

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

WEATHERFORD U.S., L.P.,

Petitioner,

Case No. IPR2024-00990

V.

HALLIBURTON ENERGY SERVICES,

U.S. Patent No.

INC.,

11,333,007

Patent Owner.

ORAL DEPOSITION OF
ROBERT A. DURHAM, Ph.D., PE
MAY 15, 2025

ORAL DEPOSITION OF ROBERT A. DURHAM, PhD, PE,
produced as a witness at the instance of the Petitioner,
taken in the above-styled and -numbered cause on the 15th
day of May, 2025, A.D., beginning at 8:59 a.m. to 2:09
p.m., before Kelly Hassell, RPR, CLR, CSR, in and for the
State of Texas, at the offices of Baker Botts LLP,
located at 2001 Ross Avenue, Suite 1100, Dallas, Texas,
in accordance with the Federal Rules of Civil Procedure
and the agreement hereinafter set forth.

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1 A P P E A R A N C E S

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I N D E X

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Direct Examination by Mr. Wilson..... Page 4

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Cross-Examination by Mr. Walters..... Page 153

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* No Exhibits Marked *

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1 P R O C E E D I N G S

2 THE COURT REPORTER: The time on the
3 record is 8:59 a.m. Central Time. If counsel could
4 please state their appearances for the record.

5 MR. WILSON: Douglas Wilson of Armond
6 Wilson LLP for Petitioner Weatherford.

7 MR. WALTERS: Chad Walters of Baker Botts
8 for Patent Owner Halliburton.

9 (The witness was duly sworn.)

10 THE COURT REPORTER: Thank you.

11 You may proceed.

12 ROBERT A. DURHAM, PhD, PE,
13 having been first duly cautioned and sworn to testify the
14 truth, the whole truth and nothing but the truth,
15 testified on his oath as follows:

16 DIRECT EXAMINATION

17 BY MR. WILSON:

18 Q Good morning, Dr. Durham.

19 A Good morning.

20 Q Can you please state your full name?

21 A Sure. Dr. Robert Allan, A-L-L-A-N, Durham.

22 Q And you've been deposed before, correct?

1 A Yes, sir.

2 Q About how many times?

3 A Northwards of 100.

4 Q Okay. So you're familiar with the rules of
5 depositions?

6 A Yes, sir.

7 Q Okay. You're aware that you're under oath this
8 morning?

9 A Yes, sir.

10 Q And is there any reason, medical or otherwise,
11 why you cannot testify fully, truthfully, and accurately,
12 as you sit here today?

13 A No, sir.

14 Q Okay. Now, I'm going to hand you what was
15 previously marked as Exhibit 2002.

16 MR. WALTERS: Thank you.

17 Q (BY MR. WILSON) And Exhibit 2002 is a copy of
18 one of your declarations submitted in this IPR, correct?

19 A It appears to be, yes, sir.

20 Q And if you turn to Page 115, that's your
21 signature?

22 A Yes, sir, it is.

1 Q Okay. And it's dated March 7th, 2025, correct?

2 A Yes, sir.

3 Q Now, did you review your declaration prior to
4 your deposition today?

5 A Yes, sir, I have.

6 Q Okay. Did you find any mistakes or anything
7 you think needs to be corrected?

8 A I did find one substantive mistake.

9 Q Okay. Where is that?

10 A Paragraph 126.

11 Q Okay.

12 A It reads, "Claim 4 requires the downstream
13 (first) sand screen assembly have more packing tube
14 nozzles than the upstream (second) sand screen assembly."

15 And I got the first and second backwards.

16 Q Okay. So --

17 A With regard to the '007 patent, the first is
18 upstream. I'm sorry. The first -- yeah, the first is
19 upstream.

20 Q Okay. That's the only mistake or error you
21 found?

22 A It's the only one of substance. I think I

1 found some additional typos that would be obvious typos,
2 but --

3 Q Okay.

4 A -- I don't --

5 Q So other than that mistake in Paragraph 126,
6 you are confident in all the opinions expressed in
7 Exhibit 2002?

8 A Yes, sir.

9 Q All right. Okay. I'm going to hand you what
10 was previously marked as Exhibit 2004. And Exhibit 2004
11 is your Second Declaration of Dr. Robert Durham in
12 Support of Patent Owner's Contingent Motion to Amend,
13 correct?

14 A Yes, sir, it appears to be.

15 Q Okay. And if we turn to the last page,
16 Page 44, that's your signature, correct?

17 A It is.

18 Q And it's also dated March 7th, 2025, correct?

19 A It is.

20 Q Now, did you review Exhibit 2004 before your
21 deposition today?

22 A Yes, sir.

1 Q Did you find any mistakes or errors?

2 A No, sir.

3 Q So you are confident in all the opinions you
4 expressed in Exhibit 2004?

5 A Yes, sir.

6 Q Now, in preparing Exhibits 2002 and 2004 --
7 strike that.

8 I'm also going to hand you Exhibit 2003.
9 And Exhibit 2003 is a copy of your CV submitted in this
10 IPR, correct?

11 A Yes, sir.

12 Q Okay. Did you review Exhibit 2003 before your
13 deposition this morning?

14 A No, I didn't.

15 Q Okay. Is Exhibit 2003 current as of today?

16 A Well, the work history is not up to date. It
17 says 2022. You can take both of those to 2025.

18 It appears that there's a -- one
19 publication -- at least one publication missing that was
20 published last year, last September.

21 Q Okay. So you're saying, on Page 3, the work
22 history for D2 Tech Solutions, Inc., and THEWAY

1 Corporation should be extended to 2025?

2 A Yes, sir.

3 Q And you said there's an additional publication
4 published September of 2024?

5 A Yes, sir.

6 Q And do you know the title of that publication?

7 A I don't have the title, no, sir.

8 Q Do you know what subject matter it pertains to?

9 A Yes, sir. It had to do with electric
10 submersible pumps used in oil and gas wells.

11 Q Okay. Anything else that needs to be corrected
12 in Exhibit 2003?

13 A I mean, clearly, there's been some additional
14 depositions since January. I think one, maybe. Probably
15 one.

16 Q Okay. And for the additional deposition that
17 you've had since January, what was the subject matter of
18 the case you were testifying in?

19 A I think that one was an aggregate handling
20 system at a fracturing location. It was an intellectual
21 property matter as well.

22 Q You're saying, for example, like a conveyor

1 system?

2 A Yes.

3 Q Okay.

4 A That type of concept.

5 Q Okay. So in preparing Exhibits 2002 through
6 2004 for this IPR, did you work with Baker Botts?

7 A Yes, sir, I did.

8 Q Okay. Who specifically at Baker Botts?

9 A Mr. Walters and Mr. McDonald.

10 Q Did you work with anybody at Halliburton in
11 preparing these exhibits?

12 A No, sir.

13 Q Did you speak to anyone at Halliburton about
14 these exhibits?

15 A No, sir.

16 Q Okay. Let's take a look at Exhibit 2002. I
17 want to look at Paragraph 14.

18 Okay. The last sentence of Paragraph 14,
19 right at the bottom of Page 9, says, "In forming my
20 opinions, I have reviewed the materials cited in the list
21 of exhibits and the materials cited throughout my
22 declaration."

1 Did I read that correctly?

2 A Yes, sir.

3 Q And that's a true statement?

4 A Yes, sir, it is.

5 Q And so you reviewed the exhibits that are
6 listed here under Paragraph 14, under the heading "List
7 of Exhibits," correct?

8 A Yes, sir, I did.

9 Q Okay. And is this a complete list of the
10 materials that you considered in -- in preparing
11 Exhibits 2002 -- or Exhibit 2002, sorry?

12 A Yes, sir.

13 Q Now let's take a look at Exhibit 2004. And
14 Paragraph 17.

15 So last sentence of Paragraph 17 says, "In
16 forming my opinions, I reviewed the materials list --
17 cited in the list of exhibits and the materials cited
18 throughout my declaration."

19 Did I read that correctly?

20 A Yes, sir, you did.

21 Q Okay. And so is this a complete list, then,
22 under "List of Exhibits" of the materials you considered

1 in preparing Exhibit 2004?

2 A Yes, sir.

3 Q And you reviewed all the materials listed under
4 the "List of Exhibits," correct?

5 A Yes, I did.

6 Q Okay. So let's now turn to Exhibit 2003. And
7 looking at Page 3.

8 A Okay.

9 Q Okay. And Page 3 lists the degrees that you've
10 earned, correct?

11 A Yes, sir.

12 Q The first degree there is a Bachelor of Science
13 in electrical engineering with honors from the University
14 of Tulsa, correct?

15 A Yes, sir.

16 Q And you completed that in 1992?

17 A Yes.

18 Q All right. So as part of your Bachelor of
19 Science degree in electrical engineering at the
20 University of Tulsa, did you take any courses in
21 mechanical engineering?

22 A Yes.

1 Q Which courses?

2 A Wow. There was at least an instrumentation
3 course that covered mechanical engineering concepts. A
4 fluid dynamics course. There may have been a statics
5 course as well. I'm not sure exactly where I took --
6 when I took that. For 30-plus years, that's pretty good
7 to remember those.

8 Q Okay. And what aspects of mechanical
9 engineering were covered in an instrumentation course?

10 A Basic concepts of -- it was kind of a, if you
11 will, introduction to mechanical engineering concepts
12 from an electrical perspective. In order to properly
13 instrumentate and control processes, you have to
14 understand the processes. So it's heat transfer, fluid
15 dynamics, some strengths of materials concepts for, you
16 know, implementing stress and strain gauges, those kind
17 of instruments.

18 But those kind of concepts. So it was
19 a -- it was a, hey, you may not get out of school with an
20 awful lot of mechanical engineering or chemical
21 engineering or petroleum engineering concepts, but here
22 are some that you need to know in order to instrument and

1 control them.

2 Q Okay. As part of your Bachelor of Science
3 degree in electrical engineering, did you take any
4 courses in petroleum engineering?

5 A Not directly, no, sir.

6 Q Did you complete any coursework related to oil
7 or gas drilling as part of your Bachelor of Science?

8 A Not directly, no, sir.

9 Q Did you complete any courses related to
10 completions?

11 A No.

12 Q How about geology?

13 A No, sir, I don't believe so.

14 Q Now, you said you completed a course in fluid
15 dynamics?

16 A Yes, fluid dynamics.

17 Q Okay. Is that a regular part of the electrical
18 engineering curriculum?

19 A It was. It's certainly not anymore, but it
20 certainly was.

21 Q Okay. Did you complete any courses related to
22 mechanics of materials?

1 A Instrumentation course, of course, had the
2 strength of materials section, as I -- as I recited
3 earlier.

4 Q Okay. Back to Exhibit 2003. You received your
5 Master of Engineering in technology management from the
6 University of Tulsa in 1997, correct?

7 A Yes, sir.

8 Q How long did it take to complete this degree?

9 A Five years. I got married in the middle, so it
10 slowed things down.

11 Q Now, the Master's of Engineering degree in
12 technology management was offered through University of
13 Tulsa's College of Business Administration, correct?

14 A Yes, sir, in conjunction with the College of
15 Engineering.

16 Q Okay. So as part of your Master's of
17 Engineering degree, did you take any engineering courses?

18 A Yes. About half. Well, exactly half.

19 Q Did you take any engineering courses related to
20 mechanical engineering?

21 A Well, I don't recall when the statics course
22 was, if that was bachelor's or master's. So it was one

1 of the two.

2 Q Okay.

3 A Or, I mean, it's a possibility that's a
4 continuing ed course as well. I don't -- it all kind of
5 jumbles together there in the '90s.

6 Q Okay. So other than statics, did you complete
7 any coursework in mechanical engineering as part of your
8 Master's in Engineering degree?

9 A No, sir.

10 Q Did you complete any coursework in petroleum
11 engineering as part of your Master's of Engineering?

12 A No, sir.

13 Q Did you complete any coursework related to
14 geology?

15 A I have a taken a geology class. I'm thinking
16 that was a continuing ed class, not a degreed class. So
17 I took it, but earned no credit. But I think that's
18 true. To -- to the extent it may have shown up in my
19 degree program, I don't -- I don't think that's right.

20 Q Okay. Now, you referred to the class in fluid
21 mechanics [sic] as part of your bachelor's degree. Did
22 you take any additional coursework in fluid mechanics

1 after your bachelor's degree?

2 A Fluid dynamics. And no, sir.

3 Q Okay. Did you complete any coursework after
4 your bachelor's degree related to mechanics of materials?

5 A No.

6 Q Did you complete any coursework after your
7 bachelor's degree related to oil or gas drilling or
8 completion?

9 A No, sir. Not -- not formal coursework.

10 Q Okay. You received your PhD in Engineering
11 Management from Kennedy Western University in 2004,
12 correct?

13 A That sounds right.

14 Q And how many years did it take you to complete
15 that degree?

16 A About two and a half.

17 Q Okay. Exhibit -- take a look at Exhibit 2003,
18 Page 6. The second item listed there, entitled "How
19 Should Generating Asset Acquisitions by Regulated,
20 Vertically Integrated Utilities be Overseen in Today's
21 Quasi-Regulated Electric Utility Environment, a
22 Dissertation Presented to the Faculty and School of

1 Engineering, Kennedy Western University," was that entry
2 your PhD dissertation?

3 A Yes, it is.

4 Q Okay.

5 THE COURT REPORTER: When you-all are
6 reading, if you could slow down, please.

7 MR. WILSON: Okay. Sorry.

8 THE WITNESS: Yeah, you're right.

9 Q (BY MR. WILSON) Okay. Does your dissertation
10 discuss oil or gas well drilling or completion?

11 A No, sir.

12 Q As part of your PhD work, did you do any
13 research related to oil or gas well drilling or
14 completion?

15 A No.

16 Q Okay. As part of your PhD coursework, did you
17 take any courses regarding oil or gas well completion or
18 drilling?

19 A No, sir.

20 Q During your PhD work, did you do any research
21 on oil or gas well geology?

22 A No, sir.

1 Q Okay. And as part of your PhD work, did you
2 take any additional courses in mechanical or petroleum
3 engineering?

4 A I'm trying to recall where -- what the type of
5 courses -- where they were located. I did take some
6 courses on -- I guess that would be more industrial
7 engineering. So, no, sir.

8 Q Okay.

9 A Yeah, more industrial engineering and
10 electrical.

11 Q Okay. Okay. As part of your PhD coursework,
12 did you take any additional courses in fluid mechanics or
13 mechanics of materials?

14 A I don't think so.

15 Q Okay. Now let's take a look at Exhibit 2003.
16 And at the bottom of Page 3, continuing on to Page 4,
17 lists your work history, correct?

18 A Yes, sir.

19 Q And you mentioned that D2 Tech Solutions, Inc.
20 and THEWAY Corporation should be extended to 2025,
21 correct?

22 A Yes, sir.

1 Q Are you currently employed by both of them?

2 A Well, I'm employed by D2 Tech Solutions, and I
3 serve as principal scientist under contract to THEWAY
4 Corp.

5 Q Okay. So -- and you list yourself as a
6 principal of D2 Tech Solutions?

7 A Yes, sir.

8 Q Are there any other principals of D2 Tech
9 Solutions?

10 A Yes, sir.

11 Q And how many other are there?

12 A Three -- two. Three total.

13 Q Okay. And what are their backgrounds,
14 technically?

15 A One in mechanical engineering, and one in
16 electrical engineering.

17 Q And what does D2 Tech Solutions do?

18 A It's an engineering firm. Most of my time is
19 now spent, as I said, under contract with THEWAY Corp. as
20 principal scientist. So that's the vast bulk of my time
21 today. That's increased over the years.

22 Q Okay. So if we turn back to Page 2 of

1 Exhibit 2003. So the first paragraph at the top there
2 says that you are the principal of D2 Tech Solutions.

3 A Uh-huh.

4 Q "A technology-related firm concentrating on
5 mechanical and electrical systems and energy
6 conversions."

7 Did I read that correctly?

8 A Yes, sir.

9 Q Okay. So when you say "mechanical and
10 electrical systems," what do you mean by that?

11 A I'm not sure how to describe those any better.
12 Mechanical systems and electrical systems. Mechanical
13 systems, meaning piping, pumps, tanks, vessels,
14 et cetera. Well, that's not limited to that, of course.
15 Any kind of -- not structural, but loading, those kind of
16 things.

