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UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF LOUISIANA

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IN RE: OIL SPILL BY THE OIL RIG *DEEPWATER HORIZON* IN THE GULF OF MEXICO ON APRIL 20, 2010
CIVIL

Docket No. MDL-2179
Section "J"
New Orleans, LA
Thursday, October 10, 2013

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IN RE: THE COMPLAINT AND PETITION OF TRITON ASSET LEASING GmbH, ET AL

Docket No. 10-CV-2771
Section "J"

****

UNITED STATES OF AMERICA
V.
BP EXPLORATION & PRODUCTION, INC., ET AL

Docket No. 10-CV-4536
Section "J"

****

DAY 8, MORNING SESSION
TRANSCRIPT OF NON-JURY TRIAL PROCEEDINGS
HEARD BEFORE THE HONORABLE CARL J. BARBIER
UNITED STATES DISTRICT JUDGE

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I N D E X

P R O C E E D I N G S

(THURSDAY, OCTOBER 10, 2013)

(MORNING, AFTERNOON SESSION)

(OPEN COURT.)

08:05:27 THE COURT: Good morning, everyone. Just give me one second. Give you guys a heads-up on the time, but I forgot mine back on my desk, so I am going to ask Ben to tell everybody what the clock time is.

08:05:50 THE LAW CLERK: For the United States, you have used 11 hours and 6 minutes, you have 33 hours and 54 minutes remaining; BP has used 10 hours, 39 minutes. You have 34 hours and 21 minutes remaining.

08:06:01 THE COURT: All right. Okay. Preliminary matters?

08:06:06 MR. REGAN: Yes, your Honor, Matt Regan on behalf of BP. I have a series of exhibits to offer, and I will do them one at a time just for clarity on the record. First, BP offers the exhibits used with Dr. Pooladi-Darvish.

08:06:19 THE COURT: All right. Any objection? Hearing none, those are admitted.

08:06:23 MR. REGAN: BP offers the exhibits used with Dr. Kelkar.

08:06:27 THE COURT: Any objection? No objection, those are admitted.

08:06:30 MR. REGAN: BP would now offer the exhibits it used with Dr. Zick.

08:06:35 THE COURT: No objection, those are admitted.

08:06:37 MR. REGAN: BP offers the exhibits it used with Dr. Griffiths.

08:06:40 THE COURT: No objection, those are admitted.

08:06:42 MR. REGAN: And BP --

08:06:43 THE COURT: You're on a roll here, Mr. Regan.

08:06:47 MR. REGAN: BP offers the exhibits it used with Dr. Dykhuizen.

08:06:50 THE COURT: Any objection? All right, those are admitted.

08:06:53 MR. REGAN: Thank you, your Honor.

08:06:56 MR. LANGAN: Your Honor, Andy Langan for BP. Last night we sent a letter about the deposition designations for Dr. Bushnell. The DOJ has responded. I think we're essentially in agreement. So I wanted to tell you --

08:07:10 THE COURT: Ben told me this morning, and I have not had a chance to look at it.

08:07:14 MR. LANGAN: Perhaps, I don't know, but perhaps we can cut through this and save everybody some time and trouble.

08:07:19 THE COURT: Okay.

08:07:20 MR. LANGAN: So I believe, and counsel can correct me, that we've agreed that there is not going to be any submission of a Bushnell deposition bundle. We may disagree as to why that is, but the bottom line is there is not going to be a submission of a Bushnell deposition bundle.

Second thing is I think the DOJ said the other day, yesterday or the day before, and I have confirmed, that there is not going to be a Bushnell report proffered or admitted in any way.

THE COURT: Correct, too?

MS. HIMMELHOCH: Yes, your Honor.

MR. LANGAN: And, finally, our position is Magistrate Judge Shushan's September 12th order still stands. I don't know if the DOJ agrees or not, but -- I am not sure how important that is, but our position is it still stands. And that's essentially where we are.

THE COURT: I've made occasional exceptions to the order, put it that way.

MR. LANGAN: Understood. Thank you, your Honor.

MS. PENCAK: Good morning, your Honor, Erica Pencak for the United States. With respect to the exhibits that were used by the United States with Dr. Dykhuizen on Monday, there is still one objection from BP to those. Would you like to speak to that?

MR. REGAN: Sure. Your Honor, Matt Regan on behalf of BP. The exhibit is TREX 11191, which I believe is a Post-it note that was used with Dr. Dykhuizen. Dr. Dykhuizen did not have foundation for the document, and what he cited was a deposition of Trevor Hill, who also said he didn't know who wrote the document.

The government contends that it was written by a Dr. Saidi, but they didn't ask Dr. Saidi about the document. So we don't think the document has foundation, and we object to its admission through an expert who is relying on Trevor Hill, because we don't think that establishes foundation either.

MS. PENCAK: Thank you. Yesterday the deposition clip of Trevor Hill was played discussing this TREX, which is 11191, and he said that based on context, more likely than not, it was Ms. Saidi's handwriting. Also Monday in court, your Honor did allow the witness to testify about the exhibit.

THE COURT: I did. I didn't recall what he said. I'll look -- you all submitted -- we have the deposition transcript of Mr. Hill, Ben? We'll look at that and make a ruling on that.

MS. PENCAK: Thank you, your Honor. One other matter. I have the list of the exhibit callouts and demonstratives used by the United States with Dr. Zick. There have been no objections to that list.

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

MS. PENCAK: Thank you, your Honor.

THE COURT: Sure. Anything else? All right. BP can call its first witness.

MR. BROCK: Your Honor, BP calls Dr. Martin Blunt.

THE COURT: Okay. I have not seen any sort of *Daubert* motion or any other motion in limine regarding Dr. Blunt; is that correct?

MR. CERNICH: That's correct, your Honor.

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

(WHEREUPON, MARTIN J. BLUNT, WAS SWORN IN AND TESTIFIED AS FOLLOWS:)

THE DEPUTY CLERK: If you'll take a seat. If you'll state and spell your name for the record.

THE WITNESS: My name is Martin Julian Blunt, last name spelled B-L-U-N-T.

MR. BROCK: Your Honor, may I approach just to put a bottle of water on the stand?

THE COURT: Sure.

MR. BROCK: May I proceed?

THE COURT: Yes.

VOIR DIRE EXAMINATION

BY MR. BROCK:

Q. Would you please state your full name and current employment for the Court.

A. Yes, my name is Martin Julian Blunt. I am a professor of petroleum engineering at Imperial College London.

Q. Dr. Blunt, could you pull that microphone up just a little closer to where you are.

A. Does that work?

Q. That's better, thank you. Dr. Blunt, what were you asked to do for BP in this case?

A. I was asked to perform an analysis of Macondo reservoir, and from that analysis to determine the volume of oil that was released.

Q. I want to talk first a little bit about your educational background, and I have pulled up D-23501, and actually we're going to address here your educational background and some of your early industry experience. So if you would share with Judge Barbier a general summary about your educational background and then what you did in your first few years of employment in the area of reservoir engineering.
A. Yes. My first degrees and Ph.D. from the University of Cambridge. My Ph.D. was in physics. When I graduated in 1988, I worked for BP, their offices in Sunbury, which is near London. I was working as a reservoir engineer. My work there was principally on determining better methods for reservoir simulation, better numerical methods. And those methods were then implemented into a commercial simulator that BP was using.
Q. When you say you were working on reservoir simulation, what do you mean by that?
A. Reservoir simulation is where you model on a computer how fluid flows underground. As an example, for instance, Dr. Pooladi-Darvish yesterday presented a reservoir simulation model. So I was trying to improve the accuracy of models such as those that have already been presented in this case.
Q. What was the result of your work at BP in terms of reservoir modeling and the other work that you did?
A. Well, the main result of my work was an improved numerical scheme, an improved way of modeling this, that was then implemented

into the simulator.

I also began what has been a career-long theme of my work, which is to understand core data and then make predictions of flow properties.

Q. When you say that you have an interest in core data, what do you mean by that?

A. Measurements that are made on core samples, by which I mean samples of rock that are taken from the reservoir.

Q. And why is it important for a reservoir engineer to analyze core data and understand the meaning of the core data?

A. Because those are measurements that are made on the samples of rock that come from the reservoir, those measurements determine properties such as permeability that are very important in flow models that are used to predict oil production and used to design how you're going to optimize oil production in field.

Q. Will you be using those principles as we get into your opinions in this case?

A. Yes, I will.

Q. Let me direct your attention now to D-23502, and let's talk a little bit about what you did after you left BP. And if you would just remind the Court, how long were you at BP and then in what year did you make a change of employment?

A. So I worked for BP for four years, and in 1992 I was offered a job working on the faculty of petroleum engineering at Stanford University. And I was at Stanford for seven years.

Q. Why was Stanford University a place that you were interested in participating -- let me reask that.
Why was Stanford University attractive to you?
A. I suppose the major reason was I would consider the time. It was the best petroleum engineering department in the world, and it's still certainly one of the best. And obviously Stanford is in a very attractive location and generally fantastic university, and greatly enjoyed my time there.
Q. And what was your area of interest in terms of research and teaching while you were at Stanford?
A. So while I was at Stanford I taught a number of classes, but the ones most relevant to this case are on reservoir engineering, which one of the basic concepts that I taught was material balance which I am going to apply here.
In terms of research, there were two strands to my research, one was continuing the development of better numerical methods for reservoir simulation, and the other was, again, understanding fluid flow, the small scale or the scale of little pieces of rock, particularly the analysis of the flow of oil, water and gas.
Q. Could you focus, Dr. Blunt, on this bullet point here, "Founder of Streamsim Technologies and winner of the SPE Uren award, U-R-E-N. And then also research that you did that was sponsored by the United States government and major oil companies during your years at Stanford.

A. Yes. So as I said, we developed new methods for looking at or simulating numerical methods, computer methods for looking at flow in reservoirs, and one of those is based on a technique which is known as streamlines.

So myself and two of my former Ph.D. students in 1996 formed a start-up company that's called Streamsim Technologies, still operating, based in California.

It's not quite correct -- I have been awarded the SPE Uren award, but, in fact, specifically based on that research, we were awarded the Ferguson medal from the Society of Petroleum Engineers, which is for the best paper written by an author under the age of 33. So we were recognized for the Society of Petroleum Engineers for that work at the time that I was at Stanford.

Q. You've also mentioned here that you have done research for the United States government and major oil companies. What was that research and what department of government sponsored your research?

A. So the U.S. government sponsorship was from the U.S. Department of Energy. I received substantial funding from them to look at what's technically called three-phase flow, that's the flow of oil, water and gas, and also had sponsorship from a consortium of major oil companies.

Q. Dr. Blunt, after you left Stanford, where did you go?

A. I became a professor of petroleum engineering at Imperial College London, that's my present position.

Q. I have up now D-23503, and could you just use this slide to describe for Dr. Barbier a little bit about the history of Imperial College in the area of petroleum engineering, and then talk about what you've done there that is pertinent to the opinions that you bring to the Court today.

A. Yes. Imperial College is a technical university in that it does science, engineering and medicine. And it's always had very much a sort of practical aspect, so it was very -- it's highly ranked academically. But we do try and do things that are relevant to industries in our founding charter.

Just a couple of weeks ago, we celebrated our centennial of petroleum teaching research, I gave a presentation of a centennial celebration. So we've been working on this for 100 years, 1913 we started.

And I've -- as well as being a professor, I've headed up a research group in this area, petroleum engineering and rock mechanics research group. And until two years ago, I served as the head of the department or department chair in the Department of Earth Science and Engineering. That brings together both engineers, but also geologists and geophysicists in one department working together.

Q. Did you continue to write and teach subjects about subjects that are relevant to your opinions in this case?

A. Yes. I teach all our master students. These are master students in petroleum engineering, petroleum geoscience, petroleum geophysics; so it's over 100 students a year, and I teach material balance. I've thought thousands of students material balance, and that's essentially the basis of what I am going to present my calculations today.

Q. I want to talk a little bit about industry applications of your research and some of the work that you've done. I think we've talked about the streamline -- Streamsim issue, but can I ask you, have you provided reservoir simulation services for major oil companies?

A. Yes, or at least through Streamsim, it provides essentially reservoir simulators, so the numerical, the computer tools that all companies use. And those tools are used by a number of major oil companies all around the world.

Q. And then speak to the issue a little more about iRock Technologies and what your role is with iRock.

A. So this has been a continuing interest of mine ever since when I was at BP. What it is, is taking samples of rock, small samples of rock, indeed sometimes very small samples of rock from the reservoir, imaging, that is looking at what these samples look like, and from that making predictions, making predictions in properties such as, for instance, permeability or elastic properties from which you can get compressibility.

This has sort of burst into the commercial domain in the last few years. In 2010, a company iRock Technologies was founded by one of my former Ph.D. students. I am the chief technology officer of that company.

BY MR. BROCK:
Q. This bullet right here where you talk about providing predictions of rock properties for major oil companies, can you describe that work, Dr. Blunt?
A. Yes, as I think I said, companies will give us small samples of rock, and it can be a whole core, they can be a rotary sidewall core, they can be actually just a chip of rock. We image the rock so we can look and sort of zoom in and look at what's called the pore space using an X-ray microscope, and from that we then make predictions. So we have numerical models, computer models that make predictions of fluid properties or flow properties.
Q. I want to talk about just a couple of other things in terms of industry background. I've called up now D-23505, and I'll ask you first, do you have experience consulting with major oil companies with regard to Gulf of Mexico deepwater reservoirs?
A. Yes, indeed I do. I think the main thing here to point out is Statoil, which is a Norwegian oil company, has a series of workshops, and I was invited to a workshop a couple of years ago to discuss reservoir engineering issues associated with deep reservoirs in the Gulf of Mexico. It's a workshop for a week, there are only about a dozen people who are invited there. I was one, I think, of two academics and the rest were leading reservoir engineers from major oil companies, and we discussed essentially, brainstormed issues associated with recovery from those reservoirs.
Q. We have a second bullet point here, "World's largest sandstone

reservoir Kuwait Oil Company hired Dr. Blunt to analyze measurements from cores."

Can you describe your engagement for the Kuwait Oil Company and how it's relevant to your opinions in this case?

A. Yes. And I've worked on this for a few years now. So the Kuwait Oil Company has the world's largest sandstone reservoir. In fact, it's the second largest oil reservoir in the world. They have over 1,000 wells. They've taken measurements from thousands of cores, and they want to make sense of those measurements. They say, how can we use these measurements wisely in our reservoir simulations to predict and manage oil recovery.

So I've been given access to all of that data and I've reviewed all of that data, and including there is measurements of rock mechanics measurements including pore volume compressibility.

Q. Like what you will be discussing today?

A. Indeed. That's relevant to the discussion of that today.

Q. Last slide on general background. D-23506. I am going to have to ask you to just brag on yourself just a little bit here, Dr. Blunt. If you could just describe for the Court the awards that you have received that recognize the work that you've done in the area of reservoir engineering.

A. Yes. The two major ones that I note, the second and third there, so two years ago I received an award from the Society of Petroleum Engineers, and that was the Uren award that you mentioned previously, and that's for outstanding contributions to petroleum engineering technology made before the age of 45.

And then last year I was honored by the Society of Core Analysts, that's the society that looks at core samples, develop measurement techniques and how to predict what's going on, so I was given their Darcy Award. That's for lifetime achievement.

Q. In the year that you were awarded the Society of Petroleum Engineers award for outstanding contributions to the field before age 45, how many recipients of that award were there that year?

A. It was just one, me. There's one award a year.

Q. We've talked about Darcy's equation some in this case. The year that you were given this award for lifetime achievement, how many recipients were there that year?

A. Again, there's one each year.

Q. Now, just very quickly in the area of publishing. You say here 200 scientific papers and over 8,000 citations. What's the reference here to 8,000 citations?

A. Okay. Citation means that another engineer or scientist has referred to my work in one of his or her publications. So that's happened more than 8,000 times.

Q. In the field of petroleum engineering, do you know of any author who has had their work cited more than 8,000 times?

A. Well, it's not something I've really checked in detail, but I am not aware of anyone else. In fact, the only person I do know who's got a similar number of citations at least is Professor Robert Zimmerman, one of my colleagues at Imperial, and he is one of the BP-retained experts in this case.

MR. BROCK: Your Honor, at this point, we would tender Dr. Blunt as an expert in reservoir and petroleum engineering.

THE COURT: Any objection? Without objection, he is admitted -- accepted, I mean.

DIRECT EXAMINATION

BY MR. BROCK:

Q. Dr. Blunt, let me turn now to your approach to the case. What method did you use to determine the cumulative flow of oil from the Macondo reservoir?

A. I used the material balance method.

Q. And how did you decide what method to use?

A. It was based on my review of the data, the information that we had pertaining to Macondo, obviously in the light of my expertise.

Q. Did you consider methodologies other than material balance?

A. Yes, I did.

Q. Can you describe for the Court other methodologies where you have expertise that you've considered and the reasons that you did not use those methodologies and instead chose material balance?

A. Yes. In fact, when I was first retained on this case, which was about two years ago, initially I considered using the reservoir simulation method, so conceptually similar to the approach that Dr. Pooladi-Darvish has used. But I decided actually quite quickly to abandon that approach.

