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UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF LOUISIANA

IN RE: OIL SPILL BY THE OIL RIG	*	Docket 10-MD-2179
<i>DEEPWATER HORIZON</i> IN THE	*	
GULF OF MEXICO ON APRIL 20, 2010	*	Section J
	*	
Applies to:	*	New Orleans, Louisiana
	*	
Docket 10-CV-02771,	*	October 8, 2013
<i>IN RE: THE COMPLAINT AND</i>	*	
<i>PETITION OF TRITON ASSET</i>	*	
<i>LEASING GmbH, et al.</i>	*	
	*	
Docket 10-CV-4536,	*	
<i>UNITED STATES OF AMERICA v.</i>	*	
<i>BP EXPLORATION & PRODUCTION,</i>	*	
<i>INC., et al.</i>	*	
	*	
* * * * *		

DAY 6, AFTERNOON SESSION
TRANSCRIPT OF NONJURY TRIAL BEFORE
THE HONORABLE CARL J. BARBIER
UNITED STATES DISTRICT JUDGE

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25 computer-aided transcription software.

I N D E X

	<u>Page</u>
1	
2	
3	
4	Stewart Griffiths, Ph.D.
5	Direct Examination By Mr. Benson: 1637
6	Cross-Examination By Mr. Regan: 1674
7	Redirect Examination By Mr. Benson: 1744
8	
9	Aaron Zick, Ph.D.
10	Voir Dire Examination By Ms. Cross: 1752
11	Direct Examination By Ms. Cross: 1754
12	Cross-Examination Ms. Karis 1784
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	

1 AFTERNOON SESSION

2 (October 8, 2013)

3 * * * * *

01:02 4 THE DEPUTY CLERK: All rise.

01:21 5 THE COURT: All right. Please be seated, everyone.

01:21 6 All right, preliminary matters?

01:21 7 MR. LANGAN: Your Honor, Andy Langan for BP.

01:21 8 I would like to raise one preliminary issue, if
01:21 9 I might. It has to do with the issue that's come up a couple
01:21 10 of times regarding the opinion of Mr. Bushnell.

01:21 11 THE COURT: Okay.

01:21 12 MR. LANGAN: There's a bit of a history here that I
01:21 13 think is important to understand.

01:21 14 The United States -- I mean, there were limits
01:21 15 on the number of experts. The United States decided not to
01:22 16 bring Mr. Bushnell live to trial. They made a tactical
01:22 17 decision not to do that, just like some tactical decisions BP
01:22 18 had made not to bring some experts.

01:22 19 What happened was, thereafter, there was a hotly
01:22 20 contested dispute in front of Judge Shushan about attempts by
01:22 21 the Department of Justice to bring in use of Bushnell through
01:22 22 other means, fully briefed, argued. And Judge Shushan ruled on
01:22 23 this on September 12th.

01:22 24 May I hand up a copy of the order?

01:22 25 THE COURT: Yeah -- I've read the order. I'm

01:22 1 familiar with the order.

01:22 2 **MR. LANGAN:** Well, thank you, Your Honor.

01:22 3 **THE COURT:** In fact, I have it right here on the
01:22 4 bench.

01:22 5 **MR. LANGAN:** Terrific.

01:22 6 In any event, as Your Honor knows, then, as a
01:22 7 result of that order, Mr. Bushnell's deposition was excluded
01:22 8 from the deposition bundles because he was not testifying and
01:22 9 because Judge Shushan found that no United States expert was
01:22 10 relying on him. And she took a very close look at that and
01:22 11 made that decision. The United States contested it, but that's
01:22 12 what she ruled.

01:23 13 Now, the U.S. appealed on September 15th, I
01:23 14 think it was, or whenever, and, of course, we never responded
01:23 15 because under Pretrial Order 15, Your Honor, if he was going to
01:23 16 consider that, would have asked us to respond. So the appeal's
01:23 17 never been ruled upon and we've never really had a chance to
01:23 18 respond to the appeal --

01:23 19 **THE COURT:** Well, I -- as I've done in several
01:23 20 instances, in order to save trees -- what do you save
01:23 21 electronically now? Bits?

01:23 22 Rather than have you all brief the same thing in
01:23 23 front of Judge Shushan, I read Judge Shushan's order, I read
01:23 24 what you submitted to her, I read what they submitted to her.
01:23 25 So I was fully conversant with the issue, and I decided to just

01:23 1 not rule on it until the issue came up at trial, and I ruled on
01:23 2 it yesterday, so that's where we are.

01:23 3 **MR. LANGAN:** All right. Well, so what the United
01:23 4 States is telling us now is that they think Judge Shushan's
01:24 5 prior order is of no effect, and they're going to be able to
01:24 6 say whatever they want about Bushnell with any expert. And we
01:24 7 don't think the door's been opened that way.

01:24 8 **THE COURT:** Well, that's not the case. I decided
01:24 9 I'll just take it as the questions came up, and I'll rule on it
01:24 10 as they come up.

01:24 11 **MR. LANGAN:** All right. Your Honor, but we don't
01:24 12 think there should be open season here on this.

01:24 13 **THE COURT:** Yeah. We're certainly not going to
01:24 14 indirectly let the entire report of Dr. Bushnell come in --

01:24 15 **MS. HIMMELHOCH:** That is not --

01:24 16 **THE COURT:** -- by the back door.

01:24 17 **MS. HIMMELHOCH:** I apologize, Your Honor. It's not
01:24 18 the intention of the United States. As we set forth in our
01:24 19 briefing papers, three of our experts relied upon
01:24 20 Dr. Bushnell's work in similar manner: Dr. Griffiths,
01:24 21 Dr. Dykhuizen, and Dr. Pooladi-Darvish

01:24 22 **THE COURT:** Okay. They've said what they said, I
01:24 23 heard it and I'll give it whatever weight I think it deserves,
01:24 24 you know.

01:24 25 **MR. LANGAN:** We disagree with counsel's

01:24 1 characterization. Judge Shushan specifically held they hadn't
01:24 2 relied on it.

01:24 3 **THE COURT:** I understand.

01:24 4 **MR. LANGAN:** Okay. Thank you, Your Honor.

01:24 5 **THE COURT:** All right. Thank you.

01:24 6 Any other preliminary matters?

01:25 7 **MS. PENCAK:** Yes, Your Honor. Good afternoon. Erica
01:25 8 Pencak for the United States.

01:25 9 I have the list of the United States' call-outs
01:25 10 and demonstratives used yesterday in the examination of
01:25 11 Dr. Hunter --

01:25 12 **THE COURT:** Wait, wait, wait. We had some peanut
01:25 13 gallery activity going on there.

01:25 14 All right. Go ahead. Start over.

01:25 15 **MS. PENCAK:** I have the list of the United States'
01:25 16 exhibits, call-outs, and demonstratives used in yesterday's
01:25 17 examination of Dr. Hunter. We circulated the list to the
01:25 18 parties last night and received no objections. We'd file,
01:25 19 offer, and introduce these exhibits, call-outs, and
01:25 20 demonstratives into evidence.

01:25 21 **THE COURT:** All right. Any objections to
01:25 22 Dr. Hunter's exhibits?

01:25 23 Hearing none, those are admitted.

01:25 24 **MS. PENCAK:** Thank you, Your Honor.

01:25 25 **MR. IRPINO:** Anthony Irpino for the aligned parties,

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01:25 1 Your Honor.

01:25 2 One clean-up matter. There was an exhibit that
01:25 3 you ruled on -- it was the last thing of the Source Control
01:25 4 part of the trial -- that was previously on the list for James
01:25 5 Dupree. You had ruled that it was admitted, so we have an
01:26 6 amended list for James Dupree to include a notation that that
01:26 7 exhibit is, in fact, admitted. So we attached the minute
01:26 8 entry.

01:26 9 **THE COURT:** All right. Any objection?

01:26 10 That's admitted.

01:26 11 Okay. I think we're ready.

01:26 12 **MR. BENSON:** Okay. I thought I'd get in line there
01:26 13 and make sure I got my spot.

01:26 14 (WHEREUPON, STEWART GRIFFITHS, PH.D., having been
01:26 15 previously duly sworn, testified as follows.)

01:26 16 **DIRECT EXAMINATION**

01:26 17 **BY MR. BENSON:**

01:26 18 **Q.** Good afternoon, Dr. Griffiths. Tom Benson for the United
01:26 19 States resuming your direct examination.

01:26 20 **MR. BENSON:** If we could have Demonstrative 21223,
01:26 21 please.

01:26 22 **BY MR. BENSON:**

01:26 23 **Q.** So before we broke for lunch, we were talking about your
01:26 24 alternate calculations. So we talked about your best estimate.
01:26 25 We talked about Alternate 1. Now, I'd ask you to go through

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01:26 1 what we have here in this demonstrative, which is known as
01:26 2 Alternate 2 calculation.

01:26 3 A. Okay. So Alternate 2 calculation relies on BOP pressure
01:27 4 and ambient sea pressure. So this is -- you can see that in
01:27 5 the diagram.

01:27 6 **THE COURT:** Can everybody hear? It sounds kind of
01:27 7 low.

01:27 8 Stephanie, did we turn the sound off or
01:27 9 something?

01:27 10 All right. Pull your mic up, too, a little bit.
01:27 11 Why don't you put it on your tie, I think it works better.
01:27 12 Okay. Closer up. There you go. Okay.

01:27 13 All right. Go ahead.

01:27 14 **THE WITNESS:** Can you hear me?

01:27 15 **THE COURT:** Yes. Go ahead.

01:27 16 **THE WITNESS:** Okay. Good.

01:27 17 So the Alternate 2 calculation uses the pressure
01:27 18 difference between the BOP and ambient sea pressure. So it
01:27 19 does, again, rely on PT-B. It has the issues of no data before
01:27 20 May 8th, so that sort of thing.

01:27 21 It does not account for any erosion in the BOP,
01:27 22 but it does account for any erosion that would have occurred in
01:27 23 the reservoir or wellbore. That's just because it's based on
01:28 24 K-BOP, the resistance of the BOP. And if that were changing
01:28 25 over time, then it would not account for that.

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01:28 1 So, nevertheless, you get, once again, a result
01:28 2 of 5.1 million barrels. So we know from the Alternate 1
01:28 3 calculation that erosion did not significantly -- erosion of
01:28 4 the BOP did not significantly impact cumulative discharge. And
01:28 5 so from this, we reach some conclusion that, then, also erosion
01:28 6 did not impact -- erosion in the reservoir and the wellbore
01:28 7 also did not impact the cumulative discharge.

01:28 8 **BY MR. BENSON:**

01:28 9 **Q.** So looking at your best estimate and your two alternate
01:28 10 calculations together, what do you conclude?

01:28 11 **A.** I conclude that at least from May 8th on, that erosion in
01:29 12 the BOP had negligible impact on the cumulative discharge, and
01:29 13 I conclude that erosion in the reservoir and the wellbore had a
01:29 14 negligible impact on the cumulative discharge.

01:29 15 **Q.** And in your career at Sandia, was doing alternate
01:29 16 calculations of this type part of your practice?

01:29 17 **A.** Sure. Any time you can calculate things by more than one
01:29 18 means, you can learn additional information. It's done all the
01:29 19 time.

01:29 20 **Q.** Now, let's turn to uncertainty analysis. Did you do
01:29 21 anything to estimate the uncertainty on your 5-million-barrel
01:29 22 estimate?

01:29 23 **A.** I did.

01:29 24 **Q.** And why did you do an uncertainty analysis?

01:29 25 **A.** Well, uncertainties are about what confidence you should

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01:29 1 place in your results. So I have quite a narrow range of
01:30 2 uncertainties, so I offer my best estimate, 5 million barrels,
01:30 3 and that's accompanied with statements or belief that I have
01:30 4 high confidence in that number.

01:30 5 If my uncertainties had covered a very, very broad
01:30 6 range, I might still offer you 5.0 million as my best estimate,
01:30 7 but that would be accompanied with statements that you should
01:30 8 not have high confidence in that number; you should take it
01:30 9 with a grain of salt.

01:30 10 **MR. BENSON:** If we could have Demonstrative 21224,
01:30 11 please.

01:30 12 **BY MR. BENSON:**

01:30 13 **Q.** This is Table 1 from your expert report.

01:30 14 In broad terms, what did you do for your uncertainty
01:30 15 analysis?

01:30 16 **A.** Well, in broad terms, I looked at multiple sources of
01:30 17 uncertainties, and those -- there's two main categories there.
01:30 18 One is things that would have happened that are not included in
01:31 19 my model; that's one category.

01:31 20 And the other category is just more classic
01:31 21 uncertainties in measurements. So there's -- you measure
01:31 22 pressures, there are uncertainties in that; you measure flow
01:31 23 rates, there are uncertainties in that. So those are the two
01:31 24 main contributors to uncertainties.

01:31 25 What's shown here -- they're not grouped that way in

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01:31 1 this figure. In this table, the yellow section are all
01:31 2 uncertainties from those couple of sources associated with my
01:31 3 parameter estimation. And the bottom section there is all
01:31 4 associated with things that would have varied or changed over
01:31 5 the 86 days.

01:31 6 Q. Now, let's just walk through one of the entries on this
01:31 7 table. We won't do all of them, but to explore how the table
01:31 8 works, can you walk us through the first entry?

01:31 9 A. Sure.

01:31 10 The first entry is uncertainties associated with the
01:31 11 flow through the BOP. And this is specifically associated with
01:31 12 uncertainties in my discharge coefficient for the BOP based on
01:32 13 the data I used to determine the parameter. So this is
01:32 14 uncertainty in the parameter that describes K-BOP.

01:32 15 So what I do is I -- so I assume that's a constant.
01:32 16 What I do is I look at -- while I know that density will vary,
01:32 17 I know that there are two-phase flow effects that will deviate
01:32 18 from that idealized constant discharge coefficient, and so I
01:32 19 calculate -- using an equation of state, I calculate over the
01:32 20 range of conditions I'm interested in, how much variability
01:32 21 would I expect in the flow through the BOP due to those effects
01:32 22 that are not included in my model.

01:32 23 And that -- you see this plus or minus 3.4 percent.
01:32 24 So over the range of conditions of interest during the shut-in,
01:32 25 I estimate that the flow rate through the BOP could vary by

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01:33 1 plus or minus 3.4 percent relative to my assumption that it's
01:33 2 just a constant.

01:33 3 Then I look at how that uncertainty propagates into
01:33 4 cumulative discharge. So if you look at the two columns, minus
01:33 5 1.6 and 1.8, those are the uncertainties in the cumulative
01:33 6 discharge based on that uncertainty in the BOP during the
01:33 7 shut-down period.

01:33 8 **THE COURT:** So I think I understand what you said,
01:33 9 but I want to make sure. Is it just coincidental that the
01:33 10 minus 1.6 and the plus 1.8 add up to 3.4? But that doesn't
01:33 11 equate to the plus or minus 3.4?

01:33 12 **THE WITNESS:** That's right. If that's the case --
01:33 13 well, there could be a physical reason that happened, but in
01:33 14 general, it would just be coincidental.

01:33 15 **THE COURT:** So plus or minus 3.4, meaning the effect
01:34 16 of the BOP only, you believe, could vary by that amount?

01:34 17 **THE WITNESS:** That's correct.

01:34 18 **THE COURT:** But the BOP being only one part of a
01:34 19 larger system, it wouldn't necessarily mean that there would be
01:34 20 a plus or minus 3.4 percent on the ultimate calculation?

01:34 21 **THE WITNESS:** Correct.

01:34 22 **THE COURT:** Okay.

01:34 23 **MR. BENSON:** Thank you, Your Honor.

01:34 24 **BY MR. BENSON:**

01:34 25 **Q.** Now, later on, we're going to talk about some of the

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01:34 1 criticisms that BP had made of your model. I want to just walk
01:34 2 through those quickly and see if they're addressed in your
01:34 3 uncertainty table here.

01:34 4 In your uncertainty analysis, did you do anything to
01:34 5 consider the potential effects of erosion?

01:34 6 A. Yes. Well, certainly -- well, my two alternate
01:34 7 calculations directly address that and for the period after
01:34 8 May 8th. For the period before May 8th, the last entry -- the
01:34 9 last row in that table specifically addresses those issues
10 associated with erosion, yes.

01:34 11 Q. And how about the potential impacts for multiphase flow,
12 is that present in your uncertainty table?

01:35 13 A. Sure. If you look at at least the top four -- the top
01:35 14 four entries in the yellow section are all associated with
01:35 15 changes in density, changes in two-phase flow factors. So
16 those definitely address two-phase flow effects.

01:35 17 Q. And we'll talk a little bit later about a criticism that
18 BP has made about the reliability of PT-B. Is that addressed
19 in your uncertainty analysis?

01:35 20 A. Yes. Again, uncertainties associated with PT-B are
21 explicitly called out and they are the second-to-the-bottom
22 row, I think, in that bluish-grayish section.

01:35 23 Q. Now, Dr. Griffiths, what did you conclude was the overall
24 uncertainty associated with your 5-million-barrel estimate?

01:35 25 A. It was roughly minus 14 percent to plus 10, so the actual

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01:35 1 numbers worked out 13.9 to 9.7.

01:36 2 Q. And how did you come up with those numbers based on the
01:36 3 rest of the table?

01:36 4 A. Well, I did something that represents just a phenomenal
01:36 5 worst case. I grouped all of these just according to their
01:36 6 signs. All the negative ones, I took all the negative ones and
01:36 7 added them together. That's the minus 13.9. I took all the
01:36 8 positive ones and added all those together. And I refer to
01:36 9 this as the worst case because, in reality, something like that
01:36 10 will never happen. Some of the uncertainties will be positive;
01:36 11 some will wind up being negative. So there's some canceling
01:36 12 out of things that would go on in reality.

01:36 13 And so I just wanted to do it in a way that would
01:36 14 provide very hard bounds on my very best estimate.

01:36 15 Q. So do you think the total could be 4.3 million or less?

01:37 16 A. Oh, the probability that it is 4.3 or less is miniscule.

01:37 17 Q. Now, let's turn now to the criticisms that BP has raised
01:37 18 toward your model. Have you reviewed the reports of the BP
01:37 19 experts in this case that address your work?

01:37 20 A. Yes, I have.

01:37 21 MR. BENSON: Could we turn to Demonstrative 21225.

01:37 22 BY MR. BENSON:

01:37 23 Q. And can you just sum up, just broad categories, the
01:37 24 criticisms that BP experts have made?

01:37 25 A. Sure. I think use of constant discharge coefficients over

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01:37 1 time, my treatment of potential erosion has been criticized.

01:37 2 Criticisms on multiphase flow effects.

01:37 3 Accuracy of PT-B has been raised as an issue and
01:37 4 then, of course, that I used a nonindustry-standard model.

01:37 5 Q. And we'll walk through those in a minute, but let me first
01:37 6 ask you: You've been working on the same basic methodology
01:37 7 since the summer of 2010. Have you considered these issues
01:38 8 before?

01:38 9 A. Yes. I think I considered all of these in the past.

01:38 10 Q. And have you sort of -- are you comfortable with these --
01:38 11 are you comfortable that you've sort of worked through these
01:38 12 criticisms in your own mind?

01:38 13 A. Yeah, I think so. When you do modeling, modeling is
01:38 14 always about driving down uncertainty. Usually from a business
01:38 15 point of view, it's about driving down risk. So most -- you
01:38 16 reduce your uncertainties down to some point that they become
01:38 17 irreducible, and then you put them in a table and say, Ah,
01:38 18 that's -- that's the best I can do. There are certain things
01:38 19 that can never be known more accurately.

01:38 20 So a lot of these things, like inaccurate BOP
01:38 21 pressures, you get to the point where you can say, Well, I can
01:38 22 bound it by this; I probably can't do better than that. I
01:38 23 addressed it through and through, so, yes.

01:38 24 Q. We'll walk through the criticisms, and we'll start with
01:38 25 your use of constant discharge coefficients over time.

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01:39 1 First, I want to understand what BP is saying.

01:39 2 What's your understanding why BP has suggested that your
01:39 3 discharge coefficients might change over time?

01:39 4 A. Well, I think the main thing is erosion.

01:39 5 Q. What did you conclude about whether erosion was changing
01:39 6 the discharge coefficient over time?

01:39 7 A. Well, I certainly concluded that post May 8th, there were
01:39 8 no significant changes. I concluded that prior to May 8th,
01:39 9 there was erosion very early on that in the end significantly
01:39 10 impacts the cumulative discharge, but it happens very quickly.

01:39 11 MR. BENSON: If we could have Demonstrative 21226,
01:39 12 please.

01:39 13 BY MR. BENSON:

01:39 14 Q. So why did you conclude, Dr. Griffiths, that erosion was
01:39 15 not significantly affecting total flow after that early period?

01:39 16 A. Well, again, we just talked about the two -- the best
01:40 17 estimate and two alternates, and I don't need to repeat
01:40 18 anything there.

01:40 19 I know that over the long term the decay of the BOP
01:40 20 pressures are consistent with decay of the reservoir pressures.
01:40 21 And through my model, I know that there has to be a certain
01:40 22 relationship between those and that relationship -- if these
01:40 23 are not changing and this ratio of the decay in the reservoir
01:40 24 pressure to the decay in the BOP pressures observes that,
01:40 25 behaves in a way that they are not changing. And finally,

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01:40 1 well, I know that that sort of thing, the resistance in the BOP
01:40 2 relative to the resistance in the wellbore and the reservoir,
01:40 3 remain essentially constant on a continuing basis over the time
01:40 4 period from May 8th on.

01:40 5 And then I think I already alluded to this, you know,
01:41 6 I know that erosion is a phenomena that can occur very, very
01:41 7 rapidly and then slows once apertures get opened a little bit.

01:41 8 Q. Let's focus on that last point for a minute. Can you
01:41 9 describe why erosion happens quickly.

01:41 10 A. Well, why it happens quickly in this case is just there's
01:41 11 high pressures, there's great potential to erode things very
01:41 12 quickly. So, I mean, if -- I'm not sure. The potential exists
01:41 13 to do great damage in a short while.

01:41 14 The business about it happens fast and then slows is
01:41 15 really about, you know, if I have flow through a very small
01:41 16 orifice, forgetting flow rate, I get very high velocities
01:41 17 through those. It's just like a nozzle on the end of a hose.
01:41 18 Erosion rates depend very strongly on fluid velocities. So
01:42 19 when an aperture is small, I have very high fluid velocities,
01:42 20 very high erosion rates. As that aperture opens, the flow rate
01:42 21 can stay the same, but the velocities go down. So as it opens,
01:42 22 velocity goes down, erosion rates drop very, very rapidly
01:42 23 because they depend on power from fluid speeds.

01:42 24 MR. BENSON: Now let's turn to Demonstrative 21227,
01:42 25 please.

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01:42 1 **BY MR. BENSON:**

01:42 2 **Q.** Can you describe some of the physical evidence you've seen
01:42 3 of rapid erosion.

01:42 4 **A.** Sure. So these are laser scans of a piece of pipe that
01:42 5 was recovered with the BOP and riser. The images on the left
01:42 6 are laser scans. This is a piece of pipe that sort of -- at
01:42 7 the time of the explosion, when the upper annular was being
01:42 8 closed and all that, at that point in time, this piece of pipe
01:43 9 was in the upper annular. And the lower part of that is the
01:43 10 tool joint that was in that upper annular. So you see a
01:43 11 tremendous bunch of erosion of that tool joint.

01:43 12 And then above that, where the pipe ends, that's
01:43 13 actually the top end of the upper annular. The pipe at that
01:43 14 point was eroded entirely through the pipe and the pipe was
01:43 15 also broken, but there was just tremendous erosion. And the
01:43 16 thing about this that tells us about the speed of erosion is
01:43 17 that that piece of pipe was, in fact, ejected up out of the BOP
01:43 18 and was in the riser at the time the riser collapsed.

01:43 19 And we know that because, if you look at the bottom
01:43 20 right corner, there's a big kink in that piece of pipe. It was
01:43 21 actually broken, but it's reconstructed here to show the kink.
01:43 22 So we know that this erosion was all associated with its
01:44 23 presence in the upper annular and that we know that within
01:44 24 36 hours, it was no longer in the upper annular. So that we
01:44 25 can say this erosion had to have occurred within that 36-hour

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01:44 1 period.

01:44 2 It might have been faster. We don't know that, but
01:44 3 we know that it happened within 36 hours.

01:44 4 **MR. BENSON:** Let's turn to Demonstrative 21228.

01:44 5 **BY MR. BENSON:**

01:44 6 **Q.** Have you seen other parties agreeing that erosion happened
01:44 7 fast in this incident?

01:44 8 **A.** Yes.

01:44 9 **Q.** Okay. And what we have here are TRES-1, which is the Bly
01:44 10 report; TRES-4248, which is the TO investigation report; and
01:44 11 then testimony from Phase One expert Earl Shanks.

01:44 12 **A.** Uh-huh.

01:44 13 **Q.** What did BP in the Bly report conclude about erosion?

01:44 14 **A.** Well, the quote at the top there is from the Bly report.
01:45 15 The highlighted part is: "Drill pipe had likely already failed
01:45 16 at the eroded section by this time." And the time frame
01:45 17 they're talking about is when the top drive fell. And I don't
01:45 18 know the exact timing of that, but I think it was within a half
01:45 19 an hour of the explosion, maybe an hour.

01:45 20 But in any case, so we've got physical evidence that
01:45 21 it happened within 36 hours. And here we have presumably
01:45 22 experts saying that they think it could have happened within an
01:45 23 hour.

01:45 24 **Q.** Now, let's turn to Mr. Shanks' Phase One testimony. What
01:45 25 did Mr. Shanks say about the timing?

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01:45 1 A. Here he's talking about erosion at the upper variable bore
01:45 2 rams. And the highlighted part of this is that he believed
01:45 3 that erosion -- and, again, there was very significant erosion
01:45 4 at that location -- he believes that it could have occurred in
01:46 5 less than a second.

01:46 6 Q. Now, what does erosion in the drill pipe during those
01:46 7 first hours, minutes, seconds tell you about erosion in the
01:46 8 system as a whole?

01:46 9 A. Well, it tells you the capacity to erode things in these
01:46 10 very short time frames exists. You would expect that anywhere
01:46 11 in this system that that capacity exists. So whether you're
01:46 12 talking about something in the reservoir or the float collar,
01:46 13 those sorts of things, that you should expect corrosion, very
01:46 14 significant erosion on time scales of seconds, minutes, hours,
01:46 15 maybe a couple of days, not on time scales of weeks, months.

01:46 16 Q. Did you review testimony -- I'm sorry. Did you review the
01:46 17 modeling of BP's Phase One expert, Dr. Emilsen?

01:47 18 A. I did.

01:47 19 Q. What did you determine from Dr. Emilsen's work about
01:47 20 erosion in the reservoir?

01:47 21 A. I determined that he -- his results supported similar
01:47 22 conclusions: that erosion in the reservoir or bottom of the
01:47 23 well was occurring on a time scale of hours, minutes, days, not
01:47 24 weeks and months.

01:47 25 Q. Did you personally examine elements of the system after

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01:47 1 they were recovered from the Gulf?

01:47 2 A. I did.

01:47 3 Q. And have you reviewed documents looking at the condition
01:47 4 of the riser, the BOP, the drill pipe, after recovery?

01:47 5 A. I'm sorry. Could you repeat that, please.

01:47 6 Q. Sure. Let me fix my mic.

01:47 7 Have you reviewed documents that looked at the
01:47 8 condition of the riser, the BOP, and the drill pipe after they
01:47 9 were recovered?

01:47 10 A. Yes.

01:47 11 Q. And your findings, are those reported in Appendix I of
01:48 12 your expert report and Appendix D of your rebuttal report?

01:48 13 A. I believe they are.

01:48 14 Q. So we won't go into each element of the system, but let's
01:48 15 talk about a couple of examples here.

01:48 16 Did you examine the blind shear rams?

01:48 17 A. I did.

01:48 18 **MR. BENSON:** Let's go to Demonstrative 21229, please.

01:48 19 **BY MR. BENSON:**

01:48 20 Q. What can you conclude about the blind shear rams and how
01:48 21 they affected flow over time?

01:48 22 A. Well, again, much like with the drill pipe and the upper
01:48 23 annulars, you can make statements about the speed of erosion in
01:48 24 the BSRs. So if you look at the top-right figure, what you see
01:48 25 is that there's a great deal of erosion in the upper left part

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01:48 1 of the ram.

01:48 2 So this is looking at the face of the ram, if that's
01:48 3 familiar. So there's the two faces of the ram with the blades
01:48 4 that come together. So we're looking on that face with -- and
01:48 5 then the pink part shows where the pipe would have set during
01:49 6 that -- during the closure.

01:49 7 So what you see in this is a tremendous amount of
01:49 8 erosion in the upper-left corner, across the back face, that
01:49 9 recess across the back, and then in the top right corner a
01:49 10 little bit more erosion.

01:49 11 What's really interesting here is that there's open
01:49 12 channels at both sides of this. But if you look at the
01:49 13 bottom-right corner there, very little erosion. And this is
01:49 14 the top-right figure, still, very little erosion down there.

01:49 15 The figure in the bottom left is just the side view
01:49 16 of all this. And then in the bottom right is the figure where
01:49 17 you see that sort of directly above that pipe, you know, that
01:49 18 whole area of the yellow -- the yellow-colored ram there, that
01:49 19 whole area is missing. Like if you look down on it directly,
01:50 20 you just see a hole down through there where that pipe is.

01:50 21 So when you look at all that erosion, you conclude
01:50 22 that all that erosion occurred in the upper half of this -- of
01:50 23 these blocks. It occurred all downstream of the end of the
01:50 24 pipe that extended below the BSRs.

01:50 25 At this point, when the BSRs were closed, that pipe

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01:50 1 ran, you know, all the way down to below the BOP. So all of
01:50 2 the erosion resulted from flow through that pipe.

01:50 3 That pipe was cut on April 29th by the casing shear
01:50 4 ram. So we know with -- just like with the pipe in the
01:50 5 annulars, we know that that erosion occurred in the interval
01:50 6 between the time the BSR was closed on April 22nd and the time
01:50 7 the CSR was closed on April 29th.

01:51 8 Q. So that's, at most, seven days' worth of erosion?

01:51 9 A. I think so, yes.

01:51 10 Q. Did you also look at the holes in the riser kink,
01:51 11 Dr. Griffiths?

01:51 12 A. I did.

01:51 13 Q. Did you reach any conclusion about whether the riser kink
01:51 14 holes are evidence of continuing erosion?

01:51 15 A. I did. It is my opinion that all of the leaks in the
01:51 16 riser originated as fractures. If you look in the vicinity of
01:51 17 all those leaks, you see cracks growing off.

01:51 18 And, you know, the kink in the riser was tremendous.
01:51 19 That material is, you know, inches thick. It's been kinked
01:51 20 entirely, the material's horribly strained.

01:51 21 It's fairly ductile material, but there are cracks.
01:51 22 And those cracks will continue to grow over time. And when
01:51 23 they get big enough, they start to seep; and when they start to
01:52 24 seep, very quickly they get washed out, eroded, and become the
01:52 25 leaks that were observed.

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01:52 1 So I actually believe that all of the leaks in the
01:52 2 risers were not a direct result of erosion but instead came
01:52 3 about through fractures.

01:52 4 Q. Now, let's turn to the opinions from a couple of BP
01:52 5 experts on erosion. First let's talk about BP expert
01:52 6 Dr. Adrian Johnson. He may come to testify that there are
01:52 7 other possible trends for PI, the productivity index, and the
01:52 8 discharge coefficients that are consistent with the pressure
01:52 9 data.

01:52 10 A. Uh-huh.

01:52 11 Q. Is that something you've considered, Dr. Griffiths?

01:52 12 A. Yes.

01:52 13 MR. BENSON: If we could go to Demonstrative 21231.

01:52 14 BY MR. BENSON:

01:52 15 Q. What does this depict, sir?

01:52 16 A. This is a figure from Dr. Johnson's report. It shows
01:52 17 histories of the productivity index as a function of time.
01:53 18 Again, this is over the 86 days, sort of.

01:53 19 The black curve up at the top is my constant PI of
01:53 20 about 44, you know, stock tank barrels a day per psi. And then
01:53 21 he gives two alternate -- these are simply hypotheticals, so --
01:53 22 which is fine. But there's two hypotheticals: Path A, that's
01:53 23 just a linear increase over the entire 86 days; and then
01:53 24 Path B, which remains constant for the first 30 days and then
01:53 25 begins, it increases linearly for the balance of the 86.

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01:53 1 Q. As a theoretical matter, why might the PI increase over
01:53 2 time?

01:53 3 A. Well, if there was something eroding in the bottom, it
01:53 4 could be associated with skin, it could be associated with
01:53 5 cement, you know, something changing in the bottom of the well
01:53 6 that would be increasing the productivity index.

01:54 7 Q. And, Dr. Griffiths, do you believe that Path A and Path B,
01:54 8 as set forth here by Dr. Johnson, are plausible alternatives
01:54 9 for the PI trend?

01:54 10 A. I don't. And the reason is this business of consistency
01:54 11 with the data. So the data says that the resistance in the BOP
01:54 12 relative to the resistance in the reservoir and wellbore
01:54 13 remained unchanged over the 86 days.

01:54 14 So if you're going to have a change in the PI, so
01:54 15 along one of these, like the red curve -- if you're going to
01:54 16 have a change in the PI, it has to be accompanied by a very
01:54 17 specific change in the BOP, which is two and a half miles away.
01:55 18 And that those changes have to occur together like that over
01:55 19 the entire 86 days.

01:55 20 So I'm talking about the green line, the Path B, for
01:55 21 example. It says the PI stays constant for 30 days, carries
01:55 22 with it -- the BOP resistance had to stay constant for 30 days.
01:55 23 Then the productivity index starts up. When you're linked at
01:55 24 that point, the BOP resistance has to be going down or matching
01:55 25 that at just that time. And then they have to move together

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01:55 1 for that entire period.

01:55 2 So I think that winds up -- these hypotheticals wind
01:55 3 up being, you know, within -- it's possible. You can't prove
01:55 4 they didn't happen, but -- but they require this coordination
01:55 5 between two things that are pretty much unrelated. And so
01:56 6 that's why I think it's just -- that's part of why I think this
01:56 7 is -- is not a plausible explanation.

01:56 8 Q. Now, let's turn to Dr.-- BP's expert, Dr. Nestic, for a
01:56 9 minute, and we'll wrap up our discussion of erosion by talking
10 about his report.

01:56 11 Have you reviewed Dr. Nestic's expert report in this
12 case?

01:56 13 A. Yes, I have.

01:56 14 Q. Can you describe briefly what Dr. Nestic did.

01:56 15 A. Well, he was examined -- he examined a couple of elements
01:56 16 within the BOP. So he looked at the casing shear ram, the
01:56 17 blind shear ram, upper annular, kinked riser. He calculated
01:56 18 pressure drops through these at two states. So he did this for
01:56 19 April 22nd. And what he used, I think, were laser scans of
01:56 20 piece parts of these things to try to reconstruct what the
01:56 21 geometry would be like. He did calculations of the pressure
01:56 22 drop through these as of April 22nd.

01:57 23 He then used laser scans of recovered parts, eroded
01:57 24 parts, and did a very similar sort of calculation for May 27th.
01:57 25 So he got pressure drops through these different elements.

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01:57 1 And he then presents a result where he has relative
01:57 2 pressure drop through these collection of resistances from
01:57 3 April 22nd through May 27th, and he connects these times with
01:57 4 straight lines.

01:57 5 And as part of all that, he asserts that this plot,
01:57 6 these curves, that line, are -- his word is "universal" with
01:57 7 respect to flow rate for all flow rates between 5,000 and
01:58 8 65,000 barrels a day.

01:58 9 Q. Does that make sense to you, Dr. Griffiths?

01:58 10 A. That makes no sense to me at all.

01:58 11 I think I would agree with him that pressure drops
01:58 12 are universal for given geometries, but the geometries
01:58 13 themselves, how they would have evolved between April 22nd and
01:58 14 May 27th, tremendously depended on flow rate.

01:58 15 So flow rate -- well, so particle velocity determines
01:58 16 erosion rate; particle velocities track fluid velocities; fluid
01:58 17 velocities for a given geometry are going to be proportional to
01:58 18 flow rate.

01:58 19 So I think we can just say erosion rates are going to
01:58 20 depend on flow rate, and they depend on a flow rate or a
01:59 21 velocity to a power, and a power's typically around 3. I think
01:59 22 in Dr. Johnson's own modeling he reported things that suggested
01:59 23 that the power was about 3.3.

01:59 24 Q. Let me interrupt you for a minute. You said Dr. Johnson?

01:59 25 A. I'm sorry. I'm sorry. Dr. Nesic. My apologies.

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01:59 1 Q. Go ahead.

01:59 2 A. So you got flow rate of 5,000 and 65,000. The ratio of
01:59 3 that is 13. 13 raised to a power of 3.3 is something a little
01:59 4 less than 5,000. I think it's about 4,700.

01:59 5 So for that range of flow rates, erosion rates would
01:59 6 differ very -- by a factor of almost 5,000. That's the
01:59 7 difference between 26 minutes and 86 days.

01:59 8 So the suggestion by Dr. Nestic that the same results
02:00 9 apply for all flow rates in that range and that that history --
02:00 10 excuse me -- history of what happened between April 22nd and
02:00 11 May 27th, I think, based on his analyses, it would be
02:00 12 impossible to say whether those obey this sort of flow linear
02:00 13 decay or whether that decay was almost immediate, followed by
02:00 14 nothing happening over the balance of the period.

02:00 15 **MR. BENSON:** Could we have Demonstrative 21253,
02:00 16 please.

02:00 17 **BY MR. BENSON:**

02:00 18 Q. Dr. Griffiths, it looks like the first bullet is what you
02:00 19 were just explaining. Is that right?

02:00 20 A. Yes, it is.

02:00 21 Q. And did Dr. Nestic provide opinions about how erosion would
02:00 22 change the flow rate over time?

02:00 23 A. He did.

02:00 24 Q. What are those opinions?

02:00 25 A. Well, his main opinion is that this erosion between

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02:01 1 April 22nd and May 27th would have doubled the flow rate. That
02:01 2 is based on -- I guess I would -- the word would probably be
02:01 3 "flawed analysis." Because, again, he looked at casing shear
02:01 4 ram, variable bore rams, upper annular, kinked riser. Those
02:01 5 were the only resistances he looked at.

02:01 6 So he didn't even look at the entire resistance of
02:01 7 the BOP. Because half of the resistance of the BOP sets in the
02:01 8 test rams and the two variable bore rams. And the BOP itself
02:01 9 is roughly half the resistance of the wellbore. And then
02:01 10 there's resistance in the reservoir as well.

02:01 11 So what happens when you just look at -- you've got a
02:01 12 bunch of resistances that determine your overall flow rate. If
02:01 13 you change one of them, in fact, it doesn't change the flow
02:02 14 rate very much. But if you look at just a subset of those and
02:02 15 say, well, these four things changed, and base your assessment
02:02 16 of the change in flow rate on that, it exaggerates the impact
02:02 17 of your erosion.

02:02 18 So doubling makes no sense at all to me. In fact,
02:02 19 BP -- during the response, BP estimated that removal of the
02:02 20 entire BOP, along with the riser, would only increase the flow
02:02 21 rate from the well by 15 to 30 percent. And I would agree that
02:02 22 that's the right sort of ballpark numbers. So a factor of 2,
02:02 23 doubling due to erosion in a couple of the elements of the BOP
02:02 24 just -- just really doesn't make any sense.

02:02 25 Q. Now, we talked earlier about the validation that you did

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02:02 1 for your model, Dr. Griffiths. Did Dr. Nestic do anything to
02:02 2 validate his modeling of the pressures?

02:03 3 A. He didn't, and I don't quite understand that.

02:03 4 His second date that he was modeling was May 27th.
02:03 5 May 27th is a day on which -- you know, this is during Top
02:03 6 Kill -- pressures were measured at multiple points through the
02:03 7 BOP. So these pressure drops that he's calculating were
02:03 8 measured on May 27th. And at least as far as I could see in
02:03 9 his report, he made no attempt to compare his calculated
02:03 10 pressures to these -- these pressures that were measured on the
02:03 11 same day.

02:03 12 Q. Is Dr. Nestic's opinion about slow, gradual erosion
02:03 13 consistent with the physical evidence that you've reviewed?

02:03 14 A. It's not.

02:03 15 Q. And we talked about that earlier?

02:03 16 A. Erosion occurs on time scales of seconds, minutes, hours,
02:03 17 a day or two, not weeks and months. Dr. Nestic's analysis has
02:03 18 this very slow, gradual erosion spread over 35 days. I don't
02:04 19 think that's consistent with the evidence.

02:04 20 Q. Let's turn to the second BP criticism that we identified
02:04 21 earlier, and that's multi- -- the effect of multiphase flow.

02:04 22 What's your understanding of this criticism?

02:04 23 A. I think it's simply that a constant discharge coefficient
02:04 24 can't capture the sort of richness and complexity of the
02:04 25 multiphase phenomena.

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02:04 1 Q. Does your model actually account for multiphase flow?

02:04 2 A. It does. I don't have to put it in there. Because,
02:04 3 again, it's based on measured flow rates of collected oil.
02:04 4 Whatever multiphase effects were present are reflected in my
02:04 5 model.

02:04 6 Q. And we talked earlier about the validation you did. Did
02:04 7 any of that validation relate to the issue of multiphase flow
02:04 8 effects?

02:04 9 A. Sure. All of Appendix C was about that. All of the first
02:05 10 several uncertainties in that table, in the yellow section of
02:05 11 that table were related to multiphase effects.

02:05 12 Q. In fluid dynamics, how are area, a flowing area and flow
02:05 13 rate related?

02:05 14 A. Let's see. For a given fluid speed, flow rate is exactly
02:05 15 proportional to the cross-sectional area.

02:05 16 Q. Now, BP expert Dr. Johnson has offered a criticism of your
02:05 17 model, looking at a case with a drill pipe in the production
02:05 18 casing. Do you recall that?

02:05 19 A. Yes, I do.

02:05 20 Q. Have you reviewed that modeling?

02:05 21 A. Yes, I have.

02:05 22 MR. BENSON: Could we go to Demonstrative 21232,
02:05 23 please.

02:05 24 BY MR. BENSON:

02:05 25 Q. What do we see here, Dr. Griffiths?

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02:05 1 A. Well, these are figures from the input -- input or output
02:06 2 files for Dr. Johnson's MAXIMUS calculations. He considered
02:06 3 three cases: a wellbore with no pipe in it, a wellbore with
02:06 4 the drill pipe that was hanging below the BOP dropped into the
02:06 5 well, and the third case, a wellbore with the pipe high --
02:06 6 high, still attached to the BOP.

02:06 7 MR. REGAN: Your Honor, I object to this testimony.
02:06 8 At the time of his deposition, Dr. Griffiths testified that the
02:06 9 only modeling of Dr. Johnson that he had seen -- he had it in a
02:06 10 footnote of his report -- it was modeling that was done by a
02:06 11 different expert, Dr. Pooladi-Darvish. I don't believe
02:06 12 Dr. Griffiths was using Dr. Johnson's modeling. He certainly
02:06 13 wasn't testifying about it at the time of his deposition.

02:06 14 So if this is something he's looked at since his
02:06 15 deposition, I don't think it's been disclosed.

02:06 16 MR. BENSON: It's not, Your Honor, and I can explain
02:07 17 or I can ask the witness.

02:07 18 THE COURT: Well, I'll sustain the objection.

02:07 19 MR. BENSON: Can we get into whether the witness has
02:07 20 reviewed this modeling? He's already testified that he did
02:07 21 review the modeling.

02:07 22 THE COURT: It wasn't fairly disclosed in his
02:07 23 rebuttal report.

02:07 24 MR. REGAN: It was not.

02:07 25 THE COURT: Okay. Sustain the objection.

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02:07 1 **MR. BENSON:** Can I speak to that issue, Your Honor?

02:07 2 **THE COURT:** No. I sustained the objection.

02:07 3 **BY MR. BENSON:**

02:07 4 **Q.** Dr. Griffiths, in your rebuttal report, did you address
02:07 5 whether Dr. Johnson's modeling used the correct area for the
02:07 6 drill pipe in the annulus?

02:07 7 **A.** I did.

02:07 8 **Q.** And what conclusion did you reach about that?

02:07 9 **A.** I concluded that Dr. Johnson had done calculations
02:08 10 where -- for the wellbore with a pipe inside it, where he
02:08 11 treated -- so that has a drill pipe and it has the annulus
02:08 12 between the drill pipe and the production casing, so annulus
02:08 13 between those.

02:08 14 He treated those as two drill pipes -- two pipes, not
02:08 15 drill pipes, just two pipes, one representing the true size of
02:08 16 the drill pipe and one, second pipe, representing the annulus
02:08 17 between the drill pipe and the casing.

02:08 18 Now, the size of that pipe is incorrect. It does not
02:08 19 represent the correct area of the annulus. And, in fact, the
02:08 20 pipe that represents the annulus, the size of that pipe is an
02:09 21 error by a factor of 4. It's a huge error.

02:09 22 **Q.** So in real life, Dr. Griffiths, which pipe is bigger?

02:09 23 **A.** The annulus is --

02:09 24 **MR. REGAN:** Pardon me. Pardon me, Dr. Griffiths.

02:09 25 Maybe there's a citation that you could give to

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02:09 1 me in his rebuttal report. But the only discussion he has of
02:09 2 parallel flow path by Dr. Johnson, he talks about the
02:09 3 composition of the fluid.

02:09 4 Perhaps I'm missing it here, but is there a
02:09 5 citation to the report where this --

02:09 6 **MR. BENSON:** Yeah. Page 10, the third paragraph.
02:09 7 The discussion Dr. Griffiths is referring to right now, he says
02:09 8 flow rates through the much larger annulus -- and that's
02:09 9 through the production casing that's used to describe it -- the
02:09 10 flow rates through the much larger annulus are smaller than the
02:09 11 flow rates through the drill pipe, just like a distinction in
02:09 12 size.

02:09 13 **MR. REGAN:** There's no calculations here. It's just
02:09 14 a statement. There's a footnote, then, that cites the model
02:09 15 runs, which were looked at by Dr. Pooladi-Darvish, not this
02:09 16 witness.

02:09 17 So, I mean, we're trying to bring things in
02:10 18 through witnesses that are the wrong witnesses. This is not
02:10 19 disclosed.

02:10 20 **MR. BENSON:** Your Honor, with respect, it is
02:10 21 disclosed in his report, and he's just explaining the sentence
02:10 22 in his report. Would it help if we call it up?

02:10 23 **THE COURT:** What page of his report?

02:10 24 **MR. BENSON:** It's page 10.

02:10 25 **THE COURT:** What part of it?

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02:10 1 **MR. BENSON:** It's the third paragraph of page 10, and
02:10 2 he's discussing various problems with Dr. Johnson's model.

02:10 3 The sentence begins, "For example, these
02:10 4 solutions exhibit flow down the wellbore annulus," and then,
02:10 5 "flow rates through the much larger annulus that are smaller
02:10 6 than those through the drill pipe."

02:10 7 **THE COURT:** Wait a minute. I'm still not on it --
02:10 8 oh, I'm on the wrong page. That's fine.

02:10 9 **MR. BENSON:** We've got it up on the screen, Your
02:10 10 Honor, if that's easier.

02:10 11 **THE COURT:** Page 10?

02:10 12 **MR. BENSON:** It's page 10, third paragraph.

02:10 13 If we could highlight starting at "flow rates
02:10 14 through the much larger annulus," that third line from the
02:11 15 bottom.

02:11 16 **THE COURT:** This is in his --

02:11 17 **MR. BENSON:** This is in his rebuttal report, Your
02:11 18 Honor.

02:11 19 **THE COURT:** I'm on the wrong page and the wrong
02:11 20 report.

02:11 21 **MR. BENSON:** I apologize, sir. We've got it up on
02:11 22 the screen.

02:11 23 **THE COURT:** Let me look. Okay. I see where you are.

02:11 24 **MR. REGAN:** May I be heard on that, Your Honor?

02:11 25 **THE COURT:** Go ahead.

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02:11 1 **MR. REGAN:** What he's referencing there -- see in
02:11 2 Footnote 15? That's a reference to modeling runs. Those
02:11 3 modeling runs were not done by Dr. Griffiths. They were looked
02:12 4 at by Dr. Pooladi-Darvish. And it says "extremely poor
02:12 5 convergence." We're going to hear about that from
02:12 6 Dr. Pooladi-Darvish. This is the wrong witness for this topic.

02:12 7 There's nothing in this report about him
02:12 8 calculating diameters or sizes. It is a generic comment.

02:12 9 He was asked about this footnote, and the
02:12 10 question: "Did you ever try to use the software that
02:12 11 Dr. Johnson used, that is, the MAXIMUS software, to try to
02:12 12 investigate his work?

02:12 13 "Answer: I did not."

02:12 14 **MR. BENSON:** If I can speak just to that point, Your
02:12 15 Honor. He cites the modeling in his report. He looked at the
02:12 16 results of the modeling. He needed another expert to convert
02:12 17 it into something that he could read, because Dr. Griffiths
02:12 18 doesn't have the MAXIMUS model that Dr. Johnson happened to
02:12 19 use. It's not a commonly used model in this case. So it was
02:12 20 converted by another expert. Dr. Griffiths looked at it, saw
02:12 21 the results, and was able to reach conclusions that he can
02:12 22 testify to.

02:12 23 **THE COURT:** All right. Let me go back to see what
02:12 24 your original question was that started all this conversation.

02:13 25 I think what he was trying to say is that the --

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02:13 1 you addressed whether Dr. Johnson's modeling used correct area
02:13 2 of the drill pipe in the annulus.

02:13 3 How does that relate to what you said in your
02:13 4 report? Are you talking about the larger annulus?

02:13 5 **THE WITNESS:** It is. I mean, this whole discussion
02:13 6 is about areas of different parts of it. And, in fact, what I
02:13 7 had -- I was provided outputs from the calculations. Because I
02:13 8 don't have the model, and so I looked at those outputs. And
02:13 9 those statements are based on my examination of the outputs of
02:13 10 the model.

02:13 11 **THE COURT:** Okay. I'm going to let him answer the
02:13 12 question. It's kind of vague, but I think it's loosely related
02:13 13 to what he says in his report. Go ahead.

02:13 14 **BY MR. BENSON:**

02:13 15 **Q.** Okay. Dr. Griffiths, can you just explain what you meant
02:13 16 by the difference in size and what effect that has on a flow
02:13 17 rate.

02:13 18 **MR. REGAN:** I might -- just one point, Your Honor, on
02:14 19 the issue. The prior page -- it was page 389 of his deposition
02:14 20 where he gave that answer. And he was instructed not to answer
02:14 21 a question about his interaction with Dr. Pooladi-Darvish on
02:14 22 this question.

02:14 23 I respect your ruling. But we were blocked from
02:14 24 asking him further questions about this in terms of his
02:14 25 interaction with that expert.

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02:14 1 THE COURT: Okay. I understand.

02:14 2 MR. BENSON: I can speak to that, if you want, Your
02:14 3 Honor.

02:14 4 THE COURT: No. Just go ahead.

02:14 5 MR. BENSON: Okay.

02:14 6 BY MR. BENSON:

02:14 7 Q. So, Dr. Griffiths, I think the question is: Can you
02:14 8 describe what the issue is with the sizes of the pipe versus
02:14 9 the annulus and how those would affect flow rate.

02:14 10 A. What's used in Dr. Johnson's MAXIMUS models is not the
02:14 11 correct area for the annulus. It is the area of the hydraulic
02:14 12 diameter. That is an improper area to use in the calculation
02:14 13 of flow rate.

02:14 14 There's a very specific way you calculate
02:14 15 approximate. And it's a valid -- it's an approximation, but
02:15 16 it's the flow in an annulus. So this is a disk with a hole in
02:15 17 it. You calculate the fluid speed based on the hydraulic
02:15 18 diameter. The hydraulic diameter is just the diameter of a
02:15 19 pipe that's -- that's -- whose diameter is the difference
02:15 20 between the inner and outer diameters of the annulus.

02:15 21 So you use hydraulic diameter to calculate fluid
02:15 22 speed. You then calculate flow rate by taking that fluid speed
02:15 23 and multiplying it by the true cross-sectional area of the
02:15 24 annulus. In the case of Dr. Johnson's calculation, he used the
02:15 25 area of the diameter. That area is in error by a factor of 4.

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02:15 1 Huge difference.

02:16 2 And so, in essence, Dr. Johnson's modeling something
02:16 3 that never did, never could have existed in the Macondo well.

02:16 4 Q. And just to sum up the testimony, you're saying that
02:16 5 Dr. Johnson is modeling a smaller amount of flow through the
02:16 6 bigger flowing space?

02:16 7 A. Well, what's happened --

02:16 8 MR. REGAN: Objection. Objection, Your Honor. The
02:16 9 witness testified that he only examined this a tiny bit. That
02:16 10 was his phrase. He did not disclose a factor of 4. He did not
02:16 11 disclose this opinion.

02:16 12 MR. BENSON: Well, I'm just trying to sum up because
02:16 13 we've had a number of interruptions.

02:16 14 THE COURT: Well, you don't necessarily get to sum up
02:16 15 a witness. So you've asked the questions; I've heard his
02:16 16 answers.

02:16 17 MR. BENSON: Okay. I'll move on, Your Honor.

02:16 18 BY MR. BENSON:

02:16 19 Q. Okay. Dr. Griffiths, let's turn on -- turn our attention
02:16 20 to the next criticism that BP has raised and that's the
02:16 21 accuracy of PT-B, the BOP pressure gauge.

02:16 22 A. Yes.

02:16 23 Q. What did you personally conclude about the accuracy of
02:16 24 PT-B?

02:16 25 A. I concluded that once corrected, that the pressures would

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02:17 1 be correct within plus or minus 130 psi.

02:17 2 Q. And you've been talking about a correction. Does that
02:17 3 mean the gauge is inaccurate?

02:17 4 A. No, those are corrections for offsets. So offsets in a
02:17 5 gauge in the simplest form is just like having a watch that --
02:17 6 that's always off by 10 minutes. You know, if you have a watch
02:17 7 that's off by 10 minutes, it's an inaccurate watch. If you
02:17 8 know it's off by 10 minutes always, you just subtract the
02:17 9 10 minutes and -- and so that's what these corrections are
10 about.

02:17 11 Q. Now, in your expert report, you describe the offsets that
02:17 12 you concluded were appropriate for PT-B. We won't go into
02:17 13 those here. Did any of BP's experts also analyze PT-B and
02:17 14 propose their own offsets?

02:17 15 A. Yes, Dr. Trusler did.

02:17 16 Q. Okay. At a high level, what did Dr. Trusler conclude
02:17 17 about the accuracy of PT-B?

02:17 18 A. He concluded that once corrected per his corrections, that
02:18 19 the accuracy would be plus or minus 200 psi.

02:18 20 Q. And how did Dr. Trusler's corrections compare to yours?

02:18 21 A. Well, he did corrections at multiple periods; I only did
02:18 22 two. For the period up to about July 11th, he provided two
02:18 23 corrections. My correction for that period was 740 psi. His
02:18 24 two corrections were something very close to 600 and 800. So
02:18 25 my corrections sit just sort of right in between his -- his

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02:18 1 two. He had one for each of two periods there.

02:18 2 Q. And how about for the period after July 12th?

02:18 3 A. After July 12th, we disagree on the corrections. I
02:18 4 believe that the information provided to Dr. Trusler and to me
02:18 5 already contained a correction of 966 psi. So Dr. Trusler and
02:19 6 I disagree on that. I have done calculations using his
02:19 7 corrections.

02:19 8 Q. What do you see if you do those calculations?

02:19 9 A. Well, let's see. If I use -- only use his corrections for
02:19 10 the period before July 11th, I get exactly 5 million barrels
02:19 11 still. If I use his corrections for, you know, that period up
02:19 12 to July 11th, as well as his corrections for after July 11th,
02:19 13 my cumulative discharge goes up to 5.4 million barrels.

02:19 14 Q. You're not saying that your opinion is 5.4 million barrels
02:19 15 today, are you?

02:19 16 A. No. I don't believe his corrections are correct, and so I
02:19 17 would not be inclined to increase my best estimate based on
02:19 18 those.

02:19 19 Q. Now, did any other BP experts rely on PT-B for their
02:19 20 calculations in this case?

02:20 21 A. I believe Dr. Gringarten did.

02:20 22 **MR. REGAN:** Your Honor, I'm going to interpose an
02:20 23 objection to testimony of this witness about Dr. Gringarten.
02:20 24 Dr. Gringarten's name does not appear in his report or in his
02:20 25 rebuttal report. And under the four corners rule, he wrote a

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02:20 1 rebuttal report after Dr. Gringarten's work and report was
02:20 2 issued. If he had something to say about Dr. Gringarten at the
02:20 3 time, he would have put it in his rebuttal report. He did not.
02:20 4 He should not testify as to it.

02:20 5 **MR. BENSON:** We're moving on. That was it,
02:20 6 your Honor.

02:20 7 **THE COURT:** Okay.

02:20 8 **BY MR. BENSON:**

02:20 9 **Q.** Now, Dr. Griffiths, we've walked through three of the four
02:20 10 BP criticisms.

02:20 11 Let's quickly look at the last criticism that we
02:20 12 identified earlier. Did BP also suggest that you should use a
02:20 13 commercial flow rate model rather than your model in this case?

02:20 14 **A.** Yes.

02:20 15 **Q.** Are you aware of industry models that could calculate flow
02:20 16 rate in a situation like this?

02:20 17 **A.** No. Commercial software could be used to model, like,
02:20 18 flow in the capping stack and choke and kill line and things
02:21 19 like that. But the problem I was solving with the BOB -- BOP,
02:21 20 excuse me, wellbore and the PI, the geometries are just not
02:21 21 known.

02:21 22 I mean, if you want to do a calculation with
02:21 23 commercial software, general-purpose software, you have to know
02:21 24 the geometry. If you do not know the geometry, you cannot do
02:21 25 accurate calculations of flow rate.

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02:21 1 Q. Let's just wrap up your testimony. Based on your work,
02:21 2 what's your best estimate of the total discharge for the
02:21 3 Macondo well?

02:21 4 A. 5.0 million barrels.

02:21 5 Q. And do you have confidence that the total flow was about
02:21 6 5 million?

02:21 7 A. I do. After all the number crunching is done, I spent a
02:21 8 lot of time thinking about this -- is there any basis for
02:21 9 increasing it to 5.1, is there any basis for reducing it to
02:21 10 4.9. At the end of the day, I have the highest confidence in
02:22 11 5.0.

02:22 12 Q. Dr. Griffiths, how does the quality of the work that you
02:22 13 performed in developing your total flow estimate compare to the
02:22 14 work you did at Sandia in areas like nuclear weapons design and
02:22 15 nuclear test containment?

02:22 16 A. I would say very comparable. I think in the end, I've
02:22 17 actually checked these calculations more carefully than I have
02:22 18 ever checked any calculations in my -- in my career.

02:22 19 MR. BENSON: Thank you, Dr. Griffiths.

02:22 20 No further questions at this time, Your Honor.

02:22 21 THE COURT: All right. Mr. Regan.

02:23 22 MR. REGAN: May I proceed, Your Honor?

02:23 23 THE COURT: Yes.

24

25

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CROSS-EXAMINATION

1 **BY MR. REGAN:**

2 **Q.** Good afternoon, Dr. Griffiths. Matt Regan on behalf of
3 BP, and I have you on cross-examination.
4

5 Dr. Griffiths, you have a method where you estimate
6 wellbore and reservoir productivity -- wellbore discharge
7 coefficient resistance, reservoir productivity, and parameters
8 as of July 15th; correct?

9 **A.** That's correct.

10 **Q.** You take those July 15th values and you apply them to
11 every day before July 15th back to April 20th; correct?

12 **A.** That is the methodology of my best estimate, yes.

13 **Q.** You then use what you call as the measured available data,
14 but you use the PT-B data that existed to then calculate flow
15 rate over the entire flow period; correct?

16 **A.** That's correct.

17 **Q.** And you only have PT-B data from May 8th through
18 July 15th; correct?

19 **A.** Correct.

20 **Q.** So using that methodology, you calculate a
21 5-million-barrel -- 5-million-barrel cumulative -- cumulative
22 estimate; correct?

23 **A.** That's correct.

24 **Q.** You have uncertainty of negative 13.9 percent and positive
25 9.7 percent on that estimate; correct?

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02:24 1 A. Correct.

02:24 2 Q. So your lower end cumulative release is 4.3 million
02:24 3 barrels; correct?

02:24 4 A. Very much so a worst case, yes.

02:24 5 Q. It's within your range; correct?

02:24 6 A. Yes.

02:24 7 Q. You have an upper bound of 5.5 million barrels; correct?

02:25 8 A. Yes.

02:25 9 Q. Now, with respect to April 20th to May 8th, the time
02:25 10 period that we just spoke about, you calculate daily flow rates
02:25 11 for each of those days; correct?

02:25 12 A. Could you repeat the dates, please?

02:25 13 Q. Yes, sir. April 20th to May 8th.

02:25 14 A. Yes.

02:25 15 Q. You calculate daily flow rates for each of those days;
02:25 16 correct?

02:25 17 A. Yes, nominally.

02:25 18 Q. And with respect to your best estimate, the highest flows
02:25 19 that you calculate are in those earliest days; correct?

02:25 20 A. Yes.

02:25 21 Q. And the largest uncertainty that you have in your work is
02:25 22 as to that same time period; correct?

02:25 23 A. Yes.

02:25 24 Q. So the time period where you calculate the largest
02:25 25 proportion of your cumulative flow is also the time period

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02:25 1 where you have the greatest uncertainty; correct?

02:25 2 A. Well, I think so. I'm not sure what the largest portion
02:25 3 of my flow is, but I think I agree with you, but I'm not
02:26 4 positive on that point.

02:26 5 Q. You calculate about a million barrels of your
02:26 6 5-million-barrel estimate in the time period where you have no
02:26 7 PT-B data; correct?

02:26 8 A. That's correct.

02:26 9 Q. Your prior work was endorsed -- or you issued a report at
02:26 10 Sandia, correct, in 2011?

02:26 11 A. Yes.

02:26 12 Q. And you have a publication also in 2011 that you cited in
02:26 13 your direct exam; correct?

02:26 14 A. The journal papers?

02:26 15 Q. Yes.

02:26 16 A. Uh-huh.

02:26 17 Q. And the discussion that you had earlier today about
02:26 18 effects of erosion in the BOP, that's not found in either your
02:26 19 2011 peer-reviewed publication or your 2011 Sandia report;
02:26 20 correct?

02:26 21 A. Correct.

02:26 22 Q. There's been no peer review of your erosion opinions in
02:26 23 that respect; correct?

02:26 24 A. I suppose that's correct.

02:26 25 Q. You're not an expert in oil and gas?

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02:26 1 A. I'm not. That's safe to say.

02:27 2 Q. As you said on your direct, you did not use
02:27 3 industry-standard models for calculating your flows; correct?

02:27 4 A. Correct. Well, other than the -- in the validation where
02:27 5 those were commercial software to validate my methodology. I
02:27 6 didn't use it directly.

02:27 7 Q. Your method is not what you would call a general-purpose
02:27 8 tool; correct?

02:27 9 A. It describes Macondo well and only Macondo well because
02:27 10 it's based on data from Macondo well.

02:27 11 Q. Your approach, in your own words, is not the approach that
02:27 12 a traditional fluid dynamics person would go to; correct?

02:27 13 A. Computational person, yeah, somebody that works with big
02:27 14 CFD codes probably would throw up their hands and say, I can't
02:27 15 do that problem, I don't know the geometry.

02:27 16 Q. Your approach, Dr. Griffiths, is not the sort of
02:27 17 traditional fluid dynamics approach that someone would go to;
02:28 18 correct?

02:28 19 A. I don't know. It depends on what you mean by
02:28 20 "traditional" and -- actually, mine is probably very much
02:28 21 traditional, meaning old school. If you'd ask somebody in 1955
02:28 22 or 1960, they probably would have done what I did.

02:28 23 Q. Dr. Griffiths, was the methodology that you used generally
02:28 24 accepted in the scientific world that you work in?

02:28 25 A. Well, it is. I just -- you know, it depends how you look

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02:28 1 at it. If I had a commercial tool and I chose that as my path,
02:28 2 what would I do? I would take that commercial tool, I would
02:28 3 build a model, similar to mine, of the whole system. I would
02:28 4 take measured pressures during shut-in. I would take measured
02:28 5 flow rates of collected oil, and I would tune my model to all
02:28 6 the data. And once I had tuned my big computational CFD tool
02:29 7 to all of the data, I would have exactly -- not exactly, too
02:29 8 strong -- almost exactly the same model I built.

02:29 9 I just didn't take commercial software, tune it to
02:29 10 the data. I just said, let's just start with the data and
02:29 11 build a model around the data.

02:29 12 Q. Doctor --

02:29 13 A. So it is -- it's the same thing that you do with
02:29 14 commercial software when you tune using data. I just said,
02:29 15 let's skip all that, start with the data, and work toward the
02:29 16 model.

02:29 17 Q. Dr. Griffiths, your approach that you're using in your
02:29 18 expert testimony here today is not an approach, the sort of
02:29 19 traditional fluid dynamics approach, that someone normally
02:29 20 would go to; correct?

02:29 21 A. I don't know exactly how to answer any better than I have.

02:30 22 MR. REGAN: If we could pull up your deposition,
02:30 23 November 14th, 561, lines 11 through 21.

02:30 24 BY MR. REGAN:

02:30 25 Q. Were you asked this question and did you give this answer

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02:30 1 at your deposition, Dr. Griffiths:

02:30 2 "Question: Was the methodology you used generally
02:30 3 accepted in the scientific world that you work in?

02:30 4 "Answer: It would depend on who you ask. I would --
02:30 5 I would characterize these as -- my overall approach is
02:30 6 somewhat -- orthodox is too much strong a word. It is not an
02:30 7 approach that -- that the sort of traditional fluid dynamics
02:30 8 sort of person would -- you know, that had a model would --
02:30 9 would go to."

