

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF LOUISIANA

IN RE: OIL SPILL BY THE DOCKET NO. MDL-2179
OIL RIG *DEEPWATER HORIZON* SECTION "J"
IN THE GULF OF MEXICO ON NEW ORLEANS, LA
APRIL 20, 2010 OCTOBER 16, 2013

IN RE: THE COMPLAINT AND DOCKET NO. 10-CV-2771
PETITION OF TRITON ASSET SECTION "J"
LEASING GMBH, ET AL

UNITED STATES OF AMERICA DOCKET NO. 10-CV-4536
V. SECTION "J"
BP EXPLORATION & PRODUCTION,
INC., ET AL

DAY 10 MORNING SESSION
TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
HEARD BEFORE THE HONORABLE CARL J. BARBIER
UNITED STATES DISTRICT JUDGE

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ROBERT CLIFFORD MERRILL, JR.

Direct by Mr. Boles 2642

Cross by Mr. Chakeres 2682

MICHAEL ZALDIVAR

Direct by Mr. Fields 2700

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 6

08:06AM 7 THE COURT: Morning, everyone. Please be seated.

08:07AM 8 All right. Go ahead, Mr. Brock. I'm just opening
08:07AM 9 something up here. I'm listening. Go ahead.08:07AM 10 MR. BROCK: Our first witness this morning, Your Honor,
08:07AM 11 will be Mr. Bob Merrill.08:07AM 12 I had two preliminary matters before we call him
08:07AM 13 to the stand, if that's okay.

08:07AM 14 THE COURT: Sure.

08:07AM 15 MR. BROCK: First, I have the exhibits for Dr. Curtis
08:07AM 16 Whitson. They've been circulated, and there are no objections
08:07AM 17 to these exhibits.

08:07AM 18 THE COURT: Without objection, those are admitted.

08:07AM 19 (Exhibits admitted.)

08:07AM 20 MR. BROCK: Second, there was an issue that came up
08:07AM 21 yesterday that I just want to address very briefly and give Your
08:07AM 22 Honor a bit of background so that you'll understand I hope a
08:07AM 23 little better what we're doing.08:07AM 24 As Your Honor may remember, we had deadlines set
08:08AM 25 for the exchange of demonstrative exhibits. That was originally

08:08AM 1 September the 27th. And the idea was to disclose all exhibits
08:08AM 2 that we could anticipate using at trial.

08:08AM 3 On that disclosure date, we disclosed 287 exhibits
08:08AM 4 and the United States disclosed a handful, I think around 20.

08:08AM 5 On the eve of trial, the 4th and evening of the
08:08AM 6 4th and 5th, the United States disclosed 120 new demonstrative
08:08AM 7 exhibits that they said that they would use in their direct
08:08AM 8 examinations. 100 on Saturday night. And I apologize for the
08:08AM 9 detail --

08:08AM 10 THE COURT: Let me just stop you for just a second.
08:08AM 11 I'm wondering why you're raising this. This was brought to my
08:08AM 12 attention on the morning the trial started, and I had word from
08:08AM 13 Judge Shushan that you all had worked out any remaining issues
08:08AM 14 pertaining to this.

08:08AM 15 MR. BROCK: Yes, sir. And I thought that we had, so I
08:09AM 16 was just trying to give you the background on that so I could
08:09AM 17 give you the next statement, and I'll do it very quickly if
08:09AM 18 that's okay.

08:09AM 19 The resolution of that was that we withdraw our
08:09AM 20 timeliness objection to the late-filed exhibits, and the United
08:09AM 21 States said as to those demonstrative exhibits that he had
08:09AM 22 disclosed prior to that date, that they would not object to
08:09AM 23 those.

08:09AM 24 So when our lawyers say to Your Honor in court
08:09AM 25 when we're examining a witness there's no objection to that

08:09AM 1 exhibit, that's what we are referring to, the resolution that we
08:09AM 2 made that there would not be objections to our exhibits.

08:09AM 3 This has come up several times, but it came up
08:09AM 4 three times yesterday with Exhibit D-23603, D-24222, and
08:09AM 5 D-23608.A.1. I don't think there's any useful purpose at this
08:09AM 6 point in me offering the deconvolution exhibit, so I won't offer
08:09AM 7 that.

08:09AM 8 We would have had a discussion about it if it had
08:09AM 9 been permitted.

08:09AM 10 THE COURT: You're talking about exhibits that the
08:10AM 11 government objected to?

08:10AM 12 MR. BROCK: Yesterday, yes, sir. Where they had said
08:10AM 13 they did not have objections.

08:10AM 14 THE COURT: Okay. Well, let me just say, I don't
08:10AM 15 recall the basis of the -- I didn't think that the basis of
08:10AM 16 those objections yesterday -- the ones I recall, and I'm sure
08:10AM 17 you know more about the details of this than I do right now --
08:10AM 18 but my recollection is the objections were based on other
08:10AM 19 matters, not on a timeliness issue. I don't know if that's
08:10AM 20 right or not.

08:10AM 21 MR. BROCK: No. There's no issue about timeliness.
08:10AM 22 These are disclosed on September the 27th, so that's not the
08:10AM 23 issue.

08:10AM 24 I'll get right to it.

08:10AM 25 The only thing I wanted to tell you is when we say

08:10AM 1 there's not an objection to the exhibit, what we mean is this is
08:10AM 2 something we worked out at the beginning of the trial. That's
08:10AM 3 why we're saying that there is a no objection, because we
08:10AM 4 withdrew our timeliness objection, they withdrew their other
08:10AM 5 objections.

08:10AM 6 I'm now going to offer 24222.1 and 236603.1, and
08:11AM 7 my understanding is that the government does not object to these
08:11AM 8 demonstratives beings admitted.

08:11AM 9 THE COURT: These are in connection with whose
08:11AM 10 testimony?

08:11AM 11 MR. BROCK: Dr. Gringarten yesterday.

08:11AM 12 THE COURT: Is that correct, Ms. Himmelhoch?

08:11AM 13 MS. HIMMELHOCH: Your Honor, it is correct that the
08:11AM 14 United States does not object to the demonstratives. My
08:11AM 15 objections yesterday were directed to the testimony based upon
08:11AM 16 the demonstratives.

08:11AM 17 THE COURT: So you don't object to what Mr. Brock just
08:11AM 18 offered?

08:11AM 19 MS. HIMMELHOCH: No, we do not, and we --

08:11AM 20 THE COURT: Okay. That's it. That's all. That's
08:11AM 21 admitted.

08:11AM 22 MR. BROCK: That's all I wanted.

08:11AM 23 THE COURT: Okay. No problem. That was a long way
08:11AM 24 around to get to that point. You could have just said you had
08:11AM 25 two exhibits that nobody objected to them.

08:11AM 1 MR. BROCK: Well, I could have. You're right.

08:11AM 2 I just wanted you to know that when we're saying
08:11AM 3 that, it's not something we're just pulling out of the blue. We
08:11AM 4 have a reason for saying it.

08:11AM 5 THE COURT: I understand.

08:11AM 6 MR. BROCK: These are things we think we've worked out,
08:11AM 7 and that's why we've done it. For the benefit of our examiners,
08:12AM 8 I wanted you to know that.

08:12AM 9 THE COURT: Well, I'm happy you all were able to work
08:12AM 10 it out again.

08:12AM 11 MR. BROCK: Thank you, Your Honor.

08:12AM 12 With that, we call Mr. Bob Merrill.

08:12AM 13 MS. KING: Rachel King for the United States, Your
08:12AM 14 Honor.

08:12AM 15 I have here the list of exhibits that the United
08:12AM 16 States used with Dr. Whitson. Exhibits, call-outs, and
08:12AM 17 demonstratives. This list has been circulated, and there are no
08:12AM 18 objections.

08:12AM 19 THE COURT: All right. Without objection, those are
08:12AM 20 admitted.

08:12AM 21 (Exhibit admitted.)

08:12AM 22 MS. KING: Thank you, Your Honor.

08:12AM 23 THE COURT: Any other preliminary matters?

08:12AM 24 Remember, we're going to recess right at noon
08:12AM 25 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.

08:14AM 1 Q What's your job?

08:14AM 2 A I'm currently director of reservoir engineering for the
08:14AM 3 corporation. I oversee the health of the engineering community,
08:14AM 4 the reservoir engineering community.

08:14AM 5 Q By health, what do you mean?

08:15AM 6 A Organizational capability; make sure we have the right
08:15AM 7 people in the right locations and that they're properly trained.

08:15AM 8 Q So is part of what your work involves is teaching other
08:15AM 9 reservoir engineers?

08:15AM 10 A I do teach on occasion internal and some courses for
08:15AM 11 partners.

08:15AM 12 Q When you say courses for partners, what does that industry
08:15AM 13 term mean, partners specifically?

08:15AM 14 A We have partnerships with other firms, such as the Gulf of
08:15AM 15 Suez Petroleum Company, or with Reliance Industries. I go and I
08:15AM 16 sometimes teach our methods to them.

08:15AM 17 Q Dr. Merrill, how long have you been a reservoir engineer?

08:15AM 18 A I've been a reservoir engineer in one form -- a reservoir
08:15AM 19 engineer in one form or another for about 30 years.

08:15AM 20 Q Are you a member of any professional societies?

08:15AM 21 A Yes. I'm a member of the Society of Petroleum Engineers,
08:16AM 22 and I'm a licensed professional engineer in the state of Texas.

08:16AM 23 Q In addition to the leadership position you described at BP,
08:16AM 24 do you have leadership positions outside of BP?

08:16AM 25 A Yes. I am an Episcopal priest, and I am rector and pastor

08:16AM 1 of Saint Bartholomew Episcopal Church in Hempstead, Texas.

08:16AM 2 Q I want to focus in on the work you did at BP related to the
08:16AM 3 Macondo incident. When did you first start doing any work
08:16AM 4 relating to the Macondo incident?

08:16AM 5 A With the exception of a few stray questions, I started
08:16AM 6 working on the Macondo incident in about mid-May of 2010.

08:16AM 7 Q Now, Dr. Merrill, I want you to listen very carefully to my
08:16AM 8 questions. At some point in the summer of 2010, did you start
08:16AM 9 doing a separate work stream to provide scientific analysis to
08:16AM 10 the lawyers defending BP in this case?

08:16AM 11 A Yes. I started what I was told was called privileged work
08:17AM 12 in August of 2010.

08:17AM 13 Q Dr. Merrill, I'm going to now go back and be asking you
08:17AM 14 about the nonprivileged work you did in analyzing the Macondo
08:17AM 15 well. And I just want to ask you, in my questions for the rest
08:17AM 16 of the morning or as long as I ask you questions, will you
08:17AM 17 understand that I am not asking you to describe the privileged
08:17AM 18 work you did with the lawyers?

08:17AM 19 A Yes, I understand that.

08:17AM 20 Q What were you doing when you started in May? What were you
08:17AM 21 doing to assist in the response to the incident?

08:17AM 22 A Most of my work for the Macondo incident involved the
08:17AM 23 estimation of pressures in the face of the large uncertainties
08:17AM 24 we had about the flow rate. You know, what sort of pressures
08:17AM 25 might be encountered at various horizons in the reservoir in the

08:18AM 1 stratographic section; what pressures might be encountered at
08:18AM 2 the wellhead were we to shut it in.

08:18AM 3 This started in mid-May for the Top Kill. It then
08:18AM 4 continued in June for the planning of the relief wells. And
08:18AM 5 towards the end of June, early July, we turned our attentions to
08:18AM 6 the wellbore integrity test, which was the capping stack for the
08:18AM 7 -- which ultimately closed the well.

08:18AM 8 Q Now, in this modeling you were doing to predict pressure,
08:18AM 9 did you work with a team of other scientists or engineers?

08:18AM 10 A Well, I was working for the engineering team that was led by
08:18AM 11 Paul Tooms. And I was working very closely with Kate Baker from
08:18AM 12 whom I was taking most of my instructions.

08:18AM 13 I had a team of people who were working for me on
08:18AM 14 a number of different issues. I had a few people help me with
08:19AM 15 reservoir simulation and a few people working on pressure
08:19AM 16 transient analysis, including Michael Levitan, who was our
08:19AM 17 technical advisor for pressure transient analysis.

08:19AM 18 Q Now, when you and your team were doing analysis to try to
08:19AM 19 predict pressure related to the Macondo incident, did you have
08:19AM 20 inputs into that modeling or analytical work for rock
08:19AM 21 compressibility?

08:19AM 22 A I did.

08:19AM 23 Q Why?

08:19AM 24 A Well, rock compressibility is one of those fundamental
08:19AM 25 properties you need to perform reservoir simulation. It's like

08:19AM 1 permeability -- it's not like permeability, but it's of the
08:19AM 2 nature of the permeability porosity or net to gross. It's one
08:19AM 3 of the rock properties which a simulation package requires in
08:20AM 4 order to make predictions about pressure based on flow.

08:20AM 5 Q In the modeling work you were doing as a general matter,
08:20AM 6 what is the effect of rock compressibility on the pressure that
08:20AM 7 you're predicting?

08:20AM 8 A Rock compressibility, we're talking depletion, so when
08:20AM 9 you're withdrawing something from the reservoir, rock
08:20AM 10 compressibility is the measure of how spongy the rock is.

08:20AM 11 Now, we might think that rocks are solid like the
08:20AM 12 wood around me, but under the pressures of the earth above them
08:20AM 13 they actually act much more like sponges.

08:20AM 14 And so as you take fluid out of the reservoir, the
08:20AM 15 rock around it pushes down. Compressibility is a measure of how
08:20AM 16 much the rock actually gives under this pressure.

08:20AM 17 So with a high compressibility, relatively high
08:21AM 18 compressibility, when you pull a certain amount of fluid out of
08:21AM 19 the reservoir, you will see a small pressure change. With a low
08:21AM 20 compressibility, you take the same amount of fluid out of
08:21AM 21 otherwise the same reservoir, you see a larger pressure change.

08:21AM 22 Q Now, in terms of -- we'll get to the specific modeling a
08:21AM 23 little later. Where was the source of data you used to
08:21AM 24 determine the input for rock compressibility when you first
08:21AM 25 started using that input in your modeling mode?

08:21AM 1 A I have received is from either Kelly McAughan or Steve
08:21AM 2 Wilson.

08:21AM 3 Q Who is Steve Wilson?

08:21AM 4 A Steve Wilson was the geomechanical advisor for the Gulf of
08:21AM 5 Mexico.

08:21AM 6 Q How does geomechanics relate to rock compressibility?

08:21AM 7 A Geomechanics is the study of how rocks deform under stress.

08:21AM 8 Q So is a geomechanics person a person whose specialty
08:22AM 9 includes rock compressibility?

08:22AM 10 A It's one the things in the geomechanics specialty, yes, sir.

08:22AM 11 Q What about Kelly McAughan, what was her job?

08:22AM 12 A Kelly McAughan was the reservoir engineer who was actually
08:22AM 13 assigned to the well during its drilling. She worked in the
08:22AM 14 exploration function.

08:22AM 15 Q Was she a geomechanics specialist?

08:22AM 16 A No. She was a general reservoir engineer.

08:22AM 17 Q Let's look at TREX-10859.1.1. And this is a call-out of a
08:22AM 18 portion of a document dated June 29, 2010.

08:22AM 19 At this time, Dr. Merrill, were you doing modeling
08:22AM 20 of the Macondo reservoir?

08:22AM 21 A I was doing simulation -- modeling is a general term. This
08:23AM 22 is a -- refers to a simulation model that I had prepared for
08:23AM 23 Macondo.

08:23AM 24 Q What were you trying to simulate?

08:23AM 25 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

08:24AM 1 prior to Macondo, had you ever heard of any concerns about using
08:24AM 2 rotary sidewall cores to measure rock compressibility?

08:24AM 3 MR. CHAKERES: Your Honor, I'm going to object. This
08:24AM 4 goes beyond the scope of what he was doing in his response and
08:25AM 5 is calling for expert testimony.

08:25AM 6 MR. BOLES: It's fact testimony.

08:25AM 7 THE COURT: It sounds like a fact question. Overrule
08:25AM 8 the objection.

08:25AM 9 BY MR. BOLES:

08:25AM 10 A Until one meeting we had during the Macondo incident, it
08:25AM 11 never -- I was unaware of any controversy regarding the
08:25AM 12 reliability of rotary sidewall core data.

08:25AM 13 Q And, in your prior work at BP as a reservoir engineer for
08:25AM 14 decades, had you in the past input into your models rock
08:25AM 15 compressibility numbers based on measurements of from rotary
08:25AM 16 sidewall cores?