Q. Why is that?

A. Well, it's not actually the reservoir simulation itself that I considered the issue here. It's that you couple a model of the reservoir underground with the well, so you have to simulate the fluid flow not just through the reservoir, but the potentially restricted flow into the well, the flow up through the well, and the flow through the surface equipment. So you have to have a couple model. That's completely standard in reservoir engineering. There's nothing unusual necessarily about it, but --
Q. Go ahead.
A. But the difficulty in this case is it's a complex calculation even if, for instance, we're looking at the final day. At that time, there aren't many impediments to flow downhole. There was at least some understanding of the surface equipment, so you can do a calculation. And calculations have been presented already.
The problem is that the restrictions downhole have changed over time. We know that there were restrictions at the beginning of the accident that weren't there at the end. We know there have been lots of changes to the configuration of the surface equipment.
And then there's the problem of erosion. Now, I am not an expert in this area and not pretending that I would know, so when I was looking at this problem, I said, well, that quotes outflow performance, the flow into the well up through the well and the surface equipment.
Q. In the context of modeling when you use the term "outflow

performance," what is that; and if that's a challenge here, why is that?
A. It's a challenge because it's difficult to calculate at any one time and it's very difficult to know how it varied over time. So my view there was I couldn't have a good quantitative description of the outflow performance as a function of time.
Q. How did the experts that engaged in modeling in this case deal with that issue, just generally?
A. In general what appears to have happened is made a calculation of outflow performance normally near the end of the spill and then simply asserted that that's remained constant throughout the spill period or possibly allowed a short period at the beginning of the accident where that changed.
And the problem I have is having reviewed all of the expert reports in this case, I haven't seen what I've described as a precise, accurate quantification of how the outflow performance varied over time.
Q. Dr. Blunt, did you prepare a report in support of the material balance methodology that you elected to use in this case?
A. Yes, I did.
Q. I am going to put up D-23507. And is this the cover page to your report?
A. Yes, it is.
MR. BROCK: Your Honor, at this point, we would offer Dr. Blunt's report, which is TREX 011553R, into evidence.

THE COURT: All right. Any objection? Without objection, it's admitted. Is there only a single report?

MR. BROCK: It's just a single report, yes.

THE COURT: Okay.

BY MR. BROCK:

Q. Dr. Blunt, at a high level, what did you do to prepare this report?

A. What I did was I reviewed all of the data pertinent to the Macondo reservoir, and then I used that data in the light of my knowledge and experience and review of the scientific literature to perform a calculation of how much oil was released.

Q. Now, I want to pull up D-23508, and I'd like for you to state, Dr. Blunt, your view as to the cumulative oil released, and then I'll ask you some questions about these other bullet points here.

A. My best estimate of the cumulative oil released is 3.26 million stock-tank barrels. I have considered a range based on the range of measured data, and that range is between 2.9 and 3.7 million stock-tank barrels.

Q. When you say here, or we say here in this next bullet point that you helped us put together, "U.S. estimates higher than 3.7 million stock-tank barrels dishonor measured data and ignore scientific facts and engineering methods." Can you give the Court just a quick overview of what you mean by that? We're going to get into some of the detail as we go through, but just at a high level what do you refer to there?

A. Because all of the details are in my report. But what I am mentioning here is we do have data that enables me to do my calculation, actually good quality data. If you come up with an estimate that's more than 3.7 million stock-tank barrels, you've had to dishonor that data, you've had to disregard some of the measured data pertinent to this case, and/or you've had to disregard fundamental physical phenomena.

Q. We'll talk about that a little bit as we go. One issue on methodology here I would like to ask you about. Several of the experts for the United States have talked about uncertainty ranges. We've heard about 10 percent, 12 percent, 20 percent, 30 percent, 30 percent plus. Is your range here, this 2.9 to 3.7, is that an uncertainty range?

A. No, I wouldn't describe it in that way. Let me do describe what I've done. That is the range that honors the data, so from the data I was given, those are the range of values consistent with that. But, in doing my calculations there have been a number of times where a certain degree of judgment could be used. And where that has happened I've made the judgment, a reasonable judgment, that would lead to the highest amount of oil released.

So this isn't really an uncertainty range. I am not saying, for instance, it's not possible that the oil release could be less than 2.9 million. It's more of a range that's consistent with the data and a reasonable upper bound on that.

So I am pretty sure, as I sit here, that the data does not support a number that's higher than 3.7, and my best estimate under those conservative assumptions is around 3.26.

Q. Just for purposes of giving an example, what's an example of an area in which you have elected to use a conservative number if there's a question about a data point?

A. Okay. I'll give you two examples because I think they're the two most significant here.

The first is we're going to talk about the connected oil volume, and to determine that I need a determination of permeability. And I discuss in my report a number of different determinations of permeability, but in the end, I used the highest possible value, which is what's called the P10, the highest plausible value that's been determined by Professor Gringarten. There are other determinations that are slightly lower, it's certainly higher than his mid range or best case. I've taken the upper bound.

The other one is -- are we going to talk about this because it affects one of the key inputs into my calculations, is this issue of cooling. And we're going to talk about wellbore cooling, or at least I discuss it in my report. I completely ignore the fact that the cold ocean will cool the oil. Clearly, if you include that, you get more cooling. So again, very much erring on the side of allowing more oil to be released. I don't think they're unreasonable assumptions, but they're certainly assumptions that are on the generous side.

Q. And again, generally, we'll look at this in a little more detail as we go. But can you summarize the difference between your approach to measured data and judgment calls and decisions that witnesses for the United States have made about those same types of issues?
A. Yes. As I said, I've followed best scientific practice. I've primarily based my calculations on the prime resource material; which is, what were the measurements? What were the measurements on Macondo? On the field as a whole? On the samples that were taken from the field? On both the fluid and the rock samples? And I've also considered, you know, the fundamental physics, hot things, cool down. I've looked at the geology.
In contrast, again as discussed in my report in detail, in many significant respects, the U.S. government experts have disregarded experimental data without scientific foundation, or -- and/or they have ignored -- they haven't looked at the geology. And they've said that hot things don't cool down for some reason.
So there are a number of different cases where they've simply not followed best practice, ignored fundamental scientific phenomena, and disregarded the data.
Q. Thank you, Dr. Blunt. Let's turn, now, to a discussion of what you did in this case, and I guess we'll just ask this for the record. In terms of the study that you undertook to arrive at your conclusion on cumulative flow, did you study the Macondo reservoir?
A. I studied the Macondo reservoir, yes. I am a reservoir

engineer.

Q. So just with that as a set up, we have a demonstrative up now. It's D-23509. That is basically just a teaching model, but can you just walk Judge Barbier through how this model reflects how a well flows through a reservoir, and some of the information that you can derive predrill about the reservoir as well as information you can derive after the well is drilled.

A. Well, let's -- the focus of my work and, in fact, everything I do, is deep underground. It's often quite difficult to sort of get that focus. So actually, what I proposed here is just some simple, essentially, teaching tools, if you don't mind, your Honor.

So here I've just got some sand. There's nothing special about this sand. It's just ordinary beach sand. And you can see the little grains of sand. Why am I talking about this? If we were to look out to the Mississippi, we see that the Mississippi is flowing and it's ladened with tons and tons and tons of this sand. Where does this sand come from? It comes from eroding the meltings of the continental U.S. grain by grain. And the Mississippi and its antecedents have been doing this for at least the last 50 million years --

Q. Fifty?

A. Fifty. So for millions of years thousands and thousands and thousands of tons of sand have been eroded away, brought down through the Mississippi, and then dumped into the Gulf of Mexico.

As well as that, of course there's mud. That's why when you look at the Mississippi it looks cloudy, so there's a mixture of sand and mud.

So what happens? As you deposit all of this sand at the seabed, but we're depositing more and more sand. So if I sort of indicate here, this is the seabed. We have lots and lots of sand, even today, being deposited in the Gulf of Mexico. Well, of course, if you're doing this over millions of years, you're going to get a huge column of sand. And, in fact, when we were looking at Macondo it was deposited probably about 13 million years ago and it's about 13,000 feet below the seabed.

So if you think about it, well, is it still sand? As you can imagine with 13,000 feet of sediment weighing down on it, these grains of sand are crushed. It's hot, it's boiling hot that deep. What happens is the sands get crushed and fused together and you form something like this. A solid piece of rock.

Now, I'll say straight away, this isn't a piece of Macondo rock. It's, in fact, a Bentheimer sandstone from a quarry in Germany. But the reason why I am showing it is this is more or less a pure quartz sand, basically sand crushed together. That's more or less the mineralogy of Macondo.

The porosity, which is how much is solid and how much is still there in these microscopic gaps between the sand grains, is about the same as Macondo. It's about the same as was measured on Macondo. So we have, when we're looking at Macondo as a reservoir, what we're thinking about here is rock like this. The oil is contained in microscopic pores between the sand grain. You can't see them with the naked eye. You would need a microscope to see those. And the oil flows through that, and of course, as you can imagine, the rock is under very high pressure as, indeed, are the fluid.

Q. Is reservoir engineering the study of how this oil that we've depicted here, and I will let you describe this for the Court instead of me doing it, but how oil will flow through this sandstone and be produced from a well? Is that what reservoir engineering does?

A. Yes.

Q. So just if we use this as just a teaching tool, Dr. Blunt, can you just describe for the Court what we've depicted here and what the effect is of drilling a well into a sandstone reservoir, like the demonstrative that you have shown to the Court today?

A. Yeah. I have to say, one of the sort of I want to say conceptual challenges of reservoir engineering are the leaps and scale. In this picture, that's 13,000 feet, so it's several miles. What we're showing here in black are bits of sandstone, and the black is to indicate that it contains oil.

The green, you might say, "Well, what's this sort of the greeny color?" I mentioned the mud in the Mississippi. What happens to the mud? Well, that also gets deposited, that also gets crushed down at high temperatures and pressure. That forms shale. So in Macondo surrounding the sandstone is shale. The shale doesn't allow flow.

So you have these channels of sand containing oil. These channels may be up to a mile or so wide. They're going to extend out of the plane of the picture and meander several miles. Macondo is about five miles long. It's a reservoir.

Q. So when you drill a well -- just zooming in a little bit now -- if you drill a well into a reservoir, what effect is that going to have on the sandstone reservoir and how -- what are the things that derive production of the oil through that sandstone to the well?

A. So, your Honor, in normal oilfield operations and also in Macondo, of course, you drill a well deep underground; and in Macondo, it contacted some oil bearing sandstone. The oil is at very, very high pressures. It's about 800 -- in Macondo, about 800 times normal atmospheric pressure. Of course, the well, that's a conduit to the surface at lower pressure, flow goes from high to low pressure.

So what happens is you drill the well. When oil flows, what happens is you go from high pressure to low pressure.

Q. I have the pressure gauge moving now.

A. The pressure decreases, the oil is expanding and moving out into the well, and that's your oil production. And what we've shown here is the sort of light gray is supposed to indicate the oil at lower pressure. That's oil that's flowed to the well. You don't necessarily -- you don't drill one well that connects the entire field, so you can have some regions of sandstone there that

weren't connected to the well, so they stay unaffected.
Q. Now, in terms of how you apply your discipline to this process, what do you do, Dr. Blunt to try to understand the ability of the well to flow -- of the reservoir to flow to the well?
A. Well, you need to understand the properties of the fluid and rock, and you need to use measurements of pressure. So essentially, the data you need is, well, what's the extent of the whole field? How much of that field is connected to the well? What are the properties of the rock that you measure from taking out rock samples? What are the properties of the fluid and what's the change in pressure?
Q. And is that information that is available to you for this case in order to utilize the material balance equation?
A. Yes, it is, your Honor. And in my opinion, actually, quite good quality data as well.
Q. I want to talk about that just for a second. This is a demonstrative that we used in opening statement, but you can see that we've depicted April 12th MDT pressure and fluid samples, and April 14th core samples. I don't want to get into too much detail here on these, but how is this information helpful to you, Dr. Blunt, in formulating your opinion that the material balance equation is an appropriate and good tool to answer this question?
A. Well, your Honor, material balance is simply conservation of mass. So what you do is you work out how much oil was connected to the well to begin with, and then in the end when the flow stops,

how much oil was left. The difference is how much oil was produced. So to do that -- and this is what's pointed out, I think, with the data is -- you need to know how much oil was there to begin with. You have a seismic survey that looked at the extent of the field that was done before drilling --
Q. The seismic survey is not depicted here, but that occurred at an earlier point in time.
A. That was even earlier, right.
Q. And it was a predrill data point for you to utilize in thinking about the size of the reservoir?
A. Yeah.
Q. And we'll talk about that.
A. And then before the accident, there was what's called an MDT tool that measured the initial pressure, so I know where we start. Fluid samples were taken from the reservoir, so we know about the properties of the fluids. A couple of days later core samples were drilled out of the reservoir, and so we got some idea of the rock properties.
Then we need to know -- so that's enough for us to know what happened, you know, how much oil was there to begin with. We need to know the final state of the reservoir, and for that, principally, we need to know the final pressure.
Q. And is that information also available to you through the final measured pressure over here that we've depicted as the August 3rd entry?

A. Indeed. So there were pressure measurements made on the capping stack just before the well was closed and for 19 days afterwards. And again, it's described in my expert report. This 19 days of pressure measurements are extremely valuable for determining a number of important things, of which the most important one was what the final pressure was.
Q. Now, in the middle here we've depicted 86 days of flow and some of events that could be seen and things that were known during the life of the well. Are these items that we have depicted here some of the challenging -- challenges to using a hydraulics model to solve this question?
A. Indeed. That's the beauty of the material balance analysis, it doesn't matter what happened in between. As long as you know where you started and where you ended up, you know the cumulative. If you have a hydraulics approach, you need to know every detail and nuance of what was happening for 86 days.
Now, if you did know that, it's not that the material balance approach is invalid, you would come up with a calculation that has to be consistent with material balance, but it might help refine the uncertainty, reduce your uncertainty.
But in my opinion, as I said, I haven't seen anyone who has really quantified how this varied over time.
Q. Dr. Blunt, you were here yesterday when Dr. Kelkar testified that the amount of oil that spilled from the Macondo well can be accurately estimated using the material balance. Did you hear

that?

A. Yes.

Q. And do you agree with that?

A. Yes, I do.

Q. Now, I want to turn our attention to D-23511A. And just in terms of the Court's understanding of material balance and how it works in simple terms, have you helped us develop an analogy using a truck that can be used to explain what we're doing with material balance to solve for the problem of quantity of oil?

A. Yes. This is an analogy, your Honor, to maybe try and understand what material balance is and to help motivate the three key inputs that we are going to have into the equation.

So we've illustrated here a truck. What the key thing here is, imagine you have a truck and you've got a leaking tire so you're going to get a flat tire. And the calculation we're going to do in this analogy is how much air has come out of the tire.

Q. I am going to flatten the tire.

A. We have the little video. So what we want to know is how much air came out of the tire. Well, when you first pumped up the tire you inflate the tire, you have a pressure gauge, so you measure what the pressure is, you know what the pressure was to begin with.

Now the tire is deflated. You can also measure the pressure. It's going to be a lower pressure, of course, and the amount of air that's come out of the tire is going to be proportional to that pressure drop, that change in pressure.

Exactly analogous to Macondo, the initial pressure was measured, capping stack pressures were measured, and again, as detailed in my expert report, you can, then, work out with reasonable accuracy what the final pressure was, so what the pressure drop was.

But that's not everything. It's not just pressure. The next thing that, again, hopefully is reasonably obvious, is if you have a big truck tire, you're going to release more air than if you had a small bicycle tire. So the amount of air that's released is proportional to how much air you had in the tire to begin with. Exactly the same as in Macondo. One of the key inputs is how much oil was there originally that could flow to the well. That's the second input.

Then there's a third input. And the Court has already heard quite a lot of discussion about this third input, so it is important, and it's technically called the compressibility. Let me explain it with air. If you're pumping up a bicycle tire and you press on the air, it compresses. If you release the pressure, it expands. Now, when you're talking about air in this tire, the air is expanding because it starts off at high pressure and then goes to low pressure and it expands. But we use the word compressibility anyway. We're really talking about expandability, but it's compressibility.

Q. This is another one of the petroleum engineering backwards terms that we are struggling with?

A. Yes, it's a backwards term. And you can't blame petroleum engineers, it's universal in science.

So in Macondo, it's exactly the same. You've got the oil at very high pressures. As the pressure drops that oil expands and we need to know the compressibility of the oil. That was measured experimentally at three independent service labs, and actually, among all of the various experts, there's no particular disagreement over that number.

But there's a second feature. We look at this. What forces the air out of the tire? It's not just the air expanding. What's the purpose of a tire? The tire is pumped up to high pressure to keep up the truck, to keep the truck off the road. When you allow a leak, you've got this heavy truck that's pressing down on the tire. You've got this elastic tire that's very taut, and it squeezes and it's pushing out more air.

That's exactly what happens in Macondo. We're talking about this 13,000 feet of sand and rock above the reservoir. You got the oil at very high pressure. The oil comes out. The oil is now at lower pressure, and like squeezing a sponge, the huge weight of rock presses down and it compresses the rock. And that's an additional contribution. And so there's what I've described here is the elasticity of the tire. The analogy in Macondo is the rock compressibility, and that's one key point of disagreement among the experts in this case.

Q. If you used the material balance analogy like we have here and you have data and information that allows you to understand the

amount or volume of oil, the change in pressure, and the elasticity or the compressibility, can you reliably calculate the amount of oil that flowed from the well if -- or the amount of air that came out of the tire if you were solving for that?
A. Yes. I mean, this is -- if you imagine this analogy. If you wanted to know how much air came out of the tire, you multiply those three numbers together, fundamentally, and that's what we're doing for the material balance calculation in Macondo.
Q. Now, if you were using a hydraulics methodology to try to understand how much air came out of the tire, and let's say, hypothetically, that we're looking at a tire that had a puncture on Day 1 and you're trying to solve for the problem at Day 86, what would you have to know if you're doing hydraulics modeling to solve that problem?
A. Well, the analogy here, your Honor, would be, yes, imagine you realized that you had run over a piece of glass about three months ago and now you have this flat tire. I am going to examine the tire and look at the hole that I've got at the tire right at the end. It's not unreasonable to say, if you got a good analysis of exactly what the hole was like and you know all of the flow properties and you run the most sophisticated fluid dynamics or air dynamics codes, you could probably get an estimate of how fast the air was coming out of the tire on the last day.
But you need to know how the air was coming out of the tire for the last three months. Well, how did that hole evolve

over time? How does it depend on, you know, what was in the truck or how you were driving it? It's a highly uncertain calculation. In fact, frankly, I don't think anyone would approach the calculation that way because you would say, but you know the pressure in the tires to begin with, you knew the pressure at the end, you would use that information surely.

