

BEFORE THE PUBLIC UTILITIES COMMISSION  
OF THE  
STATE OF CALIFORNIA

ADMINISTRATIVE LAW JUDGES JESSICA T. HECHT and MARCELO  
POIRIER, co-presiding

Order Instituting Investigation on ) EVIDENTIARY  
the Commission's Own Motion into the ) HEARING  
Operations and Practices of Southern )  
California Gas Company with Respect )  
to the Aliso Canyon storage facility )  
and the release of natural gas, and )  
Order to Show Cause Why Southern )  
California Gas Company Should Not Be )  
Sanctioned for Allowing the ) Investigation  
Uncontrolled Release of Natural Gas ) 19-06-016  
from its Aliso Canyon Storage )  
Facility. (U904G) )

REPORTERS' TRANSCRIPT  
Virtual Proceeding  
March 22, 2021  
Pages 611 - 803  
Volume 5

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VIRTUAL PROCEEDING

MARCH 22, 2021 - 10:01 A.M.

\* \* \* \* \*

ADMINISTRATIVE LAW JUDGE HECHT: We'll be on the record.

The Commission will please come to order. This is day five of the evidentiary hearings in the Order Instituting Investigation on the Commission's Own Motion into the Operations and Practices of Southern California Gas Company with Respect to the Aliso Canyon storage facility and the release of natural gas, and the Order to Show Cause Why Southern California Gas Should Not Be Sanctioned for Allowing the Uncontrolled Release of Natural Gas from its Aliso Canyon Storage Facility.

I am Administrative Law Judge Jessica Hecht. I will be presiding today along with my co-assigned judge, Judge Marcelo Poirier. We are both here this morning, and one of us will be the lead at each time. This morning, I will be the lead.

With that, I'm going to reiterate some of the ground rules we went through last week for the benefit of our new participants, and then we can get, I think, pretty well into things quickly.

1           The basic ground rules are that  
2 counsel and parties agree to adhere to the  
3 rules and maintain professional decorum.  
4 Please speak slowly and clearly. Identify  
5 yourselves each time you begin to speak. If  
6 there is one primary attorney questioning a  
7 witness, it is not necessary for the  
8 questioning attorney or the witness to  
9 restate their name every time. Please do not  
10 interrupt or speak over one another. Please  
11 speak only when addressed and called on by  
12 the ALJs, unless you're making an objection  
13 to a question during the course of  
14 examination of a witness. In such instances,  
15 after the completion of a question, the  
16 attorney may orally interject, provide  
17 his/her name, and briefly state the  
18 objection. And when there are inaudible  
19 statements, the reporter may interrupt the  
20 speakers, when it is possible to do so  
21 without disrupting the proceeding, or the  
22 reporter may insert the word "inaudible" in  
23 the transcript when there is dropped, garbled  
24 or otherwise indecipherable audio.  
25 Therefore, to ensure a -- a complete and  
26 accurate record of these proceedings, please  
27 adhere to these ground rules.  
28           There are a few other guidelines.

1 Because we're doing this hearing remotely due  
2 to the COVID pandemic, because we are using  
3 telephone-only for audio and we are using  
4 Webex, but only for video, everybody's Webex  
5 will be on mute. We ask that the persons who  
6 are classified as speakers for today on  
7 telephone keep your phone on mute until or  
8 unless you have something to say and you're  
9 called on. So everybody please mute your  
10 phone when you're not speaking. The ALJs  
11 will call upon each person directly, and the  
12 speaking party must have both audio and video  
13 activated. You need to be visible when  
14 testifying, asking questions and so forth.  
15 If you experience video problems, we need to  
16 know about them. So please let us know.  
17 Only the ALJs and the parties that are  
18 expected to speak during a particular portion  
19 of hearing should be visible on Webex at a  
20 given time. This helps the ALJs and our  
21 court reporters keep track of who is speaking  
22 and narrows down the names so we can match  
23 names with faces. During each session, we  
24 ask that each participating party designates  
25 a single lead for that session, and other  
26 participants, even those who may speak later,  
27 should turn their cameras off, please, until  
28 you're directly participating. We didn't

1 have problems with any of these things last  
2 week, and I don't anticipate that we will  
3 have them today.

4 Now, there are two last things to  
5 do, and those also relate to this being a  
6 remote hearing. We discussed last week and  
7 at our earlier status conference the need to  
8 do this remotely. All participants must  
9 agree to remote appearances and the remote  
10 swearing in of witnesses. In addition for  
11 regular swearing in of a witness, we will  
12 require both the attorneys and the witnesses  
13 to agree to a number of attestations that we  
14 will go over now.

15 So first, we will do the  
16 attestations for the attorney, Ms. Frazier,  
17 and then we'll continue with the witness.

18 Ms. Frazier, are you ready?

19 MS. FRAZIER: I am.

20 ALJ HECHT: Great. I -- our IT people,  
21 I believe, have a copy of this posted, so you  
22 may refer to it in one of the grid boxes on  
23 your Webex. And I will read it out loud, in  
24 any case.

25 Do you attest that you agree to the  
26 evidentiary hearing in this proceeding being  
27 held via Webex, do you agree that you attest  
28 to the witness testimony and exhibits being

1 presented via Webex, do you agree and attest  
2 that -- to the oaths and remote witnesses are  
3 going to be received via Webex, and their  
4 testimony via Webex, do you attest that you  
5 agree to adhere to all formal rules of  
6 decorum, including the prohibition against  
7 coaching witnesses, do you attest and you  
8 agree that you will not make any recording of  
9 the proceeding, do you attest that you agree  
10 that you understand that any recording of a  
11 proceeding held by Webex or teleconference,  
12 including screenshots or other visual copying  
13 of the hearing, is absolutely prohibited, do  
14 you attest that you understand that a  
15 violation of these prohibitions may result in  
16 sanctions, restricted entry to future  
17 hearings, denial of entry to future hearings,  
18 or any other sanctions deemed necessary by  
19 the Commission, do you attest that during the  
20 evidentiary hearings you'll use only the  
21 exhibits premarked and identified by the  
22 parties, and do you attest that you agree  
23 during the evidentiary hearing you will not  
24 use documents not previously shared with the  
25 opposing attorneys? Do you agree to --

26 MS. FRAZIER: I do. I do.

27 ALJ HECHT: Thank you very much,  
28 Ms. Frazier.

1 All right. As I think we discussed  
2 last week, we are starting a new witness  
3 today, and that witness is Mr. Ravi  
4 Krishnamurthy. He is the witness of Blade,  
5 which is an independent organization, not  
6 technically a party in this proceeding.

7 As I said, in addition to the  
8 regular swearing in, we're going to go  
9 through a very, very similar set of  
10 attestations for the witness.

11 So first, I would like the witness  
12 to please state and spell his name and  
13 provide his business address for the record.

14 MR. KRISHNAMURTHY: My name is Ravi  
15 Krishnamurthy. The business address for  
16 Blade Energy Partners in Houston is 16285  
17 Park Ten Place, Suite 500, Houston, Texas,  
18 77084. Actually, it's Suite 600.

19 ALJ HECHT: Thank you. Could you also  
20 please spell your name, at least your last  
21 name, for the record?

22 MR. KRISHNAMURTHY: Sure. My first  
23 name is R-a-v-i. My last name is  
24 K-r-i-s-h-n-a-m-u-r-t-h-y.

25 ALJ HECHT: Thank you very much. Do  
26 you solely affirm this testimony you are  
27 about to give will be the truth, the whole  
28 truth, and nothing but the truth?

1 THE WITNESS: I affirm, yes.

2 RAVI KRISHNAMURTHY, having been  
3 affirmed, testified as follows:

4 ALJ HECHT: Great. And then we have a  
5 few follow-up attestations that you've heard  
6 versions of before.

7 Do you agree to tell the truth based  
8 on your personal knowledge?

9 THE WITNESS: Yes. Yes, I do.

10 ALJ HECHT: And -- thank you. And I'll  
11 go through the rest.

12 Do you attest that you will testify  
13 based on your knowledge and memory, and free  
14 from external influences and pressures, that  
15 you will adhere to all formal requirements of  
16 testifying under oath, including the  
17 prohibition against being coached, do you  
18 attest that you will refer to the -- only to  
19 materials previously shared with all parties,  
20 including exhibits premarked and identified  
21 by the parties, do you attest that you will  
22 not make any recording of the proceeding, and  
23 do you understand that any recording of the  
24 proceeding held via Webex or teleconference,  
25 including screenshots or other visual copying  
26 of the hearing, is prohibited, and finally,  
27 do you attest that you know that a violation  
28 of these prohibitions may result in

1 sanctions, including remote -- removal from  
2 the evidentiary hearing, restricted entry to  
3 future hearings, denial of entry to future  
4 hearings, or any other sanctions deemed  
5 necessary by the Commission? Do you  
6 attest --

7 THE WITNESS: I do. I do.

8 ALJ HECHT: Thank you.

9 THE WITNESS: I do attest.

10 ALJ HECHT: Thank you very much.

11 Before we continue, do we have any  
12 housekeeping that we need to do?

13 MR. GRUEN: Your Honor, this is not  
14 necessarily urgent, but we did -- SED did  
15 re-serve Exhibits SED-204, SED-C-204 and  
16 SED-216 on Friday at the end of the day.  
17 Would you like to go through the exercise  
18 marking those now, or would you like to -- to  
19 look -- address that later?

20 ALJ HECHT: Let's address that later.  
21 But, thank you for the reminder, and I'll put  
22 it on my list for later in the day.

23 MR. GRUEN: Okay. Thank you, your  
24 Honor.

25 ALJ HECHT: Thank you. Aside from  
26 that, I will note that the Blade report is an  
27 important document in this case. It was  
28 attached to the Order Instituting

1 Investigation for this proceeding when the  
2 investigation was opened. It has not been  
3 marked as an exhibit, and we can discuss  
4 later if we want to mark it as an exhibit so  
5 that it is part of the evidentiary record and  
6 easier to refer to. If anybody has a strong  
7 feeling about that, you can speak in a  
8 moment.

9 I am suggesting it is a possibility  
10 that we mark it as something like Commission  
11 Exhibit-1000, or something like that, just so  
12 that we have a number similar to the other  
13 exhibits that we're doing. Any thoughts?

14 MR. LOTTERMAN: Your Honor, this is Tom  
15 Lotterman. I will be examining  
16 Dr. Krishnamurthy today, and my view is as  
17 long as we perhaps at the beginning of  
18 examination understand that when we say,  
19 "main report," we are talking about the root  
20 cause analysis report, that's fine. I will  
21 note that there may be a possibility that I  
22 will refer to other volumes of his report,  
23 and I just didn't want that to get messy, as  
24 far as exhibit numbers and all. So I defer  
25 to you, but there may be some value, at some  
26 point, giving these reports specific numbers  
27 so that the record will be clear.

28 ALJ HECHT: Thank you very much. I'm

1 inclined to agree with that. The main Blade  
2 report has four volumes, I believe, of  
3 attached reports, which are more specific.  
4 They are Volumes 1 through 4, I believe. And  
5 my suggestion would be that we mark the main  
6 report Commission Exhibit-1000, and we mark  
7 the volumes 1001, 1002, 1003, 1004. I,  
8 however, do not have the specific titles of  
9 the volumes in front of me, so we can either  
10 do that now, if one of you can supply the  
11 volume names, and we can identify them, or we  
12 can defer on that until they come up, and do  
13 it at that time.

14 Does anybody have a preference?

15 MR. LOTTERMAN: Glad to do it, your  
16 Honor, all -- although, I'll defer to  
17 Mr. Gruen.

18 MR. GRUEN: Yes, your Honor. I -- I --  
19 I think this all makes sense. It will take  
20 me just a moment to -- well, I can provide  
21 the -- the name of the Blade report right  
22 away. I have that at my disposal. The  
23 others may take a moment.

24 ALJ HECHT: Let's start with that.

25 MR. GRUEN: Okay. And your Honor,  
26 if -- if I was tracking, you want that  
27 exhibit to be marked as Commission  
28 Exhibit-1000, the -- the main report, as

1 Mr. Lotterman referred to?

2 ALJ HECHT: Yes. Correct. I think  
3 what I'm going to do --

4 MR. GRUEN: Okay.

5 ALJ HECHT: -- is I'm going to go off  
6 the record for a minute, let us get  
7 everything together, and then we can state  
8 them all into the record.

9 We'll be off the record.

10 (Off the record.) ]

11 ALJ HECHT: We'll be back on the  
12 record. All right.

13 While we were off the record, we  
14 were finding the titles and subtitles to the  
15 various volumes of the Blade Report. I'm  
16 going to go through our way of referring to  
17 them as we move forward, because it sounds  
18 like the cross-examination may involve some  
19 of the supporting volumes, in addition to the  
20 main report.

21 The main report, the Blade Report, I  
22 think we already identified. It was the  
23 Blade Root Cause Analysis issued in May of  
24 2019.

25 The supplemental reports are:

26 Volume 1, Approach;

27 Volume 2, SS-25 Well Failure

28 Causes;

1                   Volume 3, Post-22 through -25 leak  
2 events;

3                   And Volume 4, Aliso Canyon Casing  
4 Integrity.

5                   Does anybody have anything  
6 different from that?

7                   (No response.)

8                   ALJ HECHT: I'll take that as a no.

9                   We're going to mark the Blade Report  
10 as Commission Exhibit 1000, Volume 1,  
11 Approach as 1001;

12                   Volume 2, SS-25 Well Failure Causes  
13 as 1002;

14                   Volume 3, Post-22 through -25 leak  
15 events as 1003;

16                   And Volume 4, Aliso Canyon Casing  
17 Integrity, as Commission Exhibit 1004.

18                   (Exhibit No. 1000 was marked for  
19 identification.)

20                   (Exhibit No. 1001 was marked for  
21 identification.)

22                   (Exhibit No. 1002 was marked for  
23 identification.)

24                   (Exhibit No. 1003 was marked for  
25 identification.)

26                   (Exhibit No. 1004 was marked for  
27 identification.)

28                   ALJ HECHT: Is everybody pretty clear

1 on those for now?

2 And are there any questions before  
3 we go to direct and then cross?

4 (No response.)

5 MR. GRUEN: Your Honor, SED is clear on  
6 your guidance. No questions.

7 ALJ HECHT: Thank you very much.

8 All right. Then, Ms. Frazier,  
9 please go ahead.

10 MS. FRAZIER: Your Honor, I think Mr.  
11 Lotterman was going to start the questioning  
12 of Mr. Krishnamurthy.

13 ALJ HECHT: Okay. Here we often have  
14 the attorney representing the witness just  
15 identify them again. But we have already  
16 done that, so I don't think it's necessary to  
17 do that now.

18 MS. FRAZIER: Okay. Sorry about that.

19 ALJ HECHT: That's okay. You have no  
20 way of knowing.

21 All right. I'll start with Mr.  
22 Lotterman.

23 MR. LOTTERMAN: Thank you, your Honor.

24 Ms. Frazier and I are in the same  
25 boat. And that is that neither of us have  
26 appeared before this Commission before. So I  
27 wanted to start off by thanking you for the  
28 opportunity to do so. And, also, to tell you

1 that if I stumble along the way, it's not  
2 because I haven't read the Commission's rules  
3 and all, I just may not be familiar with your  
4 procedures and may call for Mr. Stoddard or  
5 Ms. Patel to give me a -- throw me a lifeline  
6 from time to time, so...

7 ALJ HECHT: That's fine. Thank you. I  
8 definitely understand.

9 CROSS-EXAMINATION

10 BY MR. LOTTERMAN:

11 Q All right.

12 Dr. Krishnamurthy, are you there?

13 A Sorry. I'm here. I just unmutated  
14 myself.

15 Q Oh, all right. Good. There you  
16 are. Hello again.

17 How are you?

18 A Pretty good.

19 Q Good. I wanted to check a couple  
20 things.

21 Actually, before we do that, I want  
22 to say it's good to see you again. Because  
23 we met in Downtown Houston back in  
24 November 2019; right?

25 A That is correct. Yes. A while  
26 ago.

27 Q Right. And these days, when you  
28 say, "It's good to see you again," it means

1 something, doesn't it?

2 A Virtually, yes.

3 Q Yes. Absolutely. Yes. Yes.

4 And so, if you recall, we spent  
5 three days in deposition; is that right?

6 A That is correct.

7 Q I believe I had the opportunity to  
8 examine you on the third day.

9 Do you remember that?

10 A Yes, I do.

11 Q And there's been a transcript --  
12 and I believe you actually reviewed the  
13 transcript for accuracy, and you've submitted  
14 an errata.

15 Is that true?

16 A That is correct.

17 Q Good.

18 And do you understand that you are  
19 under oath today, just like you were under  
20 oath at that deposition in November 2019?

21 A Yes, I do.

22 Q Good.

23 Quick question for you, are you  
24 alone today in your office?

25 A Yes, I am. I'm in my office, and  
26 my door is closed.

27 Q Okay. Good. So here's what I  
28 wanted to accomplish:

1 I want to walk through various  
2 topics that are raised in your main report.  
3 And I believe I let your counsel know that if  
4 you have a copy of the report handy, it will  
5 greatly expedite this examination.

6 I will, for the record, clarify the  
7 pages. Mr. Moshfegh will put them up on the  
8 screen. But I think we can proceed fairly  
9 quickly -- if you have the report in front of  
10 you, we can look at a sentence or two, I can  
11 ask for clarifications, and that type of  
12 thing.

13 Okay?

14 A Yes. I have it with me.

15 Q Good.

16 I also may go into some of the  
17 supplemental reports. I hope not to, but I  
18 have a couple sections here that we may put  
19 on the screen. But, again, you should feel  
20 free to refer to anything you want to before  
21 you answer a question.

22 If I recall back to November of  
23 2019, your ability to recollect the facts in  
24 this project were quite remarkable. And so  
25 I'm hoping that happens again today. But I  
26 want to let you know that if, for whatever  
27 reason, you draw a blank or you're unclear,  
28 we will stop and we will make sure you have a

1 chance to refresh your recollection.

2 Okay?

3 A Thank you.

4 Q Good.

5 The other thing I was going to tell  
6 you is, you are free to defer to others on  
7 your team if you need to. And I say that,  
8 but I also tell you that while you're  
9 testifying today, it has to be your  
10 testimony. So I'm assuming you have no  
11 ability to communicate with your team sort of  
12 offline or through chat, or whatever, while  
13 you're on the stand, so to speak, today?

14 A No. I'm alone. And I have no chat  
15 or anything set up, no.

16 Q Good.

17 Now, I don't expect you to need to  
18 defer to them, because we're not going to get  
19 too deep into the weeds. I'm going to start  
20 at, sort of, the Google-Maps level and work  
21 our way down the well. But you have that  
22 opportunity. And if you -- if there's  
23 something that you need someone else to  
24 answer, we will accommodate that need.

25 Okay?

26 A Okay. Thank you.

27 Q All right. And, by the way, the  
28 other thing I was going to mention to you is,

1 we are going to spend a lot of time on the  
2 main report. And that has now been marked as  
3 Commission Exhibit 1000.

4 So if I say "Main report" or  
5 "Exhibit 1000," can we understand that it's  
6 the main report that Mr. Gruen read into the  
7 record just a while ago?

8 A Yes.

9 Q Okay. Good.

10 I also am going to ask you today to  
11 explain some concepts, to explain some  
12 equipment, and to explain some issues. And  
13 that's for me to lay a foundation. That's  
14 for the ability for the judges to understand  
15 not only your testimony, but future testimony  
16 of some of the SoCalGas witnesses, and just  
17 to keep the record clear. So I ask your  
18 patience in that regard.

19 Okay?

20 A Sure.

21 Q Finally, I'll defer to the judges  
22 when breaks are needed. But, obviously, if  
23 something comes up and you need a break,  
24 please let us know, and we will endeavor to  
25 accommodate you.

26 Okay?

27 A Thank you.

28 Q Before we begin, and this is sort

1 of a last minute thing that we always do is,  
2 there's a concern that some third party may  
3 attempt to record these proceedings. And I  
4 wanted -- and I can tell you that I have not  
5 consented to anyone recording what I'm doing  
6 here today.

7 And I'm asking you, do you consent  
8 to this proceeding being recorded by a third  
9 party?

10 A I do not.

11 Q Okay. All right.

12 Finally, let's talk about some  
13 terms. When I say "Blade," obviously, I mean  
14 the Blade Energy Partners and you and your  
15 team.

16 Okay?

17 A Okay.

18 Q I may say from time to time you  
19 personally, and that's -- that's, I guess, an  
20 opportunity for you to maybe step away from  
21 your role as the lead investigator of Blade  
22 and to give your personal view. But if I say  
23 you or Blade today, I'm really asking you to  
24 speak on behalf of the -- of Blade Energy  
25 Partners.

26 Okay?

27 A Yes.

28 Q Good.

1 Another shorthand is "Aliso  
2 Canyon." By now, I think everyone else in  
3 this proceeding knows that that pertains to  
4 SoCalGas's Aliso Canyon gas storage facility.  
5 But I wanted to confirm that with you.

6 A Yes.

7 (Crosstalk.)

8 BY MR. LOTTERMAN:

9 Q Also, we talk about "incident" or  
10 "leak." And that is the leak that started on  
11 October 23rd 2015, and -- well, actually, it  
12 was first detected on that date. And it was  
13 at the well now called "SS-25."

14 Agreed?

15 A Yes, agreed.

16 Q All right.

17 And, obviously, the well itself is  
18 SS-25. That's short for "Standard Sesnon  
19 25."

20 True?

21 A Yes.

22 Q All right. Good. Thank you very  
23 much. Let's begin the examination.

24 And, by the way, I believe you've  
25 got a PhD in Material Science from the great  
26 institution of University of the Virginia; is  
27 that correct?

28 A That is correct, yeah, UVA.

1 Q Well, I'm sorry about your NCAA  
2 experience recently. But we won't go there.

3 What I will do though, with your  
4 permission, is I believe you go by Dr.  
5 Krishnamurthy; is that correct?

6 A No. Just "Ravi" is fine. No  
7 "Dr.," please.

8 Q No, "Dr." Okay.

9 (Crosstalk.)

10 BY MR. LOTTERMAN:

11 Q Well, I can't go "Ravi" today, sir,  
12 because this is a formal proceeding.

13 So forgive me, I've got "Dr." In my  
14 head. I'll try to adjust. But I'm 65 years  
15 old, and that's more difficult as every day  
16 goes by. Okay.

17 So, tell us, are you currently  
18 employed, sir?

19 A Yes. I'm employed with Blade  
20 Energy Partners. Yes.

21 Q How long have you been with Blade?

22 A Since 2004, I believe. Yeah.

23 Q And if you had to, sort of,  
24 summarize in two sentences, or more or less,  
25 what are your primary duties and  
26 responsibilities with Blade these days?

27 A My primary duty is, I'm an  
28 Executive Vice President. Actually, that's

1 my title. But I work actively on projects as  
2 an engineer. And, also, I'm responsible for  
3 the financial results and overall for  
4 Blade --

5 Q Okay.

6 A -- so, yeah. I'm one of the  
7 principals at Blade.

8 Q Do you consider yourself a  
9 corrosion engineer by training and  
10 experience?

11 A I consider myself a  
12 metallurgical/corrosion/fracture mechanics.  
13 The corrosion is a very specific area to me.  
14 That is one of the areas I was trained in and  
15 have experience in, but it's a broader range.  
16 Yeah.

17 Q Okay. So if I understand your  
18 answer correctly, you have expertise in a  
19 number of areas. But one of those subareas  
20 is corrosion.

21 True?

22 A That is correct. Yeah.

23 Q All right. Okay.

24 And where did you work before you  
25 joined Blade?

26 A Before Blade, I worked for GEPII.  
27 That was an entity that used to work on  
28 pipeline integrity and integrity inspection.

1 But my focus was on pipeline integrity  
2 engineering. And then prior to that for  
3 nearly ten years -- I'm giving you  
4 approximate numbers -- mobile (inaudible), a  
5 few years in research, few years in the  
6 field, and then in drilling towards the end  
7 of --

8 (Crosstalk.)

9 BY MR. LOTTERMAN:

10 Q Thank you. I'm sorry for stepping  
11 on your answer. I just broke Judge Hecht's  
12 rule.

13 Are you -- are you familiar with  
14 the phrase "oil patch"?

15 A Yes.

16 Q What does that mean to you?

17 A Oil patch is somebody who has been  
18 fortunate enough or unfortunate enough to  
19 have spent their life in the oil and gas  
20 industry. It's an oil and gas industry  
21 domain that's pretty much drilling,  
22 exploration, completion, a variety of things.  
23 That's what we term as "oil patch."