17 And electrical systems, those things that
18 depend on the flow of electrons -- or the vibration of
19 electrons in order to get things accomplished.

20 Q When you say "not structural, but loading,"
21 what do you mean?

22 A Well, structural has a specific connotation.

1 It's actually changed over the past 30 years or so.
2 Whereas, in the past, mechanical systems would include
3 building systems, mechanical loading and building
4 systems, now they're -- it's less so. They've become
5 more specialized in structural engineering.

6 I hire structural engineers when we need
7 that. So those -- that's really not under mechanical
8 systems anymore. But you still have loading of piping,
9 loading of decks, holding equipment, platforms, those
10 kind of things.

11 Q Okay. Are -- sorry. Strike that.

12 Was D2 Tech Solutions -- or is D2 Tech
13 Solutions in the business of designing mechanical
14 systems?

15 A We have in the past, yes.

16 Q Okay. Is D2 Tech Solutions in the business of
17 testing mechanical systems?

18 A Certainly.

19 Q Okay. When you say you have designed systems
20 in the past, what systems -- what mechanical systems have
21 you designed?

22 A We've designed piping flow systems for oil and

1 gas locations facilities. We've designed -- golly,
2 you're asking me to go back an awful lot of years --
3 eductor systems. An eductor is -- is the element where
4 you flow through the middle and it draws in fluid from
5 the outside to increase the total flow. If you get an
6 Oxygenic's shower head today, that's a -- that's an
7 eductor-type system. Or some pool skimmers operate on
8 eductors. Those are kind of some non-technical examples.

9 Designed -- design and implementation of
10 heater systems for oil and gas locations, in particular,
11 production operations for separation of oil and water.

12 Those are some examples. I mean, it would
13 take a dig through the archive files, if we even still
14 have them, to figure out that.

15 Q Okay. Have you ever designed, as part of
16 D2 Tech Solutions, a downhole tool?

17 A Not as part of D2 Tech Solutions, no. Well, I
18 mean -- no, that's -- that's not true. I'm a principal
19 of PEDOCS, which is a oil and gas --

20 THE COURT REPORTER: I'm sorry. At "PEDOT
21 Switches"?

22 A Which is an oil and gas operating company,

1 production company. But we're actually in the middle of
2 divesting that. But in those situations, I've designed
3 and ordered and specified all sorts of downhole tools.

4 Q (BY MR. WILSON) Okay. So the second employer
5 you list here is THEWAY Corporation, correct?

6 A Yes, sir.

7 Q Okay. So it says you -- and I'm on Page 2 of
8 Exhibit 2003. It says you also serve as a principal
9 scientist of THEWAY Labs, Tulsa, Oklahoma --

10 A Right.

11 Q -- "an engineering and energy consulting firm
12 that provides design and failure analysis of facilities
13 and system installations," correct?

14 A Yes, sir.

15 Q Okay. So when you say "design and failure
16 analysis of facilities and system installations," what do
17 you mean by that?

18 A Again, I'm not sure how to describe that more
19 than that. Design of facilities, designs of systems,
20 and -- and failure analysis of -- of those systems. And
21 those design and failure analysis, particularly failure
22 analysis, is very, very broad.

1 Q Okay. So what facilities and system
2 installations are you providing design and failure
3 analysis for?

4 A We do work all the way from residential to
5 downstream refining facilities, which are about as
6 complex as they come.

7 Q So what kind of design and failure analysis
8 have you done for, for example, a refinery?

9 A For a refinery? We've done failure analysis on
10 tank explosions. Design for lightning protection.
11 Design for personnel protection during over -- turnover.
12 We've done design for -- not really in the process side.
13 Design for electrical systems; of course, for those, how
14 to power different areas of the system.

15 Failure analysis on piping systems.
16 Failure analysis on structures. Some pretty strange
17 studies on interaction of -- interaction of different
18 components in the system, particularly in the stormy
19 environment, like South Texas.

20 All sorts of things for refineries.

21 Q Okay. Have you done any design or failure
22 analysis for downhole tools?

1 A Yes.

2 Q What kinds, specifically?

3 A Exactly that. The -- one of the papers we just
4 talked about was electrical submersible pumps, which is a
5 downhole tool. I actually serve as the chair of the
6 standards working groups for four different standards
7 on -- on those systems, ESP-type systems.

8 I've also designed and studied completion
9 systems, fracturing systems, drilling systems, sand
10 control systems. And some of this is conflating with
11 THEWAY Labs and PEDOCS. I'm not sure, some days, when
12 the -- what hat I pick up, but that's probably which
13 one's more I can bill for --

14 THE COURT REPORTER: I'm sorry. "I'm not
15 sure" which days, what had I pick up?

16 THE WITNESS: What hat I pick up. Yep.

17 MR. WILSON: Hat. Like --

18 THE WITNESS: Hat.

19 MR. WILSON: Hat on your head.

20 A But, nevertheless, all those type systems,
21 drilling -- from drilling to completion of production.
22 All the downhole systems, I've either designed,

1 specified, used or -- or studied.

2 Q (BY MR. WILSON) Okay. So unclear whether
3 we're talking about THEWAY Labs or PEDOCS --

4 A Right.

5 Q -- but let's -- let's move on to -- well,
6 first, at THEWAY Labs, it says that you are a principal
7 scientist.

8 Are there any other principal scientists
9 at THEWAY Labs?

10 A No.

11 Q Okay. Is -- does THEWAY Labs employ anyone
12 else, other than you?

13 A Yes.

14 Q How many employees?

15 A There's -- we run a -- I hate to use the term
16 here, but unconsolidated system, a -- a less structured
17 system. So we range from eight to 10, somewhere in that
18 range, maybe 12, depending on the loading. Like -- like
19 I am, most of our technical and professional people are
20 contractors. So we scale up and scale down.

21 Q Okay. Do the eight to 10 employees -- do they
22 have technical backgrounds?

1 A Most do. We have two office people.

2 Q Okay. So those with technical backgrounds,
3 what is the technology related to?

4 A Electrical engineering, mechanical engineering,
5 structural engineering, chemical engineering. Of course,
6 my background also includes petroleum engineering and
7 fire protection as well as control systems, fire
8 investigation, contractor.

9 Q Okay.

10 A That covers the gamut, I think.

11 Q Okay. Now, you mentioned that you are also --
12 okay. You mentioned that you are also a principal of
13 PEDOCS, P-E-D-O-C-S, Inc., correct?

14 A Yes, sir.

15 Q And you say that's an oil and gas production
16 company operating over 50 oil and gas production wells in
17 Oklahoma, correct?

18 A Yes, sir. Currently. I -- that number's
19 probably dropped below 50 since now, but that's okay.

20 Q Okay. Is PEDOCS an acronym?

21 A Sort of.

22 Q What does it stand for?

1 A PE doctors.

2 Q Okay. Are there other principals of PEDOCS?

3 A Yes.

4 Q How many?

5 A One.

6 Q And does that person have any sort of technical
7 background?

8 A Yes.

9 Q What is that technical background?

10 A PhD engineer.

11 Q In what field?

12 A I'm not sure I could answer that. I know his
13 bachelor's is electrical, but it's -- like a lot of us,
14 he's learned an awful lot more in the past 60 years. So
15 I'm not sure what all degrees he has currently. At least
16 four.

17 Q Okay. Do any -- do any other parties own an
18 interest in PEDOCS?

19 A No.

20 Q Now, have you ever been involved in drilling
21 completion or production of any oil and gas wells, other
22 than those owned by PEDOCS?

1 A Yes, sir.

2 Q And in what capacity?

3 A Two capacities. One, for about two years, I
4 was an employee of New Dominion LLC. My title, it was
5 manager of electric infrastructure. My unofficial role
6 was one of the partners' field guy. So in that role, I
7 continuously interfaced and was involved in drilling and
8 completion, as well as production operations, for the
9 several hundred wells that New Dominion owned and
10 operated at the time.

11 I've also continued to consult for New
12 Dominion, up until kind of its demise in 2020, when the
13 partner I was working for passed, unfortunately. So off
14 and on, I was consulting with them over the years.

15 And, additionally, I've consulted with 20
16 or 30 additional operators and oil and gas facilities, as
17 well as analyzed and been involved in the failure
18 analysis of dozens of incidents at oil and gas drilling,
19 completion, and production locations.

20 Q Okay. The 20 to 30 additional operators that
21 you've been involved with, are those as part of your work
22 with D2 Tech Solutions or THEWAY?

1 A THEWAY Labs, yes, sir.

2 Q Okay. Now, the 50 or so wells owned by PEDOCS,
3 was PEDOCS involved in any of the exploration to identify
4 the locations for any of these wells?

5 A No, sir. Those were all -- we call stripper
6 wells.

7 Q Okay. And what do you mean by "stripper
8 wells"?

9 A A stripper well is one that's been drilled
10 and -- not abandoned, but -- but moved on from the --
11 most of our wells were drilled by majors back in the --
12 back in the heyday. And they move on. And they were
13 fractional -- some were fractional barrel wells, or
14 energy barrel wells. So we're just stripping the
15 remaining hydrocarbons from the wells.

16 Q Okay. So was PEDOCS involved in drilling any
17 of its wells?

18 A No. We have not drilled any wells.

19 Q Okay. Now, in the stripper wells -- well, let
20 me strike that.

21 So are all of the PEDOCS wells stripper
22 wells?

1 A Yes, they would generally be considered that.
2 Anything under 10 barrels a day is generally considered a
3 stripper well.

4 Q Okay. Was PEDOCS involved in any completion
5 works on any of its wells?

6 A Yes, sir. We regularly recomplete the wells as
7 necessary.

8 Q Okay. When you say you com- -- you recomplete
9 the wells, are you doing any stimulation activities?

10 A Yes, sir.

11 Q Fracturing?

12 A Yes, sir. We've done some fracturing.

13 Q Acid stimulation?

14 A Certainly acid.

15 Q Okay. Are any of these PEDOCS wells sand
16 producing?

17 A Yes. Unfortunately.

18 Q And in what formation are the sand-producing
19 wells?

20 A We've had problem in the Red Fork. We've had
21 problem in the Dutcher Sand. And we've had problem in
22 the Wilcox.

1 Q Now, in any of these problem formations, have
2 you implemented any sort of sand control devices?

3 A Yes, sir, we do.

4 Q Okay. And what, specifically, have you
5 implemented?

6 A We -- we tried a couple different things.
7 We've tried just bay screens. And we've tried prepacks.
8 Or we've used both of those, bay screens and prepacks.

9 Q Okay. Have you ever used a sand screen with
10 shunting?

11 A No, sir.

12 Q And when you say you've used screens and
13 prepacks, from whom did you purchase those?

14 A The tool company. I don't recall.

15 Q Okay.

16 A Yeah.

17 Q Okay. And were you involved in the design or
18 specification of any of the screens or prepacks?

19 A Yes, sir, all of them. Specifications for all
20 of them.

21 Q When you say "specifications," what
22 specifically was your role?

1 A Deciding which -- from the catalogue of
2 devices, which would be most appropriate for the location
3 we had, based on the size of the finds and the flow rates
4 and the depth, the distance of the formation. All of our
5 wells are vertical wells, so that distance is shorter,
6 but still different methods -- require different -- if
7 it's longer, you're more likely to go to a prepack than
8 you are just a regular sand screen.

9 Q Okay. Did you -- let me strike that.

10 Were you responsible for performing any
11 sort of engineering calculations on the screens or
12 prepacks used by PEDOCS?

13 A Yes, sir. That was my role.

14 Q What kinds of engineering calculations?

15 A Calculations based on how it was going to
16 infect -- affect flow into the well, whether the
17 reduction in flow, hydrocarbon flow, into the well would
18 offset the benefits gained from reducing the sand
19 content.

20 You know, it was a situation of trading
21 out downhole equipment pumps and pipes more often, with
22 no sand control device, versus purchasing the sand

1 control device, having the restriction in flow, but the
2 pumps and downhole equipment lasting longer.

3 Those kind of calculations. Pretty
4 standard stuff.

5 Q Okay. Did you perform any sort of calculations
6 on the pressure containment capacity of any of the sand
7 screens?

8 A No. Those sand screens don't have pressure --
9 well, I guess they do have a pressure containment, or
10 pressure collapse rating. But, no. Our wells down --
11 those wells downhole were not enough to worry about that.

12 Q Now, you also referred to 20 to 30 additional
13 operators for whom you performed work as part of THEWAY,
14 correct?

15 A Yes, sir.

16 Q Okay. For any -- for those additional
17 operators, did you perform any sand screen specification
18 or design work?

19 A I don't recall that I have. I'm not sure it
20 would stick out in my mind if I did, but I don't recall
21 that I have.

22 Q Now, the wells that you've done screens and

1 prepacks for PEDOCS, about what time frame -- or over
2 about what time frame did you do that work?

3 A 2008 to probably -- well, to about 2020, when
4 we started tailing off operations. I don't recall if we
5 put any in since '20 or not. Probably not.

6 Q Okay. And do you know about how many wells
7 were involved that needed some sort of sand protection?

8 A About a half dozen. It may be up to 10.

9 Q Now, let's take a look at Exhibit 2002 and
10 Paragraph 10. In the middle of Paragraph 10 you have a
11 sentence that says, "I have specified and used sand
12 control devices in production wells, particularly in
13 loosely consolidated sand formations."

14 Did I read that correctly?

15 A Yes, sir.

16 Q Now, we've talked about a number of your
17 experiences involving sand control devices. Is that what
18 you were referring to here?

19 A Yes, sir.

20 Q Okay. You say, "Additionally, I was familiar
21 with sand control devices when employed at New Dominion
22 LLC."

1 Did I read that correctly?

2 A Yes, sir.

3 Q Okay. What types of sand control devices did
4 you work with at New Dominion LLC?

5 A Prepacks.

6 Q Okay. And what was your role regarding
7 prepacks at New Dominion LLC?

8 A As I -- as I mentioned earlier, one of the
9 partners of New Dominion, I was his field guy. So in
10 addition to my regular roles, which are different enough,
11 I would interface with the completion folks and with the
12 drilling folks on behalf of Dave Chernicky, who was a
13 geology type.

14 So it was -- it was a back-and-forth with
15 him, what are they seeing in the field. And then
16 oftentimes he would specify the sand screen control
17 device, and -- and I would relay that to the guys in the
18 field, or sometimes he would do it directly. Or
19 sometimes the guys in the field would do it, and I would
20 report back to him the results of that so that he could
21 determine from a geological perspective where we were
22 going.

1 So I - I became very familiar with at
2 least prepacks during that period.

3 Q Okay. But you weren't responsible for
4 designing or specifying sand control devices at New
5 Dominion?

6 A That's correct. I was familiar with them.
7 That was my introduction to them, which is why we used
8 them at PEDOCS in the subsequent years.

9 Q Okay. The next sentence in Paragraph 10 you
10 say, "I have studied gravel pack technologies in a
11 consulting role, even before this engagement, and have
12 testified regarding such technology."

13 Did I read that correctly?

14 A Yes, sir.

15 Q Okay. In what cases have you studied gravel
16 pack technologies in a consulting role?

17 A At the least, case in Western District of
18 Texas, and I don't remember the exact style. But the
19 parties were Halliburton and U.S. Wells, ProFrac. And I
20 don't remember which was plaintiff and which was
21 defendant at the end of the day.

22 Q Okay. What type of gravel pack technology was

1 involved in that case?

2 A That was a -- it was offshore gravel pack
3 technology using screens and shunt tubes.

4 Q And was the case about gravel pack screens with
5 shunt tubes?

6 A The case was about fracturing operations, and
7 my role there was an analysis of the gravel pack systems
8 and how they related to the fracturing systems and how
9 gravel pack systems were a -- a prior art reference in
10 that case to fracturing systems, because they were very
11 re- -- very closely related technologies.

12 In fact, oftentimes in gravel pack systems
13 you go into a frac pack, which pumps at a high enough
14 pressure to not only fracture -- not only pack off the
15 sand screens, but also fracture the well and put proppant
16 back into the well.