And that's the analogy with Macondo. You know what was in Macondo to begin with, you calculate what was there at the end, that's the difference. And you don't need to essentially speculate about what happened in between.

Q. Let's turn to the material balance equation quickly, D-23513, as on the screen now. Judge Barbier has heard about the formula, I think you've discussed the components of the formula. I just want to ask you one question about this before we move forward.

We heard yesterday that the use of the material balance is more uncertain here than the way that it's historically been used. And I'll just ask you, sir, do you agree with that and then your response.

A. Okay. Let's put it this way, this is exactly the same equation that was employed by Dr. Kelkar and I don't have any problem with the equation. And Dr. Kelkar was also quite right to say that traditionally the equation is used in slightly different way, and that is, you measure the oil released and use it to find that end variable how much oil you have underground.

So in principle, we're using the slightly different way and the uncertainty, and there is uncertainty, is related to how uncertain the variables are here. But material balance has been around for 60 years, and it's quite an old method and it's traditionally used for oilfields where there isn't actually very good quality data. In particular, there isn't seismic data. The sort of good quality seismic data that we're looking at for Macondo has only been around for a few years. It's much more recent.

So while there's still uncertainty in this calculation, specifically, what Dr. Kelkar mentioned was the uncertainty in N; but as described in my report, we have good quality seismic data and that combined with an analysis of the geology and the pressure enables me to put a robust upper bound on it. Let's not exaggerate the uncertainties. They do exist, but they don't want to, say, invalidate this calculation at all.

Q. And are there checks on consistency that you can utilize within your discipline on the issue of the oil volume connected to the well? I don't want to get into the details of that yet, but are there consistency checks that can be utilized to verify the calculations that are made?

A. Yes. The other thing, again, that is stressed in Section 5 of my expert report is, the way it's presented here, it looks like it's a bit of -- I hate to say this, sort of pick and choose. You just determine N in isolation, then C, then delta P. But it's not like that, your Honor. Those three numbers have to fit in a single coherent picture of the reservoir. The essence of reservoir engineering is does the totality of the data make sense? So I can't pick any old numbers here. I am certainly going to be constrained by the data, but even then I have to make sure that they're all mutually consistent. And that's a final consistency check that gives confidence that what you're doing is reasonable and it helps narrow the uncertainty.

Q. I want to turn now, just briefly, in order to frame the issues to areas where there are agreement -- where there is agreement between you and experts for the United States and where there is disagreement. And I think I would ask you right now just to focus on where you and Dr. Kelkar agree and where you disagree in terms of the components utilized for the material balance equation, and then we'll get to the details of it.

A. Yes. So the green indicates that --

Q. I'm sorry. Let me, for the record, say I have up now D-23514.

A. It's actually a reproduction of one of the tables in my expert report.

The green basically means in the end, even if we get there in different ways, there's not a big difference in the number. And the red is there is a big difference, makes a big impact on the oil released.

So if we look at Dr. Kelkar with his oil volume as he presented yesterday, he does have a lower bound, or what he describes as a lower bound of 110 million stock-tank barrels, very similar to what I have. So that's why there's a bit of green in that box. But he also considers oil volumes that I can show, I can demonstrate are implausible.

For compressibility, and, I think, this is the most significant point of disagreement between us, he doubles the measured value without scientific foundation, so that's a big point of disagreement.

The pressure drop -- and again, there's a lot of discussion about details, and we approach this problem in a very different way. But in the end, although he noted yesterday that there was a difference in our pressure drops, and I agree with him there, it's not that significant. It's not the reason why we have such different numbers for oil released.

Q. Now, let me ask you to focus just for a minute on Dr. Pooladi-Darvish. Are the inputs that you utilized, that is, oil connected to well, compressibility, and pressure drop, are they components of his analysis?

A. Yes. There is a point here. Dr. Pooladi-Darvish doesn't employ material balance, however, material balance is just conservation of mass. So in his simulation model, you can say, on how much oil did he have in his model to begin with? How much was there at the end? And the difference is what was released. And he has values of oil in place, compressibility, and pressure drop. And I've checked, and of course, you know, he is using perfectly reasonable software. You could use a material balance approach to analyze what's happened.

So in the case of Dr. Pooladi-Darvish, his oil volume certainly for his base case, but for virtually all of his cases, he is much larger than I consider to be credible.

For compressibility, however, he does use the measured data. So we agree on compressibility. He has a base case of 6 microsips, no problem there.

And on pressure drop there is a big disagreement. He basically has essentially an implausible hot oil in his well.

Q. Thank you. And then for Dr. Hsieh, did your review of the records indicate that he has agreement with you on oil volume?

A. Yes.

MR. CERNICH: Your Honor, I am going to object to the discussion of Dr. Hsieh. His expert testimony was excluded here in the court, and as Dr. Hsieh testified, he received these inputs from BP.

MR. BROCK: This is a chart from his report, your Honor.

THE COURT: He didn't have -- Dr. Hsieh testified as a fact witness.

MR. BROCK: This is a demonstrative from Dr. Blunt's report that has not been objected to. We've given them this exhibit, it has not been objected to.

MR. CERNICH: We're objecting to the testimony, your Honor. Dr. Hsieh had to be removed from being an expert due to the Court's limit on experts, and now Professor Blunt is rebutting an expert who wasn't here, who also testified that these inputs were provided by BP.

THE COURT: He testified only as a fact witness, as I recall, and not as an expert. So to the extent --

MR. BROCK: I can move on.

THE COURT: Let's do that, it would be easier.

BY MR. BROCK:

Q. Dr. Blunt, let's now turn to the first variable of the material balance equation, and that is the connected oil volume. And I'll just ask you if we look at D-24605, this is just the material balance equation, and now we're going to discuss oil volume. Do you see that?

A. Yes.

Q. And, Dr. Blunt, what is your evaluation of the connected oil volume at the Macondo reservoir?

A. My best determination is that it's 112 million stock-tank barrels. I do present in my report a range of numbers, and I considered these to be a robust upper bound on what the connected oil volume could be.

Q. And that's D-24605, Dr. Blunt's connected oil volume of 112 million stock-tank barrels.

Dr. Blunt, I am now going to pull up D-24465 and ask you if you can use this demonstrative to explain to the Court one of the data points that you utilized for calculating connected oil volume.

A. Okay. So what you see on the left there, your Honor, is a seismic image of the Macondo reservoir. What happens there, this is before drilling, you send sound waves down through the rock. The sound waves reflect back up where there are changes in his rock properties or indeed when there's changes because the fluid has changed, so you go from water in the pore space to hydrocarbons.

What is actually shown here is an interpretation of that survey performed by BP geophysicists. And the bright colors --

Q. Dr. Blunt, you're doing fine. I was just going to ask you, just so that Judge Barbier is oriented to this picture, show him where the Macondo well was actually drilled, and then I think you're going to get to talking about the reservoir.

A. So there's the Macondo well, although this image was done before drilling. And this is BP's license block, so this is the scale that's three miles.

Q. What are the other two red dots above the Macondo well?

A. Those I am having difficulty seeing them. Yes, I can see them on my screen. Those were other wells that BP planned to drill and actually did not.

Q. I'm sorry I interrupted you, but go ahead.

A. So what are the colors indicating? The colors are indicating how much or what thickness of hydrocarbon-bearing sandstone are you likely to encounter. So the pale colors, sort of green and yellow here, means a lot of oil. If you go to the blue, it's less thick. The purple is even less thick, and the black basically there isn't any oil.

So if you're a geophysicist, you look at this picture and you need to decide where to drill the well, and it comes as no surprise that BP targeted their well right in the center of the thickest portion of sandstone, and that's more or less what they encountered.

Q. When was this data collected that's reflected in this seismic image?

A. This was predrill, this is before the accident.

Q. And what did you do with this seismic analysis?

A. So the seismic tells you the total rock volume that holds oil. And it's -- again, this in itself is not controversial; it's been adopted by Dr. Kelkar and was the foundation of his calculations.

Q. Why do you get a different number than Dr. Kelkar?

A. The reason is that Dr. Kelkar assumes that all of this volume is connected to the well. And from his testimony yesterday, it could be misinterpreted. The seismic survey here is simply looking at the total volume of hydrocarbon-bearing sandstone, it is not making a comment on connectivity.

That requires additional information, and the additional information you need to do is you need to study the likely geology of the field and you need to perform a pressure analysis to quantify.

Q. Is it a standard reservoir engineering technique or practice to consider the geology of the reservoir after you have this information?

A. Of course, it's absolutely standard. You create a geological model, you have a model that's consistent with the pressure because if we're looking here, you've drilled one well. Do you need to drill more wells? How much of the oil are you going to produce? It's absolutely fundamental to understand the connectivity of the reservoir.

Q. I am going to put up now, Dr. Blunt, D-23518. And if you could just describe for the Court, briefly -- this is actually the cover page to your report -- what this depicts and how it's relevant to your evaluation of considering the geology -- let me just ask you to do that first.

A. Okay. So what's shown in the background is sort of a blow-up of some of the seismic survey. The problem with the seismic survey is it's an average. You don't know for certain where exactly that sandstone is located.

So this is a picture that was prepared by a BP geologist, and what he's done is he's placed over that map where it is possible that there could be channels of sandstone running across the reservoir.

Now, I've performed my own analysis of this as well.

Q. Is this part of what you do as a reservoir engineer?

A. Yes. You take your geological and geophysical information and construct a geological model and use it for reservoir engineering calculations.

Q. Have you brought with you today a teaching tool that you might could use to show Judge Barbier how these channels are created and then how you can sort of see them in three dimensions in terms of what happens in the reservoir?

A. Yes. Certainly. Your Honor, I know it seems a bit strange, but this hopefully helps you visualize it. What I have got here is colored modeling clay, as you can see. What this represents is a sandstone channel. So I said, well, the sand flows out into the Gulf of Mexico and is dumped on the seabed. How is it, what's the shape? So, in fact, what we see here is that the sand tends to be dumped in a sort of meandering channel. And what this strand of clay is supposed to represent is this is about 100 feet wide, this meandering channel is several miles long. So that gives you an idea of the scale.

So a whole load of sediment is dumped in this sort of configuration. Then later you may have another channel that's deposited in those channels sort of intertwined.

Q. This is the process you described earlier that's occurring over millions of years?

A. Yes. And technically, as we see in this picture first, one of those strands of clay that's a channel, a collection of these strands of channel is called what's known as a channel complex, and you then may, over geological time, have a sequence of channel complexes.

So if you'll allow me, your Honor --

MR. BROCK: Is it okay if he stands up, Judge, just to show you his model?

THE WITNESS: So what I am showing here, your Honor, is exactly the real clay model, and I've got a picture of this in my expert report, so I just took a picture of this model. So let me explain what I am showing you here.

These are the so-called channel complexes, the individual channels. I've overlaid it on the seismic map. So this is the extent of Macondo, this is about five miles.

The channels tend to run in this northwest-southeasterly direction, meandering through the field, sort of the dome-shaped structure, so the oil is trapped into this dome. The brown here represents the shale, the shale below and above and between these sand channels.

And then I said, well, we drill the Macondo well -- just for simplicity, I have a straw here, that's where the Macondo well was drilled. It went through three of these channels. The straw looks a bid crude, but it's actually more or less to scale, this length of the straw is about 13,000 feet, so it's roughly to scale, this gives you sort of depth here.

Now, what you can see immediately is the well will connect these sandstone channels, but not necessarily all of them. What I've simply for illustrative purposes in a different color, this sort lilac, this sort of purply-gray color, these are channels that contain oil but are not necessarily connected to the well.

Now, this is a geological model. I think it's a

09:15:37 perfectly reasonable and plausible model of how the sandstone might be arranged in Macondo. But I don't know the locations of each individual channel for sure; I need additional information to quantify connectivity.

09:15:49 So what I'm saying is, this oil is likely to be connected, this oil is likely not to be (INDICATING).

09:15:57 Q. And is one of the principles in standard reservoir engineering to utilize available data to evaluate how much of the reservoir is connected to a well site?

09:16:12 A. Well, of course, it's absolutely key because if you've got poor connectivity, you're not going to produce much from your well and you need to drill more wells. If you have good connectivity, that's obviously good in normal oilfield operations.

09:16:27 Q. Let's look at D-24362, and can you describe for Judge Barbier, does this show the drilling of a well through three reservoirs sort of like you demonstrated on -- with your straw?

09:16:42 A. So this was a three-dimensional model. What we're doing here is we're taking a vertical slice through the reservoir where the well was drilled.

09:16:50 Now, this is the one thing we do know, because we drilled the well, we can take measurements. So we know that the well went through three of these so-called channel complexes. This is a BP diagram, but consistent with my understanding of the geology, there's another package of sandstone, right, there's another sandstone channel. Remember it comes out of the plane of the board, but that's not connected to the well, so that wouldn't produce oil.

Q. What is your conclusion from your review of the information and data as to whether or not the reservoir was fully connected?

A. At this stage we haven't quite got enough information to put a number on it, but what seems likely is that the well has encountered three of these channels, that there's pretty good connectivity along those channels. That makes sense. It's sort of a ripple of sandstone running across the reservoir. But there's going to be little or no flow between the channels because there's shale between them, and so there may be some channels that are not connected to the well.

Q. Did you review anything from the predrill analysis from BP that supported your view as to the likely geology of this reservoir?

A. Yes. So predrill obviously this was a concern that BP had, it's a general concern of these channel deepwater turbidite that there may be limited connectivity.

Q. Let me pull up Demonstrative 23520. And is this making the point that you just shared with the Court?

A. Yes. I mean, BP planned to drill three wells in the field. Why would they do that if one well connects everything? Well, you drill three wells for two reasons: One, of course, is with three wells you can produce the oil faster. But there is another reason, which is you hope with three wells you're going to hit all of the channels.

So, you know, even with a single well, they were suggesting that you'd only really confirm that you've accessed about 60 percent, and they were suggesting that if compartmentalization exists, and that they determined in production from pressure data, they may need to drill more wells.

Q. Let me ask you about your conclusions from the geological analysis, and I have here an excerpt from your report D-23521. And, Dr. Blunt, can you just look there at the highlighted portions of this demonstrative exhibit there in paragraph three and paragraph four and summarize quickly for Judge Barbier your conclusions with regard to limited connectivity?

A. Yeah. I mean, I think at this stage you're going to say it's really something we need to consider. Because you can have flow along the sandstone channels, but these channels don't necessarily all interconnect, there isn't necessarily flow between them. And that in Macondo, you know, clearly it didn't contact all, it contacted three of the complexes in the I want to say thickest part of the field, and those are the three layers for which we really have data because they were encountered when drilling the well.

Q. I want to now turn your attention to pressure analysis and whether or not that can be utilized to understand connectivity of the well. Did you quantify the impact of limited connectivity using information other than the seismic data?

A. Yes.

Q. Let me turn your attention to Demonstrative 23522, and ask you to explain to the Court how you were able to quantify the impact of limited connectivity.

A. Limited connectivity is potentially an issue in these sorts of deepwater turbidites. Well, how do you know? You actually don't know until you start producing oil from the field. You can't just look at the seismic and hypothesize about the geology and come up with a connectivity number. What you need to do is you need to have additional data, you need to have data about how does the oil flow in this reservoir. And that data comes from, in this particular case, from the capping stack pressure analysis.

Q. And have you analyzed the capping stack pressure?

A. Yes.

Q. Let me just turn now to the next demonstrative, and if you will describe for the Court, please, how pressure can be used to define the contours of the reservoir and help you understand the issue of connectivity.

A. Okay. So as I think I've already mentioned, your Honor, for -- the capping stack was measuring for pressure after the well was closed in, and the pressure was increasing over time for 19 days.

Now, that's a diagnostic test in standard reservoir engineering. We look at how the pressure builds up when you stop flow in a well. You normally actually only do it for one day, so the fact that we got 19 days has given us a lot of valuable information. And a bit like a physician looking at a chest X-ray that can diagnose what's wrong with a patient, the shape of this

buildup has characteristics which enable you to say things about the reservoir. And that's essentially what I've done.
Q. Let me just go to the next slide here, and you can see how this pressure signal is developing. Can you describe for Judge Barbier how this pressure allows you to understand the boundaries of the reservoir?
A. Yes. So what that was representing was how the influence of pressure moves out through the reservoir. And as you saw, to begin with, it went out in circles like ripples in a pond, that's known technically as the radial flow regime. Then it encounters barriers to flow on the channel side, so it's hit the end of the channels, it's hit shale and then you --
Q. How do you know from looking at the data that the pressure has hit the boundary?
A. From the diagnostic signature of the pressure. The data -- the details are in Appendix 4.3 of my report. But actually there's no -- again, among the experts, there's no disagreement about this. We all know that there's radial flow to begin with, that we then have flow confined in a channel. It's just the use of that data to quantify how much oil is connected that is my analysis.
So you see this going out like ripples in a pond. It hits no-flow barriers, barriers to flow. But it takes time for the pressure to move all the way out to the ends of the field. That's why having 19 days of pressure data was so valuable, because there's sufficient time to see the pressure, the impact of the

pressure at the well from barriers to flow like the south and the north end.

So what I can say here is in the pressure analysis, I know the size of this connected box. I know that it's a box and I don't, for instance, assume that there is no aquifer. I determined that there is no aquifer. The shape, the diagnostic shape of the pressure response says very clearly that there are no-flow boundaries here at the edges of the channel and there are no barriers to flow at these two ends (INDICATING).