08:25AM 17 A Yes, I had.

08:25AM 18 Q Now, we've been focusing on this particular document and the
08:25AM 19 6 microsips input for rock compressibility. In predicting
08:25AM 20 pressures you were doing here, what would be the effect of
08:25AM 21 increasing that number?

08:25AM 22 A Well, if you held all other things equal, then if you
08:26AM 23 increase the compressibility, you would increase -- well, you
08:26AM 24 would decrease the amount of depletion observed in the reservoir
08:26AM 25 or from wherever you were withdrawing fluid, and therefore you

08:26AM 1 would increase the final pressure in the reservoir.

08:26AM 2 Q Now, you mentioned this meeting July 6th, and we're going to
08:26AM 3 get to that next.

08:26AM 4 In your simulations or other modeling of Macondo
08:26AM 5 prior to July 6th, did you use 6 microsips as the rock
08:26AM 6 compressibility input for all of those models and analyses?

08:26AM 7 A Yes, sir.

08:26AM 8 Q Let's take a look at D-24698.1 in order to set the
08:26AM 9 timeframe.

08:26AM 10 So you did a number of analyses and modeling to
08:27AM 11 predict pressure from Macondo reservoir prior to July 6th;
08:27AM 12 correct?

08:27AM 13 A Yes, sir.

08:27AM 14 Q You used 6 microsips as an input for all of those?

08:27AM 15 A I input -- in those cases where I input compressibility,
08:27AM 16 yes, I used 6 microsips.

08:27AM 17 Q Did your focus -- did you have a particular focus then
08:27AM 18 toward the end of June and early July in terms of the work you
08:27AM 19 were doing about the Macondo incident?

08:27AM 20 A In June and early July the bulk of my -- well, actually
08:27AM 21 mostly in June -- the bulk of my work was involved in relief oil
08:27AM 22 planning and the pressures that might be observed as you drill
08:27AM 23 through the stratographic column because of the possible flow
08:27AM 24 between horizons.

08:27AM 25 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

08:29AM 1 there was a meeting on July 6th.

08:29AM 2 A Yes, sir.

08:29AM 3 Q And what was the purpose of that meeting?

08:29AM 4 A The purpose of the meeting on July 6th was to review my
08:29AM 5 simulation work up to that point, with the principal focus on
08:30AM 6 what it might tell us about pressures.

08:30AM 7 Q Let's take a look at TREX-140863.5.1.

08:30AM 8 Is this a portion of a presentation you gave at
08:30AM 9 that meeting?

08:30AM 10 A Yes, sir, it is.

08:30AM 11 Q Who attended that meeting?

08:30AM 12 A That was an internal BP meeting. It was attend by a number
08:30AM 13 of people, including Paul Tooms, Kate Baker, James Dupree, a
08:30AM 14 number of reservoir engineers who were working in the producing
08:30AM 15 fields in the Gulf of Mexico, some geologists. I believe we
08:30AM 16 also had some flow specialists there as well.

08:30AM 17 Q And let's look at TREX-14863.5.2.

08:31AM 18 What was the value you were using in the modeling
08:31AM 19 you presented for rock compressibility?

08:31AM 20 A I was using a value of 6 microsips.

08:31AM 21 Q Was there discussion about that during the meeting?

08:31AM 22 A Yes, there was.

08:31AM 23 Q What was the discussion?

08:31AM 24 A I had been consistently using either the fluid withdrawal
08:31AM 25 rate or the presence or absence of an aquifer to control the

08:31AM 1 energy, the final pressures you might encounter in the
08:31AM 2 reservoir.

08:31AM 3 And during the discussion of compressibility --
08:31AM 4 well, during the discussion of the inputs to the model, one of
08:31AM 5 the reservoir engineers in the meeting raised the possibility
08:31AM 6 that rotary sidewall cores could provide data that was biased
08:31AM 7 low compared to data collected from other methods.

08:31AM 8 Q Who was that reservoir engineer?

08:31AM 9 A I believe it was Dave Schott.

08:32AM 10 Q And do you know what he based that concern on?

08:32AM 11 A During the meeting, I did not. He raised it as anecdotal
08:32AM 12 evidence that in his experience he had observed this at a nearby
08:32AM 13 field in Galápagos.

08:32AM 14 Q And were there other reservoir engineers at that meeting
08:32AM 15 from other nearby BP Gulf of Mexico fields?

08:32AM 16 A I don't remember exactly who was there. I'm fairly sure
08:32AM 17 Kelly was there. And I think Jessica was there, but I honestly
08:32AM 18 don't remember.

08:32AM 19 Q Were there other reservoir engineers there?

08:32AM 20 A Yes.

08:32AM 21 Q Who had worked on other fields?

08:32AM 22 A Yes.

08:32AM 23 Q And did any of them other than Dave Schott raise this
08:32AM 24 concern about rotary sidewall cores?

08:32AM 25 A Not to my recollection.

08:32AM 1 Q What was the decision that was made at that meeting about
08:32AM 2 what to do with rock compressibility in modeling the risk from
08:32AM 3 pressure buildup from the shut-in of the Macondo well?

08:33AM 4 A The purpose of the meeting was to look at the risks around
08:33AM 5 pressure. And the decision that came out of the meeting was
08:33AM 6 that we would increase the compressibilities that we were using
08:33AM 7 to look at the high side of the pressures that might be
08:33AM 8 encountered.

08:33AM 9 We also made the decision in that meeting to
08:33AM 10 increase the aquifer size, the largest aquifer we were looking
08:33AM 11 at to accomplish the same purpose.

08:33AM 12 Q Now, how does increasing the aquifer size in the modeling to
08:33AM 13 assess risk of shut-in, how is that analysis or why was that
08:33AM 14 part of the same decision to increase rock compressibility
08:33AM 15 numbers or look at alternative higher cases of rock
08:33AM 16 compressibility?

08:33AM 17 A Final reservoir pressure or the reservoir pressure for a
08:33AM 18 given withdrawal rate is dependent on the reservoir energy.

08:34AM 19 Now, you take reservoir energy out when you
08:34AM 20 produce fluids from the reservoir, and you put reservoir energy
08:34AM 21 in either by water that surrounds the reservoir flowing in
08:34AM 22 behind the fluid, which is the aquifer, or by changing the
08:34AM 23 properties of the rock, the compressibility.

08:34AM 24 Q Now, did anybody at this July 6th meeting, yourself or the
08:34AM 25 managers there or the reservoir engineers there, say that they

08:34AM 1 had made a scientific conclusion that the rock compressibility
08:34AM 2 of 6 that you had been using for Macondo was incorrect?

08:34AM 3 A No. It was a possibility that because it was measured on
08:34AM 4 rotary sidewall cores it might be biased low.

08:34AM 5 Q So then why would you then going forward use higher numbers?

08:34AM 6 A For the purposes of the wellbore integrity test, we wanted
08:35AM 7 to understand how high the pressures were that we might
08:35AM 8 encounter in the well.

08:35AM 9 Because it was the magnitude of the pressure that
08:35AM 10 would either drive the pressure that was seen at the wellhead,
08:35AM 11 which to my understanding was also an issue because of the
08:35AM 12 possibilities of causing burst disc failure.

08:35AM 13 Or if the other burst discs or other integrity has
08:35AM 14 failed in the well, the magnitude of the pressure would actually
08:35AM 15 drive the flow rate into the shallower formations, which would
08:35AM 16 increase the risk of a surface breach.

08:35AM 17 We were very concerned about how much time we
08:35AM 18 would have to actually recognize a failure of integrity and the
08:35AM 19 bad things that would happen if we had a surface breach.

08:36AM 20 Q And would a surface breach or causing of a surface breach be
08:36AM 21 more likely if the rock compressibility was higher other lower?

08:36AM 22 A It has nothing to do with rock compressibility.

08:36AM 23 Q In terms of the pressure buildup?

08:36AM 24 A Well, with a higher compressibility you end up with a higher
08:36AM 25 final reservoir pressure, and it's the pressure that actually

08:36AM 1 drives the -- you know, if you had a lack of integrity, it would
08:36AM 2 have been the pressure that would have driven things.

08:36AM 3 It has nothing to do with the compressibility.

08:36AM 4 Q Going forward in your modeling work -- which we'll look at a
08:36AM 5 few examples of it -- -going forward, what rock compressibility
08:36AM 6 number or numbers did you use leading up to the shut-in on July
08:36AM 7 15th?

08:36AM 8 A After some back and forth between Steve Wilson, Dave Schott,
08:37AM 9 Kelly, and myself, the decision was made to double the measured
08:37AM 10 values to 12, and also to triple them to 18 to provide high
08:37AM 11 estimates for the rock compressibility.

08:37AM 12 Q Did you also continue in any of your modeling to use 6
08:37AM 13 microsips?

08:37AM 14 A I continued to use 6 throughout my modeling efforts.

08:37AM 15 Q Now, you mentioned Steve Wilson. Remind Judge Barbier who
08:37AM 16 he is again.

08:37AM 17 A Steve Wilson was the geomechanics technical advisor for the
08:37AM 18 government.

08:37AM 19 Q Was he at this July 6th meeting?

08:37AM 20 A He was not.

08:37AM 21 Q So let's see what role he played in this afterwards. Let's
08:37AM 22 look at TREX-11557.2.1.

08:37AM 23 Did you receive this email from Mr. Wilson,
08:37AM 24 Dr. Merrill?

08:37AM 25 A I did.

08:38AM 1 Q And focusing your attention on the sentence: I don't think
08:38AM 2 you can go much above 6 microsips and still honor the data.

08:38AM 3 Do you see that?

08:38AM 4 A Yes, sir.

08:38AM 5 Q Do you remember hearing that from Steve Wilson?

08:38AM 6 A Yes.

08:38AM 7 Q And did you talk to him after this email in response to it?

08:38AM 8 A Yes, I did.

08:38AM 9 Q What did you talk about with him?

08:38AM 10 A I went and I --

08:38AM 11 MR. CHAKERES: I object to this on hearsay grounds.

08:38AM 12 THE COURT: Sustained.

08:38AM 13 BY MR. BOLES:

08:38AM 14 Q Let's take a look at TREX-1157.1.1.

08:38AM 15 Is this an email that you received from Mr.

08:38AM 16 Wilson, Dr. Merrill?

08:38AM 17 A Yes, I did.

08:38AM 18 Q And it says in the first sentence: I have spoken with Bob

08:38AM 19 Merrill and have more context now around the question being

08:39AM 20 asked.

08:39AM 21 A Yes, sir.

08:39AM 22 Q Had you had a conversation with Steve Wilson to explain the

08:39AM 23 reason for looking at alternative higher rock compressibility

08:39AM 24 values coming out of that July 6th meeting?

08:39AM 25 A Yes, I had.

08:39AM 1 MR. CHAKERES: Same objection, Your Honor, as to the
08:39AM 2 content of that communication.

08:39AM 3 MR. BOLES: Your Honor, the government has put into
08:39AM 4 issue why BP was looking at or the significance of BP looking at
08:39AM 5 alternative rock compressibility.

08:39AM 6 So these are facts and offered for the fact of the
08:39AM 7 discussions going on. Let the decision...

08:39AM 8 THE COURT: You can't. You can't use -- I mean, this
08:39AM 9 is clearly hearsay if he's going to say what someone else at BP
08:39AM 10 told him. I don't know how you get around the hearsay rule.

08:39AM 11 MR. BOLES: I don't think that was part of my question.

08:39AM 12 I'll re-ask the question. Maybe it will be a
08:39AM 13 different question. If not, then I'm sure I will hear an
08:39AM 14 objection and then I'll move on.

08:39AM 15 THE COURT: Okay.

08:40AM 16 BY MR. BOLES:

08:40AM 17 Q Had you had a conversation with Steve Wilson about the July
08:40AM 18 6th meeting where rock compressibility was discussed?

08:40AM 19 A Yes, I did.

08:40AM 20 Q What did you tell him?

08:40AM 21 MR. CHAKERES: Your Honor, that's still hearsay. It's
08:40AM 22 an out-of-court statement.

08:40AM 23 THE COURT: No. The fact that he had a meeting, that's
08:40AM 24 not hearsay. Go ahead. Overrule that objection.

08:40AM 25 BY MR. BOLES:

08:40AM 1 A I told Steve that we were looking for higher values of
08:40AM 2 compressibility that were still within the realms of possibility
08:40AM 3 so that we could calculate a higher final depleted pressure.

08:40AM 4 Q And did Steve Wilson eventually provide to your team for
08:40AM 5 modeling the risks of shut-in alternative higher rock
08:40AM 6 compressibility numbers to use in that modeling?

08:40AM 7 A Not exactly. Yes, after some discussion he came out with a
08:40AM 8 range of numbers. But the final numbers we used for modeling
08:41AM 9 were simple multiples of the measured rock compressibility.

08:41AM 10 Q Which was?

08:41AM 11 A Two times and three times, so 12 microsips and 18 microsips.

08:41AM 12 Q And the measured number was what, Dr. Merrill?

08:41AM 13 A 6 microsips.

08:41AM 14 Q Did the geomechanics specialist, Mr. Wilson, ever deliver to
08:41AM 15 your team for use in your modeling a scientific study showing
08:41AM 16 that the rock compressibility of 6 measured in the Macondo
08:41AM 17 reservoir was incorrect?

08:41AM 18 A He did not present a written study, no, sir.

08:41AM 19 Q Did he provide any study to you showing you and convincing
08:41AM 20 you that the rotary sidewall core measurements were biased low?

08:41AM 21 A No, he did not.

08:42AM 22 Q Let's take a look at TREX-20849.1.

08:42AM 23 Do you recognize in a document, Dr. Merrill?

08:42AM 24 A It's hard to recognize something straight from the title
08:42AM 25 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.

08:43AM 1 Q We've heard you say that 12 microsips was an increase from
08:43AM 2 the measured value of 6; correct?

08:43AM 3 A Yes, sir.

08:43AM 4 Q And what about the 3.8 times aquifer? How can that relate
08:43AM 5 to prior modeling you had done?

08:43AM 6 A 3.8 was actually on the high side of the aquifer modeling I
08:44AM 7 had done to that point. That was based on a geological
08:44AM 8 examination, a map, which mapped a four time, roughly four times
08:44AM 9 aquifer size.

08:44AM 10 Q Why were you using an aquifer number on the high side in
08:44AM 11 this?

08:44AM 12 A Well, one of the decisions we made in July 6th, in the July
08:44AM 13 6th meeting, was to increase the aquifer size. And so four
08:44AM 14 times aquifer here, 3.8, became a middle case, because we were
08:44AM 15 going up to 14 times and 24 times aquifer size in the scenarios
08:44AM 16 we were examining for the wellbore integrity test.

08:44AM 17 Q Why were you looking at these higher numbers?

08:44AM 18 A We wanted to understand just how high the pressure might be
08:44AM 19 in those scenarios.

08:44AM 20 Q And I see here an alternative aquifer case of 24 times.

08:45AM 21 A Yes, sir.

08:45AM 22 Q Is that what you believe the aquifer was at Macondo?

08:45AM 23 A No. There was a similar conversation with the -- I don't
08:45AM 24 know if they were geologists or geophysicists, but the
08:45AM 25 exploration team who were mapping the structure. We asked them

08:45AM 1 how big might it be. And, well, getting to 4 times was not
08:45AM 2 difficult. Getting to 14 times, you know, you'd have to expand
08:45AM 3 your channel boundaries a little bit. And getting to 24 times
08:45AM 4 was their upper estimate.

08:45AM 5 Q Had you ever modeled any reservoir on an aquifer of 24 times
08:45AM 6 in your career?

08:45AM 7 A Oh, yes, sir.

08:45AM 8 Q Now, the 35,000 barrels per day, was that a flow rate that
08:45AM 9 you had analyzed and had concluded was the rate at Macondo at
08:45AM 10 this time?

08:45AM 11 A No, sir. I had made no flow rate analyses at these times.

08:46AM 12 What I did was I ran the model under flow rate control and I
08:46AM 13 specified how much oil would flow from the model.

08:46AM 14 Q Let take a look at TREX-9324.3.

08:46AM 15 Do you recognize this document, Dr. Merrill?

08:46AM 16 A This is the start of a presentation or a number of
08:46AM 17 presentations that were held with the government to examine the
08:46AM 18 risks of shutting in the well with the Capping Stack.

08:46AM 19 Q And did you make a presentation during --

08:46AM 20 A I made at least one presentation during this day-long
08:46AM 21 meeting.

