UNITED STATES DISTRICT COURT

EASTERN DISTRICT OF LOUISIANA

IN RE: OIL SPILL BY THE OIL RIG *DEEPWATER HORIZON* IN THE GULF OF MEXICO ON APRIL 20, 2010	*	Docket 10-MD-2179 Section J
Applies to:	*	New Orleans, Louisiana
Docket 10-CV-02771, *IN RE: THE COMPLAINT AND PETITION OF TRITON ASSET LEASING GmbH, et al.*	*	October 7, 2013
Docket 10-CV-4536, *UNITED STATES OF AMERICA v. BP EXPLORATION & PRODUCTION, INC., et al.*	*	

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DAY 5, AFTERNOON SESSION
TRANSCRIPT OF NONJURY TRIAL BEFORE
THE HONORABLE CARL J. BARBIER
UNITED STATES DISTRICT JUDGE

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AFTERNOON SESSION

(October 7, 2013)

* * * * *

THE DEPUTY CLERK: All rise.

THE COURT: All right. Please be seated.

(WHEREUPON, **THOMAS HUNTER, PH.D.**, having been previously duly sworn, testified as follows:)

THE DEPUTY CLERK: Please state your full name and correct spelling for the record.

THE WITNESS: Thomas Hunter, T-H-O-M-A-S, H-U-N-T-E-R.

MR. REGAN: May I proceed, Your Honor?

THE COURT: Yes.

CROSS-EXAMINATION

BY MR. REGAN:

Q. I'm Matt Regan on behalf of BP and, Doctor, I have you on cross-examination. Good afternoon, Dr. Hunter.

A. Good afternoon.

Q. I want to pick up with something you said on your direct examination that the best way to determine flow was having a known geometry and pressure readings on both sides of it; do you recall that?

A. That's correct.

Q. And so what you really need is two reliable pressures and a known geometry in between. Is that another way of saying the

same thing?
A. I should have clarified that it's not better than collecting it in the shift.
Q. Fair enough. So two of the things that you were looking at in your independent assessment of flow at Macondo was related to the geometry of the situation and then the pressure information that you had available; correct?
A. That's correct.
Q. With respect to the geometry, it was not just learning the geometry as it was as of the time of the accident but also any changes or restrictions that might have happened during the course of the flow period; correct?
A. I can't really answer that because it depends on whether you're referring to the estimate that was made on day 87 or the day -- or the estimates that were made at earlier times.
Q. Let's talk about the estimates prior to the capping stack. The capping stack was the first time that you felt that you had a known geometry for purposes of pressure; correct?
A. That's correct. And accurate pressure measurements.
MR. REGAN: So if we pull up TREX-9692.3.2.
BY MR. REGAN:
Q. Just on the topic of looking at restrictions for the Court's benefit, the types of restrictions that could exist -- this is from a presentation that Dr. Dykhuizen and Dr. Morrow had put together in mid-May of 2010. And there's a chart here

talking about restrictions here on the right side. Do you see that?

A. I do. And I believe this is actually a BP chart that was borrowed by them.

Q. Okay. It was borrowed by them and put into their presentation?

A. I think that's right. And they may have added some of the wording on the sides.

Q. If you're looking at the question of what are the restrictions to take into account at Macondo during the flow period, they would include mechanical restrictions such as in the riser when it was kinked over; correct?

A. That's correct.

Q. It would include restrictions in the BOP such as the restrictions caused by rams or the annulars or other mechanical restrictions; correct?

A. That's correct.

Q. And then within the wellbore itself -- that is, below the mud line, which is represented right here -- you could have restrictions that could include cement, skin, mechanical restrictions, friction restrictions, and also sanding; correct?

A. That's correct.

Q. And if you wanted to do a flow rate estimate using hydraulics -- that is, two pressures and a known geometry in between -- you'd have to come to some assessment or assumption

about what those restrictions were doing in that flow area; correct?

A. It depends on which calculation we're doing. If you're trying to do what I call a complete nodal analysis from top to bottom, you would do that. If you had some way to measure solely at the top and understood the impact, you could do that as well.

Q. But the uncertainty about these restrictions was one of the challenges that you appreciated in May and in June of 2010 in looking at the problem; correct?

A. Sure. If one were doing a complete system assessment, that's correct.

Q. Now we'll talk a little bit about pressures. With respect to the capping stack, you said one of the real benefits of it is that you had known pressure instrumentation; correct?

A. That's correct.

Q. So those gauges were put on the capping stack before it was installed and you had great confidence in them; correct?

A. That's correct.

Q. Prior to that time period, there was much more limited pressure information available?

A. That's also correct.

Q. And again, just -- just to get us oriented here as we walk through these pressure information over the next several weeks, really.

1:25PM **MR. REGAN:** Can we put up D-24368.
1:25PM **BY MR. REGAN:**
1:25PM **Q.** And, Dr. Hunter, this is just a schematic, very generic,
1:25PM of the well. I have listed here ambient pressure, the PT-B
1:25PM pressure gauge, and then reservoir pressure. Do you see that?
1:26PM **A.** I do.
1:26PM **Q.** Okay. Reservoir pressure was something that was measured
1:26PM before the blowout, basically initial reservoir pressure;
1:26PM correct?
1:26PM **A.** Before the blowout, that's correct, at the -- what I would
1:26PM call day zero, yes.
1:26PM **Q.** Right. Ambient pressure is the pressure of the sea right
1:26PM around the point of the BOP or the point of exit of flow;
1:26PM correct?
1:26PM **A.** That's correct.
1:26PM **Q.** And the PT-B pressure gauge was at the bottom of the BOP;
1:26PM correct?
1:26PM **A.** That is correct.
1:26PM **Q.** All right. The PT-B pressure gauge means a pressure that
1:26PM is a combination of things that are happening below it -- that
1:26PM is, upstream -- and things that are happening above it,
1:26PM downstream level; correct? It reflects the combination of
1:26PM those two areas; right?
1:26PM **A.** The pressure that it reads is influenced by what is below
1:26PM and what's above. It reads whatever the pressure is at that

point or what it thinks the pressure is, yes.
Q. And that was really one of the challenges of the PT-B pressure gauge is trying to understand you had one gauge, one pressure, and two unknown geometries on either side; correct?
A. As far as a complete well, that would be correct.
Q. Okay. You personally did not rely, in making judgments about flow rate, on the pressure readings from the PT-B gauge; correct?
A. That's not entirely correct. And by the way, there is a missing -- the mud boost line also had a pressure gauge for a period of time at the top.

Now, when one looked at the differential from such things as the riser cut, one did look at the PT-B and I did that myself, actually, but that was about differential flow, not about total flow.
Q. Right. For purpose -- for purposes of arriving at a calculation of flow, it was your view, and you told your team that it was your view, that you did not think the PT-B gauge was something that should be viewed as accurate or precise for a flow rate determination; right?
A. I believe my statement to the team was that the pressure gauge didn't read totally true pressure, but it -- it was used for differential pressures, meaning from one time to another.
Q. You didn't -- you testified there was two flow rate estimates that you and your team put together, one in mid-June,

1:28PM probably the 15th of June, and then one being based on the capping stack; correct?
A. That -- that's correct.
Q. You did not calculate a flow rate during the time period of May; correct?
A. That's correct.
Q. And from your perspective, there was not enough data available from the well to calculate a defensible flow rate in May of 2010; correct?
A. I would not say it that way. I would say there was a team of people looking at the techniques to do visualization of other methods to determine flow. We -- I was perfectly happy to let them proceed. I didn't spend any resources of our team looking at that during that period.
Q. Well, it was your view that there was not sufficient data from the well to make a flow rate estimate in May of 2010; correct?
A. There was not sufficient data from -- that we had compared to, for example, the capping stack pressure data that we chose not to make a pressure estimate during that time.
Q. Okay. All right. You did not make any flow rate estimate coming out of the Top Kill events; correct?
A. That's correct. And if I could clarify it, "you" means both myself, personally, and the team?
Q. Yes.

1:29PM **A.** And the answer is neither made an estimate.
1:29PM **Q.** So I'll talk briefly about the Top Hat measurement that you testified about on direct.
1:29PM **MR. REGAN:** If we could put up 21006.1.
1:29PM **BY MR. REGAN:**
1:29PM **Q.** This was the demonstrative that you were shown and you explained the device to the Court and you explained basically the three things about it: It had a -- in essence, a riser for collection, you had ports on the top of it, and you had what was called the skirt; correct?
1:29PM **A.** Not exactly. This one's not leaking oil.
1:29PM **Q.** Okay.
1:29PM **A.** The other one portrayed where the oil was coming from.
1:29PM **Q.** Right. But in terms of the -- understanding the piece -- the pieces of the device --
1:29PM **A.** That's correct. There were three areas where oil was exiting into the gulf and you pointed them out and I agree with what you said.
1:29PM **Q.** The other thing that's not accurate about this is that actually when it was installed, it was -- it ended up being on an angle; correct?
1:30PM **A.** Many times it was on an angle.
1:30PM **MR. REGAN:** So if we can pull up D-24388-2.
1:30PM **BY MR. REGAN:**
1:30PM **Q.** This is from -- actually from Dr. Dykhuizen's expert

report, but this is a representation of the Top Hat being on an angle in June of 2010. And you saw that?
A. Yes. Yes. It is accurate to say it did tilt when it was on there at various times and various cants.
Q. And because of it, this skirt area that is at the bottom of the Top Hat, that had great uncertainty when it came to trying to get a flow rate estimate using the Top Hat; correct?
A. It had great uncertainty because of the tilt, but also because of the -- the differences in diameter and the skirt material which was actually present.
Q. And so in terms of the flow rate estimate that was -- that were done by your team, the DOE teams, they had three components; that is, flow from the bottom of the Top Hat, the skirt, flow from the ports there on the top, and flow -- and collection; correct?
A. That's correct. In this case the ports aren't shown -- only one port is shown.
Q. It's sliced in half so you can see the inside; right?
A. Right.
Q. Okay. And as to the flow from the skirt, it's your view that that flow is largely unquantifiable; correct?
A. I don't know if I said unquantifiable. Anything is quantifiable. It was certainly greater than zero. It was significantly -- you could visually observe it was significant. To get a completely accurate estimate was much more difficult.

1:31PM 1 **Q.** Right. Because using visual observation made it difficult
1:31PM 2 to quantitatively assess the flow from the Top Hat; correct?
1:31PM 3 **A.** To precisely estimate the flow. You could quantify it,
1:31PM 4 but it would have a significant --
1:31PM 5 **Q.** The most imprecise part of this estimate was the flow
1:31PM 6 coming out of the skirt; correct?
1:31PM 7 **A.** That's correct.
1:31PM 8 **Q.** And it was the largest part of this estimate; correct?
1:31PM 9 **A.** I believe in our calculations, it was bigger than the
1:32PM 10 other two components. I don't recall exactly the numbers, but
1:32PM 11 I believe that is correct.
1:32PM 12 **Q.** So the least quantifiable part also was the largest
1:32PM 13 component of the flow rate estimate?
1:32PM 14 **A.** I think that's right.
1:32PM 15 **Q.** If we then go to talking about the capping stack period
1:32PM 16 you testified about on your direct examination, on Monday, the
1:32PM 17 26th of July, your team, the DOE team or Tri-Lab team, you had
1:32PM 18 a presentation that was given to you; correct?
1:32PM 19 **A.** Yes. I believe that's the date, the 26th.
1:32PM 20 **MR. REGAN:** If we pull up TREX-9706.1.
1:32PM 21 **BY MR. REGAN:**
1:32PM 22 **Q.** There was a PowerPoint presentation that we'll show here
1:32PM 23 in a second, Dr. Hunter. This was what was presented to you on
1:32PM 24 that Monday; correct?
1:32PM 25 **A.** That's correct.

1:32PM **Q.** All right.
1:32PM **A.** It appears to be.
1:32PM **Q.** And if we go to 9706.4, the DOE team or the Tri-Lab team,
1:33PM which for reference purposes is the three national labs, walked
1:33PM through what they called a history of flow-based estimates from
1:33PM well flow rate prior to shutting with the capping stack. Do
1:33PM you see that?
1:33PM **A.** I do now, yes.
1:33PM **Q.** Okay. And it has the attempts that were made prior to it
1:33PM and it includes the Top Hat there on July -- on June 15th,
1:33PM correct?
1:33PM **A.** June 15 would include the Top Hat, yeah.
1:33PM **Q.** Right. And it includes the range of estimates, 72,000 to
1:33PM 83,000, with a range of 51,000 to 104,000. Is that right?
1:33PM **A.** That's correct. And that would be as of the date
1:33PM June 15th, whenever the observation was made.
1:33PM **Q.** Right. And it notes there was great uncertainty in the
1:33PM skirt flow resistance; correct?
1:33PM **A.** That's correct.
1:33PM **Q.** And if we turn to the next page, which is 9706.5, the team
1:33PM provides some additional notes about the efforts to calculate
1:33PM flow prior to capping stack and provides them on this page to
1:33PM you; correct?
1:33PM **A.** That's correct.
1:33PM **Q.** And with respect again to the Top Hat flow, the Tri-Lab

1:34PM effort to calculate total flow based on Top Hat 4 leak paths and known surface collection, they told you there was great uncertainty in the leak -- skirt leak path and some uncertainty in pressure measurement inside the Top Hat; correct?

A. They told me, but I had my own view and I agreed with that view, that there was more uncertainty with the skirt because it had this, as you -- as you pointed out, different geometry.

Q. And in terms of the uncertainty from the pressure measurements of the Top Hat, you could have a pressure difference of just 1 psi, just 1 psi, and it could have major, major differences in terms of the flow rate calculations for Top Hat because of the nature of that device; correct?

A. The Top Hat flow, we had -- I had guessed at the pressure. I said it was between 1 and 3 psi and that was used as the parameter range. I thought that's about what it was. Because if it gets too high, it will blow the Top Hat off of the top of the well. So the -- and within that range, there was quite a variation between 1 and 3, that's correct. So the pressure made a difference.

Q. So you've had some additional uncertainty because you were reading such small pressure gauges with instrumentation that was 5,000 feet deep?

A. You would -- you would have uncertainty in the skirt. You'd have virtually no uncertainty in what was collected at the ship.

1:35PM **Q.** Okay. But in terms of the pressure readings in the Top Hat, you had uncertainty there, too?
A. There would be uncertainty in the pressure readings, that's correct.
Q. As reflected in the presentation?
A. That's correct.
Q. And the conclusion of the Tri-Labs, the three national labs, was that none of the methods listed above provide believable mass flow results. That was the conclusion they expressed to you on July 26th; correct?
A. That's what they said, yes.
Q. With respect, then, to the capping stack calculations, once the capping stack was installed with its instrumentation and with its geometry, you now finally had the data you were looking for, two known pressures and a known geometry in between; correct?
A. That's correct.
Q. And you did a variety -- your team, you and your team did a variety of estimates of flow from looking into the kill line or looking at the kill line and collection periods or looking at the choke line; right?
A. That's correct, as we pointed out in direct.
Q. Okay. Well, if we look at that same Monday presentation, 9706, if we look at the page 26, 9706.26.1, as of Monday of -- the 26th of July, the actual flow rates were still to be

1:36PM 1 determined; right?
1:36PM 2 **A.** What day did you have for that?
1:36PM 3 **Q.** July 26th, Dr. Hunter.
1:36PM 4 **A.** I don't know if the flow rates had been calculated. They
1:36PM 5 had not been assembled and put into the common viewgraph format
1:36PM 6 that we had. I can't say what the status of the calculation
1:36PM 7 was.
1:36PM 8 **Q.** Fair enough. Two days later on the Wednesday of that
1:36PM 9 week, you were informed that Secretary Chu wanted to have a new
1:37PM 10 flow rate by Friday; correct?
1:37PM 11 **A.** That's correct. I believe there's an e-mail to that
1:37PM 12 effect as well.
1:37PM 13 **Q.** And so that Wednesday would have been the first that you
1:37PM 14 had heard for you, yourself and your team that Secretary Chu
1:37PM 15 and others in the administration wanted to have a flow rate and
1:37PM 16 they wanted to have it done in the next 48 hours; correct?
1:37PM 17 **A.** No, I can't say that I -- I can't say that's the first I
1:37PM 18 heard. Because I had conversations with Steve Chu virtually
1:37PM 19 every day in that period and we could have discussed it, you
1:37PM 20 know, a week earlier and we certainly didn't do a calculation
1:37PM 21 in the 48-hour period.
1:37PM 22 **MR. REGAN:** Go to Exhibit 9718.1.1.
1:37PM 23 **BY MR. REGAN:**
1:37PM 24 **Q.** This is an e-mail that you received, and we've blacked out
1:37PM 25 some of the e-mail information there. But just -- that's your

1:37PM personal e-mail address, at least part of it. Do you see that?
1:37PM **A.** Yes.
1:37PM **Q.** Okay. We tried to cover that as much as we could. Because at this point in time, you were no longer at Sandia National Labs; right?
1:38PM **A.** That is certainly correct.
1:38PM **Q.** Okay. So as of Wednesday, the 28th of July, 4:00 p.m., Marcia McNutt told you that she had just gotten off the phone, "What we really need, hopefully by Friday, is the total amount that had leaked out since the beginning of the accident"; correct?
1:38PM **A.** That's correct.
1:38PM **Q.** You did not have that number calculated by Wednesday, July 28th; correct?
1:38PM **A.** I don't know when we had that number calculated. I had begun the calculations, you know, way back on the 11th of July telling people to get ready, and I discussed the methodology with the team about how to do both the last day and -- and the interval over time had been discussed as a matter of doing the work and those discussions -- this e-mail did not initiate those discussions.
1:38PM **Q.** Okay. Well, you responded to this e-mail, if we look at 9718.1.2. This is your response to that e-mail on the same date. Do you recognize it?
1:38PM **A.** I do.

1:38PM **Q.** And you responded saying: "This is the track we are on, but it is unlikely we can get the full time frame analyzed from the beginning of the incident by Friday."

Correct?

A. That's correct.

Q. And you said: "We need to be sure the logic and all the events have been carefully reviewed. We can probably get the recent cap flow and the correction for cap installation. We will then need an event by event description to look at adjustments and overlay of that by a depletion assumption."

You wrote that; correct?

A. That's correct.

Q. And then your last sentence says: "We need to assure that the pace for getting these results is consistent with the subsequent need for accuracy."

Correct?

A. That's also correct.

Q. And that's something you believed as a scientist?

A. I absolutely thank you for protecting my e-mail. Other people haven't.

Q. I hope to be uniform in that, but if we see one up there, we can try to fix it.

Now, with respect to the pace, the pace for getting these results, you didn't set that pace; correct?

A. Well, sir, I'd say I'm probably the principal setter of

1:39PM 1 the pace, because I initiated the work. I asked people to get
1:39PM 2 prepared and to do it. And I knew that we should start as soon
1:40PM 3 as the data came in from the capping stack, and people were
1:40PM 4 geared up to do it. I recall numerous conversations with the
1:40PM 5 analysts about, Let's get it as soon as we can. And as you
1:40PM 6 pointed out, Steve Chu then added to that, "It would be nice if
1:40PM 7 we could get it by Friday of that week."
1:40PM 8 **Q.** So you believe that you were already working on the
1:40PM 9 information as of the time that you wrote this e-mail and said:
1:40PM 10 "This is the track we are on, but it is unlikely we can get it
1:40PM 11 analyzed by Friday"?
1:40PM 12 **A.** As of July 28th, I know we were working on it. And I
1:40PM 13 didn't know how much we would get done by the 30th, but it was
1:40PM 14 clear we were able to.
1:40PM 15 **Q.** The request for having the thing -- the estimate done by
1:40PM 16 Friday, though, was one that came from Secretary Chu and other
1:40PM 17 members of the cabinet?
1:40PM 18 **A.** Yes, and I had to tell the secretary that we might not get
1:40PM 19 there and we're going to do it accurately.
1:40PM 20 **Q.** Consistent with what you testified in your direct exam;
1:40PM 21 correct?
1:40PM 22 **A.** Uh-huh. Correct.
1:40PM 23 **Q.** Now, with respect to the work that was done, though, it
1:41PM 24 was primarily done over a critical weekend; correct?
1:41PM 25 **A.** Oh, no, I don't think that's correct at all. The Flow

Rate Technical Group had begun back at the end of May doing their calculations and their observations. I initiated the work on the 11th of July and it was reported out on the 30th of July. So I don't think it was critically done over -- are we speaking of the weekend of the 28th?

Q. Let me show you a document and see if it might refresh your recollection.

A. Okay.

MR. REGAN: If we can pull up TREX-9908.

BY MR. REGAN:

Q. This is an e-mail that was sent to --

MR. REGAN: Just go down. Take off the top. That one's not redacted.

BY MR. REGAN:

Q. This is an e-mail to you in response to the oil spill commission. Do you recall responding to them in December of 2010 about their presentation about the flow rate estimate?

A. I recall talking to the commission and -- because I thought they didn't accurately reflect the flow rate calculation and I had a conversation with them. But I may have written them something, but I don't recall.

Q. Let's go to the second page, 9908.2.2, and the middle paragraph there. This is from your e-mail. Do you recall telling them with respect to this calculation of the government's official estimate, starting there in the middle of

the page: "The pressure measurements taken in the capping stack allowed a fairly straightforward engineering calculation to be done and the flow to the sea was only out of the new kill valve, and part of the flow was still going to the surface from the lower lines. This changed everything and the understanding of the flow will be the basis for all future deliberations on the flow, including interaction between the U.S. Government and parties held liable for the accident. These critical measurements allowed a quantitative basis to evaluate the flow which was done by DOE scientists over a critical weekend and culminated in bringing together all the flow rate teams that ultimately agreed that the DOE estimate was the one to claim as the official government estimate."

Does that refresh your recollection, Dr. Hunter?

A. Yeah. In fact, I think it reinforces what I said. The calculations had been ongoing for some time. They were asked to be put into a standard format for that weekend. The standard format required summarizing -- getting final results, putting them together, and then ultimately looking at them with other scientists over that weekend. So the "critical weekend" was referring to the fact that we had all the information put together in a standard format and we worked the best we could to bring everybody together, including this other team of -- other five teams' information over the weekend.

Q. So you presided over a meeting then on Friday, July 30th,

with a variety of teams estimating flow; correct?
A. That's correct.
Q. And you had a Flow Visualization Team; correct --
A. At the meeting, there was a Flow Visualization Team, yes.
Q. You had multiple Reservoir Teams; correct?
A. Two, I believe.
Q. You had a Nodal Analysis Team?
A. That's correct.
Q. You had a team from Woods Hole doing Doppler velocity issues?
A. Yes.
Q. And then you had your DOE Team or the Tri-Lab Team as is reflected in these documents?
A. It should be a total of six.
Q. And you have some notes that you took as the moderator of that meeting. I'd like to put those up.

MR. REGAN: Exhibit 9929.95.

BY MR. REGAN:

Q. And you recognize Exhibit 9929 as your handwriting, Dr. Hunter?
A. I do. My handwriting is not the best, and I think in my deposition, I said, yes, I can tell by the sloppiness of the numbers that it's mine.
Q. You might have some competition there.

With respect to then what you've listed here on this

1:44PM page, these are the six flow rate estimates that were presented
1:44PM by the multiple teams to you in that meeting; correct?
1:45PM **A.** That's correct. That is my note from them. They actually
1:45PM had on their viewgraph materials more specific information.
1:45PM **Q.** And you wrote down numbers that you were hearing from
1:45PM these different teams on July 30th, 2010, as to their flow rate
1:45PM estimates; correct?
1:45PM **A.** I did, yes.
1:45PM **Q.** And those numbers range from 24 to 40, 42 to 49. We see
1:45PM 33 to 63. We see a range here from 52 to 115. We see one at
1:45PM 59,200, and we see 53-64, 51-60.
1:45PM And then No. 6, is that the DOE Team?
1:45PM **A.** That's the DOE Team. That's correct.
1:45PM **Q.** 53 and you wrote "plus or minus 5"; correct?
1:45PM **A.** I did, yes.
1:45PM **Q.** So at this meeting, you were presented with this range of
1:45PM flow rate estimates from the various teams who had been looking
1:45PM at the question of flow; correct?
1:45PM **A.** Correct. And I believe the individual presentations are
1:45PM basically consistent with this. I would point out they're not
1:45PM at the same times, but they're at different times in the flow.
1:46PM **Q.** So some of these teams were looking at flow at different
1:46PM periods of time, and some of them were looking at the capping
1:46PM stack?
1:46PM **A.** That's correct.

1:46PM 1 I think it's clear, when the capping stack was shut,
1:46PM 2 there was no flow to observe.
1:46PM 3 **Q.** With respect to choosing the DOE number, that was really a
1:46PM 4 recommendation that you made; correct?
1:46PM 5 **A.** After discussion, I think I said earlier, it was my job to
1:46PM 6 synthesize what I thought was the best representation of all of
1:46PM 7 the information and I recommended that number go forward.
1:46PM 8 That's correct.
1:46PM 9 **MR. REGAN:** If I could pull up some notes that were
1:46PM 10 taken then at the meeting, 9906.3.3.
1:46PM 11 **BY MR. REGAN:**
1:46PM 12 **Q.** As these are coming up, Dr. Hunter, there was a
1:46PM 13 Dr. Ratzell who was a member of the Tri-Lab Team; correct?
1:46PM 14 **A.** That's correct.
1:46PM 15 **Q.** And he worked with Dr. Dykhuizen?
1:46PM 16 **A.** Yes. He was the assigned team lead during much of the
1:46PM 17 period there.
1:46PM 18 **Q.** There was also a Dr. Charlie Morrow; is that correct?
1:46PM 19 **A.** That's correct.
1:46PM 20 **Q.** And he also worked with Dr. Dykhuizen; correct?
1:47PM 21 **A.** That's correct.
1:47PM 22 **Q.** Dr. Ratzell made the presentation on July 30th; correct?
1:47PM 23 **A.** Yes, he did.
1:47PM 24 **Q.** And with respect to the capping stack that he said to you
1:47PM 25 and others, including Secretary Chu, "it is 3-ram capping

stack; all above the BOP so don't have to deal with its complexity"; correct?

A. Yes. Which I think should be read as "don't have to deal with the complexity of the BOP."

Q. With respect to uncertainties, he presented that some of the uncertainties, though, in the DOE's numbers were "multiphase flow models and EOS; K-factors are uncertain."

Correct?

A. That's correct. EOS means equations of state.

Q. So Dr. Ratzell represented that the DOE numbers that he gave to you and others at that meeting had uncertainties because of the multiphase flow model. You had differences in the equations of state, or EOS, and K-factor uncertainties; correct?

A. That's what he -- that's what -- I'm not sure who took these notes, but whoever took the notes said that.

Q. Do you recall Dr. Ratzell saying those things?

A. Oh, sure, sure.

Q. K-factors refers to resistance in a given area that you're trying to examine or flow. It's a resistance coefficient?

A. It's sort of the same, but it's a relationship between pressure drop and whatever geometric feature is there.

Q. "Equation of state" is talking about the fluid that you're analyzing and it's a way that you can then try to figure out its density?

1:48PM **A.** Equation of state generally talks about all the properties and the relationship between them of any substance. For example, for fluid, it would be temperature, pressure, density, all the different variables that describe it.

1:48PM **Q.** If we turn then to one of Dr. Ratzell's slides, 8635.97.1. This slide summarizes again the DOE Tri-Labs calculations from capping stack; correct?

1:49PM **A.** That's correct.

1:49PM **Q.** It said: "There was good to excellent comparison of their results."