So we know that we're producing oil from a contained box when we're trying to calculate how much oil was released and we know the shape of the box and we know the size of the box.

And again, all of the experts who have looked at this agree that mathematically, on average, we're looking at flow that looks like from a rectangular-shaped reservoir. What I am doing is now putting it in the context of additional data, the seismic and the geology.

Q. Now, using this pressure analysis and being able to define the rectangle -- and we've seen this from other witnesses -- what reservoir volume do you opine was connected to the well and how much was not?

A. Okay. So I've got a box here that gives me a connected area. As an aside, the size of the box is also related to the number that I used for permeability, and as I think I discussed at the outset, I used the highest plausible value of permeability from a robust flow-based determination, and that's Professor Gringarten's P10 value, the 329 millidarcies. It's higher than his best case. It's higher that I am going to show that I think the capping stack data gives you, but that's to give you the most generous assessment of connectivity, but it's not unreasonable because it's saying essentially the field is across all the way across. So I don't necessarily have a problem with it. So that's just an area.

What's the volume? What I've done is we know the total volume of oil, right, we know the total volume of oil. That comes from the seismic. Again, no disagreement about that. How much of that volume do I put in the red box and how much do I leave out?

Q. How did you approach that issue?

A. Again, using a conservative assumption to put as much oil in the box as possible. What I did was I said, look, this box overlays most of the thicker channels, doesn't it. So the most generous assumption was to say everything outside here is just purple, it's the smallest thickness it could be. And then I put all of the rest of the oil giving the maximum possible plausible thickness in here.

Q. And when you do that, thinking about it from a reservoir engineering perspective, what percentage of the total oil do you assign as connected oil to the Macondo reservoir?

A. That comes up --

Q. For the Macondo well, I mean. Sorry.

A. That comes up with a connectivity that I think is between 87 and 90 percent. That actually would be considered very good connectivity.

Q. And do you believe that that is a conservative input?

A. Yes, I think it's implausible to suggest that the connectivity is any higher. It may indeed be lower. But I don't think this is an unreasonable calculation.

Q. Now, a couple of questions about the pressure data that you analyzed. We heard from Dr. Kelkar yesterday that you didn't utilize the first 10,000 seconds of pressure data from the capping stack. First of all, for the record, how long is 10,000 seconds?

A. It's about three hours.

Q. And can you explain to the Court what the issues were, from your perspective, in terms of the question you were trying to answer about the first three hours of pressure data that was available?

A. So I talked about pressure being a sort of diagnostic. But there are different diagnostics and different reservoir properties that you get from different time periods. So I in my quantitative analysis didn't actually consider the first hour. So the first hour out of 19 days, I didn't consider.

What do you get after the first hour? You get properties such as wellbore storage and skin, very valuable pieces of information often, but those numbers don't affect my analysis. I don't need them for my analysis. So not considering that data was not a problem.

The reason why I didn't consider it is in that early time period, there's quite a lot of noise in the data, it's difficult to interpret and it is indeed very sensitive to exactly what the flow rate changes were choke closure.

But after about three hours -- and I've demonstrated this in Appendix E of my report. After about three hours, the diagnostic settles down. More or less regardless of what you're assuming about flow rate history, you still see the same diagnostic signature. And the diagnostic signature is this radial flow, the ripples in the pond. When you hit the sides of your channels and when you hit the ends. And it is well known in pressure transient analysis that looking at the boundaries of the reservoir, what I'm really interested is how big is that box. Looking at the boundaries is when the pressure gets to the boundaries. That's a late time response. That's something that you see after days. It's not a problem if you don't analyze the first few hours.

Q. Now, let me ask you just to look very quickly at D-24606, which we've styled "Dr. Blunt's Pressure Analysis." Is this a chart or an analysis from your report?

A. Yes. This is -- your Honor, this is one of the figures from Section 4.3 of my report. It does contain a lot of information and it is somewhat detailed. And I'll try not to bore you too much with details.

Q. If you would just address the issue of whether or not this helps you understand the reservoir size.

A. Yes. So what we have on the X axis here is time, but it's logarithmic time, and this is traditionally how it's done. So that's three hours, that's about 30 hours, that's about 300 hours. So that's looking at a couple of weeks, okay.

So the late times are already compressed up and the early times are expanded. So what you see here if you're an expert is you look at the slope, so this is the pressure going up. And what you do is you look at the slope. When you look at the slope, you get lots of valuable information. You get a sort of a constant slope, that's your radial flow, and then you see that the slope starts increasing, and that's a diagnostic of hitting boundaries, and that's channel flow. You see that after about 60,000 seconds, about 19 hours. So it's well beyond where I need to consider things.

And then you get this channel flowing. But that doesn't last forever, it begins to sort of flatten out there. One of the reasons for that is you're seeing the other barriers to flow at the ends.

So the thing that's really important to me is what's happening at about 19 hours, but it's channel flow, no ambiguity there from any of the experts, we all know it's channel flow. And then what's really happening there after 19 days to see the no-flow boundaries at the end. That's the sort of, one would say, X-ray diagnostic that an expert in this area can more or less read off the graph.

Q. Now, once you make a determination about the size of the reservoir and how much would be connected to the Macondo well or the location of the Macondo well, do you next need to look at converting reservoir barrels to stock-tank barrels?
A. Yes.
Q. And can you describe for Judge Barbier what your approach to that issue is or was. And I am going to put up for you D-23529, and I guess I'll just ask you first to briefly explain what you did to convert the connected reservoir volume.
A. Yes. So our focus so far has been on the reservoir. So we're deep underground and we're calculating volume, volumes in the reservoir or volumes of oil released fundamentally at reservoir conditions. But I am quoting numbers, as indeed is standard in the industry, in stock-tank barrels.
So what I have to do is I have to take this oil that's deep underground, bring it up to the surface. As it goes up to the surface, the pressure drops and bubbles of gas exsolves from the oil, like opening a can of soda, so the bubbles get to come up. And then when I reach the surface, I separate it out into oil, the liquid and the gas.
Q. And as part of that process, what method did you use to determine the value for the oil formation volume factor?
A. So the correction that you use, the oil actually shrinks because lots of gas has come out of the solution through the oil formation volume factor. Using the approach in my report, I used

the measured data, I used three sets of measured data from the three independent services that did the measurements, and the measurements were using the single-stage separation.

Q. Now, when you say that you used the measured values and there were three laboratories, what are you referring to there?

A. So fluid samples were taken from the well before the accident and there were measurements performed on them at Schlumberger, at Intertek and Core Labs, so three labs looked at them. I've taken those measured values and I've used all three in my calculations.

Q. And why did you choose to use the single-stage flash methodology, Dr. Blunt?

A. Okay. There are a number of reasons. The original reason is, well, I've got the directly measured data, it's unambiguous what it means, it simply means that the oil and gas remain in contact and then you separate them. And it's the industry standard, you commonly do encounter it in oilfield operations, but more to the point, it's the default option when you don't know for sure what the real separation process was.

Q. There's been discussion about a four-stage separation. Why did you not use that methodology?

A. So there is experimental data for a four-stage separation process, and that's also been discussed by Dr. Zick and it's what he recommended in his expert report. I have not done that, and let me explain why, is a multistage separation is what you may routinely do in normal oilfield operations to maximize the amount of oil that's produced. But the problem here is there are infinite number of possible multistage separations.

I know there was one particular case looked at experimentally, but there's no evidence to suggest that that is exactly what BP would have done. They might have used fewer separators. They might have conceivably used more. They might have mixed oil from Macondo with oil from other fields. We simply don't know.

So even if you say that's the appropriate methodology, you don't know the number to use.

Q. And in using the four-stage separator methodology, is that something in practice that is conducted with a hundred percent efficiency?

A. No. And actually --

THE COURT: Dr. Blunt, I think when demonstrating something, you moved the microphone away from you. Pull it back up to you a little bit.

THE WITNESS: Maybe I should move forward.

THE COURT: Either way.

MR. BROCK: Pull it over even closer to you.

THE WITNESS: Is that okay?

MR. BROCK: That's much better.

THE WITNESS: So, yes, in these thermodynamic calculations and indeed in the experiments, they're very careful. And what they do is they have a hundred percent efficiency, so they say the oil and the gas separate perfectly.

But in real oilfield operations, it's not like that. What a separator is, your Honor, I mean, crudely speaking, imagine a giant tank, and oil comes gushing into this tank and you have to separate the oil and gas. Well, the oil settles at the bottom and you have a pipe with the oil coming out, and the gas is at the top and you have a pipe coming out there.

Now, if you wait for days or weeks nice and carefully, you get this perfect separation, but you can't because you're producing oil really rapidly. So what happens is the gas comes rushing out of the top, but entrained in that are droplets of oil. You've lost that oil. So you never operate these separators at a hundred percent efficiency. So --

MR. CERNICH: Your Honor, I am going to object. Professor Blunt has no discussion in his report whatsoever about how separators are operated. He does -- I will admit that he does discuss the process of multi-stage separation and single-stage separation or he mentions those, but there is absolutely no discussion in his report about how these separators are operated. And he's demonstrated no expertise in this either in his CV, in his report, or -- anywhere in his report.

THE COURT: Okay. Are you going any farther with that?

MR. BROCK: That's basically it.

THE COURT: Okay. All right. I'll overrule the objection, but let's just move on.

MR. BROCK: All right. We will move on.
BY MR. BROCK:
Q. Dr. Blunt, you're also aware that Dr. Whitson developed an oceanic separation model, correct?
A. Yes.
Q. And did you review his report?
A. Yes.
Q. And does his oceanic separation model output a number that in terms of the formation volume factor that is similar to yours?
A. Yes. Dr. Whitson, I would consider him is widely regarded as the foremost expert in hydrocarbon phase behavior in the world. He has provided in his expert report a detailed analysis of what he thinks plausibly happened as the oil was released into the ocean and moved to the surface.
Q. In terms of the formation volume factor that is utilized by you, can you describe to Judge Barbier what that is in terms of the number?
A. Yeah. The number for the single-stage flash and the number for Dr. Whitson's oceanic process are essentially the same. And on good physical grounds this does not surprise me at all.
Q. Do you recall your number? That is, what is your formation volume factor number?
A. Well, I use a range of values based on the measurements, but the range is, off the top of my head under initial conditions, I think between 2.3 and 2.4.

Q. I am going to put up D-23532, just in the interest of time so we can keep moving. I would like for you to summarize, now, for Judge Barbier your opinion regarding oil volume; and then if you could also, as you do this, speak to how your analysis is different from the approach of the experts from the United States.
A. Yeah. So just to repeat, my best estimate of the connected oil volume is 112 million stock-tank barrels. I do consider a range of values, but as we discussed before, that isn't necessarily an uncertainty range. It's more providing an upper bound. I don't think it's plausible to suggest that it's significantly larger than that.
And the reason why the U.S. experts can present different numbers is they haven't considered the geology of the Macondo field; and they don't use the pressure analysis, even though there was pressure data available, to assess connectivity which is a standard best practice in reservoir engineering; and in my opinion, the conversion to stock-tank barrels that is used is ambiguous. There are an infinite number of possible conversions and it's based on something that is hypothetical or physically rather implausible.
Q. What is the impact, Dr. Blunt, of the assumptions made by the United States that are different from yours? And I'll just put up D-23533 as demonstrative that you can use to discuss this.
A. So what does it mean in terms of oil released? So I've got 112. What does Pooladi-Darvish use, Dr. Pooladi-Darvish? He has a range of values, so what I've used is his base case. And I think

it's already been discussed already in court. The difference here is principally a different conversion process and ignoring connectivity, and they both have about the same contribution. So if you add those two together, it's a difference of about 930,000 stock-tank barrels.

Dr. Kelkar, as I've said, has a lower bound that's more or less the same as mine, and an upper bound that he's higher, actually, more like Dr. Pooladi-Darvish's. I've taken the mid range, the number that gives you 5 million barrels essentially. So again, I consider that too large, and I don't use their conversion process. And that has an impact of about 480,000 stock-tank barrels on the calculation.

Q. Now, Dr. Blunt, let's turn to the second variable with regard to the material balance equation, and that is the issue of compressibility. And I'll just put the form D-23535. We're now talking about the second variable in the equation, correct?

A. Yes.

Q. And Dr. Blunt, if you'll look at D-24607, and just state for the record what you determined to be the value for rock compressibility?

A. Yes, the best determination of rock compressibility I consider to be 6.35 microsips; although, again, I do consider a range of values in my calculations consistent with the measurements.

Q. Let's look, now, at D-23536A, and I'll just ask you if you would, please, to now use these photographs to describe what is

09:44:39 compressibility; that is, what are we looking at and how does the
09:44:45 reservoir rock compress?
09:44:46 A. So the emphasis on this discussion is going to be on rock
09:44:50 compressibility because that's where there is the point of
09:44:54 disagreement. What you see on the left is a photograph of one of
09:44:58 the Macondo cores. It's about an inch across here. What I've
09:45:05 shown here is actually from my report is an X-ray image actually of
09:45:10 this Bentheimer sandstone. And the reason for showing that is you
09:45:14 can, then, really see what we're talking about here.
09:45:16 What you've got is you've got grains of sand, quartz
09:45:21 grains that are fused together so they're crunched together. So
09:45:24 what we're looking at when we look at compressibility is how
09:45:26 compressible is that rock. Now, if we think about compressibility,
09:45:34 it's very easy to consider what you think about compressibility if
09:45:37 you're looking at the sand. So, your Honor, if we go back to the
09:45:40 sand and you imagine you're walking on the beach and you put your
09:45:43 foot down, obviously, you can see that it's compressible, you can
09:45:46 tap it down.
09:45:47 And how does that lead to more oil release? It's a bit
09:45:50 like when you're on the beach, your footprint gets filled with
09:45:55 water, you've actually squeezed water out of the sand. And that's
09:45:59 essentially what we're looking at with core volume compressibility.
09:46:01 But, of course, we are not dealing with the sand in
09:46:03 Macondo. We're dealing, as you can see, a core sample of sand,
09:46:06 stone. It does have a compressibility under the huge pressures

that we're dealing with, and there will be a change in volume. And this rock will crush down, but not, obviously, by a huge amount, but it is a significant component to the calculations.

Q. And that compression affects how much oil will flow to the well?

A. Yes, the more it compresses --

Q. Let's use this diagram to look at that just a second, D-23537. Dr. Blunt, can you use this diagram to sort of explain to Judge Barbier how is it that this compressibility of rock issue is so important?

A. So a cartoon to try and describe it because it's not the easiest concept to understand. So we sort of got a blow-up of the grains here. As I said, imagine the Macondo rock, and it's got 13,000 feet of rock above it, so it's a bit, like, sort of Atlas with the weight of the world on his shoulders. But the oil is also at very high pressures, and the oil, if you imagine, is sort of trying to force the grains apart. The oil is sort of pushing back and that's sort of holding everything up.

Then when you drill a well --

Q. Let me go to the next demonstrative and see if this is helpful, D-23538. We've now got a well that's drilled into the reservoir.

A. So we drill a well. The oil flows from high pressure to low pressure into the well, so the oil pressure drops so the sort of helping, pushing back on the rock decreases, the weight crushes down on you and the rock begins to compress.

And of course, as it compresses, like squeezing a sponge, there's less room for the oil to be, there's less pore space, and that squeezes out an additional amount of oil.

So when we're looking at oil production from Macondo, there's essentially two components: There's the expansion of the oil itself, simply because the pressure drops and the oil expands; but there's also this extra contribution from the compression of the rock.

Q. So compressibility drives flow because compressed oil expands, driving out more oil, and the reduced oil pressure allows the overlying rock, in this case 13,000 feet of rock, to compress and that also squeezes out more oil?

A. Exactly.

Q. So that's the concept that we're looking at here.

Now, you've testified earlier today that Dr. Kelkar and Dr. Pooladi-Darvish use a value of 12 microsips. And I've got up D-23540. In their analysis -- excuse me. Dr. Kelkar -- just to keep us moving, I am not going to ask you about Dr. Hsieh. Dr. Kelkar uses a rock compressibility value of 12. What's the impact of that on this case?

A. Yeah. So, roughly speaking, the impact of Dr. Kelkar using 12 microsips rather than the measured value of 6 is about one million stock-tank barrels in his estimate of oil released.

Q. Now, let's talk about the way in which you came to your conclusion that the compressibility of the rock is in the range of

6. How did you calculate that value? And I'll just ask you, if you can start with D-23541, to explain to Judge Barbier the first step in the process.

A. Yeah. I mean, following best scientific practice, you go back to the primary material and the primary material are the measurements. So Weatherford Laboratories measured the pore volume compressibility on rock samples from Macondo. Weatherford is a well-respected service laboratory. I use them myself, for experimental measurements, and the best determination of the average of those measurements is 6.35 microsips.

Q. You also referenced Professor Zimmerman in your report. The Court has heard a little bit about Dr. Zimmerman. Who is Dr. Zimmerman and what is -- why is it that you refer to Dr. Zimmerman in your report?

A. Dr. Zimmerman is, in my opinion, the world's foremost expert on rock mechanics. He's even written the -- literally, written the book on sandstone compressibility. The book is *The Compressibility of Sandstones*. So the number 6.35 has been taken from his expert report, and I deferred to his superior expertise.

However, I have my own opinions on pore volume compressibility outlined in Section 4.2 of my report, because I, too, have looked at the data and other supporting scientific evidence.