08:46AM 22 Q Let's look at TREX-9324.17.

08:46AM 23 Is this a slide from your presentation?

08:46AM 24 A It is.

08:46AM 25 Q And were there members of the government science team at

08:46AM 1 this meeting?

08:46AM 2 A There were.

08:47AM 3 Q And in red it says next to a assumptions, C, sub script R.

08:47AM 4 What does that refer to?

08:47AM 5 A That's the rock compressibility.

08:47AM 6 Q And it has number of 12 microsips?

08:47AM 7 A Yes, sir.

08:47AM 8 Q Did you use the words Most Likely on this slide?

08:47AM 9 A I did not.

08:47AM 10 Q Did you use them in any part of this presentation?

08:47AM 11 A I don't believe so.

08:47AM 12 Q Did you tell anybody at the government who was at this

08:47AM 13 meeting that you thought a rock compressibility number of 12

08:47AM 14 microsips was most likely?

08:47AM 15 A I don't recall saying that. If I did, I would have used air

08:47AM 16 quotes most likely.

08:47AM 17 Q You also have as sensitivities for rock compressibility 6

08:47AM 18 and 18 microsips.

08:47AM 19 A Yes, sir.

08:47AM 20 Q And, again, 6 was the measured value?

08:47AM 21 A Yes, sir.

08:47AM 22 Q Why at the time of this presentation were you presenting 12

08:47AM 23 and 18 microsips as well as 6 microsips?

08:47AM 24 A This was a presentation where we were describing the risks

08:48AM 25 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 --

08:49AM 1 D-24698-2. So we looked at the early modeling you did with 6
08:49AM 2 microsips and the July 6th meeting and ensuing presentations
08:50AM 3 leading up to these July 8th and 9th presentations using 12
08:50AM 4 microsips.

08:50AM 5 What was the date of shut-in?

08:50AM 6 A The 15th.

08:50AM 7 Q And let's take a look at a presentation from the day after
08:50AM 8 that, TREX-10845.1.

08:50AM 9 Do you recognize this, Dr. Merrill?

08:50AM 10 A Yes, sir.

08:50AM 11 Q What were you presenting at this time?

08:50AM 12 A I wasn't the only person presenting at this presentation.
08:50AM 13 But my portion of the presentation, it was about the
08:50AM 14 interpretation of the pressure buildup data observed at the
08:50AM 15 wellhead between the meeting we just discussed on the 9th of
08:50AM 16 July and the actual shut-in of the well.

08:50AM 17 We had done some serious thoughts about how we
08:51AM 18 might actually recognize a lack of integrity in the well, and we
08:51AM 19 had recommended to the government science team, as well as to
08:51AM 20 BP, that we'd use a classical form of pressure transient
08:51AM 21 analysis called a Horner plot to do the analysis.

08:51AM 22 Q Was there a difference in your focus or concern or approach
08:51AM 23 to the pressure modeling that's reflected or the pressure
08:51AM 24 analysis that's reflected here a day after the shut in of the
08:51AM 25 well as compared to the modeling you did in the days immediately

08:51AM 1 prior to the shut in that we just looked at?

08:51AM 2 A The purposes of the two modeling efforts were completely
08:51AM 3 distinct. Before we shut in the well, we didn't actually know
08:51AM 4 what the data would demonstrate. We didn't know what we would
08:51AM 5 see, and so we were actually considering a range of
08:52AM 6 possibilities with particular worry to the high side pressures.

08:52AM 7 After we started collecting data, then we were
08:52AM 8 much more concerned about understanding the character of the
08:52AM 9 pressure buildup to see if it was actually illustrating or
08:52AM 10 demonstrating or providing information about whether we had
08:52AM 11 wellbore integrity or not.

08:52AM 12 So going from having no data and making
08:52AM 13 predictions to actually trying to understand the data that
08:52AM 14 you're collecting.

08:52AM 15 Q Now, let's take look at some of your analysis of that
08:52AM 16 pressure data that started coming in after the shut-in.
08:52AM 17 TREX-10845.10.

08:52AM 18 A Yes, sir.

08:52AM 19 Q What is this, Dr. Merrill?

08:52AM 20 A This is just 24 hours after the shut-in of the well. And
08:52AM 21 you can see in the lower right-hand corner is this Horner plot
08:52AM 22 which I mentioned. The Horner plot can be constructed
08:53AM 23 completely from the data. There's no interpretation in a Horner
08:53AM 24 plot. You do not need to use compressibility. You do not need
08:53AM 25 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

08:56AM 1 had performed prior to shut-in.

08:56AM 2 Q When you say the range of scenarios prior to shut-in, are
08:56AM 3 you referring to the scenarios we saw in your July 8 and 9
08:56AM 4 presentations that included alternative cases such as 12
08:56AM 5 microsips?

08:56AM 6 A That is correct. Now, in this particular graph -- it's been
08:56AM 7 a long time. I don't know if I re-ran some of these simulations
08:56AM 8 after the actual shut in of the well.

08:56AM 9 But certainly simulation takes a long time to run
08:57AM 10 relative to other things, and so we did not update any of our
08:57AM 11 assumptions at this point.

08:57AM 12 Q In other words, Dr. Merrill, when do you think this slide
08:57AM 13 and this modeling using 12 microsips was done?

08:57AM 14 A The slide was certainly prepared for this 2 p.m. meeting on
08:57AM 15 the 16th. The simulations may have been done overnight on the
08:57AM 16 15th. And the reason I say that is there's a slow shut-in here,
08:57AM 17 and our early simulations all assumed an instantaneous shut-in.

08:57AM 18 But we didn't change any of the other assumptions
08:57AM 19 in the model.

08:57AM 20 Q Now, does this slide, and it has Xs and dots on it, is there
08:57AM 21 anywhere on there a display or presentation of actual pressure
08:57AM 22 data from the pressure gauge on a Capping Stack after shut-in?

08:58AM 23 A No, sir.

08:58AM 24 Q And what did that data end up telling you about your
08:58AM 25 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?

08:59AM 1 A Because that was the measured value.

08:59AM 2 Q Did you believe that was the most likely value?

08:59AM 3 A It was the measured value, and there was no evidence to the
08:59AM 4 contrary to the use the measured value. Most likely yes,
08:59AM 5 because it was measured.

08:59AM 6 Q Do you know someone named Dr. Paul Hseih of the United
09:00AM 7 States Geological Survey?

09:00AM 8 A I do. I worked closely with Paul throughout the incident,
09:00AM 9 particularly during the wellbore integrity test.

09:00AM 10 Q After the shut in, did you have occasion to talk with him
09:00AM 11 about rock compressibility?

09:00AM 12 A Yes, sir.

09:00AM 13 Q What did you tell him?

09:00AM 14 A I told him we were using 6 microsips.

09:00AM 15 Q Let's take a look at TREX-142325.1.1.

09:00AM 16 Do you recognize this email as we've called it out
09:00AM 17 here, Dr. Merrill?

09:00AM 18 A Yes, sir.

09:00AM 19 Q And what is this?

09:00AM 20 A Paul wasn't actually in Houston during the actual shut in of
09:00AM 21 the well. He went somewhere.

09:00AM 22 But we talked with him by phone. And, in the
09:00AM 23 course of that phone call, we were discussing a number of
09:00AM 24 things. This email confirmed the numbers we had used in that
09:00AM 25 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 1 A Well, these weren't actually presented. These were the
09:04AM 2 slides that I sent to Mike Levitan to review prior to the
09:04AM 3 presentation to the government.

09:04AM 4 Q And did you use 6 microsips in your analysis that you
09:04AM 5 presented to the government?

09:04AM 6 A Yes, we did.

09:04AM 7 Q Let's look at TREX-9318.1.1.

09:04AM 8 Another email from you with copies to Tooms and
09:04AM 9 Yeilding and Baker.

09:04AM 10 Do you know what this is, Dr. Merrill?

09:04AM 11 A Yes. This appears to be the email that I sent following the
09:04AM 12 previous email once we had finalized our presentation to the
09:04AM 13 government. The attachments, for example, say: Bob match 25th
09:05AM 14 of July; ML for Mike Levitan review, final.

09:05AM 15 Q And, again, let's go look at portions from what was
09:05AM 16 transmitted TREX-9318.4.1.

09:05AM 17 What was the rock compressibility input you were
09:05AM 18 using in this work?

09:05AM 19 A 6 microsips.

09:05AM 20 Q Let's go back to our timeline, D-24698-3.

09:05AM 21 Dr. Merrill, you briefly used the alternative
09:05AM 22 cases of 12 and 18 in evaluating the risks of shut-in.

09:05AM 23 After the shut-in, what number were you using for
09:05AM 24 rock compressibility in the analyses you did of Macondo?

09:05AM 25 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 1 A Yes, sir.

09:10AM 2 Q What's that referring to, Dr. Merrill?

09:10AM 3 A Those were the three reservoir layers that we believed were
09:10AM 4 contributing to flow in this incident.

09:10AM 5 Q Can you explain to Judge Barbier how you used these four
09:10AM 6 columns of data, if you used them, in coming up with
09:10AM 7 permeability numbers you used as a senior reservoir engineer in
09:10AM 8 your modeling and analytical work for BP during the incident?

09:10AM 9 A Well, the first two -- the first two columns where it says
09:11AM 10 arithmetic air permeability show the values that are log derived
09:11AM 11 from a correlation between porosity and permeability that's
09:11AM 12 based on core data.

09:11AM 13 Then you look at the squiggles on the log and you
09:11AM 14 actually build up a more detailed distribution of permeability
09:11AM 15 versus depth.

09:11AM 16 And then you average them across those intervals,
09:11AM 17 and there's an arithmetic average there and a geometric average
09:11AM 18 there, and that's a measure of how variable the permeability is
09:11AM 19 within the layer.

09:11AM 20 So, for example, M56E, you see the arithmetic air
09:11AM 21 perm average is about 500 and the geometric air perm average is
09:11AM 22 about 300. That's actually fairly close for those two averages.

09:12AM 23 And so you would conclude that the M56E was fairly
09:12AM 24 homogenous. But the M56F, the arithmetic perm average is over
09:12AM 25 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 1 A Yes, sir.

09:13AM 2 Q Did you consider using a different number or than 85 percent
09:14AM 3 for Macondo?

09:14AM 4 A No, sir.

09:14AM 5 Q Were there other lower numbers that you had available that
09:14AM 6 you didn't use because you wanted to be estimating on the high
09:14AM 7 side of permeability?

09:14AM 8 A No, sir. It was actually not my call to use that factor.

09:14AM 9 Q Now, you mentioned that you wouldn't ever use air
09:14AM 10 permeability in your work. I want to go back though to the air
09:14AM 11 permeability number.

09:14AM 12 MR. BOLES: Yes, counsel?

09:14AM 13 MR. CHAKERES: There's no question, but I was objecting
09:14AM 14 in case there was expert testimony elicited. So the objection
09:14AM 15 stands.

09:14AM 16 THE COURT: All right. I guess there's no objection.

09:14AM 17 BY MR. BOLES:

09:14AM 18 Q All right. Let's go to the first column, arithmetic air
09:14AM 19 permeability. You see in that first column of numbers there,
09:14AM 20 Dr. Merrill, going down to the highlighted part, and I want to
09:14AM 21 focus only M56D and E, the first two of those three highlighted
09:15AM 22 rows.

09:15AM 23 A Yes, sir.

09:15AM 24 Q Those were the two thicker layers?

09:15AM 25 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

09:16AM 1 permeability of 250 to 500 millidarcies based on air

09:16AM 2 permeability?

09:16AM 3 A I don't think so. Not under my direction.

09:16AM 4 MR. BOLES: Thanks, Dr. Merrill.

09:17AM 5 MR. CHAKERES: Good morning, Your Honor. My name is
09:17AM 6 Nat Chakeres on behalf of the United States.

09:17AM 7 THE COURT: Go ahead.

09:17AM 8 CROSS EXAMINATION

09:17AM 9 BY MR. CHAKERES:

09:17AM 10 Q Good morning, Dr. Merrill. My name is Nat Chakeres, and I
09:17AM 11 have you on cross examination.

09:17AM 12 A Good morning.

09:17AM 13 Q I would like to go back to what you talked about this
09:17AM 14 morning about the period in early July 2010.

09:17AM 15 A Yes, sir.

09:17AM 16 Q You understood at that time that a Capping Stack was going
09:17AM 17 to be installed; correct?

09:17AM 18 A Yes, sir.

09:17AM 19 Q And there's going to be attempts to shut the Capping Stack;
09:18AM 20 correct?

09:18AM 21 A Yes, sir.

09:18AM 22 Q And there's concern about what you call well integrity;
09:18AM 23 correct?

09:18AM 24 A Yes, sir.

09:18AM 25 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

09:19AM 1 meeting. That was Exhibit 10839, and I'd like to go to page 31
09:19AM 2 of that exhibit. So 10839.31.31.US.

09:19AM 3 A This was on the 6th of July?

09:19AM 4 Q This is on the 6th of July. I can go back to the cover page
09:19AM 5 if you want to.

09:19AM 6 A No. I just wanted to make sure which meeting it was. There
09:19AM 7 are a lot of meetings.

09:20AM 8 Q There are a lot of meetings. You were discussing some of
09:20AM 9 this this morning, right? You had a concern about crossflow
09:20AM 10 into the M110 sand; correct?

09:20AM 11 A Yes, sir.

09:20AM 12 Q And you see here that it's small, five feet thick, and in
09:20AM 13 one scenario could fill to fracture pressure in ten days;
09:20AM 14 correct?

09:20AM 15 A Yes, sir.

09:20AM 16 Q And that's what you were talking about this morning, you
09:20AM 17 were worried about how fast those sands could fill up and then
09:20AM 18 start fracturing to surface; correct?

09:20AM 19 A Yes, sir.

09:20AM 20 Q And if we could go to your exhibit, your presentation that
09:20AM 21 you gave on July 8th, that's Exhibit 1084. If we could go to
09:21AM 22 page 38 of that exhibit.

09:22AM 23 While we're getting that up, Dr. Merrill, in the
09:22AM 24 modeling that you performed --

09:22AM 25 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

09:23AM 1 confused. Between the 6th and the 8th we added the cases we've
09:23AM 2 already discussed about increased aquifer size and increased
09:23AM 3 compressibility.

09:23AM 4 Q And those cases showed that when you shut in the well, for
09:23AM 5 keeping all else equal, the reservoir is going to recover to a
09:23AM 6 higher pressure; correct?

09:23AM 7 A That is correct.

09:23AM 8 Q Now, if we could look at back to your presentation on July
09:23AM 9 6th, that's Exhibit 10839.

09:24AM 10 Now, in this exhibit, you had been -- you
09:24AM 11 presented on page 19.

09:24AM 12 A Can we make it bigger?

09:24AM 13 Q Yeah. Let's just pull this out. This is your July 6th
09:24AM 14 presentation.

09:24AM 15 A I can read that. I couldn't read the other.

09:24AM 16 Q Okay, yeah.

09:24AM 17 So you testified earlier that you didn't know what
09:24AM 18 the flow rate was at this time; correct?

09:24AM 19 A That is correct.

09:24AM 20 Q And if we could call out the third bullet.

09:24AM 21 You had actually been requested by Kate Baker to
09:24AM 22 avoid making any conclusions about likely flow rates; hadn't
09:24AM 23 you?

09:24AM 24 A That is correct.

09:24AM 25 Q And after the well was shut in, you were never told of any

09:24AM 1 of the flow rate calculations that were performed through the
09:24AM 2 Capping Stack; were you? During the July timeframe.

09:24AM 3 A I was aware that the government had a team that was actually
09:25AM 4 calculating some number because we talked to them every day.

09:25AM 5 So I was aware in July during the incident that
09:25AM 6 the government was doing some calculations.

09:25AM 7 Q Were you aware that anybody at BP was doing some
09:25AM 8 calculations?

09:25AM 9 A I was not.

09:25AM 10 Q Were you ever informed of the numbers that either the
09:25AM 11 government or BP was coming up with at that time?

09:25AM 12 A I may -- I do not remember the numbers. I may have
09:25AM 13 overheard the government's numbers, but I don't recall what they
09:25AM 14 were at the time.

09:25AM 15 Q Now, I'd like to move to the period after the well was shut
09:25AM 16 in. You testified that at that point you were no longer worried
09:25AM 17 about high pressures.

09:25AM 18 A That is correct.

09:25AM 19 Q Now, if we could go to Exhibit 10931.2.1.US.