02:30 10 Were you asked that question and did you give that
02:30 11 answer, Dr. Griffiths?

02:30 12 A. Yes, certainly.

02:30 13 Q. It's not an approach that you used on any other oil well
02:30 14 in the past prior to Macondo; correct?

02:30 15 A. Excuse me, that I had used on any other oil well?

02:30 16 Q. Yes.

02:30 17 A. Correct.

02:30 18 Q. You had never analyzed flows at an oil well prior to
02:30 19 working on the Macondo accident; correct?

02:31 20 A. That's correct.

02:31 21 Q. You described your methodology as a specialized model;
02:31 22 correct?

02:31 23 A. Yes.

02:31 24 Q. It addresses only this particular well and only the
02:31 25 particular conditions at this particular well; correct?

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02:31 1 A. Yes.

02:31 2 Q. It is not a general-purpose tool, in your own words;
02:31 3 correct?

02:31 4 A. Correct.

02:31 5 Q. It would not be useful for modeling flows at any other
02:31 6 well; correct?

02:31 7 A. Well, yes, but that's because the parameters, the data
02:31 8 used to get the parameters are -- come from the Macondo well.
02:31 9 The methodology would certainly work on other wells. If you
02:31 10 tell me, here's pressures and here's measured flow rates, I
02:31 11 could use the same model to describe another well.

02:31 12 When I say that, it's only because the parameters
02:31 13 that I have come from Macondo, they describe Macondo, nothing
02:32 14 else.

02:32 15 Q. You have never tried to use this same approach to analyze
02:32 16 another well to see if it would work; correct?

02:32 17 A. I have never analyzed another well.

02:32 18 Q. Your method does not use a detailed description of the
02:32 19 physical geometries at Macondo as inputs; correct?

02:32 20 A. It does not require those as inputs.

02:32 21 Q. Does not require them and does not use them; correct?

02:32 22 A. Both true.

02:32 23 Q. You do not use an equation of state in calculating your
02:32 24 best estimate; correct?

02:32 25 A. Again, not required by my methodology.

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02:32 1 Q. And not used?

02:32 2 A. And not used, yes.

02:32 3 Q. You do not use gas-oil ratios or temperature inputs or
02:32 4 parameters for multiphase flow as inputs into your model;
02:32 5 correct?

02:32 6 A. All of the same, not used, but also not required.

02:32 7 Q. You do not include any description of the flow path in
02:32 8 your model; correct?

02:32 9 A. Oh, that's not true. You know, it's true I don't have to
02:32 10 know the details of the flow path, but my little colored
02:33 11 diagrams are specifically about what the flow path was. I do
02:33 12 need to know that the -- the way the various elements are
02:33 13 connected, which is what the flow path is.

02:33 14 Q. You need to know the flow segments in the order in which
02:33 15 they appear at the well; correct?

02:33 16 A. Right.

02:33 17 Q. But you don't need to know anything about their actual
02:33 18 characteristics?

02:33 19 A. That was one -- that's one of the great strengths of the
02:33 20 methodology, yes.

02:33 21 Q. And the only actual flow input, flow input, in your
02:33 22 methodology is from data taken on July 15th from a single hour;
02:33 23 correct?

02:33 24 A. Well, not exactly. But because I used information from
02:33 25 July 14th, which had the same physical configuration. And at

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02:33 1 that time the flow rate of collected oil was zero, so I have
02:34 2 one value that's zero and one that's not zero.

02:34 3 Q. So your 5-million-barrel cumulative estimate is based on
02:34 4 two flow inputs, a value of zero on July 14th and a value of
02:34 5 collected oil on July 15th; correct?

02:34 6 A. That's true. I did -- I did discuss uncertainties
02:34 7 associated with those.

02:34 8 Q. And when validating issues with respect to uncertainties
02:34 9 for your flow, you validated against other periods of
02:34 10 collection, three other periods of collection; correct?

02:34 11 A. I did.

02:34 12 Q. And all of those were, again, in July 14th and July 15th;
02:34 13 correct?

02:34 14 A. That's correct.

02:34 15 MR. REGAN: If we could pull up D-23401.

02:34 16 BY MR. REGAN:

02:34 17 Q. I'd like to talk a little bit about your parameter
02:34 18 estimation. This is a description of your constant discharge
02:34 19 coefficients; correct?

02:34 20 A. Uh-huh.

02:34 21 MR. REGAN: If we go to D-24372.

02:35 22 BY MR. REGAN:

02:35 23 Q. This relates them to the well. And I think as you said in
02:35 24 your direct, you don't need to know the specific geometry, as
02:35 25 you just said a minute ago, just the order in which these

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02:35 1 things appear; correct?

02:35 2 A. Correct.

02:35 3 Q. Each of the parameters on the left side of the screen are
02:35 4 unknowns; correct?

02:35 5 A. Well, before you do parameter estimation, yeah, they
02:35 6 are -- the model is constructed. It contains six constants
02:35 7 that until you use the data, you do not know.

02:35 8 Q. The purpose of the parameter estimation is to try to
02:35 9 estimate values for these six unknown parameters; correct?

02:35 10 A. Correct.

02:35 11 Q. You do not have any direct measurements of any of these
02:35 12 parameters?

02:35 13 A. Well, that's true.

02:35 14 Q. You estimate all of them using data from July 14th and
02:35 15 July 15th; correct?

02:35 16 A. That's true.

02:35 17 Q. The pressures that you use for your parameter estimation
02:36 18 are pressures from July 14th and July 15th; correct?

02:36 19 A. Yes.

02:36 20 Q. And as you said, the flows that you used, you use a single
02:36 21 flow rate of collection plus a flow of zero from July 14th and
02:36 22 July 15th; correct?

02:36 23 A. Correct.

02:36 24 Q. And the collected flow rate is just a partial flow, not
02:36 25 complete flow from the well; correct?

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02:36 1 A. That's correct.

02:36 2 Q. And so you would agree, Dr. Griffiths, that when we look
02:36 3 at how you developed your parameters, the pressures that you
02:36 4 used and the flow rates that you use are by definition a
02:36 5 product of the flow path, the geometry, and flow conditions
02:36 6 that existed as of July 15th -- 14th or 15th, 2010; correct?

02:36 7 A. Correct.

02:36 8 Q. You also used some constraints in your parameter
02:36 9 estimation; is that right?

02:36 10 A. Yes.

02:36 11 Q. And in your baseline case -- let me go to this. In terms
02:37 12 of estimating these six parameters, you estimate them all at
02:37 13 the exact same time; right?

02:37 14 A. Well, you have -- you have the collection of -- I don't
02:37 15 know what "exact same time" means. You have the collection of
02:37 16 data, you have a requirement that you have to satisfy
02:37 17 conservation of mass. There's a piece of software that varies
02:37 18 all six parameters to satisfy conservation of mass as best as
02:37 19 is possible given the measured pressures and measured flow
02:37 20 rates of collected oil.

02:37 21 Q. When you run this parameter estimation, all six unknown
02:37 22 parameters are moving and then you try to get them as close to
02:37 23 a flow rate constraint that you have in your model and then you
02:37 24 lock in their values?

02:37 25 A. Well, it's not known. It's not just the flow rate. There

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02:37 1 are -- there are about 30 residuals that are defined that
02:38 2 define, you know, states as the variable choke is closed. So
02:38 3 there are 30 of those. You have to satisfy -- you try to
02:38 4 satisfy conservation of mass as best you can for each of those
02:38 5 conditions, plus the two constraints that have flow rates.

02:38 6 So it's much more than just trying to match a flow
02:38 7 rate.

02:38 8 Q. However the model works, you end up with a single value
02:38 9 for each of these six discharge coefficients as of July 15th;
10 correct?

02:38 11 A. Uh-huh, yes.

02:38 12 Q. And then you would lock in that value and use a portion of
13 those parameters for your cumulative flow; correct?

02:38 14 A. I do use those values over the preceding 86 days for
15 calculating flow rates, yes.

02:38 16 Q. You did not independently calculate any of these
17 parameters for any dates prior to July 15th; correct?

02:39 18 A. No, I did not.

02:39 19 Q. So you cannot determine if, in fact, the parameter values
20 that you arrived at on July 15th would be the appropriate
21 parameter values for any of the preceding 85 days?

02:39 22 A. No, I would -- I guess I wouldn't agree with anything that
23 broad.

02:39 24 Q. You had --

02:39 25 A. I might have to hear it again, but...

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02:39 1 Q. You did not independently calculate what these parameters
02:39 2 would be, what their values would be, for any days other than
02:39 3 July 15th; correct?

02:39 4 A. That's correct.

02:39 5 Q. You didn't have the data to do it for any day prior to
02:39 6 July 15th?

02:39 7 A. That's correct.

02:39 8 Q. So you can't say whether ten days earlier or 30 days
02:39 9 earlier or 50 days earlier, these parameters would have the
02:39 10 same value as they do on July 15th?

02:39 11 A. Well, that's what I disagree with.

02:39 12 Q. So you did calculate them at an earlier date?

02:40 13 A. I did not do it by calculating at the earlier date, but
02:40 14 there was sort of a leap in there between your two questions
02:40 15 and from my two alternate calculations, from what we know about
02:40 16 decay rates of the BOP pressures relative to reservoir
02:40 17 pressures, from all of the physical evidence and the speed of
02:40 18 erosion and from my own examination of physical evidence and
02:40 19 opinions about how and when erosion occurred, I have concluded
02:40 20 to a very high level of confidence that there was a lot of
02:40 21 erosion and it all occurred within the first week or something.

02:40 22 So I do have reasons to believe that those values,
02:40 23 based on July 14th/15th, are reasonable and applicable and
02:40 24 justifiable for use over the preceding, maybe not 86 days, but
02:41 25 we could say 84 days or 85 days.

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02:41 1 Q. Simple question, Dr. Griffiths: You only calculated them
02:41 2 for July 14th/July 15th?

02:41 3 A. Yes, I've already agreed to that.

02:41 4 Q. In your best estimate, you use two of these parameters,
02:41 5 what you refer to as productivity index and wellbore discharge
02:41 6 coefficient?

02:41 7 A. Uh-huh.

02:41 8 Q. Along with reservoir pressure and PT-B; correct?

02:41 9 A. Correct.

02:41 10 Q. What you use as a PI is the constant estimate from
02:41 11 July 15th. It's not a measured number; correct?

02:41 12 A. It's the number that I determined. I also did validate it
02:41 13 against what BP thought would be a reasonable value.

02:41 14 Q. It's not a measured number. Your constant value of PI is
02:41 15 not a measured number; correct?

02:41 16 A. I can't quite agree with that. Because, again, it's
02:41 17 determined from data. To the extent -- it's determined in part
02:42 18 from data, it's determined in part from my model. So to say
02:42 19 simply it's a calculated number isn't the full story. Because
02:42 20 it -- if it weren't for the measured flow rates and the
02:42 21 measured pressures, which are data, which is about
02:42 22 measurements, I would have no estimate of the Productivity
02:42 23 Index at all, so --

02:42 24 Q. You calculate the PI; correct? Through your parameter
02:42 25 estimation; correct?

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02:42 1 A. It is a numerical algorithm. I do calculate it, but its
02:42 2 origins are in data and that makes it a measurement. So I
02:42 3 can't say that it's simply a calculated number, because it's
02:42 4 not. Because it comes from the measured flow rates and the
02:42 5 measured pressures and that makes it, at least in part, a
02:42 6 measurement.

02:42 7 Q. You do not have a data point that you could point the
02:43 8 Court to to say, this is a data point for PI that I grabbed
02:43 9 from Macondo; correct? All you have is a calculation?

02:43 10 A. No, it's not just a calculation. It's partly a
02:43 11 calculation; it's partly a measurement. If there were no -- if
02:43 12 I were going to calculate PI, I would start with permeability
02:43 13 and velocity and all that sort of stuff and formation volume
02:43 14 factors and everything else, and I could calculate a PI. I did
02:43 15 not do that.

02:43 16 I determined a PI partly through calculation but
02:43 17 largely through measurements of pressures and flow rates and
02:43 18 then that becomes, in part, a measured PI.

02:43 19 MR. REGAN: D-24374.

02:44 20 BY MR. REGAN:

02:44 21 Q. This is a demonstrative exhibit, Dr. Griffiths.

02:44 22 And for your best estimate, you used the values for
02:44 23 K-well, that's your wellbore discharge coefficient, and your
02:44 24 value for PI, productivity index, the constant value you
02:44 25 calculated on July 15th, and you apply those two values

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02:44 1 uniformly over the entire flow period; correct?

02:44 2 **MR. BENSON:** Objection. I think we've been over
02:44 3 this.

02:44 4 **THE COURT:** Overruled.

02:44 5 **THE WITNESS:** Yes. My best estimate methodology uses
02:44 6 a PI and the wellbore discharge coefficient as determined, you
02:44 7 know, based on the data from July 14th and 15th.

02:44 8 **BY MR. REGAN:**

02:44 9 **Q.** So practically speaking, Dr. Griffiths, in your best
02:44 10 estimate, everything below the wellbore does not change from
02:44 11 April 20th to July 15th?

02:45 12 **A.** No, no. I think that's -- that's an overstatement.

02:45 13 **Q.** You use a constant value from July 15th for K-well and PI;
02:45 14 correct?

02:45 15 **A.** I don't dispute that that's how my best estimate is
02:45 16 calculated, PI, K-well, constant 86 days, period. But then you
02:45 17 asked, so in that nothing changed over those 86 days, and
02:45 18 that's a leap that I don't agree with.

02:45 19 **Q.** In your best estimate, because you --

02:45 20 **A.** In the calculation -- yeah, in the calculation, there's no
02:45 21 doubt they are held constant during that period. Yes.

02:45 22 **Q.** And the practical import of that, for the Court to
02:45 23 understand, is in your calculation, you are effectively holding
02:45 24 everything below the BOP as being unchanged over 86 days, in
02:45 25 your calculation?

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02:45 1 A. Unchanged as it significantly affects flow rate and
02:46 2 cumulative discharge. As long as we add that, I agree with
02:46 3 you.

02:46 4 Q. You hold it constant? Yes or no?

02:46 5 A. I'm having trouble here understanding because I've said
02:46 6 now three or four times, I hold the PI in K-well constant over
02:46 7 the 86 days. There's no doubt about that. That's how my best
02:46 8 estimate calculation is done.

02:46 9 But then you say, So nothing at all changed down
02:46 10 there over those 86 days?

02:46 11 And that's where I say, Well, no, those are not
02:46 12 equivalent.

02:46 13 So I apologize, but I'm...

02:46 14 Q. You agree, Dr. Griffiths, that if there was erosion at the
02:46 15 reservoir sandface, such as in the cement at the bottom of the
02:46 16 well or other damage to the sandface, that could cause the PI
02:46 17 to change over the 86-day time period. Do you agree with that?

02:47 18 A. I discussed that at length in my appendix on the period
02:47 19 before May 8th. Yes.

02:47 20 Q. So you agree with that?

02:47 21 A. I do.

02:47 22 Q. Do you agree that if there's erosion in the wellbore or
02:47 23 changes, such as a change in the location of the drill pipe,
02:47 24 that that could lead the -- the wellbore discharge coefficient
02:47 25 to change in time over the 86 days?

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02:47 1 A. Yes.

02:47 2 Q. And your best estimate calculation, by holding those two
02:47 3 values constant, would not capture those changes, if they were
02:47 4 to have occurred?

02:47 5 A. Well, yes. If they vary -- if -- yes, I will agree with
02:47 6 that. Sure.

02:47 7 Q. In your 2011 Sandia report and in your peer-reviewed
02:48 8 article, you use the same methodology of holding PI constant;
02:48 9 correct?

02:48 10 A. Yes.

02:48 11 Q. But in your 2013 expert report in this litigation, you
02:48 12 acknowledge that there is data about what the effect of PI was
02:48 13 as of the time of the accident; correct?

02:48 14 A. Well, I don't know "data." There were --

02:48 15 Q. Information?

02:48 16 A. Information, sure.

02:48 17 Q. You cite it in your expert report, correct, Dr. Griffiths?

02:48 18 A. Correct.

02:48 19 Q. You cite Dr. Emilsen's -- Mr. Emilsen's work; correct?

02:48 20 A. Yes.

02:48 21 Q. And you cite Mr. Emilsen's transient multiphase flow
02:48 22 simulation where he matched the pressure data on the night of
02:48 23 April 20th to what the effective reservoir face would be.
02:48 24 That's what you cite in your report?

02:48 25 A. Correct, correct, yes.

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02:48 1 Q. 13 feet to 16.5 feet of the 86 feet exposed; correct?

02:48 2 A. Correct.

02:48 3 Q. And you translate that into a PI; correct?

02:48 4 A. Yes.

02:49 5 Q. The PI is 7.4 to 9.4, according to your calculation;
02:49 6 correct?

02:49 7 A. Correct.

02:49 8 Q. So from 7.4 to 9.4 PI, as of the moment of the accident --
02:49 9 so 43, which is your constant value -- the PI at the bottom of
02:49 10 the well must change?

02:49 11 A. Yes. Yes.

02:49 12 Q. In your expert --

02:49 13 A. For the sake of keeping it simple, yes.

02:49 14 Q. Well, in your expert report, you state that based on
02:49 15 Dr. Emilsen's report, you calculated that that change -- a
02:49 16 factor of 5 -- happened in nine hours; correct?

02:49 17 A. No, I calculate that it would have happened in 9 hours.
02:49 18 But I also state in my report that neither Mr. Emilsen or I or
02:49 19 anybody else knows what was actually going on down there, so we
02:50 20 don't even for a fact know that we're talking about variation
02:50 21 in productivity index. So...

02:50 22 Q. And your solution to the ambiguity about what's going on
02:50 23 down there is to apply the constant value from July 15th to
02:50 24 April 21 for PI?

02:50 25 A. From which date to which?

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02:50 1 Q. July 15th to April 21st.

02:50 2 A. Yes.

02:50 3 Q. But you cited Mr. Emilsen's work as a basis for changing
02:50 4 PI five times in nine hours; correct?

02:50 5 A. Well, it was -- it's supporting information. I actually
02:50 6 don't think I did -- ever did anything with the nine hours, so
02:50 7 it was just -- it was additional information that supported
02:50 8 some -- some other things that I had observed. So the nine
02:50 9 hours is -- you know, I say -- all I did with the nine hours
02:50 10 was say, Ah, if you extrapolate this, you get to my value in
02:51 11 about nine hours. That's consistent with my expectations that
02:51 12 things unfold in minutes, you know, hours, maybe a day or so.
02:51 13 We're not talking weeks or months.

02:51 14 So there is no special significance to nine hours.
02:51 15 And I think when we last met, I said, Ah, I don't -- nine
02:51 16 hours, 18 hours, whatever, it really makes no difference as far
02:51 17 as any of my analysis is concerned.

02:51 18 Q. It made a difference in your expert report when you used
02:51 19 that nine-hour value to conclude that it indicated whatever
02:51 20 downhole restriction existed at the time, regardless of whether
02:51 21 it was debris, float collar, or cement, failed in nine hours;
02:51 22 correct?

02:51 23 A. I don't think that that's what I stated in my report. It
02:51 24 might be --

02:51 25 MR. REGAN: TREX-11485R.11.3.

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02:51 1 THE WITNESS: I mean, I certainly say nine hours, but
02:52 2 I'm just not sure that the words you used were really exactly
02:52 3 the words I had in my report. That was the only issue.

02:52 4 BY MR. REGAN:

02:52 5 Q. Well, let's read the words then and test that proposition.

02:52 6 You state here -- at the top, you talk about
02:52 7 variations in the wellbore discharge coefficient. You then
02:52 8 say: "Under conditions that most closely replicate measured
02:52 9 pressures and observable events, their analyses" --

02:52 10 And you're referring to ADD Energy, Mr. Emilsen.

02:52 11 -- "indicate that the effective productivity index
02:52 12 increased by over 25 percent between 9:00 and 9:30 on
02:52 13 April 20th. This indicates that whatever downhole restriction
02:52 14 existed at that time was failing rapidly, regardless of whether
02:52 15 this restriction resided in wellbore debris, the float collar,
02:52 16 or cement barrier. For continued failure at this rate, I
02:52 17 estimated that the productivity index would further increase to
02:52 18 my best estimate value in less than nine hours. At this point,
02:53 19 the cement barrier or other impediments would provide no
02:53 20 significant restriction to flow from the reservoir into the
02:53 21 casing."

02:53 22 Is that your expert report, Dr. Griffiths?

02:53 23 A. Yes. But I don't -- that wasn't what I heard when you --
02:53 24 when you asked earlier, so, yeah, I think that's exactly how I
02:53 25 feel about it.

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02:53 1 Q. As of your rebuttal report, you then change from nine
02:53 2 hours to "hours or days, not weeks or months."

02:53 3 Correct?

02:53 4 A. Pardon me?

02:53 5 Q. In your rebuttal report, your rate of erosion was no
02:53 6 longer nine hours; now it was "hours or days, not weeks or
02:53 7 months."

02:53 8 Correct?

02:53 9 A. I don't -- I don't remember or know what that's about, but
02:53 10 I'll take your word for it.

02:53 11 **MR. REGAN:** TREX-11486R.14.1.

02:54 12 **BY MR. REGAN:**

02:54 13 Q. Do you see here in this section of your rebuttal report
02:54 14 that you cite the drill pipe that was above the upper annular
02:54 15 in the BOP, the same one you looked at on the screen about an
02:54 16 hour ago --

02:54 17 A. Right.

02:54 18 Q. -- and you used that rate of erosion. You say, "This did
02:54 19 not occur in weeks or months, it occurred in a matter of
02:54 20 hours"; correct?

02:54 21 A. Yes.

02:54 22 Q. So you conclude in your rebuttal report, "Because the flow
02:54 23 rates are the same throughout the system, I therefore believe
02:54 24 that erosion in the reservoir cement plug, reamer shoe, and/or
02:54 25 float collar would have occurred on a comparable time scale,

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02:54 1 hours or a few days -- not weeks, and this view is consistent
02:54 2 with Mr. Emilsen's calculations"; correct?

02:54 3 A. Yeah.

02:54 4 Q. And by the time of your deposition, it was no longer hours
02:54 5 or days, it was now three days -- 36 hours -- of how long it
02:54 6 would take; correct?

02:54 7 A. I don't know what your questions are. I'm having trouble
02:54 8 with reading the text and then -- so if you ask me a question
02:55 9 that I can understand, I'd be happy to answer.

02:55 10 Q. When you were deposed, Dr. Griffiths, it was at that time
02:55 11 your opinion that it was not a matter of nine hours or ten
02:55 12 hours or 12 hours or one day. It was now 36 hours you said
02:55 13 that the erosion would take place; correct?

02:55 14 A. Excuse me, but when I use words like "comparable" in this,
02:55 15 I'm talking, could be seconds, minutes, hours, a few days.
02:55 16 Those are -- they cover a huge range there, but -- but they're
02:55 17 all very fast compared to 86 days. So I think I'm just saying,
02:55 18 you know, in different ways here, nine hours, there's 36 hours,
02:55 19 somebody thinks it could be minutes.

02:55 20 That it sets a time scale for these events to occur
02:56 21 in that is very fast, not weeks, not months; minutes, hours, a
02:56 22 few days.

02:56 23 Q. Well, your uncertainty calculation, if, in fact, PI took
02:56 24 longer than 36 hours to change to its July 15th value, your
02:56 25 uncertainty calculation does not include that; correct?

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02:56 1 A. Yeah. But it also makes almost -- no difference. I think
02:56 2 my flow rate, that 36 hours -- which, you know, by the way,
02:56 3 once you get down to 36 hours, almost nothing matters. You
02:56 4 know, flow rate's 20,000, it's 50,000, it's a short period of
02:56 5 time. It can't significantly change the cumulative discharge.

02:56 6 So I think for the first 36 hours, I have
02:56 7 36,000 barrels a day. For the next, all the way out to I think
02:56 8 it's April 29th, so a whole week, that goes up to 41. So it's
02:57 9 hardly any -- any change. So maybe -- maybe it didn't take
02:57 10 36 hours. Maybe it took three days. So I have -- then I lined
02:57 11 up with a day and a half with a discrepancy between 36,000 and
02:57 12 41,000. These things just don't matter.

02:57 13 Q. The uncertainty chart that you put before the Court on
02:57 14 your direct examination does not include the uncertainty that
02:57 15 would result from the PI, productivity index, taking more than
02:57 16 36 hours to get to your July 15th value; correct?

02:57 17 A. That's true. And as I just said, if it stood to five days
02:57 18 or four days or seven days, it would make almost no difference
02:57 19 at all in what those uncertainties were.

02:57 20 Q. You haven't calculated that number?

02:57 21 A. Oh, I know -- I know -- I have a feel for all those
02:58 22 numbers.

02:58 23 Q. You may have a feel for those numbers, but those numbers
02:58 24 are not disclosed by you in your expert report anywhere; fair?

02:58 25 A. That's -- that's correct, yes.

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02:58 1 Q. In fact, the uncertainties that you put up during your
02:58 2 direct exam, those uncertainties were based on your work in
02:58 3 2011, not your best estimate that you put forth in your expert
02:58 4 report; correct?

02:58 5 A. Partly, partly, but partly not. So --

02:58 6 Q. Everything except the last entry on that uncertainty chart
02:58 7 and the reservoir entry were based on your 2011 work where you
02:58 8 had a different estimate of flow, not your 2013 work; correct?

02:58 9 A. Well, but they're all percentages, so the sources of
02:58 10 uncertainties did not change. And as percentages, they still
02:58 11 accurately reflect what uncertainties would be -- it's the same
02:58 12 methodology. The assumptions have the same impact. The
02:59 13 uncertainties that measure pressures are the same. Why should
02:59 14 they change?

02:59 15 Q. Just a simple question, Dr. Griffiths: You did not
02:59 16 recalculate the uncertainties for the best estimate number that
02:59 17 you set forth here today; you used your uncertainties from your
02:59 18 work in 2011 where you had a different estimate?

02:59 19 A. Largely. There is one small thing there. When I did
02:59 20 read -- when I looked at the uncertainties, I calculated
02:59 21 variations in my Appendix C. I checked whether or not those
02:59 22 variations, due to two-phase effects, were bigger or smaller
02:59 23 than the values I had already used. And I determined they were
02:59 24 always smaller than the values I used, so I did not decrease
02:59 25 those uncertainties based on that. I left them as they were.

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03:00 1 Q. I'd like to talk to you about the time period of
03:00 2 April 20th to May 8th.

03:00 3 MR. REGAN: If we could pull up D-23997.1.

03:00 4 BY MR. REGAN:

03:00 5 Q. As represented here on this chart, you had, I think, over
03:00 6 90,000 values of PT-B; correct?

03:00 7 A. Yes.

03:00 8 Q. The first value starts on May 8th; correct?

03:00 9 A. Yes.

03:00 10 Q. So you had to make an assumption about what happened over
03:00 11 the first 18 days with PT-B; correct?

03:00 12 A. Yes.

03:00 13 MR. REGAN: If we could bring up D-23997-2A.

03:00 14 BY MR. REGAN:

03:00 15 Q. What you did, Dr. Griffiths, is you drew a line from
03:01 16 May 8th backwards to Time Zero; correct?

03:01 17 A. Yes.

03:01 18 Q. You extrapolated from your first data point backwards to a
03:01 19 time period where you did not have a data point; correct?

03:01 20 A. No -- oh, well -- yes and no. The extrapolation threw me
03:01 21 because what I actually did is fit the trend over a long period
03:01 22 of time and use that extrapolation to obtain the Time Zero
03:01 23 pressure.

03:01 24 Q. Okay.

03:01 25 A. The connection to the first data point on May 8th isn't an

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03:01 1 extrapolation. You just connect those two times.

03:01 2 Q. There is data available to try to determine what the
03:01 3 pressure would be at the BOP as of the start of the accident,
03:01 4 as of the start of the flow period; correct?

03:02 5 A. I'm not sure I think there's any data that's actually
03:02 6 relevant, but...

03:02 7 Q. Well, whether you might not think it's relevant, there is
03:02 8 data from drill pipe pressures, working from the top down or
03:02 9 from reservoir pressures working from the reservoir up, where
03:02 10 you could get a range of what the BOP pressure was as of the
03:02 11 start of the flow period; correct?

03:02 12 A. Well, I think that's pretty much what I did, in my
03:02 13 perspective, but go ahead. Yeah, there are drill pipe
03:02 14 pressures measured on April 20th. The reservoir pressure was
03:02 15 known on that date or thereabouts. So, yes, there were
03:02 16 pressures.

03:02 17 Q. If we could pull up a chart from your report.

03:02 18 MR. REGAN: TREX-11485R.9.1.

03:02 19 BY MR. REGAN:

03:02 20 Q. This is from your report. Do you recognize it,
03:02 21 Dr. Griffiths?

03:02 22 A. This is from my Sandia report -- oh, no, this is from my
03:03 23 expert report. Okay, yes.

03:03 24 Q. You have an initial reservoir pressure of 11,850; correct?

03:03 25 A. Yes.

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03:03 1 Q. Then you have, "Reservoir less flowing head -- elevation
03:03 2 head"; correct?

03:03 3 A. Yes.

03:03 4 Q. And your calculate value is 8,730 psi; correct?

03:03 5 A. Yes.

03:03 6 Q. Where is the elevation head? Where does it go in terms of
03:03 7 the well?

03:03 8 A. From the bottom of the well to, in this case, the BOP.

03:03 9 Q. So based most your calculation of the reservoir pressure
03:03 10 up to the base of the BOP, the pressure at the base of the BOP
03:03 11 would be 8,730 psi; correct?

03:03 12 A. Well, no. I mean, I don't know. That's, you know, in an
03:03 13 unflowing state, but the well was clearly flowing. So I don't
03:03 14 know...

03:03 15 Q. Dr. Griffiths, at the moment the flow started, based on
03:04 16 your own chart, the pressure of the BOP would be 8,730 psi;
03:04 17 correct?

03:04 18 A. But that's with no flow.

03:04 19 Q. The moment the flow started; correct?

03:04 20 A. Well, wait a minute. I don't know what "the moment the
03:04 21 flow started" means. I mean, before it started, there's no
03:04 22 flow, it would be 8700. As soon as there's flow, within
03:04 23 minutes, it would drop to 4300. So I don't know -- I don't
03:04 24 know how to parse it any finer than that.

03:04 25 Q. Okay. You did not use 8,730 psi as your initial BOP

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03:04 1 pressure; correct?

03:04 2 A. Well, that makes no sense at all. The well was flowing.

03:04 3 Q. You did not use that value?

03:04 4 A. That's correct.

03:04 5 Q. You did not use a value that can be derived from drill
03:04 6 pipe pressure for PT-B as of April 20th; correct?

03:04 7 A. Not entirely correct.

03:04 8 Q. You're aware that you can calculate a pressure -- PT-B
03:04 9 pressure using the drill pipe pressures; correct?

03:05 10 A. Under what conditions? Flowing? Nonflowing? Yes, you
03:05 11 can -- okay, yes, you can.

03:05 12 Q. Dr. Johnson calculates that PT-B value to be approximately
03:05 13 8700 psi; correct?

03:05 14 A. It's a nonflowing, static pressure. That's a nonflowing,
03:05 15 static, shut-in pressure.

03:05 16 **MR. REGAN:** TREX-11488.17.2.

03:05 17 **BY MR. REGAN:**

03:05 18 Q. This is a chart from Dr. Johnson's report?

03:05 19 A. Yeah.

03:05 20 Q. You see that he calculates initial PT-B pressure at 8700
03:05 21 and it has your calculation of about 4300 psi; do you see that?

03:05 22 A. Yes.

03:05 23 Q. Okay. One of the DOJ, Department of Justice's, experts
03:05 24 also has a calculation of BOP pressure as of the time of the
03:05 25 start of the flow period; correct?

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03:05 1 A. Well, let's see -- well, I don't know. Another
03:06 2 department -- I'm not really aware of what other DOJ experts
03:06 3 do.

03:06 4 MR. REGAN: TRES-11653.27.1.

03:06 5 BY MR. REGAN:

03:06 6 Q. This is a chart out of Dr. Pooladi-Darvish's report. Do
03:06 7 you see what his initial value is for PT-B on this figure?

03:06 8 A. On that figure would be about 85-, 8700 psi.

03:06 9 Q. And do you agree, Dr. Griffiths, that, in fact, if you had
03:06 10 used 8700 psi as your starting number instead of your number of
03:06 11 approximately 4300 psi, that it would lower the cumulative flow
03:06 12 that you calculate in your best estimate?

03:06 13 MR. BENSON: Let me make an objection, Your Honor.
03:06 14 Mischaracterizes Dr. Pooladi-Darvish's expert report. We'll
03:06 15 hear from him later, and Dr. Griffiths has already said he
03:06 16 hasn't reviewed this report, so there's no foundation.

03:06 17 THE COURT: Okay. I will --

03:06 18 Can you answer? Do you remember the question?

03:07 19 MR. REGAN: It was two questions ago.

03:07 20 THE COURT: Okay.

03:07 21 BY MR. REGAN:

03:07 22 Q. The question before you, Dr. Griffiths, is: If you had
03:07 23 taken 8700 psi as your initial PT-B value, like we see in this
03:07 24 chart from Dr. Pooladi-Darvish's report, like we've seen in the
03:07 25 preceding chart from Dr. Johnson's report, you would agree that

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03:07 1 it would have a reducing effect on your cumulative flow
03:07 2 estimate?

03:07 3 A. If I had done that, it would reduce my cumulative
03:07 4 discharge.

03:07 5 But I do feel I should add, it makes no sense at all
03:07 6 to do that. Those pressures are shut-in pressures. Those are
03:07 7 pressures associated with the well when nothing is flowing. If
03:07 8 I look -- you asked, you know, what information there was. So
03:07 9 Mr. Emilsen calculated BOP pressures as part of his best case,
03:07 10 Case 7 in his report.

03:08 11 And what he shows is that when the well is flowing at
03:08 12 fairly low flow rates, that he's got calculated BOP pressures
03:08 13 that are down 2500, 3,000 psi at the BOP. Okay. Those numbers
03:08 14 are quite consistent with my extrapolation back. They're
03:08 15 actually lower than my -- than what Mr. Emilsen shows is that
03:08 16 when the annulars and the VBRs, especially the VBRs, were
03:08 17 closed, that over a period of just a couple of minutes, five
03:08 18 minutes, ten minutes or something, the BOP pressures zoom from
03:08 19 3,000 psi or less up to 8700 psi. That is with the well
03:09 20 shut-in.

03:09 21 Immediately -- again, immediately, when flow resumed,
03:09 22 those pressures would have dropped again, over minutes back
03:09 23 down to this 3,000, 4,000 psi range.

03:09 24 Q. You agree, Dr. Griffiths, that the chart you just
03:09 25 described from Mr. Emilsen shows that when the BOP was

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03:09 1 activated shortly before 9:49 p.m. on April 20th, the BOP
03:09 2 pressures went up to a range of about 8700 psi; correct? Is
03:09 3 that true?

03:09 4 A. That was a shut-in pressure.

03:09 5 Q. The question is: Was that true?

03:09 6 A. The well was shut in at that instant, very temporarily.
03:09 7 The traveling block fell; the seal on the pipe was gone
03:09 8 within -- within, you know, minutes. And as soon as the seal
03:09 9 on the end of the pipe was gone, that well was flowing, those
03:10 10 BOP pressures would be back down to 2-, 3-, 4,000 psi.

03:10 11 Q. Everything after the moment of a measurement of 8700 psi,
03:10 12 you just testified to, is your speculation about how quickly
03:10 13 that pressure would decrease to --

03:10 14 A. Mr. Emilsen's calculations show very clearly the well is
03:10 15 flowing. You seal the well, pressures zoom up to 8700; his
03:10 16 calculations even show it's flat. Mr. Emilsen in his report
03:10 17 says that things would have continued to evolve, continued to
03:10 18 change after that. He makes no statement about what would have
03:10 19 happened.

03:10 20 My only statement -- my only reliance on his
03:10 21 conclusions is: You seal the well, the pressure goes up within
03:10 22 minutes. When you unseal the well, when the traveling block
03:10 23 fell, when the seal was lost on the top of the pipe, the
03:10 24 pressure would drop in a matter of minutes.

03:11 25 Q. The impact of using 8700 psi to the -- at April 20th to

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03:11 1 the first May 8th value on your cumulative flow impact estimate
03:11 2 is approximately 500,000 barrels; correct?

03:11 3 I understand you disagree with it, but if you --
03:11 4 A. Okay. Okay. I don't know offhand if I ever did that
03:11 5 calculation, so I'm not sure -- I don't think I did. I agree
03:11 6 with you: Had I used that 8700 linear down to May 8th, I would
03:11 7 get a lower discharge. I don't disagree with that. I don't
03:11 8 think I ever did those calculations, so I'm not sure I know the
03:11 9 impact -- the magnitude of that.

03:11 10 Q. At the time you gave your 2011 peer-reviewed article in
03:11 11 your Sandia report, you did not discuss anything with respect
03:11 12 to erosion rates inside the BOP; correct?

03:12 13 A. I don't have a clear recollection. I guess perhaps not.

03:12 14 Q. Okay. And, in fact, it's your view, Dr. Griffiths, that
03:12 15 you don't believe anybody knows anything about the actual true
03:12 16 dimensions anywhere in the BOP; correct?

03:12 17 A. No. No. The piece parts are all out there. You know,
03:12 18 they've been measured. They've been scanned. You know what
03:12 19 all the dimensions of those parts are. The bores through the
03:12 20 thing have been measured. So I don't -- I don't agree with
03:12 21 that statement.

03:12 22 Q. Let's pull up your deposition of June 26th, page 43, maybe
03:12 23 page 42 to pull in the question. It's the June 26th
03:12 24 deposition. Let's start on 42, because I think the question
03:12 25 starts on 42.

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03:12 1 Do you see the question there at the bottom: "Can
03:13 2 CFD tools be used with unknown geometries to determine range of
03:13 3 possible flow rates, if you have a known starting position and
03:13 4 a known ending position?"

03:13 5 And you say: "Big, big -- well, big caveats there.
03:13 6 I don't believe anybody knows anything about the actual, true
03:13 7 dimensions anywhere in the BOP."

03:13 8 Do you recall giving that answer, Dr. Griffiths?

03:13 9 A. I don't. It's -- you know, I don't remember the exact
03:13 10 contents, what happened before. It's an overstatement.

03:13 11 I think this same -- if it's the conversation I
03:13 12 recall, it goes on to say, Yes, we know the dimensions of all
03:13 13 the piece parts. The big issue is: You don't know how the
03:13 14 piece parts fit together, and that's where the uncertainty is.

03:13 15 So that's an overstatement on my part.

03:13 16 Q. Dr. Griffiths, you did not use any computational fluid
03:13 17 dynamics in reaching conclusions about erosion in the BOP;
03:13 18 correct?

03:13 19 A. Not directly. I use them as part of validation.

03:14 20 Q. You, yourself, did not perform any computational fluid
03:14 21 dynamics work in arriving at your views on erosion rates inside
03:14 22 the BOP; correct?

03:14 23 A. That's correct.

03:14 24 Q. You did testify at your deposition that you looked at
03:14 25 pictures in the DNV report; correct?

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03:14 1 A. Yes.

03:14 2 Q. And you formed mental images about the size of the holes
03:14 3 that would have been in the BOP based on your view of those
03:14 4 pictures; correct?

03:14 5 A. Well, pictures and of looking at the actual hardware.

03:14 6 Q. You never took those mental pictures and actually put them
03:14 7 down on paper or drew them or did any type of computational
03:14 8 fluid dynamics to see if it was consistent with your mental
03:14 9 picture?

03:14 10 A. Well, you know, I -- I vaguely remember this conversation
03:14 11 because I think I was holding my fingers up and saying things
03:14 12 like, "They're about this big."

03:14 13 But do keep in mind that when I hold my fingers up
03:14 14 and say, Well, they're about this big, I have all kinds of
03:15 15 things to reference that to. So "this big" or "this big" or
03:15 16 something means something quantitative to me.

03:15 17 It's not just -- and it doesn't require CFD. So it's
03:15 18 not just mental imagery.

03:15 19 Q. Dr. Griffiths, in your uncertainty about what happened
03:15 20 with the BOP, you postulate that the flow rate in the first
03:15 21 36 hours could be at a lower bound of approximately
03:15 22 36,000 barrels per day; correct?

03:15 23 A. Yeah, or even a little bit lower.

03:15 24 Q. You have the blind shear rams activated on April 21st --
03:15 25 or by April 22nd; correct?

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03:15 1 A. 22nd, yes.

03:15 2 Q. And it's your opinion that after the blind shear rams were
03:15 3 activated, the flow rate went up to 41,000 barrels per day;
03:15 4 correct?

03:16 5 Q. No, that's not a -- the increase occurs at 36 hours. The
03:16 6 BSRs are at 33 hours. So the increase from 36 to 41 really has
03:16 7 to do with -- with the collapse of the riser. It's not -- that
03:16 8 change is not a consequence of the BSR's main function.

03:16 9 Q. In your expert report you estimate a flow rate at the time
03:16 10 of blind shear activation as being approximately 41,000 stock
03:16 11 tank barrels; correct?

03:16 12 A. Yes.

03:16 13 Q. That's a higher flow rate than the time period before the
03:16 14 blind shear rams were activated; correct?

03:16 15 A. Yes.

03:16 16 Q. So is it your testimony that activating the blind shear
03:16 17 rams increased the flow rate at the well?

03:16 18 **MR. BENSON:** Objection. Asked and answered.

03:16 19 **THE COURT:** Overruled.

03:16 20 **THE WITNESS:** Well, I have to think about that.

03:16 21 Well, I think it does because if before then you've got the
03:16 22 entire length of pipe, you know, all the way to the surface,
03:16 23 then you've got a lot of resistance in there. If that's your
03:17 24 flow path, is that piece of pipe through the BOP and all the
03:17 25 way to the surface, when you function the BSR, it cuts that

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03:17 1 pipe. And the flow path now isn't through that long pipe all
03:17 2 the way to the surface; the flow path is now through the riser.

03:17 3 So, yes, I think it does -- it would have
03:17 4 increased the flow rate just because it changed the flow paths.

03:17 5 **BY MR. REGAN:**

03:17 6 **Q.** So activating the blind shear rams made the flow at
03:17 7 Macondo go up under your analysis of the BOP?

03:17 8 **A.** I suppose, yes.

03:17 9 **Q.** And then is it also your opinion that a few days later,
03:17 10 when the casing shear rams were activated, the flow rate went
03:17 11 up again, from 41,000 barrels per day to 61,000 barrels per
03:17 12 day?

03:17 13 **A.** Well, wait a minute. I'm -- you're talking now about my
03:18 14 discussion period before May 8th, and I think, before we get
03:18 15 too far along there, we need to make clear that there are a
03:18 16 bunch of assumptions in there to get lower bounds, upper bounds
03:18 17 that influence these things.

03:18 18 So to say that my methodology or my model or my, you
03:18 19 know, analysis shows some peculiar behavior is -- isn't quite
03:18 20 right. Because you make assumptions to get a lower bound on
03:18 21 what you think the flow rates are, and you make different
03:18 22 assumptions to get an upper bound. It's an exercise in
03:18 23 understanding uncertainties, not in predicting at these
03:18 24 different states, you know, what would the flow rates be.

03:18 25 **Q.** In your appendix to your report, where you go in and give

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03:19 1 your views about what happened to the BOP, you predict that the
03:19 2 flow rate was at least 41,000 stock tank barrels per day prior
03:19 3 to the activation of the casing shear rams; correct?

03:19 4 A. No. See, when you say your -- "you predict," I don't know
03:19 5 exactly the words in that that bother me. But when say "I
03:19 6 predict," I make assumptions to give me a lower bound on the
03:19 7 flow rate, upper bound on the flow rate, it's for purposes of
03:19 8 uncertainties, not purposes of predicting exactly what's going
03:19 9 to happen in this.

03:19 10 Q. Dr. Griffiths, did you write the number 41,000 stock tank
03:19 11 barrels per day for your flow rate for the period of April 26th
03:19 12 to April 29th in your Appendix G? Did you write that number?

03:19 13 A. Yes.

03:19 14 Q. And did you write a number, 61,000 stock tank barrels per
03:20 15 day, starting April 29th, after the casing shear rams were
03:20 16 closed?

03:20 17 A. Yes.

03:20 18 Q. And did you write a number of 36,000 stock tank barrels
03:20 19 per day before the blind shear rams were closed?

03:20 20 A. Yes.

03:20 21 Q. So under your assessment of uncertainties and under your
03:20 22 looking at the BOP, the flow rate, as you wrote in your
03:20 23 appendix, went up when the blind shear rams were closed and
03:20 24 went up when the casing shear rams were closed, as set forth in
03:20 25 your report?

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03:20 1 A. But not because of those things. I mean, that's the
03:20 2 thing. You know, the flow rate goes from 41,000 to 63,000 on
03:20 3 April 29th. It's not because that's when the casing shear rams
03:20 4 were closed; it's because other things are going on. That
03:20 5 change actually has to do with that's the point in time which I
03:20 6 estimated the pipe dropped below.

03:20 7 So that increase isn't because the CSRs were
03:20 8 functioned; that increase is because in that time period, I no
03:21 9 longer have a pipe below the BOP.

03:21 10 Q. How much of the 20,000-barrel increase at the time the
03:21 11 casing shear ram was closed is due to the rams being closed or
03:21 12 due to your belief that the drill pipe fell?

03:21 13 A. Well, I think, if you look at the discussion of that, I
03:21 14 still have all of the VBRs -- you know, at least one VBR all
03:21 15 that seal, perfectly sealed. So I'm making assumptions to give
03:21 16 me a low bound on the flow rates. I have all these things
03:21 17 sealed on the pipe, perfectly sealed, no leak.

03:21 18 So I think that increase you asked about to, say, 61
03:21 19 has to result simply from the drill pipe dropping from the
03:21 20 bottom of the BOP.

03:21 21 Q. So you believe the drill pipe fell no later than
03:21 22 April 29th. Is that your opinion?

03:21 23 A. Yeah. I think April 29th -- if I had to pick a single
03:22 24 day, I would have picked April 29th.

03:22 25 Q. Okay. Your conclusion, after examining pictures of the

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03:22 1 BOP and forming some images of them in your mind, was that
03:22 2 there was no great uncertainty in your assumption of a constant
03:22 3 wellbore coefficient and a constant PI over April 20th to
03:22 4 May 8th; correct?

03:22 5 A. Well, 3.3 percent is -- and that's 3.3 percent of the
03:22 6 whole fifth -- 5 million, not just of that period. So
03:22 7 that's -- I think that's my single largest uncertainty, is
03:22 8 that.

03:22 9 Q. Right. About 170,000 barrels uncertainty?

03:22 10 A. I don't remember -- I don't know the numbers in those
03:22 11 units.

03:22 12 Q. But the fact is your 3.3 percent uncertainty includes
03:22 13 uncertainty as to whether the PI changed faster or slower than
03:22 14 9 hours, includes uncertainty as to whether you drew the right
03:22 15 line for PT-B, and includes uncertainty as to whether your
03:23 16 assessment of the BOP, from looking at pictures and looking at
03:23 17 piece parts, is accurate.

03:23 18 All of those things, you conclude, result in a
03:23 19 3.3 percent uncertainty. Is that correct?

03:23 20 A. Well, it is. But to understand it, you have to know
03:23 21 what's possible there. So I could have done an alternate
03:23 22 calculation saying -- let's just assume there was zero flow,
03:23 23 zero flow any time until May 8th. What would my uncertainty
03:23 24 be? 20 percent, that's the most. I mean, I got
03:23 25 4 million barrels after that. There's 1 million barrels

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03:23 1 missing before that. That's 20 percent.

03:23 2 So if you look at it from the perspective of I start
03:23 3 with a maximum uncertainty for that period before May 8th of
03:23 4 20 percent and ask me, do you think you could drive that
03:23 5 uncertainty down by a factor of 5 or 6 through analysis of, you
03:24 6 know, the state of the rams and the BOP and when different
03:24 7 things happened, I think that's very reasonable.

03:24 8 And if you take 20 percent and drive those
03:24 9 uncertainties down by a factor of 5, 6, you wind up with 3,
03:24 10 4 percent, which is where I am.

03:24 11 Q. You can take a percentage of here and a percentage of
03:24 12 there, and you ultimately arrive at 3.3 percent. Is that what
03:24 13 you --

03:24 14 A. That's not what I was trying to say. I hope that's not
03:24 15 what came out.

03:24 16 I'm just saying that 3.3 percent is a small number.
03:24 17 I mean, I don't disagree with that. But it is of that period.
03:24 18 That's 3.3 percent of the whole 86 days. Of that, 17 days it's
03:24 19 something like 20-something percent -- 15 percent of the flow
03:24 20 during that time.

03:24 21 But the issue is the uncertainties associated with
03:24 22 that 17 days aren't infinite that I can reduce to 3 percent.
03:25 23 The biggest they can possibly be on the negative side is
03:25 24 20 percent.

03:25 25 Q. You know how to do computational fluid dynamics analysis,

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03:25 1 right, CFD analysis?

03:25 2 A. Yes. I've written lots of CFD codes.

03:25 3 Q. You did not do any CFD analysis of the riser kink;

03:25 4 correct?

03:25 5 A. I did not.

03:25 6 Q. You're aware that Dr. Nestic did; correct?

03:25 7 A. Yes.

03:25 8 Q. You did not do any CFD analysis of the blind shear rams;

03:25 9 correct?

03:25 10 A. That's correct.

03:25 11 Q. You're aware that Dr. Nestic did; correct?

03:25 12 A. Yes.

03:25 13 Q. You did not do any CFD analysis of the casing shear rams;

03:25 14 correct?

03:25 15 A. Correct.

03:25 16 Q. And you're aware that Dr. Nestic used those tools to

03:25 17 analyze the BOP during that time period; correct?

03:25 18 A. Yes.

03:25 19 **MR. REGAN:** Your Honor, I'm going to transition to a

03:26 20 new topic. I'm happy to keep going or pause here.

03:26 21 **THE COURT:** All right. Let's go ahead and take a

03:26 22 15-minute recess.

03:26 23 **THE DEPUTY CLERK:** All rise.

03:26 24 (WHEREUPON, the Court took a recess.)

03:48 25 **THE DEPUTY CLERK:** All rise.

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03:49 1 THE COURT: All right. Please be seated.

03:49 2 All right. Mr. Regan.

03:49 3 MR. REGAN: Thank you, Your Honor.

03:49 4 BY MR. REGAN:

03:49 5 Q. Dr. Griffiths, I'd like to put up TREX-41026.54.1, which
03:49 6 is an excerpt from the Add Energy Appendix W that you cite in
03:49 7 your report.

03:49 8 My question is: Did I read the top paragraph
03:49 9 correctly with respect to Case 7?

03:49 10 "Case 7 assumes a lower volume of hydrocarbon influx
03:49 11 was taken prior to 2130 hours; this was achieved by using
03:49 12 13 feet of net pay of 12.6 ppg sand. When the pumps are shut
03:49 13 down at 2130 hours, the pressure drops, creating a higher
03:49 14 drawdown on the reservoir and from this point forward,
03:49 15 16.5 feet of net pay is assumed in the simulation."

03:49 16 Did I read that correctly?

03:49 17 A. I believe so.

03:49 18 Q. There's nothing in that report that suggests that a change
03:50 19 from 13 feet to 16 feet took place over 30 minutes; correct?

03:50 20 A. That's correct.

03:50 21 Q. There's an instantaneous change in the Appendix W between
03:50 22 13 feet and 16 feet; correct?

03:50 23 A. Yes.

03:50 24 Q. At 9:30?

03:50 25 A. I think the 30 minutes is the preceding 30 minutes of data

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03:50 1 that he was looking at, so --

03:50 2 **THE COURT:** Pull the microphone a little closer to
03:50 3 you, please.

03:50 4 **THE WITNESS:** I'm sorry. From 2100 to 2130 is the
03:50 5 30 minutes.

03:50 6 **BY MR. REGAN:**

03:50 7 **Q.** Mr. Emilsen used 13 feet of net pay from 9:00 to 9:30 in
03:50 8 this simulation; correct?

03:50 9 **A.** Correct.

03:50 10 **Q.** And he used 16.5 from 9:30 to the time of the accident;
03:50 11 correct?

03:50 12 **A.** Yes.

03:50 13 **Q.** So there was a change at exactly 9:30; correct?

03:50 14 **A.** Yes.

03:50 15 **Q.** There's no change over 30 minutes, is there?

03:50 16 **A.** Well, in his report, he says he, in fact, calculates these
03:51 17 with constant net pay heights, but he also says that he
03:51 18 believes that they're more likely variable pay heights, and I
03:51 19 think the word "likely" is exactly the word he used.

03:51 20 So he acknowledges freely that he's just got a
03:51 21 constant for some period of time and then he changes it to
03:51 22 another constant. But he says within his first two pages of
03:51 23 his report that varying PI or net pay height would be more
03:51 24 likely.

03:51 25 **Q.** You recognize the exhibit in front of you is actually his

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03:51 1 report?

03:51 2 A. Yes.

03:51 3 Q. And you know that he testified in the Phase One trial
03:51 4 about this exact topic?

03:51 5 A. That, I don't know anything about -- well, I guess I do.
03:51 6 Yeah, I do. Because I think I -- I think I read his testimony,
03:51 7 but I don't -- I don't remember for sure.

03:51 8 Q. With respect to PT-B, after May 8th, you finally have PT-B
03:52 9 data; correct?

03:52 10 A. After May 8th, yes, PT-B.

03:52 11 Q. Once you have that data, you don't use all of it; correct?

03:52 12 A. I exclude the Top Kill period and then there's some noise
03:52 13 just before July 11th that I exclude.

03:52 14 Q. You exclude dropouts, you exclude what you view as noise,
03:52 15 and you exclude the Top Kill period; correct?

03:52 16 A. Yes.

03:52 17 Q. And then in your best estimate, your flow rates are
03:52 18 derived by the difference between reservoir pressure and the
03:52 19 pressure shown on PT-B; correct?

03:52 20 A. Correct.

03:52 21 Q. But before you use PT-B, you then add additional
03:52 22 corrections to it; is that right?

03:52 23 A. To correct for persistent offset, yes.

03:52 24 Q. Right. So you add 740 psi through July 9th, thereabouts;
03:52 25 is that right?

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03:52 1 A. Yes.

03:52 2 Q. And you add a different offset for the last time period;
03:52 3 correct?

03:52 4 A. Yes.

03:52 5 Q. And then after you take the data and add an offset, you
03:52 6 then add an error to the offset PT-B data; right?

03:53 7 A. Yes, the plus or minus 130.

03:53 8 Q. So in your best estimate, you're using PT-B data that
03:53 9 includes an offset and then has a plus or minus 130-psi error
03:53 10 on top of the offset; correct?

03:53 11 A. Well, more or less correct.

03:53 12 Q. You agree that if you use the higher offset for PT-B, you
03:53 13 would get a lower cumulative discharge?

03:53 14 A. Only if I used it during the period before July 11th.
03:53 15 Then, yes.

03:53 16 Q. And, in fact, when you did your report in 2011, you used a
03:53 17 different PT-B offset than what you have in here in 2013;
03:53 18 correct?

03:53 19 A. Correct. I had very limited data available to me then.

03:53 20 Q. And one of the conclusions you had in 2011 was one of the
03:53 21 drawbacks of your approach was uncertainty -- well, first, the
03:54 22 sparse nature of BOP pressure measurements; correct?

03:54 23 A. This is my Sandia report?

03:54 24 Q. Yes.

03:54 25 A. At that time, yes, sparse data.

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03:54 1 Q. And also uncertainties in the BOP gauge offsets; correct?

03:54 2 A. Yes.

03:54 3 Q. And given that your entire best estimate is leveraged off
03:54 4 of PT-B, those are significant uncertainties?

03:54 5 A. Well, those were uncertainties that existed at that time.
03:54 6 I think by the time I wrote my expert report -- well,
03:54 7 certainly, there was data -- I had no data in most of June and
03:54 8 into July at the time I wrote that report, so I had additional
03:54 9 data and I had a great deal more information about offset PT-B
03:54 10 at the time I wrote my expert report.

03:54 11 MR. REGAN: If we could put up D-24368, just so that
03:54 12 we can all be using the same terms.

03:54 13 BY MR. REGAN:

03:54 14 Q. You see here in D-24368 that I have ambient pressure, PT-B
03:54 15 pressure, and reservoir pressure. Do you see that,
03:54 16 Dr. Griffiths?

03:54 17 A. Yes.

03:54 18 Q. And you see the PT-B gauge is right at the mud line at the
03:55 19 bottom of the BOP; correct?

03:55 20 A. Yes.

03:55 21 MR. REGAN: If we go to 24369, D-24369.

03:55 22 BY MR. REGAN:

03:55 23 Q. If we talk about upstream of PT-B, we're talking about the
03:55 24 reservoir and wellbore resistance. Is that fair, in the way
03:55 25 you use the terms?

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03:55 1 A. Yes.

03:55 2 Q. Okay.

03:55 3 MR. REGAN: If we could go to 24370.

03:55 4 BY MR. REGAN:

03:55 5 Q. If we're talking about downstream, we're talking about
03:55 6 downstream flow, so downstream is the area above the BOP, above
03:55 7 the gauge; is that fair?

03:55 8 A. Yes.

03:55 9 MR. REGAN: D-24401.

03:55 10 BY MR. REGAN:

03:55 11 Q. Just to orient the Court, do you agree, Dr. Griffiths,
03:55 12 that if the PT-B pressure decreases, that can happen for two
03:55 13 reasons: Either the resistance downstream has decreased or the
03:55 14 reservoir in the wellbore resistance has increased? Do you
03:56 15 agree?

03:56 16 A. I believe that's correct.

03:56 17 Q. Would you also agree that if the PT-B pressure increases,
03:56 18 that can happen either because the reservoir in the wellbore
03:56 19 resistance has decreased or the BOP or downstream resistance
03:56 20 has increased? Do you agree?

03:56 21 A. I would agree.

03:56 22 Q. And, finally, if you have a resistance of BOP -- a
03:56 23 decrease in BOP resistance or a decrease in reservoir
03:56 24 resistance, you could have your flow increase; correct?

03:56 25 A. I'm not sure I followed the whole question, but I think

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03:56 1 it's probably right. So far you've been right about these
03:56 2 things, so I'll trust that you continue to be so.

03:56 3 Q. All right.

03:56 4 THE COURT: It's dangerous to trust a lawyer,
03:56 5 particularly when he's cross-examining you.

03:56 6 BY MR. REGAN:

03:56 7 Q. Well, let's try to right that.

03:57 8 A. Okay.

03:57 9 Q. Do you agree that if the reservoir resistance increases or
03:57 10 the BOP resistance increases, you would expect flow to go down?
03:57 11 Right?

03:57 12 A. If the reservoir -- I'm sorry, one more time. It's just a
03:57 13 little bit hard for me to follow --

03:57 14 Q. Okay.

03:57 15 A. -- those words.

03:57 16 Q. If you have the reservoir and wellbore resistance increase
03:57 17 or the BOP resistance increase, you would expect flow to
03:57 18 decrease in either of those situations; correct?

03:57 19 A. Yes.

03:57 20 Q. If you had the resistance in the BOP or the resistance in
03:57 21 the reservoir and wellbore decrease, less resistant, you'd
03:57 22 expect more flow; correct?

03:57 23 A. Yes.

03:57 24 Q. Your PT-B, if it goes down, that could be either because
03:57 25 the BOP is less resistant or the reservoir is more resistant;

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03:57 1 correct?

03:57 2 A. That's -- that's possible, yes.

03:57 3 Q. And if PT-B goes up, it can go up for two reasons: The
03:57 4 reservoir resistance has decreased, less resistance in the
03:58 5 well, or you've had more resistance in the BOP; correct?

03:58 6 A. Correct.

03:58 7 Q. And one example you cite in your report as to this
03:58 8 phenomenon is that when the test rams were closed; correct?

03:58 9 When the test rams were closed -- I'll give you a
03:58 10 little more context. When the test rams were closed, you had
03:58 11 an increase resistance in the BOP and, therefore, your PT-B
03:58 12 pressure increased; right?

03:58 13 A. Uh-huh.

03:58 14 Q. And you saw that in the data; correct?

03:58 15 A. Yes.

03:58 16 Q. But this gauge, because it's in the middle of downstream
03:58 17 and upstream, what it actually reflects is the combination of
03:58 18 what's going on above it, or downstream of it, and upstream of
03:58 19 it?

03:58 20 A. Yes.

03:58 21 Q. It represents the combined effects of what is going on in
03:58 22 the reservoir and wellbore and what's going on in the BOP;
03:58 23 correct?

03:58 24 A. It does.

03:58 25 Q. And because you have resistances on each side of this

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03:59 1 gauge, just looking at the changes in PT-B alone, you can't
03:59 2 know whether a change in PT-B is because of a downstream change
03:59 3 or an upstream change; correct?

03:59 4 A. I would agree, if that's the only piece of information you
03:59 5 have.

03:59 6 Q. You would have to get additional information to reach a
03:59 7 judgment that just because PT-B has either gone down or up, you
03:59 8 know exactly what's going on in the wellbore; correct?

03:59 9 A. I agree with that.

03:59 10 Q. Okay.

03:59 11 MR. REGAN: Let's pull up TREX -- sorry, D-24531.

03:59 12 BY MR. REGAN:

03:59 13 Q. What I have here, Dr. Griffiths, on D-24531, is a chart
03:59 14 that contains three lines. The lowest line is your adjusted
03:59 15 and extrapolated PT-B pressure, the middle line is your flow
03:59 16 rate calculation under your best estimate, and I have a green
04:00 17 line for reservoir pressure. Do you see that there?

04:00 18 A. Yes.

04:00 19 Q. Okay. This May 8th to May 14th time period, there's
04:00 20 approximately 800-psi drop in PT-B; correct?

04:00 21 A. That number -- I don't know that number off the top of my
04:00 22 head, but let's see. It would be something like -- oh, 800 in
04:00 23 the trend? No, I think that's too high.

04:00 24 Q. From May 8th to May 14th, right here on your chart --

04:00 25 A. May 8th to May 14th, yes.

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04:00 1 Q. Okay. Are you with me? 800-psi drop; correct?

04:00 2 A. Okay.

04:00 3 Q. That drop is greater than your error bar for PT-B;
04:00 4 correct?

04:00 5 A. It is.

04:00 6 Q. And in your report, you discuss this drop; correct?

04:00 7 A. Yes.

04:00 8 MR. REGAN: We go to TREN-11486R.29.2.

04:01 9 BY MR. REGAN:

04:01 10 Q. In your report you say: "Between May 8th and May 14th,
04:01 11 the ratio of pressure drops falls very significantly, and this
04:01 12 indicates that the resistance in the BOP fell relative to that
04:01 13 in the reservoir and wellbore." Correct?

04:01 14 A. Yes.

04:01 15 Q. So PT-B went down because, in your view, the BOP became
04:01 16 less resistant; correct?

04:01 17 A. That's what's stated here.

04:01 18 Q. You say: "This conceivably resulted from some sudden and
04:01 19 real change in either resistance or might conceivably result
04:01 20 from expected inaccuracies in the BOP pressures. If real, this
04:01 21 sudden fall could represent a drop in BOP resistance or sudden
04:01 22 increase in the reservoir and wellbore resistance."

04:01 23 That sentence is what we just went through; right?

04:01 24 A. Yes.

04:01 25 Q. PT-B can go down either because the BOP is less resistant

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04:01 1 or the wellbore is more resistant; correct?

04:02 2 A. Uh-huh.

04:02 3 Q. You say: "The first of these seems most likely. In this
04:02 4 case, the drop in BOP resistance might be, for example, the
04:02 5 drop in the pipe below the BOP or sudden failure of the seal in
04:02 6 one of the rams."

04:02 7 Did I read that correctly?

04:02 8 A. Uh-huh.

04:02 9 Q. You testified about 40 minutes ago that you believe the
04:02 10 drill pipe fell on April 29th; correct?

04:02 11 A. Yes.

04:02 12 Q. You now say the data between May 8th and May 14th, that
04:02 13 drop may actually -- that may be when the drill pipe dropped;
04:02 14 correct?

04:02 15 A. These are all hypotheticals. I'm just -- I'm speculating
04:02 16 about it could mean this, it could mean that. It is not saying
04:02 17 that I believe those things occurred. It's just a discussion
04:02 18 of what -- what might have occurred.

04:02 19 Q. You are speculating about when the drill pipe dropped in
04:02 20 saying that it either was on April 29th or May 14 -- between
04:02 21 May 8th and May 14th; correct? You don't know?

04:02 22 A. Wait. This statement ends with -- I mean, I know the
04:02 23 drill pipe didn't drop after May 8th. This is a just
04:03 24 discussion of the sort of things that you might be able to
04:03 25 conclude just from this, but there's all kinds of other

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04:03 1 information that you bring into it.

04:03 2 Q. This discussion is in your expert report; correct?

04:03 3 A. I think that's right.

04:03 4 Q. Okay. But you rule out the drill pipe drop because you
04:03 5 say it's "irreversible, while the ratio of the pressure drop
04:03 6 largely recovers on May 19th. As such, I can offer no physical
04:03 7 reason for this behavior."

04:03 8 What you're referring to there is that the PT-B
04:03 9 starts to go up again; correct?

04:03 10 A. Yes.

04:03 11 MR. REGAN: If we could go back to D-24531.

04:03 12 BY MR. REGAN:

04:03 13 Q. This is the increase in PT-B, May 14th to May 19th;
04:03 14 correct?

04:04 15 A. Yes.

04:04 16 Q. We know that that increase in PT-B could be the wellbore
04:04 17 and reservoir becoming less resistant; correct?

04:04 18 A. I presume there's something that would allow that, yes.

04:04 19 Q. The gauge, the pressure that we read, PT-B going from a
04:04 20 lower value to a higher value, that could represent actually
04:04 21 erosion in the reservoir or wellbore that's allowing PT-B to go
04:04 22 up; correct?

04:04 23 A. It could.