17 Q Okay. Any other consulting or testifying cases
18 that involve gravel pack technologies?

19 A That's the one I can remember. I've been aware
20 of gravel pack for a number of years. But it's likely I
21 was introduced into a consulting role at some point, but
22 nothing I've testified about.

1 And it looks like we've been going about
2 an hour, so when you get to a stop.

3 MR. WILSON: Okay. Sure, we can take a
4 break.

5 THE COURT REPORTER: Off the record at
6 9:47 a.m.

7 (Break taken from 9:47 a.m. to 10:00 a.m.)

8 THE COURT REPORTER: We're on the record
9 at 10:00 a.m.

10 Q (BY MR. WILSON) Dr. Durham, let's look at
11 Page 4 of Exhibit 2002 -- or, sorry, 2003.

12 A 2003. Which one is that? Okay.

13 Q Okay. You see "Professional Memberships"?

14 A Yes, sir.

15 Q Is this a complete list of all of your current
16 professional affiliations?

17 A No, sir.

18 Q What other professional affiliations do you
19 have?

20 A Society of Petroleum Engineers.

21 Q And when did you join SPE?

22 A 2002 or '3.

1 Q Okay. Any other professional memberships?

2 A I'm looking. Not that I can recall right now.

3 Yeah, in that page -- yeah. Hold on a second.

4 No, I think that's -- that looks to be
5 complete.

6 Q Okay. Out of all of these professional
7 memberships, which of them relate in any way to oil or
8 gas well drilling or completion?

9 A Society of Petroleum Engineers, of course.
10 Petroleum Chemical Industry Committee re- -- relates
11 to production -- subcommittee which I was a chair of,
12 relates to completion operations and some drilling.
13 Standard subcommittee, we have standards on drilling rigs
14 and completion facilities as well.

15 Q Now, any others?

16 A I think that's it.

17 Q Okay. When you say the standard subcommittee
18 has standards on completions and drilling, what aspects
19 of completion and drilling do you have standards on?

20 A The equipment.

21 Q What equipment specifically?

22 A The rigs, the motors, the pumps, switch gear.

1 Q So --

2 A Sur- -- surface equipment.

3 Q Electrical equipment?

4 A Not all.

5 Q What equipment other than electrical equipment
6 do you have standards on?

7 A The rigs, which is a -- comprises an awful lot
8 of equipment, the drilling rigs. The -- I think that's
9 probably it. Most of the other equipment is electrical.

10 Q Okay. You don't have any standards on downhole
11 tools, correct?

12 A No. That would be SPE and API. Well, API for
13 standards.

14 Q Okay. And you're not a member of API, correct?

15 A No. API membership is -- you can't get a
16 membership as an individual. It's companies.

17 Q Okay. Now, Pages 5 through 12 of Exhibit
18 2002 -- I'm sorry, Exhibit 2003 lists your publications,
19 correct?

20 A Yes, sir.

21 Q Now, which of these publications, if any,
22 relate to oil or gas well drilling or completion?

1 A On Page 7, "PD Testing of Motors for Hostile
2 Environments," that paper -- the principles in that paper
3 would also include electric drill motors for those.

4 There are not many of them left, but there are electric
5 motors used in drilling still. That would include those.

6 As well as all of the ones on downhole
7 cable for the same reason, having to do with drilling.
8 You have to feed those motors with downhole cable, and so
9 those standards and papers deal with downhole cable.
10 There's probably a dozen of them or more relate to those
11 same drill motors.

12 Production. It looks like the rest of
13 them have to do with oil and gas production. To the
14 extent they have to do with oil and gas, it's mostly
15 production.

16 Q Okay. Do any of your publications relate to
17 oil or gas well geology?

18 A Not directly, no. Although, I think we do
19 address the geology of certain locations in some of the
20 papers, but that's not the focus of the paper.

21 Q Okay. Do --

22 A For example, the geology of the Permian as it

1 impacts selection of equipment.

2 Q Do any of your publications relate to
3 unconsolidated formations in oil or gas wells?

4 A No.

5 Q Do any of your publications relate to uses of
6 sand control methods or devices in oil or gas wells?

7 A No, sir.

8 Q Now, if you take a look at Page 13 of Exhibit
9 2003, earlier you testified that you previously addressed
10 gravel pack technology in a case involving Halliburton
11 and U.S. Well Services, correct?

12 A Yes, sir.

13 Q Is that the eighth case from the bottom on
14 Page 13?

15 A Yes, sir, that's correct.

16 Q Okay. And did you testify at trial in that
17 case?

18 A I did.

19 Q Now, let's take a look at Exhibit 2002, and
20 let's take a look at Paragraph 71.

21 Now, in Paragraph 71 on Page 41, the last
22 full sentence on that page says, "Other formations such

1 as the Austin Chalk in south central Texas and the Red
2 Fork Sand around Glenpool, Oklahoma, are examples of
3 unconsolidated formations."

4 Did I read that correctly?

5 A Yes, sir.

6 Q Now, what makes you think that the Austin Chalk
7 is an unconsolidated formation?

8 A It -- probably better quali- -- classified as
9 loosely consolidated. Aus- -- Austin would be a loosely
10 consolidated lime formation in that it will produce
11 fines, limestone fines, into the wells.

12 Q Okay. What's your understanding of the term
13 "chalk"?

14 A Chalk is a loosely consolidated lime formation.

15 Q Now, in your experience, is it typical for
16 wells in the Austin Chalk to require sand control?

17 A It -- no, not sand control --

18 Q Okay.

19 A -- because it's not a sand formation.

20 Q Okay. So is it typical for wells in the Austin
21 Chalk to require any sort of technology to remove fines
22 from producing fluids?

1 A I think it depends from well to well. It's --
2 it's loosely consolidated, and so there would be
3 locations where it would require some kind of protection
4 from those fines, but maybe not all. It depends I
5 would -- well, sorry to speculate, but...

6 Q Are you familiar with wells in the Austin
7 Chalk -- specific wells in the Austin Chalk that require
8 fine removal?

9 A No, sir.

10 Q And so what's the basis for your opinion that
11 the Austin Chalk requires fine removal?

12 A I don't think I said that.

13 Q Well, you said as an unconsolidated formation,
14 correct?

15 A Right. It's better described as a loosely
16 consolidated formation.

17 Q Okay. But in your opinion, that doesn't
18 necessarily require any sort of fine removal?

19 A Not necessarily, no. It's just an example of
20 a -- it would have been better for me to say in both
21 cases the Red Fork and the Austin Chalk are loosely
22 consolidated. We have Red Fork wells that have no

1 problem. We have other red Fork wells that do have
2 problems.

3 Q Okay. Let's take a look at Paragraph 99 of
4 Exhibit 2002.

5 A Okay.

6 Q Now, you would agree that Yeh discloses using a
7 sand screen assembly with a high-pressure shunt tube
8 system toward the heel of a horizontal well in
9 combination with a sand screen assembly with a
10 low-pressure shunt tube system towards the toe of the
11 horizontal well, correct?

12 A Yes. The concentric screens in Yeh have a
13 higher pressure rating than do the eccentric screens he
14 describes.

15 Q I hand you what was previously marked as
16 Exhibit 1005. And Exhibit 1005 is the Yeh reference,
17 correct?

18 A Let me get there. Yes, sir, it is.

19 Q Okay. Let's look at Column 16 and Lines 26
20 through 35, and you can go ahead and read it if you would
21 like.

22 A Sure. Thank you. Okay.

1 Q So there Yeh discusses both a concentric flow
2 channel sand screen and an eccentric flow channel sand
3 screen, correct?

4 A Yes, sir.

5 Q And Yeh's concentric flow channel sand screen
6 is -- or has the high-pressure shunt tube system,
7 correct?

8 A That's how Yeh describes it, yes, sir.

9 Q Okay. And Yeh discloses there, if you look at
10 Lines 28 through 30, "Two or more shunt tubes are placed
11 radially around the central bore in the concentric flow
12 channel sand screen," correct?

13 A I'm sorry. I was in the wrong location. Let
14 me get back to 2- -- oh, (reads). Yes, sir.

15 Q Okay. So Yeh discloses that the concentric
16 sand screen has two or more shunt tubes, correct?

17 A Yes.

18 Q And Yeh also discloses at Lines 33 to 34 that
19 the eccentric screen has two or more shunt tubes,
20 correct?

21 A Yes, sir.

22 Q Now, let's go backwards to -- or sorry, let's

1 flip forward to Column 24, and at the same time if you
2 can have available Figure 8C.

3 Now, looking at Column 24, Line 10, Yeh
4 says, "The alternate flow channel in the illustrative
5 sand screens 800A, 800C are rectangular or round shunt
6 tubes."

7 Did I read that correctly?

8 A Yes, sir.

9 Q And Figure 8C shows an eccentric screen with
10 round shunt tubes, correct?

11 A It does.

12 Q Now, let's take a look at Paragraph 42 of your
13 declaration, Exhibit 2002. Now, in Paragraph 42 you're
14 discussing the prosecution history of the '007 patent,
15 correct?

16 A Yes, sir, that's correct.

17 Q And midway through the paragraph you say, "In a
18 response dated October 6, 2021, applicant argued against
19 these rejections and amended the claims, arguing that the
20 combination does not teach changing characteristics of
21 the shunt tube assemblies along the length of a
22 production zone."

1 Did I read that correctly?

2 A Yes, sir.

3 Q Now -- so during prosecution the applicant
4 asserted that the combination of prior art present in the
5 prosecution does not teach changing characteristics of
6 the shunt tube assemblies along the length of a
7 production zone, correct?

8 A That's my recollection, yes, what I wrote.

9 Q Okay. But Yeh does teach changing
10 characteristics of the shunt tube assemblies along the
11 length of a production zone, correct?

12 A Yes.

13 Q Now, let's take a look at Paragraph 45. There
14 in the first sentence you explain that Yeh was directed
15 to a crossover tool for fluid reconnecting two wellbore
16 tools that do not have matching primary flow paths,
17 correct?

18 A That's a paraphrase of that. I quoted Yeh,
19 where the "radial center of the primary flow path in the
20 first wellbore tool is offset from the radial center of
21 the primary flow path in the second wellbore tool." Your
22 paraphrase is probably generally correct.

1 Q Okay. And if you take a look at Figure 10 in
2 Yeh, Figures 10A, B, and C illustrate the crossover joint
3 1000, correct?

4 A Yes, they do.

5 Q And you can see from that figure that Yeh
6 crossover tool has a primary flow path identified as Item
7 1005, correct?

8 A Yes.

9 Q And it also has a secondary flow path
10 identified as 1020, correct?

11 A That's correct.

12 Q And primary flow path 1005 is meant to fluidly
13 connect the primary flow paths of the first and second
14 wellbore tools, correct?

15 A Exactly.

16 Q And the secondary flow path 1020 is meant to
17 fluidly connected the secondary flow paths of the first
18 and second wellbore tools, correct?

19 A If you combine 1020 and 1030, I would agree
20 with that from my recollection.

21 Q Okay. And a wellbore tool can be a sand
22 screen, correct?

1 A Yes.

2 Q Now, if you look at Figure 10A there in Yeh,
3 you can see that the center line of the primary flow path
4 or axis of the primary flow path from side 1012 on the
5 left to side 1014 on the right moves, correct?

6 A That's -- that's what Yeh is about.

7 Q Let's take a look at Yeh at Column 27. Now,
8 I'm going to focus on the passage starting at the
9 Column 27, Line 53 where it describes Figure 11C.

10 Do you see that?

11 A Yes, sir, I see 53.

12 Q Now, at about Line 55 Yeh says, "Here, the
13 graph 1100C compares how the center of the bore of a
14 crossover joint moves relative to a longitudinal center
15 line of the tool for two different bore profiles."

16 Did I read that correctly?

17 A Yes, sir.

18 Q And that's shown in Figure 11C, correct?

19 A Yes.

20 Q And starting at Line 58, Yeh says, "Line 1110B
21 is the same as Line 1110B from Figure 11B. This, again,
22 was from a curved profile."

1 Did I read that correctly?

2 A Yes, sir.

3 Q And you can see that curved profile in

4 Figure 11C, correct?

5 A Yes. The sigmoid function, yes.

6 Q And Yeh goes on to say at Column 27, Line 60,

7 "Line 1115 is provided to show a profile having straight
8 segments," correct?

9 A Correct, that's what it says.

10 Q Now. Yeh says in the next line at 27, Line 62,

11 "The axis-offset and curvature of a crossover joint 1000
12 are important considerations. The primary flow path of
13 the crossover joint 1000 should be able to accommodate
14 movement of a tool such as the setting tool 750 of
15 Figure 7C through the bore 1005."

16 Did I read that correctly?

17 A Yes, sir.

18 Q So Yeh explains that this crossover joint

19 primary flow path, even though curved, should be able to
20 accommodate movement of a tool such as the setting tool
21 750 of Figure 7C through the Bore 1005, correct?

22 A Right. Right. That's why it is curved.

1 Q And Yeh explains that, "One way to improve the
2 crossover tool is to reduce the rate of change of
3 direction by lengthening the crossover joint to 8 feet
4 long," correct?

5 A If you could point me to that, I'd be glad to
6 look at that.

7 Q So if you follow Column 27, Line 66 says, "It
8 can be seen that the curvature range shown at Line 1120A
9 in Figure 11A has a smaller range than the curvature
10 range shown at Line 1120B in Figure 11B. This is to be
11 expected as the crossover joint of Figure 11A has twice
12 the length of the crossover joint of Figure 11B, thereby
13 reducing the rate of change of direction for the
14 curvature."

15 A Yes, that's what it says.

16 Q Okay. And if you look at Column 27, Line 55,
17 you can see that 1100C is for an 8-foot crossover joint,
18 correct?

19 A It is.

20 Q So Yeh explains that one way to improve the
21 crossover tool is to reduce the rate of change of
22 direction by lengthening the crossover joint to 8 feet

1 long, correct?

2 A I disagree.

3 Q And why do you disagree with that?

4 A Because 8 foot is not a lengthening. That's a
5 reduction from Figure 11A.

6 Q Okay. So let me correct that. Sorry.

7 So the crossover joint of Figure 11A is 16
8 feet long, correct?

9 A It is.

10 Q And Yeh explains that by making it twice as
11 long as the 8-foot-long crossover joint of Figure 11B, it
12 reduces the rate of change of direction for the
13 curvature, correct?

14 MR. WALTERS: Objection; form.

15 A Yes. That's -- reduce the rate -- yes.
16 This -- the 16-foot tool has a smaller rate of change of
17 direction than does the 8-foot tool.

18 Q (BY MR. WILSON) And Yeh is explaining that
19 that is one way to mitigate the curvature impact on the
20 primary flow path, correct?

21 A Right. By -- by lengthening the amount of
22 distance that the tool has to change direction, it makes

1 it easier to move the tool in place. It's like making
2 a -- making a broad curve versus a right angle drive when
3 your -- curve when you're driving.

4 Q Now, at Column 8, Line 5, Yeh explains that
5 another way to mitigate the curvature impact on the
6 primary flow path is to increase the internal diameter of
7 the crossover joint, correct?

8 A Yes.

9 Q And Yeh explains that the increased diameter
10 eases the run of the other downhole tools through the
11 curved crossover joint, correct?

12 A Yes, that's one advantage, correct.

13 Q So Yeh is essentially explaining here at the
14 bottom of Column 27 and the top of Column 28 that the
15 offset center lines due to combining concentric and
16 eccentric tools create a restriction in the primary flow
17 path that has to be overcome, correct?

18 MR. WALTERS: Objection; form.

19 A Could you read that one back again? It was a
20 long question.

21 Q (BY MR. WILSON) Sure. Yeh is teaching here at
22 the bottom of Column 27 and the top of Column 28 that the

1 offset center line due to combining eccentric and
2 concentric tools create a restriction in the primary flow
3 path that has to be overcome, correct?

4 A Yes, I would --

5 MR. WALTERS: Objection; form.

6 A Sorry. Yes, I would agree with that.

7 Q (BY MR. WILSON) Now, let's take a look at
8 Column 28, Line 14. Now, at Column 28, Line 14 Yeh says,
9 "Additionally, a high differential pressure may occur
10 between the secondary flow paths and the annulus between
11 the crossover joint and the surrounding wellbore, that
12 is, the wellbore annulus. For example, a 6500 psi
13 differential pressure is expected near the heel of when
14 gravel -- when gravel packing a 5,000-foot horizontal
15 completion interval."