1:49PM Correct?

1:49PM **A.** That's correct.

1:49PM **Q.** And they told you 53,000 barrels per day, plus or minus 5,000 barrels per day; right?

1:49PM **A.** That's correct.

1:49PM **Q.** So that's plus or minus 10 to 20 percent error; right?

1:49PM **A.** I believe it would be interpreted that way. Five would be -- if it's plus or minus 5, it's 10 percent; plus or minus 10 would be 20 percent.

1:49PM **Q.** Dr. Ratzell told you the Analysis Team -- that is, Dr. Dykhuizen, Dr. Morrow, and the other scientists -- had significant concerns that the uncertainty remained large; correct?

1:49PM **A.** That's correct.

1:49PM **Q.** And they told you that their greater uncertainty was

multiphase correlation; correct?
A. Yes, that's what they say.
Q. And they say: Especially for choke line flow analyses -- because when they modeled the choke closure, the models that these scientists put together predicted that the flow was going up as the valve was being closed; correct?
A. That's because -- right. There was what they call an anomaly; because as you closed the choke, in fact, it does get smaller; it should restrict the flow. The transition happens, but in general, that's right.
Q. Turn to the next, 8635.96.1. The scientists also told you on June -- July 30th, 2010, that they had insufficient information to perform an uncertainty analysis on a flow rate and total flow at the time of the meeting; correct?
A. That's correct. You got two images up there. I think they are -- are they both the same?
Q. They are. One is just probably unnecessary.
A. Yes. I believe this is an exact copy of the viewgraphs that I was presented. And I can't recall if I was presented these also on the 26th, four days prior. But certainly on the 30th, they were presented.
Q. Now, at the conclusion of Dr. Ratzell's presentation on the 30th, there then was a discussion amongst you and Secretary Chu and Director McNutt and others; correct?
A. To be honest with you, I don't recall Marcia -- excuse me,

Dr. McNutt's role, but certainly Secretary Chu and myself and the rest of the team.

Q. And it's true that, at that point in time, what you discussed was the purpose of arriving at this flow rate number on that day, and one of the purposes was the oil budget; correct?

A. That's correct.

Q. A second purpose that you discussed as the reason for arriving at a flow rate number that day was damages charged to BP; correct?

A. See, I don't know how to refer to you, but the conversation people brought -- Steve Chu, for example, brought that into the conversation. That's correct.

Q. And Secretary Chu's perspective was with respect to arriving at a number for damages charged to BP, high accuracy was not needed there; correct?

A. That was the gist of what he said. I don't recall what he actually said, but that's correct.

Q. He also made it clear that there was not time to wait, that the number needed to be done by -- in the next day, rather than waiting for the next week; correct?

A. If you're speaking of the 30th, he stated -- you are speaking of the 30th?

Q. Yes.

A. His statement was we need to get a number as quick as we

1:52PM 1 can. His hope was that it could be done that weekend. It
1:52PM 2 wasn't done that weekend, but that was his hope.
1:52PM 3 **Q.** Well, the press release that went out with the 53,000
1:52PM 4 estimate for July 15th was issued on Monday, August 2nd;
1:52PM 5 correct?
1:52PM 6 **A.** That's correct.
1:52PM 7 **Q.** And the meetings about -- where the teams said they had
1:52PM 8 insufficient information to perform an uncertainty analysis on
1:52PM 9 flow rate was on Friday, July 30th; correct?
1:52PM 10 **A.** That's correct.
1:52PM 11 **Q.** And then you had another meeting on Saturday, July 31st;
1:52PM 12 correct?
1:52PM 13 **A.** That is correct.
1:52PM 14 **Q.** Okay. And if we could turn to TREX-9725.2.1, which are
1:52PM 15 additional notes that were taken at this meeting on July 30th.
1:53PM 16 You heard, Dr. Hunter, Secretary Chu also say, as you
1:53PM 17 just testified to: "With respect to damages, 10 to 20 percent
1:53PM 18 uncertainty is all that was needed because they'll settle, so
1:53PM 19 it doesn't matter."
1:53PM 20 Correct?
1:53PM 21 **A.** Did I hear that? I don't recall. It's certainly written
1:53PM 22 here. I don't know whose notes these are. But I thought the
1:53PM 23 statement was 10 percent, but I don't have a recollection of
1:53PM 24 that. It wasn't a strong factor in my mind.
1:53PM 25 **Q.** Right. Let me turn now then to the meeting on Saturday,

the 31st. If we could go to 8628.58.1, your notes from that meeting. And you attended that meeting; correct?

A. I actually conducted both meetings.

Q. Understood.

Secretary Chu was at a meeting on Saturday, the 31st; correct?

A. I believe that's correct. Certainly on the 30th; I believe also on the 31st.

Q. And these notes indicate: "Tom Hunter still pushing for 10 percent integral or daily."

Do you see that?

A. I see that now. I may have seen this in depositions, too.

Q. I think you did.

With respect to the word "integral," what does that mean?

A. Well, "integral" in this case, I believe, refers to the flow from Day Zero to Day 87, adding it all up.

MR. CHAKERES: Your Honor, I'm going to object, Dr. Hunter just testified that he does not know the provenance of these notes and, you know, he's just using them to flash notes on the screen without establishing a foundation.

MR. REGAN: Dr. Hunter was not only at these meetings, but he was designated as the United States' witness about these discussions, as a 30(b)(6) witness. And he's testified about them at his deposition already as that

representative.

THE COURT: All right. I'll overrule that objection.

BY MR. REGAN:

Q. So you -- on the 31st of July, you were pushing for 10 percent for both the cumulative flow -- that's what's referred to as "integral" -- and also for the last day of flow; is that right?

A. It was my belief that that was an accurate assessment of the uncertainty, given the data and the fact that I performed some of the calculations myself. And if this person said I was "pushing for them," I probably stated that that was my view.

Q. And were you told in that meeting that the cabinet wants a nice, clean number, as reflected here in the --

A. I really don't recall that at all. I was more concerned about what -- what we could do to get an accurate number than what the cabinet wanted.

Q. Dr. Dykhuizen, you recall him expressing a different view at the meeting about what the appropriate percentage for uncertainty was on the --

THE COURT: Just -- are these actually your notes?

THE WITNESS: No.

THE COURT: Who took these notes, do you know?

THE WITNESS: I don't know. I don't know, sir.

THE COURT: Do we know who took these notes?

MR. REGAN: I think these are notes taken by a

gentleman named Curt Ammerman.

THE WITNESS: Curt Ammerman?

MR. REGAN: Curt Oldenburg; he was one of the FRTG members.

THE COURT: Do you know who that is?

THE WITNESS: I probably saw the name, but I do not know the individual.

MR. REGAN: I can get that in a second.

THE COURT: Okay.

BY MR. REGAN:

Q. So with respect to the press release that went out, it went out with a 53,000 July 15th final number; correct?

A. For the Day 87 flow, it said 53,000, yes.

Q. And it had an integral, that is an extrapolation from that number back to April 20th, to calculate a 4.9 million-barrel cumulative flow number; correct?

A. I wouldn't call it an extrapolation back from that number. It had another day upon it, Day Zero, which was derived from understanding something about well depletion and starting at 53 at Day 87.

Q. The understanding about well depletion was just that you could have a linear relationship between flow and depletion; correct?

A. And reservoir pressure; correct. That is correct.

Q. But the way that the line was developed, the integral was

1:56PM to start at 53 and work backwards; correct?
1:57PM **A.** That's probably a nuance of the arithmetic. But, basically, if you knew there was a 10 percent change in reservoir pressure -- that is, the pressure at the bottom of the well -- you would increase the Day Zero amount by 10 percent and draw that point, then draw a line between them.
1:57PM **Q.** The 4.9 million number in the August 2nd press release did not account for any changes in restrictions in the well during that time period other than putting the capping stack on and cutting the riser; correct?
1:57PM **A.** And that is correct, yes.
1:57PM **Q.** The 4.9 million cumulative flow, 10 percent uncertainty figure did not account for any geometry changes either; correct?
1:57PM **A.** Well, there was certainly a sense there could be geometry changes and everyone had a view of uncertainty. So it was what I call "engineering judgment" about the uncertainty. And I know, in people's mind, it had to be some context of geometry changes, unquantifiable. But, basically, the judgment was 10 percent with people being aware that, yes, there might have been geometry changes.
1:58PM **Q.** Your judgment was 10 percent uncertainty on the 53,000 single-day estimate; correct?
1:58PM **A.** My judgment or the team's judgment?
1:58PM **Q.** Well, you, as the leader of the team.

1:58PM **A.** My judgment was it was an estimate that was good for the Day 87, 53, and it was also good for the integral amount.
Q. So you had the same uncertainty for both the single-day and for the entire time period; correct?
A. I actually had less uncertainty on the 53. I thought it was tighter than that. I think you could find somewhere that I actually expressed that I thought Day 87 was better than 10 percent. And, of course, that would allow more leeway at the other end, which it could be greater than 10 percent and still average out to 10 percent.
Q. Let me ask you this, Dr. Hunter: The final day is a component of the cumulative estimate; correct?
A. The final day is one of the numbers -- one of 87 numbers that went into it.
Q. And when you use that final day number to calculate a cumulative number, you bring with it its uncertainty; correct?
A. That's correct.
Q. And you had the same uncertainty for 53,000 as you did for cumulative flow, as you recommended on July 31st to the administration; correct? 10 percent for each?
A. Yes. The statement is that 10 percent uncertainty covered it all. What I just said was I thought the 53 number was tighter, and there was probably more uncertainty as one moved to the left. Hence, 10 percent would cover it all.
Q. The 10 percent uncertainty for the cumulative flow, for

1:59PM 1 the 4.9 million number, that does not include the fact that BOP
1:59PM 2 resistances may have been changed over the 86-day time period;
1:59PM 3 correct?
1:59PM 4 **A.** Correct. No matter which way they changed.
1:59PM 5 **Q.** The 10 percent uncertainty for cumulative flow does not
2:00PM 6 include any potential multiphase effects that may have occurred
2:00PM 7 over the 86 days that could impact flow; correct?
2:00PM 8 **A.** No, I don't think that's correct. I think the calculation
2:00PM 9 certainly included multiphase flow; that means oil and gas.
2:00PM 10 What it did not account for was any significant changes in the
2:00PM 11 two-phase flow.
2:00PM 12 **Q.** So changes in multiphase flow were not included in the
2:00PM 13 10 percent for the cumulative number; correct?
2:00PM 14 **A.** That's correct.
2:00PM 15 **Q.** The potential for different flow paths over 86 days, that
2:00PM 16 was not included in the 10 percent uncertainty; correct?
2:00PM 17 **A.** If you mean by different flow paths down within the well,
2:00PM 18 they were not included.
2:00PM 19 **Q.** And you never saw any calculation where someone actually
2:00PM 20 tried to determine the uncertainty for that 4.9 million
2:00PM 21 cumulative flow where they did include the effect of potential
2:00PM 22 geometry changes, BOP changes, wellbore changes, or flow path
2:00PM 23 changes, have you?
2:00PM 24 **A.** I believe that's correct. No one did the composite, in
2:00PM 25 fact, of those effects you just mentioned. They did, however,

have them in their mind as we talked about what overall uncertainty to assign.

Q. If we go to TREX-9361.46, at the top of the page, this is the DOE NNSA report that was summarizing the outcome of those meetings in late July. Do you recognize this chart that's found on page 46?

A. Is that two questions? Yes, it is that; and I do recognize it, yes.

Q. Thank you, Dr. Hunter.

This is the line that was drawn from 53,000 on July 15th, extrapolating back to approximately 63,000 as of the third day of the spill?

A. I still don't quite -- would not use the language of "line that was drawn."

The point at the right was determined from those measurements we described in the capping stack. The point at the left, the far left, was determined by knowing the reservoir pressure was different and making the assumption that it was linearly different. That gives you that point. Then you would have a line between the two, and then you have those two adjustments that have to be made for cutting the riser and placing the capping stack.

Q. You agree, Dr. Hunter, that the further you get away from the capping stack, July 15th, the further you move backwards towards April 20th, the less certainty you have in the validity

of the daily flow rates that are represented by this line?
A. I wouldn't doubt the validity of the measure. I think there's more uncertainty in specifically what the number is. I believe there are other factors which could contribute, but I have no way of knowing and don't judge that they were significant.
Q. But factually true: The further you get back away from July 15th, the more uncertainty you have?
A. The more phenomena you would have that could have an impact on uncertainty.
Q. And with respect to factors such as erosion, if there was erosion that took place past Day 2, would that have the affect of increasing this cumulative estimate or decreasing it?
A. Well, I think you're taking the case, for example, of which there would be something blocking the flow, and that eroded away and the flow would go up. So for those days in which it was blocking, it would reduce the flow, but it would be critical that erosion occurred at a place that was actually blocking the flow, and that's not known.
Q. With respect to the time that the August 2nd press release went out, the BOP was still down in the seabed; correct?
A. That's correct.
Q. It was not recovered until September of 2010; correct?
A. I don't remember the date, but I think the month is definitely September.

2:03PM **Q.** And after it was recovered, your work with respect to this team was largely done?

2:03PM **A.** That's -- my work with this team was basically done on September 20th, and I believe it was recovered prior to that.

2:04PM **MR. REGAN:** If you could pull up TREX-9671.2.1.

2:04PM **BY MR. REGAN:**

2:04PM **Q.** Do you recall receiving an e-mail from Marcia McNutt in early January 2011, titled with respect to issue of BOP forensics?

2:04PM **A.** Yes. Do I recall getting the e-mail? No, but this is an e-mail that I got and it makes sense that I would get it. And I may have seen it in deposition, too.

2:04PM **Q.** And Director McNutt is referring to new information that had been recovered from DNV analyses of the BOP in December of 2010 that she had been alerted to; correct?

2:04PM **A.** Yes.

2:04PM **Q.** And she's giving you the heads-up on that.

2:04PM If we could go to 9710.3.1.

2:05PM In the body of the e-mail, just focusing, we can just focus on the top and then what she has on Number 4. She says: "DNV is conducting an exact laser scan to get the cross-sectional area of the region through which flow could have occurred. It seems to me on first blush that this new evidence affects our work in the following manner."

2:05PM Do you see that?

2:05PM **A.** I do.
2:05PM **Q.** She asks: "Does anyone have any ideas for how to model the erosion from the opening with time?"
2:05PM Correct?
2:05PM **A.** Yes.
2:05PM **Q.** And then she says: "In looking at our final curve for flow rate as a function of time, we do need to consider carefully the competing processes of depletion of the reservoir, which causes the flow rate to decrease, and possible widening of the flow path, which causes the flow to increase. The final curve may be peaked in the middle, for all I know."
2:05PM That's what she wrote to you in January 2011?
2:05PM **A.** That's correct.
2:05PM **Q.** And you responded to this e-mail; correct?
2:05PM **A.** I probably did. I wasn't working on this problem at all, but I probably responded to the e-mail.
2:06PM **Q.** Go to TREX-9671.1.1. You responded to Director McNutt that this is indeed interesting. You said you wanted to inject a word of caution and you referred to "Ron D."
2:06PM Is that Ron Dykhuizen?
2:06PM **A.** That would be Ron Dykhuizen?
2:06PM **Q.** And "Art" is Art Ratzell?
2:06PM **A.** Yes.
2:06PM **Q.** You said: "Your comment about the trend had merit, but I don't know what should be discussed via e-mail" and continue;

2:06PM correct?
2:06PM **A.** Right. Because my assumption was none of this should be discussed in e-mail, but I didn't know that at all, wasn't something I was engaged in, the legal process. I just cautioned what we shouldn't use that mechanism.
2:06PM **Q.** You wrote to Director McNutt: "I would be cautious with another prediction, especially one with such great uncertainty."
2:07PM Correct?
2:07PM **A.** Yes.
2:07PM **Q.** And at the very bottom, you say: "This whole effort needs a systemic correlation of data and forensics."
2:07PM Correct?
2:07PM **A.** Yes. I believe that's one of my statements.
2:07PM **Q.** And that was your view as of January of 2011; correct?
2:07PM **A.** That's correct.
2:07PM **Q.** With respect to the impact of the BOP on the August 2nd, 2010 4.9 million flow rate estimate, there was no -- nothing in that estimate that accounted for any changes in the BOP; correct?
2:07PM **A.** That's correct.
2:07PM By the way, can I point out that 4.9 was an estimate of what came out of the well, not an estimate of what went into the ocean. We -- in our estimate, it says that 800,000 barrels went into -- immediately into the collection system.

2:07PM **Q.** So you would -- the 4.9 would be a gross number and you would subtract the 810,000?

2:07PM **A.** We -- and we did. Whenever this topic comes up, I always point out that the estimate into the ocean was 4.1.

2:08PM **MR. REGAN:** Okay. Thank you, Dr. Hunter.

2:08PM **THE COURT:** Redirect?

2:08PM **MR. CHAKERES:** Your Honor, we have no redirect.

2:08PM **THE COURT:** Okay. Thank you very much, Dr. Hunter.

2:08PM **THE WITNESS:** Thank you, sir. Does that mean I'm done?

2:08PM **THE COURT:** You're done.

2:08PM Okay. The government can call its next witness.

2:08PM **MR. O'ROURKE:** Your Honor, Steve O'Rourke for the United States.

2:08PM We are going to call the next witness by video deposition. It's Mike Mason, former vice president of BP. It runs for less than six minutes. Just for planning purposes, we're going to have a total of three videos during our case in chief, just one right now.

2:08PM **THE COURT:** Okay.

2:08PM **MR. O'ROURKE:** We've also provided courtesy copies of the transcripts, too.

2:08PM (WHEREUPON, the videotaped deposition of Mike Mason was played.)

12:27PM (WHEREUPON, **RONALD DYKHUIZEN, PH.D.**, having been duly sworn, testified as follows:)

2:14PM **THE DEPUTY CLERK:** Please state your full name and correct spelling for the record.

2:15PM **THE WITNESS:** My name is Dr. Ronald Dykhuizen. That's spelled D-Y-K-H-U-I-Z-E-N.

2:15PM **THE COURT:** You've got to -- you can pull the whole thing a little closer to you.

2:15PM **THE WITNESS:** Is this better?

2:15PM **THE COURT:** Yes, that's better.

2:15PM **THE WITNESS:** Thank you.

2:15PM **MR. REGAN:** Your Honor, Matt Regan on behalf of BP. We have a *Daubert* motion that's pending with respect to Dr. Dykhuizen. It's in combination with a motion that's --

2:16PM **THE COURT:** Yes. I've read the motion and the opposition. I'm going to overrule the motion and let him testify. Again, if there are -- if there's any particular question that you have a problem with, you can object, and I'll rule on it at the time. Okay?

2:16PM **MR. REGAN:** Very well. Thank you.

2:16PM **THE COURT:** All right.

2:16PM Go ahead. I'm sorry.

2:16PM **MR. CERNICH:** May it please the Court, Scott Cernich on behalf of the United States.

2:16PM Could I please have demonstrative D-21145,

please.

Your Honor, this is just a road map of what we'll be covering today with Dr. Dykhuizen.

THE COURT: Okay.

VOIR DIRE EXAMINATION

BY MR. CERNICH:

Q. Dr. Dykhuizen, what is your expertise as it relates to this case?

A. I have a Ph.D. in mechanical engineering. I have done lots of work in multiphase flow, analyzing flow systems. I've also been on a number of accident investigation teams.

Q. How long have you done that work for?

A. I've worked in this field for about 35 years.

Q. And you mentioned multiphase flow. Can you tell Judge Barbier what multiphase flow is.

A. Multiphase flow is a flow typically through a piping system -- but it doesn't have to be -- where we have a mixture of phases. It could be a mixture of gas and liquid or liquids and solid or a gas, liquid, and solids. So a boiling flow is a condition of multiphase flow, where you'd have liquid and steam traveling in a pipe.

Q. Is multiphase flow something you've worked in throughout your career?

A. Yes, it is.

MR. CERNICH: Could I have demonstrative D-21140,

please.

BY MR. CERNICH:

Q. Is this a summary of your educational background, Dr. Dykhuizen?

A. Yes, it is.

Q. How does your educational background relate to your work in this case?

A. I have a B.S. and an M.S. degree in nuclear engineering, specializing in flow systems. I have a Ph.D. in mechanical engineering. I did my thesis topic on the stability of multiphase flows.

Q. And how does a background in nuclear engineering relate to your work in this case?

A. My specialty in nuclear engineering was analyzing flow and, therefore, I've done a lot of calculations of flow in nuclear engineering.

Q. Where are you currently employed?

A. Sandia Laboratories.

Q. What do you do there?

A. I'm an engineer. Principal member of the technical staff is my title.

Q. How long have you been employed at Sandia?

A. For approximately 30 years.

Q. What position do you hold there?

A. Principal member of the technical staff. I direct other

engineers and programs. I have no line responsibility as a staff member, as you might expect.

Q. But do you supervise other engineers?

A. On programs, yes. On their raises and salaries, no.

MR. CERNICH: Could I have D-21141, please.

BY MR. CERNICH:

Q. Is this a summary of your relevant work experience?

A. Yes, it is.

Q. Does your professional experience in mechanical engineering and fluid mechanics experience relate to your work on this case?

A. Yes, it does.

MR. CERNICH: Could I have D-21142.

BY MR. CERNICH:

Q. Dr. Dykhuizen, does this demonstrative summarize some of your relevant experience in multiphase flow and fluid mechanics?

A. Yes, it does. I've worked in geothermal wells. That is a well geometry very similar to the well at Macondo. We have single-phase water at the bottom of a geothermal well, typically. And as the water rises, the pressure changes, the water boils. This is hot water in a geothermal well. So we would have two-phase flow through most of the well.

CO2 fire suppression systems.

Something also I studied, that would be three-phase

2:20PM flow. Because CO2 can have a liquid, gas, and solid phase all at the same time, and did in my analysis.

I've been involved in a number of investigative teams, most notably the Three Mile Island nuclear reactor incident that happened in 1979. In that particular case I was involved in calculating the flow that was released from the nuclear reactor.

We were very concerned with maintaining an inventory of water. We were pumping water into the reactor at the time while water and steam was escaping, and therefore I have to perform an interval of that flow to find out how much water is left compared to how much water we're putting in.

Q. Why was it important to keep track of the amount of water that was going into the reactor?

A. Well, on Three Mile Island, the reactor was generating a significant amount of heat, and we're trying to keep the reactor cool to keep it from melting down. Unfortunately, we weren't completely successful with that and we did have a certain amount of meltdown.

Q. Did you apply standard fluid mechanics engineering methods and principles to your work there?

A. Yes, I did.

Q. Are those the same types of fluid mechanics engineering methods and principles you applied in this case?

A. Yes, it is.

2:21PM **Q.** Were your calculations submitted to the Nuclear Regulatory Commission?
2:21PM **A.** Yes. That work was done while the accident was proceeding. We submitted all of our work to the Nuclear Regulatory Commission, and they passed that on to the owners of the reactor.
2:21PM **Q.** The calculations you performed in this case, did you perform those by hand?
2:21PM **A.** Most of those were considered hand calculations. What I tried to do was put most of those into a spreadsheet. I have a couple spreadsheet programs, and that way they could be repeated, whereas the inputs might change or our guesses of the conditions changed.

2:22PM So in a sense they were hand calculations but most often performed on a spreadsheet application.
2:22PM **Q.** And are the equations you used the types that can be found in fluid mechanics textbooks?
2:22PM **A.** Yes.
2:22PM **Q.** Do you have experience calculating multiphase flows of hydrocarbons?
2:22PM **A.** Hydrocarbons is also -- often used in geothermal power systems. So we have multiphase flow of hydrocarbons in a geothermal power system. It's also used as a surrogate model for water because it's much cheaper to run experiments used with hydrocarbons than it is with using water. And so I've

done it there in that case also.
Q. Did you have any experience in the oil field prior to your work on this case?
A. No, none at all.
Q. Did that pose any challenges for you?
A. The only real challenge it posed to me was the fact that the names of concepts were quite often different, although the concepts were identical. And so I quickly helped -- had Charles Morrow help me. He was a person at Sandia Laboratories I knew that had extensive experience in the petroleum field, and he helped translate the terms that the petroleum engineers used into terms that I would better understand. But that was my only difficulty.
Q. Is there a significant difference between calculating hydrocarbons multiphase flows and multiphase flows of other fluids?
A. No, there isn't. It's just that you use a different equation of state to find out what the density of the gas is, what the densities of the liquid are, and what the properties of viscosity and a number of different properties that you would need. But the equations governing the flow were identical.
Q. Did you have an adequate equation of state?
A. Yes. Charles Morrow generated an equation of state for me based on the information that BP gave us. We compared that

2:24PM equation of state with BP results and found we matched very closely. In fact, BP kept modifying their results, and they seemed to get closer and closer to the values that Charlie calculated originally. So I was very pleased with Charlie's work in that area.

Q. Thank you, Dr. Dykhuizen.

Now, you were involved in the response to the Macondo well?

A. Yes, I was. I received a call from Dr. Tom Hunter and Tom Bickel -- they were both on the line -- and asked me in the first week of May to contribute to the government helping BP.

Q. Did you spend time in Houston during the response?

A. Yes. Usually Charles Morrow or myself were alternating back and forth in Houston. There were some time periods where neither of us were there, but, yes, we were there quite often.

Q. And were you also working on the response when you were back at Sandia?

A. Yes. Typically, it was difficult to get much work done while you were at Houston, so the person -- whether it was Charles Morrow or myself -- would be doing the calculations back at Sandia while the person in Houston was interacting with BP engineers and listening to presentations.

Q. Did Tom Hunter ask you to perform modeling during the response?

A. Yes. He asked me to perform a number of different

2:25PM 1 modeling tasks.
2:25PM 2 **Q.** Did you work on diagnosing well conditions?
2:25PM 3 **A.** Yes.
2:25PM 4 **Q.** Did you review BP's source control plans?
2:25PM 5 **A.** Yes.
2:25PM 6 **Q.** Did you participate in the well integrity analysis in July
2:25PM 7 of 2010?
2:25PM 8 **A.** Yes. I was there for that.
2:25PM 9 **Q.** Did you perform flow rate estimates?
2:25PM 10 **A.** Yes.
2:25PM 11 **Q.** And did you work with BP engineers during the response?
2:25PM 12 **A.** Yes. We worked with BP engineers, trading thoughts of
2:25PM 13 what might be going on and trying to interpret data.
2:25PM 14 **Q.** Did you perform some calculations in mid-May of 2010 at
2:26PM 15 BP's request?
2:26PM 16 **A.** Yes.
2:26PM 17 **Q.** And did you ever meet a BP engineer named Mike Mason
2:26PM 18 during the response?
2:26PM 19 **A.** Yes. I met him a couple of times.
2:26PM 20 **Q.** And who is Mr. Mason?
2:26PM 21 **A.** Mr. Mason was presented to me as a supervisor of a
2:26PM 22 calculational group at BP.
2:26PM 23 **Q.** Could you very briefly describe that work that you did in
2:26PM 24 mid-May at BP's request.
2:26PM 25 **A.** BP was concerned. They were using one of their standard

codes to calculate the flowing conditions in the well. They were concerned that this code may not be used properly in the odd geometries that they were proposing.

The geometry that they were most interested in -- they had the flow going up one flow path, turning 180 degrees, going back down, and then turning 180 degrees going back up again.

And they were concerned that their results may not be correct. So they asked myself and other national laboratory scientists to reproduce that calculation, given the same boundary conditions they were using, and try to calculate a pressure at the bottom of the well that you would get with these flow paths. I did that for four different geometries and presented that to BP blindly, without knowing what their results were.

