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	DOCKET NO. MDL-2179 SECTION "J" NEW ORLEANS, LA OCTOBER 16, 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 10 MORNING SESSION

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
HEARD BEFORE THE HONORABLE CARL J. BARBIER
UNITED STATES DISTRICT JUDGE

APPEARANCES:

FOR THE PLAINTIFFS:

HERMAN HERMAN & KATZ
BY: STEPHEN J. HERMAN, ESQ.
820 O'KEEFE AVENUE
NEW ORLEANS, LA 70113

DOMENGEAUX WRIGHT ROY & EDWARDS
BY: JAMES P. ROY, ESQ.
556 JEFFERSON STREET, SUITE 500
POST OFFICE BOX 3668
LAFAYETTE, LA 70502

APPEARANCES CONTINUED:

LEVIN PAPANTONIO THOMAS MITCHELL
RAFFERTY & PROCTOR
BY: BRIAN H. BARR, ESQ.
316 SOUTH BAYLEN STREET, SUITE 600
PENSACOLA, FL 32502

WEITZ & LUXENBERG
BY: ROBIN L. GREENWALD, ESQ.
700 BROADWAY
NEW YORK CITY, NY 10003

IRPINO LAW FIRM
BY: ANTHONY IRPINO, ESQ.
2216 MAGAZINE STREET
NEW ORLEANS, LA 70130

LUNDY, LUNDY, SOILEAU & SOUTH
BY: MATTHEW E. LUNDY, ESQ.
501 BROAD STREET
LAKE CHARLES, LA 70601

MORGAN & MORGAN
BY: FRANK M. PETOSA, ESQ.
188 EAST CAPITOL STREET, SUITE 777
JACKSON, MS 39201

FOR THE STATES' INTERESTS:

ALABAMA ATTORNEY GENERAL'S OFFICE
BY: COREY L. MAZE, ESQ.
WINFIELD J. SINCLAIR, ESQ.
500 DEXTER AVENUE
MONTGOMERY, AL 36130

APPEARANCES CONTINUED:

FOR THE STATE OF LOUISIANA:

STATE OF LOUISIANA
BY: JAMES D. CALDWELL,
ATTORNEY GENERAL
1885 NORTH THIRD STREET
POST OFFICE BOX 94005
BATON ROUGE, LA 70804

KANNER & WHITELEY
BY: ALLAN KANNER, ESQ.
DOUGLAS R. KRAUS, ESQ.
701 CAMP STREET
NEW ORLEANS, LA 70130

FOR THE UNITED STATES OF AMERICA:

U.S. DEPARTMENT OF JUSTICE
TORTS BRANCH, CIVIL DIVISION
BY: STEPHEN G. FLYNN, ESQ.
POST OFFICE BOX 14271
WASHINGTON, DC 20044

U.S. DEPARTMENT OF JUSTICE
ENVIRONMENT & NATURAL RESOURCES
DIVISION
ENVIRONMENTAL ENFORCEMENT SECTION
BY: THOMAS BENSON, ESQ.
STEVEN O'ROURKE, ESQ.
SCOTT CERNICH, ESQ.
A. NATHANIEL CHAKERES, ESQ.
ANNA CROSS, ESQ.
BETHANY ENGEL, ESQ.
RICHARD GLADSTEIN, ESQ.
JUDY HARVEY, ESQ.
SARAH HIMMELHOCH, ESQ.
P.O. BOX 7611
WASHINGTON, DC 20044

APPEARANCES CONTINUED:

FOR BP EXPLORATION & PRODUCTION INC., BP AMERICA PRODUCTION COMPANY, BP PLC:

LISKOW & LEWIS
BY: DON K. HAYCRAFT, ESQ.
ONE SHELL SQUARE
701 POYDRAS STREET
SUITE 5000
NEW ORLEANS, LA 70139

KIRKLAND & ELLIS
BY: J. ANDREW LANGAN, ESQ.
HARIKLIA KARIS, ESQ.
PAUL D. COLLIER, ESQ.
MATTHEW T. REGAN, ESQ.
BARRY E. FIELDS, ESQ.
300 N. LASALLE
CHICAGO, IL 60654

KIRKLAND & ELLIS
BY: MR. BOLES, ESQ.
333 SOUTH HOPE STREET
LOS ANGELES, CA 90071

KIRKLAND & ELLIS
BY: ROBERT R. GASAWAY, ESQ.
JOSEPH A. EISERT, ESQ.
BRIDGET K. O'CONNOR, ESQ.
655 FIFTEENTH STREET, N.W.
WASHINGTON, DC 20005

COVINGTON & BURLING
BY: ROBERT C. "MIKE" BROCK, ESQ.
1201 PENNSYLVANIA AVENUE, NW
WASHINGTON, DC 20004

APPEARANCES CONTINUED:

FOR TRANSOCEAN HOLDINGS LLC, TRANSOCEAN OFFSHORE DEEPWATER DRILLING INC., AND TRANSOCEAN DEEPWATER INC.:

FRILOT
BY: KERRY J. MILLER, ESQ.
ENERGY CENTRE
1100 POYDRAS STREET, SUITE 3700
NEW ORLEANS, LA 70163

SUTHERLAND ASBILL & BRENNAN
BY: STEVEN L. ROBERTS, ESQ.
1001 FANNIN STREET, SUITE 3700
HOUSTON, TX 77002

MUNGER TOLLES & OLSON
BY: MICHAEL R. DOYEN, ESQ.
BRAD D. BRIAN, ESQ.
LUIS LI, ESQ.
GRANT A. DAVIS-DENNY, ESQ.
ALLEN M. KATZ, ESQ.
335 SOUTH GRAND AVENUE, 35TH FLOOR
LOS ANGELES, CA 90071

FOR HALLIBURTON ENERGY SERVICES, INC.:

GODWIN LEWIS
BY: DONALD E. GODWIN, ESQ.
JENNY L. MARTINEZ, ESQ.
BRUCE W. BOWMAN, JR., ESQ.
PRESCOTT W. SMITH, ESQ.
SEAN W. FLEMING, ESQ.
RENAISSANCE TOWER
1201 ELM STREET, SUITE 1700
DALLAS, TX 75270.

APPEARANCES CONTINUED:

GODWIN LEWIS
BY: R. ALAN YORK, ESQ.
GWENDOLYN E. RICHARD, ESQ.
1331 LAMAR, SUITE 1665
HOUSTON, TX 77010

FOR ANADARKO
PETROLEUM CORPORATION,
ANADARKO E&P COMPANY LP:

KUCHLER POLK SCHELL
WEINER & RICHESON
BY: DEBORAH D. KUCHLER, ESQ.
1615 POYDRAS STREET, SUITE 1300
NEW ORLEANS, LA 70112

BINGHAM MCCUTCHEN
BY: WARREN A. FITCH, ESQ.
KY E. KIRBY, ESQ.
2020 K STREET, NW
WASHINGTON, DC 20006

OFFICIAL COURT REPORTER: SUSAN A. ZIELIE RMR, FCCR
CERTIFIED REALTIME REPORTER
REGISTERED MERIT REPORTER
500 POYDRAS STREET, ROOM HB406
NEW ORLEANS, LA 70130
(504) 589-7781
susan_zielie@laed.uscourts.gov

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I N D E X

Testimony of:

P-R-O-C-E-E-D-I-N-G-S

OCTOBER 16, 2013

M O R N I N G S E S S I O N

(COURT CALLED TO ORDER)

8:00 A.M.

08:06AM

08:06AM THE COURT: Morning, everyone. Please be seated.

08:07AM All right. Go ahead, Mr. Brock. I'm just opening something up here. I'm listening. Go ahead.

08:07AM MR. BROCK: Our first witness this morning, Your Honor, will be Mr. Bob Merrill.

08:07AM I had two preliminary matters before we call him to the stand, if that's okay.

08:07AM THE COURT: Sure.

08:07AM MR. BROCK: First, I have the exhibits for Dr. Curtis Whitson. They've been circulated, and there are no objections to these exhibits.

08:07AM THE COURT: Without objection, those are admitted.

08:07AM (Exhibits admitted.)

08:07AM MR. BROCK: Second, there was an issue that came up yesterday that I just want to address very briefly and give Your Honor a bit of background so that you'll understand I hope a little better what we're doing.

08:07AM As Your Honor may remember, we had deadlines set for the exchange of demonstrative exhibits. That was originally

September the 27th. And the idea was to disclose all exhibits that we could anticipate using at trial.

On that disclosure date, we disclosed 287 exhibits and the United States disclosed a handful, I think around 20.

On the eve of trial, the 4th and evening of the 4th and 5th, the United States disclosed 120 new demonstrative exhibits that they said that they would use in their direct examinations. 100 on Saturday night. And I apologize for the detail --

THE COURT: Let me just stop you for just a second. I'm wondering why you're raising this. This was brought to my attention on the morning the trial started, and I had word from Judge Shushan that you all had worked out any remaining issues pertaining to this.

MR. BROCK: Yes, sir. And I thought that we had, so I was just trying to give you the background on that so I could give you the next statement, and I'll do it very quickly if that's okay.

The resolution of that was that we withdraw our timeliness objection to the late-filed exhibits, and the United States said as to those demonstrative exhibits that he had disclosed prior to that date, that they would not object to those.

So when our lawyers say to Your Honor in court when we're examining a witness there's no objection to that

exhibit, that's what we are referring to, the resolution that we made that there would not be objections to our exhibits.

This has come up several times, but it came up three times yesterday with Exhibit D-23603, D-24222, and D-23608.A.1. I don't think there's any useful purpose at this point in me offering the deconvolution exhibit, so I won't offer that.

We would have had a discussion about it if it had been permitted.

THE COURT: You're talking about exhibits that the government objected to?

MR. BROCK: Yesterday, yes, sir. Where they had said they did not have objections.

THE COURT: Okay. Well, let me just say, I don't recall the basis of the -- I didn't think that the basis of those objections yesterday -- the ones I recall, and I'm sure you know more about the details of this than I do right now -- but my recollection is the objections were based on other matters, not on a timeliness issue. I don't know if that's right or not.

MR. BROCK: No. There's no issue about timeliness. These are disclosed on September the 27th, so that's not the issue.

I'll get right to it.

The only thing I wanted to tell you is when we say

there's not an objection to the exhibit, what we mean is this is something we worked out at the beginning of the trial. That's why we're saying that there is a no objection, because we withdrew our timeliness objection, they withdrew their other objections.

I'm now going to offer 24222.1 and 236603.1, and my understanding is that the government does not object to these demonstratives beings admitted.

THE COURT: These are in connection with whose testimony?

MR. BROCK: Dr. Gringarten yesterday.

THE COURT: Is that correct, Ms. Himmelhoch?

MS. HIMMELHOCH: Your Honor, it is correct that the United States does not object to the demonstratives. My objections yesterday were directed to the testimony based upon the demonstratives.

THE COURT: So you don't object to what Mr. Brock just offered?

MS. HIMMELHOCH: No, we do not, and we --

THE COURT: Okay. That's it. That's all. That's admitted.

MR. BROCK: That's all I wanted.

THE COURT: Okay. No problem. That was a long way around to get to that point. You could have just said you had two exhibits that nobody objected to them.

MR. BROCK: Well, I could have. You're right.

I just wanted you to know that when we're saying that, it's not something we're just pulling out of the blue. We have a reason for saying it.

THE COURT: I understand.

MR. BROCK: These are things we think we've worked out, and that's why we've done it. For the benefit of our examiners, I wanted you to know that.

THE COURT: Well, I'm happy you all were able to work it out again.

MR. BROCK: Thank you, Your Honor.

With that, we call Mr. Bob Merrill.

MS. KING: Rachel King for the United States, Your Honor.

I have here the list of exhibits that the United States used with Dr. Whitson. Exhibits, call-outs, and demonstratives. This list has been circulated, and there are no objections.

THE COURT: All right. Without objection, those are admitted.

(Exhibit admitted.)

MS. KING: Thank you, Your Honor.

THE COURT: Any other preliminary matters?

Remember, we're going to recess right at noon today. No later than noon, let me put it that way.

08:12AM 1 Okay.
08:12AM 2 By the way, let me announce our times. According
08:12AM 3 to our timekeepers, these are our times according to Ben. I
08:13AM 4 think it will be a moot issue, because the way we're going I
08:13AM 5 don't think we're not going to exhaust all the time anyway.
08:13AM 6 But the United States has used 16 hours and 13
08:13AM 7 minutes; has 28:47 remaining.
08:13AM 8 BP has used 18 hours 45 minutes; has 26:15
08:14AM 9 remaining.
08:14AM 10 **ROBERT CLIFFORD MERRILL, JR.**, being first duly
08:14AM 11 sworn, testified as follows:
08:14AM 12 THE CLERK: State and spell your name for the record.
08:14AM 13 THE WITNESS: My name is Robert Clifford Merrill,
08:14AM 14 Junior, M-E-R-R-I-L-L.
08:14AM 15 MR. BOLES: Your Honor, Mr. Boles for BP and Anadarko.
08:14AM 16 If may proceed?
08:14AM 17 THE COURT: Yes.
08:14AM 18 DIRECT EXAMINATION
08:14AM 19 BY MR. BOLES:
08:14AM 20 Q Good morning, Dr. Merrill.
08:14AM 21 A Good morning.
08:14AM 22 Q Maybe speak up a little bit.
08:14AM 23 A Okay.
08:14AM 24 Q Tell us where you work, Dr. Merrill.
08:14AM 25 A I work for BP Exploration in Houston.

Q What's your job?
A I'm currently director of reservoir engineering for the corporation. I oversee the health of the engineering community, the reservoir engineering community.
Q By health, what do you mean?
A Organizational capability; make sure we have the right people in the right locations and that they're properly trained.
Q So is part of what your work involves is teaching other reservoir engineers?
A I do teach on occasion internal and some courses for partners.
Q When you say courses for partners, what does that industry term mean, partners specifically?
A We have partnerships with other firms, such as the Gulf of Suez Petroleum Company, or with Reliance Industries. I go and I sometimes teach our methods to them.
Q Dr. Merrill, how long have you been a reservoir engineer?
A I've been a reservoir engineer in one form -- a reservoir engineer in one form or another for about 30 years.
Q Are you a member of any professional societies?
A Yes. I'm a member of the Society of Petroleum Engineers, and I'm a licensed professional engineer in the state of Texas.
Q In addition to the leadership position you described at BP, do you have leadership positions outside of BP?
A Yes. I am an Episcopal priest, and I am rector and pastor

of Saint Bartholomew Episcopal Church in Hempstead, Texas.
Q I want to focus in on the work you did at BP related to the Macondo incident. When did you first start doing any work relating to the Macondo incident?
A With the exception of a few stray questions, I started working on the Macondo incident in about mid-May of 2010.
Q Now, Dr. Merrill, I want you to listen very carefully to my questions. At some point in the summer of 2010, did you start doing a separate work stream to provide scientific analysis to the lawyers defending BP in this case?
A Yes. I started what I was told was called privileged work in August of 2010.
Q Dr. Merrill, I'm going to now go back and be asking you about the nonprivileged work you did in analyzing the Macondo well. And I just want to ask you, in my questions for the rest of the morning or as long as I ask you questions, will you understand that I am not asking you to describe the privileged work you did with the lawyers?
A Yes, I understand that.
Q What were you doing when you started in May? What were you doing to assist in the response to the incident?
A Most of my work for the Macondo incident involved the estimation of pressures in the face of the large uncertainties we had about the flow rate. You know, what sort of pressures might be encountered at various horizons in the reservoir in the

stratographic section; what pressures might be encountered at the wellhead were we to shut it in.

This started in mid-May for the Top Kill. It then continued in June for the planning of the relief wells. And towards the end of June, early July, we turned our attentions to the wellbore integrity test, which was the capping stack for the -- which ultimately closed the well.

Q Now, in this modeling you were doing to predict pressure, did you work with a team of other scientists or engineers?

A Well, I was working for the engineering team that was led by Paul Tooms. And I was working very closely with Kate Baker from whom I was taking most of my instructions.

I had a team of people who were working for me on a number of different issues. I had a few people help me with reservoir simulation and a few people working on pressure transient analysis, including Michael Levitan, who was our technical advisor for pressure transient analysis.

Q Now, when you and your team were doing analysis to try to predict pressure related to the Macondo incident, did you have inputs into that modeling or analytical work for rock compressibility?

A I did.

Q Why?

A Well, rock compressibility is one of those fundamental properties you need to perform reservoir simulation. It's like

permeability -- it's not like permeability, but it's of the nature of the permeability porosity or net to gross. It's one of the rock properties which a simulation package requires in order to make predictions about pressure based on flow.

Q In the modeling work you were doing as a general matter, what is the effect of rock compressibility on the pressure that you're predicting?

A Rock compressibility, we're talking depletion, so when you're withdrawing something from the reservoir, rock compressibility is the measure of how spongy the rock is.

Now, we might think that rocks are solid like the wood around me, but under the pressures of the earth above them they actually act much more like sponges.

And so as you take fluid out of the reservoir, the rock around it pushes down. Compressibility is a measure of how much the rock actually gives under this pressure.

So with a high compressibility, relatively high compressibility, when you pull a certain amount of fluid out of the reservoir, you will see a small pressure change. With a low compressibility, you take the same amount of fluid out of otherwise the same reservoir, you see a larger pressure change.

Q Now, in terms of -- we'll get to the specific modeling a little later. Where was the source of data you used to determine the input for rock compressibility when you first started using that input in your modeling mode?

A I have received is from either Kelly McAughan or Steve Wilson.
Q Who is Steve Wilson?
A Steve Wilson was the geomechanical advisor for the Gulf of Mexico.
Q How does geomechanics relate to rock compressibility?
A Geomechanics is the study of how rocks deform under stress.
Q So is a geomechanics person a person whose specialty includes rock compressibility?
A It's one the things in the geomechanics specialty, yes, sir.
Q What about Kelly McAughan, what was her job?
A Kelly McAughan was the reservoir engineer who was actually assigned to the well during its drilling. She worked in the exploration function.
Q Was she a geomechanics specialist?
A No. She was a general reservoir engineer.
Q Let's look at TREX-10859.1.1. And this is a call-out of a portion of a document dated June 29, 2010.

At this time, Dr. Merrill, were you doing modeling of the Macondo reservoir?
A I was doing simulation -- modeling is a general term. This is a -- refers to a simulation model that I had prepared for Macondo.
Q What were you trying to simulate?
A We purposely put this -- the reason we put this simulation

08:23AM 1 model together was to predict what sort of pressures the relief
08:23AM 2 well drillers would encounter during the drilling of the relief
08:23AM 3 wells.
08:23AM 4 We used it for a number of other purposes as well,
08:23AM 5 but the purpose it was originally put together for was for
08:23AM 6 relief well planning.
08:23AM 7 Q What number did you input for rock compressibility in that
08:23AM 8 modeling?
08:23AM 9 A Six microsips, which would be 6 times 10 to the minus 6
08:23AM 10 inverse psi.
08:23AM 11 Q Is that what is symbolized by the last line of the call-out
08:23AM 12 by the notation C with a subscript F?
08:23AM 13 A Yes, sir. F for formation.
08:24AM 14 Q Where did you get or how did you decide to use 6 microsips
08:24AM 15 in this simulation?
08:24AM 16 A It was provided to me by Steve Wilson or Kelly.
08:24AM 17 Q And do you know what they based it on?
08:24AM 18 A It was my understanding at the time that it was based on
08:24AM 19 experimental measurements from rotary sidewall cores.
08:24AM 20 Q At that time, did they give you any precautions about using
08:24AM 21 measured data from rotary sidewall cores to base an estimate of
08:24AM 22 rock compressibility?
08:24AM 23 A No, sir.
08:24AM 24 Q Had you ever or have you ever in your 30 years at the
08:24AM 25 Macondo well -- I'm sorry -- in your 30 years of word at BP

prior to Macondo, had you ever heard of any concerns about using rotary sidewall cores to measure rock compressibility?

