeter, the wetted perimeter ratio. So for that hydraulic diameter that Mr. Benson put up on the screen, that ratio is the same for both the annulus and for the hydraulic diameter case.
And what that does, and this has been proven many times empirically and in many, many textbooks and papers, and what that does is it preserves the pressure drop/flow rate relationship for the annulus and so that it's the same, that relationship is the same in the hydraulic diameter case.
Now, the result of that is that you then get the correct pressure drop across the drill pipe annulus section, which means you get the correct pressure at the bottom of the drill pipe, which means you get the correct pressure at the bottom of the well, which means you get the correct back pressure on the reservoir and, therefore, the correct flow out of the reservoir. And that flow out of the reservoir is the number we're interested in here.

Q. Finally, you were asked about whether you can say what the correct PI trend was or whether you could say what the correct PT-B trend was when there was no data. Can Dr. Griffiths say what the correct PI trend is from April 20th to July 15th?
A. No, he can't, no.
Q. Can Dr. Griffiths say what the correct PT-B trend is when there is no PT-B data available?
A. No, he can't. It's highly uncertain.
Q. And what is the impact of the fact that Dr. Griffiths does not know what the appropriate PI trend is and does not know what the appropriate PT-B data is, what's the impact of that on his cumulative estimate that he presents as his best estimate to the Court?
A. Well, it makes the uncertainty bound on his cumulative estimate very, very wide, and far wider than he concluded in his report. He didn't really do a proper uncertainty analysis, and so it makes the cumulative estimate really totally unreliable, I believe.
MR. REGAN: Thank you, Dr. Johnson.
THE WITNESS: Thank you.
THE COURT: Thank you, sir, you're done.
THE WITNESS: Thank you.
MR. BROCK: I wasn't encouraging you to finish.
MR. REGAN: You looked like you were ready for me to be done. Let's keep it moving.
MR. BROCK: Good morning, your Honor. May I proceed?

THE COURT: Yes.

MR. BROCK: First, Judge Barbier, BP would like to offer the exhibits that were used with Bob Merrill, Dr. Zaldivar, Mr. Hampstead, Dr. Ratzel and Mr. Hill. A couple of these relate to videos that were played in the court. These exhibits have been circulated and there are no objections to these. And I have copies here for others who might want them.

THE COURT: Any objection?

MS. HIMMELHOCH: No, your Honor.

THE COURT: Without objection, they will be admitted.

MR. BROCK: And at this time, your Honor, BP and Anadarko rest their case, subject to the following:

We are still preparing the customary list of exhibits, callouts and demonstratives used with the last few witnesses. We have some issues that we are working through, we are working with the United States and trying to work through with regard to exhibits on Blunt, Gringarten and Nesic, so I think probably in the interest of time, probably the best thing to do on those is to let us continue to see if we can work those out and just deal with those at the final marshaling conference. If we can't work them out, we will come back to you.

THE COURT: What's the date that we have scheduled for you all to meet with Judge Shushan on that?

MS. HIMMELHOCH: The 29th, your Honor.

THE COURT: 29th of October?

MS. HIMMELHOCH: Yes -- I'm sorry, November, November 7th, I'm sorry, your Honor. I shouldn't speak without checking with Ms. Pencak.

THE COURT: Okay. Very well.

MR. BROCK: I wasn't going to speak at all because I didn't know. I was looking over to Mr. Langan. So, okay. So we will try to work those out, and if we can't, we will tee those up for the Court in the appropriate way.

MS. HIMMELHOCH: No objection, your Honor.

THE COURT: Okay.

MR. BROCK: We will also submit a list of the Category 2 and Category 4 exhibits and seek those exhibits' admission at the final marshaling conference. That's the protocol that we worked out in advance of trial. So there will be some work to do on that. And then that's another matter that we will present, Anadarko and BP will present jointly.

We also offer into evidence at this time a list of the 11 Phase Two deposition bundles that BP and Anadarko designated for the Phase Two trial. These bundles were not previously offered by the Aligned Parties or BP in the source control segment or by the United States in the quantification segment, and I have a thumb drive that I will offer up in just a second that contains this testimony of the deposition bundles.

THE COURT: Those relate to which part of Phase Two? Just quantification?

MR. BROCK: The ones I am talking about now relate to the quantification case. I guess we have the understanding, I believe this is right, that anything that's in evidence in the Phase Two trial can be cited, but these are primarily quantification.

THE COURT: Right, of course.

MR. BROCK: Quantification matters. With those deposition bundles that we are offering, we also have the -- a list of the bundle exhibits. I am told that we've got the right list here, but if there is a problem with this list and it needs to be sorted out amongst the parties, we are certainly open to do that, if we need to add something or take something off. I will offer them now. I am told this is right, but if there's an issue with that, we will take care of that.

THE COURT: Okay. Let's deal with the deposition bundles. 11 deposition -- Phase Two quantification-related deposition bundles offered by BP and Anadarko.

MS. HIMMELHOCH: No objection, your Honor.

THE COURT: No objection, okay. Those are admitted.

MR. BROCK: In the interest of time, your Honor, I have a list of those names here, and so I'll just hand that up for the record, if that's okay, and then I won't have to read them.

THE COURT: That's fine. Okay.

MS. HIMMELHOCH: Trusting that it's the same as what we've seen, we're fine with that.

MR. BROCK: We won't try to run one past you on that, so...

And this disk here is identified as exhibits designated by all parties within the deposition bundles offered, admitted by BP today. So this is the exhibits to the depositions, I think I misnamed that earlier.

THE COURT: And, again, you have the designations by both sides and the related exhibits from both sides?

MR. BROCK: Yes, sir.

THE COURT: Okay. No objection from the government?

MS. HIMMELHOCH: No, your Honor.

THE COURT: Okay. Those are admitted.

MR. BROCK: I need to say for the record that by offering each of these deposition bundles into evidence in regard to all of the deposition bundles offered into evidence by the parties during the Phase Two trial, BP does not waive, but maintains all of its general and specific objections to the designated testimony and the exhibits contained within the deposition bundles. I think I said BP there, but I am presenting this both for BP and Anadarko.

There's one outstanding legal issue, your Honor, that I thought I might just get your guidance on. And that's the issue of the summary judgment motion that was filed by the United States on the issue of the conversion of oil to stock-tank barrels.

THE COURT: I am just going to deal with that on the merits.

MR. BROCK: I was going to suggest that we just deal with that in our post trial brief and not respond to the summary judgment specifically, but if you thought that was something you wanted to deal with --

THE COURT: Really you all already did -- I think Ms. Karis said that you all had briefed it. There was a motion for summary judgment, but it was really also a motion in limine.

MR. BROCK: It is, but we have probably -- I'm sorry.

THE COURT: And I just said I would let him testify and I would sort it all out later.

MR. BROCK: Right. Our response -- our motion in limine does not set out completely our argument. Our motion in limine is a little narrower than what we will be saying on the legal side. But we will take that up as a post trial motion and will not worry about responding to the summary judgment specifically.

THE COURT: Okay.

MR. BROCK: I think that's it, your Honor. So with those qualifications, BP rests its case at this time.

THE COURT: And Anadarko, right?

MR. BROCK: I'm sorry. BP and Anadarko rest their case. Thank you.

THE COURT: Okay. Very well. Okay. Before we get to the government's rebuttal evidence, I want to just make sure everybody understands where we are. When we left late yesterday evening -- or yesterday evening, I expressed my view. I don't believe the government's actually filed anything else, right?

MS. HIMMELHOCH: That's correct, your Honor.

THE COURT: There was a statement that you all might file something. I haven't seen anything else being filed.

MS. HIMMELHOCH: Your Honor, we intended to address that in the post trial briefing. I can assure you that none of the testimony elicited today will relate to the disputed portions of Dr. Huffman or Dr. Roegiers' reports.

THE COURT: The way -- I think the best way to handle this for the record is that I've told you what my ruling is that I thought part of the rebuttal experts' testimony was really case in chief stuff, and so I'm not going to allow it in your rebuttal case. Obviously you can proffer whatever evidence you want on that point in terms of the expert -- you know, if you want to proffer the entire expert report, for example, and related deposition testimony. And then I think in fairness, what I will do then is allow BP and Anadarko to proffer in response any -- it would be in the form of surrebuttal.

In other words, if I was allowing them to go into that in their rebuttal case, in fairness, I would allow you surrebuttal on that point. Okay. So you all can both make your proffers along those lines.

MS. HIMMELHOCH: So today when we offer the expert reports, it will be subject to the additional redactions?

THE COURT: Right.

MS. HIMMELHOCH: Understood, your Honor.

THE COURT: Right. Okay. Anybody have any questions about that?

MR. BROCK: I think that's clear.

THE COURT: Okay. All right.

MS. HIMMELHOCH: Your Honor, at this time, the United States calls our first rebuttal witness, Dr. Leif Larsen.

THE COURT: Dr. Larsen.

THE DEPUTY CLERK: If you'll raise your right hand.

(WHEREUPON, LEIF LARSEN, WAS SWORN IN AND TESTIFIED AS FOLLOWS:)

THE DEPUTY CLERK: If you would take a seat. If you would state and spell your name for the record, please.

THE WITNESS: My name is Leif Larsen, L-E-I-F L-A-R-S-E-N.

MS. HIMMELHOCH: I'm going to let the opposing counsel settle in before we get started, Dr. Larsen.

THE WITNESS: Sure.

MS. HIMMELHOCH: Your Honor, Sarah Himmelhoch for the United States. May I proceed?

THE COURT: Yes.

VOIR DIRE EXAMINATION

BY MS. HIMMELHOCH:

Q. Good morning, Dr. Larsen.

A. Good morning.

Q. You've been hired as an expert for the United States; is that

correct?
A. Yes.
Q. What question were you asked to answer?
A. I was asked to review the probability estimate that Dr. Gringarten derived from the data he selected before the explosion and determine if it was reasonable.
Q. And what is your understanding of the role that permeability plays in Dr. Gringarten's analysis?
A. He uses permeability as a key estimate to compute the cumulative volume of oil released.
Q. And is Dr. Gringarten the only BP expert who uses Dr. Gringarten's permeability estimates?
A. No, Dr. Blunt also used the permeability from Dr. Gringarten to do computations of cumulative oil, of oil released.
Q. We will get to the answer to your question after we've introduced you to the Court. Please call up D-21701.
Dr. Larsen, is this a summary of your educational and work experience?
A. Yes.
Q. And let's begin by asking you what you consider to be your expertise as it relates to the work that you did in this case.
A. Well test analysis.
Q. And please remind the judge very briefly what you mean by "well test analysis."
A. Well test analysis is the -- we're looking at pressure changes

caused by rate changes, and use that signal to determine formation properties.
Q. And is one of those formation properties permeability?
A. Yes.
Q. Do you hold any advanced degrees, Dr. Larsen?
A. Yes, I have a Ph.D. in mathematics from the University of California at Irvine.
Q. Once you got your Ph.D., let's now turn to your experience, and we'll work backwards in time. So where do you work now?
A. I work at Kappa Engineering, which is a software company.
Q. Is Kappa well known within the oil and gas industry?
A. Yeah, it's one of the leading companies in -- for software for petroleum engineering.
Q. And what position do you hold at Kappa Engineering?
A. I'm the senior reservoir engineer.
Q. What do you do as a senior reservoir engineer?
A. I do both software development and I do consulting work for the industry through Kappa.
Q. What types of software do you develop?
A. It's for well test analysis and also for use in production analysis, which is sort of the opposite.
Q. And what type of consulting analysis do you provide for your clients?
A. I look at both the MDT data and DSTs and analyze production data and also do some studies that related to rock mechanics, like

stress testing.
Q. And by DST, you mean well test analysis for well tests?
A. Yes.
Q. How long have you been with Kappa Engineering?
A. Since January of 2008.
Q. Where did you work before you joined Kappa?
A. In Statoil.
Q. Is this the same Statoil that the Court has heard about throughout this case?
A. Yes.
Q. And where is Statoil headquartered?
A. In Stavanger, Norway.
Q. Is that where you reside, Dr. Larsen?
A. Yes.
Q. How many years did you work for Statoil?
A. Roughly 20 years.
Q. During the years that you worked for Statoil, what type of work did you perform?
A. Well, initially my role was divided between continuing work on in-house software that we used for well test analysis, and at the same time, also the analysis of the field data. But after the industry turned away from in-house program to commercial software, since then I worked only or mostly with analysis of field data.
Q. And we'll get to your field data analysis in a minute, but you said you finished the design of software that you had started

before you joined Statoil?
A. Yes.
Q. Where were you working at the time that you began the work on Statoil's well test analysis program?
A. That was Rogaland Research Institute, also in Stavanger.
Q. Approximately how long did you work for Rogaland Research Institute?
A. I was there for ten years.
Q. Let's turn now back to the consulting work or the analysis of field data, more appropriately, that you did while you were working for Statoil. What was that analysis addressed to?
A. While I was in Stavanger I had a similar role in well test analysis, so I probably looked at almost all of the past and present well tests within the company and especially when new wells were put in production, we had to go back and redo all of the analysis and write the summary of the results. So I came across everything.
And for the international operation, it is mostly a lot of the work done when we are considering buying into existing -- or buying new acreage or buying into other operations; but then again, we would do -- go through all of the analysis done in the past. So I looked at quite a few different types of analysis.
Q. Were any of the acquisitions that you looked at in the Gulf of Mexico?
A. Yes, I looked at a lot of data from the Gulf of Mexico.