24 Q Have you spent time in the oil  
25 patch?

26 A Yes. Yes, I have. Yeah.

27 Q How much time, roughly?

28 A Oh, God. I don't want to date

1 myself, but over 25 years, maybe.

2 Q All right.

3 A I need to do some counting, but  
4 yeah.

5 Q Do you try to keep current on new  
6 trends and issues in the oil and gas  
7 business?

8 A I do my best. Yeah.

9 Q Okay.

10 Do you belong to any professional  
11 societies?

12 A I believe a few, yeah. A few.

13 Q Okay. I saw one called the  
14 National Association of Corrosion Engineers?

15 Is that one of them?

16 A Yes. That is one of them.

17 Q Okay. Is that the group where you  
18 keep current on new trends and issues in, at  
19 least, the corrosion world?

20 A Yes, we do.

21 Q Okay. Have you seen a lot of  
22 corrosion over the years?

23 A Yes. Yes, I have. Yes.

24 Q On pipelines?

25 A Everything. On pipeline and  
26 downhole. Because my primary experience --  
27 initially, my experience was downhole, then  
28 it became pipeline. It's pretty much both.

1 What I'm not experienced in is refining or  
2 refineries. But pretty much downhole,  
3 surface, facilities, and transmission  
4 systems. ]

5 Q When you say "downhole," sir, what  
6 are you referring to?

7 A Downhole I'm referring to anywhere  
8 from liner, casing, tubing, packer,  
9 subsurface safety valve, various completion  
10 components, you know, the conduit to produce  
11 hydrocarbons, which is pretty much  
12 everything.

13 Q Including the well itself? Excuse  
14 me. Including the well itself, correct?

15 A Yes. Yes. When we discuss what I  
16 would call available system, we mean all the  
17 casing strings, the wellhead, the trees, the  
18 completion tubing, everything. That's what  
19 we refer to.

20 Q When was your first experience with  
21 corrosion on a wellbore system?

22 A '91 maybe. '91 or '92.

23 Q Was that when you were with -- was  
24 that when you were with Mobile?

25 A That's correct, yeah. That's  
26 Mobile, yeah.

27 Q And I believe you told us in your  
28 deposition that was corrosion on a tubing; is

1 that correct?

2 A I believe so. It's been ages ago,  
3 but yes, that's what I -- what I recall.

4 Q And I believe your memory at the  
5 time was that it was corrosion caused by  
6 carbon dioxide; is that right?

7 A Correct. CO2 corrosion, yeah.  
8 That's right. You're absolutely right.  
9 Yeah.

10 Q What are the types of corrosion  
11 that you've seen on well pipe?

12 A CO2 corrosion, pitting corrosion,  
13 cracking, various types of corrosion. I  
14 could go through a litany of those including  
15 microbiological, various, various ranges, and  
16 also cracking. So a lot people use corrosion  
17 and cracking interchangeably. I like to  
18 split them up. Corrosion is kind of a metal  
19 loss kind of phenomenon, whereas cracking  
20 involves the presence of a crack that is  
21 extremely sharp where there is a fracture  
22 possibility. So a combination thereof. I've  
23 seen that in carbon steels. I've seen it in  
24 stainless steels, thirteen chrome, sub 22  
25 chrome, and then also that's for the  
26 nickel-based alloys, the difference in the  
27 alloy system.

28 (Interruption by reporter.)

1 THE WITNESS: I apologize. I'll speak  
2 slowly.

3 ALJ HECHT: We had this issue last week  
4 with more than one person. It is not  
5 unusual. Please try to keep to a measured  
6 pace. It's very helpful for our court  
7 reporters to do that.

8 THE WITNESS: I will do that. Sorry  
9 about that.

10 ALJ HECHT: Thank you very much. We'll  
11 be back on the record if we were off of it.

12 MR. LOTTERMAN: Thank you, your Honor.

13 Q Dr. Krishnamurthy, have you seen  
14 any microbial-induced corrosion in the oil  
15 patch?

16 A Yes, I have.

17 Q Okay. What types traditionally  
18 have you experienced there?

19 A Traditionally, it's been  
20 sulfate-reducing bacteria corrosion. That's  
21 the specific variation of microbial  
22 corrosion. That's what I'm traditionally  
23 used to. That's what I have personally seen.

24 Q What about iron-related bacteria?

25 A What do you mean by -- oh. You're  
26 talking aerobic bacteria, anaerobic bacteria.  
27 Aerobic bacteria I have personally not seen  
28 I'm aware of those. I have personally not

1 seen those. I've seen sulfate-reducing  
2 bacteria. I have not seen what you're  
3 calling aerobic bacteria. The SRBs and  
4 anaerobic bacteria, they happen in the  
5 absence of oxygen whereas aerobic bacteria  
6 are the type I believe you are referring to.  
7 Happens in the presence of oxygen, which is  
8 called aerobic corrosion.

9 Q All right. So let's -- thank you  
10 for that background. Let's now turn to the  
11 root cause analysis. It's my understanding,  
12 Dr. Krishnamurthy, that you were hired  
13 technically by SoCalGas at the Commission's  
14 and DOGGR's direction to conduct a root cause  
15 analysis at the Aliso Canyon facility; is  
16 that correct?

17 A Yes, that's correct.

18 Q And I was going to actually show  
19 you a copy of the contract, which I believe I  
20 provided in advance. I'm told now that that  
21 contract has some confidential information in  
22 it. So I'm going to endeavor to ask you a  
23 couple of questions about it without actually  
24 putting it into the record. So let me go at  
25 it this way, if I can. The contract shows --  
26 showed that it was signed as of January 26,  
27 2006.

28 Does that comport with your

1 recollection?

2 A That's correct. Yeah.

3 Q And it says under "scope" -- and  
4 again, I can show it you to if you want, but  
5 let me just read it to you. It says under  
6 scope, "performance of a technical root cause  
7 analysis" -- and in parens it's RCA -- "on  
8 the nature of failure of the S" -- "of the  
9 Standard Sesnon 25 well and the technical  
10 cause of the leak."

11 Do you remember that generally?

12 A Yes, I remember that generally.  
13 Yeah.

14 Q Okay. So let me just ask you about  
15 each phrase. You talk about performing an  
16 RCA on the nature of the failure of the  
17 Standard Sesnon 25 well. What did you  
18 interpret that to mean when you walked into  
19 this project in January of 2016?

20 A To understand the failure of the  
21 SS-25 -- why the SS-25 failed. Literally why  
22 SS-25 failed.

23 Q Okay. And then what was your  
24 understanding as to the aspect of the project  
25 where you were going to identify the  
26 technical cause of the leak? Is that the  
27 same thing?

28 A Yeah. Yeah. Again, by technical

1 RCA, what we intended to mean -- at least  
2 that was the intent when we wrote the  
3 proposal -- in a root cause analysis or  
4 failure analysis, when you get -- you have an  
5 idea in your mind what the scope is, what the  
6 approach is going to be, and then as data  
7 presents itself, your approach and scope  
8 evolves. And that is common in any root  
9 cause analysis work we have done in the past.  
10 The terminology that we -- I like to use  
11 technical -- is we were not -- we were not  
12 planning nor was our intent of the project to  
13 understand management-related issues or stuff  
14 beyond -- beyond what we would call  
15 technical. That was the intent. Okay.

16 Q Understood. Thank you. And you  
17 completed that work about three and a half  
18 years later; is that true?

19 A That's correct.

20 Q And it culminated in the reports  
21 that we just marked as Commission 1,000,  
22 Commission 1,001, Commission 1,002 and all  
23 the way up to Commission 1,004; is that  
24 correct?

25 A That's correct.

26 Q No, how much of your time during  
27 that three-and-a-half-year period was  
28 dedicated to that project?

1           A    I don't -- I don't recall but a  
2 bulk of my time.

3           Q    Okay.

4           A    A bulk of my time.

5           Q    All right.  And was that project a  
6 lengthy effort by Blade's standards?

7           A    Yes.

8           Q    Okay.  Was it complex?

9           A    Yes.  It was complex.

10          Q    I mean, I saw at some point that  
11 you hired more than 23 service companies.  
12 Does that roughly comport with your  
13 recollection?

14          A    Yeah.  That's what we had in our  
15 acknowledgment sections, yeah.  And that  
16 was -- SoCal guided us in there.  It was  
17 SoCalGas' service companies, and we tried to  
18 stick with them where it made sense.

19          Q    Was the project difficult and  
20 challenging?

21          A    Yes, it was.  Yes, it was.

22          Q    Including weather delays?

23          A    Yes.  Weather delays, which is  
24 common in Aliso.

25          Q    And I saw something in your report  
26 about having to design a special tool to  
27 extract the pipe, and we'll get to that in a  
28 minute.  But is that part of the challenging

1 aspect of this project?

2           A     Yes.  Can I elaborate on that a  
3 little bit?  May I elaborate on that a  
4 little?  So when you're looking at a downhole  
5 failure, even though this was a shallow  
6 failure, pulling it out without damaging  
7 anything is a challenge -- operational  
8 challenge.  And because this was a well that  
9 had failed, there were a lot regulatory  
10 hurdles we had to jump over.  So the  
11 regulatory, which was the entity that was to  
12 approve any operations on that well,  
13 vis-à-vis extraction of tubing or casing had  
14 to go through DOGGR, and that was a -- quite  
15 a lengthy process where everybody had to be  
16 convinced it was safe, justifiably so since  
17 we had just got that well under control.

18                     So that added to the time that --  
19 time and effort that it took.  And on top of  
20 that, a lot of the protocols had to be  
21 approved by the regulatory entities.  And  
22 SoCalGas also reviewed them.  So all parties  
23 reviewed them.  So it was quite extensive.  
24 And then there was a period -- I'm really  
25 going deep into my memory bank.  But it was  
26 early in 2017 where DOGGR was concerned that  
27 25A, which had a stage collar leak, which was  
28 a really -- a cementing tool that was nothing

1 to do with integrity of the casing of the  
2 tubing. So they wanted to fix that before we  
3 do any activity on SS-25. So all of that  
4 just added to the time and effort required.

5 Q Dr. Krishnamurthy, you'll be  
6 pleased to hear that at some point in time  
7 we're going to talk about each one of those.  
8 So I appreciate you giving us the preview,  
9 but I actually had those on my list to  
10 discuss. So thank you for that introduction,  
11 shall we say.

12 You know, you said something at the  
13 deposition in Houston that struck me at the  
14 time, but I didn't ask you to follow-up. And  
15 I'd like to do that today. You said, quote,  
16 "Everything surprised me about this project."  
17 And I'm wondering could you explain what you  
18 meant by that? And again, just briefly,  
19 because we're going to get into the various  
20 stages of the root cause analysis. But what  
21 about this project generally surprised you?

22 A Yeah. I may have -- I don't want  
23 to say everything surprised me. Some things  
24 surprised me definitely, and let me touch on  
25 the technical aspects. And perhaps I may  
26 answer some of your other questions that may  
27 come up. But let me -- because I can't be  
28 specific with a general question.

1           So any time you walk into a  
2 failure, whether -- and we attempt to be  
3 purely data driven. By "we," I mean Blade.  
4 We're very picky about data has to drive our  
5 decisions. We may have some preconceived  
6 notions or ideas as to why something  
7 happened. You have to wait for the data. So  
8 as we were waiting and as we were doing  
9 things in different phases, which we will go  
10 to at some point down the road here, you are  
11 looking at the data you have. And it doesn't  
12 jibe with what you think may have happened.

13           So for example, when we came to the  
14 location -- I was on the location, I believe,  
15 February 1st or 2nd. Bill Whitney was ahead  
16 of me. I was there a day later. And so if  
17 you looked at everybody's account and  
18 newspapers and everywhere it would be,  
19 "internal corrosion," "internal corrosion."  
20 We didn't know whether the gas was wet and  
21 all that. So very quickly, by April, we knew  
22 internal corrosion was not an issue. So we  
23 were trying to think what would cause this  
24 failure. So pretty much all the data we  
25 saw -- the results we saw was that was  
26 inconsistent with some preconceived views we  
27 had -- or I had.

28           Q     Okay. So Dr. Krishnamurthy, I

1 promise you we're going to get into that. So  
2 that's very helpful. I just wanted to  
3 understand that -- let me ask it this way so  
4 we -- so you don't sort of spoil the story  
5 here: Is it fair to say that during this  
6 project something surprised you?

7 A Yes.

8 Q All right. All right. And your  
9 role during the project was primary leader of  
10 the team, true?

11 A Yes, that's correct.

12 Q And I believe you told us in  
13 Houston that you -- if you did not -- well,  
14 first of all, you did not write all of the  
15 reports but you wrote much of the main  
16 report; is that correct?

17 A I wrote portions of the main report  
18 extracting -- I reviewed the main report in  
19 details. And it's a team effort. And I  
20 wrote -- I helped with some of the  
21 supplementary reports but not all of them.

22 Q But is it safe to say that you  
23 blessed what you -- that you reviewed and  
24 blessed all of the reports once they were  
25 submitted?

26 A Yes, I did.

27 Q Okay. So the root cause analysis,  
28 by contract, began on January 26, 2016. I

1 believe your team -- or you and your team  
2 arrived on-site three days later, January 29;  
3 is that accurate?

4 A That's accurate, I believe, yes.

5 Q All right. So when you arrived at  
6 the Aliso Canyon facility, what was the  
7 status of the leak? ]

8 A It was still leaking. The well was  
9 still leaking. And if I remember right, the  
10 relief well was getting closer to SS-25.  
11 That's the condition when I arrived on site.

12 Q Okay. Did you witness any top  
13 kills by either SoCalGas or Boots & Coots  
14 upon arrival?

15 A No, I didn't.

16 Q Did you or anyone else --  
17 (Crosstalk.)

18 BY MR. LOTTERMAN:

19 Q I'm sorry.

20 A No, I did not. Neither me nor  
21 anybody at Blade witnessed anything, any of  
22 the top kills.

23 Q Did you or anyone from your Blade  
24 team play any role in designing or  
25 implementing the top kills?

26 A No.

27 Q What about designing or  
28 implementing the relief well?

1           A    No, we did not have a role.

2           Q    Okay.  So how soon after your --  
3 your arrival at the Aliso Canyon facility on  
4 January 29, 2016 did you visit the -- the  
5 actual well pad?

6           A    Really, let me think about it.  It  
7 was the -- the -- let me step back to the  
8 story I mentioned earlier.

9                    There was a lot of newspaper  
10 reports and speculation by various experts  
11 in -- saying that internal corrosion was a  
12 problem, so immediately I sent a request to  
13 SoCalGas requesting samples of the gas.  
14 Before that, I asked if anybody had done a  
15 gas analysis.  I found out that there was a  
16 lot of EPA or environmental-type analysis,  
17 but nobody had done an analysis with the  
18 intent of corrosion or understanding the  
19 failure.  So I requested gas samples right  
20 away.  So I forget the timeline and the  
21 details around it, but I was on SS-25 site  
22 collecting gas samples probably three,  
23 four days after I arrived.

24          Q    Okay.

25          A    I do not --

26          Q    What did you see --

27          A    I did not -- sorry.  I -- I do not  
28 remember the exact dates and all, but, yeah.

1 That's -- I was there.

2 ALJ HECHT: Just a reminder --

3 THE WITNESS: So --

4 ALJ HECHT: -- to take a breath and  
5 stop before you speak over someone. Thank  
6 you.

7 MR. LOTTERMAN: Thank you.

8 Q So I -- I'm breaking all the rules  
9 today, Dr. Krishnamurthy. I apologize. I --  
10 so all right.

11 So the contract was January 26.  
12 You arrived a couple days later, and a couple  
13 days after that you first visited the SS-25  
14 well pad. Is that correct?

15 A That's correct.

16 Q What did you see?

17 A Oh, gosh. I don't remember. I saw  
18 the crater. I -- there was a pipe coming  
19 away from the wellbore. I forget -- which  
20 was -- I -- my guess is 60, 70 feet from the  
21 wellbore, where we could sample the gas. Me  
22 and -- and -- and two other individuals from  
23 Oil-Tech were with me, I believe, if I  
24 remember right. It was covered in oil. I  
25 mean --

26 Q Well -- sorry. I thought you were  
27 done. My apologies.

28 Did you see the wellhead sticking

1 out of the ground in the middle of the  
2 crater?

3 A I believe I did, yeah.

4 Q How large was the crater, roughly?

5 A We -- we measured it later. I  
6 don't remember, offhand. Your -- I have to  
7 go to my reports to check. We measured it;  
8 quite -- it's quite big.

9 Q Okay. I have a picture --

10 A I would -- yeah. Sorry. Go ahead.

11 Q I have a picture that I'm going to  
12 show in a minute, which I think will help  
13 clear that up.

14 When you approached the pad to do  
15 your gas samples, did you smell gas?

16 A I believe I did. Okay? At any --  
17 I'm really digging deep into my gray cells,  
18 and I believe I did. It was -- it was a  
19 unique smell there on location. I believe it  
20 was hydrocarbon gas smell. Yeah, absolutely  
21 I did.

22 Q Okay. And you say in the main  
23 report -- and -- and I'm looking at page 22.  
24 You don't need to refer to it, unless you  
25 want to. You said that -- that the location  
26 and type of failure were unknown when the RCA  
27 began. Is that a true statement?

28 A That's correct.

1           Q    Okay.  And I believe you said in  
2 your deposition:  "We didn't know where, we  
3 didn't know what, we didn't know how at that  
4 stage, so everything was up for grabs."

5                    Not quite as technical as the  
6 language in the main report, but does that  
7 capture the same idea?

8           A    Yes.  Yes.

9           Q    Okay.

10          A    We -- we didn't -- we didn't know  
11 what depth it was.  You could speculate on  
12 all of that, but at that point, it was  
13 speculation.

14          Q    And you -- I think you -- you  
15 started talking about this earlier, and I  
16 want to just clarify for the record.

17                    What were your initial -- your  
18 being you and your team's initial suspicions  
19 of the cause of the leak when you walked up,  
20 when you drove up to the Aliso Canyon  
21 facility?

22          A    I -- I honestly -- we did not have  
23 any opinion at that point.  Down the road, a  
24 few months later, we had some opinions.  But,  
25 at that point, we didn't have any opinions  
26 other than -- I honestly did not.  We did not  
27 know whether the wellhead had failed, we did  
28 not know whether the casing had failed,

1 because remember, I had not looked at any of  
2 the data. We had not looked at the  
3 temperature logs. Like you appropriately  
4 mentioned, we were not there for the kill  
5 attempts. So we didn't -- we didn't look at  
6 any of those data sets. We had not  
7 interpreted anything as we had walked up, so  
8 at that point, we were void of looking at any  
9 information. So at that point, we probably  
10 did not have an opinion, that's correct.

11 Q Okay. I was actually asking you  
12 about your initial suspicions, but let me ask  
13 it this way.

14 You had mentioned during one of  
15 your earlier answers some people were talking  
16 about in colonel -- internal corrosion.  
17 Did -- did members of your team share that  
18 suspicion?

19 A No. Members of my team shared  
20 the -- Rudy Hausler is our chemist, who's one  
21 of the authors of the internal corrosion  
22 section. If there is water in the gas,  
23 corrosion is possible. So -- but, once we  
24 had the gas analysis results back from Oil --  
25 Oil-Tech, I believe, we were pretty  
26 comfortable saying there was -- it's not an  
27 internal corrosion.

28 Q All right. And just so everyone

1 understands what we're talking about, we may  
2 throw these terms around a little bit later,  
3 when you say, "internal corrosion," you mean  
4 corrosion that's inside the pipe sort of  
5 corroding the -- what do you call it, the  
6 interior, the ID, the interior diameter. Is  
7 that right?

8 A That's correct. Let me clarify,  
9 just to make sure I'm clear, I -- I  
10 appropriately communicate.

11 What I'm talking about is corrosion  
12 happening from the internal diameter of the  
13 production casing.

14 Q Got it.

15 A That's what I'm referring to.

16 Q Okay. And then today or tomorrow,  
17 perhaps, we talk about external corrosion.  
18 Is that the corrosion that typically will  
19 attack the outside of the pipe?

20 A Yeah. A -- as -- as -- as we have  
21 articulated in the report, the corrosion on  
22 the seven-inch production casing happened  
23 from the outside diameter, or the OD, of the  
24 pipe.

25 Q Okay. All right. And from your  
26 experience in the oil patch, is there  
27 internal corrosion and external corrosion on  
28 well pipes?

1           A    It's more internal.  It's more  
2 often internal.

3           Q    Why is that?

4           A    Because in -- in production  
5 situations, your gas can be wet gas, and  
6 depending on the reservoir, even in  
7 underground storage well, your gas can be  
8 wet, and if it is wet, you can have internal  
9 corrosion, wet meaning you need water.  For  
10 corrosion to happen, you always have to have  
11 water.  And quite often, in producing wells,  
12 when you produce gas, or even when you  
13 produce oil, you may have some (inaudible)  
14 water or water being produced along with the  
15 gas or along with the oil, and that may cause  
16 some corrosion.

17                        There was water in the Aliso Canyon  
18 gas, but it was so low that it was -- it --  
19 gas -- the -- the gas that you produce  
20 absorbs some water as vapor, or water vapor,  
21 and so all the water was water vapor in the  
22 gas as it came up.  So unless the water  
23 condenses as water on the ID of the casing,  
24 you cannot have corrosion.

25           Q    I see.  Okay.  Thank you.  That's  
26 very helpful.

27                        So it's my understanding -- and I  
28 believe your -- your report sets this forth,

1 that the leak was stopped on February 11,  
2 2016. Is that right?

3 A That's correct, yeah.

4 Q So roughly 111 days after it was  
5 first detected on October 23rd. True?

6 A True.

7 Q All right. Good. And -- and once  
8 the leak stopped, Blade proceeded with six  
9 phases of its analysis. Is that generally  
10 true?

11 A I believe so. I have to check,  
12 but, yes, five or six --

13 Q Now --

14 A -- phases.

15 Q -- again, sir, I'm -- it is my hope  
16 today not to challenge your recollection  
17 unduly, so let's turn to pages 23 and 24 of  
18 the main report, which has been previously  
19 marked as Commission Exhibit-1000. And I'm  
20 not going to go through these in detail, or  
21 even generally, but I just want to refresh  
22 your recollection.

23 Does that report on pages 23 and 24  
24 set out six phases of the root cause  
25 analysis?

26 A Yes, it does.

27 Q All right. And again -- and I want  
28 these answers to be short, because this is --

1 this is not that important in the -- in the  
2 grand scheme of things, but just to -- just  
3 to set the -- the table, Phase 1, I take it,  
4 was -- was generally the data collection,  
5 collation, analysis. Is that true?

6 A Yeah. We called it Phase 0, and  
7 that was well and field data collection,  
8 collation, yes.

9 Q So that kind of surprised me.  
10 Is -- do corrosion engineers have Phase 0s,  
11 typically?

12 A Not -- again, I'm not a  
13 corrosion -- I would like to say, "Yes, I'm a  
14 corrosion engineer." But, in an RCA, one of  
15 the most important aspect (sic), especially  
16 in a problem like this, especially in  
17 downhole problems, data collection and  
18 analysis is probably the most important part  
19 of the project.

20 Q Okay. And I take it that, then,  
21 also fed into what you call Phase 1, where  
22 you actually collected site evidence. Is  
23 that correct?

24 A Yeah. Phase 1 was -- if you -- as  
25 you asked me a question before, the crater  
26 was there, the hole -- the well was  
27 successfully killed. So we didn't know what  
28 had -- what -- what had happened, so we were

1 looking for any phys- -- physical evidence of  
2 the failure, if there was something that came  
3 up when the gas came out of the well. That  
4 was the intent of that exercise.

5 Q Okay. And it looks like Phase 0s  
6 (sic) and Phase 1 occurred during the same  
7 time. Is that accurate?

8 A No. Phase 0 started in February of  
9 2015, went until May of 2019, if you look at  
10 it. So it went all the way 'til the end of  
11 the project, because as we discovered -- as  
12 we analyzed the data -- sorry, as we analyzed  
13 the physical evidence, all the data, we had  
14 new data requests, and SoCalGas was kind  
15 enough to provide us additional information.  
16 It was a lot of data required for this  
17 project. And that was Phase --

18 Q That was a good catch, though.  
19 Sorry. That was a good catch, because I  
20 looked at the dates, and I assumed they were  
21 equivalent, but one was through May of 2019,  
22 and Phase 1 was through May of 2016. True?

23 A That's correct.

24 Q All right. And what you're saying,  
25 if I understand you correctly, is that the  
26 process of collecting data and collating it  
27 and ana- -- analyzing it, that started from  
28 the day you got involved with that project

1 from, it looks like, the -- the very month  
2 you published this main report. True?