16 Did I read that correctly?

17 A Yes, grammatical errors and all.

18 Q So Yeh teaches a high differential pressure
19 between secondary flow paths and the wellbore annulus
20 during gravel packing toward the heel of a horizontal
21 well, correct?

22 A Right, that's how he describes it.

1 Q Now, a person of ordinary skill understood that
2 the high differential pressure taught by Yeh between the
3 secondary flow paths and the annulus was true for both
4 the sand screens and the crossover joints, correct?

5 A Well, he's certainly just talking about the
6 crossover joint in this paragraph. Certainly, that high
7 differential pressure would exist other places.

8 Q And it would exist in the sand screens,
9 correct?

10 A All things being equal, yes.

11 Q Okay. And you can see in this passage we just
12 read that Yeh is describing a 5,000-foot horizontal
13 completion, correct?

14 A Yes, he is.

15 Q Okay. Now, if Yeh's recommendation of using
16 concentric sand screens followed by eccentric sand
17 screens were followed, only a single crossover joint
18 would be needed in this example, correct?

19 A That's kind of an incomplete hypothetical. Can
20 you expand that a little bit?

21 Q Sure. What do you need to know?

22 A The intervals. Are there additional packers?

1 Is it packed off on either end or in the middle?

2 There's -- there's an awful lot that goes into a short
3 answer on that question.

4 Q Okay. Let's assume there are no packers.

5 A Assume there's no packers. Okay. Kind of
6 strange, but okay. And...

7 Q What else do you need to know?

8 A Well, are -- are there any interruptions in the
9 concentric or eccentric sand screen assemblies?

10 Q No. Assume there are none.

11 A So assuming there are none, assuming there are
12 no packers, there would only need to be one crossover --
13 assuming that the concentric is upstream, as is described
14 in Yeh, then there would only need to be one crossover
15 tool between the concentric and the eccentric -- well, at
16 least to the bottom of the eccentric sand screen
17 assembly.

18 There may be another one if there's a
19 rathole or something below the eccentric.

20 Q Okay. And where would that crossover tool be
21 located along the 5,000-foot horizontal well?

22 A At the point of transition between the

1 concentric screen and the eccentric screen, wherever that
2 may be.

3 Q Okay. And based on Yeh's teaching that you
4 need 6500 psi differential pressure near the heel, where
5 would you expect that crossover joint to be located along
6 that 5,000-foot horizontal?

7 A At the point that you'd want to transition to
8 the eccentric screen, the particular flow characteristics
9 of each well may be different. There's particular
10 embodiments in Yeh that may give us an example -- in Yeh
11 or Yeh2 that can give us some examples for those
12 particular embodiments. But it would just be wherever
13 you would want to transition.

14 That's what Yeh's all about is the
15 flexibility to transition wherever and whenever you want
16 to.

17 Q Okay. In Column 30 at Line 17, Yeh says, "For
18 example, known concentric screens are capable of gravel
19 packing 5,000 feet compared to 3,000 feet with the
20 commercial eccentric screens," correct?

21 A Correct.

22 Q If you're using a commercial eccentric screen,

1 the transition would have to be 3,000 feet from the toe
2 or less, correct?

3 A Yes. So medial point 3,000 feet or less,
4 depending on the particular well configuration.

5 Q Okay. So in my hypothetical of using
6 concentric screens followed by eccentric screens with no
7 packers, there's a single crossover joint. And that
8 single crossover joint is located 3,000 feet from the toe
9 or less, correct?

10 A In the particular embodiments described here,
11 yes.

12 Q Okay. That crossover joint would not see 6500
13 psi in that scenario, correct?

14 A I don't think you can say "would not."

15 Q Okay. In the scenario of pumping a gravel
16 pack --

17 A Right.

18 Q -- with gravel slurry flowing down the shunt
19 tubes, the shunt tubes of the secondary flow path in that
20 crossover joint would not see 6500 psi, correct?

21 MR. WALTERS: Objection; form.

22 A No. I -- I disagree that you could make such a

1 general statement. You would hope in normal operations
2 that you would not see that if everything goes well, but
3 I don't think you can say it would not.

4 Q (BY MR. WILSON) Okay. In what scenario could
5 it?

6 A In the scenario where you're pumping, you've
7 packed the upper section in the concentric assembly, for
8 example, and you have a good gravel pack around that
9 where it's holding pressure and you plug the downhole
10 assembly base pipe, for example, for the crossover
11 tool -- well, there's no crossover tool -- but if you
12 plug the downhole assembly where you essentially stopped
13 flow, then you would see high differential pressure at
14 the crossover tool upwards of 6500 or whatever you pump
15 with your partial -- I'm sorry, positive displacement
16 pumps would have.

17 So that's -- that's why it was common for
18 piping systems, including shunt tube systems, to have the
19 same rating throughout their length to handle those
20 emergency-type situations.

21 Q Okay. But Yeh specifically teaches not having
22 the same pressure rating throughout the length of the

1 shunt tube system, correct?

2 A He -- he teaches that, if you choose to, you
3 can switch over to the eccentric screens at some point
4 where they would be appropriate, yeah.

5 Q Okay. So during normal gravel packing
6 operations in the hypothetical that I described
7 involving concentric screens followed by eccentric
8 screens in a 5,000-foot-long horizontal with no breaks
9 and no packers between the screens, you would not see
10 6500 psi in the crossover tool's secondary flow path.

11 MR. WALTERS: Objection; form.

12 Q (BY MR. WILSON) Correct?

13 A Under those considerations under normal --
14 normal operations, everything going the way the designer
15 wants it to, I would agree.

16 Q Okay. But the secondary flow paths of the
17 concentric screens near the heel would see 6500 psi,
18 correct?

19 A Under those broad generalizations, yes.

20 Q Now, back to Column 20 in Yeh. If we take a
21 look at -- sorry, not Column 20. Sorry. Back to
22 Column 28. In Line 20 Yeh says, "In order to maintain

1 the mechanical integrity (that is, to stay within the
2 burst, bending, and collapse ratings) of the secondary
3 flow paths, a certain surrounding wall thickness is
4 required."

5 Did I read that correctly?

6 A Yes.

7 Q Now, so Yeh teaches that a certain mechanical
8 integrity is needed to stay within the burst, bending,
9 and collapse ratings of secondary flow paths which
10 required a certain surrounding wall thickness, correct?

11 A Yes.

12 Q And a person of ordinary skill in the art
13 understood that the mechanical integrity including wall
14 thickness Yeh described needing -- was needed in both the
15 sand screen and crossover joint secondary flow paths,
16 correct?

17 MR. WALTERS: Objection; form.

18 A Not the same considerations. But in general,
19 there needs to be mechanical integrity of both.

20 Q (BY MR. WILSON) And that's, in fact, why Yeh
21 taught using a high-pressure shunt tube system toward the
22 heel and a low-pressure pressure shunt tube system toward

1 the toe of a horizontal well, correct?

2 MR. WALTERS: Objection; form.

3 A I don't know that they follow. He recognized
4 that eccentric screens had a lower pressure rating
5 because of their -- because of their nature at the time
6 and recognized they could only be used towards the toe,
7 and I think that's what he's teaching.

8 Q (BY MR. WILSON) So Yeh is teaching that a high
9 pressure inside the secondary flow path is needed toward
10 the heel in a long horizontal gravel pack, correct?

11 A Yes.

12 Q And so he's teaching that you need a
13 high-pressure shunt tube system and using concentric
14 screens to contain that high pressure, correct?

15 A Yes.

16 Q And a person of ordinary skill in the art
17 understood that the same mechanical integrity is needed
18 to contain that pressure in the secondary flow path shunt
19 tubes, correct?

20 MR. WALTERS: Objection; form.

21 A A similar consideration, yes. Maybe not the
22 exact same. But mechanical integrity does have to be

1 maintained.

2 Q (BY MR. WILSON) And a person of ordinary skill
3 also understood that the pressure containment capacity of
4 shunt tubes was directly proportional to their wall
5 thickness, correct?

6 MR. WALTERS: Objection; form.

7 A No, sir, not all -- not all the time.

8 Q (BY MR. WILSON) Okay. And when is that not
9 true?

10 A When you change, for example, the outer
11 diameter, then the thickness -- the pressure rating
12 changes on a round tube. If you change the outer
13 diameter, the pressure rating changes without a change in
14 thickness. If you change configurations, for example, to
15 a rectangular tube, the same thickness, has a much lower
16 pressure rating given the similar dimensional size.

17 So there's a lot of factors that go into
18 it. What -- how many tubes are there, how the pressure
19 is separated. So it's not always directly proportional
20 in all cases.

21 Q Okay. So assuming all other parameters stay
22 the same, in a shunt tube the pressure rating of the tube

1 is directly proportional to the wall thickness of the
2 tube, correct?

3 MR. WALTERS: Objection; form.

4 A In a round tube I can agree with that.

5 Q (BY MR. WILSON) Do you disagree that's true in
6 a rectangular tube?

7 A Yes, I do.

8 Q Why?

9 A Because the stress concentrations are different
10 than a rectangular tube, and I'm -- I don't believe you
11 always have the same linear relationship because of the
12 way the stresses are -- the stresses exist in a
13 rectangular tube.

14 Q Okay. In a rectangular tube, assuming all
15 other parameters stay the same, the pressure containment
16 capacity of the rectangular tube is going to be
17 proportional to its wall thickness, correct?

18 MR. WALTERS: Objection; form.

19 A In some way proportional. I don't agree -- in
20 fact, I know it's not directly proportional. But it is
21 in some way related to it.

22 We don't -- we don't have -- well, there

1 are places that attempt to model pressure ratings of
2 rectangular tubes. But really the only way to do it is
3 to do a stress analysis, an FEM analysis, to determine
4 what that pressure rating would be in a particular
5 configuration.

6 Q (BY MR. WILSON) Okay. But you agree that
7 whatever the relationship is between proportional and
8 directly proportional, the pressure containment capacity
9 of a rectangular tube, all other parameters staying
10 equal, is in some way proportional to the thickness of
11 the walls of that tube, correct?

12 A It --

13 MR. WALTERS: Objection; form.

14 A It's in some way related, yeah.

15 Q (BY MR. WILSON) Okay. Take a look at your
16 declaration, Exhibit 2002, Paragraph 86.

17 A Okay.

18 Q And I'm focused -- you can read as much of it
19 as you need to to familiarize yourself, but I'm focused
20 on the last sentence at the bottom of the paragraph on
21 Page 56.

22 A So the last sentence in Paragraph 86 on 56?

1 Q Yes.

2 A Okay. All right. Let's see. Okay.

3 Q Okay. You say, "Further, there simply is no

4 direct analysis or rationale as to why a POSITA,"

5 P-O-S-I-T-A, "would have applied general industry tubing

6 (such as that shown in Exhibit 1031) into the specific

7 space-constrained and limited environment of a gravel

8 packing screen."

9 Did I read that correctly?

10 A Yes, sir.

11 Q Now, did you review Exhibit 1031?

12 A Yes, I did.

13 Q Okay. I'm going to hand you what was

14 previously marked as Exhibit 1031, and take a look at

15 Paragraph 4 of Exhibit 1031.

16 A Okay.

17 Q And I want to focus on the last sentence.

18 A Okay.

19 Q The last sentence there says, "A Weatherford

20 representative requested such information from Fischer in

21 January 2017, and Fischer provided Exhibit A in response

22 via email on January 6, 2017, under no obligation of

1 confidentiality."

2 Did I read that correctly?

3 A Yes, sir.

4 Q Now, do you have any reason to believe that
5 that is a false statement?

6 A No, sir.

7 Q So you understand that a Weatherford
8 representative requested this part number list for
9 tubing, stainless steel tubing, from Fischer, correct?

10 A Yes, sir.

11 Q Okay. Now, would it surprise you if that
12 tubing shown on Exhibit 1031 were, in fact, the shunt
13 tubing used in Weatherford's sand screens?

14 A I wouldn't be surprised either way.

15 Q Okay.

16 A It looks like we've been going probably a
17 little over another hour. If we can take a break
18 sometime soon.

19 Q Okay. Sure. One last thing.

20 A Sure.

21 Q You understand that you are not permitted to
22 discuss the substance of your testimony or my questions

1 with anyone during the break of this deposition?

2 A Yes, sir, of course.

3 Q Okay. Have you done that today?

4 A No, sir.

5 MR. WILSON: Okay. Then we can go off the
6 record.

7 THE COURT REPORTER: Off the record at
8 10:49 a.m.

9 (Break taken from 10:49 to 11:01 a.m.)

10 THE COURT REPORTER: Back on the record at
11 11:01 a.m.

12 Q (BY MR. WILSON) Okay. Dr. Durham, would you
13 turn to Paragraph 94 of Exhibit 2002.

14 Now, in the first sentence of Paragraph
15 94, you opine that, "It was well-known at the time of the
16 '007 patent, and before, that the pressure rating of the
17 sand screen assembly limited the effective length of such
18 an assembly used in a gravel pack compression
19 particularly for an eccentric configuration that was
20 generally in use at the time," correct?

21 A Yes.

22 Q Now take a look at Paragraph 96. And there I

1 want to focus on the second sentence. And there you
2 opine that, "It was widely known that the pressure rating
3 of eccentric screens prior to the '007 patent was limited
4 to 3000 psi, which in turn limited the overall gravel
5 pack length to around 3,200 feet," correct?

6 A Yes, sir. You read that correctly.

7 Q Now, what do you mean by "pressure rating"
8 there?

9 A Just simply that, the pressure that -- the
10 rating of the screen limited the pressure that could
11 be -- the differential pressure that could be applied to
12 the screen.

13 Q Are you referring to the burst pressure?

14 A Burst pressure and rating pressure are related,
15 but they're not usually the same number. Usually the
16 burst pressure exceeds the rated pressure.

17 Q Okay. So when you say "pressure rating," are
18 you referring to the amount of pressure that -- the
19 internal pressure that the shunt tubing can contain?

20 A The internal pressure -- well, it comprises
21 both internal burst pressure considerations and external
22 collapsed pressure considerations. So essentially the

1 rating is less than the burst pressure so that you don't
2 approach the burst pressure.

3 Q Okay. So -- and how is, then, mathematically,
4 pressure rating related to burst pressure?

5 A It's less than.

6 Q Is it some factor?

7 A I don't know that there's any standard of
8 factors for this type of design. I'm not familiar with
9 an API standard that would give a particular number.

10 Q Do you know what a typical safety factor would
11 be?

12 A I believe one of the references discusses some
13 safety factors, but I think these particular designs, the
14 safety factor probably varies from design to design,
15 manufacturer to manufacturer.

16 Q Okay. But what you are referring to as the
17 difference between pressure rating and burst pressure is
18 a safety factor, correct?

19 A Yeah, generally speaking, that's some kind of
20 safety factor.

21 Q Okay. So when you say it was widely known that
22 the pressure rating of eccentric screens was limited to

1 3000 psi, you're talking about the burst pressure less
2 the safety factor, correct?

3 A The -- I prefer to stick with pressure rating.
4 So whoever -- the designer of the device said, you can
5 only put 3000 psi, for example in this, for whatever --
6 whatever factors they considered, that was still a rating
7 of the device.

8 Q Okay. And what you mean by that is you
9 shouldn't have an operating condition in which the
10 pressure exceeds the pressure rating, correct?

11 A Correct. The differential pressure between the
12 internal, external of the tube, either pressure internal
13 or collapsed pressure, slightly different but similar,
14 should not exceed 3000 psi.

15 Q Okay. Are you familiar with the collapsed
16 pressure rating of eccentric shunt tubes at this time?

17 A Well, it was -- it would have been greater than
18 3000 psi.

19 Q Okay. And what leads you to that conclusion?

20 A Well, because the rating is 3000 psi. That's
21 the differential pressure. The differential pressure,
22 most -- well, in a round tube, the collapse pressure

1 typically exceeds the burst pressure, so the rating would
2 depend solely on the burst pressure considerations, with
3 some safety factor.