Q. And on an order of magnitude level, approximately how many well test analyses have you performed or reviewed in the course of your career?
A. It's difficult to say, but it's in the thousands.
Q. And during your career, have you become familiar with the wireline formation test tool or MDT tool that was used in the Macondo well before the explosion?
A. Yes.
Q. And what type of work have you done with such wireline formation tests?
A. Well, in Statoil we did quite a few MDT oil -- ran MDTs as DST replacements, as a low-cost replacement. But also when we do sampling with such tools at Statoil, we would always plan for -- to do a proper flow shut-in to have a good data set so we can determine probability at the same time, not just the sampling.
Q. And rounding out the discussion of your work experience, do you have any work experience in academia relating to well test analysis?
A. Yes, I am an adjunct professor at the University of Stavanger.
Q. What do you teach at the University of Stavanger?
A. I teach a master's course in well test analysis.
Q. How long have you been teaching that master's course in well test analysis?
A. Since '87.
Q. Let's go ahead and call up TREX 012102R. Dr. Larsen, is this a

copy of your expert report?
A. Yes.
Q. And does this document accurately summarize your opinions in this matter and the bases for those opinions?
A. It does.
Q. And let's turn to TREX 12102R.064. Dr. Larsen, this is the first page of your curriculum vitae; is that correct?
A. Yes, it is.
Q. And does this accurately summarize your qualifications and publications?
A. Yes.
Q. Let's go back to D-21701 just one last time. Dr. Larsen, in your over 30 years of work in the petroleum industry, have you received any awards?
A. I was the SPE distinguished lecturer from '98 to '99, and last year I received SPE Formation Evaluation Award.
Q. And for what work did you receive your -- the SPE Formation Evaluation Award last year?
A. That's for my work in well test analysis through the years.
MS. HIMMELHOCH: Your Honor, at this time I tender Dr. Leif Larsen as an expert in well test analysis. Neither BP nor Anadarko have filed a *Daubert* motion with respect to Dr. Larsen.
MR. BOLES: No objection, your Honor. Obviously, we will be cross-examining.
THE COURT: All right. Without objection, he is

accepted.

DIRECT EXAMINATION

BY MS. HIMMELHOCH:

Q. Dr. Larsen, do you adopt the entirety of your report, TREX-012102R, as your testimony here today?

A. Yes.

MS. HIMMELHOCH: Your Honor, at this time, I move Dr. Larsen's expert report into evidence.

MR. BOLES: No objection.

THE COURT: Without objection, it's admitted.

BY MS. HIMMELHOCH:

Q. We're going to take a short detour before we get into your permeability analysis to address an issue that came up during BP's case.

During BP's case they put up a demonstrative that indicated that you had reached certain conclusions regarding the porosity of the Macondo reservoir. Did you, in fact, develop any opinions regarding the porosity of the Macondo reservoir?

A. No.

Q. Did you use porosity as an input into your analysis?

A. We have to input the porosity and compressibility as part of the model data, so -- but I just took those values from Dr. Gringarten's report.

Q. And if you varied the porosity of the reservoir, would that have a significant impact on your analysis of the permeability?

A. No, it doesn't affect computation of the permeability.
Q. Now let's turn to the heart of your opinion, which is the permeability analysis that you were asked to perform. And you indicated that you were asked to determine whether Dr. Gringarten's estimate of the permeability based on the MDT data before the explosion, to determine whether or not that was reasonable. What, if any, conclusion did you reach?
A. I concluded it was clearly underestimated.
Q. And in the course of developing that conclusion, did you also develop your own estimate of permeability?
A. Yes.
Q. And what was your opinion as to the permeability of the Macondo reservoir?
A. My -- it has to be between 400 and 500 millidarcies or higher.
Q. Let's call up D-21702. Dr. Larsen, does this summarize your conclusions and compare those to Dr. Gringarten's?
A. Yes.
Q. And you indicate here on the graph that your thickness-based average is 438 millidarcies.
A. Yeah.
Q. What is a thickness-based average, very briefly?
A. Well, both I and Dr. Gringarten, we do the analysis layer by layer, and then afterwards you come up with a permeability that would drive flow from all layers. We use the thickness-based average; that is, you use the fraction of the total thickness for

each layer as a weight.
Q. You so weight the average by the thickness of the layer?
A. Yes.
Q. Now, Dr. Gringarten has already testified that the M56E lower layer is the thickest, with the M56D next, and then the M56E upper the thinnest. Do you agree with that testimony?
A. Yes.
Q. What is the significance of the fact that the M56E lower layer is thicker than the other two layers you analyzed?
A. Being the thickest layer, it would have the greatest impact on the average.
Q. Before we jump right into a detailed discussion of your analysis, are there any layers on which you and Dr. Gringarten are substantially in agreement?
A. Yes. For the M56E upper, we are roughly on par.
Q. If we can go ahead and bring this demonstrative down. Dr. Larsen, what is your -- what are your and Dr. Gringarten's estimates for the M56E upper layer?
A. My best estimate for that layer is 150 millidarcies. And Dr. Gringarten in his direct analysis is first -- sort of direct analysis, he came with 120 millidarcies, but then after his Monte Carlo analysis his P50 was 117, slightly lower.
Q. If you could slow down just a little bit to help the court reporter out, I think that would be appreciated.
Do you have an opinion as to why your estimate and

Dr. Gringarten's are so close for the M56E upper layer?
A. Yeah, for the E upper layer, they are -- obviously the mobility is much lower and then you get data easier to work with. Then different people come up with similar result.
Q. Using different methodologies?
A. Pardon?
Q. Using different methodologies?
A. Similar methodology, yeah.
Q. And what is the reason for the slight difference between your estimate and Dr. Gringarten's estimate for the M56E upper layer?
A. Yeah. In my direct analysis, if I just focus sort of at the end of the data, just looking for permeability alone, then I would come up with quite similar result as Dr. Gringarten. But you have to match all of the data during flow, and then to avoid having an unrealistic flow model, I had to go slightly higher on the permeability.
Q. And when you said model, you were referring to the wellbore model?
A. Yes.
Q. Let's call up D-21709. Dr. Larsen, what is shown on this demonstrative D-21709?
A. This schematic here shows the two different models. So on the left you have the single probe model that I used, and there we have flow into the wellbore going through a small hole on the side of the wellbore. The model that Dr. Gringarten used is traditional

limited flow entry model where you have the short opening and you have flow from all sides.

Q. What is the most significant difference between those two models?

A. In applications, it's normally the area, the flow area, because it's easier with a probe model to constrain dimension with a wellbore. And so the importance of this is Darcy's Law says that the rate by area is equal to mobility times pressure gradient. And from data you have the rates, you have the gradient, and you can compensate for -- if the permeability is too low you can compensate by using a slightly bigger flow area. And that's the main sort of difference. As long as you keep the flow area small, also in the limited flow entry model, that it was small wellbore radius, then they were quite similar, but this is easily overlooked. It has to do with the flowing, not for the buildups.

Q. So does Dr. Gringarten --

THE COURT: Tell me again, which one of these is your model?

THE WITNESS: The one on the left. It's difficult to see from here, but there is a small hole.

THE COURT: I can see it on the screen in front of me better. The one on the right is what Dr. Gringarten used?

THE WITNESS: Yes, that's a conventional limited flow into the well, when you just have flow from all sides.

BY MS. HIMMELHOCH:

Q. So the one labeled "single probe model" is yours, Dr. Larsen?
A. Yes.
Q. And the one labeled "limited flow entry" is Dr. Gringarten's?
A. Yes.
Q. And what was the impact of Dr. Gringarten's use of too large an effective area on his permeability analysis?
A. Like I said, it has to do with the flow periods because when you do the analysis, you're focusing just on the buildup data, you can sort of overlook this as a problem, but you have to match also the flow and then you will see that you are constrained by the dimensions here. You have to increase the permeability to actually match the performance of the two.
Q. Now, we talked about the M56E upper layer in which you and Dr. Gringarten are largely in agreement. Are you largely in agreement on the other two layers?
A. No.
Q. Please call up D-21703. To help the judge understand the differences between your analysis and Dr. Gringarten's, let's just do a brief overview of the analysis that you performed and then we will walk through it step by step for the M56D layer. In very short terms, can you describe for the judge what was your methodology in analyzing the permeability of the Macondo reservoir?
A. The first step is always the same, you locate or identify buildups through your data set, and then you have select buildups that you find --

THE COURT: What's a buildup?

THE WITNESS: That's when you flow the well or the tool, then you draw the pressure down in the formation next to the tool. And when you shut in the well, the pressure will build back up. So that's what we call a buildup.

THE COURT: Okay.

THE WITNESS: And that's the main source of the information in the analysis in terms of trends and properties.

BY MS. HIMMELHOCH:

Q. And did you and Dr. Gringarten do anything different in identifying the buildups?

A. No, this is standard for the industry.

Q. After identification of buildups, can you run through the remaining steps?

A. Yeah, then we use a log-log plot for the best buildup, the one to me that appeared to be the best buildup just to get the initial estimate of the show of the pressure change and the permeability. And this is also traditional approach.

Then I used the semi-log plot to more accurately in my analysis due to the recording of the data to get the properties, and then I would verify with the rest of the buildups.

Q. So let's walk through everything after the first step, since you and Dr. Gringarten agree on that. Let's turn to your second step which you identified as selecting the buildups. Before you went about selecting the buildups, were there any buildups that you

knew you were going to analyze?
A. Yeah. The pretests at the end of the data set, those tests were run specifically for pressure data, so I knew -- and also since they came at the end of the entire flow period, I expect that you have oil next to the tool, so you should be at the right pressure level and also should be fairly good quality data in terms of at least being at the right level.
Q. Let's call up D-21705. What did you do to select the other buildups or buildup that you were going to analyze for the M56D layer?
A. Having identified or located all of the buildups in the data set, we normally set up a log-log diagnostic plot of everything.
Q. And is that log-log diagnostic plot in the graphic that's shown on this slide?
A. Yes.
Q. I'm sorry. Keep going.
A. And then looking for consistency in the behavior or the response from the -- during the tests, then we're looking for -- if you can pick up some general trends toward the end, that would give an indication of where is the radial flow.
Q. Is that because radial flow is where you derive your estimate of permeability from?
A. Yes, that's the most important source for determining permeability, yes.
Q. For the M56D layer, did you see general consistency between the

buildups and a dominating trend?
A. Just looking at the -- I mean, there is some consistency in the behavior. There is sort of a downturn towards -- I mean, the main -- the upper part of the pressure changes, they are scattered a lot. This is because of the dimension of the tool is very sensitive to changes just in the probe opening and so on. So the scatter there is due to cleanup, due to different pumps being operated and so on. So we can't really -- so that is not a surprise.
But what you're looking for is the derivative, the lower points, and we expect certain behavior from these tools, initially sort of a downward trend in the data, and we see that to some extent. But we would expect to see a levelling off of the derivatives, and that doesn't really stand out as one would hope.
Q. And once you determined that you couldn't see a dominating trend on the log-log plot, what did you do next?
A. Then I would go to more of a semi-log, looking directly at the pressure data to focus more on detail and see if I can -- even with this, you know, see if it's possible in that type of a coordinating system to actually identify buildups that are consistent, that have the proper trends and so on.
Q. And you went -- when you say semi-log, that means that time is in the log scale, but pressure is not?
A. Pressure isn't in the scale, but log is and the superposition time, but that is indirectly a log scale.