09:26AM 20 MR. CHAKERES: My apologies, Your Honor. I'll keep
09:26AM 21 this moving along. While that's coming up -- here we go.

09:26AM 22 If we could actually go back and call out the
09:26AM 23 entire email from which this call-out is taken to provide
09:26AM 24 context.

09:26AM 25 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;

09:33AM 1 correct?

09:33AM 2 A Then I assumed that's what he was using at this time.

09:33AM 3 Q And he had a flow rate of 50,000 barrels per day; correct?

09:33AM 4 A That was constant throughout the period. All of these are
09:33AM 5 constant rates.

09:33AM 6 Q And the original oil in place corresponding to that pressure
09:33AM 7 signature was 110 million stock tank barrels; correct?

09:33AM 8 A That is what was input into Paul's model. Paul's model was
09:33AM 9 not a pressure transient analysis program. It was a
09:33AM 10 hydrological simulator, and so Paul had to input parameters into
09:33AM 11 his model that we did not use in pressure transient analysis.

09:33AM 12 For example, in classical pressure transient
09:34AM 13 analysis, you are changing the boundary sizes dynamically with
09:34AM 14 the -- to adjust the shape of your model to the buildup curve.

09:34AM 15 What Paul did, as I understand it, because we
09:34AM 16 discussed it a little bit, was he added a Lee Squares program to
09:34AM 17 his program to actually change various parameters, including the
09:34AM 18 permeability and I think the compressibility as well, to match
09:34AM 19 the curve.

09:34AM 20 So it's not quite the same thing. And so these
09:34AM 21 were what his parameters were given to us, and we then input
09:34AM 22 them into our pressure transient analysis program. So this is
09:34AM 23 probably not pressure transient analysis, but this is a
09:34AM 24 reflection of what his model showed in a pressure transient
09:34AM 25 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 1 A Yes, sir.

09:37AM 2 MR. CHAKERES: No further questions. Thank you.

09:37AM 3 THE COURT: All right. Redirect, Mr. Boles?

09:37AM 4 MR. BOLES: Yes, a few questions, Your Honor.

09:37AM 5 REDIRECT EXAMINATION

09:37AM 6 BY MR. BOLES:

09:38AM 7 Q Dr. Merrill, I think the phrase you used was you were
09:38AM 8 shadowing the work of Dr. Hseih and other government scientists
09:38AM 9 and engineers.

09:38AM 10 A Yes, sir.

09:38AM 11 Q So for example, let's look at TREX-9318.8.1.

09:38AM 12 In the course of shadowing them, did you sometimes
09:38AM 13 run models with their input numbers such as rock
09:39AM 14 compressibility?

09:39AM 15 A I think I just said that, yes.

09:39AM 16 Q So for example, in this TREX-9318 where it says 14
09:39AM 17 microsips, it says in the caption on the top the second row,
09:39AM 18 blowout, USGS parameters, correct?

09:39AM 19 A Yes, sir.

09:39AM 20 Q And that references the United States geological survey?

09:39AM 21 A Yes, sir.

09:39AM 22 Q And you also were shown TREX-10931.2. If we can look at
09:39AM 23 that.

09:39AM 24 I don't have a blowup of that, but let's just look
09:39AM 25 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

09:41AM 1 shut-in. I just don't remember every run that I made after the
09:41AM 2 shut-in.

09:41AM 3 But I tended to use 6 for the flow rates that we
09:41AM 4 were assuming. It was not an issue.

09:41AM 5 Q When it came to modeling the pressures to be predicted in
09:41AM 6 drilling of the relief well, what number did you use?

09:41AM 7 A I have always used 6.

09:41AM 8 Q And did you, in your decision making as a reservoir engineer
09:41AM 9 deciding what input to put in, what did you regard as the most
09:41AM 10 likely value for rock compressibility?

09:41AM 11 A For all of my simulation work related to the relief well, I
09:41AM 12 used --

09:41AM 13 MR. CHAKERES: Objection, Your Honor, this is calling
09:41AM 14 for expert testimony.

09:41AM 15 MR. BOLES: Again, they put in issue his decision
09:41AM 16 making and that of other BP engineers and scientists about why
09:41AM 17 they used and what they used for rock compressibility.

09:41AM 18 MR. CHAKERES: He asked for his opinion. We're just
09:42AM 19 bringing out what they used.

09:42AM 20 MR. BOLES: If counsel wants to stipulate that the
09:42AM 21 beliefs of BP reservoir engineers and scientists are not
09:42AM 22 relevant to what the value of rock compressibility is, I'll drop
09:42AM 23 the question.

09:42AM 24 But otherwise, I think they've put this in issue.

09:42AM 25 THE COURT: Re-ask the question.

09:42AM 1 BY MR. BOLES:

09:42AM 2 Q Sure. In the modeling work you did, Dr. Merrill, when you
09:42AM 3 were deciding what number to put in for rock compressibility,
09:42AM 4 what was your judgment as to what the most likely value was of
09:42AM 5 the true rock compressibility of the Macondo reservoir?

09:42AM 6 THE COURT: I'm going to sustain the objection. I
09:42AM 7 think the question -- I think the witness has already answered
09:42AM 8 that he got that number from the only so-called measured data
09:42AM 9 that was available, the Weatherford sidewall cores; right?

09:42AM 10 THE WITNESS: It's my understanding that the only
09:42AM 11 measured data there was, Your Honor, was the sidewall cores.

09:42AM 12 THE COURT: That's what you used.

09:42AM 13 MR. CHAKERES: Yes, sir.

09:43AM 14 BY MR. BOLES:

09:43AM 15 Q Dr. Merrill, do reservoir engineers, in deciding what inputs
09:43AM 16 to put into reservoir models, use judgment about how to use the
09:43AM 17 data and come up with inputs?

09:43AM 18 A Excuse me? I don't understand your question.

09:43AM 19 Q Sure. What was the basis for your decision to put in a
09:43AM 20 number for rock compressibility?

09:43AM 21 MR. CHAKERES: Your Honor, I am going to object to
09:43AM 22 that.

09:43AM 23 THE COURT: Sustained. Sustained. I think he answered
09:43AM 24 that.

09:43AM 25 MR. BOLES: That's all I have, Your Honor.

09:43AM 1 THE COURT: Okay. Thank you, sir. You're done.

09:43AM 2 All right. Let's take a 15-minute recess.

09:43AM 3 (Proceedings in recess.)

10:00AM 4 THE COURT: Mr. Fields.

10:00AM 5 MR. FIELDS: Good morning, Your Honor, Barry Fields.

10:00AM 6 BP and Anadarko call as their next witness Dr. Michael Zaldivar.

10:00AM 7 **MICHAEL ZALDIVAR**, being first duly sworn,

10:00AM 8 testified as follows:

10:00AM 9 THE CLERK: Take a seat. If you'll state and spell

10:00AM 10 your name for the record, please.

10:00AM 11 THE WITNESS: My name's Michael Zaldivar, M-I-C-H-A-E-L

10:00AM 12 Z-A-L-D-I-V-A-R.

10:00AM 13 DIRECT EXAMINATION

10:00AM 14 BY MR. FIELDS:

10:00AM 15 Q Dr. Zaldivar, my name is Barry Fields, and I will be

10:01AM 16 conducting your direct examination on behalf of BP and Anadarko.

10:01AM 17 THE COURT: There appears to be a pending *Daubert*

10:01AM 18 motion or a motion in limine?

10:01AM 19 MR. CHAKERES: Yes, Your Honor.

10:01AM 20 THE COURT: I have looked at that, by the government,

10:01AM 21 pertaining to this witness. It appears to me that the

10:01AM 22 government's objection really goes to the weight that I should

10:01AM 23 give to Dr. Zaldivar's testimony, so I'm going to overrule or

10:01AM 24 deny the motion.

10:01AM 25 MR. CHAKERES: Thank you, Your Honor.

10:01AM 1 MR. FIELDS: Thank you, Your Honor.

10:01AM 2 May we proceed?

10:01AM 3 THE COURT: Sure.

10:01AM 4 BY MR. FIELDS:

10:01AM 5 Q Dr. Zaldivar, would you please introduce yourself to the
10:01AM 6 Court.

10:01AM 7 A My name is Dr. Michael Zaldivar. I'm president and founder
10:01AM 8 Evoleap.

10:01AM 9 Q We'll get into more details about your qualifications, but
10:01AM 10 for right now will you provide the Court with just a thumbnail
10:01AM 11 sketch on your expertise.

10:01AM 12 A Sure. I have 11 years experience as a multiphase flow
10:01AM 13 expert and flow assurance engineer. A flow assurance engineer
10:02AM 14 is an engineer that ensures that hydrocarbons that leave the
10:02AM 15 reservoir make it to the receiving facilities topside. So they
10:02AM 16 focus on wells, flow lines or pipelines, and risers.

10:02AM 17 Q BP and Anadarko hired you in this case?

10:02AM 18 A That's correct.

10:02AM 19 MR. FIELDS: Let's pull up D-24552-1.

10:02AM 20 BY MR. FIELDS:

10:02AM 21 Q Can you give us an overview of the general issues or
10:02AM 22 questions that you were asked to address by BP and Anadarko?

10:02AM 23 A Sure.

10:02AM 24 First, I was asked to determine whether a flow
10:02AM 25 pattern known as slug flow was present during mid-May of 2010.

10:02AM 1 Second, if that pattern was present -- since slug
10:02AM 2 flow means there are certain bounds to the flow rate, what
10:02AM 3 conclusions could be drawn about the flow rate during that
10:02AM 4 period.

10:02AM 5 Q Now, have you formed opinions on the two questions that are
10:02AM 6 set forth on D-245521?

10:03AM 7 A I have.

10:03AM 8 Q Before getting into those opinions in more detail, let's
10:03AM 9 discuss your background.

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

10:03AM 11 BY MR. FIELDS:

10:03AM 12 Q Using this particular demonstrative, can you provide the
10:03AM 13 Court with an overview of your educational background.

10:03AM 14 A Yes. I received my Bachelors of Science in chemical
10:03AM 15 engineering from the University of Houston in 1997.

10:03AM 16 I then went to the University of Michigan where I
10:03AM 17 received a Masters and Ph.D. in chemical engineering in 2002.

10:03AM 18 Q Let's take a look at your work experience, which is also
10:03AM 19 listed on this particular demonstrative exhibit. Let me ask you
10:03AM 20 the question: Have you been involved in the oil and gas
10:03AM 21 industry since you obtained your Ph.D. in 2002?

10:03AM 22 A Yes. My first job was directly in the oil and gas industry.

10:03AM 23 Q Was your first job Multiphase Solutions?

10:03AM 24 A Yes, that's correct.

10:03AM 25 Q Tell us what you did at Multiphase Solutions while were you

10:04AM 1 working there it looks like from 2002 to 2008?

10:04AM 2 A During that period, I served as a flow assurance engineer,
10:04AM 3 Which means that I built models to look at systems just like
10:04AM 4 we'll be discussing today.

10:04AM 5 Q As a flow assurance engineer at Multiphase Solutions, were
10:04AM 6 you involved in either modeling or analyzing slug flow and pipes
10:04AM 7 or pipelines?

10:04AM 8 A Yes. Slug flow is a very common problem that flow assurance
10:04AM 9 engineers are faced with daily, and I looked at that problem
10:04AM 10 numerous times over that period, building models to study that
10:04AM 11 problem, analyze that problem.

10:04AM 12 Q Where did you go after leaving Multiphase Solutions in 2008?

10:04AM 13 A I went to Knowledge Reservoir.

10:04AM 14 Q What did you do there?

10:04AM 15 A At Knowledge Reservoir I was the director of knowledge
10:04AM 16 management. I was responsible for looking at and improving
10:05AM 17 subsurface work flows or looking at the business practices
10:05AM 18 around all of the things that happen below the surface,
10:05AM 19 reservoir engineering, geomechanics, geology, those things.

10:05AM 20 Q While were you at Knowledge Reservoir, were you involved in
10:05AM 21 developing any models of flow?

10:05AM 22 A I wasn't directly responsible for the building of models.
10:05AM 23 However, a colleague that I used to work with at MSI came across
10:05AM 24 to Knowledge Reservoir with me. He was responsible for flow
10:05AM 25 assurance. We often discussed the work that he did during that

10:05AM 1 time.

10:05AM 2 Q After you left Knowledge Reservoir in approximately 2010,
10:05AM 3 what did you do next?

10:05AM 4 A I went to Kongsberg Oil and Gas Technologies, where I was
10:05AM 5 the Americas geomarket manager for LedaFlow. LedaFlow is a
10:05AM 6 multi-phase simulator like OLGA.

10:05AM 7 In that capacity, I was responsible for the
10:06AM 8 management of two different teams: a team of engineers
10:06AM 9 responsible for the engineering support and engineering studies
10:06AM 10 and training around LedaFlow, as well as a team of developers or
10:06AM 11 personnel responsible for developing the software.

10:06AM 12 Q And, while you were at Kongsberg, were you involved in
10:06AM 13 developing various models to simulate multiphase flow?

10:06AM 14 A I was. In my capacity I was responsible for engineering
10:06AM 15 support, so quite frequently models were built and lots of
10:06AM 16 discussions around that process.

10:06AM 17 But that was one of my primary responsibilities.

10:06AM 18 Q Finally, tell us about what type of work you do at Evoleaf
10:06AM 19 where you've been, looks like since 2012, or last year?

10:06AM 20 A So in 2012 I started my own company. It is an engineering
10:06AM 21 service company. We provide flow assurance services to
10:07AM 22 operators around the world, and we also provide software in the
10:07AM 23 flow assurance community to those same customers.

10:07AM 24 Q You referenced, I think, LedaFlow and OLGA. Those are
10:07AM 25 multiphase flow simulators?

10:07AM 1 A They are.

10:07AM 2 Q Help the Court understand what a multiphase flow simulator
10:07AM 3 is in general.

10:07AM 4 A So a multiphase flow simulator is a simulator that looks at
10:07AM 5 oil, gas, and potentially water and their behavior in wells,
10:07AM 6 pipelines, and risers.

10:07AM 7 Typically you have information about -- you have
10:07AM 8 measurement on the top side or you'll have a couple measurements
10:07AM 9 in the well, but you don't really understand what's happening.

10:07AM 10 These models focus on all of the things that
10:07AM 11 happen in between the measurement points.

10:05AM 12 MR. FIELDS: Let's pull up D-24563, which I believe is
10:08AM 13 from appendix C of your report.

10:05AM 14 BY MR. FIELDS:

10:08AM 15 Q And this particular slide lists various transient multiphase
10:08AM 16 simulators?

10:08AM 17 A It does. It lists both OLGA and LedaFlow which are used
10:08AM 18 specifically in this investigation. It references both the
10:08AM 19 history, so both of these simulators have a long history. OLGA
10:08AM 20 was the dominant software in this field for 30-plus years.

10:08AM 21 LedaFlow has about a ten-year history of studying and producing
10:08AM 22 results of multiphase flow and studying that phenomena.

10:08AM 23 Q As a flow assurance engineer or expert, do you have
10:08AM 24 experience in using OLGA to model or evaluate multiphase flow in
10:09AM 25 pipes or pipelines?

10:09AM 1 A I do. During my career I've used OLGA repeatedly throughout
10:09AM 2 that career.

10:09AM 3 Q You also referenced this LedaFlow simulator. Do you have
10:09AM 4 experience using LedaFlow to analyze or evaluate multiphase flow
10:09AM 5 through pipes or pipelines?

10:09AM 6 A I do. I am rather unique in my experience with LedaFlow. I
10:09AM 7 was hired in quite early in that software process or the taking
10:09AM 8 of that process from a research tool to a commercial tool.

10:09AM 9 I would say that I have maybe the most experience,
10:09AM 10 or certainly arguably one of the most experiences with that
10:09AM 11 particular piece of software.

10:09AM 12 Q As a flow assurance engineer, why do you need to use
10:09AM 13 multiphase flow simulators?

10:09AM 14 A Again, multiphase simulators are really about the
10:09AM 15 understanding of oil and gas. It's about, you know, if you have
10:10AM 16 some measurements at the well and you have some measurements at
10:10AM 17 the receiving facilities, there are a host of problems that can
10:10AM 18 occur between one measurement and another measurement.

10:10AM 19 It's about understanding the evolution of what's
10:10AM 20 occurring between those two points.

10:10AM 21 Q Do flow assurance engineers such as yourself use multiphase
10:10AM 22 simulators such as OLGA and LedaFlow to model multiphase flows
10:10AM 23 in various pipelines around the world?