MR. CHAKERES: Your Honor, I'm going to object. This goes beyond the scope of what he was doing in his response and is calling for expert testimony.

MR. BOLES: It's fact testimony.

THE COURT: It sounds like a fact question. Overrule the objection.

BY MR. BOLES:

A Until one meeting we had during the Macondo incident, it never -- I was unaware of any controversy regarding the reliability of rotary sidewall core data.

Q And, in your prior work at BP as a reservoir engineer for decades, had you in the past input into your models rock compressibility numbers based on measurements of from rotary sidewall cores?

A Yes, I had.

Q Now, we've been focusing on this particular document and the 6 microsips input for rock compressibility. In predicting pressures you were doing here, what would be the effect of increasing that number?

A Well, if you held all other things equal, then if you increase the compressibility, you would increase -- well, you would decrease the amount of depletion observed in the reservoir or from wherever you were withdrawing fluid, and therefore you

would increase the final pressure in the reservoir.

Q Now, you mentioned this meeting July 6th, and we're going to get to that next.

In your simulations or other modeling of Macondo prior to July 6th, did you use 6 microsips as the rock compressibility input for all of those models and analyses?

A Yes, sir.

Q Let's take a look at D-24698.1 in order to set the timeframe.

So you did a number of analyses and modeling to predict pressure from Macondo reservoir prior to July 6th; correct?

A Yes, sir.

Q You used 6 microsips as an input for all of those?

A I input -- in those cases where I input compressibility, yes, I used 6 microsips.

Q Did your focus -- did you have a particular focus then toward the end of June and early July in terms of the work you were doing about the Macondo incident?

A In June and early July the bulk of my -- well, actually mostly in June -- the bulk of my work was involved in relief oil planning and the pressures that might be observed as you drill through the stratographic column because of the possible flow between horizons.

Q Now, referring to the timeline, did there come a time when

08:27AM 1 the Macondo well was shut in?
08:28AM 2 A The well itself was shut in on the 15th of July.
08:28AM 3 Q And did you at some point -- I think you actually testified
08:28AM 4 to this -- start doing modeling to predict the pressure that
08:28AM 5 would build up if the well was shut in?
08:28AM 6 A Yes. That work actually started towards the end of June. I
08:28AM 7 don't remember exactly when. The last part of June. And it
08:28AM 8 continued through -- the predicted work continued through to the
08:28AM 9 point of shut-in.
08:28AM 10 Q Why were you trying to predict pressure buildup that might
08:28AM 11 happen from shut-in?
08:28AM 12 A One of the concerns that everyone had in the course of this
08:28AM 13 incident was that the well's integrity, that is the steel that
08:28AM 14 separated the hole in the ground, which was the well, from the
08:28AM 15 formations was damaged in some way. It had no integrity. There
08:29AM 16 was a hole in it.
08:29AM 17 And I don't know if the Court has heard anything
08:29AM 18 about burst discs, but in particular there was a hypothesis that
08:29AM 19 these burst discs in the well had failed and that you could have
08:29AM 20 established flow between the inside of the well and the outside
08:29AM 21 of the well.
08:29AM 22 And, if that were to occur, you could have high
08:29AM 23 pressure fluid flowing in the well and then out into a shallower
08:29AM 24 formation that could not actually contain it.
08:29AM 25 Q Now let's take a look at TREX -- well, you mentioned that

there was a meeting on July 6th.
A Yes, sir.
Q And what was the purpose of that meeting?
A The purpose of the meeting on July 6th was to review my simulation work up to that point, with the principal focus on what it might tell us about pressures.
Q Let's take a look at TREX-140863.5.1.
Is this a portion of a presentation you gave at that meeting?
A Yes, sir, it is.
Q Who attended that meeting?
A That was an internal BP meeting. It was attend by a number of people, including Paul Tooms, Kate Baker, James Dupree, a number of reservoir engineers who were working in the producing fields in the Gulf of Mexico, some geologists. I believe we also had some flow specialists there as well.
Q And let's look at TREX-14863.5.2.
What was the value you were using in the modeling you presented for rock compressibility?
A I was using a value of 6 microsips.
Q Was there discussion about that during the meeting?
A Yes, there was.
Q What was the discussion?
A I had been consistently using either the fluid withdrawal rate or the presence or absence of an aquifer to control the

energy, the final pressures you might encounter in the reservoir.

And during the discussion of compressibility -- well, during the discussion of the inputs to the model, one of the reservoir engineers in the meeting raised the possibility that rotary sidewall cores could provide data that was biased low compared to data collected from other methods.

Q Who was that reservoir engineer?

A I believe it was Dave Schott.

Q And do you know what he based that concern on?

A During the meeting, I did not. He raised it as anecdotal evidence that in his experience he had observed this at a nearby field in Galápagos.

Q And were there other reservoir engineers at that meeting from other nearby BP Gulf of Mexico fields?

A I don't remember exactly who was there. I'm fairly sure Kelly was there. And I think Jessica was there, but I honestly don't remember.

Q Were there other reservoir engineers there?

A Yes.

Q Who had worked on other fields?

A Yes.

Q And did any of them other than Dave Schott raise this concern about rotary sidewall cores?

A Not to my recollection.

Q What was the decision that was made at that meeting about what to do with rock compressibility in modeling the risk from pressure buildup from the shut-in of the Macondo well?

A The purpose of the meeting was to look at the risks around pressure. And the decision that came out of the meeting was that we would increase the compressibilities that we were using to look at the high side of the pressures that might be encountered.

We also made the decision in that meeting to increase the aquifer size, the largest aquifer we were looking at to accomplish the same purpose.

Q Now, how does increasing the aquifer size in the modeling to assess risk of shut-in, how is that analysis or why was that part of the same decision to increase rock compressibility numbers or look at alternative higher cases of rock compressibility?

A Final reservoir pressure or the reservoir pressure for a given withdrawal rate is dependent on the reservoir energy.

Now, you take reservoir energy out when you produce fluids from the reservoir, and you put reservoir energy in either by water that surrounds the reservoir flowing in behind the fluid, which is the aquifer, or by changing the properties of the rock, the compressibility.

Q Now, did anybody at this July 6th meeting, yourself or the managers there or the reservoir engineers there, say that they

had made a scientific conclusion that the rock compressibility of 6 that you had been using for Macondo was incorrect?

A No. It was a possibility that because it was measured on rotary sidewall cores it might be biased low.

Q So then why would you then going forward use higher numbers?

A For the purposes of the wellbore integrity test, we wanted to understand how high the pressures were that we might encounter in the well.

Because it was the magnitude of the pressure that would either drive the pressure that was seen at the wellhead, which to my understanding was also an issue because of the possibilities of causing burst disc failure.

Or if the other burst discs or other integrity has failed in the well, the magnitude of the pressure would actually drive the flow rate into the shallower formations, which would increase the risk of a surface breach.

We were very concerned about how much time we would have to actually recognize a failure of integrity and the bad things that would happen if we had a surface breach.

Q And would a surface breach or causing of a surface breach be more likely if the rock compressibility was higher other lower?

A It has nothing to do with rock compressibility.

Q In terms of the pressure buildup?

A Well, with a higher compressibility you end up with a higher final reservoir pressure, and it's the pressure that actually

drives the -- you know, if you had a lack of integrity, it would have been the pressure that would have driven things.

It has nothing to do with the compressibility.

Q Going forward in your modeling work -- which we'll look at a few examples of it -- -going forward, what rock compressibility number or numbers did you use leading up to the shut-in on July 15th?

A After some back and forth between Steve Wilson, Dave Schott, Kelly, and myself, the decision was made to double the measured values to 12, and also to triple them to 18 to provide high estimates for the rock compressibility.

Q Did you also continue in any of your modeling to use 6 microsips?

A I continued to use 6 throughout my modeling efforts.

Q Now, you mentioned Steve Wilson. Remind Judge Barbier who he is again.

A Steve Wilson was the geomechanics technical advisor for the government.

Q Was he at this July 6th meeting?

A He was not.

Q So let's see what role he played in this afterwards. Let's look at TREX-11557.2.1.

Did you receive this email from Mr. Wilson, Dr. Merrill?

A I did.

Q And focusing your attention on the sentence: I don't think you can go much above 6 microsips and still honor the data.

Do you see that?

A Yes, sir.

Q Do you remember hearing that from Steve Wilson?

A Yes.

Q And did you talk to him after this email in response to it?

A Yes, I did.

Q What did you talk about with him?

A I went and I --

MR. CHAKERES: I object to this on hearsay grounds.

THE COURT: Sustained.

BY MR. BOLES:

Q Let's take a look at TREX-1157.1.1.

Is this an email that you received from Mr. Wilson, Dr. Merrill?

A Yes, I did.

Q And it says in the first sentence: I have spoken with Bob Merrill and have more context now around the question being asked.

A Yes, sir.

Q Had you had a conversation with Steve Wilson to explain the reason for looking at alternative higher rock compressibility values coming out of that July 6th meeting?

A Yes, I had.

MR. CHAKERES: Same objection, Your Honor, as to the content of that communication.

MR. BOLES: Your Honor, the government has put into issue why BP was looking at or the significance of BP looking at alternative rock compressibility.

So these are facts and offered for the fact of the discussions going on. Let the decision...

THE COURT: You can't. You can't use -- I mean, this is clearly hearsay if he's going to say what someone else at BP told him. I don't know how you get around the hearsay rule.

MR. BOLES: I don't think that was part of my question.

I'll re-ask the question. Maybe it will be a different question. If not, then I'm sure I will hear an objection and then I'll move on.

THE COURT: Okay.

BY MR. BOLES:

Q Had you had a conversation with Steve Wilson about the July 6th meeting where rock compressibility was discussed?

A Yes, I did.

Q What did you tell him?

MR. CHAKERES: Your Honor, that's still hearsay. It's an out-of-court statement.

THE COURT: No. The fact that he had a meeting, that's not hearsay. Go ahead. Overrule that objection.

BY MR. BOLES:

A I told Steve that we were looking for higher values of compressibility that were still within the realms of possibility so that we could calculate a higher final depleted pressure.
Q And did Steve Wilson eventually provide to your team for modeling the risks of shut-in alternative higher rock compressibility numbers to use in that modeling?
A Not exactly. Yes, after some discussion he came out with a range of numbers. But the final numbers we used for modeling were simple multiples of the measured rock compressibility.
Q Which was?
A Two times and three times, so 12 microsips and 18 microsips.
Q And the measured number was what, Dr. Merrill?
A 6 microsips.
Q Did the geomechanics specialist, Mr. Wilson, ever deliver to your team for use in your modeling a scientific study showing that the rock compressibility of 6 measured in the Macondo reservoir was incorrect?
A He did not present a written study, no, sir.
Q Did he provide any study to you showing you and convincing you that the rotary sidewall core measurements were biased low?
A No, he did not.
Q Let's take a look at TREX-20849.1.
Do you recognize in a document, Dr. Merrill?
A It's hard to recognize something straight from the title page.

08:42AM 1 Q All right. Let's take a look at TREX-020841N.3.1.
08:42AM 2 A Yes, I recognize this slide.
08:42AM 3 Q And what is this, Dr. Merrill?
08:42AM 4 A I prepared this slide for a meeting -- we had lots of
08:42AM 5 meetings -- in which I was discussing the depleted pressures
08:42AM 6 that one would calculate based on a number of scenarios.
08:42AM 7 Q Now, it says on this page of the presentation: Recommends
08:42AM 8 new, quote, most likely, end quote, 3.8 times aquifer, 12
08:42AM 9 microsips, and 35.
08:43AM 10 What does MDB stand for?
08:43AM 11 A Thousands of barrels a day.
08:43AM 12 Q What does that refer to, Dr. Merrill?
08:43AM 13 A That was the flow rate that we were using in the simulation
08:43AM 14 as our mid-case here.
08:43AM 15 Q And in the middle does it say 12 microsips?
08:43AM 16 A It does.
08:43AM 17 Q Now, what did you mean by putting most -- and did you put
08:43AM 18 most likely in quotation marks there?
08:43AM 19 A I did.
08:43AM 20 Q Why did you do that?
08:43AM 21 A These parameters were not statistically most likely. They
08:43AM 22 were our mid-case, our reference case.
08:43AM 23 Q What did you regard as the most likely number for rock
08:43AM 24 compressibility at this time?
08:43AM 25 A I was using 6 as the experimentally measured values.

Q We've heard you say that 12 microsips was an increase from the measured value of 6; correct?
A Yes, sir.
Q And what about the 3.8 times aquifer? How can that relate to prior modeling you had done?
A 3.8 was actually on the high side of the aquifer modeling I had done to that point. That was based on a geological examination, a map, which mapped a four time, roughly four times aquifer size.
Q Why were you using an aquifer number on the high side in this?
A Well, one of the decisions we made in July 6th, in the July 6th meeting, was to increase the aquifer size. And so four times aquifer here, 3.8, became a middle case, because we were going up to 14 times and 24 times aquifer size in the scenarios we were examining for the wellbore integrity test.
Q Why were you looking at these higher numbers?
A We wanted to understand just how high the pressure might be in those scenarios.
Q And I see here an alternative aquifer case of 24 times.
A Yes, sir.
Q Is that what you believe the aquifer was at Macondo?
A No. There was a similar conversation with the -- I don't know if they were geologists or geophysicists, but the exploration team who were mapping the structure. We asked them

how big might it be. And, well, getting to 4 times was not difficult. Getting to 14 times, you know, you'd have to expand your channel boundaries a little bit. And getting to 24 times was their upper estimate.

Q Had you ever modeled any reservoir on an aquifer of 24 times in your career?

A Oh, yes, sir.

Q Now, the 35,000 barrels per day, was that a flow rate that you had analyzed and had concluded was the rate at Macondo at this time?

A No, sir. I had made no flow rate analyses at these times. What I did was I ran the model under flow rate control and I specified how much oil would flow from the model.

Q Let take a look at TREX-9324.3.

Do you recognize this document, Dr. Merrill?

A This is the start of a presentation or a number of presentations that were held with the government to examine the risks of shutting in the well with the Capping Stack.

Q And did you make a presentation during --

A I made at least one presentation during this day-long meeting.

Q Let's look at TREX-9324.17.

Is this a slide from your presentation?

A It is.

Q And were there members of the government science team at

this meeting?
A There were.
Q And in red it says next to a assumptions, C, sub script R. What does that refer to?
A That's the rock compressibility.
Q And it has number of 12 microsips?
A Yes, sir.
Q Did you use the words Most Likely on this slide?
A I did not.
Q Did you use them in any part of this presentation?
A I don't believe so.
Q Did you tell anybody at the government who was at this meeting that you thought a rock compressibility number of 12 microsips was most likely?
A I don't recall saying that. If I did, I would have used air quotes most likely.
Q You also have as sensitivities for rock compressibility 6 and 18 microsips.
A Yes, sir.
Q And, again, 6 was the measured value?
A Yes, sir.
Q Why at the time of this presentation were you presenting 12 and 18 microsips as well as 6 microsips?
A This was a presentation where we were describing the risks of what would happen if you did not have wellbore integrity.

08:48AM 1 It's a magnitude of the pressure that drives the
08:48AM 2 rate of speed at which you would have seen a subsea broach if
08:48AM 3 you did not have well integrity.
08:48AM 4 And that's what we were discussing.
08:48AM 5 Q And the higher rock compressibility assumptions would have
08:48AM 6 done what to the expected pressure?
08:48AM 7 A It would have increased the pressure and made the
08:48AM 8 conclusions drawn from the exercise more conservative.
08:48AM 9 Q Why at this time before shut-in were you trying to look at
08:48AM 10 higher compressibilities to look at higher possible pressures?
08:48AM 11 A Because we really did not understand what was happening in
08:48AM 12 the reservoir. And it was a -- the right thing to do. It was
08:48AM 13 just the right thing to do to seeing how high the pressure could
08:49AM 14 be, since that would determine how quickly the shallower
08:49AM 15 formations actually filled with oil and exceeded their fracture
08:49AM 16 gradient and fracture to surface and caused a subsea blowout.
08:49AM 17 That would have been a very bad thing to occur.
08:49AM 18 Q In the same section where there's 12 microsips, the
08:49AM 19 assumptions section, there's also the number aquifer 3.8 times.
08:49AM 20 A Yes.
08:49AM 21 Q Was that an increase from what you had previously modeled
08:49AM 22 and considered most likely?
08:49AM 23 A Well, as I said, in my previous modeling efforts I had used
08:49AM 24 a variety of aquifer sizes from 0 to .5 to 3.8.
08:49AM 25 Q Let's take a look now, go back to TREX -- not TREX --

D-24698-2. So we looked at the early modeling you did with 6 microsips and the July 6th meeting and ensuing presentations leading up to these July 8th and 9th presentations using 12 microsips.

What was the date of shut-in?

A The 15th.

Q And let's take a look at a presentation from the day after that, TREX-10845.1.

Do you recognize this, Dr. Merrill?

A Yes, sir.

Q What were you presenting at this time?

A I wasn't the only person presenting at this presentation. But my portion of the presentation, it was about the interpretation of the pressure buildup data observed at the wellhead between the meeting we just discussed on the 9th of July and the actual shut-in of the well.

We had done some serious thoughts about how we might actually recognize a lack of integrity in the well, and we had recommended to the government science team, as well as to BP, that we'd use a classical form of pressure transient analysis called a Horner plot to do the analysis.

Q Was there a difference in your focus or concern or approach to the pressure modeling that's reflected or the pressure analysis that's reflected here a day after the shut in of the well as compared to the modeling you did in the days immediately

prior to the shut in that we just looked at?

A The purposes of the two modeling efforts were completely distinct. Before we shut in the well, we didn't actually know what the data would demonstrate. We didn't know what we would see, and so we were actually considering a range of possibilities with particular worry to the high side pressures.

After we started collecting data, then we were much more concerned about understanding the character of the pressure buildup to see if it was actually illustrating or demonstrating or providing information about whether we had wellbore integrity or not.

So going from having no data and making predictions to actually trying to understand the data that you're collecting.

Q Now, let's take look at some of your analysis of that pressure data that started coming in after the shut-in. TREX-10845.10.

A Yes, sir.

Q What is this, Dr. Merrill?

A This is just 24 hours after the shut-in of the well. And you can see in the lower right-hand corner is this Horner plot which I mentioned. The Horner plot can be constructed completely from the data. There's no interpretation in a Horner plot. You do not need to use compressibility. You do not need to use flow rate.

08:53AM 1 You do not need to use permeability or any rock
08:53AM 2 properties. You simply do a small manipulation on the time
08:53AM 3 available and you plot the pressure. So each one of those
08:53AM 4 crosses is an actual data point, a collected data point from the
08:53AM 5 well shut-in and the period after the well shut-in.
08:53AM 6 However, to do anything quantitative with pressure
08:53AM 7 transient analysis, you have to make a rate assumption and you
08:53AM 8 have to provide physical properties for the analysis. And
08:53AM 9 that's illustrated by the black line, which is a model fit to
08:53AM 10 this early time dates.
08:53AM 11 You can see we assumed that it was a radio
08:53AM 12 composite model. We used the measured rock compressibility of 6
08:54AM 13 microsips. We used the oil in place number that the geologists
08:54AM 14 had provided. It says mid-case rate, but I don't remember what
08:54AM 15 the mid-case rate was.
08:54AM 16 And it says limited or no aquifer. Because at
08:54AM 17 this time, it was really clear, even 24 hours after the shut-in
08:54AM 18 of the well, that our high side fears were not justified. There
08:54AM 19 was nothing to suggest that we either had an aquifer that was
08:54AM 20 providing pressure support, nor was there any evidence that the
08:54AM 21 rock compressibility was other than what was measured.
08:54AM 22 Q Now, where is the rock compressibility shown on this slide?
08:54AM 23 A Well, explicitly stated right there, CR. It's implicit in
08:54AM 24 the black lines.
08:54AM 25 Q And that's the second bullet point on the right-hand side?