Q. And can you in one sentence explain to the judge what superposition time is?
A. Well, it's not that easy. But roughly, it tries to take into account pressure change or rate change prior to shut-in so that the behavior is more or less the same that you would see if you actually had just one rate.
Q. So it's a mathematical way to chart differing rates on the same graph?
A. That's another part, that's the normalization part. But it's a way of transforming the time axis so that the behavior, it looks like the flow, even though it is the shut-in.
Q. Using the semi-log plots, were you able to select additional buildups beyond the pretest to perform analysis on?
A. For the D sand there is one other buildup that stands out having good quality, the others -- I mean, together with the pretest. They are the same level. And this other buildup, it does have a consistent shape, as expected, pressure building up. The others are more clearly influenced by operator interaction, the sampling operations.
Q. Did you apply a numbering convention to the buildups for ease of reference?
A. Pardon?
Q. Did you apply a numbering convention, did you number the buildups?
A. Yeah, the buildups are numbered. So No. 1, 2, 3 and so on. In

the software, Dr. Gringarten, he numbers everything from the first probe, second probe, so on, regardless if they are flowing or shut-in. So our numbers are quite different. To me, the one in the middle was No. 4; and the one at the end, the pretest, was No. 6.
Q. Once you decided -- well, before we move on to the next step. Dr. Gringarten only analyzed in detail the pretest. Why did you look for other buildups beyond the pretest?
A. It's because the pressure response is directly proportional to the rate, and here we know that this is a high mobility formation; and with a low rate, it's very challenging to do a convincing analysis.
Q. And why is it challenging to do a convincing analysis in a low-rate buildup?
A. Because of gauge resolution issues.
Q. Can you explain a little bit more what you mean by gauge resolution issues?
A. When you have a high mobility and low rate, the pressure will recover quite quickly after you shut in the well, shut in the tool. So the pressure recovers quickly and it quickly approaches and goes below the resolution of the gauge, so you cannot rely -- actually record or measure the changes that you need.
Q. So once you had decided that you were going to analyze Buildup 4 and Buildup 6 -- let's go to D-21708 -- what did you do next?

A. Next I would -- like I said, initially I would then go to --

MS. HIMMELHOCH: Your Honor, I am going to ask the witness to pause because I'm seeing Mr. Boles stand up for an objection.

MR. BOLES: Thank you, Counsel. We've had some back and forth about this before. Your Honor, this graph is not in the report, nor -- and I don't think there's any dispute about that.

MS. HIMMELHOCH: That's correct.

MR. BOLES: Nor is the analysis in the report. This is the opposite of what he describes in his report. We've seen a distinction described just now between the semi-log and a log-log plot. What's described in the report is Dr. Larsen using the semi-log, and then comparing it against the log plot here, he is deriving -- he is doing the opposite. So this analysis is not presented in the report, let alone depicted in the report.

MS. HIMMELHOCH: Your Honor, it is correct that this particular graph does not appear in the report, but on Page 26 is a similar plot showing his final permeability estimate --

THE COURT: Is this a demonstrative that you disclosed?

MR. BOLES: Yes, it is.

THE COURT: Was there any objection to this?

MS. HIMMELHOCH: Yes, there was, your Honor.

MR. BOLES: I am objecting to it. It is outside of the scope of the report.

MS. HIMMELHOCH: So he does present the log-log analysis on a different permeability value graphically in his report, but he also states in two places that he looks at the shape of the curves in relation to both the log-log and the semi-log plot. For instance, on page 21 --

THE COURT: Okay. I am going to allow it. Let's go on.

MS. HIMMELHOCH: Thank you, your Honor.

THE COURT: Overrule the objection.

BY MS. HIMMELHOCH:

Q. So, Dr. Larsen, what do you get first when you put the measured data into the software program on this graph?

A. When you're looking at the new data set, the first thing you come up on the screen is just the data, not the curves. So it would be the dots at the top and the dots towards the bottom here (INDICATING).

Q. And then what is this dashed line that is labeled "Derivative Value"?

A. The dashed line is what -- the software always assumes that the end of your derivatives will give you an indication of radial flow and, indirectly, the permeability. So it's an estimate of radial flow stabilization.

Q. And how does that give you a permeability value?

A. Well, from the value of the derivative, you can compute the value of the M which is the semi-log slope that we use in this, so it's the equation that's on the screen that relates the slope M obtained from the derivative and the permeability.

Q. And once you got that -- what was the value of the permeability estimate that the computer first gave you?
A. From the location of the dashed line here, it's 125 millidarcies.
Q. And then once you have that initial estimate of permeability, what you did do next?
A. Then I would do what's already up on the screen. I would -- well, when you do these type of analysis, you select a model, but we already know the model that we are going to use is the single probe. The permeability which is always part of all modeling efforts is already in there. That's from the dashed line.
But I have to enter a vertical permeability also as part of the input, and then, of course, a skin value that sort of controls the shift in the data at the top. So I just run the model with -- initially, I would just do a default for the vertical permeability, it's the same as the horizontal, just to see what it looks like and use the reference --
Q. Let's stop there for a moment. You're talking about vertical and horizontal permeability. Are those exactly what those terms mean, permeability up and down and permeability across?
A. Yes.
Q. And you indicated that the default is one. Do you consider that to be an appropriate value for this reservoir?
A. Especially for the D sand there was every indication in the BP technical memorandum that this is a heterogeneous formation, and

also shows clear sort of anisotropic feature. So here you would expect for sure the vertical permeability is going to be clearly less than horizontal.

Q. And just for the Court's reference, can we call up TREX 003533. Let me ask you this: Have you seen a TREX stamped version -- there we go. Dr. Larsen, is this the subsurface technical memo to which you were referring?

A. Yes.

Q. Let's go ahead and bring that down then, and go back to the slide. Thank you.

So once you had adjusted the model to address the vertical to horizontal permeability ratio, what did you do next?

A. Here considered well scatter in the derivative, you cannot pinpoint what a reasonable value for the permeability is, it's just an indication. So then I would go on to a semi-log and look at this more carefully.

Q. And what does -- the one set of lines we haven't described on this graph, before we move on from D-21708, the green lines, what do those represent?

A. The one on top is a model output for pressure change during this buildup, and the one on the bottom just shows the slope of the model input -- output.

Q. And let's, now, show the Judge how you take this model and go to the semi-log plot. Let's call up D-21710.

MS. HIMMELHOCH: And, your Honor, there's an objection to this demonstrative as well.

MR. BOLES: For the same reason, your Honor, we object because this is not -- this graph is not in his report nor is this analysis described in the report.

MS. HIMMELHOCH: I can, again, refer you to the pages in his report if you would like. On page 21 he states, "Software based determination of point by point trends cannot be trusted offhand. Results must be verified by considering the data directly." That's what he is doing in moving to a semi-log plot.

He also discusses on page 11 the effect of changing the shape of this curve that is represented on the semi-log plot --

THE COURT: Okay. Let's continue. Overrule the objection.

MS. HIMMELHOCH: Thank you, your Honor.

BY MS. HIMMELHOCH:

Q. So, Dr. Larsen, just briefly describe to the judge how you move from the log-log plot to the semi-log plot.

A. The semi-log plot just shows the data from the top of the log-log plot, just the pressures. So that's what's showed there, the pressures versus the same superposition time.

MS. HIMMELHOCH: And we're going to, now, go to D-21711 which has the same objection to it.

MR. BOLES: And, your Honor, I'll just make a note of continuing objection to all of these exhibits, that way I won't keep interrupting the flow of the examination.

THE COURT: Okay. All right. Go ahead.
BY MS. HIMMELHOCH:
Q. So if we can go to D-21711, please. And, Dr. Larsen, I want to start on just one note. What did the green lots represent on this plot?
A. Those are the data from Buildup 4, so this is a high rate buildup.
Q. Let's focus for a moment and I want you to listen very carefully to my questions. At your deposition did BP raise any challenge to the data that you had used?
A. Yes.
Q. And what did they challenge? What did they say about the data that you had used?
A. Turned out that I had undersampled the data. I assumed that the file that was provided was a complete file, so I just used it as I found it with 8 point -- or a pressure value per -- for each -- one per second.
Q. And what did it turn out that data represented? Let me ask it a little more clear.
A. Two different things here. First of all, the raw data actually came one point every 300-millisecond. I used one per second and since this doesn't go up, so when I'm -- I'm not doing this, but when the Schlumberger toolkit asked for pressure at a given point, if there isn't one, they would just interpolate between neighbors.
Q. So in essence, you used interpolated data as opposed to the

direct data in certain points?
A. It's a mix of direct and interpolated.
Q. And is interpolation the same thing as data smoothing?
A. No.
Q. I just want to ask you this, and, again, listen very carefully to my question. Using only the information that you considered in preparing your report and nothing that you have learned since or done since, what opinion do you have regarding the effect of using interpolated data on your results?
A. It would not change anything.
Q. And why is that?
A. Because any trend that you can pick up in this data set has to fall within the full data set.
Q. So now let's turn back to the graph, and we're in the midst of your analysis of the M56D layer. And we're looking at this graph, and you've indicated that the green line is that initial estimate transferred to the semi-log plot, correct?
A. Yes.
Q. What is the permeability for the green line?
A. 125 millidarcies.
Q. And what did you conclude regarding that initial estimate provided by the software?
A. Well, since the upper from the model does not follow the data, then I know that this is poor estimate.
Q. And what did you do once you determined that that computer

generated estimate was too low?
A. For this type of data set here, this is a very long flow prior to the shut-in for the Buildup 4, so it's a very -- sort of -- there was a logical connection between permeability and the output there, so it's obvious that I have to increase the permeability to match the data.
Q. And ultimately, what permeability did you determine matched the data?
A. The purple line represents 500 millidarcies for this sand.
Q. And once you had determined that the purple line or the 500 millidarcies estimate matched the data points better for Buildup 4, which is the high rate buildup, what did you do next?
A. Then I would go on and verify that the -- this model also matches the pretest.
Q. And did you do that?
A. Yes.
Q. And so based on the analysis that we've just walked through, what did you conclude based -- for the permeability of the M56D layer?
A. My best estimate is this value of 500.
Q. Now, we've gone through all of the steps of your analysis and what -- we can go ahead and bring this demonstrative down -- what I didn't hear in your description of your analysis that we did hear from Dr. Gringarten was the use of de-convolution, so I want to talk for just a short moment about de-convolution. Are you

familiar with de-convolution?
A. Yes, this is a mathematical method I fully understand. I use it from time to time if I have a data set that really is appropriate.
Q. Did you use de-convolution in your analysis of the MDT data for the Macondo?
A. No.
Q. Why not?
A. No, because I don't have the initial pressure. If you don't have the initial pressure, you cannot use de-convolution based on data and, therefore, I don't do it.
Q. What did Dr. Gringarten use for the initial pressure if he didn't have a measured initial pressure?
A. He used the estimate from the pretest as input to the de-convolution.
Q. So he used his calculated value to get -- to put into his de-convolution?
A. Yes.
Q. Now, Dr. Gringarten testified in his direct that de-convolution is a more modern technique and, therefore, superior to your methodology. Do you agree with that conclusion?
A. It all depends on what type of data that you're looking at. I mean, for some data set this is a quick way to sampling that you can do also interactively with some experience; but, yeah, it's newer and for certain data sets I've used it -- I mean,

successfully used it for certain types, but not here, no.
Q. And not here because of the pressure issue that you just described?
A. Yeah, you don't have the key input.
Q. So let's now compare your estimate to Dr. Gringarten's estimate. Let's call up D-21713. Dr. Larsen, this is an excerpt from Dr. Gringarten's report, correct?
A. Yes.
Q. And we saw a similar plot like this in Dr. Gringarten's direct testimony; isn't that true?
A. Yeah, for the E upper sand.
Q. And that looked like a very good data match, right?
A. Yes.
Q. And that's the sand on which you and Dr. Gringarten largely agree?
A. Yes.
Q. Let's focus on the M56D. What values is he confirming or checking in this Horner plot?
A. This is his 110 millidarcies upward from the main trend, what he refers to as the main trend analysis.
Q. What is the value that he is looking at?
A. 110 millidarcies.
Q. And in your opinion is this a good match to the data?
A. No.
Q. Why not?

A. No, because it misses most of the data. These sort of the different levels of data that sort of stands out there on the screen, they are shifted by the resolution of the gauge roughly. There's .01, .02, depends on the type of resolution in the data, so they have been clustered at these steps.

So to honor the information in this buildup, you have to be sort of in the middle of the area part, you have to be in the middle of the middle part to have -- be in the middle or the end, and this particular model output does not honor that. It just sort of selects a -- sort of, you know, a trend stands out. But his analysis based on the average trend is more true to the data.