3 A That's correct.

4 Q All right. Phase 2 is called Site  
5 Restoration to Rig Readiness. Can you  
6 briefly tell the Commission what Phase 2  
7 entailed?

8 A So, Phase 2, if you remember --  
9 and -- and we can look at pictures a little  
10 later. There was a big crater there. We  
11 recognized that gas had -- was blowing out  
12 for 111 days. So we didn't realize where the  
13 gas had gone. You know, some of it could  
14 have gone just below surface. So a lot of  
15 those questions remained.

16 And so in Phase 1, we did some  
17 logging to understand the condition of the  
18 location. We may also have done some small  
19 surface boreholes in Phase 1 or Phase 2.

20 And then in Phase 2, the idea was  
21 to restore the site. In order to pull the  
22 casing, you need to bring a rig in; whether  
23 it was a work oil rig or an actual drilling  
24 rig, you needed to bring in some heavy  
25 equipment on-site, and we need to prepare the  
26 site for that. And so crater had to be  
27 filled out. It was a massive undertaking.  
28 And -- and SoCalGas managed Phase 2 with our

1 insight and input.

2 Q Got it. It looks like Phase 3,  
3 then, was the actual extraction of the tubing  
4 and casing and wellhead?

5 A That's correct. Phase 3 was the  
6 most important data collection portion of it.  
7 And -- and as we just spoke about it a few  
8 minutes ago, moment we finished Phase 1, we  
9 started drafting protocols for Phase 3, that  
10 is tubing, casing, wellhead extractions, and  
11 there were a lot of back and forth with  
12 SoCalGas, with DOGGR, with CPUC, all -- all  
13 parties involved, discussing how to do that.  
14 That's when it all started. And --

15 Q Okay.

16 A Yeah. Sorry. I'll leave it at  
17 that.

18 Q No problem. Got it.

19 Okay. Phase 4, top of page 24,  
20 non-destruction (sic) evaluation and  
21 laboratory metallurgical examination. Could  
22 you tell a political science major like  
23 myself what that involves?

24 A So that was -- once we pulled the  
25 tubing and the casing, the goal was to assess  
26 them nondestructively. So when you do  
27 metallurgical evaluations, before you break  
28 or open anything, you want to evaluate them

1 nondestructively as much as possible to get a  
2 picture of what you're looking at prior to  
3 opening things and cutting things. So that  
4 was all of the laboratory work and analysis  
5 associated with this project, was in Phase 4.

6 Q Understood. And then the final  
7 phase, Phase 5, again, at the bot -- or  
8 the -- again, on page 24 of Commission  
9 Exhibit-1000, you talk about integration,  
10 interpretation and final reports. And I take  
11 it that's just your sitting down with your  
12 team, everyone taking a piece of this, and  
13 basically analyzing the results, putting them  
14 on a piece of paper, and making sure they're  
15 completed at -- as -- to the best of your  
16 abilities as far as completeness, accuracy  
17 and that type of thing. Is that right?

18 A That's correct. We did some  
19 modeling ahead of that, but by October 2018,  
20 or approximately in that timeframe, I believe  
21 we were still drilling the SS-9 borehole for  
22 water, but I -- I'm not a hundred percent  
23 sure exactly when we finished that. But, at  
24 that point, we had enough data that we could  
25 make interpretations. So the metallurgical  
26 interpretation has to integrate with the  
27 thermal-hydraulic modeling so we can time  
28 things and everything. So that is a very

1 important phase. That is literally  
2 integrating information, the interpret --  
3 finalizing interpretations, and then once you  
4 have some of these key conclusions,  
5 conducting the RCA, the root cause  
6 assessment.

7 MR. LOTTERMAN: Okay. Judge Hecht, I'm  
8 going to jump to the back of the report. If  
9 this is a good time to break, fine;  
10 otherwise, I'll keep going.

11 ALJ HECHT: I think this is a good time  
12 to take a short morning break. We will take  
13 a ten-minute break, and be back at 11:11.

14 We'll be off the record.

15 (Off the record.)

16 ALJ HECHT: We'll be back on the  
17 record.

18 We just took a short morning break.  
19 And I'm hearing a little bit of feedback;  
20 hopefully, that will go away.

21 But, we're back on the record, and  
22 Mr. Lotterman can continue.

23 MR. LOTTERMAN: Thank you, your Honor.

24 Q Dr. Krishnamurthy, are you with us?

25 A Yeah, I'm back.

26 Q Good. All right. Is your camera  
27 on?

28 A I believe it's on.

1 Q Okay. Good. I just don't see you.  
2 That's fine.

3 So I want to -- I want to skip  
4 through this 250-page report back to  
5 page 242, which I think in this panel is  
6 called the credits.

7 A Yeah.

8 Q All right. And I'll ask  
9 Mr. Moshfegh to put that up, and you can  
10 either use your hard copy, which is what I  
11 typically do, Doctor, or you're welcome to  
12 look on the screen.

13 But, this page is actually the last  
14 page of the main report, Commission  
15 Exhibit-1000. True?

16 A Yes.

17 Q And on that page, it looks like  
18 Blade attempted to acknowledge the various  
19 parties involved. Is that correct?

20 A Yeah. I wouldn't say, "attempted."  
21 We acknowledged.

22 Q You did acknowledge. Fair enough.  
23 Fair enough. That's a -- that's a much more  
24 precise answer. I appreciate that.

25 Did you write this acknowledgement?

26 A Yes. Yes. I was in -- myself and  
27 a couple of our colleagues reviewed it,  
28 and -- yes.

1           Q    Okay.  And if you look at the first  
2 sentence, there you're talking about how long  
3 and complex the project was.  Do you see  
4 that?  And I think we talked about that  
5 earlier, so there's no need to re-plow that  
6 field.  Okay?

7           A    Yes.

8           Q    And then the beginning of the  
9 second paragraph, you say, "We would like to  
10 acknowledge CPUC and DOGGR's overall support  
11 by Blade -- of Blade's RCA efforts," and you  
12 go on to talk about it.  Do you see that?

13          A    Yes.

14          Q    So that's obviously good for client  
15 relations, but we'll -- let's -- let's leave  
16 that aside.

17                    Tell us what DOGGR's role was in  
18 the RCA.

19          A    I'm thinking, yes.  So DOGGR --  
20 DOGGR's role was, number one, let's say, I --  
21 we had to have clear traceability, so when we  
22 extract something from the wellbore, the --  
23 it has to be marked.  There's a process --  
24 I -- I don't want to bore you guys.  There's  
25 a document that describes the process, which  
26 we shared with all parties, and we needed  
27 CPUC or DOGGR to sign off as witness as we  
28 transfer custody from the SS-25 site to

1 Blade. And so DOGGR played a very important  
2 role in that. DOGGR also played a role in --  
3 in reviewing our -- our protocols, and those  
4 protocols would go to national labs. I was  
5 not -- and those -- that input was given back  
6 to us. So that was -- that was one of the  
7 elements of what DOGGR helped us with. I'm  
8 trying to think of something else, but that's  
9 what I remember at the moment.

10 Q Did you rely on their expertise?

11 A No, I -- I did not rely. But,  
12 if -- if it -- to me, if anybody gave us  
13 input on the protocol, if it improved our --  
14 our protocol, absolutely, I would -- I would  
15 follow.

16 Q From time to time, did DOGGR give  
17 you input on various aspects of the root  
18 cause analysis, whether you followed it or  
19 not?

20 A No, not on the investigation  
21 itself. Their input was more on perhaps data  
22 collection, you know. It -- you know, they  
23 would -- they would talk about the sample  
24 that has come out, but, really, they had no  
25 input on the investigation itself, no.

26 Q Did they attend or were they  
27 present at the -- at the site or during the  
28 investigation for most of it?

1           A    Yes, they were on-site for most of  
2 it. That's correct.

3           Q    Okay. Were there CPUC  
4 representatives on-site for most, if not all,  
5 of the root cause analysis investigation?

6           A    Yes, CPUC was also on-site.

7           Q    What role did they play?

8           A    Same role. They -- they  
9 facilitated any needs we had. Let's say I  
10 needed a printer or we needed some space to  
11 work on on-site, they would help us with  
12 SoCalGas. So as we got to know each other,  
13 we may ask SoCal directly, but quite often,  
14 CPUC would facilitate those kind of needs or  
15 practical needs on-site. So that's the role  
16 that CPUC fail -- played. And also, CPUC was  
17 very clear to us all along that need -- this  
18 needed to be an independent investigation  
19 with input from nobody, and we took it to  
20 heart.

21           Q    And then in that -- in that very  
22 same sentence that we just read, you talk  
23 about overall support. You said, "as well as  
24 providing guidance for navigating the  
25 regulatory, evidentiary and legal  
26 requirements."

27                       Which or both entities provided  
28 that guidance to Blade?

1           A    So the -- so let me go through each  
2 of them a little separately.

3                   Regulatory guidance is approval  
4 from DOGGR for any operations on-site, so  
5 that's regulatory guidance.

6                   The evidentiary guidance would be,  
7 you know, traceability requirements that they  
8 would like to see or -- which is part of our  
9 normal RCA process, but they would reiterate  
10 that.

11                   To me, legal falls under regulatory  
12 or legal requirements, right, you know? They  
13 were -- you know, we didn't have any legal --  
14 you know, the people may -- you know, I would  
15 be on a call where we would have SoCal  
16 attorneys, CPUC attorneys talking about some  
17 activities coming up. So that's what we  
18 meant by that.

19           Q    Okay. Now, if you could move to  
20 the next paragraph, see where it says, "We  
21 also acknowledge SoCalGas's willing support  
22 and cooperation for all aspects of RCA work,  
23 including providing data for numerous data  
24 requests"?

25           A    Yes. Yes.

26           Q    Why did you put that in the final  
27 report?

28           A    You know, I like to -- we just

1 spoke about the phases. Phase 0, which was  
2 the data phase, that was essential to our  
3 analysis. So I would -- we were repeatedly  
4 asked sometimes the same questions to ensure  
5 that -- that our analysis is accurate and  
6 appropriate, so that -- we would not have  
7 been able to -- to make the conclusions in  
8 the root cause analysis without that data.  
9 And we also had in-person meeting with  
10 SoCalGas, really probably the first one in  
11 February of 2016, and then I believe in '18,  
12 also, we had two meetings, where both CPUC  
13 and DOGGR attended, and we went through data  
14 requests. In an RCA like this, if the data  
15 request is -- if data is not provided, then  
16 the analysis is incomplete or inadequate.  
17 So, yeah, that's why we --

18 Q And were your requests to SoCalGas  
19 numerous?

20 A I believe it was numerous, yes.

21 Q Because I looked at your report,  
22 which we've -- we've marked as  
23 Commission-1001, and I counted about 40 sets  
24 of requests. Does that roughly comport with  
25 your recollection?

26 A I would have to look at it. There  
27 is a supplementary report, I believe, where  
28 we summarized this somewhere. But, I

1 would -- but, yeah, sounds about right,  
2 Mr. Lotterman.

3 Q Yeah. And then -- and I guess  
4 that's what I was referring to, sir.

5 Volume I under Phase 0 summary  
6 report, I believe you laid out all the data  
7 requests you propounded to SoCalGas. Is that  
8 true?

9 A That's true.

10 Q Okay. And it looks like they  
11 started just pretty -- pretty soon after you  
12 arrived at the facility, and it looks like  
13 they went right through April 2019 before you  
14 finished the final report. Is that right?

15 A That's correct.

16 Q And if you look at -- again, this  
17 would be Commission-1001.

18 But, the Phase 3 summary, it talks  
19 about all the data that SoCalGas did provide.  
20 And is it fair to say it was voluminous?

21 A Yes. Yes.

22 Q Okay.

23 A I'm looking at it --

24 Q And --

25 A -- yeah.

26 Q And as far as you were concerned,  
27 was it complete?

28 A Again, I -- I can't answer that. I

1 believe it was complete. It allowed us to  
2 make the conclusions we made. Yeah, I  
3 believe it was complete. We -- we -- certain  
4 aspects we requested multiple times. We had  
5 in-person meetings, because I'm nervous about  
6 writing a report where some data is not  
7 provided to us. So we made multiple -- I had  
8 multiple conversations personally on this  
9 topic.

10 Q So it's --

11 A So I believe it's complete.

12 Q And so is it safe to say, then,  
13 that Blade was satisfied -- whether or not it  
14 was complete, satisfied with the data  
15 production from SoCalGas as part of the root  
16 cause analysis?

17 A Yes, we were.

18 Q Okay. And as part of that process,  
19 did you find any categories of data that  
20 SoCalGas should have had, but were -- they  
21 were unable to provide to you?

22 A I don't think so. I -- by that,  
23 you mean they should have had the data, but  
24 they didn't have?

25 Q Correct. In other words, as I --  
26 as your -- a typical underground storage  
27 operator should have had "X," we asked for  
28 it, they didn't have it. Did that ever

1 happen during your root cause analysis?

2 A I don't believe so. The only  
3 reason I hesitate, Mr. Lotterman, there is  
4 because we do identify one of the root causes  
5 as lack of failure analysis. But, that has  
6 nothing to do with data. That is activity.  
7 So --

8 Q All right. I appreciate that  
9 clarification. I -- I believe we'll get to  
10 that at some point, too.

11 All right. So then, who were your  
12 main contacts at SoCalGas during the root  
13 cause analysis? Do you remember any names?

14 A Sure. At one point, it was Jill  
15 Tracy for a period of time, and then my  
16 primary contact was Glenn La Fevers. Glenn  
17 was my primary contact all along, all the way  
18 through.

19 Q What about Tom McMahon?

20 A Oh, yeah, sorry, Tom McMahon.  
21 There were a lot of them. Larry -- I -- I  
22 apologize. I may have missed a lot of names.  
23 It's been a while.

24 Q Yeah.

25 A There's a lot of them, but Glenn  
26 was my primary contact. If I didn't have  
27 something, I would call Glenn.

28 Q Did you find them overall

1 professional?

2 A Yes, absolutely. Absolutely.

3 Q What about --

4 A It's reflected in our  
5 acknowledgments. It's reflected in our  
6 acknowledgements.

7 Q What about responsive?

8 A Extremely responsive.

9 Q Did they seem to share your sense  
10 of urgency with getting the project done?

11 A Yes, they did.

12 Q Were they collaborative? And when  
13 I say that, I mean were they willing to work  
14 together with you toward a common goal,  
15 whatever the issue was at the moment?

16 A Yes, they did.

17 Q Were they creative? Did they help  
18 Blade solve problems as they arose, whether  
19 they were regulatory hurdles you talked about  
20 earlier or technical issues?

21 A Yes, they were. They were  
22 collaborative and creative and contributive  
23 to the success of the project, yes.

24 Q Were they committed to safety?

25 A Yes, they were.

26 Q And in your view, in their minds,  
27 was, in fact, safety paramount?

28 A Yes.

1 Q And was that commitment 24/7?

2 A Yes.

3 Q Okay. So did they give you a --  
4 trailers, for example?

5 A Yes, they did.

6 Q Did they help you set up a lab on a  
7 relief well pad, which we'll look about --  
8 look at in a minute?

9 A Yes, they did.

10 Q Dedicated fiber access? ]

11 A Yes, at multiple locations.

12 Q Multiple rig setups. They gave you  
13 a workover rig and then an automated drilling  
14 rig with a smaller footprint?

15 And we'll get to that in a minute,  
16 as well.

17 A Yes, they did.

18 Q By the way, you mentioned site  
19 stability earlier.

20 Why was that needed once the well  
21 was killed?

22 A It was an unknown more than  
23 anything else. We didn't know where the gas  
24 went or where the kill fluids would have  
25 gone. So there was concern about stability.  
26 So a civil engineering firm came in, they did  
27 measurements, and confirmed the stability of  
28 the site. So, absolutely, it was a valid

1 concern and had to verify everything was  
2 okay. So that was part of the phase 2  
3 process.

4 Q Okay. Did SoCalGas give you full  
5 access to its personnel?

6 A Yes, they did. Yeah.

7 Q Did they give you unrestricted site  
8 access?

9 A Yes, they did.

10 Q Did they provide you a dedicated  
11 support team to give you whatever expertise  
12 they could lend to your efforts?

13 A Yes, they did.

14 Q Including downhole expertise?

15 A Yeah. Tim McMahon is the downhole  
16 -- a lot of folks downhole there. Yeah.

17 Q What about geology?

18 A Yes. We chatted with a geologist;  
19 Hillary, I believe. We had conversations  
20 with her. We had conversations with the  
21 reservoir team at one point early on to  
22 understand their process and their approach.

23 They also provided, as part of the  
24 data request, earth visual model, which is a  
25 geological model they were using, so, yeah...

26 ALJ HECHT: I'm going to break in here  
27 with a reminder to speak slowly and not speak  
28 over one another. I know that can be

1 difficult, but our court reporters appreciate  
2 it. Thank you.

3 THE WITNESS: Sorry.

4 MR. LOTTERMAN: Thank you, your Honor.  
5 We'll try to slow it down just a little bit.

6 Q What about site preparation?

7 Did SoCalGas ask you or assist you  
8 in that effort, sir?

9 A I don't follow what you mean by  
10 "site preparation." If you're talking about  
11 Phase 2, yes. SoCalGas was accountable for a  
12 completed Phase 2, which was making it  
13 rig-ready.

14 Q Okay. That's what I did mean, yes.

15 A Okay.

16 Q Okay. And did SoCalGas assist you  
17 in getting whatever approvals you needed as  
18 part of these regulatory hurdles that you  
19 discussed earlier?

20 A Yes, absolutely.

21 Q And --

22 A We --

23 (Crosstalk.)

24 THE WITNESS: Sorry. I apologize.

25 We had multiple meetings with DOGGR  
26 district, which was the approving authority.  
27 We had meetings with the entire DOGGR  
28 district team, which was very helpful to us.

1 And SoCal was part of those conversations and  
2 getting the approvals.

3 Q And did SoCalGas's efforts, its  
4 commitment to you, start from the first day  
5 you showed up and go all the way through the  
6 end of the project?

7 A Yes, absolutely. Yes.

8 Q Now, you also mentioned on  
9 page 242, you acknowledge SoCalGas's support  
10 of the independence of the investigation.

11 Do you see that on the screen?

12 A Yeah.

13 Q Can that be a concern when  
14 performing a technical RCA?

15 A It was. It was a concern of ours  
16 to be -- because we are there investigating a  
17 failure, and that concern -- we are a bit  
18 apprehensive. I wouldn't say concerned.  
19 Apprehensive is the right word that comes to  
20 mind. But all the parties, including  
21 SoCalGas gas, insisted and urged us to be  
22 independent and never -- and it's reflected  
23 in the report. It was essential to the  
24 process, as far as I was concerned.

25 Q That was my next question.

26 Were your apprehensions justified?

27 A No, they were not justified.

28 Q And how did SoCalGas support

1 Blade's independence of the investigation?

2 A So we were never asked what our  
3 conclusions are, where we were headed, never.  
4 Never once were we asked about it. Never  
5 once until we released the final report on, I  
6 forget, May 16th, I believe, when we released  
7 the final May report. We released the  
8 supplemental 15 days later. But the May  
9 report was May 16th, I believe.

10 I had nobody from SoCal requesting  
11 a preview or wanting to know anything. So we  
12 were truly independent. And that's true for  
13 CPUC. That is true for DOGGR.

14 Q And this independence is critical  
15 for an RCA; correct?

16 A Essential. Yes, I agree.

17 Q All right.

18 And, finally, if you look at the  
19 second to last paragraph, you say -- I'm  
20 going to read this slowly, since I think  
21 we've been reading quickly so far. I'm going  
22 to fight the urge.

23 This RCA project would not  
24 have been possible without  
25 the unconditional support  
26 through the entire period  
27 from CPUC, DOGGR, and  
28 SoCalGas.

1 Do you see that?

2 A Yes. Yes.

3 (Crosstalk.)

4 THE WITNESS: Sorry. Go ahead.

5 BY MR. LOTTERMAN:

6 Q Sitting here today, Dr.

7 Krishnamurthy, do you personally have any  
8 criticisms of SoCalGas's support and  
9 cooperation with your root cause analysis  
10 investigation?

11 A I personally, and on behalf of my  
12 team, I can tell you -- because a lot of my  
13 team members interacted with various SoCalGas  
14 personnel during the project, we could not  
15 have completed this without their support --  
16 unconditional support, as we state.

17 Q I guess that was what I was going  
18 to say. You actually state that on page 242  
19 of the main report.

20 True?

21 A Yes.

22 Q All right. Enough of the credits.  
23 Let's go back to the story.

24 I want to turn you to page 15 of  
25 the main report, sir. And I want to look at  
26 the Aliso Canyon facility itself.

27 And I'm going to ask Mr. Moshfegh  
28 to put up Figure 1 on the screen and do his

1 best to enhance it. Thank you, sir.

2 So if you look at page 15 of your  
3 main report, Dr. Krishnamurthy, you provide a  
4 brief description of the overall facility.

5 Do you see that?

6 A Yes.

7 Q And you note it's in the Foothills  
8 of Oat Mountain.

9 Do you see that?

10 A Yes.

11 Q Okay.

12 Was it difficult to access?

13 A Yeah. It was a long drive. And  
14 SS-25 was towards the top. So, yeah, it was  
15 a bit of a challenge, especially on, you  
16 know -- yeah. It's a bit of a drive. And  
17 access was challenging. Yeah.

18 Q Did you ever walk it?

19 A Oh, no. No. I drove it.

20 Q Too far?

21 A No, I couldn't walk it.

22 Q Would you consider this area to be  
23 remote?

24 A Yeah. Once you enter the facility,  
25 it appears remote. But, yeah, specifically  
26 as you can see on the map, it's close by  
27 Porter Ranch. But it does appear remote in  
28 the mountains and the hills.

1           Q    I mean, it's my understanding that  
2 this facility was about six square miles.

3                   Is that roughly your understanding,  
4 overall?

5           A    Yeah. Yes.

6           Q    And if you turn to page 14 -- I'm  
7 sorry -- 17 of the main report, and you look  
8 at Figure 3, you can see that the actual  
9 six-square-mile facility shows different  
10 sectors.

11                   (Audio interruption.)

12                   (Reporter clarification.)

13           ALJ HECHT: We'll be back on the  
14 record.

15                   We were off the record due to a  
16 technical problem. Unfortunately, we have to  
17 back up slightly. And I am hopeful that Mr.  
18 Lotterman and Witness Krishnamurthy both know  
19 where to pick up.

20                   So, go ahead.

21           MR. LOTTERMAN: I do, your Honor.  
22 Thank you. I also note that your description  
23 of this process being clunky was probably one  
24 of the most diplomatic descriptions I've  
25 heard in the many hearings I've done since  
26 last March. So we will get by the  
27 "clunkiness" here as we can.

28           Q    Dr. Krishnamurthy, let me back up a

1 little bit, because we lost Ms. Powers at  
2 some point in time. I was directing your  
3 attention to Figure 3 on page 17 of the main  
4 report.

5 Do you see that?

6 A Yes, I do.

7 Q And I believe you testified that  
8 the facility was actually broken into or  
9 divided into three sectors. You have the  
10 left section to the left.

11 Do you see that?

12 A Yes.

13 Q And then the central section and  
14 the east section.

15 True?

16 A Correct. Yes.

17 Q And I believe you also testified in  
18 that -- this is right in your report, just  
19 blow that figure -- that there were 119  
20 active or idle wells at the Aliso Canyon  
21 facility during the 2015 timeframe.

22 True?

23 A Yes.

24 Q And then I asked you what an idle  
25 well was, and you were about to describe it  
26 when we learned Ms. Powers was no longer with  
27 us.

28 Would you tell the Commission what

1 an idle well is?

2 A Yeah. Idle well would be a well  
3 that is neither, in this particular case,  
4 withdrawing or getting gas out of the well or  
5 injecting gas in the well. It was just shut  
6 in and just sitting. Whereas, an active well  
7 will be operating either as withdrawing gas  
8 or injecting gas.

9 Q And a day before the incident  
10 occurred on October 23rd, 2015, was SS-25 an  
11 active well?

12 A I believe it was an active well.

13 Q And what sector of the Aliso Canyon  
14 field is it located in?

15 A I believe it's the west sector.

16 Q All right. I have a couple  
17 questions about that a little later.

18 And then one final question about  
19 this overall field, are there other wells  
20 operated by other producers there?

21 A I believe so. And we have  
22 articulated that in the report. I don't  
23 remember how many wells. But, yes, there are  
24 other operators.

25 Q Is that unusual for an underground  
26 storage facility, if you know?

27 A Yeah. I don't know. I don't think  
28 it is unusual. Because the only reason I'm

1 saying it may not be unusual, you could be  
2 storing gas in a second zone, and you could  
3 be producing oil from a shallow reserve. So  
4 it may not be that untypical. But I'm not  
5 qualified to say whether that is common or  
6 not common. I don't have that kind of data.