10:10AM 24 A Yeah. These are the two commercially available tools, and
10:10AM 25 they are used almost for every pipeline or nearly all pipelines

10:10AM 1 around the world to understand what's going on.

10:10AM 2 Q Now, I don't want to get into a dissertation about this, but
10:10AM 3 can you in a very brief fashion sort of tell the Court the
10:10AM 4 general differences between OLGA on the one hand and LedaFlow on
10:11AM 5 the other hand?

10:11AM 6 A Well, OLGA and LedaFlow are very similar models. They are
10:11AM 7 first principle mechanistic models, meaning they incorporate the
10:11AM 8 physics of the problem into the model as opposed to an empirical
10:11AM 9 model which is derived from just experimental evidence.

10:11AM 10 Both of these models have similar equations. The
10:11AM 11 subtleties are very small and very technical. As an example of
10:11AM 12 that, LedaFlow has taken a physics-based approach to the
10:11AM 13 modeling of hydrodynamic slugging; whereas OLGA takes a
10:11AM 14 different approach that is not physics based for that particular
10:11AM 15 phenomenon.

10:11AM 16 Q How do flow assurance engineers such as yourself know that
10:11AM 17 OLGA or LedaFlow or other multiphase flow simulators can
10:11AM 18 accurately model multiphase flow in pipes or pipelines?

10:11AM 19 A Well, these are considered enabling technologies. So as oil
10:12AM 20 production moved from onshore to offshore, and in particular
10:12AM 21 into deep water, the industry needed tools to understand what
10:12AM 22 was happening. If there was a problem, it was a very expensive
10:12AM 23 problem to fix as you moved into deeper and deeper water.

10:12AM 24 That's what started the development of these
10:12AM 25 tools. The fact, that we've been developing in deeper and

10:12AM 1 deeper water is a tribute to how well these tools work.

10:12AM 2 In addition to that, there's a huge body of
10:12AM 3 experimental or of experiments that focus on multiphase flow.
10:12AM 4 Both of these models incorporate that and compare against those
10:12AM 5 experimental results.

10:12AM 6 All of that would lead you to conclude that these
10:12AM 7 models are very accurate in their predictions of multiphase
10:12AM 8 flow.

10:12AM 9 Q If we focus on your use of multiphase flow simulators
10:12AM 10 throughout your career, on roughly how many projects or fields
10:13AM 11 have you been involved in sort of performing modeling services
10:13AM 12 using multiphase flow simulators?

10:13AM 13 A I don't have a specific number, but certainly over 50.

10:13AM 14 Q Have you previously used software such as OLGA and LedaFlow
10:13AM 15 to actually calculate or evaluate the gas or oil flow rates that
10:13AM 16 go through pipes or pipelines?

10:13AM 17 A Yes. It's quite common to look at flow rates through gas
10:13AM 18 pipelines, specifically if you were to think about slug flow,
10:13AM 19 which is the context of this. Since slug flow is a problem and
10:13AM 20 it's a bounded problem, meaning it only occurs in a certain
10:13AM 21 range of flow rates, it's a very regular exercise for a flow
10:13AM 22 assurance engineer to determine the boundaries of where slug
10:14AM 23 flow would occur and advise an operator how to avoid slug flow,
10:14AM 24 or in the case that it's unavoidable, how to operate when slug
10:14AM 25 flow would be present.

10:14AM 1 MR. FIELDS: Thank you.

10:14AM 2 You Honor, BP and Anadarko tender Dr. Michael
10:14AM 3 Zaldivar as an expert in modeling and evaluating multiphase flow
10:14AM 4 through pipes and pipelines, including evaluating slug flow.

10:14AM 5 THE COURT: All right. He'll be accepted.

10:14AM 6 BY MR. FIELDS:

10:14AM 7 Q Dr. Zaldivar, you prepared an expert report in this case?

10:14AM 8 A I did.

10:14AM 9 Q And that expert report set forth your opinions as well as
10:14AM 10 the reasons for your opinions?

10:14AM 11 A That's correct.

10:14AM 12 MR. FIELDS: If we could pull up D-24560.

10:14AM 13 BY MR. FIELDS:

10:14AM 14 Q Is this the cover page of the expert report that you
10:14AM 15 prepared in this litigation?

10:14AM 16 A It is.

10:14AM 17 MR. FIELDS: You Honor, we offer TREX Exhibit 11683 and
10:14AM 18 2 into evidence.

10:14AM 19 THE COURT: All right. Those are admitted.

10:14AM 20 (Exhibits admitted.)

10:15AM 21 THE COURT: Is that one report or two?

10:15AM 22 MR. FIELDS: It's just one report, Your Honor.

10:15AM 23 THE COURT: That report is in there, okay.

10:15AM 24 MR. FIELDS: Let's pull up D-24561.

10:15AM 25 BY MR. FIELDS:

10:15AM 1 Q Before getting into the details of your analysis, can you
10:15AM 2 provide the Court with an executive summary or a high level
10:15AM 3 summary of the analysis that you performed in order to address
10:15AM 4 the two questions that you were asked to answer.

10:15AM 5 A Sure.

10:15AM 6 In order to address those questions, it started
10:15AM 7 with of course reviewing lots of the information and
10:15AM 8 documentation about the existence of slug flow. Several
10:15AM 9 scientists had noted that it existed.

10:15AM 10 And then there was a very comprehensive process to
10:15AM 11 review hundreds of videos, or really hundreds of hours of ROV
10:15AM 12 videos documenting slug flow in order to bound where slug flow
10:15AM 13 occurred.

10:15AM 14 During that process, I was also able to link slug
10:16AM 15 flow to a portion of the riser that was moving, which I refer to
10:16AM 16 as the buoyant loop. Once I had done that, I built multiple
10:16AM 17 models of the full riser system and the kink using both LedaFlow
10:16AM 18 and OLGA.

10:16AM 19 I performed well in excess of a thousand
10:16AM 20 simulations, and all of this took me about six months to
10:16AM 21 accomplish, with the ultimate goal to provide some sort of
10:16AM 22 conclusion with regards to the flow rate.

10:16AM 23 MR. FIELDS: Let's pull up D-24552-2.

10:16AM 24 BY MR. FIELDS:

10:16AM 25 Q We'll obviously get into the details of your analysis as

10:16AM 1 well as the reasons for your opinions, but can you provide the
10:16AM 2 Court with just a high level answer to the questions that you
10:16AM 3 were asked to address?

10:16AM 4 A Sure.

10:16AM 5 To the first question as to whether slug flow was
10:16AM 6 present during mid-May 2010, I was able to conclude that it was,
10:17AM 7 in fact, present, And that it was present specifically between
10:17AM 8 May 13th and May 20th.

10:17AM 9 What was particularly unique in this case is that
10:17AM 10 slug flow exhibited very regular or patterned behavior; whereas
10:17AM 11 slug flow is generally characterized as a chaotic or random sort
10:17AM 12 of phenomena.

10:17AM 13 With respect to No. 2, what conclusions could be
10:17AM 14 drawn about the flow rate, I was able to conclude that the total
10:17AM 15 flow rate from the Macondo well during that same period, from
10:17AM 16 May 13 to May 20, was a best estimate of 30,000 stock tank
10:17AM 17 barrels per day, for a range of possible flow rates between
10:17AM 18 24,900 and 35,900 stock tank barrels per day.

10:17AM 19 MR. FIELDS: Let's pull up D-23468.

10:17AM 20 BY MR. FIELDS:

10:17AM 21 Q We've heard a fair amount about multiphase flow.

10:17AM 22 Can you use this demonstrative exhibit to help us
10:18AM 23 understand multiphase flow patterns in horizontal pipes,
10:18AM 24 including slug flow?

10:18AM 25 A Sure.

10:18AM 1 So what's complicated about multiphase flow is
10:18AM 2 that it can orient itself spatially.

10:18AM 3 Q What does that mean?

10:18AM 4 A It means that the liquid and the gas can be in all sorts of
10:18AM 5 configurations inside the pipe, which also means differences
10:18AM 6 with respect to pressure drop, differences with respect to all
10:18AM 7 of the properties that you would expect in a flow rate.

10:18AM 8 If we were to look -- and this is examples of flow
10:18AM 9 patterns or these geospacial orientations in a pipe, starting at
10:18AM 10 the top, this is very common at low flow rates where the gas
10:18AM 11 velocity is low and the liquid velocity is low or that they are
10:18AM 12 similar in speed. This is referred to as stratified smooth
10:19AM 13 where the gas is flowing across the top. It looks like pipe,
10:19AM 14 and the bottom is the oil.

10:19AM 15 If you to imagine the gas velocity increasing with
10:19AM 16 the liquids flowing at the same rate, you would see waves form
10:19AM 17 on the surface, and that's referred to as stratified wavy flow.

10:19AM 18 If you were to continue to increase the gas, you
10:19AM 19 would you see those waves eventually bridge the pipe, and that
10:19AM 20 would form something called slug flow, which we'll be talking a
10:19AM 21 lot about today.

10:19AM 22 The other two that are listed, annular flow,
10:19AM 23 occurs at even faster velocity other lower level holdups.

10:19AM 24 Bubble flow would occur if the pipe was almost
10:19AM 25 liquid full and gas was bubbling through.

10:19AM 1 Q You used a phrase a liquid holdup what is that?

10:19AM 2 A The liquid holdup refers to the amount of liquid that's in a
10:20AM 3 pipe section.

10:20AM 4 MR. FIELDS: Why don't we pull up D-23840, which is a
10:20AM 5 demonstrative exhibit that you helped us prepare.

10:20AM 6 BY MR. FIELDS:

10:20AM 7 Q Can you sort of set this up and explain what this particular
10:20AM 8 demonstrative exhibit shows.

10:20AM 9 A So what we're going to see in this video in a second is
10:20AM 10 we're going to see a slug from an experimental setup.

10:20AM 11 If you'll recall from the previous slide, slug
10:20AM 12 flow was characterized by a liquid-dominant flow followed by a
10:20AM 13 gas pocket or what looked like stratified flow.

10:20AM 14 What we're going to see here if we can go ahead
10:20AM 15 and hit play, is we will see the start of a slug and you're
10:20AM 16 seeing the crashing, the very high turbulence area which
10:20AM 17 entrains bubbles in. I can't really see the bubbles, but there
10:20AM 18 are some bubbles in the main slug body or the oil slug, then
10:21AM 19 followed by a gas pocket.

10:21AM 20 Now, a gas pocket normally has liquid flowing
10:21AM 21 along the bottom, so it looks like a lot like the stratified
10:21AM 22 flow regimes that we were talking about here.

10:21AM 23 Here we're seeing it loop again. Again, this is
10:21AM 24 the start of the slug followed by the main slug body, and then
10:21AM 25 we'll see the tail of the slug in a second.

10:21AM 1 (Videotape played.)

10:21AM 2 BY MR. FIELDS:

10:21AM 3 Q Obviously, you've talked about slug flow and the existence
10:21AM 4 of slug flow.

10:21AM 5 What are some of the reasons that you actually
10:21AM 6 have slug flow in pipes or pipelines?

10:21AM 7 A When slug flow occurs, it is an undesirable event, or at
10:21AM 8 least with respect to oil and gas production. But it occurs at
10:21AM 9 specific ratios of oil and gas speeds.

10:21AM 10 Q And what does the existence of slug flow tell you, if
10:22AM 11 anything, about flow rate, or what can it tell you?

10:22AM 12 A Well, slug flow, as I mentioned earlier, it provides a
10:22AM 13 bound. At very, very high flow rates slug flow doesn't exist at
10:22AM 14 all. It breaks down into miss flow or some other flow regimes
10:22AM 15 that we saw earlier. It is generally characterized as a lower
10:22AM 16 flow rate phenomena.

10:22AM 17 Q Before we talk about your analysis and opinions in depth,
10:22AM 18 let's get a lay of the land.

10:22AM 19 MR. FIELDS: Let's pull up D-24679, which is an
10:22AM 20 animation you helped us create, and sort of give the Court a lay
10:22AM 21 of the land.

10:22AM 22 BY MR. FIELDS:

10:22AM 23 Q What does this show? And we'll be looking at this later;
10:22AM 24 but just provide us with some information about what does this
10:22AM 25 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 1 riser end or the riser end plume.

10:24AM 2 At this time, from May 13th to May 20th, when
10:24AM 3 you're seeing both the riser motion, you only have really two
10:24AM 4 main sources for leaks, which are the kink section and the riser
10:24AM 5 end.

10:24AM 6 Q It indicates here on this demonstrative, D-24679, that this
10:24AM 7 is at 5 times the playback speed. Why is that the case?

10:24AM 8 A So what we're showing -- just so that we can perceive the
10:24AM 9 motion of the riser, we're showing that at a faster pace on May
10:24AM 10 13th. The full motion of the riser took over four minutes for
10:25AM 11 it to go to seafloor to floating back down to the seafloor, and
10:25AM 12 it wouldn't be perceptible. It would take a long time to watch
10:25AM 13 the full scale.

10:25AM 14 MR. FIELDS: Let's pull up D-24680.

10:25AM 15 BY MR. FIELDS:

10:25AM 16 Q There are two locations where you just described -- there
10:25AM 17 are two locations where you're seeing leaks in May 2010.

10:25AM 18 So, if we pull up that one, can you walk us
10:25AM 19 through D-24680?

10:25AM 20 A So now we have a focus on the riser end. What we are seeing
10:25AM 21 is ROV videos of the riser end on May 24th. This is what the
10:25AM 22 riser end plume looks like on that date.

10:25AM 23 Q The riser is not moving?

10:25AM 24 A Yeah.

10:25AM 25 Q Why is that?

10:25AM 1 A After May 20th the riser is no longer moving, so we're
10:26AM 2 seeing relatively steadily flow at this point.

10:26AM 3 MR. FIELDS: Would you pull up D-24681.

10:26AM 4 BY MR. FIELDS:

10:26AM 5 Q And what does this show?

10:26AM 6 A So this is just showing you some of the ROV video footage
10:26AM 7 like the video footage that I reviewed. This, again, is from
10:26AM 8 the May 24th timeframe.

10:26AM 9 And this is just showing you what the kinked
10:26AM 10 section of the riser looked like and the resulting leaks from
10:26AM 11 the kinked section of the riser.

10:26AM 12 Again, this is from May 24th outside the time
10:26AM 13 period that we'll be discussing a lot of, but when the riser had
10:26AM 14 fully settled to the seafloor.

10:26AM 15 Q Now, I want to talk a little bit about the first question
10:26AM 16 that you answered, which was whether or not a slug flow pattern
10:26AM 17 occurred in mid-May 2010.

10:26AM 18 Where in the system was slug flow -- were you
10:26AM 19 seeing slug flow?

10:26AM 20 A Slug flow was only present at the riser end, and at the
10:27AM 21 riser end plume.

10:27AM 22 Q Let's pull up D-24564.

10:27AM 23 As part of your work in this case, did you review
10:27AM 24 various documents that were produced by the government?

10:27AM 25 A I did.

10:27AM 1 Q And, in those documents, did you see evidence that the
10:27AM 2 government experts believed that slug flow might exist in May of
10:27AM 3 2010?

10:27AM 4 A Not that it might exist. In fact, several governmental
10:27AM 5 scientists confirmed the existence of slug flow.

10:27AM 6 Q And what is demonstrative Exhibit D-24564?

10:27AM 7 A This is the flow rate technical group's plume team report,
10:27AM 8 and this is one expert from that report confirming the presence
10:27AM 9 of slug flow.

10:27AM 10 Q Now, did you review Dr. Dykhuizen's testimony, trial
10:27AM 11 testimony from earlier this week?

10:27AM 12 A I did.

10:28AM 13 Q Why don't we pull up trial transcript 1487.1.

10:28AM 14 These were some questions that were asked of
10:28AM 15 Dr. Dykhuizen earlier in the trial. The first one I wanted to
10:28AM 16 ask you about is -- the question says: And slug flow can only
10:28AM 17 occur until certain boundary conditions; right?

10:28AM 18 And Dr. Dykhuizen's answer was: That is correct.

10:28AM 19 Do you agree that slug flow can only occur in
10:28AM 20 certain boundary conditions?

10:28AM 21 A Yeah. It can only occur in certain flow rate ranges, so
10:28AM 22 that is correct.

10:28AM 23 Q One of the other questions that was asked of Dr. Dykhuizen
10:28AM 24 says: You testified about slug flow. You don't dispute that
10:28AM 25 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 1 BY MR. FIELDS:

10:30AM 2 Q Will you describe what this particular demonstrative exhibit
10:30AM 3 shows.