Q. Now, for what purpose have you used or relied on Weatherford Laboratories' work in this case?

A. In this case, I've looked at their measurements of pore volume compressibility. In fact, drilling down even more into this, actually, looked at exactly in their experimental procedures how the pore volume of the rock varied with pressure. I made a determination of what the correct pore volume compressibility for my calculations would be.
Q. Now, when you use the term "pore volume compressibility," just for the record, are you referring to the compressibility of rock now?
A. Yes.
Q. Now, have you utilized Weatherford data in your work?
A. Yes.
Q. Separate and apart from Macondo?
A. Apart from Macondo, yes, as I think I already referred to. Personally, I have great respect for Weatherford Laboratories. Routinely in my laboratories at Imperial, we send out core samples for testing from Weatherford.
Q. And have you found their work to be reliable and accurate?
A. Yes. I mean, we've used quite frequently data measured by Weatherford in our scientific publications, for instance.
Q. Now, you mentioned earlier in your examination work that you had done for -- with regard to the Kuwaiti sandstone reservoir over the past few years, I think you mentioned you had looked at lots of cores as part of that engagement as well as in other areas.
I just ask you, in your experience, have you analyzed

rock compressibility tests?
A. Yes. I mean, I've looked at the test protocols. I've looked at the test protocols for Weatherford as part of my review for Kuwait Oil Company, I also looked at the test protocols that they used to measure compressibility.
Q. And in your experience, under what conditions were those tests conducted?
A. Well, my understanding is both the Weatherford tests and certainly all of the Kuwaiti tests were performed at the appropriate pressure conditions, so the appropriate stress condition because that's really very important to reproduce; but they were performed at room temperature.
Q. And is that appropriate for the analysis that you do?
A. I would consider it appropriate. There is evidence in the scientific literature that there is a small correction that may need to be applied to the pore volume compressibility value if you look at elevated temperatures, but it's a small correction.
MR. CERNICH: Your Honor, we are going to object. None of these opinions are contained in Professor Blunt's report. This is the first time we've heard about his discussions -- about his opinions on Weatherford Labs or any of these types of discussions.
MR. BROCK: He is talking about his experience and why he is relying on these values, which we're about to show, your Honor.
MR. CERNICH: And the literature that Professor Blunt is referring to is surrebuttal that has been specifically excluded

from Professor Zimmerman that he gave in his deposition.

MR. BROCK: He is talking about his experience. He's described his experience in looking at samples of Weatherford and why he considers these to be reliable. He's not done anything more than that.

MR. CERNICH: And he quantified the attempt of temperature, your Honor, and that is not contained in his report.

THE COURT: That is more of an opinion. As long as he's talking about factual experience and not opinions I guess in that area he's okay.

BY MR. BROCK:

Q. Let's look at D-24469, and I think you mentioned this in general terms, but did you analyze the cores from Macondo?

A. Yes. I looked at all of the data, and also, as shown here, looked at both the core photographs. And, in fact, these pictures, these are actually X-ray images looking inside the rock to look at their internal structure.

Q. Now, on this chart here from the Weatherford files, do you see that there are three measured values for rock compressibility?

A. Yes.

Q. Did you consider the range of values?

A. Yes, I did. Your Honor, I think I need to clarify because the testimony of Dr. Kelkar and Dr. Pooladi-Darvish said that I used just one value of 6. That's actually not correct. As in my expert report, 6 is the base case. I think it's the best estimate of what the real pore volume compressibility is. But I didn't just stick with 6, I looked at range of data. So I have a low case, which was about four, but I also considered, and I carried through in all of my calculations, a high case, right, of about 8.5. I consider that a reasonable range of pore volume compressibility. That's the range of the measurements.

Q. What, if anything, did your analysis of the cores tell you about the Macondo formation?

A. The analysis of the core certainly as illustrated in this picture, certainly my experience, again, in looking at probably hundreds, if not thousands, of X-ray images of core samples is that this looks very uniform sand. It's a quartz sand, and it has what I would say uniformly internal structure. What that means specifically in relevance to this case is you would expect the properties measured in one direction to be very similar to properties measured in another direction.

Q. And I believe you said that 6 microsips is an average compressibility?

A. It's the average of the three values that are shown here.

MR. CERNICH: Objection. Your Honor, Professor Blunt's continuing to opine on areas that aren't included in his report. The discussion of orientation of sidewall cores is not discussed in his report. I think that BP is trying to push the bounds here with Professor Blunt well beyond his report. He's already --

THE COURT: Did he express that opinion in his report?

MR. BROCK: I don't know if that is specifically in his report. I do know that he has said that these values are reliable and he is telling the reasons why.

THE COURT: That's a different opinion. I am going to strike that last part of that answer about whether properties measured in one direction are similar to properties measured in another direction.

MR. BROCK: Fine. Okay.

BY MR. BROCK:

Q. Now, let's look, Dr. Blunt, at the next Exhibit, D-23544. Did you look at other measured data that support your rock compressibility value?

A. Yes. What I did was I considered the measured data in the light of the totality of the scientific evidence. So what's shown here is a photograph blown up, microscope photograph, taken from one of the papers that I reference in my expert report.

And what you take away from this is that Macondo has a very high quartz content, almost entirely quartz fused together. And that's represented, though it's not Macondo, it's another high quartz content rock on the right. And here you've got basically a hard material. Quartz is essentially glass fused together so that gives you quite hard rock.

On the other hand, if you had a mineralogy with more ductile easily compressed material such as clay, you might expect the pore volume compressibility to be higher, but Macondo seems to

be more on the pure quartz end.
Q. And what is the significance of being higher in quartz as relates to the compressibility of the Macondo rock as well as your evaluation of that issue?
A. Well, what this would suggest is you would be expecting from Macondo or you would not be surprised from Macondo to see relatively low value of pore volume compressibility.
Q. Let's look at D-23545. And I'll just ask you, first of all, before we get into a discussion of this, if you would describe for the Court what is referred to on this axis porosity, and then we have pore volume compressibility over here. I think we talked about this one a good bit. What is porosity?
A. Porosity is a number which is how much of the total volume of the rock is pore space, so basically how open is the rock. And porosity was measured in two ways from Macondo, both from the samples of rock that were taken from the field, but also in what's called a log analysis; essentially measurements that were taken while they were drilling or after you drilled the well.
So what this is -- this is, again, a figure from my expert report but it was prepared by BP, and it was prepared by BP before drilling. So what it shows on the Y axis is the pore volume compressibility. And you see there's a wide range of values, right. This goes from zero all the way up to 70.
And on this axis, the X axis, we have the porosity. And the values here -- there have been a lot of discussion about other

wells. This is the data, this is the measured data that BP had acquired on other fields in the Gulf of Mexico. And what BP's geomechanics expert has done here is said, "Well, we anticipate a porosity here of about 22 percent."
Q. Is that the red line here (INDICATING)?
A. That's the red one, which is more or less what was measured. And looking at this trend, this is sort of a trend line he puts here. He says, "I think I'm going to get a pore volume compressibility of about 6 microsips."
Now, again, what does that mean? It means if you, then, measure the pore volume compressibility and get 6, it's not a surprise; but there is a lot of scatter in this graph. You wouldn't just use this graph and take a number with any reliability because, as you can see, you know, other values are also plausible.
So what it shows in context is that the measured value of about 6 microsips is not the least bit surprising, it's consistent with other wells in the Gulf of Mexico of similar porosity, but you do need to make the measurements in order to reduce your uncertainty.
Q. This value for porosity, what is the value that you used?
A. The value for porosity that I've used in my quantitative determinations comes from the log analysis, that's considered best practice in reservoir engineering, and that's 21.7 percent.
Q. And is that the same value that Dr. Kelkar uses in his analysis?

A. Yes.
Q. Let's turn to the issue of published literature on the topic. And this is just a callout here and it's showing in a little more detail where the intersection occurs with the porosity value; is that right?
A. Yes, it is, just shows that.
Q. So let's turn to one of the articles that relates to this issue, and I'll just ask you: Did you review literature to figure out what compressibility you might expect at Macondo?
A. Yes. I mean, I looked at the measured data in the light of the scientific literature, and one of the papers I cite in my expert report is the one that's shown here.
Q. And this, when you say, "shown here" we're referring to D-24471. Can you see that in the bottom corner here (INDICATING)? D-24471, is that right?
A. Yes, yes. Sorry, yes.
Q. Thank you. Now, Dr. Kelkar testified yesterday on redirect examination that he was not the primary author on this paper after he had been questioned about it. And I'll just ask you: Do you have an understanding of what it means to be the last author listed on a paper?
A. Let's put it this way, if this was a similar situation and I was publishing a paper, you would normally expect that first author, which Dr. Kelkar described as the primary author, was the student, you know, who did the work. The last author is normally

the Senior author. What I mean by that is that is the professor who is supervising and is in charge of the research.
Q. What is the responsibility of the professor who supervises and is in charge of the work as to the reliability and the rigor with which the paper is written?
A. Well, if it were a paper of mine and I were the senior author, it would indicate that I had designed the research study, I framed what the paper would be about, I had reviewed carefully every detail of the research, I had been involved in writing the paper, and essentially, I would take responsibility for all of the contents of the paper.
Q. Now, let's turn to -- back to the issue of this well. Not ready for that yet.
Dr. Kelkar testified yesterday that his value of 12 microsips for rock compressibility was based on BP documents, and I'll just ask this question of you, sir. Did you consider and evaluate whether a rock compressibility value of 12 microsips could possibly be consistent with the actual data related to Macondo?
A. Yes, I did. There's essentially a final check, something that's standard in reservoir engineering and which is discussed in Section 5 of my expert report. And it's about tying all of the pieces of data together. So, of course, I am aware of the BP e-mails. I am aware, of course, of uncertainty and that there is some scatter in the data. So it's not unreasonable to consider hypothetically other values, even though that doesn't appear to be

direct scientific evidence to support them. But it's this consistency check that's absolutely key to that.
Q. So let me turn to our next demonstrative. And let me just get you to say, first of all, for the record, Dr. Blunt, what is the consistency check that you performed with regard to the Macondo well to understand the issue of rock compressibility?
A. Okay. So what we see here in a graphic is, again, schematic of the pressure. And as I said, I've determined where the barriers to flow are in the reservoir, where that sort of connected area is. But in doing that, I needed to input a number for compressibility.
Now, what I mean by "reservoir engineering consistency check" is, if I use my number of 6 microsips and my analysis to pressure data, do I get an extent of the reservoir that makes geological sense? And the answer is, it does. Because we seem to see an extent to the reservoir that more or less is the extent of the reservoir geologically speaking.
The fact that it isn't the width of the reservoir and there are other channels is, again, perfectly plausible geologically and supported by the literature. But -- there's a but to this. What about if it's 12 microsips?
Q. And if it's 12 microsips, what does that do to the analysis in terms of the consistency check?
A. In the consistency check, if you assume a larger compressibility, then, essentially, the pressure wave moves slower. And what that would mean is that this connected box here would be

smaller.

Now, that has two consequences. The first is you can't just bump up the compressibility number and say you've got more oil released, because if the connected area was lower, then your end number, your oil volume number, must go down. And those two effects partially cancel. As I said, it's not you can't just pick each number in isolation.

The second problem is that if the boundaries, the no-flow boundaries of your box are sort of cut halfway through the channel, I won't say that's impossible. There are lots of reasons, sub-seismic faults, shale drapes that could restrict connectivity; but not it's such a neat, not such a consistent geological picture. So basically, 6 fits, 12 doesn't, and that's the reserve engineering analysis.

Q. When we talk about this issue here of increased compressibility slows down the pressure wave, I think you have designed maybe a teaching tool that we might use with Judge Barbier or show to Judge Barbier that would describe while you can't change one value without considering how that affects others?

A. Yes, yes, I have.

MR. BROCK: Your Honor, would it be okay if I approach and just grab this. I have permission from the staff to put this right here, if that's okay, just so you can see it.

THE COURT: Okay.

BY MR. BROCK:

Q. So if you will, first of all, Dr. Blunt, describe for Judge Barbier what's represented by the slinky, and then what's represented by the coil that is wound a little tighter.
A. Okay. Yes, your Honor, I am trying to sort of illustrate this because it is important. As I've said, I devoted a whole section of my expert report to this issue. The slinky spring is clearly quite compressible, you can easily squeeze it.
MR. BROCK: Keep talking while I move our exhibit around.
THE WITNESS: That, if you like, for illustrative purposes, is a highly compressible model, say 12 microsips.
The other spring, the smaller spring, is clearly a lot stiffer, you can't compress it so easily. So that has a lower compressibility. So for illustrative purposes, if you like, we'll call that 6 microsips.
Now, I've done a pressure analysis, and the pressure analysis tells me how long it takes to see these barriers to flow, but to locate them physically on my geological model or the seismic maps so I have a picture in my head of exactly what the reservoir is like, I need to know the speed with which the pressure moves.
Q. What affects speed?
A. What affects speed is compressibility. So if Mr. Brock will give this a wiggle, that's a pressure wave. And if you look at that, it takes -- make it more vigorous. As you can see, it takes about --
Q. I was really good at this when I was a kid. I loved these

things.

A. What I am trying to illustrate here is it takes a couple of seconds for the wave to move from one end to the next.

Now let's do it with the stiffer spring. What you notice is when Mr. Brock moves one end, more or less instantly, the other end is affected. So with a higher compressibility, the wave moves fast -- with a low compressibility, the wave moves fast, it goes further; with a high compressibility, the wave moves slower, it goes less far.

And the consequence here is, if I stick to the measured data, everything makes sense. I have the size of the box, it goes from one end of the reservoir to the other, completely consistent with good connectivity along these channel sands. It fits. Any reservoir engineer would say that's fine.

If instead we think, well, what happens if it's 12? What that would mean is the box would be smaller, the consequence in my calculations would be I would have to dial down my end number.

Q. Your reservoir size?

A. My reservoir size. But it's also not such a good picture. It's not so geologically consistent. It's not impossible, but it's not so consistent and I can't just bump -- the point is I can't just bump up C and get a bigger number. It's not consistent.

Q. Does this consistency check give you confidence about your opinion on the compressibility of rock at Macondo?

A. Yes.

Q. And why is that?
A. Because this is an additional check using additional data at the field scale. And, you know, if I may, you know, refer to the BP e-mails, my interpretation as a reservoir engineer is these reservoir engineers are trying to perform a calculation and they're asking for input from rock mechanics experts, that's fine. But it's the reservoir engineers who make the final call on the number in the light of all of the data. But at the time of the discussion, there wasn't the capping stack data; or, at most, there was only a couple of days of data.
In order to make a determination of where the no-flow boundaries at the end of the field is, you need all 19 days. So this consistency check that says 6 fits, 12 doesn't, is only possible once you have all of the capping stack data.
So it's perfectly legitimate to have a discussion among experts about plausible values and there is a range of uncertainty. But this check -- and this is the essence of reservoir engineering -- helps narrow that uncertainty and it makes me very confident that the range of pore volume compressibility -- and it's still a range of about two, from about four to eight and a half -- is indeed the right databased range that is consistent with the totality of the evidence.
Q. Let me have D-23547, please. I'm just having trouble locating, sorry, Judge Barbier.
So just to sum up on the issue of compressibility, when

you look at your analysis based on the data and the consistency check, compared to Dr. Kelkar, have you evaluated what difference that makes in your outcomes?

A. Yes. So in Dr. Kelkar's analysis, because he doesn't perform this consistency check, he is, I want to say, able to put in any number and see what effect it is. And so if you take his 12 microsips and put in 6, it makes a difference of about 1 million stock-tank barrels. And indeed Dr. Kelkar himself has performed a similar calculation and arrived at a similar conclusion.

Q. Let's move to the third variable, pressure change.

THE COURT: Mr. Brock, why don't we use this transition to take a 15-minute recess.

MR. BROCK: Sure. Thank you, your Honor.

THE DEPUTY CLERK: All rise.

(WHEREUPON, A RECESS WAS TAKEN.)

(OPEN COURT.)

MS. HIMMELHOCH: Your Honor, before the witness comes, I have a short evidentiary matter I can address.

THE COURT: All right. Everyone be seated.

MS. HIMMELHOCH: Judge, just quickly, in the kerfuffle over the Ron Dykhuizen objected-to exhibit, we didn't actually formally move in the remainder of the exhibits. So the United States is offering and seeking admission of all of the documents on this list except TREX 11191 and its associated callout TREX 11 -- sorry, TREX 11191.1.1.US. for admission. There are no objections with the exception of those two documents.

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

MS. HIMMELHOCH: Thank you, your Honor.

MR. BROCK: Judge Barbier, just one issue for the record. Mr. Irpino has helped me out with this. I put on the screen Document 23523, it's a demonstrative, and then there were two additional callouts from that same document which were 23524, which was the pressure signal that went out from the well, and then there was an additional exhibit, 23525, which I think is when the rectangle was formed showing the shape of the reservoir. So I just wanted to note for the record that I had called those out in court, and he was kind enough to remind me to get that in the record.

THE COURT: All right. Very well. Let me just say, we are going to -- I have a lunch meeting outside the courthouse that I have to attend, so I am going to -- wherever we are in the testimony, I am going to have to break, you know, five minutes to 12, something like that.

MR. BROCK: Okay. Sure.

THE COURT: Go ahead.