08:54AM 1 A Yes, sir.
08:54AM 2 Q Now, the pressure data that you were actually getting at
08:55AM 3 this time after the well was shut in and the Capping Stack gauge
08:55AM 4 was measuring pressure, is that shown on this slide by those
08:55AM 5 little crosses on the left-hand side?
08:55AM 6 A Yes, sir.
08:55AM 7 Q And by the dots on the Horner plot?
08:55AM 8 A Well, those are courses too, yes.
08:55AM 9 Q Are there any actual pressure data points in any of the
08:55AM 10 earlier presentations we saw where you used alternative cases of
08:55AM 11 rock compressibility of 12 and 18 microsips?
08:55AM 12 A No, sir.
08:55AM 13 Q Now, let's take a look at TREX-10845.11. Is this from the
08:55AM 14 same presentation?
08:55AM 15 A Yes, sir.
08:55AM 16 Q And in this slide you've got in the lower right-hand side
08:55AM 17 both 6 and 12 microsips; is that correct?
08:56AM 18 A Yes, sir.
08:56AM 19 Q And you also have the higher aquifer assumption that we saw
08:56AM 20 pre-shut-in of 3.8.
08:56AM 21 A Yes, sir.
08:56AM 22 Q Why is that, Dr. Merrill?
08:56AM 23 A The presentation here, we were trying to demonstrate
08:56AM 24 confidence that the pressure data we were actually observing at
08:56AM 25 the wellhead was not inconsistent with the range of scenarios we

had performed prior to shut-in.

Q When you say the range of scenarios prior to shut-in, are you referring to the scenarios we saw in your July 8 and 9 presentations that included alternative cases such as 12 microsips?

A That is correct. Now, in this particular graph -- it's been a long time. I don't know if I re-ran some of these simulations after the actual shut in of the well.

But certainly simulation takes a long time to run relative to other things, and so we did not update any of our assumptions at this point.

Q In other words, Dr. Merrill, when do you think this slide and this modeling using 12 microsips was done?

A The slide was certainly prepared for this 2 p.m. meeting on the 16th. The simulations may have been done overnight on the 15th. And the reason I say that is there's a slow shut-in here, and our early simulations all assumed an instantaneous shut-in.

But we didn't change any of the other assumptions in the model.

Q Now, does this slide, and it has Xs and dots on it, is there anywhere on there a display or presentation of actual pressure data from the pressure gauge on a Capping Stack after shut-in?

A No, sir.

Q And what did that data end up telling you about your alternative cases that you had built in pre-shut-in of 12 and 18

08:58AM 1 microsips?
08:58AM 2 A There was no reason to invoke a higher compressibility or an
08:58AM 3 aquifer in order to explain the data we observed in the well
08:58AM 4 test.
08:58AM 5 Q What was it you were observing in the data that told you you
08:58AM 6 no longer needed to look at 12 and 18?
08:58AM 7 A The pressure was coming in at a level -- 6600 pounds or
08:58AM 8 thereabouts, I believe -- that was consistent with a combination
08:58AM 9 of compressibilities, and no aquifer and flow rates that we had
08:58AM 10 previously modeled and were using as our base case.
08:58AM 11 It's hard to be definitive. There's uncertainty.
08:58AM 12 We did not know the flow rate. You can't use pressure transient
08:59AM 13 analysis data quantitative without a flow rate.
08:59AM 14 But there was no evidence that there was anything
08:59AM 15 incorrect with the input parameters that we had been using prior
08:59AM 16 to July the 6th.
08:59AM 17 Q Henceforth, Dr. Merrill, after this immediate shut in time
08:59AM 18 period, after July 16th, did you continue to do modeling or
08:59AM 19 analyses of the Macondo reservoir?
08:59AM 20 A I did.
08:59AM 21 Q What number -- and, again, I don't want you to talk about
08:59AM 22 privileged work you did for the lawyers -- but what number did
08:59AM 23 you use for rock compressibility?
08:59AM 24 A I almost always used a value of 6 microsips.
08:59AM 25 Q Why?

A Because that was the measured value.
Q Did you believe that was the most likely value?
A It was the measured value, and there was no evidence to the contrary to the use the measured value. Most likely yes, because it was measured.
Q Do you know someone named Dr. Paul Hseih of the United States Geological Survey?
A I do. I worked closely with Paul throughout the incident, particularly during the wellbore integrity test.
Q After the shut in, did you have occasion to talk with him about rock compressibility?
A Yes, sir.
Q What did you tell him?
A I told him we were using 6 microsips.
Q Let's take a look at TREX-142325.1.1.

Do you recognize this email as we've called it out here, Dr. Merrill?

A Yes, sir.
Q And what is this?
A Paul wasn't actually in Houston during the actual shut in of the well. He went somewhere.

But we talked with him by phone. And, in the course of that phone call, we were discussing a number of things. This email confirmed the numbers we had used in that phone call.

09:00AM 1 And, in particular, what's called out here, we
09:01AM 2 confirmed that the measured compressibility was 6 microsips and
09:01AM 3 it was based on sidewall cores.
09:01AM 4 Q Did you express any doubt to Dr. Hseih about the reliability
09:01AM 5 of this number?
09:01AM 6 A No.
09:01AM 7 Q Let's go to TREX-11551.1.1.
09:01AM 8 After the shut-in, did you resume your work on
09:01AM 9 modeling and predicting the pressure that the drillers working
09:01AM 10 on the relief well would encounter?
09:01AM 11 A Yes, sir.
09:01AM 12 Q And is this TREX-11551.1.1 a call-out from modeling work you
09:01AM 13 did to predict pressure in the relief well?
09:01AM 14 A Yes, sir.
09:01AM 15 Q Let's look at TREX-11551.3.1.
09:02AM 16 What number were you using for rock
09:02AM 17 compressibility in trying to predict the pressure that the
09:02AM 18 drillers would encounter in drilling the relief well?
09:02AM 19 A 6 microsips.
09:02AM 20 Q Was it important to get that input correct?
09:02AM 21 A Yes, it was.
09:02AM 22 Q Why?
09:02AM 23 A Because the drillers were depending upon these pressure
09:02AM 24 predictions to prepare their mud weight. You have to be careful
09:02AM 25 when you are drilling a well, because you want to balance your

09:02AM 1 mud weight to the pressures you're likely to encounter.
09:02AM 2 Q Let's look at TREX-10924.1.1.
09:02AM 3 This is an email from you to Michael Levitan. Do
09:02AM 4 you recognize this, Dr. Merrill?
09:02AM 5 A Yes, sir.
09:02AM 6 Q And in the highlighted portion it says: Here is a new
09:02AM 7 request from the science team (Tom Hunter/Secretary Chu) and
09:02AM 8 makes a reference to a request for a plot of pressure data.
09:03AM 9 Do you remember this?
09:03AM 10 A Yes, sir.
09:03AM 11 Q And what were you doing?
09:03AM 12 A Well, the science -- the government wanted us to actually
09:03AM 13 generate some of these derivative plots because I believe their
09:03AM 14 software they were using at the time didn't do derivative
09:03AM 15 analyses.
09:03AM 16 And, although Cindy bobbled the nomenclature here,
09:03AM 17 there are not revisions of a Horner plot. But we were asked to
09:03AM 18 actually present not only a Horner analysis, but also a
09:03AM 19 derivative analysis for certain flow rate assumptions.
09:03AM 20 Because, again, you have to assume a flow rate to
09:03AM 21 construct one of these derivative plots.
09:03AM 22 Q And let's take a look at TREX-10924.21.1.
09:03AM 23 And these plots that you prepared for Secretary
09:03AM 24 Chu and Tom Hunter, what input value were you using for rock
09:04AM 25 compressibility?

09:04AM A Well, these weren't actually presented. These were the slides that I sent to Mike Levitan to review prior to the presentation to the government.
09:04AM Q And did you use 6 microsips in your analysis that you presented to the government?
09:04AM A Yes, we did.
09:04AM Q Let's look at TREX-9318.1.1.
09:04AM Another email from you with copies to Tooms and Yeilding and Baker.
09:04AM Do you know what this is, Dr. Merrill?
09:04AM A Yes. This appears to be the email that I sent following the previous email once we had finalized our presentation to the government. The attachments, for example, say: Bob match 25th of July; ML for Mike Levitan review, final.
09:05AM Q And, again, let's go look at portions from what was transmitted TREX-9318.4.1.
09:05AM What was the rock compressibility input you were using in this work?
09:05AM A 6 microsips.
09:05AM Q Let's go back to our timeline, D-24698-3.
09:05AM Dr. Merrill, you briefly used the alternative cases of 12 and 18 in evaluating the risks of shut-in.
09:05AM After the shut-in, what number were you using for rock compressibility in the analyses you did of Macondo?
09:05AM A 6 microsips.

09:05AM 1 Q Did you ever use something other than 6 microsips?
09:05AM 2 A At the time of the wellbore integrity test, because we were
09:05AM 3 very concerned with wellbore integrity and we wanted to be
09:05AM 4 aligned with the government, we also used the values that the
09:05AM 5 government were using for their interpretation.
09:06AM 6 And so, when we ran those internally, we used
09:06AM 7 other values.
09:06AM 8 Q In terms of your own modeling using your own engineering
09:06AM 9 judgment and that of other BP scientists and engineers provided
09:06AM 10 to you, what number did you use following the shut-in?
09:06AM 11 A 6 microsips.
09:06AM 12 Q Let's go over one more document, TREX-10923.1. Do you
09:06AM 13 recognize this, Dr. Merrill?
09:06AM 14 A This is a note to Mike Levitan.
09:06AM 15 Q And what are you writing to Mike Levitan about?
09:06AM 16 A This is related to the derivative plots in the modeling that
09:06AM 17 we were just discussing.
09:06AM 18 Q Let's go to TREX-10933.3.1.
09:07AM 19 What rock compressibility number were you using in
09:07AM 20 this modeling?
09:07AM 21 A 6 microsips.
09:07AM 22 Q Dr. Merrill, let me just wrap up the discussion about rock
09:07AM 23 compressibility by asking you based on your engineering career,
09:07AM 24 your reservoir engineering career at BP, what was, in your
09:07AM 25 decisions with respect to modeling pressure buildup or analyzing

09:07AM 1 the Macondo reservoir, what was your reasoning behind using 6
09:07AM 2 microsips for rock compressibility other than the period just
09:07AM 3 before shut-in? What's your --
09:07AM 4 MR. CHAKERES: Your Honor, I think this is --
09:07AM 5 THE WITNESS: I'm not sure.
09:07AM 6 THE COURT: Wait one second.
09:07AM 7 MR. CHAKERES: This is trying to dress up expert
09:07AM 8 testimony as fact testimony. We'd object.
09:08AM 9 MR. BOLES: If they are not going to enquire into the
09:08AM 10 engineering, judgment, or thought process of BP engineers and
09:08AM 11 scientists, then I'll withdraw the question.
09:08AM 12 Otherwise, I think that's relevant to what their
09:08AM 13 raising and what their experts are apparently basing their
09:08AM 14 decisions on rock compressibility on.
09:08AM 15 THE COURT: I don't know what they're going to ask.
09:08AM 16 We'll deal with that when we get to it.
09:08AM 17 But I agree with the objection, so sustained.
09:08AM 18 BY MR. BOLES:
09:08AM 19 Q Let me switch to a different parameter, Dr. Merrill, which
09:08AM 20 is permeability.
09:08AM 21 Did you, in some of your modeling, need an input
09:08AM 22 for permeability?
09:08AM 23 A Yes, sir.
09:08AM 24 Q Briefly, what is permeability?
09:08AM 25 A Permeability is a measure of however easily fluid, either

09:08AM 1 gas, water, or oil, flows through a rock.
09:08AM 2 Again, it's hard to conceive of fluid flowing
09:08AM 3 through a rock because it's not our experience. But it's a
09:09AM 4 measure of just how easily fluid flows through a rock when a
09:09AM 5 pressure drop is applied across it.
09:09AM 6 Q And where did you get the data or where did you get the
09:09AM 7 number that you used in your modeling for permeability?
09:09AM 8 A I received it in a spreadsheet that was provided to me by
09:09AM 9 Kelly McAughan.
09:09AM 10 Q Let's take a look at D-24727, which is a more legible
09:09AM 11 call-out of what I believe was TREX 130138.
09:09AM 12 Do you recognize this, Dr. Merrill?
09:09AM 13 A Well, I recognize the Excel spreadsheet behind the --
09:09AM 14 whatever this is.
09:09AM 15 Q Right. And let's take a look at the numbers in this more
09:09AM 16 legible call-out from that spreadsheet.
09:09AM 17 Do you recall looking at reported numbers for
09:09AM 18 Macondo permeability under the categories such as arithmetic air
09:10AM 19 permeability, referring to the first column there, geometric air
09:10AM 20 permeability, perm converted to oil and perm used in model?
09:10AM 21 A Yes, sir.
09:10AM 22 Q And can you explain to Judge Barbier what you did -- by the
09:10AM 23 way, the yellow highlighting on the bottom if we look at the
09:10AM 24 left-hand column, it says M56D, M56E, and M56F.
09:10AM 25 Do you see that?

09:10AM A Yes, sir.
09:10AM Q What's that referring to, Dr. Merrill?
09:10AM A Those were the three reservoir layers that we believed were
09:10AM contributing to flow in this incident.
09:10AM Q Can you explain to Judge Barbier how you used these four
09:10AM columns of data, if you used them, in coming up with
09:10AM permeability numbers you used as a senior reservoir engineer in
09:10AM your modeling and analytical work for BP during the incident?
09:10AM A Well, the first two -- the first two columns where it says
09:11AM arithmetic air permeability show the values that are log derived
09:11AM from a correlation between porosity and permeability that's
09:11AM based on core data.
09:11AM Then you look at the squiggles on the log and you
09:11AM actually build up a more detailed distribution of permeability
09:11AM versus depth.
09:11AM And then you average them across those intervals,
09:11AM and there's an arithmetic average there and a geometric average
09:11AM there, and that's a measure of how variable the permeability is
09:11AM within the layer.
09:11AM So, for example, M56E, you see the arithmetic air
09:11AM perm average is about 500 and the geometric air perm average is
09:11AM about 300. That's actually fairly close for those two averages.
09:12AM And so you would conclude that the M56E was fairly
09:12AM homogenous. But the M56F, the arithmetic perm average is over
09:12AM 1400 and the geometric air permeability average is about 130.

09:12AM 1 So you would conclude on that basis that the M56F was less
09:12AM 2 homogenous.
09:12AM 3 But you would never use the air permeability. You
09:12AM 4 then need to convert the measured air permeability to what the
09:12AM 5 effective permeability is in the presence of oil.
09:12AM 6 And so, in the model, you can see that I used the
09:12AM 7 permeability converted to oil values of -- we use a conversion
09:12AM 8 factor of .85 for all of the layers except for those which had
09:12AM 9 very, very low permeabilities to start with.
09:12AM 10 I was deliberate to actually -- in fact, you can
09:13AM 11 actually see I added some permeability to a layer which didn't
09:13AM 12 have any reported permeability. And the sole reason I did that
09:13AM 13 was because this model, as I mentioned, was originally created
09:13AM 14 for relief well planning, and we wanted to actually understand
09:13AM 15 the maximum depletion in these other layers.
09:13AM 16 And, frankly, not a lot's going to flow out of the
09:13AM 17 layer with three millidarcy permeability.
09:13AM 18 Q That 85 percent conversion factor that you used to go from
09:13AM 19 air permeability to oil permeability, where did you get that,
09:13AM 20 Dr. Merrill?
09:13AM 21 A During the time of the incident I -- I was not aware where
09:13AM 22 this value came from. I understood that it was based on an
09:13AM 23 analog, but I don't know. I did not know the basis of it.
09:13AM 24 Q And had you ever done conversions of air permeability to oil
09:13AM 25 permeability from other reservoirs?

09:13AM A Yes, sir.
09:13AM Q Did you consider using a different number or than 85 percent
09:14AM for Macondo?
09:14AM A No, sir.
09:14AM Q Were there other lower numbers that you had available that
09:14AM you didn't use because you wanted to be estimating on the high
09:14AM side of permeability?
09:14AM A No, sir. It was actually not my call to use that factor.
09:14AM Q Now, you mentioned that you wouldn't ever use air
09:14AM permeability in your work. I want to go back though to the air
09:14AM permeability number.
09:14AM MR. BOLES: Yes, counsel?
09:14AM MR. CHAKERES: There's no question, but I was objecting
09:14AM in case there was expert testimony elicited. So the objection
09:14AM stands.
09:14AM THE COURT: All right. I guess there's no objection.
09:14AM BY MR. BOLES:
09:14AM Q All right. Let's go to the first column, arithmetic air
09:14AM permeability. You see in that first column of numbers there,
09:14AM Dr. Merrill, going down to the highlighted part, and I want to
09:14AM focus only M56D and E, the first two of those three highlighted
09:15AM rows.
09:15AM A Yes, sir.
09:15AM Q Those were the two thicker layers?
09:15AM A I think so, But the numbers are on that little bit that

09:15AM 1 nobody can read, so...
09:15AM 2 Q Now, can you read that for the M56D arithmetic air
09:15AM 3 permeability that it's 257.67?
09:15AM 4 A Yes, sir.
09:15AM 5 Q And that for M56E arithmetic air permeability it's 514.04?
09:15AM 6 A Yes, sir.
09:15AM 7 Q Have you ever seen those reported or heard those discussed
09:15AM 8 in BP as sort of a rounded off way as permeabilities between 250
09:15AM 9 and 500 millidarcies?
09:15AM 10 MR. CHAKERES: Excuse me, Your Honor, that calls for
09:15AM 11 hearsay.
09:15AM 12 THE WITNESS: I don't actually understand the question.
09:15AM 13 BY MR. BOLES:
09:15AM 14 Q Sure. Did you ever use a range of permeabilities in your
09:16AM 15 modeling as suggested by the numbers for arithmetic air
09:16AM 16 permeability, which I'm going to round off of 250 to 500
09:16AM 17 millidarcies?
09:16AM 18 A I don't recall using any numbers in my simulation work
09:16AM 19 except for the last column here.
09:16AM 20 Q Which is labeled permeability used in model?
09:16AM 21 A Yes, sir.
09:16AM 22 Q Which had that discount factor or conversion factor of 85
09:16AM 23 percent from air permeability to oil permeability?
09:16AM 24 A Yes, sir.
09:16AM 25 Q Did any reservoir engineer on your team use a range of

permeability of 250 to 500 millidarcies based on air permeability?

A I don't think so. Not under my direction.

MR. BOLES: Thanks, Dr. Merrill.

MR. CHAKERES: Good morning, Your Honor. My name is Nat Chakeres on behalf of the United States.

THE COURT: Go ahead.

CROSS EXAMINATION

BY MR. CHAKERES:

Q Good morning, Dr. Merrill. My name is Nat Chakeres, and I have you on cross examination.