Q. And what was his analysis? What was the result of his analysis on the average trend?

A. That was 282 millidarcies.

Q. Now, let's focus for a moment on his final estimate for the M56D. That was 116 millidarcies, correct?

A. 116, yes.

Q. And in your opinion, would plotting a Horner plot using 116 match the data significantly better than this plot of 110?

A. No. On a scale like this, if you change 110 to 116, you would not be able to see it.

MS. HIMMELHOCH: Let's call up D-21714. This also is objected to.

MR. BOLES: That's right, your Honor, for the same reason. It's not in the report either in depiction or in discussion and substance.

MS. HIMMELHOCH: And I rely on the same segments.

THE COURT: All right. I'll let him go.

BY MS. HIMMELHOCH:

Q. Dr. Larsen, what does the line that's labeled "116" on this semi-log plot represent?

A. This -- what I've done here, I've taken the permeability 116, but that's an output from the Monte Carlo analysis. This is not one of his actually analysis, so I don't know exactly which vertical permeability to go with this number. But I just used the same ratio that he had for the 110. So that is using those same assumptions, and looking at what you get out of the single probe model, and that's this curve here and the diagonal curve (INDICATING).

Q. So it's using Dr. Gringarten's KvKh from his main trend analysis, yes?

A. Yes.

Q. And your probe model?

A. Yes.

Q. If you would use Dr. Gringarten's probe model as opposed to yours, would it significantly change the shape of the 116 millidarcies?

A. Not if you use a small wellbore radius so that you have a consistent in-flow area. The contact between the tube and the formation is similar, then there will be a slight difference in the very beginning, but not the rest.

Q. And what does the upper green line labeled "500 millidarcies" represent?

A. That's the 500 millidarcies from before just for reference.

Q. So once you compared your results to Dr. Gringarten's, did you change your conclusion that 500 millidarcies was the best estimate of the permeability for the M56D layer?

A. No.

Q. Now, Dr. Larsen, we've gone in very great detail and -- you can go ahead and bring this down -- we've gone in very great detail through your methodology for the M56D. To save the Court some time and hopefully finish today, I am just going to ask you: Did you use a similar analysis for the M56E lower layer?

A. Yes, I followed exactly the same steps.

Q. And using those steps, what did you conclude regarding the permeability of the M56E lower layer?

A. For the best estimate, I came up -- well, the same number also served quite well as the best estimate, sort of the middle, 500 millidarcies.

Q. Other than the graphs that you have drawn, are there any other reasons why you think 500 millidarcies is your best estimate for the M56E lower layer?

A. For these three data sets, the pretest sort of same, it's the same tool, same gauge, everything is the same, so if you just compare the output from the D sand, E upper, E lower, as soon as you have one, you have a pretty good handle on what the others are. And here, just by looking at the gauge problems, it's quite clear that the total -- I mean, the thickness times the permeability here has to be clearly higher than for the D sand, and we already know that it's thicker so that could explain it. But the permeability cannot be lower.

Q. So now that we've come up -- we've talked through your best estimates, I just want to talk about for the M56E lower and the M56D layers, did you try to attempt -- did you attempt to match any values other than 500 to the data?

A. I had to establish a range. I mean, how low can you go and still have any sort of match of your data and then do the same thing in the other direction, so to pinpoint what is possible range.

Q. And how low were you able to bring the permeability and still match your data?

A. For the D sand, I could do down to -- well, I went down to 250 millidarcies with the .3 KvKh ratio; so the ratio seemed high, but also the match was not that good. So I cannot really go much below 500 for that sand to have something that looks acceptable. But I can go up to 750 with less restriction because you can always compensate that then by reducing the KvKh ratio.

For the E lower, I had to go to isotropic formation to use 250 millidarcies and still had a poor match, so there, clearly, the permeability has to be, again, close to 500 or higher. And I

also tried 750 there to see how far up I could go.
Q. You used the word "isotropic," is that the same thing as having a KvKh ratio of one?
A. Yes.
Q. And the reason that you think that is unreasonable is the same reason you discussed earlier?
A. Yes.
Q. So wrapping up, based on the analysis you have presented here and in your report, what is your conclusion regarding Dr. Gringarten's estimate of the permeability of the Macondo reservoir?
A. It's underestimated.
Q. And in your opinion, what is your best estimate of the permeability of the Macondo reservoir?
A. It has to lie between four and 500 millidarcies or more likely slightly higher.
MS. HIMMELHOCH: Thank you. I have no further questions, your Honor.
THE COURT: All right. Mr. Boles, why don't we take our morning recess first.
MR. BOLES: All right. Thanks, your Honor.
THE COURT: We will come back in 15 minutes.
MS. MARTINEZ: All rise.
(WHEREUPON, A RECESS WAS TAKEN.)
(OPEN COURT.)

THE COURT: All right. Please be seated, everyone.

MR. YORK: Good morning, your Honor. Alan York for Halliburton and the Aligned Parties. One very brief preliminary matter.

I am happy to report that through conversations with BP, the Aligned Parties have reached an agreement with regard to redactions to the initial and rebuttal expert reports of Ed Ziegler, a source control expert. We're completing the actual technical redactions, and those will be submitted as part of the final marshaling conference. But in conjunction with that agreement, we're prepared to now offer the list of exhibits, callouts, and demonstratives used with Mr. Ziegler. The list has been circulated and has received no objection.

THE COURT: All right. Any remaining objections? Hearing none, those are admitted.

MR. BOLES: Good morning, your Honor, Martin Boles on behalf of BP and Anadarko. If I may begin?

THE COURT: Yes.

CROSS-EXAMINATION

BY MR. BOLES:

Q. Good morning, Dr. Larsen.

A. Good morning.

Q. My name is Martin Boles. We haven't had the pleasure of meeting yet.

I wanted to, mostly for the benefit of Judge Barbier, just go over sort of a few terminology things just to kind of make this more clear and efficient, so I put these two boards up in front of you. And this one on the right here in the gold and brown summarizes the different layers of the M56 reservoir. Let's begin with D-24739.

TECHNICAL OPERATOR: I don't have that.

MR. BOLES: All right. We'll just go with the board I have then.

BY MR. BOLES:

Q. So, Dr. Larsen, are you looking at D-24746 now, the board on the right there?

A. Yes.

Q. And you see, I'll point them out there, there's these three sublayers, if you call them that, of the M56 Macondo reservoir, correct?

A. Yes.

Q. And the top one is the M56D, right?

A. Yes.

Q. And you came up with a permeability analysis of that layer, correct?

A. Yes.

Q. And we've got your estimate there on the right-hand side and Dr. Gringarten's next to yours, correct?

A. Yes.

Q. And then the M56E you and Dr. Gringarten divided into two

sublayers and you have permeability estimates for each of those?
A. Yes.
Q. And then down at the bottom is the M56F. You did not do an analysis of the permeability of that layer; is that correct?
A. No, because an MDT was not run there, so I didn't have pressure data to work with.
Q. And just in terms of so we can speed this along, there's certain things, I believe, you were not analyzing or you were not offering opinions about that were within the scope of Dr. Gringarten's work, and I just want to confirm that.
He went beyond his MDT data analysis of permeability to use de-convolution and other methods to calculate Macondo incident flow rates. You're not offering an opinion on that, are you, sir?
A. No.
Q. Or on his cumulative production numbers?
A. No.
Q. And I think you said that, on your direct that you and Dr. Gringarten essentially agree on the permeability for the M56E upper, the one I am pointing to there (INDICATING); is that correct?
A. Yes, that's correct.
Q. And again, there is a lot of terminology in the documents and used in the direct, and will be on the cross-examination as well, with respect to the well test analysis methods that you and Dr. Gringarten used, so I just wanted to review those with you and

we put those on this board to your left. You used -- is it fair to say that your primary basis -- the primary method you used to estimate permeability for Macondo was a semi-log plot?
A. No, I always start from the log-log, from the log-log diagnostic, that's the standard approach. So I guess my initial estimate from the log-log derivatives and then I move on, if necessary, to improve on the analysis.
Q. So let's take a look at this board, then, because we will be coming back to this again and again. By log-log, that's also called the derivative plot; is that correct?
A. Well, a log-log in itself doesn't have to have derives included; but when you say, "log-log diagnostics" you normally assume that it's all there, both pressures and derives.
Q. And when you refer to using the log-log approach, you're trying -- you're using a derivative plot; is that correct?
A. Both.
Q. Okay. And when you look at the derivative plot, you look for the radial flow stabilization, where it flattens out to the right; is that correct?
A. Yes.
Q. And that's what tells you the permeability number?
A. Yeah, I mean, that's an estimate. It's a starting point. If you have high quality data that's very straightforward, then that might be -- you draw a lot of your conclusions right there and then. I mean, this is the easy way, but if you have more

challenging data, then you have to do more.
Q. And I know I heard you that say that a number of times that the methodology determines -- is determined -- the appropriateness of the methodology is determined by the quality of the data set, correct?
A. Yes.
Q. And, for example, you mentioned that the de-convolution method, you would have used it here if the data was appropriate, right?
A. If I had the data.
Q. And likewise, you criticize Dr. Gringarten for trying to derive permeability from primarily from the derivative plot or the log-log analysis because of the quality of data that was available from the MDT?
A. Yeah, you cannot conclude -- I mean, in the two, for the D sand and the lower sand, of course, he only came up with a range, and you had rectangle in there, but in there he indicated that's the radial flow stabilization uncertainty range, so it's very similar.
Q. I'm sorry, I didn't mean to cut you off.
A. It's very similar.
Q. But the uncertainty that you're talking about in your criticisms of Dr. Gringarten, the recurring theme in your report is that there's not enough data, and it's the quality of the data; isn't that true, Dr. Larsen?
A. Quality of the data, yes.
Q. So, for example, in page 4 -- let's look at page four of

TREX 12102R.004. The heading, "2.1 Uncertainties in the Data." And in the second sentence you say, "The data under consideration are very noisy and limited." Don't you, sir?

A. Yes.

Q. And likewise, in TREX 12102R.006, Section 2.3, your critique of Dr. Gringarten's methodology, the second paragraph, fourth line down, you say, "There are too few points for such algorithms to work properly," correct?

A. Yes.

Q. You're referring to the algorithm Dr. Gringarten is using?

A. I'm talking about the general. Some of these filtering algorithms, they require a lot of points to do the statistics properly.

Q. Is this a criticism of Dr. Gringarten or isn't it?

A. Yes.

Q. I am not going to go through every page, but you refer repeatedly to the -- to this idea of the limited amount and quality of the data from the MDT, correct?

A. Yes.

Q. And at the time you wrote this report, as you said on direct, you had made a mistake in sampling the data so that you only had one third of the available points, correct?

A. I did not sample the data. That was a file made available and apparently that came from BP.

Q. Well, are you talking about the LAS file?

A. Yes.

Q. Which was sampled every one second, correct?

A. Yes.

Q. But the file that actually got all of the data from the MDT was something called the DLIS file, correct?

A. Yes.

Q. And you had access to that?

A. Yeah. Normally do, but normally I don't use those.

Q. But the DLIS file with all of the data was made available to you?

A. Yes, that was there on the web site, yes.

Q. So when you did your analysis and you did your criticism of Dr. Gringarten, including these criticisms that his methods are not appropriate given the limitations of the data, you did not have the full data set?

A. I did not use the full data set, yes.

Q. And if you had known that there was three times as much data as you ended up having and using, you would have used that full amount of data for your analysis, correct?

A. Yeah. Normally, when you do a test like this or any test, you would first load all of the data and look, but normally we undersample more or less immediately when we go on to actually do the real work.