04:04 24 Q. Just as you say the decrease in PT-B could be the BOP
04:04 25 becoming less resistant; correct?

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04:04 1 A. It could be.

04:04 2 Q. In your best estimate, you have flow increasing when the
04:04 3 BOP becomes less resistant. That's the purple line, May 14th;
04:04 4 correct? Right there.

04:04 5 A. Well, in my best estimate, keep in mind, there's nothing
04:04 6 about the resistance. The BOP is not involved in that. I
04:04 7 looked at BOP pressures. What you said, the resistance of the
04:04 8 BOP changed in such and such a way and I'm just reminding you
04:05 9 that, in fact, my best estimate calculation does not involve in
04:05 10 any way K-BOP.

04:05 11 Q. I'm not talking about K-BOP. You've testified that your
04:05 12 best estimate allows you to predict any erosion that happens
04:05 13 downstream of PT-B; correct?

04:05 14 A. Correct.

04:05 15 Q. So you have --

04:05 16 A. No, I -- I don't know predict. It accounts for it.

04:05 17 Q. Okay.

04:05 18 A. If that erosion occurred, that methodology would account
04:05 19 for erosion that occurred downstream of PT-B.

04:05 20 Q. Your methodology has flow going up when PT-B goes down;
04:05 21 correct?

04:05 22 A. Okay.

04:05 23 Q. Is that correct?

04:05 24 A. Well, those are the plots of the curves.

04:05 25 Q. Is that correct, Dr. Griffiths?

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04:05 1 A. Well --

04:05 2 Q. Is that your flow rate curve above your PT-B curve?

04:05 3 A. Yes. Yes, yes.

04:05 4 Q. You then have flow rate going down when PT-B goes up
04:06 5 between May 14th and May 19th; correct?

04:06 6 A. Correct.

04:06 7 Q. What is happening in the BOP to make it more resistant to
04:06 8 have your flow rate go down?

04:06 9 A. I don't think we know with any certainty at all that
04:06 10 anything is happening. You know, that first swing, the very
04:06 11 first swing is a big one. All the rest of these things are
04:06 12 just dancing around inside the bands of what you expect from
04:06 13 uncertainties in the PT-B gauge.

04:06 14 So there's no -- there is no meaning -- you can't
04:06 15 read, well, this went up and that went up. This is just
04:06 16 uncertainties in pressure. This is just noise on the PT-B, and
04:06 17 you get these changes accompanying changes in flow rate. That
04:06 18 doesn't say anything at all about resistances actually
04:06 19 changing.

04:06 20 Q. Well, Dr. Griffiths, it's your testimony that your best
04:06 21 estimate, the value of it is that it's actually capturing all
04:07 22 the changes downstream of PT-B; correct?

04:07 23 A. It does, yes.

04:07 24 Q. So these dancing around, this is actually how you're
04:07 25 calculating your 5 million flow rate; correct?

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04:07 1 A. Yes.

04:07 2 Q. You're adding up all of these days that include all of
04:07 3 this dancing around; correct?

04:07 4 A. Yes.

04:07 5 Q. And you can't explain why you have flow rate going down
04:07 6 when PT-B goes up between May 15th and May 19th; correct?

04:07 7 A. No. No. The flow rate is going to go down if PT-B goes
04:07 8 up.

04:07 9 Q. Not necessarily; right, Dr. Griffiths?

04:07 10 A. Barring like really bizarre things, yes, necessarily.

04:07 11 Q. If the wellbore and the reservoir became less resistant,
04:07 12 PT-B would go up and flow rate would go up?

04:07 13 A. Assuming that they have the ability to decide that
04:07 14 collectively, we're both going to do this at the same time --
04:07 15 which I don't believe they do have that ability -- then those
04:08 16 things are possible. Otherwise, what you described is not
04:08 17 possible.

04:08 18 Q. So what is happening then in the BOP to make it more
04:08 19 resistant to have your flow rate go down?

04:08 20 A. It is not more resistant. You're trying to interpret
04:08 21 noise on a gauge through physical mechanisms. It doesn't make
04:08 22 any sense to do that.

04:08 23 Q. So the line that you drew using your best estimate through
04:08 24 which you calculate your integrated flow rate is noise? I
04:08 25 don't think you mean that, but I think that's what you just

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04:08 1 said.

04:08 2 A. There are fluctuations and there are uncertainties in
04:08 3 PT-B, plus or minus 130, I said. Dr. Trusler says plus or
04:08 4 minus 200. Maybe that's the right number. It hardly makes any
04:08 5 difference in any of this. Those pressures are just -- you
04:08 6 know, there's some uncertainty in them, they go up, they go
04:09 7 down.

04:09 8 From my methodology, all that happens is when they're
04:09 9 high, I underpredict flow rate a little bit; when they're low,
04:09 10 I overpredict the flow rate a little bit. They go up and down.
04:09 11 Almost all that stuff cancels out.

04:09 12 Q. So the actual daily flow rates that you're calculating to
04:09 13 get your 5 million to you don't really matter because of the
04:09 14 average of them --

04:09 15 A. No, no, they matter tremendously. The little ups and
04:09 16 downs in them don't matter. Those -- the values themselves do
04:09 17 matter.

04:09 18 Q. The ups and downs between May 8th and May 19th are outside
04:09 19 your error range for PT-B; correct?

04:09 20 A. Certainly the first one is, and that's why I discussed it.
04:09 21 It's not way outside; it's, unfortunately, kind of in a gray
04:09 22 area. It's a little bit outside the bounds, which is, you
04:09 23 know, something I need to think about, but it's not terribly
04:09 24 outside the bounds.

04:09 25 So it's a little hard to say is it just uncertainty

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04:10 1 in PT-B or is it something physical.

04:10 2 MR. REGAN: Go to D-24527.

04:10 3 BY MR. REGAN:

04:10 4 Q. Dr. Griffiths, this is just the PT-B chart with some dates
04:10 5 on it of the events that were going on at the time. Again, we
04:10 6 have May 8th to May 14th, a decrease in PT-B. Do you see that?

04:10 7 A. Yes.

04:10 8 Q. And May 14th to May 19th, an increase in PT-B. Do you see
04:10 9 that?

04:10 10 A. Yes.

04:10 11 Q. And those events are happening at exactly the same time in
04:10 12 exactly the same time period as Dr. Zaldivar's predicting slug
04:10 13 flow appearing at the well; correct?

04:10 14 A. I -- I have no idea.

04:10 15 Q. Well, you are predicting an increase in flow as this line
04:10 16 goes from May 8th to May 14th. You are predicting flow rate is
04:10 17 increasing during this time period; correct?

04:10 18 A. I don't think I'm going to be able to discuss

04:11 19 Dr. Zaldivar's work. I have not read carefully his work, so --

04:11 20 Q. Okay. Let me ask you about a different data point. Do
04:11 21 you see the peak of PT-B from May 14th to May 19th is May -- is
04:11 22 May 19th. Do you see that?

04:11 23 A. Yes.

04:11 24 Q. And that's the day that a third hole appeared in the
04:11 25 riser, additional erosion; correct?

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04:11 1 A. These -- these are not associated with holes in the riser.
04:11 2 I just -- that's not possible.

04:11 3 Q. So this additional information is not helping you
04:11 4 interpret PT-B?

04:11 5 A. What additional information?

04:11 6 Q. The fact that physical evidence of erosion appeared on
04:11 7 May 19th with the third hole in the kink of the riser.

04:11 8 A. What -- oh, no, I mean, there are many things that
04:11 9 Dr. Nesic and I agreed on, but we both agreed that holes didn't
04:11 10 do much of anything to affect flow rate from the well. I mean,
04:11 11 I think he -- he concluded that it changed the pressure drop
04:11 12 through the riser by 20 percent or something, you know, from
04:12 13 zero holes to all holes.

04:12 14 Well, the pressure drop through the riser was at most
04:12 15 about 300 psi, 20 percent of 300 psi. We're talking tens of
04:12 16 psi. That's not related to any of this stuff.

04:12 17 Q. Dr. Griffiths, let me turn to your alternate methods.
04:12 18 Your first alternate method is one where you hold three things
04:12 19 constant, that is, the BOP resistance, the well resistance, and
04:12 20 the reservoir resistance; correct?

04:12 21 A. Alternate 1?

04:12 22 Q. Yes.

04:12 23 A. Yes.

04:12 24 MR. REGAN: If we can go to D-24375.

25

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04:12 1 **BY MR. REGAN:**

04:12 2 **Q.** So you're holding K-BOP locked, K-well locked, and PI
04:12 3 locked all over 86 days; correct?

04:12 4 **A.** They're held constant, yes.

04:12 5 **Q.** And you predict a flow rate by comparing these three
04:12 6 constants to the decrease in reservoir -- the difference
04:12 7 between reservoir pressure and ambient pressure; correct? In
04:13 8 Alternative 1?

04:13 9 **A.** Yes.

04:13 10 **Q.** And because your reservoir pressure is a straight line,
04:13 11 effectively, and your ambient pressure is a straight line, and
04:13 12 you're using three constants, your flow rate line for
04:13 13 Alternative 1 is a perfectly straight line; correct?

04:13 14 **A.** No, I don't think it is, huh-huh. Because if -- if --
04:13 15 if -- well, I don't think it is.

04:13 16 **MR. REGAN:** D-24532.

04:13 17 **THE WITNESS:** I could be wrong, but my immediate
04:13 18 response is no, it would not be a perfectly straight line.

04:13 19 **BY MR. REGAN:**

04:13 20 **Q.** Let's test it out. In terms of Alternative 1, you have
04:13 21 three constants for BOP, PI, and wellbore as of July 15th;
04:13 22 correct? As of the last day, you have three things held
04:13 23 constant in Alternative 1; correct?

04:13 24 **A.** Okay.

04:13 25 **Q.** And the only thing you're comparing for pressure change is

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04:13 1 reservoir pressure and ambient sea pressure; correct?

04:14 2 A. Yes.

04:14 3 Q. So in your methodology, you would end up with a flow rate
04:14 4 that's a perfectly straight line?

04:14 5 A. Huh-uh, no.

04:14 6 Q. Why not?

04:14 7 A. Because of -- because if you have the ambient sea pressure
04:14 8 as a constant --

04:14 9 Q. Yes.

04:14 10 A. -- that means the -- and the other is linear, that means
04:14 11 that the difference is linear, but the flow rate is not
04:14 12 linearly proportional to pressure differences. It is dominated
04:14 13 in these cases by the square root, so it would not be a
04:14 14 perfectly straight line. It would -- it would have some
04:14 15 curvature to it.

04:14 16 Q. But you're holding all of your discharge coefficients
04:14 17 constant; correct?

04:14 18 A. Yes.

04:14 19 Q. Have you ever drawn the line, the actual flow rate line
04:14 20 for your Alternative 1?

04:14 21 A. No. It cannot be -- it is not a straight line. It is
04:14 22 just simply not possible that it is a perfectly straight line.

04:14 23 Q. How about Alternative 2? If we could talk about that.

04:15 24 **MR. REGAN:** Alternative 2, D-24376.

25

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04:15 1 **BY MR. REGAN:**

04:15 2 **Q.** In your Alternative 2, you hold 1 discharge coefficient
04:15 3 constant, that is, K-BOP, and you compare reservoir pressure --
04:15 4 PT-B pressure and ambient; correct?

04:15 5 **A.** Yes.

04:15 6 **Q.** Well, because, again, you're comparing now PT-B and
04:15 7 ambient with ambient being a straight line, your Alternative 2
04:15 8 flow rate is going to look exactly like the signature of PT-B;
04:15 9 correct?

04:15 10 **A.** Could you repeat that, please?

04:15 11 **Q.** Sure. Let me put it up on the board. It might be easier
04:15 12 to see.

04:15 13 **MR. REGAN:** D-24408.

04:15 14 **BY MR. REGAN:**

04:15 15 **Q.** In Alternative 2, you're only comparing two pressures.
04:15 16 One of them is constant. The other one is PT-B; correct?

04:16 17 **A.** Okay.

04:16 18 **Q.** You're comparing a constant pressure and PT -- against
04:16 19 PT-B pressure?

04:16 20 **A.** Yes.

04:16 21 **Q.** And as a result, in your model, if you calculate flow rate
04:16 22 in Alternative 2, your flow rate is going to look exactly like
04:16 23 PT-B in terms of its shape because it's going to follow this
04:16 24 difference between PT-B and ambient; correct?

04:16 25 **A.** The ups and downs do track, but to say that it follows it

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04:16 1 exactly is not correct because in this case, for sure, the flow
04:16 2 rate is proportional to the square root of that difference.
04:16 3 And so it is not going to be any kind of one-to-one mapping of
04:16 4 flow rates and PT-B pressures.

04:16 5 **MR. REGAN:** Go to D-24409.

04:16 6 **BY MR. REGAN:**

04:16 7 **Q.** What I have on this demonstrative, Dr. Griffiths, is a
04:16 8 calculation of what the flow rate lines look like under your
04:17 9 Alternative 1, under your Alternative 2, and under your best
04:17 10 estimate.

04:17 11 We've looked at all three of these flow rate lines,
04:17 12 and do you agree that under your alternative methods you will
04:17 13 have different flow rates for the same day in each of the
04:17 14 different methods, as represented here in D-24409?

04:17 15 **A.** That I will have different flow rates for the same day by
04:17 16 the different methods. Yeah -- well, they'll be slightly
04:17 17 different, sure.

04:17 18 **Q.** Well, we can see in your best estimate, flow rate goes up
04:17 19 when PT-B goes down. In your Alternative 2 method, you have
04:17 20 flow rate going down when PT-B goes up.

04:17 21 So for the very same day, on May 8th, one of your
04:17 22 methods has a flow rate of almost 70,000, and your best
04:17 23 estimate has a flow rate of a little bit less than 60,000. Is
04:18 24 that fair?

04:18 25 **A.** Well, I suppose.

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04:18 1 Q. Your testimony is, well, all of these flow rates, they all
04:18 2 add up to the same total number.

04:18 3 But it is a fact that if you actually chart the daily
04:18 4 flow rates of your alternative methods, you'll get wildly
04:18 5 different flow rates for the same days; correct?

04:18 6 A. I don't think these plots are even credible. I didn't
04:18 7 make these plots; they're not mine. But something seems very
04:18 8 screwed up here because you have Alternative 2 flow rate.
04:18 9 Clearly -- just visually the integral of that is going to be
04:18 10 larger than Alternative 1. In fact, they're very, very
04:18 11 similar, like 5.1, in both cases.

04:18 12 So I don't know exactly what I'm looking at, but I
04:18 13 sort of am a little suspicious already that something here is
04:18 14 screwed up.

04:18 15 Q. You've never used your Fortran code that you produced in
04:19 16 this litigation to actually derive the flow rate signature of
04:19 17 your Alternative 1 and Alternative 2, have you?

04:19 18 A. Well, sure I do.

04:19 19 Q. So you know what your lines would look like; correct?

04:19 20 A. Yes. I calculate them. That's how I calculate the
04:19 21 cumulative discharge.

04:19 22 Q. Exactly. So you know that they don't -- they are not the
04:19 23 same line for the same day; correct? Regardless of whether you
04:19 24 accept this chart --

04:19 25 A. Oh, no, no. They're not exactly the same. But, you know,

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04:19 1 as long as we're at it, you've got a chart here with no zero on
04:19 2 it, and we've talked about that in the past. It's called
04:19 3 "whoopie plots." It starts at 50,000. So it really
04:19 4 exaggerates all these variabilities. We're looking at things
04:19 5 that around 60, 65, they peak up to 70. Those are significant
04:19 6 differences, but they're not, you know, like, whoa, this one's
04:19 7 1,000 and that one's 15.

04:19 8 Q. The simple fact is, Dr. Griffiths, that the three
04:20 9 alternative methods -- your best method, Alternative 1, and
04:20 10 Alternative 2 -- that you say verify each other, actually have
04:20 11 different daily flow rates amongst -- along the time scale from
04:20 12 Day Zero to Day 86?

04:20 13 A. Well, absolutely. They're independent -- they use
04:20 14 different datasets. So they shouldn't have the same flow rate
04:20 15 on a given day by the three different methods. I mean, that
04:20 16 would be just very strange.

04:20 17 Q. But there is only one true flow rate for each day;
04:20 18 correct?

04:20 19 A. And calculations are always an approximation of that one
04:20 20 true flow rate.

04:20 21 Q. Amongst your alternative methods, Dr. Griffiths, there's
04:20 22 no method that you ran where you allowed the parameters for PI,
04:20 23 wellbore coefficient, and BOP coefficient to be anything other
04:20 24 than constant over the 86 days?

04:20 25 **THE COURT:** All right. Mr. Regan, this is getting

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04:21 1 very repetitive now.

04:21 2 MR. REGAN: Okay.

04:21 3 THE COURT: I've given you a lot of leeway, but it
04:21 4 seems like you're beating this to death.

04:21 5 MR. REGAN: Just one more question on this, Your
04:21 6 Honor, and then I'll change right into the -- turn to the
04:21 7 report.

04:21 8 THE COURT: Let's try to move on.

04:21 9 BY MR. REGAN:

04:21 10 Q. If both the PI and the BOP resistance varied in your work,
04:21 11 Dr. Griffiths, none of your cases would yield a cumulative
04:21 12 discharge that is a true discharge. All of your cases -- let
04:21 13 me say it again.

04:21 14 If both the PI and the BOP varied over time, all
04:21 15 three of your cases would yield a cumulative discharge that
04:21 16 differs from the true value?

04:21 17 A. If both the PI and the BOP varied over time, then my
04:21 18 calculations would differ from the true value? My calculations
04:21 19 always differ from the true value.

04:21 20 Q. Let me show you your report, 11486R.12.6.

04:22 21 My final question on this topic is, reading your
04:22 22 report, the last sentence, did you write, "If both the PI and
04:22 23 BOP varied, then all three of" your cases -- referring to best
04:22 24 estimate, Alternative 1 and 2 -- "would yield a cumulative
04:22 25 discharge that differs from the true value"? Is that correct?

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04:22 1 A. Yes.

04:22 2 Q. You talked a little on direct about the work of Tony Liao.
04:22 3 Do you remember that?

04:22 4 A. Yes.

04:22 5 Q. Do you know what Dr. Liao was actually modeling in
04:22 6 terms -- for your comparison? Do you know what he was actually
04:22 7 modeling?

04:22 8 A. He was modeling the Macondo well.

04:22 9 Q. Well, was he modeling casing or casing with drill pipe or
04:22 10 casing with no drill pipe? Do you know?

04:22 11 A. Well, I think there were a couple of different ones. I
04:22 12 think that one was the casing normally compared with.

04:22 13 Q. Do you know how many models he actually ran?

04:23 14 A. You mean how many cases?

04:23 15 Q. Yes, sir.

04:23 16 A. No.

04:23 17 Q. And you matched one of his cases; correct?

04:23 18 A. Yes.

04:23 19 Q. Okay. Dr. Griffiths, in your uncertainty chart that you
04:23 20 put up, you have an uncertainty if you have the wrong final
04:23 21 reservoir pressure; is that right?

04:23 22 A. I'm sorry?

04:23 23 Q. Let me put up the chart and see if we can do this faster.

04:23 24 MR. REGAN: D-21224.

25

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04:23 1 BY MR. REGAN:

04:23 2 Q. Directing your attention to the line that says "Res
04:23 3 Press" -- that's reservoir pressure; correct?

04:23 4 A. Uh-huh.

04:23 5 Q. -- "7260 versus 6605."

04:23 6 A. Uh-huh.

04:23 7 Q. That's a reference to what the appropriate final reservoir
04:23 8 pressure is less an elevation head; correct?

04:23 9 A. Yes.

04:23 10 Q. And it's your calculation, using your models, that if the
04:23 11 final reservoir pressure less elevation head increases -- that
04:23 12 means there's less depletion -- your flow rate numbers go up?

04:24 13 A. That's correct.

04:24 14 Q. So as the -- using your methodology, as there is less
04:24 15 depletion of the reservoir over time, your flow rate
04:24 16 calculations actually increase the amount of flow from the
04:24 17 well; correct?

04:24 18 A. Different delta P is not the same as less depletion. I
04:24 19 mean, it depends what you're talking about, "depletion" here.
04:24 20 But, okay, I'll agree, sort of, so far. Go ahead.

04:24 21 Q. And it's true, Dr. Griffiths, that using your methodology,
04:24 22 if you held reservoir pressure as an average value over time or
04:24 23 as a constant, you would still calculate a cumulative flow of
04:24 24 approximately 5 million barrels?

04:24 25 A. Yes. If I -- my methodology is based on calculating flow

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04:24 1 rates and integrating those in time to get the discharge.

04:24 2 If I had used -- instead of the decaying reservoir
04:25 3 pressure, if I had instead used the average reservoir pressure
04:25 4 over that time, I would still have gotten a calculated
04:25 5 discharge close to 5 million.

04:25 6 Q. In fact, Dr. Griffiths, if you used the initial reservoir
04:25 7 pressure of 11,850 and held that constant over the entire time
04:25 8 period, no depletion, you would still calculate 5 million
04:25 9 barrels using your model?

04:25 10 A. Well, it wouldn't be 5 million, but, you know, you could
04:25 11 do a calculation like that. And as long as -- I mean, an
04:25 12 integral is sort of the beginning of an average. If I used the
04:25 13 average pressure over the time to calculate my flow rates, then
04:25 14 on average they're going to be right. And if they don't change
04:25 15 on average, then my cumulative discharge does not change.

04:25 16 Q. I'll try it one more time, Dr. Griffiths.

04:26 17 You could run your model with either just an average
04:26 18 reservoir pressure or even a final reservoir pressure that was
04:26 19 the same as the initial reservoir pressure, 11,850, and your
04:26 20 model would still predict a cumulative flow of around 5 million
04:26 21 barrels; correct?

04:26 22 A. True.

04:26 23 MR. REGAN: Thank you, Dr. Griffiths.

04:26 24 THE COURT: Redirect?

04:26 25 MR. BENSON: Yes, Your Honor.

STEWART GRIFFITHS, PH.D. - CROSS

REDIRECT EXAMINATION

04:26 1
04:27 2 **BY MR. BENSON:**

04:27 3 Q. Okay. Dr. Griffiths, a couple things I want to just
04:27 4 return to quickly.

04:27 5 First, you had a lot of questions from Mr. Regan
04:27 6 about PT-B data, especially early on in May. Do you recall
04:27 7 that?

04:27 8 A. Yes.

04:27 9 **MR. BENSON:** Could we have TREX 11486R.27.

04:27 10 **BY MR. BENSON:**

04:27 11 Q. While we call that up, Dr. Griffiths, did you do anything
04:28 12 to average out some of the ups and downs in the PT-B data?

04:28 13 A. I'm not sure what you mean. Sometimes, when I want to fit
04:28 14 them with a curve, I do some daily averaging to get rid of
04:28 15 issues associated with episodic sampling.

04:28 16 **MR. BENSON:** If we could call out Figure 3 on this
04:28 17 page.

04:28 18 **BY MR. BENSON:**

04:28 19 Q. And this is from your rebuttal report; correct?

04:28 20 A. Yes.

04:28 21 Q. And, Dr. Griffiths, is this a daily average plot you've
04:28 22 made of the PT-B data?

04:28 23 A. Yes, it is.

04:28 24 Q. And the one -- and the red lines are a plus or minus
04:28 25 200 psi; is that right?

STEWART GRIFFITHS, PH.D. - REDIRECT

04:28 1 A. That's correct. Those are the -- those would correspond
04:28 2 to Dr. Trusler's assessment.

04:28 3 Q. And you see the area -- the plots that go beneath that red
04:28 4 line on about May 26th to May 30th, what are those?

04:29 5 A. Well, those are the test rams being opened. So you see
04:29 6 that on May 26th, the test rams are opened. They stayed open
04:29 7 for about three or four days. As soon as you close those, the
04:29 8 pressures go right back up. So that's the trough in the
04:29 9 middle.

04:29 10 At the left there -- this is when I was responding to
04:29 11 questions by Mr. Regan -- this issue is these first two sets of
04:29 12 pressures are just a little bit outside the plus or minus 200,
04:29 13 and so it's a little bit hard to say are they, you know, just
04:29 14 uncertainties associated with PT-B, or is there something
04:29 15 physical happening here.

04:29 16 So it's just a gray area. It's hard to discern.

04:29 17 Q. And based on your review of the PT-B data, what did you
04:29 18 conclude about what was going on in the well over time?

04:30 19 A. Over time? Well, the decay in a very reasonable way,
04:30 20 consistent with the decay in the reservoir.

04:30 21 Q. Let me switch topics. You and Mr. Regan had a lengthy
04:30 22 discussion about some of -- I think what's in your Appendix I,
04:30 23 and that was the discussion about when the BSRs, the blind
04:30 24 shear rams, the casing shear rams shut in and what the flow
04:30 25 rates were associated with happening around those events.

STEWART GRIFFITHS, PH.D. - REDIRECT

04:30 1 A. Uh-huh.

04:30 2 Q. Let me just ask you, in broad terms, what was the purpose
04:30 3 of your Appendix I?

04:30 4 A. Well, the entire purpose of it was to characterize the
04:30 5 uncertainties associated with that period.

04:30 6 Q. And so the flow rates that you were talking about with
04:30 7 Mr. Regan, those aren't your best estimate flow rates for
04:30 8 particular days?

04:30 9 A. No, no. Because of those uncertainties, I had a set of
04:30 10 assumptions that would give me lower bounds on what I thought
04:30 11 were reasonable for the flow rates as well as upper bounds.
04:31 12 But those -- those sorts of assumptions aren't consistent with
04:31 13 an effort to obtain a best estimate.

04:31 14 Q. And the conclusion of your Appendix I was -- what
04:31 15 conclusion did you reach about your uncertainty for that
04:31 16 period?

04:31 17 A. Well, that it was, you know, plus or minus a few percent.

04:31 18 Q. Plus or minus. Was it --

04:31 19 A. Minus 3.3 was the lower bound.

04:31 20 Q. I think, as Mr. Regan said during your cross-examination,
04:31 21 that's about 170,000 barrels?

04:31 22 A. I think that's -- again, I don't have that number in my
04:31 23 head, but I will -- it's 5 times 3.3. It must be about that,
04:31 24 yes.

04:31 25 Q. Let's -- you had some questions from Mr. Regan about

STEWART GRIFFITHS, PH.D. - REDIRECT

04:31 1 Mr. Emilsen's report -- I'm sorry, Dr. Emilsen's report. Or
04:32 2 Mr.--

04:32 3 A. Mister.

04:32 4 Q. First let me ask -- there were some questions about how
04:32 5 Mr. Emilsen varied the net K over time and what conclusions you
04:32 6 drew from that?

04:32 7 A. Uh-huh.

04:32 8 **MR. BENSON:** Could we have TREN-41026.8, please.

04:32 9 If we could call out the paragraph that begins
04:32 10 "constant net pay" in the middle of that page.

04:32 11 **BY MR. BENSON:**

04:32 12 Q. Dr. Griffiths, is this paragraph from Mr. Emilsen's report
04:32 13 consistent with how you looked at Mr. Emilsen's results?

04:32 14 A. Well, it is. And, in fact, I referred to some of this
04:32 15 when I was talking. He just says, I used constant values, but
04:32 16 he acknowledges that varying the net pay -- varying net pay is
04:32 17 more likely and, I think, importantly, can also explain some --
04:32 18 you know, remaining discrepancies between his calculations and
04:33 19 the data.

04:33 20 **MR. BENSON:** And if we could go to TREN-41026.57,
04:33 21 also in Mr. Emilsen's report.

04:33 22 This is a slightly different topic. If we could
04:33 23 call out the bottom figure there.

04:33 24 **BY MR. BENSON:**

04:33 25 Q. On a different topic, you also talked with Mr. Regan about

STEWART GRIFFITHS, PH.D. - REDIRECT

04:33 1 the PT-B extrapolation and what was going on in PT-B before the
04:33 2 blowout?

04:33 3 A. Yes.

04:33 4 Q. Is this data that you reviewed?

04:33 5 A. Yes.

04:33 6 Q. And this is something you referenced in your answers to
04:33 7 Mr. Regan?

04:33 8 A. Yes. They're actually calculations rather than data, but,
04:33 9 yes.

04:33 10 Q. Okay. And what is Mr. Emilsen showing here about the
04:33 11 pressure before the blowout?

04:33 12 A. Okay. So he's showing -- these are calculations for his
04:33 13 best estimate case, Case 7, pressures above and below the BOP.
04:33 14 So once the BOP is sealed, those diverge, they split.

04:34 15 And so the blue line there is the pressure below the
04:34 16 BOP and -- so this is the moment, like 2140 is when the VBRs
04:34 17 were closed, right in that time frame.

04:34 18 And you see the pressure below the BOP over a period
04:34 19 of a very few minutes goes up and then is flat. At that point,
04:34 20 that's a shut-in state. There is zero flow from the well in
04:34 21 that condition.

04:34 22 And so my comments to Mr. Regan were, okay, that's
04:34 23 fine, that's interesting; but there's no flow, and we certainly
04:34 24 know there was flow. And that shortly after this the seal on
04:34 25 the top of the pipe would have been lost, flow would have

STEWART GRIFFITHS, PH.D. - REDIRECT

04:34 1 resumed, and this pressure, this 8700 psi would drop right back
04:34 2 down to -- Mr. Emilsen has it at about 3,000, mine was about
04:35 3 4300 -- drop right back down in a couple of minutes, back to
04:35 4 these 3 or 4,000 psi pressures.

04:35 5 Q. Is it possible to get a pressure here higher than what
04:35 6 you're calling the shut-in pressure?

04:35 7 A. No. It's the maximum possible pressure that you could
04:35 8 have at the BOP.

04:35 9 MR. BENSON: If we could have Demonstrative 21230,
04:35 10 please.

04:35 11 BY MR. BENSON:

04:35 12 Q. And this is another version of the chart that Mr. Regan
04:35 13 showed you on your cross-examination; correct?

04:35 14 A. Yes.

04:35 15 Q. And what Mr. Regan suggested is that you should use 8700
04:35 16 or 8600 as your pressure for the first day; is that right?

04:35 17 A. Yes.

04:35 18 Q. Do you think that's a reasonable thing to do?

04:35 19 A. No, I don't.

04:35 20 Q. And then the extrapolation he suggested would be a
04:35 21 straight line from Day Zero to May 8th.

04:35 22 Again, do you think that's reasonable?

04:35 23 A. Not at all.

04:35 24 Q. Why not?

04:35 25 A. Well, again, you know, 8700 is a nonflowing well. There's

STEWART GRIFFITHS, PH.D. - REDIRECT

04:36 1 no doubt that there was flow and high flow rates from the well
04:36 2 at this time. And the 8700 exists only because there is no
04:36 3 flow. So I think 8700, fine, that's a good pressure at 2150 on
04:36 4 April 20th.

04:36 5 And two minutes later or five minutes later, when the
04:36 6 seal was lost on the pipe, pressure would be back down at 3 or
04:36 7 4,000 psi.

04:36 8 Q. And let's just -- last question. Let's look at the
04:36 9 final -- or the other end of that extrapolation. Is there any
04:36 10 physical reason you're aware of that the pressure trend over
04:36 11 time would go down from 8700, sort of sharply decline, and then
04:36 12 take a left turn at May 8th?

04:36 13 A. No, I know of no physical basis for that sort of behavior.

04:37 14 MR. BENSON: No further questions. Thank you,
04:37 15 Dr. Griffiths.

04:37 16 THE COURT: All right. Thank you, sir. You're done.

04:37 17 All right. Next witness.

04:37 18 (WHEREUPON, AARON ZICK, PH.D., having been duly
04:37 19 sworn, testified as follows:)

04:37 20 THE DEPUTY CLERK: Please state your full name and
04:37 21 correct spelling for the record.

04:38 22 THE WITNESS: My name is Aaron Zick. First name
04:38 23 A-A-R-O-N; last name, Z as in zebra, I-C-K.

04:38 24 MS. KARIS: Your Honor, we do have an issue with
04:38 25 respect to Dr. Zick's testimony.

04:38 1 THE COURT: I have not seen any Daubert motion.

04:38 2 MS. KARIS: That's correct.

04:38 3 THE COURT: In fact, I was rather shocked that I
04:38 4 didn't see a Daubert motion.

04:38 5 MS. KARIS: I don't have a Daubert motion.

04:38 6 THE COURT: Okay. So what do you have?

04:38 7 MS. KARIS: What we have is -- just by way of
04:38 8 background, Dr. Zick initially, as part of his opinions,
04:38 9 offered that a four-stage separator process is appropriate.

04:38 10 When he issued his rebuttal report, he then
04:38 11 opined that rather than the four-stage separator process, he
04:38 12 was now recommending an oceanic separator process.

04:39 13 However, none of the experts retained by the
04:39 14 United States in this case, including those that we've heard in
04:39 15 the last couple days -- and this is why it's become mature or
04:39 16 ripe, if you will -- rely on Dr. Zick's oceanic separator for
04:39 17 any purpose for any of their opinions. So his opinions with
04:39 18 respect to the oceanic separator are not relevant to any of the
04:39 19 issues.

04:39 20 THE COURT: Well, I don't know if they're relevant or
04:39 21 not. We'll see where it goes. Okay?

04:39 22 MS. KARIS: Okay.

04:39 23 MS. CROSS: Thank you, Your Honor. Good afternoon.
04:39 24 Anna Cross on behalf of the United States.

04:39 25 There is one preliminary matter I would like to

04:39 1 raise, and it relates to an issue of Dr. Zick's testimony.

04:39 2 The United States is offering Dr. Zick as an
04:39 3 affirmative witness on the conversion from reservoir barrels to
04:39 4 stock tank barrels. We're also offering him as a rebuttal
04:39 5 witness to BP/Anadarko expert Dr. Curtis Whitson. Like we are
04:39 6 already aware, Dr. Whitson offers an opinion regarding
04:39 7 dissolution of hydrocarbons in the ocean.

04:39 8 The United States has filed two motions that are
04:40 9 currently pending relating to Dr. Whitson's testimony about
04:40 10 dissolution, a motion in limine and a partial summary judgment
04:40 11 motion -- those are Docket Nos. 11056 and 10752 -- to preclude
04:40 12 Dr. Whitson's testimony regarding what the United States
04:40 13 regards to be a pure question of law, which is whether
04:40 14 dissolved hydrocarbons are nonetheless discharged into the
04:40 15 waters of the United States.

04:40 16 Since these motions have not been ruled on, I'm
04:40 17 ready to proceed with questioning Dr. Zick about his rebuttal
04:40 18 opinion to Dr. Whitson's dissolution --

04:40 19 **THE COURT:** All right. Go ahead and do that.

04:40 20 **VOIR DIRE EXAMINATION**

04:40 21 **BY MS. CROSS:**

04:40 22 **Q.** Dr. Zick, you've been retained as an expert for the United
04:40 23 States; right?

04:40 24 **A.** That's correct.

04:40 25 **Q.** Did you prepare a set of demonstratives to assist you

AARON ZICK, PH.D. - VOIR DIRE

04:40 1 today?

04:40 2 A. Yes, I did.

04:40 3 MS. CROSS: Would you please call up D-22001.

04:40 4 BY MS. CROSS:

04:40 5 Q. Do you hold any degrees, Dr. Zick?

04:40 6 A. I have a Ph.D. in chemical engineering from Stanford
04:40 7 University.

04:40 8 Q. Let's turn to your professional experience as it relates
04:40 9 to the modeling of fluid phase behavior.

04:40 10 Where are you currently employed?

04:41 11 A. I'm the founder and president of my own company, Zick
04:41 12 Technologies. I've been doing that since 1993.

04:41 13 Q. What does Zick Technologies do?

04:41 14 A. I provide petroleum engineering consulting and software
04:41 15 services particularly related to the thermodynamic modeling of
04:41 16 hydrocarbon fluids.

04:41 17 Q. What is thermodynamic modeling?

04:41 18 A. That's the modeling or the prediction of the properties
04:41 19 and phase behavior of the hydrocarbon fluids.

04:41 20 Q. Can you briefly describe your professional background
04:41 21 prior to forming your own company, Zick Technologies.

04:41 22 A. Upon leaving Stanford, I went to work for ARCO Oil & Gas
04:41 23 company in Plano, Texas. I was there from 1983 to 1991, where
04:41 24 I -- my principal duties were the equation of state -- were the
04:42 25 equation-of-state modeling of petroleum reservoir fluids and

AARON ZICK, PH.D. - VOIR DIRE

04:42 1 the development of equation-of-state modeling software.

04:42 2 In 1991, I took a position with Reservoir Simulation
04:42 3 Research Corporation, a small Tulsa-based petroleum engineering
04:42 4 software company, where I was the director of research, and my
04:42 5 duties were the development and improvement of their
04:42 6 equation-of-state software.

04:42 7 Q. What expertise did you draw on to do your work in this
04:42 8 matter?

04:42 9 A. Well, my principal activities for the last 30 years have
04:42 10 been the equation-of-state modeling of petroleum reservoir
04:42 11 fluids and the development of equation-of-state fluid
04:42 12 characterization. In particular, I've -- during the course of
04:42 13 that work, I've analyzed PT-B laboratory reports, I've built
04:43 14 equation-of-state fluid models, I've simulated separation
04:43 15 processes and analyzed the results of those.

04:43 16 MS. CROSS: Your Honor, at this point the United
04:43 17 States offers Dr. Aaron Zick as an expert in fluid phase
04:43 18 behavior. Ask the Court to note that there are no Daubert
04:43 19 motions pending against Dr. Zick.

04:43 20 THE COURT: He'll be accepted as an expert in that
04:43 21 field.

DIRECT EXAMINATION

04:43 22 BY MS. CROSS:

04:43 23 Q. Dr. Zick, did you prepare an expert report in this matter?

04:43 24 A. I did.

AARON ZICK, PH.D. - DIRECT

04:43 1 MS. CROSS: Could you please call up TREX-11490R.

04:43 2 BY MS. CROSS:

04:43 3 Q. Is this a copy of the front page of your opening expert
04:43 4 report?

04:43 5 A. Yes, it is.

04:43 6 Q. Did you prepare a rebuttal report in this matter?

04:43 7 A. Yes, I did.

04:43 8 MS. CROSS: Would you please call up TREX-114901R.

04:43 9 BY MS. CROSS:

04:43 10 Q. Is that a copy of the front page of your expert rebuttal
04:43 11 report?

04:43 12 A. Yes, it is.

04:43 13 Q. Are you adopting the content of your two expert reports as
04:44 14 your testimony to the Court today?

04:44 15 A. Yes, I am. Although I have one small correction to note
04:44 16 regarding Table 6 of my rebuttal report.

04:44 17 Q. What is that correction?

04:44 18 A. I inadvertently, in building that table, made an editing
04:44 19 mistake. That's a table regarding single-stage shrinkage
04:44 20 factors. In the line of that table related to the Intertek
04:44 21 sample, I accidentally left in data from the four-stage shrinkage
04:44 22 factors of the Schlumberger sample that were found in Table 7.

04:44 23 Q. Does that error that you just identified have any impact
04:44 24 on the opinions you're offering?

04:44 25 A. No, it doesn't.

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04:44 1 MS. CROSS: I move Dr. Zick's expert report and his
04:44 2 rebuttal expert report, TREX-11490R and TREX-11491R, into
04:45 3 evidence.

04:45 4 THE COURT: I'll admit those with the understanding
04:45 5 that Ms. Karis may convince me that some of his rebuttal report
04:45 6 is not relevant, and I can decide that later. Okay?

04:45 7 MS. KARIS: Thank you, Your Honor.

04:45 8 THE COURT: All right.

04:45 9 What was the table that you said had the error?

04:45 10 THE WITNESS: Table 6, the last line.

04:45 11 THE COURT: Table 6, that's on...

04:45 12 MS. KARIS: On page 19, Your Honor.

04:45 13 THE COURT: Page 19. What part -- are you going to
04:45 14 talk about that?

04:45 15 THE WITNESS: Not really. It's the line relating to
04:45 16 the Intertek.

04:45 17 THE COURT: The last line, which has the title
04:45 18 Intertek, "Sample Intertek"?

04:45 19 THE WITNESS: Right, right.

04:45 20 THE COURT: Okay. Thank you.

04:45 21 MS. CROSS: Would you please call up D-22002.

04:45 22 BY MS. CROSS:

04:45 23 Q. Dr. Zick, can you please summarize the opinions you'll be
04:45 24 testifying about here in court today.

04:45 25 A. Yes. It's my opinion that the most appropriate conversion

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04:45 1 method for dividing the stock tank oil from the Macondo
04:46 2 reservoir fluid is through some sort of multistage separation
04:46 3 process. And my first recommendation would be to use the
04:46 4 oceanic separation process that I developed because I believe
04:46 5 that's most representative of what -- of the separation process
04:46 6 that the ocean would have subjected the fluids to.

04:46 7 My second recommendation, which is also a viable
04:46 8 alternative, would be to use a four-stage separation, the
04:46 9 separation process that BP had directed its contractor
04:46 10 laboratories to perform on each sample. I believe that that --
04:46 11 or in my opinion, that would have been the likely separation
04:47 12 process that BP would have used during production, had there
04:47 13 been normal production.

04:47 14 Q. Are you offering an opinion about whether single-stage
04:47 15 separation should be used for the conversion?

04:47 16 A. Yes. It is my opinion that single-stage separation would
04:47 17 not be appropriate for the conversion from the live Macondo
04:47 18 fluid stock tank conditions.

04:47 19 Q. Why is that?

04:47 20 A. Single-stage separation would not have been used in the
04:47 21 field --

04:47 22 THE COURT: Before you get into that, why don't you
04:47 23 briefly describe to me the three different -- the single-stage,
04:47 24 the four-stage, and the oceanic method.

04:47 25 THE WITNESS: Okay.

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04:47 1 **THE COURT:** Very -- just an overview.

04:47 2 **THE WITNESS:** The single-stage method takes the live
04:47 3 reservoir fluid directly to stock tank conditions. A lot of
04:47 4 gas is released, and with it, it takes a considerable amount of
04:48 5 the valuable hydrocarbon components that you could otherwise
04:48 6 stabilize within the stock tank liquid.

04:48 7 The multi-stage method takes the reservoir fluid
04:48 8 to stock tank conditions in incremental stages, reducing the
04:48 9 temperature and pressure stage by stage. That releases less of
04:48 10 the dissolved gases, leaving more of the stock tank oil behind.

04:48 11 And the oceanic process is -- would be similar
04:48 12 to a multi-stage process but performed at the -- in a series of
04:48 13 many, many stages -- essentially continuous stages -- that
04:48 14 would be experienced by the fluid as it floated up through the
04:48 15 ocean from the sea bed to the surface. And that turns out to
04:48 16 be a little more efficient than the four-stage multi-stage
04:49 17 process.

04:49 18 **THE COURT:** Okay. Go ahead. I forgot what your
04:49 19 original question was, but you might ask him again.

04:49 20 **MS. CROSS:** Sure.

04:49 21 **BY MS. CROSS:**

04:49 22 **Q.** Dr. Zick, let's turn to the methodology that you used to
04:49 23 come up with your opinions about what the shrinkage factors
04:49 24 would be for the single-stage, four-stage, and oceanic
04:49 25 separation.

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04:49 1 MS. CROSS: Can you please call up D-22003?

04:49 2 BY MS. CROSS:

04:49 3 Q. Dr. Zick, can you describe the steps you took to arrive at
04:49 4 your conclusion?

04:49 5 A. Yes. The first step was that I evaluated all of the
04:49 6 laboratory PT-B data -- pressure, volume, temperature -- that's
04:49 7 the phase behavior data -- and I created an equation-of-state
04:49 8 fluid characterization to accurately represent that data. So
04:49 9 it accurately represents the phase behavior of the Macondo
10 fluids.

04:50 11 I then used that equation-of-state model to simulate
04:50 12 various separation methods and to evaluate the results of those
13 methods.

04:50 14 Q. What is an equation-of-state fluid characterization?

04:50 15 A. Well, an equation of state itself is the set of equations
04:50 16 that can be used to describe the fluid properties in the phase
04:50 17 behavior of the collection of fluids. And to apply them to a
04:50 18 particular fluid, you need a fluid characterization of that
04:50 19 fluid, the set of parameters that you'll input into the
20 equation of state.

04:50 21 Q. You're aware that Dr. Whitson has presented his own
22 equation of state in this matter?

04:50 23 A. That's correct.

04:50 24 Q. For purposes of your separation analysis, can you
25 summarize how your equation of state compares to Dr. Whitson's?

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04:50 1 A. Our equations of state have differences in the details,
04:50 2 but, overall, they both reproduce the behavior of the Macondo
04:51 3 fluid reasonably well. And the differences between them, at
04:51 4 least as far as the shrinkage factors, are relatively
04:51 5 insignificant, only about 3 percent, which, relative to the
04:51 6 uncertainties in the PT-B data, I believe, are, in my opinion,
04:51 7 are not significant.

04:51 8 MS. CROSS: Please call up D-22004.

04:51 9 BY MS. CROSS:

04:51 10 Q. Dr. Zick, you're offering an opinion about the appropriate
04:51 11 conversion from reservoir fluid to stock tank fluid. Can you
04:51 12 explain what the relationship is between reservoir fluid and
04:51 13 stock tank fluid?

04:51 14 A. A reservoir fluid can't exist as a stable, single-phase
04:51 15 liquid at the surface -- at surface conditions, the standard of
04:51 16 which would be 60 degrees Fahrenheit in one atmosphere.

04:51 17 The reservoir fluid contains a lot of dissolved gas,
04:52 18 which must come out of solution when it's brought to ambient
04:52 19 conditions. Now, that makes the stock tank oil a subset of the
04:52 20 live reservoir fluid, and the surface gas would be the
04:52 21 remainder of the fluid, the gas that comes out of solution.

04:52 22 Q. Is there a way to quantify the relationship between
04:52 23 reservoir fluid and stock tank fluid?

04:52 24 A. It's quantified by a term called "shrinkage factor" or by
04:52 25 another term called "formation volume factor." Those are

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04:52 1 actually just inverses of each other, and either one can be
04:52 2 used.

04:52 3 **MS. CROSS:** Please call up D-22005.

04:52 4 **THE COURT:** What is the relationship -- is there a
04:52 5 formula, a ratio that is used? In other words, if you had a --
04:52 6 how many reservoir barrels would you need to get one stock tank
04:53 7 barrel at 60 degrees Fahrenheit?

04:53 8 **THE WITNESS:** That would be the formation volume
04:53 9 factor. So if the formation volume factor were around 2, you
04:53 10 would need two reservoir barrels to get one stock tank barrel.

04:53 11 For a given process that would take you from
04:53 12 reservoir conditions to surface conditions, the formation
04:53 13 volume factor will depend on the process that you choose. For
04:53 14 that same example, the shrinkage factor would be 1 over 2 or
04:53 15 .5.

04:53 16 **THE COURT:** But you're always going to have -- the
04:53 17 stock tank barrel number is going to be smaller than the
04:53 18 reservoir number?

04:53 19 **THE WITNESS:** Yes.

04:53 20 **THE COURT:** That's the shrinkage factor that you're
04:53 21 talking about?

04:53 22 **THE WITNESS:** Right.

04:53 23 **THE COURT:** Okay. I'm sure I'll have some other
04:53 24 questions, but go ahead.

25

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04:53 1 **BY MS. CROSS:**

04:53 2 **Q.** Dr. Zick, if you know the shrinkage factor, how do you
04:53 3 determine the formation volume factor?

04:54 4 **A.** You take the inverse of that.

04:54 5 **Q.** And the inverse means 1 over the shrinkage factor?

04:54 6 **A.** That's right.

04:54 7 **Q.** In the example that's on the screen, if you have a
04:54 8 shrinkage factor of .5 and you're trying to go from reservoir
04:54 9 barrels to stock tank barrels, how do you do it?

04:54 10 **A.** You would multiply the number of your reservoir barrels by
04:54 11 .5. Or you could divide the number of reservoir barrels by the
04:54 12 formation volume factor of 2. Either way, you get half as many
04:54 13 stock tank barrels as the number of reservoir barrels you start
04:54 14 with.

04:54 15 **THE COURT:** So is the idea of stock tank barrel --
04:54 16 let me reask that question.

04:54 17 What I'm trying to understand is: Were you
04:54 18 trying to come up with a model to replicate the stock tank
04:55 19 barrel number that would have occurred in normal operating
04:55 20 procedures for this well if this blowout never occurs and
04:55 21 they're just producing oil from this well?

04:55 22 **THE WITNESS:** Yes, that's one of the processes that I
04:55 23 simulated.

04:55 24 **THE COURT:** That's the four-stage method?

04:55 25 **THE WITNESS:** That's right.

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04:55 1 **THE COURT:** Is the other method that you talked
04:55 2 about, the oceanic method, instead trying to model what you
04:55 3 believe happened in the case where the oil is not being brought
04:55 4 up directly to the surface, but is coming out of the blowout
04:55 5 preventer or broken riser and coming up through the sea?

04:55 6 **THE WITNESS:** That's correct.

04:55 7 **THE COURT:** Which one would likely give you a bigger
04:55 8 or smaller number? What would be the relationship there?

04:55 9 **THE WITNESS:** Well, when I set out to determine that,
04:56 10 I didn't know, but it turns out that the oceanic separation
04:56 11 process gives you slightly more -- about 2 1/2 percent more
04:56 12 stock tank oil than the four-stage separation. It's just able
04:56 13 to stabilize more of the hydrocarbons in the liquid phase.

04:56 14 **THE COURT:** It sounds like it's not a huge
04:56 15 difference.

04:56 16 **THE WITNESS:** It's not.

04:56 17 **THE COURT:** Okay. All right.

04:56 18 **BY MS. CROSS:**

04:56 19 **Q.** Dr. Zick, you testified that you looked at a single-stage
04:56 20 separation and a four-stage separation and an oceanic
04:56 21 separation process. How did you decide to look at those three
04:56 22 separation processes?

04:56 23 **A.** Well, a single-stage process is routinely done by the PT-B
04:56 24 laboratories every time they analyze a bottom hole sample,
04:56 25 because they can't analyze the sample directly without first

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04:56 1 separating it at ambient conditions. And so they always report
04:56 2 those results. They're available for use in tuning the
04:57 3 equation of state. And so I always include those for that
04:57 4 purpose.

04:57 5 But it's not a very efficient process for performing
04:57 6 the separation in the field. So oil companies generally ask
04:57 7 the laboratories to perform multi-stage separator tests, and
04:57 8 those tests were performed on each of the four samples that
04:57 9 were collected in this case. They were all performed at the
04:57 10 same set of separator conditions, and so those were the
04:57 11 conditions that I used for my simulations of the four-stage
04:57 12 separator process.

04:57 13 **MS. CROSS:** Please call up D-22006.

04:57 14 **BY MS. CROSS:**

04:57 15 **Q.** Dr. Zick, you just testified that the labs conducted
04:57 16 four-stage separations. Which labs are you talking about?

04:57 17 **A.** PENCOR, also known as Core Lab; Schlumberger; and
04:58 18 Intertek.

04:58 19 **Q.** And can you also identify on this demonstrative what is
04:58 20 depicted here as the front pages of TRES-60988, TRES-130815,
04:58 21 TRES-11575, and TRES-130963.

04:58 22 **A.** Yes, these are the cover pages of the PT-B reports for the
04:58 23 four primary samples upon which the most extensive laboratory
04:58 24 experiments were run.

04:58 25 **Q.** When were those laboratory experiments run?

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04:58 1 A. The experiments, I believe, were run -- well, the reports
04:58 2 came out in June of 2010, so the -- and the fluids were
04:58 3 collected in mid-April of the same year, just a few days before
04:58 4 the blowout. So I imagine the experiments were performed
04:59 5 sometime between then and early June.

04:59 6 MS. CROSS: Please call up TREN-60988.003.001.US.

04:59 7 BY MS. CROSS:

04:59 8 Q. This is an excerpt from TREN-60988. This is an excerpt
04:59 9 from one of the PENCOR reports we just looked at. And this
04:59 10 specifically is from the page with the scope of work. Can you
04:59 11 read what the top line says?

04:59 12 A. "Multi-stage separator test of reservoir fluid
04:59 13 (stimulation of production facility)."

04:59 14 Q. Can you explain what you understand that description, that
04:59 15 scope of work, to mean?

04:59 16 A. Yes. That means that the laboratory performed a
04:59 17 multi-stage separator test on this particular fluid sample, and
04:59 18 they -- they described that test as a way to simulate the
05:00 19 surface production process.

05:00 20 Q. What is your understanding, Dr. Zick, of why four-stage
05:00 21 tests are run prior to production?

05:00 22 A. Well, they -- on the -- a multi-stage separation process
05:00 23 is normally what's used in the field to separate the stock tank
05:00 24 oil from the live reservoir fluid because it's more efficient
05:00 25 than a simpler, single-stage process at stabilizing more of the

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05:00 1 stock tank oil, which, of course, is much more valuable than
05:00 2 the surface gas that is removed.

05:00 3 MS. CROSS: Please call up D-22007.

05:00 4 BY MS. CROSS:

05:00 5 Q. Dr. Zick, can you describe the process that is depicted
05:00 6 here?

05:00 7 A. This is a simple schematic of a four-stage separation
05:00 8 process in which the reservoir fluid is brought to the surface
05:00 9 and it's put into the first-stage separator, which is
05:01 10 equilibrated at the conditions of that separator. The gas is
05:01 11 removed. The liquid then is passed to the second stage, where
05:01 12 the fluid is again equilibrated. The gas is then removed and
05:01 13 the liquid is passed to the third-stage separator, where it is
05:01 14 equilibrated one more time, recovering more gas. And then the
05:01 15 liquid is finally passed to stock tank conditions, which may
05:01 16 give off even a small amount of additional stock tank gas.

05:01 17 And the end result, the residual liquid from the
05:01 18 whole process, is your stock tank oil.

05:01 19 Q. Did your four-stage separation analysis produce a
05:01 20 shrinkage factor?

05:01 21 A. Yes, it did.

05:01 22 Q. What was that?

05:01 23 A. Going from the original reservoir fluid at original
05:01 24 reservoir condition of 243 degrees Fahrenheit and 11,850 psi,
05:02 25 one barrel of that average reservoir fluid would produce

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05:02 1 0.494 barrels of stock tank oil, according to my
05:02 2 equation-of-state model.

05:02 3 Q. Did you compare the .494 shrinkage factor that you
05:02 4 obtained from your four-stage separation to that obtained by
05:02 5 the labs?

05:02 6 A. The labs actually measured the shrinkage factors from a
05:02 7 different initial starting condition. They measured it from
05:02 8 saturation pressure conditions. So the numbers they report
05:02 9 would have to be converted into numbers relative to the
05:02 10 original reservoir fluid.

05:02 11 But in the course of tuning my equation of state, I
05:02 12 just simulated the laboratory experiments directly and matched
05:02 13 the reported laboratory results directly.

05:02 14 Q. And what was the difference between the
05:02 15 laboratory-reported results and your four-stage results?

05:03 16 A. I overpredicted the results by about 3, 3 1/2 percent on
05:03 17 average except for the Intertek fluid sample, which was an
05:03 18 obvious outlier that both Dr. Whitson, BP's corresponding fluid
05:03 19 behavior expert, and I both realized that that fluid -- there
05:03 20 was something wrong with the data, that it was an outlier.

05:03 21 But of the data that appeared reasonably reliable, I
05:03 22 overpredicted it by just 3 1/2 percent or so.

05:03 23 Q. Did you run a single-stage separation using your EOS as
05:03 24 well?

05:03 25 A. Yes, I did.

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05:03 1 Q. How did the results of your single-stage separation using
05:03 2 your equation of state compare to the results you obtained for
05:03 3 the four-stage separation using your equation of state?

05:03 4 A. The single-stage separation results in about 9.9 percent
05:04 5 less stock tank oil than the multi-stage separation would. Or
05:04 6 put it another way: The multi-stage separation would stabilize
05:04 7 about 11 percent more stock tank oil than the single-stage
05:04 8 separation would, given the same conditions otherwise.

05:04 9 Q. Let's turn briefly to your oceanic separation model.

05:04 10 MS. CROSS: Would you please pull up D-22008?

05:04 11 BY MS. CROSS:

05:04 12 Q. Dr. Zick, can you please explain, using D-22008, your
05:04 13 oceanic separation model?

05:04 14 A. Yes. Let's see if I can use this laser pointer. The
05:04 15 separation process begins at the exit of the well on the
05:04 16 seabed. At the exit conditions of the well, the exiting
05:04 17 reservoir fluid is not in a single stage. It's at equilibrium
05:05 18 in those conditions in two phases, an oil phase and a gas
05:05 19 phase. So that's the first stage of the separation.

05:05 20 My model then tracks the oil stream as it rises to
05:05 21 the surface and the gas stream as it rises to the surface. And
05:05 22 along the way, as the oil encounters ever-decreasing pressures,
05:05 23 additional gases will evolve from that stream. I combine those
05:05 24 gases with the main gas stream for purposes of separation at
05:05 25 the next stage.

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05:05 1 Similarly, as the gas stream rises to the surface and
05:05 2 encounters an initially much lower temperature than the well
05:05 3 exit temperature, then lower and lower pressures as it rises,
05:05 4 it will condense additional liquids as it moves up through the
05:06 5 water. And those liquids, I combine with the main oil stream
05:06 6 for purposes of separation at the next stage.

05:06 7 And at the -- once the two streams reach the surface,
05:06 8 the final liquid stream defines your stock tank oil and the
05:06 9 final gas stream defines your surface gas.

05:06 10 Q. Why did you model the oil and gas as separate streams?

05:06 11 A. Well, because it's my opinion that the ocean would tend to
05:06 12 separate these streams. These streams aren't continuous, nice
05:06 13 flowing streams. They're actually -- they're actually jets of
05:06 14 small oil droplets and small gas bubbles. And the water will
05:06 15 keep those -- those droplets and those bubbles isolated from
05:07 16 each other, for the most part.

05:07 17 MS. CROSS: Please call up D-21023.

05:07 18 BY MS. CROSS:

05:07 19 Q. Dr. Zick, having discussed your single-stage separation
05:07 20 and your four-stage separation and your oceanic separation, can
05:07 21 you explain using this demonstrative what the results of each
05:07 22 of those separations were?

05:07 23 A. Yes. If you start with 100 barrels of reservoir fluid at
05:07 24 the initial reservoir conditions, the single-stage separation
05:07 25 process would result in 44 1/2 stock tank barrels. The

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05:07 1 four-stage separation process would result in 49.4; that's
05:07 2 11 percent more. The oceanic separation process would depend
05:07 3 very slightly on the exit temperature of the well, but it would
05:07 4 produce between about 50.6 and 50.7 stock tank barrels, which
05:08 5 is almost 14 percent more than the single-stage process would
05:08 6 produce.

05:08 7 Q. And can you explain, based on this demonstrative, which
05:08 8 separation mechanisms you believe are appropriate in this case?

05:08 9 A. Well, it's my opinion that the oceanic separation process
05:08 10 is the most appropriate because I believe that that's how the
05:08 11 fluids would be separated by the conditions they would
05:08 12 encounter within the ocean. But the four-stage separator
05:08 13 process would be a good alternative because that's what I
05:08 14 believe would have been used -- or something very similar to
05:08 15 that -- had the fluids been produced in a normal fashion.

05:08 16 Q. Let's turn now to Dr. Whitson.

05:08 17 What is your understanding of the criticisms
05:08 18 Dr. Whitson offers of your work?

05:09 19 A. Well, he had -- he had some criticisms of the accuracy of
05:09 20 my equation of state, particularly in matching the four-stage
05:09 21 separator shrinkage factors. I mentioned my predictions were
05:09 22 about 3 1/2 percent off on those, which I felt was
05:09 23 insignificant, but he felt that that -- that those were errors
05:09 24 that could have been less.

05:09 25 Of course, the converse could be said. I found many

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05:09 1 other data points within his that were predicted less
05:09 2 accurately by his equation of state than by mine. My opinion's
05:10 3 still that the 3 percent difference between my equation of
05:10 4 state and his on the shrinkage factors is not particularly
05:10 5 significant.

05:10 6 He also felt that a four-stage separation was not the
05:10 7 most appropriate, and he proposed either a single-stage
05:10 8 separation or the oceanic separation process that he put forth,
05:10 9 which is a little bit different than the one I put forth.

05:10 10 Q. But Dr. Whitson offers an opinion about the dissolution of
05:10 11 the hydrocarbons. Are you aware of that?

05:10 12 A. Yes. That's another difference between our view of the
05:10 13 separation of the fluids.

05:10 14 Q. What is your understanding of Dr. Whitson's dissolution
05:10 15 opinion?

05:10 16 A. Well, in his modeling work, he subjected his -- at the
05:11 17 Macondo -- the live Macondo reservoir fluid to his oceanic
05:11 18 separation process and produced a stock tank oil from that
05:11 19 process. And then he subsequently argued that the volume of
05:11 20 that stock tank oil should be discounted by removing all of the
05:11 21 light hydrocarbon components that he believed were readily
05:11 22 soluble in the water.

05:11 23 Those included all of the light alkanes, methane
05:11 24 through pentane, and all of the light aromatics up to about
05:11 25 C12, and those included benzene, toluene, xylene, ethylbenzene,

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05:11 1 trimethylbenzene. He believed that all of those components
05:11 2 would dissolve in the water and that, therefore, they should be
05:12 3 removed from the volume of the resulting stock tank oil.

05:12 4 Q. What is your opinion regarding Dr. Whitson's dissolution
05:12 5 analysis?

05:12 6 A. Well, I don't believe that -- in my opinion, that's not an
05:12 7 appropriate method for modifying the stock tank fluid. That,
05:12 8 basically, changes the definition of the stock tank liquid to
05:12 9 something that is unlike the stock tank liquid that would be
10 produced in a normal fashion.

05:12 11 And also those hydrocarbons that he allows to
05:12 12 dissolve in the water, it's not like they're suddenly gone.
05:12 13 They're still in the water. They're just not going to be in
05:12 14 the liquid oil phase, if you believe his model.

05:12 15 And, also, those oil -- those hydrocarbon components
05:13 16 would not dissolve in the water instantly. They would take
05:13 17 some time to dissolve, but he makes no estimates of how long it
05:13 18 would take or -- or provides any sort of mass transfer rates or
05:13 19 anything that would tell you whether that happens in an hour or
05:13 20 a day or a week.

05:13 21 And so I just overall find it to be inappropriate.

05:13 22 Q. In a normal production scenario, what happens to the
05:13 23 hydrocarbon components that Dr. Whitson assumed dissolved in
05:13 24 the Gulf?

05:13 25 A. They would still be present in the stock tank oil to some

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05:13 1 degree. Those components may predominantly leave the stock
05:13 2 tank oil in surface gas, but the stock tank oil will still
05:13 3 retain a significant amount of those components.

05:13 4 **MS. CROSS:** Would you please pull up
05:13 5 TREX-60988.26.001.US?

05:14 6 **BY MS. CROSS:**

05:14 7 **Q.** This is an excerpt from the PENCOR 19 lab report that we
05:14 8 looked at earlier, TREX-60988.

05:14 9 Dr. Zick, can you explain what this excerpt from
10 page 26 depicts?

05:14 11 **A.** Yes. This is the compositional analysis of the stock tank
05:14 12 oil that resulted from their multi-stage separator test on this
05:14 13 particular sample. It shows the percentages in terms of moles,
05:14 14 volume, and weight, for each of the components up to -- this
05:14 15 particular part of the table shows up to C12.

05:14 16 **Q.** And can you identify which of these components Dr. Whitson
05:14 17 excludes as dissolving in the ocean?

05:14 18 **A.** Yes. He excludes the first seven components, methane
05:14 19 through N-pentane. And then he also excludes certain fractions
05:14 20 of the C7 to C12 components, roughly 10 percent of those -- of
05:15 21 those total components.

05:15 22 **Q.** And what percentage of the volume of stock tank oil from
05:15 23 this Macondo sample at surface conditions is in Dr. Whitson's
05:15 24 "Dissolved" category?

05:15 25 **A.** Well, just the components methane through pentane comprise

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05:15 1 a total of about 6 1/2 volume percent, which could be
05:15 2 determined by adding up the volume percentages for those
05:15 3 components. And then I've looked at his modeling runs and have
05:15 4 seen that the components like benzene and toluene and so forth
05:15 5 would comprise about 3.1 additional volume percent and making
05:15 6 the total that he's removing -- that he would remove from this
05:16 7 particular stock tank oil about 9 1/2 percent.

05:16 8 **Q.** How is Dr. Whitson's dissolution analysis related to his
05:16 9 oceanic separation opinion?

05:16 10 **A.** It's completely separate. He first performs his oceanic
05:16 11 separation calculations to determine a stock tank oil volume
05:16 12 and composition. And then he modifies that composition by
05:16 13 removing all of these water-soluble components and
05:16 14 recalculating the volume of the resulting stock tank oil. And
05:16 15 that results in a reduction between 7 and 13 percent in volume,
05:16 16 according to his report, although he doesn't actually offer any
05:16 17 actual calculated results.

05:16 18 **MS. CROSS:** Would you please pull up
05:16 19 TREN-11491R.0012.

05:17 20 We can just start with 11491R. Could you please
05:17 21 go to page 12.

05:17 22 **BY MS. CROSS:**

05:17 23 **Q.** Dr. Zick, is this your depiction of Dr. Whitson's oceanic
05:17 24 separation model?

05:17 25 **A.** Yes, it is.

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05:17 1 Q. Can you focus on the differences between your oceanic
05:17 2 separation model and Dr. Whitson's and explain what those are?

05:17 3 A. Well, they start off exactly the same where they -- the
05:17 4 fluid coming out of the well is separated into an oil stream
05:17 5 and a gas stream by the conditions at the exit of the well.
05:17 6 His oil stream travels up toward the surface and at each stage,
05:17 7 much like mine, a gas stream -- an additional gas stream
05:18 8 evolves because of the decrease in pressure.

05:18 9 What's a little bit different is that he takes those
05:18 10 gas streams straight to the surface then. He doesn't try to
05:18 11 recombine those with the main gas stream. On the other hand,
05:18 12 he takes the gas stream that exits from the well and he takes
05:18 13 that straight to surface conditions for separation at standard
05:18 14 temperature and pressure, which condenses a small amount of
05:18 15 liquid from that stage.