It turned out that 3 and 4, I agreed very well with BP, and the fourth was slightly different. And I was able to convince BP that they were indeed using their code incorrectly in the fourth case and showed them that my calculations were better than theirs.

Q. And did BP agree with you that your calculations for that case were better?

A. Yes, they did.

Q. For that modeling did BP ask you to assume a flow rate of the 5,000 barrels per day?

A. Yes. That was one of the boundary conditions we were given to use.

Q. Did you share other flow modeling with BP during the response?

A. All during the response, any calculation I did was shared with BP, yes.

Q. Did that include flow rate calculations?

A. Yes.

Q. Did anyone from BP ever complain to you about your calculations or the support the national labs were providing during the response?

A. No. They seemed pleased with the support, and nobody ever told me that my calculations were incorrect.

MR. CERNICH: Your Honor, the United States tenders Dr. Dykhuizen as an expert in mechanical engineering, fluid mechanics, and multiphase flow.

THE COURT: All right. Do you have any other questions other than what was in your Daubert motion?

MR. REGAN: Other than Daubert motion, I'll take it up on the cross-examination, Your Honor.

THE COURT: Very well.

I'll accept him. Go ahead.

MR. CERNICH: Thank you, Your Honor.

DIRECT EXAMINATION

2:28PM **BY MR. CERNICH:**
Q. Dr. Dykhuizen, did you write an expert report and a rebuttal report in this case?
A. Yes, I did.
MR. CERNICH: Could we please have TREX-11452, please.
BY MR. CERNICH:
Q. Dr. Dykhuizen, is this your expert report in this case?
A. Yes. This is the title page of my expert report.
Q. Could we have TREX 11463-R, please.
Is this your rebuttal report?
A. Yes. This is the title page of my rebuttal report.
Q. Do you adopt these reports as your expert testimony in this case?
A. Yes, I do.
MR. CERNICH: In addition, Your Honor, the United States would like to offer into evidence these reports, which are marked as Exhibits 11452 and 11463-R. Dr. Dykhuizen's CV is included with his initial report. Each report lists the materials he considered in forming his opinions.
THE COURT: All right. Those will be admitted.
MR. CERNICH: Thank you.
BY MR. CERNICH:
Q. Turning to your expert opinions in this case, Dr. Dykhuizen, what were you asked to do?

2:29PM 1 **A.** I was asked to calculate the flow from the Macondo well at
2:29PM 2 any period of time I thought I had enough data to perform an
2:29PM 3 estimate. And I was also asked to integrate that flow to find
2:29PM 4 the integrated cumulative amount released from the reservoir.
2:29PM 5 **Q.** Did you calculate a flow rate through the capping stack?
2:29PM 6 **A.** Yes. That was one of the time periods I used. I
2:29PM 7 calculated 53,000 barrels of oil per day through the capping
2:30PM 8 stack.
2:30PM 9 **Q.** And did you calculate a flow rate at the time of Top Kill?
2:30PM 10 **A.** Yes. At the time of Top Kill, I estimated over
2:30PM 11 60,000 barrels of oil per day.
2:30PM 12 **Q.** And did you calculate a flow rate for the Top Hat period?
2:30PM 13 **A.** Yes. For the Top Hat period, I estimated approximately
2:30PM 14 60,000 barrels of oil per day.
2:30PM 15 **Q.** And did you calculate a cumulative, or integrated, flow?
2:30PM 16 **A.** Yes. I estimated 5 million barrels of oil was released
2:30PM 17 from the Macondo reservoir.
2:30PM 18 **Q.** Is that your best estimate?
2:30PM 19 **A.** Yes, it is.
2:30PM 20 **MR. CERNICH:** Could I have D-21143, please.
2:30PM 21 **BY MR. CERNICH:**
2:30PM 22 **Q.** Is this a summary of your expert opinions in this case?
2:30PM 23 **A.** Yes, it is.
2:30PM 24 **Q.** Could I go to D-21122, please.
2:30PM 25 And is this a demonstrative summarizing your three

2:30PM individual flow rate calculations on that time line?
2:30PM **A.** Yes, it is.
2:30PM **Q.** Dr. Dykhuizen, are you being compensated for your work in this case?
2:30PM **A.** I received my regular salary. Department of Justice has negotiated with my employer to pay for the time that I'm not working directly for my employer.
2:31PM **Q.** And did you have any involvement in those negotiations?
2:31PM **A.** No, I did not.
2:31PM **Q.** Now, I'd like to walk through each of your calculations. Let's start with the capping stack.
2:31PM And you said you calculated a flow rate of 53,000 barrels per day out of the capping stack?
2:31PM **A.** Yes, that is correct.
2:31PM **Q.** Did you prepare any demonstratives to assist you in explaining your calculations?
2:31PM **A.** Yes, I have.
2:31PM **MR. CERNICH:** Could we go to 21100.1.
2:31PM **BY MR. CERNICH:**
2:31PM **Q.** Is this the capping stack, Dr. Dykhuizen?
2:31PM **A.** Yes. That's a representation of the capping stack with the kill line on the left and the choke line on the right.
2:31PM **Q.** And how did the capping stack allow you to calculate flow rates?
2:31PM **A.** The capping stack allowed me to calculate flow rates

because I had a well-defined geometry that the flow was going through. I have a pressure gauge in the bottom of the capping stack that allows me to measure an upstream pressure. We're dumping to the sea at either one of the two points, with the middle ram closed. I can see if I can do that. The middle ram is right here.

So I have a pressure, let's say, at the exit of the kill line, a pressure gauge here, a known pressure difference. And then I would try to estimate the flow through that path when this path was blocked and this path was blocked based on those two pressures.

MR. CERNICH: Could we go to D-21101, please.

BY MR. CERNICH:

Q. Does this demonstrative assist in explaining how you calculated those flow rates?

A. Yes. What I've tried to show here is just a standard flow meter. This could be used in single-phase flow or multiphase flow. We put an obstruction in the middle of the device here that is represented by this green orifice. We measure the pressure upstream and the pressure downstream.

By knowing the change in pressure, or the difference in pressure; by knowing the resistance -- I could look it up because of the known geometry of the orifice; by knowing the equation of state, I know the density; and I only have one equation to determine the velocity. The change in the pressure

helps me to determine the velocity.

Then with the velocity I can multiply it by the density, multiply it by the appropriate area; and the density times the velocity times the area is the mass flow rate. And I can express that in standard barrels of oil per day.

Q. Are these standard fluid mechanics equations?

A. Yes. These are standard equations you'd find in a first-year undergraduate course.

Q. When did you first perform your capping stack calculations?

A. We knew the capping stack was going to be installed days before. We knew the geometry of the capping stack. So we had generated spreadsheets to do this calculation, and we did them within hours of getting the pressure data.

Q. And why did you first perform those calculations?

A. Knowing the flow from the well is very important for well integrity. There was a potential that the well had holes below grade that we didn't know about; and if we closed the well and now the oil was forced to go out the holes underground, that oil could percolate to the surface and create an even worse disaster than we had with the oil coming up the top, because now there would be no way to plug the system.

Q. Dr. Dykhuizen, did you use three methods to calculate flow rates through the capping stack?

A. Yes, I divided it into three methods.

2:34PM **Q.** And was Method 1 flow rates through the kill line of the capping stack?

2:34PM **A.** Yes.

2:34PM **MR. CERNICH:** Could we go to D-21102, please.

2:34PM **BY MR. CERNICH:**

2:34PM **Q.** Would you please explain to the judge your Method 1 calculations.

2:34PM **A.** Sure. We have the pressure here upstream. We have identified in red a number of resistances. Even the valves that are open provide a certain amount of resistance. We have an exit pressure. So with the known pressures and the known resistances in between, I calculate a flow rate.

2:35PM And we had two types of calculations, subtypes here. I could have all the flow being forced through the kill line, like it was in some time periods, and that would be the total flow coming out of the Macondo well. And there were other times where we had -- below the system we were collecting some flow to send up to a ship and, therefore, I would just add the measured collection rate to the amount of flow that was going through the kill line. If I had a reduced flow going through the kill line, I ended up measuring a reduced pressure with a pressure gauge.

2:35PM **Q.** Did you use something called K-factors to account for the pipe bends and contractions?

2:36PM **A.** Yes. We used Ks to calculate for all the resistances. We

looked up Ks from standard textbook references.

Q. What are K-factors?

A. K-factors are a measure of resistance. The higher the K-value, the tougher it is to push the flow through the system.

Q. And what sort of standard engineering text did you use?

A. My preferred text was the Crane manual, which is used in the U.S.; but I also looked in a text called Miller and another by a Dillchek (phonetic) that are used in other countries, trying to find as many representations of K-factors and geometries as close as possible to the geometries that we have here.

Q. Did you also calculate flow rates through the capping stack choke line?

A. Yes, I did. I called that Method 2.

MR. CERNICH: Can we go to D-21103.

BY MR. CERNICH:

Q. Would you please explain to the judge your Method 2 calculation.

A. Method 2 is essentially the same. We have the same upstream pressure. We have a slightly different downstream pressure because this exit is a different elevation. So as I get higher up, the pressure is reduced a little. We have many more resistances. But it allows us an independent way of calculating the flow, another flow estimate for essentially the same time period.

2:37PM 1 And none of the time periods that I chose to do this
2:37PM 2 analysis did we have any collection, so all the flow that I
2:37PM 3 chose to do the analysis was what I calculate the flow through
2:37PM 4 the system here.
2:37PM 5 **Q.** Was this the choke valve that ultimately shut in the
2:37PM 6 Macondo well?
2:37PM 7 **A.** Yes. This choke valve here was what we used to turn off
2:37PM 8 the well. All the flow was forced through this system. We
2:37PM 9 closed this valve in a number of small increments, in case we
2:37PM 10 saw the pressures going someplace that we were concerned about.
2:37PM 11 We didn't want the pressures to be so large that it would blow
2:37PM 12 apart the capping stack, so we did this slowly.
2:37PM 13 And we -- this is what was used to turn off the well.
2:38PM 14 Once this valve was closed, the well stopped flowing.
2:38PM 15 **Q.** Did you also calculate flow rates as the choke valve was
2:38PM 16 being closed?
2:38PM 17 **A.** Yes. This method could be used during the process of
2:38PM 18 closing the choke valve.
2:38PM 19 And we saw some interesting, unexpected results. As
2:38PM 20 we first closed the choke valve, the model indicated that the
2:38PM 21 flow was increasing. This didn't seem logical to us, and I
2:38PM 22 still don't think it's logical.
2:38PM 23 But eventually, as we continued to close the choke
2:38PM 24 valve, the flow predicted from the model showed that the flow
2:38PM 25 was decreasing, and eventually it showed that the flow was

zero.

We had some concerns and that led us to have less confidence in our calculated flows than we would have otherwise because we had this anomalous calculation.

Q. Does that make your calculations unreliable?

A. No. That just forces me to use a larger estimate of the uncertainty than I might have used otherwise.

Q. Now, did you also use a third method, something you called the "alternate method," to calculate flow through the capping stack?

A. Yes. A third method was also used.

MR. CERNICH: Could we go to D-21105.

BY MR. CERNICH:

Q. Does this demonstrative illustrate the time periods you used for your alternate method of calculation?

A. Yes. In the alternate method, we had some time period where the flow through the capping stack was reduced because we were collecting oil below in the BOP and, therefore, only part of the flow went up through the capping stack. Other time periods, these valves were closed and all the flow went through the capping stack.

I can formulate equations for both of those conditions and by manipulating the equations, I can predict not only the flow for these two conditions, but I can also predict the resistances. So this takes away my requirement of looking

up resistances and trying to justify their value. This allows me to calculate the resistances.

MR. CERNICH: Could we go to D-21104, please.

BY MR. CERNICH:

Q. How does the alternate method differ -- differ from Methods 1 and 2?

A. Well, the Method 1 and 2 are simple. You have two pressures and their resistance. Here I have two pressures, but I need two flowing conditions with at least a portion of the flow measured, and that portion that I have measured is the portion collected.

So knowing the portion collected and knowing these two conditions and the two different pressures I get, I can combine these equations and predict not only the flow rate at both of those two times, but predict what the resistance is, and I get resistances very similar to what I calculate in a normal, straightforward method.

Q. Did you compare the results of your three methods?

A. Yes, I did.

MR. CERNICH: Could we go to D-21106.

BY MR. CERNICH:

Q. Does this demonstrative show your comparison of your three methods?

A. Yes. I attempted Method 1, or at least I presented Method 1 three different times. I've actually attempted it

more times, but it got redundant. All the results were very similar.

Method 2, we're presenting the fully open case.

And the alternate method is combining the -- this case and that case together to get one alternate method.

And the other alternate method, I combine the third case and the first case and I get these six cases with all approximately the same flow rate.

I averaged the six cases and I get 53,000 barrels of oil per day, which constitutes my best estimate of what the flow is from the well.

Q. Dr. Dykhuizen, since July of 2010, have you done anything to improve or refine your calculations?

A. I've redone the calculations many times with different assumptions to try to find out what -- how sensitive they were to different assumptions and changing geometries.

Q. Did you explore multiphase effects?

A. Yes. One of the criticisms that was identified in the original DOE-NNSA report was we were using single-phase K-factors and were they applicable to this multiphase flow.

So I went into the literature, picked out a classic paper that is in use all -- all -- in many different fields and Chisholm correlation provides correlations for K-factors for multiphase flow.

I recalculated the flow with multiphase flow factors,

found out that the flow increased, my estimate increased by approximately 4 percent. I considered that 4 percent small compared to my original 20 percent error bar that I applied to my flows, and so I considered that the effect of multiphase flow was not a significant effect.

Q. Did you also consider the spacing of the flow elements, the elbows and contractions in the capping stack?

A. Yes. That concern was also identified in the original report. We were concerned that the tabulated values of K-factors were generated from experiments. And the experiments would, say, place an elbow preceded by a long, straight pipe and followed by a long, straight pipe.

In this example, we did not have that geometry. The elbow was followed closely by some valves, followed closely by another elbow. This is very standard. That effect is typically ignored. We can attack that approximation a number of different ways.

One way is the alternate method makes no assumption about what the K-values are and calculates the proper K-values with these elements placed where they are. Also --

Q. Dr. Dykhuizen, can I stop you there?

MR. CERNICH: Your Honor, there's a pending motion that you have on appeal regarding Dr. Dykhuizen's reliance on one of our relied-upon experts that is permitted under the Court's order, rec doc 11087. And before Dr. Dykhuizen goes

into this part of his testimony, I just wanted to alert you to that pending motion.

Judge -- Magistrate Judge Shushan issued an order excluding Dr. Dykhuizen and other U.S. experts' reliance on Dr. Bushnell. We opposed -- and we appealed that motion to you.

THE COURT: Okay. I did look at this. I didn't realize this was coming up with this witness. Tell me what the issue is again, Mr. Regan.

MR. REGAN: Yes, Your Honor. The issue is that Dr. Bushnell is an expert that the United States is not calling and has not been designated as one who they're relying upon either as a testifying expert or as a non-testifying relied-upon expert. He didn't fit into either category.

Because of that, it is not proper for their -- their testifying experts to rely upon him. That issue was briefed before Judge Shushan in Record Document 11352 --

THE COURT: So as I recall, the protocol was going to be that if one expert was going to rely on a non-testifying expert's opinion on anything, the non-testifying expert's opinion would have to be disclosed in the testifying expert's report and then that non-testifying expert's deposition testimony -- the relevant portions of that non-testifying expert's deposition testimony would be admitted.

Is that -- am I recalling that right?

2:46PM **MR. CERNICH:** Right. And that's the procedure we followed here, Your Honor. Dr. Dykhuizen specifically relies upon Dr. Bushnell in his expert report. BP argued in its original motion that Dr. Dykhuizen was simply using Dr. Bushnell to corroborate his results. Magistrate Judge Shushan agreed with the United States that he was not, but then added another layer to the analysis that he had to somehow describe an analysis of Dr. Bushnell's work in his report.

That requirement to describe an analysis is not in Rule 703 and it's not in the Court's order. Had we known that, we would have included such analysis. That order was actually issued after expert reports were done, after expert depositions are done.

Mr. Regan questioned Dr. Dykhuizen during his deposition and asked him specifically about his reliance on Dr. Bushnell in this case.

THE COURT: Let me ask the witness: What is it that -- without describing what the result was, but what is it that Dr. Bushnell did that's different than what you did?

THE WITNESS: Dr. Bushnell was able to perform a calculation to show that the effect of the -- he did a number of things, but in this particular case was to show that the effect of closely placed flow elements did not impact the -- resulted in a flow rate very similar to mine and, therefore, by implication, since he had all the flow elements in their proper

location, that I should not be concerned with the fact that the flow elements were close together.

MR. REGAN: Yes, Your Honor. As Judge Shushan ruled, she first read Dr. Dykhuizen's report where he just references Dr. Bushnell's opinions as providing confidence that his approach was correct. And as Judge Shushan wrote in her report -- this is Record No. 11352 in her opinion -- "The report by Dr. Dykhuizen does not demonstrate any independent analysis of the computational fluid dynamics models constructed and used by Dr. Bushnell, nor does he rely on Dr. Bushnell's analysis in forming any of his opinions."

And that's the key, he's not relying upon it, he's just bringing in another expert by saying, Well, I see what he's done over there and it gives me confidence --

THE COURT: It seems like he's relying on it in a sense. He's relying on it -- he didn't do -- you didn't do a separate analysis of what Dr. Bushnell did; that's what Mr. Regan says?

THE WITNESS: I did not repeat his analysis, no.

THE COURT: But you relied on it in what sense? To corroborate or confirm support which you came up with? Tell me how you relied on it.

THE WITNESS: I tried to demonstrate -- one criticism that was given to me was that the resistances I used were based on experiments where the flow elements were far apart.

Dr. Bushnell received a very similar result as I got by placing the flow elements close together, which justifies me assuming that they were sufficiently far apart that I could use the K-factors that I used in my report.

THE COURT: Okay. I'm going to let him make reference to that. Go ahead and move on.

MR. CERNICH: Thank you, Your Honor.

THE COURT: So I don't know if you had actually posed a question or not.

MR. CERNICH: Well, I had posed a question and I stopped Dr. Dykhuizen before I --

THE COURT: Okay. So get back to where you were.

MR. CERNICH: Yes, Your Honor.

BY MR. CERNICH:

Q. You were about to -- I believe you were about to talk about Dr. Bushnell.

A. Dr. Bushnell performed a CFD analysis, which is essentially a three-dimensional analysis of the flow by -- and he showed -- he placed every flow element in their exact position, or at least as exact as we know. He was able to come up with a flow rate that was very similar to my flow rate; therefore, it implies that my assumption to use K-factors based on widely separated flow elements was justified because he came up with a very similar result that I do solving the same problem.

2:50PM **Q.** And did Dr. Bushnell use something called "computational fluid dynamics"?
2:50PM **A.** Yes, he did.
2:51PM **Q.** And are you familiar with computational fluid dynamics?
2:51PM **A.** Yes. I've done computational fluid dynamics myself. In my position now, I direct a number of people doing computational fluid dynamics and they report their results to me. I try to make sure that that analysis is done correctly. I check their results, I check their work, similar to me reviewing Dr. Bushnell's work.
2:51PM **Q.** Just in a nutshell, can you tell Judge Barbier what computational fluid dynamics is?
2:51PM **A.** Yes. If you have a piping system with elbows and Ts and crosses, you would represent that with a bunch of little sugar cubes representing small volumes, much smaller than the diameter of the pipe. Then you would watch the flow in three dimensions as it would go around corners and what sort of eddies you would get and so on.

In my calculations, I just get an average velocity in the pipe. And so his calculations are much more accurate than mine.

2:52PM **Q.** Did you consider -- and what do you mean by "more accurate"?
2:52PM **A.** More --

MR. REGAN: Your Honor --

2:52PM **THE WITNESS:** More accurate is more detailed.
2:52PM **MR. CERNICH:** I'm not presenting --
2:52PM **MR. REGAN:** At a certain point we now have Dr. Dykhuizen testifying as Dr. Bushnell as to the work that he did. All he did was look at the results and say they were the same as his.
2:52PM **MR. CERNICH:** I'm not going any further, Your Honor. I just wanted to establish that Dr. Dykhuizen had a basis to rely on this work.
2:52PM **THE COURT:** All right.
2:52PM **MR. CERNICH:** I'll move on.
2:52PM **BY MR. CERNICH:**
2:52PM **Q.** Did you consider temperature sensitivities in your calculations?
2:52PM **A.** That was also a concern that was raised in the original report. In the original report, we had a base case of 180 degrees F. We repeated the calculation with 200 degrees F and got 2 percent reduction in flow, and that was presented.
2:52PM If you -- I was given criticism that I should use 220 degrees F. That would also give another 2 percent reduction, although I do not agree with using 220 degrees F.
2:53PM **Q.** Okay. Why did you use 180 F in your original calculations?
2:53PM **A.** The temperature of the flow was always unknown. I had asked BP engineers for a measurement or a calculation. Their

measurements and calculations were changing with time as different people would model it and they would use different assumptions. The current assumption at the time when I originally did those calculations was provided to Dr. Ratzell by BP and then provided to me as 180 degrees F.

And so that was what we used as a base case. We also determined that the 200 degrees F knowing that BP had previously given us numbers of 200 degrees F. And so we wanted to cover a range and demonstrate the sensitivity of our result to a range in temperatures.

Q. In performing your calculations to the capping stack, did you rely on pressure data from BP?

A. Yes. BP provided me with the pressure data that I needed.

Q. Did you rely on collection rates from BP?

A. Yes. I needed collection rates for the alternate methods and even for the Methods 1 and 2, BP provided those also.

Q. And the capping stack geometry?

A. BP provided the capping stack geometry to us.

Q. Did you expect BP to provide you with accurate data?

A. Yes, I did.

Q. Did you examine the geometry of the capping stack after it was recovered to shore?

A. Yes. I went to Michoud and saw the capping stack, and I witnessed the measurements of the capping stack.

Q. And how did those measurements compare with the geometry

you used in your initial calculations?
A. They were very close, within a few thousandths, except for one exception. I redid the calculations using the exact measurements that were provided from that session and got less than a 1 percent change.
Q. Did you consider any potential uncertainty in your capping stack calculations?
A. Yes. I assigned an uncertainty based on my expert judgment. Essentially, this is an uncalibrated flow meter. We have some resistance down there that we can estimate and it's used in multiphase flow.

If I have an uncalibrated multiphase flow meter in my work at Sandia, I would not assign an uncertainty -- I would -- I would assign an uncertainty of approximately 20 percent.
Q. Do you recall saying at your deposition something like, all my estimates are inaccurate?
A. Yes. That was an accurate statement of what I said.
Q. Did you mean that your estimates are wrong or unreliable?
A. No. I like to think that my estimates are reliable, but in any model of any system, estimates have a certain uncertainty to it and I tried to express my uncertainty. And that makes all my models and all anybody's models inaccurate.
Q. To some degree?
A. To some degree. Some models are more accurate than others.

2:56PM **Q.** Is 53,000 barrels a day your best estimate?
2:56PM **A.** That is my estimate.
2:56PM **Q.** And the -- what was the uncertainty range that you ascribed to your estimate?
2:56PM **A.** Plus or minus 20 percent, so nominally that's 43,000 to 63,000. We would expect 53,000 to be the best guess. You would have a bell curve centered at 53,000. Once you got to 43 or 63, the probabilities would be small. Like if you flipped a coin ten times, you would expect to get five heads and five tails, maybe four and six. There's a chance of getting all 10 heads, but that probability is very small.
2:56PM **Q.** And is the flow rate through the capping stack, in your opinion, just as likely to be 20 percent higher than 53,000 barrels per day as it is to be lower?
2:56PM **A.** Yes.
2:56PM **Q.** Do you consider yourself conservative when it comes to uncertainty?
2:57PM **A.** I have that reputation. I would hate to have somebody show up with a calculation that is definitive and shows that the answer is not within the range I specify, so I quite often have larger uncertainty ranges than other engineers put forward.
2:57PM **Q.** Dr. Dykhuizen, do you know a BP employee named Trevor Hill?
2:57PM **A.** Yes. I met him on a number of occasions.

Q. And who is Mr. Hill?

A. Mr. Hill is obviously a senior engineer at BP. He came from England to help in the response, and I interacted with him in Houston a number of times.

Q. And what did you discuss with him?

A. Any of my calculations I would discuss with him. He was interested in all my calculations. He seemed particularly interested in the calculations that involved my estimate of the flow.

MR. CERNICH: Could we go to TREX-6196.

BY MR. CERNICH:

Q. Have you seen this document before, Dr. Dykhuizen?

A. Yes. I've reviewed this document.

Q. Is this a PowerPoint presentation prepared by Mr. Hill dated August 17th, 2010?

A. Yes, it is.

MR. CERNICH: Could we go to call-out TREX-6196.4.1.US.

BY MR. CERNICH:

Q. And here in the presentation, Mr. Hill writes that -- it's titled "Estimate of Flow Rate on July 14/15." And the first bullet, "Information from preparation and execution of well integrity test may be used to estimate flow rate from MC 252 to GoM on July 14/15."

Do you use information from the preparation and

execution of the well integrity test to estimate the flow rate?
A. Yes. That's exactly what I did in Method 1, 2, and 3.
Q. And he writes: "The flow rate estimate may be made by prorating against different vessel collection rates and direct calculation by modeling of 3-ram stack piping."
Is that what you did, Dr. Dykhuizen?
A. Yes. The first one is the alternate method, and the bottom line is Methods 1 and 2.
Q. Did you ever ask Trevor Hill whether BP had calculated flow rates through the capping stack?
A. I assume that he had done that since it's a fairly simple calculation. He told me -- and I asked. He told me that that information was proprietary and he would not share it with me.
Q. At any point during the response or otherwise, did BP share any of its capping stack flow rate estimates with you?
A. No, I did not see any during the response.
Q. Did you later have the opportunity to review any of BP's capping stack calculations?
A. Yes. Since I've been contacted by Department of Justice, I've reviewed some.
Q. Did you review capping stack calculations by BP engineers Farah Saidi and Adam Ballard?
A. Yes, I reviewed those too.
Q. Do you know Richard Lynch?
A. He was a vice president of BP. I met him during the

response.
Q. Did you read his deposition testimony regarding BP's capping stack flow rate calculations?
A. Yes, I did.
MR. CERNICH: Could we go to D-21123, please.
BY MR. CERNICH:
Q. Does this demonstrative summarize the documents you reviewed?
A. Yes, it summarizes these three documents.
Q. And Mr. Lynch testified: "All I know is after the fact, I believe" -- I'm sorry, let me start over.
"Answer: All I know is after the fact now, I would know that we -- somebody in the team -- team, I believe, calculated 56,000 barrels per day.
"Question: Do you have any reason to doubt that calculation?
"Answer: That's a pretty straight calculation. No, I don't."
Did you review that testimony?
A. Yes, I did.
Q. And is the next -- the next estimate the one prepared by Ms. Saidi?
A. Yes.
Q. What did she calculate?
A. She calculated 51,500 standard barrels a day.