7 Q I appreciate that. I appreciate  
8 that.

9 And can you answer this question  
10 for me:

11 Can the presence of wells operated  
12 by other producers complicate underground  
13 storage facilities operations?

14 A Absolutely.

15 Q Okay. We'll talk about that in a  
16 bit.

17 I want to jump back a page to  
18 Figure 2 at the main report, page 16. And I  
19 just want to clarify one thing so the  
20 Commission understands this.

21 When we talk about the SS-25 well  
22 site or well pad, is that the area depicted  
23 in white on Figure 2 of your main report?

24 A Yes. That is the SS-25 pad -- well  
25 site or pad. That is the pad, exactly. If  
26 you zoom in, you'll see the pad.

27 Q And does that pad contain three  
28 wells?

1           A    Yes.  It contains 25, 25-A, and  
2  25-B.

3           Q    Okay.  Thank you.  And I think  
4  we'll have a picture of that in a minute to  
5  show where they line up with each other.

6                    So let me ask you another  
7  big-picture question, and then we're going to  
8  start going down the well.

9                    Is it true that Aliso Canyon is a  
10 converted, depleted oil reservoir?

11           A    Yes.

12           Q    What does that mean?

13           A    It -- I'm going to attempt to  
14 explain that.  And I hope I explain it  
15 correctly, carefully.

16                    The -- you have porosity and  
17 permeability in the rocks.  So porosity is  
18 volume of oil in the rock.  It defines the  
19 volume of hydrocarbon in the rock.  
20 Permeability establishes conductivity.

21                    So the standard sesnon had good  
22 porosity, good permeability.  So a lot of oil  
23 was produced.  And then there's a point at  
24 which it either becomes uneconomical or it  
25 becomes -- it's not zero, but the oil levels  
26 are very low in that reservoir.  But since  
27 I've removed the oil from where the oil was,  
28 those -- that porosity can provide a space to

1 store gas. That's really what an old,  
2 depleted oil well can be used as a gas  
3 storage.

4 ALJ POIRIER: ALJ Hecht, it looks like  
5 Mr. Lotterman might have lost audio.

6 ALJ HECHT: All right. We'll be off  
7 the record.

8 (Off the record.)

9 ALJ HECHT: We'll be on the record. We  
10 were off the record due to another very  
11 similar technical problem, which I believe  
12 has now been addressed. And we will continue  
13 with questions by Mr. Lotterman.

14 BY MR. LOTTERMAN:

15 Q Dr. Krishnamurthy, when we left  
16 off, you were explaining what a converted,  
17 depleted oil reservoir was. And we don't  
18 need the revisit that.

19 I want the pull up for you  
20 though -- and, again, this is just a very  
21 quick line of questions. I want to pull up  
22 for you Figure 5 from one of your  
23 sub-reports. And, for the record, this would  
24 be from Exhibit 1002, which is Volume 2  
25 entitled "SS-25 Well Failure Causes." It's  
26 the eighth supplement called "Geology  
27 Summary." And I just want to use it for  
28 demonstrative purposes.

1           So, Dr. Krishnamurthy, I believe --  
2 I'm not sure you need to look at the report  
3 itself, but you are more than welcome to  
4 refer to it.

5           A     Okay.

6           Q     So we're looking at page 14,  
7 Figure 5, Mr. Moshfegh. Thank you.

8           So, Dr. Krishnamurthy, again, I  
9 don't want to spend a whole lot of time on  
10 this, but you were throwing out some terms  
11 there about sesnon zones, et cetera. And I  
12 just want the Commission to understand what  
13 exactly SS-25 has to go through to get from  
14 the well head down to the storage reservoir.  
15 So let's start at the top if you would, sir.  
16 And then I'm going to just walk you through  
17 this very, very quickly.

18           If you look at the top of Figure 5,  
19 it identifies four different sets of wells.

20           Do you see that?

21           Frew, standard sesnon, or SS,  
22 Porter, and Fernando Fee.

23           A     Yes.

24           Q     Do you know why those wells are  
25 named differently?

26           A     They -- again, it's a geological  
27 naming convention. They may be going to  
28 different zones at a lower level. And that's

1 probably why they were named different. That  
2 is my guess.

3 Frew is going through frew fault  
4 there. And sesnon is going through a  
5 different fault. So that's my guess. I  
6 don't know the exact reasons for that. But  
7 those would be some reasons you would name  
8 them differently.

9 Q All right. I appreciate that. And  
10 I understand that you weren't there when  
11 these were drilled. But I think that's a  
12 pretty educated guess, shall we say.

13 And, just for the record, if you  
14 look at the middle of the diagram, there is  
15 SS-25.

16 True?

17 A Yes.

18 Q Okay. And it looks like it's  
19 drilled down -- and we're going to talk about  
20 this in a minute -- but it looks like it's  
21 drilled down. And it basically ends up in  
22 the sesnon zone there, that kind of apricot  
23 color?

24 A Yes.

25 Q Okay. And we're going to get to  
26 some of this in a bit, so I want you to make  
27 sure you clarify for me, are you saying that  
28 that sesnon zone at one point produced oil?

1           A    That is my understanding --

2           Q    Okay --

3                   (Crosstalk.)

4                   (Court reporter clarification.)

5           ALJ HECHT:  We have crosstalk.  We will  
6 be off the record.

7                   (Off the record.)

8           ALJ HECHT:  Thank you, all.  We'll be  
9 back on the record.

10                   Please, go ahead.

11 BY MR. LOTTERMAN:

12           Q    Dr. Krishnamurthy, is the sesnon  
13 zone, to your understanding, the zone where  
14 oil was produced for years before SoCalGas  
15 took the field and converted it to gas  
16 storage?

17           A    That is my understanding.

18           Q    Okay.  And you're going to hear the  
19 word -- we're going to use the word "caprock"  
20 later on today.

21                   Would you explain to the Commission  
22 what caprock is, and where you would find it  
23 along the sesnon zone?

24           A    The caprock should be on top of the  
25 sesnon.  Okay?  It should be the zone that  
26 you have to penetrate to get to the sesnon.  
27 That is the one at separates the producing  
28 zone from above.  That's the --

1           Q     Right.  And at the risk of botching  
2     that description, is it fair to say that it's  
3     because of the caprock that the oil that was  
4     produced did not -- well, let me put it this  
5     way.  Let me strike that.

6                     Is it fair to say that it was  
7     because of the caprock that oil was contained  
8     in that sesnon zone for millennia?

9           A     That is correct.  The caprock is  
10    what prevents vertical flow.  Yeah.

11          Q     And, likewise, when SoCalGas  
12    decided to convert the facility to gas  
13    storage once the oil production was depleted,  
14    that's the same caprock that keeps natural  
15    gas from escaping from that sesnon zone and  
16    going to atmosphere; is that correct?

17          A     That is correct.

18          Q     All right.  And one last question,  
19    just to give us a sense of scale -- because I  
20    see it here, but I don't quite understand the  
21    at -- the axis here.

22                     It's my understanding that, for  
23    example, the SS-25 well, that blue  
24    description that starts at the top of the  
25    mountain there and goes down into the sesnon  
26    zone, it's my understanding that that's  
27    8,000 feet deep.

28                     Is that true?

1           A    Yes.  8 -- around 8,000.  
2   8,300-something, yeah.

3           Q    Right.  So roughly a mile and a  
4   half deep, well from surface, down to storage  
5   zone; correct?

6           A    Yes.

7           Q    Okay.  Now, couple last questions  
8   and then we're going to move on to the SS-25  
9   itself.

10                    Is it a common practice, to your  
11   understanding, in the United States to  
12   convert former oil production fields into  
13   natural gas storage fields?

14           A    Yes.

15           Q    And is it a common practice in this  
16   country, and perhaps even elsewhere, to  
17   convert former oil production wells into gas  
18   storage wells?

19           A    Yes.

20           Q    And as part of your root cause  
21   analysis, did Blade examine SoCalGas's  
22   conversion of this field, Aliso Canyon, and  
23   its wells to gas storage?

24           A    Yes, we did.

25           Q    And did you find any deficiencies  
26   in that conversion?

27           A    No.

28           Q    And, in fact, while that conversion

1 was going on, did Blade find instances where  
2 SoCalGas identified leaks in the  
3 then-existing oil production wells?

4 A Yes.

5 Q And is that a common practice  
6 during conversion?

7 A Yes.

8 Q And when you watched it -- when you  
9 examined SoCalGas's conversion of this field  
10 -- and, again, this is back in the 1970s, but  
11 we'll talk about that in a minute -- did you  
12 see anything that SoCalGas should have done  
13 that it didn't do?

14 A You mean during the conversion;  
15 correct?

16 Q Yes, sir.

17 A No, we did not find anything.

18 Q All right. Okay.

19 Let's sharpen our focus now. Let's  
20 look at SS-25 itself. Okay?

21 As I promised, we're starting at  
22 Google Maps and working our way down the  
23 well. All right.

24 So it's my understanding, sir, that  
25 the root cause analysis included reviewing  
26 the well itself, SS-25.

27 True?

28 A Yes.

1 Q Its conversion.

2 True?

3 A Yes.

4 Q It's operational history.

5 True?

6 A Yes.

7 Q And even some nearby wells on the  
8 same pad; correct?

9 A Yes.

10 Q Give me a second here.

11 And it's my understanding that  
12 SS-25, as a well -- as an oil well, was  
13 drilled in 1954 -- and I can give you the  
14 cite off your main report if you would like?

15 A 1953, yes.

16 Q Well, '53 was the spud date;  
17 correct?

18 A Yes.

19 Q Okay. And could you tell the  
20 Commission what the difference between the  
21 spud date and drill date is?

22 A Well, the spud date would be the  
23 date they have the conductor in place or get  
24 the location ready to get started drilling.  
25 That was October 1, 1953.

26 Q Okay. So if I understand what  
27 you're saying, sir, is that that well was  
28 drilled a hundred -- or that one and a half

1 miles deep -- that completion, was in 1954.

2 True?

3 A I'm looking at my records, Mr.  
4 Lotterman. I'm not able to confirm that  
5 date. But, yeah, that well was completed,  
6 yes, with the gas in 1954. That is right.

7 Q Yeah. I --

8 A February 15th.

9 Q Yes, sir. And I see those dates,  
10 for your information, right on main report,  
11 page 20 -- 25.

12 So what I would like to do now, and  
13 this won't take long. But just for sake of  
14 clarification, I would like to ask Mr.  
15 Moshfegh to bring up Figure 9 from your main  
16 report. And that's on page 27. And this is  
17 going to be a little bit hard to read, but I  
18 think we're stuck with -- oh, that's better.  
19 Okay. All right. Mr. Moshfegh is showing  
20 off.

21 All right. Let's see what we can  
22 do here. So let's talk about Figure 9 a  
23 minute. And I want to make sure everyone  
24 understands, when we get into the technical  
25 details of the root cause analysis, what  
26 exactly we're talking about. Okay?

27 First of all, this scale here, this  
28 is obviously not in miles; correct?

1           A    No.  This is feet, I think.  Yeah.

2           Q    Okay.  Right.  Right.

3                    And if you look at the top  
4 left-hand corner, there you go, it does show,  
5 as you suggested, a spud date of sometime in  
6 October 1953.

7                    True?

8           A    Yes.

9           Q    Now, I want to start on the -- I  
10 want to build this well.  I want to start on  
11 the outside of the well and work our way in.  
12 If you look at the very top of the diagram,  
13 there is a -- I'm not sure how you describe  
14 it.  It looks like, sort of, a line with a  
15 foot on the end -- do you see that? -- and it  
16 ends at 990 feet?                                 ]

17           A    Yes.

18           Q    Is that the surface casing?

19           A    Yeah.  That is the 11 3/4-inch  
20 diameter surface casing and (inaudible) 40,  
21 42-pound per foot.  Yeah.

22           Q    And that's the obvious, but I'm  
23 going to anyway.  Is that a steel pipe?

24           A    Yes, it's a steel pipe.

25           Q    And what is the purpose of a  
26 surface casing on a -- either an oil well or  
27 a gas storage -- or at an oil well upon being  
28 drilled?

1           A     The role of the surface casing, the  
2 990 feet is primarily to isolate any aquifers  
3 or water zones, or something like that,  
4 depending on where you are in the country or  
5 the well. That's really the role of the  
6 surface casing.

7           Q     Is it used to keep the hole in  
8 place when the well is being drilled?

9           A     Correct. It's primary function is  
10 to get you to 990 and then allow you to drill  
11 from 990 to TD.

12          Q     Is it intended to carry pressure?

13          A     It is not designed to carry  
14 pressure, no.

15          Q     And would you explain to the  
16 Commission what "carry pressure" means?

17          A     Basically it is not intended as  
18 what we call a structural element. So the  
19 surface casing, the 11 3/4-inch is intended  
20 to just allow you to drill at beyond 990  
21 feet, isolate the water zone, but if there is  
22 any gas pressure or oil pressure or anything  
23 on the ID, it may not -- it may not have  
24 enough structural strength to carry that  
25 pressure.

26          Q     Okay. And why, if you know, was  
27 SS-25 drilled -- or why was the well that --  
28 let me back up. I'll withdraw the question.

1           Why was Well SS-25's surface casing  
2 drilled to 990 feet?

3           A     Normally the intent of that 990 is  
4 to hold back any water zones that were there.  
5 That would have been the intent.

6           Q     Yeah. I'm sorry. My question was  
7 imprecise. So let me rephrase it.

8                     Who decided that SS-25's surface  
9 casing be drilled to 990 feet?

10          A     The operator at that point would  
11 have decided that. And he would have had to  
12 have -- if I remember right -- and I don't  
13 remember this -- would have to -- it needs to  
14 get regulatory approval for that depth, but  
15 that's my guess.

16          Q     Okay --

17          A     But the operator would be the --  
18 would be the one who designed that, the  
19 operator then.

20          Q     I understand the designing aspect  
21 of it, Dr. Krishnamurthy. I guess what I'm  
22 wondering -- and let me ask you my question a  
23 little more directly. Is it your  
24 understanding that the regulatory agency like  
25 DOGGR decides what depth a surface casing  
26 should be drilled for a well?

27          A     And this is -- my knowledge may not  
28 be deep enough here, Mr. Lotterman, but my

1 assumption is that DOGGR would have to  
2 approve whether it's 990 or 500 or 1,000.  
3 Whatever depth it is, DOGGR would have to  
4 approve.

5 Q All right.

6 A I --

7 Q We will -- we will -- excuse me. I  
8 just broke my promise. We will clarify that  
9 with later testimony, Dr. Krishnamurthy, of  
10 someone who was involved with the particulars  
11 of this well, but I just was seeing if you  
12 knew.

13 Final question on the surface  
14 casing. Is -- are they difficult to monitor  
15 once the whole well was in place?

16 A Yes, because you have two -- you  
17 have a production casing beyond that, the  
18 7-inch production casing, and you have a  
19 tubing. So it's not easy to inspect or  
20 access it, yes.

21 Q Even with today's technology?

22 A In today's technology, there are  
23 some tools that will look beyond multiple  
24 strengths, but yeah, there are some  
25 technologies that will do it. They are  
26 qualitative in nature, but that's correct.  
27 It's very new technology and not necessarily  
28 quantitative in nature. But yeah, it's very

1 difficult to do that.

2 Q And was that qualitative technology  
3 available in 2015 to your understanding?

4 A I don't remember exactly when it  
5 became available, but '15 it was probably  
6 available but it was pretty new in the market  
7 at that point. And so I can't comment on  
8 that, Mr. Lotterman. I'll have to look it  
9 up, but it could be somewhere prior to 2015  
10 where they started using it at some wells in  
11 the world. But it was very new technology in  
12 2015.

13 Q And as far as you knew, was it a  
14 prevailing practice to use that technology in  
15 2015 to monitor surface casing pipe?

16 A No, it was not.

17 Q All right. What's that little  
18 stippled stuff -- that's a word -- above the  
19 990 feet? Looks like kind of a little dot --  
20 you know, dot, dot, dot, dot, dot. What's  
21 that supposed to designate?

22 A That's supposed to designate  
23 presence of cement.

24 Q Why would an operator put cement  
25 outside that surface casing?

26 A Again, in surface casing, the idea,  
27 again, would be to keep the water away from  
28 the surface casing and ensure the surface

1 casing is protected from water. That would  
2 be one reason. Isolate the carbon steel from  
3 the water. That would be the primary reason  
4 for the cement there.

5 Q Would it also be there to stabilize  
6 the surface casing before you drill the  
7 production casing?

8 A Yes, you would. That's a good  
9 point. Yeah. You would apply the cement to  
10 hold it in place.

11 Q In fact, would that be the primary  
12 purpose?

13 A Yeah. That would be the primary  
14 purpose. The secondary purpose would be the  
15 water. You are correct.

16 Q All right. So let's work our way  
17 in here, and we'll get through this pretty  
18 quickly. Is there typically -- or at least  
19 with SS-25 is there a pipe inside the surface  
20 casing pipe?

21 A Yes. That is the production  
22 casing, the 7-inch casing.

23 Q Okay. And I don't see it. I don't  
24 see an arrow actually pointing to it.

25 Mr. Moshfegh, could you maybe  
26 highlight one side or the other of the  
27 production casing and just -- just so Dr.  
28 Krishnamurthy can make sure we're on the same

1 pipe, shall we say. There you go.

2 You see where there -- you see  
3 where we're indicating, Dr. Krishnamurthy?  
4 Is that the production casing there?

5 A Yes. That is the production  
6 casing.

7 Q And the other diameter is on the  
8 other side, right? There you go.

9 A Yeah. That is a 2 7/8.

10 Q Okay.

11 A Yeah. That is a 7-inch. Where  
12 you're showing right now it's still the  
13 7-inch.

14 Q And could you give the Commission a  
15 sense as to how thick that -- by the way,  
16 that's made of steel as well, correct?

17 A Yes, it's also made of steel.

18 Q Can you give the Commission a sense  
19 as to how thick that casing is? And I've got  
20 a site for you, if you need it?

21 A Yeah. It is about .317 inches, I  
22 believe, up to 6,308 feet, if I remember  
23 right -- if my memory serves me right. So  
24 you see -- under 7-inch, you see the  
25 different weights there, 23 pounds per foot,  
26 26 pound per foot, 29 pound per foot. So it  
27 was J55 -- or that is the grade of the pipe,  
28 which is 55 ksi, that was run from 0 to 2,398

1 feet. And then there was 23 pound N80 that  
2 was around from 2,398 to 6,308 feet and so  
3 on.

4 Q So I have on page 63 of your report  
5 that the pipe was .321 inches thick or 8.15  
6 millimeters. Does that roughly comport with  
7 your recollection?

8 A Yeah. That should be correct. The  
9 number in the report would succumb my memory.

10 Q Good. Okay. And we don't need  
11 to -- you know, that is what it is. And I'm  
12 not sure we need to spend time confirming  
13 that, but -- and to be clear, this production  
14 pipe -- I mean the surface casing stops at  
15 990 feet. That production pipe goes a  
16 hundred -- goes one -- a mile and a half deep  
17 into the formation, correct?

18 A Yes.

19 Q And it's my understanding that the  
20 hole that was drilled into which to put that  
21 7-inch casing was roughly 10-plus inches  
22 wide, correct?

23 A That's correct.

24 Q Okay. And again, this is the  
25 political science major in me, but it's my  
26 understanding you don't just drop all that  
27 pipe in. You have to sort of put the pipe in  
28 in sections, and then what? Do you screw the

1 threads together? Is that how it works?

2 A Yeah. You would drill a hole, then  
3 you will pedal surface and keep increasing  
4 the depth of that casing as you go down.

5 Q And explain to us very, very  
6 briefly how those sections of pipe are  
7 connected -- are joined?

8 A I hope my length is correct.  
9 Approximately about 40 feet of casing pipe  
10 would be in place. Then you have -- had a  
11 threaded connection. Here this was -- this  
12 was a special connection called speed type  
13 connection. So -- so you would thread it in  
14 at every 40 feet. I hope I got that 40 feet  
15 right. That number changes. It's 40 to 45  
16 feet, I believe. And you'll thread it in,  
17 and you'll run the casing all the way to the  
18 bottom.

19 Q And when you say it's threaded in,  
20 do you mean you literally are screwing like  
21 pipe A into pipe B through threads -- using  
22 threads?

23 A Correct.

24 Q And when you look at the SS-25  
25 well, were the threaded connections used at  
26 that time? And granted this was 1953, '54,  
27 were they considered premium connections  
28 then?

1           A    Yes.  They were.  It was speed  
2 types ideal, I believe.  Yeah.  It is premium  
3 connection those days.

4           Q    All right.  So we put in the  
5 surface casing to 990 feet.  We drilled a  
6 10-plus-inch-wide hole down through the cap  
7 rock into the former oil production  
8 reservoir.  We then sort of put sections in  
9 at a time, screw them in and work those all  
10 the way down passed the cap rock as well, but  
11 what, if anything, goes between the outside  
12 of that 7-inch production casing and the  
13 earth, in the formation?

14          A    Again, as you're showing on the  
15 screen right now, you cement it, and you're  
16 cementing it all the way to 7,000 feet from  
17 about -- I'm reading it from the screen --  
18 8,585 -- 8,585 to 7,000 feet is cemented in  
19 place.

20          Q    Okay.  And then, Mr. Moshfegh, if  
21 you would scroll up a little bit.

22                    But SS-25 was not cemented from  
23 7,000 feet up to the surface casing, correct?

24          A    That's correct.

25          Q    Was that a common practice when it  
26 was drilled in the mid-1950s?

27          A    Yes.

28          Q    Okay.  And scroll to the top, if

1 you would, Mr. Moshfegh.

2 Between the surface casing that --  
3 sort of that line that has -- like it has the  
4 shoe on it and the production casing, there's  
5 a space. Do you see that?

6 A Yes.

7 Q In your business, is that called an  
8 annulus?

9 A Yeah, that is the annulus.

10 Q Okay. And as part of the drilling,  
11 the well process in the 1950s, is anything  
12 contained within that annulus as the well is  
13 being drilled and completed?

14 A Yeah. When you apply cement to  
15 7,000 feet, you would displace that cement  
16 into place with another fluid behind the  
17 cement on top of the cement and behind you  
18 would have drilling mud, which is very  
19 common. Drilling mud is what you would have  
20 behind that.

21 Q And what is drilling mud?

22 A And drilling mud would be probably  
23 a water-based mud weighted with barite. That  
24 is my guess. I have to go back. I remember  
25 we analyzed it. It is a water-based mud. In  
26 the report we got some electric log data  
27 which showed us the nature of that fluid. It  
28 had a PH of about 10 to 12, which is common

1 for drilling mud, and that is what you would  
2 have. That would be the fluid on top of the  
3 cement.

4 Q So if I understand you correctly,  
5 as you're drilling this production well into  
6 the formation down into the cap rock,  
7 drilling fluid is left or exists on the  
8 outside of that pipe certainly up around the  
9 surface casing and certainly down the bottom  
10 around the shoe; is that correct?

11 A Yes. All the way to surface. Yes.

12 Q Got it. And is that drilling fluid  
13 or drilling mud, as you called it, that -- is  
14 it corrosion resistant?

15 A Yeah. It is really typical, when  
16 you run these muds, you run them at a high  
17 PH, like 10 to 12 or 9 or 10 to 12  
18 intended -- these higher PH corrosion is not  
19 a factor. That is why they -- that's why one  
20 uses it. And we had data to indicate that  
21 that was used here.

22 Q Okay. So I guess that was my next  
23 question. As far as you know -- and I'm not  
24 holding you to amounts or duration or  
25 whatever, because we'll get to that in a  
26 bit -- but as far as you know, when SS-25 was  
27 drilled in the 1950s, there was drilling  
28 fluid between that outer surface casing and

1 that next inner-production casing. True?

2 A Yes.

3 Q All right. And if that drilling  
4 fluid did what it was designed to do, at  
5 least while it was there, it would resist or  
6 try to prevent corrosion; is that accurate?

7 A That's correct.

8 Q All right. All right. Let's go to  
9 the final -- let's finish this well. So I  
10 see two lines inside the production casing.  
11 In fact, I see an arrow here. It says,  
12 "2 7/8-inch," and then it gives some numbers,  
13 which I'm not sure we have to deal with  
14 today, but what does that depict?

15 A That is the tubing. That is the  
16 2 7/8 tubing that is run within the  
17 production casing, and there is a packer at  
18 the bottom.

19 Q What's a packer?

20 A A packer is an element. Perhaps an  
21 element of elastomer -- combination of  
22 elastomer and steel that isolates the annulus  
23 from the environment within the tubing.