10:30AM 4 A So, yes. We're going to see here what slug flow -- we're
10:30AM 5 going to see the transition from oil-dominant to gas-dominant
10:30AM 6 flow.

10:30AM 7 This first video clip is from May 14th. Actually,
10:30AM 8 this full series is all from May 14th, and we're just going to
10:30AM 9 jump forward.

10:30AM 10 Here we're seeing a predominantly dark plume that
10:30AM 11 is now transitioning. You can see the gas breaking through, and
10:30AM 12 you will you see it reaches basically what appears to be a white
10:30AM 13 plume, which is the gas dominant flow.

10:31AM 14 Now we're 30 seconds later in that same video, and
10:31AM 15 now we're going to see the gas-dominant flow cycle back to the
10:31AM 16 oil-dominant flow.

10:31AM 17 We'll do a couple more jumps just to demonstrate
10:31AM 18 the pattern repeated. Now we are going to see oil-dominant flow
10:31AM 19 transition back to gas-dominant flow 15 seconds later in the
10:31AM 20 video, and then we'll jump one more time where we'll see gas
10:31AM 21 dominant back to oil.

10:31AM 22 Q Now, I see we have the dark fluid and the light fluid, but I
10:31AM 23 wanted to talk about the analysis you did.

10:31AM 24 Oh, you still have one more. This is going on for
10:31AM 25 a bit.

10:31AM 1 (Video played.)

10:31AM 2 THE WITNESS: I think what's important is, you know, if
10:31AM 3 you just saw this transition once, you wouldn't know that it was
10:31AM 4 slug flow. What you're really looking for is this back and
10:31AM 5 forth sort of gas, oil, gas, oil.

10:31AM 6 Specifically in this case it exhibits a very
10:32AM 7 regular pattern, and we'll -- that can be observed. And that
10:32AM 8 was the full pattern on May 14th.

10:32AM 9 BY MR. FIELDS:

10:32AM 10 Q Let's talk about how you were able to assess whether this
10:32AM 11 light and dark flows were oil versus gas.

10:32AM 12 MR. FIELDS: If we can pull up D-24252.

10:32AM 13 BY MR. FIELDS:

10:32AM 14 Q Dr. Zaldivar, help us understand what this particular
10:32AM 15 demonstrative exhibit shows and how it helped you in reaching
10:32AM 16 conclusions about the existence of slug flow during May 2010?

10:32AM 17 A So what we know -- this is the same video, and what we're
10:32AM 18 looking at is the trajectory of these two flows. We would
10:32AM 19 expect that oil being denser than gas would have a lower
10:32AM 20 trajectory, and gas being less dense than oil would have a
10:33AM 21 higher trajectory.

10:33AM 22 So this was a just a trajectory analysis to
10:33AM 23 confirm that the dark fluid was, in fact, oil dominant or mostly
10:33AM 24 oil and the light fluid was gas dominant or mostly gas.

10:33AM 25 Q You mentioned this earlier in your testimony, but let me

10:33AM 1 pull up a section of your report.

10:33AM 2 MR. FIELDS: If we can go to TREX-11683.16.1.

10:33AM 3 BY MR. FIELDS:

10:33AM 4 Q In this excerpt from your report, you say: The slugging at
10:33AM 5 the riser end had some unique characteristics that change over
10:33AM 6 time.

10:33AM 7 Do you see that?

10:33AM 8 A I do.

10:33AM 9 Q What was unique about the slug flow that you observed during
10:33AM 10 the time period May 13th to May 20th?

10:33AM 11 A So slug flow is physically a chaotic process, and what I
10:33AM 12 mean by that is it's very hard to predict. It normally results
10:34AM 13 in random alternation between oil and gas. Meaning the periods
10:34AM 14 of time between the oil plume changing to the gas plume would,
10:34AM 15 generally speaking, be, or would -- not generally speaking --
10:34AM 16 would almost always be random.

10:34AM 17 In this particular case, what we saw was a very
10:34AM 18 patterned and regular transition between oil and gas and gas to
10:34AM 19 oil, and that pattern repeated itself.

10:34AM 20 Q Let's pull up D-24257.

10:34AM 21 Now, what is this document and what does this
10:34AM 22 show?

10:34AM 23 A So this figure is taken directly from the Flow Rate
10:34AM 24 Technical Group Plume Team report. In that report, they had
10:34AM 25 done an analysis of the brightness of the video.

10:34AM 1 So they took an ROV video and they focused on the
10:35AM 2 brightness level of that video to say something about the color
10:35AM 3 changes in the physical system. On the y-axis, they refer to it
10:35AM 4 as intensity, which is the inverse of brightness, meaning that
10:35AM 5 the darker -- the more intense you are, the darker the fluid
10:35AM 6 would be. At the bottom you would see what would appear to be
10:35AM 7 white fluid.

10:35AM 8 What's particularly shown well in this figure is
10:35AM 9 the pattern. So I've bracketed a slug period, which is the time
10:35AM 10 for the pattern to repeat. So you see here this pattern repeats
10:35AM 11 itself three times in this particular figure.

10:35AM 12 Q And is this a pattern that was occurring over and over
10:35AM 13 again?

10:35AM 14 A Yes. This pattern continued from May 13th to 15th, this
10:35AM 15 specific pattern.

10:35AM 16 MR. FIELDS: Let's go to D-23916.

10:35AM 17 BY MR. FIELDS:

10:36AM 18 Q Now, this is a demonstrative that you helped us prepare.

10:36AM 19 What does this show?

10:36AM 20 A So we've taken the same figure at the bottom, and this is
10:36AM 21 going to be a time trace of that figure. So, the red line, once
10:36AM 22 they start, will move forward, and it will show you in time the
10:36AM 23 transitions between oil and gas, remembering that oil is when
10:36AM 24 you're at the higher side y-axis and gas is at the lower side.

10:36AM 25 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 1 Again, by the nature of the physics, you would
10:38AM 2 expect it to be chaotic, random, meaning the duration of those
10:38AM 3 slugs would be different lengths.

10:38AM 4 Q Now, in your report you sometimes talk about the slug flow
10:38AM 5 exhibiting a double peak behavior and sometimes exhibits a
10:38AM 6 single peak behavior.

10:38AM 7 What does that mean?

10:38AM 8 MR. FIELDS: And let's go back to D-24257.

10:38AM 9 BY MR. FIELDS:

10:38AM 10 A Yes. So what I refer to as double peak behavior, again, if
10:38AM 11 we look at the slug period, I'm referring to the fact that there
10:38AM 12 are two oil slugs in the pattern. So, over that period and that
10:38AM 13 pattern that repeats, there are two oil slugs or there are two
10:38AM 14 alternation of flows.

10:39AM 15 Single peak behavior would be a single alternation
10:39AM 16 or a repeated oil, gas, oil, gas, but only one slug per period.

10:39AM 17 Q When did you see double peak behavior during May 2010?

10:39AM 18 A Double peak behavior was only present between May 13th and
10:39AM 19 May 15th.

10:39AM 20 Q And when did you observe single peak behavior in May of
10:39AM 21 2010?

10:39AM 22 A Single peak behavior was present between May 16th and May
10:39AM 23 20th.

10:39AM 24 Q Was the existence of single peak and double peak behavior
10:39AM 25 important to you as part of your analysis?

10:39AM 1 A Yeah. It's these very characteristics that my model
10:39AM 2 attempts to match, and in fact does match. Yes.

10:39AM 3 Q Did you observe slug flow, these regular patterns, before
10:39AM 4 May 13th?

10:40AM 5 A No. Before May 13th, there was no slug flow that was
10:40AM 6 present with regular patterns.

10:40AM 7 Q Did you observe these regular patterns of slug flow after
10:40AM 8 May 20th?

10:40AM 9 A No. There was no slug flow after May 20th.

10:40AM 10 Q Now, you observed that the regular pattern of slug flow
10:40AM 11 started on May 13th.

10:40AM 12 In your opinion, what caused this slug flow to
10:40AM 13 start on May 13th?

10:40AM 14 A Well, the start of slug flow or the very first slug was
10:40AM 15 caused by the falling of the riser.

10:40AM 16 If you remember, on April 22nd, I mentioned
10:40AM 17 earlier that the drilling rig, the riser attaches from the
10:40AM 18 drilling rig and it falls and it takes some time to fall.

10:40AM 19 Now, when it finally reaches the seafloor, it
10:40AM 20 releases a ton of oil, and that's the first real slug.

10:40AM 21 THE COURT: You say it takes some time to fall. Are
10:40AM 22 you talking about days? Hours? What?

10:41AM 23 THE WITNESS: Yeah. So from April 22nd until when it
10:41AM 24 finally settles was May 20th. So multiple -- 20 days, 22 days.

10:41AM 25 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

10:42AM 1 peak position that it achieves while floating.

10:43AM 2 At that position you're going to see liquid
10:43AM 3 accumulating on the upstream section or this section closest to
10:43AM 4 the BOP, and it will weigh down -- that accumulation of liquid
10:43AM 5 will weigh down riser.

10:43AM 6 The riser will then touch the ground. It will
10:43AM 7 release all that oil that it trapped in the upstream section.
10:43AM 8 Then once all of that oil's been released, it now is filled with
10:43AM 9 a mix of oil and gas but that's considerably lighter, and so it
10:43AM 10 will then move up again.

10:43AM 11 Once it moves up again, it then starts to
10:43AM 12 accumulate oil at the upstream section of the riser.

10:43AM 13 Q You indicated that once slug flow started it became a
10:43AM 14 complex relationship between the loop and the flow through the
10:43AM 15 loop.

10:43AM 16 Did you investigate other causes of slug flow?

10:44AM 17 A I did. The most common causes of slug flow are
10:44AM 18 terrain-induced slug flow and hydrodynamic slug flow. I
10:44AM 19 investigated both of those as potential mechanisms that would
10:44AM 20 match the slug flow behavior.

10:44AM 21 Q And did you reach any conclusions regarding whether or not
10:44AM 22 this slug flow was hydrodynamically induced or terrain induced?

10:44AM 23 A I did. I ruled both of those mechanisms out as potentially
10:44AM 24 responsible for the slug flow that was observed from the riser
10:44AM 25 end.

10:44AM 1 Q And how were you able to rule out those two mechanisms?

10:44AM 2 A I built a detailed model of the riser and I studied both of
10:44AM 3 those mechanisms through simulations.

10:44AM 4 Q Now, as part of your analysis, in the end does it really
10:44AM 5 matter what started the slug flow?

10:44AM 6 A It does not. What's most important here is that there's a
10:45AM 7 link, and that in the end the model matches the point of
10:45AM 8 comparison.

10:45AM 9 In this particular case, the point of comparison
10:45AM 10 is the observed slug flow by the ROVs. What's causing or what
10:45AM 11 started the slug flow really has no relevance on my conclusions.

10:45AM 12 Q And I think you sort of indicated this earlier, but between
10:45AM 13 May 13 and May 20th is there only one section of the riser that
10:45AM 14 is moving at that point?

10:45AM 15 A There is. Only the buoyant loop. I mean, we can re-show
10:45AM 16 that diagram and I can highlight that.

10:45AM 17 Q Is that D-24679 maybe?

10:45AM 18 A Yeah. This will work. So this diagram, if you look at the
10:45AM 19 screen, only this piece that's floating between here and here
10:46AM 20 would we refer to as the buoyant loop, and that's the piece
10:46AM 21 that's moving as they play back.

10:46AM 22 Q Now, did the buoyant loop move on regular periods during May
10:46AM 23 13th through 20th?

10:46AM 24 A In short timeframes the period was regular. Over time, like
10:46AM 25 days time, the period was decreasing.

10:46AM 1 MR. FIELDS: Let's look at D-24682.A.

10:46AM 2 BY MR. FIELDS:

10:46AM 3 Q And can you explain this demonstrative to the Court?

10:46AM 4 A Yes. So during all my investigation I was looking at ROV
10:46AM 5 videos. Initially, it wasn't obvious to me that the riser
10:46AM 6 motion was at all relevant. In fact, the two primary causes for
10:46AM 7 slug flow are terrain-induced and hydrodynamic.

10:46AM 8 And, prior to ruling those out, I wasn't even
10:46AM 9 focused on the riser motion. What we are going to see here is
10:47AM 10 on May 16th a video of the riser end plume played back again at
10:47AM 11 a higher speed, and then we're going to see the riser motion as
10:47AM 12 characterized by me. Different ROVs observed the motion of the
10:47AM 13 riser, and in taking that motion from those ROVs, we're going to
10:47AM 14 see a sync between the two.

10:47AM 15 At one specific moment on May 16th, there were
10:47AM 16 ROVs that were surveying that buoyant loop and watching its
10:47AM 17 motion, while also watching the riser end plume.

10:47AM 18 If we can play it back.

10:47AM 19 MR. FIELDS: Before we do that, there was a correction.
10:47AM 20 It's actually just a typo. But if would pull up D-24862-A.
10:47AM 21 Same one but the heading is changed.

10:47AM 22 Can you pull that up?

10:47AM 23 MR. CHAKERES: That's fine.

10:47AM 24 MR. FIELDS: This was just a typo on the heading.

10:48AM 25 So why don't we start this one over so

10:48AM 1 Dr. Zaldivar can walk us through it.

10:48AM 2 BY MR. FIELDS:

10:48AM 3 A I guess, just to point out the typo, it shouldn't say Slow
10:48AM 4 Flow, it should say Slug Flow Linked to Riser Motion.

10:48AM 5 So this is a May 16th ROV video. At the same
10:48AM 6 time, again, there were ROVs monitoring the buoyant loop.

10:48AM 7 From the same time, which was in the early hours
10:48AM 8 of May 16th, about 1 a.m., we were able to conclude that the
10:48AM 9 riser motion period, meaning the time it took from the sitting
10:48AM 10 on the seafloor to floating back down to sitting on the
10:48AM 11 seafloor, was identical to the observed slug flow behavior or
10:48AM 12 the period from going from oil dominant to gas dominant back to
10:48AM 13 oil dominant.

10:48AM 14 What we're seeing here is the two linked together
10:48AM 15 so that it demonstrates the link between the two that was
10:48AM 16 observed.

10:48AM 17 MR. FIELDS: Let's go to D-24567.

10:48AM 18 BY MR. FIELDS:

10:49AM 19 Q I believe part of this was in your report.

10:49AM 20 But, in any event, can you explain what D-24567
10:49AM 21 shows about riser motion as compared to slug flow periods?

10:49AM 22 A Right. So just a reminder, slug flow is the period of time
10:49AM 23 that the pattern takes to repeat.

10:49AM 24 What we're seeing in this chart is period on the
10:49AM 25 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 1 Q Let's take a look at TREX-11683.9.1. This is from your
10:51AM 2 expert report. You say the signature of the slug flow, riser
10:51AM 3 motion, and flow through the riser are intricately linked.

10:51AM 4 What do you mean by that statement?

10:51AM 5 A So, again, I am referring to the characteristics now of the
10:51AM 6 slug flow as well as the oscillatory motion of the riser.

10:51AM 7 In our investigation, we determined that there is
10:51AM 8 a direct link between the motion of the buoyant loop during this
10:51AM 9 period and those specific characteristics, or that very
10:51AM 10 patterned slug flow that we saw at the riser end.

10:51AM 11 Q Let's turn back to D-24552-4, and let's focus on the second
10:52AM 12 issue or question that you were asked, which has to do with
10:52AM 13 trying to determine whether you can determine a flow rate based
10:52AM 14 on the existence of slug flow. So let's talk about that.

10:52AM 15 What was your general opinion that you reached on
10:52AM 16 this particular question?

10:52AM 17 A Using the very unique characteristics and that very
10:52AM 18 patterned slug flow, I was able to build a model and match those
10:52AM 19 characteristics and then determine that the slug flow was
10:52AM 20 bounded during that timeframe, and that it was bounded between
10:52AM 21 24,900 and 35,900 stock tank barrels per day, with a best
10:52AM 22 estimated flow rate during that period of 30,000 stock tank
10:53AM 23 barrels per day.

10:53AM 24 MR. FIELDS: Let's pull up D-24569.

10:53AM 25 BY MR. FIELDS:

10:53AM 1 Q You've been referring to building or creating a model. Is
10:53AM 2 this a mathematical model?