Q. Because you didn't have enough data points, because you only had one third of the data points that had been made available to

you in your analysis, most of the pressure points you took and analyzed were interpolated, correct?
A. Yes.
Q. And your belief in well test analysis is that, in general, interpolation should be avoided?
A. Well, what I said in the report is that you should not oversample by interpolation because then you put in linear trends in your data and they will sometimes show up in your derivatives with a special feature. That's different from the undersampling and interpolation. That's very different.
Q. It may be different from my question which is, you agree that interpolation should be avoided, correct?
A. Yes. But I said specifically in that context you should avoid oversampling with interpolation.
Q. That it's always better to take the data points themselves than an interpolation of the data points?
A. Yeah. Until you know. If you don't know, then you should, of course, work with real data, the actual data.
Q. Interpolation may hide things that may actually be in the data; isn't that correct?
A. Pardon me -- yes, yes, I remember.
Q. And interpolated data can introduce error into your analysis and conclusions, can't it?
A. That's possible.
Q. And you would not have used interpolation if you had realized

that you had access to the full data set from the MDT tool?
A. Now, here, since this is a fairly short test, I would probably not undersample. But I might have, so we probably just work with the full data set if I had it. But not adding anything or very little.
Q. Let me just ask my question again, Dr. Larsen. You would not have used interpolation of this data if you had known about and utilized the full data set that was made available to you from this MDT tool; isn't that right?
A. Yeah. If I had worked -- if I had used the full data set, then, by design, I would not interpolate; but since I am undersampling, then the interpolation there is not really doing much difference. If you're undersampling by picking every third point or 10 points and stuff like that that we normally do, then you pick data points. But when you're undersampling and more or less end up with interpolation as part of that, then it's -- that's very different.
Q. As of the time you wrote this report, Dr. Larsen, you did not know the effect on your -- well, first of all, you didn't know you had only used one third of the data points, correct?
A. Correct.
Q. And as of the time of your deposition, in any event, you did not know the affect on this analysis that you're presenting to the court of interpolating rather than using the full data?
A. No.

Q. Is that -- am I correct?

A. Yes. I did see there was some differences between the data that I used and those Dr. Gringarten used. But since he describes that he uses over two different -- at least, for the D sand, two different ways of smoothing the data, I thought it was some upward event.

Q. Now, in terms of the smoothing that Dr. Gringarten did, there are two kinds of smoothing in this kind of well test analysis to determine permeability, correct? There's smoothing of the original data and then there's smoothing of the derivative such as the derivative being shown in this -- on our illustrative board there; isn't that correct, sir?

A. That's correct.

Q. And smoothing of the derivative is standard in well test analysis, correct?

A. Yes. There are different algorithms but they're standard. Different softwares have slightly different approaches, but it's trying to do the same thing.

Q. Right. And, in fact, a smoothing is a default built into this kind of software that the industry uses, correct?

A. Yes.

Q. And Dr. Gringarten only smoothed the derivative, the industry standard practice, correct?

A. Yeah. But in his report, he describes the smoothing of data and illustrates what his smooth data looks like compared to the

original. So I had every reason to believe that he did that.
Q. But you don't -- at least, as of the time of the deposition, you didn't know whether Dr. Gringarten had smoothed the derivative, which is industry standard built into all of the software, or smoothed the original data; isn't that right?
A. That's right. But even now reading his report, I am not a hundred percent certain exactly, but it appears that he used -- he illustrated what the smooth data would look like compared to his data, but he didn't use the smooth data in his -- as they move forward. He just used it as an input to computing derivatives, which is the standard.
Q. It appears toy you, doesn't it, sir, that Dr. Gringarten did not smooth the original data?
A. Pardon?
Q. Doesn't it appear to you, sir, that Dr. Gringarten did not smooth the original data?
A. Even though he seemed to say the opposite, it appears that he did not.
Q. Now, Dr. Gringarten used the -- he used -- he started with the log-log or the derivative plot in his analysis; isn't that right?
A. Yes.
Q. And then he used the other type of analysis, a Horner plot which is a kind of a semi-log plot, as a verification of what he came up with in the derivative analysis; isn't that right?
A. Yes.

Q. Now, Dr. Larsen, is part of what you talk about in your report is that because of the nature of the MDT tool there is noise in the data, correct?
A. Yes.
Q. And I believe part of your opinion is that the signal to noise ratio or the ability to see through that noise and get something meaningful is, in part, a function of the mobility of the formation being studied?
A. Yeah. For the signal, yeah, as far as the signal.
Q. And you have a certain threshold that you've talked about that, a mobility above that might not have a reliable result from an MDT tool test and data for assessing permeability?

MS. HIMMELHOCH: Objection, your Honor. He is asking questions about a portion of his report that, at their objection, we chose not to offer. It was a supplement given at his deposition. So they're going beyond his four corners at this point.

MR. BOLES: That's right, I am. I am looking at the supplement. I am not aware that you've withdrawn the supplement that was given to us at the time of his deposition.

MS. HIMMELHOCH: We did not offer it into evidence because BP objected to it as improperly supplementing his report.

THE COURT: Well --

MR. BOLES: Can I just ask one question of either the witness or counsel?

THE COURT: Go ahead.

MR. BOLES: Are they taking the position that the mobility of the Macondo reservoir means that the MDT tool test cannot be reliably used as to permeability?

MS. HIMMELHOCH: I have no objection to his asking that question. I have an objection to his asking questions on the supplement that we did not offer because of BP's objection.

THE COURT: Why don't you ask the witness that question.

MR. BOLES: All right. Thank you.

BY MR. BOLES:

Q. There's no absolute rule that says that above a certain mobility you cannot use the MDT tool to determine permeability, correct, Dr. Larsen?

A. Yeah, those are just sort of indications that we use during the planning phase. You know, whether or not you can go ahead and try to do it.

Q. And then when you get the data, you look at the signal-to-noise ratio?

A. You look at the data, yes.

Q. Or at least as much of the data that you end up sampling, correct?

A. Yes.

Q. Now, you looked at the -- you did an analysis of the amount of noise in the MDT tool pressure and rate data to see if it could be used to come up with a permeability?

A. Meaning computing a number?
Q. Well, that is actually my point. Let me ask this: Do you criticize Dr. Gringarten for trying to use the MDT tool to calculate permeability because this data is just too noisy to do it?
A. Yeah. From the -- especially because he relied on the low rate buildup, then you are really pushing the limits of what you can reliably conclude.
Q. Now, were you pushing the limits when you used the same data or, at least one third of that data, to come up with your permeability estimates using the measurements from the MDT tool?
A. No, I used the higher rate buildups. And for the D sand that the rate there was 12 times higher, that is the same as actually improving the quality of the gauge by the same factor.
Q. So is the basis of your criticism, sir, that Dr. Gringarten didn't look at all of the buildups?
A. Yeah. When I refer to the problem with the data, is the part of the data that's been used.
Q. The problem of the substance of the data that you use or the totality of the data that Dr. Gringarten --
A. No, I mean the data from the buildups that have been looked up. That's the key.
Q. But, Dr. Larsen, Dr. Gringarten looked at all of the buildups, didn't he?
A. He did the same sort of overview-type approach that I had.

Q. In your view, is there a problem in Dr. Gringarten's analysis and its reliability because of the noise in the data he used?
A. Yeah, the noise is the source of the uncertainty and not using the higher rate buildups he is not -- yeah, I mean, that's the main problem.
Q. So just so it's clear because Judge Barbier will have Dr. Gringarten's report. It's the basis of your criticism is that Dr. Gringarten didn't analyze some or all of the buildups; is that right?
A. That's the main reason why we draw different conclusions as far as I can figure out.
Q. Now, did you analyze the noise in the data to see what kind of problems it could cause?
A. No, I don't do any type of analysis. I mean, it's just look at it. You see the scatter in the data and the slope, the underlying trend, I mean, that's what you're looking for.
Q. You didn't use the kind of quantitative or computerized analysis of noise that you would sometimes do on other projects here?
A. Not here, no.
Q. You just looked at it?
A. Yes.
Q. Now, you talked in your discussion in your direct examination about the way -- where the probe was that was lowered into the hole in order to sample the fluids in the Macondo and what kind of --

the word you used was a wellbore model. What kind of wellbore model should be used in analyzing permeability? Either a single probe model or the limited flow entry model. Do you remember that?

A. Yes.

Q. And you used the limited flow entry model, correct?

A. No, I used the single probe model.

Q. Okay. Thank you. You use the single probe model, Dr. Gringarten used the limited flow entry model?

A. Yes.

Q. And you don't -- that's not really a basis of your criticism of the permeability numbers that Dr. Gringarten has come up with, is it, sir?

A. No. Like I said, you have to also be able to match the flow part of your data, and that's where the two models really make a difference.

Q. Dr. Larsen, it's not your view that Dr. Gringarten should have used the your single probe model; isn't that correct?

A. Yes.

Q. Now, when you did your -- when you were looking at some of your plots, when you did your match of your semi-log plots, you determined the quality of the match. And let's step back a minute. The way you do this analysis, and Dr. Gringarten did the same thing, is you create a model of the reservoir; is that right?

A. Yes.

Q. So it's going to try and imitate or simulate the reservoir's behavior?

A. Yes.

Q. And you put some parameters into it?

A. Yes.

Q. And by the way, when we saw all of those demonstratives that I objected to, I don't know if we can call those up, but let's see if we can look at, for example, D-21710. Now, if I understood it correctly, Dr. Larsen, this purple line is based on your prediction of permeability?

A. Yes.

Q. And then we have this green line hanging way down here, right?

A. Yes.

Q. That's not made with Dr. Gringarten's model, is it?

A. No.

Q. And that's true of all of those spots like that where you show the green line way below the plot that fits the points, right?

A. Yes. But the question was raised through the direct, and I said that it would make a slight difference in the very beginning, otherwise they would track perfectly.

Q. But that -- the green line is not Dr. Gringarten's model, is it?

A. No, this is my initial estimate of 125 millidarcies.

Q. With your model?

A. Yeah. But the key thing is that the dimension of the model, if you use a small wellbore radius, I mean, very small, then I

indicated they would be similar. You can reproduce the same type of response. But it's very easy when you have a limited flow into the well to overlook this problem, and then you end up using an incorrect inner boundary area.
Q. Now, when you come up with your model, you -- your model generates this purple line, correct?
A. Yes.
Q. And then you see how well am I fitting the data points, correct?
A. Yeah. I'm looking at whether or not I can sort of track the test response, and I do that. I don't compute a sort of a number given the quality of the distance or root mean square or any things because it's scattered.
Q. And so if your purple line fits the points pretty well then you think you've got a good match, as they say, or good fit to the data?
A. Yes.
Q. And if there's a good fit to the data, then your model is confirmed and the permeability built into it is confirmed; is that right?
A. Yes.
Q. And this is, again, going over to our little taxonomies of methods here, this is the semi-log method. That's down here, right (INDICATING)?
A. Yes.

Q. And that semi-log because you've got a version of logarithmic time called superposition time on the horizontal axis?
A. Yes.
Q. But this is not logarithmic, right?
A. It's linear time -- I'm sorry, linear pressure.
Q. But that's semi-log, right?
A. Yes.
Q. And this is log-log?
A. Yes.
Q. Also known as the derivative plot, correct?
A. Like I said, you can -- when you say "log-log diagnostic," normally you think in terms of both. But the plot you have indicated here is just derivative. It's the same thing as a log-log plot. What you have on there you have to -- if you see the derivatives at the bottom, you can say it's a derivative plot, but here it's both.
Q. And when you assess the quality of your match to see if you've got the right permeability in this semi-log plot, you did that based on a visual analysis?
A. Yes.
Q. You often in your work outside of this case you use a computer to assess the quality of your matches, correct?
A. Yes.
Q. For this work you didn't do that?
A. I can't remember if I did the regression. Quite often you do.

It's just hit the button and do a regression on the model, but here I probably did not.

Q. Now, there was some discussion about this concept of KvKh. That's the ratio of vertical permeability going this way through the reservoir and horizontal permeability going that way through the reservoir, correct (INDICATING)?

A. Yes.

Q. Is that an important part of your analysis and your critique of Dr. Gringarten in this case?

A. It's an important input to the models. And I can't remember right off as somebody's -- for the D sand he did two models, and I think on both of that he had KvKh ratio of .277 or something. And that seemed to be on the high side, but it's not -- that's not the key point here really.

Q. Okay. If it's not the key point then, I'll move on. If that's not a basis of your criticism of Dr. Gringarten.

A. For the D sand he is -- I mean, it would not really have much of an impact on the -- you can put B off a little bit off your permeability if you go low, but some of the others, of course, you had a higher ratios.

Q. Do you criticize him for that?

A. I cannot remember directly if I made a direct reference to his choice of this ratio compared to mine. I can't remember.

Q. You don't have any measurement based evidence of what the true Kv over Kh ratio is; isn't that correct, Dr. Larsen?

A. That's not possible to get. You normally would do a test like this just to get that number, but then you would have to do a little more -- a little bit more careful than was done here. But it's very difficult to get that dynamic KvKh ratio without running a test that is specifically designed for this purpose.
Q. Can we go back to that last demonstrative again? In terms of these matching of your purple model to the points that's part of your determination or estimate of permeability, there are other matches, other curves that could have been drawn that would also visually match the data; isn't that right?
A. It depends on how much you change. I mean, here you can move up in permeability and at the same time go down in KvKh ratio. It depends on the length. But you cannot move that far off the main sort of trend here without noticing it.
Q. Let's take a look, let's walk through some of those then. Let's look at TREX 12102R.6.1. Now, we're going to start with M56D, Dr. Larsen, right here, this top row, right (INDICATING)?
A. Yeah, the yellow, yes.
Q. You've got -- Dr. Gringarten has 116 millidarcies permeability and you've got 500, right?
A. Yes.
Q. So let's take a look at Figure 5 in your report, TREX 12102R.13.2. So this is your plot for Buildup 4 for the M56D, correct?
A. Yes.