BY MR. BROCK:

Q. Dr. Blunt, we're now going to turn to the third variable in the material balance equation, which is the issue of pressure change. And so let's start with the discussion of that. Again, we have here demonstrative 246 -- excuse me, 23550, and we're talking now

about the third variable there, pressure drop. Do you see that?
A. Yes, I do.
Q. I now am putting up D-24608, and I would like for you to just state for the record what is your value for the pressure drop at Macondo?
A. My best estimate of the pressure drop is 1,367 psi. But, again, following the approach the other two variables, I do look at a range of pressure drops based on the range of the measured fluid properties.
Q. I am going to put up now Demonstrative 23551, and we'll go back to the analogy of the tire, but what I would like for you to describe for Judge Barbier now is why does change in pressure make a difference to the output of the well?
A. So we're looking at a decrease in pressure from the initial pressure to the final pressure. In Macondo, the initial pressure, as I said, was 11,856 psi to be precise, about 800 times atmospheric pressure. It went down by about 1,400, so actually only a small fraction of the total pressure. So the more the pressure declines, the more the fluids expand, the more the rock compresses. And the amount of oil that's released is directly proportional to what this pressure drop is.
Q. I want to pull up a new demonstrative to talk a little bit about where pressure is measured when these pressures were obtained and how they fit together. D-23554 shows the initial reservoir pressure of April the 12th, and this is 2010. How, Dr. Blunt, is

this pressure obtained?
A. This pressure was obtained by downhole measurements taken after drilling but before the accident using an MDT tool, and the value more or less in the center of the reservoir, my baseline, is 11,856 psi. And, again, as I think I've already mentioned, there is no substantive disagreement among the experts in this case over this value.
Q. Now, I am going to click this, and this is still D-23554, which is the build-out of the slide. And do you see there that we have a capping stack pressure of 6555 psi on July 15th to August the 3rd? Do you see that?
A. Yes. I think the number that's referred to there is the pressure at about the time of choke closure. So the pressure was measured on the capping stack when the well was shut in. And as I've already mentioned, for 19 days afterwards, the pressure did rise quite slowly, and I think the final pressure was recorded on the 3rd of July -- 3rd of August, sorry, was about 6,950 psi, so about 400 psi greater than this.
Q. So the pressure data that you are using here is derived from information that is obtained at the time of the shut-in of the well and then for 19 days thereafter?
A. That's correct.
Q. Now, when we look at the issue of pressure change, are we concerned with the pressure here at the reservoir or are we concerned with the pressure here at the BOP?

A. This is a reservoir analysis. What we really need to know is the final reservoir pressure, not the pressure of the capping stack.

Q. Now, if we turn to D-23555, I'll ask you to just describe for Judge Barbier what this chart reflects and how it is helpful to you in understanding the issue of final reservoir pressure.

A. Right. There are two steps, and I'll say briefly what they are and then refer to this one. We've got the capping stack pressures that are increasing over time, and this is what's shown in this graph here. On the Y axis is the pressured capping stack pressure, those are the little crosses you've got. And on the X axis at the time since choke closure, can be a little bit confusing, but basically that's the time from the 15th of July to August the 3rd.

So the first step is we want the final pressure. Now, as you can see, the pressure at the capping stack is increasing, it's continuing to increase. Where is it going to end up?

Q. Why is that? Explain that.

A. The reason physically is you've been withdrawing fluid from the reservoir for 86 days. Pressure goes from high -- flow goes from high to low pressure. We talked about the pressure waves. So there's a region of reduced pressure that extends all the way across the field. But the pressure's lowest at the well because the flow goes towards the low pressure point. When you stop the flow, there's still oil moving, but it's now backing up, so the pressure of the well builds back up.

So the first step and a step that all of the experts in this case have done, is here is the measured data, where is it going to end up. How do we predict where we're going to have the final pressure.
Q. This place here where we have this last X, this is the final pressure measurement that is taken on August the 3rd; is that right?
A. That's correct.
Q. So what do you have to do to understand the final reservoir pressure in terms of what you can see at the BOP or at the capping stack?
A. So best practice in reservoir engineering is to have an analytic flow model, and what that means is something that can be written in pen and paper, or in my specific case, an Appendix C of my expert report. You have a flow model that makes predictions, there are parameters in the flow model. You match the parameters of the flow model to match the data as accurately as you can, and then from that, you can determine what the final pressure is. You can essentially predict forward in time of where the pressure would end up.
Q. And is that the analysis that you have conducted in this case?
A. Yes.
Q. Now, just remind us again, this is the exhibit that we were just referring to, D-23552, how is this analysis of pressure that we're talking about here related to what we talked about in terms

of connectivity earlier?
A. So earlier when we talked about connectivity, we looked at the pressure analysis specifically to look at the time, how long did it take for the pressure wave to encounter the barriers to flow at the sides of the channel and how long did it take for the pressure wave to encounter the barriers to flow of the south and north ends of the field.
That was for the connectivity analysis. Now our emphasis here is going to shift on what is the final reservoir pressure, using the same concept, the same flow model, but we're looking at a different variable here.
Q. Now, let's look at an animation that you have helped us pull together of the Macondo well. This is D-23553. And I guess, first of all, if you can just describe for Judge Barbier's benefit what this is and how you are able to develop this animation.
A. So, your Honor, what I prepared here is an animation. All of the data in this animation, incidentally, is my base case -- one of my base case calculations that are where all of the parameters are described in Appendix D of my report. What we're going to be doing here is to illustrate that data, trying to bring it to life.
Here we have the reservoir. This is the reservoir box, so to speak. Mathematically, the flow can be very accurately described -- at least the pressure response can be very accurately described as a flow in this box. The red color here is indicating that initially we have a high reservoir pressure and then you're

going to see the Macondo well placed in this box here, that's where it's located. This is our pressure scale, that's high pressure, that's low pressure.

And we're looking at the 20th of April, and to a good approximation, we can assume that the pressure was uniform throughout the reservoir because there was no flow.

Q. Now, after shut-in, then what happens?

A. Well, actually this isn't the shut-in.

Q. I'm sorry. Let's look, first, at pressure signal that you would see?

A. Yes.

Q. So now, what's the pressure signal?

A. This is the time of the accident. This is my prediction of what the pressure could be. As you can see, the pressure of the well continues to decrease. You see these little pressure waves moving out sort of radially and then linearly, and you are seeing that there's an affect on the pressure. It gets to the sides here, it gets to the ends, and, obviously, from the diagnostic signature, that is what enables us to find the size of the connected volume.

And the pressure is continuing to decrease as more and more oil is coming out of the reservoir.

Then on the 15th of July there's a pause. Now, we close in the reservoir. We actually have high pressure here, low pressure here and the pressure is going to equilibrate. And I've shown one pressure contour that's 10,400 psi, and very slowly over time, see almost linear flow here, the straight line pressure contours moving towards the well, and we are going to end on the 3rd of August, which is when the well was cemented, we were close to equilibrium, but not quite there. And the final pressure, if we were to run this animation from that time, would be just above 10,400 psi.

Q. And that's what you were showing there at the very end of that animation?

A. Yes.

Q. And does that represent your view of what happened with regard to the pressure in the well?

A. Yes. It's one of a number of models I've run, and I consider it a perfectly plausible representation of the pressure response of Macondo, and it very accurately matches the measured data.

Q. Now, let's look at the next demonstrative. It's D-23556. And let's turn to the issue that we talked about just a few minutes ago, which is conversion of the capping stack pressure to reservoir pressure. Okay. And why is it that we're going to translate those pressures?

A. Right. So, your Honor, we've been talking about the pressure response and there are different ways of finding that final reservoir pressure and the different flow models. Myself and Professor Gringarten have used analytic flow models, Dr. Pooladi-Darvish did use a simulation technique, Dr. Kelkar did essentially a curve fitting exercise. I consider what I've done best practice.

But in the end, that isn't the thing that causes the big disagreement in the pressure drop variable. Where, in terms of a quantitative sense, the big disagreement is, is we've got measurements here at the capping stack, but of course, we all agree, everyone agrees that what we want to do is find the final reservoir pressure, so we have to convert these measurements or predictions downhole.

Q. Now, is it right that at the time of shut-in you have a 13,000 plus foot column of oil in the well?

A. Yes.

Q. How does that affect what you need to do in terms of making a calculation for this reservoir pressure using a known capping stack pressure?

A. Well, conceptually it's reasonably straightforward. You know where the capping stack is, you know where the reservoir is, you have a wellbore that's full of oil. The oil has a weight. Essentially, the reservoir pressure is going to be the capping stack pressure plus the weight of oil.

Q. Now, if I scroll ahead or click ahead to D-23557, at the time of shut-in, generally, what's the makeup or the composition of this oil that's in the well?

A. So the time of shut-in we need to make a conversion. Again, all of the experts in this case have made this conversion. It's not controversial that you need to do it, it's just how you do it that's the issue.

So what we have here is we've been producing for 86 days. As I said, the oil in the reservoir is hot. It's boiling hot, about 240 degrees F, and so that hot oil has been flowing up through the well and it's been heating the surrounding rock. And so at the time of shut-in, we have a column of hot oil sitting there in the wellbore.

Q. I am calling up now D-23558, and the title of this demonstrative is "The Second Law of Thermodynamics, Hot Things Cool Down." Why, Doctor, does that matter to this analysis?

A. Turns out it's absolutely crucial to the analysis.

So you've got this column initially of hot oil. Hot things tend to be lighter, so in the beginning, relatively speaking, the weight of the oil is not that high. All of the U.S. experts have calculated what it is. They're all, as we know, measurements of what the oil density is, it's a function of temperature and pressure, but they've assumed a fix conversion. They've essentially assumed that the oil stays hot.

Q. What's the effect of that?

A. The effect of that -- there are two effects: One is the oil's going to cool down, that's what we're going to talk about, or at least that's what I discuss in my expert report. So it tends to understate what the weight of oil is, and that tends to say the reservoir pressure is too high and your pressure drop is too low. So it's a bias that understates the oil released.

10:51:00 It also distorts your interpretation of pressure response, and that's also very significant.
10:51:05 Q. If you have a cool column -- if you have a hot column of oil and you're using that for your measurement, it will result in a lower final reservoir pressure than if you account for the changes that were to occur to that oil over time?
10:51:26 A. Yes.
10:51:27 Q. And a lower final reservoir pressure means that you have a larger pressure drop?
10:51:35 A. Yes.
10:51:36 Q. And a larger pressure drop results in more oil, in a general sense, flowing from the Macondo well?
10:51:45 A. Yes.
10:51:45 Q. So understanding the change in temperature is important to your analysis?
10:51:51 A. Yes. Not only is it important, it's not as though we're introducing here anything unusual. Everyone has recognized that this is a phenomenon, it's just I've actually gone ahead and analyzed it using some very fundamental principles.
10:52:12 The reason why the oil cools down is, it starts off hot, it's coming out of the reservoir, but of course, the capping stack you have cold ocean, it's 40 degrees F. As you go down, as you go underground, the temperature essentially varies more or less at any depth from 40 degrees at the seabed to 240 degrees at ocean depths. So if you wait long enough, if you wait for infinite time, what's

the temperature going to be? It has to vary nearly from 40 to 240. There's no other possibility. So you know it's got to cool. It can't be 240 everywhere.

Q. Now, do the experts for the United States agree that this is something that should be accounted for?

A. Yes, as far as I can tell. I mean, there's no disagreement. Everyone knows hot things cool down.

Q. And do any of the United States experts make provision for hot things cooling down and making the proper adjustment to the weight of the head in order to calculate a final reservoir pressure?

A. No, they do not. They all use a fixed conversion.

Q. Now, have you prepared for the Court's benefit a demonstrative to show the cooling over time? And I am going to pull this up as D-23559. I would like to just answer the question as to whether or not you've done it; and then before we get into it, I would like for you to describe for the Court also the basis for this work.

A. Okay. So, your Honor, again, we're going to have a little animation, but the animation is based on data that's presented in Appendix B of my expert report.

So what we're showing here is at the time of choke closure, in fact, just before the time of choke closure here, we have the oil sitting here. It's shown in red, which represents it being hot. The ocean is cold, that represents 40 degrees F. And way away from the well, the temperature goes from about 40 degrees F down to 240 in the way I described.

So what we show here is the temperature. It's not the temperature at any location, it's actually the temperature just below the seabed when I calculate. So it's the temperature just below the seabed in the oil as a function of time, and in particular, from the 15th of July when the well was shut-in to the 3rd of August when the well was cemented.

Q. You tell me when you're ready to go forward. Is this a good time to click forward?

A. Yes, let's run.

Q. So what are we showing here?

A. So what we're showing here, this is the temperature profile in the well and here we have the time. We're slowing down for the first day. Notice in the first day, right, the oil is really hot, it cools down really quite rapidly. And now it's speeding up the video, and you can see subsequently we get more and more cooling but it's much slower.

So as you would expect, if you got a boiling hot cup of coffee, it's going to cool down quite rapidly to begin with. When it's lukewarm, the rate of cooling is going to be much less.

Q. Have you conducted the calculation as to what the final reservoir pressure will be if we take into account the second law of thermodynamics, hot things cool down.

A. Yes. I mean, the calculation, the details, the mathematical details are in Appendix B of my report, but the principles are really very sound. And actually, they're well established and recognized in petroleum engineering.

All I'm doing here, your Honor, is conserving energy. We've got energy in the formation, heat energy in the formation, we've got heat energy in the oil, and I'm simply conserving energy. Mathematically, the equations are actually rather similar to what you see in the pressure analysis.

Q. You take account of the second law of thermodynamics, and the experts for the government use a constant hydrostatic head as I appreciate it?

A. That's correct.

Q. And let's look at D-23560. What difference does it make in the analysis that you have conducted versus Drs. Kelkar and Pooladi-Darvish?

A. So as I said, there are two components. One is what model do you use, essentially, to move the capping stack pressures further in time. But that's not the big difference, the big difference is how you do this conversion. And because I am allowing for this cooling, in general, as things cool down they get denser, the weight of oil is larger. I'm accounting for that. And of course, that's the major difference in our pressure drop calculations.

So if you compare with Dr. Kelkar, Dr. Kelkar has already shown this in his testimony, he does get a slightly larger pressure drop. But the difference, to be honest, I mean, it's 220,000 stock-tank barrels, isn't the biggest disagreement between us. So there is a difference, but it's not as significant as the others.

But for Dr. Pooladi-Darvish, it is very significant. What I've shown here is his pressure drop for his base case. And in my opinion, he is using an implausibly small weight of oil, a small and fixed weight of oil to do his conversion. And that's the principle reason for the disagreement between us, and that does have a significant impact on the calculations.

Q. Does this slide reflect the calculations that you have made as to the difference that this factor makes in the outcomes of Drs. Kelkar and Pooladi-Darvish?

A. Yes.

Q. Let me now turn to just the basic issue of differences between your approach and Dr. Kelkar's material balance approach. This is slide D-23561. And, Dr. Blunt, I don't think we need to go through every one of these, but if you could quickly walk through the differences that exist between your values and those of the United States and why they matter.

A. Okay. There are essentially differences in our approach to the three key variables. And the things that are ignored in Dr. Kelkar's analysis, and to some extent in Dr. Pooladi-Darvish's analysis, also introduce a bias. So if we're looking at the connected oil volume, if you just take the full seismic volume, you're assuming 100 percent connectivity. Well, connectivity can't be greater than a hundred percent, and it really is highly unlikely that it is a hundred percent. So that overstates that.

When we look at compressibility, we discussed this, rather than going to the primary source material, which is the measured data, they're looking at sort of upsides on compressibility that I don't consider supported by the scientific evidence. And again, that introduces a bias.

And then, when it comes to the pressure analysis, the principle thing is that assuming that this wellbore oil doesn't cool down or ignore the cooling in the calculations, and that, too, introduces a bias.

Q. Dr. Blunt, just one final slide on this looking at Dr. Kelkar's approach. Does this slide reflect -- and this is Demonstrative D-23562. Does this reflect the values that you have described for the Court today in terms of your outcome as well as what Dr. Kelkar's outcome would be in terms of total barrels if the appropriate adjustments were made?

A. Yes, it does. His mid range value is about five million barrels of oil. What I've shown here is if, instead, we put in the values that come out in my analysis, these are what the corrections would be. The most significant correction is, I think we've already talked about, is the rock compressibility number. But there are also other corrections for the oil volume and the pressure depletion.

Q. Thank you, Dr. Blunt. I want to come back, now, and explore just a couple of topics in a little more detail. First of all, this is in the area of consistency checks and work that you've done. There's been discussion in the case about reservoir

simulation by experts for the United States. And I'll just ask you in the context of that, and this slide that we have here, which is D-23563, what input is typically used in those flow rate calculations?
A. Yes. Another rock property that we've already heard a lot of discussion about is permeability. And Dr. Pooladi-Darvish has presented a reservoir simulation model, and what you do in reservoir simulation model is you're predicting flow rates over time. And in the reservoir, for a given pressure drop, the flow rate is proportional to permeability. So permeability is a very important input into a reservoir simulation. Essentially, you double the permeability, you're going to double the flow rate.
Q. We've heard the statement that permeability is proportional to flow rate. Is that the same thing that you're saying?
A. That is correct. For the same pressure drop. But Dr. Pooladi-Darvish, as I am and as other experts are doing, he is matching the pressure data. So we've got the same pressure data, that isn't changing; but if you change the permeability, you're going to change your predictions of flow rate.
Q. So let's just do just a very short tutorial on the issue of permeability, what it is and how it affects flow. And I've put up D-23564. And, Dr. Blunt, can you use this to describe the context of permeability and how it relates to the values that you are looking at when you are trying to ascertain total flow from a well?
A. Yes. So I think we talked about this concept of the Macondo

reservoir being this sand where the grains have been fused together, but permeability is how easily the oil can flow between these fused grains. And it's very subtly dependent on the details of the pore structure. What we show on the left with these arrows being blocked is that the grains are arranged such that we don't really get much flow, so that would be a low permeability. Essentially, it's like, you know, driving along a road network where there are lots of road works and everywhere you try and go you're blocked.

The high permeability is more where the nice freeways and there's access to flow. There are connected pathways through the pore space. So we are looking here at the microscopic level, that's fundamentally what controls permeability, and it is an important number and absolutely vital number to get right in any reservoir simulation.

Q. And how is this number derived in the context of the information that's available to you and others to evaluate this reservoir?

A. There are a number of different ways in which permeability can be evaluated being such important concept. It's not a surprise that that's the case. So, your Honor, the most direct way is take a sample of rock from the reservoir and you measure permeability in the laboratory. And that was done for Macondo. It was done on, I think, 16 different core samples. And the average permeability, again, looking at the data, is about 360 millidarcies.