A Good morning.

Q I would like to go back to what you talked about this morning about the period in early July 2010.

A Yes, sir.

Q You understood at that time that a Capping Stack was going to be installed; correct?

A Yes, sir.

Q And there's going to be attempts to shut the Capping Stack; correct?

A Yes, sir.

Q And there's concern about what you call well integrity; correct?

A Yes, sir.

Q Now, you discussed a presentation you gave regarding

09:18AM 1 reservoir depletion modeling around July 6th; correct?
09:18AM 2 A Yes, sir.
09:18AM 3 Q In that meeting you described there was Paul Tooms, Kate
09:18AM 4 Baker, James Dupree, yourself, a number of individuals from the
09:18AM 5 Gulf of Mexico and elsewhere in BP; correct?
09:18AM 6 A Yes, sir.
09:18AM 7 Q And one reservoir engineer, Dave Schott, raised an issue
09:18AM 8 about the values of core quality and compressibility from rotary
09:18AM 9 sidewall cores; correct?
09:18AM 10 A Yes, sir.
09:18AM 11 Q Did Dave Schott steamroll everybody else in that meeting,
09:18AM 12 all those executives and senior individuals from BP into
09:18AM 13 accepting his view of things?
09:18AM 14 A No, sir. But there was a lively discussion, and so
09:18AM 15 steamroll would be the wrong term. Dave can be quite passionate
09:19AM 16 when he has a subject that is of interest to him.
09:19AM 17 Dave made the case that we should consider higher
09:19AM 18 values for the purposes of examining what the highest pressure
09:19AM 19 would be when we shut-in the well.
09:19AM 20 Q Dave made the case, and after he made the case, a number of
09:19AM 21 individuals, including yourself and Steve Wilson, decided to use
09:19AM 22 the higher values; correct?
09:19AM 23 A For the purposes of planning the well integrity test and the
09:19AM 24 highest pressures we could see, that is correct.
09:19AM 25 Q Now, let's look at your presentation that you gave in that

meeting. That was Exhibit 10839, and I'd like to go to page 31 of that exhibit. So 10839.31.31.US.

A This was on the 6th of July?

Q This is on the 6th of July. I can go back to the cover page if you want to.

A No. I just wanted to make sure which meeting it was. There are a lot of meetings.

Q There are a lot of meetings. You were discussing some of this this morning, right? You had a concern about crossflow into the M110 sand; correct?

A Yes, sir.

Q And you see here that it's small, five feet thick, and in one scenario could fill to fracture pressure in ten days; correct?

A Yes, sir.

Q And that's what you were talking about this morning, you were worried about how fast those sands could fill up and then start fracturing to surface; correct?

A Yes, sir.

Q And if we could go to your exhibit, your presentation that you gave on July 8th, that's Exhibit 1084. If we could go to page 38 of that exhibit.

While we're getting that up, Dr. Merrill, in the modeling that you performed --

THE COURT: Is that what you were looking for?

09:22AM 1 MR. CHAKERES: One page further. If you could rotate
09:22AM 2 that.
09:22AM 3 BY MR. CHAKERES:
09:22AM 4 Q So here we are two years later after we have your about
09:22AM 5 using the higher compressibility values, you are still concerned
09:22AM 6 about the shut-in wellhead pressures. You have the exact same
09:22AM 7 calculation here about the speed at which the M110 sands are
09:22AM 8 going to fill up, don't you?
09:22AM 9 A Yes, sir.
09:22AM 10 Q You did not, at any point between July 6th and July 8th,
09:22AM 11 perform an additional calculation about how fast the 110 sands
09:22AM 12 are going to fill up, did you?
09:22AM 13 A I do not recall, but we didn't -- I don't think this slide
09:22AM 14 has changed between the two dates.
09:22AM 15 Q That's correct. This slide hasn't changed, has it? You are
09:22AM 16 still presenting the same rate at which the M110 sands are going
09:22AM 17 to fill up, aren't you?
09:22AM 18 A The number is the same here.
09:22AM 19 Q Okay.
09:22AM 20 Now, you did change the reservoir depletion
09:23AM 21 calculations between July 6th and July 8th; correct?
09:23AM 22 A I'm not actually sure we did anything more than add a few
09:23AM 23 more simulation cases. The ones we discussed. I had already
09:23AM 24 run the cases -- no, no.
09:23AM 25 Between the 6th and the 8th -- I don't want to get

confused. Between the 6th and the 8th we added the cases we've already discussed about increased aquifer size and increased compressibility.

Q And those cases showed that when you shut in the well, for keeping all else equal, the reservoir is going to recover to a higher pressure; correct?

A That is correct.

Q Now, if we could look at back to your presentation on July 6th, that's Exhibit 10839.

Now, in this exhibit, you had been -- you presented on page 19.

A Can we make it bigger?

Q Yeah. Let's just pull this out. This is your July 6th presentation.

A I can read that. I couldn't read the other.

Q Okay, yeah.

So you testified earlier that you didn't know what the flow rate was at this time; correct?

A That is correct.

Q And if we could call out the third bullet.

You had actually been requested by Kate Baker to avoid making any conclusions about likely flow rates; hadn't you?

A That is correct.

Q And after the well was shut in, you were never told of any

of the flow rate calculations that were performed through the Capping Stack; were you? During the July timeframe.

A I was aware that the government had a team that was actually calculating some number because we talked to them every day.

So I was aware in July during the incident that the government was doing some calculations.

Q Were you aware that anybody at BP was doing some calculations?

A I was not.

Q Were you ever informed of the numbers that either the government or BP was coming up with at that time?

A I may -- I do not remember the numbers. I may have overheard the government's numbers, but I don't recall what they were at the time.

Q Now, I'd like to move to the period after the well was shut in. You testified that at that point you were no longer worried about high pressures.

A That is correct.

Q Now, if we could go to Exhibit 10931.2.1.US.

MR. CHAKERES: My apologies, Your Honor. I'll keep this moving along. While that's coming up -- here we go.

If we could actually go back and call out the entire email from which this call-out is taken to provide context.

You asked a person named David Hutchison to help

09:26AM 1 with some of your modeling, didn't you?
09:26AM 2 A He was one of the people who was helping me do the pressure
09:26AM 3 transient analysis.
09:26AM 4 Q Do you recall asking him to perform some of this work on
09:26AM 5 July 19, 2010?
09:26AM 6 A No, I don't specifically. But I don't deny it either.
09:26AM 7 Q Okay. And if we look at -- so that's 10931.2.1.US.
09:27AM 8 Did you ask David Hutchison on July 19, 2010, to
09:27AM 9 run pressure transient analysis using both compressibility
09:27AM 10 values of 6 microsips and 12 microsips?
09:27AM 11 A I don't recall. I'd have to see the context.
09:27AM 12 Q Okay. Hopefully we can get that up.
09:27AM 13 A What were the two values you said?
09:27AM 14 Q 6 microsips and 12 microsips.
09:27AM 15 A I don't know. I'd have to see the context.
09:27AM 16 Q But the context on July 19, 2010, was that you were no
09:27AM 17 longer worried about the high of the pressures, were you? You
09:27AM 18 were just trying to get it right; right?
09:27AM 19 A We were trying to understand the data we were collecting to
09:27AM 20 make sure that we could -- that it wasn't -- it didn't have any
09:28AM 21 of the anomalies.
09:28AM 22 Q All right. Here's the email from yourself to David
09:28AM 23 Hutchison on July 19th.
09:28AM 24 Do you see that?
09:28AM 25 A Yes, sir.

09:28AM 1 Q And you state in the first line, David, as we discussed, I'd
09:28AM 2 like it second set of eyes on this data; right?
09:28AM 3 A Yes, sir.
09:28AM 4 Q And then down at the bottom you have the list of other
09:28AM 5 important items.
09:28AM 6 Do you see that?
09:28AM 7 A Yes, sir.
09:28AM 8 Q And you provide parameters?
09:28AM 9 A Um-hum.
09:28AM 10 Q At the parameters are on the far side of that line. You
09:28AM 11 have CF, and that would be rock compressibility in this case;
09:28AM 12 right?
09:28AM 13 A Yes, it would.
09:28AM 14 Q And it says either 6 microsips or 12 microsips; right?
09:28AM 15 A Yes, sir.
09:28AM 16 Q Now, you were asked some questions about Exhibit 9318, And
09:28AM 17 I'd like to ask you about some of those.
09:28AM 18 Before I go into the specifics, if we could pull
09:28AM 19 up Exhibit 938.4.1.US. I'd like to ask some questions to
09:29AM 20 confirm what you were doing at this time.
09:29AM 21 At this time, you were looking at the pressure
09:29AM 22 buildups; correct? At the time of July 26, 2010.
09:29AM 23 A Yes, sir.
09:29AM 24 Q And you were presented some cases that you ran in the July
09:29AM 25 25th-July 26th timeframe during your direct exam; correct?

09:29AM 1 A Yes, sir.
09:29AM 2 Q And in those -- at that timeframe, is it correct that what
09:29AM 3 you were trying to do was capture reasonable matches to the
09:29AM 4 pressure transient data that showed these could be reasonable
09:29AM 5 reservoirs consistent with that data?
09:29AM 6 A Would you repeat the question?
09:29AM 7 Q Yes. At the time you were running pressure transient
09:29AM 8 analysis in late July, you were trying to find reasonable
09:29AM 9 matches to the pressure transient analysis data, to the pressure
09:29AM 10 data; correct?
09:30AM 11 A Yes.
09:30AM 12 Q Now, this is one of the cases that was an, Exhibit 9318,
09:30AM 13 that you were shown on direct.
09:30AM 14 Do you see that?
09:30AM 15 A Yes, sir.
09:30AM 16 Q And the flow rate that you assumed here was 45,000 barrels
09:30AM 17 per day; right?
09:30AM 18 A Yes, sir.
09:30AM 19 Q That's at the top.
09:30AM 20 And, again, you assumed that flow rate because you
09:30AM 21 had been given no flow rate information; correct? You assumed
09:30AM 22 the flow rate because it was an unknown.
09:30AM 23 A It was an unknown. We actually did a number of flow rates.
09:30AM 24 Q Right. You were varying the flow rates because it was
09:30AM 25 considered an unknown; correct?

09:30AM 1 A Yes.
09:30AM 2 Q And to match the data at 45,000 barrels per day, you also
09:30AM 3 used a rock compressibility of 6 microsips; correct?
09:30AM 4 A Yes, sir.
09:30AM 5 Q And then if we scroll down a little bit you have a
09:30AM 6 permeability there of 450 millidarcies; don't you?
09:30AM 7 A That's the number on the screen, yes.
09:30AM 8 Q And that was the number that corresponded to a match of the
09:31AM 9 data with 6 microsips and 45,000 barrels per day; correct?
09:31AM 10 A I believe it was because it was prepared on that day, yes.
09:31AM 11 Q And the original oil in place corresponding to that match
09:31AM 12 was 137 million stock tank barrels; correct?
09:31AM 13 A Yes, sir. And that's because when you're doing the pressure
09:31AM 14 transient analysis, what you're actually trying to do is match
09:31AM 15 the boundaries that you're observing during the test with the
09:31AM 16 pressure signature.
09:31AM 17 As a consequence, as you move these things around,
09:31AM 18 the oil changes.
09:31AM 19 Q So let me ask a follow-up question to that. So you can't
09:31AM 20 get a unique solution to what the reservoir looks like from the
09:31AM 21 pressure transient analysis if you didn't have a flow rate;
09:31AM 22 could you?
09:31AM 23 A No, sir. Pressure transient balances and modern pressure
09:31AM 24 transient analysis requires a flow rate as an input.
09:31AM 25 Q Let's go to page 6 of this exhibit.

09:32AM 1 And this is call-out 9318.6.1.US. Then just call
09:32AM 2 it out, these parameters you were you just discussing.
09:32AM 3 You also were able to match the reservoir assuming
09:32AM 4 a flow rate of 30,000 barrels per day; correct?
09:32AM 5 A Yes, sir.
09:32AM 6 Q With a compressibility again of 6 microsips; correct?
09:32AM 7 A Yes, sir.
09:32AM 8 Q And a permeability of 280 millidarcies; correct?
09:32AM 9 A If that's there, yes, sir.
09:32AM 10 Q And the corresponding matching original oil in place that
09:32AM 11 allowed you to match the pressure signature with these other
09:32AM 12 parameters was 84 million stock tank barrels; correct?
09:32AM 13 A Yes, sir.
09:32AM 14 Q Let's go on to page 8 of this exhibit. And this is a match
09:32AM 15 using parameters that you understood Paul Hseih for the United
09:32AM 16 States to be using in his pressure transient analysis; correct?
09:32AM 17 A Yes, sir.
09:32AM 18 Q And that's why it says at the top USGS parameters; correct?
09:32AM 19 A Yes, sir.
09:32AM 20 Q And as you note at the top, Paul Hseih was using, at that
09:33AM 21 time, a higher rock compressibility value than you had been;
09:33AM 22 correct?
09:33AM 23 A Yes, sir.
09:33AM 24 Q He was using compressibility -- well, you have here that
09:33AM 25 he's using a rock compressibility value of 14 microsips;

correct?

A Then I assumed that's what he was using at this time.

Q And he had a flow rate of 50,000 barrels per day; correct?

A That was constant throughout the period. All of these are constant rates.

Q And the original oil in place corresponding to that pressure signature was 110 million stock tank barrels; correct?

A That is what was input into Paul's model. Paul's model was not a pressure transient analysis program. It was a hydrological simulator, and so Paul had to input parameters into his model that we did not use in pressure transient analysis.

For example, in classical pressure transient analysis, you are changing the boundary sizes dynamically with the -- to adjust the shape of your model to the buildup curve.

What Paul did, as I understand it, because we discussed it a little bit, was he added a Lee Squares program to his program to actually change various parameters, including the permeability and I think the compressibility as well, to match the curve.

So it's not quite the same thing. And so these were what his parameters were given to us, and we then input them into our pressure transient analysis program. So this is probably not pressure transient analysis, but this is a reflection of what his model showed in a pressure transient analysis program.

09:34AM 1 Q In your pressure transient analysis program, you were able
09:35AM 2 to use these inputs that you understood he was using and get a
09:35AM 3 match to the pressure data; correct?
09:35AM 4 A We were able to reproduce his pressure signature in our
09:35AM 5 pressure transient analysis program.
09:35AM 6 Q If we could go to page 10 of this exhibit.
09:35AM 7 And these are the conclusions that you present on
09:35AM 8 July 26th; aren't they?
09:35AM 9 A Yes, sir.
09:35AM 10 Q And I'd like to focus on the second bullet. You have stated
09:35AM 11 at that time that there were numerous subsurface realizations
09:35AM 12 that could match the data reasonably well; correct?
09:35AM 13 A Yes, sir.
09:35AM 14 Q And then you said considering there is uncertainty in flow
09:35AM 15 rate, because you did not believe you knew the flow rate at that
09:35AM 16 time; correct?
09:35AM 17 A Yes, sir.
09:35AM 18 Q There's uncertainty in connected volume, correct?
09:35AM 19 A Yes, sir.
09:35AM 20 Q There are uncertainty in static parameters, including
09:35AM 21 compressibility and channel size; correct?
09:35AM 22 A That's what's written here.
09:35AM 23 Q There's uncertainty in flowing bottom hole pressure;
09:36AM 24 correct?
09:36AM 25 A Yes, sir.

09:36AM 1 Q And there's uncertainty in final static bottom hole
09:36AM 2 pressure; correct?
09:36AM 3 A Yes, sir.
09:36AM 4 Q So even with that pressure buildup data that you had, and
09:36AM 5 even with the Weatherford lab data that you had, you were still
09:36AM 6 stating that there was uncertainty in things like flow rate,
09:36AM 7 connected volume and static parameters like compressibility?
09:36AM 8 A At this point, the government was using 12 microsips or 14,
09:36AM 9 or whatever the number was. It bounced around. And it was
09:36AM 10 uncertain, because they were running models that required a
09:36AM 11 higher compressibility to get the match that they did.
09:36AM 12 We weren't going to disagree with the match. Our
09:36AM 13 principal concern here all along was wellbore integrity. We
09:36AM 14 wanted to ensure when we matched their models and shadowed their
09:36AM 15 work that they wouldn't come up with an interpretation that
09:37AM 16 would catch us by surprise, and, you know, that would indicate
09:37AM 17 that there was a loss of integrity.
09:37AM 18 We were not doing any of this work for flow rate
09:37AM 19 purposes.
09:37AM 20 Q Wasn't my question. My question was just that even with the
09:37AM 21 pressure data you had and the other data you had regarding the
09:37AM 22 reservoir, what you were doing here was not uniquely defining
09:37AM 23 the reservoir. What you were doing here was showing that there
09:37AM 24 were multiple cases with well integrity that matched the data;
09:37AM 25 correct?

09:37AM A Yes, sir.

MR. CHAKERES: No further questions. Thank you.

THE COURT: All right. Redirect, Mr. Boles?

MR. BOLES: Yes, a few questions, Your Honor.

REDIRECT EXAMINATION

BY MR. BOLES:

Q Dr. Merrill, I think the phrase you used was you were shadowing the work of Dr. Hseih and other government scientists and engineers.

A Yes, sir.

Q So for example, let's look at TREX-9318.8.1.

In the course of shadowing them, did you sometimes run models with their input numbers such as rock compressibility?

A I think I just said that, yes.

Q So for example, in this TREX-9318 where it says 14 microsips, it says in the caption on the top the second row, blowout, USGS parameters, correct?

A Yes, sir.

Q And that references the United States geological survey?

A Yes, sir.

Q And you also were shown TREX-10931.2. If we can look at that.

I don't have a blowup of that, but let's just look at it. This is the email from Hutchinson to you, or from --

09:39AM 1 emails between you and Hutchison?
09:39AM 2 A Yes, sir.
09:39AM 3 Q And you were shown this because of the reference to 12
09:39AM 4 microsips?
09:39AM 5 A Excuse me?
09:39AM 6 Q Were you shown this document because there was a reference
09:39AM 7 there to 12 microsips?
09:40AM 8 A Yes, there is.
09:40AM 9 Q And, sir, do you know whether that number involved this
09:40AM 10 parallel effort you were making to shadow the government
09:40AM 11 analysis?
09:40AM 12 A As I previously testified, I don't actually remember this
09:40AM 13 correspondence, but it might have been. I don't know.
09:40AM 14 Q Did you ever run models that you're aware of or do any
09:40AM 15 analysis on the Macondo well after the shut-in decision using a
09:40AM 16 compressibility number other than 6 microsips?
09:40AM 17 A Well, yes, because I was using sometimes the USGS geological
09:40AM 18 survey's values.
09:40AM 19 Q Well taken.
09:40AM 20 Other than the shadowing of the government
09:40AM 21 modeling using their inputs, in terms of your own judgment that
09:40AM 22 you applied in deciding what to input for rock compressibility
09:40AM 23 to model the behavior of the Macondo reservoir, did you
09:41AM 24 consistently use 6 microsips after shut-in?
09:41AM 25 A I believe so. I don't recall every run I made after the

shut-in. I just don't remember every run that I made after the shut-in.

But I tended to use 6 for the flow rates that we were assuming. It was not an issue.

Q When it came to modeling the pressures to be predicted in drilling of the relief well, what number did you use?

A I have always used 6.

Q And did you, in your decision making as a reservoir engineer deciding what input to put in, what did you regard as the most likely value for rock compressibility?

A For all of my simulation work related to the relief well, I used --

MR. CHAKERES: Objection, Your Honor, this is calling for expert testimony.