05:18 16 MS. KARIS: Your Honor -- I'm sorry.

05:18 17 THE WITNESS: That differs from my --

05:18 18 THE COURT: One second.

05:18 19 MS. KARIS: Your Honor, I'm sorry to interrupt. But
05:18 20 I believe this is beyond the scope of what Dr. Zick has
05:18 21 disclosed in his report. His entire criticism of Dr. Whitson's
05:18 22 work is in his rebuttal report at pages 2 and 3. And this
05:19 23 stage-by-stage analysis is nowhere in the report. Instead,
05:19 24 Dr. Zick does say he disagrees that the dissolved components
05:19 25 should not be accounted for.

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05:19 1 He does conclude by saying: "Whether the oil
05:19 2 counts for purposes of this case is a legal question."

05:19 3 So this entire analysis that we're seeing here I
05:19 4 don't believe is stated anywhere in his report.

05:19 5 **MS. CROSS:** It's stated on page 8 of Document 11491
05:19 6 where Dr. Zick says: "My oceanic process differs from
05:19 7 Dr. Whitson's with one significantly different assumption,
05:19 8 however. Dr. Whitson made a serious omission by assuming that
05:19 9 the gas stream would rise all the way to the ocean surface
05:19 10 before any additional liquids would condense from it," and it
05:19 11 continues on.

05:19 12 **THE COURT:** Okay. It sounds like it's fairly within
05:19 13 the bounds, so go ahead.

05:19 14 **THE WITNESS:** All right. So his gas stream, as I
05:19 15 said, is he takes it straight to surface conditions where he
05:19 16 separates out a small amount of additional condensate, but that
05:20 17 differs from my model in that my model allows condensate to
05:20 18 condense from this rising gas stream at every stage along the
05:20 19 way, at every --

05:20 20 **THE COURT:** Is this because -- I'm trying to
05:20 21 understand. You had said before that there was essentially oil
05:20 22 and gas -- there was -- initial separation occurred at the
05:20 23 wellhead; right?

05:20 24 **THE WITNESS:** Right.

05:20 25 **THE COURT:** But it's not like we see two distinct

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05:20 1 streams. I'm just referring back visually to the videos that
05:20 2 I've seen. It looked like one big large plume, essentially,
05:20 3 but within that they had streams of oil and gas. Is that what
05:20 4 you're saying?

05:20 5 **THE WITNESS:** That's right. That's right. They
05:20 6 exist as gas bubbles and oil droplets, but they're -- there
05:20 7 would be a distinction between the oil phase and the gas phase.

05:20 8 **THE COURT:** Going up together in a sense but at
05:21 9 different rates?

05:21 10 **THE WITNESS:** They could be traveling -- they could
05:21 11 be traveling at different speeds because of the --

05:21 12 **THE COURT:** And is that how you believe there's
05:21 13 this -- I guess you call it transfer during the trip up to the
05:21 14 surface between oil and gas back and forth?

05:21 15 **THE WITNESS:** Yeah. The oil bubbles would give off
05:21 16 additional gas -- or, I mean, the oil droplets would give off
05:21 17 additional gas bubbles and they would -- you know, in the
05:21 18 turbulence of all these rising droplets and bubbles, if they
05:21 19 should happen to encounter another gas bubble, they would
05:21 20 easily coalesce with that gas bubble.

05:21 21 They may then equilibrate with that bubble and
05:21 22 they may break apart again. But the bubbles will tend to
05:21 23 coalesce together and the droplets will tend to coalesce
05:21 24 together. But it's my opinion that the bubbles and the
05:22 25 droplets won't -- won't mix together for any appreciable time

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05:22 1 to re-equilibrate. And so the gases that evolve from the
05:22 2 rising oil bubbles will end up mixing with the other gas
05:22 3 bubbles, and the liquid that condenses from the rising gas
05:22 4 bubbles will end up mixing with the rising oil droplets.

05:22 5 **THE COURT:** Okay. Go ahead.

05:22 6 **BY MS. CROSS:**

05:22 7 **Q.** Do both you and Dr. Whitson assume that there would be
05:22 8 separate oil and gas streams?

05:22 9 **A.** That's correct.

05:22 10 **MS. CROSS:** And turning to the results of
05:22 11 Dr. Whitson's analysis, could we please have D-22009.

05:22 12 **BY MS. CROSS:**

05:22 13 **Q.** Dr. Zick, can you explain what shrinkage factor
05:22 14 Dr. Whitson derives from his oceanic separation model?

05:23 15 **A.** Yes. He gets a shrinkage factor of about 46.7 to
05:23 16 48.0 barrels of stock tank oil for every 100 barrels of initial
05:23 17 reservoir fluid. Depending on the exit temperature that he
05:23 18 assumes for the well, the higher that temperature, the more
05:23 19 hydrocarbon -- the more liquid-like hydrocarbons will -- will
05:23 20 go into the original gas stream and those he doesn't account
05:23 21 for, as well, so that would produce a lower shrinkage factor,
05:23 22 the 46.7.

05:23 23 **Q.** Can you explain why the shrinkage factor of 46.7 to 48.0
05:23 24 is reduced in this slide to 43.3?

05:23 25 **A.** Well, this is where he applies his separate dissolution

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05:23 1 theory. So he takes the stock tank oil that results from his
05:24 2 oceanic separation, the 46.7 to 48 barrels, and then he removes
05:24 3 all of those light hydrocarbons that he claims should dissolve
05:24 4 readily in the water. And that reduces the volume of the stock
05:24 5 tank oil to approximately the same volume that he says he would
05:24 6 get from his single-stage separation.

05:24 7 He doesn't offer any of the exact calculated results
05:24 8 in his report, but he just says that after you remove those
05:24 9 components from his oceanic separated stock tank oil, you get
05:24 10 basically the same amount as you would get from the
05:24 11 single-stage separation, which he reports is 43.3 barrels.

05:24 12 Q. I'd like to turn now to another expert offered by BP and
05:24 13 Anadarko, Dr. Blunt. Did you review Dr. Blunt's report?

05:24 14 A. Yes.

05:24 15 Q. Do you have an understanding of whether Dr. Blunt applied
05:25 16 Dr. Whitson's separation analysis?

05:25 17 A. No. He didn't apply any of Dr. Whitson's separation
05:25 18 analyses directly. Dr. Blunt offered -- or he adopted the
05:25 19 single-stage separation model, and he chose an experimental
05:25 20 value from the -- one of the lab reports. The only mention he
05:25 21 makes of Dr. Whitson's analysis is to use Dr. Whitson's
05:25 22 observation that if you perform Dr. Whitson's oceanic
05:25 23 separation and remove the soluble -- the water-soluble
05:25 24 components, that you get about the same result as a
05:25 25 single-stage separation.

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05:25 1 So he uses that observation to bolster his argument
05:25 2 for using single stage. And he also claims that Dr. Whitson
05:26 3 supports the idea of using a single-stage separation directly
05:26 4 as well.

05:26 5 I didn't read that from Dr. Whitson's report.
05:26 6 Actually, Dr. Whitson doesn't come right out in his report and
05:26 7 make a recommendation. He provides the shrinkage factors for
05:26 8 the single-stage separation, the four-stage separation, his
05:26 9 oceanic separation at two different exit temperatures, and then
05:26 10 he makes the claim that the result of removing the
05:26 11 water-soluble components from those stock tank oils would
05:26 12 result in about the same amount as single-stage separation, but
05:26 13 he doesn't actually provide that calculated shrinkage factor
05:26 14 separately.

05:26 15 And I didn't see any real recommendation from him as
05:27 16 to which process to use.

05:27 17 Q. How does Dr. Blunt characterize the difference between
05:27 18 four-stage separation and single-stage separation?

05:27 19 A. Well, he says in his report that a multi-stage separation
05:27 20 process is the normal way that oil companies produce their
05:27 21 fields in order to maximize the amount of stock tank oil, and
05:27 22 yet he disregards that normal production separation scheme and
05:27 23 says that the single-stage separation scheme is more
05:27 24 appropriate in this case.

05:27 25 MS. CROSS: Could we please see

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05:27 1 TREX-11553RNoHC-2.27.1.US.

05:27 2 **BY MS. CROSS:**

05:27 3 **Q.** Is this the excerpt from Dr. Blunt's report that you're
05:28 4 referring to?

05:28 5 **A.** Yes.

05:28 6 **MS. CROSS:** And could you please call up D-24467.

05:28 7 **BY MS. CROSS:**

05:28 8 **Q.** And, Dr. Zick, this is a slide from BP's opening statement
05:28 9 characterizing Dr. Blunt's reasons for accepting single-stage
05:28 10 flash -- or advancing single-stage flash as the appropriate
05:28 11 methodology. I'd like to question you about his five points.

05:28 12 **Dr. Blunt** says that single-stage flash is standard in
05:28 13 the industry. Do you believe that to be the case?

05:28 14 **A.** Well, not exactly. It's -- it's standard -- it's a
05:28 15 standard experiment performed by the laboratories in the
05:28 16 process of performing compositional analyses. And if an
05:28 17 engineer were told to simulate a field with no information
05:29 18 about how the surface processing would be done, he would be
05:29 19 likely to assume single-stage flash just to be able to perform
05:29 20 some calculations.

05:29 21 **But** it's not the -- it's not what would be standardly
05:29 22 applied in the field to perform the separations. It's just too
05:29 23 inefficient. The oil companies would lose a lot of money by
05:29 24 doing single-stage separations in the field instead of a
05:29 25 multistage separation.

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05:29 1 Q. Let's turn to the second bullet. "Unambiguous, don't need
05:29 2 to know conditions on any given day."

05:29 3 For a four-stage separation or an oceanic separation,
05:29 4 do you need to know the conditions on any given day?

05:29 5 A. Well, you need to know the conditions, but in this case we
05:29 6 do know the conditions. We have the conditions for the
05:29 7 four-stage separation that were specified by BP and
05:30 8 experimented upon by all the laboratories.

05:30 9 And for the oceanic separation process, it's not too
05:30 10 difficult to determine the temperature and pressure profiles
05:30 11 within the ocean that are used to simulate that process.

05:30 12 Q. And with regard to the third bullet, "realistic, oil and
05:30 13 gas will stay in equilibrium," what is your opinion about
05:30 14 whether that is an accurate statement scientifically?

05:30 15 A. Well, neither Dr. Whitson nor I believe that assumption.
05:30 16 Both of our oceanic separation models assume that the oil
05:30 17 stream and the gas stream will remain isolated from each other.

05:30 18 Q. The fourth bullet: "Approximates Whitson's oceanic
05:30 19 process."

05:30 20 Do you believe that, in fact, single-stage flash
05:30 21 approximates Dr. Whitson's oceanic process?

05:30 22 A. No, it doesn't. It only approximates Whitson's oceanic
05:30 23 process if you then subsequently remove all of the
05:31 24 water-soluble hydrocarbons, then you get about the same
05:31 25 shrinkage factor, but it doesn't approximate Dr. Whitson's

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05:31 1 oceanic process directly.

05:31 2 Q. Finally: "Conservative, other processes would result in
05:31 3 less oil released."

05:31 4 Do you believe that's accurate?

05:31 5 A. No, that's not true. Of all the processes that we're
05:31 6 looking at in this study, the single-stage separation process
05:31 7 produces the least amount of stock tank oil.

05:31 8 MS. CROSS: Could you please pull up D-22013?

05:31 9 BY MS. CROSS:

05:31 10 Q. Dr. Zick, could you please explain what this demonstrative
05:31 11 shows?

05:31 12 A. This shows on a line to scale the different shrinkage
05:31 13 factors in terms of barrels of stock tank oil per 100 barrels
05:31 14 of initial reservoir oil that have either been proposed or
05:32 15 recommended in this case, ranging from the value used by
05:32 16 Dr. Blunt on the far left to the two values on the far right
05:32 17 and highlighted in yellow, which are the ones that I can
05:32 18 recommend.

05:32 19 Q. To summarize, what is your opinion about the appropriate
05:32 20 shrinkage factor to be used in this case?

05:32 21 A. Well, it's my opinion that the most appropriate shrinkage
05:32 22 factor would be the one from my oceanic separation model and --
05:32 23 because I believe that that would best represent how the ocean
05:32 24 itself would separate the fluids.

05:32 25 Q. What is that shrinkage factor?

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05:32 1 A. It would be about 50.6 or 50.7.

05:32 2 Q. What is the shrinkage factor for your four-stage
05:32 3 separation?

05:32 4 A. That's about 49.4, about 2 1/2 relative percent less or a
05:33 5 little more than one barrel per 100 original reservoir barrels
05:33 6 difference.

05:33 7 MS. CROSS: Thank you. I pass the witness.

05:33 8 THE COURT: All right.

05:33 9 MS. KARIS: Your Honor, I am not going to finish
05:33 10 today.

05:33 11 THE COURT: I'm sorry?

05:33 12 MS. KARIS: I'm sorry, I'm not going to finish today.

05:33 13 THE COURT: That's okay. We'll go to at least around
05:33 14 6:00. When you get around 6:00, tell me when it's a convenient
05:33 15 place to break for you.

05:33 16 MS. KARIS: Great. Thank you.

05:33 17 **CROSS-EXAMINATION**

05:34 18 MS. KARIS: May I proceed?

05:34 19 THE COURT: Yes.

05:34 20 MS. KARIS: Thank you.

05:34 21 **BY MS. KARIS:**

05:34 22 Q. Good afternoon, Dr. Zick. Hariklia Karis. For the
05:34 23 record, I have you on cross-examination on behalf of BP.

05:34 24 Now, you're offering opinions in this case on two
05:34 25 separate topics. One is the equation-of-state fluid

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05:34 1 characterization model; is that correct?

05:34 2 A. That's correct.

05:34 3 Q. And the second one is the separator process that you
05:34 4 recommend be used; correct?

05:34 5 A. That's correct.

05:34 6 Q. And you recognize the issue of what the proper separator
05:35 7 process to be used in your own opinion is a legal issue for the
05:35 8 Court to decide?

05:35 9 A. Yes, that's correct.

05:35 10 Q. Okay. Now, to back up, you are not offering an opinion on
05:35 11 what the cumulative flow from the Macondo well was; correct?

05:35 12 A. That's correct.

05:35 13 Q. And you're also not offering any opinions on what the
05:35 14 daily flow rate for any particular day from the well was,
05:35 15 regardless of which separator process is used; correct?

05:35 16 A. That's correct.

05:35 17 Q. You're not offering even any estimates as to the amount of
05:35 18 flow coming out of the well on any day using any separator
05:35 19 process; correct?

05:35 20 A. That's correct.

05:35 21 Q. Likewise, you are not offering any opinions on the
05:35 22 pressures that were encountered by the Macondo reservoir fluids
05:35 23 between the reservoir and the point that they exited at the
05:36 24 ocean; correct?

05:36 25 A. Between the point they exited at the seabed, correct.

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05:36 1 Q. So you're not offering any opinions as to either the
05:36 2 pressures or the temperatures encountered by the Macondo
05:36 3 reservoir fluids between the reservoir at the point that it
05:36 4 exited into the ocean at the seabed; correct?

05:36 5 A. Correct.

05:36 6 Q. And I know you mentioned Dr. Blunt. Just to be clear, you
05:36 7 have no opinions regarding the compressibility of the rock or
05:36 8 what effect that had on any of the oil that was coming out of
05:36 9 the reservoir; correct?

05:36 10 A. That's correct.

05:36 11 Q. You, likewise, have no opinion regarding what effect
05:36 12 erosion or similar issues had with respect to the oil coming
05:36 13 out of the reservoir; correct?

05:36 14 A. That's correct.

05:36 15 Q. Now, I want to talk a little bit about your experience in
05:37 16 doing equation-of-state fluid characterization. You performed
05:37 17 approximately four to six equation-of-state fluid
05:37 18 characterizations while you were with ARCO; correct?

05:37 19 A. Correct.

05:37 20 Q. And then similarly, during your time with Zick
05:37 21 Technologies, your company, you developed approximately another
05:37 22 12 to 15 equation-of-state models yourself; correct?

05:37 23 A. Yes.

05:37 24 Q. And then you've developed an equation-of-state
05:37 25 characterization model for purposes of this case?

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05:37 1 A. Correct.

05:37 2 Q. Now, approximately half of your work, about 50 percent of
05:37 3 your work has involved software development as opposed to
05:37 4 equation-of-state modeling; correct?

05:37 5 A. Yes.

05:37 6 Q. Now, you testified briefly about your critiques of
05:37 7 Dr. Whitson. You know Dr. Whitson for years; correct?

05:38 8 A. That's correct.

05:38 9 Q. You're aware that he has been retained by BP to offer
05:38 10 opinions in this case on fluid characterization and separator
05:38 11 processes, the same subjects you're talking about?

05:38 12 A. Yes.

05:38 13 Q. And you're aware -- or are you aware that he has done over
05:38 14 200 equation-of-state fluid characterizations?

05:38 15 A. I don't doubt that.

05:38 16 Q. Okay. You used a software called PhazeComp?

05:38 17 A. PhazeComp.

05:38 18 Q. PhazeComp. Excuse me. PhazeComp with a Z,
05:38 19 P-H-A-Z-E-C-O-M-P, for the record; correct?

05:38 20 A. That's correct.

05:38 21 Q. And you were the author of that program?

05:39 22 A. I was.

05:39 23 Q. Dr. Whitson's company actually financed the creation of
05:39 24 that program; correct?

05:39 25 A. It provided partial financing for the creation of that

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05:39 1 program.

05:39 2 Q. All right. And you consider PhazeComp to be state of the
05:39 3 art, to use your language?

05:39 4 A. That's correct.

05:39 5 Q. In fact, in your opinion, you wouldn't use anything else
05:39 6 if you were doing equation-of-state characterization; correct?

05:39 7 A. That's correct.

05:39 8 Q. And in your opinion, it is the most reliable way to
05:39 9 determine the fluid characterization using equation-of-state
10 modeling; correct?

05:39 11 A. I would say so.

05:39 12 Q. Okay. Now, have you looked at which of the government's
05:39 13 experts have used the model that you contend to be the most
05:39 14 reliable way to do fluid characterizations; yes or no?

05:40 15 A. The equation-of-state fluid characterization model or
16 the --

05:40 17 Q. Yes. Yes, the one that you developed.

05:40 18 A. I'm not exactly sure what they ended up using, but I think
19 Dr. Kelkar has used it.

05:40 20 Q. All right. We'll talk about that briefly. But it sounds
21 at least like you looked at which of the United States
22 Government that looked at fluid characterization used the model
23 that you contend to be the most reliable; correct?

05:40 24 A. Yes.

05:40 25 Q. Now, before we go to that, I want to discuss briefly your

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05:40 1 opinion of Dr. Whitson since you offered some critiques of his
05:40 2 work. It's correct that you used to have a close personal and
05:40 3 professional relationship with Dr. Whitson; correct?

05:40 4 A. That's correct.

05:40 5 Q. And approximately three to five years ago, you guys had a
05:41 6 falling-out, but you still respect him professionally?

05:41 7 A. That's correct.

05:41 8 Q. And you agree that Dr. Whitson is proficient in
05:41 9 equation-of-state fluid characterization modeling?

05:41 10 A. Yes.

05:41 11 MS. KARIS: If we can look at 11492.2.2, please.

05:41 12 BY MS. KARIS:

05:41 13 Q. Dr. Zick, do you recognize this as a recommendation you
05:41 14 wrote for Dr. Whitson?

05:41 15 A. Yes, I wrote this recommendation for the LinkedIn website
05:41 16 about six years ago, I think.

05:41 17 Q. And the Curtis, you say, "I have known Curtis for over
05:41 18 20 years," that's Dr. Curtis Whitson; correct?

05:41 19 A. That's correct.

05:41 20 Q. And you say you've known him for 20 years, you've
05:41 21 collaborated with him on many projects during that time. And
05:41 22 then you go on to write that, "He wrote the book, literally, on
05:42 23 reservoir fluid characterization and phase behavior"; correct?

05:42 24 A. That's correct. I'm referring there to his SPE monograph
05:42 25 entitled "Phase Behavior."

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05:42 1 Q. And in your opinion, as you stated here, "There is no one
05:42 2 in the world with more experience in these areas"?

05:42 3 A. Expertise.

05:42 4 Q. I'm sorry. Expertise. Thank you for correcting me.

05:42 5 A. Yes. That's what I stated.

05:42 6 Q. And you still hold that belief today, don't you?

05:42 7 A. Yes, that's still a true belief.

05:42 8 Q. Dr. Whitson's book on phase behavior, monograph, is that
05:42 9 one of the materials that you relied on in reaching your
10 opinions in this case?

05:42 11 A. Yes, I referred to it during the -- yes.

05:42 12 Q. And you agree that it is the book for fluid
13 characterization and phase behavior?

05:43 14 A. It's the best reference source that I know of that's been
15 written on the subject.

05:43 16 Q. Okay. Now, let's talk a little bit about
17 equation-of-state models in general. You agree that the way to
18 judge the accuracy of an equation-of-state model is to look at
19 how well your model matches measured data; correct?

05:43 20 A. That's one of the criteria, correct.

05:43 21 Q. And the measured data for the equation-of-state modeling
22 that you did was samples that were taken from the Macondo
23 reservoir and tested at three different laboratories; correct?

05:43 24 A. Correct.

05:43 25 Q. And those laboratories would be Schlumberger, Pencor --

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05:43 1 A. Yes.

05:43 2 Q. -- and I think Intertek you said?

05:44 3 A. Yes.

05:44 4 Q. And you did, in fact, look at those samples and rely on
05:44 5 those samples in building your model?

05:44 6 A. Yes.

05:44 7 Q. And I heard you express some disagreements that you had
05:44 8 with Dr. Whitson, minor I think you characterized them, with
05:44 9 respect to his equation-of-state model. But just to be clear,
05:44 10 both you and Dr. Whitson used the Peng-Robinson 1978 equation
05:44 11 of state. You both started from the same baseline; correct?

05:44 12 A. That's correct.

05:44 13 Q. And overall, you believe that Dr. Whitson created an
05:44 14 equation-of-state model that accurately predicts the most
05:44 15 important fluid behaviors for the Macondo well fluids; correct?

05:44 16 A. For the most part, yes.

05:44 17 Q. And you call it -- in fact, quote, you say his model --
05:45 18 you consider his model to be a good model; correct?

05:45 19 A. Yes, for the most part.

05:45 20 Q. Okay. And, in fact, I think it's your opinion that you
05:45 21 think Dr. Whitson's equation-of-state model is better than
05:45 22 yours in predicting some parameters and in other parameters you
05:45 23 view yours as slightly better than his?

05:45 24 A. That's correct.

05:45 25 Q. And so to be clear, you are not critical of the overall

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05:45 1 conclusions of Dr. Whitson's model because, again, as you said,
05:45 2 it's a good model?

05:46 3 A. Yes. I -- the calculations that he made with his model
05:46 4 are valid to within the uncertainties between his model and
05:46 5 mine, I would say.

05:46 6 Q. And you called his model a good model -- a good EOS model;
05:46 7 correct?

05:46 8 A. For the most part.

05:46 9 Q. Okay. Now, we talked about -- briefly you talked about
05:46 10 your equation-of-state model. I think I heard you testify that
05:46 11 you built that model based upon some data that had come from
05:46 12 the various labs.

05:46 13 You saw the four reports; correct?

05:46 14 A. That's correct.

05:46 15 Q. And the data that the various labs looked at, that
05:46 16 basically looked at the volume of liquid oil at stock tank
05:47 17 conditions -- at different stock tank conditions; correct?

05:47 18 A. That amounted to about .8 percent of the available data.

05:47 19 MS. CROSS: Okay. And just to be clear, if we can
05:47 20 pull up 11490R.34.1.

05:47 21 BY MS. CROSS:

05:47 22 Q. And this is from Appendix C of your report. You recognize
05:47 23 this table; correct?

05:47 24 A. Yes.

05:47 25 Q. And what you have charted here on the left-hand side are

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05:47 1 the different samples that you looked at. You've got Intertek,
05:47 2 you've got PENCOR, and then samples from each of those
05:47 3 companies and then some of the conditions. And one is
05:47 4 atmospheric flash and the other one is multistage separator
05:47 5 test; correct?

05:47 6 A. Correct.

05:47 7 Q. And is the atmospheric flash the same as single-stage
05:47 8 flash?

05:47 9 A. Yes.

05:47 10 Q. And then the multistage flash, that's the four-stage flash
05:48 11 that you told us about; correct?

05:48 12 A. Correct.

05:48 13 Q. Okay. And you looked at the test results that existed for
05:48 14 those models both at single stage as well as multistage;
05:48 15 correct?

05:48 16 A. That's correct.

05:48 17 Q. Now, part of the analysis in looking at going from a
05:48 18 single stage to a multistage separator test is to look at how
05:48 19 much gas and liquid is separated at some points in time in the
05:48 20 process based on temperature and pressure changes; correct?

05:48 21 A. Yes.

05:48 22 Q. And the reservoir temperature for Macondo was
05:49 23 approximately 243 degrees Fahrenheit?

05:49 24 A. Yes.

05:49 25 Q. And the initial reservoir pressure was approximately

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05:49 1 11,800 psi; correct?

05:49 2 A. 11,850 is the value I assumed.

05:49 3 Q. 11,850.

05:49 4 And you agree that as fluid rises, temperature
05:49 5 decreases?

05:49 6 A. As fluid rises from where to where?

05:49 7 Q. From the wellbore to the surface.

05:49 8 A. From the wellbore to the --

05:49 9 Q. From the reservoir -- I'm sorry. If I can correct myself.
05:49 10 As fluid is released from the reservoir, it rises through the
05:49 11 wellbore up to the surface, the temperature decreases?

05:49 12 A. I believe so, but that's not what I -- I didn't look at
05:49 13 that. I didn't try to model that, so I'd rather not speculate.

05:50 14 Q. Okay. And did you look at whether the pressure also
05:50 15 decreases as fluid rises from the reservoir up to surface?

05:50 16 A. Yes. That would have to occur.

05:50 17 Q. Now, you said you didn't look at whether the temperature
05:50 18 changes, but you're aware that at stock tank conditions, that's
05:50 19 approximately 60 degrees Fahrenheit; correct?

05:50 20 A. Yes. But now we're talking about outside of the well and
05:50 21 outside of the ocean.

05:50 22 Q. Okay. And you didn't look at what point in time it gets
05:50 23 to that 60 degrees Fahrenheit other than outside the well and
05:50 24 outside the ocean?

05:50 25 A. Well, actually, it never reached those -- that temperature

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05:50 1 because the -- well, no, that's not true. Somewhere between
05:50 2 the seabed and the surface of the ocean, the temperature will
05:50 3 be 60 degrees, because it's 40 degrees at the seabed and
05:50 4 roughly 80 degrees at the surface. So somewhere in there, the
05:51 5 temperature will pass the 60-degree point, but at higher
05:51 6 pressure than 1 atmosphere, of course.

05:51 7 Q. But you didn't look at what point in time that happens, is
05:51 8 my point.

05:51 9 A. I could -- my models included pressure at that point from
05:51 10 which you could determine the approximate depth, but I don't
05:51 11 know at what -- how long it would take for the fluids to float
05:51 12 from the seabed to that point.

05:51 13 Q. Is it fair to say that your equation-of-state model
05:51 14 overpredicts the amount of stock tank oil when compared to the
05:51 15 laboratory results no matter which surface process is used?

05:51 16 A. For the four-stage separation process, that's true. But
05:51 17 for the single-stage process, that is not true.

05:51 18 Q. Okay. If we can look at your deposition, 346, lines 4 to
05:52 19 line 10.

05:52 20 **BY MS. KARIS:**

05:52 21 Q. Were you asked the following question, "Is it fair to say
05:52 22 that your equation-of-state model overpredicts the amount of
05:52 23 stock tank oil when compared to the laboratory results no
05:52 24 matter what surface process is used?"

05:52 25 And did you give the following answer, "For the --

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05:52 1 for the measured surface processes, it slightly overpredicts,
05:52 2 yes"?

05:52 3 Did you give that answer?

05:52 4 A. Yes, apparently I did, but I mis-- I misspoke slightly.
05:52 5 Because there are -- on at least one of the single-stage
05:52 6 processes, my equation of state actually underpredicts the
05:53 7 stock tank oil.

05:53 8 Q. Now, you produced a comparison of your equation-of-state
05:53 9 stock tank oil figures as opposed to the measured or laboratory
05:53 10 data stock tank barrel predictions or calculations; correct?

05:53 11 A. Yes, I have.

05:53 12 MS. KARIS: Your Honor, I'm happy to stop here
05:53 13 because we're going to go into this table, which will take some
05:53 14 time, but whatever the Court pleases.

05:53 15 THE COURT: All right. We can recess.

05:53 16 It's 10 minutes to 6:00. We'll recess until
05:53 17 8:00 a.m. tomorrow morning.

05:53 18 Before we leave, I have a question. There's an
05:53 19 issue that Ms. Himmelhoch reminded me of -- somebody reminded
05:53 20 me of a pending U.S. motion regarding the issue of whether oil
05:53 21 that is allegedly dissolved in water should be counted or not.

05:53 22 MS. HIMMELHOCH: Yes. We have a pending summary
05:53 23 judgment motion. It was Ms. Cross, but, yes, we did remind you
05:54 24 of that, sir.

05:54 25 THE COURT: So it's also this -- also the subject of

05:54 1 a motion in limine; right?

05:54 2 **MS. HIMMELHOCH:** That is correct, Your Honor.

05:54 3 **THE COURT:** So it's all the same issue.

05:54 4 So who is going to respond to that for BP --
05:54 5 first of all, when is -- is it Dr. Whitson? When is he
05:54 6 expected to be called to testify?

05:54 7 **MR. BROCK:** I don't think he'll be this week. It's
05:54 8 likely next week. We're doing some juggling on the scheduling
05:54 9 now for Thursday.

05:54 10 **THE COURT:** Maybe what I'd ask you all to do, then,
11 is to file a response.

05:54 12 Have you filed a response?

05:54 13 **MS. KARIS:** We have, Your Honor.

05:54 14 **THE COURT:** You have. Okay.

05:54 15 **MS. HIMMELHOCH:** On the motion in limine, they have.
16 On the motion for --

05:54 17 **THE COURT:** If it's the same issue, then I don't want
18 people to repeat what they've already done.

05:54 19 **MS. KARIS:** I'm happy to give the Court a copy if you
20 like.

05:54 21 **THE COURT:** No, I must have it here. I have a
22 package. I just haven't read it yet. I'm sorry. I didn't
23 realize that just a second ago there was the same issue raised
24 in a motion in limine. I thought we only had the motion for
25 summary judgment.

05:55 1 So I'll look at that between now and before
05:55 2 Monday or by Monday, so I may be able to rule on that. Okay.

05:55 3 **MR. BROCK:** We return on Tuesday next week.

05:55 4 **THE COURT:** That's right.

05:55 5 **MS. HIMMELHOCH:** You gave all of us a little bit of a
05:55 6 heart attack there, Your Honor.

05:55 7 **THE COURT:** Well, actually, I wanted to work on
05:55 8 Monday, but with all this crazy stuff going on in Washington,
05:55 9 the marshals told me I would put a serious dent in their budget
05:55 10 if I -- which they have little of now. So they convinced me
05:55 11 not to hold Court on a federal holiday.

05:55 12 **MR. BROCK:** Just for planning, do you all know if
05:55 13 we'll see Dr. Pooladi-Darvish or Dr. Kelkar after this witness
05:55 14 tomorrow?

05:55 15 **MS. HIMMELHOCH:** We'll go in our stated order, Your
05:55 16 Honor.

05:55 17 **THE COURT:** So next would be Dr. Kelkar?

05:55 18 **MR. O'ROURKE:** Yes, sir.

05:55 19 **THE COURT:** And then Dr. Pooladi-Darvish; correct?

05:56 20 **MR. O'ROURKE:** With a 15-minute video deposition in
05:56 21 between. So we're assuming we're going to be finished
05:56 22 tomorrow, depending on the cross-examinations.

05:56 23 Are you going to address Thursday? People don't
05:56 24 know what's coming.

05:56 25 **MR. BROCK:** Thursday, my plan is to have Dr. Martin

05:56 1 Blunt here. He has arrived, but I haven't talked to him yet,
05:56 2 so just to make sure everything is okay with that.

05:56 3 If there is any change to that, I will let you
05:56 4 know as soon as I get back.

05:56 5 **MR. O'ROURKE:** Who's the second witness?

05:56 6 **MR. BROCK:** Right now...

05:56 7 **MR. O'ROURKE:** You're sticking with the same order?

05:56 8 **MR. BROCK:** No. I don't recall who we've got second.

05:56 9 **THE COURT:** You received their order of witnesses?
05:56 10 It's in here? You put it in here? Okay.

05:56 11 **MR. O'ROURKE:** I think he's changing it.

05:56 12 **MS. KARIS:** I think, Your Honor, one of the issues is
05:57 13 just getting people here, because a lot of our witnesses are
05:57 14 traveling. We weren't expecting that you would be done this
05:57 15 early. That's what Mr. Brock is addressing.

05:57 16 **THE COURT:** You still expect that Martin Blunt will
05:57 17 be your first witness?

05:57 18 **MR. BROCK:** Yes, sir.

05:57 19 **THE COURT:** Whenever that is.

05:57 20 **MR. BROCK:** Whenever that is. It sounds like it will
05:57 21 be first thing Thursday morning. He will not be ready tomorrow
05:57 22 afternoon, so if we get to tomorrow afternoon --

05:57 23 **THE COURT:** Well, I don't think it's likely we'll get
05:57 24 to him tomorrow afternoon.

05:57 25 **MR. BROCK:** We'll start with him first thing on

05:57 1 Thursday morning.

05:57 2 And I don't think we have Dr. Zimmerman in town
05:57 3 yet, so I don't think he would be the next --

05:57 4 **THE COURT:** So if he's not here and we get past
05:57 5 Blunt, who would be your next witness, likely?

05:57 6 **MS. HIMMELHOCH:** Dr. Gringarten is next on their
05:57 7 list, and I know he's in town because I've seen him.

05:57 8 **MR. BROCK:** I don't think that's the order in which
05:57 9 we prefer to call our witnesses. We could do Dr. Whitson. I
05:57 10 actually need about 15 minutes just to chat with the team just
05:57 11 to see what we can do --

05:57 12 **THE COURT:** Maybe you can let them know this evening.

05:58 13 **MR. BROCK:** I will just as soon as we get back.

05:58 14 **MR. O'ROURKE:** Your Honor, we have to prepare. This
05:58 15 is the day after --

05:58 16 **THE COURT:** He's going to let you know this evening.

05:58 17 **MR. O'ROURKE:** What time?

05:58 18 **MR. BROCK:** Well, we'll get back at 6:15, and I'll
05:58 19 get a note to you about 6:45.

05:58 20 **MR. O'ROURKE:** Thank you.

05:58 21 **THE COURT:** Anything else before we recess?

05:58 22 All right. See everyone at 8:00 a.m.

05:58 23 **THE DEPUTY CLERK:** All rise.

05:58 24 (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

.	130963 [1] 1764/21	21228 [1] 1649/4
.494 [1] 1767/3	1331 [1] 1631/9	21229 [1] 1651/18
.5 [3] 1761/15 1762/8 1762/11	14 [1] 1726/20	21230 [1] 1749/9
.8 [1] 1792/18	14 percent [2] 1643/25 1770/5	21231 [1] 1654/13
.8 percent [1] 1792/18	14271 [1] 1629/7	21232 [1] 1661/22
0	14th [10] 1678/23 1681/25 1724/24	21253 [1] 1658/15
0.494 barrels [1] 1767/1	1724/25 1725/10 1726/12 1726/21	2130 [3] 1716/11 1716/13 1717/4
02771 [1] 1627/7	1728/3 1732/6 1732/16	2140 [1] 1748/16
1	14th or [1] 1684/6	2150 [1] 1750/3
1 million barrels [1] 1713/25	15 [6] 1634/15 1659/21 1666/2 1739/7	2179 [1] 1627/4
1,000 [1] 1739/7	1786/22 1800/10	21st [2] 1693/1 1708/24
1.6 [2] 1642/5 1642/10	15 percent [1] 1714/19	22001 [1] 1753/3
1.8 [2] 1642/5 1642/10	15-minute [2] 1715/22 1798/20	22002 [1] 1756/21
1/2 [1] 1767/22	15th [23] 1634/13 1674/8 1674/11	22003 [1] 1759/1
10 [11] 1643/25 1664/6 1664/24 1665/1	1674/18 1682/5 1682/12 1683/15	22004 [1] 1760/8
1665/11 1665/12 1670/6 1670/7 1670/8	1683/18 1683/22 1684/6 1684/6 1685/9	22005 [1] 1761/3
1795/19 1796/16	1685/17 1686/3 1686/6 1686/10	22006 [1] 1764/13
10 minutes [1] 1670/9	1686/23 1687/2 1687/11 1688/25	22007 [1] 1766/3
10 percent [1] 1773/20	1689/7 1689/11 1734/21	22008 [2] 1768/10 1768/12
10-CV-02771 [1] 1627/7	16 feet [2] 1716/19 1716/22	22009 [1] 1778/11
10-CV-4536 [1] 1627/9	16.5 [1] 1717/10	22013 [1] 1783/8
10-MD-2179 [1] 1627/4	16.5 feet [2] 1692/1 1716/15	2216 [1] 1628/7
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100 barrels [3] 1769/23 1778/16	1665 [1] 1631/9	1658/10 1708/25 1709/1
1783/13	17 [2] 1714/18 1714/22	23401 [1] 1682/15
10003 [1] 1628/11	170,000 barrels [2] 1713/9 1746/21	23997.1 [1] 1699/3
1001 [1] 1630/16	1700 [1] 1631/5	243 degrees [2] 1766/24 1793/23
10752 [1] 1752/11	18 [2] 1693/16 1699/11	24368 [2] 1720/11 1720/14
11 [1] 1678/23	188 [1] 1628/16	24369 [2] 1720/21 1720/21
11 percent [2] 1768/7 1770/2	1885 [1] 1628/23	24370 [1] 1721/3
11,800 psi [1] 1794/1	19 [3] 1756/12 1756/13 1773/7	24372 [1] 1682/21
11,850 [5] 1700/24 1743/7 1743/19	1955 [1] 1677/21	24374 [1] 1688/19
1794/2 1794/3	1960 [1] 1677/22	24375 [1] 1733/24
11,850 psi [1] 1766/24	1978 [1] 1791/10	24376 [1] 1735/24
1100 [1] 1630/13	1983 [1] 1753/23	24401 [1] 1721/9
11056 [1] 1752/11	1991 [2] 1753/23 1754/2	24408 [1] 1736/13
11485R.11.3 [1] 1693/25	1993 [1] 1753/12	24409 [2] 1737/5 1737/14
11485R.9.1 [1] 1700/18	19th [6] 1727/6 1727/13 1729/5 1730/6	24467 [1] 1781/6
11486R.12.6 [1] 1740/20	1732/8 1732/22	24527 [1] 1732/2
11486R.14.1 [1] 1695/11	2	24531 [3] 1724/11 1724/13 1727/11
11486R.27 [1] 1744/9	2 1/2 [2] 1763/11 1784/4	24532 [1] 1734/16
11486R.29.2 [1] 1725/8	2.27.1.US [1] 1781/1	25 percent [1] 1694/12
11488.17.2 [1] 1702/16	20 [3] 1627/5 1714/1 1789/20	2500 [1] 1704/13
114901R [1] 1755/8	20 percent [6] 1713/24 1714/4 1714/8	26 [2] 1658/7 1773/10
11490R [2] 1755/1 1756/2	1714/24 1733/12 1733/15	26th [4] 1706/22 1706/23 1711/11
11490R.34.1 [1] 1792/20	20 years [1] 1789/18	1745/6
11491 [1] 1776/5	20,000 [1] 1697/4	27th [7] 1656/24 1657/3 1657/14
11491R [2] 1756/2 1774/20	20,000-barrel [1] 1712/10	1658/11 1659/1 1660/4 1660/8
11491R.0012 [1] 1774/19	20-something [1] 1714/19	29th [8] 1653/7 1697/8 1711/15 1712/3
11492.2.2 [1] 1789/11	200 [3] 1731/4 1745/12 1787/14	1712/22 1712/23 1712/24 1726/10
11575 [1] 1764/21	200 psi [2] 1670/19 1744/25	2A [1] 1699/13
11653.27.1 [1] 1703/4	20004 [1] 1630/11	3
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12th [3] 1633/23 1671/2 1671/3	1706/10 1719/16 1719/20	1714/12 1746/19 1746/23
13 [2] 1658/3 1658/3	2013 [5] 1627/7 1633/2 1691/11 1698/8	3.3 percent [4] 1713/12 1713/19
13 feet [5] 1692/1 1716/12 1716/19	1719/17	1714/16 1714/18
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13 percent [1] 1774/15	20th [6] 1674/11 1694/13 1700/14	3.4 percent [3] 1641/23 1642/1 1642/20
13.9 [2] 1644/1 1644/7	1702/6 1705/1 1750/4	30 [9] 1654/24 1655/21 1655/22 1685/1
13.9 percent [1] 1674/24	21 [2] 1678/23 1692/24	1685/3 1716/25 1716/25 1717/15
130 [2] 1719/7 1731/3	2100 [1] 1717/4	1754/9
130 psi [1] 1670/1	21023 [1] 1769/17	30 days [1] 1686/8
130-psi [1] 1719/9	21223 [1] 1637/20	30 minutes [2] 1716/19 1717/5
1300 [1] 1631/12	21224 [2] 1640/10 1741/24	30 percent [1] 1659/21
130815 [1] 1764/20	21225 [1] 1644/21	300 [1] 1629/23
	21226 [1] 1646/11	300 psi [2] 1733/15 1733/15
	21227 [1] 1647/24	30th [1] 1745/4

3	5.4 million barrels [2] 1671/13 1671/14 5.5 million barrels [1] 1675/7 50 days [1] 1686/9 50 percent [1] 1787/2 50,000 [2] 1697/4 1739/3 50.6 [2] 1770/4 1784/1 50.7 [2] 1770/4 1784/1 500 [3] 1627/23 1628/20 1631/18 500,000 barrels [1] 1706/2 5000 [1] 1629/18 501 [1] 1628/13 504 [1] 1631/19 556 [1] 1627/23 561 [1] 1678/23 589-7780 [1] 1631/19	86 [20] 1641/5 1654/18 1654/23 1654/25 1655/13 1655/19 1658/7 1685/14 1686/24 1689/16 1689/17 1689/24 1690/7 1690/10 1690/25 1696/17 1714/18 1734/3 1739/12 1739/24 86 feet [1] 1692/1 86-day [1] 1690/17 8600 [1] 1749/16 8700 [9] 1701/22 1702/20 1705/15 1706/6 1749/15 1749/25 1750/2 1750/3 1750/11 8700 psi [9] 1702/13 1703/8 1703/10 1703/23 1704/19 1705/2 1705/11 1705/25 1749/1 8:00 a.m [2] 1796/17 1800/22 8th [19] 1638/20 1643/8 1643/8 1646/8 1675/9 1675/13 1690/19 1699/2 1699/8 1706/6 1710/14 1713/4 1713/23 1718/8 1718/10 1726/23 1737/21 1749/21 1750/12	
316 [1] 1628/4 32591 [1] 1628/5 33 [1] 1709/6 333 [1] 1630/3 346 [1] 1795/18 35 [1] 1660/18 355 [1] 1630/21 35th [1] 1630/21 36 [1] 1709/6 36 hours [14] 1648/24 1649/3 1649/21 1696/5 1696/12 1696/18 1696/24 1697/2 1697/3 1697/6 1697/10 1697/16 1708/21 1709/5 36,000 [2] 1697/11 1711/18 36,000 barrels [2] 1697/7 1708/22 36-hour [1] 1648/25 36130 [1] 1628/20 3668 [1] 1627/23 3700 [2] 1630/13 1630/16 389 [1] 1667/19 39201 [1] 1628/17	6 6 1/2 [1] 1774/1 60 [1] 1739/5 60 degrees [5] 1760/16 1761/7 1794/19 1794/23 1795/3 60,000 [1] 1737/23 60-degree [1] 1795/5 600 [2] 1628/4 1670/24 60654 [1] 1629/24 60988 [3] 1764/20 1765/8 1773/8 60988.003.001.US [1] 1765/6 60988.26.001.US [1] 1773/5 61 [1] 1712/18 61,000 [1] 1711/14 61,000 barrels [1] 1710/11 63,000 [1] 1712/2 65 [1] 1739/5 65,000 [1] 1658/2 65,000 barrels [1] 1657/8 655 [1] 1630/7 6605 [1] 1742/5 6:00 [3] 1784/14 1784/14 1796/16 6:15 [1] 1800/18 6:45 [1] 1800/19	8:00 a.m [2] 1796/17 1800/22 8th [19] 1638/20 1643/8 1643/8 1646/8 1675/9 1675/13 1690/19 1699/2 1699/8 1706/6 1710/14 1713/4 1713/23 1718/8 1718/10 1726/23 1737/21 1749/21 1750/12	
4	4 million barrels [1] 1713/25 4 percent [1] 1714/10 4,000 [1] 1749/4 4,000 psi [3] 1704/23 1705/10 1750/7 4,700 [1] 1658/4 4.3 [2] 1644/15 1644/16 4.3 million [1] 1675/2 4.9 [1] 1673/10 40 [1] 1726/9 40 degrees [1] 1795/3 406 [1] 1631/18 41 [2] 1697/8 1709/6 41,000 [5] 1697/12 1709/10 1711/2 1711/10 1712/2 41,000 barrels [2] 1709/3 1710/11 41026.54.1 [1] 1716/5 41026.57 [1] 1747/20 41026.8 [1] 1747/8 42 [3] 1706/23 1706/24 1706/25 4248 [1] 1649/10 43 [2] 1692/9 1706/22 43.3 [1] 1778/24 43.3 barrels [1] 1779/11 4300 [2] 1701/23 1749/3 4300 psi [2] 1702/21 1703/11 44 [1] 1654/20 44 1/2 [1] 1769/25 4536 [1] 1627/9 46.7 [4] 1778/15 1778/22 1778/23 1779/2 48 barrels [1] 1779/2 48.0 [1] 1778/23 48.0 barrels [1] 1778/16 49.4 [2] 1770/1 1784/4	7 7.4 [2] 1692/5 1692/8 70 [1] 1739/5 70,000 [1] 1737/22 700 [1] 1628/10 701 [2] 1629/4 1629/18 70112 [1] 1631/13 70113 [1] 1627/20 70130 [3] 1628/8 1629/4 1631/19 70139 [1] 1629/19 70163 [1] 1630/14 70502 [1] 1627/24 70601 [1] 1628/14 70804 [1] 1628/24 7260 [1] 1742/5 740 psi [2] 1670/23 1718/24 75270 [1] 1631/6 7611 [1] 1629/15 77002 [1] 1630/17 77010 [1] 1631/9 777 [1] 1628/16 7780 [1] 1631/19	9 9 1/2 [1] 1774/7 9.4 [2] 1692/5 1692/8 9.7 [1] 1644/1 9.7 percent [1] 1674/25 9.9 percent [1] 1768/4 90,000 [1] 1699/6 90071 [2] 1630/4 1630/22 94005 [1] 1628/23 966 psi [1] 1671/5 9:00 and [1] 1694/12 9:00 to [1] 1717/7 9:30 [5] 1694/12 1716/24 1717/7 1717/10 1717/13 9:49 p.m [1] 1705/1 9th [1] 1718/24
5	5 million [6] 1673/6 1713/6 1729/25 1731/13 1743/8 1743/20 5 million barrels [3] 1640/2 1671/10 1742/24 5,000 [4] 1657/7 1658/2 1658/4 1658/6 5-million-barrel [6] 1639/21 1643/24 1674/21 1674/21 1676/6 1682/3 5.0 [1] 1673/11 5.0 million [1] 1640/6 5.0 million barrels [1] 1673/4 5.1 [2] 1673/9 1738/11 5.1 million barrels [1] 1639/2	8 8,730 psi [4] 1701/4 1701/11 1701/16 1701/25 80 degrees [1] 1795/4 800 [2] 1670/24 1724/22 800-psi [2] 1724/20 1725/1 820 [1] 1627/19 84 [1] 1686/25 85 [3] 1685/21 1686/25 1703/8	A A-A-R-O-N [1] 1750/23 a.m [2] 1796/17 1800/22 AARON [3] 1750/18 1750/22 1754/17 ability [3] 1730/13 1730/15 1801/6 able [7] 1635/5 1666/21 1726/24 1732/18 1763/12 1781/19 1798/2 about [185] above [9] 1648/12 1652/17 1695/14 1721/6 1721/6 1723/18 1729/2 1748/13 1801/8 above-entitled [1] 1801/8 absolutely [1] 1739/13 accept [1] 1738/24 accepted [3] 1677/24 1679/3 1754/20 accepting [1] 1781/9 accident [5] 1679/19 1691/13 1692/8 1700/3 1717/10 accidental [1] 1755/21 accompanied [3] 1640/3 1640/7 1655/16 accompanying [1] 1729/17 according [4] 1644/5 1692/5 1767/1 1774/16 account [6] 1638/21 1638/22 1638/25 1661/1 1728/18 1778/20 accounted [1] 1775/25 accounts [1] 1728/16 accuracy [7] 1645/3 1669/21 1669/23 1670/17 1670/19 1770/19 1790/18 accurate [4] 1672/25 1713/17 1782/14 1783/4 accurately [6] 1645/19 1698/11 1759/8 1759/9 1771/2 1791/14 achieved [1] 1716/11

<p>A</p> <p>acknowledge [1] 1691/12 acknowledges [2] 1717/20 1747/16 across [2] 1652/8 1652/9 activated [5] 1705/1 1708/24 1709/3 1709/14 1710/10 activating [2] 1709/16 1710/6 activation [2] 1709/10 1711/3 activities [1] 1754/9 activity [1] 1636/13 actual [9] 1643/25 1681/17 1681/21 1706/15 1707/6 1708/5 1731/12 1735/19 1774/17 actually [40] 1648/13 1648/21 1654/1 1661/1 1673/17 1677/20 1692/19 1693/5 1699/21 1700/5 1704/15 1708/6 1712/5 1717/25 1723/17 1726/13 1727/20 1729/18 1729/21 1729/24 1738/3 1738/16 1739/10 1741/5 1741/6 1741/13 1742/16 1748/8 1761/1 1767/6 1769/13 1769/13 1774/16 1780/6 1780/13 1787/23 1794/25 1796/6 1798/7 1800/10 add [11] 1642/10 1690/2 1694/10 1704/5 1716/6 1718/21 1718/24 1719/2 1719/5 1719/6 1738/2 ADD Energy [2] 1694/10 1716/6 added [2] 1644/7 1644/8 adding [2] 1730/2 1774/2 additional [17] 1639/18 1693/7 1718/21 1720/8 1724/6 1732/25 1733/3 1733/5 1766/16 1768/23 1769/4 1774/5 1775/7 1776/10 1776/16 1777/16 1777/17 address [5] 1643/7 1643/16 1644/19 1663/4 1798/23 addressed [4] 1643/2 1643/18 1645/23 1667/1 addresses [2] 1643/9 1679/24 addressing [1] 1799/15 adjusted [1] 1724/14 admit [1] 1756/4 admitted [4] 1636/23 1637/5 1637/7 1637/10 adopted [1] 1779/18 adopting [1] 1755/13 Adrian [1] 1654/6 advancing [1] 1781/10 affect [2] 1668/9 1733/10 affected [1] 1651/21 affecting [1] 1646/15 affects [1] 1690/1 affirmative [1] 1752/3 after [24] 1643/7 1646/15 1650/25 1651/4 1651/8 1671/2 1671/3 1671/12 1672/1 1673/7 1705/11 1705/18 1709/2 1711/15 1712/25 1713/25 1718/8 1718/10 1719/5 1726/23 1748/24 1779/8 1798/13 1800/15 afternoon [10] 1627/14 1633/1 1636/7 1637/18 1674/3 1751/23 1784/22 1799/22 1799/22 1799/24 again [27] 1638/19 1639/1 1643/20 1646/16 1650/3 1651/22 1654/18 1659/3 1661/3 1680/25 1682/12 1685/25 1687/16 1704/21 1704/22 1710/11 1727/9 1732/5 1736/6 1740/13 1746/22 1749/22 1749/25 1758/19 1766/12 1777/22 1792/1 against [4] 1682/9 1687/13 1736/18 1754/19 ago [7] 1682/25 1695/16 1703/19 1726/9 1789/5 1789/16 1797/23</p>	<p>agree [33] 1657/11 1659/21 1676/3 1684/2 1685/22 1687/16 1689/18 1690/2 1690/14 1690/17 1690/20 1690/22 1691/5 1703/9 1703/25 1704/24 1706/5 1706/20 1719/12 1721/11 1721/15 1721/17 1721/20 1721/21 1722/9 1724/4 1724/9 1737/12 1742/20 1789/8 1790/12 1790/17 1794/4 agreed [3] 1687/3 1733/9 1733/9 agreeing [1] 1649/6 Ah [3] 1645/17 1693/10 1693/15 ahead [15] 1636/14 1638/13 1638/15 1658/1 1665/25 1667/13 1668/4 1700/13 1715/21 1742/20 1752/19 1758/18 1761/24 1776/13 1778/5 aided [1] 1631/24 al [2] 1627/8 1627/11 Alabama [1] 1628/20 ALAN [1] 1631/8 algorithm [1] 1688/1 aligned [1] 1636/25 alkanes [1] 1771/23 all [140] 1633/4 1633/5 1633/6 1634/22 1635/3 1635/11 1636/5 1636/14 1636/21 1637/9 1638/10 1638/13 1639/18 1641/1 1641/3 1641/7 1643/14 1644/5 1644/6 1644/6 1644/7 1644/8 1645/9 1648/8 1648/22 1652/16 1652/21 1652/22 1652/23 1653/1 1653/1 1653/15 1653/17 1654/1 1657/5 1657/7 1657/10 1658/9 1659/18 1661/9 1661/9 1666/23 1666/24 1673/7 1673/21 1678/5 1678/7 1678/15 1681/6 1682/12 1683/14 1684/12 1684/18 1684/21 1686/17 1686/21 1687/23 1688/9 1688/13 1690/9 1693/9 1696/17 1697/7 1697/19 1697/21 1698/9 1702/2 1704/5 1706/17 1706/19 1707/12 1708/14 1709/22 1709/24 1710/1 1712/14 1712/14 1712/16 1713/18 1715/21 1715/23 1715/25 1716/1 1716/2 1718/11 1720/12 1722/3 1726/15 1726/25 1729/9 1729/11 1729/18 1729/21 1730/2 1730/2 1731/8 1731/11 1733/13 1734/3 1735/16 1737/11 1738/1 1738/1 1739/4 1739/25 1740/12 1740/14 1740/23 1749/23 1750/16 1750/17 1752/19 1756/8 1759/5 1763/17 1764/9 1771/20 1771/23 1771/24 1772/1 1774/13 1776/9 1776/14 1777/18 1779/3 1782/8 1782/23 1783/5 1784/8 1788/2 1788/20 1796/15 1797/3 1797/5 1797/10 1798/5 1798/8 1798/12 1800/22 1800/23 ALLAN [1] 1629/3 allegedly [1] 1796/21 ALLEN [1] 1630/21 allow [1] 1727/18 allowed [1] 1739/22 allowing [1] 1727/21 allows [3] 1728/12 1772/11 1776/17 alluded [1] 1647/5 almost [9] 1658/6 1658/13 1678/8 1697/1 1697/3 1697/18 1731/11 1737/22 1770/5 alone [1] 1724/1 along [7] 1655/15 1659/20 1687/8 1710/15 1739/11 1768/22 1776/18 already [10] 1647/5 1649/15 1662/20 1671/5 1687/3 1698/23 1703/15 1738/13 1752/6 1797/18 also [34] 1639/5 1639/7 1648/15</p>	<p>1653/10 1670/13 1672/12 1675/25 1676/12 1681/6 1684/8 1687/12 1692/18 1697/1 1702/24 1710/9 1717/17 1720/1 1721/17 1747/17 1747/21 1747/25 1752/4 1757/7 1764/17 1764/19 1771/6 1772/11 1772/15 1773/19 1780/2 1785/13 1794/14 1796/25 1796/25 alternate [15] 1637/24 1637/25 1638/2 1638/3 1638/17 1639/2 1639/9 1639/15 1643/6 1654/21 1686/15 1713/21 1733/17 1733/18 1733/21 Alternate 1 [1] 1639/2 Alternate 2 [2] 1638/3 1638/17 alternates [1] 1646/17 alternative [27] 1734/8 1734/13 1734/20 1734/23 1735/20 1735/23 1735/24 1736/2 1736/7 1736/15 1736/22 1737/9 1737/9 1737/12 1737/19 1738/4 1738/8 1738/10 1738/17 1738/17 1739/9 1739/9 1739/10 1739/21 1740/24 1757/8 1770/13 Alternative 1 [10] 1734/8 1734/13 1734/20 1734/23 1735/20 1737/9 1738/10 1738/17 1739/9 1740/24 Alternative 2 [10] 1735/23 1736/2 1736/7 1736/15 1736/22 1737/9 1737/19 1738/8 1738/17 1739/10 alternatives [1] 1655/8 although [2] 1755/15 1774/16 always [9] 1645/14 1670/6 1670/8 1698/24 1739/19 1740/19 1761/16 1764/1 1764/3 am [4] 1714/10 1738/13 1755/15 1784/9 ambient [13] 1638/4 1638/18 1720/14 1734/7 1734/11 1735/1 1735/7 1736/4 1736/7 1736/7 1736/24 1760/18 1764/1 ambiguity [1] 1692/22 amended [1] 1637/6 AMERICA [8] 1627/10 1629/6 1629/10 1629/18 1629/21 1630/3 1630/6 1630/10 amongst [2] 1739/11 1739/21 amount [16] 1642/16 1652/7 1669/5 1742/16 1758/4 1766/16 1773/3 1775/14 1776/16 1779/10 1780/12 1780/21 1783/7 1785/17 1795/14 1795/22 amounted [1] 1792/18 Anadarko [6] 1631/11 1631/11 1631/14 1631/15 1752/5 1779/13 analyses [4] 1658/11 1694/9 1779/18 1781/16 analysis [27] 1639/20 1639/24 1640/15 1643/4 1643/19 1659/3 1660/17 1693/17 1710/7 1710/19 1714/5 1714/25 1715/1 1715/3 1715/8 1715/13 1759/24 1766/19 1772/5 1773/11 1774/8 1775/23 1776/3 1778/11 1779/16 1779/21 1793/17 analyze [5] 1670/13 1680/15 1715/17 1763/24 1763/25 analyzed [4] 1679/18 1680/17 1754/13 1754/15 and/or [1] 1695/24 ANDREW [1] 1629/21 Andy [1] 1633/7 Angeles [2] 1630/4 1630/22 ANNA [2] 1629/13 1751/24 annular [9] 1648/7 1648/9 1648/10 1648/13 1648/23 1648/24 1656/17 1659/4 1695/14 annulars [3] 1651/23 1653/5 1704/16</p>
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A	1692/23 1759/17 1779/17 appreciable [1] 1777/25 approach [12] 1677/11 1677/11 1677/16 1677/17 1678/17 1678/18 1678/19 1679/5 1679/7 1679/13 1680/15 1719/21 appropriate [15] 1670/12 1685/20 1742/7 1751/9 1756/25 1757/17 1760/10 1770/8 1770/10 1771/7 1772/7 1780/24 1781/10 1783/19 1783/21 approximate [3] 1668/15 1782/25 1795/10 approximately [15] 1702/12 1703/11 1706/2 1708/21 1709/10 1724/20 1742/24 1779/5 1786/17 1786/21 1787/2 1789/5 1793/23 1793/25 1794/19 approximates [3] 1782/18 1782/21 1782/22 approximation [2] 1668/15 1739/19 APRIL [38] 1627/5 1653/3 1653/6 1653/7 1656/19 1656/22 1657/3 1657/13 1658/10 1659/1 1674/11 1675/9 1675/13 1689/11 1691/23 1692/24 1693/1 1694/13 1697/8 1699/2 1700/14 1702/6 1705/1 1705/25 1708/24 1708/25 1711/11 1711/12 1711/15 1712/3 1712/22 1712/23 1712/24 1713/3 1726/10 1726/20 1750/4 1765/3 April 20th [4] 1674/11 1694/13 1700/14 1750/4 April 20th to [7] 1675/9 1675/13 1689/11 1691/23 1699/2 1705/25 1713/3 April 21 [1] 1692/24 April 21st [2] 1693/1 1708/24 April 22nd [5] 1653/6 1656/19 1656/22 1658/10 1708/25 April 22nd and [2] 1657/13 1659/1 April 22nd through [1] 1657/3 April 26th [1] 1711/11 April 29th [8] 1653/7 1697/8 1711/15 1712/3 1712/22 1712/23 1712/24 1726/10 April 29th by [1] 1653/3 April 29th in [1] 1711/12 April 29th or [1] 1726/20 ARCO [2] 1753/22 1786/18 are [148] 1635/2 1636/23 1639/25 1640/18 1640/22 1640/23 1640/23 1641/1 1641/17 1641/22 1642/5 1643/14 1643/20 1643/21 1645/10 1645/11 1645/18 1646/20 1646/23 1646/25 1648/4 1648/6 1649/9 1651/11 1651/13 1653/14 1653/21 1654/6 1654/8 1654/21 1655/8 1656/5 1657/6 1657/12 1657/17 1657/19 1658/24 1661/4 1661/12 1662/1 1664/10 1664/18 1665/5 1665/23 1667/4 1667/9 1670/4 1670/9 1671/15 1671/16 1672/15 1672/20 1675/19 1680/8 1681/11 1681/12 1683/3 1683/6 1683/18 1684/4 1684/22 1685/1 1685/1 1685/1 1685/3 1686/23 1687/21 1688/2 1689/21 1689/23 1690/11 1695/23 1696/7 1696/16 1697/24 1698/13 1700/13 1704/6 1704/6 1704/13 1704/14 1706/17 1706/19 1709/6 1710/15 1710/21 1712/4 1716/12 1718/17 1720/4 1725/1 1726/15 1726/19 1728/24 1729/11 1730/16 1731/2 1731/2 1731/5 1731/18 1732/11 1732/15 1732/16 1733/1 1733/8 1738/6	1738/22 1739/5 1739/19 1744/24 1745/1 1745/4 1745/5 1745/6 1745/12 1745/13 1748/12 1751/18 1752/5 1752/8 1752/11 1752/14 1753/10 1754/18 1755/13 1756/13 1757/14 1760/4 1760/6 1760/7 1760/25 1764/16 1764/22 1765/21 1770/8 1771/11 1775/2 1782/11 1783/17 1785/10 1785/21 1787/13 1791/25 1792/4 1792/25 1796/5 1798/23 1799/13 area [18] 1652/18 1652/19 1661/12 1661/12 1661/15 1663/5 1663/19 1667/1 1668/11 1668/11 1668/12 1668/23 1668/25 1668/25 1721/6 1731/22 1745/3 1745/16 areas [3] 1667/6 1673/14 1790/2 aren't [4] 1714/22 1746/7 1746/12 1769/12 argued [2] 1633/22 1771/19 argument [1] 1780/1 aromatics [1] 1771/24 around [11] 1657/21 1678/11 1729/12 1729/24 1730/3 1739/5 1743/20 1745/25 1761/9 1784/13 1784/14 arrive [2] 1714/12 1759/3 arrived [2] 1685/20 1799/1 arriving [1] 1707/21 art [1] 1788/3 article [2] 1691/8 1706/10 as [170] 1634/6 1634/6 1634/19 1635/9 1635/10 1635/18 1637/15 1638/1 1640/6 1644/9 1645/3 1647/20 1647/21 1650/8 1653/16 1654/17 1655/1 1655/8 1656/22 1657/5 1659/10 1660/8 1660/8 1663/14 1671/12 1671/12 1672/4 1674/8 1674/13 1675/22 1677/2 1678/1 1679/5 1679/21 1680/19 1680/20 1681/4 1682/23 1682/24 1683/20 1684/6 1684/18 1684/18 1684/22 1685/2 1685/4 1685/9 1686/10 1687/5 1687/10 1689/6 1689/24 1690/1 1690/2 1690/2 1690/15 1690/23 1691/13 1692/8 1693/3 1693/16 1693/17 1695/1 1697/17 1698/10 1698/25 1699/5 1700/3 1700/4 1700/10 1701/22 1701/22 1701/25 1702/6 1702/24 1703/10 1703/23 1704/9 1705/8 1705/8 1707/19 1709/10 1711/22 1711/24 1713/13 1713/14 1713/15 1718/14 1723/7 1727/6 1727/24 1732/12 1732/15 1734/21 1734/22 1735/8 1736/21 1737/14 1739/1 1739/1 1742/14 1742/14 1742/18 1742/22 1742/23 1743/11 1743/11 1743/19 1745/7 1745/7 1746/11 1746/11 1746/20 1749/16 1750/19 1750/23 1751/8 1752/2 1752/4 1752/22 1753/8 1754/17 1754/20 1755/13 1758/14 1760/4 1760/4 1760/14 1762/12 1762/13 1764/17 1764/20 1765/18 1767/23 1768/20 1768/21 1768/22 1769/1 1769/3 1769/4 1769/10 1773/17 1776/14 1777/6 1778/21 1779/10 1779/24 1780/4 1780/12 1780/15 1781/10 1785/17 1786/1 1787/3 1789/13 1790/1 1791/23 1792/1 1793/7 1793/14 1793/14 1794/4 1794/6 1794/10 1794/15 1796/9 1799/4 1799/4 1800/13 1800/13 Asbill [1] 1630/15 ask [14] 1637/25 1645/6 1662/17 1677/21 1679/4 1696/8 1714/4 1732/20 1746/2 1747/4 1754/18 1758/19 1764/6
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<p>A</p> <p>ask... [1] 1797/10 asked [11] 1634/16 1666/9 1669/15 1678/25 1679/10 1689/17 1694/24 1704/8 1709/18 1712/18 1795/21 asking [1] 1667/24 asserts [1] 1657/5 assessment [4] 1659/15 1711/21 1713/16 1745/2 ASSET [1] 1627/8 assist [1] 1752/25 associated [19] 1641/2 1641/4 1641/10 1641/11 1643/10 1643/14 1643/20 1643/24 1648/22 1655/4 1655/4 1682/7 1704/7 1714/21 1733/1 1744/15 1745/14 1745/25 1746/5 assume [5] 1641/15 1713/22 1778/7 1781/19 1782/16 assumed [3] 1716/15 1772/23 1794/2 assumes [2] 1716/10 1778/18 assuming [3] 1730/13 1776/8 1798/21 assumption [5] 1642/1 1699/10 1713/2 1776/7 1782/15 assumptions [8] 1698/12 1710/16 1710/20 1710/22 1711/6 1712/15 1746/10 1746/12 atmosphere [2] 1760/16 1795/6 atmospheric [2] 1793/4 1793/7 attached [2] 1637/7 1662/6 attack [1] 1798/6 attempt [1] 1660/9 attempts [1] 1633/20 attention [2] 1669/19 1742/2 Attorney [2] 1628/18 1628/22 author [1] 1787/21 available [5] 1674/13 1700/2 1719/19 1764/2 1792/18 Avenue [4] 1627/19 1628/20 1630/10 1630/21 average [12] 1731/14 1742/22 1743/3 1743/12 1743/13 1743/14 1743/15 1743/17 1744/12 1744/21 1766/25 1767/17 averaging [1] 1744/14 aware [14] 1672/15 1702/8 1703/2 1715/6 1715/11 1715/16 1750/10 1752/6 1759/21 1771/11 1787/9 1787/13 1787/13 1794/18 away [1] 1655/17</p>	<p>1710/11 1710/11 1711/2 1711/11 1711/14 1711/18 1713/9 1713/25 1713/25 1742/24 1743/9 1743/21 1746/21 1752/3 1752/4 1761/6 1761/10 1762/9 1762/9 1762/10 1762/11 1762/13 1762/13 1767/1 1769/23 1769/25 1770/4 1778/16 1778/16 1779/2 1779/11 1783/13 1783/13 1784/5 barrier [2] 1694/16 1694/19 Barring [1] 1730/10 BARRY [1] 1629/23 base [3] 1659/15 1701/10 1701/10 based [28] 1638/23 1641/12 1642/6 1644/2 1658/11 1659/2 1661/3 1667/9 1668/17 1671/17 1673/1 1677/10 1682/3 1686/23 1689/7 1692/14 1698/2 1698/7 1698/25 1701/9 1701/15 1708/3 1742/25 1745/17 1754/3 1770/7 1792/11 1793/20 baseline [2] 1684/11 1791/11 basic [1] 1645/6 basically [3] 1772/8 1779/10 1792/16 basis [5] 1647/3 1673/8 1673/9 1693/3 1750/13 Baton [1] 1628/24 Baylen [1] 1628/4 be [144] 1633/5 1635/5 1635/12 1640/7 1642/13 1642/14 1642/19 1644/10 1644/15 1645/19 1646/21 1655/4 1655/4 1655/6 1655/16 1655/24 1656/21 1657/17 1658/11 1659/2 1665/24 1670/1 1670/19 1671/17 1672/17 1680/5 1685/20 1686/2 1686/2 1687/13 1691/23 1693/24 1696/9 1696/15 1696/19 1698/11 1700/3 1701/11 1701/16 1701/22 1702/5 1702/12 1703/8 1705/10 1707/2 1708/21 1710/24 1713/24 1714/23 1716/1 1717/23 1720/12 1722/2 1722/24 1724/22 1726/4 1726/13 1726/24 1727/16 1727/24 1728/1 1732/18 1734/17 1734/18 1735/13 1735/21 1736/11 1737/3 1737/16 1738/9 1739/16 1739/23 1743/10 1743/14 1746/23 1749/20 1750/6 1752/13 1754/20 1756/23 1757/3 1757/8 1757/15 1757/17 1758/11 1758/14 1758/16 1758/24 1759/16 1760/16 1760/20 1761/1 1761/8 1761/14 1761/17 1763/8 1767/9 1770/11 1770/13 1770/25 1771/20 1772/2 1772/9 1772/13 1772/21 1772/25 1774/1 1775/25 1777/7 1777/10 1777/11 1778/7 1781/13 1781/18 1781/18 1781/19 1781/21 1783/20 1783/22 1784/1 1785/4 1785/7 1786/6 1788/2 1788/13 1788/23 1790/25 1791/9 1791/18 1791/25 1792/19 1795/3 1796/21 1797/6 1797/7 1798/2 1798/17 1798/21 1799/14 1799/17 1799/21 1799/21 1800/3 1800/5 beating [1] 1740/4 became [2] 1725/15 1730/11 because [73] 1634/8 1634/9 1634/15 1638/23 1644/9 1647/23 1648/19 1659/3 1659/7 1661/2 1666/17 1667/7 1669/12 1677/9 1680/7 1680/12 1681/24 1687/16 1687/19 1688/3 1688/4 1689/19 1690/5 1695/22 1699/21 1706/24 1708/11 1709/21 1710/4 1710/20 1712/1 1712/3 1712/4</p>	<p>1712/7 1712/8 1718/6 1721/18 1722/24 1723/16 1723/25 1724/2 1724/7 1725/15 1725/25 1727/4 1731/13 1734/10 1734/14 1735/7 1735/7 1736/6 1736/23 1737/1 1738/8 1746/9 1750/2 1757/4 1763/25 1765/24 1769/11 1770/10 1770/13 1775/8 1776/20 1777/11 1783/23 1792/1 1795/1 1795/3 1796/5 1796/13 1799/13 1800/7 become [3] 1645/16 1653/24 1751/15 becomes [2] 1688/18 1728/3 becoming [2] 1727/17 1727/25 bed [1] 1758/15 been [32] 1634/17 1635/7 1637/14 1645/1 1645/3 1645/6 1649/2 1653/19 1662/15 1670/2 1676/22 1689/2 1706/18 1706/18 1706/20 1708/3 1722/1 1748/25 1750/18 1752/16 1752/22 1753/12 1754/10 1757/11 1757/13 1757/20 1770/14 1770/15 1770/24 1783/14 1787/9 1790/14 before [34] 1627/14 1637/23 1638/19 1643/8 1645/8 1671/10 1674/11 1683/5 1690/19 1697/13 1701/21 1703/22 1705/1 1707/10 1709/13 1709/21 1710/14 1710/14 1711/19 1714/1 1714/3 1718/13 1718/21 1719/14 1748/1 1748/11 1757/22 1765/3 1776/10 1776/21 1788/25 1796/18 1798/1 1800/21 beginning [1] 1743/12 begins [4] 1654/25 1665/3 1747/9 1768/15 behalf [3] 1674/3 1751/24 1784/23 behaves [1] 1646/25 behavior [15] 1710/19 1727/7 1750/13 1753/9 1753/19 1754/18 1759/7 1759/9 1759/17 1760/2 1767/19 1789/23 1789/25 1790/8 1790/13 behaviors [1] 1791/15 behind [1] 1758/10 being [10] 1642/18 1644/11 1648/7 1656/3 1689/24 1709/10 1712/11 1736/7 1745/5 1763/3 belief [4] 1640/3 1712/12 1790/6 1790/7 believe [38] 1642/16 1651/13 1654/1 1655/7 1662/11 1671/4 1671/16 1671/21 1686/22 1695/23 1706/15 1707/6 1712/21 1716/17 1721/16 1726/9 1726/17 1730/15 1757/4 1757/10 1760/6 1763/3 1765/1 1770/8 1770/10 1770/14 1772/6 1772/14 1775/20 1776/4 1777/12 1781/13 1782/15 1782/20 1783/4 1783/23 1791/13 1794/12 believed [3] 1650/2 1771/21 1772/1 believes [2] 1650/4 1717/18 below [11] 1652/24 1653/1 1662/4 1689/10 1689/24 1712/6 1712/9 1726/5 1748/13 1748/15 1748/18 bench [1] 1634/4 beneath [1] 1745/3 BENSON [2] 1629/11 1637/18 benzene [2] 1771/25 1774/4 best [48] 1637/24 1639/9 1640/2 1640/6 1644/14 1645/18 1646/16 1671/17 1673/2 1674/12 1675/18 1680/24 1684/18 1685/4 1687/4 1688/22 1689/5 1689/9 1689/15 1689/19 1690/7 1691/2 1694/18 1698/3 1698/16 1703/12 1704/9 1718/17 1719/8 1720/3 1724/16 1728/2 1728/5 1728/9 1728/12 1729/20 1730/23 1737/9 1737/18 1737/22</p>
<p>B</p> <p>back [20] 1635/16 1652/8 1652/9 1666/23 1674/11 1704/14 1704/22 1705/10 1727/11 1745/8 1749/1 1749/3 1749/3 1750/6 1777/1 1777/14 1785/10 1799/4 1800/13 1800/18 background [2] 1751/8 1753/20 backwards [2] 1699/16 1699/18 balance [2] 1654/25 1658/14 ballpark [1] 1659/22 bands [1] 1729/12 bar [1] 1725/3 BARBIER [1] 1627/15 BARR [1] 1628/3 barrel [15] 1639/21 1643/24 1674/21 1674/21 1676/6 1682/3 1712/10 1761/7 1761/10 1761/17 1762/15 1762/19 1766/25 1784/5 1796/10 barrels [50] 1639/2 1640/2 1654/20 1657/8 1671/10 1671/13 1671/14 1673/4 1675/3 1675/7 1676/5 1697/7 1706/2 1708/22 1709/3 1709/11</p>		