4 For various rectangular tubes, that's
5 probably still true, depending on how eccentric they get,
6 how -- how wide they are compared to how tall, that may
7 change that configuration. But in -- generally speaking,
8 burst pressure exceeds -- it -- internal -- I'm sorry.
9 Burst pressure ratings are less than collapsed pressure
10 ratings for most tube designs.

11 Q Okay. And that includes both round and
12 rectangular tubes?

13 A Right. It's certainly true for round. For
14 rectangular tubes, it's generally -- it's a general rule
15 of thumb.

16 Q Now, on this page for that sentence, you say
17 you have a Footnote 88, which says, "See, e.g., Yeh
18 Column 30, Lines 15 to 20."

19 Do you see that?

20 A Right. That's one of those references, yes,
21 sir.

22 Q Okay. So let's take a look at Yeh, Column 30,

1 Lines 15 to 20. And there, Yeh says -- and I'm going to
2 start at Line 16 -- "Concentric sand screens can be more
3 robust for gravel packing long intervals. For example,
4 nonconcentric screens are capable of gravel packing 5,000
5 feet compared to 3,000 feet with the commercial eccentric
6 screens."

7 Did I read that correctly?

8 A Yes, sir.

9 Q So Yeh doesn't actually refer to a pressure
10 rating there, correct?

11 A I disagree.

12 Q Okay. And how do you think Yeh refers to a
13 pressure rating?

14 A Because the length of the tube is related to
15 the -- how much pressure can be applied to the tubes.

16 Q Okay.

17 A The length that can be -- and I need correct
18 something that I said earlier that's not quite right.
19 The collapse pressure rating is not often greater than
20 the burst pressure rating for all tube designs, depending
21 on the materials and other considerations. So I made a
22 general statement that's not always true. But still,

1 most of the time, your pressure rating depends on the
2 burst pressure in these applications.

3 Q Okay. And when you say "most the time," the
4 pressure rating depends on the burst pressure rating,
5 you're saying most of the time the collapse rating
6 exceeds the burst pressure rating for round and
7 rectangular tubes, correct?

8 A Most the time, a configuration that can handle
9 a particular pressure -- burst pressure-related rating
10 can also handle a collapse pressure, but that's not
11 always true because you can have a -- for example, a 500
12 psi HDPE tube or pipe; and if you pull a vacuum on it, it
13 may collapse just from 15 psi differential from
14 atmospheric and internal.

15 So it widely depends, but the pressure
16 rating we're talking about here is talking about a
17 burst -- related to burst pressure considerations.

18 MR. WILSON: Okay. I want to take a look
19 now at Exhibit 1006.

20 MR. WALTERS: Thanks.

21 Q (BY MR. WILSON) And Exhibit 1006, which was
22 previously marked as IPTC 12549, what we've referred to

1 as Yeh2, correct?

2 A Yes, sir, appears to be correct.

3 Q Okay. Now, if I -- if you take a look at
4 Figure 15, of Exhibit 1006, and that is on Page 13. And
5 you're familiar with Yeh2, correct?

6 A Yes, sir.

7 Q Okay. Now, Figure 15 illustrates data related
8 to gravel packing 5,000 feet with multiple shunt manifold
9 system, correct?

10 A Yes, sir, it does.

11 Q Okay. And left or Y axis shows the pressure in
12 transport tubes in psi, correct?

13 A That's what it says, yes.

14 Q And the X axis shows the gravel packing length
15 in feet with the heel of the horizontal interval at zero
16 feet on the left side of the graph, correct?

17 A Yes, it does.

18 Q Okay. The right axis or Y axis shows slurry
19 rate in barrels per minute or gravel concentration in PPA
20 in transport tubes, correct?

21 A Yes, sir.

22 Q Now, Figure 15 specifically illustrates the

1 relationship of shunt tube pressure, gravel
2 concentration, and slurry rate along the length of a
3 5,000 feet horizontal interval, correct?

4 A Under certain considerations -- certain
5 configurations, yes, sir, one example.

6 Q All right. And the solid blue line represents
7 the pressure profile, correct?

8 A That's what it says.

9 Q Now, the pressure profile quantity shown in the
10 solid blue line reflects the differential pressure
11 between internal pressure in the shunt tubes and the
12 annular pressure outside the shunt tubes, correct?

13 A Correct. Under -- under one flow condition.

14 Q Okay. The solid yellow line represents gravel
15 concentration in the slurry, correct?

16 A Correct. Under the same single-flow condition.

17 Q And the red dashed line represents the slurry
18 flow rate, correct?

19 A Correct. Again, under the particular example
20 here.

21 Q Okay. Now, a person of ordinary skill in the
22 art would understand, based on the pressure profile data

1 in Yeh2's Figure 15, that conventional eccentric screens
2 that were limited to a pressure tolerance of about 3000
3 psi could be installed along the horizontal beginning at
4 around 2,000 feet from the heel where the transport tube
5 pressure is at or around 3000 psi, correct?

6 MR. WALTERS: Objection; form.

7 A Under this particular flow condition, yes, sir,
8 that's correct.

9 Q (BY MR. WILSON) Now, a conventional sand
10 screen pressure rated at 3000 psi, could also operate
11 further downstream closer to the toe where the eccentric
12 screen is subjected to less pressure than when installed
13 at 2000 feet from the heel, correct?

14 MR. WALTERS: Objection; form.

15 A Yes, that's correct.

16 Q (BY MR. WILSON) Now, if we look at the far
17 right on the graph, the toe, do you see that?

18 A Yes.

19 Q What would a person of ordinary skill in the
20 art understand the pressure to be within the shunt tube
21 system at the toe in this horizontal well example in
22 Yeh2?

1 A A few psi -- under the this particular example,
2 a few psi greater than the formation pressure, maybe a
3 100-ish.

4 Q Okay. The differential pressure that the shunt
5 tubes are containing is around 100 psi, correct?

6 A Correct. In this example, yes.

7 Q Now, take a look at Exhibit 2002, Paragraph
8 170, but don't throw away Yeh2 yet.

9 A Okay.

10 Q Okay. Now, in your opinion -- I'm looking at
11 the sentence at the top of Page 112, it's about the
12 middle of Paragraph 170.

13 A Okay.

14 Q You opine that, "Yeh teaches using an eccentric
15 screen in the lower pressure sections of the wellbore,
16 near the toe, because the eccentric screens are less
17 expensive, easier to acquire, and lower friction."

18 Did I read that correctly?

19 A Yes, sir.

20 Q Okay. So looking back at Yeh2's graph, a
21 person of ordinary skill in the art, based on Yeh's
22 teachings, would want to use eccentric screens for as

1 much of that horizontal interval as possible, correct?

2 MR. WALTERS: Objection; form.

3 A I can agree with that, yes, sir. In fact, I
4 say so at the bottom of that paragraph.

5 Q (BY MR. WILSON) And a person of ordinary skill
6 in the art wanting to use eccentric screens for as much
7 of that horizontal interval as possible would know that
8 they could start about 2,000 feet from the heel and run
9 all the way to the toe, correct?

10 A In using this particular example, somewhere in
11 there. Some medial point around there.

12 Q In general, a person of ordinary skill in the
13 art seeking to maximize the use of eccentric screens
14 based on Yeh and Yeh2's teaching would use them anywhere
15 the pressure was less than 3000 psi, correct?

16 MR. WALTERS: Objection; form.

17 A Somewhere around there, yeah. I mean, the 3000
18 psi number is not a hard -- hard number and it's going to
19 depend on other factors. But for this particular well,
20 in this particular environment, in these particular
21 situations, somewhere around there, yeah.

22 Q (BY MR. WILSON) Okay. And so it would be --

1 strike that.

2 A person of ordinary skill in the art
3 would understand based on Yeh and Yeh2's teachings that
4 they could begin using eccentric screens with a 3000 psi
5 pressure rating at any point past 2,000 feet from the
6 heel, roughly, correct?

7 A In a 5,000 foot well, somewhere in there,
8 right.

9 Q Okay. Now let's look at Exhibit 2002,
10 Paragraph 91.

11 Okay. And I'm looking at a sentence just
12 below the middle of the paragraph, and it's right after
13 Footnote 77, that begins "In sum."

14 Do you see that?

15 A Yes.

16 Q It says, "In sum, Yeh is disclosing to maximize
17 the primary flow path but to leave enough room for
18 secondary flow paths," correct?

19 A Yes, sir.

20 Q Now, take a look at Paragraph 92, and I want to
21 focus on the last two sentences. It begins at the top of
22 Page 60 with "Accordingly."

1 Do you see that?

2 A Yes, I do. After 79?

3 Q Yep. Okay. You say, "Accordingly, the shunt
4 tubes of Yeh must fit in the space constrained by
5 limiting the OD and maximizing the ID of the primary flow
6 path. Yeh does not provide direction on shunt tube
7 design other than to maintain mechanical integrity, and
8 Yeh makes clear that this mechanical integrity must be
9 achieved in limited space."

10 Did I read that correctly?

11 A Yes.

12 Q So Yeh taught that enlarging the secondary flow
13 paths could you cause a reduction in the primary flow
14 path, correct?

15 A Yes. Particularly in relation to the crossover
16 tool, but in general, that's true.

17 Q And Yeh taught that nevertheless, reserving
18 some space for secondary flow paths, even at the expense
19 of the primary flow path, achieves a benefit to the
20 gravel packing, correct?

21 A I don't know if it's a benefit. It just
22 actually makes it useable, but I guess that is a benefit.

1 Right?

2 Q Right.

3 A But yeah, you have -- it's a trade-off between
4 the two.

5 Q Right. So a person of ordinary skill in the
6 art understood that Yeh was teaching that there were
7 known benefits and detriments to adjusting the size of
8 primary and secondary flow paths in sand screens,
9 correct?

10 A Correct. You can't just do things in a vacuum.
11 You have to consider all the factors, yes.

12 Q Okay. So let's take a look at Paragraph 94 of
13 Exhibit 2002. And I'm going to focus on the portion that
14 is on Page 61.

15 A All right. Let me get there. Okay.

16 Q So there you say in the last sentence,
17 "Further, Yeh teaches that the use of eccentric designs
18 would, quote, reduce the overall friction, close quote,
19 of the gravel pack system, allowing for longer lengths."

20 Did I read that correctly?

21 A Yes.

22 Q And for that, you cite Yeh at Column 24, Lines

1 57 through 59, correct?

2 A I do.

3 Q All right. Let's look at Yeh, Column 24. And
4 starting at Line 57, Yeh says, "It is believed that the
5 use of eccentric screens at the toe of a horizontal
6 completion will reduce the overall friction or extend the
7 maximum gravel packing length of the completion."

8 Did I read that correctly?

9 A Yes, sir.

10 Q So Yeh says "It is believed," correct?

11 A Correct.

12 Q Why might that not be true?

13 A It depends on the particular configuration of
14 the eccentric screen, where there actually does have
15 lower friction than the related concentric screen.

16 Q And what do you mean by that?

17 A Well, this is on the premise -- this is based
18 on the premise that eccentric screens typically have
19 larger cross-sectional areas for the transport tubes and
20 the packing tubes. It's kind of why eccentric designs
21 came into play, so you could have a larger
22 cross-sectional area without increasing the tool size,

1 and that larger cross-sectional area reduces friction
2 loss. And if you do -- reduce friction loss per foot,
3 then given other considerations, such as a maximum
4 pressure, then if there's fewer psi foot lost, then you
5 can pack longer.

6 Q Okay. Is it always the case that a rectangular
7 tube with a larger cross-sectional area than a round tube
8 produces lower friction?

9 A Well, you're going to get me in the situation
10 where I almost never answer yes to an "always" question.
11 So I would not -- I would not say it's always true. I
12 would say it's generally true.

13 Q Okay. Take a look at Paragraph 102. And if
14 I'm looking at Page 68, four lines up from the bottom, do
15 you see the phrase "The larger CSA"?

16 A I'm getting there.

17 Okay. "Further, the larger CSA," right.

18 Q Okay. And CSA in that sense refers to
19 cross-sectional area, right?

20 A Yes, sir, it does.

21 Q Okay. And you say, "The larger cross-sectional
22 area was the reason that eccentric screens had lower

1 friction," correct?

2 A Yes.

3 Q But that's not always true, correct?

4 A I would say that's a general statement, a
5 general -- generally true and certainly consistent with
6 the teachings of Yeh, that larger CSAs reduce friction.

7 Q Okay. So let's now go back to Paragraph 96 of
8 Exhibit 2002.

9 A Okay.

10 Q Now I want to look at the last sentence of
11 Paragraph 96. Now, in Paragraph 96, you explain that
12 eccentric screens were limited to 3,000 feet because
13 eccentric screens' "shunt tubes are typically formed from
14 thin-walled steel" and that "Even with some increased
15 wall thickness, the working pressure rating of these
16 eccentric designs was still limited to 3000 psi,"
17 correct?

18 A Yes.

19 Q Now, when you say "working pressure rating," do
20 you mean pressure rating?

21 A Yes.

22 Q Okay. Now, the last sentence there, where you

1 say, "Even with some increased wall thickness, the
2 working pressure rating of these eccentric designs was
3 still limited to 3000 psi, limiting the overall length of
4 the sand screen assembly," you do not cite anything in
5 support of that statement, correct?

6 A Correct. There's an awful lot of citations
7 prior to that, other places I've talked about 3000 psi or
8 3,000 feet, 3,200 feet and 3000 psi.

9 Q So you did --

10 A I do not quote -- requote them here, but
11 there's lots of them out there.

12 Q Okay. Take a look at Paragraph 99.

13 A Okay.

14 Q Okay. You say in the first sentence that, "Yeh
15 and Yeh2 teach the solution to increase gravel pack
16 length was to use concentric designs with more shunt tube
17 located around the base pipe to reduce friction and have
18 a higher pressure rating due to the round configuration
19 in the higher pressure portion of the gravel pack system
20 towards the heel, and use the lower pressure rating and
21 reduced friction eccentric design in the lower pressure
22 portions of the gravel pack system towards the toe."

1 Did I read that correctly?

2 A Yes, sir.

3 Q When you say reduce friction -- so let me point
4 you to specifically where I am. So rolling over from
5 Page 65 to 66, you're referring to concentric designs.

6 A Right.

7 Q With more shunt tubes located around the base
8 pipe to reduce friction.

9 A Correct.

10 Q Okay. Reduce friction relative to what?

11 A To having -- to having only the same number of
12 shunt tubes. For example, eccentric design has two
13 transport tubes. A concentric design has six transport
14 tubes. So there's more in a concentric design, and that
15 reduces friction versus only having two smaller in the
16 concentric design.

17 Q Okay. Now, later in that same sentence, you
18 refer to eccentric designs with reduced friction.

19 A Correct.

20 Q Reduced friction relative to what?

21 A Concentric designs.

22 Q So you're saying that the eccentric screen

1 shunt tube systems have lower gravel slurry friction
2 relative to the concentric designs?

3 A Correct. That's what Yeh teaches, and that's
4 consistent with -- with the other references as well.
5 And the more shunt tubes is examples of six compared to
6 the two. So a six increase -- reduce friction compared
7 to only having two in the concentric design. My English
8 was probably not the best there.

9 Q Now, take a look at Paragraph 100. Now, in the
10 first sentence there -- take your time and review as much
11 as you need to -- you refer to, "The conventional wisdom
12 was that wall thickness, and associated pressure
13 ratings," do you see that?

14 A Yes, sir.

15 Q So a person of ordinary skill in the art
16 understood that wall thickness of tubing and the pressure
17 rating were proportional, correct?

18 A Were associated.

19 Q Okay. And by "associated," you mean they are
20 proportional in some sense. As wall thickness goes up,
21 pressure rating goes up, correct?

22 A They're associated. For a rectangular tube,

1 that's not always a direct relationship, we discussed
2 earlier. But in general, they are associated, yes.

3 Q And when you say "associated," you mean that
4 when the wall thickness of a rectangular tube goes up,
5 the pressure rating also goes up, correct?

6 A Not in all circumstances.

7 Q So there are circumstances in which the wall
8 thickness of the rectangular tube goes up and the
9 pressure rating goes down?

10 A Or doesn't change, yes.

11 Q Okay. Describe for me that scenario.

12 A Well, you could have one where the -- where the
13 pressure rating of the tubes -- well, for the dimensions
14 the tube changed. The pressure -- the thickness goes up,
15 and the pressure rating goes down or stays the same.