Q. And again, your model is the green line, right?
A. Yes.
Q. Now the top green line -- you're applying two things if I understand it, the top green line is that just raw pressure?
A. This is the pressure change from the last flowing point before the shut-in and then afterwards, and this is what Dr. Gringarten referred to as the signal.
Q. And this, the lower green line generated by your model, is that the derivative?
A. Yes.
Q. And these red dots, that's the actual derivative data, correct?
A. Yeah. Of my data set, yes, with my software.
Q. Now I am going to go to the more simplified version, generic version of the derivative plot. What you look for is where that derivative plot flattens out, correct? That's called the radial flow stabilization?
A. Yes.
Q. And if your model gets a match and flattens out with a good fit to those points, then that tells you what the permeability is, doesn't it?
A. It might.
Q. Well, isn't that the standard way of doing it, sir?
A. Yeah, but you always have to verify.
Q. Okay.
A. And of course -- that's Dr. Gringarten also did that.

Q. Right, he verified --
A. Normally, yeah. If there's limited noise and it really stands out clearly like this and is consistent with your model, that is it never soft, stays constant. I would be surprised if it didn't really do the job.
Q. I wasn't intending to leave out Dr. Gringarten's verifications, let's go through that. He verified the derivative permeability first of all with a semi-log plot; is that right?
A. Yes.
Q. And then he also did the de-convolution, right?
A. By going back to the semi-log he doesn't verify a number, he had an upper and a lower, and he said both --
Q. He takes into account an uncertainty range?
A. Yes. He doesn't have a unique match, but he said he can match sort of paying attention to part of the data for this once case and then he can pay attention to other parts of the data for the other case, so there's no uniqueness.
Q. Well, we'll -- Dr. Gringarten's already testified his matches are in his report, I want to talk about your matches now.
A. Okay.
Q. So the radial flow stabilization, as you've -- in your model it's happening down here right at this just, so happens it's this dark, black horizontal line that goes over to 0.01 on the vertical axis, correct?
A. Well, okay. It doesn't go over to, I mean it's just a value,

it's a number, and it's showed across the screen, yes.
Q. But that's what you approximated when we talked to you last time, that's what you approximated the radial flow stabilization would be right about 0.01 as indicated by your model, correct?
A. That's correct.
Q. Now, if there was another model of the reservoir and it showed a radial flow stabilization higher, let's say going right through the middle of those red points, the actual data, that would be a different radial flow stabilization, wouldn't it?
A. Yes.
Q. And in the topsy-turvy world that we've seen here in this case, a higher radial flow stabilization means a lower permeability, correct?
A. Yes. I already showed that it's not possible for this data set. I mean, the derivative is fine, but the derivatives here are not capable of picking out what's going on.
Q. You could, in fact, match this data, this actual derivative data with a model having a lower permeability, couldn't you?
A. On this plot, yes.
Q. This is your plot, correct?
A. Yeah. I mean, on the log-log plot, you can do that, but you would quickly see there was something wrong if you moved on to try and verify on the semi-log.
Q. And this, in fact, would even be -- this cluster of data points could even be consistent with a permeability of 100 millidarcies?

A. On the log-log plot, yes. But you couldn't verify it.
Q. Let's take a look at -- let's look at -- I am going to skip the upper, the E upper since we have a substantial agreement, I guess, or reasonable agreement, according to your testimony, between you and Dr. Gringarten.
So let's go to the lower M56E, where Dr. Gringarten's got an average value of 285 millidarcies and you have 500 millidarcies. Let's take a look at TREX 12102R.6.1. Let's look at the plot which is TREX 12102R57.1. Again, this is your model, right, sir, this kind of greenish-blue line in Figure 63 from your report?
A. Yes.
Q. And these red dots are the actual derivative data; is that right?
A. Yes.
Q. And if a radial flow stabilization were found by a different model to go right through the middle of those points, that would be a lower permeability, wouldn't it?
A. Yes. But you have to verify by looking at the data, not on the derivatives. The derivatives is just a guide.
Q. Well, the derivative is the standard approach in well test analysis for determining permeability, isn't it, sir?
A. Only if it works.
Q. But it is the standard approach in well test analysis for determining permeability?
A. Yes, if it works. I mean, if it can reproduce the

characteristics of your pressure response then, yes, that's the easy way, quick way to move forward. But you have to verify it.
Q. You were asked about -- you testified about -- I think I've already covered that. I'll withdraw that and start over.
I want to go back to this document that we keep seeing in this case, the BP post drill subsurface technical memorandum that you were shown in your direct examination. Let's look at a chart that you reviewed as part of your analysis in this case at the end of that document, TREX 3533.36.2. Do you remember seeing this, sir?
A. Yes.
Q. And this is permeability measurements on drill cores?
A. Yes.
Q. The rotary sidewall cores?
A. Yes.
Q. And these last two columns are the permeability numbers, right?
A. Yeah, the two to the right.
Q. And one says arithmetic air permeability, correct?
A. Yes.
Q. One says geometric air permeability, right?
A. Yes.
Q. And let's go to the bottom three rows, let's see, that's the Macondo reservoir, right, that I am circling in green, M56D, E and F?
A. Yes.

Q. And the thick ones, the ones you've concentrated on, are the D and the E, right? That's the ones you've done permeability for?
A. The E here is combined for the upper and the lower as one unit.
Q. That's right. Now, if you look -- if we go over -- and can we just highlight D and E, please. That was the right shot. So let's just look at the D and E layers, the permeability goes from about, rounding off here, 250 millidarcies to about 500 millidarcies, correct?
A. Yes.
Q. And that is an air permeability, isn't it, sir?
A. Yes.
Q. And the oil permeability would be lower than that, wouldn't it?
A. Yes.

MR. BOLES: That's all I have. Thank you.

THE COURT: Any redirect?

MS. HIMMELHOCH: No redirect, your Honor.

THE COURT: Okay. Thank you, sir. Thank you for your time.

Okay. The government can call its next witness.

MS. HARVEY: Judy Harvey for the United States. We'll call Dr. Jean-Claude Roegiers.

THE DEPUTY CLERK: If you'll raise your right hand.

(WHEREUPON, JEAN-CLAUDE ROEGIERS, WAS SWORN IN AND TESTIFIED AS FOLLOWS:)

THE DEPUTY CLERK: If you'll come around and take a seat.

And if you'll state and spell your name for the record.

THE WITNESS: Jean-Claude, J-E-A-N hyphen C-L-A-U-D-E, Roegiers, R-O-E-G-I-E-R-S.

MS. HARVEY: Your Honor, may it please the Court, Judy Harvey on behalf of the United States.

VOIR DIRE EXAMINATION

BY MS. HARVEY:

Q. Dr. Roegiers, what is the subject of your expert opinion in this case?

A. Geomechanics.

Q. I'm sorry, the subject of the opinion that you reached in this case.

A. I have been reviewing the -- provided a rebuttal to the report from Professor Zimmerman regarding the interpretation of the UPVC for the Macondo well.

Q. And by UPVC, do you mean the uniaxial core volume compressibility?

A. Correct.

Q. Let's pull up, please, TREX 011698R. And is this a copy of the rebuttal report you prepared?

A. Yes.

Q. And do you adopt that report as your testimony today?

A. Yes.

Q. Dr. Roegiers, what is your area of expertise?

A. Geomechanics, especially experimental geomechanics where I have lots of experience, and also applied geomechanics or rock mechanics.

Q. Let's please pull up D-21305 to discuss your educational background and work experience. Dr. Roegiers, can you please summarize your educational background for the Court?

A. Yes, I obtained a civil engineering degree at the Universite de Liege in Belgium in 1969, followed by a Ph.D. at the University of Minnesota in geomechanics.

Q. And working forward to the closest in time period, can you please summarize your employment history?

A. Upon completion of Ph.D., I was hired by Los Alamos Scientific Lab in Los Alamos, New Mexico to work on the dry rock project, which was an injection of cold water and retrieval of steam for energy purposes. I was in charge of starting a rock mechanics lab for this project, geothermal energy project.

After that I was called to join the University of Toronto, where I started a program in geomechanics, but this time applied to the civil engineering, which would mean essentially underground openings, slopes ability, dam foundations. After that, I went to Dowell Schlumberger, later on it became bought by Schlumberger in Tulsa, Oklahoma in the research area where I got the leadership of the rock and fluid mechanics research, and that was my first approach to the petroleum industry. I started their lab for problems that you might solve from research point of view.

And then more recently, since 1988, I accepted chair, McCasland Chair at the University of Oklahoma in petroleum and geological engineering where I retired from as an emeritus a little bit more than three years ago. Again, started a lab and do research and applied on petroleum engineering side.

Q. And can we, please, turn now D-21306. And, Dr. Roegiers, over the course of your career, about how many rock mechanics labs were you involved in starting?

A. I started nationally and internationally seven rock mechanics. The ones that I've mentioned before, plus internationally a rock mechanics lab in Venezuela for Pervesa (PHONETIC); a rock mechanics lab in Japan, in Waikiki for nuclear waste repository and subsidence; and a rock mechanics lab in Germany for the transit administration using fracturing.

I have supervised an enormous amount of projects around the world in my consulting, and some of them were in the Gulf of Mexico. But I worked around the world.

Q. And, Dr. Roegiers, during your work in the laboratories that you started, were you involved in developing procedures for rock mechanics tests?

A. Obviously, because, you know, when I start the lab, you have to buy some equipment, and each equipment has different capabilities that specifically we had to develop some procedure for that particular equipment to run the tests.

Q. And in terms of the tests that you helped develop procedures for, did that include a UPVC tests?

A. Yes.
Q. And can you please summarize some of the focus of your consulting work that you've done over the course of your 44 years of experience?
A. Well, I've been involved in consulting work ever since I was a grad student in different areas. In the petroleum more specifically, I was involved with major -- most major oil companies nationally and international and also in the service companies. And my areas have been essentially -- my specialty has been trying to understand strange behavior of reservoirs.
Q. And let's turn to D-21307 to discuss your publications and some of your awards. Dr. Roegiers, can you please summarize for the Court some of the publications you've had over the course of your career?
A. I've published over 230 papers which I either published in technical journals or in symposium conferences that have a broad scope of my expertise, including bore stability, thermo-poroelasticity, in-situ stress measurements, very more recently gas yeilds, fracking as you call it here, and also spent quite a bit of time recently in temperature fix by looking at the high pressure/high temperature reservoirs.
Q. And, Dr. Roegiers, can you please tell the Court about some of the recognitions you've received over the course of your career.
A. I received quite a bit of recognition, of which I only mention here the four ones that I am proud of, or the proudest of the four.

I was recently, three years ago, became a Fellow for the American Rock Mechanics Association. Before that, I became nominated by the State of Oklahoma as most eminent scholar. I am honorary professor in two universities in China. And last, but not least, I received International Francqui Chair, and that involves all of the disciplines including medicine in Europe.

MS. HARVEY: Your Honor, at this time I would like to tender Dr. Jean Claude Roegiers as an expert in geomechanics, and move in his expert report TREX 11698, subject to objection, pending objections from BP into evidence. Dr. Roegiers' CV is included in his report, along with a list of materials he considered in forming his opinions. There are no *Daubert* motions that have been filed with respect to Dr. Roegiers.

THE COURT: Mr. Fields.

MR. FIELDS: Thank you, your Honor. Barry Fields on behalf of BP. We will reserve questions for Dr. Roegiers on cross-examination. And with respect to the issue on the expert report, obviously we will work with the parties, the U.S. to resolve any issue.

THE COURT: Right. With that understanding I will accept him as an expert in that field. And we will introduce his report after the redaction, any necessary redactions are agreed upon.

MS. HARVEY: Just for clarification, there's only about from Dr. Roegiers' report one page or paragraph.

THE COURT: Okay, fine.