B	1704/18 1704/25 1705/1 1705/10 1706/12 1706/16 1707/7 1707/17 1707/22 1708/3 1708/20 1709/24 1710/7 1711/1 1711/22 1712/9 1712/20 1713/1 1713/16 1714/6 1715/17 1719/22 1720/1 1720/19 1721/6 1721/19 1721/22 1721/23 1722/10 1722/17 1722/20 1722/25 1723/5 1723/11 1723/22 1725/12 1725/15 1725/20 1725/21 1725/25 1726/4 1726/5 1727/24 1728/3 1728/6 1728/7 1728/8 1728/10 1728/11 1729/7 1730/18 1733/19 1734/2 1734/21 1736/3 1739/23 1740/10 1740/14 1740/17 1740/23 1748/13 1748/14 1748/16 1748/18 1749/8 bore [3] 1650/1 1659/4 1659/8 bores [1] 1706/19 both [17] 1652/12 1680/22 1730/14 1733/9 1738/11 1740/10 1740/14 1740/17 1740/22 1760/2 1767/18 1767/19 1778/7 1782/16 1791/10 1791/11 1793/14 bother [1] 1711/5 bottom [18] 1641/3 1643/21 1648/19 1650/22 1652/13 1652/15 1652/16 1655/3 1655/5 1665/15 1690/15 1692/9 1701/8 1707/1 1712/20 1720/19 1747/23 1763/24 bottom-right [1] 1652/13 bound [9] 1645/22 1675/7 1708/21 1710/20 1710/22 1711/6 1711/7 1712/16 1746/19 bounds [8] 1644/14 1710/16 1710/16 1731/22 1731/24 1746/10 1746/11 1776/13 BOWMAN [1] 1631/4 Box [5] 1627/23 1628/4 1628/23 1629/7 1629/15 BP [46] 1627/10 1629/17 1629/18 1629/19 1629/20 1629/21 1629/22 1630/2 1630/3 1630/4 1630/5 1630/6 1630/7 1630/9 1630/10 1630/10 1633/7 1633/17 1643/1 1643/18 1644/17 1644/18 1644/24 1646/1 1646/2 1649/13 1654/4 1654/5 1659/19 1659/19 1660/20 1661/16 1669/20 1671/19 1672/10 1672/12 1674/4 1687/13 1752/5 1757/9 1757/12 1779/12 1782/7 1784/23 1787/9 1797/4 BP's [5] 1650/17 1656/8 1670/13 1767/18 1781/8 BP/Anadarko [1] 1752/5 BRAD [1] 1630/19 Branch [1] 1629/6 break [2] 1777/22 1784/15 Brennan [1] 1630/15 BRIAN [2] 1628/3 1630/19 BRIDGET [1] 1630/10 brief [1] 1634/22 briefed [1] 1633/22 briefing [1] 1635/19 briefly [8] 1656/14 1753/20 1757/23 1768/9 1787/6 1788/20 1788/25 1792/9 bring [6] 1633/16 1633/18 1633/21 1664/17 1699/13 1727/1 broad [7] 1628/13 1640/5 1640/14 1640/16 1644/23 1685/23 1746/2 Broadway [1] 1628/10 BROCK [2] 1630/9 1799/15 broke [1] 1637/23 broken [3] 1648/15 1648/21 1763/5 brought [3] 1760/18 1763/3 1766/8	BRUCE [1] 1631/4 BSR [2] 1653/6 1709/25 BSR's [1] 1709/8 BSRs [5] 1651/24 1652/24 1652/25 1709/6 1745/23 bubble [3] 1777/19 1777/20 1777/21 bubbles [11] 1769/14 1769/15 1777/6 1777/15 1777/17 1777/18 1777/22 1777/24 1778/2 1778/3 1778/4 budget [1] 1798/9 build [2] 1678/3 1678/11 building [2] 1755/18 1791/5 built [3] 1678/8 1754/13 1792/11 bullet [4] 1658/18 1782/1 1782/12 1782/18 bunch [3] 1648/11 1659/12 1710/16 bundles [1] 1634/8 Burling [1] 1630/9 Bushnell [5] 1633/10 1633/16 1633/21 1635/6 1635/14 Bushnell's [2] 1634/7 1635/20 business [3] 1645/14 1647/14 1655/10
	C	
best... [8] 1739/9 1740/23 1746/7 1746/13 1748/13 1783/23 1790/14 1801/6 BETHANY [1] 1629/13 better [5] 1638/11 1645/22 1678/21 1791/21 1791/23 between [48] 1638/18 1646/22 1653/6 1656/5 1657/7 1657/13 1658/7 1658/10 1658/25 1663/12 1663/13 1663/17 1668/20 1670/25 1686/14 1694/12 1697/11 1716/21 1718/18 1725/10 1726/12 1726/20 1729/5 1730/6 1731/18 1734/7 1736/24 1747/18 1760/3 1760/12 1760/22 1765/5 1767/14 1770/4 1771/3 1771/12 1774/15 1775/1 1777/7 1777/14 1780/17 1785/23 1785/25 1786/3 1792/4 1795/1 1798/1 1798/21 beyond [1] 1775/20 big [14] 1648/20 1653/23 1677/13 1678/6 1707/5 1707/5 1707/5 1707/13 1708/12 1708/14 1708/15 1708/15 1729/11 1777/2 bigger [4] 1663/22 1669/6 1698/22 1763/7 biggest [1] 1714/23 Bingham [1] 1631/14 bit [20] 1633/12 1638/10 1643/17 1647/7 1652/10 1669/9 1682/17 1708/23 1722/13 1731/9 1731/10 1731/22 1737/23 1745/12 1745/13 1771/9 1775/9 1786/15 1790/16 1798/5 Bits [1] 1634/21 bizarre [1] 1730/10 black [1] 1654/19 blades [1] 1652/3 blind [13] 1651/16 1651/20 1656/17 1708/24 1709/2 1709/10 1709/14 1709/16 1710/6 1711/19 1711/23 1715/8 1745/23 block [2] 1705/7 1705/22 blocked [1] 1667/23 blocks [1] 1652/23 blowout [5] 1748/2 1748/11 1762/20 1763/4 1765/4 blue [1] 1748/15 bluish [1] 1643/22 bluish-grayish [1] 1643/22 Blunt [10] 1779/13 1779/15 1779/18 1780/17 1781/12 1783/16 1786/6 1799/1 1799/16 1800/5 Blunt's [3] 1779/13 1781/3 1781/9 Bly [3] 1649/9 1649/13 1649/14 board [1] 1736/11 BOB [1] 1672/19 BOLES [1] 1630/3 bolster [1] 1780/1 book [3] 1789/22 1790/8 1790/12 BOP [119] 1638/3 1638/18 1638/21 1638/24 1638/24 1639/4 1639/12 1641/11 1641/12 1641/14 1641/21 1641/25 1642/6 1642/16 1642/18 1645/20 1646/19 1646/24 1647/1 1648/5 1648/17 1651/4 1651/8 1653/1 1655/11 1655/17 1655/22 1655/24 1656/16 1659/7 1659/7 1659/8 1659/20 1659/23 1660/7 1662/4 1662/6 1669/21 1672/19 1676/18 1686/16 1689/24 1695/15 1700/3 1700/10 1701/8 1701/10 1701/10 1701/16 1701/25 1702/24 1704/9 1704/12 1704/13	C12 [3] 1771/25 1773/15 1773/20 C7 [1] 1773/20 calculate [33] 1639/17 1641/19 1641/19 1668/14 1668/17 1668/21 1668/22 1672/15 1674/14 1674/20 1675/10 1675/15 1675/19 1675/24 1676/5 1685/16 1686/1 1686/12 1687/24 1688/1 1688/12 1688/14 1692/17 1701/4 1702/8 1703/12 1730/24 1736/21 1738/20 1738/20 1742/23 1743/8 1743/13 calculated [16] 1656/17 1660/9 1687/1 1687/19 1688/3 1688/25 1689/16 1692/15 1697/20 1698/20 1704/9 1704/12 1743/4 1774/17 1779/7 1780/13 calculates [3] 1702/12 1702/20 1717/16 calculating [9] 1660/7 1666/8 1677/3 1680/23 1685/15 1686/13 1729/25 1731/12 1742/25 calculation [32] 1638/2 1638/3 1638/17 1639/3 1642/20 1656/24 1668/12 1668/24 1672/22 1688/9 1688/10 1688/11 1688/16 1689/20 1689/20 1689/23 1689/25 1690/8 1691/2 1692/5 1696/23 1696/25 1701/9 1702/21 1702/24 1706/5 1713/22 1724/16 1728/9 1737/8 1742/10 1743/11 calculations [31] 1637/24 1639/10 1639/16 1643/7 1656/21 1662/2 1663/9 1664/13 1667/7 1671/6 1671/8 1671/20 1672/25 1673/17 1673/18 1686/15 1696/2 1705/14 1705/16 1706/8 1739/19 1740/18 1740/18 1742/16 1747/18 1748/8 1748/12 1774/11 1781/20 1792/3 1796/10 CALDWELL [1] 1628/22 California [2] 1630/4 1630/22 call [25] 1636/9 1636/16 1636/19 1664/22 1674/13 1677/7 1744/11 1744/16 1747/9 1747/23 1753/3 1755/1 1755/8 1756/21 1759/1 1760/8 1761/3 1764/13 1765/6 1766/3 1769/17 1777/13 1781/6 1791/17 1800/9 call-outs [3] 1636/9 1636/16 1636/19 called [7] 1643/21 1739/2 1760/24 1760/25 1787/16 1792/6 1797/6 calling [1] 1749/6 came [6] 1635/1 1635/9 1654/2 1714/15	

C	CERTIFICATE [1] 1801/2 certify [1] 1801/5	closer [2] 1638/12 1717/2 closure [1] 1652/6
came... [2] 1765/2 1792/11	CFD [9] 1677/14 1678/6 1707/2 1708/17 1715/1 1715/2 1715/3 1715/8 1715/13	coalesce [3] 1777/20 1777/23 1777/23
Camp [1] 1629/4	CHAKERES [1] 1629/12	code [1] 1738/15
can [81] 1638/4 1638/6 1638/14 1639/17 1639/18 1641/8 1644/23 1645/18 1645/19 1645/21 1645/21 1647/6 1647/8 1647/21 1648/2 1648/25 1651/20 1651/23 1656/14 1657/19 1662/16 1662/17 1662/19 1663/1 1666/14 1666/21 1667/15 1668/2 1668/7 1685/4 1696/9 1702/5 1702/8 1702/11 1702/11 1703/18 1707/1 1714/11 1714/22 1714/23 1720/12 1721/12 1721/18 1723/3 1725/25 1727/6 1733/24 1737/18 1741/23 1747/17 1753/20 1756/6 1756/23 1759/1 1759/3 1759/16 1759/24 1760/11 1761/1 1764/19 1765/10 1765/14 1766/5 1768/12 1768/14 1769/20 1770/7 1773/9 1773/16 1774/20 1775/1 1778/13 1778/23 1783/17 1789/11 1792/19 1794/9 1795/18 1796/15 1800/11 1800/12	chance [1] 1634/17 change [36] 1646/3 1655/14 1655/16 1655/17 1658/22 1659/13 1659/13 1659/16 1689/10 1690/17 1690/23 1690/25 1692/10 1692/15 1695/1 1696/24 1697/5 1697/9 1698/10 1698/14 1705/18 1709/8 1712/5 1716/18 1716/21 1717/13 1717/15 1724/2 1724/2 1724/3 1725/19 1734/25 1740/6 1743/14 1743/15 1799/3 changed [8] 1641/4 1659/15 1689/17 1690/9 1710/4 1713/13 1728/8 1733/11 changes [14] 1643/15 1643/15 1646/8 1655/18 1690/23 1691/3 1717/21 1724/1 1729/17 1729/17 1729/22 1772/8 1793/20 1794/18 changing [8] 1638/24 1646/5 1646/23 1646/25 1655/5 1693/3 1729/19 1799/11	coalesced [3] 1777/20 1777/23 1777/23 code [1] 1738/15 codes [2] 1677/14 1715/2 coefficient [14] 1641/12 1641/18 1646/6 1660/23 1674/7 1687/6 1688/23 1689/6 1690/24 1694/7 1713/3 1736/2 1739/23 1739/23 coefficients [7] 1644/25 1645/25 1646/3 1654/8 1682/19 1685/9 1735/16 coincidental [2] 1642/9 1642/14 collaborated [1] 1789/21 collapse [1] 1709/7 collapsed [1] 1648/18 collar [4] 1650/12 1693/21 1694/15 1695/25 collected [8] 1661/3 1678/5 1682/1 1682/5 1683/24 1684/20 1764/9 1765/3 collection [7] 1657/2 1682/10 1682/10 1683/21 1684/14 1684/15 1759/17 collectively [1] 1730/14 COLLIER [1] 1629/22 colored [2] 1652/18 1681/10 columns [1] 1642/4 combination [1] 1723/17 combine [2] 1768/23 1769/5 combined [1] 1723/21 come [12] 1633/9 1635/10 1635/14 1644/2 1652/4 1654/6 1680/8 1680/13 1758/23 1760/18 1762/18 1780/6 comes [2] 1688/4 1760/21 comfortable [2] 1645/10 1645/11 coming [7] 1763/4 1763/5 1775/4 1785/18 1786/8 1786/12 1798/24 comment [1] 1666/8 comments [1] 1748/22 commercial [8] 1672/13 1672/17 1672/23 1677/5 1678/1 1678/2 1678/9 1678/14 commonly [1] 1666/19 companies [4] 1764/6 1780/20 1781/23 1793/3 company [13] 1629/19 1629/22 1630/4 1630/7 1630/10 1631/12 1631/15 1753/11 1753/21 1753/23 1754/4 1786/21 1787/23 comparable [3] 1673/16 1695/25 1696/14 compare [6] 1660/9 1670/20 1673/13 1736/3 1767/3 1768/2 compared [4] 1696/17 1741/12 1795/14 1795/23 compares [1] 1759/25 comparing [5] 1734/5 1734/25 1736/6 1736/15 1736/18 comparison [2] 1741/6 1796/8 COMPLAINT [1] 1627/7 complete [1] 1683/25 completely [1] 1774/10 complexity [1] 1660/24 components [20] 1758/5 1771/21 1772/1 1772/15 1772/23 1773/1 1773/3 1773/14 1773/16 1773/18 1773/20 1773/21 1773/25 1774/3 1774/4 1774/13 1775/24 1779/9 1779/24 1780/11 composition [3] 1664/3 1774/12 1774/12 compositional [2] 1773/11 1781/16 compressibility [1] 1786/7 comprise [2] 1773/25 1774/5 computational [6] 1677/13 1678/6 1707/16 1707/20 1708/7 1714/25
can't [13] 1645/22 1656/3 1660/24 1677/14 1686/8 1687/16 1688/3 1697/5 1724/1 1729/14 1730/5 1760/14 1763/25	channels [1] 1652/12 characteristics [1] 1681/18 characterization [16] 1636/1 1754/12 1759/8 1759/14 1759/18 1785/1 1786/16 1786/25 1787/10 1788/6 1788/9 1788/15 1788/22 1789/9 1789/23 1790/13 characterizations [3] 1786/18 1787/14 1788/14 characterize [3] 1679/5 1746/4 1780/17 characterized [1] 1791/8 characterizing [1] 1781/9 Charles [1] 1628/14 chart [19] 1697/13 1698/6 1699/5 1700/17 1701/16 1702/18 1703/6 1703/24 1703/25 1704/24 1724/13 1724/24 1732/4 1738/3 1738/24 1739/1 1741/19 1741/23 1749/12 charted [1] 1792/25 chat [1] 1800/10 checked [3] 1673/17 1673/18 1698/21 chemical [1] 1753/6 Chicago [1] 1629/24 choke [2] 1672/18 1685/2 choose [1] 1761/13 chose [2] 1678/1 1779/19 circulated [1] 1636/17 citation [2] 1663/25 1664/5 cite [7] 1691/17 1691/19 1691/21 1691/24 1695/14 1716/6 1723/7 cited [2] 1676/12 1693/3 cites [2] 1664/14 1666/15 Civil [1] 1629/6 claim [1] 1780/10 claims [2] 1779/3 1780/2 classic [1] 1640/20 clean [1] 1637/2 clean-up [1] 1637/2 clear [6] 1706/13 1710/15 1786/6 1791/9 1791/25 1792/19 clearly [3] 1701/13 1705/14 1738/9 close [6] 1634/10 1670/24 1684/22 1743/5 1745/7 1789/2 closed [17] 1648/8 1652/25 1653/6 1653/7 1685/2 1704/17 1711/16 1711/19 1711/23 1711/24 1712/4 1712/11 1712/11 1723/8 1723/9 1723/10 1748/17 closely [1] 1694/8	canceling [1] 1644/11 cancels [1] 1731/11 cannot [3] 1672/24 1685/19 1735/21 capacity [2] 1650/9 1650/11 Capital [1] 1628/16 capping [1] 1672/18 capture [2] 1660/24 1691/3 capturing [1] 1729/21 career [2] 1639/15 1673/18 carefully [2] 1673/17 1732/19 CARL [1] 1627/15 CARRIE [1] 1629/21 carries [1] 1655/21 case [39] 1635/8 1642/12 1644/5 1644/9 1644/19 1647/10 1649/20 1656/12 1661/17 1662/5 1666/19 1668/24 1671/20 1672/13 1675/4 1684/11 1701/8 1704/9 1704/10 1716/9 1716/10 1726/4 1737/1 1748/13 1748/13 1751/14 1763/3 1764/9 1770/8 1776/2 1780/24 1781/13 1782/5 1783/15 1783/20 1784/24 1786/25 1787/10 1790/10 Case 7 [1] 1748/13 cases [9] 1662/3 1735/13 1738/11 1740/11 1740/12 1740/15 1740/23 1741/14 1741/17 casing [20] 1653/3 1656/16 1659/3 1661/18 1663/12 1663/17 1664/9 1694/21 1710/10 1711/3 1711/15 1711/24 1712/3 1712/11 1715/13 1741/9 1741/9 1741/10 1741/12 1745/24 categories [2] 1640/17 1644/23 category [3] 1640/19 1640/20 1773/24 cause [1] 1690/16 caveats [1] 1707/5 cement [6] 1655/5 1690/15 1693/21 1694/16 1694/19 1695/24 CERNICH [1] 1629/12 certain [3] 1645/18 1646/21 1773/19 certainly [10] 1635/13 1643/6 1646/7 1662/12 1679/12 1680/9 1694/1 1720/7 1731/20 1748/23 certainty [1] 1729/9

<p>C</p> <p>computer [1] 1631/24 computer-aided [1] 1631/24 conceivably [2] 1725/18 1725/19 concerned [1] 1693/17 conclude [17] 1639/10 1639/11 1639/13 1643/23 1646/5 1646/14 1649/13 1651/20 1652/21 1669/23 1670/16 1693/19 1695/22 1713/18 1726/25 1745/18 1776/1 concluded [9] 1646/7 1646/8 1663/9 1669/25 1670/12 1670/18 1686/19 1733/11 1800/24 conclusion [7] 1639/5 1653/13 1663/8 1712/25 1746/14 1746/15 1759/4 conclusions [7] 1650/22 1666/21 1705/21 1707/17 1719/20 1747/5 1792/1 condensate [2] 1776/16 1776/17 condense [3] 1769/4 1776/10 1776/18 condenses [2] 1775/14 1778/3 condition [5] 1651/3 1651/8 1748/21 1766/24 1767/7 conditions [38] 1641/20 1641/24 1679/25 1684/5 1685/5 1694/8 1702/10 1757/18 1758/3 1758/8 1760/15 1760/19 1761/12 1761/12 1764/1 1764/10 1764/11 1766/10 1766/15 1767/8 1768/8 1768/16 1768/18 1769/24 1770/11 1773/23 1775/5 1775/13 1776/15 1782/2 1782/4 1782/5 1782/6 1782/6 1792/17 1792/17 1793/3 1794/18 conducted [1] 1764/15 confidence [6] 1639/25 1640/4 1640/8 1673/5 1673/10 1686/20 configuration [1] 1681/25 connect [1] 1700/1 connected [1] 1681/13 connection [1] 1699/25 connects [1] 1657/3 consequence [1] 1709/8 conservation [3] 1684/17 1684/18 1685/4 Conservative [1] 1783/2 consider [4] 1634/16 1643/5 1788/2 1791/18 considerable [1] 1758/4 considered [4] 1645/7 1645/9 1654/11 1662/2 consistency [1] 1655/10 consistent [11] 1646/20 1654/8 1660/13 1660/19 1693/11 1696/1 1704/14 1708/8 1745/20 1746/12 1747/13 constant [42] 1641/15 1641/18 1642/2 1644/25 1645/25 1647/3 1654/19 1654/24 1655/21 1655/22 1660/23 1682/18 1687/10 1687/14 1688/24 1689/13 1689/16 1689/21 1690/4 1690/6 1691/3 1691/8 1692/9 1692/23 1713/2 1713/3 1717/17 1717/21 1717/22 1733/19 1734/4 1734/23 1735/8 1735/17 1736/3 1736/16 1736/18 1739/24 1742/23 1743/7 1747/10 1747/15 constants [4] 1683/6 1734/6 1734/12 1734/21 constraint [1] 1684/23 constraints [2] 1684/8 1685/5 constructed [1] 1683/6 consulting [1] 1753/14 contained [1] 1671/5</p>	<p>contains [1] 1673/15 contains [3] 1683/6 1724/14 1760/17 contend [2] 1788/13 1788/23 content [1] 1755/13 contents [1] 1707/10 contested [2] 1633/20 1634/11 context [1] 1723/10 continue [2] 1653/22 1722/2 continued [3] 1694/16 1705/17 1705/17 continues [1] 1776/11 continuing [2] 1647/3 1653/14 continuous [2] 1758/13 1769/12 contractor [1] 1757/9 contributors [1] 1640/24 Control [1] 1637/3 convenient [1] 1784/14 convergence [1] 1666/5 conversant [1] 1634/25 conversation [3] 1666/24 1707/11 1708/10 converse [1] 1770/25 conversion [5] 1752/3 1756/25 1757/15 1757/17 1760/11 convert [1] 1666/16 converted [2] 1666/20 1767/9 convince [1] 1756/5 convinced [1] 1798/10 coordination [1] 1656/4 copy [4] 1633/24 1755/3 1755/10 1797/19 Core [1] 1764/17 Core Lab [1] 1764/17 COREY [1] 1628/19 corner [4] 1648/20 1652/8 1652/9 1652/13 corners [1] 1671/25 Corporation [3] 1631/11 1631/15 1754/3 correct [330] corrected [2] 1669/25 1670/18 correcting [1] 1790/4 correction [5] 1670/2 1670/23 1671/5 1755/15 1755/17 corrections [15] 1670/4 1670/9 1670/18 1670/20 1670/21 1670/23 1670/24 1670/25 1671/3 1671/7 1671/9 1671/11 1671/12 1671/16 1718/22 correctly [3] 1716/9 1716/16 1726/7 correspond [1] 1745/1 corresponding [1] 1767/18 corrosion [1] 1650/13 could [84] 1637/20 1640/10 1641/25 1642/13 1642/16 1644/15 1644/21 1646/11 1649/22 1650/4 1651/5 1654/13 1655/4 1655/4 1658/15 1660/8 1661/22 1663/25 1665/13 1666/17 1669/3 1672/15 1672/17 1675/12 1678/22 1680/11 1682/15 1686/25 1688/7 1688/14 1690/16 1690/24 1696/15 1696/19 1699/3 1699/13 1700/10 1700/17 1708/21 1713/21 1714/4 1720/11 1721/3 1721/24 1722/24 1725/21 1726/16 1726/16 1727/11 1727/16 1727/20 1727/23 1727/24 1728/1 1734/17 1735/23 1736/10 1743/10 1743/17 1744/9 1744/16 1747/8 1747/9 1747/20 1747/22 1749/7 1749/9 1755/1 1758/5 1762/11 1770/24 1770/25 1774/1 1774/20 1777/10 1777/10 1778/11 1780/25 1781/6 1783/8 1783/10 1795/9 1795/10 1800/9 counsel's [1] 1635/25 counted [1] 1796/21</p>	<p>counts [1] 1776/2 couple [12] 1633/9 1641/2 1650/15 1651/15 1654/4 1656/15 1659/23 1704/17 1741/11 1744/3 1749/3 1751/15 course [7] 1634/14 1645/4 1754/12 1766/1 1767/11 1770/25 1795/6 court [17] 1627/1 1631/18 1688/8 1689/22 1697/13 1715/24 1721/11 1754/18 1755/14 1756/24 1785/8 1796/14 1797/19 1798/11 1801/3 1801/4 1801/12 cover [2] 1696/16 1764/22 covered [1] 1640/5 Covington [1] 1630/9 cracks [3] 1653/17 1653/21 1653/22 crazy [1] 1798/8 created [2] 1759/7 1791/13 creating [1] 1716/13 creation [2] 1787/23 1787/25 credible [1] 1738/6 criteria [1] 1790/20 critical [1] 1791/25 criticism [7] 1643/17 1660/20 1660/22 1661/16 1669/20 1672/11 1775/21 criticisms [9] 1643/1 1644/17 1644/24 1645/2 1645/12 1645/24 1672/10 1770/17 1770/19 criticized [1] 1645/1 critiques [2] 1787/6 1789/1 cross [13] 1629/13 1661/15 1668/23 1674/1 1674/4 1722/5 1746/20 1749/13 1751/24 1784/17 1784/23 1796/23 1798/22 cross-examination [6] 1674/1 1674/4 1746/20 1749/13 1784/17 1784/23 cross-examinations [1] 1798/22 cross-examining [1] 1722/5 cross-sectional [2] 1661/15 1668/23 crunching [1] 1673/7 CSR [1] 1653/7 CSRs [1] 1712/7 cumulative [29] 1639/4 1639/7 1639/12 1639/14 1642/4 1642/5 1646/10 1671/13 1674/21 1674/21 1675/2 1675/25 1682/3 1685/13 1690/2 1697/5 1703/11 1704/1 1704/3 1706/1 1719/13 1738/21 1740/11 1740/15 1740/24 1742/23 1743/15 1743/20 1785/11 currently [2] 1752/9 1753/10 Curtis [4] 1752/5 1789/17 1789/17 1789/18 curvature [1] 1735/15 curve [5] 1654/19 1655/15 1729/2 1729/2 1744/14 curves [2] 1657/6 1728/24 cut [1] 1653/3 cuts [1] 1709/25 CV [2] 1627/7 1627/9</p> <p>D</p> <p>D-21023 [1] 1769/17 D-21224 [1] 1741/24 D-22001 [1] 1753/3 D-22002 [1] 1756/21 D-22003 [1] 1759/1 D-22004 [1] 1760/8 D-22005 [1] 1761/3 D-22006 [1] 1764/13 D-22007 [1] 1766/3 D-22008 [2] 1768/10 1768/12 D-22009 [1] 1778/11 D-22013 [1] 1783/8</p>
---	--	--

D		
D-23401 [1] 1682/15	1660/14 1675/11 1675/15 1675/19	1707/24 1795/18 1798/20
D-23997-2A [1] 1699/13	1685/14 1685/21 1686/2 1686/8 1686/8	depth [1] 1795/10
D-23997.1 [1] 1699/3	1686/9 1686/24 1686/25 1686/25	derive [1] 1738/16
D-24368 [2] 1720/11 1720/14	1689/16 1689/17 1689/24 1690/7	derived [2] 1702/5 1718/18
D-24369 [1] 1720/21	1690/10 1690/25 1695/2 1695/6 1696/1	derives [1] 1778/14
D-24372 [1] 1682/21	1696/5 1696/5 1696/15 1696/17	describe [13] 1647/9 1648/2 1656/14
D-24374 [1] 1688/19	1696/22 1697/10 1697/17 1697/18	1664/9 1668/8 1670/11 1680/11
D-24375 [1] 1733/24	1697/18 1699/11 1710/9 1714/18	1680/13 1753/20 1757/23 1759/3
D-24376 [1] 1735/24	1714/18 1714/22 1730/2 1734/3 1738/5	1759/16 1766/5
D-24401 [1] 1721/9	1739/24 1745/7 1746/8 1751/15 1765/3	described [4] 1679/21 1704/25 1730/16
D-24408 [1] 1736/13	days' [1] 1653/8	1765/18
D-24409 [2] 1737/5 1737/14	deal [2] 1651/25 1720/9	describes [2] 1641/14 1677/9
D-24467 [1] 1781/6	death [1] 1740/4	description [4] 1680/18 1681/7 1682/18
D-24527 [1] 1732/2	DEBORAH [1] 1631/12	1765/14
D-24531 [3] 1724/11 1724/13 1727/11	debris [2] 1693/21 1694/15	deserves [1] 1635/23
D-24532 [1] 1734/16	decay [9] 1646/19 1646/20 1646/23	design [1] 1673/14
D.C [5] 1629/8 1629/16 1630/7 1630/11	1646/24 1658/13 1658/13 1686/16	detailed [1] 1680/18
1631/16	1745/19 1745/20	details [2] 1681/10 1760/1
daily [8] 1675/10 1675/15 1731/12	decaying [1] 1743/2	determine [12] 1641/13 1650/19
1738/3 1739/11 1744/14 1744/21	decide [4] 1730/13 1756/6 1763/21	1659/12 1685/19 1700/2 1707/2 1762/3
1785/14	1785/8	1763/9 1774/11 1782/10 1788/9
Dallas [1] 1631/6	decided [3] 1633/15 1634/25 1635/8	1795/10
damage [2] 1647/13 1690/16	decision [2] 1633/17 1634/11	determined [9] 1650/21 1687/12
dancing [3] 1729/12 1729/24 1730/3	decisions [1] 1633/17	1687/17 1687/17 1687/18 1688/16
dangerous [1] 1722/4	decline [1] 1750/11	1689/6 1698/23 1774/2
Darvish [8] 1635/21 1662/11 1664/15	decrease [10] 1698/24 1705/13 1721/23	determines [1] 1657/15
1666/4 1666/6 1667/21 1798/13	1721/23 1722/18 1722/21 1727/24	developed [5] 1684/3 1757/4 1786/21
1798/19	1732/6 1734/6 1775/8	1786/24 1788/17
Darvish's [3] 1703/6 1703/14 1703/24	decreased [3] 1721/13 1721/19 1723/4	developing [1] 1673/13
data [74] 1638/19 1641/13 1654/9	decreases [4] 1721/12 1794/5 1794/11	development [4] 1754/1 1754/5 1754/11
1655/11 1655/11 1674/13 1674/14	1794/15	1787/3
1674/17 1676/7 1677/10 1678/6 1678/7	decreasing [1] 1768/22	deviate [1] 1641/17
1678/10 1678/10 1678/11 1678/14	DEEPWATER [7] 1627/4 1630/13	Dexter [1] 1628/20
1678/15 1680/7 1681/22 1683/7	1630/14 1630/16 1630/17 1630/19	diagram [1] 1638/5
1683/14 1684/16 1686/5 1687/17	1630/20	diagrams [1] 1681/11
1687/18 1687/21 1688/2 1688/7 1688/8	define [1] 1685/2	diameter [7] 1668/12 1668/18 1668/18
1689/7 1691/12 1691/14 1691/22	defined [1] 1685/1	1668/18 1668/19 1668/21 1668/25
1699/18 1699/19 1699/25 1700/2	defines [2] 1769/8 1769/9	diameters [2] 1666/8 1668/20
1700/5 1700/8 1716/25 1718/9 1718/11	definitely [1] 1643/16	did [138] 1638/8 1639/3 1639/4 1639/6
1719/5 1719/6 1719/8 1719/19 1719/25	definition [2] 1684/4 1772/8	1639/7 1639/20 1639/23 1639/24
1720/7 1720/7 1720/9 1723/14 1726/12	degree [2] 1773/1 1795/5	1640/14 1643/4 1643/23 1644/2 1644/4
1732/20 1744/6 1744/12 1744/22	degrees [10] 1753/5 1760/16 1761/7	1646/5 1646/14 1649/13 1649/25
1745/17 1747/19 1748/4 1748/8	1766/24 1793/23 1794/19 1794/23	1650/16 1650/16 1650/18 1650/19
1755/21 1759/6 1759/7 1759/8 1760/6	1795/3 1795/3 1795/4	1650/25 1651/2 1651/16 1651/17
1767/20 1767/21 1771/1 1790/19	delta [1] 1742/18	1653/10 1653/12 1653/13 1653/15
1790/21 1792/11 1792/15 1792/18	delta P [1] 1742/18	1656/14 1656/18 1656/21 1656/24
1796/10	demonstrative [18] 1637/20 1638/1	1658/21 1658/23 1659/25 1660/1
datasets [1] 1739/14	1640/10 1644/21 1646/11 1647/24	1661/6 1661/6 1662/20 1663/4 1663/7
date [5] 1660/4 1686/12 1686/13	1649/4 1651/18 1654/13 1658/15	1663/8 1666/10 1666/13 1669/3
1692/25 1700/15	1661/22 1688/21 1737/7 1749/9	1669/10 1669/10 1669/23 1670/13
dates [3] 1675/12 1685/17 1732/4	1764/19 1769/21 1770/7 1783/10	1670/15 1670/16 1670/20 1670/21
Daubert [4] 1751/1 1751/4 1751/5	demonstratives [4] 1636/10 1636/16	1670/21 1671/19 1671/21 1672/3
1754/18	1636/20 1752/25	1672/12 1673/14 1677/2 1677/22
DAVIS [1] 1630/20	DENNY [1] 1630/20	1678/25 1679/10 1682/6 1682/6
DAVIS-DENNY [1] 1630/20	density [2] 1641/16 1643/15	1682/11 1685/16 1685/18 1686/1
day [41] 1627/14 1654/20 1657/8	dent [1] 1798/9	1686/12 1686/13 1687/12 1688/14
1660/5 1660/11 1660/17 1673/10	department [5] 1629/6 1629/9 1633/21	1693/6 1693/6 1693/9 1695/18 1698/10
1674/11 1686/5 1690/17 1693/12	1702/23 1703/2	1698/15 1698/19 1698/24 1699/15
1696/12 1697/7 1697/11 1708/22	depend [7] 1647/18 1647/23 1657/20	1699/19 1699/21 1700/12 1701/25
1709/3 1710/11 1710/12 1711/2	1657/20 1679/4 1761/13 1770/2	1702/3 1702/5 1706/4 1706/5 1706/8
1711/11 1711/15 1711/19 1712/24	depended [1] 1657/14	1706/11 1707/16 1707/20 1707/24
1732/24 1734/22 1737/13 1737/15	depending [2] 1778/17 1798/22	1708/7 1711/10 1711/12 1711/14
1737/21 1738/23 1739/12 1739/12	depends [3] 1677/19 1677/25 1742/19	1711/18 1715/3 1715/5 1715/6 1715/8
1739/15 1739/17 1749/16 1749/21	depict [1] 1654/15	1715/11 1715/13 1716/8 1716/16
1772/20 1782/2 1782/4 1785/14	depicted [2] 1764/20 1766/5	1719/16 1726/7 1740/22 1744/11
1785/18 1800/15	depiction [1] 1774/23	1745/17 1746/15 1752/25 1753/2
Day 86 [1] 1739/12	depicts [1] 1773/10	1754/7 1754/24 1754/25 1755/6 1755/7
Day Zero [1] 1749/21	depletion [5] 1742/12 1742/15 1742/18	1763/21 1766/19 1766/21 1767/3
days [55] 1641/5 1650/15 1650/23	1742/19 1743/8	1767/23 1767/25 1768/1 1769/10
1654/18 1654/23 1654/24 1655/13	deposed [1] 1696/10	1779/13 1790/22 1791/4 1794/14
1655/19 1655/21 1655/22 1658/7	deposition [14] 1634/7 1634/8 1662/8	1795/25 1796/3 1796/4 1796/23
	1662/13 1662/15 1667/19 1678/22	didn't [21] 1656/4 1659/6 1660/3 1677/6
	1679/1 1696/4 1706/22 1706/24	1678/9 1686/5 1697/9 1726/23 1733/9

D		
didn't... [12] 1738/6 1751/4 1763/10 1779/17 1780/5 1780/15 1794/12 1794/13 1794/17 1794/22 1795/7 1797/22	dissolution [8] 1752/7 1752/10 1752/18 1771/10 1771/14 1772/4 1774/8 1778/25	don't [94] 1635/7 1635/11 1638/11 1646/17 1649/2 1649/17 1655/10 1660/3 1660/18 1661/2 1662/11 1662/15 1667/8 1669/14 1671/16 1677/15 1677/19 1678/21 1681/9 1681/17 1682/24 1684/14 1689/15 1689/18 1691/14 1692/20 1693/6 1693/15 1693/23 1694/23 1695/9 1695/9 1696/7 1697/12 1701/12 1701/13 1701/20 1701/23 1701/23 1703/1 1706/4 1706/5 1706/7 1706/7 1706/13 1706/15 1706/20 1706/20 1707/6 1707/9 1707/9 1707/13 1711/4 1713/10 1713/10 1714/17 1718/5 1718/7 1718/7 1718/11 1724/21 1726/21 1728/16 1729/9 1730/15 1730/25 1731/13 1731/16 1732/18 1734/14 1734/15 1738/6 1738/12 1738/22 1743/14 1746/22 1749/19 1751/5 1751/20 1757/22 1772/6 1776/4 1782/1 1787/15 1790/6 1795/10 1797/7 1797/17 1798/23 1799/8 1799/23 1800/2 1800/3 1800/8 DONALD [1] 1631/3
differ [3] 1658/6 1740/18 1740/19	dissolve [5] 1772/2 1772/12 1772/16 1772/17 1779/3	done [17] 1634/19 1639/18 1662/10 1663/9 1666/3 1671/6 1673/7 1677/22 1690/8 1704/3 1713/21 1750/16 1763/23 1781/18 1787/13 1797/18 1799/14
difference [21] 1638/18 1658/7 1667/16 1668/19 1669/1 1693/16 1693/18 1697/1 1697/18 1718/18 1731/5 1734/6 1735/11 1736/24 1737/2 1763/15 1767/14 1771/3 1771/12 1780/17 1784/6	dissolved [7] 1752/14 1758/10 1760/17 1772/23 1773/24 1775/24 1796/21	door [1] 1635/16
differences [5] 1735/12 1739/6 1760/1 1760/3 1775/1	dissolving [1] 1773/17	door's [1] 1635/7
different [37] 1656/25 1662/11 1667/6 1696/18 1698/8 1698/18 1710/21 1710/24 1714/6 1719/2 1719/17 1732/20 1737/13 1737/14 1737/15 1737/16 1737/17 1738/5 1739/11 1739/14 1739/15 1741/11 1742/18 1747/22 1747/25 1757/23 1767/7 1771/9 1775/9 1776/7 1777/9 1777/11 1780/9 1783/12 1790/23 1792/17 1793/1	distinct [1] 1776/25	doubled [1] 1659/1
differes [5] 1740/16 1740/25 1775/17 1776/6 1776/17	distinction [2] 1664/11 1777/7	doubling [2] 1659/18 1659/23
difficult [1] 1782/10	DISTRICT [5] 1627/1 1627/2 1627/15 1801/4 1801/4	doubt [4] 1689/21 1690/7 1750/1 1787/15
dimensions [4] 1706/16 1706/19 1707/7 1707/12	diverge [1] 1748/14	DOUGLAS [1] 1629/3
DIRE [1] 1752/20	divide [1] 1762/11	down [44] 1642/7 1645/14 1645/15 1645/16 1647/21 1647/22 1652/14 1652/19 1652/20 1653/1 1655/24 1665/4 1690/9 1692/19 1692/23 1697/3 1700/8 1704/13 1704/23 1705/10 1706/6 1708/7 1714/5 1714/9 1716/13 1722/10 1722/24 1724/7 1725/15 1725/25 1728/20 1729/4 1729/8 1730/5 1730/7 1730/19 1731/7 1731/10 1737/19 1737/20 1749/2 1749/3 1750/6 1750/11
direct [11] 1637/16 1637/19 1654/2 1676/13 1677/2 1682/24 1683/11 1697/14 1698/2 1741/2 1754/22	dividing [1] 1757/1	downhole [2] 1693/20 1694/13
directed [1] 1757/9	Division [1] 1629/6	downs [4] 1731/16 1731/18 1736/25 1744/12
Directing [1] 1742/2	DNV [1] 1707/25	downstream [12] 1652/23 1721/5 1721/6 1721/6 1721/13 1721/19 1723/16 1723/18 1724/2 1728/13 1728/19 1729/22
directly [13] 1643/7 1652/17 1652/19 1677/6 1707/19 1758/3 1763/4 1763/25 1767/12 1767/13 1779/18 1780/3 1783/1	do [125] 1633/9 1633/17 1634/20 1639/10 1639/20 1639/24 1640/14 1641/7 1641/15 1641/16 1643/4 1644/13 1644/15 1645/13 1645/18 1645/22 1647/13 1655/7 1660/1 1661/18 1661/19 1661/25 1671/8 1671/8 1672/22 1672/24 1672/24 1673/5 1673/7 1677/15 1678/2 1678/13 1680/23 1681/3 1681/7 1681/11 1683/5 1683/7 1683/11 1685/14 1686/5 1686/10 1686/13 1686/22 1688/1 1688/7 1688/15 1690/17 1690/21 1690/22 1695/13 1700/20 1702/21 1703/3 1703/6 1703/9 1703/18 1704/5 1704/6 1707/1 1707/8 1708/13 1709/7 1712/5 1714/4 1714/25 1715/3 1715/8 1715/13 1718/5 1718/6 1720/15 1721/11 1721/14 1721/20 1722/9 1724/17 1730/14 1730/15 1730/22 1731/16 1732/6 1732/8 1732/20 1732/22 1733/10 1736/25 1737/12 1738/18 1741/3 1741/5 1741/6 1741/10 1741/13 1741/23 1743/11 1744/6 1744/11 1744/14 1749/18 1749/18 1749/22 1750/24 1751/6 1752/19 1753/5 1753/13 1754/7 1762/2 1762/9 1762/9 1778/7 1779/15 1781/13 1782/4 1782/6 1782/20 1783/4 1788/14 1789/13 1797/10 1798/12 1800/9 1800/11 1801/5	DOYEN [1] 1630/19
director [1] 1754/4	Docket [4] 1627/4 1627/7 1627/9 1752/11	Dr [8] 1656/8 1667/1 1670/16 1752/9 1752/18 1754/17 1779/13 1786/6 Dr. [244]
disagree [7] 1635/25 1671/3 1671/6 1686/11 1706/3 1706/7 1714/17	Doctor [1] 1678/12	Dr. Adrian [1] 1654/6
disagreements [1] 1791/7	Document [1] 1776/5	Dr. Blunt [6] 1779/13 1779/15 1779/18 1780/17 1781/12 1783/16
disagrees [1] 1775/24	Document 11491 [1] 1776/5	Dr. Blunt's [2] 1781/3 1781/9
discern [1] 1745/16	documents [2] 1651/3 1651/7	Dr. Bushnell [1] 1635/14
discharge [40] 1639/4 1639/7 1639/12 1639/14 1641/12 1641/18 1642/4 1642/6 1644/25 1645/25 1646/3 1646/6 1646/10 1654/8 1660/23 1671/13 1673/2 1674/6 1682/18 1685/9 1687/5 1688/23 1689/6 1690/2 1690/24 1694/7 1697/5 1704/4 1706/7 1719/13 1735/16 1736/2 1738/21 1740/12 1740/12 1740/15 1740/25 1743/1 1743/5 1743/15	does [32] 1638/19 1638/21 1638/22 1650/6 1654/15 1657/9 1661/1 1661/2 1663/18 1667/3 1670/2 1671/24 1673/12 1680/18 1680/20 1680/21 1680/21 1689/10 1696/25 1697/14 1701/6 1709/21 1710/3 1723/24 1728/9 1729/23 1743/15 1753/13 1755/23 1775/24 1776/1 1780/17	Dr. Bushnell's [1] 1635/20
discharged [1] 1752/14	doesn't [16] 1642/10 1659/13 1659/24 1666/18 1708/17 1729/18 1730/21 1755/25 1774/16 1775/10 1778/20 1779/7 1780/6 1780/13 1782/22 1782/25	Dr. Curtis [2] 1752/5 1789/18
disclose [2] 1669/10 1669/11	doing [6] 1639/15 1753/12 1781/24 1786/16 1788/6 1797/8	Dr. Dykhuizen [1] 1635/21
disclosed [6] 1662/15 1662/22 1664/19 1664/21 1697/24 1775/21	DOJ [2] 1702/23 1703/2	Dr. Emilsen [1] 1650/17
discounted [1] 1771/20	Domengeaux [1] 1627/21	Dr. Emilsen's [4] 1650/19 1691/19 1692/15 1747/1
discrepancies [1] 1747/18	dominated [1] 1735/12	Dr. Griffiths [77] 1635/20 1637/18 1643/23 1646/14 1653/11 1654/11 1655/7 1657/9 1658/18 1660/1 1661/25 1662/8 1662/12 1663/4 1663/22
discrepancy [1] 1697/11	DON [1] 1629/18	
discuss [5] 1682/6 1706/11 1725/6 1732/18 1788/25		
discussed [3] 1690/18 1731/20 1769/19		
discussing [1] 1665/2		
discussion [12] 1656/9 1664/1 1664/7 1667/5 1676/17 1710/14 1712/13 1726/17 1726/24 1727/2 1745/22 1745/23		
disk [1] 1668/16		
dispute [2] 1633/20 1689/15		

D	<p>Dr. Griffiths... [62] 1663/24 1664/7 1666/3 1666/17 1666/20 1667/15 1668/7 1669/19 1672/9 1673/12 1673/19 1674/3 1674/5 1677/16 1677/23 1678/17 1679/1 1679/11 1684/2 1687/1 1688/21 1689/9 1690/14 1691/17 1694/22 1696/10 1698/15 1699/15 1700/21 1701/15 1703/9 1703/15 1703/22 1704/24 1706/14 1707/8 1707/16 1708/19 1711/10 1716/5 1720/16 1721/11 1724/13 1728/25 1729/20 1730/9 1732/4 1733/17 1737/7 1739/8 1739/21 1740/11 1741/19 1742/21 1743/6 1743/16 1743/23 1744/3 1744/11 1744/21 1747/12 1750/15</p> <p>Dr. Gringarten [4] 1671/21 1671/23 1672/2 1800/6</p> <p>Dr. Gringarten's [2] 1671/24 1672/1</p> <p>Dr. Hunter [2] 1636/11 1636/17</p> <p>Dr. Hunter's [1] 1636/22</p> <p>Dr. Johnson [10] 1655/8 1657/24 1661/16 1662/9 1663/9 1664/2 1666/11 1666/18 1669/5 1702/12</p> <p>Dr. Johnson's [11] 1654/16 1657/22 1662/2 1662/12 1663/5 1665/2 1668/10 1668/24 1669/2 1702/18 1703/25</p> <p>Dr. Kelkar [3] 1788/19 1798/13 1798/17</p> <p>Dr. Liao [1] 1741/5</p> <p>Dr. Martin [1] 1798/25</p> <p>Dr. Nestic [10] 1656/8 1656/14 1657/25 1658/8 1658/21 1660/1 1715/6 1715/11 1715/16 1733/9</p> <p>Dr. Nestic's [3] 1656/11 1660/12 1660/17</p> <p>Dr. Pooladi-Darvish [8] 1635/21 1662/11 1664/15 1666/4 1666/6 1667/21 1798/13 1798/19</p> <p>Dr. Pooladi-Darvish's [3] 1703/6 1703/14 1703/24</p> <p>Dr. Trusler [4] 1670/15 1671/4 1671/5 1731/3</p> <p>Dr. Trusler's [2] 1670/20 1745/2</p> <p>Dr. Whitson [25] 1752/6 1759/21 1767/18 1770/16 1770/18 1771/10 1772/23 1773/16 1776/8 1778/7 1778/14 1780/2 1780/6 1782/15 1787/7 1787/7 1789/1 1789/3 1789/8 1789/14 1791/8 1791/10 1791/13 1797/5 1800/9</p> <p>Dr. Whitson's [23] 1752/12 1759/25 1771/14 1772/4 1773/23 1774/8 1774/23 1775/2 1775/21 1776/7 1778/11 1779/16 1779/17 1779/21 1779/21 1779/22 1780/5 1782/21 1782/25 1787/23 1790/8 1791/21 1792/1</p> <p>Dr. Zaldivar's [2] 1732/12 1732/19</p> <p>Dr. Zick [28] 1751/8 1752/2 1752/17 1752/22 1753/5 1754/19 1754/24 1756/23 1758/22 1759/3 1760/10 1762/2 1763/19 1764/15 1765/20 1766/5 1768/12 1769/19 1773/9 1774/23 1775/20 1775/24 1776/6 1778/13 1781/8 1783/10 1784/22 1789/13</p> <p>Dr. Zick's [4] 1750/25 1751/16 1752/1 1756/1</p> <p>Dr. Zimmerman [1] 1800/2</p> <p>draw [1] 1754/7</p> <p>drawbacks [1] 1719/21</p> <p>drawdown [1] 1716/14</p> <p>drawn [1] 1735/19</p>	<p>drew [5] 1699/15 1708/7 1713/14 1730/23 1747/6</p> <p>drill [33] 1649/15 1650/6 1651/4 1651/8 1651/22 1661/17 1662/4 1663/6 1663/11 1663/12 1663/14 1663/15 1663/16 1663/17 1664/11 1665/6 1667/2 1690/23 1695/14 1700/8 1700/13 1702/5 1702/9 1712/12 1712/19 1712/21 1726/10 1726/13 1726/19 1726/23 1727/4 1741/9 1741/10</p> <p>Drilling [3] 1630/13 1630/16 1630/19</p> <p>drive [3] 1649/17 1714/4 1714/8</p> <p>driving [2] 1645/14 1645/15</p> <p>drop [20] 1647/22 1656/22 1657/2 1701/23 1705/24 1724/20 1725/1 1725/3 1725/6 1725/21 1726/4 1726/5 1726/13 1726/23 1727/4 1727/5 1733/11 1733/14 1749/1 1749/3</p> <p>droplets [8] 1769/14 1769/15 1777/6 1777/16 1777/18 1777/23 1777/25 1778/4</p> <p>dropouts [1] 1718/14</p> <p>dropped [5] 1662/4 1704/22 1712/6 1726/13 1726/19</p> <p>dropping [1] 1712/19</p> <p>drops [6] 1656/18 1656/25 1657/11 1660/7 1716/13 1725/11</p> <p>ductile [1] 1653/21</p> <p>due [5] 1641/21 1659/23 1698/22 1712/11 1712/12</p> <p>duly [2] 1637/15 1750/18</p> <p>Dupree [2] 1637/5 1637/6</p> <p>during [21] 1641/24 1642/6 1650/6 1652/5 1652/6 1659/19 1660/5 1678/4 1689/21 1698/1 1714/20 1715/17 1719/14 1732/17 1746/20 1754/12 1757/12 1777/13 1786/20 1789/21 1790/11</p> <p>duties [2] 1753/24 1754/5</p> <p>Dykhuizen [1] 1635/21</p> <p>dynamics [9] 1661/12 1677/12 1677/17 1678/19 1679/7 1707/17 1707/21 1708/8 1714/25</p>	<p>efficient [3] 1758/16 1764/5 1765/24</p> <p>effort [1] 1746/13</p> <p>EISERT [1] 1630/6</p> <p>either [15] 1676/18 1721/13 1721/18 1722/18 1722/24 1724/7 1725/19 1725/25 1726/20 1743/17 1761/1 1762/12 1771/7 1783/14 1786/1</p> <p>ejected [1] 1648/17</p> <p>electronically [1] 1634/21</p> <p>element [1] 1651/14</p> <p>elements [5] 1650/25 1656/15 1656/25 1659/23 1681/12</p> <p>elevation [4] 1701/1 1701/6 1742/8 1742/11</p> <p>Ellis [3] 1629/20 1630/2 1630/5</p> <p>Elm [1] 1631/5</p> <p>else [5] 1680/14 1688/14 1692/19 1788/5 1800/21</p> <p>Emilsen [11] 1650/17 1692/18 1694/10 1704/9 1704/15 1704/25 1705/16 1717/7 1747/5 1748/10 1749/2</p> <p>Emilsen's [13] 1650/19 1691/19 1691/19 1691/21 1692/15 1693/3 1696/2 1705/14 1747/1 1747/1 1747/12 1747/13 1747/21</p> <p>employed [1] 1753/10</p> <p>encounter [2] 1770/12 1777/19</p> <p>encountered [2] 1785/22 1786/2</p> <p>encounters [2] 1768/22 1769/2</p> <p>end [14] 1646/9 1647/17 1648/13 1652/23 1673/10 1673/16 1675/2 1685/8 1705/9 1735/3 1750/9 1766/17 1778/2 1778/4</p> <p>ended [1] 1788/18</p> <p>ending [1] 1707/4</p> <p>endorsed [1] 1676/9</p> <p>ends [2] 1648/12 1726/22</p> <p>Energy [4] 1631/2 1631/7 1694/10 1716/6</p> <p>Enforcement [1] 1629/10</p> <p>ENGEL [1] 1629/13</p> <p>engineer [1] 1781/17</p> <p>engineering [3] 1753/6 1753/14 1754/3</p> <p>enough [1] 1653/23</p> <p>entire [14] 1635/14 1654/23 1655/19 1656/1 1659/6 1659/20 1674/15 1689/1 1709/22 1720/3 1743/7 1746/4 1775/21 1776/3</p> <p>entirely [3] 1648/14 1653/20 1702/7</p> <p>entitled [2] 1789/25 1801/8</p> <p>entries [2] 1641/6 1643/14</p> <p>entry [6] 1637/8 1641/8 1641/10 1643/8 1698/6 1698/7</p> <p>Environment [1] 1629/10</p> <p>Environmental [1] 1629/10</p> <p>EOS [2] 1767/23 1792/6</p> <p>episodic [1] 1744/15</p> <p>equate [1] 1642/11</p> <p>equation [47] 1641/19 1680/23 1753/24 1753/25 1754/1 1754/6 1754/10 1754/11 1754/14 1759/7 1759/11 1759/14 1759/15 1759/20 1759/22 1759/25 1764/3 1767/2 1767/11 1768/2 1768/3 1770/20 1771/2 1771/3 1784/25 1786/16 1786/17 1786/22 1786/24 1787/4 1787/14 1788/6 1788/9 1788/15 1789/9 1790/17 1790/18 1790/21 1791/9 1791/10 1791/14 1791/21 1792/10 1795/13 1795/22 1796/6 1796/8</p> <p>equation-of-state [31] 1753/25 1754/1 1754/6 1754/10 1754/11 1754/14 1759/7 1759/11 1759/14 1767/2</p>
E	<p>each [20] 1651/14 1671/1 1675/11 1675/15 1683/3 1685/4 1685/9 1723/25 1737/13 1739/10 1739/17 1757/10 1761/1 1764/8 1769/16 1769/21 1773/14 1775/6 1782/17 1793/2</p> <p>Earl [1] 1649/11</p> <p>earlier [13] 1659/25 1660/15 1660/21 1661/6 1672/12 1676/17 1686/8 1686/9 1686/9 1686/12 1686/13 1694/24 1773/8</p> <p>earliest [1] 1675/19</p> <p>early [5] 1646/9 1646/15 1744/6 1765/5 1799/15</p> <p>easier [2] 1665/10 1736/11</p> <p>easily [1] 1777/20</p> <p>East [1] 1628/16</p> <p>EASTERN [2] 1627/2 1801/4</p> <p>editing [1] 1755/18</p> <p>Edwards [1] 1627/22</p> <p>effect [8] 1635/5 1642/15 1660/21 1667/16 1691/12 1704/1 1786/8 1786/11</p> <p>effective [2] 1691/23 1694/11</p> <p>effectively [2] 1689/23 1734/11</p> <p>effects [11] 1641/17 1641/21 1643/5 1643/16 1645/2 1661/4 1661/8 1661/11 1676/18 1698/22 1723/21</p>		