3:01PM **Q.** What did Dr. Ballard calculate?
3:01PM **A.** He had two attempts at the alternate method, and they both field numbers around 60,000 barrels of oil per day.
3:01PM **Q.** All right. Did you read the depositions of these individuals?
3:01PM **A.** Yes, I did.
3:01PM **Q.** Did BP ever inform you that they had verified the Government capping stack flow rate predictions of 51 to 54,000 barrels per day?
3:01PM **A.** No, BP did not inform me of that.
3:01PM **MR. CERNICH:** Could I have TREX-11191, please. And could I have the call-out 11191.1.US.
3:01PM **BY MR. CERNICH:**
3:01PM **Q.** Have you seen this document before?
3:01PM **A.** Yes, I have.
3:01PM **Q.** Is this a note reporting a calculation prepared by Ms. Saidi?
3:01PM **MR. REGAN:** Objection, Your Honor. I don't think the witness has the foundation to say that.
3:01PM **BY MR. CERNICH:**
3:01PM **Q.** Dr. Dykhuizen, did you read the deposition of Trevor Hill?
3:01PM **A.** Yes, I did.
3:01PM **Q.** Was Mr. Hill questioned about this document in his deposition?
3:02PM **A.** Yes.

3:02PM **Q.** And what did he testify?
3:02PM **A.** He testified that this was a note from Farah Saidi saying that she had confirmed the government prediction which she represented as being 51 to 54,000 barrels of oil per day.
3:02PM **Q.** This says: "K-factor calculated based on 3-K method."
Do you know what the 3-K method is?
3:02PM **A.** 3-K method is attempt to be a little more accurate than simply looking up values of K from tables. In this particular flow regime, the 3-K method would yield identical K-factors to what I used. The correction factors are nil for the conditions that we are looking at here.
3:02PM **Q.** And does the bottom of this note say, "Government prediction verified, 51 to 54 K"?
3:02PM **A.** Yes, it does.
3:02PM **Q.** Does any BP expert in this case propose an opposing capping stack flow rate calculation to yours?
3:02PM **A.** I have not seen an opposing capping stack calculation, no.
3:03PM **Q.** Dr. Dykhuizen, I'd like to move on to your Top Kill flow rate calculation. What was your Top Kill flow rate calculation?
3:03PM **A.** This calculation tried to estimate the flow coming from the well representative of the time period during Top Kill.
3:03PM **Q.** And what was that number?
3:03PM **A.** I obtained a number of over 60,000 barrels of oil per day.
3:03PM **Q.** Did you also calculate a lower bound estimate?

3:03PM **A.** Yes. I had to make a number of assumptions to get the over 60,000 barrels of oil per day, but I found that I could reformulate the equations in a conservative manner that would allow me not to make a number of assumptions and I calculate a hard lower bound of 43,000 barrels of oil per day as a lower bound.

Q. Did you use pressure pumping data from Top Kill -- pressure and pumping data from Top Kill to prepare that calculation?

A. Yes, I did. That was provided to me from BP.

Q. Did you prepare any demonstratives to assist in explaining your Top Kill calculation?

A. Yes, I have.

MR. CERNICH: Can we go to D-21117, please.

BY MR. CERNICH:

Q. Can you explain to Judge Barbier how you calculated a lower bound flow rate for the time of Top Kill?

A. Yes, I can. This is a depiction of the BOP. We're injecting mud at the bottom, right on top of the test ram. The test ram is open during the process. And the mud was supposed to travel down the well and stop the well from flowing. The mud did not travel down the well. Top Kill was unsuccessful.

During the time period of the accident, it was thought that maybe the mud traveled down the well a little bit and went out one of the burst disks. That was later discounted

3:04PM on inspection of the well, that mud did not flow in that path.

3:04PM And so I assumed all the mud, instead of going down

3:05PM the well, went up the well. That's a reasonable assumption

3:05PM because maybe initially some of the mud went down the well, but

3:05PM eventually everything steadied out and the BOP pressure gauge

3:05PM was giving a relatively constant reading. That implied the

3:05PM amount of mud in the well was either zero and nonchanging or a

3:05PM constant value and unchanging.

3:05PM So if the mud in the well is unchanging, all the mud

3:05PM has to be moving up. So with a known pump rate of the mud, I

3:05PM know how much mud is flowing up. I formulate some equations.

3:05PM I now know the resistance I can calculate of the BOP and the

3:05PM LMRP above because I know the pressure below or an estimate of

3:05PM the pressure based on the BOP pressure reading. I know the

3:05PM pressure at the top because I have -- I'm releasing to the sea.

3:06PM I can back out a resistance.

3:06PM I back out a very conservative resistance because I'm

3:06PM assuming the oil flow is zero. We did not achieve pressure

3:06PM significant enough to stop the well from flowing oil. That was

3:06PM determined because we didn't achieve pressures that were

3:06PM required to shut in the well. Those pressures were determined

3:06PM on the well integrity test, what pressures did we get when we

3:06PM shut in the well? So by assuming the oil flow is zero, I get a

3:06PM very conservative value for the resistance. Really, the flow

3:06PM was more than just mud. It had some oil flow also.

3:06PM 1 So with this conservative value of the resistence, I
3:06PM 2 then go to a time period when I'm not injecting mud, predict
3:06PM 3 how much oil flow I have through the system, and then correct
3:06PM 4 for closing the test ram, because the test ram was closed most
3:07PM 5 of the time.
3:07PM 6 And I can predict a conservative lower bound of
3:07PM 7 43,000 standard barrels of oil per day.
3:07PM 8 **Q.** Now, you used the PT-B pressure gauge that was down at the
3:07PM 9 bottom of the BOP for this?
3:07PM 10 **A.** Yes.
3:07PM 11 **Q.** And you used the ambient seabed pressure in your
3:07PM 12 calculations?
3:07PM 13 **A.** Yes, I did.
3:07PM 14 **Q.** And is what -- in your opinion, what is the likelihood
3:07PM 15 that the flow rate was less than 43,000 barrels per day during
3:07PM 16 the time of Top Kill?
3:07PM 17 **A.** I don't think that the -- the probability it was less than
3:07PM 18 43,000 is very small. This is a very hard lower bound that I
3:07PM 19 have calculated based on a very conservative assumption.
3:07PM 20 **MR. CERNICH:** Could we go to D-21118, please.
3:07PM 21 **BY MR. CERNICH:**
3:07PM 22 **Q.** And now could you explain to Judge Barbier your best
3:07PM 23 estimate of the Top Kill flow rate?
3:07PM 24 **A.** The best estimate is much more uncertain because now I
3:08PM 25 have three things flowing in the well: I've got mud flowing, I

3:08PM have oil flowing, and I have gas flowing. I have to come up with properties, effective properties for a mixture of all three of those phases. I did that and documented it into my report.

I came up with 60,000 standard barrels of oil per day -- actually, more than 60,000 standard barrels of oil per day. To get the solution with an iterative method, I guessed 60, went around the loop and got 70, said, Well, that's close to my initial guess; I will quit. This procedure is not very accurate. Ideally, I guess 60, go around the loop, I would get 60 back.

So I probably could have -- maybe should have now guessed 65, gone around the loop and got 64, guessed 64 1/2, gone around the loop and got 64 1/2, and eventually converged. But since I knew this method was approximate, I didn't think that it justified that effort. So I just left it as more than 60,000 barrels of oil per day.

Q. Is your best estimate for the Top Kill period greater than 60,000 barrels per day?

A. Yes.

Q. And was this similar to your alternate method that you used in the capping stack?

A. Yes. The equations that I used here are very similar, if not identical, to the alternate method, yes.

Q. And are they similar to the equations and formulas that

Dr. Ballard used in his capping stack calculations?
A. Yes. He used the same set of equations, except he was only applying it to the capping stack. He didn't apply it to the BOP during the Top Kill period.
Q. Were flow rates before and after Top Kill approximately the same as your Top Kill best estimate?
A. Yes, it was.
Q. And what is the basis for that opinion?
A. You can look at the BOP pressure gauge at the bottom of the BOP and see that that pressure gauge yielded a consistent value for time periods before and after the Top Kill event.
MR. CERNICH: Could we go to TREX-5066, please.
BY MR. CERNICH:
Q. Have you seen this document before, Dr. Dykhuizen?
A. Yes, I have.
MR. CERNICH: Could we go to TREX-5066.1.1.US.
BY MR. CERNICH:
Q. This is an e-mail from Paul Tooms, dated June 11, 2010. Do you know Mr. Tooms?
A. Yes, I met Mr. Tooms a number of times. He seemed to be leading all the engineers at Houston and in the response.
MR. CERNICH: And it's to a number of BP employees, including James Dupree, Your Honor, who testified last week during the source control part of this case.
BY MR. CERNICH:

3:10PM **Q.** The subject is "Historical BOP Pressure," and there's an attachment, "BOP Pressure History."

Did I read that correctly?

A. Yes.

Q. Did you review the attachments to this document as well?

A. Yes, I did.

MR. CERNICH: Could we go to 5066.1.2.US.

BY MR. CERNICH:

Q. And Mr. Tooms writes here: "Attached is a chart showing BOP pressure over time."

He says: "A number of points can be taken from the graphs, including, No. 1, pressures above and across the BOP with test rams closed are broadly the same now as they were prior to Top Kill. This suggests that overall flow rates have not changed much, unless there is some unexplained mechanism in the well."

Did I read that correctly?

A. Yes, you did.

Q. Are you and Mr. Tooms in agreement that the pressure suggests that overall flow rates have not changed much before and after Top Kill?

A. Yes.

MR. CERNICH: Can we go to 5066.3.1.US.

BY MR. CERNICH:

Q. What is this chart, Dr. Dykhuizen?

3:11PM **A.** This is from the attachment. This is a chart. If we just look at the top, it's showing BOP pressure with changes on a number of days. These three low values are obtained with the test ram open because we needed the test ram open when we were performing the three different phases of Top Kill. So that represents a reduction in the resistance of the BOP because we opened one of the valves.

But if we ignore those and just look at the rest of them, we see a generally decreasing pressure with time that's consistent with the conditions aren't changing much and also consistent with the general observation that the reservoir is depleting and the flow is slowly reducing with time over this time period.

But, in general, the flow rate after and the flow rate before are the same.

Q. Did BP engineer Tim Lockett perform modeling of the Top Kill after the Top Kill?

A. Yes. He performed modeling based on different modeling than mine, but, yes.

Q. Did he use OLGA to do that modeling?

A. Yes, he used OLGA to do that modeling.

Q. What's OLGA?

A. OLGA is an industry standard code for calculating pressure drop for oil flow through piping systems, and they simulated the well as a piping system, which is a logical use of OLGA.

3:13PM **Q.** Did you read Dr. Lockett's deposition?
3:13PM **A.** Yes, I did.
3:13PM **MR. CERNICH:** Can we go to TREX-9452.
3:13PM **BY MR. CERNICH:**
3:13PM **Q.** Have you seen this document, Dr. Dykhuizen?
3:13PM **A.** Yes, I have.
3:13PM **MR. CERNICH:** Go to 94512.1.1.US.
3:13PM **BY MR. CERNICH:**
3:13PM **Q.** Is this Dr. Lockett's modeling?
3:13PM **A.** Yes. This is an e-mail discussing Dr. Lockett's modeling of Top Kill.
3:13PM **Q.** This is dated June 29th, 2010, from Tim Lockett to Trevor Hill, who we already discussed.
3:13PM "Trevor, I've now looked at Top Kill No. 1 and 2 using the same resistance and well PI as are needed to get a first pass 'reasonable' match to Top Kill No. 3... Attached is my previous write-up extended with these latest results."
3:14PM Did I read that correctory?
3:14PM **A.** Yes.
3:14PM **MR. CERNICH:** Can we go to TREX-9452.2.1.US.
3:14PM **BY MR. CERNICH:**
3:14PM **Q.** And this lists data.
3:14PM Dr. Dykhuizen, did you also use some of this data for your Top Kill calculation?
3:14PM **A.** I just used Top Kill 3 data, which was the third attempt

3:14PM 1 at Top Kill, yes.
3:14PM 2 **Q.** Do you recall what Dr. Lockett concluded was the flow rate
3:14PM 3 range during the Top Kill?
3:14PM 4 **A.** He concluded between 44,000 and 77,000 barrels of oil per
3:14PM 5 day.
3:14PM 6 **Q.** Do you know whether the rates he calculated were with the
3:14PM 7 test rams opened or closed?
3:14PM 8 **A.** I understood his were based with the test ram open.
3:15PM 9 Therefore, they aren't completely consistent with mine. We
3:15PM 10 should reduce his numbers by approximately 10 percent to be
3:15PM 11 consistent with mine.
3:15PM 12 **MR. CERNICH:** Could we go to 9452.9.1.US.
3:15PM 13 **BY MR. CERNICH:**
3:15PM 14 **Q.** Did Dr. Lockett write, "The implication is that the flow
3:15PM 15 rate from the well is now probably in the range of 44,000 to
3:15PM 16 77,000 stbl per day"?
3:15PM 17 **A.** Yes, he wrote that.
3:15PM 18 **Q.** Does BP's expert, Dr. Johnson, criticize your Top Kill
3:15PM 19 flow rate calculations?
3:15PM 20 **A.** Yes. He has a number of criticisms of my Top Kill
3:15PM 21 calculations.
3:15PM 22 **Q.** Now, Dr. Johnson contends that you didn't account for
3:15PM 23 erosion. How do you respond to that?
3:15PM 24 **A.** I assumed erosion was small during the Top Kill event, and
3:15PM 25 if any erosion occurred, it was counterbalanced by extra

resistance added by the junk.

Q. He also said that you didn't consider the density of the Junk Shot. How do you respond to that?

A. That didn't seem to be a reasonable concern. The junk was injected very early in the Top Kill, not during the time periods that I chose to analyze. Therefore, the junk was not flowing during the time period that I analyzed, so it shouldn't impact the flowing density that I used.

Q. Now, he also argues that you should have analyzed other Top Kill periods. How do you respond to that?

A. I could analyze other Top Kill periods. He chose to do that using my model, which I assume it means he accepts my model. And he did it for Top Kill 1, I think. And he followed my procedure and logically got a lower lower bound. I have no problem with that. A lower lower bound is not of interest.

To say that my age is -- has a lower bound of 50 gives people some information. To say that my age has a lower bound of 10 is equally correct but doesn't give anybody enough information -- or as much information as a lower bound of my age is 50.

Q. So does a higher lower bound give you more information?

A. Yes. A higher lower bound is something that an engineer would desire to get.

Q. Now, Dr. Dykhuizen, I'd like to move on to your Top Hat calculations. Could -- what flow rates did you calculate using

Top Hat 4?

A. I calculated, when Top Hat 4 was installed on the well, a flow rate of approximately 60,000 barrels of oil per day.

Q. The Court has already seen some images of Top Hat 4, so we'll skip the additional images right now.

How long was the Top Hat installed on the well?

A. A month and 10 days or a month and a half, somewhere along that line.

Q. And did you calculate flow rates using Top Hat 4 during the response?

A. Yes. During the response, this was really our first indication, based on our own calculations, that the well was flowing a significant amount.

Q. And when did you do those calculations?

A. We did it as soon as the pressure gauge was installed on the Top Hat 4. Top Hat 4 was initially installed without a pressure gauge. So we needed pressure measurements to do that calculation.

Q. Did you share those calculations with BP in June of 2010?

A. Yes, I did.

Q. Did anyone from BP express disagreement with your calculations at that time?

A. No, not to me; and none was relayed to me if they expressed it to other people.

Q. And did you perform additional Top Hat 4 flow rate

3:18PM 1 calculations as part of your expert work in this case?
3:18PM 2 **A.** Yes. I tried to reproduce the calculations in a more
3:19PM 3 conservative manner, so that they would be more defendable.
3:19PM 4 **Q.** And how did you do it in a more conservative manner?
3:19PM 5 **A.** Well, the original calculations were based on a visual
3:19PM 6 reading of a pressure gauge. The pressure gauge was known to
3:19PM 7 be inaccurate, and we had to read it based on putting a camera
3:19PM 8 on it and reading the gauge.
3:19PM 9 Now, whether the camera was looking straight on to
3:19PM 10 the gauge or with an angle, that would always give people
3:19PM 11 uncertainty.
3:19PM 12 So I was able to find a lower limit of the pressure
3:19PM 13 based on the procedures that were used when Top Hat 4 was
3:19PM 14 installed.
3:19PM 15 **Q.** What do you mean by "the procedures"?
3:19PM 16 **A.** Well, it was -- Top Hat was installed with a rubber skirt
3:19PM 17 around the bottom and it was supposed to seal against the well.
3:20PM 18 The skirt did not seal against the well. It was damaged while
3:20PM 19 it was installed. So we were very concerned that we didn't
3:20PM 20 want to suck water into the Top Hat. Because if we sucked
3:20PM 21 water in, we might form hydrates and the hydrates might clog
3:20PM 22 the system and make the Top Hat useless.
3:20PM 23 So to keep water from sucking in, the BP engineers
3:20PM 24 were required to make sure that the pressure underneath the
3:20PM 25 Top Hat was sufficient; not water, oil, and gas was always

flowing out. And so they had the ability to adjust the pressure in the Top Hat by closing valves on the top to make sure that oil and gas was always flowing out.

Well, I calculated what pressure that had to be to make sure that oil and gas was always flowing out. I think that pressure ended up to be about 1.1 psi. Not very large, but just enough pressure to make sure that oil was always flowing out.

As a matter of fact, at that pressure, zero oil would be flowing out, but at least we wouldn't have water flowing in. So that gave me a minimum value of the pressure in the Top Hat that I could use to calculate flow out the vents in the top of the Top Hat.

Q. And is that pressure lower than the pressure you used for your Top Hat 4 calculations in 2010?

A. Yes. I used the measured value, which is approximately 2 psi, and now I'm using 1.1 psi to force the oil out the vents, which gives me a lower estimate and a more defendable estimate. I don't have to make assumptions about how accurate the gauge is.

MR. CERNICH: Could we go to D-21109.

BY MR. CERNICH:

Q. Can you explain your lower bound estimate in light of the discussion you've already given to the judge about the pressure gauge -- could you explain this?

3:22PM **A.** Okay. Here is a depiction of the Top Hat. It didn't fit on very well, so it was cocked. This rubber seal was supposed to go around this flange and it didn't fit very well and it broke upon installation.

We're collecting oil up the top. I have a measurement of that given to me from BP. So I know that fairly certainly. Certain with -- with low uncertainty. We have flow going out three of these vents. The fourth one was closed. They closed this many to make sure that we had oil leaking out the bottom. So with my internal pressure, the flow is driven by this internal pressure of 1.1 psi and also driven by the fact that the oil is lighter and wants to escape. So we have a buoyancy force. I calculate a lower bound of 18,000 barrels of oil per day coming out the three vents.

Then I also know that, on the last day, they collected approximately 25,000 barrels of oil per day. Or at least for a period of a few hours, they were collecting that much.

So they're collecting that much. We have 18,000 going out the three vents. I add those two together, I get 43,000, which assigns zero flow out the skirt, which leads me to believe this is a very good lower limit that I can use.

Now, since this 25,000 was on the last day, in my view, the flow of oil is decreasing with time, due to depletion of reservoir. Any lower bound I can establish on the last day

must be a lower bound on previous days. And so I can use this lower bound on any day, and 43,000 seems -- is my lower bound.

Q. Is your -- in your opinion, is there any likelihood that the flow rate was below 43,000 barrels per day through the Top Hat?

A. No, I think there was a very small probability of below 43,000 barrels per day. This is a reasonable hard lower bound.

MR. CERNICH: Could we go to D-21110?

BY MR. CERNICH:

Q. How did you arrive at your best estimate?

A. The best estimate, I needed to add some to the skirt. I can also add some because my flow is -- out the vents is a lower bound. I could increase that some. We know we are collecting what we're collecting. But I did the flow of the skirt in a different method.

We know that the collection changed suddenly by 10- or 15,000 barrels of oil per day at different time periods, and we're observing that. As a matter of fact, we had video that we looked at. So we've looked at the skirt flow coming out when we had a significant amount of collection, and then we looked at the skirt flow an hour later or a few minutes later after the collection stopped.

And we said, gee, we can't tell the difference between when the collection is going and when the collection stops. It seems to be about the same. That tells me that the

flow coming out the skirt must be at least in the order of 20,000 or 10- or 15,000 barrels per day, because if we can't see a change, then the change must be small compared to the flow coming out.

So I assigned 20,000 as a round number for the flow out the skirt. We add the 20,000 to the 43,000, and we get 60,000. Since 20,000's a round number, I can round the 43,000 to 40.

Q. Thank you, Dr. Dykhuizen.

BP expert Dr. Johnson criticized your calculations; is that correct?

A. Yes. He criticized these calculations, also.

Q. And he criticized the K-factor for the skirt and he contended that the vent and skirt flows could not be treated independently. How do you respond?

A. He didn't like the K-factor that I assigned in my original calculation of the skirt, and he said, due to the fact that I was using the wrong K-factor, I was off by two or three orders of magnitude in flow. In other words, the flow should have been a factor of 100 or 1,000 less than I predicted.

I thought that was ridiculous. It didn't make any sense whatsoever. I responded in my rebuttal four or five different ways why I was right and he was wrong.

He since came back in his deposition and conceded that I was right and calculated flows and presented in a

produced document that were very similar to mine. He also calculated the flows independently out the skirt and the vent, which was the same way that I calculated it. So I assume he took back his criticism that I could calculate those independently.

Q. Dr. Dykhuizen, now I'd like to move on to your cumulative or integrated estimate. What is that estimate?

A. I estimate that there's 5 million barrels of oil that came out of the reservoir.

Q. When did you first prepare an integrated flow estimate?

A. That was first prepared with Dr. Ratzell for the NNSA report.

Q. And what was your estimate then?

A. The estimate then was presented as 4.9 million barrels of oil.

Q. Since then, did you consider the effects of temperature and the final reservoir pressure on your calculation?

A. Yes. The temperature has the same effect on the integrated calculation as it does on the flow of the last day, a 2 percent change in temperature for every 20 degrees rise -- 2 percent change in the flow rate for every 20 degrees rise in temperature.

Q. And what about the final average reservoir pressure?

A. I looked at that also. There was some concern that the final reservoir pressure was used incorrectly. This was

identified in the NNSA report, that a change from 10,050 to 10,600 resulted in approximately 3 percent change or a 3 percent reduction in the flow from the reservoir.

MR. CERNICH: Can we go to D-21119, please.

BY MR. CERNICH:

Q. Dr. Dykhuizen, does this demonstrative summarize the components of your cumulative estimate?

A. Yes, it does. We're showing here how the flow changes due to the decreasing reservoir pressure. We have decreasing flow versus time. To account for erosion, which I think was very rapid initially and tails off, I assigned the first two days of zero flow. We have a time period from the end of July where the flow is reduced, because when we put the capping stack on, that adds extra resistance and reduces the flow.

And we have a time period in June where the flow increases, because when we cut off the riser, we have less restriction and the flow increases.

Q. Did you do a calculation for the riser cut-off?

A. Yes. I did that at the time of the response and redid that later on and said that the riser cutoff would be, at most, a 4 percent change in flow.

Q. Did you share that calculation with BP?

A. Yes, I did.

Q. And did BP agree with you?

A. They didn't disagree with me, but I did not see their

calculations either. They seemed to accept it.
Q. How did you account for erosion in your calculation?
A. Erosion is difficult to estimate. I think Dr. Stewart Griffiths has a very interesting model that he shows that erosion is negligible based on BOP pressure measurements. However, the BOP pressure measurements started May 8th, so it's difficult for me to extract before May 8th. So I assigned zero flow for the first two days. You could potentially assign half flow for four days or a third flow for six days. That's essentially the same. But that's my -- a proxy for erosion. We know we didn't have zero flow for the first two days.
Q. Do you believe that erosion happened quickly?
A. Yes, I think erosion happens quickly. We have the smallest channels in the BOP the first few days. We, therefore, have the highest velocities and, most importantly, the highest change in velocities in the BOP in the first few days.

I've been told by reservoir engineers that the sand production of the well is very high, especially if the well starts flowing rapidly, as this well seemed to do.
Q. Were those BP reservoir engineers?
A. Yes. BP reservoir engineers told me that, and we were discussing that because, when we put on the capping stack and we closed it for a number of days, there was a possibility that we would have to open the well. And they wanted to make sure

3:32PM that we were -- the government agreed with opening the well very gradually to limit sand production. So they wanted to open the well gradually if we ever had to.

Q. Were they concerned that opening the well quickly would result in more sand production?

A. That was what --

MR. REGAN: Objection.

Pardon me, Dr. Dykhuizen.

Your Honor, the question now is asking Dr. Dykhuizen to articulate the concerns of unnamed people about some conversation at an unnamed time. I think we're getting a little far from being able to even tell if it's relevant.

THE COURT: Are you referring to your conversations with BP -- I see a reference to "BP reservoir engineers."

THE WITNESS: Yes.

THE COURT: That's who you're talking about?

THE WITNESS: Yes.

THE COURT: These are the conversations?

THE WITNESS: Yes. These were done during the well integrity where we had meetings with the government and BP.

THE COURT: When you said, "They wanted to open the well," were they concerned that opening the well quickly would result in more sand production -- you're talking about the BP reservoir engineers?

3:33PM **THE WITNESS:** Yes.

3:33PM **THE COURT:** Okay. Overrule the objection.

3:33PM **MR. CERNICH:** Thank you, Your Honor. I'll try to ask better questions.

3:33PM **THE COURT:** Okay.

3:33PM **BY MR. CERNICH:**

3:33PM **Q.** Now, did you testify at your deposition that you ascribed a 30 percent uncertainty to your integrated estimate?

3:33PM **A.** Yes, I did.

3:33PM **Q.** Is the cumulative oil discharge as likely to be 30 percent greater as it is to be 30 percent less than 5 million barrels?

3:34PM **A.** This one, I don't think is symmetric. I think the 20 percent greater is probably as far as we can go.

3:34PM There are some -- the flow at the last day, I assigned a 20 percent -- could be 20 percent greater or 20 percent less. If I make the flow on the last day 20 percent greater, the integral gets to be 20 percent greater.

3:34PM But here, we have to worry about a number of things, some big and some small. But the biggest one is erosion. And erosion only happens in one direction. And so if we account for erosion, it's only going to decrease my integral. And that's why I have an unsymmetric error bar.

3:34PM **Q.** Does that uncertainty range you described encompass all of your uncertainty?

3:34PM **A.** Yes, it does.

3:34PM **Q.** And you mentioned if your flow rate is 20 percent higher. If the capping stack flow rate is 20 percent higher, does that mean the cumulative estimate is also 20 percent higher?

3:35PM **A.** Yes.

3:35PM **Q.** Do you believe your 5-million-barrel estimate is reliable?

3:35PM **A.** Yes, I do.

3:35PM **Q.** Now, we've talked about your uncertainty. Do you apply the same uncertainty to other U.S. experts in this case?

3:35PM **A.** I think the other experts know their own models better than I do and can apply their own uncertainties to their own models. That seems to be a fair way.

3:35PM **Q.** Now, do you know Dr. Griffiths, who's another U.S. expert in this case?

3:35PM **A.** Yes. I met Dr. Griffiths 30 years ago and have very -- fairly infrequent contact him. But recently, he started helping in the response on the last few days and I had more regular contact with him at the end of July -- June -- end of June and through July and August.

3:36PM **Q.** Of 2010?

3:36PM **A.** Of 2010, yes.

3:36PM **Q.** And Dr. Griffiths was also employed at Sandia?

3:36PM **A.** Dr. Griffiths was employed at Sandia originally at the site where I was. But before I arrived at Sandia, he moved to a separate site a thousand miles away. That's why I don't interact with him very often.