24 Q All right. Is that the packer,  
25 those three kind of gray lines at the bottom  
26 there?

27 A I don't know. It's the black --  
28 no, no. It's the black line outside of the

1 tubing.

2 Q Okay. Got ya. All right. And if  
3 I were to ask you to point out the casing  
4 shoe on this well, where would that be on  
5 this figure?

6 A It would be at 8,585 feet. That's  
7 where I see it.

8 Q So to be clear -- and is that  
9 typical to have a casing shoe that deep?

10 A Yeah. Yeah. There are wells -- it  
11 depends on the wells, yeah, but it's not  
12 atypical.

13 Q And if I read this figure 9  
14 correctly, is that casing shoe below the cap  
15 rock?

16 A It should be below the cap rock. I  
17 believe it should be below the cap rock.  
18 Yeah.

19 Q Okay. Why would an oil production  
20 company in the 1950s put tubing inside  
21 production casing?

22 A They were produced through the  
23 tubing. They will have -- I believe this is  
24 a gas lift oil producer. So they would have  
25 pumped -- they may have. I don't remember  
26 the -- we didn't look at it carefully. But  
27 they would have pumped gas to lift oil from  
28 the bottom to surface to produce -- produce

1 oil through the tubing. And 2 7/8 may have  
2 been adequate -- or whatever tubing they used  
3 would have been adequate for the amount of  
4 oil they were anticipating. So it's a design  
5 issue.

6 MR. LOTTERMAN: Okay. Judge Hecht, I'm  
7 about to turn to a different topic or  
8 slightly. If you'd like, we can keep going  
9 or we can break.

10 ALJ HECHT: I think we should take our  
11 lunch break now. I think that this is good  
12 timing. Thank you for letting me know. All  
13 right. I'm going to say we're going to have  
14 a lunch break until 1:15, and then we will  
15 return with the same witness and  
16 cross-examination.

17 We'll be off the record.

18 (Whereupon, at the hour of 12:13  
19 p.m., a recess was taken until 1:15  
20 p.m.)

21 \* \* \* \* \* ]

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AFTERNOON SESSION - 1:15 P.M.

\* \* \* \* \*

RAVI KRISHNAMURTHY

resumed the stand and testified further as follows:

ALJ POIRIER: We will be back on the record.

Good afternoon. This is ALJ Marcelo Poirier. We are -- this is the afternoon session for the hearings for Aliso Canyon I.19-06-016. Prior to the lunch break, Mr. Lotterman with SoCalGas was cross-examining Mr. Krishnamurthy with Blade, and let's continue with that.

Please move ahead, Mr. Lotterman. Thank you.

MR. LOTTERMAN: Thank you, your Honor.

CROSS-EXAMINATION RESUMED

BY MR. LOTTERMAN:

Q Dr. Krishnamurthy, I forgot to ask you, when we first began this examination, whether you had an opportunity to watch any of the earlier proceedings last week?

A I watched for a few minutes maybe on Thursday or Friday but not much. Not much. Not much.

1           Q    Okay.  The other question I wanted  
2 to ask you is you don't seem comfortable with  
3 my calling you a corrosion engineer, and I  
4 understand that.  But is there a phrase I can  
5 use so if I ask you a question as a whatever  
6 engineer going forward that you're  
7 comfortable with?

8           A    I don't know.  I'm okay.  I'm okay,  
9 Mr. Lotterman.  I'm fine.  You can call me a  
10 corrosion engineer or a materials engineer.  
11 That should be fine.  That's okay.

12          Q    Got it.  Thank you, sir.  Let's go  
13 back to figure 9 on page 27 of the main  
14 report, which has been identified as  
15 Commission Exhibit 1000.  I have a couple  
16 minor questions, and then we're going to go  
17 down the well.

18                    So couple follow-up questions, Dr.  
19 Krishnamurthy, is what are those -- what are  
20 those sort of gray slots at the bottom of the  
21 well horizontally just above the packer?

22          A    They are probably representative of  
23 the annular flow system or the gas lift  
24 mandrel or a nipple there.  So those are  
25 some -- what we call completion components.  
26 That's how I would describe that.

27          Q    All right.  And where are the stage  
28 collars on this well?

1           A    I don't believe this well had a  
2 stage collar. I don't think that is used --  
3 that's my -- that's what I remember.

4           Q    Okay. And if a well does have a  
5 stage collar, where would it typically be on  
6 this 1 1/2-mile continuum?

7           A    I think they use stage collars --  
8 it was more in the gas -- in the natural  
9 gas -- sorry. In the gas storage wells that  
10 were drilled in the '80s or '90s. I would  
11 say it is used for cementing purposes. So  
12 wherever you are cementing, that's where  
13 you're trying to have a stage collar. That  
14 is my understanding. I am not -- I don't  
15 have any expertise to go beyond that, Mr.  
16 Lotterman, but that's my understanding.

17          Q    Fair enough, sir. And then the  
18 final question I wanted to ask you is -- and  
19 Mr. Moshfegh, if you would maybe scroll down  
20 to the top of the well a minute. We're going  
21 to be talking about annuli or annuluses on  
22 this well and wells in particular. And to  
23 clarify, on a well like SS-25, there are  
24 actually two annuli; is that right?

25          A    That's correct.

26          Q    There is an annuli between that  
27 surface casing, that 990-foot surface casing  
28 and the production casing, correct?

1           A     Yes, that's correct.

2           Q     And then there's an annuli, I  
3 assume, between the production casing and the  
4 tubing or the tubing casing, correct?

5           A     Correct. Between the -- between  
6 the -- the annulus you're talking about is  
7 between the production casing and the tubing.

8           Q     Right. And so -- and I guess what  
9 I was struggling to say earlier -- so you  
10 have sort of a 2 and 7-inch tubing on the  
11 inside, right? And then you've got an  
12 annulus. And then you have a 7-inch casing  
13 outside of that, and then you have an  
14 annulus, and then, at least at the top of the  
15 well, you have an 11 3/4-inch surface casing,  
16 right?

17          A     That's correct.

18          Q     And if -- if you were to say that a  
19 well flows tubing flow only, which aspect of  
20 this well would that gas or the oil be  
21 flowing through?

22          A     If it is tubing only, it will flow  
23 to 2 7/8-inch tubing -- inside the  
24 2 7/8-inch. That's correct. And wherever  
25 you're marking. Yeah.

26          Q     Got it. And if you were to say it  
27 was performing in a dual-flow capacity, which  
28 aspects of this well would the gas or the --

1 the gas in this case, I guess, be flowing  
2 through?

3 A It could be flowing just through  
4 the annulus, which is between the 2 7/8 and  
5 the 7-inch. It could be flowing just through  
6 there, or it could be flowing through the  
7 2 7/8 by 7-inch and through the 2 7/8  
8 depending on what you are trying to do.

9 Q And if I understand how -- sort of  
10 the difference between an oil production well  
11 and a gas storage well, oil production well  
12 is basically the fluid being produced; i.e.,  
13 the oil is going in one direction that is out  
14 of the well, correct?

15 A Yes, that's correct.

16 Q And in the gas storage business,  
17 it's not uncommon for a well to not only be  
18 used to withdraw gas out of the storage  
19 reservoir but also to inject gas into the  
20 storage reservoir, correct?

21 A Yes, that's correct.

22 Q Very common in the industry?

23 A Yes, very common.

24 Q Did that practice bother you in any  
25 way?

26 A No.

27 Q Okay. By the way, when you -- I  
28 assume you put this wellbore schematic

1 together, you being Blade, yourself, correct?

2 A That's correct.

3 Q Did you use the SS-25 well file  
4 either in preparing these types of diagrams  
5 or in your overall RCA analysis?

6 A Yes. We used the SS-25 well files  
7 to develop these diagrams, the details around  
8 everything.

9 Q Did you find that well file  
10 complete?

11 A Yes. As far as we could see, we  
12 had all the information we needed, yes.

13 Q All right. Now I want to talk  
14 about not just converting an overall facility  
15 to gas storage but converting this well to  
16 gas storage. Okay?

17 A Yes.

18 Q And I'm looking at page 25 of your  
19 report, because there's some dates in here.  
20 Is it your understanding, sir, that SS-25 was  
21 converted from oil production to gas storage  
22 in 1973?

23 A That's correct, yeah.

24 Q And so if I can do the math, that  
25 means it produced oil for about 20 years,  
26 right?

27 A Yes.

28 Q Okay. And I want to give the

1 Commission a sense as to what SoCalGas did  
2 when it converted this well from oil  
3 production to gas storage. First of all, it  
4 pulled all of the tubing, correct?

5 A Yes.

6 Q Okay. And then if you remember  
7 that little thing way down at the bottom  
8 below the cap rock, it actually replaced the  
9 packer, correct?

10 A Yes.

11 Q Okay. And any seal assemblies and  
12 seals, those were are replaced, correct?

13 A Yes.

14 Q And then I assume that, as part of  
15 that process, it also replaced the wellhead?

16 A Yes.

17 Q Okay. And by the way, when you  
18 walked up to that facility in October -- I'm  
19 sorry. Excuse me -- in January of 2016, did  
20 you sort of do a visual fit-for-purpose  
21 evaluation?

22 A Can you repeat that, Lotterman.  
23 Are you talking -- Mr. Lotterman. Are you  
24 talking about the SS-25, because it had --  
25 that already had a crater and everything.

26 Q Yes.

27 A So -- okay.

28 Q Right. So. Let me ask you a

1 little more precise question. When you began  
2 your root cause analysis, was it your view  
3 that that equipment on the SS-25 was fit for  
4 purpose?

5 A Yes. I believe -- I don't remember  
6 which phase it was. I think it was one or  
7 two where we actually did an MPI, magnetic  
8 particle inspection and all that of they  
9 wellhead and the tree and everything else.  
10 So, yeah, everything looked together, and  
11 there was no issues.

12 Q And is that basically what  
13 fit-for-purpose means?

14 A Yeah. Fit-for-purpose implies, to  
15 me, for the application that you're using,  
16 that particular equipment is appropriate from  
17 a design, structural strength, load  
18 perspective.

19 Q Okay. So when SoCalGas converted  
20 that Well SS-25 to a gas storage well in  
21 1973, it basically replaced anything and  
22 everything that could be removed, correct?

23 A Yes.

24 Q So, really, I mean, to look at the  
25 other side of the coin, the only aspect of  
26 the -- the only aspects generally of the well  
27 that were not removed and replaced was the  
28 surface casing, right?

1 A Yeah.

2 Q The production casing?

3 A Yes.

4 Q And the casing shoe?

5 A Yes.

6 Q Okay. And the reason for that is,  
7 as you learned in your three-and-a-half years  
8 on the RCA, that's pretty hard to do,  
9 correct?

10 A Yes. You're talking about  
11 extracting the casing, correct? That's what  
12 you mean by "hard to do"?

13 Q Yeah.

14 A Yeah, yeah. Absolutely.

15 Q And in fact, it basically destroyed  
16 the well, didn't it?

17 A Yes.

18 Q Okay. And given your knowledge of  
19 the oil patch business, when someone is  
20 converting a well like SS-25 to gas storage,  
21 does it typically do what SoCalGas did?

22 A Yeah. This would be a very typical  
23 conversion you would do of an application of  
24 a wellbore. As you can see on the screen, it  
25 was just pressure-tested. I have to test to  
26 make sure the casing is in good shape.

27 Q Hold that thought. Hold that  
28 taught a minute. You're getting ahead of me.

1           A    Okay.

2           Q    And conversely, you know, if a  
3 company or utility like SoCalGas is  
4 converting a well and it runs into problems,  
5 issues with well integrity, mechanical  
6 issues, whatever, it doesn't have to convert  
7 the well, correct?  It can just what?  Plug  
8 and abandon it?

9           A    Correct.  It can P and A it and  
10 move on.  Yeah.

11          Q    Okay.  All right.  Now, next  
12 question then.  You were getting a little bit  
13 ahead of me.  That's why I sort of shortened  
14 your answer a bit.  Forgive me.

15                   And that is, if you look at the  
16 bottom of page 25, in addition to SoCalGas'  
17 basically replacing every part it could  
18 replace in SS-25, absent destroying the well,  
19 it also pressure-tested that production  
20 casing, correct?

21          A    Yes.

22          Q    Explain to this Commission what  
23 that entails.

24          A    Yeah.  We've discussed this in a  
25 few places.  What you're trying to do is  
26 confirm that the 7-inch casing can handle the  
27 pressure of injection of gas and withdrawal  
28 of gas.  So what you're looking at in the

1 production casing is there's an external  
2 pressure, which is what we call pore  
3 pressure, and then you have internal  
4 pressure. What you're looking for is the  
5 difference between those two is what a casing  
6 string should be able to handle in terms of  
7 internal pressure. So that was the version  
8 of this test. So 1,500 psi from 8,525 to  
9 surface. And these were the different  
10 pressures. As you go up, the pressure was  
11 increased, and that is reflective that on the  
12 top the pore pressure is lowest. At the  
13 bottom, the pore pressure is highest. So  
14 that was the vision of this test. And as we  
15 state in the last sentence there, these  
16 pressure tests were higher than the  
17 anticipated essential pressure loading on the  
18 7-inch that would be experienced through the  
19 life of this well.

20 Q That's the sentence I wanted to  
21 explore for a minute or two now. And that  
22 is, if I understand this portion of your  
23 report correctly, what you're saying is that  
24 various aspects of that production casing  
25 were pressure-tested, and when you get to  
26 that very last bullet on the top of page 26,  
27 it actually was pressure-tested to 3,400 psi;  
28 is that correct?

1           A    Yes.

2           Q    And what typically is a pressure in  
3 the reservoir -- so-called discovery pressure  
4 of a well like SS-25?

5           A    I don't remember, but I know on  
6 surface it was 2,700. So my guess is around  
7 2,800 or 3,000. It's not more than that. I  
8 don't have that --

9           Q    So basically -- excuse me. Right.  
10 So basically, when SoCalGas converted this  
11 well, not only did it change out all the  
12 parts that could be changed, but it  
13 pressure-tested the production casing above  
14 and beyond the discovery pressure in the  
15 reservoir itself; is that fair? ]

16          A    Yes.

17          Q    Okay. And is that a common  
18 practice in the oil storage business -- gas  
19 storage business? Excuse me.

20          A    Yes. You -- you would want to go  
21 higher than you expect, just so that you have  
22 some margin there.

23          Q    And -- and is the thought there  
24 that if that well has any sort of thinness  
25 that if you pressure it beyond what the  
26 reservoir itself would pressure that if that  
27 thinness is -- is so significant that the  
28 pipe would burst, and that well cannot be

1 used in the future?

2 A Yeah. Again, you -- you have what  
3 you call a safety margin there. Okay? I  
4 don't have that number in front of me, but  
5 there's a safety margin to the pressure test,  
6 and that safety depends on your design basis.  
7 It is designed to account for uncertainty in  
8 material property, uncertainty in loading in  
9 the wellbore, and in some cases, depending on  
10 your design basis, you also will design for  
11 some amount of corrosion wall loss or metal  
12 wall loss. So it depends on the design  
13 basis.

14 Q Okay. So wrapping up this  
15 discussion we've had about converting the  
16 Aliso Canyon facility overall and converting  
17 the SS-25 well, in particular, did Blade  
18 identify any issues with that conversion?

19 A No, we did not.

20 Q So the well is converted, and four  
21 years later it started operating as a gas  
22 storage well in 1977. Is that correct?

23 A That's correct.

24 Q Okay. So although the well was  
25 drilled in 1953, it had a significant  
26 overhaul in the 1973 to 1977 timeframe,  
27 didn't it?

28 A Yes. The tubing was replaced and

1 the casing was pressure tested, and  
2 demonstrated to be more than adequate, yeah.

3 Q And the packer?

4 A And the packer, yeah. The --

5 Q And the seal -- the seal assembly?

6 A Yes. The entire completion was  
7 replaced, tubing completion was replaced.

8 Q And -- and the wellhead?

9 A And the wellhead, yes.

10 Q Okay. Did Blade also examine the  
11 operations at that well from 1977 until 2015,  
12 or for the next 38 years?

13 A We -- we examined all the data,  
14 yes, we did. Yes, we did.

15 Q Okay. And it's my understanding  
16 that that well had a workover in 1979. Is  
17 that right?

18 A Yes, '79 or '80. I think it's '79.  
19 You're right.

20 Q Fair enough.

21 A So --

22 Q What is a workover?

23 A Workover is, you know, replacing  
24 something, either a component or you're  
25 interrupting the operation of the well,  
26 and -- to remove something -- some issue with  
27 the packet -- packer, tubing; depends on the  
28 issue. In this particular case, it was to

1 re-install the annular flow safety system,  
2 yeah.

3 Q Okay. That was my next question,  
4 but -- but, hold that thought.

5 So when you kill a well, do you  
6 first have to put it out of operation?

7 A Yes.

8 Q What does that entail?

9 A You would -- what you would do is  
10 you would pump a fluid that has a density  
11 more than that is well pressure at the bottom  
12 so that you don't have any inflow or  
13 something coming up the well, and that's what  
14 we call kill operations. We put some kill --  
15 kill fluid in there, and make sure that well  
16 is stable. Then you would do all the other  
17 operations.

18 Q Okay. So -- so when you -- when  
19 you conduct a workover on a well, you  
20 essentially kill the well first. Right?

21 A Yes.

22 Q Okay. And then if there's an  
23 issue, say, on the production casing, that --  
24 that outside right against the formation  
25 pipe, you know, deep into the well, not --  
26 not at the top where the surface casing is,  
27 but if there's an issue with that production  
28 casing, that workover has to pull all the

1 tubing, too, doesn't it?

2 A Yeah, depending on the workover,  
3 you may have to pull the tubing, yes.

4 Correct.

5 Q Got it. And is that dangerous to  
6 do?

7 A It's -- it's not dangerous. It's  
8 very safe, because you've killed the well, so  
9 the operation is pretty standard in the oil  
10 patch. So you kill the well, you load the  
11 oil pressure pretty accurately, and you have  
12 a lot of history in this particular case. So  
13 to me, it's a pretty safe oper- -- I wouldn't  
14 call it dangerous, no.

15 Q All right. Well, I guess let me  
16 ask it quite a different way.

17 In conducting a workover on a well,  
18 whatever the issue, and let's assume it's a  
19 significant issue, does that activity have  
20 risks?

21 A Yes, it always has -- absolutely.  
22 Okay. In -- in -- yeah. In order to  
23 mitigate that risk, you're killing the well.  
24 You're making sure the well won't come at you  
25 unexpectedly. So you're trying to do it  
26 safe. So, yeah, it is always -- always a  
27 difficult operation when you operate -- when  
28 you work on a well. So, yes.

1 Q Right.

2 A However, by killing the well, you  
3 are making sure and -- making sure all the  
4 components are working and making --  
5 mitigating that -- those risks.

6 Q And during that difficult  
7 operation, have workers been injured?

8 A Can you repeat the question,  
9 Mr. Lotterman? Sorry.

10 Q Sure. During that difficult  
11 operation of conducting a workover in this  
12 country, have workers been injured?

13 A Yes.

14 Q Same question, have workers been  
15 killed?

16 A Yes.

17 Q So this is not an activity that  
18 someone does lightly. Correct?

19 A No. It requires a lot of planning.

20 Q Okay. All right. And the workover  
21 that SoCalGas conducted in 1979, you said,  
22 was that to replace a subsurface safety  
23 valve?

24 A We use a different terminology in  
25 the report. It's not a subsurface safety  
26 valve. It's the annular flow safety system,  
27 is what we -- that is the terminology we use,  
28 as you can see in the report. That's what I

1 believe that workover was.

2 Q Okay. And -- and did SoCalGas  
3 replace that system in 1979, remove it,  
4 basically?

5 A Yeah, I believe they removed it.

6 Q And did they remove it because it  
7 went bad?

8 A They were servicing it. If I read  
9 my paragraph there, I have to read it,  
10 because I don't recollect the exact details,  
11 they attempted to service it in January 7,  
12 1980, and this was all based on the SS-25  
13 well file. That's where we're extracting  
14 this information from. And they continued to  
15 have problems, and then on January 28th, they  
16 decided to pull it.

17 Q And when you pull a system like  
18 that, does the housing stay in the -- in the  
19 well?

20 A I don't know the details of this  
21 particular well, but my guess is yes.  
22 Anything that it can -- you know, you would  
23 pull what is easy to pull, and leave the rest  
24 there. As long as it doesn't interfere with  
25 the flow, you'd leave it alone.

26 Q Okay. Let's -- let's move on, and  
27 I want to talk about the -- the monitoring of  
28 this well, in particular, and let's turn, if

1 you would, sir, to the top of page 30 of your  
2 main report, Commission Exhibit 1000. Are  
3 you there?

4 A Yeah, I'm there.

5 Q Good. Okay. And -- and before we  
6 proceed, I want to make sure that our  
7 nomenclature is clear, because I think I  
8 misspoke earlier.

9 When you talk about monitoring a  
10 well, are you talking about conducting, for  
11 example, temperature and noise logs?

12 A In this context, that's what we are  
13 talking about. Again, you could monitor  
14 various things, so I want to be careful with  
15 the word "monitoring." But here, we are  
16 measuring -- running temperature -- or -- or  
17 SoCalGas ran temperature and noise logs over  
18 the years. That's what we are talking about  
19 as monitoring devices. You could monitor  
20 various things, so that's what's being  
21 monitored. That's correct, yes.

22 Q Okay. Let's focus on -- on  
23 SoCalGas's monitoring of this well as  
24 depicted on page 30. Okay?

25 So if I read this Figure 13  
26 correctly, and then -- and the narrative  
27 around it, basically, over the next 38 years  
28 that this well was in operation it had 65

1 temperature surveys. True?

2 A Yes.

3 Q Now, can you briefly describe to  
4 the Commission what purpose a temperature  
5 survey has?

6 A Okay. So if there is a leak -- so  
7 what you're looking for in a temperature  
8 survey, and very similar to the noise survey,  
9 is we are looking for any leaks in the casing  
10 or around the shoe or anywhere else. So when  
11 a gas -- when you have a gas leakage, what  
12 happens to gas is it goes from high -- it's  
13 what is called Joule-Thomson effect. You  
14 expand the gas. When you expand the gas,  
15 there is a drop in temperature, and you're  
16 looking for that signature to say, "I have a  
17 leak here or I have -- I have a cooling  
18 anomaly," you will say, and you confirm that  
19 there is a leak or a -- or some other -- some  
20 other cause for that temperature drop.

21 Q Okay. And if I understand this --  
22 this logging properly, there are no --  
23 there's no need to pull the tubing when you  
24 do it. Is that right?

25 A That's correct. You can --

26 Q So --

27 (Crosstalk.)

28 ///

1 BY MR. LOTTERMAN:

2 Q So there's no need to do a  
3 workover. Correct?

4 A Yes.

5 Q So if you're sort of debating  
6 between doing a workover and those risks and  
7 a temperature log and those risks, is it fair  
8 to say that a temperature log is less risky?

9 A Yeah. Pulling the tubing is a more  
10 onerous process, yes.

11 Q Okay. All right. And -- and if I  
12 look at your Figure 13 correctly, it depicts,  
13 just above the years in red "Ts," all the 65  
14 temperature surveys that were conducted on  
15 SS-25 from the time that SoCalGas converted  
16 the well to gas storage until up until the  
17 incident. Correct?

18 A Yes.

19 Q And if I understand your earlier  
20 answer correctly, and I think you talked  
21 about the Jule effect or the Thomson Jule  
22 effect, something like that, but basically,  
23 for those of us who are -- who didn't go to  
24 engineering school, what that means is if you  
25 have like a pinhole leak in that production  
26 casing, or even a -- a -- a larger leak, and  
27 gas is escaping from the well into the  
28 formation, that gas cools the area around it,

1 and hence, the temperature log shows a  
2 cooling. Is that right?

3 A That's exactly correct, yes.

4 Q Okay. And I believe we'll --  
5 talked about this earlier, but is it your  
6 understanding that SoCalGas conducted those  
7 65 temperature surveys pursuant to DOGGR  
8 requirements?

9 A Yes.

10 Q Okay. And then if you look at that  
11 Figure 13, if you look above it, you've got  
12 some blue "Ps." Do you see those?

13 A Yeah.

14 Q Do -- well, actually, let's hold  
15 that thought. Let's -- let's -- let's focus  
16 on the "Ns" first.

17 Above the "Ps" I see some black  
18 "Ns." Do you see those?

19 A Yes.

20 Q Are those the eight noise surveys  
21 that you show at -- just above the Figure 13?

22 A Yes, those are the noise surveys.

23 Q So describe what a noise survey is  
24 and why one would do that in addition to a  
25 temperature survey.

26 A Okay. A temperature survey, if  
27 there's a leak, you will see it. But,  
28 occasionally, the temperature survey may not

1 may give you some -- some cooling events, and  
2 you have to be careful interpreting it.