<p>E</p> <p>equation-of-state... [21] 1784/25 1786/16 1786/17 1786/22 1786/24 1787/4 1787/14 1788/6 1788/9 1788/15 1789/9 1790/17 1790/18 1790/21 1791/9 1791/14 1791/21 1792/10 1795/13 1795/22 1796/8</p> <p>equations [2] 1759/15 1760/1</p> <p>equilibrate [2] 1777/21 1778/1</p> <p>equilibrated [3] 1766/10 1766/12 1766/14</p> <p>equilibrium [2] 1768/17 1782/13</p> <p>equivalent [1] 1690/12</p> <p>Erica [1] 1636/7</p> <p>erode [2] 1647/11 1650/9</p> <p>eroded [4] 1648/14 1649/16 1653/24 1656/23</p> <p>eroding [1] 1655/3</p> <p>erosion [82] 1638/21 1638/22 1639/3 1639/3 1639/5 1639/6 1639/11 1639/13 1643/5 1643/10 1645/1 1646/4 1646/5 1646/9 1646/14 1647/6 1647/9 1647/18 1647/20 1647/22 1648/3 1648/11 1648/15 1648/16 1648/22 1648/25 1649/6 1649/13 1650/1 1650/3 1650/3 1650/6 1650/7 1650/14 1650/20 1650/22 1651/23 1651/25 1652/8 1652/10 1652/13 1652/14 1652/21 1652/22 1653/2 1653/5 1653/8 1653/14 1654/2 1654/5 1656/9 1657/16 1657/19 1658/5 1658/21 1658/25 1659/17 1659/23 1660/12 1660/16 1660/18 1676/18 1676/22 1686/18 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1688/22 1689/5 1689/10 1689/15 1689/19 1690/8 1691/2 1694/18 1698/3 1698/8 1698/16 1698/18 1703/12 1704/2 1706/1 1709/9 1718/17 1719/8 1720/3 1724/16 1728/2 1728/5 1728/9 1728/12 1729/21 1730/23 1737/10</p>	<p>1737/18 1737/23 1740/24 1746/7 1746/13 1748/13</p> <p>estimated [3] 1659/19 1694/17 1712/6</p> <p>estimates [2] 1772/17 1785/17</p> <p>estimating [1] 1684/12</p> <p>estimation [8] 1641/3 1682/18 1683/5 1683/8 1683/17 1684/9 1684/21 1687/25</p> <p>et [2] 1627/8 1627/11</p> <p>ethylbenzene [1] 1771/25</p> <p>evaluate [1] 1759/12</p> <p>evaluated [1] 1759/5</p> <p>even [8] 1659/6 1692/20 1705/16 1708/23 1738/6 1743/18 1766/16 1785/17</p> <p>evening [2] 1800/12 1800/16</p> <p>event [1] 1634/6</p> <p>events [5] 1694/9 1696/20 1732/5 1732/11 1745/25</p> <p>ever [7] 1666/10 1673/18 1693/6 1706/4 1706/8 1735/19 1768/22</p> <p>ever-decreasing [1] 1768/22</p> <p>every [5] 1674/11 1763/24 1776/18 1776/19 1778/16</p> <p>everybody [1] 1638/6</p> <p>everyone [2] 1633/5 1800/22</p> <p>everything [6] 1688/14 1689/10 1689/24 1698/6 1705/11 1799/2</p> <p>evidence [10] 1636/20 1648/2 1649/20 1653/14 1660/13 1660/19 1686/17 1686/18 1733/6 1756/3</p> <p>evolve [3] 1705/17 1768/23 1778/1</p> <p>evolved [1] 1657/13</p> <p>evolves [1] 1775/8</p> <p>exact [6] 1649/18 1684/13 1684/15 1707/9 1718/4 1779/7</p> <p>exactly [25] 1661/14 1671/10 1678/7 1678/7 1678/8 1678/21 1681/24 1694/2 1694/24 1711/5 1711/8 1717/13 1717/19 1724/8 1732/11 1732/12 1736/8 1736/22 1737/1 1738/12 1738/22 1738/25 1775/3 1781/14 1788/18</p> <p>exaggerates [2] 1659/16 1739/4</p> <p>exam [2] 1676/13 1698/2</p> <p>examination [16] 1636/10 1636/17 1637/16 1637/19 1667/9 1674/1 1674/4 1686/18 1697/14 1744/1 1746/20 1749/13 1752/20 1754/22 1784/17 1784/23</p> <p>examinations [1] 1798/22</p> <p>examine [2] 1650/25 1651/16</p> <p>examined [3] 1656/15 1656/15 1669/9</p> <p>examining [2] 1712/25 1722/5</p> <p>example [6] 1655/21 1665/3 1723/7 1726/4 1761/14 1762/7</p> <p>examples [1] 1651/15</p> <p>except [2] 1698/6 1767/17</p> <p>excerpt [6] 1716/6 1765/8 1765/8 1773/7 1773/9 1781/3</p> <p>exclude [5] 1718/12 1718/13 1718/14 1718/14 1718/15</p> <p>excluded [1] 1634/7</p> <p>excludes [3] 1773/17 1773/18 1773/19</p> <p>excuse [5] 1658/10 1672/20 1679/15 1696/14 1787/18</p> <p>exercise [1] 1710/22</p> <p>exhibit [5] 1637/2 1637/7 1665/4 1688/21 1717/25</p> <p>exhibits [3] 1636/16 1636/19 1636/22</p> <p>exist [2] 1760/14 1777/6</p> <p>existed [7] 1669/3 1674/14 1684/6 1693/20 1694/14 1720/5 1793/13</p>	<p>exists [4] 1647/12 1650/10 1650/11 1750/2</p> <p>exit [7] 1768/15 1768/16 1769/3 1770/3 1775/5 1778/17 1780/9</p> <p>exited [3] 1785/23 1785/25 1786/4</p> <p>exiting [1] 1768/16</p> <p>exits [1] 1775/12</p> <p>expect [8] 1641/21 1650/10 1650/13 1722/10 1722/17 1722/22 1729/12 1799/16</p> <p>expectations [1] 1693/11</p> <p>expected [2] 1725/20 1797/6</p> <p>expecting [1] 1799/14</p> <p>experience [3] 1753/8 1786/15 1790/2</p> <p>experienced [1] 1758/14</p> <p>experiment [1] 1781/15</p> <p>experimental [1] 1779/19</p> <p>experimented [1] 1782/8</p> <p>experiments [5] 1764/24 1764/25 1765/1 1765/4 1767/12</p> <p>expert [43] 1634/9 1635/6 1640/13 1649/11 1650/17 1651/12 1654/5 1656/8 1656/11 1661/16 1662/11 1666/16 1666/20 1667/25 1670/11 1676/25 1678/18 1691/11 1691/17 1692/12 1692/14 1693/18 1694/22 1697/24 1698/3 1700/23 1703/14 1709/9 1720/6 1720/10 1727/2 1752/5 1752/22 1754/17 1754/20 1754/24 1755/3 1755/10 1755/13 1756/1 1756/2 1767/19 1779/12</p> <p>expertise [3] 1754/7 1790/3 1790/4</p> <p>experts [13] 1633/15 1633/18 1635/19 1644/19 1644/24 1649/22 1654/5 1670/13 1671/19 1702/23 1703/2 1751/13 1788/13</p> <p>explain [14] 1662/16 1667/15 1730/5 1747/17 1760/12 1765/14 1768/12 1769/21 1770/7 1773/9 1775/2 1778/13 1778/23 1783/10</p> <p>explaining [2] 1658/19 1664/21</p> <p>explanation [1] 1656/7</p> <p>explicitly [1] 1643/21</p> <p>EXPLORATION [6] 1627/10 1629/17 1629/20 1630/2 1630/5 1630/9</p> <p>explore [1] 1641/7</p> <p>explosion [2] 1648/7 1649/19</p> <p>exposed [1] 1692/1</p> <p>express [1] 1791/7</p> <p>extended [1] 1652/24</p> <p>extensive [1] 1764/23</p> <p>extent [1] 1687/17</p> <p>extrapolate [1] 1693/10</p> <p>extrapolated [2] 1699/18 1724/15</p> <p>extrapolation [7] 1699/20 1699/22 1700/1 1704/14 1748/1 1749/20 1750/9</p> <p>extremely [1] 1666/4</p> <hr/> <p>F</p> <p>face [4] 1652/2 1652/4 1652/8 1691/23</p> <p>faces [1] 1652/3</p> <p>facility [1] 1765/13</p> <p>fact [29] 1634/3 1637/7 1648/17 1659/13 1659/18 1663/19 1667/6 1685/19 1692/20 1696/23 1698/1 1703/9 1706/14 1713/12 1717/16 1719/16 1728/9 1733/6 1738/3 1738/10 1739/8 1743/6 1747/14 1751/3 1782/20 1788/5 1791/4 1791/17 1791/20</p> <p>factor [32] 1658/6 1659/22 1663/21 1668/25 1669/10 1692/16 1714/5 1714/9 1760/24 1760/25 1761/9 1761/9 1761/13 1761/14 1761/20 1762/2</p>
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<p>G</p> <p>geometries [5] 1657/12 1657/12 1672/20 1680/19 1707/2</p> <p>geometry [7] 1656/21 1657/17 1672/24 1672/24 1677/15 1682/24 1684/5</p> <p>get [46] 1637/12 1639/1 1645/21 1647/7 1647/16 1653/23 1653/24 1662/19 1669/14 1671/10 1680/8 1684/22 1693/10 1697/3 1697/16 1700/10 1706/7 1710/14 1710/16 1710/20 1710/22 1719/13 1724/6 1729/17 1731/13 1738/4 1743/1 1744/14 1749/5 1757/22 1761/6 1761/10 1762/12 1779/6 1779/9 1779/10 1779/24 1782/24 1784/14 1799/4 1799/22 1799/23 1800/4 1800/13 1800/18 1800/19</p> <p>gets [2] 1778/15 1794/22</p> <p>getting [2] 1739/25 1799/13</p> <p>give [16] 1635/23 1663/25 1678/25 1679/10 1710/25 1711/6 1712/15 1723/9 1746/10 1763/7 1766/16 1777/15 1777/16 1795/25 1796/3 1797/19</p> <p>given [11] 1657/12 1657/17 1661/14 1684/19 1720/3 1739/15 1740/3 1761/11 1768/8 1782/2 1782/4</p> <p>gives [2] 1654/21 1763/11</p> <p>giving [1] 1707/8</p> <p>GLADSTEIN [1] 1629/14</p> <p>GmbH [1] 1627/8</p> <p>go [67] 1636/14 1637/25 1638/12 1638/13 1638/15 1644/12 1647/21 1651/14 1651/18 1654/13 1658/1 1661/22 1665/25 1666/23 1667/13 1668/4 1670/12 1677/12 1677/17 1678/20 1679/9 1682/21 1684/11 1700/13 1701/6 1710/7 1710/25 1715/21 1720/21 1721/3 1722/10 1723/3 1725/8 1725/25 1727/9 1727/11 1727/21 1729/8 1730/7 1730/12 1730/12 1730/19 1731/6 1731/6 1731/10 1732/2 1733/24 1737/5 1742/12 1742/20 1745/3 1745/8 1747/20 1750/11 1752/19 1758/18 1761/24 1762/8 1774/21 1776/13 1778/5 1778/20 1784/13 1788/25 1789/22 1796/13 1798/15</p> <p>Godwin [3] 1631/2 1631/3 1631/7</p> <p>goes [18] 1647/22 1671/13 1697/8 1705/21 1707/12 1712/2 1722/24 1723/3 1728/20 1729/4 1730/6 1730/7 1732/16 1737/18 1737/19 1737/20 1748/19 1751/21</p> <p>going [56] 1634/15 1635/5 1635/13 1636/13 1642/25 1655/14 1655/15 1655/24 1657/17 1657/19 1666/5 1667/11 1671/22 1688/12 1692/19 1692/22 1711/8 1712/4 1715/19 1715/20 1723/18 1723/21 1723/22 1724/8 1727/19 1728/20 1729/4 1730/5 1730/7 1730/14 1732/5 1732/18 1736/8 1736/22 1736/23 1737/3 1737/20 1738/9 1743/14 1745/18 1748/1 1756/13 1761/16 1761/17 1766/23 1772/13 1777/8 1784/9 1784/12 1793/17 1796/13 1797/4 1798/8 1798/21 1798/23 1800/16</p> <p>gone [4] 1705/7 1705/9 1724/7 1772/12</p> <p>good [12] 1636/7 1637/18 1638/16 1674/3 1750/3 1751/23 1770/13 1784/22 1791/18 1792/2 1792/6 1792/6</p>	<p>got [16] 1637/13 1649/20 1656/25 1658/2 1659/11 1665/9 1665/21 1704/12 1709/21 1709/23 1713/24 1717/20 1739/1 1793/1 1793/2 1799/8 1799/10 1743/4</p> <p>Government [1] 1788/22</p> <p>government's [1] 1788/12</p> <p>grabbed [1] 1688/8</p> <p>gradual [2] 1660/12 1660/18</p> <p>grain [1] 1640/9</p> <p>Grand [1] 1630/21</p> <p>GRANT [1] 1630/20</p> <p>gray [2] 1731/21 1745/16</p> <p>grayish [1] 1643/22</p> <p>great [7] 1647/11 1647/13 1651/25 1681/19 1713/2 1720/9 1784/16 1725/3</p> <p>greater [1] 1725/3</p> <p>greatest [1] 1676/1</p> <p>green [2] 1655/20 1724/16</p> <p>GREENWALD [1] 1628/10</p> <p>Griffiths [78] 1635/20 1637/14 1637/18 1643/23 1646/14 1653/11 1654/11 1655/7 1657/9 1658/18 1660/1 1661/25 1662/8 1662/12 1663/4 1663/22 1663/24 1664/7 1666/3 1666/17 1666/20 1667/15 1668/7 1669/19 1672/9 1673/12 1673/19 1674/3 1674/5 1677/16 1677/23 1678/17 1679/1 1679/11 1684/2 1687/1 1688/21 1689/9 1690/14 1691/17 1694/22 1696/10 1698/15 1699/15 1700/21 1701/15 1703/9 1703/15 1703/22 1704/24 1706/14 1707/8 1707/16 1708/19 1711/10 1716/5 1720/16 1721/11 1724/13 1728/25 1729/20 1730/9 1732/4 1733/17 1737/7 1739/8 1739/21 1740/11 1741/19 1742/21 1743/6 1743/16 1743/23 1744/3 1744/11 1744/21 1747/12 1750/15</p> <p>Gringarten [4] 1671/21 1671/23 1672/2 1800/6</p> <p>Gringarten's [2] 1671/24 1672/1</p> <p>grouped [2] 1640/25 1644/5</p> <p>grow [1] 1653/22</p> <p>growing [1] 1653/17</p> <p>guess [5] 1659/2 1685/22 1706/13 1718/5 1777/13</p> <p>GULF [3] 1627/5 1651/1 1772/24</p> <p>guys [1] 1789/5</p> <p>GWENDOLYN [1] 1631/8</p>	<p>hanging [1] 1662/4</p> <p>happen [6] 1644/10 1656/4 1711/9 1721/12 1721/18 1777/19</p> <p>happened [19] 1633/19 1640/18 1642/13 1649/3 1649/6 1649/21 1649/22 1658/10 1666/18 1669/7 1692/16 1692/17 1699/10 1705/19 1707/10 1708/19 1711/1 1714/7 1763/3</p> <p>happening [7] 1658/14 1729/7 1729/10 1730/18 1732/11 1745/15 1745/25</p> <p>happens [10] 1646/10 1647/9 1647/10 1647/14 1659/11 1728/12 1731/8 1772/19 1772/22 1795/7</p> <p>happy [4] 1696/9 1715/20 1796/12 1797/19</p> <p>hard [5] 1644/14 1722/13 1731/25 1745/13 1745/16</p> <p>hardly [2] 1697/9 1731/4</p> <p>hardware [1] 1708/5</p> <p>HARIKLIA [2] 1629/21 1784/22</p> <p>HARVEY [1] 1629/14</p> <p>has [45] 1633/9 1638/19 1643/18 1644/17 1645/1 1645/3 1646/2 1646/21 1655/16 1655/24 1657/1 1660/17 1661/16 1662/19 1663/11 1663/11 1664/1 1667/16 1669/20 1702/21 1702/24 1703/15 1709/6 1712/5 1712/19 1719/9 1721/13 1721/14 1721/19 1721/20 1723/4 1724/7 1728/20 1737/22 1737/23 1749/2 1752/8 1756/17 1759/21 1775/20 1787/3 1787/9 1787/13 1788/19 1799/1</p> <p>hasn't [1] 1703/16</p> <p>have [214]</p> <p>haven't [3] 1697/20 1797/22 1799/1</p> <p>having [6] 1637/14 1670/5 1690/5 1696/7 1750/18 1769/19</p> <p>HAYCRAFT [1] 1629/18</p> <p>HB [1] 1631/18</p> <p>HB-406 [1] 1631/18</p> <p>he [147] 1634/8 1634/15 1650/2 1650/4 1650/21 1654/6 1654/21 1656/15 1656/15 1656/16 1656/17 1656/18 1656/19 1656/21 1656/23 1656/25 1657/1 1657/1 1657/3 1657/5 1657/22 1658/23 1659/3 1659/5 1659/6 1660/3 1660/4 1660/9 1662/2 1662/9 1662/9 1662/12 1662/20 1663/10 1663/14 1664/1 1664/2 1664/7 1666/9 1666/15 1666/15 1666/16 1666/17 1666/21 1666/25 1667/13 1667/20 1667/20 1668/24 1669/9 1669/10 1669/10 1670/18 1670/21 1670/22 1671/1 1671/25 1672/2 1672/3 1672/3 1672/4 1691/22 1702/20 1703/15 1704/11 1705/18 1717/1 1717/10 1717/16 1717/16 1717/17 1717/17 1717/19 1717/20 1717/21 1717/22 1718/3 1733/11 1733/11 1741/6 1741/8 1741/9 1741/13 1747/15 1747/16 1749/20 1751/10 1751/10 1751/11 1770/19 1770/19 1770/23 1771/6 1771/7 1771/8 1771/16 1771/19 1771/21 1772/1 1772/11 1772/17 1773/18 1773/19 1774/6 1774/10 1774/12 1774/16 1775/9 1775/10 1775/12 1775/12 1775/24 1776/1 1776/15 1776/15 1778/15 1778/17 1778/20 1778/25 1779/1 1779/2 1779/3 1779/5 1779/5 1779/7 1779/8 1779/11 1779/17 1779/18 1779/19 1779/20 1780/1 1780/2 1780/7 1780/10 1780/13 1780/19 1780/22 1781/18 1787/9</p>
	<p>H</p> <p>had [67] 1633/18 1634/17 1636/12 1637/5 1639/12 1639/13 1640/5 1643/1 1648/25 1649/15 1655/22 1662/9 1662/9 1663/9 1667/7 1669/13 1671/1 1672/2 1676/17 1678/1 1678/6 1679/8 1679/15 1679/18 1681/25 1685/24 1693/8 1694/3 1698/8 1698/18 1698/23 1699/5 1699/10 1703/9 1703/22 1704/3 1706/6 1712/23 1719/19 1719/20 1720/7 1720/8 1720/9 1722/20 1723/5 1723/10 1743/2 1743/3 1744/5 1745/21 1746/9 1746/25 1756/9 1757/9 1757/12 1761/5 1770/15 1770/19 1770/19 1776/21 1777/3 1786/8 1786/12 1789/5 1791/7 1792/11 1797/24</p> <p>hadn't [1] 1636/1</p> <p>half [8] 1649/18 1652/22 1655/17 1659/7 1659/9 1697/11 1762/12 1787/2</p> <p>Halliburton [2] 1631/2 1631/7</p> <p>hand [3] 1633/24 1775/11 1792/25</p> <p>hands [1] 1677/14</p>	

<p>H</p> <p>he... [7] 1787/13 1789/22 1792/3 1797/5 1799/1 1799/21 1800/3</p> <p>he'll [2] 1754/20 1797/7</p> <p>he's [16] 1650/1 1660/7 1662/14 1662/20 1664/21 1665/2 1666/1 1704/12 1717/20 1722/5 1748/12 1774/6 1799/11 1800/4 1800/7 1800/16</p> <p>head [7] 1701/1 1701/2 1701/6 1724/22 1742/8 1742/11 1746/23</p> <p>hear [5] 1638/6 1638/14 1666/5 1685/25 1703/15</p> <p>heard [7] 1635/23 1665/24 1669/15 1694/23 1751/14 1791/7 1792/10</p> <p>Hearing [1] 1636/23</p> <p>heart [1] 1798/6</p> <p>height [1] 1717/23</p> <p>heights [2] 1717/17 1717/18</p> <p>held [6] 1636/1 1689/21 1734/4 1734/22 1742/22 1743/7</p> <p>help [1] 1664/22</p> <p>helping [1] 1733/3</p> <p>her [2] 1634/24 1634/24</p> <p>here [52] 1633/12 1634/3 1635/12 1638/1 1640/25 1643/3 1648/21 1649/9 1649/21 1650/1 1651/15 1652/11 1655/8 1661/25 1664/4 1664/13 1670/13 1678/18 1690/5 1694/6 1695/13 1696/18 1698/17 1699/5 1714/11 1715/20 1719/17 1720/14 1724/13 1724/24 1725/17 1737/14 1738/8 1738/13 1739/1 1742/19 1745/15 1748/10 1749/5 1756/24 1764/20 1766/6 1776/3 1790/1 1792/25 1796/12 1797/21 1799/1 1799/10 1799/10 1799/13 1800/4</p> <p>here's [2] 1680/10 1680/10</p> <p>hereby [1] 1801/5</p> <p>Herman [3] 1627/18 1627/18 1627/19</p> <p>high [13] 1640/4 1640/8 1647/11 1647/16 1647/19 1647/20 1662/5 1662/6 1670/16 1686/20 1724/23 1731/9 1750/1</p> <p>higher [7] 1709/13 1716/13 1719/12 1727/20 1749/5 1778/18 1795/5</p> <p>highest [2] 1673/10 1675/18</p> <p>highlight [1] 1665/13</p> <p>highlighted [3] 1649/15 1650/2 1783/17</p> <p>him [16] 1634/10 1657/11 1666/7 1667/11 1667/24 1703/15 1752/4 1758/19 1789/6 1789/6 1789/20 1789/21 1799/1 1799/24 1799/25 1800/7</p> <p>HIMMELHOCH [2] 1629/15 1796/19</p> <p>his [99] 1650/21 1656/10 1657/6 1658/11 1658/25 1660/2 1660/4 1660/9 1660/9 1662/8 1662/10 1662/13 1662/14 1662/22 1664/1 1664/21 1664/22 1664/23 1665/16 1665/17 1666/12 1666/15 1667/13 1667/19 1667/21 1667/24 1669/10 1669/15 1670/18 1670/23 1670/25 1670/25 1671/6 1671/9 1671/11 1671/12 1671/16 1671/24 1671/24 1672/3 1703/7 1704/9 1704/10 1705/15 1705/16 1705/20 1717/16 1717/22 1717/23 1717/25 1718/6 1732/19 1741/17 1747/18 1748/12 1751/8 1751/10 1751/17 1752/17 1756/1 1756/5 1759/21 1771/1 1771/2 1771/4 1771/16 1771/16 1771/17 1772/14 1774/3 1774/8 1774/10 1774/16 1775/6</p>	<p>1775/21 1775/21 1775/22 1776/4 1776/14 1778/14 1778/25 1779/1 1779/6 1779/8 1779/9 1780/1 1780/6 1780/8 1780/19 1781/11 1789/1 1789/24 1791/9 1791/17 1791/18 1791/23 1792/3 1792/4 1792/6</p> <p>histories [1] 1654/17</p> <p>history [3] 1633/12 1658/9 1658/10</p> <p>hold [8] 1690/4 1690/6 1708/13 1733/18 1736/2 1753/5 1790/6 1798/11</p> <p>holding [6] 1689/23 1691/2 1691/8 1708/11 1734/2 1735/16</p> <p>Holdings [3] 1630/12 1630/15 1630/18</p> <p>hole [5] 1652/20 1668/16 1732/24 1733/7 1763/24</p> <p>holes [7] 1653/10 1653/14 1708/2 1733/1 1733/9 1733/13 1733/13</p> <p>holiday [1] 1798/11</p> <p>Honor [47] 1633/7 1634/2 1634/6 1634/15 1635/11 1635/17 1636/4 1636/7 1636/24 1637/1 1642/23 1662/7 1662/16 1663/1 1664/20 1665/10 1665/18 1665/24 1666/15 1667/18 1668/3 1669/8 1669/17 1671/22 1672/6 1673/20 1673/22 1703/13 1715/19 1716/3 1740/6 1743/25 1750/24 1751/23 1754/16 1756/7 1756/12 1775/16 1775/19 1784/9 1796/12 1797/2 1797/13 1798/6 1798/16 1799/12 1800/14</p> <p>HONORABLE [1] 1627/15</p> <p>hope [2] 1630/3 1714/14</p> <p>HORIZON [1] 1627/4</p> <p>horribly [1] 1653/20</p> <p>hose [1] 1647/17</p> <p>hotly [1] 1633/19</p> <p>hour [8] 1648/25 1649/19 1649/19 1649/23 1681/22 1693/19 1695/16 1772/19</p> <p>hours [49] 1648/24 1649/3 1649/21 1650/7 1650/14 1650/23 1660/16 1692/16 1692/17 1693/4 1693/6 1693/9 1693/9 1693/11 1693/12 1693/14 1693/16 1693/16 1693/21 1694/1 1694/18 1695/2 1695/2 1695/6 1695/6 1695/20 1696/1 1696/4 1696/5 1696/11 1696/12 1696/12 1696/12 1696/15 1696/18 1696/18 1696/21 1696/24 1697/2 1697/3 1697/6 1697/10 1697/16 1708/21 1709/5 1709/6 1713/14 1716/11 1716/13</p> <p>Houston [2] 1630/17 1631/9</p> <p>how [50] 1641/7 1641/20 1642/3 1643/11 1644/2 1651/20 1657/13 1658/21 1661/12 1667/3 1668/9 1670/20 1671/2 1673/12 1677/25 1678/21 1684/3 1686/19 1689/15 1690/7 1694/24 1696/5 1701/24 1705/12 1707/13 1712/10 1714/25 1729/24 1735/23 1738/20 1741/13 1741/14 1747/4 1747/13 1759/25 1761/6 1762/2 1762/9 1763/21 1768/1 1770/10 1772/17 1774/8 1777/12 1780/17 1781/18 1783/23 1790/19 1793/18 1795/11</p> <p>however [3] 1685/8 1751/13 1776/8</p> <p>huge [4] 1663/21 1669/1 1696/16 1763/14</p> <p>huh [16] 1649/12 1654/10 1676/16 1682/20 1685/11 1687/7 1723/13 1726/2 1726/8 1734/14 1734/14 1735/5 1742/4 1742/6 1746/1 1747/7</p> <p>huh-huh [1] 1734/14</p>	<p>Huh-uh [1] 1735/5</p> <p>Hunter [2] 1636/11 1636/17</p> <p>Hunter's [1] 1636/22</p> <p>hydraulic [4] 1668/11 1668/17 1668/18 1668/21</p> <p>hydrocarbon [8] 1716/10 1753/16 1753/19 1758/5 1771/21 1772/15 1772/23 1778/19</p> <p>hydrocarbons [8] 1752/7 1752/14 1763/13 1771/11 1772/11 1778/19 1779/3 1782/24</p> <p>hypotheticals [4] 1654/21 1654/22 1656/2 1726/15</p> <p>I</p> <p>I'd [10] 1637/12 1637/25 1682/17 1696/9 1699/1 1716/5 1779/12 1781/11 1794/13 1797/10</p> <p>I'll [15] 1635/9 1635/9 1635/23 1662/18 1669/17 1695/10 1722/2 1723/9 1740/6 1742/20 1743/16 1756/4 1761/23 1798/1 1800/18</p> <p>I'm [63] 1633/25 1641/20 1647/12 1650/16 1651/5 1655/20 1657/25 1657/25 1664/4 1665/7 1665/8 1665/19 1667/11 1669/12 1671/22 1676/2 1676/3 1677/1 1690/5 1690/13 1694/2 1696/7 1696/15 1696/17 1700/5 1703/2 1706/5 1706/8 1710/13 1712/15 1714/16 1715/19 1715/20 1717/4 1721/25 1722/12 1726/15 1726/15 1728/8 1728/11 1732/18 1738/12 1741/22 1744/13 1747/1 1752/16 1753/11 1761/23 1762/17 1775/16 1775/19 1776/20 1777/1 1784/11 1784/12 1784/12 1788/18 1789/24 1790/4 1794/9 1796/12 1797/19 1797/22</p> <p>I've [16] 1633/25 1634/19 1669/15 1673/16 1687/3 1690/5 1715/2 1740/3 1753/12 1754/12 1754/13 1754/13 1754/14 1774/3 1777/2 1800/7</p> <p>I-C-K [1] 1750/23</p> <p>idea [3] 1732/14 1762/15 1780/3</p> <p>idealized [1] 1641/18</p> <p>identified [3] 1660/20 1672/12 1755/23</p> <p>identify [2] 1764/19 1773/16</p> <p>Illinois [1] 1629/24</p> <p>imagery [1] 1708/18</p> <p>images [3] 1648/5 1708/2 1713/1</p> <p>imagine [1] 1765/4</p> <p>immediate [2] 1658/13 1734/17</p> <p>immediately [2] 1704/21 1704/21</p> <p>impact [11] 1639/4 1639/6 1639/7 1639/12 1639/14 1659/16 1698/12 1705/25 1706/1 1706/9 1755/23</p> <p>impacts [2] 1643/11 1646/10</p> <p>impediments [1] 1694/19</p> <p>import [1] 1689/22</p> <p>important [2] 1633/13 1791/15</p> <p>importantly [1] 1747/17</p> <p>impossible [1] 1658/12</p> <p>improper [1] 1668/12</p> <p>improvement [1] 1754/5</p> <p>inaccuracies [1] 1725/20</p> <p>inaccurate [3] 1645/20 1670/3 1670/7</p> <p>inadvertently [1] 1755/18</p> <p>inappropriate [1] 1772/21</p> <p>INC [14] 1627/11 1629/18 1629/21 1630/3 1630/6 1630/9 1630/13 1630/14 1630/16 1630/17 1630/19 1630/20 1631/3 1631/8</p> <p>inches [1] 1653/19</p>
---	--	---

incident [1] 1649/7	interpose [1] 1671/22	1637/6
inclined [1] 1671/17	interpret [2] 1730/20 1733/4	Jefferson [1] 1627/23
include [6] 1637/6 1681/7 1696/25	interrupt [2] 1657/24 1775/19	JENNY [1] 1631/3
1697/14 1730/2 1764/3	interruptions [1] 1669/13	jets [1] 1769/13
included [5] 1640/18 1641/22 1771/23	Intertek [8] 1755/20 1756/16 1756/18	Jodi [5] 1631/18 1631/20 1801/3
1771/25 1795/9	1756/18 1764/18 1767/17 1791/2	1801/11 1801/11
includes [4] 1713/12 1713/14 1713/15	1793/1	Johnson [11] 1654/6 1655/8 1657/24
1719/9	interval [1] 1653/5	1661/16 1662/9 1663/9 1664/2 1666/11
including [1] 1751/14	introduce [1] 1636/19	1666/18 1669/5 1702/12
incorrect [1] 1663/18	inverse [2] 1762/4 1762/5	Johnson's [12] 1654/16 1657/22 1662/2
increase [21] 1654/23 1655/1 1659/20	inverses [1] 1761/1	1662/12 1663/5 1665/2 1667/1 1668/10
1671/17 1694/17 1709/5 1709/6 1712/7	investigate [1] 1666/12	1668/24 1669/2 1702/18 1703/25
1712/8 1712/10 1712/18 1721/24	investigation [1] 1649/10	joint [2] 1648/10 1648/11
1722/16 1722/17 1723/11 1725/22	involve [1] 1728/9	JOSEPH [1] 1630/6
1727/13 1727/16 1732/8 1732/15	involved [2] 1728/6 1787/3	journal [1] 1676/14
1742/16	Irpino [3] 1628/6 1628/7 1636/25	JR [1] 1631/4
increased [6] 1694/12 1709/17 1710/4	irreducible [1] 1645/17	judge [9] 1627/15 1633/20 1633/22
1721/14 1721/20 1723/12	irreversible [1] 1727/5	1634/9 1634/23 1634/23 1635/4 1636/1
increases [5] 1654/25 1721/17 1722/9	is [467]	1790/18
1722/10 1742/11	isn't [5] 1687/19 1699/25 1710/1	Judge Shushan [3] 1634/9 1634/23
increasing [4] 1655/6 1673/9 1728/2	1710/19 1712/7	1636/1
1732/17	isolated [2] 1769/15 1782/17	judgment [4] 1724/7 1752/10 1796/23
incremental [1] 1758/8	issue [22] 1633/8 1633/9 1634/25	1797/25
independent [1] 1739/13	1635/1 1645/3 1661/7 1663/1 1667/19	JUDY [1] 1629/14
independently [2] 1685/16 1686/1	1668/8 1694/3 1707/13 1714/21	juggling [1] 1797/8
index [11] 1654/7 1654/17 1655/6	1745/11 1750/24 1752/1 1785/6 1785/7	July [46] 1670/22 1671/2 1671/3
1655/23 1687/5 1687/23 1688/24	1796/19 1796/20 1797/3 1797/17	1671/10 1671/12 1671/12 1674/8
1692/21 1694/11 1694/17 1697/15	1797/23	1674/10 1674/11 1674/18 1681/22
indicate [1] 1694/11	issued [3] 1672/2 1676/9 1751/10	1681/25 1682/4 1682/5 1682/12
indicated [1] 1693/19	issues [8] 1638/19 1643/9 1645/7	1682/12 1683/14 1683/15 1683/18
indicates [2] 1694/13 1725/12	1682/8 1744/15 1751/19 1786/12	1683/18 1683/21 1683/22 1684/6
indirectly [1] 1635/14	1799/12	1685/9 1685/17 1685/20 1686/3 1686/6
industry [3] 1672/15 1677/3 1781/13	it [316]	1686/10 1686/23 1687/2 1687/2
industry-standard [1] 1677/3	it's [137] 1635/17 1638/23 1639/18	1687/11 1688/25 1689/7 1689/11
inefficient [1] 1781/23	1642/1 1645/15 1647/17 1648/21	1689/13 1692/23 1693/1 1696/24
infinite [1] 1714/22	1653/19 1653/21 1656/3 1656/6 1658/4	1697/16 1718/13 1718/24 1719/14
influence [1] 1710/17	1660/14 1660/23 1661/3 1662/15	1720/8 1734/21
influx [1] 1716/10	1662/16 1663/21 1664/13 1664/24	July 11th [5] 1670/22 1671/10 1671/12
information [15] 1639/18 1671/4	1665/1 1665/12 1666/19 1667/12	1671/12 1719/14
1681/24 1691/15 1691/16 1693/5	1667/12 1668/15 1668/15 1668/16	July 11th that [1] 1718/13
1693/7 1704/8 1720/9 1724/4 1724/6	1670/7 1670/8 1675/5 1677/10 1678/13	July 12th [2] 1671/2 1671/3
1727/1 1733/3 1733/5 1781/17	1679/13 1680/12 1681/9 1684/25	July 14th [1] 1681/25
initial [13] 1700/24 1701/25 1702/20	1684/25 1685/6 1687/11 1687/12	July 14th and [6] 1682/4 1682/12
1703/7 1703/23 1743/6 1743/19 1767/7	1687/14 1687/16 1687/17 1687/18	1683/14 1683/18 1683/21 1689/7
1769/24 1776/22 1778/16 1783/14	1687/19 1688/3 1688/3 1688/10	July 14th/15th [1] 1686/23
1793/25	1688/10 1688/11 1693/5 1697/4 1697/4	July 14th/July 15th [1] 1687/2
initially [2] 1751/8 1769/2	1697/8 1697/8 1698/11 1700/7 1702/14	July 15th [17] 1674/8 1674/18 1682/5
inner [1] 1668/20	1705/16 1706/14 1706/23 1707/9	1682/12 1683/15 1683/18 1683/22
input [5] 1662/1 1662/1 1681/21	1707/10 1707/11 1708/17 1708/17	1684/6 1685/9 1685/17 1686/3 1686/6
1681/21 1759/19	1709/2 1709/7 1710/22 1711/7 1712/3	1686/10 1687/11 1688/25 1689/11
inputs [5] 1680/19 1680/20 1681/3	1712/4 1714/18 1722/1 1722/4 1722/12	1734/21
1681/4 1682/4	1723/16 1726/17 1727/5 1729/20	July 15th for [1] 1689/13
inside [4] 1663/10 1706/12 1707/21	1729/21 1731/21 1731/21 1731/22	July 15th from [1] 1681/22
1729/12	1731/23 1731/25 1736/23 1739/2	July 15th to [2] 1692/23 1693/1
insignificant [2] 1760/5 1770/23	1742/10 1742/21 1745/13 1745/16	July 15th value [2] 1696/24 1697/16
instances [1] 1634/20	1745/16 1746/23 1749/7 1751/15	July 15th values [1] 1674/10
instant [1] 1705/6	1756/15 1756/25 1760/18 1760/24	July 15th would [1] 1685/20
instantaneous [1] 1716/21	1763/12 1763/14 1763/16 1764/5	July 9th [1] 1718/24
instantly [1] 1772/16	1765/24 1766/9 1768/11 1769/11	June [5] 1706/22 1706/23 1720/7
instead [7] 1654/2 1703/10 1743/2	1770/9 1772/12 1774/10 1776/5	1765/2 1765/5
1743/3 1763/2 1775/23 1781/24	1776/12 1776/25 1777/24 1781/14	June 26th [2] 1706/22 1706/23
instructed [1] 1667/20	1781/14 1781/14 1781/21 1781/21	just [139] 1633/17 1634/25 1635/9
integral [2] 1738/9 1743/12	1781/22 1782/9 1783/21 1784/14	1638/23 1640/20 1641/6 1642/2 1642/9
integrated [1] 1730/24	1789/2 1790/14 1791/20 1792/2 1795/3	1642/14 1643/1 1644/4 1644/5 1644/13
integrating [1] 1743/1	1796/16 1796/25 1797/3 1797/7	1644/23 1644/23 1646/16 1647/10
intention [1] 1635/18	1797/17 1799/10 1799/23	1647/17 1648/15 1652/15 1652/20
interaction [2] 1667/21 1667/25	its [5] 1648/22 1688/1 1696/24 1736/23	1653/4 1654/23 1655/25 1656/6
interest [1] 1641/24	1757/9	1657/19 1658/19 1659/11 1659/14
interested [1] 1641/20	itself [3] 1659/8 1759/15 1783/24	1659/24 1659/24 1663/15 1664/11
interesting [2] 1652/11 1748/23		1664/13 1664/21 1666/14 1667/15
Interests [1] 1628/19		1667/18 1668/4 1668/18 1669/4
		1669/12 1670/5 1670/8 1670/25
		1672/20 1673/1 1675/10 1677/25
	J	
	Jackson [1] 1628/17	
	JAMES [4] 1627/22 1628/22 1637/4	

<p>J</p> <p>just... [90] 1678/9 1678/10 1678/10 1678/14 1682/25 1682/25 1683/24 1684/25 1685/6 1688/10 1693/7 1694/2 1696/17 1697/12 1697/17 1698/15 1700/1 1704/17 1704/24 1705/12 1708/17 1708/18 1710/4 1713/6 1713/22 1714/16 1717/20 1718/13 1720/11 1721/11 1722/12 1724/1 1724/7 1725/23 1726/15 1726/17 1726/23 1726/25 1727/24 1728/8 1729/12 1729/15 1729/16 1730/25 1731/5 1731/25 1732/4 1733/2 1735/22 1738/9 1739/16 1740/5 1743/17 1744/3 1745/12 1745/13 1745/16 1746/2 1747/15 1750/8 1751/7 1755/23 1758/1 1761/1 1762/21 1763/12 1764/15 1765/3 1765/9 1767/12 1767/22 1772/13 1772/21 1773/25 1774/20 1777/1 1779/8 1781/19 1781/22 1786/6 1791/9 1792/19 1797/22 1797/23 1798/12 1799/2 1799/13 1800/10 1800/10 1800/13</p> <p>Justice [3] 1629/6 1629/9 1633/21</p> <p>Justice's [1] 1702/23</p> <p>justifiable [1] 1686/24</p>	<p>1738/22 1738/25 1739/6 1741/5 1741/6 1741/10 1741/13 1743/10 1745/13 1746/17 1747/18 1748/24 1749/25 1750/13 1751/20 1762/2 1763/10 1777/17 1782/2 1782/4 1782/5 1782/6 1786/6 1787/7 1790/14 1795/11 1798/12 1798/24 1799/4 1800/7 1800/12 1800/16</p> <p>known [10] 1638/1 1645/19 1672/21 1684/25 1700/15 1707/3 1707/4 1764/17 1789/17 1789/20</p> <p>knows [4] 1634/6 1692/19 1706/15 1707/6</p> <p>KRAUS [1] 1629/3</p> <p>Kuchler [2] 1631/11 1631/12</p> <p>KY [1] 1631/15</p>	<p>1725/16 1725/25 1727/17 1727/25 1728/3 1730/11 1737/23 1742/8 1742/11 1742/12 1742/14 1742/18 1758/9 1768/5 1770/24 1771/1 1783/3 1784/4</p> <p>let [22] 1635/14 1645/5 1651/6 1657/24 1665/23 1666/23 1667/11 1684/11 1703/13 1732/20 1733/17 1736/11 1740/12 1740/20 1741/23 1745/21 1746/2 1747/4 1762/16 1799/3 1800/12 1800/16</p> <p>let's [41] 1639/20 1641/6 1644/17 1647/8 1647/24 1649/4 1649/24 1651/14 1651/18 1654/4 1654/5 1656/8 1660/20 1661/14 1669/19 1671/9 1672/11 1673/1 1678/10 1678/15 1694/5 1703/1 1706/22 1706/24 1713/22 1715/21 1722/7 1724/11 1724/22 1734/20 1740/8 1746/25 1750/8 1750/8 1753/8 1758/22 1768/9 1768/14 1770/16 1782/1 1790/16</p> <p>level [2] 1670/16 1686/20</p> <p>leveraged [1] 1720/3</p> <p>Levin [1] 1628/2</p> <p>Lewis [3] 1629/17 1631/2 1631/7</p> <p>LI [1] 1630/20</p> <p>Liao [2] 1741/2 1741/5</p> <p>life [1] 1663/22</p> <p>light [4] 1771/21 1771/23 1771/24 1779/3</p> <p>like [52] 1633/8 1633/17 1644/9 1645/20 1647/17 1651/22 1652/19 1653/4 1655/15 1655/18 1656/21 1658/18 1664/11 1670/5 1672/16 1672/17 1672/19 1673/14 1682/17 1696/14 1699/1 1703/23 1703/24 1708/12 1714/19 1716/5 1724/22 1730/10 1736/8 1736/22 1737/8 1738/11 1738/19 1739/6 1740/4 1743/11 1748/16 1751/25 1752/5 1763/14 1772/12 1774/4 1775/7 1776/12 1776/25 1777/2 1778/19 1779/12 1781/11 1788/21 1797/20 1799/20</p> <p>likely [12] 1649/15 1717/18 1717/19 1717/24 1726/3 1747/17 1757/11 1763/7 1781/19 1797/8 1799/23 1800/5</p> <p>likewise [2] 1785/21 1786/11</p> <p>limine [4] 1752/10 1797/1 1797/15 1797/24</p> <p>limited [1] 1719/19</p> <p>limits [1] 1633/14</p> <p>line [38] 1637/12 1655/20 1657/6 1665/14 1672/18 1699/15 1713/15 1720/18 1724/14 1724/15 1724/17 1728/3 1730/23 1732/15 1734/10 1734/11 1734/12 1734/13 1734/18 1735/4 1735/14 1735/19 1735/19 1735/21 1735/22 1736/7 1738/23 1742/2 1745/4 1748/15 1749/21 1755/20 1756/10 1756/15 1756/17 1765/11 1783/12 1795/19</p> <p>linear [5] 1654/23 1658/12 1706/6 1735/10 1735/11</p> <p>linearly [2] 1654/25 1735/12</p> <p>lined [1] 1697/10</p> <p>lines [8] 1657/4 1678/23 1724/14 1737/8 1737/11 1738/19 1744/24 1795/18</p> <p>linked [1] 1655/23</p> <p>LinkedIn [1] 1789/15</p> <p>liquid [16] 1758/6 1760/15 1763/13 1766/11 1766/13 1766/15 1766/17 1769/8 1772/8 1772/9 1772/14 1775/15 1778/3 1778/19 1792/16 1793/19</p>
<p>K</p> <p>K-BOP [6] 1638/24 1641/14 1728/10 1728/11 1734/2 1736/3</p> <p>K-well [5] 1688/23 1689/13 1689/16 1690/6 1734/2</p> <p>Kanner [2] 1629/2 1629/3</p> <p>KARIS [3] 1629/21 1756/5 1784/22</p> <p>Katz [2] 1627/18 1630/21</p> <p>keep [4] 1708/13 1715/20 1728/5 1769/15</p> <p>keeping [1] 1692/13</p> <p>Kelkar [3] 1788/19 1798/13 1798/17</p> <p>KERRY [1] 1630/13</p> <p>kill [4] 1660/6 1672/18 1718/12 1718/15</p> <p>kind [4] 1638/6 1667/12 1731/21 1737/3</p> <p>kinds [2] 1708/14 1726/25</p> <p>kink [7] 1648/20 1648/21 1653/10 1653/13 1653/18 1715/3 1733/7</p> <p>kinked [3] 1653/19 1656/17 1659/4</p> <p>KIRBY [1] 1631/15</p> <p>Kirkland [3] 1629/20 1630/2 1630/5</p> <p>know [133] 1635/24 1639/2 1641/16 1641/17 1646/19 1646/21 1647/1 1647/5 1647/6 1647/15 1648/19 1648/22 1648/23 1649/2 1649/3 1649/18 1652/17 1653/1 1653/4 1653/5 1653/18 1653/19 1654/20 1655/5 1656/3 1660/5 1670/6 1670/8 1671/11 1672/23 1672/24 1677/15 1677/19 1677/25 1678/21 1679/8 1681/9 1681/10 1681/12 1681/14 1681/17 1682/24 1683/7 1684/15 1685/2 1686/15 1689/7 1691/14 1692/20 1693/9 1693/12 1695/9 1696/7 1696/18 1697/2 1697/4 1697/21 1697/21</p> <p>1701/12 1701/12 1701/14 1701/20 1701/23 1701/24 1703/1 1704/8 1705/8 1706/4 1706/8 1706/17 1706/18 1707/9 1707/12 1707/13 1708/10 1709/22 1710/19 1710/24 1711/4 1712/2 1712/14 1713/10 1713/20 1714/6 1714/25 1718/3 1718/5 1724/2 1724/8 1724/21 1726/21 1726/22 1727/16 1728/16 1729/9 1729/10 1731/6 1731/23 1733/12 1738/12 1738/19</p>	<p>L</p> <p>lab [3] 1764/17 1773/7 1779/20</p> <p>laboratories [7] 1757/10 1763/24 1764/7 1781/15 1782/8 1790/23 1790/25</p> <p>laboratory [11] 1754/13 1759/6 1764/23 1764/25 1765/16 1767/12 1767/13 1767/15 1795/15 1795/23 1796/9</p> <p>laboratory-reported [1] 1767/15</p> <p>labs [6] 1764/15 1764/16 1767/5 1767/6 1792/12 1792/15</p> <p>laed.uscourts.gov [1] 1631/20</p> <p>Lafayette [1] 1627/24</p> <p>Lake [1] 1628/14</p> <p>Lamar [1] 1631/9</p> <p>LANGAN [2] 1629/21 1633/7</p> <p>language [1] 1788/3</p> <p>large [1] 1777/2</p> <p>largely [3] 1688/17 1698/19 1727/6</p> <p>larger [7] 1642/19 1664/8 1664/10 1665/5 1665/14 1667/4 1738/10</p> <p>largest [4] 1675/21 1675/24 1676/2 1713/7</p> <p>Lasalle [1] 1629/23</p> <p>laser [5] 1648/4 1648/6 1656/19 1656/23 1768/14</p> <p>last [17] 1636/18 1637/3 1643/8 1643/9 1647/8 1672/11 1693/15 1698/6 1719/2 1734/22 1740/22 1750/8 1750/23 1751/15 1754/9 1756/10 1756/17</p> <p>later [8] 1642/25 1643/17 1703/15 1710/9 1712/21 1750/5 1750/5 1756/6</p> <p>law [2] 1628/6 1752/13</p> <p>lawyer [1] 1722/4</p> <p>lead [1] 1690/24</p> <p>leak [1] 1712/17</p> <p>leaks [4] 1653/15 1653/17 1653/25 1654/1</p> <p>leap [2] 1686/14 1689/18</p> <p>learn [1] 1639/18</p> <p>LEASING [1] 1627/8</p> <p>least [11] 1639/11 1643/13 1660/8 1688/5 1711/2 1712/14 1760/4 1783/7 1784/13 1788/21 1796/5</p> <p>leave [2] 1773/1 1796/18</p> <p>leaving [2] 1753/22 1758/10</p> <p>leeway [1] 1740/3</p> <p>left [11] 1648/5 1651/25 1652/8 1652/15 1683/3 1698/25 1745/10 1750/12 1755/21 1783/16 1792/25</p> <p>left-hand [1] 1792/25</p> <p>legal [2] 1776/2 1785/7</p> <p>length [2] 1690/18 1709/22</p> <p>lengthy [1] 1745/21</p> <p>less [29] 1644/15 1644/16 1650/5 1658/4 1694/18 1701/1 1704/19 1719/11 1722/21 1722/25 1723/4</p>	<p>1725/16 1725/25 1727/17 1727/25 1728/3 1730/11 1737/23 1742/8 1742/11 1742/12 1742/14 1742/18 1758/9 1768/5 1770/24 1771/1 1783/3 1784/4</p> <p>let [22] 1635/14 1645/5 1651/6 1657/24 1665/23 1666/23 1667/11 1684/11 1703/13 1732/20 1733/17 1736/11 1740/12 1740/20 1741/23 1745/21 1746/2 1747/4 1762/16 1799/3 1800/12 1800/16</p> <p>let's [41] 1639/20 1641/6 1644/17 1647/8 1647/24 1649/4 1649/24 1651/14 1651/18 1654/4 1654/5 1656/8 1660/20 1661/14 1669/19 1671/9 1672/11 1673/1 1678/10 1678/15 1694/5 1703/1 1706/22 1706/24 1713/22 1715/21 1722/7 1724/11 1724/22 1734/20 1740/8 1746/25 1750/8 1750/8 1753/8 1758/22 1768/9 1768/14 1770/16 1782/1 1790/16</p> <p>level [2] 1670/16 1686/20</p> <p>leveraged [1] 1720/3</p> <p>Levin [1] 1628/2</p> <p>Lewis [3] 1629/17 1631/2 1631/7</p> <p>LI [1] 1630/20</p> <p>Liao [2] 1741/2 1741/5</p> <p>life [1] 1663/22</p> <p>light [4] 1771/21 1771/23 1771/24 1779/3</p> <p>like [52] 1633/8 1633/17 1644/9 1645/20 1647/17 1651/22 1652/19 1653/4 1655/15 1655/18 1656/21 1658/18 1664/11 1670/5 1672/16 1672/17 1672/19 1673/14 1682/17 1696/14 1699/1 1703/23 1703/24 1708/12 1714/19 1716/5 1724/22 1730/10 1736/8 1736/22 1737/8 1738/11 1738/19 1739/6 1740/4 1743/11 1748/16 1751/25 1752/5 1763/14 1772/12 1774/4 1775/7 1776/12 1776/25 1777/2 1778/19 1779/12 1781/11 1788/21 1797/20 1799/20</p> <p>likely [12] 1649/15 1717/18 1717/19 1717/24 1726/3 1747/17 1757/11 1763/7 1781/19 1797/8 1799/23 1800/5</p> <p>likewise [2] 1785/21 1786/11</p> <p>limine [4] 1752/10 1797/1 1797/15 1797/24</p> <p>limited [1] 1719/19</p> <p>limits [1] 1633/14</p> <p>line [38] 1637/12 1655/20 1657/6 1665/14 1672/18 1699/15 1713/15 1720/18 1724/14 1724/15 1724/17 1728/3 1730/23 1732/15 1734/10 1734/11 1734/12 1734/13 1734/18 1735/4 1735/14 1735/19 1735/19 1735/21 1735/22 1736/7 1738/23 1742/2 1745/4 1748/15 1749/21 1755/20 1756/10 1756/15 1756/17 1765/11 1783/12 1795/19</p> <p>linear [5] 1654/23 1658/12 1706/6 1735/10 1735/11</p> <p>linearly [2] 1654/25 1735/12</p> <p>lined [1] 1697/10</p> <p>lines [8] 1657/4 1678/23 1724/14 1737/8 1737/11 1738/19 1744/24 1795/18</p> <p>linked [1] 1655/23</p> <p>LinkedIn [1] 1789/15</p> <p>liquid [16] 1758/6 1760/15 1763/13 1766/11 1766/13 1766/15 1766/17 1769/8 1772/8 1772/9 1772/14 1775/15 1778/3 1778/19 1792/16 1793/19</p>

L	LP [2] 1631/12 1631/15 LUIS [1] 1630/20 lunch [1] 1637/23 Lundy [3] 1628/12 1628/12 1628/13 Luxenberg [1] 1628/9	1725/10 1726/12 1726/12 1726/13 1726/13 1726/20 1726/21 1726/21 1726/23 1727/6 1727/13 1727/13 1728/3 1729/5 1729/5 1730/6 1730/6 1731/18 1731/18 1732/6 1732/6 1732/8 1732/8 1732/16 1732/16 1732/21 1732/21 1732/21 1732/22 1733/7 1737/21 1744/6 1745/4 1745/4 1745/6 1749/21 1750/12 1756/5 1766/15 1773/1 1777/21 1777/22 1784/18 1798/2 May 14 [1] 1726/20 May 14th [8] 1724/24 1724/25 1725/10 1726/12 1726/21 1728/3 1732/6 1732/16 May 14th and [1] 1729/5 May 14th time [1] 1724/19 May 14th to [3] 1727/13 1732/8 1732/21 May 15th and [1] 1730/6 May 19th [6] 1727/6 1727/13 1729/5 1730/6 1732/8 1732/22 May 19th are [1] 1731/18 May 19th is [1] 1732/21 May 19th with [1] 1733/7 May 26th [1] 1745/6 May 26th to [1] 1745/4 May 27th [7] 1656/24 1657/3 1657/14 1658/11 1659/1 1660/4 1660/8 May 27th is [1] 1660/5 May 30th [1] 1745/4 May 8th [19] 1638/20 1643/8 1643/8 1646/8 1675/9 1675/13 1690/19 1699/2 1699/8 1706/6 1710/14 1713/4 1713/23 1718/8 1718/10 1726/23 1737/21 1749/21 1750/12 May 8th and [4] 1725/10 1726/12 1726/21 1731/18 May 8th backwards [1] 1699/16 May 8th isn't [1] 1699/25 May 8th of [1] 1714/3 May 8th on [2] 1639/11 1647/4 May 8th through [1] 1674/17 May 8th to [5] 1724/19 1724/24 1724/25 1732/6 1732/16 May 8th value [1] 1706/1 May 8th, there [1] 1646/7 maybe [12] 1649/19 1650/15 1663/25 1686/24 1693/12 1697/9 1697/9 1697/10 1706/22 1731/4 1797/10 1800/12 MAZE [1] 1628/19 McCutchen [1] 1631/14 MD [1] 1627/4 me [50] 1638/14 1645/5 1651/6 1657/10 1657/24 1658/10 1659/18 1663/24 1663/24 1664/1 1665/23 1666/23 1671/4 1672/20 1679/15 1680/10 1684/11 1695/4 1696/8 1696/14 1699/20 1703/13 1708/16 1711/5 1711/6 1712/16 1714/4 1719/19 1722/13 1725/1 1732/20 1733/17 1736/11 1740/13 1740/20 1741/23 1745/21 1746/2 1746/10 1747/4 1756/5 1757/23 1762/16 1784/14 1787/18 1790/4 1796/19 1796/20 1798/9 1798/10 mean [27] 1633/14 1642/19 1647/12 1664/17 1667/5 1670/3 1672/22 1677/19 1694/1 1701/12 1701/21 1712/1 1713/24 1714/17 1726/16 1726/16 1726/22 1730/25 1733/8 1733/10 1739/15 1741/14 1742/19 1743/11 1744/13 1765/15 1777/16
liquid-like [1] 1778/19 liquids [3] 1769/4 1769/5 1776/10 Liskow [1] 1629/17 list [6] 1636/9 1636/15 1636/17 1637/4 1637/6 1800/7 literally [1] 1789/22 litigation [2] 1691/11 1738/16 little [31] 1638/10 1643/17 1647/7 1652/10 1652/13 1652/14 1658/3 1681/10 1682/17 1708/23 1717/2 1722/13 1723/10 1731/9 1731/10 1731/15 1731/22 1731/25 1737/23 1738/13 1741/2 1745/12 1745/13 1758/16 1771/9 1775/9 1784/5 1786/15 1790/16 1798/5 1798/10 live [6] 1633/16 1757/17 1758/2 1760/20 1765/24 1771/17 LLC [8] 1627/18 1627/22 1629/2 1630/12 1630/13 1630/16 1630/19 1631/11 LLP [8] 1628/12 1629/20 1630/2 1630/5 1630/9 1630/15 1630/18 1631/14 location [2] 1650/4 1690/23 lock [2] 1684/24 1685/12 locked [3] 1734/2 1734/2 1734/3 long [9] 1646/19 1690/2 1696/5 1699/21 1710/1 1739/1 1743/11 1772/17 1795/11 longer [5] 1648/24 1695/6 1696/4 1696/24 1712/9 look [39] 1634/10 1641/16 1642/3 1642/4 1643/13 1648/19 1651/24 1652/12 1652/19 1652/21 1653/10 1653/16 1659/6 1659/11 1659/14 1665/23 1672/11 1677/25 1684/2 1704/8 1712/13 1714/2 1736/8 1736/22 1737/8 1738/19 1750/8 1763/21 1789/11 1790/18 1791/4 1793/18 1794/12 1794/14 1794/17 1794/22 1795/7 1795/18 1798/1 looked [29] 1640/16 1651/7 1656/16 1659/3 1659/5 1662/14 1664/15 1666/3 1666/15 1666/20 1667/8 1695/15 1698/20 1707/24 1728/7 1737/11 1747/13 1763/19 1765/9 1773/8 1774/3 1777/2 1788/12 1788/21 1788/22 1792/15 1792/16 1793/1 1793/13 looking [15] 1639/9 1651/3 1652/2 1652/4 1661/17 1708/5 1711/22 1713/16 1713/16 1717/1 1724/1 1738/12 1739/4 1783/6 1793/17 looks [1] 1658/18 loosely [1] 1667/12 Los [2] 1630/4 1630/22 lose [1] 1781/23 lost [3] 1705/23 1748/25 1750/6 lot [10] 1645/20 1673/8 1686/20 1709/23 1740/3 1744/5 1758/3 1760/17 1781/23 1799/13 lots [1] 1715/2 LOUISIANA [15] 1627/2 1627/6 1627/20 1627/24 1628/8 1628/14 1628/22 1628/24 1629/3 1629/4 1629/19 1630/14 1631/13 1631/19 1801/5 low [4] 1638/7 1704/12 1712/16 1731/9 lower [19] 1648/9 1675/2 1703/11 1704/15 1706/7 1708/21 1708/23 1710/16 1710/20 1711/6 1716/10 1719/13 1727/20 1746/10 1746/19 1769/2 1769/3 1769/3 1778/21 lowest [1] 1724/14	M Macondo [27] 1669/3 1673/3 1677/9 1677/9 1677/10 1679/14 1679/19 1680/8 1680/13 1680/13 1680/19 1688/9 1710/7 1741/8 1757/1 1757/17 1759/9 1760/2 1771/17 1771/17 1773/23 1785/11 1785/22 1786/2 1790/22 1791/15 1793/22 made [13] 1633/16 1633/18 1634/11 1643/1 1643/18 1644/24 1660/9 1693/18 1710/6 1744/22 1755/18 1776/8 1792/3 Magazine [1] 1628/7 magnitude [1] 1706/9 main [8] 1640/17 1640/24 1646/4 1658/25 1709/8 1768/24 1769/5 1775/11 make [18] 1637/13 1642/9 1651/23 1657/9 1659/24 1697/18 1699/10 1703/13 1710/15 1710/20 1710/21 1711/6 1729/7 1730/18 1730/21 1738/7 1780/7 1799/2 makes [14] 1657/10 1659/18 1688/2 1688/5 1693/16 1697/1 1702/2 1704/5 1705/18 1731/4 1760/19 1772/17 1779/21 1780/10 making [2] 1712/15 1774/5 manner [1] 1635/20 many [9] 1733/8 1741/13 1741/14 1758/13 1758/13 1761/6 1762/12 1770/25 1789/21 mapping [1] 1737/3 marshals [1] 1798/9 MARTIN [3] 1630/3 1798/25 1799/16 MARTINEZ [1] 1631/3 mass [4] 1684/17 1684/18 1685/4 1772/18 match [1] 1685/6 matched [3] 1691/22 1741/17 1767/12 matches [1] 1790/19 matching [2] 1655/24 1770/20 material [2] 1653/19 1653/21 material's [1] 1653/20 materials [1] 1790/9 Matt [1] 1674/3 matter [18] 1637/2 1655/1 1695/19 1696/11 1697/12 1705/24 1731/13 1731/15 1731/16 1731/17 1751/25 1754/8 1754/24 1755/6 1759/22 1795/15 1795/24 1801/8 matters [3] 1633/6 1636/6 1697/3 MATTHEW [2] 1628/13 1629/22 mature [1] 1751/15 maximize [1] 1780/21 maximum [2] 1714/3 1749/7 MAXIMUS [4] 1662/2 1666/11 1666/18 1668/10 may [87] 1633/24 1638/20 1639/11 1643/8 1643/8 1646/7 1646/8 1647/4 1654/6 1656/24 1657/3 1657/14 1658/11 1659/1 1660/4 1660/5 1660/8 1665/24 1673/22 1674/17 1675/9 1675/13 1690/19 1697/23 1699/2 1699/8 1699/16 1699/25 1706/1 1706/6 1710/14 1713/4 1713/23 1714/3 1718/8 1718/10 1724/19 1724/19 1724/24 1724/24 1724/25 1724/25 1725/10	