MR. BOLES: Again, they put in issue his decision making and that of other BP engineers and scientists about why they used and what they used for rock compressibility.

MR. CHAKERES: He asked for his opinion. We're just bringing out what they used.

MR. BOLES: If counsel wants to stipulate that the beliefs of BP reservoir engineers and scientists are not relevant to what the value of rock compressibility is, I'll drop the question.

But otherwise, I think they've put this in issue.

THE COURT: Re-ask the question.

09:42AM BY MR. BOLES:
09:42AM Q Sure. In the modeling work you did, Dr. Merrill, when you
09:42AM were deciding what number to put in for rock compressibility,
09:42AM what was your judgment as to what the most likely value was of
09:42AM the true rock compressibility of the Macondo reservoir?
09:42AM THE COURT: I'm going to sustain the objection. I
09:42AM think the question -- I think the witness has already answered
09:42AM that he got that number from the only so-called measured data
09:42AM that was available, the Weatherford sidewall cores; right?
09:42AM THE WITNESS: It's my understanding that the only
09:42AM measured data there was, Your Honor, was the sidewall cores.
09:42AM THE COURT: That's what you used.
09:42AM MR. CHAKERES: Yes, sir.
09:43AM BY MR. BOLES:
09:43AM Q Dr. Merrill, do reservoir engineers, in deciding what inputs
09:43AM to put into reservoir models, use judgment about how to use the
09:43AM data and come up with inputs?
09:43AM A Excuse me? I don't understand your question.
09:43AM Q Sure. What was the basis for your decision to put in a
09:43AM number for rock compressibility?
09:43AM MR. CHAKERES: Your Honor, I am going to object to
09:43AM that.
09:43AM THE COURT: Sustained. Sustained. I think he answered
09:43AM that.
09:43AM MR. BOLES: That's all I have, Your Honor.

09:43AM THE COURT: Okay. Thank you, sir. You're done.
09:43AM All right. Let's take a 15-minute recess.
09:43AM (Proceedings in recess.)
10:00AM THE COURT: Mr. Fields.
10:00AM MR. FIELDS: Good morning, Your Honor, Barry Fields. BP and Anadarko call as their next witness Dr. Michael Zaldivar.
10:00AM **MICHAEL ZALDIVAR**, being first duly sworn, testified as follows:
10:00AM THE CLERK: Take a seat. If you'll state and spell your name for the record, please.
10:00AM THE WITNESS: My name's Michael Zaldivar, M-I-C-H-A-E-L Z-A-L-D-I-V-A-R.
10:00AM DIRECT EXAMINATION
10:00AM BY MR. FIELDS:
10:00AM Q Dr. Zaldivar, my name is Barry Fields, and I will be conducting your direct examination on behalf of BP and Anadarko.
10:01AM THE COURT: There appears to be a pending *Daubert* motion or a motion in limine?
10:01AM MR. CHAKERES: Yes, Your Honor.
10:01AM THE COURT: I have looked at that, by the government, pertaining to this witness. It appears to me that the government's objection really goes to the weight that I should give to Dr. Zaldivar's testimony, so I'm going to overrule or deny the motion.
10:01AM MR. CHAKERES: Thank you, Your Honor.

10:01AM MR. FIELDS: Thank you, Your Honor.

10:01AM May we proceed?

10:01AM THE COURT: Sure.

10:01AM BY MR. FIELDS:

10:01AM Q Dr. Zaldivar, would you please introduce yourself to the

10:01AM Court.

10:01AM A My name is Dr. Michael Zaldivar. I'm president and founder

10:01AM Evoleap.

10:01AM Q We'll get into more details about your qualifications, but

10:01AM for right now will you provide the Court with just a thumbnail

10:01AM sketch on your expertise.

10:01AM A Sure. I have 11 years experience as a multiphase flow

10:01AM expert and flow assurance engineer. A flow assurance engineer

10:02AM is an engineer that ensures that hydrocarbons that leave the

10:02AM reservoir make it to the receiving facilities topside. So they

10:02AM focus on wells, flow lines or pipelines, and risers.

10:02AM Q BP and Anadarko hired you in this case?

10:02AM A That's correct.

10:02AM MR. FIELDS: Let's pull up D-24552-1.

10:02AM BY MR. FIELDS:

10:02AM Q Can you give us an overview of the general issues or

10:02AM questions that you were asked to address by BP and Anadarko?

10:02AM A Sure.

10:02AM First, I was asked to determine whether a flow

10:02AM pattern known as slug flow was present during mid-May of 2010.

10:02AM Second, if that pattern was present -- since slug flow means there are certain bounds to the flow rate, what conclusions could be drawn about the flow rate during that period.

10:02AM Q Now, have you formed opinions on the two questions that are set forth on D-245521?

10:03AM A I have.

10:03AM Q Before getting into those opinions in more detail, let's discuss your background.

10:03AM MR. FIELDS: Can you pull up D-24553.

10:03AM BY MR. FIELDS:

10:03AM Q Using this particular demonstrative, can you provide the Court with an overview of your educational background.

10:03AM A Yes. I received my Bachelors of Science in chemical engineering from the University of Houston in 1997.

10:03AM I then went to the University of Michigan where I received a Masters and Ph.D. in chemical engineering in 2002.

10:03AM Q Let's take a look at your work experience, which is also listed on this particular demonstrative exhibit. Let me ask you the question: Have you been involved in the oil and gas industry since you obtained your Ph.D. in 2002?

10:03AM A Yes. My first job was directly in the oil and gas industry.

10:03AM Q Was your first job Multiphase Solutions?

10:03AM A Yes, that's correct.

10:03AM Q Tell us what you did at Multiphase Solutions while were you

working there it looks like from 2002 to 2008?
A During that period, I served as a flow assurance engineer, Which means that I built models to look at systems just like we'll be discussing today.
Q As a flow assurance engineer at Multiphase Solutions, were you involved in either modeling or analyzing slug flow and pipes or pipelines?
A Yes. Slug flow is a very common problem that flow assurance engineers are faced with daily, and I looked at that problem numerous times over that period, building models to study that problem, analyze that problem.
Q Where did you go after leaving Multiphase Solutions in 2008?
A I went to Knowledge Reservoir.
Q What did you do there?
A At Knowledge Reservoir I was the director of knowledge management. I was responsible for looking at and improving subsurface work flows or looking at the business practices around all of the things that happen below the surface, reservoir engineering, geomechanics, geology, those things.
Q While were you at Knowledge Reservoir, were you involved in developing any models of flow?
A I wasn't directly responsible for the building of models. However, a colleague that I used to work with at MSI came across to Knowledge Reservoir with me. He was responsible for flow assurance. We often discussed the work that he did during that

time.

Q After you left Knowledge Reservoir in approximately 2010, what did you do next?

A I went to Kongsberg Oil and Gas Technologies, where I was the Americas geomarket manager for LedaFlow. LedaFlow is a multi-phase simulator like OLGA.

In that capacity, I was responsible for the management of two different teams: a team of engineers responsible for the engineering support and engineering studies and training around LedaFlow, as well as a team of developers or personnel responsible for developing the software.

Q And, while you were at Kongsberg, were you involved in developing various models to simulate multiphase flow?

A I was. In my capacity I was responsible for engineering support, so quite frequently models were built and lots of discussions around that process.

But that was one of my primary responsibilities.

Q Finally, tell us about what type of work you do at Evoleaf where you've been, looks like since 2012, or last year?

A So in 2012 I started my own company. It is an engineering service company. We provide flow assurance services to operators around the world, and we also provide software in the flow assurance community to those same customers.

Q You referenced, I think, LedaFlow and OLGA. Those are multiphase flow simulators?

10:07AM A They are.
10:07AM Q Help the Court understand what a multiphase flow simulator is in general.
10:07AM A So a multiphase flow simulator is a simulator that looks at oil, gas, and potentially water and their behavior in wells, pipelines, and risers.

Typically you have information about -- you have measurement on the top side or you'll have a couple measurements in the well, but you don't really understand what's happening.

These models focus on all of the things that happen in between the measurement points.

10:05AM MR. FIELDS: Let's pull up D-24563, which I believe is from appendix C of your report.
10:05AM BY MR. FIELDS:
10:08AM Q And this particular slide lists various transient multiphase simulators?
10:08AM A It does. It lists both OLGA and LedaFlow which are used specifically in this investigation. It references both the history, so both of these simulators have a long history. OLGA was the dominant software in this field for 30-plus years. LedaFlow has about a ten-year history of studying and producing results of multiphase flow and studying that phenomena.
10:08AM Q As a flow assurance engineer or expert, do you have experience in using OLGA to model or evaluate multiphase flow in pipes or pipelines?

10:09AM A I do. During my career I've used OLGA repeatedly throughout
10:09AM that career.
10:09AM Q You also referenced this LedaFlow simulator. Do you have
10:09AM experience using LedaFlow to analyze or evaluate multiphase flow
10:09AM through pipes or pipelines?
10:09AM A I do. I am rather unique in my experience with LedaFlow. I
10:09AM was hired in quite early in that software process or the taking
10:09AM of that process from a research tool to a commercial tool.
10:09AM I would say that I have maybe the most experience,
10:09AM or certainly arguably one of the most experiences with that
10:09AM particular piece of software.
10:09AM Q As a flow assurance engineer, why do you need to use
10:09AM multiphase flow simulators?
10:09AM A Again, multiphase simulators are really about the
10:09AM understanding of oil and gas. It's about, you know, if you have
10:10AM some measurements at the well and you have some measurements at
10:10AM the receiving facilities, there are a host of problems that can
10:10AM occur between one measurement and another measurement.
10:10AM It's about understanding the evolution of what's
10:10AM occurring between those two points.
10:10AM Q Do flow assurance engineers such as yourself use multiphase
10:10AM simulators such as OLGA and LedaFlow to model multiphase flows
10:10AM in various pipelines around the world?
10:10AM A Yeah. These are the two commercially available tools, and
10:10AM they are used almost for every pipeline or nearly all pipelines

around the world to understand what's going on.

Q Now, I don't want to get into a dissertation about this, but can you in a very brief fashion sort of tell the Court the general differences between OLGA on the one hand and LedaFlow on the other hand?

A Well, OLGA and LedaFlow are very similar models. They are first principle mechanistic models, meaning they incorporate the physics of the problem into the model as opposed to an empirical model which is derived from just experimental evidence.

Both of these models have similar equations. The subtleties are very small and very technical. As an example of that, LedaFlow has taken a physics-based approach to the modeling of hydrodynamic slugging; whereas OLGA takes a different approach that is not physics based for that particular phenomenon.

Q How do flow assurance engineers such as yourself know that OLGA or LedaFlow or other multiphase flow simulators can accurately model multiphase flow in pipes or pipelines?

A Well, these are considered enabling technologies. So as oil production moved from onshore to offshore, and in particular into deep water, the industry needed tools to understand what was happening. If there was a problem, it was a very expensive problem to fix as you moved into deeper and deeper water.

That's what started the development of these tools. The fact, that we've been developing in deeper and

deeper water is a tribute to how well these tools work.

In addition to that, there's a huge body of experimental or of experiments that focus on multiphase flow. Both of these models incorporate that and compare against those experimental results.

All of that would lead you to conclude that these models are very accurate in their predictions of multiphase flow.

Q If we focus on your use of multiphase flow simulators throughout your career, on roughly how many projects or fields have you been involved in sort of performing modeling services using multiphase flow simulators?

A I don't have a specific number, but certainly over 50.

Q Have you previously used software such as OLGA and LedaFlow to actually calculate or evaluate the gas or oil flow rates that go through pipes or pipelines?

A Yes. It's quite common to look at flow rates through gas pipelines, specifically if you were to think about slug flow, which is the context of this. Since slug flow is a problem and it's a bounded problem, meaning it only occurs in a certain range of flow rates, it's a very regular exercise for a flow assurance engineer to determine the boundaries of where slug flow would occur and advise an operator how to avoid slug flow, or in the case that it's unavoidable, how to operate when slug flow would be present.

10:14AM MR. FIELDS: Thank you.

10:14AM You Honor, BP and Anadarko tender Dr. Michael Zaldivar as an expert in modeling and evaluating multiphase flow through pipes and pipelines, including evaluating slug flow.

10:14AM THE COURT: All right. He'll be accepted.

10:14AM BY MR. FIELDS:

10:14AM Q Dr. Zaldivar, you prepared an expert report in this case?

10:14AM A I did.

10:14AM Q And that expert report set forth your opinions as well as the reasons for your opinions?

10:14AM A That's correct.

10:14AM MR. FIELDS: If we could pull up D-24560.

10:14AM BY MR. FIELDS:

10:14AM Q Is this the cover page of the expert report that you prepared in this litigation?

10:14AM A It is.

10:14AM MR. FIELDS: You Honor, we offer TREX Exhibit 11683 and 2 into evidence.

10:14AM THE COURT: All right. Those are admitted.

10:14AM (Exhibits admitted.)

10:15AM THE COURT: Is that one report or two?

10:15AM MR. FIELDS: It's just one report, Your Honor.

10:15AM THE COURT: That report is in there, okay.

10:15AM MR. FIELDS: Let's pull up D-24561.

10:15AM BY MR. FIELDS:

10:15AM Q Before getting into the details of your analysis, can you provide the Court with an executive summary or a high level summary of the analysis that you performed in order to address the two questions that you were asked to answer.

10:15AM A Sure.

In order to address those questions, it started with of course reviewing lots of the information and documentation about the existence of slug flow. Several scientists had noted that it existed.

And then there was a very comprehensive process to review hundreds of videos, or really hundreds of hours of ROV videos documenting slug flow in order to bound where slug flow occurred.

During that process, I was also able to link slug flow to a portion of the riser that was moving, which I refer to as the buoyant loop. Once I had done that, I built multiple models of the full riser system and the kink using both LedaFlow and OLGA.

I performed well in excess of a thousand simulations, and all of this took me about six months to accomplish, with the ultimate goal to provide some sort of conclusion with regards to the flow rate.

MR. FIELDS: Let's pull up D-24552-2.

BY MR. FIELDS:

Q We'll obviously get into the details of your analysis as

10:16AM well as the reasons for your opinions, but can you provide the
10:16AM Court with just a high level answer to the questions that you
10:16AM were asked to address?
10:16AM A Sure.
10:16AM To the first question as to whether slug flow was
10:16AM present during mid-May 2010, I was able to conclude that it was,
10:17AM in fact, present, And that it was present specifically between
10:17AM May 13th and May 20th.
10:17AM What was particularly unique in this case is that
10:17AM slug flow exhibited very regular or patterned behavior; whereas
10:17AM slug flow is generally characterized as a chaotic or random sort
10:17AM of phenomena.
10:17AM With respect to No. 2, what conclusions could be
10:17AM drawn about the flow rate, I was able to conclude that the total
10:17AM flow rate from the Macondo well during that same period, from
10:17AM May 13 to May 20, was a best estimate of 30,000 stock tank
10:17AM barrels per day, for a range of possible flow rates between
10:17AM 24,900 and 35,900 stock tank barrels per day.
10:17AM MR. FIELDS: Let's pull up D-23468.
10:17AM BY MR. FIELDS:
10:17AM Q We've heard a fair amount about multiphase flow.
10:17AM Can you use this demonstrative exhibit to help us
10:18AM understand multiphase flow patterns in horizontal pipes,
10:18AM including slug flow?
10:18AM A Sure.

10:18AM So what's complicated about multiphase flow is that it can orient itself spatially.

Q What does that mean?

A It means that the liquid and the gas can be in all sorts of configurations inside the pipe, which also means differences with respect to pressure drop, differences with respect to all of the properties that you would expect in a flow rate.

If we were to look -- and this is examples of flow patterns or these geospacial orientations in a pipe, starting at the top, this is very common at low flow rates where the gas velocity is low and the liquid velocity is low or that they are similar in speed. This is referred to as stratified smooth where the gas is flowing across the top. It looks like pipe, and the bottom is the oil.

If you to imagine the gas velocity increasing with the liquids flowing at the same rate, you would see waves form on the surface, and that's referred to as stratified wavy flow.

If you were to continue to increase the gas, you would you see those waves eventually bridge the pipe, and that would form something called slug flow, which we'll be talking a lot about today.

The other two that are listed, annular flow, occurs at even faster velocity other lower level holdups.

Bubble flow would occur if the pipe was almost liquid full and gas was bubbling through.

10:19AM Q You used a phrase a liquid holdup what is that?
10:19AM A The liquid holdup refers to the amount of liquid that's in a
10:20AM pipe section.
10:20AM MR. FIELDS: Why don't we pull up D-23840, which is a
10:20AM demonstrative exhibit that you helped us prepare.
10:20AM BY MR. FIELDS:
10:20AM Q Can you sort of set this up and explain what this particular
10:20AM demonstrative exhibit shows.
10:20AM A So what we're going to see in this video in a second is
10:20AM we're going to see a slug from an experimental setup.
10:20AM If you'll recall from the previous slide, slug
10:20AM flow was characterized by a liquid-dominant flow followed by a
10:20AM gas pocket or what looked like stratified flow.
10:20AM What we're going to see here if we can go ahead
10:20AM and hit play, is we will see the start of a slug and you're
10:20AM seeing the crashing, the very high turbulence area which
10:20AM entrains bubbles in. I can't really see the bubbles, but there
10:20AM are some bubbles in the main slug body or the oil slug, then
10:21AM followed by a gas pocket.
10:21AM Now, a gas pocket normally has liquid flowing
10:21AM along the bottom, so it looks like a lot like the stratified
10:21AM flow regimes that we were talking about here.
10:21AM Here we're seeing it loop again. Again, this is
10:21AM the start of the slug followed by the main slug body, and then
10:21AM we'll see the tail of the slug in a second.

10:21AM (Videotape played.)

BY MR. FIELDS:

Q Obviously, you've talked about slug flow and the existence of slug flow.

What are some of the reasons that you actually have slug flow in pipes or pipelines?

A When slug flow occurs, it is an undesirable event, or at least with respect to oil and gas production. But it occurs at specific ratios of oil and gas speeds.

Q And what does the existence of slug flow tell you, if anything, about flow rate, or what can it tell you?

A Well, slug flow, as I mentioned earlier, it provides a bound. At very, very high flow rates slug flow doesn't exist at all. It breaks down into miss flow or some other flow regimes that we saw earlier. It is generally characterized as a lower flow rate phenomena.

Q Before we talk about your analysis and opinions in depth, let's get a lay of the land.

MR. FIELDS: Let's pull up D-24679, which is an animation you helped us create, and sort of give the Court a lay of the land.

BY MR. FIELDS:

Q What does this show? And we'll be looking at this later; but just provide us with some information about what does this show about the configuration of the pipes and the blowout

10:22AM 1 preventer on the bottom of the Gulf of Mexico.
10:22AM 2 A Sure. What we're seeing here is the riser once it's fallen
10:23AM 3 to the seafloor as far as it got on May 13th.
10:23AM 4 And, just to take one step backward, what we know
10:23AM 5 is that on April 22nd, the riser detached from the drilling rig
10:23AM 6 and then it fell. And it took some time to fall to the
10:23AM 7 seafloor. And, in fact, during this period it hasn't completely
10:23AM 8 fallen to the seafloor. What we're seeing here is its position
10:23AM 9 or the highest position it reaches on May 13th.
10:23AM 10 If you were to look at the left side of this
10:23AM 11 diagram, this is the BOP. Just above that is the leak or the
10:23AM 12 kink section of the riser. Then it goes underground for a
10:23AM 13 little bit, comes back up.
10:23AM 14 What you're seeing here with the rectangle in the
10:23AM 15 center, that is the drilling rig wreckage. What I am showing
10:23AM 16 accurately, I don't know about the scale of the wreckage, but I
10:23AM 17 am showing where the wreckage touches the riser.
10:24AM 18 And then it comes around to this section of the
10:24AM 19 riser.
10:24AM 20 I believe this is a video but it doesn't appear to
10:24AM 21 be playing.
10:24AM 22 So the riser is moving. Then this is what I refer
10:24AM 23 to as the buoyant loop, and this moves up and down. So it hits
10:24AM 24 the seafloor and then did goes back to floating.
10:24AM 25 And then, in the center of the screen, we have the

10:24AM riser end or the riser end plume.