DIRECT EXAMINATION

BY MS. HARVEY:

Q. Dr. Roegiers, when did you start work on the Macondo Project?

A. In May of this year.

Q. And what were you asked to do?

A. I was asked to review the reports from Dr. Zimmerman and the Weatherford reports, essentially doing two things, review the computation of how the number that, interpretation was made by Professor Zimmerman; and also to review at the same time the standard testing procedure that were followed to obtain these numbers.

Q. And let's pull up D-21309. And, Dr. Roegiers, can you please summarize your key opinions in rebuttal to Dr. Zimmerman?

A. Yes. My key opinions essentially, number one, are that the UPVC data generated by Weatherford from rotary sidewall cores cannot be used to generate reliable estimates for the Macondo reservoir, that's number one.

Number two, that the two other tests that were carried out, one which is referred to as a "stairstep" hydrostatic test and the other one is the ultrasonic velocity measurements are indirect methods and therefore you cannot use them to validate the UPVC data to obtain the number one.

Q. Can now we, please, turn to D-21310. Dr. Roegiers, can you please tell me why it's your opinion that the lab data here cannot be used to generate a reliable and representative estimate of UPVC

for the Macondo reservoir?
A. Yes. We have to realize that the data was generated using rotary sidewall cores that cannot be used to obtain reliable data for two reasons: Number one, as you will see, the poor recovery of the core and the sample condition were not representative at all; then the Weatherford's testing in the lab was flawed on the sidewall cores and, therefore, yield very unreliable results.
Q. And let's begin with the discussion of the core recovery and sample condition issues you just raised. Can you please provide the Court with an overview of the core recovery that happened with respect to the Macondo well?
A. Yes. This is based on document that was an inventory of the cores that were retrieved. In this inventory there's about 44 cores retrieved. From those 44 cores when you look at the inventory only about 29 of them showed some distress.
Q. And we can pull up, please, TREX 01510. And we'll actually go to the TREX 011510.2.2.US. Dr. Roegiers, is this the sample inventory you just referred to?
A. Yes. This is the report of the core inventory provided by Weatherford, they generated that when they received the cores. On the left side column, right there (INDICATING), are the 44 cores. And if you go to the fifth column here, it's visual inspection and you will see all of the ones that are outlined in yellow have been rejected either due to they were rubblized or refractured --
THE COURT: What was what word you used?

THE WITNESS: Rubblized, rubble.

THE COURT: Rubberized.

THE WITNESS: Yes.

THE COURT: Oh, okay.

THE WITNESS: R-U-B --

THE COURT: Like a rubber band?

THE WITNESS: Exactly. Pieces. So that only not even half of them have cylindrical shape that can be used for rock mechanics testing.

BY MS. HARVEY:

Q. And just to be clear, I believe your Honor heard rubber, and did you rubble?

A. No, no, no, rubble. I'm sorry.

THE COURT: Then I did mishear it. So it's not rubber, rubber band?

THE WITNESS: No, rubblized.

THE COURT: Like rubble, broken up.

THE WITNESS: Many pieces.

THE COURT: I got it, okay.

BY MS. HARVEY:

Q. And just to be clear, you also added highlights to show which of the pieces you saw couldn't be used for this rock mechanics tests that were done here because they were fractured or rubble, you added those highlights?

A. Can you repeat?

Q. Sorry. Just to be clear for the Court, with respect to the highlighting that is shown here, that was highlighting that you did to illustrate that the pieces, the samples that were fractured --
A. Yes, yes, the pieces you could not use.
Q. And some of them under sample condition there's the notation CYL, what is that?
A. Cylindrical. In other words, you need to have a cylindrical specimen, decent specimen to be able to do some tests in geomechanics.
Q. And could the condition of the samples we have here have an impact on whether the tested samples are representative of the reservoir?
A. Yes. Obviously you end up with the most strong specimen that you're going to bias the numbers right away from the start.
Q. And bias them in a particular direction?
A. Well, yes. What's happening is that since you have the strongest ones you're going to underestimate the compressibility.
Q. In the course of your work on this case, did you review any commentary regarding the cores that were recovered for the Macondo well?
A. Yes. I recollect there were about three internal e-mails from Weatherford that written by Loos, that lady that you saw on the television a few days ago --
Q. And we can pull up now --
A. Can you pull up it?

Q. Yes, we can pull up TREX 008794.1.1.US. Dr. Roegiers, is this the e-mail you were just referring to in your testimony?
A. Yes, those are the three e-mails started with from Loos --
Q. Do you know who Ms. Loos is?
A. Yes, she works at Weatherford and I believe she is one of the senior -- two days ago, she is one of the managers of properties including the rock mechanics.
But look at the wording there, she said she looked at the cores and said they were really ugly. And her response --
THE COURT: Can you blow that up, the part, whatever parts he is referring to because it's hard to read?
THE WITNESS: See, they are really ugly.
Go to the next one. There was only one disagreement this time. This time they are iffy. I don't know what the difference between ugly and iffy is.
And then it says also here, "hope we can get some useful data."
And last one. The top one. "This won't give us much to work with." In other words, they are questioning really if the data are going to be able to be produced, that it's very poor and ugly cores that the data will be valuable.
MS. HARVEY: Thank you.
THE COURT: Just to be clear, these were all, these 44 I think you said samples?
THE WITNESS: Yeah, it was a total of 44 samples taken

out of about more than half of them had to be rejected.

THE COURT: Right, I understand that. But all of these were -- these were samples taken before the blowout?

THE WITNESS: Yes.

THE COURT: But they analyzed afterwards?

THE WITNESS: Correct. Correct, your Honor.

THE COURT: Okay. Thank you. Go ahead.

BY MS. HARVEY:

Q. Thank you. We can pull that down.

Before we turn to your critique of the testing procedure conducted by Weatherford, can you just please provide the Court with an overview of how a UPVC test is conducted?

A. Yes. As we've seen this very good animation from Professor Zimmerman a couple of days ago, the way you conduct a UPVC test is you take a core --

Q. Wait. And, Dr. Roegiers, what are you holding in your hand? Is that something you brought to assist in your explanation?

A. Just a core to later on discuss some of the implications. But I just want to show how you do a UPVC test.

You take a core and then you apply a certain loads on top of the core and what does that going to do is going to shorten the rock. At the same time it's going to expand the rock. And a UPVC test is a special test because what you do, you do not allow the lateral displacement to occur because you want to mimic what's happening in the reservoir in the field. In order to do that, you apply a certain confining pressure. So what is happening is that you have a load that's applied there, and also because you don't want any displacement, a lateral confining pressure. Well, that is the characteristics of a triaxial test.

Q. And what is a triaxial test?

A. Triaxial test is essentially by definition a test where you a normal load and two equal lateral loads. The definition can be found in Professor Zimmerman's book actually in Chapter 6.

So you have a triaxial test, which means for me that you can consider UPVC test as a special case of a triaxial test, which means also that everything that are regulations to run triaxial test have to be followed.

Q. Thank you. So let's turn to your critique of the specific procedures that were followed here, and call up please D-21311.1.

And, Dr. Roegiers, does this table summarize the opinions contained in your report and your opinions in this case regarding your concerns with the Weatherford test procedures and the possible effect those concerns had on the reliability of the Weatherford data?

A. Yes. I listed here on the first column what I would, what I would call the best practices that should have been followed. That's my opinion. On the second column I show what was done on the Macondo by Weatherford. And then I tried to, since there was differences I tried to say what kind of importance are the differences here, and in most cases it's underpredicted

compressibility by ignoring the best practice; or if some cases if I didn't know if it was going underpredict or overpredict, I said increases uncertainty.
Q. And what is the source of the best practices that you list here?
A. Well, obviously my 44 years of experience is one of them. And also, the International Society of Rock Mechanics has decided to form a small commission working group to come up with some numbers and some protocol for the UPVC. And I had the privy to see the first working I would say proposals, not the final one, they are working on that. And that should be finished, finalized within the next two years.
Q. And can we please call up TREX 011508. And is this the proposal, the ISRM proposal you were referring to?
A. Yes. In order to have the blessing from the International Society of Rock Mechanics, a group of people wrote a proposal to establish a working group. That proposal is being accepted and the working group is working.
Q. It says here, "uniaxial strain compressibility testing".
A. That's the same UPVC, you have uniaxial strain, we'll talk about that a little bit later how important that is.
Q. And let's go back, please, to D-21311.2 to discuss the first issue you list regarding Weatherford's test procedure. The dimensions and size of the UPVC samples that were tested here. And let's go to .2, please. Just the 21311 and instead of .1, .2.

If you could please summarize your opinion with respect to the potential impact of sample dimensions on the reliability of the Weatherford test results?
A. Yes. In general I think universally worldwide we expect to have a two to one length to diameter ratio to the testing. Actually, for the triaxial test, Professor Zimmerman treat his dimension with the same number he agreed with us; two to one, even three to one.
Q. And what do you mean by length to diameter ratio?
A. As it says, the length is twice the diameter.
Q. Of the testing core?
A. Of the testing core.
Q. And here what happens with respect to the Macondo core?
A. Due to the fact that you had very poor core recovery and also the geometry, the best cores they could have show an L over D of 1.1 to 1.2 ratio. And this underpredicts definitely the compressibility and invalidates the UPVC. I think I have a sketch on that.
Q. Yes. Let's please go to TREX 11698R.24.1.US. And this is a diagram from your report, correct?
A. Yes.
Q. And can you explain to the court what is happening here?
A. Let me make it clear here. Okay. On the left side is my core, let's say a two to one core. And the loads are applied by steel platens on the top and on the bottom. When you apply a load, as I

said just before, you will shorten the core but that you also try to expand.

What's happening here is the expansion occurs in the core but also in the steel due to what we call Poisson's ratio. Now, what's happening there, and due to the fact that the steel also expand differently than the rock core, you create friction at the interfaces right here, here too (INDICATING). Those friction at interfaces will essentially restrain this core and create what they call here friction cones. Okay. So that you have two zones where the stress is lot more uniform strain but you have traction state of stress on both sides and you only have small amount of area here where you have uniaxial strain.

Q. Why is it important to have uniaxial strain condition?

A. Because that's a better definition what you want to mimic in the reservoir.

Now what's happening here, you can see the end effect -- we call this end effect -- end effects we create here two cones which are essentially intact, and you can very realize if I start to reduce the length of the core those two cones come close to each other and you don't have any zone anymore for uniform strain. That's why this test that if you don't have two to one should be rejected completely, you don't know what the stress conditions are.

Q. And in your work have you ever investigated the impact of length to diameter ratios and size effects in rock mechanics testing?

A. Yes. In the beginning when I was a grad student at the University of Minnesota we did, we had a very large project where we had to look at size effects, which means that we started to plot effects of strains or other properties related to compressibility; not directly compressibility but related to. And where we would plot N over D as a function of a certain property, and we found out that all of the time when you start to have two to one or even two to one and three to one, you didn't have anymore side effect. That work was carried out over a period of three years, and an enormous amount of publications by two other people.
Q. And, Dr. Roegiers, what is your opinion about the effect that having a length to diameter ratio of 1.2 as we had here with the three UPVC samples, as opposed to your recommendation of two to one, what effect would that have on the reliability of the test results?
A. Well, as I just explained, what's happening is that this friction cones make this core stronger, therefore, if you run at the small length diameter issue you would underpredict the compressibility.
Q. And please call you up D-21311.3 to move on to your next opinion regarding whole core samples and test direction.
Dr. Roegiers, can you please summarize your opinion with respect to these issues?
A. Yes. What's happening here is the cores or the tests were run on sidewall cores. Sidewall cores have complete different problem.

Number one, it's in a direction that does not mimic the field conditions; in other words, you take a core on the side and you don't mimic the condition of vertical. You don't have this issue, you don't have this problem with the whole core because the whole core takes essentially the diameter of the hole itself and you can take plugs in different orientations.

So that they have measured the compressibility in the direction that is 90 degrees from what it should have been and that is definitely an underprediction of compressibility because the ones that are -- when you test parallel or let's say if take a sidewall core it's going to be stiffer than a vertical core.

Q. And in your work when you're trying to characterize formation properties such as rock compressibility, does it matter to you what type of core you use?

A. Yes. When I want to determine the characteristics of the rock itself, I like a whole core because, number one, it is longer, it's usually 30 feet long so I can select where I want to take my cores and I can do the test in his different orientation and answer the question that was raised by Professor Zimmerman yesterday that and I saw to be so important.

THE COURT: Let me ask a couple of questions. Doctor, what would be the reason why a company would take these sidewall cores if they're not as usable or reliable?

THE WITNESS: Okay. Sidewall cores are useful, but they are useful for two other purposes: Number one, to check how well the geophysicist interpreted the logs; number two, to check the geologies to see if where he predicted the hydrocarbons were are there, are they really there.