M		
meaning [3] 1642/15 1677/21 1729/14	1746/17 1746/18 1746/19	1766/14 1766/14 1768/7 1770/2 1770/5
means [10] 1633/22 1639/18 1684/15	minute [11] 1637/7 1645/5 1647/8	1778/18 1778/19 1780/23 1784/5
1701/21 1708/16 1735/10 1735/10	1656/9 1657/24 1665/7 1682/25	1790/2
1742/12 1762/5 1765/16	1701/20 1710/13 1715/22 1798/20	Morgan [2] 1628/15 1628/15
meant [1] 1667/15	minutes [33] 1650/7 1650/14 1650/23	morning [3] 1796/17 1799/21 1800/1
measure [3] 1640/21 1640/22 1698/13	1658/7 1660/16 1670/6 1670/7 1670/8	most [22] 1645/15 1653/8 1694/8
measured [28] 1660/6 1660/8 1660/10	1670/9 1693/12 1696/15 1696/19	1701/9 1713/24 1720/7 1726/3 1733/14
1661/3 1674/13 1678/4 1678/4 1680/10	1696/21 1701/23 1704/17 1704/18	1756/25 1757/5 1764/23 1769/16
1684/19 1684/19 1687/11 1687/14	1704/18 1704/22 1705/8 1705/22	1770/10 1771/7 1783/21 1788/8
1687/15 1687/20 1687/21 1688/4	1705/24 1716/19 1716/25 1716/25	1788/13 1788/23 1791/14 1791/16
1688/5 1688/18 1694/8 1700/14	1717/5 1717/15 1726/9 1748/19 1749/3	1791/19 1792/8
1706/18 1706/20 1767/6 1767/7	1750/5 1750/5 1796/16 1800/10	motion [12] 1751/1 1751/4 1751/5
1790/19 1790/21 1796/1 1796/9	mis [1] 1796/4	1752/10 1752/11 1796/20 1796/23
measurement [4] 1688/2 1688/6	Mischaracterizes [1] 1703/14	1797/1 1797/15 1797/16 1797/24
1688/11 1705/11	missing [3] 1652/19 1664/4 1714/1	1797/24
measurements [5] 1640/21 1683/11	Mississippi [1] 1628/17	motions [3] 1752/8 1752/16 1754/19
1687/22 1688/17 1719/22	misspoke [1] 1796/4	move [4] 1655/25 1669/17 1740/8
mechanical [1] 1631/24	mistake [1] 1755/19	1756/1
mechanisms [2] 1730/21 1770/8	Mister [1] 1747/3	moves [1] 1769/4
mental [4] 1708/2 1708/6 1708/8	Mitchell [1] 1628/2	moving [2] 1672/5 1684/22
1708/18	mix [1] 1777/25	Mr [3] 1691/19 1691/21 1747/2
mention [1] 1779/20	mixing [2] 1778/2 1778/4	Mr. [37] 1633/10 1633/16 1634/7
mentioned [2] 1770/21 1786/6	model [80] 1640/19 1641/22 1643/1	1649/24 1649/25 1673/21 1692/18
met [1] 1693/15	1644/18 1645/4 1646/21 1660/1 1661/1	1693/3 1694/10 1696/2 1704/9 1704/15
methane [3] 1771/23 1773/18 1773/25	1661/5 1661/17 1664/14 1665/2	1704/25 1705/14 1705/16 1716/2
method [15] 1674/5 1677/7 1680/18	1666/18 1666/19 1667/8 1667/10	1717/7 1739/25 1744/5 1745/11
1733/18 1737/19 1739/9 1739/22	1672/13 1672/13 1672/17 1678/3	1745/21 1746/7 1746/20 1746/25
1757/1 1757/24 1758/2 1758/7 1762/24	1678/5 1678/8 1678/11 1678/16 1679/8	1747/1 1747/5 1747/12 1747/13
1763/1 1763/2 1772/7	1679/21 1680/11 1681/4 1681/8 1683/6	1747/21 1747/25 1748/7 1748/10
methodology [24] 1645/6 1674/12	1684/23 1685/8 1687/18 1710/18	1748/22 1749/2 1749/12 1749/15
1674/20 1677/5 1677/23 1679/2	1736/21 1743/9 1743/17 1743/20	1799/15
1679/21 1680/9 1680/25 1681/20	1759/11 1762/18 1763/2 1767/2 1768/9	Mr. Brock [1] 1799/15
1681/22 1689/5 1691/8 1698/12	1768/13 1768/20 1769/10 1772/14	Mr. Bushnell [2] 1633/10 1633/16
1710/18 1728/18 1728/20 1731/8	1774/24 1775/2 1776/17 1776/17	Mr. Bushnell's [1] 1634/7
1735/3 1742/14 1742/21 1742/25	1778/14 1779/19 1783/22 1785/1	Mr. Emilsen [10] 1692/18 1694/10
1758/22 1781/11	1786/25 1788/13 1788/15 1788/22	1704/9 1704/15 1704/25 1705/16
methods [11] 1733/17 1737/12 1737/14	1790/18 1790/19 1791/5 1791/9	1717/7 1747/5 1748/10 1749/2
1737/16 1737/22 1738/4 1739/9	1791/14 1791/17 1791/18 1791/18	Mr. Emilsen's [7] 1693/3 1696/2 1705/14
1739/15 1739/21 1759/12 1759/13	1791/21 1792/1 1792/2 1792/3 1792/4	1747/1 1747/12 1747/13 1747/21
MEXICO [1] 1627/5	1792/6 1792/6 1792/6 1792/10 1792/11	Mr. Regan [14] 1673/21 1716/2 1739/25
mic [2] 1638/10 1651/6	1794/13 1795/13 1795/22	1744/5 1745/11 1745/21 1746/7
MICHAEL [1] 1630/19	modeling [38] 1645/13 1645/13 1650/17	1746/20 1746/25 1747/25 1748/7
microphone [1] 1717/2	1657/22 1660/2 1660/4 1661/20 1662/9	1748/22 1749/12 1749/15
mid [1] 1765/3	1662/10 1662/12 1662/20 1662/21	Mr. Shanks [1] 1649/25
mid-April [1] 1765/3	1663/5 1666/2 1666/3 1666/15 1666/16	Mr. Shanks' [1] 1649/24
middle [4] 1723/16 1724/15 1745/9	1667/1 1669/2 1669/5 1680/5 1741/5	Ms. [3] 1756/5 1796/19 1796/23
1747/10	1741/7 1741/8 1741/9 1753/9 1753/15	Ms. Cross [1] 1796/23
might [15] 1633/9 1640/6 1646/3 1649/2	1753/17 1753/18 1753/25 1754/1	Ms. Himmelhoch [1] 1796/19
1655/1 1667/18 1685/25 1693/24	1754/10 1771/16 1774/3 1787/4	Ms. Karis [1] 1756/5
1700/7 1725/19 1726/4 1726/18	1788/10 1789/9 1790/21	much [19] 1641/20 1651/22 1656/5
1726/24 1736/11 1758/19	models [11] 1668/10 1672/15 1677/3	1659/14 1664/8 1664/10 1665/5
MIKE [1] 1630/9	1741/13 1742/10 1754/14 1782/16	1665/14 1675/4 1677/20 1679/6 1685/6
miles [1] 1655/17	1786/22 1790/17 1793/14 1795/9	1700/12 1712/10 1733/10 1766/1
MILLER [1] 1630/13	modifies [1] 1774/12	1769/2 1775/7 1793/19
million [28] 1639/2 1639/21 1640/2	modifying [1] 1772/7	mud [1] 1720/18
1640/6 1643/24 1644/15 1671/10	moles [1] 1773/13	multi [12] 1660/21 1758/7 1758/12
1671/13 1671/14 1673/4 1673/6	moment [6] 1692/8 1701/15 1701/19	1758/16 1764/7 1765/12 1765/17
1674/21 1674/21 1675/2 1675/7 1676/5	1701/20 1705/11 1748/16	1765/22 1768/5 1768/6 1773/12
1676/6 1682/3 1713/6 1713/25 1713/25	Monday [3] 1798/2 1798/2 1798/8	1780/19
1729/25 1731/13 1742/24 1743/5	money [1] 1781/23	multi-stage [11] 1758/7 1758/12
1743/8 1743/10 1743/20	monograph [2] 1789/24 1790/8	1758/16 1764/7 1765/12 1765/17
mind [4] 1645/12 1708/13 1713/1	Montgomery [1] 1628/20	1765/22 1768/5 1768/6 1773/12
1728/5	months [8] 1650/15 1650/24 1660/17	1780/19
mine [7] 1677/20 1678/3 1738/7 1749/2	1693/13 1695/2 1695/7 1695/19	multiphase [10] 1643/11 1645/2 1660/21
1771/2 1775/7 1792/5	1696/21	1660/25 1661/1 1661/4 1661/7 1661/11
miniscule [1] 1644/16	more [41] 1639/17 1640/20 1645/19	1681/4 1691/21
minor [1] 1791/8	1652/10 1673/17 1685/6 1697/15	multiple [3] 1640/16 1660/6 1670/21
minus [20] 1641/23 1642/1 1642/4	1717/18 1717/23 1719/11 1720/9	multiply [1] 1762/10
1642/10 1642/11 1642/15 1642/20	1722/12 1722/22 1722/25 1723/5	multiplying [1] 1668/23
1643/25 1644/7 1670/1 1670/19 1719/7	1723/10 1726/1 1729/7 1730/18	multistage [6] 1757/2 1781/25 1793/4
1719/9 1731/3 1731/4 1744/24 1745/12	1730/20 1740/5 1743/16 1747/17	1793/10 1793/14 1793/18
	1758/10 1758/16 1763/11 1763/11	Munger [1] 1630/18
	1763/13 1765/24 1765/25 1766/1	must [4] 1692/10 1746/23 1760/18

<p>M</p> <p>must... [1] 1797/21</p> <p>my [119] 1637/13 1640/2 1640/5 1640/6 1640/19 1641/2 1641/12 1641/22 1642/1 1643/6 1644/14 1645/1 1646/21 1651/6 1653/15 1654/19 1657/25 1661/4 1667/9 1670/23 1670/25 1671/13 1671/17 1673/18 1673/18 1674/12 1676/3 1677/5 1678/1 1678/5 1678/6 1679/5 1680/25 1681/10 1686/15 1686/18 1687/18 1689/5 1689/15 1690/7 1690/18 1692/18 1693/10 1693/11 1693/17 1693/23 1694/3 1694/18 1697/2 1698/21 1700/12 1700/22 1700/22 1704/3 1704/14 1704/15 1705/20 1705/20 1707/15 1708/11 1708/13 1710/13 1710/18 1710/18 1710/18 1713/7 1713/23 1716/8 1719/23 1720/6 1720/10 1724/21 1728/5 1728/9 1731/8 1734/17 1740/17 1740/18 1740/21 1742/25 1743/13 1743/15 1746/22 1748/22 1750/22 1753/11 1753/24 1754/4 1754/9 1755/16 1756/25 1757/3 1757/7 1757/11 1757/16 1760/6 1764/11 1767/1 1767/11 1768/20 1769/11 1770/9 1770/20 1770/21 1771/2 1771/3 1772/6 1775/17 1776/6 1776/17 1776/17 1777/24 1783/21 1783/22 1795/8 1795/9 1796/6 1798/25 1801/6</p> <p>myself [1] 1794/9</p>	<p>night [2] 1636/18 1691/22</p> <p>nine [16] 1692/16 1693/4 1693/6 1693/8 1693/9 1693/11 1693/14 1693/15 1693/19 1693/21 1694/1 1694/18 1695/1 1695/6 1696/11 1696/18</p> <p>nine-hour [1] 1693/19</p> <p>no [106] 1634/9 1635/5 1636/18 1638/19 1646/8 1648/24 1657/10 1659/18 1660/9 1662/3 1663/2 1664/13 1668/4 1670/4 1671/16 1672/17 1673/20 1676/6 1676/22 1685/18 1685/22 1687/22 1688/10 1688/11 1689/12 1689/12 1689/20 1690/4 1690/7 1690/11 1692/17 1693/14 1693/16 1694/19 1695/5 1696/4 1697/1 1697/18 1699/20 1699/20 1700/22 1701/12 1701/18 1701/21 1702/2 1703/16 1704/5 1705/18 1706/17 1706/17 1709/5 1711/4 1712/8 1712/17 1712/21 1713/2 1717/15 1720/7 1724/23 1727/6 1728/16 1729/14 1729/14 1730/7 1730/7 1731/15 1731/15 1732/14 1733/8 1734/14 1734/18 1735/5 1735/21 1738/25 1738/25 1739/1 1739/22 1741/10 1741/16 1743/8 1746/9 1746/9 1748/23 1749/7 1749/19 1750/1 1750/2 1750/13 1750/13 1750/14 1754/18 1755/25 1772/12 1779/17 1781/17 1782/22 1783/5 1786/7 1786/11 1788/14 1790/1 1795/1 1795/15 1795/23 1797/21 1799/8</p> <p>noise [5] 1718/12 1718/14 1729/16 1730/21 1730/24</p> <p>nominally [1] 1675/17</p> <p>none [3] 1636/23 1740/11 1751/13</p> <p>nonetheless [1] 1752/14</p> <p>nonflowing [4] 1702/10 1702/14 1702/14 1749/25</p> <p>nonindustry [1] 1645/4</p> <p>nonindustry-standard [1] 1645/4</p> <p>NONJURY [1] 1627/14</p> <p>normal [7] 1757/13 1762/19 1770/15 1772/10 1772/22 1780/20 1780/22</p> <p>normally [3] 1678/19 1741/12 1765/23</p> <p>North [1] 1628/23</p> <p>Nos [1] 1752/11</p> <p>not [226]</p> <p>notation [1] 1637/6</p> <p>note [3] 1754/18 1755/15 1800/19</p> <p>nothing [9] 1658/14 1666/7 1680/13 1689/17 1690/9 1697/3 1704/7 1716/18 1728/5</p> <p>November [1] 1678/23</p> <p>November 14th [1] 1678/23</p> <p>now [54] 1634/13 1634/21 1635/4 1637/25 1639/20 1641/6 1642/25 1643/23 1644/17 1644/17 1647/24 1649/24 1650/6 1654/4 1656/8 1659/25 1661/16 1663/18 1664/7 1670/11 1671/19 1672/9 1675/9 1690/6 1695/6 1696/5 1696/12 1710/1 1710/2 1710/13 1726/12 1736/6 1740/1 1751/12 1760/19 1770/16 1779/12 1784/24 1785/10 1786/15 1787/2 1787/6 1788/12 1788/25 1790/16 1792/9 1793/17 1794/17 1794/20 1796/8 1797/9 1798/1 1798/10 1799/6</p> <p>nowhere [1] 1775/23</p> <p>nozzle [1] 1647/17</p> <p>nuclear [2] 1673/14 1673/15</p> <p>number [32] 1633/15 1640/4 1640/8 1669/13 1673/7 1687/11 1687/12</p>	<p>1687/14 1687/15 1687/19 1688/3 1697/20 1698/16 1703/10 1703/10 1711/10 1711/12 1711/14 1711/18 1714/16 1724/21 1724/21 1731/4 1738/2 1746/22 1761/17 1761/18 1762/10 1762/11 1762/13 1762/19 1763/8</p> <p>numbered [1] 1801/8</p> <p>numbers [11] 1644/1 1644/2 1659/22 1697/22 1697/23 1697/23 1704/13 1713/10 1742/12 1767/8 1767/9</p> <p>numerical [1] 1688/1</p>
<p>N</p> <p>N-pentane [1] 1773/19</p> <p>N.W [3] 1630/7 1630/10 1631/16</p> <p>name [5] 1671/24 1750/20 1750/22 1750/22 1750/23</p> <p>narrow [1] 1640/1</p> <p>NATHANIEL [1] 1629/12</p> <p>Natural [1] 1629/10</p> <p>nature [1] 1719/22</p> <p>necessarily [4] 1642/19 1669/14 1730/9 1730/10</p> <p>need [14] 1646/17 1681/12 1681/14 1681/17 1682/24 1710/15 1731/23 1759/18 1761/6 1761/10 1782/1 1782/4 1782/5 1800/10</p> <p>needed [1] 1666/16</p> <p>negative [5] 1644/6 1644/6 1644/11 1674/24 1714/23</p> <p>negligible [2] 1639/12 1639/14</p> <p>neither [2] 1692/18 1782/15</p> <p>Nesic [10] 1656/8 1656/14 1657/25 1658/8 1658/21 1660/1 1715/6 1715/11 1715/16 1733/9</p> <p>Nesic's [3] 1656/11 1660/12 1660/17</p> <p>net [9] 1716/12 1716/15 1717/7 1717/17 1717/23 1747/5 1747/10 1747/16 1747/16</p> <p>never [14] 1634/14 1634/17 1634/17 1644/10 1645/19 1669/3 1669/3 1679/18 1680/15 1680/17 1708/6 1738/15 1762/20 1794/25</p> <p>nevertheless [1] 1639/1</p> <p>new [11] 1627/6 1627/20 1628/8 1628/11 1628/11 1629/4 1629/19 1630/14 1631/13 1631/19 1715/20</p> <p>next [11] 1669/20 1697/7 1750/17 1768/25 1769/6 1797/8 1798/3 1798/17 1800/3 1800/5 1800/6</p> <p>nice [1] 1769/12</p>	<p>noise [5] 1718/12 1718/14 1729/16 1730/21 1730/24</p> <p>nominally [1] 1675/17</p> <p>none [3] 1636/23 1740/11 1751/13</p> <p>nonetheless [1] 1752/14</p> <p>nonflowing [4] 1702/10 1702/14 1702/14 1749/25</p> <p>nonindustry [1] 1645/4</p> <p>nonindustry-standard [1] 1645/4</p> <p>NONJURY [1] 1627/14</p> <p>normal [7] 1757/13 1762/19 1770/15 1772/10 1772/22 1780/20 1780/22</p> <p>normally [3] 1678/19 1741/12 1765/23</p> <p>North [1] 1628/23</p> <p>Nos [1] 1752/11</p> <p>not [226]</p> <p>notation [1] 1637/6</p> <p>note [3] 1754/18 1755/15 1800/19</p> <p>nothing [9] 1658/14 1666/7 1680/13 1689/17 1690/9 1697/3 1704/7 1716/18 1728/5</p> <p>November [1] 1678/23</p> <p>November 14th [1] 1678/23</p> <p>now [54] 1634/13 1634/21 1635/4 1637/25 1639/20 1641/6 1642/25 1643/23 1644/17 1644/17 1647/24 1649/24 1650/6 1654/4 1656/8 1659/25 1661/16 1663/18 1664/7 1670/11 1671/19 1672/9 1675/9 1690/6 1695/6 1696/5 1696/12 1710/1 1710/2 1710/13 1726/12 1736/6 1740/1 1751/12 1760/19 1770/16 1779/12 1784/24 1785/10 1786/15 1787/2 1787/6 1788/12 1788/25 1790/16 1792/9 1793/17 1794/17 1794/20 1796/8 1797/9 1798/1 1798/10 1799/6</p> <p>nowhere [1] 1775/23</p> <p>nozzle [1] 1647/17</p> <p>nuclear [2] 1673/14 1673/15</p> <p>number [32] 1633/15 1640/4 1640/8 1669/13 1673/7 1687/11 1687/12</p>	<p>O</p> <p>O'CONNOR [1] 1630/10</p> <p>O'Keefe [1] 1627/19</p> <p>O'ROURKE [1] 1629/11</p> <p>obey [1] 1658/12</p> <p>object [1] 1662/7</p> <p>objection [10] 1637/9 1662/18 1662/25 1663/2 1669/8 1669/8 1671/23 1689/2 1703/13 1709/18</p> <p>objections [2] 1636/18 1636/21</p> <p>observable [1] 1694/9</p> <p>observation [2] 1779/22 1780/1</p> <p>observed [2] 1653/25 1693/8</p> <p>observes [1] 1646/24</p> <p>obtain [2] 1699/22 1746/13</p> <p>obtained [3] 1767/4 1767/4 1768/2</p> <p>obvious [1] 1767/18</p> <p>occur [5] 1647/6 1655/18 1695/19 1696/20 1794/16</p> <p>occurred [17] 1638/22 1648/25 1650/4 1652/22 1652/23 1653/5 1686/19 1686/22 1691/4 1695/19 1695/25 1726/17 1726/18 1728/18 1728/19 1762/19 1776/22</p> <p>occurring [1] 1650/23</p> <p>occurs [3] 1660/16 1709/5 1762/20</p> <p>ocean [14] 1752/7 1757/6 1758/15 1769/11 1770/12 1773/17 1776/9 1782/11 1783/23 1785/24 1786/4 1794/21 1794/24 1795/2</p> <p>oceanic [35] 1751/12 1751/16 1751/18 1757/4 1757/24 1758/11 1758/24 1763/2 1763/10 1763/20 1768/9 1768/13 1769/20 1770/2 1770/9 1771/8 1771/17 1774/9 1774/10 1774/23 1775/1 1776/6 1778/14 1779/2 1779/9 1779/22 1780/9 1782/3 1782/9 1782/16 1782/18 1782/21 1782/22 1783/1 1783/22</p> <p>October [2] 1627/7 1633/2</p> <p>off [12] 1638/8 1653/17 1670/6 1670/7 1670/8 1720/3 1724/21 1766/16 1770/22 1775/3 1777/15 1777/16</p> <p>offer [7] 1636/19 1640/2 1640/6 1727/6 1774/16 1779/7 1787/9</p> <p>offered [5] 1661/16 1751/9 1779/12 1779/18 1789/1</p> <p>offering [11] 1752/2 1752/4 1755/24 1757/14 1760/10 1784/24 1785/10 1785/13 1785/17 1785/21 1786/1</p> <p>offers [4] 1752/6 1754/17 1770/18 1771/10</p> <p>offhand [1] 1706/4</p> <p>Office [7] 1627/23 1628/4 1628/18 1628/22 1628/23 1629/7 1629/15</p> <p>Official [3] 1631/18 1801/3 1801/12</p> <p>offset [9] 1718/23 1719/2 1719/5 1719/6 1719/9 1719/10 1719/12 1719/17 1720/9</p> <p>offsets [5] 1670/4 1670/4 1670/11</p>

<p>○</p> <p>offsets... [2] 1670/14 1720/1</p> <p>Offshore [3] 1630/13 1630/16 1630/19</p> <p>oh [9] 1644/16 1665/8 1681/9 1697/21 1699/20 1700/22 1724/22 1733/8 1738/25</p> <p>oil [80] 1627/4 1627/4 1661/3 1676/25 1678/5 1679/13 1679/15 1679/18 1681/3 1682/1 1682/5 1684/20 1753/22 1757/1 1758/10 1760/19 1762/21 1763/3 1763/12 1764/6 1765/24 1766/1 1766/18 1767/1 1768/5 1768/7 1768/18 1768/20 1768/22 1769/5 1769/8 1769/10 1769/14 1771/18 1771/20 1772/3 1772/14 1772/15 1772/25 1773/2 1773/2 1773/12 1773/22 1774/7 1774/11 1774/14 1775/4 1775/6 1776/1 1776/21 1777/3 1777/6 1777/7 1777/14 1777/15 1777/16 1778/2 1778/4 1778/8 1778/16 1779/1 1779/5 1779/9 1780/20 1780/21 1781/23 1782/12 1782/16 1783/3 1783/7 1783/13 1783/14 1786/8 1786/12 1792/16 1795/14 1795/23 1796/7 1796/9 1796/20</p> <p>oils [1] 1780/11</p> <p>okay [80] 1633/11 1635/22 1636/4 1637/11 1637/12 1638/3 1638/12 1638/12 1638/16 1642/22 1649/9 1662/25 1665/23 1667/11 1667/15 1668/1 1668/5 1669/17 1669/19 1670/16 1672/7 1699/24 1700/23 1701/25 1702/11 1702/23 1703/17 1703/20 1704/13 1706/4 1706/4 1706/14 1712/25 1721/2 1722/8 1722/14 1724/10 1724/19 1725/1 1725/2 1727/4 1728/17 1728/22 1732/20 1734/24 1736/17 1740/2 1741/19 1742/20 1744/3 1748/10 1748/12 1748/22 1751/6 1751/21 1751/22 1756/6 1756/20 1757/25 1758/18 1761/23 1763/17 1776/12 1778/5 1784/13 1785/10 1787/16 1788/12 1790/16 1791/20 1792/9 1792/19 1793/13 1794/14 1794/22 1795/18 1797/14 1798/2 1799/2 1799/10</p> <p>old [1] 1677/21</p> <p>Olson [1] 1630/18</p> <p>omission [1] 1776/8</p> <p>once [9] 1639/1 1647/7 1669/25 1670/18 1678/6 1697/3 1718/11 1748/14 1769/7</p> <p>one [74] 1633/8 1637/2 1639/17 1640/18 1640/19 1641/6 1642/18 1649/11 1649/24 1650/17 1655/15 1659/13 1663/15 1663/16 1667/18 1671/1 1681/19 1681/19 1682/2 1682/2 1695/15 1696/12 1698/19 1702/23 1712/14 1718/3 1719/20 1719/20 1722/12 1723/7 1726/6 1729/11 1731/20 1733/18 1736/16 1736/16 1737/3 1737/3 1737/21 1739/17 1739/19 1740/5 1741/12 1741/17 1743/16 1744/24 1751/25 1755/15 1760/16 1761/1 1761/6 1761/10 1762/22 1763/7 1765/9 1766/14 1766/25 1771/9 1775/18 1776/7 1777/2 1779/20 1783/22 1784/5 1784/25 1785/3 1788/17 1790/1 1790/9 1790/20 1793/3 1793/4 1796/5 1799/12</p> <p>one's [2] 1739/6 1739/7</p> <p>one-to-one [1] 1737/3</p>	<p>ones [5] 1644/6 1644/6 1644/8 1741/11 1783/17</p> <p>only [29] 1642/16 1642/18 1659/5 1659/20 1662/9 1664/1 1669/9 1670/21 1671/9 1674/17 1677/9 1679/24 1679/24 1680/12 1681/21 1687/1 1694/3 1705/20 1705/20 1719/14 1724/4 1734/25 1736/15 1739/17 1750/2 1760/5 1779/20 1782/22 1797/24</p> <p>open [3] 1635/12 1652/11 1745/6</p> <p>opened [4] 1635/7 1647/7 1745/5 1745/6</p> <p>opening [2] 1755/3 1781/8</p> <p>opens [2] 1647/20 1647/21</p> <p>operating [1] 1762/19</p> <p>opined [1] 1751/11</p> <p>opinion [37] 1633/10 1653/15 1658/25 1660/12 1669/11 1671/14 1696/11 1709/2 1710/9 1712/22 1752/6 1752/18 1756/25 1757/11 1757/14 1757/16 1760/6 1760/10 1769/11 1770/9 1771/10 1771/15 1772/4 1772/6 1774/9 1777/24 1782/13 1783/19 1783/21 1785/7 1785/10 1786/11 1788/5 1788/8 1789/1 1790/1 1791/20</p> <p>opinion's [1] 1771/2</p> <p>opinions [18] 1654/4 1658/21 1658/24 1676/22 1686/19 1751/8 1751/17 1751/17 1755/24 1756/23 1758/23 1784/24 1785/13 1785/21 1786/1 1786/7 1787/10 1790/10</p> <p>opposed [2] 1787/3 1796/9</p> <p>order [15] 1633/24 1633/25 1634/1 1634/7 1634/15 1634/20 1634/23 1635/5 1681/14 1682/25 1780/21 1798/15 1799/7 1799/9 1800/8</p> <p>orient [1] 1721/11</p> <p>orifice [1] 1647/16</p> <p>original [7] 1666/24 1758/19 1766/23 1766/23 1767/10 1778/20 1784/5</p> <p>originated [1] 1653/16</p> <p>origins [1] 1688/2</p> <p>Orleans [8] 1627/6 1627/20 1628/8 1629/4 1629/19 1630/14 1631/13 1631/19</p> <p>orthodox [1] 1679/6</p> <p>other [38] 1633/22 1636/6 1640/20 1649/6 1654/7 1671/19 1677/4 1679/13 1679/15 1680/5 1680/9 1682/9 1682/10 1686/2 1690/16 1693/8 1694/19 1703/2 1712/4 1726/25 1735/10 1736/16 1739/10 1739/23 1750/9 1761/1 1761/5 1761/23 1763/1 1769/16 1771/1 1775/11 1778/2 1782/17 1783/2 1791/22 1793/4 1794/23</p> <p>otherwise [3] 1730/16 1758/5 1768/8</p> <p>our [10] 1635/18 1635/19 1656/9 1669/19 1760/1 1771/12 1782/16 1798/15 1799/13 1800/9</p> <p>out [30] 1643/21 1644/1 1644/12 1648/17 1653/24 1697/7 1703/6 1706/17 1714/15 1727/4 1731/11 1734/20 1744/12 1744/16 1747/9 1747/23 1758/15 1760/18 1760/21 1763/4 1763/9 1763/10 1765/2 1775/4 1776/16 1780/6 1785/18 1786/8 1786/13 1789/6</p> <p>outer [1] 1668/20</p> <p>outlier [2] 1767/18 1767/20</p> <p>output [1] 1662/1</p> <p>outputs [3] 1667/7 1667/8 1667/9</p> <p>outs [3] 1636/9 1636/16 1636/19</p>	<p>outside [9] 1731/18 1731/21 1731/22 1731/24 1745/12 1794/20 1794/21 1794/23 1794/24</p> <p>over [59] 1636/14 1638/25 1641/4 1641/19 1641/24 1644/25 1645/25 1646/3 1646/6 1646/19 1647/3 1651/21 1653/22 1654/18 1654/23 1655/1 1655/13 1655/18 1658/14 1658/22 1660/18 1674/15 1685/14 1686/24 1689/1 1689/2 1689/17 1689/24 1690/6 1690/10 1690/17 1690/25 1694/12 1699/5 1699/10 1699/21 1704/17 1704/22 1713/3 1716/19 1717/15 1734/3 1739/24 1740/14 1740/17 1742/15 1742/22 1743/4 1743/7 1743/13 1745/18 1745/19 1747/5 1748/18 1750/10 1761/14 1762/5 1787/13 1789/17</p> <p>overall [7] 1643/23 1659/12 1679/5 1760/2 1772/21 1791/13 1791/25</p> <p>overpredict [1] 1731/10</p> <p>overpredicted [2] 1767/16 1767/22</p> <p>overpredicts [3] 1795/14 1795/22 1796/1</p> <p>Overruled [2] 1689/4 1709/19</p> <p>overstatement [3] 1689/12 1707/10 1707/15</p> <p>overview [1] 1758/1</p> <p>own [11] 1645/12 1657/22 1670/14 1677/11 1680/2 1686/18 1701/16 1753/11 1753/21 1759/21 1785/7</p> <p>P</p> <p>P-H-A-Z-E-C-O-M-P [1] 1787/19</p> <p>p.m [1] 1705/1</p> <p>PA [1] 1628/3</p> <p>package [1] 1797/22</p> <p>page [23] 1632/2 1664/6 1664/23 1664/24 1665/1 1665/8 1665/11 1665/12 1665/19 1667/19 1667/19 1706/22 1706/23 1744/17 1747/10 1755/3 1755/10 1756/12 1756/13 1765/10 1773/10 1774/21 1776/5</p> <p>page 26 [1] 1773/10</p> <p>pages [4] 1717/22 1764/20 1764/22 1775/22</p> <p>Papantonio [1] 1628/2</p> <p>paper [1] 1708/7</p> <p>papers [2] 1635/19 1676/14</p> <p>paragraph [6] 1664/6 1665/1 1665/12 1716/8 1747/9 1747/12</p> <p>parallel [1] 1664/2</p> <p>parameter [12] 1641/3 1641/13 1641/14 1682/17 1683/5 1683/8 1683/17 1684/8 1684/21 1685/19 1685/21 1687/24</p> <p>parameters [21] 1674/7 1680/7 1680/8 1680/12 1681/4 1683/3 1683/9 1683/12 1684/3 1684/12 1684/18 1684/22 1685/13 1685/17 1686/1 1686/9 1687/4 1739/22 1759/19 1791/22 1791/22</p> <p>Pardon [3] 1663/24 1663/24 1695/4</p> <p>parse [1] 1701/24</p> <p>part [26] 1637/4 1639/16 1642/18 1648/9 1649/15 1650/2 1651/25 1652/5 1656/6 1657/5 1664/25 1687/17 1687/18 1688/5 1688/18 1704/9 1707/15 1707/19 1751/8 1756/13 1769/16 1773/15 1791/16 1791/19 1792/8 1793/17</p> <p>partial [3] 1683/24 1752/10 1787/25</p> <p>particle [2] 1657/15 1657/16</p> <p>particular [11] 1679/24 1679/25 1679/25 1746/8 1754/12 1759/18 1765/17</p>
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P	performs [1] 1774/10 perhaps [2] 1664/4 1706/13 period [52] 1642/7 1643/7 1643/8 1646/15 1647/4 1649/1 1656/1 1658/14 1670/22 1670/23 1671/2 1671/10 1671/11 1674/15 1675/10 1675/22 1675/24 1675/25 1676/6 1689/1 1689/16 1689/21 1690/17 1690/18 1697/4 1699/1 1699/19 1699/21 1700/4 1700/11 1702/25 1704/17 1709/13 1710/14 1711/11 1712/8 1713/6 1714/3 1714/17 1715/17 1717/21 1718/12 1718/15 1719/2 1719/14 1724/19 1732/12 1732/17 1743/8 1746/5 1746/16 1748/18 periods [4] 1670/21 1671/1 1682/9 1682/10 permeability [1] 1688/12 persistent [1] 1718/23 person [3] 1677/12 1677/13 1679/8 personal [1] 1789/2 personally [2] 1650/25 1669/23 perspective [2] 1700/13 1714/2 PETITION [1] 1627/8 PETOSA [1] 1628/16 petroleum [6] 1631/11 1631/14 1753/14 1753/25 1754/3 1754/10 PH.D [3] 1637/14 1750/18 1753/6 phase [25] 1641/17 1643/15 1643/16 1649/11 1649/24 1650/17 1698/22 1718/3 1753/9 1753/19 1754/17 1759/7 1759/9 1759/16 1760/14 1763/13 1768/18 1768/19 1772/14 1777/7 1777/7 1789/23 1789/25 1790/8 1790/13 Phase One [1] 1718/3 phases [1] 1768/18 PhazeComp [5] 1787/16 1787/17 1787/18 1787/18 1788/2 phenomena [2] 1647/6 1660/25 phenomenal [1] 1644/4 phenomenon [1] 1723/8 phrase [1] 1669/10 physical [15] 1642/13 1648/2 1649/20 1660/13 1680/19 1681/25 1686/17 1686/18 1727/6 1730/21 1732/1 1733/6 1745/15 1750/10 1750/13 PI [42] 1654/7 1654/19 1655/1 1655/9 1655/14 1655/16 1655/21 1672/20 1687/10 1687/14 1687/24 1688/8 1688/12 1688/14 1688/16 1688/18 1688/24 1689/6 1689/13 1689/16 1690/6 1690/16 1691/8 1691/12 1692/3 1692/5 1692/8 1692/9 1692/24 1693/4 1696/23 1697/15 1713/3 1713/13 1717/23 1734/2 1734/21 1739/22 1740/10 1740/14 1740/17 1740/22 pick [1] 1712/23 picked [1] 1712/24 picture [1] 1708/9 pictures [6] 1707/25 1708/4 1708/5 1708/6 1712/25 1713/16 piece [13] 1648/4 1648/6 1648/8 1648/17 1648/20 1656/20 1684/17 1706/17 1707/13 1707/14 1709/24 1713/17 1724/4 pink [1] 1652/5 pipe [71] 1648/4 1648/6 1648/8 1648/12 1648/13 1648/14 1648/14 1648/17 1648/20 1649/15 1650/6 1651/4 1651/8 1651/22 1652/5 1652/17 1652/20 1652/24 1652/25 1653/2 1653/3 1653/4 1661/17 1662/3 1662/4 1662/5 1663/6	1663/10 1663/11 1663/12 1663/16 1663/16 1663/17 1663/18 1663/20 1663/20 1663/22 1664/11 1665/6 1667/2 1668/8 1668/19 1690/23 1695/14 1700/8 1700/13 1702/6 1702/9 1705/7 1705/9 1705/23 1709/22 1709/24 1710/1 1710/1 1712/6 1712/9 1712/12 1712/17 1712/19 1712/21 1726/5 1726/10 1726/13 1726/19 1726/23 1727/4 1741/9 1741/10 1748/25 1750/6 pipes [4] 1663/14 1663/14 1663/15 1663/15 place [4] 1640/1 1696/13 1716/19 1784/15 Plaintiffs [7] 1627/18 1627/21 1628/2 1628/6 1628/9 1628/12 1628/15 plan [1] 1798/25 planning [1] 1798/12 Plano [1] 1753/23 plausible [2] 1655/8 1656/7 PLC [5] 1629/19 1629/22 1630/4 1630/7 1630/10 please [39] 1633/5 1637/21 1640/11 1646/12 1647/25 1651/5 1651/18 1658/16 1661/23 1675/12 1716/1 1717/3 1736/10 1747/8 1749/10 1750/20 1753/3 1755/1 1755/8 1756/21 1756/23 1759/1 1760/8 1761/3 1764/13 1765/6 1766/3 1768/10 1768/12 1769/17 1773/4 1774/18 1774/20 1778/11 1780/25 1781/6 1783/8 1783/10 1789/11 pleases [1] 1796/14 plot [2] 1657/5 1744/21 plots [5] 1728/24 1738/6 1738/7 1739/3 1745/3 plug [1] 1695/24 plume [1] 1777/2 plus [19] 1641/23 1642/1 1642/10 1642/11 1642/15 1642/20 1643/25 1670/1 1670/19 1683/21 1685/5 1719/7 1719/9 1731/3 1731/3 1744/24 1745/12 1746/17 1746/18 point [32] 1645/15 1645/16 1645/21 1647/8 1648/8 1648/14 1652/25 1655/24 1666/14 1667/18 1676/4 1688/7 1688/7 1688/8 1694/18 1699/18 1699/19 1699/25 1712/5 1716/14 1732/20 1748/19 1754/16 1785/23 1785/25 1786/3 1794/22 1795/5 1795/7 1795/8 1795/9 1795/12 pointer [1] 1768/14 points [4] 1660/6 1771/1 1781/11 1793/19 Polk [1] 1631/11 Pooladi [11] 1635/21 1662/11 1664/15 1666/4 1666/6 1667/21 1703/6 1703/14 1703/24 1798/13 1798/19 poor [1] 1666/4 portion [2] 1676/2 1685/12 position [3] 1707/3 1707/4 1754/2 positive [4] 1644/8 1644/10 1674/24 1676/4 possible [12] 1654/7 1656/3 1684/19 1707/3 1713/21 1723/2 1730/16 1730/17 1733/2 1735/22 1749/5 1749/7 possibly [1] 1714/23 post [6] 1627/23 1628/4 1628/23 1629/7 1629/15 1646/7 postulate [1] 1708/20 potential [5] 1643/5 1643/11 1645/1 1647/11 1647/12
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<p>P</p> <p>power [4] 1647/23 1657/21 1657/23 1658/3</p> <p>power's [1] 1657/21</p> <p>Poydras [4] 1629/18 1630/13 1631/12 1631/18</p> <p>ppg [1] 1716/12</p> <p>practical [1] 1689/22</p> <p>practically [1] 1689/9</p> <p>practice [1] 1639/16</p> <p>preceding [5] 1685/14 1685/21 1686/24 1703/25 1716/25</p> <p>preclude [1] 1752/11</p> <p>predict [7] 1711/1 1711/4 1711/6 1728/12 1728/16 1734/5 1743/20</p> <p>predicted [1] 1771/1</p> <p>predicting [6] 1710/23 1711/8 1732/12 1732/15 1732/16 1791/22</p> <p>prediction [1] 1753/18</p> <p>predictions [2] 1770/21 1796/10</p> <p>predicts [1] 1791/14</p> <p>predominantly [1] 1773/1</p> <p>prefer [1] 1800/9</p> <p>preliminary [4] 1633/6 1633/8 1636/6 1751/25</p> <p>prepare [4] 1752/25 1754/24 1755/6 1800/14</p> <p>PRESCOTT [1] 1631/4</p> <p>presence [1] 1648/23</p> <p>present [3] 1643/12 1661/4 1772/25</p> <p>presented [1] 1759/21</p> <p>presents [1] 1657/1</p> <p>president [1] 1753/11</p> <p>Press [1] 1742/3</p> <p>pressure [100] 1638/3 1638/4 1638/17 1638/18 1646/24 1654/8 1656/18 1656/21 1656/25 1657/2 1657/11 1660/7 1669/21 1687/8 1691/22 1699/23 1700/3 1700/10 1700/14 1700/24 1701/9 1701/10 1701/16 1702/1 1702/6 1702/8 1702/9 1702/14 1702/15 1702/20 1702/24 1705/4 1705/13 1705/21 1705/24 1716/13 1718/18 1718/19 1719/22 1720/14 1720/15 1720/15 1721/12 1721/17 1723/12 1724/15 1724/17 1725/11 1727/5 1727/19 1729/16 1733/11 1733/14 1734/7 1734/7 1734/10 1734/11 1734/25 1735/1 1735/1 1735/7 1735/12 1736/3 1736/4 1736/18 1736/19 1741/21 1742/3 1742/8 1742/11 1742/22 1743/3 1743/3 1743/7 1743/13 1743/18 1743/18 1743/19 1748/11 1748/15 1748/18 1749/1 1749/5 1749/6 1749/7 1749/16 1750/3 1750/6 1750/10 1758/9 1759/6 1767/8 1775/8 1775/14 1782/10 1793/20 1793/25 1794/14 1795/6 1795/9</p> <p>pressures [52] 1640/22 1645/21 1646/20 1646/20 1646/24 1647/11 1660/2 1660/6 1660/10 1660/10 1669/25 1678/4 1680/10 1683/17 1683/18 1684/3 1684/19 1686/16 1686/17 1687/21 1688/5 1688/17 1694/9 1698/13 1700/8 1700/9 1700/14 1700/16 1702/9 1704/6 1704/6 1704/7 1704/9 1704/12 1704/18 1704/22 1705/2 1705/10 1705/15 1725/20 1728/7 1731/5 1736/15 1737/4 1745/8 1745/12 1748/13 1749/4 1768/22 1769/3 1785/22 1786/2</p> <p>presumably [1] 1649/21</p>	<p>presume [1] 1727/18</p> <p>Pretrial [1] 1634/15</p> <p>pretty [2] 1656/5 1700/12</p> <p>preventer [1] 1763/5</p> <p>previously [2] 1637/4 1637/15</p> <p>primary [1] 1764/23</p> <p>principal [2] 1753/24 1754/9</p> <p>prior [12] 1635/5 1646/8 1667/19 1676/9 1679/14 1679/18 1685/17 1686/5 1711/2 1716/11 1753/21 1765/21</p> <p>probability [1] 1644/16</p> <p>probably [6] 1645/22 1659/2 1677/14 1677/20 1677/22 1722/1</p> <p>problem [2] 1672/19 1677/15</p> <p>problems [1] 1665/2</p> <p>procedures [1] 1762/20</p> <p>proceed [3] 1673/22 1752/17 1784/18</p> <p>proceedings [3] 1631/24 1800/24 1801/7</p> <p>process [54] 1751/9 1751/11 1751/12 1757/3 1757/4 1757/5 1757/9 1757/12 1758/11 1758/12 1758/17 1761/11 1761/13 1763/11 1763/21 1763/23 1764/5 1764/12 1765/19 1765/22 1765/25 1766/5 1766/8 1766/18 1768/15 1769/25 1770/1 1770/2 1770/5 1770/9 1770/13 1771/8 1771/18 1771/19 1776/6 1780/16 1780/20 1781/16 1782/9 1782/11 1782/19 1782/21 1782/23 1783/1 1783/6 1785/3 1785/7 1785/15 1785/19 1793/20 1795/15 1795/16 1795/17 1795/24</p> <p>processes [8] 1754/15 1762/22 1763/22 1783/2 1783/5 1787/11 1796/1 1796/6</p> <p>processing [1] 1781/18</p> <p>Proctor [1] 1628/3</p> <p>produce [6] 1766/19 1766/25 1770/4 1770/6 1778/21 1780/20</p> <p>produced [5] 1738/15 1770/15 1771/18 1772/10 1796/8</p> <p>produces [1] 1783/7</p> <p>producing [1] 1762/21</p> <p>product [1] 1684/5</p> <p>production [21] 1627/10 1629/18 1629/18 1629/21 1629/21 1630/3 1630/3 1630/6 1630/6 1630/9 1630/10 1661/17 1663/12 1664/9 1757/12 1757/13 1765/13 1765/19 1765/21 1772/22 1780/22</p> <p>productivity [13] 1654/7 1654/17 1655/6 1655/23 1674/6 1674/7 1687/5 1687/22 1688/24 1692/21 1694/11 1694/17 1697/15</p> <p>professional [3] 1753/8 1753/20 1789/3</p> <p>professionally [1] 1789/6</p> <p>proficient [1] 1789/8</p> <p>profiles [1] 1782/10</p> <p>program [3] 1787/21 1787/24 1788/1</p> <p>projects [1] 1789/21</p> <p>propagates [1] 1642/3</p> <p>proper [1] 1785/6</p> <p>properties [2] 1753/18 1759/16</p> <p>proportion [1] 1675/25</p> <p>proportional [4] 1657/17 1661/15 1735/12 1737/2</p> <p>propose [1] 1670/14</p> <p>proposed [2] 1771/7 1783/14</p> <p>proposition [1] 1694/5</p> <p>prove [1] 1656/3</p> <p>provide [5] 1644/14 1658/21 1694/19 1753/14 1780/13</p> <p>provided [4] 1667/7 1670/22 1671/4 1787/25</p>	<p>provides [2] 1772/18 1780/7</p> <p>psi [36] 1654/20 1670/1 1670/19 1670/23 1671/5 1701/4 1701/11 1701/16 1701/25 1702/13 1702/21 1703/8 1703/10 1703/11 1703/23 1704/13 1704/19 1704/19 1704/23 1705/2 1705/10 1705/11 1705/25 1718/24 1719/9 1724/20 1725/1 1733/15 1733/15 1733/16 1744/25 1749/1 1749/4 1750/7 1766/24 1794/1</p> <p>PT [98] 1638/19 1643/18 1643/20 1645/3 1669/21 1669/24 1670/12 1670/13 1670/17 1671/19 1674/14 1674/17 1676/7 1687/8 1699/6 1699/11 1702/6 1702/8 1702/12 1702/20 1703/7 1703/23 1713/15 1718/8 1718/8 1718/10 1718/19 1718/21 1719/6 1719/8 1719/12 1719/17 1720/4 1720/9 1720/14 1720/18 1720/23 1721/12 1721/17 1722/24 1723/3 1723/11 1724/1 1724/2 1724/7 1724/15 1724/20 1725/3 1725/15 1725/25 1727/8 1727/13 1727/16 1727/19 1727/21 1727/24 1728/13 1728/19 1728/20 1729/2 1729/4 1729/13 1729/16 1729/22 1730/6 1730/7 1730/12 1731/3 1731/19 1732/1 1732/4 1732/6 1732/8 1732/21 1733/4 1736/4 1736/6 1736/8 1736/16 1736/18 1736/19 1736/23 1736/24 1737/4 1737/19 1737/20 1744/6 1744/12 1744/22 1745/14 1745/17 1748/1 1748/1 1754/13 1759/6 1760/6 1763/23 1764/22</p> <p>PT-B [97] 1638/19 1643/18 1643/20 1645/3 1669/21 1669/24 1670/12 1670/13 1670/17 1671/19 1674/14 1674/17 1676/7 1687/8 1699/6 1699/11 1702/6 1702/8 1702/12 1702/20 1703/7 1703/23 1713/15 1718/8 1718/8 1718/10 1718/19 1718/21 1719/6 1719/8 1719/12 1719/17 1720/4 1720/9 1720/14 1720/18 1720/23 1721/12 1721/17 1722/24 1723/3 1723/11 1724/1 1724/2 1724/7 1724/15 1724/20 1725/3 1725/15 1725/25 1727/8 1727/13 1727/16 1727/19 1727/21 1727/24 1728/13 1728/19 1728/20 1729/2 1729/4 1729/13 1729/16 1729/22 1730/6 1730/7 1730/12 1731/3 1731/19 1732/1 1732/4 1732/6 1732/8 1732/21 1733/4 1736/4 1736/6 1736/8 1736/16 1736/19 1736/23 1736/24 1737/4 1737/19 1737/20 1744/6 1744/12 1744/22 1745/14 1745/17 1748/1 1748/1 1754/13 1759/6 1760/6 1763/23 1764/22</p> <p>publication [2] 1676/12 1676/19</p> <p>pull [14] 1638/10 1678/22 1682/15 1699/3 1700/17 1706/22 1706/23 1717/2 1724/11 1768/10 1773/4 1774/18 1783/8 1792/20</p> <p>pumps [1] 1716/12</p> <p>pure [1] 1752/13</p> <p>purple [1] 1728/3</p> <p>purpose [8] 1672/23 1677/7 1680/2 1683/8 1746/2 1746/4 1751/17 1764/4</p> <p>purposes [7] 1711/7 1711/8 1759/24 1768/24 1769/6 1776/2 1786/25</p> <p>put [19] 1638/11 1645/17 1661/2 1672/3 1697/13 1698/1 1698/3 1708/6 1716/5 1720/11 1736/11 1741/20 1741/23 1766/9 1768/6 1771/8 1771/9 1798/9 1799/10</p>
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<p>Q</p> <p>quality [1] 1673/12 quantified [1] 1760/24 quantify [1] 1760/22 quantitative [1] 1708/16 question [30] 1666/10 1666/24 1667/12 1667/21 1667/22 1668/7 1678/25 1679/2 1679/10 1687/1 1696/8 1698/15 1703/18 1703/22 1705/5 1706/23 1706/24 1707/1 1716/8 1721/25 1740/5 1740/21 1750/8 1752/13 1758/19 1762/16 1776/2 1781/11 1795/21 1796/18 questioning [1] 1752/17 questions [13] 1635/9 1667/24 1669/15 1673/20 1686/14 1696/7 1703/19 1744/5 1745/11 1746/25 1747/4 1750/14 1761/24 quickly [9] 1643/2 1646/10 1647/9 1647/10 1647/12 1653/24 1672/11 1705/12 1744/4 quite [5] 1640/1 1660/3 1687/16 1704/14 1710/19 quote [2] 1649/14 1791/17</p>	<p>1647/22 1657/7 1657/19 1658/5 1658/5 1658/9 1661/3 1664/8 1664/10 1664/11 1665/5 1665/13 1675/10 1675/15 1678/5 1680/10 1684/4 1684/20 1685/5 1685/15 1686/16 1687/20 1688/4 1688/17 1695/23 1704/12 1706/12 1707/3 1707/21 1710/21 1710/24 1712/16 1718/17 1731/12 1737/4 1737/13 1737/15 1738/1 1738/4 1738/5 1739/11 1743/1 1743/13 1745/25 1746/6 1746/7 1746/11 1750/1 1772/18 1777/9 rather [6] 1634/22 1672/13 1748/8 1751/3 1751/11 1794/13 ratio [5] 1646/23 1658/2 1725/11 1727/5 1761/5 ratios [1] 1681/3 re [3] 1627/4 1627/7 1778/1 re-equilibrate [1] 1778/1 reach [7] 1639/5 1653/13 1663/8 1666/21 1724/6 1746/15 1769/7 reached [1] 1794/25 reaching [2] 1707/17 1790/9 read [17] 1633/25 1634/23 1634/23 1634/24 1666/17 1694/5 1698/20 1716/8 1716/16 1718/6 1726/7 1727/19 1729/15 1732/19 1765/11 1780/5 1797/22 readily [2] 1771/21 1779/4 reading [2] 1696/8 1740/21 ready [3] 1637/11 1752/17 1799/21 real [4] 1663/22 1725/19 1725/20 1780/15 realistic [1] 1782/12 reality [2] 1644/9 1644/12 realize [1] 1797/23 realized [1] 1767/19 really [12] 1634/17 1647/15 1652/11 1659/24 1693/16 1694/2 1703/2 1709/6 1730/10 1731/13 1739/3 1756/15 reamer [1] 1695/24 reask [1] 1762/16 reason [4] 1642/13 1655/10 1727/7 1750/10 reasonable [7] 1686/23 1687/13 1714/7 1745/19 1746/11 1749/18 1749/22 reasonably [2] 1760/3 1767/21 reasons [4] 1686/22 1721/13 1723/3 1781/9 rebuttal [22] 1651/12 1662/23 1663/4 1664/1 1665/17 1671/25 1672/1 1672/3 1695/1 1695/5 1695/13 1695/22 1744/19 1751/10 1752/4 1752/17 1755/6 1755/10 1755/16 1756/2 1756/5 1775/22 recalculate [1] 1698/16 recalculating [1] 1774/14 recall [5] 1661/18 1707/8 1707/12 1744/6 1799/8 received [2] 1636/18 1799/9 recess [6] 1652/9 1715/22 1715/24 1796/15 1796/16 1800/21 recognize [5] 1700/20 1717/25 1785/6 1789/13 1792/22 recollection [1] 1706/13 recombine [1] 1775/11 recommend [2] 1783/18 1785/4 recommendation [6] 1757/3 1757/7 1780/7 1780/15 1789/13 1789/15 recommended [1] 1783/15 recommending [1] 1751/12 reconstruct [1] 1656/20 reconstructed [1] 1648/21</p>	<p>record [4] 1750/21 1784/23 1787/19 1801/7 recorded [1] 1631/24 recovered [4] 1648/5 1651/1 1651/9 1656/23 recovering [1] 1766/14 recovers [1] 1727/6 recovery [1] 1651/4 red [3] 1655/15 1744/24 1745/3 Redirect [2] 1743/24 1744/1 reduce [3] 1645/16 1704/3 1714/22 reduced [1] 1778/24 reduces [1] 1779/4 reducing [3] 1673/9 1704/1 1758/8 reduction [1] 1774/15 refer [2] 1644/8 1687/5 reference [4] 1666/2 1708/15 1742/7 1790/14 referenced [1] 1748/6 referencing [1] 1666/1 referred [2] 1747/14 1790/11 referring [7] 1664/7 1694/10 1727/8 1740/23 1777/1 1781/4 1789/24 reflect [1] 1698/11 reflected [1] 1661/4 reflects [1] 1723/17 REGAN [16] 1629/22 1673/21 1674/3 1716/2 1739/25 1744/5 1745/11 1745/21 1746/7 1746/20 1746/25 1747/25 1748/7 1748/22 1749/12 1749/15 regard [1] 1782/12 regarding [9] 1633/10 1752/6 1752/12 1755/16 1755/19 1772/4 1786/7 1786/11 1796/20 regardless [4] 1693/20 1694/14 1738/23 1785/15 regards [1] 1752/13 relate [2] 1661/7 1667/3 related [7] 1661/11 1661/13 1667/12 1733/16 1753/15 1755/20 1774/8 relates [3] 1682/23 1752/1 1753/8 relating [2] 1752/9 1756/15 relationship [7] 1646/22 1646/22 1760/12 1760/22 1761/4 1763/8 1789/3 relative [9] 1642/1 1647/2 1655/12 1657/1 1686/16 1725/12 1760/5 1767/9 1784/4 relatively [1] 1760/4 release [1] 1675/2 released [3] 1758/4 1783/3 1794/10 releases [1] 1758/9 relevant [5] 1700/6 1700/7 1751/18 1751/20 1756/6 reliability [1] 1643/18 reliable [4] 1767/21 1788/8 1788/14 1788/23 reliance [1] 1705/20 relied [3] 1635/19 1636/2 1790/9 relies [1] 1638/3 rely [4] 1638/19 1671/19 1751/16 1791/4 relying [1] 1634/10 remain [2] 1647/3 1782/17 remainder [1] 1760/21 remained [1] 1655/13 remaining [1] 1747/18 remains [1] 1654/24 remember [7] 1695/9 1703/18 1707/9 1708/10 1713/10 1718/7 1741/3 remember or [1] 1695/9 remind [1] 1796/23 reminded [2] 1796/19 1796/19</p>
<p>R</p> <p>Rafferty [1] 1628/3 raise [2] 1633/8 1752/1 raised [5] 1644/17 1645/3 1658/3 1669/20 1797/23 ram [9] 1652/1 1652/2 1652/3 1652/18 1653/4 1656/16 1656/17 1659/4 1712/11 rams [30] 1650/2 1651/16 1651/20 1659/4 1659/8 1659/8 1708/24 1709/2 1709/14 1709/17 1710/6 1710/10 1711/3 1711/15 1711/19 1711/23 1711/24 1712/3 1712/11 1714/6 1715/8 1715/13 1723/8 1723/9 1723/10 1726/6 1745/5 1745/6 1745/24 1745/24 ran [3] 1653/1 1739/22 1741/13 range [13] 1640/1 1640/6 1641/20 1641/24 1658/5 1658/9 1675/5 1696/16 1700/10 1704/23 1705/2 1707/2 1731/19 ranging [1] 1783/15 rapid [1] 1648/3 rapidly [3] 1647/7 1647/22 1694/14 rate [89] 1641/25 1647/16 1647/20 1657/7 1657/14 1657/15 1657/16 1657/18 1657/20 1657/20 1658/2 1658/22 1659/1 1659/12 1659/14 1659/16 1659/21 1661/13 1661/14 1667/17 1668/9 1668/13 1668/22 1672/13 1672/16 1672/25 1674/15 1682/1 1683/21 1683/24 1684/23 1684/25 1685/7 1690/1 1694/16 1695/5 1695/18 1697/2 1708/20 1709/3 1709/9 1709/13 1709/17 1710/4 1710/10 1711/2 1711/7 1711/7 1711/11 1711/22 1712/2 1724/16 1729/2 1729/4 1729/8 1729/17 1729/25 1730/5 1730/7 1730/12 1730/19 1730/24 1731/9 1731/10 1732/16 1733/10 1734/5 1734/12 1735/3 1735/11 1735/19 1736/8 1736/21 1736/22 1737/2 1737/8 1737/11 1737/18 1737/20 1737/22 1737/23 1738/8 1738/16 1739/14 1739/17 1739/20 1742/12 1742/15 1785/14 rate's [1] 1697/4 rates [53] 1640/23 1647/18 1647/20</p>		