10:24AM At this time, from May 13th to May 20th, when you're seeing both the riser motion, you only have really two main sources for leaks, which are the kink section and the riser end.

10:24AM Q It indicates here on this demonstrative, D-24679, that this is at 5 times the playback speed. Why is that the case?

10:24AM A So what we're showing -- just so that we can perceive the motion of the riser, we're showing that at a faster pace on May 13th. The full motion of the riser took over four minutes for it to go to seafloor to floating back down to the seafloor, and it wouldn't be perceptible. It would take a long time to watch the full scale.

10:25AM MR. FIELDS: Let's pull up D-24680.

10:25AM BY MR. FIELDS:

10:25AM Q There are two locations where you just described -- there are two locations where you're seeing leaks in May 2010.

10:25AM So, if we pull up that one, can you walk us through D-24680?

10:25AM A So now we have a focus on the riser end. What we are seeing is ROV videos of the riser end on May 24th. This is what the riser end plume looks like on that date.

10:25AM Q The riser is not moving?

10:25AM A Yeah.

10:25AM Q Why is that?

10:25AM A After May 20th the riser is no longer moving, so we're
10:26AM seeing relatively steadily flow at this point.
10:26AM MR. FIELDS: Would you pull up D-24681.
10:26AM BY MR. FIELDS:
10:26AM Q And what does this show?
10:26AM A So this is just showing you some of the ROV video footage
10:26AM like the video footage that I reviewed. This, again, is from
10:26AM the May 24th timeframe.
10:26AM And this is just showing you what the kinked
10:26AM section of the riser looked like and the resulting leaks from
10:26AM the kinked section of the riser.
10:26AM Again, this is from May 24th outside the time
10:26AM period that we'll be discussing a lot of, but when the riser had
10:26AM fully settled to the seafloor.
10:26AM Q Now, I want to talk a little bit about the first question
10:26AM that you answered, which was whether or not a slug flow pattern
10:26AM occurred in mid-May 2010.
10:26AM Where in the system was slug flow -- were you
10:26AM seeing slug flow?
10:26AM A Slug flow was only present at the riser end, and at the
10:27AM riser end plume.
10:27AM Q Let's pull up D-24564.
10:27AM As part of your work in this case, did you review
10:27AM various documents that were produced by the government?
10:27AM A I did.

10:27AM Q And, in those documents, did you see evidence that the government experts believed that slug flow might exist in May of 2010?

10:27AM A Not that it might exist. In fact, several governmental scientists confirmed the existence of slug flow.

10:27AM Q And what is demonstrative Exhibit D-24564?

10:27AM A This is the flow rate technical group's plume team report, and this is one expert from that report confirming the presence of slug flow.

10:27AM Q Now, did you review Dr. Dykhuizen's testimony, trial testimony from earlier this week?

10:27AM A I did.

10:28AM Q Why don't we pull up trial transcript 1487.1.

10:28AM These were some questions that were asked of Dr. Dykhuizen earlier in the trial. The first one I wanted to ask you about is -- the question says: And slug flow can only occur until certain boundary conditions; right?

10:28AM And Dr. Dykhuizen's answer was: That is correct.

10:28AM Do you agree that slug flow can only occur in certain boundary conditions?

10:28AM A Yeah. It can only occur in certain flow rate ranges, so that is correct.

10:28AM Q One of the other questions that was asked of Dr. Dykhuizen says: You testified about slug flow. You don't dispute that slug flow was observed in May of 2010; do you?

10:28AM 1 And the answer is: No, I do not.
10:28AM 2 As part of your analysis, did you reach a
10:28AM 3 conclusion about whether slug flow was occurring in May of 2010?
10:29AM 4 A I did.
10:29AM 5 Q Let's talk about some of the work you did or the analysis
10:29AM 6 you did to reach that conclusion.
10:29AM 7 So what analysis did you perform in order to reach
10:29AM 8 your own conclusion that slug flow was occurring in May of 2010?
10:29AM 9 A Well, it was quite easy to confirm the existence of slug
10:29AM 10 flow. As you'll recall, slug flow's characterized by
10:29AM 11 oil-dominant flows or oil and then gas and that pattern
10:29AM 12 repeating.
10:29AM 13 You'll see that that's very evident from the
10:29AM 14 review of just one ROV video. What was a little more difficult
10:29AM 15 and time consuming was to figure out where it occurred over this
10:29AM 16 mid-May timeframe.
10:29AM 17 That required quite literally hundreds of hours of
10:29AM 18 ROV video to be reviewed, all the way from April 22nd to May 26,
10:29AM 19 in order to isolate this time period down to this May 13th to
10:30AM 20 May 20th time period that we're discussing.
10:30AM 21 Q So, in your evaluation, you were not just focused on the May
10:30AM 22 13th to 20th time period to start the analysis?
10:30AM 23 A No. I looked at the full range, April 22nd to May 26th, for
10:30AM 24 the presence of slug flow.
10:30AM 25 MR. FIELDS: Let's pull up D-23470.

10:30AM BY MR. FIELDS:

10:30AM Q Will you describe what this particular demonstrative exhibit shows.

10:30AM A So, yes. We're going to see here what slug flow -- we're going to see the transition from oil-dominant to gas-dominant flow.

10:30AM This first video clip is from May 14th. Actually, this full series is all from May 14th, and we're just going to jump forward.

10:30AM Here we're seeing a predominantly dark plume that is now transitioning. You can see the gas breaking through, and you will you see it reaches basically what appears to be a white plume, which is the gas dominant flow.

10:31AM Now we're 30 seconds later in that same video, and now we're going to see the gas-dominant flow cycle back to the oil-dominant flow.

10:31AM We'll do a couple more jumps just to demonstrate the pattern repeated. Now we are going to see oil-dominant flow transition back to gas-dominant flow 15 seconds later in the video, and then we'll jump one more time where we'll see gas dominant back to oil.

10:31AM Q Now, I see we have the dark fluid and the light fluid, but I wanted to talk about the analysis you did.

10:31AM Oh, you still have one more. This is going on for a bit.

(Video played.)

THE WITNESS: I think what's important is, you know, if you just saw this transition once, you wouldn't know that it was slug flow. What you're really looking for is this back and forth sort of gas, oil, gas, oil.

Specifically in this case it exhibits a very regular pattern, and we'll -- that can be observed. And that was the full pattern on May 14th.

BY MR. FIELDS:

Q Let's talk about how you were able to assess whether this light and dark flows were oil versus gas.

MR. FIELDS: If we can pull up D-24252.

BY MR. FIELDS:

Q Dr. Zaldivar, help us understand what this particular demonstrative exhibit shows and how it helped you in reaching conclusions about the existence of slug flow during May 2010?

A So what we know -- this is the same video, and what we're looking at is the trajectory of these two flows. We would expect that oil being denser than gas would have a lower trajectory, and gas being less dense than oil would have a higher trajectory.

So this was a just a trajectory analysis to confirm that the dark fluid was, in fact, oil dominant or mostly oil and the light fluid was gas dominant or mostly gas.

Q You mentioned this earlier in your testimony, but let me

10:33AM pull up a section of your report.

MR. FIELDS: If we can go to TREX-11683.16.1.

BY MR. FIELDS:

Q In this excerpt from your report, you say: The slugging at the riser end had some unique characteristics that change over time.

Do you see that?

A I do.

Q What was unique about the slug flow that you observed during the time period May 13th to May 20th?

A So slug flow is physically a chaotic process, and what I mean by that is it's very hard to predict. It normally results in random alternation between oil and gas. Meaning the periods of time between the oil plume changing to the gas plume would, generally speaking, be, or would -- not generally speaking -- would almost always be random.

In this particular case, what we saw was a very patterned and regular transition between oil and gas and gas to oil, and that pattern repeated itself.

Q Let's pull up D-24257.

Now, what is this document and what does this show?

A So this figure is taken directly from the Flow Rate Technical Group Plume Team report. In that report, they had done an analysis of the brightness of the video.

10:34AM So they took an ROV video and they focused on the brightness level of that video to say something about the color changes in the physical system. On the y-axis, they refer to it as intensity, which is the inverse of brightness, meaning that the darker -- the more intense you are, the darker the fluid would be. At the bottom you would see what would appear to be white fluid.

What's particularly shown well in this figure is the pattern. So I've bracketed a slug period, which is the time for the pattern to repeat. So you see here this pattern repeats itself three times in this particular figure.

Q And is this a pattern that was occurring over and over again?

A Yes. This pattern continued from May 13th to 15th, this specific pattern.

MR. FIELDS: Let's go to D-23916.

BY MR. FIELDS:

Q Now, this is a demonstrative that you helped us prepare.

What does this show?

A So we've taken the same figure at the bottom, and this is going to be a time trace of that figure. So, the red line, once they start, will move forward, and it will show you in time the transitions between oil and gas, remembering that oil is when you're at the higher side y-axis and gas is at the lower side.

You can go ahead and start the video.

10:36AM 1 We'll start with what appears to be oil-dominant
10:36AM 2 flow. You'll see it transition as it goes down. You'll see
10:36AM 3 more and more white present. When it reaches the bottom, you'll
10:36AM 4 see lots of white, and then it will sharply transition back to
10:36AM 5 oil.
10:36AM 6 It remains -- this is a large oil slug.
10:37AM 7 Q And you sped this -- this is sped up as well?
10:37AM 8 A Yeah. This specific video is sped up 3.5 times real time.
10:37AM 9 Again, the pattern cycle here is about four minutes, and we're
10:37AM 10 trying to squeeze it into a palatable timeframe.
10:37AM 11 Now we're looking at the oil-dominant flow. We
10:37AM 12 will now see that transition to the gas dominant and then back
10:37AM 13 up to the start of the pattern, which is at the start of that
10:37AM 14 middle peak here to here, which will transition back to the
10:37AM 15 oil-dominant flow.
10:37AM 16 Q Now, as a flow assurance engineer, do you typically see the
10:37AM 17 types of flow patterns that you saw or observed when you were
10:37AM 18 looking at the plume that was coming from the riser end during
10:37AM 19 May 13 to May 20th?
10:37AM 20 A The flow pattern, yes. Slug flow, again, is very, very
10:37AM 21 common. This is something that a flow assurance engineer really
10:38AM 22 focuses on.
10:38AM 23 But if you mean the specific pattern of slugs, no,
10:38AM 24 that's very, very rare. I've never in my career seen slug flow
10:38AM 25 exhibit a regular pattern.

10:38AM Again, by the nature of the physics, you would expect it to be chaotic, random, meaning the duration of those slugs would be different lengths.

Q Now, in your report you sometimes talk about the slug flow exhibiting a double peak behavior and sometimes exhibits a single peak behavior.

What does that mean?

MR. FIELDS: And let's go back to D-24257.

BY MR. FIELDS:

A Yes. So what I refer to as double peak behavior, again, if we look at the slug period, I'm referring to the fact that there are two oil slugs in the pattern. So, over that period and that pattern that repeats, there are two oil slugs or there are two alternation of flows.

Single peak behavior would be a single alternation or a repeated oil, gas, oil, gas, but only one slug per period.

Q When did you see double peak behavior during May 2010?

A Double peak behavior was only present between May 13th and May 15th.

Q And when did you observe single peak behavior in May of 2010?

A Single peak behavior was present between May 16th and May 20th.

Q Was the existence of single peak and double peak behavior important to you as part of your analysis?

10:39AM A Yeah. It's these very characteristics that my model
10:39AM attempts to match, and in fact does match. Yes.
10:39AM Q Did you observe slug flow, these regular patterns, before
10:39AM May 13th?
10:40AM A No. Before May 13th, there was no slug flow that was
10:40AM present with regular patterns.
10:40AM Q Did you observe these regular patterns of slug flow after
10:40AM May 20th?
10:40AM A No. There was no slug flow after May 20th.
10:40AM Q Now, you observed that the regular pattern of slug flow
10:40AM started on May 13th.
10:40AM In your opinion, what caused this slug flow to
10:40AM start on May 13th?
10:40AM A Well, the start of slug flow or the very first slug was
10:40AM caused by the falling of the riser.
10:40AM If you remember, on April 22nd, I mentioned
10:40AM earlier that the drilling rig, the riser attaches from the
10:40AM drilling rig and it falls and it takes some time to fall.
10:40AM Now, when it finally reaches the seafloor, it
10:40AM releases a ton of oil, and that's the first real slug.
10:40AM THE COURT: You say it takes some time to fall. Are
10:40AM you talking about days? Hours? What?
10:41AM THE WITNESS: Yeah. So from April 22nd until when it
10:41AM finally settles was May 20th. So multiple -- 20 days, 22 days.
10:41AM Most of the riser had settled by May 13th. There

10:41AM 1 was only one piece of the riser that was moving up and down, and
10:41AM 2 that's the buoyant loop. It's very interrelated to the slug
10:41AM 3 flow phenomena.
10:41AM 4 BY MR. FIELDS:
10:41AM 5 Q Talking about the buoyant loop -- first of all, how do you
10:41AM 6 know that the riser motion caused the slug flow to start?
10:41AM 7 A Well, prior to May 13th, slug flow wasn't present, so the
10:41AM 8 riser motion clearly initiated the first slug.
10:41AM 9 After it initiated that first slug, there was a
10:41AM 10 very complicated relationship between the slug flow and the
10:41AM 11 moving portion of the buoyant loop.
10:41AM 12 MR. FIELDS: Let's show D-24568.
10:41AM 13 BY MR. FIELDS:
10:42AM 14 Q Can you explain the process of slug flow through the
10:42AM 15 *Deepwater Horizon's* riser in May of 2010 using this
10:42AM 16 demonstrative?
10:42AM 17 A Yeah. So what's shown here is a 2D projection of the
10:42AM 18 buoyant loop, and this is that small piece of riser that was
10:42AM 19 bouncing up and down or moving up and down.
10:42AM 20 So, once it starts, when the cycle -- there's a
10:42AM 21 very complicated relationship between the slug flow and the
10:42AM 22 motion of the buoyant loop. So we're going to start the cycle
10:42AM 23 at a high position here, and at a high position --
10:42AM 24 Q What do you mean a high position? What does that mean?
10:42AM 25 A I mean that the buoyant loop is floating and it's at its

peak position that it achieves while floating.

At that position you're going to see liquid accumulating on the upstream section or this section closest to the BOP, and it will weigh down -- that accumulation of liquid will weigh down riser.

The riser will then touch the ground. It will release all that oil that it trapped in the upstream section. Then once all of that oil's been released, it now is filled with a mix of oil and gas but that's considerably lighter, and so it will then move up again.

Once it moves up again, it then starts to accumulate oil at the upstream section of the riser.

Q You indicated that once slug flow started it became a complex relationship between the loop and the flow through the loop.

Did you investigate other causes of slug flow?

A I did. The most common causes of slug flow are terrain-induced slug flow and hydrodynamic slug flow. I investigated both of those as potential mechanisms that would match the slug flow behavior.

Q And did you reach any conclusions regarding whether or not this slug flow was hydrodynamically induced or terrain induced?

A I did. I ruled both of those mechanisms out as potentially responsible for the slug flow that was observed from the riser end.

10:44AM Q And how were you able to rule out those two mechanisms?
10:44AM A I built a detailed model of the riser and I studied both of those mechanisms through simulations.
10:44AM Q Now, as part of your analysis, in the end does it really matter what started the slug flow?
10:44AM A It does not. What's most important here is that there's a link, and that in the end the model matches the point of comparison.
10:45AM In this particular case, the point of comparison is the observed slug flow by the ROVs. What's causing or what started the slug flow really has no relevance on my conclusions.
10:45AM Q And I think you sort of indicated this earlier, but between May 13 and May 20th is there only one section of the riser that is moving at that point?
10:45AM A There is. Only the buoyant loop. I mean, we can re-show that diagram and I can highlight that.
10:45AM Q Is that D-24679 maybe?
10:45AM A Yeah. This will work. So this diagram, if you look at the screen, only this piece that's floating between here and here would we refer to as the buoyant loop, and that's the piece that's moving as they play back.
10:46AM Q Now, did the buoyant loop move on regular periods during May 13th through 20th?
10:46AM A In short timeframes the period was regular. Over time, like days time, the period was decreasing.

10:46AM MR. FIELDS: Let's look at D-24682.A.

BY MR. FIELDS:

Q And can you explain this demonstrative to the Court?

A Yes. So during all my investigation I was looking at ROV videos. Initially, it wasn't obvious to me that the riser motion was at all relevant. In fact, the two primary causes for slug flow are terrain-induced and hydrodynamic.

And, prior to ruling those out, I wasn't even focused on the riser motion. What we are going to see here is on May 16th a video of the riser end plume played back again at a higher speed, and then we're going to see the riser motion as characterized by me. Different ROVs observed the motion of the riser, and in taking that motion from those ROVs, we're going to see a sync between the two.

At one specific moment on May 16th, there were ROVs that were surveying that buoyant loop and watching its motion, while also watching the riser end plume.

If we can play it back.

MR. FIELDS: Before we do that, there was a correction. It's actually just a typo. But if would pull up D-24862-A. Same one but the heading is changed.

Can you pull that up?

MR. CHAKERES: That's fine.

MR. FIELDS: This was just a typo on the heading.

So why don't we start this one over so

10:48AM Dr. Zaldivar can walk us through it.
10:48AM BY MR. FIELDS:
10:48AM A I guess, just to point out the typo, it shouldn't say Slow
10:48AM Flow, it should say Slug Flow Linked to Riser Motion.
10:48AM So this is a May 16th ROV video. At the same
10:48AM time, again, there were ROVs monitoring the buoyant loop.
10:48AM From the same time, which was in the early hours
10:48AM of May 16th, about 1 a.m., we were able to conclude that the
10:48AM riser motion period, meaning the time it took from the sitting
10:48AM on the seafloor to floating back down to sitting on the
10:48AM seafloor, was identical to the observed slug flow behavior or
10:48AM the period from going from oil dominant to gas dominant back to
10:48AM oil dominant.
10:48AM What we're seeing here is the two linked together
10:48AM so that it demonstrates the link between the two that was
10:48AM observed.
10:48AM MR. FIELDS: Let's go to D-24567.
10:48AM BY MR. FIELDS:
10:49AM Q I believe part of this was in your report.
10:49AM But, in any event, can you explain what D-24567
10:49AM shows about riser motion as compared to slug flow periods?
10:49AM A Right. So just a reminder, slug flow is the period of time
10:49AM that the pattern takes to repeat.
10:49AM What we're seeing in this chart is period on the
10:49AM y-axis and then dates of time on the x-axis here.