16 Q Okay. All right. I understand.

17 A Yeah.

18 Q So assuming all other parameters stay the
19 same, if you -- you would agree that a person of ordinary
20 skill in the art understands that if I change wall
21 thickness, and only wall thickness, in a rectangular tube
22 and I increase that wall thickness, the pressure rating

1 of that tube goes up, correct?

2 A It -- if you increase it enough, it goes up.

3 If you increase it a small amount, it may not affect it
4 at all.

5 Q Well, it has to affect it some, correct?

6 A It may not affect the pressure rating, no, sir.
7 It may affect the amount of stress at a particular
8 location, but that reduction in stress may not be enough
9 to reduce the pressure rating or to increase the pressure
10 rating.

11 For example, if I have something that's
12 near my stress limit and I've limited it that way, I may
13 want to see as a designer a move into that stress further
14 away to increase -- to justify an increase of a rating of
15 100 psi, for example. I mean, you're not going to
16 increase the pressure ratings from 3000 psi to 3002 psi.
17 That's -- that's nonsensical.

18 Q Okay. So let me try a different way. So if --
19 if I have a rectangular tube and I increase the wall
20 thickness of that rectangular tube some amount, but leave
21 everything else the same, you would agree that the burst
22 pressure of that rectangular tube increases, correct?

1 A Generally speaking, yes, that's going to be
2 true.

3 Q Okay. And a person of ordinary skill in the
4 art understood that back in 2018 and before, correct?

5 A That general principle, yes, I can agree with
6 that.

7 Q Okay. Take a look at Paragraph 110.

8 A Okay.

9 Q Okay. Now, you express the opinion here that
10 using thicker-walled shunt tubing in a concentric screen
11 would be limited because there would be less room for
12 shunt tubes in the annular space between the base pipe
13 and the outer shroud, correct?

14 A Are we at 110?

15 Q Yes. Sorry. That was a paraphrase, not a
16 direct quote.

17 A Oh, can you read that again then?

18 Q How about this, let me just try the language
19 you used.

20 A Okay.

21 Q So the middle of Paragraph 110, you say, "To
22 this, I would add that changing the wall thickness of the

1 upper concentric transport tubes to be greater than the
2 lower eccentric transport tubes would mean that the base
3 pipe in the concentric arrangement would have to shrink,
4 or the overall tool size would have to increase, or there
5 would have been a reduction in cross-sectional area of
6 the upper tubes."

7 Did I read that correctly?

8 A Yes, sir.

9 Q Now, turning to Paragraph 113. So fourth line
10 down, you state, "Increasing tube thickness without any
11 change to outer diameter would restrict the flow path of
12 the shunt tubes increasing friction pressure drop and
13 requiring a higher pressure rating for the same packable
14 length."

15 Did I read that correctly?

16 A Yes, sir. Assuming the base pipe doesn't
17 change.

18 Q Now, so take a look at the bottom of
19 Paragraph 96 now. And we discussed this previously, but
20 I want to remind you of it. You refer to -- last
21 sentence on Page 64, of Paragraph 96, you refer to the
22 working pressure rating of eccentric designs being

1 limited to 3000 psi.

2 Do you see that?

3 A Yes.

4 Q So in your opinion, based on the prior art
5 you've reviewed, a person of ordinary skill in the art,
6 at the time the '007 patent was filed in 2018, believe
7 that eccentric designs could not exceed a pressure rating
8 of 3000 psi without changing to concentric designs with
9 round shunt tubes, correct?

10 A Yes, based on the art that I've -- I reviewed,
11 that's correct. Somewhere around 3000 psi or 3,000 feet.

12 Q Now, taking a look at Paragraph 103.

13 A Pardon me one moment.

14 Q And I'm looking at the sentence that wraps from
15 Page 68 to Page 69 of your declaration. And there you
16 opine that, "Reducing the wall thickness in the
17 downstream screens would further limit the use of the
18 eccentric screens as it would have reduced the pressure
19 rating of those screens and would have required the use
20 of longer concentric screens, which Yeh teaches were less
21 readily available, higher friction, and more costly."

22 Did I read that correctly?

1 A Yes, sir.

2 Q So you there opine that the wall thickness of
3 the eccentric screens is related to the pressure rating,
4 correct?

5 A Right. We discussed that.

6 Q So let's look at Paragraph 138 of your
7 declaration.

8 A Okay.

9 Q Now, in Paragraph 138, you reproduce some
10 tubing calculations that were present in Mr. Chambers'
11 declaration, correct?

12 A Yes, I do.

13 Q Now, did you review those calculations?

14 A Yes.

15 Q And you didn't find any reason to disagree with
16 his calculations, correct?

17 A I disagreed that cubic inches per foot is not
18 cross-sectional area, I pointed that out. I did not
19 duplicate his cubic inches per feet calculations. I
20 assumed those were correct, but that's not a CSA.
21 They're related, but they're not -- it's not a CSA.

22 Q So how is cubic inches per foot not a

1 cross-sectional area?

2 A Cubic inches per foot is a volume
3 consideration, not an area consideration.

4 Q So it's a volume divided by length, correct?

5 A Correct.

6 Q Which is a cross-sectional area, correct?

7 A No, no. Cubic inches per foot is not a
8 cross-sectional area. Cross-sectional area would be
9 square inches, for example.

10 Q Okay. So let's assume that I have a cylinder.

11 A Uh-huh.

12 Q And I take the volume of that cylinder and
13 decide it by the height of the cylinder.

14 A Uh-huh.

15 Q Why is that not a cross-sectional area?

16 A Well, then you do get cross-sectional area.

17 Q But that's exactly what cubic inches per foot
18 is, correct?

19 A I disagree. They are related. But for
20 example, you have a cross-sectional area of inches and a
21 length of foot, you can get the cross-sectional area from
22 that, but that is not the cross-sectional area.

1 Q So if it had said cubic inches per inch, would
2 you agree that it was a cross-sectional area?

3 A Closer but not -- still not the same.
4 Cross-sectional area relates -- is directly related to an
5 area. I'm not saying you can't get there. In fact, I
6 did, but it's not directly a cross-sectional area. A
7 cross-sectional area is a consideration with no -- that
8 takes -- does not take into account any length. It's
9 just the area.

10 Q Okay.

11 A A two-dimensional. It's two-dimensional versus
12 three-dimensional. This may be -- may be a bit pedantic,
13 but still it's accurate.

14 Q Okay. So but you would agree that if he had
15 calculated this in units of cubic inches per inch, the
16 units would literally be square inches, right?

17 A Yes.

18 Q Okay. Any other disagreements that you saw
19 with Mr. Chambers' calculation?

20 A Again, I did not duplicate his calculations
21 except for his wall thickness. I looked at those
22 numbers. I didn't duplicate his volume calculations.

1 Q Okay. So in Paragraph 139, you opine that,
2 "What Mr. Chambers actually shows is that it is possible
3 to create two round tubes with the same cross-sectional
4 area and different wall thickness, and two rectangular
5 tubes with the same cross-sectional area and different
6 wall thickness."

7 Did I read that correctly?

8 A Yes, sir.

9 Q Now, in Mr. Chambers' rectangular example,
10 which you have there on Page 93, he compares a 10-gauge
11 rectangular tubing to a 13-gauge rectangular tubing,
12 correct?

13 A Correct.

14 Q Now, which of those, 10 or 13 gauge, has a
15 greater wall thickness?

16 A A 10 gauge.

17 Q Okay. So going from 13 gauge to 10 gauge
18 tubing results in thicker walls, correct?

19 A Correct.

20 Q And as we've discussed earlier, a skilled
21 artisan understood in 2018 that increasing wall thickness
22 resulted in a higher burst pressure, correct?

1 A Yes, it would without -- all else being equal.

2 Q So a skilled artisan understood that he could
3 increase tubing wall thickness and burst pressure and
4 have no effect on the dimension of the rectangular tubing
5 in the radial direction, while still maintaining the same
6 internal flow path cross-sectional area, correct?

7 MR. WALTERS: Objection; form.

8 A No, I disagree.

9 Q (BY MR. WILSON) Why?

10 A Because with the same cross-sectional area on
11 the interior, as shown here in this chart that's
12 duplicated, if you increase the wall thickness while
13 still maintaining the same volume or cross-sectional
14 area, you've actually increased the OD of the tool in
15 both dimensions -- or of the tube in both dimensions. So
16 it does impact the radial length.

17 Q Okay. So if we look at the purple figure from
18 Mr. Chambers' declaration in the rectangular wall
19 example, the height of the tubing, which he shows you
20 there on the left, demonstrates the height.

21 Do you see that?

22 A Correct.

1 Q The outside diameter of that tubing is
2 three-quarters of an inch in both 10 gauge and 13 gauge,
3 correct?

4 A That's what he says, but that's not correct.
5 Wait a second. That's not a correct calculation.

6 Q And why is it not correct?

7 A Because 1.25 divided by two does not give .75.
8 It gives .675, so that calculation is incorrect.

9 Q What makes you think that the OD has to be
10 exactly half of the width -- of the height outside
11 diameter has to be exactly half of the width outside
12 diameter?

13 A Well -- all right. Maybe I'm looking at this
14 wrong. Hold on a second.

15 I apologize. I was looking at this wrong.
16 Yes, the height does not change. Hold on a second. The
17 width changes.

18 Q Okay.

19 A Correct.

20 Q And you understand that as these tubes would be
21 installed in an eccentric screen -- in fact, you can see
22 how they would be installed there on Page 92 of your

1 clarification and Figure 8A from Yeh, the radial
2 direction from the center line of the tool is the height
3 of that rectangular tube, correct?

4 A Correct. But now that we've changed the width,
5 the thicker, higher burst pressure does not hold
6 necessarily. In fact, it's very likely not changed or
7 gone down even.

8 Q Okay. And you're saying that because there's
9 less -- you're saying that why? Why?

10 A Well, our example earlier is you increase
11 thickness, all else being equal, then the burst pressure
12 increases; and I generally agreed with that. However,
13 all else being equal doesn't hold in this example because
14 now we've increased the width, the weak spot -- there's
15 two points of concentration of stresses in a rectangular
16 tube. One is at the corners -- not quite at the corner,
17 but a little bit off the corner, and one at the center of
18 the long piece of -- of the tubing, so the width. That's
19 probably the highest stress depending on an awful lot of
20 things.

21 So now that you've increased that width,
22 you've created more stress at that center point by making

1 it wider. So increase in thicknesses may or may not
2 increase burst pressure in that configuration. It may
3 actually decrease it. You'd just have to run the FEM for
4 both scenarios. That's FEM and -- I mean finite element
5 modeling.

6 Q Now, a person of ordinary skill in the art in
7 2018 would have also understood that the burst pressure
8 rating of rectangular tubing could be increased by using
9 higher tensile strength material with the same dimensions
10 of rectangular tubing, correct?

11 A It could be.

12 THE WITNESS: I don't know where we are on
13 time, but I could use a couple minutes if we're not quite
14 at noon.

15 MR. WALTERS: A couple more minutes until
16 noon.

17 THE WITNESS: How many?

18 MR. WALTERS: Nine.

19 THE WITNESS: All right. We can do that.

20 Q (BY MR. WILSON) Okay. Let's take a look at
21 Paragraph 107 of your declaration. Now, in Paragraph
22 107, I'm looking on Page 172, you have Footnote 115.

1 A I'm getting there. Okay. Yes.

2 Q Okay. And Footnote 115, you refer to
3 Mr. Chambers referencing ASTM A554-16, which you say is
4 applicable for tubing for use in ornamental, structural,
5 exhaust, and other applications where appearance,
6 mechanical properties or corrosion resistance is needed,
7 correct?

8 A Yes.

9 Q And you say ASTM A554-16 is not applicable to
10 pressurized piping, as would be necessary in a sand
11 screen shunt tube assembly.

12 A Correct.

13 Q Okay. Now, you understand that Mr. Chambers
14 referred to a ASTM A554-16, which is Exhibit 1018, for
15 the tensile and yield strength of various stainless
16 steels, correct?

17 A I would be glad to look at that. I don't
18 recall now, but I would be glad to look at Mr. Chambers'
19 declaration there.

20 Q All right. I'm handing you what has been
21 marked as Exhibit 1003. This is Mr. Chambers'
22 declaration. Now, I don't think you have a cite in your

1 declaration to his, but I'll refer you to Paragraph 167
2 of Exhibit 1003.

3 A Okay.

4 Q Okay. And if you take a look through
5 Exhibit -- or sorry, Exhibit 1003, Paragraph 167, you'll
6 see that Mr. Chambers refers to ASTM A554-16 for yield
7 and tensile strength of stainless steels.

8 A In that paragraph, yes.

9 Q Okay. And take a look at paragraph 231 of
10 Exhibit 1003.

11 A I'm sorry. 2,000 --

12 Q 231.

13 A 231, oh, I'm sorry. Yeah, 2,001 didn't make
14 any sense.

15 Q Page 123.

16 A Got it.

17 Q And in Paragraph 231 at the top of Page 123,
18 Mr. Chambers again refers to tensile strengths from ASTM
19 A554-16, correct?

20 A Yes, sir.

21 Q Okay. Turn to Paragraph 331. And there you
22 will see that turning over to Page 181 and the table

1 shown there at the bottom of Paragraph 331, the reference
2 to Exhibit 1018 at 7, Table S2.1.

3 Do you see that?

4 A Yes.

5 Q So again he is using Exhibit 1018 for tensile
6 strength, correct?

7 A Yes, sir.

8 Q Do you have any reason to disagree with the
9 tensile and yield strengths that are in Exhibit 1018?

10 A No, sir, not necessarily. I still stand by the
11 statement I made.

12 MR. WILSON: Okay. Now is a good time,
13 actually, for a break.

14 THE WITNESS: Great. Thank you.

15 THE COURT REPORTER: Off the record at
16 11:57 a.m.

17 (Lunch break taken from 11:57 a.m. to
18 12:41 p.m.)

19 THE COURT REPORTER: We are on the record
20 at 12:41 p.m.

21 Q (BY MR. WILSON) Okay. Dr. Durham, I'm going
22 to hand you what was previously marked as Exhibit 1016,

1 and 1016 is SPE-169440.

2 And you've reviewed this document before,
3 correct?

4 A Yes, sir, I have.

5 Q If you notice, the authors of the article are
6 A. Bonner, T. Hailey, and J. Veit, all of Halliburton.

7 Do you see that?

8 A Yes, sir, I do.

9 Q Okay. And you can see at the top that this is
10 an SPE paper that was published in 2014?

11 A Correct.

12 Q Okay. Now, I want to take a look at the
13 abstract on Page 1. And the second paragraph under the
14 abstract says, "This paper discusses an improved version
15 of the traditional shunt tube system that has recently
16 been developed by a major engineering and service company
17 to enhance sand screens for gravel packing in long
18 production intervals."

19 Did I read that correctly?

20 A Yes, sir.

21 Q Now, if we keep going there, it says, "The
22 system was designed primarily for gravel packing in

1 horizontal wells and is a system with two larger
2 transport tubes and two smaller packing tubes, all
3 mounted to standard sand screens in an eccentric design."

4 Did I read that correctly?

5 A Yes, sir.

6 Q So Bonner's improved version of the traditional
7 shunt tube system is an eccentric two-by-two sand screen,
8 correct?

9 A Yes, it is.

10 Q Now, if we look in the third paragraph, second
11 sentence, Bonner says, "Extensive test programs to ensure
12 equipment integrity, including torque, tension, and
13 compression capability of major components were used.
14 The system can be assembled more quickly due to the
15 shroud covering the joint connection being an integral
16 component of the screen with no bulky clamshell hinges or
17 pins to be assembled."

18 Did I read that correctly?

19 A Yes, sir.

20 Q Now, let's take a look at Figures 8 and 9 on
21 Page 6. Now, on the left side of Figure 8 you can see a
22 transport tube connected to a packing tube that has

1 nozzles using a box crossover or box end crossover,
2 correct?