<p>R</p> <p>reminding [1] 1728/8 removal [1] 1659/19 remove [4] 1774/6 1779/8 1779/23 1782/23 removed [4] 1766/2 1766/11 1766/12 1772/3 removes [1] 1779/2 removing [4] 1771/20 1774/6 1774/13 1780/10 repeat [5] 1646/17 1651/5 1675/12 1736/10 1797/18 repetitive [1] 1740/1 replicate [2] 1694/8 1762/18 report [114] 1635/14 1640/13 1649/10 1649/10 1649/13 1649/14 1651/12 1651/12 1654/16 1656/10 1656/11 1660/9 1662/10 1662/23 1663/4 1664/1 1664/5 1664/21 1664/22 1664/23 1665/17 1665/20 1666/7 1666/15 1667/4 1667/13 1670/11 1671/24 1671/25 1672/1 1672/1 1672/3 1676/9 1676/19 1691/7 1691/11 1691/17 1691/24 1692/14 1692/15 1692/18 1693/18 1693/23 1694/3 1694/22 1695/1 1695/5 1695/13 1695/22 1697/24 1698/4 1700/17 1700/20 1700/22 1700/23 1702/18 1703/6 1703/14 1703/16 1703/24 1703/25 1704/10 1705/16 1706/11 1707/25 1709/9 1710/25 1711/25 1716/7 1716/18 1717/16 1717/23 1718/1 1719/16 1719/23 1720/6 1720/8 1720/10 1723/7 1725/6 1725/10 1727/2 1740/7 1740/20 1740/22 1744/19 1747/1 1747/1 1747/12 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1722/25 1723/4 1723/22 1724/17</p>	<p>1725/13 1725/22 1727/17 1727/21 1730/11 1733/20 1734/6 1734/7 1734/10 1735/1 1736/3 1741/21 1742/3 1742/7 1742/11 1742/15 1742/22 1743/2 1743/3 1743/6 1743/18 1743/18 1743/19 1745/20 1752/3 1753/25 1754/2 1754/10 1757/2 1758/3 1758/7 1760/11 1760/12 1760/14 1760/17 1760/20 1760/23 1761/6 1761/10 1761/12 1761/18 1762/8 1762/10 1762/11 1762/13 1765/12 1765/24 1766/8 1766/23 1766/24 1766/25 1767/10 1768/17 1769/23 1769/24 1771/17 1778/17 1783/14 1784/5 1785/22 1785/23 1786/3 1786/3 1786/9 1786/13 1789/23 1790/23 1793/22 1793/25 1794/9 1794/10 1794/15 resided [1] 1694/15 residual [1] 1766/17 residuals [1] 1685/1 resistance [42] 1638/24 1647/1 1647/2 1655/11 1655/12 1655/22 1655/24 1659/6 1659/7 1659/9 1659/10 1674/7 1709/23 1720/24 1721/13 1721/14 1721/19 1721/19 1721/22 1721/23 1721/24 1722/9 1722/10 1722/16 1722/17 1722/20 1722/20 1723/4 1723/4 1723/5 1723/11 1725/12 1725/19 1725/21 1725/22 1726/4 1728/6 1728/7 1733/19 1733/19 1733/20 1740/10 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1751/13 1752/22 1787/9 return [2] 1744/4 1798/3 review [6] 1650/16 1650/16 1662/21 1676/22 1745/17 1779/13 reviewed [12] 1644/18 1651/3 1651/7 1656/11 1660/13 1661/20 1662/20 1676/19 1691/7 1703/16 1706/10</p>	<p>1748/4 RICHARD [2] 1629/14 1631/8 Richeson [1] 1631/11 richness [1] 1660/24 rid [1] 1744/14 RIG [1] 1627/4 right [88] 1633/5 1633/6 1634/3 1635/3 1635/11 1636/5 1636/14 1636/21 1637/9 1638/10 1638/13 1642/12 1648/20 1651/24 1652/9 1652/13 1652/14 1652/16 1658/19 1659/22 1664/7 1666/23 1670/25 1673/21 1681/16 1684/9 1684/13 1695/17 1710/20 1713/9 1713/14 1715/1 1715/21 1716/1 1716/2 1718/22 1718/24 1718/25 1719/6 1720/18 1722/1 1722/1 1722/3 1722/7 1722/11 1723/12 1724/24 1725/23 1727/3 1728/4 1730/9 1731/4 1739/25 1740/6 1741/21 1743/14 1744/25 1745/8 1748/17 1749/1 1749/3 1749/16 1750/16 1750/17 1752/19 1752/23 1756/8 1756/19 1756/19 1761/22 1762/6 1762/25 1763/17 1776/14 1776/23 1776/24 1777/5 1777/5 1780/6 1783/16 1784/8 1788/2 1788/20 1796/15 1797/1 1798/4 1799/6 1800/22 ripe [1] 1751/16 rise [5] 1633/4 1715/23 1715/25 1776/9 1800/23 riser [21] 1648/5 1648/18 1648/18 1651/4 1651/8 1653/10 1653/13 1653/16 1653/18 1656/17 1659/4 1659/20 1709/7 1710/2 1715/3 1732/25 1733/1 1733/7 1733/12 1733/14 1763/5 risers [1] 1654/2 rises [8] 1768/20 1768/21 1769/1 1769/3 1794/4 1794/6 1794/10 1794/15 rising [5] 1776/18 1777/18 1778/2 1778/3 1778/4 risk [1] 1645/15 RMR [4] 1631/18 1801/3 1801/11 1801/11 ROBERT [2] 1630/6 1630/9 ROBERTS [1] 1630/16 ROBIN [1] 1628/10 Robinson [1] 1791/10 rock [1] 1786/7 Room [1] 1631/18 root [2] 1735/13 1737/2 Rouge [1] 1628/24 roughly [4] 1643/25 1659/9 1773/20 1795/4 routinely [1] 1763/23 row [2] 1643/9 1643/22 Roy [2] 1627/21 1627/22 rule [5] 1635/1 1635/9 1671/25 1727/4 1798/2 ruled [7] 1633/22 1634/12 1634/17 1635/1 1637/3 1637/5 1752/16 ruling [1] 1667/23 run [7] 1684/21 1743/17 1764/24 1764/25 1765/1 1765/21 1767/23 runs [4] 1664/15 1666/2 1666/3 1774/3</p> <p>S</p> <p>s/Jodi [1] 1801/11 safe [1] 1677/1 said [27] 1635/22 1635/22 1642/8 1657/24 1667/3 1677/2 1678/10 1678/14 1682/23 1682/25 1683/20 1690/5 1693/15 1696/12 1697/17 1703/15 1728/7 1731/1 1731/3 1746/20</p>
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<p>S</p> <p>said... [7] 1756/9 1770/25 1776/15 1776/21 1791/2 1792/1 1794/17</p> <p>sake [1] 1692/13</p> <p>salt [1] 1640/9</p> <p>same [54] 1634/22 1645/6 1647/21 1658/8 1660/11 1675/22 1678/8 1678/13 1680/11 1680/15 1681/6 1681/25 1684/13 1684/15 1686/10 1691/8 1695/15 1695/23 1698/11 1698/12 1698/13 1707/11 1720/12 1730/14 1732/11 1732/12 1737/13 1737/15 1737/21 1738/2 1738/5 1738/23 1738/23 1738/25 1739/14 1742/18 1743/19 1761/14 1764/10 1765/3 1768/8 1775/3 1779/5 1779/10 1779/24 1780/12 1782/24 1787/11 1791/11 1793/7 1797/3 1797/17 1797/23 1799/7</p> <p>sample [10] 1755/21 1755/22 1756/18 1757/10 1763/24 1763/25 1765/17 1767/17 1773/13 1773/23</p> <p>samples [7] 1764/8 1764/23 1790/22 1791/4 1791/5 1793/1 1793/2</p> <p>sampling [1] 1744/15</p> <p>sand [1] 1716/12</p> <p>sandface [2] 1690/15 1690/16</p> <p>Sandia [8] 1639/15 1673/14 1676/10 1676/19 1691/7 1700/22 1706/11 1719/23</p> <p>SARAH [1] 1629/15</p> <p>satisfy [4] 1684/16 1684/18 1685/3 1685/4</p> <p>saturation [1] 1767/8</p> <p>save [2] 1634/20 1634/20</p> <p>saw [3] 1666/20 1723/14 1792/13</p> <p>say [54] 1635/6 1645/17 1645/21 1648/25 1649/25 1657/19 1658/12 1659/15 1666/25 1672/2 1673/16 1677/1 1677/14 1680/12 1686/8 1686/25 1687/18 1688/3 1688/8 1690/9 1690/11 1693/9 1693/10 1694/1 1694/8 1695/18 1707/5 1707/12 1708/14 1710/18 1711/4 1711/5 1712/18 1714/14 1725/10 1725/18 1726/3 1726/12 1727/5 1727/24 1729/18 1731/25 1736/25 1739/10 1740/13 1745/13 1775/24 1788/11 1789/17 1789/20 1791/17 1792/5 1795/13 1795/21</p> <p>saying [12] 1646/1 1649/22 1669/4 1671/14 1696/17 1708/11 1713/22 1714/16 1726/16 1726/20 1776/1 1777/4</p> <p>says [19] 1655/11 1655/21 1664/7 1666/4 1667/13 1705/17 1717/16 1717/17 1717/22 1731/3 1742/2 1747/15 1765/11 1776/6 1779/5 1779/8 1780/19 1780/23 1781/12</p> <p>scale [5] 1650/23 1695/25 1696/20 1739/11 1783/12</p> <p>scales [3] 1650/14 1650/15 1660/16</p> <p>scanned [1] 1706/18</p> <p>scans [4] 1648/4 1648/6 1656/19 1656/23</p> <p>scenario [1] 1772/22</p> <p>scheduling [1] 1797/8</p> <p>Schell [1] 1631/11</p> <p>schematic [1] 1766/7</p> <p>scheme [2] 1780/22 1780/23</p> <p>Schlumberger [3] 1755/22 1764/17 1790/25</p>	<p>school [1] 1677/21</p> <p>scientific [2] 1677/24 1679/3</p> <p>scientifically [1] 1782/14</p> <p>scope [3] 1765/10 1765/15 1775/20</p> <p>SCOTT [1] 1629/12</p> <p>screen [5] 1665/9 1665/22 1683/3 1695/15 1762/7</p> <p>screwed [2] 1738/8 1738/14</p> <p>sea [6] 1638/4 1638/18 1735/1 1735/7 1758/15 1763/5</p> <p>seabed [6] 1768/16 1785/25 1786/4 1795/2 1795/3 1795/12</p> <p>seal [9] 1705/7 1705/8 1705/15 1705/21 1705/23 1712/15 1726/5 1748/24 1750/6</p> <p>sealed [4] 1712/15 1712/17 1712/17 1748/14</p> <p>SEAN [1] 1631/5</p> <p>season [1] 1635/12</p> <p>seated [2] 1633/5 1716/1</p> <p>second [13] 1643/21 1650/5 1660/4 1660/20 1663/16 1757/7 1766/11 1775/18 1782/1 1785/3 1797/23 1799/5 1799/8</p> <p>second-to-the-bottom [1] 1643/21</p> <p>seconds [4] 1650/7 1650/14 1660/16 1696/15</p> <p>section [9] 1627/5 1629/10 1641/1 1641/3 1643/14 1643/22 1649/16 1661/10 1695/13</p> <p>sectional [2] 1661/15 1668/23</p> <p>see [51] 1638/4 1641/23 1643/2 1648/10 1651/24 1652/7 1652/17 1652/20 1653/17 1660/8 1661/14 1661/25 1665/23 1666/1 1666/23 1671/8 1671/9 1680/16 1695/13 1702/20 1702/21 1703/1 1703/7 1703/23 1707/1 1708/8 1711/4 1720/14 1720/15 1720/18 1724/17 1724/22 1732/6 1732/8 1732/21 1732/22 1736/12 1737/18 1741/23 1745/3 1745/5 1748/18 1751/4 1751/21 1768/14 1776/25 1780/15 1780/25 1798/13 1800/11 1800/22</p> <p>seeing [1] 1776/3</p> <p>seems [3] 1726/3 1738/7 1740/4</p> <p>seen [8] 1648/2 1649/6 1662/9 1703/24 1751/1 1774/4 1777/2 1800/7</p> <p>seep [2] 1653/23 1653/24</p> <p>segments [1] 1681/14</p> <p>sense [8] 1657/9 1657/10 1659/18 1659/24 1702/2 1704/5 1730/22 1777/8</p> <p>sentence [4] 1664/21 1665/3 1725/23 1740/22</p> <p>separate [8] 1765/23 1769/10 1769/12 1774/10 1778/8 1778/25 1783/24 1784/25</p> <p>separated [4] 1770/11 1775/4 1779/9 1793/19</p> <p>separately [1] 1780/14</p> <p>separates [1] 1776/16</p> <p>separating [1] 1764/1</p> <p>separation [85] 1754/14 1757/2 1757/4 1757/5 1757/8 1757/9 1757/11 1757/15 1757/16 1757/20 1758/25 1759/12 1759/24 1763/10 1763/12 1763/20 1763/20 1763/21 1763/22 1764/6 1765/22 1766/7 1766/19 1767/4 1767/23 1768/1 1768/3 1768/4 1768/5 1768/6 1768/8 1768/9 1768/13 1768/15 1768/19 1768/24 1769/6 1769/19 1769/20 1769/20 1769/24 1770/1 1770/2 1770/8 1770/9 1771/6 1771/8</p>	<p>1771/8 1771/13 1771/18 1774/9 1774/11 1774/24 1775/2 1775/13 1776/22 1778/14 1779/2 1779/6 1779/11 1779/16 1779/17 1779/19 1779/23 1779/25 1780/3 1780/8 1780/8 1780/9 1780/12 1780/18 1780/18 1780/19 1780/22 1780/23 1781/25 1782/3 1782/3 1782/7 1782/9 1782/16 1783/6 1783/22 1784/3 1795/16</p> <p>separations [4] 1764/16 1769/22 1781/22 1781/24</p> <p>separator [23] 1751/9 1751/11 1751/12 1751/16 1751/18 1764/7 1764/10 1764/12 1765/12 1765/17 1766/9 1766/10 1766/13 1770/12 1770/21 1773/12 1785/3 1785/6 1785/15 1785/18 1787/10 1793/4 1793/18</p> <p>September [2] 1633/23 1634/13</p> <p>September 15th [1] 1634/13</p> <p>series [1] 1758/12</p> <p>serious [2] 1776/8 1798/9</p> <p>services [3] 1631/3 1631/8 1753/15</p> <p>SESSION [2] 1627/14 1633/1</p> <p>set [11] 1635/18 1652/5 1655/8 1698/17 1711/24 1746/9 1752/25 1759/15 1759/19 1763/9 1764/10</p> <p>sets [3] 1659/7 1696/20 1745/11</p> <p>seven [3] 1653/8 1697/18 1773/18</p> <p>several [2] 1634/19 1661/10</p> <p>Shanks [2] 1649/11 1649/25</p> <p>Shanks' [1] 1649/24</p> <p>shape [1] 1736/23</p> <p>sharply [1] 1750/11</p> <p>she [2] 1634/10 1634/12</p> <p>shear [24] 1651/16 1651/20 1653/3 1656/16 1656/17 1659/3 1708/24 1709/2 1709/10 1709/14 1709/16 1710/6 1710/10 1711/3 1711/15 1711/19 1711/23 1711/24 1712/3 1712/11 1715/8 1715/13 1745/24 1745/24</p> <p>shocked [1] 1751/3</p> <p>shoe [1] 1695/24</p> <p>short [3] 1647/13 1650/10 1697/4</p> <p>shortly [2] 1705/1 1748/24</p> <p>should [17] 1635/12 1639/25 1640/7 1640/8 1650/13 1672/4 1672/12 1698/13 1704/5 1749/15 1757/15 1771/20 1772/2 1775/25 1777/19 1779/3 1796/21</p> <p>shouldn't [1] 1739/14</p> <p>show [4] 1648/21 1705/14 1705/16 1740/20</p> <p>showed [1] 1749/13</p> <p>showing [2] 1748/10 1748/12</p> <p>shown [2] 1640/25 1718/19</p> <p>shows [10] 1652/5 1654/16 1704/11 1704/15 1704/25 1710/19 1773/13 1773/15 1783/11 1783/12</p> <p>shrinkage [27] 1755/19 1755/21 1758/23 1760/4 1760/24 1761/14 1761/20 1762/2 1762/5 1762/8 1766/20 1767/3 1767/6 1770/21 1771/4 1778/13 1778/15 1778/21 1778/23 1780/7 1780/13 1782/25 1783/12 1783/20 1783/21 1783/25 1784/2</p> <p>Shushan [5] 1633/20 1633/22 1634/9 1634/23 1636/1</p> <p>Shushan's [2] 1634/23 1635/4</p> <p>shut [12] 1641/24 1642/7 1678/4 1702/15 1704/6 1704/20 1705/4 1705/6 1716/12 1745/24 1748/20 1749/6</p> <p>shut-down [1] 1642/7</p>
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S	1770/3 1791/23 1796/1 1796/4 slow [2] 1660/12 1660/18 slower [1] 1713/13 slows [2] 1647/7 1647/14 slug [1] 1732/12 small [11] 1647/15 1647/19 1698/19 1714/16 1754/3 1755/15 1766/16 1769/14 1769/14 1775/14 1776/16 smaller [7] 1664/10 1665/5 1669/5 1698/22 1698/24 1761/17 1763/8 SMITH [1] 1631/4 so [253] software [16] 1631/24 1666/10 1666/11 1672/17 1672/23 1672/23 1677/5 1678/9 1678/14 1684/17 1753/14 1754/1 1754/4 1754/6 1787/3 1787/16 Soileau [1] 1628/12 soluble [6] 1771/22 1774/13 1779/23 1779/23 1780/11 1782/24 solution [3] 1692/22 1760/18 1760/21 solutions [1] 1665/4 solving [1] 1672/19 some [43] 1633/17 1633/18 1636/12 1639/5 1642/25 1644/10 1644/11 1644/11 1645/16 1648/2 1684/8 1693/8 1693/8 1710/19 1713/1 1717/21 1718/12 1725/18 1731/6 1732/4 1735/14 1744/12 1744/14 1745/22 1746/25 1747/4 1747/14 1747/17 1756/5 1757/2 1761/23 1770/19 1772/17 1772/25 1781/20 1789/1 1791/7 1791/22 1792/11 1793/3 1793/19 1796/13 1797/8 somebody [4] 1677/13 1677/21 1696/19 1796/19 someone [2] 1677/17 1678/19 something [31] 1638/9 1644/4 1644/9 1650/12 1654/11 1655/3 1655/5 1658/3 1662/14 1666/17 1669/2 1670/24 1672/2 1686/21 1704/18 1708/16 1708/16 1714/19 1714/19 1724/22 1727/18 1731/23 1732/1 1733/12 1738/7 1738/13 1745/14 1748/6 1767/20 1770/14 1772/9 sometimes [1] 1765/5 Sometimes [1] 1744/13 somewhat [1] 1679/6 somewhere [2] 1795/1 1795/4 soon [5] 1701/22 1705/8 1745/7 1799/4 1800/13 sorry [16] 1650/16 1651/5 1657/25 1657/25 1717/4 1722/12 1724/11 1741/22 1747/1 1775/16 1775/19 1784/11 1784/12 1790/4 1794/9 1797/22 sort [26] 1638/20 1645/10 1645/11 1647/1 1648/6 1652/17 1654/18 1656/24 1658/12 1659/22 1660/24 1670/25 1677/16 1678/18 1679/7 1679/8 1686/14 1688/13 1726/24 1738/13 1742/20 1743/12 1750/11 1750/13 1757/2 1772/18 sorts [2] 1650/13 1746/12 sound [1] 1638/8 sounds [5] 1638/6 1763/14 1776/12 1788/20 1799/20 source [2] 1637/3 1790/14 sources [3] 1640/16 1641/2 1698/9 South [3] 1628/4 1628/12 1630/3 space [1] 1669/6 sparse [2] 1719/22 1719/25 SPE [1] 1789/24 speak [3] 1663/1 1666/14 1668/2	speaking [1] 1689/9 special [1] 1693/14 specialized [1] 1679/21 specific [3] 1655/17 1668/14 1682/24 specifically [5] 1636/1 1641/11 1643/9 1681/11 1765/10 specified [1] 1782/7 speculate [1] 1794/13 speculating [2] 1726/15 1726/19 speculation [1] 1705/12 speed [7] 1648/16 1651/23 1661/14 1668/17 1668/22 1668/22 1686/17 speeds [2] 1647/23 1777/11 spelling [1] 1750/21 spent [1] 1673/7 SPILL [1] 1627/4 split [1] 1748/14 spoke [1] 1675/10 spot [1] 1637/13 spread [1] 1660/18 square [2] 1735/13 1737/2 stabilize [3] 1758/6 1763/13 1768/6 stabilizing [1] 1765/25 stable [1] 1760/14 stack [1] 1672/18 stage [95] 1751/9 1751/11 1755/19 1755/21 1757/8 1757/14 1757/16 1757/20 1757/23 1757/24 1758/2 1758/7 1758/9 1758/9 1758/12 1758/16 1758/16 1758/24 1758/24 1762/24 1763/12 1763/19 1763/20 1763/23 1764/7 1764/11 1764/16 1765/12 1765/17 1765/20 1765/22 1765/25 1766/7 1766/9 1766/11 1766/13 1766/19 1767/4 1767/15 1767/23 1768/1 1768/3 1768/4 1768/5 1768/6 1768/7 1768/17 1768/19 1768/25 1769/6 1769/19 1769/20 1769/24 1770/1 1770/5 1770/12 1770/20 1771/6 1771/7 1773/12 1775/6 1775/15 1775/23 1775/23 1776/18 1779/6 1779/11 1779/19 1779/25 1780/2 1780/3 1780/8 1780/8 1780/12 1780/18 1780/18 1780/19 1780/23 1781/9 1781/10 1781/12 1781/19 1781/24 1782/3 1782/7 1782/20 1783/6 1784/2 1793/7 1793/10 1793/14 1793/18 1795/16 1795/17 1796/5 stage-by-stage [1] 1775/23 stages [3] 1758/8 1758/13 1758/13 standard [7] 1645/4 1677/3 1760/15 1775/13 1781/12 1781/14 1781/15 standardly [1] 1781/21 Stanford [2] 1753/6 1753/22 start [18] 1636/14 1645/24 1653/23 1653/23 1678/10 1678/15 1688/12 1700/3 1700/4 1700/11 1702/25 1706/24 1714/2 1762/13 1769/23 1774/20 1775/3 1799/25 started [6] 1666/24 1701/15 1701/19 1701/21 1701/21 1791/11 starting [5] 1665/13 1703/10 1707/3 1711/15 1767/7 starts [5] 1655/23 1699/8 1706/25 1727/9 1739/3 state [58] 1628/22 1629/2 1641/19 1680/23 1692/14 1692/18 1694/6 1701/13 1714/6 1748/20 1750/20 1753/24 1753/25 1754/1 1754/6 1754/10 1754/11 1754/14 1759/7 1759/11 1759/14 1759/15 1759/20 1759/22 1759/25 1760/1 1764/3 1767/2 1767/11 1768/2 1768/3 1770/20 1771/2
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[25] 1771/4 1784/25 1786/16 1786/17 1786/22 1786/24 1787/4 1787/14 1788/2 1788/6 1788/9 1788/15 1789/9 1790/17 1790/18 1790/21 1791/9 1791/11 1791/14 1791/21 1792/10 1795/13 1795/22 1796/6 1796/8 stated [7] 1693/23 1725/17 1776/4 1776/5 1790/1 1790/5 1798/15 statement [7] 1664/14 1705/18 1705/20 1706/21 1726/22 1781/8 1782/14 statements [4] 1640/3 1640/7 1651/23 1667/9 states [26] 1627/1 1627/10 1627/15 1629/6 1629/9 1633/14 1633/15 1634/9 1634/11 1635/4 1635/18 1636/8 1637/19 1656/18 1685/2 1710/24 1751/14 1751/24 1752/2 1752/8 1752/12 1752/15 1752/23 1754/17 1788/21 1801/4 States' [3] 1628/18 1636/9 1636/15 static [2] 1702/14 1702/15 stay [3] 1647/21 1655/22 1782/13 stayed [1] 1745/6 stays [1] 1655/21 stenography [1] 1631/24 step [1] 1759/5 Stephanie [1] 1638/8 STEPHEN [2] 1627/19 1629/7 steps [1] 1759/3 STEVEN [2] 1629/11 1630/16 STEWART [1] 1637/14 sticking [1] 1799/7 still [19] 1640/6 1652/14 1662/6 1665/7 1671/11 1698/10 1712/14 1742/23 1743/4 1743/8 1743/20 1771/3 1772/13 1772/25 1773/2 1789/6 1790/6 1790/7 1799/16 stimulation [1] 1765/13 stock [66] 1654/20 1709/10 1711/2 1711/10 1711/14 1711/18 1752/4 1757/1 1757/18 1758/3 1758/6 1758/8 1758/10 1760/11 1760/13 1760/19 1760/23 1761/6 1761/10 1761/17 1762/9 1762/13 1762/15 1762/18 1763/12 1765/23 1766/1 1766/15 1766/16 1766/18 1767/1 1768/5 1768/7 1769/8 1769/25 1770/4 1771/18 1771/20 1772/3 1772/7 1772/8 1772/9 1772/25 1773/1 1773/2 1773/11 1773/22 1774/7 1774/11 1774/14 1778/16 1779/1 1779/4 1779/9 1780/11 1780/21 1783/7 1783/13 1792/16 1792/17 1794/18 1795/14 1795/23 1796/7 1796/9 1796/10 stood [1] 1697/17 stop [1] 1796/12 story [1] 1687/19 straight [14] 1657/4 1734/10 1734/11 1734/13 1734/18 1735/4 1735/14 1735/21 1735/22 1736/7 1749/21 1775/10 1775/13 1776/15 strained [1] 1653/20 strange [1] 1739/16 stream [21] 1768/20 1768/21 1768/23 1768/24 1769/1 1769/5 1769/8 1769/9 1775/4 1775/5 1775/6 1775/7 1775/7 1775/11 1775/12 1776/9 1776/14 1776/18 1778/20 1782/17 1782/17 streams [9] 1769/7 1769/10 1769/12 1769/12 1769/13 1775/10 1777/1</p>	<p>1777/3 1778/8 Street [16] 1627/23 1628/4 1628/7 1628/13 1628/16 1628/23 1629/4 1629/18 1630/3 1630/7 1630/13 1630/16 1631/5 1631/12 1631/16 1631/18 strengths [1] 1681/19 strong [2] 1678/8 1679/6 strongly [1] 1647/18 study [1] 1783/6 stuff [4] 1688/13 1731/11 1733/16 1798/8 subject [2] 1790/15 1796/25 subjected [2] 1757/6 1771/16 subjects [1] 1787/11 submitted [2] 1634/24 1634/24 subsequently [2] 1771/19 1782/23 subset [2] 1659/14 1760/19 subtract [1] 1670/8 such [5] 1690/15 1690/23 1727/6 1728/8 1728/8 sudden [4] 1725/18 1725/21 1725/21 1726/5 suddenly [1] 1772/12 suggest [1] 1672/12 suggested [4] 1646/2 1657/22 1749/15 1749/20 suggestion [1] 1658/8 suggests [1] 1716/18 Suite [9] 1627/23 1628/4 1628/16 1629/18 1630/13 1630/16 1631/5 1631/9 1631/12 sum [4] 1644/23 1669/4 1669/12 1669/14 summarize [3] 1756/23 1759/25 1783/19 summary [3] 1752/10 1796/22 1797/25 summer [1] 1645/7 supported [2] 1650/21 1693/7 supporting [1] 1693/5 supports [1] 1780/3 suppose [3] 1676/24 1710/8 1737/25 sure [28] 1637/13 1639/17 1641/9 1642/9 1643/13 1644/25 1647/12 1648/4 1651/6 1661/9 1676/2 1691/6 1691/16 1694/2 1700/5 1706/5 1706/8 1718/7 1721/25 1736/11 1737/1 1737/17 1738/18 1744/13 1758/20 1761/23 1788/18 1799/2 surface [34] 1709/22 1709/25 1710/2 1758/15 1760/15 1760/15 1760/20 1761/12 1763/4 1765/19 1766/2 1766/8 1768/21 1768/21 1769/1 1769/7 1769/9 1773/2 1773/23 1775/6 1775/10 1775/13 1776/9 1776/15 1777/14 1781/18 1794/7 1794/11 1794/15 1795/2 1795/4 1795/15 1795/24 1796/1 suspicious [1] 1738/13 sustain [2] 1662/18 1662/25 sustained [1] 1663/2 Sutherland [1] 1630/15 swing [2] 1729/10 1729/11 switch [1] 1745/21 sworn [2] 1637/15 1750/19 system [7] 1642/19 1650/8 1650/11 1650/25 1651/14 1678/3 1695/23</p> <p>T</p> <p>table [22] 1640/13 1641/1 1641/7 1641/7 1643/3 1643/9 1643/12 1644/3 1645/17 1661/10 1661/11 1755/16 1755/18 1755/19 1755/20 1755/22 1756/9 1756/10 1756/11 1773/15</p>	<p>1792/23 1796/13 Table 1 [1] 1640/13 Table 6 [1] 1755/16 Table 7 [1] 1755/22 tactical [2] 1633/16 1633/17 take [22] 1635/9 1640/8 1674/10 1678/2 1678/4 1678/4 1678/9 1695/10 1696/6 1696/13 1697/9 1714/8 1714/11 1715/21 1719/5 1750/12 1761/11 1762/4 1772/16 1772/18 1795/11 1796/13 taken [4] 1681/22 1703/23 1716/11 1790/22 takes [8] 1758/2 1758/4 1758/7 1775/9 1775/12 1775/12 1776/15 1779/1 taking [2] 1668/22 1697/15 talk [13] 1642/25 1643/17 1651/15 1654/5 1682/17 1694/6 1699/1 1720/23 1735/23 1756/14 1786/15 1788/20 1790/16 talked [13] 1637/24 1637/25 1646/16 1659/25 1660/15 1661/6 1739/2 1741/2 1747/25 1763/1 1792/9 1792/9 1799/1 talking [24] 1637/23 1649/17 1650/1 1650/12 1655/20 1656/9 1667/4 1670/2 1692/20 1693/13 1696/15 1710/13 1720/23 1721/5 1721/5 1728/11 1733/15 1742/19 1746/6 1747/15 1761/21 1764/16 1787/11 1794/20 talks [1] 1664/2 tank [66] 1654/20 1709/11 1711/2 1711/10 1711/14 1711/18 1752/4 1757/1 1757/18 1758/3 1758/6 1758/8 1758/10 1760/11 1760/13 1760/19 1760/23 1761/6 1761/10 1761/17 1762/9 1762/13 1762/15 1762/18 1763/12 1765/23 1766/1 1766/15 1766/16 1766/18 1767/1 1768/5 1768/7 1769/8 1769/25 1770/4 1771/18 1771/20 1772/3 1772/7 1772/8 1772/9 1772/25 1773/2 1773/2 1773/11 1773/22 1774/7 1774/11 1774/14 1778/16 1779/1 1779/5 1779/9 1780/11 1780/21 1783/7 1783/13 1792/16 1792/17 1794/18 1795/14 1795/23 1796/7 1796/9 1796/10 team [1] 1800/10 Technologies [4] 1753/12 1753/13 1753/21 1786/21 tell [4] 1650/7 1680/10 1772/19 1784/14 telling [1] 1635/4 tells [2] 1648/16 1650/9 temperature [18] 1681/3 1758/9 1759/6 1769/2 1769/3 1770/3 1775/14 1778/17 1778/18 1782/10 1793/20 1793/22 1794/4 1794/11 1794/17 1794/25 1795/2 1795/5 temperatures [2] 1780/9 1786/2 temporarily [1] 1705/6 ten [3] 1686/8 1696/11 1704/18 tend [3] 1769/11 1777/22 1777/23 tens [1] 1733/15 term [3] 1646/19 1760/24 1760/25 terms [13] 1640/14 1640/16 1667/24 1684/11 1701/6 1720/12 1720/25 1734/20 1736/23 1741/6 1746/2 1773/13 1783/13 terribly [1] 1731/23 Terrific [1] 1634/5 test [16] 1659/8 1673/15 1694/5 1723/8 1723/9 1723/10 1734/20 1745/5 1745/6 1765/12 1765/17 1765/18 1773/12 1793/5 1793/13 1793/18</p>
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T	there [10] 1633/14 1633/19 1635/12 1636/13 1637/2 1637/12 1638/12 1640/17 1640/22 1640/23 1641/3 1641/17 1642/13 1642/19 1645/18 1646/7 1646/9 1646/18 1646/21 1648/15 1649/14 1650/3 1652/13 1652/14 1652/18 1652/20 1653/21 1654/6 1655/3 1661/2 1664/4 1666/1 1671/1 1673/8 1673/9 1684/25 1685/1 1685/3 1686/14 1686/14 1686/20 1688/11 1690/10 1690/14 1691/12 1691/14 1692/19 1692/23 1693/14 1696/16 1698/19 1698/19 1700/2 1700/7 1700/13 1700/15 1704/8 1706/17 1707/1 1707/5 1709/23 1710/15 1710/15 1710/16 1713/2 1713/21 1713/22 1714/12 1717/13 1717/15 1720/7 1724/17 1727/8 1728/4 1729/14 1731/2 1731/2 1733/8 1739/17 1741/11 1742/14 1745/10 1745/14 1747/4 1747/23 1748/15 1748/20 1748/24 1750/1 1750/2 1750/9 1751/25 1753/23 1754/18 1757/12 1760/22 1761/4 1763/8 1767/19 1776/21 1776/22 1777/6 1778/7 1789/24 1790/1 1795/4 1796/5 1797/23 1798/6 1799/3	1748/14 1760/2 1763/24 1763/25 1764/1 1764/9 1765/18 1765/18 1765/22 1767/7 1767/8 1770/11 1772/2 1772/16 1772/25 1775/3 1775/3 1777/3 1777/5 1777/10 1777/10 1777/17 1777/18 1777/19 1777/21 1777/22 1785/23 1785/25 1788/18 1797/15 1798/10 1798/10 they'll [1] 1737/16 they're [29] 1635/5 1640/25 1643/2 1649/17 1696/16 1698/9 1704/14 1708/12 1708/14 1717/18 1731/8 1731/9 1734/4 1738/7 1738/10 1738/25 1739/6 1739/13 1743/14 1748/8 1751/20 1762/21 1764/2 1769/13 1769/13 1772/12 1772/13 1772/13 1777/6 they've [4] 1635/22 1706/18 1706/18 1797/18 thick [1] 1653/19 thing [14] 1634/22 1637/3 1638/20 1646/4 1647/1 1648/16 1678/13 1698/19 1706/20 1712/2 1734/25 1749/18 1799/21 1799/25 things [39] 1639/17 1640/18 1641/4 1644/12 1645/18 1645/20 1647/11 1650/9 1650/13 1656/5 1656/20 1657/22 1659/15 1664/17 1672/18 1683/1 1693/8 1693/12 1697/12 1705/17 1708/11 1708/15 1710/17 1712/1 1712/4 1712/16 1713/18 1714/7 1722/2 1726/17 1726/24 1729/11 1730/10 1730/16 1733/8 1733/18 1734/22 1739/4 1744/3 think [108] 1633/13 1634/14 1635/4 1635/7 1635/12 1635/23 1637/11 1638/11 1642/8 1643/22 1644/15 1644/25 1645/9 1645/13 1646/4 1647/5 1649/18 1649/22 1653/9 1656/2 1656/6 1656/6 1656/19 1657/11 1657/19 1657/21 1658/4 1658/11 1660/19 1660/23 1662/15 1666/25 1667/12 1668/7 1673/16 1676/2 1676/3 1682/23 1689/2 1689/12 1693/6 1693/15 1693/23 1694/24 1696/17 1697/1 1697/6 1697/7 1699/5 1700/5 1700/7 1700/12 1706/5 1706/8 1706/24 1707/11 1708/11 1709/20 1709/21 1710/3 1710/14 1710/21 1712/13 1712/18 1712/23 1713/7 1714/4 1714/7 1716/25 1717/19 1718/6 1718/6 1720/6 1721/25 1724/23 1727/3 1729/9 1730/25 1730/25 1731/23 1732/18 1733/11 1734/14 1734/15 1738/6 1741/11 1741/12 1745/22 1746/20 1746/22 1747/17 1749/18 1749/22 1750/3 1788/18 1789/16 1791/2 1791/8 1791/20 1791/21 1792/10 1797/7 1799/11 1799/12 1799/23 1800/2 1800/3 1800/8 thinking [1] 1673/8 thinks [1] 1696/19 third [10] 1628/23 1662/5 1664/6 1665/1 1665/12 1665/14 1732/24 1733/7 1766/13 1782/12 third-stage [1] 1766/13 this [240] Thomas [2] 1628/2 1629/11 those [145] 1636/23 1640/17 1640/23 1641/2 1641/21 1642/5 1643/2 1643/9 1643/16 1644/2 1644/8 1645/5 1646/22 1647/17 1650/6 1650/13 1651/11 1653/17 1653/22 1655/18 1658/12
tested [1] 1790/23 testified [12] 1637/15 1662/8 1662/20 1669/9 1705/12 1718/3 1726/9 1728/11 1750/19 1763/19 1764/15 1787/6 testify [6] 1654/6 1666/22 1672/4 1707/24 1792/10 1797/6 testifying [3] 1634/8 1662/13 1756/24 testimony [17] 1649/11 1649/24 1650/16 1662/7 1669/4 1671/23 1673/1 1678/18 1709/16 1718/6 1729/20 1738/1 1750/25 1752/1 1752/9 1752/12 1755/14 tests [3] 1764/7 1764/8 1765/21 Texas [4] 1630/17 1631/6 1631/9 1753/23 text [1] 1696/8 than [48] 1634/22 1639/17 1645/22 1650/5 1658/4 1664/10 1665/6 1672/13 1673/17 1677/4 1678/21 1685/6 1686/2 1694/18 1696/24 1697/15 1698/23 1698/24 1701/24 1704/15 1704/15 1709/13 1712/21 1713/13 1719/17 1725/3 1737/23 1738/10 1739/24 1748/8 1749/5 1751/11 1758/16 1761/17 1763/12 1765/25 1766/1 1768/5 1768/7 1769/2 1770/5 1771/2 1771/9 1784/5 1791/21 1791/23 1794/23 1795/6 thank [18] 1634/2 1636/4 1636/5 1636/24 1642/23 1673/19 1716/3 1743/23 1750/14 1750/16 1751/23 1756/7 1756/20 1784/7 1784/16 1784/20 1790/4 1800/20 that [899] that's [189] their [15] 1644/5 1670/14 1671/19 1677/14 1681/17 1684/24 1686/2 1694/9 1751/17 1754/5 1773/12 1780/20 1798/9 1799/9 1800/6 them [28] 1641/7 1644/7 1645/17 1659/13 1674/10 1680/21 1680/21 1682/23 1683/14 1684/12 1684/22 1686/12 1687/1 1698/25 1707/19 1708/6 1708/7 1713/1 1731/6 1731/14 1731/16 1736/16 1738/20 1744/14 1759/17 1760/3 1791/8 1800/12 themselves [2] 1657/13 1731/16 then [89] 1634/6 1638/25 1639/5 1642/3 1645/4 1645/17 1647/5 1647/7 1647/14 1648/12 1649/11 1652/5 1652/9 1652/16 1654/20 1654/23 1654/24 1655/23 1655/25 1656/23 1657/1 1659/9 1664/14 1665/4 1668/22 1674/13 1674/14 1684/22 1684/23 1685/12 1688/18 1689/16 1690/9 1694/5 1694/7 1695/1 1696/8 1697/10 1701/1 1709/21 1709/23 1710/9 1717/21 1718/12 1718/17 1718/21 1719/5 1719/6 1719/9 1719/15 1719/19 1729/4 1730/15 1730/18 1740/6 1740/17 1740/23 1743/13 1743/15 1748/19 1749/20 1750/11 1751/10 1759/11 1765/5 1766/11 1766/12 1766/14 1768/20 1769/3 1771/19 1773/19 1774/3 1774/12 1775/10 1777/21 1779/2 1780/9 1782/23 1782/24 1786/20 1786/24 1789/22 1793/2 1793/3 1793/10 1797/10 1797/17 1798/19 theoretical [1] 1655/1 theory [1] 1779/1		

T		
those... [124] 1658/24 1659/4 1659/14 1663/13 1663/14 1665/6 1666/2 1667/8 1667/9 1668/9 1670/4 1670/13 1671/8 1671/18 1674/10 1675/11 1675/15 1675/19 1677/5 1680/20 1682/7 1682/12 1685/3 1685/4 1685/13 1685/14 1686/22 1688/25 1689/17 1690/10 1690/11 1691/2 1691/3 1696/16 1697/19 1697/21 1697/23 1697/23 1698/2 1698/21 1698/25 1700/1 1704/6 1704/6 1704/13 1704/22 1705/9 1706/8 1706/19 1708/3 1708/6 1712/1 1713/10 1713/18 1714/8 1715/16 1720/4 1720/5 1722/15 1722/18 1726/17 1728/24 1730/15 1731/5 1731/16 1732/11 1739/5 1743/1 1745/1 1745/1 1745/4 1745/5 1745/7 1745/25 1746/7 1746/9 1746/12 1746/12 1748/14 1751/14 1752/11 1754/15 1756/4 1759/12 1760/25 1763/21 1764/2 1764/3 1764/8 1764/10 1764/25 1768/18 1768/23 1769/5 1769/15 1769/15 1769/15 1769/22 1770/22 1770/23 1771/23 1771/25 1772/1 1772/11 1772/15 1772/15 1773/1 1773/3 1773/20 1773/21 1774/2 1775/2 1775/9 1775/11 1778/20 1779/3 1779/8 1780/11 1790/25 1791/4 1791/5 1793/2 1793/14 1794/25	1702/24 1706/10 1709/9 1709/13 1712/5 1712/8 1712/10 1713/23 1714/20 1715/17 1717/10 1717/21 1719/2 1719/25 1720/5 1720/6 1720/8 1720/10 1722/12 1724/19 1730/14 1732/5 1732/11 1732/12 1732/17 1739/11 1740/14 1740/17 1742/15 1742/22 1743/1 1743/4 1743/7 1743/13 1743/16 1745/18 1745/19 1747/5 1748/17 1750/2 1750/11 1763/24 1766/14 1772/17 1777/25 1786/20 1789/21 1793/19 1794/22 1795/7 1796/14 1800/17	tremendous [4] 1648/11 1648/15 1652/7 1653/18
thought [4] 1637/12 1687/13 1746/10 1797/24	times [6] 1633/10 1657/3 1690/6 1693/4 1700/1 1746/23	tremendously [2] 1657/14 1731/15
three [23] 1635/19 1662/3 1672/9 1682/10 1690/6 1696/5 1697/10 1724/14 1733/18 1734/5 1734/12 1734/21 1734/22 1737/11 1739/8 1739/15 1740/15 1740/23 1745/7 1757/23 1763/21 1789/5 1790/23	tiny [1] 1669/9	trend [4] 1655/9 1699/21 1724/23 1750/10
throw [1] 1699/20	title [1] 1756/17	trends [1] 1654/7
through [60] 1633/21 1637/25 1641/6 1641/8 1641/11 1641/21 1641/25 1643/2 1645/5 1645/11 1645/23 1645/23 1645/24 1646/21 1647/15 1647/17 1648/14 1652/20 1653/2 1654/3 1656/18 1656/22 1656/25 1657/2 1657/3 1660/6 1664/8 1664/9 1664/10 1664/11 1664/18 1665/5 1665/6 1665/14 1669/5 1672/9 1674/17 1678/23 1687/24 1688/16 1688/17 1706/19 1709/24 1710/1 1710/2 1714/5 1718/24 1725/23 1730/21 1730/23 1733/12 1733/14 1757/2 1758/14 1763/5 1769/4 1771/24 1773/19 1773/25 1794/10	today [10] 1671/15 1676/17 1678/18 1698/17 1753/1 1755/14 1756/24 1784/10 1784/12 1790/6	TREX [27] 1649/9 1649/10 1693/25 1695/11 1700/18 1702/16 1703/4 1716/5 1724/11 1725/8 1744/9 1747/8 1747/20 1755/1 1755/8 1756/2 1756/2 1764/20 1764/20 1764/21 1764/21 1765/6 1765/8 1773/5 1773/8 1774/19 1781/1
throughout [1] 1695/23	tomorrow [6] 1796/17 1798/14 1798/22 1799/21 1799/22 1799/24	TREX-1 [1] 1649/9
throw [1] 1677/14	Tony [1] 1741/2	TREX-11485R.11.3 [1] 1693/25
Thursday [5] 1797/9 1798/23 1798/25 1799/21 1800/1	too [7] 1638/10 1678/7 1679/6 1710/15 1724/23 1781/22 1782/9	TREX-11485R.9.1 [1] 1700/18
tie [1] 1638/11	took [10] 1634/10 1644/6 1644/7 1696/23 1697/10 1708/6 1715/24 1716/19 1754/2 1759/3	TREX-11486R.14.1 [1] 1695/11
time [106] 1638/25 1639/17 1639/19 1645/1 1645/25 1646/3 1646/6 1647/3 1648/7 1648/8 1648/18 1649/16 1649/16 1650/10 1650/14 1650/15 1650/23 1651/21 1653/6 1653/6 1653/22 1654/17 1655/2 1655/25 1658/22 1660/16 1662/8 1662/13 1672/3 1673/8 1673/20 1675/9 1675/22 1675/24 1675/25 1676/6 1682/1 1684/13 1684/15 1690/17 1690/25 1691/13 1693/20 1694/14 1695/25 1696/4 1696/10 1696/20 1697/5 1699/1 1699/16 1699/19 1699/22 1699/22	too [7] 1638/10 1678/7 1679/6 1710/15 1724/23 1781/22 1782/9	TREX-11486R.29.2 [1] 1725/8
	tools [2] 1707/2 1715/16	TREX-11488.17.2 [1] 1702/16
	top [20] 1643/13 1643/13 1648/13 1649/14 1649/17 1651/24 1652/9 1652/14 1654/19 1660/5 1694/6 1700/8 1705/23 1716/8 1718/12 1718/15 1719/10 1724/21 1748/25 1765/11	TREX-114901R [1] 1755/8
	top-kill [2] 1718/12 1718/15	TREX-11490R [2] 1755/1 1756/2
	top-right [2] 1651/24 1652/14	TREX-11491R [1] 1756/2
	topic [6] 1666/6 1715/20 1718/4 1740/21 1747/22 1747/25	TREX-11491R.0012 [1] 1774/19
	topics [2] 1745/21 1784/25	TREX-11553RNoHC-2.27.1.US [1] 1781/1
	Torts [1] 1629/6	TREX-11575 [1] 1764/21
	total [9] 1644/15 1646/15 1673/2 1673/5 1673/13 1738/2 1773/21 1774/1 1774/6	TREX-11653.27.1 [1] 1703/4
	toward [3] 1644/18 1678/15 1775/6	TREX-130815 [1] 1764/20
	town [2] 1800/2 1800/7	TREX-130963 [1] 1764/21
	track [2] 1657/16 1736/25	TREX-41026.54.1 [1] 1716/5
	tracks [1] 1768/20	TREX-41026.57 [1] 1747/20
	traditional [6] 1677/12 1677/17 1677/20 1677/21 1678/19 1679/7	TREX-41026.8 [1] 1747/8
	transcript [2] 1627/14 1801/6	TREX-4248 [1] 1649/10
	transcription [1] 1631/24	TREX-60988 [3] 1764/20 1765/8 1773/8
	transfer [2] 1772/18 1777/13	TREX-60988.003.001.US [1] 1765/6
	transient [1] 1691/21	TREX-60988.26.001.US [1] 1773/5
	transition [1] 1715/19	trial [5] 1627/14 1633/16 1635/1 1637/4 1718/3
	translate [1] 1692/3	tried [1] 1680/15
	Transocean [9] 1630/12 1630/13 1630/14 1630/15 1630/16 1630/17 1630/18 1630/19 1630/20	trimethylbenzene [1] 1772/1
	traveling [5] 1705/7 1705/22 1777/10 1777/11 1799/14	trip [1] 1777/13
	travels [1] 1775/6	TRITON [1] 1627/8
	treated [2] 1663/11 1663/14	trouble [2] 1690/5 1696/7
	treatment [1] 1645/1	trough [1] 1745/8
	trees [1] 1634/20	true [28] 1663/15 1668/23 1680/22 1681/9 1681/9 1682/6 1683/13 1683/16 1697/17 1705/3 1705/5 1706/15 1707/6 1739/17 1739/20 1740/12 1740/16 1740/18 1740/19 1740/25 1742/21 1743/22 1783/5 1790/7 1795/1 1795/16 1795/17 1801/5

<p>T</p> <p>turn... [2] 1779/12 1782/1 turning [1] 1778/10 turns [2] 1758/15 1763/10 two [51] 1639/9 1640/17 1640/23 1641/17 1642/4 1643/6 1643/15 1643/16 1646/16 1646/17 1652/3 1654/21 1654/22 1655/17 1656/5 1656/18 1659/8 1660/17 1663/14 1663/14 1663/15 1670/22 1670/22 1670/24 1671/1 1671/1 1682/4 1685/5 1686/14 1686/15 1687/4 1688/25 1691/2 1698/22 1700/1 1703/19 1717/22 1721/12 1723/3 1736/15 1745/11 1750/5 1752/8 1755/13 1761/10 1768/18 1769/7 1776/25 1780/9 1783/16 1784/24 two-phase [4] 1641/17 1643/15 1643/16 1698/22 type [2] 1639/16 1708/7 typically [1] 1657/21</p>	<p>uniformly [1] 1689/1 UNITED [25] 1627/1 1627/10 1627/15 1629/6 1629/9 1633/14 1633/15 1634/9 1634/11 1635/3 1635/18 1636/8 1636/9 1636/15 1637/18 1751/14 1751/24 1752/2 1752/8 1752/12 1752/15 1752/22 1754/16 1788/21 1801/4 units [1] 1713/11 universal [2] 1657/6 1657/12 University [1] 1753/7 unknown [3] 1683/9 1684/21 1707/2 unknowns [1] 1683/4 unlike [1] 1772/9 unrelated [1] 1656/5 unseal [1] 1705/22 until [4] 1635/1 1683/7 1713/23 1796/16 up [122] 1633/9 1633/24 1635/1 1635/9 1635/10 1637/2 1638/10 1638/12 1642/10 1644/2 1644/11 1644/23 1648/17 1654/19 1655/23 1656/2 1656/3 1656/9 1664/22 1665/9 1665/21 1669/4 1669/12 1669/14 1670/22 1671/11 1671/13 1673/1 1677/14 1678/22 1682/15 1685/8 1697/8 1697/11 1698/1 1699/3 1699/13 1700/9 1700/17 1701/10 1704/19 1705/2 1705/15 1705/21 1706/22 1708/11 1708/13 1709/3 1710/7 1710/11 1711/23 1711/24 1714/9 1716/5 1720/11 1723/3 1723/3 1724/7 1724/11 1727/9 1727/22 1728/20 1729/4 1729/15 1729/15 1730/2 1730/6 1730/8 1730/12 1730/12 1731/6 1731/10 1735/3 1736/11 1737/18 1737/20 1738/2 1738/8 1738/14 1739/5 1741/20 1741/23 1742/12 1744/11 1745/8 1748/19 1753/3 1755/1 1755/8 1756/21 1758/14 1758/23 1759/1 1760/8 1761/3 1762/18 1763/4 1763/5 1764/13 1765/6 1766/3 1768/10 1769/4 1769/17 1771/24 1773/4 1773/14 1773/15 1774/2 1774/18 1775/6 1777/8 1777/13 1778/2 1778/4 1781/6 1783/8 1785/10 1788/18 1792/20 1794/11 1794/15 upon [6] 1634/17 1635/19 1753/22 1764/23 1782/8 1792/11 upper [19] 1648/7 1648/9 1648/10 1648/13 1648/23 1648/24 1650/1 1651/22 1651/25 1652/8 1652/22 1656/17 1659/4 1675/7 1695/14 1710/16 1710/22 1711/7 1746/11 upper-left [1] 1652/8 ups [4] 1731/15 1731/18 1736/25 1744/12 upstream [4] 1720/23 1723/17 1723/18 1724/3 us [6] 1634/16 1635/4 1641/8 1648/16 1793/11 1798/5 use [53] 1633/21 1644/25 1645/25 1666/10 1666/19 1668/12 1668/21 1671/9 1671/9 1671/11 1672/12 1674/13 1674/14 1677/2 1677/6 1680/11 1680/15 1680/18 1680/21 1680/23 1681/3 1683/7 1683/17 1683/20 1684/4 1685/12 1685/14 1686/24 1687/4 1687/10 1689/13 1691/8 1696/14 1699/22 1701/25 1702/3 1702/5 1707/16 1707/19 1718/11 1718/21 1719/12 1720/25 1739/13 1749/15 1757/3 1757/8 1764/2 1768/14 1779/21 1780/16 1788/3 1788/5 used [73] 1636/10 1636/16 1641/13</p>	<p>1645/4 1656/19 1656/23 1663/5 1664/9 1666/11 1666/19 1667/1 1668/10 1668/24 1672/17 1677/23 1679/2 1679/13 1679/15 1680/8 1681/1 1681/2 1681/6 1681/24 1683/20 1684/4 1684/8 1688/22 1693/18 1694/2 1695/18 1698/17 1698/23 1698/24 1703/10 1706/6 1707/2 1715/16 1717/7 1717/10 1717/19 1719/14 1719/16 1738/15 1743/2 1743/3 1743/6 1743/12 1747/15 1757/12 1757/15 1757/20 1758/22 1759/11 1759/16 1761/2 1761/5 1764/11 1765/23 1770/14 1782/11 1783/15 1783/20 1785/4 1785/7 1785/15 1787/16 1788/13 1788/19 1788/22 1789/2 1791/10 1795/15 1795/24 useful [1] 1680/5 uses [3] 1638/17 1689/5 1780/1 using [29] 1631/24 1641/19 1662/12 1671/6 1674/20 1678/14 1678/17 1683/14 1702/9 1705/25 1716/11 1719/8 1720/12 1730/23 1734/12 1742/10 1742/14 1742/21 1743/9 1767/23 1768/1 1768/3 1768/12 1769/21 1780/2 1780/3 1785/18 1788/9 1788/18 Usually [1] 1645/14</p>
<p>U</p> <p>U.S [4] 1629/6 1629/9 1634/13 1796/20 uh [14] 1649/12 1654/10 1676/16 1682/20 1685/11 1687/7 1723/13 1726/2 1726/8 1735/5 1742/4 1742/6 1746/1 1747/7 Uh-huh [13] 1649/12 1654/10 1676/16 1682/20 1685/11 1687/7 1723/13 1726/2 1726/8 1742/4 1742/6 1746/1 1747/7 ultimate [1] 1642/20 ultimately [1] 1714/12 Unambiguous [1] 1782/1 uncertainties [44] 1639/25 1640/2 1640/5 1640/17 1640/21 1640/22 1640/23 1640/24 1641/2 1641/10 1641/12 1642/5 1643/20 1644/10 1645/16 1661/10 1682/6 1682/8 1697/19 1698/1 1698/2 1698/10 1698/11 1698/13 1698/16 1698/17 1698/20 1698/25 1710/23 1711/8 1711/21 1714/9 1714/21 1720/1 1720/4 1720/5 1729/13 1729/16 1731/2 1745/14 1746/5 1746/9 1760/6 1792/4 uncertainty [40] 1639/20 1639/21 1639/24 1640/14 1641/14 1642/3 1642/6 1643/3 1643/4 1643/12 1643/19 1643/24 1645/14 1674/24 1675/21 1676/1 1696/23 1696/25 1697/13 1697/14 1698/6 1707/14 1708/19 1713/2 1713/7 1713/9 1713/12 1713/13 1713/14 1713/15 1713/19 1713/23 1714/3 1714/5 1719/21 1731/6 1731/25 1741/19 1741/20 1746/15 unchanged [3] 1655/13 1689/24 1690/1 under [12] 1634/15 1671/25 1694/8 1702/10 1710/7 1711/21 1711/21 1724/16 1737/8 1737/9 1737/9 1737/12 underpredict [1] 1731/9 underpredicts [1] 1796/6 understand [13] 1633/13 1636/3 1642/8 1646/1 1660/3 1668/1 1689/23 1696/9 1706/3 1713/20 1762/17 1765/14 1776/21 understanding [10] 1646/2 1660/22 1690/5 1710/23 1756/4 1765/20 1770/17 1771/14 1779/15 1801/7 unflowing [1] 1701/13 unfold [1] 1693/12 unfortunately [1] 1731/21</p>	<p>V</p> <p>vague [1] 1667/12 vaguely [1] 1708/10 valid [2] 1668/15 1792/4 validate [3] 1660/2 1677/5 1687/12 validated [1] 1682/9 validating [1] 1682/8 validation [5] 1659/25 1661/6 1661/7 1677/4 1707/19 valuable [2] 1758/5 1766/1 value [37] 1682/2 1682/4 1682/4 1685/8 1685/12 1686/10 1687/13 1687/14 1688/24 1688/24 1689/13 1692/9 1692/23 1693/10 1693/19 1694/18 1696/24 1697/16 1699/8 1701/4 1702/3 1702/5 1702/12 1703/7 1703/23 1706/1 1727/20 1727/20 1729/21 1740/16 1740/18 1740/19 1740/25 1742/22 1779/20 1783/15 1794/2 values [17] 1674/10 1683/9 1684/24 1685/14 1685/19 1685/21 1686/2 1686/22 1688/22 1688/25 1691/3 1698/23 1698/24 1699/6 1731/16 1747/15 1783/16 variabilities [1] 1739/4 variability [1] 1641/20 variable [5] 1650/1 1659/4 1659/8 1685/2 1717/18 variation [1] 1692/20 variations [3] 1694/7 1698/21 1698/22 varied [6] 1641/4 1740/10 1740/14 1740/17 1740/23 1747/5 varies [1] 1684/17 various [5] 1665/2 1681/12 1759/12 1792/12 1792/15 vary [4] 1641/16 1641/25 1642/16 1691/5 varying [3] 1717/23 1747/16 1747/16 VBR [1] 1712/14 VBRs [4] 1704/16 1704/16 1712/14 1748/16 velocities [7] 1647/16 1647/18 1647/19 1647/21 1657/16 1657/16 1657/17 velocity [4] 1647/22 1657/15 1657/21</p>	

V
velocity... [1] 1688/13
verify [1] 1739/10
version [1] 1749/12
versus [2] 1668/8 1742/5
very [54] 1634/10 1640/5 1640/5
1644/14 1644/14 1646/9 1646/10
1647/6 1647/6 1647/11 1647/15
1647/16 1647/18 1647/19 1647/20
1647/22 1647/22 1650/3 1650/10
1650/13 1652/13 1652/14 1653/24
1655/16 1656/24 1658/6 1659/14
1660/18 1668/14 1670/24 1673/16
1675/4 1677/20 1686/20 1696/17
1696/21 1705/6 1705/14 1714/7
1719/19 1725/11 1729/10 1737/21
1738/7 1738/10 1738/10 1739/16
1740/1 1745/19 1748/19 1758/1 1764/5
1770/3 1770/14
viable [1] 1757/7
vicinity [1] 1653/16
video [1] 1798/20
videos [1] 1777/1
view [9] 1645/15 1652/15 1696/1
1706/14 1708/3 1718/14 1725/15
1771/12 1791/23
views [2] 1707/21 1711/1
visually [2] 1738/9 1777/1
VOIR [1] 1752/20
volume [22] 1688/13 1716/10 1759/6
1760/25 1761/8 1761/9 1761/13 1762/3
1762/12 1771/19 1772/3 1773/14
1773/22 1774/1 1774/2 1774/5 1774/11
1774/14 1774/15 1779/4 1779/5
1792/16

W
wait [7] 1636/12 1636/12 1636/12
1665/7 1701/20 1710/13 1726/22
walk [5] 1641/6 1641/8 1643/1 1645/5
1645/24
walked [1] 1672/9
want [11] 1635/6 1642/9 1643/1 1646/1
1668/2 1672/22 1744/3 1744/13
1786/15 1788/23 1797/17
wanted [2] 1644/13 1798/7
WARREN [1] 1631/15
was [166] 1633/19 1633/19 1634/7
1634/8 1634/9 1634/14 1634/15
1634/25 1637/2 1637/3 1637/4 1637/5
1639/15 1643/23 1643/25 1646/5
1646/9 1646/14 1648/5 1648/7 1648/9
1648/10 1648/14 1648/14 1648/15
1648/17 1648/18 1648/20 1648/22
1648/24 1649/18 1650/3 1650/23
1653/3 1653/6 1653/7 1653/18 1655/3
1656/15 1657/23 1658/13 1660/4
1660/4 1661/9 1662/4 1662/10 1662/10
1662/12 1662/24 1666/9 1666/19
1666/21 1666/24 1666/25 1667/7
1667/19 1667/20 1669/10 1670/23
1672/1 1672/5 1672/19 1673/5 1676/9
1677/23 1679/2 1681/11 1681/19
1682/1 1686/14 1686/20 1690/14
1691/12 1692/19 1693/5 1693/7 1693/7
1693/10 1693/21 1694/3 1694/14
1695/5 1695/6 1695/14 1696/4 1696/5
1696/10 1696/11 1696/12 1700/10
1700/14 1701/13 1702/2 1703/19
1704/8 1704/25 1705/4 1705/5 1705/6
1705/7 1705/9 1705/9 1705/23 1708/8
1708/11 1711/2 1712/11 1713/1 1713/2

1713/22 1714/14 1716/11 1716/11
1717/1 1717/13 1719/20 1719/21
1720/7 1726/20 1733/14 1741/5 1741/6
1741/8 1741/9 1741/12 1743/18
1745/10 1745/18 1745/23 1746/2
1746/4 1746/14 1746/17 1746/18
1746/19 1747/15 1748/1 1748/24
1749/2 1750/1 1750/6 1751/3 1751/12
1753/23 1754/4 1756/9 1758/19 1759/5
1766/22 1767/14 1767/17 1767/20
1767/20 1770/22 1771/6 1776/21
1776/22 1785/11 1785/14 1786/8
1787/22 1790/22 1793/22 1793/25
1796/23 1797/23
washed [1] 1653/24
Washington [6] 1629/8 1629/16 1630/7
1630/11 1631/16 1798/8
wasn't [3] 1662/13 1662/22 1694/23
watch [3] 1670/5 1670/6 1670/7
water [13] 1769/5 1769/14 1771/22
1772/2 1772/12 1772/13 1772/16
1774/13 1779/4 1779/23 1780/11
1782/24 1796/21
water-soluble [4] 1774/13 1779/23
1780/11 1782/24
waters [1] 1752/15
way [29] 1635/7 1640/25 1644/13
1646/25 1653/1 1668/14 1681/12
1697/2 1697/7 1709/22 1709/25 1710/2
1720/24 1728/8 1728/10 1731/21
1745/19 1751/7 1760/22 1762/12
1765/18 1768/6 1768/22 1776/9
1776/19 1780/20 1788/8 1788/14
1790/17
ways [1] 1696/18
we [127] 1634/14 1635/2 1635/6
1635/11 1635/18 1635/25 1636/12
1636/17 1637/5 1637/7 1637/20
1637/23 1637/23 1637/24 1637/25
1638/1 1638/8 1639/2 1639/5 1640/10
1641/7 1644/21 1646/11 1646/16
1648/19 1648/22 1648/23 1648/24
1649/2 1649/3 1649/9 1649/21 1651/14
1653/4 1653/5 1654/13 1657/19
1658/15 1659/25 1660/15 1660/20
1661/6 1661/22 1661/25 1662/19
1664/22 1665/13 1667/23 1670/12
1671/3 1672/11 1675/10 1678/22
1682/15 1682/21 1684/2 1686/15
1686/25 1690/2 1692/19 1693/15
1699/3 1699/13 1700/17 1703/23
1707/12 1710/14 1710/15 1720/11
1720/12 1720/21 1720/23 1721/3
1725/8 1725/23 1727/11 1727/16
1727/19 1729/9 1732/5 1733/9 1733/24
1735/23 1737/18 1741/23 1744/9
1744/11 1744/16 1747/8 1747/9
1747/20 1747/22 1748/23 1749/9
1750/24 1751/7 1752/5 1765/9 1773/7
1774/20 1776/25 1778/11 1780/25
1782/5 1782/6 1788/25 1789/11 1792/9
1792/19 1795/18 1796/15 1796/18
1796/22 1796/23 1797/13 1797/24
1798/3 1799/14 1799/22 1800/2 1800/4
1800/9 1800/9 1800/11 1800/13
1800/14 1800/21
We'd [1] 1636/18
we'll [15] 1643/17 1645/5 1645/24
1645/24 1656/9 1703/14 1751/21
1784/13 1788/20 1796/16 1798/13
1798/15 1799/23 1799/25 1800/18
we're [24] 1635/13 1637/11 1642/25
1652/4 1664/17 1666/5 1672/5 1692/20

1693/13 1720/23 1721/5 1721/5
1730/14 1733/15 1739/1 1739/4 1752/4
1776/3 1783/5 1794/20 1796/13 1797/8
1798/21 1798/21
we've [12] 1634/17 1649/20 1665/9
1665/21 1669/13 1672/9 1689/2
1703/24 1737/11 1739/2 1751/14
1799/8
weapons [1] 1673/14
website [1] 1789/15
week [6] 1686/21 1697/8 1772/20
1797/7 1797/8 1798/3
weeks [9] 1650/15 1650/24 1660/17
1693/13 1695/2 1695/6 1695/19 1696/1
1696/21
weight [2] 1635/23 1773/14
Weiner [1] 1631/11
Weitz [1] 1628/9
well [201]
wellbore [41] 1638/23 1639/6 1639/13
1647/2 1655/12 1659/9 1662/3 1662/3
1662/5 1663/10 1665/4 1672/20 1674/6
1674/6 1687/5 1688/23 1689/6 1689/10
1690/22 1690/24 1694/7 1694/15
1713/3 1720/24 1721/14 1721/18
1722/16 1722/21 1723/22 1724/8
1725/13 1725/22 1726/1 1727/16
1727/21 1730/11 1734/21 1739/23
1794/7 1794/8 1794/11
wellhead [1] 1776/23
wells [1] 1680/9
went [10] 1705/2 1709/3 1710/10
1711/23 1711/24 1725/15 1725/23
1729/15 1729/15 1753/22
were [91] 1633/14 1637/23 1638/24
1646/7 1651/1 1651/9 1652/25 1653/25
1654/2 1656/19 1658/19 1659/5 1660/6
1660/7 1660/10 1661/4 1661/11
1664/15 1666/3 1666/3 1667/23
1670/12 1670/24 1677/5 1678/25
1679/10 1682/12 1688/11 1688/12
1691/3 1691/14 1694/2 1696/10
1697/19 1698/2 1698/7 1698/22
1698/23 1698/25 1700/15 1704/16
1709/2 1709/14 1710/10 1711/15
1711/19 1711/23 1711/24 1712/4
1712/7 1720/5 1723/8 1723/9 1723/10
1732/5 1741/11 1745/25 1746/6
1746/11 1747/4 1748/17 1748/22
1753/24 1753/24 1754/5 1755/22
1761/9 1762/17 1764/8 1764/9 1764/9
1764/10 1764/24 1764/25 1765/1
1765/2 1765/4 1769/22 1770/21
1770/23 1771/1 1771/21 1781/17
1782/7 1785/22 1786/18 1787/21
1788/6 1790/22 1795/21 1800/24
weren't [2] 1687/20 1799/14
what [198]
what's [18] 1640/25 1646/2 1652/11
1660/22 1668/10 1669/7 1673/2
1692/22 1711/8 1713/21 1723/18
1723/22 1724/8 1725/17 1745/22
1765/23 1775/9 1798/24
whatever [7] 1635/6 1635/23 1661/4
1693/16 1693/19 1694/13 1796/14
when [73] 1645/13 1647/19 1648/7
1649/17 1652/21 1652/25 1653/22
1653/23 1655/23 1659/11 1678/14
1680/12 1682/8 1684/2 1684/21
1686/19 1693/15 1693/18 1694/23
1694/24 1696/10 1696/14 1698/19
1698/20 1704/7 1704/11 1704/16
1704/21 1704/25 1705/22 1705/22

W
when... [42] 1705/23 1708/13 1709/25
1710/10 1711/4 1711/5 1711/23
1711/24 1712/3 1714/6 1716/12
1719/16 1722/5 1723/8 1723/9 1723/10
1726/13 1726/19 1728/2 1728/20
1729/4 1730/6 1731/8 1731/9 1737/19
1737/20 1744/13 1745/10 1745/23
1747/15 1748/16 1750/5 1751/10
1760/18 1763/9 1764/25 1784/14
1784/14 1795/14 1795/23 1797/5
1797/5
whenever [3] 1634/14 1799/19 1799/20
where [43] 1635/2 1645/21 1648/12
1652/5 1652/16 1652/20 1657/1
1663/10 1663/10 1664/5 1665/23
1667/20 1674/5 1675/24 1676/1 1676/6
1677/4 1690/11 1691/22 1698/7
1698/18 1699/19 1700/9 1701/6 1701/6
1707/14 1710/25 1714/10 1733/18
1739/22 1751/21 1753/10 1753/23
1754/4 1763/3 1766/11 1766/13 1775/3
1776/6 1776/15 1778/25 1794/6 1794/6
WHEREUPON [4] 1637/14 1715/24
1750/18 1800/24
whether [27] 1646/5 1650/11 1653/13
1658/12 1658/13 1662/19 1663/5
1667/1 1686/8 1693/20 1694/14
1698/21 1700/7 1713/13 1713/14
1713/15 1724/2 1738/23 1752/13
1757/14 1772/19 1776/1 1779/15
1782/14 1794/14 1794/17 1796/20
which [57] 1638/1 1649/9 1649/10
1654/22 1654/24 1655/17 1660/5
1663/22 1664/15 1681/13 1681/14
1681/25 1682/25 1687/21 1687/21
1692/9 1692/25 1692/25 1697/2 1712/5
1714/10 1716/5 1730/15 1730/24
1731/22 1752/13 1756/17 1757/7
1760/5 1760/16 1760/18 1763/7
1764/16 1764/23 1766/1 1766/8 1766/9
1766/15 1767/17 1770/4 1770/7
1770/22 1771/9 1773/16 1774/1
1775/14 1779/11 1780/16 1783/17
1785/15 1788/12 1788/21 1795/10
1795/15 1796/13 1798/10 1800/8
while [5] 1641/16 1647/13 1727/5
1744/11 1786/18
Whiteley [1] 1629/2
Whitson [27] 1752/5 1752/6 1759/21
1767/18 1770/16 1770/18 1771/10
1772/23 1773/16 1776/8 1778/7
1778/14 1780/2 1780/6 1782/15 1787/7
1787/7 1789/1 1789/3 1789/8 1789/14
1789/18 1791/8 1791/10 1791/13
1797/5 1800/9
Whitson's [27] 1752/9 1752/12 1752/18
1759/25 1771/14 1772/4 1773/23
1774/8 1774/23 1775/2 1775/21 1776/7
1778/11 1779/16 1779/17 1779/21
1779/21 1779/22 1780/5 1782/18
1782/21 1782/22 1782/25 1787/23
1790/8 1791/21 1792/1
who [4] 1679/4 1797/4 1799/8 1800/5
Who's [1] 1799/5
whoa [1] 1739/6
whole [10] 1650/8 1652/18 1652/19
1667/5 1678/3 1697/8 1713/6 1714/18
1721/25 1766/18
whoopee [1] 1739/3
whose [1] 1668/19
why [20] 1638/11 1639/24 1646/2

1646/14 1647/9 1647/10 1655/1 1656/6
1656/6 1698/13 1730/5 1731/20 1735/6
1749/24 1751/15 1757/19 1757/22
1765/20 1769/10 1778/23
wildly [1] 1738/4
will [33] 1641/16 1641/17 1644/10
1644/10 1644/11 1653/22 1691/5
1703/17 1737/12 1737/15 1746/23
1751/16 1761/13 1768/23 1769/4
1769/14 1773/2 1777/22 1777/23
1778/2 1778/4 1778/19 1778/19
1782/13 1782/17 1795/2 1795/5
1796/13 1799/3 1799/16 1799/20
1799/21 1800/13
wind [3] 1644/11 1656/2 1714/9
winds [1] 1656/2
WINFIELD [1] 1628/19
within [23] 1648/23 1648/25 1649/3
1649/18 1649/21 1649/22 1656/3
1656/16 1670/1 1675/5 1686/21
1701/22 1705/8 1705/8 1705/21
1717/22 1758/6 1770/12 1771/1
1776/12 1777/3 1782/11 1792/4
without [1] 1763/25
witness [15] 1662/17 1662/19 1664/16
1666/6 1669/9 1669/15 1671/23
1750/17 1752/3 1752/5 1784/7 1798/13
1799/5 1799/17 1800/5
witnesses [5] 1664/18 1664/18 1799/9
1799/13 1800/9
won't [5] 1641/7 1651/14 1670/12
1777/25 1777/25
word [6] 1657/6 1659/2 1679/6 1695/10
1717/19 1717/19
words [9] 1677/11 1680/2 1694/2
1694/3 1694/5 1696/14 1711/5 1722/15
1761/5
work [38] 1635/20 1644/19 1650/19
1666/12 1672/1 1673/1 1673/12
1673/14 1675/21 1676/9 1677/24
1678/15 1679/3 1680/9 1680/16
1691/19 1693/3 1698/2 1698/7 1698/8
1698/18 1707/21 1732/19 1732/19
1740/10 1741/2 1753/22 1754/7
1754/13 1765/10 1765/15 1770/18
1771/16 1775/22 1787/2 1787/3 1789/2
1798/7
worked [2] 1644/1 1645/11
working [4] 1645/6 1679/19 1700/8
1700/9
works [4] 1638/11 1641/8 1677/13
1685/8
world [3] 1677/24 1679/3 1790/2
worst [3] 1644/5 1644/9 1675/4
worth [1] 1653/8
would [217]
wouldn't [4] 1642/19 1685/22 1743/10
1788/5
wrap [2] 1656/9 1673/1
Wright [1] 1627/21
write [6] 1711/10 1711/12 1711/14
1711/18 1740/22 1789/22
written [2] 1715/2 1790/15
wrong [8] 1664/18 1665/8 1665/19
1665/19 1666/6 1734/17 1741/20
1767/20
wrote [8] 1671/25 1711/22 1720/6
1720/8 1720/10 1789/14 1789/15
1789/22

X
xylene [1] 1771/25

Y
yeah [17] 1633/25 1635/13 1645/13
1664/6 1677/13 1683/5 1689/20
1694/24 1696/3 1697/1 1700/13
1702/19 1708/23 1712/23 1718/6
1737/16 1777/15
year [1] 1765/3
years [6] 1754/9 1787/7 1789/5 1789/16
1789/18 1789/20
yellow [6] 1641/1 1643/14 1652/18
1652/18 1661/10 1783/17
yellow-colored [1] 1652/18
yes [214]
yesterday [2] 1635/2 1636/10
yesterday's [1] 1636/16
yet [4] 1780/22 1797/22 1799/1 1800/3
yield [3] 1740/11 1740/15 1740/24
York [3] 1628/11 1628/11 1631/8
you [799]
you'd [2] 1677/21 1722/21
you'll [3] 1738/4 1756/23 1759/19
you're [49] 1650/11 1655/14 1655/15
1655/23 1669/4 1671/14 1676/25
1678/17 1694/10 1702/8 1710/13
1715/6 1715/11 1715/16 1719/8 1727/8
1729/24 1730/2 1730/20 1731/12
1734/2 1734/12 1734/25 1735/16
1736/6 1736/15 1736/18 1740/4
1742/19 1749/6 1750/10 1750/16
1755/24 1759/21 1760/10 1761/16
1761/20 1762/8 1777/4 1781/3 1784/24
1785/13 1785/17 1786/1 1787/9
1787/11 1787/13 1794/18 1799/7
you've [22] 1645/6 1645/11 1648/2
1654/11 1659/11 1660/13 1669/15
1670/2 1709/21 1709/23 1722/1 1723/5
1728/11 1738/15 1739/1 1744/21
1752/22 1786/24 1789/20 1789/20
1793/1 1793/2
your [381]
your Honor [1] 1672/6
yours [3] 1670/20 1791/22 1791/23
yourself [2] 1707/20 1786/22

Z
Zaldivar's [2] 1732/12 1732/19
zebra [1] 1750/23
zero [14] 1682/1 1682/2 1682/2 1682/4
1683/21 1699/16 1699/22 1713/22
1713/23 1733/13 1739/1 1739/12
1748/20 1749/21
ZICK [35] 1750/18 1750/22 1751/8
1752/2 1752/17 1752/22 1753/5
1753/11 1753/13 1753/21 1754/17
1754/19 1754/24 1756/23 1758/22
1759/3 1760/10 1762/2 1763/19
1764/15 1765/20 1766/5 1768/12
1769/19 1773/9 1774/23 1775/20
1775/24 1776/6 1778/13 1781/8
1783/10 1784/22 1786/20 1789/13
Zick's [4] 1750/25 1751/16 1752/1
1756/1
Zimmerman [1] 1800/2
zoom [2] 1704/18 1705/15