3 A noise survey, if there is any  
4 flow -- so you're literally listening to  
5 noise at various dB levels and various  
6 frequencies and altitude and frequencies, and  
7 depending on the altitude and the frequency,  
8 you can establish there is gas flowing out of  
9 the well or out of a hole or wherever.  
10 That's the intent of the noise survey.  
11 That's what you're trying to do.

12 Q So if I understand you correctly --

13 A And the --

14 Q Excuse me.

15 A Sorry. Let me -- it supplements --  
16 it supplements and further supports an  
17 interpretation within temperature surveys.

18 Q Okay. Thank you for that  
19 clarification, and my apology for stepping on  
20 you.

21 So if I understand you correctly,  
22 if you have a pinhole leak or -- or some sort  
23 of hole in the production casing, a  
24 temperature survey will show a cooling.  
25 Right?

26 A Yes.

27 Q And a noise survey will make noise?

28 A It will show you -- it'll show you

1 a -- a change in -- it'll show you a -- show  
2 you noise there, a dB in the frequency, yeah.

3 Q Right. I mean you're basically  
4 lowering a microphone down that well. Right?

5 A Pretty much; pretty much, that's  
6 correct.

7 Q All right. And just like a  
8 temperature survey, when you conduct a noise  
9 survey, there's no need to pull the --  
10 there's no need to do a workover and pull the  
11 tubing. Correct?

12 A That's correct.

13 Q Okay. All right. Now, let's look  
14 at the blue "Ps" between the "Ns" -- the  
15 black "Ns" and the red "Ts." What do those  
16 depict?

17 A Those are pressure surveys. And if  
18 I remember right, this is not a pressure  
19 test. It is a pressure survey. So you're  
20 not displacing the gas. You have -- you shut  
21 the well in and monitor the pressure to see  
22 if there's any pressure change.

23 Q And -- and why is a pressure -- why  
24 might a pressure change be important?

25 A Again, if there is -- if there is  
26 any -- any -- any, again, hole, hole or  
27 some -- some part of the casing or tubing  
28 where you have gas leaking in or out, you

1 will see a pressure change, a pressure drop,  
2 a local pressure drop.

3 Q And like the temperature survey and  
4 the noise survey, when you conduct a pressure  
5 survey there's no need to do a workover and  
6 pull the tubing. Right?

7 A That's correct.

8 Q Okay. But, I guess what I want to  
9 distinguish between, for example, temp  
10 surveys and pressure surveys, temperature  
11 surveys were required by DOGGR, but pressure  
12 surveys were not. Is that true?

13 A Yes, I believe so. There were --  
14 there was -- and we discussed this in the  
15 report. There was some issue around  
16 requiring some pressure tests and doing  
17 pressure surveys and some of that, so I don't  
18 recall that, Mr. Lotterman, so I want -- but,  
19 I believe temperature surveys were definitely  
20 required. I'm not -- I don't believe  
21 pressure surveys were required. I'll need to  
22 reference my -- refer to my report to confirm  
23 that, but that's what I recall.

24 Q Let's do this, because I promised  
25 you earlier this wouldn't be a memory test.  
26 Turn to page 199 of your main report, sir.

27 A Thank you. Yes.

28 Q Okay. Would you read -- under

1 Section 4.6.2, would you read that first  
2 sentence into the record slowly?

3 A Sure.

4 Although SoCalGas performed 41  
5 pressure surveys in 41 years, neither the  
6 DOGGR project approval letter nor the  
7 SoCalGas inventory monitoring verification  
8 operations required pressure surveys.

9 Q All right. And so basically,  
10 what -- going back to Figure 13 on page 30,  
11 what you do there is you depict a hundred and  
12 fourteen surveys of SS-25 that were conducted  
13 over 38 years. Right?

14 A Yes.

15 Q You can trust me on the math.

16 A No, I -- absolutely. Yes.

17 Q Okay.

18 A That's correct.

19 Q But, what this -- what this  
20 Figure 13 does not depict, sir, it does not  
21 depict, for example, daily site inspections.  
22 Correct?

23 A Yes, it does not.

24 Q What's the -- what's the purpose of  
25 a day -- daily site inspection on an  
26 underground storage facility?

27 A I think the site visit is to see if  
28 there's any leakage, any -- any anomalous --

1 any anomaly in the operations. That's the  
2 intent of the daily site visits.

3 Q And the daily you show on page 30  
4 and in Figure 13, also, it doesn't depict  
5 weekly pressure readings, does it?

6 A That's correct. There were weekly  
7 pressure readings.

8 Q What is the purpose of a weekly  
9 pressure reading?

10 A Again, if there is a leak event,  
11 let's say, in the casing or the tubing or  
12 somewhere, you will see variations in the  
13 pressure, whether it be tubing pressure,  
14 tubing casing pressure, casing -- surface  
15 casing pressure, any of those annulus  
16 pressures. That's what you're looking for.

17 Q All right. And your Figure 13 also  
18 does not depict monthly well site  
19 inspections. Correct?

20 A It does not.

21 Q What's the purpose of a monthly  
22 well site inspection?

23 A It's similar to a daily well site  
24 inspection, again, looking for anything  
25 anomalous, any -- any event, any -- anything  
26 that appears unusual operationally.

27 Q Okay. So getting back to -- to  
28 the -- the -- the temp logs, the 65 temp

1 surveys that you depict on Figure 13, you  
2 confirmed in your report, did you not, that  
3 DOGGR approved the use of temp logs for  
4 mechanical integrity testing?

5 A Yes.

6 Q And you also concluded that  
7 SoCalGas complied with those requirements,  
8 didn't it?

9 A That's correct.

10 Q All right. And, in fact, what you  
11 say on page 30, right, right below the  
12 figures there, you say that no anomalies were  
13 ever recorded during the measurements. Do  
14 you see that?

15 A Yeah.

16 Q And those -- and when you say  
17 during those measurements, that's basically  
18 the life of this well as a gas storage well?

19 A Yes.

20 Q From 1974 until the incident in  
21 2015, almost 40 years?

22 A Yes.

23 Q And then if you turn to page 31 --  
24 by the way, there's that temperature survey.  
25 Right?

26 A Yeah.

27 Q We won't go there. But, go down to  
28 the narrative, if you would, just below that

1 Figure 14.

2           You conclude no temperature,  
3 pressure or noise anomalies in the surveys  
4 indicated a preexisting casing failure before  
5 the incident of October 23, 2015. Is that  
6 true?

7           A    That's correct.

8           Q    Okay.

9           A    Yes.

10          Q    You also say -- -

11          A    But -- yeah.

12          Q    Sorry. And you also say, in the  
13 very next sentence, "Additionally, no  
14 physical observations from well inspections  
15 and weekly pressure measurements indicated an  
16 existing casing integrity problem." True?

17          A    Yes, that's correct.

18          Q    Okay. So if you were a diligent  
19 engineer at SoCalGas or -- or wherever in the  
20 weeks before the incident and you're working  
21 at Aliso Canyon facility and you're reviewing  
22 its 40-year operational history, including  
23 its well file, its logging data and its  
24 physical inspections, would you have seen any  
25 warning signs of a casing leak?

26          A    SS-25 data, as we discussed here,  
27 there was no indication, that's correct.

28          Q    Okay. And that was accurate when

1 you wrote the report in May of 2019. Right?

2 A At -- yes, absolutely.

3 Q And is it still accurate today?

4 A Yes.

5 Q All right. Now, let's talk about  
6 the two wells on the same pad, SS-25A and  
7 SS-25B. Let's turn to page 16 of the main  
8 report; actually, back to page 16, Figure 2.  
9 Let me know when you're there. You're there?

10 A Yeah. Yeah, I'm here. Thank you.

11 Q Okay. Good. So those wells are  
12 pretty close to each other, aren't they?

13 A Yes.

14 Q What, 10, 20 feet, maybe a little  
15 bit more?

16 A Yeah, a little bit more. I want to  
17 say 20 feet; 20, 30 feet, yeah.

18 Q Okay.

19 A I have to recollect. Yes.

20 Q But, on the same pad?

21 A It's on the same pad, yes.

22 Q Okay. And by the way, when you  
23 say, "pad," is that sort of a -- a leveling  
24 of that terrain so -- so you can drill wells  
25 and monitor wells and inspect wells safely?

26 A Yes. It's a flat area. It's kind  
27 of a -- I view the word, terminology, knoll.  
28 The SS -- if you see that road, you drive

1 around that road, there is a -- there's a  
2 pad, a well pad that was built, I'm sure ages  
3 ago, and it contains three wells, SS-25, 25A  
4 and 25B.

5 Q And did you say, "knoll," like  
6 n-o-l-l?

7 A K-n-o-l-l, yeah. It's kind of a --

8 Q Oh.

9 A It was a word we used which was to  
10 describe -- I forget. Is it 200 feet above  
11 the road below? So that kind of explains  
12 the -- the cooling on some of the logs. So  
13 we use the term k-n-o-l-l.

14 Q Got it. Thank you. And as part of  
15 your root cause analysis and inspection did  
16 you look at the history of the two other  
17 wells on that SS-25 pad?

18 A Yes, we did.

19 Q Okay. And let's -- let's take them  
20 one at a time. And again, forgive me if this  
21 is pressing your memory. And maybe we should  
22 just get to the -- the conclusion, but let  
23 me -- let me try to walk you through to make  
24 sure we're clear.

25 When you looked at well 25A, did  
26 you see any warning signs there that  
27 something might be amiss on that pad,  
28 generally?

1           A    No.  Again, I'm -- I'm going by  
2 memory, which is kind of -- I have to think  
3 carefully.  25A had -- see, they -- they --  
4 those wells were completed differently, were  
5 drilled much later in -- in the history of  
6 Aliso, so the -- the drilling and the  
7 completion is different than SS-25.  But,  
8 there was no indication in 25A or 25B about  
9 problems in the pad or -- in SS-25.

10           Q    And -- and there also was no  
11 indication, was there not, of any problems in  
12 their operational history that might  
13 correlate with the issue that arose at SS-25?

14           A    No.

15           Q    And for 25A, and you can trust me  
16 on this one, if you wish, or you can look at  
17 the -- the report, not only did you look at  
18 the logging data that historically had been  
19 done on that lot -- on that well, you ran  
20 your own logs in 2017, didn't you?

21           A    Yes, we did.

22           Q    And if I'm not mistaken, you  
23 concluded that you found no analogous  
24 corrosion.  Right?

25           A    That's correct.

26           Q    All right.  So -- so looking at the  
27 SS-25 well, in particular, there were no  
28 warning signs of a casing leak, and when you

1 looked at the two sister or brother wells on  
2 the same pad, you came to the same  
3 conclusion. Right? No warning signs about  
4 SS-25 leak either from the well itself or its  
5 two nearby wells. True?

6 A Yes.

7 Q All right. Let's go down the well.

8 Your root cause analysis included a  
9 physical investigation of the SS-25  
10 production casing wellbore itself. Correct?

11 A Can you -- can you repeat the  
12 question again? I apologize. I -- I -- can  
13 you repeat it again, Mr. Lotterman?

14 Q Do not apologize. It was a long  
15 one. Let me -- let me shorten it.

16 As part of your root cause  
17 analysis, did you inspect the physical pipe  
18 of SS-25?

19 A Oh, yes. Yes. Yes, we did.

20 Q And did it include extracting all  
21 the tubing?

22 A Yes.

23 Q Did it include extracting some of  
24 the production casing?

25 A Yes.

26 Q And is that endeavor outlined in  
27 your -- I believe it's the Phase 3 summary,  
28 which is part of Commission Exhibit 1001?

1           A    That's correct.

2           Q    So if I understand you correctly,  
3 as part of this aspect of the root cause  
4 analysis, you extracted about a mile and a  
5 half of tubing, and -- and little over  
6 990 feet of production casing. Right?

7           A    Yes.

8           Q    So not to put too blunt a point on  
9 it, about two miles of pipe?

10          A    Yeah. I -- again, the miles I'm  
11 not able to type -- line up, but  
12 approximately seven to eight thousand feet of  
13 tubing, and around thousand feet of casing  
14 string, yeah.

15          Q    Actually, to be fair to you, sir, I  
16 calculated 1.7 miles. So --

17          A    Oh.

18          Q    All right. Had -- had you ever  
19 done that before?

20          A    I have. In one other case, we have  
21 done -- a lot of casing strings were pulled;  
22 but -- but, I have pulled -- I have pulled  
23 3000 maybe feet of casing, but not this much  
24 tubing, yes. That is -- that is the first  
25 time, yes, in terms of just the length.

26          Q    And is it common in the oil and gas  
27 business to be pulling tubing and production  
28 casing out of a well?

1           A    No, you don't normally pull casing.  
2   You may pull tubing.  Casing you pull only if  
3   there is a failure, and you want to find  
4   something out.  But, that's -- that's -- and  
5   quite often, it's cemented.  So it's  
6   cemented.  You cannot pull them.  So it's  
7   quite hard.

8           Q    Okay.  But, nonetheless, for this  
9   root cause analysis, Blade decided that  
10  excavating at least a portion of the  
11  production casing was necessary here.  True?

12          A    Yes.

13          Q    Because you believe that it was the  
14  only true way to investigate what happened in  
15  that wellbore.  Right?

16          A    Yeah.  Yes, because in this  
17  particular case, the tubing had failed, as we  
18  found out through our logging in Phase 1, so  
19  pulling it was not as -- as much of a  
20  challenge as it would be if it was in place.  
21  Yeah, the direct means was the best way,  
22  since this was a failure.

23          Q    Right.  Because, you know -- and --  
24  and we'll get to this in a minute.

25                    Because when you ran cameras down  
26  that -- when you pulled the tubing out of  
27  that well, and I'm going to slow myself down  
28  a little bit, and you ran a camera down the

1 production casing, you were able to tell  
2 where that production casing failed. Right?

3 A Yes.

4 Q But, you weren't able to show how  
5 it failed, were you?

6 A No.

7 Q And you were not able to show why  
8 it failed, were you?

9 A Not at that point, yeah. That's  
10 correct.

11 Q And but for pulling that  
12 production -- but for pulling out 990 feet of  
13 production casing out of that hole, can you  
14 think of any other way to answer those two  
15 questions, how the production casing failed  
16 and why it failed?

17 A In this particular case, that was  
18 necessary, yes.

19 Q Okay. So you go on in the report  
20 to describe the extraction process, and that  
21 begins on page 37, sir. ]

22 A Yes.

23 Q And, again, you can -- I pulled  
24 this out of your report, because I was trying  
25 to keep this examination going on somewhat  
26 efficiently.

27 But here's what I gleaned,  
28 basically, is you pulled the tubing from July

1 to September of 2017; right?

2 A Yes.

3 Q And you pulled roughly 244 joints  
4 of the tubing?

5 A Yes.

6 Q Did you see anything unusual in  
7 that exercise?

8 A In the tubing you mean? No.

9 Q Okay. All right.

10 And then, as we talked about  
11 earlier, you ran what's called an EV camera  
12 down the production casing; is that right?

13 A We ran it down the production  
14 tubing first. And we looked at the casing.

15 Q Okay. And when you looked at the  
16 production casing using that special camera,  
17 you saw a -- that the casing had parted at  
18 joint 22; right?

19 A Yes.

20 Q So that was the first confirmation  
21 that anyone had that SS-25 production casing  
22 failed at that depth; right?

23 A It was a confirmation. There was  
24 suspicion based on tubing logs we ran and  
25 temperature logs that were run in November of  
26 2015. I don't have the exact date on that,  
27 sometime in the end of November, I believe,  
28 or middle November.

1           So there was a couple times at  
2           which there were cooling anomalies that  
3           showed up that suggested it could be at 892,  
4           or it could be shallower. So those were the  
5           two options. So, yeah, this was the first  
6           confirmation -- visual confirmation.

7           Q     Did that visual confirmation change  
8           the focus of your root cause analysis?

9           A     No, it didn't change the focus.  
10          Because it -- perhaps -- at that point, we  
11          didn't have a clear idea of what this was  
12          going to look like, so -- some suspicion.  
13          But, really, we had not set the direction of  
14          the investigation. So the assum- -- the fact  
15          it was parted and it was offset made the  
16          extraction operations a bit more complicated.  
17          But, perhaps, I don't want to say "RCA."

18                 At that point, we were in a prelim  
19          -- we didn't have a view on exactly why this  
20          happened or what happened, so... I wouldn't  
21          say direction of the investigation. But,  
22          yeah, the extraction approach got further  
23          refined after that.

24          Q     Fair enough. Fair enough.

25                 And to be clear, and for the  
26          record, when you ran that camera down the  
27          production casing, you found that the casing  
28          had parted at 892 feet below the surface;

1 right?

2 A Yes.

3 Q And so to put that in the  
4 perspective of someone who doesn't deal with  
5 wellbores on a routine basis, that was  
6 roughly a sixth of a mile deep; right?

7 A Yep.

8 Q Or to use, perhaps, a measurement  
9 that I'm more comfortable with, about three  
10 football fields?

11 A Okay. Yes. I'll take your word  
12 for it.

13 (Crosstalk.)

14 BY MR. LOTTERMAN:

15 Q Okay.

16 And the reason why I say that is, I  
17 want to make sure when we talk about "shallow  
18 leaks," or shallow -- you know, the shallow  
19 leak at SS-25, that we all understand that  
20 that leak was three football fields below  
21 surface; right?

22 A Yes. 892 feet, yes. That's  
23 correct.

24 Q Fair enough.

25 So, yeah -- so they're on the goal  
26 line. They're on the goal line about to  
27 break in, but -- but close enough. All  
28 right.

1                   And to sort of cut to the chase on  
2 this, Blade decided to cut and extract a  
3 total of 25 casing joints as part of this  
4 investigation; right?

5           A    I believe --

6           Q    Look at page 40, sir --

7                   (Crosstalk.)

8           ALJ POIRIER:  Let's go off the record.

9                   (Off the record.)

10          ALJ POIRIER:  We'll be back on the  
11 record.

12                   Mr. Lotterman, can you re-reference  
13 the place in the report that we're  
14 discussing?

15          MR. LOTTERMAN:  Yes --

16                   (Crosstalk.)

17          MR. LOTTERMAN:  Yes.  Thank you, your  
18 Honor.  I was asking Dr. Krishnamurthy to  
19 identify how many casing joints they decided  
20 to cut and extract from the production  
21 casing.  He was a little unclear.  And so I  
22 directed him to the main report at page 40.

23          THE WITNESS:  May I answer?  Can I  
24 clarify?

25          BY MR. LOTTERMAN:

26          Q    We're ready.

27          A    Yeah.  There was a total of 25  
28 joints, full joints, that we extracted.  But

1 we also extracted -- and I need to confirm  
2 this, which is shown on page 51 -- part of  
3 26. That's what I wanted to make sure, yeah.  
4 I believe it was 26.

5 So, yes, a total of 25 full joints,  
6 part of 26.

7 Q Right. We're going to walk through  
8 each extraction, sir. I just wanted to take  
9 this one piece at a time.

10 So the initial extraction of the  
11 production casing, until the casing was at  
12 the surface, all the way down to the parting;  
13 is that correct?

14 A That is correct.

15 Q Okay. And if I understand  
16 correctly from page 41, that began in October  
17 2017; right?

18 A Yes. Yes.

19 Q And you talk about cutting.

20 Could you tell the Commission what  
21 was involved with extracting the upper  
22 portion of the production casing from that  
23 hole in October 2017?

24 A So we were told, as shown on the  
25 figure here -- Figure 25 on the screen, we  
26 would pull the pipe above the valve and have  
27 -- there was a cutting unit from, I want to  
28 say, Cameron (phonetic). And that would

1 place a cut, I forget, 1 or 2 feet below the  
2 connection. What you're seeing there is a  
3 connection of the collar, depending on how  
4 you define it. We were cutting it. And the  
5 intent of the exercise was to maintain the  
6 integrity of the connection and assess the  
7 connections. And that's why we were cutting.

8 Q All right.

9 And -- I lost my place. One  
10 second, sir.

11 ALJ POIRIER: Let's go off the record.

12 (Off the record.)

13 ALJ POIRIER: Back on the record.

14 We will be taking a short afternoon  
15 break until 2:20.

16 Thank you.

17 (Recess taken.)

18 ALJ POIRIER: Okay. We'll be back on  
19 the record.

20 We are just returning from a short  
21 afternoon break. We will continue with Mr.  
22 Lotterman's cross-examination of Mr.  
23 Krishnamurthy.

24 MR. LOTTERMAN: Thank you, your Honor.

25 Q Dr. Krishnamurthy, I have two  
26 clarifications, and then I want to keep going  
27 down the wellbore.

28 First of all, when we were talking

1 earlier about pressure testing the SS-25, and  
2 really any well, during its conversion from  
3 oil production to gas storage, we were  
4 talking about the pressure test that's  
5 conducted.

6 And I just wanted to make clear, is  
7 it the practice in the underground storage  
8 business to pressure test above the reservoir  
9 operating pressure?

10 You're on mute, sir.

11 A Sorry. I apologize.

12 Yeah. You're talking about  
13 reservoir pressure. But what you're looking  
14 at is the pressure profile in the wellbore,  
15 the delta peak. You have the pressure inside  
16 the casing, and you have pressure outside the  
17 casing. You're looking to make sure that as  
18 you test, you are more than that delta peak  
19 at any depth. So the practice should be to  
20 be higher than that. You can't be lower than  
21 that delta peak.

22 Q Right.

23 A So to look at absolute numbers,  
24 yeah, you may be equal or similar. But you  
25 have to be higher than the delta peak to have  
26 some safety margin in there, so... which is  
27 what was done here.

28 Q Okay.

1           And so the thought is, whatever --  
2 whatever pressure the reservoir provides up  
3 that wellbore, a diligent underground storage  
4 engineer is going to design and make sure  
5 that wellbore can take that pressure and a  
6 safety factor more; is that right?

7           A     That is correct.

8           Q     All right.

9           And was that done at Aliso Canyon,  
10 generally? -- and at the SS-25 well, in  
11 particular?

12          A     It was done at SS-25. I'm not sure  
13 how many other well records we checked in  
14 terms of conversion. But we did check SS-25  
15 in some detail. And it was --

16          Q     Fair enough.

17          A     -- definitely done.

18          Q     Fair enough. Thank you.

19                The other question I have for you  
20 is, when you finally got on to the well pad  
21 after the relief well had killed the well,  
22 and it was safe to -- to go in there and  
23 start investigating, was there -- was there  
24 fluid in the -- in the formation outside of  
25 the surface casing?

26                And was there fluid in the annulus  
27 between the production casing and the surface  
28 casing?

1           And was there fluid, in fact, in  
2 the tubing?

3           A    Yes to at all of them.  There was  
4 fluid -- and I don't remember the fluid  
5 levels.  I remember reading it a couple of  
6 days ago.

7           There was a fluid level that was  
8 measured in the annulus between the  
9 production casing and surface casing, between  
10 the production casing and tubing, and in the  
11 tubing.  There was fluid everywhere.

12          Q    What was the fluid?

13          A    It would have been most probably  
14 the kill fluid or completion fluid, whatever  
15 was used either during the kill operations or  
16 during the -- or during the intersection of  
17 the relief well with the SS-25.  So a  
18 combination thereof.

19          Q    Okay.  So -- and not sure this  
20 matters -- but, just to be clear, when you  
21 were lowering that camera down the production  
22 casing to try to figure out where it had  
23 parted, you were actually lowering it down  
24 through that fluid, whatever it was; correct?

25          A    Yes.  So it is shown in one of  
26 these figures.  But we were pulling the  
27 tubing out.  And as we -- we -- we knew --  
28 because of the tubing logs we had run, we

1 knew roughly where it was -- 895, in that  
2 vicinity, was where we believed it was  
3 failed. So the camera was there at the  
4 bottom of the tubing, right around the point  
5 where the seven-inch casing had failed.

6           So that is shown in Figure 24 of  
7 the report -- or Figure 23, to see the  
8 configuration. And so the tubing -- and so  
9 what we did at that point, the fluid was, as  
10 you can imagine, was -- there was high  
11 turbidity in the fluid, so you cannot see  
12 things with the camera. So what we did was,  
13 we pumped clean fluid as that camera was in  
14 that spot to see the failure. And that's the  
15 pictures you see.

16           Q    Okay. Thank you. All right.

17                    So let's continue extracting this  
18 pipe. And let's got to the bottom of this.

19                    So if you -- I want to turn your  
20 attention to Figure 33 on main report  
21 page 45. And not the picture quite yet, but  
22 just the figure itself.