3 A Yes, that's correct.

4 Q Okay. That box crossover is also shown on the
5 far left portion of Figure 9, correct?

6 A Correct.

7 Q And the box crossover joint shown in Figure 9
8 shows that on one end of the box crossover there are two
9 openings each with a rectangular cross-sectional area,
10 correct?

11 A Yes.

12 Q The larger rectangular cross-sectional area
13 connects to the transport tube, correct?

14 A Correct.

15 Q The smaller rectangular cross-sectional area
16 connects to the packing tube, correct?

17 A Correct.

18 Q The rectangular cross-sectional area of the
19 packing tube is also shown in Figure 9, middle image,
20 correct?

21 A Yes, that's -- well, yes.

22 Q Okay. On the other end of the box crossover

1 with only one opening -- well, sorry. Let me strike
2 that.

3 On the other end of the box crossover
4 there is a single opening which is round, correct?

5 A Correct.

6 Q Now, looking at the right side of Figure 8, you
7 can also see that at the opposite end of the transport
8 tube from the box crossover there is a pin crossover,
9 correct?

10 A Yes.

11 Q The pin crossover is also shown on the far
12 right portion of Figure 9, correct?

13 A Yes, sir.

14 Q The cross-sectional area of the pin crossover
15 is rectangular at the end connected to the rectangular
16 transport tube, correct?

17 A Yes.

18 Q And the cross-sectional area of the pin
19 crossover at the other end not connected to the
20 rectangular transport tube is round, correct?

21 A Yes, it is.

22 Q Okay. Now, let's take a look at Figure 42 on

1 Page 20 of Bonner.

2 A Okay.

3 Q Now, Figure 42 illustrates using red arrows the
4 direction of gravel slurry flow in a shunt tube system
5 used in Bonner's packing tube and exit port erosion test
6 described on the bottom of Page 19, correct?

7 A Yes, that's correct.

8 Q Okay. Going from left to right following the
9 direction of the gravel slurry flow depicted using red
10 arrows, the left of Figure 42 shows a rectangular
11 trans- -- transport tube in orange, correct?

12 A Yes.

13 Q That left rectangular transport tube has a pin
14 crossover at its right end, correct?

15 A Yes, sir.

16 Q The pin crossover connects the left transport
17 tube to a round jumper tube, correct?

18 A Yes.

19 Q That jumper tube is colored gray, correct?

20 A Right. Correct.

21 Q And the right side of the jumper tube connects
22 to the box crossover of the shunt tube assembly

1 illustrated on the right, correct?

2 A Yes, sir.

3 Q The shunt tube assembly on the right includes a
4 rectangular transport tube and a rectangular packing
5 tube, correct?

6 A Correct, yes, sir.

7 Q And for this packing tube erosion test, the
8 transport tube was blocked off downstream from the
9 branched connection, correct?

10 A Yes.

11 Q So that means that the transport tube was
12 blocked off so that gravel slurry flowing from the
13 upstream jumper tube through the box crossover was
14 diverted from flowing through the transport tube and
15 limited to just flowing through the packing tube and out
16 the packing tube nozzles, correct?

17 A Corr- --

18 MR. WALTERS: Objection; form.

19 A Correct.

20 Q (BY MR. WILSON) Typically, if there were no
21 blockage, gravel slurry would flow from the upstream
22 transport tube, through the jumper tube, through the

1 downstream transport tube and packing tube by way of the
2 box crossover, correct?

3 A Can you go through that sequence again? I
4 think that's right. Let me make sure.

5 Q Typically, when there's no blockage, gravel
6 slurry flow from the upstream transport tube, through the
7 jumper tube, through the downstream transport tube box
8 crossover, and through the transport tube and packing
9 tube, correct?

10 A Yes. It would have been true in this test had
11 they not blocked it off, correct.

12 Q Okay. In Bonner's eccentric shunt system
13 example, gravel slurry flows from one shunt system to the
14 next downstream shunt system by way of the jumper tube
15 and its box and pin connectors, correct?

16 A Yes. For that test, that's correct.

17 Q So using the jumper tube and its box and pin
18 connectors, an upstream shunt tube system is fluidly
19 connected to a downstream shunt tube system, correct?

20 A Yes.

21 Q Now, let's take a look at the Basis of Design
22 section on Page 2 of Bonner. So the first sentence under

1 the heading "Basis of Design" on Page 2 of Bonner says,
2 "The main basis of design for the new system was to keep
3 it functionally the same as existing industry-proven
4 designs, in order to enjoy the empirical evidence of
5 years of successful application of shunt tube
6 gravel-packing technology," correct?

7 A Yes, sir, you read that correctly.

8 Q So if you look at the second paragraph there,
9 in the first sentence Bonner says, "In certain parts of
10 the design (i.e. for the jumper tubes across connections)
11 it was determined that round tubes instead of the common
12 industry design of rectangular tubes would be better."

13 Did I read that correctly?

14 A Yes, sir.

15 Q Now, the third sentence in that paragraph --
16 actually, let's just look at the second. It says, "This
17 choice led to a decrease in the amount of flow area in
18 certain parts of the new design. For these parts,
19 analyses were made to verify that although the flow areas
20 were less, the friction pressure loss for these parts
21 were essentially identical to those for the rectangular
22 tube designs owing to the nature of friction pressure

1 loss in round tubes versus rectangular tubes."

2 Did I read that correctly?

3 A Yes, sir.

4 Q So Bonner reported switching from rectangular
5 jumper tubes to round jumper tubes with a lower
6 cross-sectional area with no increase in friction
7 pressure loss, correct?

8 A I disagree.

9 Q Why do you disagree?

10 A It doesn't say that.

11 Q He says, "For these parts" -- well, let me back
12 up.

13 You agree that Bonner was changing from
14 rectangular jumper tubes to round jumper tubes, correct?

15 A Yes.

16 Q Okay. And you agree that Bonner says, "For
17 these parts, analyses were made to verify that although
18 the flow areas were less, the friction pressure loss for
19 these parts were essentially identical to those for the
20 rectangular tube designs owing to the nature of friction
21 pressure loss in round tubes versus rectangular tubes"?

22 A I agree with that.

1 Q Okay. But you don't think he's saying that the
2 friction pressure loss going from a larger
3 cross-sectional area rectangular tube to a smaller
4 cross-sectional area round tube was the same?

5 A No. I'm -- I think what he's -- that's not the
6 question you asked earlier, by the way.

7 But I think what he's saying is for those
8 parts, those short jumper tubes, that the pressure loss
9 was essentially identical. That doesn't mean it's the
10 same. It doesn't mean it's less. It means it's
11 essentially identical.

12 Q Okay.

13 A In other words, the increase in pressure was
14 insignificant for that application for that short
15 distance.

16 Q He didn't say there was an increase in friction
17 pressure loss, did he?

18 A Nope.

19 Q He said it was essentially identical.

20 A Essentially identical, correct.

21 Q Okay.

22 A So I can -- any change was inconsequential.

1 Q So he says that is "owing to the nature of
2 friction pressure loss in round tubes versus rectangular
3 tubes," correct?

4 A Yes.

5 Q What does he mean by that?

6 A Rounds tubes tend to have a more lamin- --
7 laminar flow characteristics. Less turbulent.

8 Q So you think -- strike that.

9 In your opinion, round tubes tend to have
10 more laminar flow versus a tendency toward more turbulent
11 flow in rectangular tubes?

12 A Yes.

13 Q And you think that's the reason that Bonner
14 says -- or refers to the nature of friction pressure loss
15 in round tubes versus rectangular tubes, correct?

16 A Well, I think that's one the factors that
17 certainly went into that. I can't speak for Mr. Bonner
18 other than the words on the page, but I think that
19 factor -- that is a characteristic of flow and friction
20 pressure loss in round tubes that is different between
21 round and rectangular.

22 Q So a person of ordinary skill in the art

1 reading Bonner's characterization of their jumper tube
2 test would have understood that you could use a smaller
3 cross-sectional area round tube in place of a larger
4 cross-sectional area rectangular tube with essentially
5 identical pressure drop for the same flow rate, correct?

6 A For those jumper tubes, relatively short jumper
7 tubes, yes, that's what they would understand.

8 Q Okay. Now, let's take a look at Figure 32 of
9 Bonner, which is on Page 16.

10 A 32. Okay.

11 Q So Figure 32 provides data for a jumper tubing
12 pressure test Sample B, correct? You'll see that at the
13 top of the figure.

14 A It's the top of the figure. Okay. Thank you.
15 Yes, Sample B.

16 Q Okay. Figure 32 shows pressure in psi on the Y
17 axis and time in seconds on the X axis, and there's a
18 horizontal dashed blue line at 5000 psi identifying 5000
19 psi as Bonner's design specification requirement value,
20 correct?

21 A Correct.

22 Q And the solid darker blue line represents the

1 pressure applied to Sample B across time, correct?

2 A Yes. Well, it represents -- yes, the pressure
3 versus time, correct.

4 Q Okay. The jumper tube experienced pressure up
5 to over 7500 psi?

6 A It did.

7 Q Sorry. Let me strike that. Let me try again.

8 The jumper tube experienced pressure up to
9 over 7500 psi before failing, correct?

10 A It expressed that, right. I don't know what
11 deformation there was. I'm not sure it describes that.
12 But it did experience 7500 psi.

13 Q Okay. In the text Figure 32 on Page 16, and
14 I'm talking about the first full paragraph on that page
15 there --

16 A Uh-huh.

17 Q -- Bonner explained that, "All jumper system
18 testing failures were above 5000 psi, easily supporting
19 the shunt tube system pressure rating of 5000 psi."

20 Did I read that correctly?

21 A Yes, sir.

22 Q Okay. Let's take a look at Figure 23 on Page

1 12. Okay. Now, Figure 23 provides data for a shunt tube
2 pressure test rectangular Sample A3C, correct?

3 A Yes.

4 Q And just like Bonner's Figure 32, Figure 23
5 shows pressure in psi on the Y axis, time and seconds on
6 the X axis, and there's a horizontal dashed red line at
7 5000 p- -- oh, sorry, identifying 5000 psi as Bonner's
8 design specification requirement value, correct?

9 A Correct.

10 Q And the solid green line represents the
11 pressure applied to rectangular Sample A3C across time,
12 correct?

13 A It does.

14 Q This rectangular shunt tube experienced
15 pressure above 6000 psi before failing, correct?

16 A Correct.

17 Q And in the text below Figure 23 on Page 12 --

18 A Well, let me back up on that answer.

19 It shows it experienced 65- -- 6000 psi.

20 I don't think it says in that particular sample whether
21 or not that sample failed or deformed. But I will agree
22 that it -- in that test it exceeded 6000 psi.

1 Q Okay. So in the text below Figure 23 on
2 Page 12 Bonner -- and I'm looking about in the middle of
3 that first paragraph -- Bonner states that, "The overall
4 testing substantiated the goal rating of 5000 psi burst
5 pressure."

6 Did I read that correctly?

7 A Yes.

8 Q Now, you also notice there that Bonner refers
9 to the fact that, "However, a 1.33 safety factor was
10 judged to be advisable for a working burst pressure for
11 the tube system in order to allow for variations in the
12 manufacturing of the tubes."

13 Did I read that correctly?

14 A Yes, sir.

15 Q So if we were to apply a 1.33 safety factor,
16 what would be the pressure rating of Bonner's shunt tube
17 system?

18 A I wouldn't know. According to Bonner, it was
19 over 5000 or supported or substantiated the goal rating
20 of 5000 burst pressure. But I would need a lot more data
21 to answer that question.

22 Q Now, a person of ordinary skill in the art in

1 2018 understood that the jumper tube connecting the shunt
2 tube of one sand screen to the shunt tube of another sand
3 screen must be able to contain the same internal pressure
4 as the shunt tubes they connect, correct?

5 A At least. That -- contain at least that
6 pressure.

7 Q Okay. And a person of ordinary skill in the
8 art in the 2018 would also understand from Bonner's
9 disclosures that a rectangular shunt tube system could be
10 fabricated to tolerate pressures of at least 5000 psi,
11 which was more than the 3000 psi expected of conventional
12 sand screens, correct?

13 A I agree with that. It could be, yes, in
14 this -- in this test configuration.

15 Q Now, based on the 5000 psi pressure tolerance
16 of Bonner's eccentric screens, these screens could be
17 used to gravel pack a horizontal interval beyond 3000
18 feet long, correct?

19 A I don't think you can draw that conclusion just
20 from this data, no.

21 Q Why not?

22 A Because this is a test apparatus. It's not

1 showing this downhole. It's actually in use. You don't
2 know the size of this tool. You don't know what
3 trade-offs were made. This is simply talking about test
4 data.

5 Q Well, Bonner's goal was to substantiate a 5000
6 psi burst pressure rating, correct?

7 A Yes.

8 Q And in Bonner's opinion they did that, correct?

9 A In these test configurations, yes.

10 Q You don't think that has any applicability to
11 the real world?

12 A Sure.

13 Q So why would you think that Bonner's shunt tube
14 system would not be able to handle 5000 psi internal
15 pressure?

16 A I don't think I said that.

17 Q So if it can handle 5000 psi internal pressure,
18 why couldn't you use it to gravel pack an interval longer
19 than 3000 feet?

20 A Because you just don't know what the rest of
21 the configuration looks like. It may be possible. This
22 is a test setup. Test setups are not meant to duplicate

1 real world, for example, lengths, et cetera, tool size,
2 trade-offs, those kind of things.

3 But what you can learn from this is
4 exactly what you said earlier, you can design a packing
5 tube -- rectangular packing tube that can withstand 5000
6 psi. That's what you can draw from this data.

7 Q Okay. You can set that Bonner aside.

8 I'm going to hand you what was previously
9 marked as Exhibit 1014. And Exhibit 1014 is a paper by
10 K.W. Lagrone.

11 Do you see that?

12 A Yes, sir.

13 Q And it's titled, "A New Development in
14 Completion Methods - The Limited Entry Technique,"
15 correct?

16 A It is.

17 Q And you reviewed this paper as part of your
18 original two declarations in this case, correct?

19 A Yes, I did. And I was familiar with this paper
20 long before.

21 Q Okay. And you can see at the bottom of
22 Page 1 -- or page 695 of Exhibit 1014 that it was

1 published in 1963, correct?

2 A Maybe my glasses are not clear, but I see 1968,
3 not 1963.

4 Q All right.

5 A I'm pretty sure it's an 8.

6 Q Okay. Maybe it's 1968. Okay. So it was
7 published at least by 1968, correct?

8 A Yes, sir.

9 Q Okay.

10 A In fact, we know it's not -- well, I don't
11 know. Anyway, there we go. That -- that's what we know.

12 Q Okay. So now, on Page 1 looking at the
13 right-hand corner column under the heading, "Limited
14 Entry Techniques" --

15 A Uh-huh.

16 Q -- Lagrone, Exhibit 1014, describes an improved
17 well simulation method called the limited entry
18 technique.

19 Do you see that?

20 A Yes.

21 Q Are you familiar with the limited entry
22 technique?

1 A I am.

2 Q And what is the limited entry technique?

3 A Limited entry technique is a process to modify
4 the perforation size in the casing, either by number of
5 perforations, size of perforations, depth of
6 perforations, in order to control the amount of
7 fracturing fluid that goes into a particular perforation
8 and, thus, getting more evenly distributed fracture
9 mechanism in the formation.

10 Q It's essentially the idea of restricting the
11 flow through the perforations so that additional pressure
12 is available to drive the flow through all the
13 perforations?

14 A Through other perforations, yes, sir, that's
15 correct.

16 Q Okay. Now, let's take a look at Figure 3 in
17 Lagrone on Page 697. And it's quite small.

18 A Uh-huh.

19 Q But we'll see if we can work through it.

20 So Figure 3 illustrates the flow rate
21 versus friction loss, laboratory measured, correct?

22 A Yes, it does.

1 Q And the Y axis shows flow rate through single
2 perforations in barrels per minute, correct?

3 A Yes, I think you can -- you can draw that from
4 the text. I can agree with that.

5 Q Okay. The X axis shows friction loss across
6 the perforation, correct?

7 A It does.

8 Q Okay. So Figure 3 shows the flow rate versus
9 friction loss for four different conditions, correct?

10 A Correct.

11 Q There's a half-inch perforation using bullet
12 and oil sand -- or sorry. Let me strike that.

13 There's a half-inch bullet perforation
14 using oil and sand, correct?

15 A Correct. Flowing oil and sand through the
16 perforation, correct.

17 Q And there's a three-eighths inch jet hole
18 flowing oil, correct?

19 A There is.

20 Q There's a three-eighths inch jet hole flowing
21 water, correct?

22 A Yes, sir.

1 Q And there's a three-eighths inch jet hole
2 flowing oil and sand, correct?

3 A There is.

4 Q Okay. The highest flow rate measurement in the
5 half-inch bullet perforation with oil and sand is about
6 three barrels per minute, correct?