3:36PM **Q.** Did you review any of Dr. Griffiths' flow estimates in 2010?
3:36PM **A.** Yes.
3:36PM **Q.** Did you have criticisms of those estimates?
3:36PM **A.** I had a lot of criticisms of his report. I did not think his report was very clear, and I tried to get him to explain to me his model in greater detail so I could have greater confidence in his result.
3:36PM **Q.** Have you since read Dr. Griffiths' peer-reviewed article in his expert report?
3:36PM **A.** Yes, I have.
3:37PM **Q.** Do you still have those criticisms?
3:37PM **A.** No. He addressed my criticisms very well. Some of those were due to the fact that I didn't understand his model, and some of those may have been justified and he expanded his work to include my criticisms.
3:37PM **Q.** And what do you think of his work now?
3:37PM **A.** I think his work is an excellent piece of work.
3:37PM **MR. CERNICH:** Thank you, Dr. Dykhuizen.
3:37PM Your Honor, we're getting close to wrapping up here. We're moving on to the rebuttal portion of Dr. Dykhuizen's testimony.
3:37PM **BY MR. CERNICH:**
3:37PM **Q.** I would like to cover your responses to the BP experts.
3:37PM **THE COURT:** How much longer are you going to be?

3:37PM **MR. CERNICH:** I would probably say 30 minutes, Your Honor.

3:37PM **THE COURT:** Let's go ahead and take a 15-minute recess. It's about 3:35, 37, something like that.

3:37PM **THE DEPUTY CLERK:** All rise.

3:45PM (WHEREUPON, the Court took a recess.)

3:59PM **THE DEPUTY CLERK:** All rise.

3:59PM **THE COURT:** All right. Please be seated, everyone. Mr. Cernich, you may resume.

3:59PM **MR. CERNICH:** Thank you, Your Honor.

3:59PM **BY MR. CERNICH:**

3:59PM **Q.** One more question to finish up your cumulative estimate, Dr. Dykhuizen. You talked about -- you testified to the concept of a bell curve regarding your capping stack calculations.

3:59PM Does the same concept apply to your cumulative estimate?

3:59PM **A.** Yes, it does. I expect that the 5 million barrels of oil total is the best estimate. Now, I just have a skewed bell because it only goes 20 percent up and 30 percent down. The probability of being 20 percent up is small, and the probability of being 30 percent down is small.

4:00PM **Q.** Now, moving on to your rebuttal of BP's experts. You write in your report that BP experts Johnson, Momber, and Nesic are incorrect when they contend that flow rate was increasing

4:00PM 1 over the course of the blowout.
4:00PM 2 Do you recall writing that in your report?
4:00PM 3 **A.** Yes, I do.
4:00PM 4 **Q.** Dr. Nesic proposes that the BOP eroded slowly over the
4:00PM 5 course of more than a month. Do you disagree with Dr. Nesic?
4:00PM 6 **A.** No, I don't think that it could erode slowly over a period
4:00PM 7 of a month. It had to erode fast initially and then slow down.
4:00PM 8 **Q.** Why is that?
4:00PM 9 **A.** As we stated before, erosion is dependent on the
4:00PM 10 velocities. We expect to have high velocities when we have
4:00PM 11 small anaerobic passages. Unless the passages widen out and
4:00PM 12 the velocity is reduced, we expect erosion to reduce.
4:00PM 13 **Q.** Now, Dr. Johnson proposes a different model for flow over
4:01PM 14 time than you; is that right?
4:01PM 15 **A.** Yes, he does.
4:01PM 16 **Q.** What is Dr. Johnson's model?
4:01PM 17 **A.** Dr. Johnson also assumes that the flow is increasing over
4:01PM 18 time, and he justifies that by discounting Dr. Stewart
4:01PM 19 Griffiths' work. He says that if the erosion in the BOP
4:01PM 20 happens at a coordinated rate with PI increase at the bottom of
4:01PM 21 the well, they could happen at such a way that you would not
4:01PM 22 notice it in the BOP pressure measurement.
4:01PM 23 I think that's not very likely, to have things happen
4:01PM 24 at two different points in well-coordinated rates, that we
4:01PM 25 would not see evidence of it.

Q. And what two points are moving at well-coordinated rates?

A. The BOP -- the erosion of the BOP is causing less resistance in the BOP. And he claims that the PI is changing at the bottom of the well, that's changing in such a way that it masks the pressure gauge and does not allow it to respond, and it stays steady.

Q. Is that believable?

A. I don't think it's believable, no. Stewart Griffiths gives a much more believable model in his report.

Q. I'd like to move on to your rebuttal of Dr. Zaldivar. The judge heard a lot about Dr. Zaldivar in the opening.

Did you respond to BP's expert, Zaldivar, in your report?

A. Yes, I did.

Q. What did Dr. Zaldivar purport to do?

A. He had a very interesting report, because it was very similar to my Ph.D. thesis. So I took a lot of interest in his report.

He noticed from observations that the flow coming out of the end of the riser while it was still attached to the BOP alternated between a light fluid and a dark fluid, back to a light fluid, back to a dark fluid, in a very regular pattern.

And he correctly proposes that that is -- means that part of the flow is mostly gas for a while, and then the change in color means the flow is mostly liquid, and then mostly gas,

and mostly liquid.

He also noticed that the riser, which was laying along the bottom of the Gulf, was rising up due to a bouyant force and then going back down again, rising up and going back down again, at the same frequency that the colors were changing at the end of the riser. And so he correctly concluded that those two were related.

And he said that as the liquid goes through the riser, it's a little heavier than the gas and forces the riser down; and as the gas goes through -- up the riser -- of course, it's not really a riser when it's laying on the bottom, but it's called the riser -- but when the gas goes through, it's more bouyant and the riser goes up. And so it goes up and down when the change in phase goes through that portion of the riser.

And so he generated a numerical model to try to predict what flow rates through the system would generate this oscillation. So based on his numerical model, he game up with a range of flow rates that would generate this oscillation.

This is very similar to my Ph.D. work where I tried to generate a range of flow rates that would result in a oscillation in a vertical channel. Lots of the same physics but different because it was a vertical channel.

Q. In your opinion, can Dr. Zaldivar's model quantitatively predict the flow rate?

A. No, I don't think he can quantitatively predict the flow rate, mainly because of my first trial in trying to match experimental data was very poor.

Q. Did you prepare any demonstratives to explain your opinions on that?

A. Yes, I do.

MR. CERNICH: Could we go to D-21124.

BY MR. CERNICH:

Q. Does this help you explain your opinions, Dr. Dykhuizen?

A. Yes.

MR. REGAN: Your Honor, I would just object to this demonstrative. This is outside the scope of the two and a half pages of Dr. Dykhuizen's report that respond to Dr. Zaldivar. There were some specific statements made as to his complaints, but I don't believe this is within the scope of those two pages.

MR. CERNICH: Your Honor, Dr. Dykhuizen spends, as Mr. Regan points out, two and a half pages of his report explaining his criticisms of Dr. Zaldivar. We can show you the pages in the report, and I can have Dr. Dykhuizen explain how he responds to Dr. Zaldivar in his report. He's using a demonstrative to explain a concept that is addressed in his expert report.

THE COURT: All right. Overrule the objection.

THE WITNESS: Dr. Zaldivar, just like what I did,

4:06PM represented the riser by a number of short sections of pipe. This is a numerical model. So at every dot I would calculate things like pressure, temperature, how much gas is in that section, how much liquid is in that section, velocity of the gas, and the velocity of the liquid. This is a very -- simplification of a numerical method.

And so Dr. Zaldivar has to make some choices. Some of these choices are obvious: How many dots do I use? How many cells do I use?

He also does the same thing with time: How many time steps do I use to represent this oscillation?

So he has to pick sizes of the time steps. And when we go on in there, we determine type of time steps. There are different types of time steps that you can take. All of these will affect the accuracy of his computer model.

But what I would like to say, in my experience when I did this for my Ph.D. thesis, one thing that's very subtle, that is not clear, is, I need to find the density as a function all the way, not only at those points but in between those points.

And there are some simple ways of doing that. I could assign the density in this section of pipe equal to the density at the center of the pipe. That would be a logical choice. Or I could define the density between this dot and that dot to be equal to the average density of those -- each of

those two points.

Both of those sound like reasonable choices. But I found that my calculation of when the flow turns stable or unstable depended on simple choices like that, that the numerical method that you use, the way you average properties resulted in different ranges of when the flow would be unstable.

So Dr. Zaldivar did not have experimental data on at what flow rate does it turn unstable. I had in my calculations, I had some experiments. When did the flow rate turn unstable? I run my model and I say, does my model match the change from stable behavior to unstable behavior?

And the first time through it didn't, and it didn't match at all. So I changed some of my averaging, and I changed some of my numerical methods until it did match and this validates my code. He never validated his code, because he doesn't have any data to validate his code. He doesn't know at what flow rate it turns unstable. He just has his first prediction of when it turns unstable.

So that is one of my concerns is that Dr. Zaldivar hasn't validated his model.

BY MR. CERNICH:

Q. Did Dr. --

MR. REGAN: Your Honor, I move to strike. There's one sentence in the report that says Dr. Zaldivar did not

validate his model, then criticizes -- Dr. Dykhuizen criticizes oscillary [verbatim] motion, fluid temperatures, and sensitivity of certain parameters -- parameters on local changes. Running a different model, talking about densities is not in the report. It may be in his Ph.D., but it's not something that's been disclosed here as an opinion from Dr. Dykhuizen.

MR. CERNICH: Your Honor, as an expert, Dr. Dykhuizen is bringing his experience to this case. When we look at Dr. -- his experience includes his Ph.D. thesis.

When we look at his report, Dr. Dykhuizen writes: "BP retained expert Dr. Zaldivar offers a unique method to estimate flow. While it's impressive for Dr. Zaldivar to demonstrate chaotic behavior... I do not think that the model of this instability can quantitatively predict flow rates. The method has never been validated to show that it can be used to estimate flow. There are numerous approximations that have been made in this study."

This is what Dr. Dykhuizen is testifying --

THE COURT: All right. I'll overrule the objection. I think he's expounding or explaining what he said in his report. I think it's fair game. Okay.

MR. CERNICH: Thank you, Your Honor.

BY MR. CERNICH:

Q. Are there other problems -- well, before we move on,

Dr. Dykhuizen, Dr. Zaldivar, did he compare his work to the OLGA computer program?

A. Yes, he did, and he presented that as a validation of his computer code. But all that validates is that a steady state flow without a moving riser, because OLGA couldn't have a moving riser, gave results similar to his code.

MR. REGAN: Same objection, Your Honor. No discussion of OLGA in his report. This is not in the report.

MR. CERNICH: Your Honor, I'll go back to the section of the report.

Again, "There are numerous approximations...."

"(The sensitivity of the result to the details of the imposed motion is not investigated.) Dr. Zaldivar admits that there is not good data for the oscillatory motion of May 13th, so he uses the same functional form..."

The sensitivity of various parameters and models of the predicted -- "He tries to address the sensitivity of various parameters and models on the predicted flow rates. He shows" change -- "that the changes in many global parameters have little impact on the final results he obtains. Some sensitivity studies regarding heat transfer are presented...."

"It is most interesting to note that he claims that 'the effect of the riser imposition on the estimated flow rates is insignificant.'"

Dr. Dykhuizen goes on ad nauseam in his report with

his critiques of Dr. Zaldivar's works. The idea that he has to say "OLGA" in his report...

THE COURT: Well, your question to him here was, did he compare his work to the OLGA computer model.

MR. CERNICH: Oh, I'm sorry. I wasn't asking if Dr. Dykhuizen did; I was asking if Dr. Zaldivar did.

THE COURT: I understand. You said, did he, Dr. Zaldivar, compare his work to the OLGA computer model, and that was the question he was answering.

MR. CERNICH: Yes, Your Honor. And he said --

THE COURT: It sounds like he wasn't -- didn't talk about that in his report, did he?

MR. CERNICH: Well, Dr. Dykhuizen said Dr. Zaldivar has not validated his model, and I was asking whether Dr. Zaldivar's comparison to OLGA validated his model.

THE COURT: I'm not going to strike the answer, but let's move on. I think you beat that horse to death.

MR. CERNICH: Okay.

BY MR. CERNICH:

Q. So do you also have opinions about the oscillatory motion that Dr. Zaldivar uses for his model?

A. Yes. I prepared a demonstrative for that also.

MR. CERNICH: Can we go to D-21125, please.

BY MR. CERNICH:

Q. Are these images from Dr. Zaldivar's report?

A. Yes, they are.

Q. And is the image at the top there, did you reproduce that into your report, Dr. Dykhuizen?

A. Yes, I did.

Q. Can you explain to the Judge your opinions regarding Dr. Zaldivar's instability modes?

A. Okay. Dr. Zaldivar observed, as I said, the motion of the riser up and down. And that observation is presented as the blue line in the upper plot. He presents the orange line is labeled "predicted," which is not a proper label. This is his -- not -- his code does not predict this motion. He is imposing this motion on the code. This is what he inputs into the code. This is how the riser moves up and down.

If you will notice that there are small inconsistencies between what he imposes and what actually happened and nowhere in his report does he say, how was my result sensitive to this approximation? Maybe these differences change the boundaries of where it is.

We would like to have him predict -- have the code be able to calculate the motion of the riser, but that was not a capability of this code, so he couldn't do that. And so I understand why he imposed the motion, because his code did not have the capability of predicting the motion.

But he imposed a motion that's obviously inaccurate in places, and maybe this has an effect. But moreover, he --

these are -- the bottom are the plots of his code results. He shows he has two modes of oscillation. During one time period, he has a large bump of oil coming through, followed by a small bump of oil, then a large bump of oil, and followed by a small bump of oil.

And he tries to correlate this to how light or how dark and what frequencies he has in his video. He doesn't have data for how large the oil slugs are. So he just correlates it, says, This looks like a reasonable representation of my 2-peak time period.

He also has a 1-peak time period. At a different time period, the oil has a large slug, followed by another large slug, followed by another large slug.

Since the densities of these slugs are what's causing the riser to go up and down, we have a problem in accepting Dr. Zaldivar's analysis. Because Dr. Zaldivar only has data for one of these two time periods. And he shows he has an imperfect fit of that data. And then he uses that same imperfect fit for the other time period where we expect the oscillation to be different. And so he never addresses how this impacts the stability boundaries.

Q. Dr. Dykhuizen, so did Dr. Zaldivar calculate flow rates on two different dates?

A. Yes. He predicted flow rates on May 13th and 16th. One of the time periods had single peaks, which was May 16th. And

4:17PM then the other time had double peaks, where he saw a different mode of oscillation. So I would expect a different mode of riser motion, and yet he used the same riser motion for both days.

Q. And did he only have data for riser motion on one of those days?

A. He had data for both days, but he discounted his data for the other day because it was very noisy and he couldn't use it.

Q. Do Dr. Zaldivar's flow rate calculations conflict with your calculations for the period between May 13th and May 16th?

A. Yes, they do.

Q. Now, Dr. Zaldivar also performed some flow rate calculations from the kink leaks; is that right?

A. That is correct.

Q. What were wrong with -- what was wrong with Dr. Zaldivar's kink calculations?

A. That's a fairly simple calculation that I could reproduce without writing a computer code, and I got approximately a factor of 2 higher.

Q. And did BP perform any similar calculations during the response?

A. BP performed similar calculations, not exactly the same area and pressures, but they got numbers that were much closer to mine. As a matter of fact, higher than mine.

Q. And did you review kink leak calculations by Dr. Tim

Lockett?

A. Yes, I did.

MR. CERNICH: Can we go to 10650, TREX-10650, please.

BY MR. CERNICH:

Q. Are these Dr. Lockett's calculations?

A. Yes, they are.

MR. CERNICH: Can we go to TREX-10650.1.1.US.

BY MR. CERNICH:

Q. And are these flow -- are these flow rates from only the kink?

A. Yes. These are flow rates from only the kink. He gets the total flow rate of approximately 11,000 standard barrels a day. But what's most interesting is to look at his equation up here where he calculates the equivalent diameter. So he's representing this odd-shaped hole in the pipe by a round hole of an equivalent diameter, which is much different than Dr. Zaldivar did.

Q. And what Dr. Zaldivar do?

A. Dr. Zaldivar represented the hole with a hydraulic diameter, which is a different concept than what Dr. Lockett did. Dr. Lockett did it correctly. Dr. Lockett did it the way I did it; Dr. Zaldivar did it differently.

Q. And what did you calculate for the kink leaks?

A. I calculated for the kink leaks 82,000 -- excuse me, 8,200 barrels of oil per day.

4:20PM 1 **Q.** And approximately what did Dr. Zaldivar calculate?
4:20PM 2 **A.** 4,200 -- or 4,900, sorry, approximately half my value.
4:20PM 3 **Q.** Now, what did you mean by "hydraulic diameter"?
4:20PM 4 **A.** That's difficult to explain. If I may, I would like to
4:20PM 5 use the easel.
4:20PM 6 **MR. CERNICH:** Your Honor, may the witness use the
4:20PM 7 easel?
4:20PM 8 **THE COURT:** We'll have to give him a microphone so
4:20PM 9 you can hear him.
4:20PM 10 (Discussion off the record.)
4:21PM 11 **BY MR. CERNICH:**
4:21PM 12 **Q.** Dr. Dykhuizen, let's use the pad that's over there.
4:21PM 13 **A.** Okay. Should I move the pad, or is it fine where it is?
4:21PM 14 **THE COURT:** Why don't you help him move it wherever
4:21PM 15 it's --
4:21PM 16 **MR. CERNICH:** Certainly.
4:21PM 17 **THE WITNESS:** Okay. In the kink of the riser, there
4:21PM 18 were some irregular-shaped holes. And I will just represent
4:21PM 19 the hole as a rectangle. And we have high-pressure fluid
4:22PM 20 inside and it's pushing oil out the hole.
4:22PM 21 Dr. Zaldivar represented this as a hole with the
4:22PM 22 same hydraulic diameter as the actual hole. The hydraulic
4:22PM 23 diameter as a concept used in piping is 4 times the area of
4:22PM 24 this O divided by the perimeter of this hole. And the only
4:22PM 25 reason the 4 is in this equation is if we have a round hole to

start with, we'll back out the same diameter as the round hole.

But what's important to notice is this hydraulic diameter model has a different area than the original model. So Dr. Zaldivar correctly uses his equations to calculate the velocity coming through that hole. But he incorrectly applies the area of his model instead of the area of the actual hole, and he gets approximately a factor of 2 wrong in the flow coming out the kink leak.

And so I reproduced his calculations, getting the same number he did by simulating the error that he did it at. Now, I didn't get exactly the same number he did, because he probably converts the standard barrels differently than I did, but I was within 10 percent. I was off by a factor of 2, if I use the proper area.

So I suspected that he is using the hydraulic diameter concept. He represents his holes in his reports with a hydraulic diameter.

BY MR. CERNICH:

Q. Dr. Dykhuizen, do Dr. Zaldivar's riser flow calculations suffer from the same problem?

MR. REGAN: Your Honor, I'm going to object to this, too. "Hydraulic diameter" is not in the report. He talks about a K-factor issue. There's one paragraph on this topic. They did have an expert on this, and they're not calling him, Martinez, and I think what -- they're now using Dr. Dykhuizen

to try to bring that testimony in. And we have a report here that tells us what the witness is supposed to testify about, and "hydraulic diameter" is not set forth in this report.

BY MR. CERNICH:

Q. Dr. Dykhuizen, did you opine in your report that you believe Dr. Zaldivar's riser flow rates were also off by a factor of 2?

A. Yes, I did.

Q. Okay. And did you learn at some point why Dr. Zaldivar's riser flow rates were, in fact, off by a factor of 2?

A. Yes. I listened to Dr. Zaldivar's deposition, and he described -- in his calculations, he described it with an error in it.

MR. REGAN: Your Honor, that's after the report, after the rebuttal report. This is not a witness who was on this topic. I have no doubt of his capability to understand the topic, but an issue of disclosure here is one where now we're having Dr. Dykhuizen testify about something that one of the other United States experts, who they're not calling, was actually used to cover.

MR. CERNICH: Your Honor, the parties were limited in the number of experts that it could bring to trial. Dr. Dykhuizen included an opinion in his report that he thought Dr. Zaldivar's calculations were off by a factor of 2. In the normal course of discovery, Dr. Dykhuizen would have written a

report; Dr. Zaldivar would have rebutted -- and would have been deposed; Dr. Zaldivar would have written a report and been deposed. And before --

THE COURT: Is this talked about in his deposition? Was this witness deposed?

MR. REGAN: I deposed him, Your Honor. He references K-factors being too large. I think what they're doing is they're now trying to use one sentence in his report to bring in an expert that they're not calling to talk about a topic that is not set forth in his report.

MR. CERNICH: Dr. Zaldivar -- I'm sorry, Your Honor. BP had the opportunity to ask -- explore Dr. Dykhuizen's calculations or his criticisms of Dr. Zaldivar during his deposition. They asked no questions regarding his opinions on the -- on his kink leak estimates or Dr. Dykhuizen's opinions regarding the flow rates on the riser.

Dr. Dykhuizen, as he testified, listened to Dr. Zaldivar --

THE COURT: Was he asked what he based his opinion on that Dr. Zaldivar was off by a factor of 2?

MR. CERNICH: No, Your Honor.

MR. REGAN: He says it in his report, Your Honor. He says why. He says he uses a K value of 4. He's talking about K values, resistance factors. He doesn't talk about this topic of hydraulic diameter. There was a different witness who was

covering that issue --

THE COURT: Okay.

MR. REGAN: -- for the United States.

THE COURT: Okay. All right. It sounds like this is getting beyond his reports. I'll sustain the objection.

MR. CERNICH: Thank you, Dr. Dykhuizen.

BY MR. CERNICH:

Q. Now, just to -- just to wrap up here, you calculated flow rates for three time periods?

A. Yes, I did.

MR. CERNICH: Okay. Could we go to D-21122.

BY MR. CERNICH:

Q. And does this demonstrative show a timeline with your calculations?

A. Yes, it does.

Q. And so is this your Top Kill period flow rate calculation?

A. Yes, it is.

Q. And what is that?

A. Over 60,000 barrels a day.

Q. And is this your Top Hat 4 period estimate?

A. Yes, it is.

Q. And what is that estimate?

A. Approximately 60,000 barrels of oil per day.

Q. And what is this estimate here?

A. Oh, that is the capping stack estimate and that is

approximately 53,000 barrels of oil per day.

MR. CERNICH: Can we go to D-21143, please.

BY MR. CERNICH:

Q. And, Dr. Dykhuizen, does this demonstrative summarize your opinions in this case?

A. Yes, it does.

Q. And in your opinion, are these reliable best estimates?

A. Yes, they are.

MR. CERNICH: Thank you, Dr. Dykhuizen.

Your Honor, we're finished. We'll pass the witness.

THE COURT: Okay.

CROSS-EXAMINATION

MR. REGAN: May I proceed, Your Honor?

THE COURT: Yes.

BY MR. REGAN:

Q. Matt Regan on behalf of BP. And this is the cross-examination of Dr. Dykhuizen.

Hello, Dr. Dykhuizen. How are you?

A. I'm fine. Thank you.

Q. I'd like to start where you finished. Your July 15th estimate of 53,000 barrels per day is based on your capping stack work; correct?

A. That is correct.

Q. And you have a plus or minus 20 percent error bar on that

4:29PM 1 number; correct?
4:29PM 2 **A.** Yes, I do.
4:29PM 3 **Q.** So that would be a range from 42,400 to 63,600 for that
4:29PM 4 single day of flow; correct?
4:29PM 5 **A.** That sounds approximately correct, yes.
4:29PM 6 **Q.** Your 20 percent uncertainty on that number is based on
4:29PM 7 your personal experience in measuring and calculating
4:29PM 8 multiphase flow; correct?
4:29PM 9 **A.** That is correct.
4:29PM 10 **Q.** I think as you said on direct, even if you had a flow
4:29PM 11 meter, you wouldn't expect it to read better than plus or minus
4:30PM 12 20 percent?
4:30PM 13 **A.** That's not exactly what I said. I said if I had an
4:30PM 14 uncalibrated flow meter, which this is what this is, I wouldn't
4:30PM 15 expect it to read any better than that.
4:30PM 16 **Q.** It's your opinion that 5 million barrels of oil were
4:30PM 17 released from April 20th to July 15th; correct?
4:30PM 18 **A.** Yes.
4:30PM 19 **Q.** And you base this cumulative estimate by taking your
4:30PM 20 53,000 estimate of July 15th and then using a backwards
4:30PM 21 extrapolation in time to April 20th and then adding up the area
4:30PM 22 for the interval; correct?
4:30PM 23 **A.** That is correct.
4:30PM 24 **Q.** When that estimate was first released, that 5 million
4:30PM 25 estimate of 4.9 in August of 2010, you did not believe that any

4:30PM 1 error bar could be applied to that number; correct?
4:30PM 2 **A.** That is correct, that's what I stated. Obviously, the
4:30PM 3 error bar is not more than 100 percent.
4:30PM 4 **Q.** And when that number -- that 4.9 million cumulative number
4:30PM 5 was released in the DOE report, you weren't willing to stand
4:31PM 6 behind an error bar on that 4.9 million cumulative number then
4:31PM 7 either; correct?
4:31PM 8 **A.** That is correct.
4:31PM 9 **Q.** For your expert report in this case now three years later,
4:31PM 10 you have a plus or minus 30 percent error bar on your own
4:31PM 11 5 million cumulative flow estimate; correct?
4:31PM 12 **A.** That is correct.
4:31PM 13 **Q.** The primary reason for your large 30 percent error
4:31PM 14 compared to your 20 percent error on the one-day estimate is
4:31PM 15 the impact of erosional processes and knowing when erosion
4:31PM 16 stopped; correct?
4:31PM 17 **A.** That is correct.
4:31PM 18 **Q.** And as you said, erosion only happens in one direction;
4:31PM 19 correct?
4:31PM 20 **A.** That is correct.
4:31PM 21 **Q.** So not understanding when the erosional processes stopped,
4:31PM 22 the impact of that uncertainty is to bring your calculation
4:31PM 23 down; correct?
4:31PM 24 **A.** That is correct.
4:31PM 25 **Q.** Now, it depends on where you start, but if you start at

4:31PM 1 53,000 on the last day and you do the integration to get
4:32PM 2 5 million and there is erosional effects or erosional processes
4:32PM 3 not accounted for in your estimate, it's going to bring your
4:32PM 4 number, the 5 million number, down; correct?
4:32PM 5 **A.** That is correct.
4:32PM 6 **Q.** But looking solely at your own work, even today, looking
4:32PM 7 at your own work, your error on that 5 million would be
4:32PM 8 significantly larger than 30 percent; correct?
4:32PM 9 **A.** I don't understand your question, so I have a hard time
4:32PM 10 agreeing with it.
4:32PM 11 **Q.** If you look solely at your own work, Dr. Dykhuizen, the
4:32PM 12 error that you have for your 5 million cumulative estimate --
4:32PM 13 that is, if you don't look at Dr. Griffiths and you don't look
4:32PM 14 at Dr. Pooladi-Darvish, just look at your own work, your error
4:32PM 15 would be greater than 30 percent; correct?
4:32PM 16 **A.** I think that's a fair statement, yes.
4:32PM 17 **Q.** So it's after looking at Dr. Griffiths' work and after
4:32PM 18 looking at Dr. Pooladi-Darvish's work and after reviewing the
4:32PM 19 record and after testifying about the things you just testified
4:32PM 20 to on direct, it's at that point you then can arrive at a plus
4:33PM 21 or minus 30 percent error on your 5 million number; correct?
4:33PM 22 **A.** That is correct, although not exactly correct. I -- on
4:33PM 23 testimony here today, I put that at plus 20 and minus 30, so
4:33PM 24 I'll give you a little bit there.
4:33PM 25 **Q.** Okay. So at the time of your deposition, it was plus or

4:33PM 1 minus 30 percent on 5 million; correct?
4:33PM 2 **A.** I might have said that. I thought I said it was a
4:33PM 3 30 percent error, and if I did say plus or minus 30, I
4:33PM 4 apologize.
4:33PM 5 **Q.** No apology necessary. I just want clarity.
4:33PM 6 Today, what is your error estimate on your 5 million
4:33PM 7 cumulative estimate?
4:33PM 8 **A.** Plus 20 and minus 30.
4:33PM 9 **Q.** So that would be 6 million barrels on the high side and
4:33PM 10 3.5 million barrels on the low side?
4:33PM 11 **A.** That is correct.
4:33PM 12 **Q.** And you agree that it is much more likely to be a lower
4:33PM 13 value than a higher value between that range?
4:34PM 14 **A.** No, that's not true.
4:34PM 15 **Q.** With respect to your 3.5 to 6.5 range that you testified
4:34PM 16 about in your deposition, you agreed it was much more likely to
4:34PM 17 be a lower value than a higher value; correct?
4:34PM 18 **A.** That is correct, and that's why my opinion is plus 20 and
4:34PM 19 minus 30. It is much more likely to be a lower value than a
4:34PM 20 higher value. If you take an integral average underneath the
4:34PM 21 bell curve, you're going to come up with more probabilities of
4:34PM 22 a lower value.
4:34PM 23 **Q.** I'm going to stay with uncertainties, although we could
4:34PM 24 get into probabilities.
4:34PM 25 **A.** Sure.