But there are two other methods. The other is actually to use the logs. The reason why there's the downhole measurements after drilling the well, the reason why I use those is, rather than just looking at 16 small core samples, you get a permeability through the 93 feet that you encounter. BP got a value of about 220 millidarcies.

And then you're thinking, well, that's actually quite different. We haven't really pinned this number down.

So the gold standard in reservoir engineering is the permeability controls the flow out to the well. So what you should be using to measure permeability is information from flow. So what you do is you do a pressure analysis of oil flow, and from that you get a permeability that isn't measured on a small rock sample, isn't even just looking near the well, it's giving you an average around the well. And an average that may extend out hundreds or even thousands of feet. And that's the gold standard. That's the best number to use.

Q. So this test that allows you to measure flow, how is that done?

A. There are two ways: The first was before the accident there was what's called this MDT tool.

Q. April 12th?

A. April 12th. And that extracted oil from the formation and the pressures and the rates and the flow rates were measured from which you can make a determination of permeability. I have not done that, your Honor. That's the expert analysis of Professor

Gringarten.

Q. Okay. Now, let's talk about the government's analysis here. What, if anything, is wrong with the government's estimates of permeability? And I'll cite you to D-23565A, please.

A. So the other method -- and again, this is standard well test analysis -- is you look at the measured pressures from the well when you close in the well. That's exactly what was done with the capping stack.

So what I am showing in this graph -- and again, it's a replot, actually, of one of the graphs we've shown earlier, your Honor. This is the increase in pressure, so from choke closure, this is the increase, how much did the pressure go up? The red is just the data. It's the data on the capping stack. So the pressure went up, as I've said, by about 400 psi.

This is time, this logarithmic axis so it sort of stretches out the early time and compresses the late time. So this is about 1 hour, 10 hours, 100 hours, and this goes out now to two weeks.

Q. Why do you have 300 millidarcies with wellbore cooling and greater than 500 millidarcies when cooling is ignored? What is the significance of that?

A. This is very significant in the sense that what the government experts have done is they've taken the capping stack data and they've converted to the reservoir with a fixed number, so the increase that they think they see in the reservoir is the same increase that you see at the capping stack.

What's the consequence of that? So they think the reservoir pressure is increasing slowly. What does that mean physically? For a given flow rate, let's assume, which there is, there is a flow rate on the final day. So let's consider that fixed.

If you've got a high permeability reservoir, it's easy to flow, which means the pressure drop is low. So the pressure in the reservoir doesn't decrease that much, and then when you stop the flow, the pressure doesn't build up that much. So what you see is a pretty gradual rise. So this gradual rise means high permeability.

So Dr. Pooladi-Darvish, for instance, in his simulation models, he does match the capping stack pressure; and when he matches the capping stack pressure, he gets permeabilities of around 500 millidarcies or more. That's entirely consistent with him ignoring wellbore cooling.

It's also entirely wrong. Because as I showed in that little animation, your Honor, in the first day, certainly in the early periods, there's this rapid cooling of the oil. What does that mean? That means the oil is getting heavier and it's getting heavier faster. So imagine that weight of oil pushing down on the reservoir. Over time it's pushing down more and it's pushing down more quickly.

What does that lead to? It leads to the reservoir pressure, which is in green. This is my conversion. The reservoir pressure is increasing faster. What does that mean physically for the given flow rate? If the permeability is low, right, you have to have a big pressure drop. It's like trying to suck a straw with a thick milkshake. When you close in the well, the pressure bounces back up rapidly.

So the true pressure response in the reservoir, if you obey conservation of energy, basic physics, is actually the reservoir pressure is rising quite rapidly. The permeability is almost certainly no more than 300 millidarcies; but by ignoring this, this is where the government experts have, I would have to say, mislead themselves, even though they've matched the pressure, into thinking that the reservoir permeability must be 500 millidarcies.

Q. Let's look at D-23566 and talk just for a minute about permeability in terms of your view and that of the other experts. So I want to ask you, first of all, with regard, Dr. Blunt, to your pressure analysis of 300. How did you make this calculation?

A. So this calculation was using the industry standard. Almost the textbook analysis of what's called this radial flow period. Now, so that gives me approximately 300 millidarcies.

Q. Then, in your report, I believe, that you used the value of 329, higher than what you evaluated it as. Why are you using 329 to evaluate the reservoir?

A. Well, this is all part of my conservative approach, so as not -- if anything, to err on the side of more oil released.

As I said, I used a textbook pressure analysis, but I do need to assume a final day flow rate. And of course, there are uncertainties in that determination. A determination incidentally that I have not made.

The advantage with Professor Gringarten is that this is an independent measurement made before the accident. But erring on the conservative side, I don't take his mid range case, I take his highest possible case. It's totally consistent with what I see. There's no disagreement because there's a range of values, but I've taken the highest possible value of permeability that is consistent with the evidence.

Q. If you used your calculated value of 300 instead of Dr. Gringarten's value of 329, what would that do to your calculation on the most likely flow from the Macondo well?

A. It would decrease my value. But I do have to emphasize, unlike the reservoir simulation models, my determination of oil released isn't proportional to permeability. So if you make a 10 percent decrease in permeability, you might see about a one percent change in my determination of oil released. So it will make a difference, but a small difference.

Q. New topic. Aquifer. There was discussion yesterday about the possibility of an aquifer at the Macondo reservoir, and testimony that you assumed that there was no flow contribution from an aquifer without investigating the issue. I'll ask you, Dr. Blunt,

did you look into the issue of aquifer?
A. Yes, I did.
Q. Could we see TREX 1553.47 at page 47. And just in the interest of time, if you could go to the paragraph -- the sentence that begins, "The clear signal of channel flow." I'll just ask you, Dr. Blunt, to look at this callout and then explain to the Court what work did you in order to understand the issue of possible aquifer.
A. Yes. There are two main pieces of evidence. The first one is my own pressure analysis. I was only able to get an accurate representation of the pressure response by having no-flow boundaries; by which, I mean barriers to flow on all sides of the reservoir.
So that strongly indicates that there is no aquifer support. There's no evidence that we're seeing a drainage region that extends beyond the oilfield. You would see a different pressure signature, particularly when you look after 19 days.
The second piece of evidence is not an analysis that I've performed, but that of the expert report of Professor Gringarten. Professor Gringarten is probably the world's greatest expert on pressure transient analysis and he's pioneered a method called deconvolution. What that allows him to do is not just look at 19 days of data, but essentially to look at the whole period, so 19 plus 86 days. So he is looking at over 100 days effectively.
And there he sees the diagnostic X-ray signature of the

pressure response, a clear signal that you are producing oil from a contained box. So that essentially excludes aquifer support. It's not an assumption, it's a determination from the data.

Q. Let's go to D-23567. I'll just ask you -- 23567.

MR. CERNICH: Your Honor, I am going to object. This doesn't appear in Professor Blunt's report. He doesn't rely on Professor Zaldivar at all for flow rate schedule.

MR. BROCK: I believe this document is in his report, isn't it?

THE COURT: Is this an exhibit from your report?

THE WITNESS: It's a graph from my report where I've simply scaled the Y axis by multiplying all of the numbers by 45,000 stock-tank barrels a day, and I've included the box from Dr. --

THE COURT: Is this exactly what was in your report or did you add something?

THE WITNESS: I've added things to it, your Honor.

THE COURT: Okay. That's the question.

MR. CERNICH: And your Honor, Dr. Zaldivar's work is not anywhere cited in Professor Blunt's report and it's not on his considered list.

MR. BROCK: Your Honor, this is a demonstrative we expect to elicit evidence that will demonstrate the range of flow that occurred with slug flow when Dr. Zaldivar testifies. So I will not discuss that with Dr. Blunt, I don't need to discuss that with him to make the point I need to make with this slide. But this is a demonstrative that will show a fact that will be proved in the case and his consistency with that.

MR. CERNICH: I would like it to be clear on the record, your Honor, that Professor Blunt didn't rely on Dr. Zaldivar's work and that he did not use that in any way in his analysis.

THE COURT: Is that correct?

THE WITNESS: That is indeed correct. Yes.

MR. BROCK: I don't have any problem with that. That's fine.

BY MR. BROCK:

Q. Dr. Blunt, I'll just ask you to use this diagram here to describe for the Court how your calculation applies to the final day flow rate and how this diagram here is relevant to your analysis.

A. So, your Honor, in Appendix E of my report, I devote a whole appendix to addressing one of the concerns that's been raised by Dr. Pooladi-Darvish and Dr. Kelkar concerning flow rate history. It is true that the pressure response is affected by the flow rate history. So what I, first of all, did is I checked out if we look at different possible flow rate histories, and this is one of a number of cases that I do examine in my expert report, it does not affect my quantitative calculations, so I am not hinging my analysis on a particular assumption of what the flow rate schedule might be.

But what I am simply illustrating here -- and I am not advancing an opinion on what the flow rate history should be, is we have here a flow rate history that starts low, reaches a maximum, declines by the time flow is stopped, with a final flow rate that is broadly consistent with expert analysis and which has a cumulative flow consistent with my material balance analysis.

So all I am trying to say here, your Honor, is there may or may not be erosion of a particular form. There may be a final flow rate, but that doesn't invalidate my analysis. There are possible flow rate schedules that I've put through my analysis that give me the same cumulative oil release that are entirely consistent with that.

Q. The Court will be glad to know I am not going to use any backup slides.

So just to summarize, Dr. Blunt, your opinion is that the best analysis would reflect that 3.26 million stock-tank barrels of oil flowed from the Macondo well; that higher cumulative flow rates, that is outside your bounds, such as higher rock compressibility would not honor the data that we have in this case; and that data from sources before and after the incident avoid the difficulties and complexities of calculating daily flow rates and give the best estimate, from your perspective, of the total flow from the Macondo well?

A. Yes. I agree with that.

MR. BROCK: Thank you, Dr. Blunt.

THE COURT: All right. Mr. Cernich.

We will go for about 30, 35 minutes and then we will recess for lunch.

MR. CERNICH: Thank you, your Honor.

THE COURT: Go ahead.

MR. CERNICH: May it please the Court, Scott Cernich for the United States, your Honor.

CROSS-EXAMINATION

BY MR. CERNICH:

Q. Good afternoon, Dr. Blunt. I have you on cross-examination.

Isn't it true that BP has named you its principal testifying expert in this case?

A. It's the title you mentioned to me at my deposition, so I am aware of it, yes.

Q. And you weren't aware of that before I mentioned it to you at your deposition?

A. Actually, I wasn't.

Q. What does it mean to be BP's principal testifying expert?

A. Honestly, I don't know. If you take the word principal literally, I suppose I come first.

Q. And your best estimate is 3.26 million barrels were released from the Macondo reservoir?

A. Yes, it is.

Q. And in your report, you say that yours and Professor Gringarten's determinations of cumulative flow are independent and

involve distinct approaches, don't you?
A. I think that's what I said in my report.
Q. But that's not quite accurate, is it?
A. I think I also state that we have some methodology in common. We both perform a well test analysis, for instance.
Q. Could we go to D-21165. In fact, you rely explicitly on Professor Gringarten's permeability calculations for your analysis; isn't that right?
A. That is correct, but I've also advanced my own opinions on the permeability of Macondo.
Q. Right, a permeability based on an assumed flow rate?
A. Yes, to do the capping stack calculation, I did need to have to have a flow rate. But I've also discussed other numbers for permeability based on other sources of data that do not require a flow rate.
Q. But the 300 millidarcies that you testified to on direct with Mr. Brock was based on an assumed flow rate of 45,000 barrels per day?
A. That is correct.
Q. And Professor Gringarten also calculated the total amount of oil released from the Macondo reservoir, didn't he?
A. Yes.
Q. And --
THE COURT: Excuse me, Mr. Cernich, let me ask Dr. Blunt. Where did you get the 45,000 barrels per day, where did that come

from?

THE WITNESS: At the time I wrote my expert report, I didn't know what the final day flow rate was, but I did have the expert report of Dr. Pooladi-Darvish. So what I did is I took the final day flow rate from his base case, but there's a technical issue, your Honor. To calculate permeability, it's not a flow rate in stock-tank barrels that I need but a reservoir condition flow rate because it's flowed from the reservoir.

So what I did was I took Dr. Pooladi-Darvish's base case, I converted it to reservoir conditions using his conversion, and then I converted it back using my conversion.

Now, I didn't get exactly 45,000 barrels a day, I think it was something like 46,000, I don't know the exact number. I didn't know whether or not that was right, so I used a round number as my assumption. So broadly speaking, I would consider it consistent with the final day flow rate determination from Dr. Pooladi-Darvish.

MR. CERNICH: Your Honor, I am going to move to strike that testimony. I asked Dr. Blunt during his deposition where he got his flow rate. He did not tell me that he got it from Dr. Pooladi-Darvish's work.

THE COURT: I prompted, I asked the question, so you can't blame him for giving the answer.

MR. CERNICH: I understand.

THE COURT: But if he said something different in his deposition, you can certainly bring that out.

MR. CERNICH: I will.

BY MR. CERNICH:

Q. Professor Blunt, I asked you in your deposition where you got the 45,000-barrel-per-day flow rate, didn't I?

A. Yes, you did, and I said it was a round number, which indeed it was. It's not directly from Dr. Pooladi-Darvish.

Q. And you didn't mention Dr. Pooladi-Darvish when I asked you where you got that flow rate?

A. I don't recall mentioning Dr. Pooladi-Darvish. That was the motivation why I chose, say, 45,000 rather than 30,000 or 60,000, your Honor. But it was a round number. I am not suggesting that I did it exactly strictly from the calculation of Dr. Pooladi-Darvish, but as a, as one would say, a back-of-the-envelope calculation, it seemed broadly consistent with the expert -- with the expert reports that I had seen at the time.

Q. And that conversion is based on you using single-stage FVF rather than a multi-stage FVF, correct?

A. Yes.

Q. Now, Dr. Gringarten started with an assumed flow rate schedule, didn't he?

A. I think he did, yes. I don't recall every detail of his expert report.

Q. Do you recall agreeing with me at your deposition that he started with an assumed flow rate schedule?

A. Again, that's perfectly reasonable, yes.
Q. Can we go to D-22100. Professor Blunt, this is a flow rate schedule that Dr. Gringarten assumed in preparing his analysis; isn't that right? This is from his report?
A. I will assume it is. I can't recall it directly, but I have no reason to disagree with you.
Q. You read Dr. Gringarten's report, didn't you?
A. I have, yes.
Q. And this flow rate schedule here assumes 30,000 stock-tank barrels per day for April 20th to May 31st and 45,000 stock-tank barrels per day from June 1st until shut-in; isn't that right?
A. That's what I can see, yes.
Q. And the integral for that assumed flow rate schedule is 3.26 million barrels, isn't it?
A. I don't think that's quite right. I think if you do the calculation properly, it's not 41, it's 42 days.
Q. So it's just a little more than 3.26 million barrels, isn't it?
A. I think doing the math, it's 3.29, yes.
Q. Do you know the basis for this step rate change in flow rate from 30,000 to 45,000 barrels on Day 41?
A. I don't actually, no.
Q. You were retained by BP in this matter in September 2011, a year after the Macondo well was cemented in, correct?
A. Yes.
Q. And isn't it true that Imperial College conducts research for

BP in the areas of reservoir characterization?
A. Yes, sir.
Q. And seismic --
A. Yes, and seismic. I definitely know in seismic, yes.
Q. And so you said you assumed so on reservoir characterization?
A. As I sit here today I'm afraid, Mr. Cernich, I can't remember a specific project involving reservoir characterization, but I certainly can recall a specific project on seismic.
Q. Professor Blunt, weren't you chair of the Imperial College earth science and engineering department from 2006 to 2011?
A. I was, yes.
Q. And your specialty is reservoir engineering, isn't it?
A. Yes.
Q. Now, BP also -- I'm sorry. Imperial College also conducts research for BP in process modeling and climate change?
A. Again, I am aware of research in climate change, not specifically on process modeling.
Q. And BP tauted that relationship in a press release last year about donating $100 million to UK universities, including Imperial College, didn't they?
A. I think I understand the context of what you're saying, but again, I don't recall the details. I am not involved in that project.
Q. Can we go to TREX 130539, and this is a BP press release entitled "BP Pledges 100 Million to UK-led Universities to Create

Industry Changing Materials." Did I read that correctly?
A. Yes.
Q. And Imperial College is one of those UK universities?
A. I think it is, but as I said, I'm afraid I am not involved in this project.
Q. Can we go to TREX 130539.0002. And here it says, "Imperial College London, conducts a wide range of research for BP including in the areas of reservoir characterization, process modeling, climate change, seismic imaging and urban energy systems." Did I read that correctly?
A. Yes.
Q. And isn't it true that three of BP's other experts in this case are also professors at Imperial College, Professor Gringarten, Professor Zimmerman and Professor Trusler?
A. That's correct.
Q. And you explicitly rely on your colleagues from Imperial College for the key inputs into your analysis; isn't that right?
A. I do use some of their expert analysis in my determination.
Q. Can we go to D-21162. You already testified that you directly input Professor Gringarten's permeability into your analysis; is that right?
A. That is correct. But I also have my own opinion on permeability.
Q. But the one that you used to do your cumulative flow rate calculation is Professor Gringarten's P90 permeability from his MDT

analysis; isn't that right?
A. That's correct. I think we need -- these P90, P10s can get a bit confusing. It's his upper bound permeability.
Q. I'm sorry, his P10. I did have that reversed. His P10 number. You used that specific number, 329 millidarcies, put it into your calculation and you come up with your cumulative flow rate?
A. That's correct. And as I've described, there are other possible numbers I could have done, and I erred on the side of having the highest permeability that was consistent with the data.
Q. And you used pressure data that was developed by Professor Trusler, correct?
A. Yes.
Q. And you needed that pressure data to do your analysis?
A. Well, I needed pressure data before Professor Trusler's data was available. There was other data actually that I had analyzed before I wrote the final version of my report. But you're right, the data I used was that interpreted by Professor Trusler.
Q. And you used Professor Zimmerman's rock compressibility numbers; is that right?
A. Again, that's correct. I have my own opinion on rock compressibility, but as I've said already, I defer to his superior expertise in that area.
Q. But just to be clear on the record, you have your own opinions, but what you use in your quantitative, cumulative flow rate calculation is Professor Zimmerman's number?