10:53AM 3 A This is a model or a representation of the riser. Under the
10:53AM 4 hood, yes, it's a bunch of equations being solved that capture
10:53AM 5 the physics of the oil and gas or of the fluid behavior in that
10:53AM 6 riser.

10:53AM 7 Q And, in general, how many different models did you develop
10:53AM 8 in order to evaluate what the flow rate might be during the May
10:53AM 9 13th to May 20th time period?

10:53AM 10 A So I built two models. I built a no-kink model and I built
10:53AM 11 a kink model. The no-kink model specifically focuses on the
10:53AM 12 flow rate through the riser end. So it starts just after the
10:53AM 13 kink section of the riser, and then focuses on matching the
10:53AM 14 observed slug flow behavior, that really unique pattern behavior
10:54AM 15 that we were seeing, and only the riser end flow.

10:54AM 16 Then I built a kink model which extends that
10:54AM 17 original model back to include the kinked section of the riser,
10:54AM 18 and then provide estimates of the kink flow rates as well as the
10:54AM 19 riser end flow rates at the same time, resulting in a total
10:54AM 20 estimate of flow rate at the *Deepwater Macondo* well.

10:54AM 21 Q Let's take a look at first of all what you call the no-kink
10:54AM 22 model. So, if we pull up D-23480.3, will you describe in
10:54AM 23 general for the Court what your no-kink model was.

10:54AM 24 A Yes. So the no-kink model is an accurate representation of
10:54AM 25 the riser. It starts just downstream or above the BOP. It

10:54AM 1 starts at joint 1 with a flow boundary where I'm able to vary
10:55AM 2 the flow rate. Then it goes over the drilling rig.

10:55AM 3 It includes the motion of the buoyant loop that
10:55AM 4 we've been talking about, all the way to a pressure boundary at
10:55AM 5 the riser end, which is the ambient pressure of the seafloor.

10:55AM 6 MR. FIELDS: Can we pull up D-23480.4.

10:55AM 7 BY MR. FIELDS:

10:55AM 8 Q You mentioned that there was a flow boundary in your no-kink
10:55AM 9 model. What is a flow boundary?

10:55AM 10 A So a flow boundary in a model allows me to input directly a
10:55AM 11 flow rate that I want to investigate into the model.

10:55AM 12 Q If you're trying to figure out the flow rate that causes
10:55AM 13 slug flow, why are you using a flow rate boundary?

10:55AM 14 A So what's unknown here is what the flow rate is that matches
10:56AM 15 the observed slug flow conditions. In order to directly explore
10:56AM 16 all of the different possible flow rates, I chose to use a flow
10:56AM 17 rate boundary because that's the most convenient -- or not
10:56AM 18 convenient -- but it's the most direct way of changing the flow
10:56AM 19 rate in order, again, to match those observed slug flow
10:56AM 20 characteristics.

10:56AM 21 Q So, in your modeling, are you varying the flow rate, or did
10:56AM 22 you vary the flow rate over wide ranges?

10:56AM 23 A Yeah. I varied the flow rate all the way from 12,000 stock
10:56AM 24 tank barrels per day all the way up to 60,000 stock tank barrels
10:56AM 25 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 1 hot conditions, and the pressure and temperature decreases as
10:58AM 2 you flow. Up the well it also decreases as you're flowing down
10:58AM 3 the riser. So you need information about the fluid and what its
10:58AM 4 doing as the pressure and temperature change.

10:58AM 5 Q The second input that you list on D-24686 is riser position.
10:58AM 6 What is that?

10:58AM 7 A So riser position is the position of the riser as it sits on
10:58AM 8 the seafloor. So the height of the riser along the seafloor,
10:58AM 9 the elevation.

10:58AM 10 Q Does that also include the riser motion?

10:58AM 11 A It does. In this particular case it includes the riser
10:58AM 12 motion which was observed by the ROVs.

10:59AM 13 Q The third input to your model that is listed here is riser
10:59AM 14 construction.

10:59AM 15 What is riser construction and how does that
10:59AM 16 differ from riser position?

10:59AM 17 A So riser construction, when you build these models you need
10:59AM 18 to also describe the heat flow outside. So how it's going to
10:59AM 19 lose temperature to the surroundings. To do that, you kind of
10:59AM 20 build the pipe in layers.

10:59AM 21 So first you need to understand the outer pipe,
10:59AM 22 what it's made of, all of the properties of that pipe. Then you
10:59AM 23 need to know what surrounds that pipe. In this case, soil or
10:59AM 24 buoyancy materials, which are materials that were used to offset
10:59AM 25 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

11:01AM 1 buoyant loop was reaching on May 13th.

11:01AM 2 Q So, if you look on the left-hand side, there's a larger hump
11:01AM 3 on the left-hand side. What is that? What does that display or
11:01AM 4 demonstrate?

11:01AM 5 A The axis is depth, so this is the depth of the riser and
11:01AM 6 this is the length of the riser. So we're just looking at the
11:01AM 7 relationship between depth and length along the riser.

11:01AM 8 Q But on the left-hand side you have this hump.
11:01AM 9 Why is that so high?

11:01AM 10 A What is the hump? The hump is the portion of the riser that
11:01AM 11 was sitting on the wreckage of the *DWH* rig.

11:01AM 12 Q Let's talk about riser motion.

11:02AM 13 MR. FIELDS: If we can go to TREX-011683.93.1.

11:02AM 14 BY MR. FIELDS:

11:02AM 15 Q This has to do with the riser motion.

11:02AM 16 The Court saw this chart I believe the other day
11:02AM 17 in Dr. Dykhuizen's testimony. Can you explain this chart for
11:02AM 18 us?

11:02AM 19 A Yes. So what we're seeing on the Y-axis is depth, and then
11:02AM 20 on the x-axis time or a time-like access.

11:02AM 21 And what we're seeing here is the blue line is the
11:02AM 22 measured movement of the riser as observed by the ROVs.

11:02AM 23 And the orange line is the fit to that motion that
11:02AM 24 was eventually inputted into the model.

11:02AM 25 It is worth noting that this is only for one

11:02AM 1 specific joint in the riser.

11:03AM 2 Q So, just so I understand, the blue line is actually how the
11:03AM 3 riser was actually moving.

11:03AM 4 What is the orange line?

11:03AM 5 A The orange line is the mathematical description. So in
11:03AM 6 order to put this into LedaFlow, you needed to be able to
11:03AM 7 describe it in a language that LedaFlow could understand.

11:03AM 8 That orange line is a mathematical description
11:03AM 9 that was then input into LedaFlow.

11:03AM 10 Q Why doesn't the orange line that is depicted on this
11:03AM 11 demonstrative exactly match the blue line?

11:03AM 12 A In this sort of -- when you're taking measurements and
11:03AM 13 you're trying to create a mathematical description, very often
11:03AM 14 there is differences between the two.

11:03AM 15 What you're seeing here is actually a very good
11:03AM 16 fit of taking an actual measurement and then characterizing it
11:03AM 17 mathematically.

11:04AM 18 Q Now, talking about the movement of the riser, were you able
11:04AM 19 to use a multiphase flow simulator in order to recreate the
11:04AM 20 movement of the riser?

11:04AM 21 A Yes, I was able to recreate this motion in LedaFlow.

11:04AM 22 Q Why did you use LedaFlow as opposed to OLGA or some other
11:04AM 23 multiphase simulator to model the moving riser?

11:04AM 24 A So LedaFlow was the only multiphase flow simulator that was
11:04AM 25 capable of including the motion of the riser.

11:04AM 1 Q So is the capability to move the pipe or the riser, was that
11:04AM 2 built in to LedaFlow or did you have to write some type of
11:04AM 3 special module to do that?

11:04AM 4 A No. That's built-in. That functionality is accessible to
11:04AM 5 the off-the-shelf version of LedaFlow that I used for this
11:04AM 6 particular soft -- investigation, which was Version 1.2.

11:05AM 7 Q Now, we have discussed the various inputs that you put into
11:05AM 8 your model. I guess one question I would have is, can you
11:05AM 9 characterize or describe the quality of the data that you had in
11:05AM 10 order to create this model that you used to evaluate the flow
11:05AM 11 rate?

11:05AM 12 A In large part, the data was good data. You know, it took a
11:05AM 13 lot of searching for the data, but in large part the material
11:05AM 14 properties, the position, all of those things were very
11:05AM 15 well-known and well-characterized.

11:05AM 16 There are a few inputs to the model that were less
11:05AM 17 known, and for that we ran sensitivities.

11:05AM 18 Q We'll get to that.

11:05AM 19 The last input that was on that slide was
11:06AM 20 something called riser geometry.

11:06AM 21 Why don't you pull up D-23484 and tell us about
11:06AM 22 riser geometry and why it was important to your model.

11:06AM 23 A So what we're seeing here is the riser is the outer pipe.
11:06AM 24 The riser had, going down the center of it, a drill pipe.
11:06AM 25 Depending on where you were in the riser it had different

11:06AM 1 diameters.

11:06AM 2 This blowup here is a cross-section, so if you
11:06AM 3 were to slice it you would see the outer ring is the riser, this
11:06AM 4 inner ring is the drill pipe, and the area for flow is the area
11:06AM 5 between these two pipes.

11:06AM 6 Q Can you model this pipe and pipe geometry that we see here
11:07AM 7 in multiphase flow simulators?

11:07AM 8 A Yes, but it requires a geometric transformation to do so.

11:07AM 9 MR. FIELDS: Why don't we pull up D-24643.

11:07AM 10 BY MR. FIELDS:

11:07AM 11 Q Help us understand something that would be another example
11:07AM 12 of -- perhaps it's counterintuitive to a layperson -- of what a
11:07AM 13 geometric transformation is.

11:07AM 14 A So these models assume and are built to model flow in a
11:07AM 15 circular pipe. That's where the focus has been scientifically.

11:07AM 16 There are situations out there where people want
11:07AM 17 to model multiphase flow or single phase flow in different
11:07AM 18 geometries, and so there's a separate scientific investigation
11:07AM 19 about how to transform all of the knowledge that you have about
11:07AM 20 circular pipes and model these other odd-shaped geometries or
11:08AM 21 different geometries.

11:08AM 22 So they developed methods in order to do so.
11:08AM 23 That's what I mean specifically by a geometric transformation.
11:08AM 24 And a geometric transformation simply takes a noncircular
11:08AM 25 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 1 Q Now, have you used hydraulic diameter for geometric
11:10AM 2 transformation in your own modeling work prior to this case?

11:10AM 3 A I have.

11:10AM 4 Q And is the hydraulic diameter used by flow assurance
11:10AM 5 engineers and specialists in order to deal with noncircular
11:10AM 6 geometries?

11:10AM 7 A Yeah. The hydraulic diameter is the gold standard
11:10AM 8 transformation. There are very few hydraulic standards that
11:10AM 9 have any scientific information outside of the hydraulic
11:10AM 10 diameter.

11:10AM 11 There are numerous teks. In this particular case,
11:10AM 12 the user manuals actually tell you to use the hydraulic diameter
11:10AM 13 for the software packages or multiphase flow simulators that
11:10AM 14 we're talking about.

11:10AM 15 Q Now, when you use this geometric transformation, it results
11:10AM 16 in a sectional area that is less than a cross-sectional area
11:11AM 17 that actually exists in the pipe?

11:11AM 18 A Yes. So one of the things that you mentioned is this is a
11:11AM 19 bit counterintuitive. The area in this section is much larger
11:11AM 20 than the resulting area using the hydraulic diameter.

11:11AM 21 Q And you've heard criticisms at trial that you did not
11:11AM 22 appropriately use the hydraulic diameter in your modeling? Have
11:11AM 23 you heard those?

11:11AM 24 A I have.

11:11AM 25 Q And how do you respond to those criticisms?

11:11AM 1 MR. CHAKERES: Your Honor, I'm going to object. This
11:11AM 2 calls for surrebuttal testimony.

11:11AM 3 MR. FIELDS: Your Honor, he was actually just
11:11AM 4 reiterating and talking about the exact opinions that are set
11:11AM 5 forth in his report.

11:11AM 6 As Your Honor indicated earlier, a witness can
11:11AM 7 hear the criticisms and he can sort of indicate why those
11:11AM 8 criticisms are unfounded in light of his prior testimony or,
11:11AM 9 sorry, in light of the prior opinions in the report.

11:11AM 10 THE COURT: Was there a motion on rebuttal, a rebuttal
11:12AM 11 -- surrebuttal report from this witness?

11:12AM 12 MR. FIELDS: No.

11:12AM 13 MR. CHAKERES: There was not. He didn't provide
11:12AM 14 surrebuttal opinions in writing, so we have not filed a motion
11:12AM 15 on that, no.

11:12AM 16 THE COURT: I'll overrule the objection.

11:12AM 17 BY MR. FIELDS:

11:12AM 18 Q How do you respond to those criticisms?

11:12AM 19 A They're absolutely unfounded and incorrect.

11:12AM 20 Q And why is that?

11:12AM 21 A Dr. Dykhuizen seems to say that the use of the hydraulic
11:12AM 22 diameter is incorrect, or that if you use it you get only some
11:12AM 23 information out of the model that then you can use later.

11:12AM 24 When, in fact, the use of the hydraulic diameter
11:12AM 25 results in the accurate relationship between pressure drop and

11:12AM 1 flow rate. The flow rates that come from my model require no
11:12AM 2 additional calculations to be corrected to a different flow
11:12AM 3 rate.

11:12AM 4 Q So you're confident that you used the correct geometric
11:13AM 5 transformation and applied it in the correct fashion?

11:13AM 6 A Not only am I confident, that's what the science tells me.

11:13AM 7 Q Let's turn to talking about the simulations you performed.

11:13AM 8 After constructing the riser model or the no-kink model with all
11:13AM 9 of the properties that we've just discussed, what did you do
11:13AM 10 next?

11:13AM 11 A Sorry, could you repeat that question?

11:13AM 12 Q Sure. After you constructed your riser model and it had all
11:13AM 13 those different inputs that we just talked about, what did you
11:13AM 14 do next?

11:13AM 15 MR. FIELDS: Maybe we can pull up D-23480.3, which was
11:13AM 16 what we looked at earlier.

11:13AM 17 BY MR. FIELDS:

11:13AM 18 A Yes. So I then -- once I built the model, I then varied the
11:13AM 19 flow rate through the model. I ran numerous simulations, in
11:13AM 20 excess of a thousand simulations, to explore the parameter
11:14AM 21 space, running flow rates from 12,000 barrels per day all the
11:14AM 22 way up a to 60,000 barrels per day, again, trying to match this
11:14AM 23 unique pattern of slug flow behavior.

11:14AM 24 Q And why did you pick the range between 12,000 and 60,000?

11:14AM 25 A Well, generally speaking, you pick a range where you see the

11:14AM 1 observed behavior, and then you pick a larger range to make sure
11:14AM 2 that that observed slug flow behavior doesn't appear someplace
11:14AM 3 else.

11:14AM 4 So I only saw the observed slug flow behavior, or
11:14AM 5 model results that matched the observed slug flow behavior,
11:14AM 6 somewhere between 17,000 to 40,000.

11:14AM 7 So then I book-ended it with 60,000 all the way
11:14AM 8 down to 12,000.

11:14AM 9 Q How many different simulations did you run in LedaFlow in
11:14AM 10 order to determine whether you were matching the behavior out of
11:14AM 11 the end of the riser?

11:15AM 12 A In total, again, in excess of a thousand. For each specific
11:15AM 13 parameter set, I ran simulations exploring both May 13th and May
11:15AM 14 16th, and I ran about 55 for each specific -- 54 specifically --
11:15AM 15 for each parameter set.

11:15AM 16 Q So give us an idea of how long it takes to run these
11:15AM 17 simulations and why it took you six months or so to complete
11:15AM 18 your analyses.

11:15AM 19 A So each simulation requires anywhere from 12 hours to 2 days
11:15AM 20 to finish. I would say on average about a day, and -- I mean
11:15AM 21 that's why. I mean, when you're running a thousand simulations,
11:15AM 22 obviously we didn't even have a thousand days. We were running
11:15AM 23 it on multiple computers.

11:15AM 24 We generated an inordinate amount of data over
11:15AM 25 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

11:22AM 1 you conclude that a flow rate that matched the double peak
11:22AM 2 behavior and matched the single peak behavior would qualify as a
11:22AM 3 possible flow rate during that range.

11:22AM 4 Q After developing this base case that you have here, what did
11:22AM 5 you do next?

11:22AM 6 A So from here I ran sensitivities on input parameters that
11:22AM 7 were uncertain.

11:22AM 8 Q What are sensitivities or sensitivity studies?