So as far as I'm concerned, that's why I like sidewall cores for that purpose. I don't like sidewall cores at all for testing and coming up with properties that you're going to effect and use for the design itself.

THE COURT: Okay.

BY MS. HARVEY:

Q. Dr. Roegiers, do you know if anyone in the industry shares your view that sidewall cores are not as reliable as whole cores for purposes of estimating formation properties across a reservoir?

A. Yes, I think quite a few people share that information based on my contacts that I have had.

But what was interesting is that I was in charge of the Rock Mechanics Institute for about 15 years at the University of Oklahoma, which is an institute that is funded by industry, about 15 companies. And we would discuss twice a year some findings --

MR. FIELDS: Excuse me, your Honor, this is outside the four corners of his report.

MS. HARVEY: This is discussing his, the basis for his opinion of why sidewall cores are less reliable than whole cores for purposes of estimating compressibility. It's the entire scope of his opinion.

THE COURT: I'll overrule the objection. Go ahead.

THE WITNESS: Can I respond?

MS. HARVEY: Yes.

THE WITNESS: Okay. So that's what's happening is that it prompted the discussions over coffee or beer in the evening where we talk about --

MR. FIELDS: Okay, that's hearsay, your Honor.

MS. HARVEY: He can rely on hearsay as an expert.

MR. FIELDS: He can rely on hearsay --

THE COURT: Overrule the objection.

THE WITNESS: So we had discussions about the usefulness or the non-usefulness of sidewall cores to determine. If you want some specific names that I have talked about that I can recollect, Sid Green which was the owner and president of Terra Tek which is probably the golden lab in rock mechanics. And then there were some people like Professor Ye or Dr. Ye from ExxonMobil, we had discussions about that.

We never really researched it because it was too obvious that there was no need to research it further.

MS. HARVEY: Thank you, Dr. Roegiers.

BY MS. HARVEY:

Q. Now let's pull up your -- actually, sorry. Do you have any personal experience in your work comparing the results of sidewall cores to whole cores from the same reservoir?

MR. FIELDS: Your Honor, this is clearly outside the scope of his report. He in no way mentions anything about his experience in comparing sidewall cores to whole cores. This is a direct violation of the court's order regarding what information should be disclosed at court versus in the report.

MS. HARVEY: Your Honor, this is a matter that was explored at the deposition and Dr. Roegiers talked about this experience --

THE COURT: Is it in his report is the question?

MS. HARVEY: The actual discussion or the data that he cited was not in his report.

THE COURT: I sustain the objection.

MS. HARVEY: Thank you.

BY MS. HARVEY:

Q. Now let's pull up -- have you prepared anything to assist the Court in explaining the differences between whole cores and sidewall cores in terms of how the core's oriented in the reservoir?

A. Yes, I have an animation.

Q. Let's pull up D-22202.

A. Here is the representation of a core that would be taken from whole core in the right direction that you pressurize it with a load on the top and then you have a certain stiffness of that spring is very small, you don't have lots of space. So that mimics essentially what's happening to the reservoir itself.

Q. And this is just to be clear, this is when you are testing in the vertical direction?

A. It's a vertical direction just like mimicking the reservoir.
Q. Let's move onto the next slide, please.
A. If I turn this on the side, which would mimic what's happening in a sidewall core, here it is, you have much less axial space because you have a material that is much stiffer than it is.
Q. And when you're trying to determine whether -- the difference in results that you get in changing the orientation of the core, is that also called anisotropy?
A. Yes, anisotropy in stresses; you get also anisotropy due to layering. And actually if you want, I took with me two samples to show whoever wants to have a look. Your Honor, if you would like to have a look at it.
This is sandstone --
Q. Let's pull up D-22838.
A. Okay.
Q. This is just a larger picture of the cores that Dr. Roegiers has brought with him. And if the Court would like to see them closer he can.
A. Okay. Those are sandstone cores they are a little bit different than the Macondo, they are consolidated and they contain some layering. And they are also diameter to length ratio of one to two.
On the left side -- they were taken of the whole core of the same formation. On the right side, the one depicted "V" is the one that should have been tested, the orientation it comes from a

whole core and it's going be to give you a lower compressibility. On the left side is the one that is imagine a sidewall core that I've taken out on the side and put it on the vertical direction, and now if I load this, it would be much different.

MR. FIELDS: Your Honor, this, again, is an issue that is not within his report, and so we're going and we're continuing to put information into the record that is not within the four corners of his report.

MS. HARVEY: Your Honor, if we can please, on page 10 of his report, Dr. Roegiers has a depiction from one of BP's memos that the Court saw several days ago with respect to Dr. Zimmerman of two different cores, and the cores have the bedding planes in one lane versus another lane. This is basically just showing --

THE COURT: Okay. I am going to let him testify about it. This seems to be similar to putting the diagram up and illustrating the difference between the orientations of the layers. So overrule the objection.

You're illustrating what would be represented by a side core versus a vertical core?

THE WITNESS: Yes. But now, this is different, those are both taken from a whole core within two different directions.

THE COURT: So you took the side core in this case was taken from a whole core?

THE WITNESS: Yes.

THE COURT: One taken --

THE WITNESS: One like that -- exactly.

THE COURT: -- one taken from the side or horizontally and one taken vertically?

THE WITNESS: Yes. And if you want to take a look at it, if you please.

THE COURT: They kind of look like a wine cork. I guess they wouldn't work for that, would they?

BY MS. HARVEY:

Q. Dr. Roegiers, are those cores approximately the same size of the cores that --

A. No, those are two to one, those are cores that should be accepted.

THE COURT: Let me see those.

THE WITNESS: You can have them if you want to.

THE COURT: No, I prefer the screw tops.

BY MS. HARVEY:

Q. So Dr. Roegiers, you're saying how the size is different as far as what was tested for at Macondo?

A. Yeah, two to one.

Q. Those cores are two to one?

A. Yes.

Q. And the Macondo cores were?

A. One to one, essentially half of them.

Q. Did you see any evidence with respect to the Macondo cores of this, of the layering that is illustrated in the demonstrative?

A. Yes. There is definitely some what we call anisotropy due to layering that occurs in the Macondo reservoir, and it was seen visually and also from CT scans.
Q. And let's pull up TREX 011523.2.2.US. And, Dr. Roegiers, is this a CT scan of one of the cores tested for UPVC?
A. That's a CT scan of one of the cores, actually one that was used I believe for the UPVC. In the scan different layers are different gray shades. I don't know if you can see this very well.
But here you can see different layers. You can even see it better in a cross-section. Go ahead, here. You can see the layering right there, layering right there (INDICATING).
Q. Is the layering indicated by different levels of lightness and darkness?
A. Yes.
Q. Based on the evidence you've reviewed in this case with respect to the laminations, can you discount the possible effect of anisotropy on your compressibility results?
A. Yes, because as I said before, if I am going to test something like this with layering in the core in that direction, which is a sidewall core, that's going to be much stiffer than the one that is going to be tested with layering like this (DEMONSTRATING).
Now, I need to make a comment because last time at the deposition there was a mentioning that 94 or 95 percent of the composition of the core is quartz and you have only maybe five percent the rest. That doesn't make any difference at all because

what they call the weakest link theory which means that the weakest link, the weakest element controls the deformations. And I believe I have a display for that.

Q. Do you want to go back to demonstrative D-22202. And it will be the third of the series.

A. It's just an analogy that I want to make people understand about the weakest link theories. No, if you skip ahead to the third. No, further. No.

Okay. Here we are. This is a schematic representation. Imagine you have a certain material that's hard and very stiff and you have a layer there. If I start pushing on that all of the deformation is going to be taken on that layer. Suffice one layer, that's what we call the weakest link is going to take all the displacement.

If you don't like this analogy, just think about you eating a sandwich with mayonnaise and you start biting it, the mayonnaise starts squeezes out on the side.

Q. And let's go to the next demonstrative to illustrate this effect on a rotary sidewall core. And you can play the animation.

And can you describe what's happening here?

A. Yes. This time you can see the weakest layer in this particular does not influence whatsoever the vertical displacement. So that you end up with the sidewall core being much stiffer than the vertical core.

Q. And, thank you, Dr. Roegiers. Let's go to D-21311.4 to talk to your opinion about in-situ liquid and temperature conditions. Why is it your recommended practice to replicate the in-situ conditions of the reservoir as best as possible?

A. Well, everybody knows that rock properties are going to be affected by the temperature and by the pore pressure and by the saturation, so that when you want to have some realistic numbers generated in the lab, you need to simulate the in-situ conditions from the reservoir itself. The Macondo, the cores were done at room temperature, all of them, all of the tests. UPVC was done using kerosene, and the hydrostatic and triaxial test were done on dry cores.

So that we violated temperature, we violated saturation, and again underpredicts the compressibility.

Q. And today let's just focus about the potential impact of temperature. And what is your recommended practice with respect to temperature when you're doing rock mechanics testing?

A. Well, some of those parameters you can qualify like I have done here, but in order to quantify them you need to look at how important different rocks are affected differently to a different percentage. So what I usually do I will take, do two tests at two different temperatures, look at the results, and if the results are within about five or six percent I wouldn't care to do anymore temperature effects, which are temperature tests of very tedious and expensive.

But I would not assume like the professor Zimmerman said that the temperatures don't have an effect or the saturation doesn't have any effect.

Q. And in your work have you seen temperature effects?

A. Yes. I've been spending the last ten years on temperature effects in rocks, both for the sandstone reservoirs and also for the rocks that involved with geothermal energy.

Now, the problem with the temperature is that some rocks are very much affected, some rocks are very poorly affected. You do not know that to start with. In general, the sandstones are going to be very much affected, especially if you have a higher porosity.

Now, one thing I need to clarify that might be a shock to everybody. If temperature effects and I say, for example, quantity, my temperature effect is an effect of 20 percent, and then I do some saturation and I find out that my temperature saturation is effect let's say another 20 percent. I cannot say that where I put the two and two together that they're going to give me four. That does not mean that you're going to get 40 percent of error when you put it together, it's usually much larger than that, it's not the normal numerical addition.

And I have some cases, if you want to go into detail to explain it.

MR. FIELDS: Your Honor, again, what we're heading into is outside the scope of his report.

MS. HARVEY: Your Honor, Dr. Roegiers says, "The temperature plays a very significant role in how stiff the rocks will behave, and the combination of wetting fluid of brine (as opposed to the kerosene used in the Macondo testing) and high temperature would cause a sandstone sample to exhibit much higher compressibility than tests done on a bench at low temperature." So he is elaborating on the basis for that opinion.

MR. FIELDS: That's exactly the problem, your Honor, is that that's exactly what he said in the report and he is trying to elaborate on that here.

THE COURT: Well, you know --

THE WITNESS: But it's --

THE COURT: Wait a minute, Dr. Roegiers. If all an expert is going to do is sit in the court and read their report word for word, we're wasting our time. So they obviously can explain and elaborate a little bit, so I overrule the objection. But I think we ought to move along, okay?

MS. HARVEY: All right.

BY MS. HARVEY:

Q. Let's move on -- first, do you want to provide your example that you were just referring to?

A. The difference? The example?

Q. Yes.

A. Okay. About three or four years ago there's been a very big controversy in the petroleum industry about property called fracture toughness because we have fracture toughness in the field which was towards the magnitude larger than what we could measure in the lab.

THE COURT: Hold on one second.

MR. FIELDS: Your Honor, again --

THE COURT: I am going to sustain your objection now. I thought I suggested we move along here. That means move to something else.

BY MS. HARVEY:

Q. All right. Let's move on to D-21311.5. And, Dr. Roegiers, let's turn to your opinion regarding loading rate. And as an initial matter can you --

THE COURT: Before we go there. I am trying to get an estimate, how much time do you have left on your direct?

MS. HARVEY: Probably about 20 minutes, your Honor.

THE COURT: Let's go ahead and recess for lunch and we'll come back at 1:15. Okay?

THE WITNESS: Okay. Thank you.

THE DEPUTY CLERK: All rise.

(WHEREUPON, A LUNCH RECESS WAS TAKEN.)

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REPORTER'S CERTIFICATE

I, Karen A. Ibos, CCR, Official Court Reporter, United States District Court, Eastern District of Louisiana, do hereby certify that the foregoing is a true and correct transcript, to the best of my ability and understanding, from the record of the proceedings in the above-entitled and numbered matter.

Karen A. Ibos, CCR, RPR, CRR, RMR
Official Court Reporter

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