23                    It's my understanding, Dr.  
24 Krishnamurthy, that sort of depicts the  
25 sections from the parted casing above that  
26 were first extracted from the wellbore;  
27 correct?

28           A    Yes.

1 Q All right.

2 And as you're pulling out the  
3 first, let's just say, 600, or so, feet of  
4 this 7-inch production casing, did you see  
5 any external -- any significant external  
6 corrosion on it?

7 A I believe around depth -- I don't  
8 remember which casing number it is -- around  
9 a depth of 14 -- C-14 was the first time we  
10 started -- which is on Figure 28 -- we  
11 started seeing some external corrosion. Up  
12 to that point, it's around 600, 700 feet in  
13 the wellbore, there was limited to no  
14 corrosion. And the corrosion started  
15 appearing at C-14, I believe.

16 Q Okay. So from 6- to 700 feet  
17 above, as you pull out this production  
18 casing, you didn't see any corrosion; right?

19 A That is correct.

20 Q Did that surprise you?

21 A No. Because I actually -- very  
22 honestly, I expected the OD to be not an  
23 issue until I saw the corrosion -- started  
24 seeing the corrosion on C-14.

25 Q All right. Okay. Hold that  
26 thought. We're getting there now.

27 So as you're pulling out this pipe,  
28 you are laying it on the rig floor and

1 inspecting it.

2 True?

3 A Yes.

4 Q And then you performed, what I  
5 believe you call, an NDE, or a  
6 non-destructive evaluation, of the regions;  
7 right?

8 A Yeah. It was more visual, I would  
9 say, at this point. We -- on the rig floor.  
10 We did a visual examination. And we would  
11 also attempt to collect scale, which was --  
12 see if there was a relevant scale, ID scale,  
13 OD scale. So -- and then we would move it  
14 from there. Because this was a big  
15 operation, so it was moved to PS-20, which  
16 was a staging location where we would do more  
17 detailed examination of the pipe.

18 Q And you took photos; right?

19 A Yes.

20 Q Lots of photos?

21 A Yes.

22 Q All right.

23 And let's turn to one of those  
24 photos right now. If you go just below this  
25 Figure 33, you've got a Figure 34.

26 And is that the upper portion of  
27 the parted casing at 892 feet?

28 A Yes.

1 Q Okay.

2 A That is correct.

3 Q So here's my question for you, sir  
4 -- and maybe it's better to turn to page 43  
5 for this. Let's do that.

6 And I want to look at the bottom  
7 two photos there, not the top one  
8 necessarily. I believe you said in your  
9 deposition that when you pulled out that  
10 portion of the casing, you saw a grooved,  
11 striated, s-t-r-a-i-t-e-d (sic), corrosion;  
12 is that right?

13 A Yes.

14 Q And is that synonymous with  
15 tunnelling and scooping?

16 A Scooping, not tunneling. Tunneling  
17 requires more investigation, which we saw  
18 first, as you well know. But at this  
19 stage -- again, when we pulled it, it looked  
20 unusual. Yeah, it looked striated grooves,  
21 as we state below.

22 But, yeah. Perhaps, scooping --  
23 not scooping the way microbiological folks  
24 talk about. There's elements of it that look  
25 scooping. Elements of it look striated, so a  
26 combination thereof.

27 Q Okay. And when you saw this  
28 grooved striated corrosion that's depicted on

1 Figure 29, had you ever seen that before?

2 A No, not in this nature. No. It  
3 was -- it's quite unique.

4 Q Yeah.

5 And, in fact, you told me in the  
6 deposition that you considered that  
7 morphology to be very unusual.

8 True?

9 A Correct.

10 Q Okay.

11 And when you say "morphology," what  
12 do you mean?

13 A By "morphology," I mean the shape  
14 and the character. The shape, the depth, the  
15 nature of it. So if you look at it, the  
16 circumferential nature of it, the  
17 longitudinal nature of it, it's quite  
18 unusual.

19 I mean, there are similarities you  
20 can find to, say, CO2 corrosion, but it's not  
21 similar to this. So it didn't match with  
22 some other sets of data we have on the well.  
23 So it is unusual, yes. That is correct.

24 Q Okay.

25 And if I'm not mistaken, Blade  
26 undertook a pretty extensive search of the  
27 literature, for example, the similarly  
28 grooved, striated corrosion; is that right?

1           A    Yes, we did.

2           Q    And if I recall from your  
3 deposition in Houston almost two years ago,  
4 you didn't find any pictures, did you?

5           A    No.

6           Q    So the morphology you saw on SS-25,  
7 to your knowledge, was not reported in the  
8 engineering and scientific literature; is  
9 that right?

10          A    I want to be careful. We  
11 researched it quite a bit to look for  
12 similarities. In the literature, they  
13 discuss it. But we didn't see any pictures.  
14 That is correct.

15          Q    Right. Right.

16                    Did that surprise you?

17          A    No, it doesn't surprise me. It's  
18 just unusual. You know, I don't know how --  
19 yeah. It is surprising there is no  
20 literature on this.

21                    But, yeah, there wasn't -- we  
22 couldn't find any pictures. There are people  
23 who describe it in words. But we didn't see  
24 it associated with the pictures.

25          Q    Here's what I don't get -- and,  
26 again, I'm not an engineer.

27                    But it's my understanding that they  
28 have been drilling oil wells in this country

1 for 150 years. And I actually Googled it,  
2 and it said the first well was drilled in  
3 1859 in Pennsylvania.

4 And yet, even though the oil and  
5 gas business has been around for a century  
6 and a half, you couldn't find a single  
7 picture of a similar morphology from what you  
8 found on SS-25; is that right?

9 A That is correct.

10 Q Okay. And that includes any lab  
11 study that someone could have done. I mean,  
12 you've got major research, engineering,  
13 colleges, universities across the world. You  
14 got Imperial College in the United Kingdom.  
15 You've got LSU and Texas A&M. And you've got  
16 your alma mater, University of West -- of  
17 Virginia -- excuse me. And none of those  
18 labs had produced pictures similar to what  
19 you found on SS-25.

20 Did that surprise you?

21 A It did surprise me. However, I  
22 want to be careful. I don't want to, by any  
23 means, tell you that I have -- we at Blade  
24 have looked at everything, and we can  
25 confirm. So in the literature search we did,  
26 we did not find it. That's how I would word  
27 it. I want to be careful. That is number  
28 one.

1           Number two, when you look at this,  
2 this is, of course, as you're well aware,  
3 it's on the OD of the 7-inch casing. And as  
4 we conclude in the report with different sets  
5 of data, that this was caused due to  
6 microbiological in the groundwater. So this  
7 is the ground water with some microbiological  
8 groups that appear to have caused it.

9           It is unusual. I -- we couldn't  
10 find it in literature. So I don't -- I want  
11 to be careful that it doesn't exist. We  
12 didn't find it. That's how I would word it.

13           Q   Fair enough.

14                   But you didn't find it after an  
15 extensive search; is that right?

16           A   Correct.

17           Q   Okay. All right.

18                   That's fine. That's fair enough.  
19 I didn't want you to -- I didn't want you to  
20 speak on behalf of the entire oil and gas  
21 industry. Okay.

22                   So did -- when you saw the grooved,  
23 striated corrossions on the OD of the  
24 production casing that you pulled out in  
25 2017, did that change the focus of the root  
26 cause analysis?

27           A   Again, I want to -- we didn't have  
28 a focus prior to pulling these casings. We

1 had a view, you know. We had some hypotheses  
2 as to how it may have happened. But we  
3 didn't know until I -- I don't want to say  
4 change. It directed us a little bit more to  
5 what we need to investigate, as far as the  
6 cause of the corrosion, yes.

7 Q All right. Let me ask you a  
8 slightly different way.

9 When you pulled off that piece of  
10 pipe and you saw that grooved striated  
11 corrosion, did MIC suddenly become the  
12 hypothesis -- or the primary hypothesis in  
13 your root cause analysis?

14 A MIC was one of them. We were very  
15 deliberate to make sure we could prove MIC.  
16 But, yeah, MIC was one of them.

17 We still -- at this stage, when  
18 you're looking at this pipe, I didn't know  
19 how the connection was leaking. So there are  
20 other parameters that could enter. Very  
21 easily, we could have argued this is CO2O.  
22 Because the connection was leaking heavily.  
23 The connection was not leaking, as you well  
24 know. So that eliminated it. So I wouldn't  
25 say that is the only mechanism. But that was  
26 one of the mechanisms on the table, in  
27 addition to CO2 corrosion.

28 Q Right.

1 I guess what I'm getting at is,  
2 when you saw that grooved striated corrosion,  
3 did MIC suddenly become a pretty significant  
4 or quite possible hypothesis in your  
5 investigation?

6 A Yeah, absolutely. It was  
7 definitely a hypothesis we had to consider  
8 and either prove or disprove. Yes.

9 Q Okay. And I guess what I'm  
10 wondering is, this investigation started in  
11 January of 2016. You pulled this pipe in  
12 October 2017, so about a year and a half  
13 later.

14 Why wasn't MIC on anyone's radar  
15 scope?

16 A Good question. Very simple reason.

17 Up until this point, there was a  
18 variety of factors to come out. You're -- if  
19 in a conventional well, you think you're  
20 drilling mud behind pipe. That drilling mud,  
21 if it was the right weight, it should hold on  
22 forever. And it should give you protection.

23 There is no -- you cannot -- I  
24 don't like to start an RCA assuming  
25 everything is off. You don't start an RCA  
26 until you have proof, otherwise, that the  
27 drilling mud has been displaced. You cannot  
28 start with that. You presume the drilling

1 mud is there, and drilling mud -- people with  
2 the drill with drilling mud, they applied  
3 ICH. So there's no reason to suspect  
4 external until you see external corrosion.

5           And then when you see external  
6 corrosion, you then start seeing what would  
7 cause external corrosion. So that is a  
8 process. We don't like to start with the  
9 assumption something went wrong. So that is  
10 not a fair assumption. You have to start  
11 with the assumption that everything is as it  
12 should be, and then see what all don't fit.  
13 So that is a process.

14           Q    No, I understand that. But I'm a  
15 little confused by your answer.

16                   I guess, you know, it's my sense,  
17 Dr. Krishnamurthy, that when you walked into  
18 that project, you had a number of hypotheses  
19 in mind. And when I say "hypotheses," I  
20 don't mean suspicions. I mean hypotheses.  
21 You had a couple theor- -- you had a couple  
22 of possibilities in mind that you were either  
23 going to prove or disprove as part of your  
24 investigation.

25                   And, I guess, what I'm wondering  
26 is, when did the possibility of MIC become  
27 the main hypotheses?

28           A    Until when we started looking at

1 the picture here that you're showing --

2 Q Right.

3 A -- failure picture.

4 Q Right.

5 And that happened in October 2017;  
6 correct?

7 A That's correct.

8 Q Okay. And as part of that, once  
9 you saw those striated grooves, you actually  
10 decided to bring in an expert in  
11 microbiology, didn't you?

12 A Yes. But she was already involved  
13 if I remember right. She was involved when  
14 we were pulling the tubing. Getty (phonetic)  
15 was there even prior to this. We did suspect  
16 it. But it was not a major hypothesis until  
17 we saw this. They were, I believe, already  
18 involved in it prior to this.

19 Q And her name was Elizabeth Summer;  
20 right?

21 A Correct.

22 Q What did she add to your root cause  
23 analysis team?

24 A She added the microbiological  
25 element that we didn't have ourselves.

26 Q Okay. And do you remember when  
27 specifically she came on board?

28 A I would have to look back. It was

1 prior to this. It was, if I remember right,  
2 when we were pulling tubing. I want to say  
3 sometime in '17, prior to this. But I'll  
4 have to check --

5 Q Okay.

6 A -- I don't have it handy.

7 Q So the root cause analysis started  
8 in January 2016. And she joined your team  
9 sometime in 2017, subject to check; right?

10 A Yeah. I can check that. I can  
11 find out.

12 Q It's not that important, sir. I  
13 just want to make sure she didn't fly in with  
14 you January 2016.

15 And I think the answer to that is  
16 no; right?

17 A Oh, no. No. No.

18 That's not what -- she -- I --  
19 again, my recollection is she was there when  
20 we were pulling tubing either from 25-A -- I  
21 want to go back to 25-A, which was in '17,  
22 actually. Again, I would have to look at my  
23 listing. But, yeah, sometime in that  
24 timeframe.

25 Q Okay.

26 A But I can have an approximate date  
27 very easily.

28 Q Okay. Let's keep going here.

1           I want to talk about -- so then at  
2 some point after you had pulled out the piece  
3 depicted in these pictures, you decided to  
4 actually extract the lower portion of the  
5 parted casing about a week or so later; is  
6 that right?

7           A     It was not a week. It was a bit  
8 longer, I think.

9           Q     Oh, what --

10          A     I don't remember. It was longer  
11 than that I thought. Let me see.

12                  The lower portion, I -- I know we  
13 had a plan. But it started -- it was a bit  
14 longer than that. I have to go back and  
15 look.

16          Q     Dr. Krishnamurthy, it's not that  
17 important. You actually caught me here,  
18 because I don't have a citation from your  
19 main report on that.

20                  But suffice it to say that -- and I  
21 think this is no surprise to anyone, you  
22 pulled out the upper portion of the parted  
23 casing before you pulled out the lower  
24 portion; correct?

25          A     That is correct.

26          Q     Okay.

27          A     And it was -- because we had to  
28 design -- like you pointed to earlier in your

1 question, we had to design a casing  
2 extraction tool. So I have a feeling it was  
3 not a couple weeks, it was month, I think. I  
4 can check.

5 Q Okay. And why did you need that  
6 special tool?

7 A Multiple reasons. There -- if you  
8 look at the -- when we pulled the top one, of  
9 course, the gas was flowing through there.  
10 It was highly eroded. So the features were  
11 destroyed. So we recognized that the bottom  
12 half becomes extremely important, and to get  
13 it without any damage to the bottom so that  
14 we can make the interpretation. So that is  
15 why it was essential to pull it carefully.

16 Q And -- and I think you mentioned  
17 this already, but let me make sure the record  
18 is clear.

19 And as part of that process, you  
20 had to basically design a special tool to  
21 allow for extraction without damaging the  
22 casing itself; is that right?

23 A Yes. I wanted to clarify that a  
24 little bit. This was a tool that NOV already  
25 had. We just repurposed it for this purpose.  
26 So we put the design in place with NOV. And  
27 one of our engineers worked with NOV to make  
28 sure it would work, and we made it work. So

1 to the existing design that required mild  
2 modifications, or even with some  
3 modifications, we made it happen.

4 Q And were those modifications part  
5 of the creative aspect we talked about  
6 earlier on the credits page?

7 A Yeah. This was, I would say, close  
8 to NOV and Nigel (phonetic). Nigel is  
9 engineers who worked with NOV. That's my  
10 assumption in this. But actual operations in  
11 field, a lot of people, SoCal, and the  
12 service providers -- a lot of people in all  
13 of that.

14 Q All right. So let's go to  
15 Figure 44. Because I want to get down to the  
16 bottom of this pipe as soon as we can.

17 So let's go to Figure 44 on page 52  
18 of the main report.

19 Okay?

20 A Yep.

21 Q And what I see there, and you tell  
22 me if I'm wrong -- and I'll -- we'll talk  
23 about the particulars in a minute. But what  
24 I see there is both a diagram of the upper  
25 portion of the casing and the lower portion  
26 on the left, and an actual picture of the  
27 pipe on the right.

28 Is that accurate?

1           A    That's correct.

2           Q    Okay.  And if you look on the -- at  
3 the diagram on the left, where you have boxed  
4 it in red, and then you point to an arrow.  
5 And then there's the word actual -- "axial"  
6 rupture.

7                    Do you see that?

8           A    Yes.

9           Q    So if I understand how this  
10 extraction went, you pulled out the upper  
11 portion of the production casing and didn't  
12 see any corrosion; you pulled out the upper  
13 portion of the parted casing and you saw  
14 grooved, striated corrosion; and then you  
15 pulled out the lower portion using this  
16 modified excavation system, and you saw an  
17 axial split.

18                   Is that accurate?

19           A    Can I clarify?

20           Q    You bet.

21           A    We -- broadly accurate.  But I just  
22 need to be a little bit clearer in this.  The  
23 top, what is called joint 22 in that figure,  
24 was pulled, first, out of the top fracture  
25 surface.  And there was striated corrosion on  
26 that piece, just to be clear, which is in one  
27 of the pictures somewhere.

28           Q    Okay.

1           A     And then we came in -- it's on  
2 Figure 35 -- then we came in with this NOV  
3 power tool. What you see as connection --  
4 you see connection 22 at the bottom, you  
5 latch onto it, you pull on the bottom  
6 portion -- you have to pull -- you pull  
7 non-to bottom portion, then come in with a  
8 cutter and cut the 7-inch casing somewhere  
9 below. That's the process.     ]

10           Q     Okay. And when you saw that axial  
11 rupture, did that have any significance in  
12 your root cause analysis?

13           A     Yeah. It was a very important part  
14 of the root cause analysis, yes.

15           Q     Why?

16           A     Because it had the -- it had the  
17 failure origin in there. With just the top  
18 half, you may not see the failure origin.  
19 The failure origin wasn't there. So we need  
20 to know where the failure originated. Then  
21 you can start building a hypothesis at this  
22 stage to say what caused it.

23           Q     Right. Right. Because that was my  
24 impression when we had your deposition. And  
25 I can show you these two pages. But let me  
26 read you the question, and let me read you  
27 your answer. You (sic) said:

28                     Now, when you personally learned

1           that the production casing had  
2           parted at roughly 890-some feet, did  
3           your suspicions of the direct cause  
4           change?

5   And your answer was:

6           It changed as I looked at  
7           everything. So first it was just  
8           the circumferential parting. So  
9           when you just look at the parting, I  
10          had a hypothesis. We had various  
11          hypotheses at face. We had 6 or 7  
12          or 8 or whatever, and of course all  
13          of them were off once we saw the  
14          axial split.

15          Is that true?

16          A    It's true. It's true. We had a  
17          lot of hypotheses. Once you look at the  
18          bottom, some of those go away. As an  
19          example, we had heard about geotechnical or  
20          some earth-movement issues. So the movement  
21          hypothesis goes away. So yeah, that's how  
22          you eliminate all of them. But when you look  
23          at the top by itself without the bottom half,  
24          yeah, you are -- your interpretation of the  
25          failure is different. But there was a  
26          corrosion patch there, but the importance is  
27          not put to the corrosion patch because that  
28          didn't appear to be involved in the failure.

1 So that is -- that's correct. And then --  
2 when you see the bottom, then a few of those  
3 go away. That is a correct statement.

4 Q Good. So tell me how -- tell me  
5 how your hypotheses changed from pulling the  
6 top portion of the parted casing to pulling  
7 the bottom portion of the parted casing?

8 A So if I look at the top one -- if I  
9 leave out the bottom one -- just say the top  
10 one is like that and the bottom one is a  
11 mirror image of that and they go together,  
12 then it's what I would call a low temperature  
13 or some sort of a brittle failure. That's  
14 what I would have hypothesized. And there  
15 are reasons why you could have a brittle  
16 failure. I don't want to go through those,  
17 but there are -- a connection is leaking. I  
18 have gas coming out. It's cooling locally.  
19 And I have a failure. There was a  
20 preexisting crack, and it's failed. So  
21 that's one. If you just give me the top,  
22 those would be some of the hypotheses.

23 And when you see the bottom, you  
24 see corrosion implicated more than it would  
25 have been without the bottom half.

26 Q I see. Okay. And when -- you  
27 talked earlier about a corrosion patch. And  
28 I guess my question is, it's my understanding

1 that sort of the corrosion patch that was at  
2 issue here -- and there may have been others  
3 around the pipe -- but the one that was a  
4 particular issue was about 9 inches long; is  
5 that right?

6 A Yeah. There were two dimensions  
7 there. There is a local dimension that is, I  
8 believe, 4.15 inches. And there's slightly  
9 broader area of 8 to 9 inches long. And --  
10 yeah. Again, that's a corrosion patch.  
11 Again, I use the terminology "patch," but  
12 it's a corroded region. Yeah.

13 Q Okay. And the corroded region also  
14 was about what? Two and -- two-plus  
15 inches -- the deep area, actually, of that  
16 corrosion region was about a little over two  
17 inches long; is that right?

18 A Yeah. That is the core of the  
19 area. It was 2 -- 2.13, yes -- yeah, that's  
20 correct. Sorry.

21 Q Okay. And so for those of us who  
22 aren't corrosion engineers, even though  
23 you're not truly comfortable with that label,  
24 is it fair to say that as you pull that pipe  
25 out, there wasn't corrosion on every meter or  
26 every inch of it?

27 A Again, Mr. Lotterman, could you  
28 repeat that question.

1           Q    Yes.  Let me come at it a different  
2 way.  I believe you said it in the  
3 deposition, as used in that, it was localized  
4 corrosion?

5                    Do you remember that?

6           A    Yes.

7           Q    What does that mean?

8           A    Okay.  Localized means -- it means  
9 it's not general corrosion.  It's not  
10 corroded up top to bottom in this length.  As  
11 you can see in this picture, or some other  
12 pictures in the report, the corrosion is  
13 localized.  There are regions of corrosion,  
14 and they were equally distributed around the  
15 casing string.

16           Q    Okay.  So you can have corrosion on  
17 one side of the pipe and not on the other,  
18 right?

19           A    Yes.  You could, but not here.  
20 Here it was on both sides.  It was  
21 distributed.  It was localized.  Okay?  By  
22 "localized," I mean -- we use that  
23 terminology to differentiate from gentle  
24 corrosion, which means I don't have corrosion  
25 everywhere in this joint or the other joint.  
26 It's local.  There are regions of corroded  
27 area.

28           Q    Okay.  Got it.  All right.  That's

1 helpful. Thank you.

2           Let's finish pulling the pipe, and  
3 then we'll move on to the actual MIC  
4 corrosion itself. So to be clear, once  
5 you -- even after you finish that lower  
6 portion of the parted casing depicted in  
7 figure 44, you continued to pull a little  
8 more pipe, didn't you?

9           A Yes. I think after we did  
10 figure -- if you look at figure 44, you would  
11 see we removed joint 23. Then we tied the  
12 7-inch back to surface, and I believe -- and  
13 this is where my memory is a challenge. I  
14 believe we ran logs to understand the  
15 condition of the casing itself because early  
16 on -- by "early on," I mean at some point  
17 earlier we were not sure whether we needed a  
18 lot more casing than we were going to extract  
19 above the shoe. So there were a lot of  
20 discussions with DOGGR and SoCalGas and CPUC  
21 about that.

22           And -- so once we got this piece  
23 out, the intent was to understand what the  
24 rest of the casing strings looked like and  
25 either affirming the need to go for more  
26 casing samples or finalizing -- saying, "Hey,  
27 I need a couple more joints, and I'm okay."  
28 And that's kind of where we landed at the end

1 of the day.

2 Q Meaning you decided to leave the  
3 rest of the production casing in place?

4 A We did pull 24, 25, part of 26, and  
5 then we left everything in place. We didn't  
6 need it.

7 Q Okay. So to be clear, you pulled  
8 out the production casing from the parted  
9 casing up. You pulled out the bottom of the  
10 parted casing, and you pulled out a couple  
11 joints below that but left the rest in place;  
12 is that right?

13 A That's correct.

14 Q Okay. And eventually you shipped  
15 all that pipe to Houston, right?

16 A That's correct.

17 Q And did you ship it to your  
18 facilities at Blade?

19 A No. We have a warehouse. We had  
20 to rent a warehouse because of the volume of  
21 pipes, and we wanted to maintain traceability  
22 and make sure everything is safe. So it is  
23 in a warehouse with security and cameras.

24 Q Okay. And it's my understanding  
25 that once you got it to Houston, you  
26 undertook a bunch of tests, which I think  
27 only you would understand, and involving  
28 proctography and casing loading analysis and

1 that type of thing, right?

2 A Yes.

3 Q And I'm not going to get into that  
4 today, but the bottom line is you shipped the  
5 pipe to Houston. You tested it, and that  
6 pipe is still in Houston today, right?

7 A Yes.

8 Q So to wrap-up this line of  
9 questioning, I have a couple more questions  
10 for you. After pulling out the tubing, a  
11 mile and whatever tubing, and pulling out  
12 three football fields of production casing,  
13 did you consider extracting the surface  
14 casing?