4:34PM **Q.** But with respect to uncertainty, when we hear your 5 million number, we should think that Dykhuizen's range is 3.5 to 6.0; correct?

A. Yes, I think that's fair.

Q. The range -- the greatest uncertainty for you is erosional processes; correct?

A. That is correct.

Q. And erosional processes work in one direction; correct?

A. That is correct.

Q. And that direction is to pull that number down, not move it up; correct?

A. That one effect will pull it down. There are other effects that will pull it up. That's why we go up to 6.

MR. REGAN: If we can put up D-23996-A, Demonstrative 23996-A.

BY MR. REGAN:

Q. Dr. Dykhuizen, I have on the screen a chart that has first a blue line. Does that appear to be the 53,000 final day rate that you testified to as your July 15th capping stack flow estimate?

A. Yes.

Q. And does this line that's then drawn back to Day 3, April 22nd through 23rd, is that how you calculated your 5-million-barrel estimate?

A. Yes, it is. That's approximately the integral. I don't

4:36PM know if it's 040 or whatever, but it's somewhere between 4.9 and 5.

Q. And again, it's the area under the curve, everything underneath the blue line, that adds up, day by day, to approximately 5 million?

A. That is correct.

Q. To reach 3.5 million, if you're -- to get to a cumulative estimate of 3.5 million, your 30 percent low, do you agree that you cannot have a flow rate that starts high and ends low?

A. No, I don't agree with that. I have point estimates at the time of Top Hat that's about 60,000, which is above 53,000. I also have a Point X estimate at the time of the Top Kill which is approximately 60,000. So I would expect, at least in that time period, it to be decreasing.

But once we get farther to the left and where it's starting running out of PT-B pressure gauge data to support Dr. Griffiths' solution, then the flow has to turn around. So I think that it is decreasing at the end period, but it's possible that it's increasing at the beginning. And I have it increasing at the beginning; I have it going from zero to 63,000.

Now, this is just a proxy for erosion. This is not my calculation of erosion. I'm saying that for the first few days, we will assign zero. I could assign for the first four days half flow. And so I go from half flow to full flow after

Day 4. Yes, we have a period of increasing flow due to erosion, but that does not have to increase over the entire time period of the accident.

Q. If you use 53,000 as your July 15th number and you use the same linear approach that you did for your 5 million number, you agree you must start with a lower number as of Day 3 to get 3.5 million barrels?

A. I don't think there's anything wrong with that statement. That is a true statement.

Q. That is a true statement.

If this number is 53,000 as of July 15th and we accept your 30 percent error bar, take it to 3.5 million, flow would start low and end high, using the linear approach that you used for your 5 million estimate; correct?

A. No. It could start low, it could have a peak in the middle, and then end higher. I don't expect that this solution makes a lot of physical sense.

It comes up with an integral that isn't out of my bounds, but I don't think the graph that you give seems defendable.

Q. You could have a line that starts low, peaks in the middle, and comes back down to 53,000 and still reach 35 million -- or 3.5 million?

A. Would you mind if I used my own pointer?

Q. Sure.

4:39PM **A.** I think the flow could start low and then go up and then follow along the line, and you could come up with an integral that is approximately 30 -- 3.5 million barrels a day. I do not think that this is a plausible solution that you have. So I can come up with a solution that starts low, maybe goes for 13 days -- starts at 10,000, goes for 13 days, then somewhere up here, attaches to my line and then continues down.

Now, these numbers, I'm making up out of my head. I'm just trying to give you an example. This sort of line does not seem reasonable to me.

4:40PM **Q.** Okay. So you could have a line that starts low and goes up faster, subject to the math actually working, about how high you could get, given that you end at 53,000; correct?

A. That is correct. I think it's pretty clear: At the end, we have flow decreasing with time.

At the beginning, I have a lack of data, and so I could start at 10,000 or 20,000, work my way up. And then I could work up higher than this because 53,000 could be enough of an estimate, and I could end up lower than this because 53,000 is just an estimate.

I don't expect 43,000 to be very probable or 63,000 to be very probable. I expect to end up near 53,000.

Q. This line that we have here and the one you just testified to, both of those flow rate paths or trends are consistent with your expert opinion about what the cumulative flow could be?

4:41PM **A.** It's consistent with the cumulative flow, yes. It is not consistent of what I think a believable flow versus time is.
4:41PM **Q.** But it's consistent with the error bar that you attached to your opinion; correct?
4:41PM **A.** Yes.
4:41PM **Q.** When you arrived at the Macondo, you testified that there was a variety of things that you worked on. I'd like you to just pull up a document that you drafted in late June of 2010, TREX-9388.1.1.
4:41PM So by June 29th, 2010, you had been at Macondo for -- at Houston or working on the problem, either in Houston or Albuquerque, for about a month and a half?
4:41PM **A.** That is correct.
4:41PM **Q.** And on June 29th, you drafted this document you call a "Flow Uncertainty Position," we've marked as TREX-9388; correct?
4:42PM **A.** That is correct.
4:42PM **Q.** And you drafted this for Tom Hunter; correct?
4:42PM **A.** That is -- I drafted that and sent it to a number of people for review, and it's indicated here that it's going to eventually go to Tom Hunter, yes.
4:42PM **Q.** So if we could turn to the first page of your "Flow Uncertainty Position," TREX-9389.2.1.
4:42PM What you were drafting in this document was all of the challenges that you had -- and your team had -- in terms of

trying to determine a flow rate, given the circumstances at Macondo; correct?

A. That is correct.

Q. So the first thing you talk about, I think -- actually, I'd call it the second page, 9389.1.1, there's two pages.

The first thing you say: "There are many parameters that determine the pressure and temperature distribution within the well."

Correct?

A. That's correct.

Q. And doing hydraulic analysis, you need to take into account pressure and temperature because it can affect density, which can then affect -- as we walk through the formulas -- the way you ultimately can calculate flow using pressure differences; correct?

A. That is correct.

Q. You also point out in the second paragraph: "We have a single pressure measurement, so a variety of resistance pairs can yield the correct BOP pressure."

Did I read that correctly?

A. That is correct.

Q. What you're referring to there is the PT-B gauge; correct?

A. Yes. That is your single pressure measurement at that one.

Q. Right.

4:43PM And by a variety of resistance pairs, you're saying that: Depending on what you assume about resistance below -- that is upstream of the PT-B -- and resistance above -- that is below the PT-B -- you could have a variety of pairs that patch the PT-B pressure?

A. That is correct.

Q. And you say in the fourth paragraph: "The geometry of flow is also unknown."

Correct?

A. That is correct. We didn't know the path and we didn't know what obstructions might be there.

Q. You mention in the fifth paragraph that: "Current observations have revealed that the drill pipe that was known to exist in the well has slipped from its last known position."

Correct?

A. Yes, that is what I wrote.

Q. If you're doing a hydraulic analysis, the location of the drill pipe can impact the nature of your calculation; correct?

A. That is correct, especially if you're including the drill pipe and the flow is going through the center of the pipe.

Q. It was another unknown?

A. That is correct.

Q. And the sixth paragraph, you said: "The current observations of the plume out of the cut-off riser reveal two distinct colors. This is consistent with the distinct colors

4:44PM out of the kink holes previously. This implies that there are two distinct flow paths through the BOP."

Correct?

A. That was a hypothesis I was putting in there, and that was exactly what I wrote.

Q. The question of what the flow path, even in the BOP, was uncertain even as of June 29th, 2010; correct?

A. That is correct.

Q. And you say in the last paragraph: "A split in flow requires a model."

You're again referring to two paths in the BOP; right?

A. Yes. We think we had two paths in the BOP, and how much goes through each path is of interest.

Q. If we turn the page then to 9389.2.1. The next uncertainty you raise is: "Reservoir depletion is another important factor."

Correct?

A. That is correct.

Q. So to do a hydraulics analysis, you need to come to an assumption about depletion of the reservoir; correct?

A. That is correct.

Q. There was only one measured reservoir pressure, 11,850 psi, that was measured before the accident; correct?

A. That is correct.

4:45PM 1 **Q.** You say in the second paragraph here: "Any model has to
4:45PM 2 not only assume various flow paths and resistances; it has to
4:45PM 3 account for potential erosion during the long flowing time. It
4:45PM 4 is assumed that the kill operation where mud was forced through
4:45PM 5 the various paths could have eroded the BOP."
4:46PM 6 This, again, is a reference to the impact of erosion,
4:46PM 7 if you're trying to do a hydraulics calculation; correct?
4:46PM 8 **A.** That's correct.
4:46PM 9 **Q.** So it's not only that you have to understand the
4:46PM 10 resistances, but you need to understand how they might change
4:46PM 11 over time; correct?
4:46PM 12 **A.** That is correct.
4:46PM 13 **Q.** And if you are going to do a flow rate that you're adding
4:46PM 14 successive days, you need it make sure that whatever the
4:46PM 15 resistances were on one day, have they changed or are they the
4:46PM 16 same on the next?
4:46PM 17 **A.** That is correct.
4:46PM 18 **Q.** "The model of the system," you write, "will have a lot of
4:46PM 19 parameters."
4:46PM 20 Correct?
4:46PM 21 **A.** Yes.
4:46PM 22 **Q.** And parameters, we're going to hear a lot about -- at
4:46PM 23 least this week -- that's talking about the way you're
4:46PM 24 designing the parameter. How would you describe "parameters"
4:46PM 25 in your own words?

4:46PM **A.** We have a number of parameters. We obviously have effective resistances of a parameter that we always use. Discharge coefficients and leaks, heat transfer coefficients, friction factors, there are many factors that go into a calculation.

4:47PM **Q.** And broadly speaking, these are the types of parameters that people that do what you do, multiphase flow analyses, have to take into account to calculate flow?

4:47PM **A.** Depending on your model, you need to take into account more or less of those, but, yes, we have to take into account parameters.

4:47PM **Q.** And you say at the bottom -- I'll skip here -- you describe an analogy here, what you say: "This is why one cannot use an inaccurate model to determine if the well is sound. It is not that the sensitivity is low; it is that our uncertainties are high."

Correct?

4:47PM **A.** I think that's correct.

4:47PM **Q.** The number of parameters or the number of things that you would have to either know or then assume was a very large number; correct?

4:47PM **A.** Depending on your models. Some models have more parameters than others. My capping stack model did not have a large number of parameters, but the integrated flow, if you wanted to do that from first principles, would have lots of

parameters.
Q. So the challenges to developing a hydraulic estimate of flow, as we've seen here in your flow uncertainty document, include understanding the fluid properties; correct?
A. Yes.
Q. Understanding the equation of state, which is, in essence, also included on these; correct?
A. Yes.
Q. That includes issues of density, viscosity, impact of crude oil; correct?
A. That's correct.
Q. You have to understand the temperature distribution; correct?
A. Yes.
Q. You have to understand the pressure distribution; correct?
A. Yes.
Q. You have to understand the geometry, including any changes in that geometry; correct?
A. Yes.
Q. You have to come to an assessment of flow path; correct?
A. In some cases, you do not; but in some cases, you do, yes.
Q. You're dealing, in Macondo, in a multiphase fluid environment; correct?
A. Yes.
Q. So then you have to determine what's the effect of

multiphase flow in this geometry, in this pressure distribution, in this temperature distribution; correct?

A. That is correct.

Q. You have to make an assumption about reservoir depletion; correct?

A. Yes.

Q. You have to make an assumption about erosion; correct?

A. Yes.

Q. And given the number of assumptions, you then -- as to the inputs, you then also have to say, Does my model have potential model error; correct?

A. Yes.

Q. And the more parameters you put into the model, the higher your potential model error; correct?

A. As long as you use "potential" in that sentence, I think we can agree with it, yes.

Q. So you would agree that, as of -- leading up to the capping stack, your team and your personal efforts to try and arrive at a definitive flow rate had been stymied, given the number of uncertainties that existed?

A. I think that's correct. The Top Hat was a very -- was a calculation, was -- in the sand that we stuck a stick in the stand and said, Gee, this looks significant compared to 5,000 barrels of oil per day that was reported in the press.

So we had some calculations before capping stack that

were very informative of the flow.

MR. REGAN: If we could pull TREX-9361.49.1.

BY MR. REGAN:

Q. This is out of the DOE-NNSA report.

Before I read the quote there, Dr. Dykhuizen, you were involved in the first drafting of this report; correct?

A. I wrote the first draft and I reviewed all the drafts afterwards.

Q. The purpose of this was to summarize the arrival -- summarize the activities that resulted in the flow rate estimate that was issued on August 23rd, 2010, at least in terms of DOE-NNSA team; correct?

A. That is correct.

Q. And here on page 49, it says in the "Summary Conclusions": "While there had been attempts throughout post-accident times to quantify the instantaneous flow rate, the DOE-NNSA flow team and other researchers directed by the DOI were generally stymied in these attempts prior to well shut-in, largely because of uncertainties in the well geometry, the BOP, and reservoir depletion."

Correct?

A. That's a correct reading of that statement.

Q. And that was your experience as a member of that team at Macondo; correct?

A. Yes.

4:51PM **Q.** And now the capping stack was installed on July 12th; it started to be activated July 14th; the well was shut in July 15th; correct?

4:51PM **A.** That is correct.

4:51PM **Q.** I'm going to turn to some of the calculations that you did with respect to the capping stack.

Before we get there, on July 26th, you had a meeting with Tom Hunter where you reviewed the efforts that had been made to calculate flow prior to the capping stack; do you recall that?

4:51PM **A.** Yes, I do.

4:51PM **Q.** Now, if we turn to TREX-9706, this is a copy of that PowerPoint. And if we go to 9706.4, this is a summary of those efforts; do you see that?

4:52PM **A.** Yes, it is.

4:52PM **Q.** And it includes a number of things including a Top Hat calculation; correct?

4:52PM **A.** Yes, it is.

4:52PM **Q.** On June 15th, 2010; is that right?

4:52PM **A.** That is correct.

4:52PM **Q.** And the range of estimates there from the DOE team was 72,700 to 83,000 with a 51,900 to 104,900 max range; correct?

4:52PM **A.** That's what it states. That's not my memory of this. I thought we had 45 to 80. I think I've reviewed documents that has that. Obviously, Dr. Ratzell, when writing this report,

has a slightly different range.

Q. You don't recall that, in fact, the three labs' estimates of Top Hat on July 15th, the lowest one was 72,700? You don't recall that? And the high range was 83,000?

A. Those numbers don't ring clear in my mind. It might be that they stated that. He's labeling these "Baseline." I think what he means by "baseline," since he coordinated these calculations, was we were told how much area to assume in the skirt and we were told how to proceed with the skirt calculation. None of the team really supported those values, but we went ahead and did those calculations for him, and that's probably what this top number is.

He gave very small ranges for what to assume in the skirt and, therefore, we get a very small range, 73,000 to 83,000. That was not supported. People redid their calculations based on what we felt were accurate at the time. I seem to recall 45 to 80. This reports here 52 to 104 -- or 105. I would have discounted 105 because the well cannot flow 105,000 barrels a day. But possibly the mathematics of the Top Hat did yield 105,000 barrels per day.

Q. Okay. TREX-11534.1, this is a presentation that was made on June 15th with the Top Hat estimates. Do you recognize this document?

A. Yes, I do.

Q. I think you attached it to your expert report?

4:54PM 1 **A.** Yes, I did.
4:54PM 2 **MR. REGAN:** Go to TREX-11534.16.
4:54PM 3 **BY MR. REGAN:**
4:54PM 4 **Q.** Do you see on there, Dr. Dykhuizen, the total oil flow
4:55PM 5 estimates of the three national labs ranging from 72,700 to
4:55PM 6 83,000?
4:55PM 7 **A.** Yes, that's, again, labeled the baseline case.
4:55PM 8 **Q.** And the largest component of that flow is out of the
4:55PM 9 skirt; correct?
4:55PM 10 **A.** That is correct.
4:55PM 11 **Q.** About 50 percent of those numbers; right?
4:55PM 12 **A.** That is correct.
4:55PM 13 **MR. REGAN:** Go back to TREX-9706.5.
4:55PM 14 **BY MR. REGAN:**
4:55PM 15 **Q.** So on July 26th, in reviewing these issues with
4:55PM 16 Dr. Hunter, it was the Tri-Lab assessment, of which you were a
4:55PM 17 member, that none of the methods listed above provided
4:55PM 18 believable max flow results, including the Top Hat estimates;
4:55PM 19 correct?
4:55PM 20 **A.** "Believable" is a relative term. If the Top Hat
4:55PM 21 calculates 100,000 barrels of oil per day, that is not
4:55PM 22 believable because the well geometry can't support that.
4:55PM 23 **Q.** The word "believable" was used by one of the members of
4:55PM 24 the team that did the calculations; correct?
4:55PM 25 **A.** Used -- it was written by Dr. Ratzell and he led the

4:56PM 1 calculations; correct.
4:56PM 2 **Q.** And he found there were too many model uncertainties
4:56PM 3 and/or data for quantitative analysis included in the Top Hat
4:56PM 4 calculations; correct?
4:56PM 5 **A.** That is correct.
4:56PM 6 **Q.** There's no -- I'm sorry?
4:56PM 7 **A.** That is the reason I tried to put in a lower bound than
4:56PM 8 the Top Hat calculation, because the estimates from the Top Hat
4:56PM 9 calculation had quite a large error bar to it.
4:56PM 10 **Q.** Later that same week, Dr. Dykhuizen, the week of
4:56PM 11 July 26th, you were then told that you needed to have a meeting
4:56PM 12 on July 30th to provide a new flow rate for the government to
4:56PM 13 announce; correct?
4:56PM 14 **A.** Yes, I think that's true.
4:56PM 15 **Q.** And that deadline, Friday, forced your team to rush to
4:56PM 16 complete its calculations; correct?
4:56PM 17 **A.** I'm not going to agree with the word "rushed." I'm also
4:56PM 18 not going to agree with the fact that we started those
4:56PM 19 calculations those days. We started the calculations the first
4:56PM 20 day the capping stack was installed, as I testified.
4:56PM 21 **Q.** There was a spreadsheet model that was used that week to
4:57PM 22 calculate the flow rate that was then discussed on Friday;
4:57PM 23 correct?
4:57PM 24 **A.** That is correct.
4:57PM 25 **MR. REGAN:** TREX 11456.1.1.

4:57PM **BY MR. REGAN:**

Q. The name of the spreadsheet was "Wednesdaynightrush.XLS"; right?

A. That is correct. Charlie named this, I think, in an attempt at humor.

Q. Now, Charlie Morrow, he was a person that you worked very closely with?

A. Yes.

Q. And he had oil and gas experience; is that right?

A. Yes.

Q. You found him to be a very reliable and credible asset to you as you looked at these problems in 2010?

A. Yes, he was.

Q. Is he still at Sandia?

A. Yes.

Q. If we can then talk a little bit about the capping stack calculations.

MR. REGAN: Can you put up D-21100.1, which I believe we saw on your direct.

BY MR. REGAN:

Q. While that's coming up, with the capping stack, you now had a well-defined geometry; correct?

A. Yes, I think that's a quote out of the report.

Q. You had calibrated pressure gauge information that you trusted; correct?

4:58PM 1 **A.** Yes.
4:58PM 2 **Q.** And this is where you described the capping stack being
4:58PM 3 equivalent to an uncalibrated flow meter?
4:58PM 4 **A.** That is correct.
4:58PM 5 **Q.** You said the calculations that are set forth on
4:58PM 6 D-21101.1 -- we'll come to it later.
4:58PM 7 "The calculations are standard, first-year
4:58PM 8 undergraduate course-type calculations"; is that right?
4:58PM 9 **A.** That's correct.
4:58PM 10 **Q.** But you had three national labs doing the calculations;
4:58PM 11 correct?
4:58PM 12 **A.** That is correct?
4:58PM 13 **Q.** Ph.D.'s all around.
4:58PM 14 **A.** I'm not sure if that's correct, but most of them had
4:58PM 15 Ph.D.'s. Charlie Morrow did not have a Ph.D.
4:58PM 16 **Q.** Smart guys?
4:58PM 17 **A.** Yes.
4:58PM 18 **Q.** All three labs were looking at the same known geometry;
4:59PM 19 correct?
4:59PM 20 **A.** That is correct.
4:59PM 21 **Q.** But the three labs used different K-factors or different
4:59PM 22 resistance factors for the same known geometry; right?
4:59PM 23 **A.** That is correct.
4:59PM 24 **MR. REGAN:** TREX-9361.24.1.
25

4:59PM 1 **BY MR. REGAN:**
4:59PM 2 **Q.** As summarized in the Ratzell report -- again, for a common
4:59PM 3 geometry -- the three national labs used different resistance
4:59PM 4 factors for the exact same pipes; right?
4:59PM 5 **A.** That is correct. Your laser pointer tends to highlight
4:59PM 6 one in particular, which is mine up here. The reason this one
4:59PM 7 seems to be different is it's based on a different diameter.
4:59PM 8 It is actually very close to, I think, one of the other two. I
4:59PM 9 can't do it off the top of my head, but I think it's very close
5:00PM 10 to .5.
5:00PM 11 **Q.** The national labs -- the three national labs looking at
5:00PM 12 the same geometry had different values for the resistances of
5:00PM 13 the flow inside those pipes; correct?
5:00PM 14 **A.** That is correct.
5:00PM 15 **Q.** And that's an uncertainty that is part of the capping
5:00PM 16 stack calculations; correct?
5:00PM 17 **A.** You could say that, but we also had the alternate method
5:00PM 18 where we didn't use any of these and we let the data determine
5:00PM 19 what the resistances were. And the data showed that the
5:00PM 20 resistances were approximately the same and we got
5:00PM 21 approximately the same flow rate. So we performed the flow
5:00PM 22 calculations without using these tables.
5:00PM 23 I also only support the column that says "Sandia
5:00PM 24 National Laboratory." That's my work. And the other two, I'm
5:00PM 25 not supporting in my expert report.

5:00PM 1 **Q.** Have I read correctly that the three national labs,
5:00PM 2 looking at the exact same geometry to do hydraulics
5:01PM 3 calculations, came up with different K-factors for that
5:01PM 4 geometry. Did I read that chart correctly?
5:01PM 5 **A.** That is correct.
5:01PM 6 **Q.** Those three labs were also looking at the same flowing
5:01PM 7 fluid through the wellbore; correct?
5:01PM 8 **A.** That is correct.
5:01PM 9 **Q.** But each of the three national labs treated it
5:01PM 10 differently; correct?
5:01PM 11 **A.** Treated the fluid differently is what I mean by it?
5:01PM 12 **Q.** Yes.
5:01PM 13 **A.** Yes.
5:01PM 14 **Q.** They had different equations of state; right?
5:01PM 15 **A.** That is correct.
5:01PM 16 **Q.** So all three labs were attempting to model multiphase flow
5:01PM 17 out of the capping stack, but they all handled it a little
5:01PM 18 differently; correct?
5:01PM 19 **A.** That is correct.
5:01PM 20 **Q.** In your calculations, you did not model or try to
5:01PM 21 determine the type of flow regime or the way the multiphase
5:01PM 22 flow would actually progress through the capping stack;
5:01PM 23 correct?
5:01PM 24 **A.** That is correct. I did not determine a flow regime. I
5:01PM 25 used K-factors, which implicitly assume that you have

5:02PM homogenous flow, that the liquid and the gas are flowing at the same velocities through the capping stack.

Q. So homogenous flow is an assumption about how the multiphase fluid is going to behave in this geometry?

A. That is correct, but the alternate method supports that assumption.

Q. Method 3 that you talked about on direct, that one flows when the choke line was closed; correct?

A. I think we got Method 2 but, yes, I did one with the choke line closing.

Q. The choke line geometry was much more complex than the kill line geometry in the capping stack?

A. Yes, it was.

Q. And all three national labs predicted that the flow would increase when the valve was closed rather than decrease with the choke valve; correct?

A. Not only did three national labs predict that, but a number of other people had similar predictions, given the data, yes.

Q. That was a non-physical result?

A. That is correct.

Q. And that outcome led you to have further uncertainty about the capping stack flow rate calculation; correct?

A. That is correct. I think that is a very good representation of my position.

5:03PM **Q.** At the meeting on July 30th, 2010, with Dr. Hunter and Secretary Chu -- you attended that meeting by phone; correct?
5:03PM **A.** That is correct.
5:03PM **Q.** And your team represented through Dr. Ratzell that there was insufficient information to perform an uncertainty analysis on flow rate and total flow at the time of that meeting; correct?
5:03PM **A.** I don't recall that statement at the time of the meeting, but that represents probably Dr. Ratzell's position, yes.
5:03PM **MR. REGAN:** TREX-8635.96.3.
5:04PM **BY MR. REGAN:**
5:04PM **Q.** Do you recognize this as one of the slides that was shown at the July 30th meeting, Dr. Dykhuizen?
5:04PM **A.** My memory isn't that good, but I will take your word for it that it's one of the slides, yes.
5:04PM **Q.** It's consistent with your memory that your team told the assembled group that, as of July 30th, 2010, you had insufficient information to perform an uncertainty analysis on flow rate and total flow at the time of meeting?
5:04PM **A.** Yes. I did not disagree with your concept of the statement; I just don't recall that statement being made. It probably was since you present this viewgraph to me.
5:04PM **Q.** And it lists some of the uncertainty sources there on the tenth line, including model form, boundary and initial conditions, and other model parameters; correct?