A. Yes, that's right.
Q. Now, you were first contacted on BP's behalf by your Imperial College colleague professor Geoff Hewitt; isn't that right?
A. Yes.
Q. Isn't it true, Professor Blunt, that BP hired Professor Hewitt in July of 2010 to provide an independent assessment of flow rate at the time of Macondo well integrity test?
A. Mr. Cernich, you did mention that at my deposition. Actually, I am not aware of that, or I wasn't aware of that.
Q. Can we go to Exhibit 11224. If we could call out the top of the e-mail, please. And this is an e-mail from Cheryl Grounds of BP to a number of individuals, including Trevor Hill, from whom we heard in court yesterday, subject "Independent analysis of flow rate range," did I read that correctly?
MR. BROCK: I am going to object on foundation. Unless there's some foundation shown for this witness's knowledge of this, I don't think this is appropriate.
MR. CERNICH: Your Honor, I think I can explore the retention of Professor Blunt.
THE COURT: Is this in evidence already?
MR. BROCK: It's not in evidence that I know of, and it's certainly not something on his reliance list.
MR. CERNICH: It's in Trevor Hill's bundle, it's been authenticated and has foundation on Trevor Hill --
THE COURT: It's an exhibit in Trevor Hill's deposition

bundle?

MR. CERNICH: Yes, your Honor.

THE COURT: And he -- well, he was a recipient of it, so he authenticated it?

MR. CERNICH: Yes, your Honor.

THE COURT: Overrule the objection.

BY MR. CERNICH:

Q. And there's an attachment here that says "Estimating Flow Rate Range V1.doc." Did I read that correctly?

A. Yes.

Q. Can we go to the attachment, please, Dawn.

And here the title of this attachment is "Estimating Flow Rate Range based on Well Integrity Test Data." Is that right?

A. Yes.

Q. And then number three says, "Contact 2 universities to offer independent assessment of estimated flow rate range," and the second university there is your university, Imperial College of London, isn't it?

A. That's correct.

Q. And there's G. Hewitt, that's Professor Geoff Hewitt?

A. Yes.

Q. And he is an expert in multiphase flow?

A. He is an expert in multiphase flow in pipes, yes.

Q. Did Professor Hewitt share with you his independent assessment of the estimated flow rate range?

A. No.
Q. I would like to talk about your specific expertise. You're not a geologist?
A. No, I wouldn't describe myself as a geologist, although the work that I've done for my analysis constructing geological models and using it one's engineering calculations is part of my expertise.
Q. It's a simple question, though, Professor Blunt, you are not a geologist?
A. No, I am not a geologist.
Q. And you didn't draw on the work of an expert geologist to perform your analysis of the Macondo reservoir, did you?
A. Well, I did to the extent that I read the BP reports and also read the relevant scientific literature on the possible structure of the deepwater turbidite.
Q. So you relied on BP's in-house experts' analysis of the Macondo reservoir to do your work?
A. Not exclusively. As I said, I also read the open literature to get an understanding of the likely arrangements of sandstone channels in Macondo.
Q. And there was nothing about specifically the Macondo reservoir in that literature that you read?
A. There was nothing about Macondo, but they were talking about geologically similar reservoirs of which there are quite a number in the Gulf of Mexico.

Q. You're not a petrophysicist, are you?

A. Again, I wouldn't describe myself as a petrophysicist, but I do have expertise in some areas of petrophysics; and petrophysics is simply the physics of rock, understanding core samples, making measurements, analyzing those, making predictions.

Q. And you're not an expert in rock mechanics, are you?

A. Again, I wouldn't describe myself as a rock mechanics expert like Professor Zimmerman, but as has already been discussed, I do have expertise in taking rock mechanics data, analyzing that data and using it in reservoir engineering calculations, just as I've done in my expert report.

Q. So, Professor Blunt, the answer is no, you're not a rock mechanics expert?

A. I wouldn't put it as strongly as that. I do have the expertise for the calculations I performed in my expert report and the expertise, for instance, that Kuwait Oil Company to look at their data.

Q. You were deposed in July in this case, weren't you?

A. Yes.

Q. And do you recall me asking you, "Are you an expert in rock mechanics?" And your answer was, "No, but I do have sufficient expertise for the analysis that I presented in my report." Was that your answer?

MR. BROCK: Your Honor, that's not impeachment, that's what he just said. I object to that.

MR. CERNICH: Your Honor, all I was asking for was a no instead of a yes or no --

THE COURT: He just didn't insert the word "no."

THE WITNESS: I will go with the answer I gave in the deposition.

MR. CERNICH: Thank you.

BY MR. CERNICH:

Q. You've never taught a course in rock mechanics?

A. No.

Q. You've never published a paper in rock mechanics?

A. No, I don't recall.

Q. And you defer to Professor Zimmerman as a rock mechanics expert?

A. Yes, there is no doubt whatsoever that he has superior expertise in this area to me.

Q. He is the real deal, in your mind?

A. That would imply that I don't have sufficient expertise for my calculations, and that wouldn't be correct. He is certainly the real deal when it comes to rock mechanics, though.

Q. You're not an expert in multiphase flow and pipes and production systems, are you?

A. No.

Q. And you're not an expert in computational fluid dynamics in pipes?

A. No.

Q. I think you already testified on direct you are not an expert in erosion?
A. No, I am not offering any opinions on the rate of erosion, except to say from my analysis, it's likely that it occurred.
Q. So you're offering an opinion based on your analysis on erosion even though you are not an expert in erosion?
A. Let me clarify. In Appendix E of my report, I evaluate what's called the skin factor at the beginning of the accident based on the Emilsen report. So I have an analysis that says that there was a significant skin at the beginning of the blowout period, and then I do an analysis of the injectivity test just before cementing that shows that those impediments to flow are not there. So I know there are impediments to flow to begin with and I know they're not there at the end. But I am not offering an opinion about what caused those necessarily or the rate at which they eroded.
Q. You referred to Mr. Emilsen. We'll come back to that later on. You're not an expert in cement?
A. No.
Q. And you have no opinions about the failure mode of the Macondo cement or whether it was set or not?
A. No, I don't.
Q. Now, isn't it true that 90 percent of your reservoir engineering analyses have been student research projects?
A. Yes, I would say that is correct. The vast majority of, one might say, the practical field-specific reservoir engineering

studies have been work in collaboration with students.
Q. And only 10 percent of your work has been actual consultancy?
A. Generally speaking, I would say that's a fair --
Q. And that's what you told me at your deposition?
A. Yes.
Q. Now, your specialty -- your specialty is actually pore scale modeling of reservoirs, isn't it?
A. It's one of my specialties, yes.
Q. And you published a variety of peer-reviewed papers and journal articles on that type of reservoir modeling?
A. Yes.
Q. And that involves using microscope images to examine pieces of reservoir rock, and you can create models of how fluid flows through those rocks?
A. Yes.
Q. Is that a fair way to put it?
A. That's a fair characterization.
Q. According to you, one of the great things about pore scale modelling is that you can create a model as long as you have just one little piece of rock?
A. Yes. Yes, you don't need -- even need a piece of rock this big (INDICATING).
Q. Actually, those three little Macondo rotary sidewall cores about the size of my thumb would have been sufficient for you to do pore scale modeling of the Macondo reservoir, right?

A. Yes, hypothetically, but I didn't need to, I would say, for this analysis because we had directly measured data.
Q. And using those pore scale images of those cores from the Macondo would have given you additional data?
A. There's no doubt that had X-ray images of sufficient resolutions, say, for instance, to see the pore structure of the rock would be additional data. But it wasn't necessary for my analysis. I didn't need to do modeling when I had direct data available.
Q. But it was available direct data that you ignored?
A. The data doesn't exist. I did look at the images of the Macondo cores that were available and I studied those carefully.
Q. But I am saying the Macondo cores were at Weatherford and you could have gotten pore scale images and that would have been additional data to add to your analysis, additional data in your specialty area, and you didn't pursue that, did you?
A. No, I didn't. I didn't need to for my analysis. We had directly measured data that was reliable. If I had done this, hypothetically, all you do is you would have a model, you compare it with the data. If it was the same as the data, you would say the model is good, but then you're using the same numbers as the measurements. And if the model disagreed with the measurements, you wouldn't know what to do and you would end up using the measurements.
So I didn't -- because it is my area of expertise, I can

critique where it is appropriate to be used and inappropriate, and I would say for Macondo that that would not be an appropriate use of pore scale modeling.
Q. You could have calculated permeability from those pore scale models, correct?
A. Yes, indeed that's one of the basic things to do, you take an image of the rock, your Honor, and do a computation fluid dynamics simulation and you get a number. You can do this calculation on a piece of rock that's this size (DEMONSTRATING). Compared to the determinations of permeability on rotary sidewall cores that are bigger and, of course, the pressure analysis determinations of permeability are much, much more robust and reliable.
So you're right, I could have done it, but I don't consider that it would have added any valuable information to my analysis.
Q. But you assumed a flow rate to do your calculation of permeability?
A. For the determination of permeability from the capping stack pressure, as I've already said, and there's no doubt about that, you need a flow rate. And I didn't independently determine final day flow rate, as I've just described. I took a round number, broadly speaking, based on Dr. Pooladi-Darvish's expert report.
Q. You used a unique method and unique equations to do your analysis here, a method and equations that can't be found in the published literature; isn't that right?

A. That's -- yes, that's right in some respects and not right in others. There are some of the analysis that's in my appendices that isn't in the literature, but all along I've applied absolutely standard best practice in reservoir engineering. There's nothing wrong to say unique in methodology.
Q. We will come back to the details of that a little later on. But this -- these methods and equations you used, you made those up for this litigation not to help BP respond to the blowout?
A. The analysis I performed has been after the blowout, yes.
Q. It's for this litigation?
A. The analysis I've done has been for this litigation, you're right. But I want to say I've applied standard methodologies. And I think as I've already said, certainly in my deposition, I derived all of the equations by hand, many of them are standard equations that are in the literature, I derived them all by hand so I understood every detail of the analysis. I wanted to be thorough as possible and I wanted to be able to describe everything as thoroughly as possible, not to rely on, say, black box methodologies.
Q. We will get back to the details of those equations that you derived by hand a little later on. Your method's never been subjected to peer review, correct?
A. Well, I am looking at my report and it says highly confidential on it, so the report itself has not been subjected to peer review. But I will say a couple of things: First of all, all of the

methodologies that I am using are reservoir engineering best practice, and the report itself has been on the web site for five months, and I have received feedback, all of it positive. I've not received any criticisms, say, of a technical nature outside of the testimony that we've heard on the work that I've done.
Q. Actually, I'm glad you raised that point, Professor Blunt. The government flow rate estimate and a variety of other independent flow rate estimates have been out in the literature for three years now, correct?
A. Yes.
Q. You've reviewed some of those?
A. Yes.
Q. And you haven't seen any of those articles in the peer-reviewed literature that contradict the government's flow rate estimate, have you?
A. That's correct. Doesn't mean to say they're right, though.
Q. We'll get -- I'm sorry. You're aware that Dr. Griffiths' work has been published in a peer-reviewed journal, aren't you?
A. Yes, I am. I think I've read that paper.
Q. And the method you used here for your expert work in this case is a method you have never used in your career to analyze a reservoir?
A. I don't think that's a fair characterization. As I've said, I'm using industry standard reservoir engineering techniques, basic scientific principles in all aspects of the analysis. Macondo is a

unique situation and there are some unique features to the analysis that are Macondo specific. But to describe the analysis as unique I don't think is a fair characterization.
Q. Well, you told me, Professor Blunt, during your deposition that you never in your career used this method to analyze a reservoir.
A. I've used material balance dozens of times to analyze reservoirs.
Q. Right. But your material balance is built on a variety of the building blocks --
MR. CERNICH: Okay, your Honor?
THE COURT: I didn't say anything. Well, I was going to make a suggestion, just as a matter of the way to impeach a witness with a deposition, you really should put it on the screen and ask him if that's what he said rather than just -- because, you know...
MR. CERNICH: I will.
THE COURT: In fairness to the witness, let him see his testimony.
MR. CERNICH: I will, your Honor, and I will get back to some of the details later and I'll move on. Thank you.
THE COURT: All right.
BY MR. CERNICH:
Q. Now, your material balance equation looks simple, Professor Blunt, but it took a lot of work to populate those variables in your equation?
A. Yes. Attention to detail is extremely important in this

calculation.
Q. Can we go to D-21163. And so, Professor Blunt, you relied on these five experts to do your analysis: Professor Gringarten, Professor Whitson, Professor Trusler, Professor Zimmerman and a seismic expert that was withdrawn by BP?
A. Well, in my quantitative calculations presented in my report, I haven't taken any information from this crossed-out seismic expert, so obviously I'll admit that I've taken information from the four other experts, but for the fifth expert, it had no impact on my calculations.
MR. BROCK: Your Honor, we have an objection to this slide, too, so I will state it for the record. I think it's -- I know this is a nonjury case and I get that, but it's just a bit argumentative to say we've withdrawn a seismic expert when we're operating in a world where the Court working with us has determined the number of experts that will be used in the trial. So I just don't think that's appropriate.
THE COURT: All right. Well, I understand and, again, since it is a bench trial, I certainly can understand and appreciate that. We don't have to worry about influencing or improperly influencing a jury.
MR. BROCK: Right, it's just the instinct to object, I think.
MR. CERNICH: Your Honor, I need to be heard on that point. BP withdrew this seismic expert before the Court imposed a

limit on experts in this case. They withdrew this expert two days before -- or if I'm wrong, about two days, it was somewhere within two or three days before Professor Blunt's deposition. So it's not quite right to say that he was removed because of the court's limit on experts in this case.

THE COURT: Okay. All right. Thank you.

BY MR. CERNICH:

Q. Now, to do your analysis you had to derive your own custom linear flow model; is that right?

A. Part of my analysis has a linear flow model, and for the reasons I've described, I wanted to understand every single detail, not rely on black box software that I didn't understand fully. I derived by hand the equations that I use, and that's in Appendix C of my report.

But the principles, your Honor, are fundamental principles: Darcy's Law which we talked about, conservation of mass. Linear flow is a recognized flow phenomenon in well test analysis. There is nothing fundamentally unusual about what I've done, except that I've gone and done it thoroughly and gone back to scratch, gone back to basics.

Q. But just to be clear, you derived your own custom linear flow model for your expert opinions in this case?

A. I derived the linear flow model. The use of the word "custom" sort of assumes that there's something particularly unusual about it. There isn't. I am using really standard equations and basic scientific principles, and even the methodology for solving the equations is standard in my well test analysis.

Q. Let me try it this way, Professor Blunt. You never used this linear reservoir model before?

A. That's correct. I have performed well test analysis in the past normally using commercial software. And in that commercial software you can see a channel or linear flow regime, so I certainly want to identify that regime from a well test analysis. But as I said, just for the reasons I described, I went back to basics, making sure that I understood every nuance and re-derived all of the equations. Those are in Appendix C of my report.

Q. I heard you during your direct testimony use the term "real oilfield operations;" is that right?

A. Yes.

Q. This model has never been used in real oilfield operations?

A. The analysis of channel flow for a reservoir is completely standard. Indeed, in my expert report I show field case showing channel flow.

Q. I'm talking about your model. We established that you developed your own linear flow model, right, Professor Blunt, that's your testimony?

A. Yes. If you put it like that, the specific flow model in Appendix C has not been published, it has not been applied to real situations, because as you quite rightly pointed out, I derived it and presented it for the purposes of this expert report.

Q. And the bottom hole pressure analysis that you used, your wellbore cooling analysis to determine the pressures that you used in your pressure analysis that determined both your reservoir -- connected reservoir volume and your final average pressure, you had never conducted that analysis before, had you? That Appendix B in your report is new work by you for this litigation?

A. Yes, it is, but it's using fundamental scientific principles. I mean, it's conservation of energy, hot things are cooling down.

And the basic principle, your Honor, which is that if you've only got measurements of the wellhead, you need to convert to the reservoir. And indeed, that there's a problem with that because of cooling is well recognized in the literature. I cite classically in the literature and I am applying standard methodologies.

Q. But there are industry tools that can do this type of analysis?

A. Yes, indeed, there are, your Honor. There are a number of commercial packages that, in principle, would enable you to do that calculation. And there are a couple of important reasons why I decided not to use them.

Q. And those have been peer-reviewed and used in the industry for years?

A. Not necessarily. Commercial software doesn't necessarily have to be peer-reviewed. I have seen some peer-reviewed papers that have analyzed similar problems; but actually, I would have to say not specifically the problem we're looking at here. But neither of

those were the main reasons I decided to do my own analysis.
Q. To determine your connected reservoir volume, Professor Blunt, you used -- you derived novel connectivity equations that you've never ever used in your career before?
A. That's correct. Some of the equations in Appendix D have been applied specifically to Macondo. But the principles, which is use pressure data to determine connectivity in the light of the seismic geological evidence, is not only is it standard in reservoir engineering, I consider it more as the essence of reservoir engineering.
So again, it's standard principles applied to a specific situation for Macondo.
THE COURT: All right. Let's recess for lunch. It's about five minutes till. We're going to come back at, take a little bit longer than normal, we'll say 1:20, okay.
THE DEPUTY CLERK: All rise.
(WHEREUPON, A LUNCH RECESS WAS TAKEN.)

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REPORTER'S CERTIFICATE

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

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

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