10:49AM 1 What we note is the blue dots are the slug flow
10:49AM 2 period, meaning measuring or looking at the actual ROV videos
10:49AM 3 and looking at the period of time it takes to alternate between
10:49AM 4 oil and gas.
10:49AM 5 And then the red dots are looking at the riser
10:49AM 6 motion period, And that was taken from ROVs monitoring the riser
10:49AM 7 motion during those same periods.
10:50AM 8 We'll note the May 16th point that we just
10:50AM 9 discussed where the slug flow period matches identically with
10:50AM 10 the riser motion on May 16th.
10:50AM 11 The other point, important point to note, is the
10:50AM 12 May 13th period where they had a survey of the motion. And
10:50AM 13 while they didn't have riser end plume available or video of the
10:50AM 14 riser end plume available at the same time, you can see that the
10:50AM 15 riser motion period does match the general trend of decline over
10:50AM 16 the days.
10:50AM 17 Q So, as I read this chart, it appears that over time the slug
10:50AM 18 flow periods decreased in time.
10:50AM 19 A That's correct.
10:50AM 20 Q Did you observe a cyclic motion of the buoyant loop prior to
10:50AM 21 May 13th?
10:51AM 22 A Prior to May 13th, no.
10:51AM 23 Q And did you observe that cycling motion of the buoyant loop
10:51AM 24 after May 20th?
10:51AM 25 A No.

10:51AM Q Let's take a look at TREX-11683.9.1. This is from your
10:51AM expert report. You say the signature of the slug flow, riser
10:51AM motion, and flow through the riser are intricately linked.
10:51AM What you do you mean by that statement?
10:51AM A So, again, I am referring to the characteristics now of the
10:51AM slug flow as well as the oscillatory motion of the riser.
10:51AM In our investigation, we determined that there is
10:51AM a direct link between the motion of the buoyant loop during this
10:51AM period and those specific characteristics, or that very
10:51AM patterned slug flow that we saw at the riser end.
10:51AM Q Let's turn back to D-24552-4, and let's focus on the second
10:52AM issue or question that you were asked, which has to do with
10:52AM trying to determine whether you can determine a flow rate based
10:52AM on the existence of slug flow. So let's talk about that.
10:52AM What was your general opinion that you reached on
10:52AM this particular question?
10:52AM A Using the very unique characteristics and that very
10:52AM patterned slug flow, I was able to build a model and match those
10:52AM characteristics and then determine that the slug flow was
10:52AM bounded during that timeframe, and that it was bounded between
10:52AM 24,900 and 35,900 stock tank barrels per day, with a best
10:52AM estimated flow rate during that period of 30,000 stock tank
10:53AM barrels per day.
10:53AM MR. FIELDS: Let's pull up D-24569.
10:53AM BY MR. FIELDS:

10:53AM Q You've been referring to building or creating a model. Is this a mathematical model?
10:53AM A This is a model or a representation of the riser. Under the hood, yes, it's a bunch of equations being solved that capture the physics of the oil and gas or of the fluid behavior in that riser.
10:53AM Q And, in general, how many different models did you develop in order to evaluate what the flow rate might be during the May 13th to May 20th time period?
10:53AM A So I built two models. I built a no-kink model and I built a kink model. The no-kink model specifically focuses on the flow rate through the riser end. So it starts just after the kink section of the riser, and then focuses on matching the observed slug flow behavior, that really unique pattern behavior that we were seeing, and only the riser end flow.

Then I built a kink model which extends that original model back to include the kinked section of the riser, and then provide estimates of the kink flow rates as well as the riser end flow rates at the same time, resulting in a total estimate of flow rate at the *Deepwater* Macondo well.

10:54AM Q Let's take a look at first of all what you call the no-kink model. So, if we pull up D-23480.3, will you describe in general for the Court what your no-kink model was.
10:54AM A Yes. So the no-kink model is an accurate representation of the riser. It starts just downstream or above the BOP. It

starts at joint 1 with a flow boundary where I'm able to vary the flow rate. Then it goes over the drilling rig.

It includes the motion of the buoyant loop that we've been talking about, all the way to a pressure boundary at the riser end, which is the ambient pressure of the seafloor.

MR. FIELDS: Can we pull up D-23480.4.

BY MR. FIELDS:

Q You mentioned that there was a flow boundary in your no-kink model. What is a flow boundary?

A So a flow boundary in a model allows me to input directly a flow rate that I want to investigate into the model.

Q If you're trying to figure out the flow rate that causes slug flow, why are you using a flow rate boundary?

A So what's unknown here is what the flow rate is that matches the observed slug flow conditions. In order to directly explore all of the different possible flow rates, I chose to use a flow rate boundary because that's the most convenient -- or not convenient -- but it's it most direct way of changing the flow rate in order, again, to match those observed slug flow characteristics.

Q So, in your modeling, are you varying the flow rate, or did you vary the flow rate over wide ranges?

A Yeah. I varied the flow rate all the way from 12,000 stock tank barrels per day all the way up to 60,000 stock tank barrels per day, in order, again, to match those unique characteristics,

10:56AM 1 that patterned behavior.
10:56AM 2 Q Let's continue talking a little bit about the model that you
10:56AM 3 built and the inputs to that model.
10:56AM 4 MR. FIELDS: If we could pull up D-24686.
10:56AM 5 BY MR. FIELDS:
10:56AM 6 Q We looked obviously at the schematic of your no-kink model,
10:57AM 7 but can you walk us through the types of inputs that you had to
10:57AM 8 use in order to develop an accurate representation of what was
10:57AM 9 going on on the bottom of the Gulf of Mexico in May 2010?
10:57AM 10 A Yes. So, in order to build a multiphase model, or a riser
10:57AM 11 model or both of the riser models in this case, you need inputs
10:57AM 12 of the fluid properties, you need to understand exactly the
10:57AM 13 position of the riser, so how it sat along the seabed, the
10:57AM 14 elevations of the riser.
10:57AM 15 Q Let's do this. Let's go through them quickly one at a time.
10:57AM 16 First of all, one of the inputs was fluid
10:57AM 17 properties. What is that input, and why is it important to your
10:57AM 18 analysis?
10:57AM 19 A So fluid properties are the thermodynamics or the PVT
10:57AM 20 properties of the fluid, and they define the density, how much
10:57AM 21 gas is present or how much liquid is present at a specific
10:58AM 22 temperature and pressure.
10:58AM 23 All that's needed in order to correctly model the
10:58AM 24 behavior of the fluid as it moves through the system.
10:58AM 25 So, when you start at a reservoir, you're really

10:58AM hot conditions, and the pressure and temperature decreases as you flow. Up the well it also decreases as you're flowing down the riser. So you need information about the fluid and what its doing as the pressure and temperature change.

Q The second input that you list on D-24686 is riser position. What is that?

A So riser position is the position of the riser as it sits on the seafloor. So the height of the riser along the seafloor, the elevation.

Q Does that also include the riser motion?

A It does. In this particular case it includes the riser motion which was observed by the ROVs.

Q The third input to your model that is listed here is riser construction. What is riser construction and how does that differ from riser position?

A So riser construction, when you build these models you need to also describe the heat flow outside. So how it's going to lose temperature to the surroundings. To do that, you kind of build the pipe in layers. So first you need to understand the outer pipe, what it's made of, all of the properties of that pipe. Then you need to know what surrounds that pipe. In this case, soil or buoyancy materials, which are materials that were used to offset some of the weight of the riser.

10:59AM 1 So that's what I mean. And all that's necessary
10:59AM 2 to get the thermal modeling correct.
10:59AM 3 Q And, when you say thermal modeling, what do you mean?
10:59AM 4 A I mean the heat loss to the environment.
10:59AM 5 Q You also have down here environmental conditions.
11:00AM 6 What is that?
11:00AM 7 A That is, again, associated with accurately capturing the
11:00AM 8 heat loss to the environment. You need to know something about
11:00AM 9 the currents and the temperature of the seawater at those
11:00AM 10 depths.
11:00AM 11 MR. FIELDS: Can we pull up D-23482.
11:00AM 12 BY MR. FIELDS:
11:00AM 13 Q This might be relevant, and you can let us know, to one of
11:00AM 14 the earlier inputs we've been talking about.
11:00AM 15 What is D-23482?
11:00AM 16 A So what we're seeing here is the riser elevation profile or
11:00AM 17 the riser position.
11:00AM 18 What you're seeing is this green line is actually
11:00AM 19 the riser position, and as it existed it was all nonmoving over
11:00AM 20 this.
11:00AM 21 And then the red line at the bottom is what the
11:00AM 22 riser looked like when it had settled to the seafloor.
11:00AM 23 The green line is what the riser looked like or
11:01AM 24 the height the riser reached on May 16th.
11:01AM 25 And then on the blue line is the height the

buoyant loop was reaching on May 13th.

Q So, if you look on the left-hand side, there's a larger hump on the left-hand side. What is that? What does that display or demonstrate?

A The axis is depth, so this is the depth of the riser and this is the length of the riser. So we're just looking at the relationship between depth and length along the riser.

Q But on the left-hand side you have this hump.

Why is that so high?

A What is the hump? The hump is the portion of the riser that was sitting on the wreckage of the *DWH* rig.

Q Let's talk about riser motion.

MR. FIELDS: If we can go to TREX-011683.93.1.

BY MR. FIELDS:

Q This has to do with the riser motion.

The Court saw this chart I believe the other day in Dr. Dykhuizen's testimony. Can you explain this chart for us?

A Yes. So what we're seeing on the Y-axis is depth, and then on the x-axis time or a time-like access.

And what we're seeing here is the blue line is the measured movement of the riser as observed by the ROVs.

And the orange line is the fit to that motion that was eventually inputted into the model.

It is worth noting that this is only for one

specific joint in the riser.

Q So, just so I understand, the blue line is actually how the riser was actually moving.

What is the orange line?

A The orange line is the mathematical description. So in order to put this into LedaFlow, you needed to be able to describe it in a language that LedaFlow could understand.

That orange line is a mathematical description that was then input into LedaFlow.

Q Why doesn't the orange line that is depicted on this demonstrative exactly match the blue line?

A In this sort of -- when you're taking measurements and you're trying to create a mathematical description, very often there is differences between the two.

What you're seeing here is actually a very good fit of taking an actual measurement and then characterizing it mathematically.

Q Now, talking about the movement of the riser, were you able to use a multiphase flow simulator in order to recreate the movement of the riser?

A Yes, I was able to recreate this motion in LedaFlow.

Q Why did you use LedaFlow as opposed to OLGA or some other multiphase simulator to model the moving riser?

A So LedaFlow was the only multiphase flow simulator that was capable of including the motion of the riser.

11:04AM Q So is the capability to move the pipe or the riser, was that
11:04AM built in to LedaFlow or did you have to write some type of
11:04AM special module to do that?
11:04AM A No. That's built-in. That functionality is accessible to
11:04AM the off-the-shelf version of LedaFlow that I used for this
11:04AM particular soft -- investigation, which was Version 1.2.
11:05AM Q Now, we have discussed the various inputs that you put into
11:05AM your model. I guess one question I would have is, can you
11:05AM characterize or describe the quality of the data that you had in
11:05AM order to create this model that you used to evaluate the flow
11:05AM rate?
11:05AM A In large part, the data was good data. You know, it took a
11:05AM lot of searching for the data, but in large part the material
11:05AM properties, the position, all of those things were very
11:05AM well-known and well-characterized.
11:05AM There are a few inputs to the model that were less
11:05AM known, and for that we ran sensitivities.
11:05AM Q We'll get to that.
11:05AM The last input that was on that slide was
11:06AM something called riser geometry.
11:06AM Why don't you pull up D-23484 and tell us about
11:06AM riser geometry and why it was important to your model.
11:06AM A So what we're seeing here is the riser is the outer pipe.
11:06AM The riser had, going down the center of it, a drill pipe.
11:06AM Depending on where you were in the riser it had different

diameters.

This blowup here is a cross-section, so if you were to slice it you would see the outer ring is the riser, this inner ring is the drill pipe, and the area for flow is the area between these two pipes.

Q Can you model this pipe and pipe geometry that we see here in multiphase flow simulators?

A Yes, but it requires a geometric transformation to do so.

MR. FIELDS: Why don't we pull up D-24643.

BY MR. FIELDS:

Q Help us understand something that would be another example of -- perhaps it's counterintuitive to a layperson -- of what a geometric transformation is.

A So these models assume and are built to model flow in a circular pipe. That's where the focus has been scientifically.

There are situations out there where people want to model multiphase flow or single phase flow in different geometries, and so there's a separate scientific investigation about how to transform all of the knowledge that you have about circular pipes and model these other odd-shaped geometries or different geometries.

So they developed methods in order to do so. That's what I mean specifically by a geometric transformation. And a geometric transformation simply takes a noncircular geometry and it transforms it into a circular pipe-like

11:08AM 1 geometry, but with the goal to maintain the pressure drop flow
11:08AM 2 rate relationships.
11:08AM 3 Q Why is there a goal to maintain the pressure drop flow rate
11:08AM 4 relationship?
11:08AM 5 A Well, that's the primary purpose of these models, to
11:08AM 6 understand the relationship between pressure drop and flow rate.
11:08AM 7 Q Let's go to the next slide, which is D-24644. Can you help
11:08AM 8 us understand what type of geometric transformation you used for
11:09AM 9 the geometry in this case?
11:09AM 10 A So what we're seeing on the left, of course the actual
11:09AM 11 geometry. The geometric transformation that I used is something
11:09AM 12 called the hydraulic diameter or the equivalent hydraulic
11:09AM 13 diameter, where I take this geometry or information about the
11:09AM 14 riser pipe and the drill pipe and I convert it into a circular
11:09AM 15 pipe-like geometry.
11:09AM 16 The hydraulic diameter focuses on maintaining the
11:09AM 17 correct ratio of area to wetted perimeter. Area is the
11:09AM 18 cross-sectional area to flow so that the area between the drill
11:09AM 19 pipe and the riser and the wetted perimeter is the length along
11:09AM 20 those two pipes.
11:09AM 21 Q Why is it important to maintain the correct ratio of area to
11:09AM 22 wetted perimeter when you're trying to perform flow rate
11:10AM 23 calculations?
11:10AM 24 A That's necessary in order to get the relationship between
11:10AM 25 pressure drop and flow rate correct.

11:10AM Q Now, have you used hydraulic diameter for geometric transformation in your own modeling work prior to this case?
11:10AM A I have.
11:10AM Q And is the hydraulic diameter used by flow assurance engineers and specialists in order to deal with noncircular geometries?
11:10AM A Yeah. The hydraulic diameter is the gold standard transformation. There are very few hydraulic standards that have any scientific information outside of the hydraulic diameter.
11:10AM There are numerous teks. In this particular case, the user manuals actually tell you to use the hydraulic diameter for the software packages or multiphase flow simulators that we're talking about.
11:10AM Q Now, when you use this geometric transformation, it results in a sectional area that is less than a cross-sectional area that actually exists in the pipe?
11:11AM A Yes. So one of the things that you mentioned is this is a bit counterintuitive. The area in this section is much larger than the resulting area using the hydraulic diameter.
11:11AM Q And you've heard criticisms at trial that you did not appropriately use the hydraulic diameter in your modeling? Have you heard those?
11:11AM A I have.
11:11AM Q And how do you respond to those criticisms?

11:11AM MR. CHAKERES: Your Honor, I'm going to object. This calls for surrebuttal testimony.

11:11AM MR. FIELDS: Your Honor, he was actually just reiterating and talking about the exact opinions that are set forth in his report.

11:11AM As Your Honor indicated earlier, a witness can hear the criticisms and he can sort of indicate why those criticisms are unfounded in light of his prior testimony or, sorry, in light of the prior opinions in the report.

11:11AM THE COURT: Was there a motion on rebuttal, a rebuttal -- surrebuttal report from this witness?

11:12AM MR. FIELDS: No.

11:12AM MR. CHAKERES: There was not. He didn't provide surrebuttal opinions in writing, so we have not filed a motion on that, no.

11:12AM THE COURT: I'll overrule the objection.

11:12AM BY MR. FIELDS:

11:12AM Q How do you respond to those criticisms?

11:12AM A They're absolutely unfounded and incorrect.

11:12AM Q And why is that?

11:12AM A Dr. Dykhuizen seems to say that the use of the hydraulic diameter is incorrect, or that if you use it you get only some information out of the model that then you can use later.

11:12AM When, in fact, the use of the hydraulic diameter results in the accurate relationship between pressure drop and

flow rate. The flow rates that come from my model require no additional calculations to be corrected to a different flow rate.

Q So you're confident that you used the correct geometric transformation and applied it in the correct fashion?

A Not only am I confident, that's what the science tells me.

Q Let's turn to talking about the simulations you performed. After constructing the riser model or the no-kink model with all of the properties that we've just discussed, what did you do next?

A Sorry, could you repeat that question?

Q Sure. After you constructed your riser model and it had all those different inputs that we just talked about, what did you do next?

MR. FIELDS: Maybe we can pull up D-23480.3, which was what we looked at earlier.

BY MR. FIELDS:

A Yes. So I then -- once I built the model, I then varied the flow rate through the model. I ran numerous simulations, in excess of a thousand simulations, to explore the parameter space, running flow rates from 12,000 barrels per day all the way up a to 60,000 barrels per day, again, trying to match this unique pattern of slug flow behavior.

Q And why did you pick the range between 12,000 and 60,000?

A Well, generally speaking, you pick a range where you see the

observed behavior, and then you pick a larger range to make sure that that observed slug flow behavior doesn't appear someplace else.

So I only saw the observed slug flow behavior, or model results that matched the observed slug flow behavior, somewhere between 17,000 to 40,000.

So then I book-ended it with 60,000 all the way down to 12,000.

Q How many different simulations did you run in LedaFlow in order to determine whether you were matching the behavior out of the end of the riser?

A In total, again, in excess of a thousand. For each specific parameter set, I ran simulations exploring both May 13th and May 16th, and I ran about 55 for each specific -- 54 specifically -- for each parameter set.

Q So give us an idea of how long it takes to run these simulations and why it took you six months or so to complete your analyses.

A So each simulation requires anywhere from 12 hours to 2 days to finish. I would say on average about a day, and -- I mean that's why. I mean, when you're running a thousand simulations, obviously we didn't even have a thousand days. We were running it on multiple computers.

We generated an inordinate amount of data over that timeframe, somewhere in the order of 5 terabytes, which is

11:16AM 1 a very large amount of data.
11:16AM 2 I don't know in that answers your question.
11:16AM 3 Q It does. So was your no-kink model able to reproduce the
11:16AM 4 slug flow behavior that you observed during the May 13th to 20th
11:16AM 5 time period?
11:16AM 6 A It does.
11:16AM 7 Q Let's pull up D-24683-A. And before we play this, can you
11:16AM 8 sort of give us a setup, tell us a little bit about what we're
11:16AM 9 going to see when we play this particular demonstrative?
11:16AM 10 A Yes. So earlier we saw a previous demonstrative that was
11:16AM 11 set up very similarly where we had the ROV video on top, and
11:16AM 12 then at the bottom we had a time trace.
11:16AM 13 Here the yellow line will be time. The video --
11:16AM 14 just to note, the video speed will be faster than real time. It
11:16AM 15 will be running 3.35 times real time. This specific video was
11:16AM 16 taken on May 16th.
11:16AM 17 Now at the bottom, what you're seeing is my model
11:17AM 18 predictions for that same time period or a flow rate during that
11:17AM 19 same time period.
11:17AM 20 What I am showing in this figure is the oil volume
11:17AM 21 rate fraction on the y-axis, and then time moving along the
11:17AM 22 x-axis here. What you will see here are the shaded regions that
11:17AM 23 appear brown. Will be dark and appear dark in the video;
11:17AM 24 whereas the grey region will be experiencing some sort of
11:17AM 25 transition, either from dark to white or white to dark.