5:04PM **A.** Yes.
5:04PM **Q.** During that meeting, you voiced your permanent view of what the appropriate uncertainty was for the capping stack calculation; correct?
5:04PM **A.** Which meeting are we at, please? I forgot.
5:05PM **Q.** July 30th, 2010.
5:05PM **A.** And the next meeting was the 31st?
5:05PM **Q.** Yes, sir. One was a Friday and one was a Saturday.
5:05PM **A.** I'm not on certain which one of those two meetings I expressed my concern. But, yes, at one of those two meetings, I expressed a concern about uncertainty values.
5:05PM **Q.** At that meeting, you expressed that you believed that the minimum uncertainty on the capping stack number should be plus or minus 20 percent; correct?
5:05PM **A.** Yes. At one of those two meetings. I can't recall right now which one it was, but I recall we had a discussion. There were some values presented for uncertainty and my vote was for 20 percent.
5:05PM **Q.** At some point after you articulated your uncertainty, you heard Secretary Chu say that he believed the uncertainty should be 10 percent; correct?
5:05PM **A.** That is correct. I think the first voice I heard said it was plus or minus 5 percent. I said that it was plus or minus 20 percent, because I thought 5 percent was ridiculous. And it seemed that Dr. Chu, attending by phone, but he has a unique

5:06PM 1 voice, I think that he said plus or minus 10 percent as a
5:06PM 2 compromise.
5:06PM 3 **Q.** Now, your coworker we spoke of a minute ago, Charlie
5:06PM 4 Morrow, he also disagreed with 10 percent uncertainty on that
5:06PM 5 53,000 estimate; correct?
5:06PM 6 **A.** That is correct. He voiced an opinion of 30 percent.
5:06PM 7 **Q.** So Charlie Morrow, the Sandia employee who had oil and gas
5:06PM 8 experience, believed that the appropriate uncertainty for the
5:06PM 9 July 15th estimate of 53,000 was plus or minus 30 percent;
5:06PM 10 correct?
5:06PM 11 **A.** That is correct.
5:06PM 12 **Q.** And that was based on his oil and gas experience; correct?
5:06PM 13 **A.** I would assume so, yes, that he based it on his
5:06PM 14 experience. I don't recall that he did any formal analysis.
5:06PM 15 **Q.** And just as you have a higher uncertainty for your
5:06PM 16 cumulative, as opposed to your July 15th number, Charlie Morrow
5:07PM 17 also had a higher uncertainty on the cumulative number than
5:07PM 18 30 percent for July 15th; correct?
5:07PM 19 **A.** I have no idea what his uncertainty was, but if he's a
5:07PM 20 bright guy and he has 30 percent uncertainty on the final day,
5:07PM 21 he should have higher than 30 percent uncertainty for the
5:07PM 22 integral.
5:07PM 23 **Q.** That's what make sense; correct?
5:07PM 24 **A.** That's the only thing that makes sense, correct.
5:07PM 25 **MR. REGAN:** TREX-8809.

5:07PM **BY MR. REGAN:**
5:07PM **Q.** This is the August 2nd press release that was issued with
5:07PM the 4.9 million cumulative flow estimate. In the first
5:07PM paragraph with the highlight that starts with "Washington."
5:07PM Do you see in the last sentence there, Dr. Dykhuizen,
5:07PM that the official estimate said that the uncertainty would be
5:07PM plus or minus approximately 10 percent?
5:07PM **A.** I see that statement. I haven't read the whole paragraph
5:07PM because I'm trying to listen to you and read at the same time
5:08PM and I'm not that quick. I assume this means for the -- let me
5:08PM read the paragraph, please.
5:08PM **Q.** If we need to highlight a portion of it for you, just let
5:08PM us know.
5:08PM **A.** This says the uncertainty is plus or minus 10 percent.
5:08PM I'm not sure that it applies to the total or to the flow on the
5:08PM final day or for all of it. If it applies for all it or if it
5:08PM just applies to either one, I disagree with that statement
5:08PM either way.
5:08PM **MR. REGAN:** TREX-8809.1.1.
5:09PM **BY MR. REGAN:**
5:09PM **Q.** You know that the Ratzel report that was issued, that we
5:09PM looked at a minute ago, also had a 10 percent uncertainty on
5:09PM the final flow rate date -- flow rate and a 10 percent
5:09PM uncertainty on the cumulative flow rate; correct?
5:09PM **A.** That is correct. I disagreed with it then; I disagree

5:09PM with it now. I was not the author of that report. I voiced my disagreement at the time.

Q. And if the estimate released on August 2nd, 2010, which the Ratzel report or the DOE report was supposed to be documenting -- if it also had 10 percent for the final flow rate and 10 percent for the cumulative, you disagree with that?

A. Yes, I would disagree with that. But the excerpt you showed me just said a 10 percent error, and I'm not certain what it applied to because the quote you showed me was vague.

Q. Fair enough.

If we go back, then, to the DOE report, 9361.1. This, again, is the report that documents the activities that happened on July 30th and 31st to arrive at that August 2nd flow rate estimate; correct?

A. That is correct.

Q. Now, amongst the three national labs, there were a number of different flow rate predictions for just the capping stack; correct?

A. That is correct.

MR. REGAN: If we could go to Demonstrative 24406.

BY MR. REGAN:

Q. This is a demonstrative, Dr. Dykhuizen, that pulls the 14 flow rate estimates that are found in Exhibit 9361 from the three national labs from the four different ways that capping stack flows were estimated.

Are you with me?

A. That is correct.

Q. Okay. The number that you are testifying to is 53,000; correct?

A. Which is the average of the bottom six numbers. Those are the numbers that I calculated, yes.

Q. It's not the average of the combined three national labs' calculations of capping stack flows; correct?

A. I'm here to represent my opinions, not the opinions of the combined three national labs, yes.

Q. But the other national labs had qualified engineers doing those calculations; correct?

A. Yes, they had qualified engineers. I'm not sure that their teams were as good as mine. I had Charlie Morrow and they did not have Charles Morrow.

Q. But you would agree with me that the number 53,000 is the second-highest estimate of the 14 that were made from the capping stack; correct?

A. I demonstrated in my testimony today that 53,000 is the average of the bottom six numbers on your chart.

MR. REGAN: D-24407.

BY MR. REGAN:

Q. If I take those 14 numbers and I just put them highest to lowest, you would agree with me that the 53,000 estimate, which is one of your Sandia estimates, is the second-highest estimate

5:12PM 1 that was made for capping stack; correct?
5:12PM 2 **A.** That is correct. And also, the 55,300 is also a Sandia
5:12PM 3 estimate.
5:12PM 4 **Q.** The 55,300, the highest number on the chart that we have
5:12PM 5 on the board, 24407, that was made on the choke line closure;
5:12PM 6 correct?
5:12PM 7 **A.** That is correct.
5:12PM 8 **Q.** That was the one where you had the anomaly of predicting
5:12PM 9 flow increasing when the valve was closing; correct?
5:12PM 10 **A.** We didn't have the anomaly on the other ones because we
5:12PM 11 didn't have the opportunity to take any data on the other ones.
5:12PM 12 55,300 may be the most accurate. As a matter of
5:12PM 13 fact, increasing the flow as the valve was changing, was
5:12PM 14 closing, maybe should indicate to us that there was more flow
5:12PM 15 coming out than we thought.
5:12PM 16 I only weighted that number by one-sixth, and I come
5:12PM 17 up with my average of 53,000.
5:12PM 18 **Q.** The fact is, Dr. Dykhuizen, that 53,000 number that we see
5:12PM 19 in the report and that we heard you testify to today is an
5:12PM 20 upper bound estimate on the flow out of the capping stack;
5:12PM 21 correct?
5:13PM 22 **A.** No, it's not, because there are many variables that go
5:13PM 23 into that calculation. We have temperature uncertainty. We
5:13PM 24 have a model uncertainty. We have a number of uncertainties.
5:13PM 25 We have an uncalibrated flow meter. It could be 20 percent

5:13PM higher or it could be 20 percent lower.
5:13PM **Q.** Dr. Ratzel described that 53,000 number to you as being an upper bound, did he not?
5:13PM **A.** Yes, he did. In one of my reviews of the report, I said, "I do not understand what you mean by 'upper bound,' and I suggest you delete that from the report."
5:13PM It made no sense to me. That was not my position.
5:13PM **MR. REGAN:** TREX-9379.1.2.
5:13PM **BY MR. REGAN:**
5:13PM **Q.** This is the e-mail from Dr. Ratzel to you with a draft of the report that we were just looking at previously.
5:13PM And he writes to you in the second paragraph: "I need you to also redo some of your analyses in the report, working with an upper bound of 53K-bopd rather than 51K. Why - everyone else is quoting our 53K as the shut-in flow rate based on the July 30-31 meetings and government press release, and I think, to be consistent, we should stay there as well. I thought hard on working to 51K and decided we should use 53K, calling it our upper bound estimate (which is true if I believe the pipe flow results for choke line). I frankly do not want any backpedaling on numbers, and as you and I are both aware, 53 or 51 are equally suspect - if we were to continually refine our work, as example, we would be using 1600 psi, not 1800 psi based on the continuing refinements by Hsieh right around July 30-31."

Did I read his e-mail to you correctly?

A. Yes, you did.

Q. Did Dr. Ratzel represent in his e-mail to you that 53,000 was an upper bound estimate?

A. He used that in his second draft of the report. I do not -- I could not figure out what he meant by upper bound. It seemed vague. It did not represent my opinion of the flow. I asked him to change that wording in the report that he added to my first draft. I do not see 53,000 was an upper bound.

Q. The 53,000 flow rate for July 15th represents the conditions that existed in the well, in the BOP, and the capping stack as of that date; correct?

A. Could you repeat the question.

Q. Sure. The 53,000 estimate for July 15th represents or reflects the conditions that existed on that day, July 15th, in the well, in the BOP, and the capping stack?

A. That is correct. I can't disagree with that statement.

Q. There's nothing about the work on your capping stack flow rate that would give you a conclusion that the well was in the exact same condition for the preceding 85 days?

A. No. There was no data from the capping stack that would -- that would allow me to find flow from the previous days. I was just using pressures reported from the capping stack on the last day.

Q. You mentioned, I think, a couple times on direct, this

notion of conversion to stock tank barrels. Do you recall talking about that just as a generality?

A. Yes.

Q. Now, go to 9361.71. This, again, is the DOE report that you drafted and reviewed. At the very top --

You can highlight the very top.

Do you see there it's describing the equation of state that was used by Sandia? We can go to the preceding page if it would be helpful for you, but that's the section of the report.

What I'd like to direct your attention to is the second bullet. It says: "SNL created computer routines to do the following."

And then it says: "Flash crude oil into liquid and gas phases as required and based on the pressure drops calculated above."

Do you see that?

A. Yes.

Q. Okay. Did you use a particular type of flash process to convert your mass flow rates into a stock tank barrel flow rate?

A. Yes, we did.

Q. What did you use?

A. We used a single-stage flash.

Q. Did you in any way in your expert reports in this case,

5:17PM Dr. Dykhuizen, rely upon the work of Dr. Zick?
5:17PM **A.** In my expert report, when I wrote that, I saw some results
5:17PM of Dr. Zick. And it -- they were close to what I had, but, no,
5:18PM I did not need to use his report.
5:18PM **Q.** But for purposes of the calculation of the number in the
5:18PM end of July, as reflected in the DOE-NNSA report, you used a
5:18PM single-stage flash process?
5:18PM **A.** Yes. Dr. Morrow's code -- Mr. Morrow's code was set up to
5:18PM do it that way. It's a much more long and involved process to
5:18PM use his code for a multiphase flash process.
5:18PM **Q.** Do you recall, Dr. Dykhuizen, when you were drafting the
5:18PM first draft of this report, that you described the model as --
5:18PM using a fictional initial state?
5:18PM **A.** Yes. I used that and ever regretted using that phrase.
5:19PM **Q.** Let me show it to you, Exhibit 9924.1.1, which is an
5:19PM e-mail that attaches a draft dated August 3rd, 2010. So
5:19PM 9924.1.1. Then I'll go to the attachment, 9924.3.2.
5:19PM In your first draft of the report, did you describe
5:19PM as follows, when talking about extrapolating back, "Note, this
5:19PM describes a fictional initial state since the model implicitly
5:19PM assumed that the well geometry does not change during the
5:19PM 85 days of flowing this well. In fact, many geometry changes
5:19PM occurred. These include, but are not limited to, the riser and
5:19PM kink being cut off, junk shots and erosion"?
5:19PM Did you write those words, Dr. Dykhuizen?

5:19PM **A.** Yes, I wrote those words.
5:19PM **Q.** And you wrote them in the context of describing the
5:20PM extrapolation back from capping stack to the beginning of the
5:20PM flow period; correct?
5:20PM **A.** That's not complete. What I did was extrapolate back to a
5:20PM fictional state, which was true, and said that if nothing
5:20PM changed, we would have this value.
5:20PM But then I said, "We need to account for the
5:20PM changes," and so I have to have a 4 percent increase when I go
5:20PM backwards. Instead of putting the capping stack on, I have to
5:20PM take the capping stack off.
5:20PM And then I have to have a 4 percent decrease when
5:20PM I -- instead of cutting the riser off, I have to cut the riser
5:20PM back on. So my final calculations included those, and this
5:20PM intermediate step was never used to perform the integral.
5:20PM **Q.** In your draft of this part of the report, and as reflected
5:21PM in the final, the model used to extrapolate back does not
5:21PM account for erosion; correct?
5:21PM **A.** That is correct. The model does not have an erosion term
5:21PM in it. The only way I account for erosion is my proxy of
5:21PM assigning zero flow for the first two days.
5:21PM **MR. REGAN:** If we could go back to D-23996-A.
5:21PM **BY MR. REGAN:**
5:21PM **Q.** You would also agree, Dr. Dykhuizen, that the further away
5:21PM that we get from July 15th, the further we move backwards in

5:21PM time away from that capping stack calculation with its known
5:21PM geometry and pressures, the less confidence you have in the
5:21PM actual calculation of a given flow rate on a given day?
5:21PM **A.** Yes, and that's mainly due to erosion.
5:21PM **Q.** If this 53,000 is adjusted to your 20 percent low number
5:22PM of 42,400, it brings your whole curve down; correct?
5:22PM **A.** That is correct. And if I adjust it up, it brings the
5:22PM whole curve up.
5:22PM **Q.** I think you testified about that part on your direct, so I
5:22PM just want to balance it out.
5:22PM **A.** I'm sorry. I didn't mean to be unfair. I should say it
5:22PM both ways, both times.
5:22PM **Q.** So if the 53,000 number moves up, your total cumulative
5:22PM moves up; correct?
5:22PM **A.** That is correct.
5:22PM **Q.** And if the 53,000 moves down, your cumulative moves down;
5:22PM correct?
5:22PM **A.** That is correct.
5:22PM **Q.** Do you agree, Dr. Dykhuizen, that it's very unlikely that
5:22PM you understated the -- overstated the amount of depletion in
5:22PM the reservoir, that is, from the initial 11,850 to the final
5:22PM number that you have for 53,000?
5:22PM **A.** This original calculation might have an error due to the
5:22PM reservoir pressure, and correcting for that error might give
5:23PM you 3 percent less flow, as I indicate in the -- as indicated

5:23PM in the NNSA report.
5:23PM **Q.** But by holding resistances constant -- that is, assuming
5:23PM that the geometry did not change, other than riser cut and
5:23PM capping stack -- but having a model that allows the reservoir
5:23PM depletion to be part of the model, this model is preordained to
5:23PM predict a flow rate that goes from high to low?
5:23PM **A.** That is correct.
5:23PM **Q.** Now, are you an expert in erosion, Dr. Dykhuizen?
5:23PM **A.** No, I'm not an expert in erosion. But I've been in
5:23PM programs where erosion has been important, yes.
5:23PM **Q.** In your initial expert report you stated that you believed
5:23PM all significant erosion was complete by the end of the second
5:23PM day of the blowout; correct?
5:23PM **A.** No. Excuse me. Could you repeat the question.
5:24PM **Q.** Sure. In your expert report you stated that you believed
5:24PM all significant erosion was complete by the end of the second
5:24PM day after the blowout?
5:24PM **A.** I might have said that. That sounds like a logical
5:24PM number. I think that's reasonable.
5:24PM But that's a proxy for erosion, to put that in my
5:24PM model. It could go on for four days at half flow or six days
5:24PM at a third flow. To say that it's complete after two days --
5:24PM obviously, there was erosion on the last day, but it's not
5:24PM significant erosion on the last day.
5:24PM **Q.** So you believe erosion could be taking place throughout

5:24PM 1 the 86-day time period?
5:24PM 2 **A.** Yes. But what we need to concern ourselves with is the
5:24PM 3 rate of erosion, and just because there's erosion on the last
5:24PM 4 day doesn't mean that it's significant to the integral.
5:24PM 5 **Q.** Is it correct, Dr. Dykhuizen, that in between your expert
5:24PM 6 report and your rebuttal report -- by the time you got your
5:25PM 7 rebuttal report, you say erosion now could have been going on
5:25PM 8 through May 14th?
5:25PM 9 **A.** That is correct. It was correct in my expert report, but
5:25PM 10 maybe I failed to mention that.
5:25PM 11 **Q.** Okay. So in the chart, when it was developed -- when the
5:25PM 12 model was developed in the summer of 2010, two days were left
5:25PM 13 off as an accommodation or, I think, as you said, a hand wave
5:25PM 14 to erosion; correct?
5:25PM 15 **A.** That misquotes me. I think I said "a wave to erosion,"
5:25PM 16 but a hand wave is a similar concept.
5:25PM 17 **MR. REGAN:** If we pull up TREX-11453.12.1, which is
5:25PM 18 your rebuttal report.
5:25PM 19 **BY MR. REGAN:**
5:25PM 20 **Q.** In your rebuttal report you say in the last sentence here:
5:25PM 21 "The agreement of the Griffiths model with the PT-B data" --
5:25PM 22 let me start with the first sentence, not in the middle of the
5:25PM 23 sentence.
5:25PM 24 "Due to the lack of PT-B data in early May, it is
5:25PM 25 possible the erosion processes continued past day two, as I

5:26PM assumed. This is a source of uncertainty in my modeling.
5:26PM However, the agreement of the Griffiths model with the PT-B
5:26PM data and the lack of significant sand observed in oil
5:26PM collection prove to me that erosion did not occur past
5:26PM May 14th"; correct?
5:26PM **A.** That's correct.
5:26PM **Q.** Is that the day you want to stand on in terms of your
5:26PM opinion as to when you believe the erosional processes that
5:26PM mattered ended?
5:26PM **A.** That seems like a reasonable statement. The erosional
5:26PM processes that mattered ended at some time before May 14th. It
5:26PM could possibly extend all the way to May 14th, or it could have
5:26PM ended sooner than May 14th.
5:26PM I have no expertise in erosion, as you say. I can
5:26PM define where the end is. But I can look at the data, read
5:26PM Dr. Griffiths' report, and make an independent conclusion that
5:26PM it must have stopped before May 14th.
5:27PM I can't say that it stopped on May 14th. I can't say
5:27PM that it stopped on May 12th. But it must have stopped before
5:27PM May 14th. Six days of erosion is stopping before May 14th.
5:27PM **Q.** Well, May 14th was 24 days into the accident; correct?
5:27PM **A.** I understand that. But six days -- the erosion could have
5:27PM stopped at six days, and that would have been well before
5:27PM May 14th.
5:27PM **Q.** You're aware that as of May 19th, a new hole appeared in

5:27PM 1 the riser; correct?
5:27PM 2 **A.** I'm not aware of the exact date, but that sounds
5:27PM 3 approximately right. Yes.
5:27PM 4 **Q.** You would agree that the appearance of these holes in the
5:27PM 5 riser kink is evidence of a continuing erosion process?
5:27PM 6 **A.** It's a continuing erosion process at that location, yes, I
5:27PM 7 will agree with that. It doesn't indicate that there was
5:27PM 8 significant erosion in flow paths that mattered. I'm relying
5:28PM 9 on Dr. Stewart Griffiths' analysis for that.
5:28PM 10 **Q.** I'm going to turn to PT-B for a little bit.
5:28PM 11 I'd like to bring up D-24369.
5:28PM 12 Dr. Dykhuizen, we talked -- maybe it was with
5:28PM 13 Dr. Hunter. But the PT-B gauge was at the bottom of the BOP;
5:28PM 14 correct?
5:28PM 15 **A.** Yes.
5:28PM 16 **Q.** And if I use the term "upstream of PT-B," do you
5:28PM 17 understand that to mean things that are below, that is, the
5:28PM 18 reservoir and the well and the drill pipe below the PT-B gauge?
5:28PM 19 **A.** Correct.
5:28PM 20 **Q.** If I go to 24370, if I use the term "downstream of PT-B,"
5:28PM 21 do you appreciate that or do you agree with me that would
5:28PM 22 reflect the BOP, the riser, or anything that's above the BOP?
5:28PM 23 **A.** That is correct.
5:28PM 24 **Q.** Now, we talked earlier about the fact that the PT-B
5:28PM 25 pressure gauges are in between those upstream and downstream

environments; correct?
A. That is correct.
Q. And the PT-B pressure gauge, what it reads is the collective impact of what's going on below it and what's going on above it; correct?
A. Essentially, it is an average of the sea pressure and the reservoir pressure, and while you weight that average, it depends on the resistance upstream and the resistance downstream.
Q. Exhibit D-24401.

See if we have this right, Dr. Dykhuizen. If we see PT-B pressure decrease, that could be caused by two phenomena. Relative to the wellbore, if the BOP resistance decreases, you would expect to see PT-B pressure decrease; correct?
A. That is correct.
Q. Conversely, if the reservoir or wellbore resistance increased, you, again, would see PT-B pressure decrease?
A. Yes.
Q. Let's talk now about PT-B going up. If PT-B pressure increases, that could be caused by either the reservoir or the wellbore resistance decreasing; correct?
A. Yeah. It took me a while to figure out that I'm supposed to look diagonally through your graph instead of vertically, but, yes.
Q. Yes?

5:30PM 1 And similarly, PT-B pressure will increase if the BOP
5:30PM 2 resistance increases; correct?
5:30PM 3 **A.** That is correct.
5:30PM 4 **Q.** Finally, if you had a situation where BOP resistance
5:30PM 5 decreased or wellbore resistance decreased, you would expect
5:30PM 6 flow to increase; correct?
5:30PM 7 **A.** Yes.
5:30PM 8 **Q.** If you had a situation where the reservoir wellbore became
5:30PM 9 more resistant or the BOP became more resistant, you would
5:30PM 10 expect flow to decrease; correct?
5:30PM 11 **A.** That is also correct.
5:30PM 12 **Q.** And as of the time of the DOE-NNSA report, there was
5:30PM 13 skepticism about the PT-B gauge; correct?
5:30PM 14 **A.** Yes.
5:30PM 15 **Q.** There was questions about its accuracy because of
5:30PM 16 variations in the readings that you would get off that gauge
5:30PM 17 during the course of the 86 days of flow; correct?
5:30PM 18 **A.** Yes. There was great concern during the response about
5:31PM 19 the PT-B gauge.
5:31PM 20 **Q.** You were skeptical of the validity of the PT-B pressure
5:31PM 21 gauge readings in 2010; correct?
5:31PM 22 **A.** Everybody was skeptical. I might have been least
5:31PM 23 skeptical of all, but, yes, I was still skeptical.
5:31PM 24 **Q.** Dr. Hunter was skeptical about that gauge; correct?
5:31PM 25 **A.** And he was on the other extreme. He was the most

skeptical about that gauge.

Q. And you say -- you understand that Dr. Griffiths' work relies extremely heavily on the PT-B pressure gauge; correct?

A. Yes. He has performed an analysis to show that you can get some very interesting results out of that gauge.

Q. But in 2010, you were not only skeptical of PT-B, you were also skeptical of Dr. Griffiths' work; correct?

A. Well, at one point in 2010 I was, but as the year proceeded, I got less skeptical of his work. He started addressing my concerns.

But, yes, there was one point in 2010, I was significantly concerned about Dr. Griffiths' work.

MR. REGAN: Pull up TREX 11435.1.1.

BY MR. REGAN:

Q. This is an e-mail that you sent to Dr. Griffiths in August of 2010. And you wrote Dr. Griffiths and you told him that you liked his approach.

But in the middle -- "however, if the parameter that I find is non-physical (i.e., heat transfer problem where a negative emissivity provides the best fit of the data) then one might question the model. The model at that point becomes a curve-fitting exercise, and if one has enough free parameters, then you can fit any data set (even if the model is bad). Extrapolation of such a model beyond the range of the data is then very suspect."

That's what you wrote to him in August of 2010; correct?

A. Yes. That was my opinion on that day.

Q. You also challenged his very small error rates, plus or minus 80, on flow rates; correct?

A. That is correct.

MR. REGAN: Go to TREX-11436.2.1.

BY MR. REGAN:

Q. This is another e-mail you sent to Dr. Griffiths in September of 2010 about his work. And did you write to Dr. Griffiths in this e-mail, Dr. Dykhuizen: "I do not think your analysis provides an independent calculation of the flow rate at any time in the accident response due to errors in the model"?

A. Yes, I wrote that.

MR. REGAN: And in the middle paragraph, Donnie, if we could -- Number 3, yes. Can you just make that a little bigger, that paragraph.

BY MR. REGAN:

Q. You talk about his treatment of PI.

A. Yes.

Q. And in the middle of that paragraph -- it's about the fourth line -- I can point at it on the screen if that helps -- you say: "The PI, or productivity index, is unknown, and this has prevented anybody from using the part from the reservoir

5:33PM pressure to any pressure to calculate a flow rate. At best, one can use an infinite PI and calculate a maximum flow. Or one can model the flow within the reservoir to estimate the upper limit on PI and calculate a more realistic maximum flow. But the resistance across the damaged concrete plug is unknown and potentially important."

Did you write that to Dr. Griffiths about his model and analysis in 2010?

A. There's two points in -- I did write that, but there's two points I'd like to make. First, when I wrote this, I assumed he was arbitrarily imposing a PI of 50; and later, when he rewrote his model in greater detail so I could see, I could see that he was determining from the data a PI of 50. So that is one concept.

Also, I've tried to read the expert reports of other people, and I've learned since then that there is a lot more known about the concrete plug at the bottom of the well than I knew at the time when I wrote this report.

Q. With respect to your Top Kill estimate, in 2010, during the accident, you did not come to an estimate of flow rate during Top Kill; correct?

A. Could you repeat the question. I'm sorry.

Q. Yes. Top Kill, you have a best estimate of 60,000 barrels per day; correct?

A. Yes. I characterized that as greater than 60,000 barrels

5:35PM a day.
5:35PM **Q.** You would also characterize that estimate as having a lot of concerns; correct?
5:35PM **A.** Yes. It is a calculation with a significant error bar to it. And so I tried to bound that error by coming up with a lower bound of 43,000. I can come up with some bound of that error.
5:35PM **Q.** You agree that your Top Kill estimate of 60,000 is not very accurate; correct?
5:35PM **A.** That is correct. Except I said greater than 60,000 in my estimate. But that's correct.
5:35PM **Q.** You don't know the properties of the mud that you're modeling; correct?
5:35PM **A.** That is correct. And I especially don't know the properties of the mud after I mix it with the oil and the gas.
5:35PM **Q.** You make an assumption that the BOP internally has exactly the same resistance during Top Kill as when it's idle; correct? T-kill versus K-idle.
5:36PM **A.** That's correct, that's one of the assumptions I make in my model.
5:36PM **Q.** You're trying to model three phases of flow; correct?
5:36PM **A.** For my best estimate, yes, I am.
5:36PM **Q.** Again, your best estimate is the 60,000-barrels-a-day number; right?
5:36PM **A.** Greater than 60,000 barrels a day, yes.