15 A We did. We did. But we discarded  
16 that idea. So if you go early on in 2016, we  
17 considered it. We -- at that point, we  
18 didn't know anything. We didn't know  
19 anything about exactly where it failed, but  
20 as we gained more knowledge -- and the  
21 surface conditions, first 300 to 400 feet is  
22 weathered rock with a lot of vertical land  
23 horizontal permeability. So it is quite  
24 impractical, or it is very difficult and --  
25 to extract the surface casing. So we did a  
26 very good logging program, which was more  
27 than adequate for our purposes. So we left  
28 it at that.

1           Q    Okay. Understood. Question for  
2 you, and then we'll move on to another topic.

3                    Is -- if you're a gas storage  
4 operator and you've got a well in place that  
5 has surface casing, production casing and  
6 tubing -- so you've got basically three pipes  
7 as well as some cement on the outside of the  
8 surface casing, how would you investigate  
9 whether you got any corrosion on the outside  
10 diameter of your surface casing?

11           A    You cannot -- other than removing  
12 the production casing, you cannot inspect the  
13 surface casing easily. So the only way to  
14 assess whether it has ID aerobic corrosion is  
15 through a wall-thickness inspection tool. In  
16 order to do that, it's quite challenging on a  
17 surface casing. And if I remember right --  
18 again, I'm testing my memory -- there were a  
19 couple of surface casing logs that we did  
20 look at. If I'm not right -- I -- it's been  
21 a while. I need to check. But, yeah, it is  
22 challenging.

23           Q    Right. So let me just ask you a  
24 couple more questions on this. So I  
25 understand your answer correctly, for a gas  
26 storage operator like SoCalGas to measure the  
27 wall thickness of the surface casing, at  
28 least in the 2015 time frame or whatever,

1 they would have had to remove the tubing and  
2 the production casing near that area,  
3 correct?

4 A That's correct.

5 Q And if an underground storage  
6 operator like SoCalGas wanted to understand  
7 the cause of that wall thinness on the  
8 exterior of the surface casing, it would have  
9 to remove the surface casing itself, wouldn't  
10 it?

11 A Yeah. If you want to do a really  
12 true root cause analysis or something, yeah,  
13 that's the only way to do it, but normally  
14 the way operators deal with surface casing  
15 corrosion is where it makes sense, not  
16 everywhere. And if you suspect your  
17 cementing is not in place or you have a water  
18 zone, you mitigate that corrosion. That's  
19 really all you can do. You cannot -- its not  
20 very practical to undertake an assessment of  
21 the surface casing. You would just try to  
22 mitigate that. That's really the practical  
23 approach.

24 Q Well, when you say it's not  
25 practical, I mean, basically, if you pull the  
26 production casing, you're destroying the  
27 well, correct?

28 A No. You're not destroying the

1 well. I want to be careful. You can always  
2 tie back to the production casing and get the  
3 well back in operation if you wanted to.  
4 It's more difficult. It's more onerous to do  
5 that. But no, you're not destroying the  
6 well. You would cut the production casing to  
7 the bottom of the surface casing, and then  
8 you would inspect the surface casing. But  
9 that's a pretty onerous undertaking.

10 Q And extremely, extremely unusual in  
11 the oil patch, isn't it?

12 A I'm thinking. I don't know how  
13 unusual or usual it is. I -- yeah, it is not  
14 normal. Yeah, that's correct.

15 Q Now, it's beyond that, isn't it,  
16 sir? It's extremely unusual for an oil gas  
17 operator or a gas storage operator to pull  
18 the tubing and to excavate or extricate the  
19 production casing out of a well to determine  
20 its corrosion, correct?

21 MR. GRUEN: Your Honor, if I may, the  
22 question's been asked and answered.  
23 Objection.

24 ALJ POIRIER: Sustained.

25 BY MR. LOTTERMAN:

26 Q Let me ask it this way, Dr.  
27 Krishnamurthy: If a gas operator wanted to  
28 remove the surface casing of a well, would

1 that destroy the well?

2 A Yes. That is extremely unusual.

3 Q Okay. All right. All right.

4 Let's talk about if this is -- Poirier, is it  
5 a good time to break, or shall I continue?

6 ALJ HECHT: Yeah. Let's take a  
7 10-minute break until 3:10, and we'll return  
8 then.

9 We'll be off the record.

10 (Off the record.)

11 ALJ POIRIER: We'll be back on the  
12 record.

13 Please continue, Mr. Lotterman.

14 BY MR. LOTTERMAN:

15 Q Dr. Krishnamurthy, let's keep going  
16 deeper and deeper into this issue, and let's  
17 talk about the corrosion on the outer portion  
18 of the production casing. Okay? And  
19 basically, if I read your report correctly,  
20 you conclude that the corrosion is caused by  
21 a MIC, a microbial induced -- or influenced  
22 corrosion species called Methanobacterium  
23 Aarhusense. And I'm going to spell that for  
24 the court reporter.

25 M-E-T-H-A-N-O-B-A-C-T-E-R-I-U-M. New word,

26 A-A-R-H-U-S-E-N-C -- S-E-N-C-E. Excuse me.

27 Is there a -- I have a handful of questions

28 on that. Is there a shorter name we can use?

1 A (Speaker on mute.)

2 Q You're on mute, sir.

3 A I apologize. Methanogens.

4 Q Okay. But I guess what I'm  
5 wondering is -- well, let me ask the question  
6 and then see if that new phrase helps.

7 I had the impression that as part  
8 of your report you couldn't rule out the  
9 presence of other methanogens in the area; is  
10 that right?

11 A No. What was done was we collected  
12 what we call a sample to match against from  
13 the location of Aliso, and we eliminated  
14 those methanogens. But the methanogen --  
15 Methanobacterium -- the two Methanobacteriums  
16 have been known to cause corrosion, and they  
17 were in abundance in two joints that was  
18 sampled on location.

19 Q Right. I understand that, and  
20 we'll talk about that in a minute. Well,  
21 actually, let me ask you this: So if I  
22 understand you correctly, what you're saying  
23 is it was the predominant species, correct?

24 A That's correct.

25 Q Okay. My question is were there  
26 other species there as well besides the  
27 predominant one?

28 A Yes, there were.

1 Q Okay. And in fact, that's not  
2 unusual to have a community of methanogens or  
3 species in an area even if one is the  
4 predominant one; is that right?

5 A That's correct.

6 Q And to state it in a slightly  
7 different way, it's rare to have only one  
8 species present, true?

9 A True.

10 Q Now, I Googled that bug, and I got  
11 a website called Microbewiki, which exists,  
12 believe it or not. And it describes the  
13 methanogen as a very picky microbe. Do you  
14 know what they are referring to?

15 A No, I have -- I don't know.

16 Q Okay. It said that it's  
17 mesophilic, M-E-S-O-P-H-I-L-I-C. Do you know  
18 what that means?

19 A I think mesophilic -- I don't know.  
20 I don't want to speculate.

21 Q Okay. It says it's moderately  
22 halophilic, H-A-L-O-P-H-I-L-I-C. Do you know  
23 what that means?

24 A There are hydrocarbon degrading  
25 bacteria that those are called Halomonas, but  
26 I don't know whether that's what they're  
27 referring to. I have not looked at the wiki  
28 page.

1           Q    Okay.  And it also said that they  
2 are non-motive, M-O-T-I-L-E (sic).  Do you  
3 know what that means?

4           A    It could mean non-mobile.  I don't  
5 know.

6           Q    Okay.  All right.

7           A    I'm not qualified to comment on  
8 that wiki page.  So I apologize for that.

9           Q    Well, I was just wondering if you  
10 knew those particular biological terms.

11                    Okay.  So if I understand your  
12 hypothesis -- or Blade's hypothesis  
13 correctly, Doctor, it is as follows -- and  
14 this is going to be a -- kind of a gross  
15 rendition, and you're free to refine it any  
16 way you wish.  Under your hypothesis, there  
17 was water in the area and there was the  
18 presence of this microbe in the area and/or  
19 in the groundwater and that the microbe  
20 entered the annulus between the surface  
21 casing and the production casing at some  
22 point via groundwater and was able to do so  
23 because whatever drilling fluid was in that  
24 annulus had left, and then the microbe was  
25 fed by seeping carbon dioxide from the pipe  
26 joints in the casing, became the predominant  
27 species and corroded the production casing  
28 until it burst on October 23, 2015.  Is that

1 kind of a rough rendition of your -- of  
2 what -- of your findings in the root cause  
3 analysis?

4 A Yes. That's a good summary.

5 Q All right. So let's unpack that a  
6 bit, if we could, in our remaining time  
7 today. First of all, where did the water  
8 come from? And I don't mean the -- I don't  
9 mean the water with the microbe in it, or  
10 whatever, but just where did the water come  
11 from that you believe got in between the  
12 surface casing and the production casing?

13 A Okay. Let me step back a little  
14 bit. So the drilling mud that is above the  
15 cement is about what we call 10 ppg mud.  
16 Okay. 10 pound per gallon. So it doesn't  
17 settle hydrostatic pressure and load. And so  
18 at around 990 feet or around that area, that  
19 height -- that drilling fluid would have  
20 leaked off because of the density by itself,  
21 and that was then replaced with groundwater  
22 that is -- because we do have a section in  
23 the report -- I don't remember where -- there  
24 are no existing aquifers in that area. So  
25 the only source of that water is rainwater  
26 that penetrates the ground through various  
27 hydrochemical reactions.

28 As we demonstrated in the bore

1 holes on SS-9, there was water at 1,000 feet,  
2 1,100 feet and 400 feet, if I remember right.  
3 And so that water went into the annulus of  
4 the -- between the 7-inch and the  
5 11 3/4-inch. And with that water, it would  
6 carry microbes, and the microbe with gross  
7 methanogens was fed with CO2.

8           Now that -- there are -- there  
9 are -- when we make one interpretation of,  
10 say, microbial corrosion or -- we look at two  
11 or three factors that guided in that point.  
12 And if one of them is a contraindicator, I  
13 have to be careful about making it our  
14 primary interpretation of the failure.

15           So the three aspects that drive us  
16 towards microbial-related corrosion was the  
17 nature of the grooves, the presence of  
18 tunnels, which really no other corrosion can  
19 cause, the fact that the connections all  
20 tested very well. There was no massive CO2  
21 leak in any of those connections. And then  
22 lastly, if you look at the temperature log,  
23 through the history of SS-24, which I believe  
24 is in one of the pages here -- I have to find  
25 it -- it shows that there was a fluctuating  
26 water level. There is a small cool-down at  
27 that depth, around 600 to 700 feet, which  
28 matches everything we found physically, where

1 there was no corrosion up to 600, 700 feet  
2 and when there was corrosion.

3 And what is important to note also  
4 is the corrosion in the 11 3/4 matches with  
5 the 7-inch corroded. So all of those data  
6 points come together. And so this is why we  
7 interpret it as micro MIC -- MIC-induced and  
8 most probably methanogens.

9 Q Okay. You got a little bit ahead  
10 of me, but that's okay. I'm going to back up  
11 a little bit and focus on the water just a  
12 little bit longer, and then we can get into  
13 the methanogens themselves.

14 So if I heard you correctly, what  
15 you said was there were no aquifers in the  
16 area. So it's not like the water was sitting  
17 there at some sort of a groundwater table,  
18 correct?

19 A That's correct.

20 Q Okay. And then what I also thought  
21 I heard you say is you believe that the water  
22 came from rainwater -- from rain, basically,  
23 right?

24 A That's correct. Precipitation.

25 Q Yup. And obviously -- or maybe not  
26 obviously, but certainly one would expect  
27 that rain -- that water level would ebb and  
28 flow because rain comes and goes. And so

1 that in itself probably fluctuated, correct?

2 A That's correct.

3 Q Did you look at whether the water  
4 came from any of SoCalGas' storage-fueled  
5 operations, for example, any of their water  
6 injection processes and that type of thing?

7 A Yeah. We -- again, that was in our  
8 initial -- in our early-on thinking, there  
9 is, I believe, if I'm not wrong, is water  
10 injection. Again, I'm searching memory, Mr.  
11 Lotterman, but I think 3,500 feet, there was  
12 some water depth, if I remember right, but I  
13 don't -- they didn't have anything to do with  
14 this. No.

15 Q Okay. So it's fair to say that you  
16 ruled out the possibility that somehow  
17 SoCalGas' water-injection system caused the  
18 corrosion on SS-25, to the best of your  
19 recollection; is that right?

20 A That's correct.

21 Q Okay. All right. And in  
22 determining whether or where that shallow  
23 water was around the SS-25 pad, you drilled  
24 two shallow water wells, true?

25 A Yeah. We and, I believe, the L.A.  
26 Water Authority was also interested in that.  
27 So we didn't want to -- we wanted to be time  
28 and cost-effective. So that -- those two

1 wells were drilled with both those objectives  
2 in mind.

3 Q And you also analyzed the rainfall  
4 during a particular period of time; is that  
5 right?

6 A Yeah. We analyzed rainfall to look  
7 for trends when the -- yeah, it's in the  
8 report. But, yeah, that's correct.

9 Q And did you do anything else  
10 besides drilling the wells and analyzing the  
11 rainfall to try to figure out the ebb and  
12 flow of the rain in and around that pad?

13 A No. The two water wells at SS-9,  
14 which is about 600 feet from SS-25, provided  
15 us adequate data to indicate how SS-25 would  
16 behave. And SS-25 -- the plan at that point  
17 in the RCA, which was, I forget, September of  
18 2018, I believe, the plan was also to drill a  
19 well on SS-25 pad itself. That was one of --  
20 it was one of our discussions we had with  
21 SoCalGas and CPUC, DOGGR. But then when we  
22 looked at the data from SS-9 and we looked at  
23 log data from SS-25, we were -- we said,  
24 "This is adequate." It was quite challenging  
25 to do these wells. It's not easy to do these  
26 wells, and we didn't want to take any risks  
27 with the SS-25 pad. So that's why we didn't  
28 do it.

1 Q Okay. Okay. All right. And then,  
2 um, where did the methanogen come from?

3 A Methanogen could have been carried  
4 to the location -- as the water seeps through  
5 the ground, it may have captured some  
6 methanogens, and they may have evolved with  
7 nucleons. It's pure speculation at this  
8 point on my part. All we can state is there  
9 was a lot of methanogens on the pipe, and it  
10 was consistent with the presence of a groove,  
11 and we couldn't find another source of water  
12 there. So that is the only source of water.  
13 So some of it is by elimination.

14 Q Okay. And is it your -- is it your  
15 hypothesis that the rainwater came into the  
16 area and went down the outside of the surface  
17 casing and then went in -- under the shoe and  
18 up into the annulus?

19 A The exact pathway I would be  
20 speculating, but all we know is it would get  
21 through to two places. There are two  
22 possibilities. Okay? One possibility is  
23 around the shoe. The other possibility we  
24 couldn't rule out is through possibly holes  
25 in the surface casing. Those are two ways it  
26 can get in there. Okay? But most  
27 probably -- because if you look at the log in  
28 one of the pages, there is a water-permeable

1 zone in SS-25 at around 1,000 feet. So the  
2 two logs from SS-9 and the bore hole or water  
3 well will be drilled on SS-9 and the SS-25  
4 logs, if you look at, you'll see permeable  
5 zones below the shoe. ]

6 Q So is it your view that the most  
7 probable explanation for how the groundwater  
8 with the methan- -- with how the, I'm sorry,  
9 rainwater runoff with the methanogen got into  
10 the annulus was under and up around the --  
11 the casing shoe?

12 A Yeah, that's -- that is -- that is  
13 definitely one strong hypothesis appearing.  
14 Strong -- that is one interpretation. The  
15 other interpretation we cannot rule out is  
16 through the surface casing.

17 Q Right. I understand that. But, I  
18 guess what I'm wondering is, if you had to  
19 sort of give 'em odds, shall we say, is it  
20 more probable than not or whatever -- and I  
21 apologize for pressing you on this, but I  
22 think it's -- it's helpful -- which -- which  
23 is a more likely scenario, in your  
24 professional view?

25 A Looking at the -- we discussed this  
26 quite a bit, as you can imagine, internally,  
27 the source of the water. I would say the --  
28 the more probable one would be through the

1 shoe.

2 Q Through the shoe, meaning under the  
3 shoe --

4 A Yeah.

5 Q -- of the surface casing?

6 A Around the shoe. If you look at  
7 the log in page -- Figure 81, you will see  
8 there are water-permeable zones, so that's  
9 where we think it came in from.

10 Q Okay. Fair enough. All right.  
11 And I understand this is -- this is somewhat  
12 of a -- there's a little speculation here,  
13 but I kind of wanted to get your best  
14 judgment on that. So a couple more items,  
15 and I think we're going to break for the day.

16 Question one for you: Were you  
17 able to find reliable data as to when those  
18 methanogens first entered the annulus?

19 A I would use methanogens and water  
20 interchangeably, if that is what you're  
21 after. It would be speculative,  
22 Mr. Lotterman, so I want to state it as such.  
23 I have no data to base it on, necessarily.  
24 It would be -- I would -- I would -- I would  
25 say it's early on in the well life, is my  
26 guess. It's a guess right now. I -- you  
27 know, it -- it requires a lot more  
28 investigation and understanding and -- to

1 time it. That's not straightforward.

2 Q Okay. And -- and -- and to be  
3 clear, I'm not pressing you to guess here, so  
4 if it's something that you weren't able to --  
5 to determine with any sort of reasonable  
6 sense of certainty, let me know. I just want  
7 to sort of try to figure out what your  
8 analysis was able to determine and what your  
9 analysis was not.

10 So if I understand you correctly,  
11 you were unable to sort of land on a reliable  
12 date as to when that methanogen and that  
13 water first entered the annulus. Is that  
14 fair?

15 A That's fair. Can I explain a  
16 little bit on that?

17 So the one thing we did note, and  
18 this is where my speculation even there  
19 (inaudible), is the corrosion is -- appears  
20 to be very slow. It is not like  
21 sulfate-reducing bacteria, the other form of  
22 metal corrosion, which is what we -- we  
23 initially suspected, and ruled it out later,  
24 as we analyzed the scale and everything else.  
25 We didn't find proof of that. The  
26 corrosion -- it would be slow, which means it  
27 took a while.

28 Q Okay. I think Judge Poirier's

1 about to jump in, sir.

2 Are you -- is it -- have we run out  
3 of time, your Honor?

4 ALJ POIRIER: No. We've got more time.  
5 I'm open to go 'til about 3:45 or 3:50.

6 MR. LOTTERMAN: Okay. Thank you.

7 Q All right. Thank you,  
8 Dr. Krishnamurthy. I appreciate that  
9 explanation.

10 Because part of what I'm trying to  
11 figure out -- and I think this is why you're  
12 unable to give us -- or unable to give kind  
13 of a reliable date is, under your hypothesis,  
14 the groundwater has to replace the drilling  
15 fluid in the annulus. Right?

16 A That's correct. It -- it -- it  
17 would have to displace, and -- and -- and it  
18 would have to -- see, the -- the terminology  
19 we have is called leak-offs. So this -- this  
20 drilling mud in the annulus would have  
21 leaked-off, and then rainwater would have  
22 come in, and so then, as -- as you can  
23 imagine, there'll be some intermixing over a  
24 period of time. So that is why speculating  
25 on time is a little difficult to do.

26 Q Okay. And is it fair, also, to say  
27 that you don't really know when those SS-25  
28 well connections first started seeping and

1 feeding carbon dioxide to the microbes?

2 A That's correct.

3 Q Okay.

4 A And -- and just to address this  
5 whole connection issue, the connection -- as  
6 we -- we have a connection testing or  
7 analysis that we did. It is a seep. I would  
8 use the word seep rather than a leak. Okay?  
9 And the reason is it is -- if you -- and  
10 that's -- you're right. It could be  
11 intermittent, it could be -- so we can't --  
12 that would be -- but, it did leak a little  
13 bit, so that is real.

14 Q Okay.

15 A But -- sorry, seep a little, seep a  
16 little bit, not leak. We need to be careful.

17 Q Understood. And when you say,  
18 "seep," I guess what I'm wondering is my  
19 sense is we're talking about a pretty small  
20 amount. True?

21 A Yes. I would have to look at the  
22 reports we have, and we have the leak rate  
23 there very small.

24 Q Right. Because the reason why I  
25 ask you is earlier on today we were talking  
26 about if there's a pinhole leak in the -- in  
27 the wellbore, you get a cooling in the temp  
28 log, or you might get a -- you might get some

1 noise in your noise log. And is it safe to  
2 assume that the seeping that you believe  
3 occurred would not have triggered either an  
4 anomaly in the temp log or the noise log?

5 A It definitely -- it can be below  
6 the threshold of that. These are -- that's  
7 why I use the word seeping. Yeah? It's  
8 below the threshold of such tools, the noise  
9 and the temp.

10 Q So does it follow, then, from that  
11 answer that, to the extent SoCalGas was  
12 conducting its annual monitoring with temp  
13 logs or noise logs are (sic) needed, it would  
14 not have picked up that seeping?

15 A Yes.

16 Q Okay.

17 A May I clarify further? So it's  
18 important. When we do a root cause, we're  
19 looking for various factors. Everything  
20 should match. So let's say the connection  
21 started leaking at a high rate, and none of  
22 the temperature logs showed us that. That  
23 would be a problem for us. Everything should  
24 match. So the review of the temperature logs  
25 from the well matched the low leak rate for  
26 the connection, really, really low leak  
27 rates. So all of those added up together,  
28 and it made sense.

1 Q Okay. Got it.

2 One final question, and then, I  
3 think, your Honors, this might be a good time  
4 to break, because I'm about to go into a  
5 whole 'nother area.

6 But, Dr. Krishnamurthy, is it -- is  
7 it safe to say that the MIC that you believe  
8 entered the annulus and began corroding the  
9 production casing did not start on the date  
10 that SS-25 was drilled in 1953?

11 A That's definitely true.

12 MR. LOTTERMAN: Okay. Your Honors,  
13 I think this is a good time to stop. I'm  
14 going to go into another long area, and I  
15 think this time of the day it's probably not  
16 a good place to start and stop in the middle.

17 ALJ POIRIER: Okay. Let's go off the  
18 record.

19 (Off the record.)

20 ALJ POIRIER: We'll be back on the  
21 record.

22 While we were off the record, we  
23 discussed various issues regarding exhibits,  
24 including the fact that SED would be moving  
25 some exhibits, and also we will be looking at  
26 an issue of making sure that we do not have  
27 too much duplication of exhibits. To the  
28 extent necessary, there may be some that may

1 have to be in there because they were marked,  
2 but that's something we're going to get to  
3 tomorrow.

4 In the meantime, Mr. Gruen, do you  
5 have a motion?

6 MR. GRUEN: Yes, your Honor.

7 At this time, SED would move to  
8 enter into the record Exhibits SED-204, the  
9 Reply Testimony Supporting Attachments,  
10 Public Version, SED-C-204, the Reply  
11 Testimony Supporting Attachments,  
12 Confidential Version, SED-216, which is SED's  
13 Sur-Reply Testimony of Margaret Felts to  
14 Violation 331. And I would note that all  
15 three revised exhibits were served at the end  
16 of the day on Friday, last Friday. Thank  
17 you.

18 ALJ POIRIER: Thank you. Do we have  
19 any objections for moving these exhibits?

20 MS. PATEL: No objection, your Honor.

21 ALJ POIRIER: Okay. Hearing none, we  
22 grant SED's request to move the Exhibits  
23 SED-204, SED-C-204, and SED-216.

24 (Exhibit No. SED-204 was received  
25 into evidence.)

26 (Exhibit No. SED-C-204 was received  
27 into evidence.)

28 (Exhibit No. SED-216 was received  
into evidence.)

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ALJ POIRIER: Okay. Let's go off the record.

(Off the record.)

ALJ POIRIER: Let's go back on the record.

We have concluded for the day. We will -- we will be reconvening tomorrow at 10:00 a.m. and continuing the cross of Mr. Krishnamurthy by SoCalGas. Thank you, all. Have a good afternoon.

Off the record.

(Whereupon, at the hour of 3:39 p.m., this matter having been continued to 10:00 a.m., March 23, 2021, the Commission then adjourned.)

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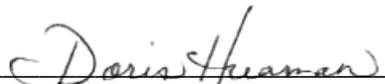
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BEFORE THE PUBLIC UTILITIES COMMISSION  
OF THE  
STATE OF CALIFORNIA

CERTIFICATION OF TRANSCRIPT OF PROCEEDING  
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EXECUTED THIS MARCH 29, 2021.

  
DORIS HUAMAN  
CSR NO. 10538

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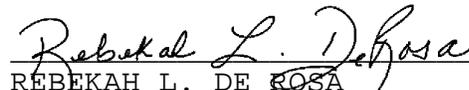
  
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EXECUTED THIS MARCH 29, 2021.

  
REBEKAH L. DE ROSA  
CSR NO. 8708

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