11:17AM 1 And then the white highlighted area will appear
11:17AM 2 white in the video.
11:17AM 3 Q You ready to play?
11:17AM 4 (Videotape Played.)
11:17AM 5 BY MR. FIELDS:
11:17AM 6 A So we start again, we're tracing through a period of time
11:17AM 7 where you're seeing a dark plume. This lasts approximately 80
11:18AM 8 seconds.
11:18AM 9 Then we'll see a sharp transition that takes 15
11:18AM 10 seconds in real time. I'm giving you numbers.
11:18AM 11 Then we'll see it reach the white plume area.
11:18AM 12 Then it will end as it transitions back to the start of the
11:18AM 13 cycle, which will be the start of the next dark plume.
11:18AM 14 What you can see from this is the excellent match
11:18AM 15 of the model-predicted results of the actual observed slug flow
11:18AM 16 behavior.
11:18AM 17 This sort of matches is really unusual when you're
11:18AM 18 looking at slug flow behavior, especially because it is so
11:18AM 19 chaotic. You will almost never match this well. This is, in
11:18AM 20 fact, the best match I've ever seen to the observed slug flow
11:18AM 21 behavior.
11:18AM 22 MR. FIELDS: Let's pull up D-23865.
11:18AM 23 BY MR. FIELDS:
11:19AM 24 Q In your report, you talk about this concept of qualifying
11:19AM 25 flow rates at least for determining flow rates out of the riser

11:19AM 1 end.
11:19AM 2 Can you describe the process you used to determine
11:19AM 3 what constituted a qualifying flow rate and how that assisted
11:19AM 4 you in determining or estimating the flow rate out of the riser
11:19AM 5 end?
11:19AM 6 A Yes. So, on May 13th, they're using the riser motion that
11:19AM 7 was present on May 13th. I would simulate from approximately
11:19AM 8 12,000 stock tank barrels up all the way up to 60,000 stock tank
11:19AM 9 barrels.
11:19AM 10 Now, during that period, as we discussed earlier,
11:19AM 11 I'm looking for double peak behavior. In this particular
11:19AM 12 example, I was able to see double peak behavior between 17,700
11:20AM 13 and 41,000 stock tank barrels.
11:20AM 14 Then using the May 16th, or the motion of the
11:20AM 15 riser on May 16th, I would run the same range of flow rates:
11:20AM 16 from approximately 12,000 all the way up to 60,000 stock tank
11:20AM 17 barrels per day.
11:20AM 18 I was able to observe the behavior that was
11:20AM 19 present then, which was the single peak behavior in the
11:20AM 20 highlighted region. And that was between 11,700 stock tank
11:20AM 21 barrels all the way up to 28,300 stock tank barrels.
11:20AM 22 But, by combining the two ranges, I'm able to
11:20AM 23 estimate the qualifying range of flow rates between 17,700 and
11:20AM 24 28,300 stock tank barrels per day.
11:20AM 25 I was then able to apply one additional criterion

11:20AM 1 to the lower bound of the flow rate for this line, this 17,700
11:21AM 2 stock tank barrels per day. I was looking specifically at the
11:21AM 3 average density of the buoyant loop, or the weight of the
11:21AM 4 buoyant loop, and ensuring that the buoyant loop wasn't moving
11:21AM 5 up when the weight of the buoyant loop was at its highest.
11:21AM 6 In doing so, I was able to further reduce the
11:21AM 7 bound or increase the lower bound up to 21,200 stock tank
11:21AM 8 barrels per day.
11:21AM 9 I do want to emphasize that this is a specific
11:21AM 10 example of a specific parameter set that I refer to as the base
11:21AM 11 case set of parameters, meaning that the inputs, the default set
11:21AM 12 of inputs that I put into the simulation before I explored my
11:21AM 13 sensitivities.
11:21AM 14 I'll also note that this -- to come up with this
11:21AM 15 one range was about 54 simulations.
11:21AM 16 Q You indicated that you were sort of combining the two
11:22AM 17 different behaviors, the double peak behavior and the single
11:22AM 18 peak behavior, in order to determine the range of qualifying
11:22AM 19 flow rates.
11:22AM 20 Why did you do that?
11:22AM 21 A Well, on May 13th, we had observed double peak behavior.
11:22AM 22 On May 16th, we had only single peak behavior.
11:22AM 23 These dates are rather close together. It was
11:22AM 24 only natural there was nothing that would indicate there would
11:22AM 25 be large changes in flow rate between that period so that would

you conclude that a flow rate that matched the double peak behavior and matched the single peak behavior would qualify as a possible flow rate during that range.

Q After developing this base case that you have here, what did you do next?

A So from here I ran sensitivities on input parameters that were uncertain.

Q What are sensitivities or sensitivity studies?

A A sensitivity study is a study where you look at input parameters that aren't certain. You vary an input, and then you run simulations to determine what effect varying the input has on the results.

Q And why did you perform sensitivity studies here?

A Specifically, there were some parameters. An example of that would be pipe roughness, that were less certain than other parameters.

MR. FIELDS: Why don't we pull up D-24570.

BY MR. FIELDS:

Q This is a table from your report, and it is titled: Sensitivity to Roughness of Riser Pipe. Why don't you help us understand how you assessed the sensitivity of the roughness of the riser pipe.

A Yes. So, starting at the top of the table, the first row, you can see that the roughness value, that is the default value that I used that was in the base case set. That value

corresponds to smooth carbon steel or carbon steel that was straight off the factory line.

I then ran two sensitivities where I increased the roughness by a factor of 10 and then by a factor of 100.

Now, for each parameter set, I varied the flow rates between 12,000 and 60,000 stock tank barrels per day on May 13th and May 16th trying to match the double peak behavior that was present on May 13th and the single peak behavior that was present on May 16th.

I then was able to come up with a range of possible flow rates which are denoted as minimum and maximum for each of the parameter sets.

Q Now, this is one type of sensitivity study that you performed. Were there other sensitivities that you have evaluated as part of your analysis?

A Yeah. I performed other sensitivities as a part of my analysis on other uncertain inputs.

MR. FIELDS: Why don't we pull up D-24571.

BY MR. FIELDS:

Q We talked about pipe roughness. What were the other sensitivities that you evaluated as part of your analysis?

A So, I also evaluated inlet temperature, the position of the riser plume. I evaluated the outer heat transfer or the ability for the environmental conditions to move heat away from the pipe.

11:25AM I evaluated pipe roughness, like we just
11:25AM discussed. I also evaluated in the kink model a sensitivity to
11:25AM the resistance of the kink, or the discharge coefficient of the
11:25AM kink, which is specific to the way I modeled the kink.
11:26AM MR. FIELDS: Why don't we pull up D-23864.
11:26AM BY MR. FIELDS:
11:26AM Q So how did you calculate a best estimate flow rate through
11:26AM the riser end using these various sensitivity studies?
11:26AM A So, for each sensitivity -- and we just focused on the
11:26AM fourth row of this table, this pipe roughness -- what we come up
11:26AM with, a minimum and a maximum running the series of simulations.
11:26AM From that minimum and maximum, you can take an
11:26AM average for that sensitivity of the two values, and that will
11:26AM result in a best estimated flow rate for that specific
11:26AM sensitivity.
11:26AM I repeated that process for all of the
11:26AM sensitivities in this table, and I was able to come up with best
11:26AM estimated values form each of those sensitivities.
11:26AM Then, taking an average of this final column here,
11:26AM I was able come up with a total best estimated flow rate of
11:26AM 25,100 stock tank barrels per day.
11:26AM What is important to note when you're looking at
11:27AM this table is how insensitive the model is to these specific
11:27AM parameters. So all of these sensitivities result in flow rates
11:27AM around this 25,000 number or 25,100 number. There's not a lot

of variance.

What that tells an expert is that the model is robust and that the model is not sensitive to these inputs despite the fact that they weren't known.

Q The bottom line, on D-23864, you say: Resulting best estimate before model uncertainty.

Do you see that?

A I do.

Q At some point in your work, did you try to evaluate or characterize model uncertainty and the impact it might have on flow rates?

A I did.

Q And what did you do?

A So, for model uncertainty, what I specifically mean is everything that we don't know about multiphase flow.

So, multiphase flow is incredibly complicated. There's lots of physics that are involved in modeling multiphase flow. As an industry, there are things that we don't know about multiphase flow.

And so I wanted to characterize that uncertainty, which is something difficult to characterize. It's always difficult to characterize what you don't know.

In this particular case, I was using or I started my investigation using three different versions of software. I was using two different versions of OLGA and one version of

LedaFlow.

Because all of those software packages are trying to estimate the true answer, you can learn something by the fact that their resultant answers are scattered. That's some indication of what the current understanding of what multiphase flow is, and that's how I was able to characterize model uncertainty.

Q I thought you indicated earlier that OLGA was not able to model a moving riser. If that's the case, how were you able to compare your results from LedaFlow with your results in OLGA?

A At the beginning of my investigation, I was using both OLGA and LedaFlow, and I was using static geometries.

Q What does that mean?

A Nonmoving geometries.

At that time, I wasn't certain that the riser motion was important, so I used an simpler model and assumed that the riser was static.

And those are the results that I was able to compare: A static version of LedaFlow and the static two versions of OLGA. And that's how I was able to characterize the understanding of multiphase flow.

Q What conclusions, if any, did you reach about the level of model uncertainty that might exist?

A So, from that investigation, I was able to estimate the model uncertainty to be plus or minus 5 percent, or a total of

11:30AM 1 10 percent uncertainty.
11:30AM 2 MR. FIELDS: So let's go to D-2866.1.1.
11:30AM 3 BY MR. FIELDS:
11:30AM 4 Q So, after taking into consideration your base case, your
11:30AM 5 sensitivity studies, and model uncertainty, what results did you
11:30AM 6 get for the flow rate out of the model end -- out of the riser
11:30AM 7 end? Sorry.
11:30AM 8 A Yeah. So I was able to conclude that the range of possible
11:30AM 9 flow rates out of the riser end was between 20,000 stock tank
11:30AM 10 barrels per day and 31,000, with a best estimate of 25,100.
11:30AM 11 Q And that's just out of the riser end?
11:30AM 12 A And that is just out of the riser end.
11:30AM 13 Q Now, let's talk about the your modeling of the flow out of
11:31AM 14 the kink leaks.
11:31AM 15 MR. FIELDS: First of all, let's pull up D-23478-A.
11:31AM 16 BY MR. FIELDS:
11:31AM 17 Q Let's first talk a little bit about the leaks from the kink.
11:31AM 18 Can you describe the kink leaks for us using this and how they
11:31AM 19 came into play with your modeling efforts?
11:31AM 20 A So what we're seeing in this demonstrative is the kink
11:31AM 21 section of the riser after it was removed on June 3rd.
11:31AM 22 What's specifically highlighted and labeled A
11:31AM 23 through F are the holes that were present at that time.
11:31AM 24 Specifically of interest for this particular time period were
11:31AM 25 holes B, C, D, and E.

11:31AM MR. FIELDS: Let's pull up D-23479.A.

11:31AM BY MR. FIELDS:

11:32AM Q When did the kink leaks appear in relationship to the range or the window that you were evaluating?

11:32AM A So, the kink holes, other two kinks holes, B and C, were present between May 13 and May 19.

11:32AM On May 19th, another hole or potentially two additional holes appear, and those would be holes D and E. Because they were so close together, you couldn't tell if it was a single hole that appeared or two holes, so I refer to them as D/E in this image. And they appeared on May 19th and were present through May 20th.

11:32AM MR. FIELDS: Let's go to D-23481.3.

11:32AM BY MR. FIELDS:

11:32AM Q Can you generally describe your second model, which is the kink model, and how it differed from your no-kink model.

11:32AM A So the kink model is very similar to the no-kink model. It's just an extension of the no-kink model. It extends back to include the kinked section of the riser, which is about a 45-foot-long extension.

11:33AM It then uses a pressure boundary at the inlet of the model and a pressure boundary at the outlet of the model, which is the same as was present in the kink model -- no-kink model, excuse me.

11:33AM MR. FIELDS: Why don't we pull up display D-23481.

BY MR. FIELDS:

Q And this is sort of a enlargement of the BOP in your kink model.

It indicates on here -- it shows the kink here and also shows pressure boundary. What is a pressure boundary and why did you use a pressure boundary in your kink model?

A So a pressure boundary is when you specify the pressure of the model at that location. In this particular case, once I extend the model back to include the kink section, I now have the benefit of a measurement that was present at that location, and that's the PTM measurement, which is just above the BOP.

Q PTM, is that different than BTB?

A Yes. That's a different measurement.

Q Now, the kink model also includes the holes that existed in the kink?

A Yes. So the kink model includes the kink section. It includes the model of the kink holes. It also includes a model of the kink itself.

The kink itself has some uncertainty as to what resistance to flow that would amount to, so I modeled the kink itself as a valve or a restriction that I could vary to vary that resistance to flow.

Q Now, in your no-kink model, you used what I think was called a flow rate boundary. Here, you use a pressure boundary.

Why did you use a pressure boundary here?

11:35AM A Pressure boundary was used here because we had a measurement, this PTM measurement that I am referring to.

Because we had a known pressure, it made sense to use and leverage that pressure.

MR. FIELDS: Let's go to TREX-011683.30.2.

BY MR. FIELDS:

Q Based on your analysis of the -- using the note -- sorry, let me step back.

Using the kink model and performing the evaluation using the kink model, what conclusions did you reach about the flow rate coming from the kink holes during the period May 13 to May 20th?

A So my approach was a little different for estimation of the kink leak flow rate. I chose to estimate a maximum flow rate during that period. I estimated that maximum to be 4,900 stock tank barreled per day.

Q Why do you consider your kink leak flow rate estimate to be a maximum flow rate as opposed to a minimum or a best flow rate?

A So, for the kink leak flow rate, I made a series of very conservative assumptions. So, given all of the conservatism built into my estimation of the kink leak flow rate, I can conceive of no possibility that could be greater than the number that I'm presenting today.

Q And what were some of those assumptions or some of the inputs that you used that you believe lead you to a conservative

11:36AM or maximum flow rate?
11:36AM A So, the first assumption or the first conservative
11:36AM assumption would be, I used the maximum number of holes that
11:36AM were present during that time period.
11:36AM So, as we saw earlier, between May 13 and May 19,
11:37AM there were only two holes present. And then, on May 19th and
11:37AM 20TH, there were four holes present, or potentially four holes
11:37AM present. I used all four holes during the full period.
11:37AM In addition to that, I used the final sizes of
11:37AM those holes. Those holes were created by erosion, so they
11:37AM likely grew. I used the sizes as they were on June 3rd when the
11:37AM riser was finally removed.
11:37AM In addition to that, I used or I modeled the leak
11:37AM holes upstream of the kinked section of the riser. So the holes
11:37AM would form at the highest velocity, at sort of the biggest
11:37AM restriction, and that would be the lowest pressure.
11:37AM I modeled them upstream of that restriction
11:37AM exposing them to the largest pressure available, which would
11:38AM result in the most conservative flow rate.
11:38AM In addition to that, there's one other
11:38AM conservative assumption, which is I used the maximum value of
11:38AM the PTM measurement during that period. So that gauge had
11:38AM indicated several pressure measurements during that period. I
11:38AM took the absolute maximum and I used that as my boundary
11:38AM condition.

11:38AM Q So did your calculations of the riser end flow and the kink leak flow give you a total estimated flow rate?
11:38AM A It does.
11:38AM MR. FIELDS: Why don't we pull up D-23866.
11:38AM BY MR. FIELDS:
11:38AM Q Were you able to calculate a final minimum, maximum, and best estimate of flow rate for the Macondo well for the period May 13th to 20th, 2010?
11:39AM And, if so, what was that?
11:39AM A I was able to calculate a possible range of flow rate between 24,900 stock tank barrels per day and 35,900, with a best estimated flow rate of 30,000 stock tank barrels per day.
11:39AM Q Based on your analysis, do you see any evidence that the flow rate during this time period was below approximately 25,000 stock tank barrels per day?
11:39AM A No. It could not have been below.
11:39AM Q Did you see any evidence that the flow rate could have been higher than approximately 36,000 barrels per day during the period of May 13th to May 20th?
11:39AM A No. Cannot have been higher.
11:39AM MR. FIELDS: Can we pull up trial transcript 11898.1.
11:39AM BY MR. FIELDS:
11:39AM Q This is also from Dr. Dykhuizen's critique, and it talks about your modeling or your model uses a pipe model that's half the size of the real pipe; so short, his numbers are off by a

11:40AM factor of 2. If you correct for that, he is getting about
11:40AM 60,000 barrels of oil per day similar to the calculations of
11:40AM Dr. Dykhuizen.
11:40AM I think this was actually from the opening
11:40AM statement.
11:40AM Do you agree with this statement?
11:40AM MR. CHAKERES: Your Honor, I'm going to renew the
11:40AM objection to that. Our motion for surrebuttal is a general
11:40AM motion, and we understood it applied to all experts.
11:40AM THE COURT: Well, does sound like we're getting into
11:40AM essentially what is surrebuttal, Mr. Fields, so I'm going to
11:40AM sustain the objection.
11:40AM MR. FIELDS: Thank you, Your Honor.
11:40AM BY MR. FIELDS:
11:40AM Q Based on your evaluation, why are you confident that the
11:41AM best estimate of flow rate from the Macondo well during the time
11:41AM period of May 13 to May 20th was 30,000 stock tank barrels per
11:41AM day?
11:41AM A I'm confident because I performed extensive analysis. I
11:41AM looked at this issue for six months. I performed thousands of
11:41AM simulations looking at this issue, and ultimately I'm very
11:41AM confident in my answer that the best estimate would be 30,000
11:41AM stock tank barrels per day.
11:41AM Q Why are you confident that the flow rate from the riser end
11:41AM and the kink leaks could not have exceeded 35,900 stock tank

11:41AM 1 barrels per day during the time period May 13th to May 20th,
11:41AM 2 2010?
11:41AM 3 A Well, ultimately, at higher flow rates, you don't match the
11:41AM 4 observed slug flow behavior. The evidence that we have is the
11:41AM 5 ROV videos with a very unique pattern. And, at flow rates
11:42AM 6 higher than 36,000, you just don't match that behavior.
11:42AM 7 MR. FIELDS: Thank you, Your Honor. No further
11:42AM 8 questions.
11:42AM 9 THE COURT: Okay.
11:42AM 10 Rather than start your examination, since we're
11:42AM 11 only going to go a few minutes, why don't we break right now.
11:42AM 12 You're going to have to come back tomorrow.
11:42AM 13 We'll recess until 8:00 in the morning.
11:42AM 14 Any other housekeeping matters we need to do
11:42AM 15 today?
11:42AM 16 MR. BROCK: I was going to let the Court know one
11:42AM 17 thing.
11:42AM 18 This is not a big issue; but, tomorrow morning,
11:42AM 19 depending on the length of the cross, we'll have Dr. Momber and
11:42AM 20 Dr. Nesic, and then hopefully at some time early in the
11:42AM 21 afternoon Dr. Johnson.
11:42AM 22 I expect Dr. Nesic to be a longer examination than
11:42AM 23 Dr. Momber. So, if we finish this cross, you know, in a
11:43AM 24 reasonable time in the morning, we might like to put Dr. Nesic
11:43AM 25 up next so that we can get him out of here before lunch and then

11:43AM come with Dr. Momber next. That would be the only change we would make for tomorrow.

THE COURT: Okay.

MR. BROCK: If that's okay.

THE COURT: All right.

All right. Everyone have a good evening and we'll see you tomorrow.

(11:42 a.m., proceedings concluded.)

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