5:36PM **Q.** You assumed that all of the mud that was pumped in immediately exited the BOP; correct?
5:36PM **A.** I assumed that for the time periods that I was examining, not for the entire time period of the Top Kill.
5:36PM **Q.** And if that's not true, your calculation is in error; correct?
5:36PM **A.** That is correct.
5:36PM **Q.** You assume that the PT-B pressure, from a time period when the top ram -- when the test rams were closed -- that's before any Top Kill and after all Top Kill -- the fact that it's the same, you conclude that means the resistance did not change; correct?
5:36PM **A.** That is correct.
5:36PM **Q.** But, in fact, during Top Kill 3, when the test rams were open, there was a pressure change from the beginning of Top Kill 3 to the last -- to the end of Top Kill 3; correct?
5:37PM **A.** I don't think that's completely correct. There was a lot of variations in the pressure and during Top Kill 3, but it returned to approximately the same value.
5:37PM **Q.** Your lower bound depends on what data set from Top Kill you analyze; correct?
5:37PM **A.** That is correct. We discussed that in my trial testimony here.
5:37PM **Q.** Three Top Kill events; correct?
5:37PM **A.** Yes.

5:37PM **Q.** You analyzed the third one; right?
5:37PM **A.** That is correct.
5:37PM **Q.** And if you apply your exact methodology to the first one, you get a lower lower bound?
5:37PM **A.** That is definitely true.
5:37PM **Q.** Neither calculation is certain?
5:37PM **A.** There are lower bounds. Obviously, the flow is not at the lower bound. The lower bound is something higher than that calculation.
5:37PM **Q.** Is it your testimony you have zero percent uncertainty on your lower bound?
5:38PM **A.** My testimony that the lower bound is a hard lower bound. But, yes, there is a small probability that the flow could be less than my lower bound.
5:38PM **Q.** And you agree that if we use your exact methodology for Top Kill 1, we get a lower lower bound?
5:38PM **A.** That is a correct statement.
5:38PM **Q.** Your Top Hat estimate, also, 60,000 barrels per day; correct?
5:38PM **A.** That is correct.
5:38PM **Q.** Your Top Hat estimate is especially inaccurate; correct?
5:38PM **A.** That's correct. It's probably equally as inaccurate as the Top Kill calculation.
5:38PM **Q.** Your most accurate is the capping stack, July 15th; right?
5:38PM **A.** That is correct.

5:38PM **Q.** Plus or minus 20 percent?
5:38PM **A.** That is correct.
5:38PM **Q.** Top Kill is less accurate?
5:38PM **A.** Oh, that's definitely correct.
5:38PM **Q.** No doubt about it?
5:38PM **A.** Yes.
5:38PM **Q.** Top Hat is even less inaccurate -- less accurate?
5:38PM **A.** Well, that's less accurate than the capping stack, but
5:39PM it's difficult to say whether it's less accurate than Top Kill.
5:39PM They're both inaccurate estimates.
5:39PM **Q.** For your best estimate of 60,000 barrels per day for
5:39PM Top Hat, you rely on analyzing the visual evidence from
5:39PM videotaped ROV footage; correct?
5:39PM **A.** That's correct.
5:39PM **Q.** After doing that, you arrive at a round number of
5:39PM 20,000 barrels per day coming out of the skirt; correct?
5:39PM **A.** Yes, a very round number.
5:39PM **Q.** You agree that that is the most inaccurate -- or that is a
5:39PM very inaccurate method?
5:39PM **A.** It is an inaccurate method. I think that the logic in
5:39PM that 20,000 is pretty reasonable. I have a certain amount
5:39PM flowing out to the skirt that I cannot quantify by visual
5:40PM observation. And then that changes by 10 or 15,000 because the
5:40PM collection rate changes, and I don't see any change in the
5:40PM flow, which leads me to believe that the original flow before

5:40PM 1 it changed was on the order of 20,000, because I have to add
5:40PM 2 20,000 and add 10 or 15 to get 30,000 and I don't see any
5:40PM 3 change.
5:40PM 4 I think I can see a change between flowing at 20 and
5:40PM 5 flowing at 30 to 35.
5:40PM 6 **Q.** With respect to what was coming out of the bottom of the
5:40PM 7 Top Hat floor, which is called the skirt, you agree that you
5:40PM 8 had a very inaccurate method because you didn't know the
5:40PM 9 geometry and you had another inaccurate method because you were
5:40PM 10 just basing it on visual observation; correct?
5:40PM 11 **A.** Yes. Those are both inaccurate methods, yes.
5:40PM 12 **Q.** And using both of those inaccurate methods, you arrive at
5:40PM 13 60,000 barrels per day?
5:40PM 14 **A.** Sure. That sounds reasonable.
5:41PM 15 **Q.** And using an inaccurate method for Top Kill, you arrive at
5:41PM 16 60,000 barrels per day?
5:41PM 17 **A.** Greater than 60,000. I keep correcting, but that's fine.
5:41PM 18 **Q.** But those 60,000 barrels per day line up exactly on your
5:41PM 19 line for your 5 million cumulative estimate; correct?
5:41PM 20 **A.** Yes, they lie very close to the line. Exactly is -- I
5:41PM 21 think for these purposes, they line up very close to the line.
5:41PM 22 **Q.** If we're to see the line of 5 million cumulative flow and
5:41PM 23 someone were to put a dot on there for Top Hat and a dot on
5:41PM 24 there for Top Kill and say, Dykhuizen has calculated
5:41PM 25 60,000 barrels per day for those two numbers, it should be

represented as both of those are very inaccurate?
A. I give an accuracy of plus or minus 20,000 for both, yes.
Q. You testified about slug flow. You don't dispute that slug flow was observed in May of 2010, do you?
A. No, I do not.
Q. Slug flow is a phenomenon of multiphase fluid flow; correct?
A. Yes, it is.
Q. And slug flow can only occur in certain boundary conditions; right?
A. That is correct.
Q. And if you can see slug flow, it can possibly inform you as to what the boundary conditions are?
A. I have no problem with Dr. Zaldivar's procedure. I think he did something very interesting. I was quite interested in his calculations.
Q. You claimed that -- you criticized Dr. Zaldivar because you say his method had never been validated to use -- to show that it can be used to estimate flow; correct?
A. That is correct.
Q. But, Dr. Dykhuizen, your method for calculating cumulative flow here has never been compared to experimental data in order to determine whether there was confidence in it; correct?
A. That's incorrect. My method has been used many times to calculate flow, and the method is a standard procedure that

5:43PM you'll find in any textbook.
5:43PM **Q.** Dr. Dykhuizen, did you ever compare the model you used to calculate cumulative flow with experimental data in order to determine whether there was confidence?
5:43PM **A.** I'm not sure what you're getting at. I'm using a standard procedure. You do not hold a standard procedure to the same rigor as you do a computational method.
5:43PM **Q.** You did not perform any independent analysis or modeling of how regular in the double-peak or single-peak behavior the slug flow was in May of 2010; correct?
5:43PM **A.** No, I took Dr. Zaldivar's word that it was regular.
5:43PM **Q.** You did not perform or disclose any independent analysis or modeling of the oscillating motion of the riser's bouyant loop; correct?
5:43PM **A.** No, I did not do any independent analysis of the oscillation of the bouyant loop.
5:44PM **Q.** You did not express any opinion on Dr. Zaldivar's calculation of the riser elevation profile; correct?
5:44PM **A.** I think I had some concerns with that in my report. Dr. Zaldivar has quite a bit of his riser buried; therefore, he had no idea how deep it was buried, how much oscillation in the flow path of the buried riser, and I thought that would be a concern.

Because this sort of oscillation is very sensitive to horizontal motions up and down of the riser. If we have

horizontal motions up and down, we can impact the stability margins. He has no idea how much it oscillates up and down as it's buried.

Q. You cite a BP document from Julian Austin and Trevor Hill to -- with respect to the size of the kink holes. You did that on your direct exam. Do you recall doing that?

A. From --

Q. Do you want me to show it to you?

A. I did have something about kink holes. I thought -- but that Julian Austin name does not --

Q. I'm happy to show it to you. I'll just show it to you and we'll finish up here.

MR. REGAN: TREX-10650.2.1.

BY MR. REGAN:

Q. I think part of the confusion, Dr. Dykhuizen, is that in this exhibit, you were not shown the top part of the document. And in the top part of the document, does it not say that the estimate of the leaks by Julian were done from interpreting photos? Do you see that?

A. Yes, that's correct.

Q. So you're relying on this document to support your opinion on the size of the kink holes and this document is relying on photo interpretation?

A. No, that's not correct. Let me please explain.

I tried to reproduce Dr. Zaldivar's kink leak. I

5:46PM 1 used his areas, not the areas of -- from this document. And I
5:46PM 2 could not reproduce his calculations unless I imposed an error.
5:46PM 3 I also looked at this e-mail, at least the copied one
5:46PM 4 below from Dr. Lockett. I noticed that he used different
5:46PM 5 areas. I noticed that he used different pressures. I could
5:46PM 6 reproduce his numbers using the correct equations and I could
5:46PM 7 also change his -- I could scale his results to the values that
5:46PM 8 Dr. Zaldivar did.
5:46PM 9 His results do not reproduce Dr. Zaldivar's and they
5:46PM 10 do not reproduce mine either, but they're on the right-hand
5:47PM 11 side of mine and -- which leads me further to suspect that
5:47PM 12 Dr. Zaldivar's calculations were wrong.
5:47PM 13 I'm not stating that these were right. I'm stating
5:47PM 14 that these used the right equations that should be used. I
5:47PM 15 think this gentleman here used different Ks than Dr. Zaldivar
5:47PM 16 used and I do not know what K values this person used, so I
5:47PM 17 could not reproduce his flows.
5:47PM 18 I'm just stating that these flows are greater than
5:47PM 19 mine. They are an indication that Dr. Zaldivar is in error.
5:47PM 20 And when I try to show what diameter holes that were used by
5:47PM 21 Dr. Lockett, they are using the same diameter hole that matches
5:47PM 22 the area.
5:48PM 23 Dr. Zaldivar uses a hole of his model that does not
5:48PM 24 match the area.
5:48PM 25 **Q.** Dr. Dykhuizen, my question was: This is a document that

you relied upon for your calculation? That's correct? That was my question.

A. It's unclear from looking at this. I looked at -- I recall an e-mail from Dr. Lockett. You may be correct, that he is copying Dr. Lockett's e-mail at the bottom. I do not recall the Julian Austin name, no.

Q. Okay.

MR. REGAN: If I could go to the ELMO then, please. This is just a copy of the same demonstrative that we've been using before, D-23996-A. A little more washed out, but I have it here on this ELMO.

BY MR. REGAN:

Q. But as we just discussed, you have an estimate for Top Kill here?

A. Correct.

Q. At 60,000?

A. And you're applying that 59, but that's fine.

Q. And it's very inaccurate; correct?

A. That's correct. I apply the inaccuracy as plus or minus 17,000.

Q. You have an estimate for Top Hat at the tail end of that time period, which would be around Day 70, the end of June, and your estimate for that is 60,000 barrels per day. Is that right?

A. That's correct. You're now drawing it in a better

location there.
Q. Also very inaccurate; correct?
A. That is correct.
Q. You extrapolate in your chart that you ended your direct exam, you said, Well, I can apply that Top Hat estimate backwards because I know flow is decreasing. So whatever I calculated for July -- June 25th, it must be -- it must be lower. You actually did that for your lower bound; correct?
Let me ask you a new question.
A. Yes, thank you.
Q. You have a lower bound of 43,000 barrels per day for Top Hat; correct?
A. Yes.
Q. And you say that's the lower bound because you assume that flow is decreasing over time; right?
A. No. I say that's a lower bound because I'm ignoring skirt flow and have a lower calculation of the vents, but I say that I can extrapolate that backwards in time because, in my view, the flow is decreasing with time.
Q. Right. So your lower bound for Top Hat is what, approximately 43,000?
A. That is correct.
Q. Somewhere around there; is that right?
A. That looks like a good number.
Q. And if, in fact, flow rate is increasing over time rather

than decreasing over that time, your lower bound can't be pushed backwards, that is, towards zero; correct?

A. If I take your assumption that the flow is increasing with time, I cannot extrapolate that backwards.

Q. You have a lower bound for Top Kill; correct?

A. Yes.

Q. Approximately 43,000 barrels per day; correct?

A. That's correct.

Q. Right about there; right?

A. That's correct.

Q. And from reviewing Dr. Zaldivar's report, you're aware that he postulates flow rates from May 13th to May 20th; correct?

A. Yes, he does.

Q. So that's right around here, Day 23 to about Day 27. And do you recall what his flow rates were?

A. I can guess. 35, I think, was the top; 24 was the low. I'm --

Q. Pretty close. Do you recall that his range was 24,900 to 35 -- 35,000 -- it was 36,000. Does that sound consistent with your review of his report?

A. Yes.

Q. So would you agree, Dr. Dykhuizen, that if we use your uncertainty range for your cumulative flow of 30 -- of minus 30 percent off of 5 million, that we would cross through the

range of flow rates that are predicted by Dr. Zaldivar, understanding you disagree with me?

A. I think Dr. Zaldivar's estimate should be increased by a factor of 2. I don't think they're validated. I think that these lower bounds are unlikely because I have a bell curve and, therefore, I do not like picking my lower bound and saying, this is what we need to do.

But with those assumptions that you've made, yes, we can get a curve that looks very much like your red line.

Q. I'm going to mark this as D-24496.

MR. REGAN: And those are the questions that I have, Dr. Dykhuizen. Thank you.

THE WITNESS: Thank you for your time.

THE COURT: Redirect?

REDIRECT EXAMINATION

THE WITNESS: I changed mics. Is mine on? For some reason I don't like talking into the lapel mic.

BY MR. CERNICH:

Q. Dr. Dykhuizen, Scott Cernich for the United States. I have you on redirect.

Dr. Dykhuizen, you were asked a number of questions about the DOE flow analysis report. Do you recall that?

A. Yes, I do.

Q. Okay. And do you rely upon that report for your expert opinions?

5:54PM **A.** No, I do not. I reference that report to demonstrate my equations that I use.
5:54PM **Q.** And do you have more confidence in your calculations than the calculations that were prepared by the other national labs?
5:54PM **A.** Yes, I do.
5:54PM **Q.** And do you recall the purpose of the DOA -- DOE-NNSA flow analysis report?
5:54PM **A.** The purpose, as clearly stated in the introduction, was to provide a basis for how the 53,000 estimate from the press release was obtained.
5:55PM **Q.** Was it -- was that report also intended to document the work of the Tri-Lab's team during the response with regard to flow rate?
5:55PM **A.** Yes, it was.
5:55PM **Q.** Did anyone from the United States ever ask you to change or adjust your calculations in any way you thought was improper?
5:55PM **A.** No.
5:55PM **Q.** And do engineers ever disagree regarding -- I'm sorry. Do engineers ever disagree as to the certainty of calculations?
5:55PM **A.** That's a common area of disagreement. People seem to calculate the same things but quite disagree on the uncertainty.
5:55PM **Q.** And is it fair for other engineers to have more confidence in your -- more confidence in your calculations than you do

5:55PM personally?
5:55PM **A.** I guess that's fair.
5:56PM **Q.** And you were asked about various things that cause uncertainty during your cross-exam. Do you remember that?
5:56PM **A.** Yes.
5:56PM **Q.** Things like erosion, the geometry, et cetera?
5:56PM **A.** Yes.
5:56PM **Q.** Are all of those things addressed in your error bars that you place on your calculations, all of those uncertainties?
5:56PM **A.** Yes, they are.
5:56PM **Q.** Now, you were asked a question about the separation method that you used for the fluid in your calculations. Do you recall that?
5:56PM **A.** Yes.
5:56PM **Q.** And does -- and you said that you used -- that the EOS that you used, the equation of state, was based on a single-stage flash?
5:56PM **A.** Yes, it was.
5:56PM **Q.** And does that result in lower flow rates?
5:56PM **A.** That results in the same mass flow rate. The mass flow rate is independent. If you use a single-phase flash, you end up with lower standard barrels when you convert it to that.
5:57PM **Q.** That was my question, Dr. Dykhuizen. So if you had used a multistage EOS characterization of the fluid, you would have calculated higher volumes of standard barrels of oil?

5:57PM **A.** That is correct.
5:57PM **Q.** Do you have any opinions regarding the proper method to use for separation of oil for the purposes of these calculations?
5:57PM **A.** Well, I used single stage because it was easier, so that's my opinion. But what the Court should use to convert from mass to standard barrels is not of my concern.
5:57PM **Q.** You were asked a variety of questions regarding uncertainties in performing hydraulic modeling and the information you would need to come up with an estimate. Do you recall that?
5:57PM **A.** Yes.
5:57PM **Q.** It was related to a paper, I believe, you wrote back in June of 2010?
5:58PM **A.** Yes.
5:58PM **Q.** And were you talking about the work that the NNSA labs were doing during the response?
5:58PM **A.** Yes, I was.
5:58PM **Q.** And you were asked some questions regarding Dr. Griffiths' work. Do you recall that?
5:58PM **A.** Yes.
5:58PM **Q.** And I know we spoke a bit about this during your direct examination, but can you explain to the Court -- well, I believe you testified on direct that you did not hold the same opinions regarding Dr. Griffiths' work as you expressed in your

5:58PM 1 e-mail critique?
5:58PM 2 **A.** When I gave a series of phone and e-mail critiques, I only
5:58PM 3 had available some initial drafts of Dr. Griffiths' work and I
5:58PM 4 did not understand the full nature of his work and so these
5:59PM 5 comments were based on his draft, not his work.
5:59PM 6 Later on, he expanded his draft, and he also expanded
5:59PM 7 his work and addressed all of my concerns satisfactorily.
5:59PM 8 **Q.** And so does he satisfy all of your concerns regarding his
5:59PM 9 work that you expressed in 2010?
5:59PM 10 **A.** Yes.
5:59PM 11 **Q.** And what do you think of his work now?
5:59PM 12 **A.** I think it's an excellent piece of work. He's
5:59PM 13 conclusively shown that you can get some very interesting data
5:59PM 14 out of PT-B, which originally was treated as not reliable.
5:59PM 15 **Q.** During your cross-examination, Mr. Regan was asking you
5:59PM 16 about calculations being accurate. I lost count of the number
5:59PM 17 of times he said "accurate." But can you explain what you mean
5:59PM 18 by "not very accurate"?
6:00PM 19 **A.** Sure. People tend to believe that scientists can
6:00PM 20 calculate things to plus or minus 1 percent, and that seems to
6:00PM 21 be the standard being used. My calculations, unfortunately,
6:00PM 22 are not to plus or minus 1 percent. My calculations are, in
6:00PM 23 some cases, plus or minus 20 percent, in some cases, plus or
6:00PM 24 minus 25 percent, and for the integral, plus or minus
6:00PM 25 30 percent.

I think this is still an informative calculation. It should help the Court determine how much was flowing on a particular day or what the cumulative rate was. That was the best I could do with the data that I had.

Q. Mr. Regan also asked you -- I'm sorry, Dr. Dykhuizen. Does the concept of the bell curve apply to all of your calculations?

A. Yes, it does. You would consider a bell curve to be a nice, symmetric Liberty Bell. The only time where it gets different is where we have the cumulative flow where I say it could be plus 20 percent or minus 30 percent. So you would have to imagine a bell curve that's still the most likely value.

The top of the bell curve is at 5 million barrels of oil. And then once you get to 43 and 63, which are approximately my extremes, the probability is very small to get near those extremes.

Q. Now, Mr. Regan asked you about a spreadsheet called "Wednesday night rush." Do you recall that?

A. Yes.

Q. Were those calculations performed in a rush?

A. No, they weren't. Those -- those calculations had been performed for a couple weeks by the time the request made was made to do it for a Friday meeting. So all we had to do was clean up the spreadsheet, put it into a form that it could be

6:02PM submitted for Dr. Ratzell to use, and that involves commenting a spreadsheet.

Spreadsheets don't typically have comments. So we would comment cells, this input is for the capping -- the capping stack pressure, this input is for the K value that you assume for this item. This was not done in a rush. This was Mr. Morrow's joke that he probably should not have done.

Q. And with regard to the capping stack calculations, all of the BP internal calculations of the flow through the capping stack that you reviewed, were all of those calculations over 50,000 barrels per day?

A. Yes, they were.

MR. CERNICH: Could we go to the ELMO, please?

BY MR. CERNICH:

Q. Dr. Dykhuizen, this is the demonstrative that Mr. Regan used with you a few moments ago during your cross-examination. Do you recall that?

A. Yes.

Q. And I'd like to look at the estimates again that were plotted out.

Can you point to me where I should put your -- and this is BP's demonstrative, D-23996-A. Can you point to me where I should put your Top Kill calculation?

A. The Top Kill was right before the riser was cut off, so a couple days before. We have 60,000. That's above the line.

6:04PM It's on the 60.
6:04PM **Q.** So is that about the right place?
6:04PM **A.** Yes, that looks about right.
6:04PM **Q.** Okay. And your --
6:04PM **A.** And it was greater than 60,000, so maybe you should put an arrow going up from that point to demonstrate that my best estimate I only quantify to be 60,000 or above.
6:04PM **Q.** Can I label that "best estimate"?
6:04PM **A.** Sure.
6:04PM **Q.** And what about your Top Hat calculation?
6:04PM **A.** The Top Hat calculation was also approximately 60,000. It was done on the last day, so that's a few days before we put in the -- put on the riser. It was also about 60,000 from there.
6:04PM **Q.** Do I have the right spot?
6:05PM **A.** Yes, I think so. Close enough for government work.
6:05PM **Q.** And can I call that a best estimate?
6:05PM **A.** Correct.
6:05PM **Q.** And can you tell me -- I believe you testified that you thought Dr. Zaldivar's calculations were off by a factor of 2. Is that right?
6:05PM **A.** Yes.
6:05PM **Q.** And if they were increased by a factor of 2, in what range would those be?
6:05PM **A.** Between 50,000 and 70,000, approximately in this range. Because you take 25 and double and get 50, and you take 35 and

6:05PM double and get 70.
6:05PM **Q.** So is that about in this range?
6:05PM **A.** I think that's correct. That looks close. It's hard to
6:05PM find May 13th and May 16th on there. But we can slide that
6:06PM left to right and it still wouldn't make that much difference
6:06PM for your point.
6:06PM **Q.** Would it be fair to call that "Dr. Zaldivar corrected"?
6:06PM **A.** Sure.
6:06PM **Q.** And your best estimate for the Top Kill calculation, that
6:06PM has a range of plus or minus 20 percent and that goes in both
6:06PM directions; is that right?
6:06PM **A.** The Top Kill we put a minimum, a lower bound, at 43, and
6:06PM it could -- I use that to estimate an upper bound also. It's
6:06PM just an approximation of how far up this could go, yes. So we
6:07PM could put 17,000 down and 17,000 up to represent my Top Kill
6:07PM calculation, but you need a bell curve where the most probable
6:07PM is somewhere near 60,000.
6:07PM **Q.** And despite the inaccuracies you were asked about, is
6:07PM greater than 60,000 still your best estimate?
6:07PM **A.** Yes.
6:07PM **Q.** And does the same apply to the Top Hat calculation?
6:07PM **A.** Using the data of the Top Hat, my best estimate is
6:07PM approximately 60,000 on that day. Using the data of the
6:07PM capping stack, I get a different estimate for the flow on that
6:07PM day, a little lower.

6:07PM **Q.** And the curve that's on this demonstrative, Dr. Dykhuizen, the red curve there, is that a fair representation of your work?

6:07PM **A.** No, it's not. I think that that flow linearly increasing over the entire time period is not a possible solution. We could have the flow starting at some low value and as we erode, we either go up above my line or we go up below my line, but we probably stay close to my line after May 14th, because that's where I have -- that's where Dr. Stewart Griffiths has his last firm data point.

He also has some points in May 8th that he may want you to believe the data back to May 8th. But I think May 14th is a pretty -- pretty good estimate that this blue line is probably decreasing all the way back to May 14th and probably all the way back to May 8th.

6:09PM **Q.** I'm going to mark this as demonstrative D-21160.

MR. CERNICH: Thank you, Dr. Dykhuizen. That's all I have.

THE COURT: All right. Thank you, sir.

THE WITNESS: Thank you.

THE COURT: You're done. Are you on furlough?

THE WITNESS: I get my salary whether I'm here or there, so it doesn't really...

THE COURT: That's good. I can't say that for everyone.

6:09PM 1 Okay. It's about almost 10 after 6:00.
6:09PM 2 Obviously, we'll recess for the evening. We'll come back --
6:09PM 3 well, before we do that, the witnesses tomorrow. Let's see,
6:10PM 4 you're going to have Mr.-- is it Mr. Hsieh?
6:10PM 5 **MS. HIMMELHOCH:** Hsieh, Your Honor.
6:10PM 6 **THE COURT:** He's testifying as a fact witness, Your
6:10PM 7 Honor.
6:10PM 8 **MS. HIMMELHOCH:** That is correct, Your Honor.
6:10PM 9 **THE COURT:** And then Dr. Griffiths?
6:10PM 10 **THE WITNESS:** Yes, Your Honor.
6:10PM 11 **THE COURT:** Will those two likely take up most of the
6:10PM 12 day tomorrow, or will we get to Mr. Zick?
6:10PM 13 **MS. HIMMELHOCH:** We hope to squeeze in at least a
6:10PM 14 little bit of Dr. Zick tomorrow, Your Honor. Of course, it
6:10PM 15 depends on how long the cross takes.
6:10PM 16 **THE COURT:** All right. Anything else?
6:10PM 17 **MS. HIMMELHOCH:** Your Honor, we have not yet received
6:10PM 18 the order of witnesses from BP, which was due today.
6:10PM 19 Can you gives us a guesstimate as to when we'll
6:10PM 20 get it?
6:10PM 21 **MR. BROCK:** Yes. There was an inquiry made earlier
6:10PM 22 today. I said you would get it around 5:30 or 6:00. So I
6:11PM 23 don't know why you're bringing that up.
6:11PM 24 I promised to give it to them as soon as we get
6:11PM 25 back.

6:11PM **MS. HIMMELHOCH:** I apologize.

6:11PM **MR. CERNICH:** Mike, it wasn't intended --

6:11PM **MR. BROCK:** We had a conversation about it. I've indicated the time we would get it --

6:11PM **THE COURT:** All right. Anything else?

6:11PM **MS. KARIS:** Your Honor, two quick carryover issues from last week's trial. The outstanding exhibit lists for both Dr. Ballard as well as Mr. Adams were circulated over the weekend.

6:11PM **THE COURT:** Did you say witness lists?

6:11PM **MS. KARIS:** I'm sorry. Exhibit lists.

6:11PM **THE COURT:** Exhibit lists.

6:11PM **MS. KARIS:** I'm sorry. I probably misspoke. It's been a long day.

6:11PM We have circulated those. Transocean -- or the aligned parties have asked me for additional time to review those. That is an open item from last week's case. I just don't want the Court to think that --

6:11PM **THE COURT:** Okay.

6:11PM **MS. KARIS:** And we are also working with the aligned parties with respect to redacting Mr. Ziegler's report, and we will have that resolved in short order.

6:11PM **THE COURT:** Okay. Very well. Everyone have a good evening. See you in the morning.

6:11PM **THE DEPUTY CLERK:** All rise.

(WHEREUPON, the proceedings were concluded.)

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CERTIFICATE

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

s/Jodi Simcox, RMR, FCRR
Jodi Simcox, RMR, FCRR
Official Court Reporter