11:22AM 9 A A sensitivity study is a study where you look at input
11:23AM 10 parameters that aren't certain. You vary an input, and then you
11:23AM 11 run simulations to determine what effect varying the input has
11:23AM 12 on the results.

11:23AM 13 Q And why did you perform sensitivity studies here?

11:23AM 14 A Specifically, there were some parameters. An example of
11:23AM 15 that would be pipe roughness, that were less certain than other
11:23AM 16 parameters.

11:23AM 17 MR. FIELDS: Why don't we pull up D-24570.

11:23AM 18 BY MR. FIELDS:

11:23AM 19 Q This is a table from your report, and it is titled:
11:23AM 20 Sensitivity to Roughness of Riser Pipe. Why don't you help us
11:23AM 21 understand how you assessed the sensitivity of the roughness of
11:23AM 22 the riser pipe.

11:23AM 23 A Yes. So, starting at the top of the table, the first row,
11:24AM 24 you can see that the roughness value, that is the default value
11:24AM 25 that I used that was in the base case set. That value

11:24AM 1 corresponds to smooth carbon steel or carbon steel that was
11:24AM 2 straight off the factory line.

11:24AM 3 I then ran two sensitivities where I increased the
11:24AM 4 roughness by a factor of 10 and then by a factor of 100.

11:24AM 5 Now, for each parameter set, I varied the flow
11:24AM 6 rates between 12,000 and 60,000 stock tank barrels per day on
11:24AM 7 May 13th and May 16th trying to match the double peak behavior
11:24AM 8 that was present on May 13th and the single peak behavior that
11:24AM 9 was present on May 16th.

11:24AM 10 I then was able to come up with a range of
11:24AM 11 possible flow rates which are denoted as minimum and maximum for
11:24AM 12 each of the parameter sets.

11:24AM 13 Q Now, this is one type of sensitivity study that you
11:24AM 14 performed. Were there other sensitivities that you have
11:25AM 15 evaluated as part of your analysis?

11:25AM 16 A Yeah. I performed other sensitivities as a part of my
11:25AM 17 analysis on other uncertain inputs.

11:25AM 18 MR. FIELDS: Why don't we pull up D-24571.

11:25AM 19 BY MR. FIELDS:

11:25AM 20 Q We talked about pipe roughness. What were the other
11:25AM 21 sensitivities that you evaluated as part of your analysis?

11:25AM 22 A So, I also evaluated inlet temperature, the position of the
11:25AM 23 riser plume. I evaluated the outer heat transfer or the ability
11:25AM 24 for the environmental conditions to move heat away from the
11:25AM 25 pipe.

11:25AM 1 I evaluated pipe roughness, like we just
11:25AM 2 discussed. I also evaluated in the kink model a sensitivity to
11:25AM 3 the resistance of the kink, or the discharge coefficient of the
11:25AM 4 kink, which is specific to the way I modeled the kink.

11:26AM 5 MR. FIELDS: Why don't we pull up D-23864.

11:26AM 6 BY MR. FIELDS:

11:26AM 7 Q So how did you calculate a best estimate flow rate through
11:26AM 8 the riser end using these various sensitivity studies?

11:26AM 9 A So, for each sensitivity -- and we just focused on the
11:26AM 10 fourth row of this table, this pipe roughness -- what we come up
11:26AM 11 with, a minimum and a maximum running the series of simulations.

11:26AM 12 From that minimum and maximum, you can take an
11:26AM 13 average for that sensitivity of the two values, and that will
11:26AM 14 result in a best estimated flow rate for that specific
11:26AM 15 sensitivity.

11:26AM 16 I repeated that process for all of the
11:26AM 17 sensitivities in this table, and I was able to come up with best
11:26AM 18 estimated values form each of those sensitivities.

11:26AM 19 Then, taking an average of this final column here,
11:26AM 20 I was able come up with a total best estimated flow rate of
11:26AM 21 25,100 stock tank barrels per day.

11:26AM 22 What is important to note when you're looking at
11:27AM 23 this table is how insensitive the model is to these specific
11:27AM 24 parameters. So all of these sensitivities result in flow rates
11:27AM 25 around this 25,000 number or 25,100 number. There's not a lot

11:27AM 1 of variance.

11:27AM 2 What that tells an expert is that the model is
11:27AM 3 robust and that the model is not sensitive to these inputs
11:27AM 4 despite the fact that they weren't known.

11:27AM 5 Q The bottom line, on D-23864, you say: Resulting best
11:27AM 6 estimate before model uncertainty.

11:27AM 7 Do you see that?

11:27AM 8 A I do.

11:27AM 9 Q At some point in your work, did you try to evaluate or
11:27AM 10 characterize model uncertainty and the impact it might have on
11:27AM 11 flow rates?

11:27AM 12 A I did.

11:27AM 13 Q And what did you do?

11:27AM 14 A So, for model uncertainty, what I specifically mean is
11:28AM 15 everything that we don't know about multiphase flow.

11:28AM 16 So, multiphase flow is incredibly complicated.
11:28AM 17 There's lots of physics that are involved in modeling multiphase
11:28AM 18 flow. As an industry, there are things that we don't know about
11:28AM 19 multiphase flow.

11:28AM 20 And so I wanted to characterize that uncertainty,
11:28AM 21 which is something difficult to characterize. It's always
11:28AM 22 difficult to characterize what you don't know.

11:28AM 23 In this particular case, I was using or I started
11:28AM 24 my investigation using three different versions of software. I
11:28AM 25 was using two different versions of OLGA and one version of

11:28AM 1 LedaFlow.

11:28AM 2 Because all of those software packages are trying
11:28AM 3 to estimate the true answer, you can learn something by the fact
11:28AM 4 that their resultant answers are scattered. That's some
11:28AM 5 indication of what the current understanding of what multiphase
11:28AM 6 flow is, and that's how I was able to characterize model
11:29AM 7 uncertainty.

11:29AM 8 Q I thought you indicated earlier that OLGA was not able to
11:29AM 9 model a moving riser. If that's the case, how were you able to
11:29AM 10 compare your results from LedaFlow with your results in OLGA?

11:29AM 11 A At the beginning of my investigation, I was using both OLGA
11:29AM 12 and LedaFlow, and I was using static geometries.

11:29AM 13 Q What does that mean?

11:29AM 14 A Nonmoving geometries.

11:29AM 15 At that time, I wasn't certain that the riser
11:29AM 16 motion was important, so I used an simpler model and assumed
11:29AM 17 that the riser was static.

11:29AM 18 And those are the results that I was able to
11:29AM 19 compare: A static version of LedaFlow and the static two
11:29AM 20 versions of OLGA. And that's how I was able to characterize the
11:29AM 21 understanding of multiphase flow.

11:29AM 22 Q What conclusions, if any, did you reach about the level of
11:29AM 23 model uncertainty that might exist?

11:29AM 24 A So, from that investigation, I was able to estimate the
11:30AM 25 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 1 MR. FIELDS: Let's pull up D-23479.A.

11:31AM 2 BY MR. FIELDS:

11:32AM 3 Q When did the kink leaks appear in relationship to the range
11:32AM 4 or the window that you were evaluating?

11:32AM 5 A So, the kink holes, other two kinks holes, B and C, were
11:32AM 6 present between May 13 and May 19.

11:32AM 7 On May 19th, another hole or potentially two
11:32AM 8 additional holes appear, and those would be holes D and E.
11:32AM 9 Because they were so close together, you couldn't tell if it was
11:32AM 10 a single hole that appeared or two holes, so I refer to them as
11:32AM 11 D/E in this image. And they appeared on May 19th and were
11:32AM 12 present through May 20th.

11:32AM 13 MR. FIELDS: Let's go to D-23481.3.

11:32AM 14 BY MR. FIELDS:

11:32AM 15 Q Can you generally describe your second model, which is the
11:32AM 16 kink model, and how it differed from your no-kink model.

11:32AM 17 A So the kink model is very similar to the no-kink model.
11:33AM 18 It's just an extension of the no-kink model. It extends back to
11:33AM 19 include the kinked section of the riser, which is about a
11:33AM 20 45-foot-long extension.

11:33AM 21 It then uses a pressure boundary at the inlet of
11:33AM 22 the model and a pressure boundary at the outlet of the model,
11:33AM 23 which is the same as was present in the kink model -- no-kink
11:33AM 24 model, excuse me.

11:33AM 25 MR. FIELDS: Why don't we pull up display D-23481.

11:33AM 1 BY MR. FIELDS:

11:33AM 2 Q And this is sort of a enlargement of the BOP in your kink
11:33AM 3 model.

11:33AM 4 It indicates on here -- it shows the kink here and
11:33AM 5 also shows pressure boundary. What is a pressure boundary and
11:33AM 6 why did you use a pressure boundary in your kink model?

11:33AM 7 A So a pressure boundary is when you specify the pressure of
11:33AM 8 the model at that location. In this particular case, once I
11:34AM 9 extend the model back to include the kink section, I now have
11:34AM 10 the benefit of a measurement that was present at that location,
11:34AM 11 and that's the PTM measurement, which is just above the BOP.

11:34AM 12 Q PTM, is that different than BTB?

11:34AM 13 A Yes. That's a different measurement.

11:34AM 14 Q Now, the kink model also includes the holes that existed in
11:34AM 15 the kink?

11:34AM 16 A Yes. So the kink model includes the kink section. It
11:34AM 17 includes the model of the kink holes. It also includes a model
11:34AM 18 of the kink itself.

11:34AM 19 The kink itself has some uncertainty as to what
11:34AM 20 resistance to flow that would amount to, so I modeled the kink
11:34AM 21 itself as a valve or a restriction that I could vary to vary
11:34AM 22 that resistance to flow.

11:34AM 23 Q Now, in your no-kink model, you used what I think was called
11:35AM 24 a flow rate boundary. Here, you use a pressure boundary.

11:35AM 25 Why did you use a pressure boundary here?

11:35AM 1 A Pressure boundary was used here because we had a
11:35AM 2 measurement, this PTM measurement that I am referring to.

11:35AM 3 Because we had a known pressure, it made sense to
11:35AM 4 use and leverage that pressure.

11:35AM 5 MR. FIELDS: Let's go to TREX-011683.30.2.

11:35AM 6 BY MR. FIELDS:

11:35AM 7 Q Based on your analysis of the -- using the note -- sorry,
11:35AM 8 let me step back.

11:35AM 9 Using the kink model and performing the evaluation
11:35AM 10 using the kink model, what conclusions did you reach about the
11:35AM 11 flow rate coming from the kink holes during the period May 13 to
11:35AM 12 May 20th?

11:35AM 13 A So my approach was a little different for estimation of the
11:35AM 14 kink leak flow rate. I chose to estimate a maximum flow rate
11:36AM 15 during that period. I estimated that maximum to be 4,900 stock
11:36AM 16 tank barreled per day.

11:36AM 17 Q Why do you consider your kink leak flow rate estimate to be
11:36AM 18 a maximum flow rate as opposed to a minimum or a best flow rate?

11:36AM 19 A So, for the kink leak flow rate, I made a series of very
11:36AM 20 conservative assumptions. So, given all of the conservatism
11:36AM 21 built into my estimation of the kink leak flow rate, I can
11:36AM 22 conceive of no possibility that could be greater than the number
11:36AM 23 that I'm presenting today.

11:36AM 24 Q And what were some of those assumptions or some of the
11:36AM 25 inputs that you used that you believe lead you to a conservative

11:36AM 1 or maximum flow rate?

11:36AM 2 A So, the first assumption or the first conservative
11:36AM 3 assumption would be, I used the maximum number of holes that
11:36AM 4 were present during that time period.

11:36AM 5 So, as we saw earlier, between May 13 and May 19,
11:37AM 6 there were only two holes present. And then, on May 19th and
11:37AM 7 20TH, there were four holes present, or potentially four holes
11:37AM 8 present. I used all four holes during the full period.

11:37AM 9 In addition to that, I used the final sizes of
11:37AM 10 those holes. Those holes were created by erosion, so they
11:37AM 11 likely grew. I used the sizes as they were on June 3rd when the
11:37AM 12 riser was finally removed.

11:37AM 13 In addition to that, I used or I modeled the leak
11:37AM 14 holes upstream of the kinked section of the riser. So the holes
11:37AM 15 would form at the highest velocity, at sort of the biggest
11:37AM 16 restriction, and that would be the lowest pressure.

11:37AM 17 I modeled them upstream of that restriction
11:37AM 18 exposing them to the largest pressure available, which would
11:38AM 19 result in the most conservative flow rate.

11:38AM 20 In addition to that, there's one other
11:38AM 21 conservative assumption, which is I used the maximum value of
11:38AM 22 the PTM measurement during that period. So that gauge had
11:38AM 23 indicated several pressure measurements during that period. I
11:38AM 24 took the absolute maximum and I used that as my boundary
11:38AM 25 condition.

11:38AM 1 Q So did your calculations of the riser end flow and the kink
11:38AM 2 leak flow give you a total estimated flow rate?

11:38AM 3 A It does.

11:38AM 4 MR. FIELDS: Why don't we pull up D-23866.

11:38AM 5 BY MR. FIELDS:

11:38AM 6 Q Were you able to calculate a final minimum, maximum, and
11:38AM 7 best estimate of flow rate for the Macondo well for the period
11:38AM 8 May 13th to 20th, 2010?

11:39AM 9 And, if so, what was that?

11:39AM 10 A I was able to calculate a possible range of flow rate
11:39AM 11 between 24,900 stock tank barrels per day and 35,900, with a
11:39AM 12 best estimated flow rate of 30,000 stock tank barrels per day.

11:39AM 13 Q Based on your analysis, do you see any evidence that the
11:39AM 14 flow rate during this time period was below approximately 25,000
11:39AM 15 stock tank barrels per day?

11:39AM 16 A No. It could not have been below.

11:39AM 17 Q Did you see any evidence that the flow rate could have been
11:39AM 18 higher than approximately 36,000 barrels per day during the
11:39AM 19 period of May 13th to May 20th?

11:39AM 20 A No. Cannot have been higher.

11:39AM 21 MR. FIELDS: Can we pull up trial transcript 11898.1.

11:39AM 22 BY MR. FIELDS:

11:39AM 23 Q This is also from Dr. Dykhuizen's critique, and it talks
11:40AM 24 about your modeling or your model uses a pipe model that's half
11:40AM 25 the size of the real pipe; so short, his numbers are off by a

11:40AM 1 factor of 2. If you correct for that, he is getting about
11:40AM 2 60,000 barrels of oil per day similar to the calculations of
11:40AM 3 Dr. Dykhuizen.

11:40AM 4 I think this was actually from the opening
11:40AM 5 statement.

11:40AM 6 Do you agree with this statement?

11:40AM 7 MR. CHAKERES: Your Honor, I'm going to renew the
11:40AM 8 objection to that. Our motion for surrebuttal is a general
11:40AM 9 motion, and we understood it applied to all experts.

11:40AM 10 THE COURT: Well, does sound like we're getting into
11:40AM 11 essentially what is surrebuttal, Mr. Fields, so I'm going to
11:40AM 12 sustain the objection.

11:40AM 13 MR. FIELDS: Thank you, Your Honor.

11:40AM 14 BY MR. FIELDS:

11:40AM 15 Q Based on your evaluation, why are you confident that the
11:41AM 16 best estimate of flow rate from the Macondo well during the time
11:41AM 17 period of May 13 to May 20th was 30,000 stock tank barrels per
11:41AM 18 day?

11:41AM 19 A I'm confident because I performed extensive analysis. I
11:41AM 20 looked at this issue for six months. I performed thousands of
11:41AM 21 simulations looking at this issue, and ultimately I'm very
11:41AM 22 confident in my answer that the best estimate would be 30,000
11:41AM 23 stock tank barrels per day.

11:41AM 24 Q Why are you confident that the flow rate from the riser end
11:41AM 25 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. Nestic, and then hopefully at some time early in the
11:42AM 21 afternoon Dr. Johnson.

11:42AM 22 I expect Dr. Nestic 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. Nestic
11:43AM 25 up next so that we can get him out of here before lunch and then

11:43AM 1 come with Dr. Momber next. That would be the only change we
11:43AM 2 would make for tomorrow.

11:43AM 3 THE COURT: Okay.

11:43AM 4 MR. BROCK: If that's okay.

11:43AM 5 THE COURT: All right.

11:43AM 6 All right. Everyone have a good evening and we'll
11:43AM 7 see you tomorrow.

8 (11:42 a.m., proceedings concluded.)

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