7 A About 2.9 is the way I read it.

8 Q Okay. And the friction loss at this 2.9 barrel
9 per minute is about 400 psi, correct?

10 A That's about 400. I would guess it's in psi.
11 It's not labeled that way. It doesn't say. That's
12 probably a reasonable inference.

13 Q Okay. So whatever the units are, whether
14 they're psi or some other pressure units, it's 400 units,
15 correct?

16 A Correct. I agree with that.

17 Q Okay. So take a look now at the flow rates of
18 the other three perforations which used a smaller
19 three-eighths inch perforation at the same friction loss
20 of 400. So going vertically downward --

21 A Uh-huh.

22 Q -- from that last point on the half-inch

1 perforation spot, you can see that the three-eighths inch
2 perforation measurements had flow rates ranging from
3 about 1.4 to 1.6 barrels per minute, correct?

4 A Yeah. I read it as 1.3 to 1.7, but...

5 Q Okay. Fair enough.

6 These three-eighths inch flow rates are
7 almost half of the half-inch perforation condition,
8 correct?

9 A About 65 percent.

10 Q Okay. So a person of ordinary skill in the art
11 understood that for a given pressure drop, flow rate was
12 proportional to perforation size, correct?

13 A More or less proportional, yes. In some -- in
14 some manner proportional.

15 Q Okay. So if we look at Page 2 -- or sorry, not
16 Page 2, Page 696 of Lagrone, and in the right-hand column
17 on the lower right, the last paragraph there, do you see
18 the sentence that begins, "Figure 3 shows that"?

19 A I do.

20 Q Lagrone says, "Figure 3 shows that, for the
21 same perforation friction, approximately twice as much
22 fluid can be injected through a half-inch hole as through

1 a three-eighths inch hole."

2 Did I read that correctly?

3 A Yes, sir.

4 Q Now, if we go back to Figure 3 and we focus
5 just on the half-inch bullet perforation line, we can see
6 that the curve is almost linear, correct?

7 A No, I disagree.

8 Q Okay. Would you agree, then, that a person of
9 ordinary skill in the art understood that for a given
10 perforation size, flow rate was almost directly
11 proportional to pressure drop across the perforation?

12 A No.

13 MR. WALTERS: Objection; form.

14 A Not at all.

15 Q (BY MR. WILSON) Okay. If the half-inch bullet
16 perforation line were a straight line, that would be
17 true, correct?

18 MR. WALTERS: Objection; form.

19 A If it were, but it's not.

20 Q (BY MR. WILSON) Okay. But you would agree
21 that a person of ordinary skill in the art in 2018
22 understood that for a given perforation size, flow rate

1 was proportional to pressure drop across the perforation,
2 correct?

3 A Again, they're related, and they're some way --
4 somewhat proportional with some factors into it. But
5 proportional implies direct proportionality. Just using
6 the term "proportional" implies direct proportionality,
7 and it's not.

8 Q Okay.

9 A So they're at least related.

10 Q And as -- as flow rate goes up, pressure drop
11 goes up for a given perforation size, correct?

12 A I agree with that, certainly.

13 Q Okay. And a person of ordinary skill in the
14 art in 2018 also understood that increasing the
15 perforation cross-sectional area would increase flow out
16 of the perforation if other conditions remained the same,
17 correct?

18 A Yes, I can agree with that, all else being
19 equal.

20 Q Okay. Now I'm going to hand you what was
21 previously marked Exhibit 1013. And you can see that
22 Exhibit 1013 is SPE-86532 authored by a G. Hurst, among

1 others.

2 Do you see that?

3 A I do.

4 Q Okay. And you've reviewed Hurst previously
5 correct?

6 A Yes, sir, I did.

7 Q Okay. So -- so Hurst provides a review of
8 alternate path sand control completions that have been
9 implemented to date, correct?

10 A Generally speaking, yes.

11 Q Okay. And the date was 2004, correct?

12 A Yes, it is.

13 Q Okay. So let's take a look at Page 3 of Hurst,
14 and you can see in the lower right the section entitled,
15 "Multi-zone Isolation Design"?

16 A Okay.

17 Q Do you see the paragraph that begins, "This
18 technique can be"?

19 A Yes.

20 Q Okay. So the sentence starting at about the
21 middle of that paragraph do you see begins, "Fracturing
22 or gravel packing"?

1 A I do.

2 Q Okay. There Hurst says, "Fracturing or gravel
3 packing of each individual zone is dictated by the rate
4 of slurry diverted into each zone, which in turn is
5 controlled by the frictional pressure drops within the
6 shunt delivering slurry into each zone. For a given
7 fluid composition and gravel concentration, friction and
8 thus the pressure applied to each zone can be controlled
9 through the shunt tube dimensions (diameter and length)
10 as well as the nozzle diameter and frequency."

11 Did I read that correctly?

12 A Yes, sir.

13 Q So a person of ordinary skill in the art in
14 2018 understood from Hurst that slurry flow out of
15 nozzles can be controlled by modifying shunt tube nozzle
16 diameter, correct?

17 A Among other things, yes, sir. Not in
18 isolation, but among other things.

19 Q And a person of ordinary skill in the art
20 understood from Hurst that slurry flow out of nozzles can
21 be controlled by modifying shunt tube nozzle frequency,
22 correct?

1 A Yes, among other things.

2 Q A person of ordinary skill in the art in 2018
3 understood that Hurst's teachings about nozzle diameter
4 and frequency are consistent with the teachings of
5 Lagrone's Figure 3, correct?

6 A Yeah, of course they are. Sure.

7 Q Okay. I'm going to hand you what was
8 previously marked as Exhibit 1008, and this is U.S.
9 Patent Number 5,113,935 to Jones, et al.

10 A Uh-huh.

11 Q And you reviewed this document previously,
12 correct?

13 A Yes, sir.

14 Q This is what is referred to in the petition and
15 Mr. Chambers' declaration as Jones 2, correct?

16 A Jones 2, that's correct.

17 Q Okay. Now, let's take a look at Column 4, and
18 I want to start at Line 50. And you can see there it
19 describes, "Figure 3 illustrating a shunt means 325 in
20 accordance with the present invention."

21 Do you see that?

22 A Yes.

1 Q Okay. So this paragraph is in reference to
2 Figure 3. And do you see Figure 3?

3 A I do, yes.

4 Q Okay.

5 A I know what Figure 3 is.

6 Q Okay. So if we take a look at Column 4,
7 Lines -- sorry, 59, Line 59 --

8 A Uh-huh.

9 Q -- it says, "During a gravel pack operation,
10 the gravel slurry will take the path of least resistance
11 through the conduits and will tend to flow through the
12 bigger perforations first until they become blocked and
13 then will flow through the next larger perforations which
14 remain open and so forth."

15 Did I read that correctly?

16 A You did, yes.

17 Q So Figure 3 depicts a shunt tube with
18 perforations 326, correct?

19 A Correct, a single -- a single packing tube is
20 what's shown in Figure 3.

21 Q Okay. The perforations 326a at the bottom of
22 the shunt tube or packing tube are larger compared to the

1 perforation 326b in the middle, correct?

2 A Correct.

3 Q And the perforations 326a at the bottom of the
4 shunt tube are larger than the perforations at the top of
5 the packing tube 326c, correct?

6 A Can you rephrase that?

7 Q The perforations 326a at the bottom of the
8 packing tube in Figure 3 are larger than the perforations
9 at the top of the packing tube 326c, correct?

10 A I guess is there a complement between packing
11 tube 326c? Because the packing tube is 325, and the
12 perforations are 326c.

13 Q Yeah. Sorry. Maybe that's unclear.

14 A Thank you.

15 Q Yeah.

16 So the perforations 326a at the bottom of
17 the packing tube in Figure 3 are larger than the
18 perforations 326c at the top of the packing tube,
19 correct?

20 A Yes.

21 Q Okay. Now, Jones says, as we just read in
22 Column 4, that the gravel slurry will take the path of

1 least resistance and tend to flow through the bigger
2 perforations first, correct?

3 A That's what it says. I don't know that I agree
4 with that statement. I think it's oversimplified, but
5 it's what it says.

6 Q Okay. So you would at least agree that the
7 larger perforations -- strike that.

8 You would agree that a person of ordinary
9 skill in the art in 2018, reading Lagrone, Hurst, and
10 Jones 2, would understand -- sorry. Let me strike that.
11 Let me start over.

12 You would agree that a skilled artisan in
13 2018, reading Lagrone, Hurst, and Jones 2, would
14 understand that gravel slurry flow out of shunt tubes
15 could be manipulated by adjusting nozzle characteristics,
16 including adjusting the nozzle cross-sectional area or
17 the number of nozzles on a shunt tube, correct?

18 A Yes, I can agree with that. It can be
19 manipulated, yeah, I can agree with that.

20 Q Okay. You would agree that a person of
21 ordinary skill in the art understood that using a larger
22 nozzle opening, which lowers the restriction through the

1 nozzle, would result in more flow with a smaller
2 differential pressure, correct?

3 MR. WALTERS: Objection; form.

4 A As compared to what?

5 Q (BY MR. WILSON) As compar- -- compared to the
6 smaller nozzle opening before the change.

7 A At the same location, given the same source and
8 destination, same differential pressure, then I would
9 agree with that.

10 Q Okay. Let's take a look at Paragraph 117 of
11 your declaration, Exhibit 2002. Now, in Paragraph 117
12 and rolling over to the top of Page 79 of your
13 declaration, you reproduce Figure 7 from Yeh2, correct?

14 A Yes, sir.

15 Q So you agree that a person of ordinary skill in
16 the art in 2018 understood that the differential pressure
17 driving force for gravel slurry injection decreased as
18 you went down the length of a packing shunt tube,
19 correct?

20 A Yes, I agree with that.

21 Q And you would agree that --

22 A Well, in an open end tube, I agree with that.

1 Q Okay. You would agree that even in Case C in
2 Yeh2's Figure 7, the differential pressure in the lowest
3 nozzle is the least among all the nozzles in the packing
4 tube, correct?

5 MR. WALTERS: Objection; form.

6 A I don't know that you can draw that conclusion
7 from Figure 7.

8 Q (BY MR. WILSON) The arrow on the far right in
9 Case C is the smallest arrow shown on that shunt tube,
10 correct?

11 A Well, I don't know if you can draw that
12 comparison. You can definitely compare it with the first
13 one on the far left and say it's shorter, but comparing
14 Number 5 with Number 6, I don't think you can say that.

15 Q Okay. So you would agree, then, at least that
16 the differential pressure driving flow out of the last
17 nozzle in Case C in Yeh2 Figure 7 is less than the
18 differential pressure driving flow out of the first
19 nozzle in that packing tube, correct?

20 A Yes, I -- I can agree with that.

21 Q Okay. Let's take a look at Paragraph 123 of
22 your declaration, Exhibit 2002.

1 A Did you say 123?

2 Q Paragraph 123.

3 A Okay.

4 Q Now, you see there about just below the middle
5 of the paragraph the sentence that begins, "For example"?

6 A Okay.

7 Q It says, "For example, increasing the number of
8 nozzles would increase friction loss, reduce packing
9 length, and increase leak-off in a similar manner to
10 increasing nozzle diameter."

11 Did I read that correctly?

12 A Yes.

13 Q So how would increasing the number of nozzles
14 increase friction loss?

15 A Because you dehydrate the fluid sooner.

16 Q So when you say "increase friction loss,"
17 you're talking about not across the nozzles, you're
18 talking about along the length of the shunt tubes?

19 A Well, it's both. Decrease friction loss both
20 along the length of the shunt tube and across the
21 nozzles.

22 Q Okay. You just said "decrease friction loss."

1 A In- -- increase, yes. As -- as the
2 concentration of the slurry increases, you increase
3 friction loss along any given tube and you increase
4 friction loss through the nozzle because the slurry has a
5 higher concentration of gravel.

6 Q Okay. So -- but that wouldn't be true along
7 the entire length of the shunt tube system, correct?

8 A Well, no. You probably would decrease the
9 friction loss of the first one if you made a nozzle
10 bigger, right?

11 Q Okay.

12 A But you -- and you would dehydrate the fluid
13 faster and make the subsequent ones at least tend towards
14 a higher pressure -- friction loss.

15 Q Okay. If you still have Exhibit 1013 in front
16 of you there, which is Hurst?

17 A I can dig it back out. Oil excavation. Okay.
18 1013.

19 Q Okay. So let's take a look at Page 2. Now,
20 the second paragraph under the heading, "Introduction of
21 Larger Tubes" --

22 A Uh-huh.

1 Q -- on Page 2 says, "Similarly, long open hole
2 horizontal gravel packs may limit the pump rates due to
3 increased frictional pressure losses. In both cases, the
4 limitation is the burst pressure of the shunt tubes,
5 which is currently 5000 psi."

6 Did I read that correctly?

7 A Yes, sir.

8 Q Now, Hurst goes on to say, "The tube dimensions
9 were modified to 0.75 by 1.5-inch external (.56 by
10 1.31-inch internal) yielding three times the flow area of
11 the original design and reducing -- reducing friction
12 pressures over the rates of interest by approximately an
13 order of magnitude, for long horizontal gravel packs."

14 Did I read that correctly?

15 A Yes, sir.

16 Q Now, Hurst goes on to say, "This of course was
17 at the expense of a reduced base pipe diameter, which in
18 many instances does not impact well productivity in
19 either frac-packed or gravel-packed horizontal
20 completions, although this should be verified through
21 reservoir simulators that couple friction in the wellbore
22 with the pressure drop through the reservoir."

1 Did I read that correctly?

2 A Yes.

3 Q Hurst is describing increasing the shunt tube
4 dimensions at the expense of the primary flow path,
5 shrinking the primary flow path, and describing that as a
6 beneficial change, correct?

7 A Increase -- well, yes. Increasing the flow
8 paths -- the secondary flow path certainly is beneficial
9 in reducing friction. He goes on to say it may not
10 impact productivity. He doesn't discuss what impact that
11 may have during a completion operation.

12 Q Okay. A person of ordinary skill in the art
13 understood by 2018 that increasing secondary flow paths
14 would decrease primary flow paths potentially, but they
15 understood the trade-offs associated with that exchange,
16 correct?

17 A They understood, yes, there would be
18 trade-off between Yeh and Hurst. There would be
19 trade-offs. And all those trade-offs have to be taken
20 into consideration.

21 Q Okay. Take a look at Page 2 on the top right.
22 Okay. You see the paragraph that begins, "Based on the

1 hole-size"?

2 A Yes.

3 Q It says, "Based on the hole-size optimization
4 tests, combined with the nozzle design as well as
5 additional experiments for confirmation, the recommended
6 nozzle diameters for commonly used gravel sizes are given
7 in Table 1."

8 Did I read that correctly?

9 A Yes, you did.

10 Q All right. So let's take a look at Table 1,
11 and that is on the last page of Hurst. And you can see
12 in Table 1 that for both 40/60 mesh and 20/40 mesh Hurst
13 recommended both quarter inch nozzles and three-eighths
14 inch nozzles, correct?

15 MR. WALTERS: Objection; form.

16 A No, I disagree.

17 Q (BY MR. WILSON) Why do you disagree?

18 A Well, we have to read the rest of the text. So
19 up to and on Page -- where we were, Page 2, "Note that
20 gravel sizes up to and including 16/30 mesh can be used
21 with quarter inch nozzles, while three-eighths inch is
22 required for 12/18 U.S. mesh with a nozzle length of

1 five-eighths in both cases."

2 So you can read Table 1 with that in mind
3 to say quarter inch is good for up to 16/30, and anything
4 finer than 16/30 would require three-eighths.

5 Q Well, when you say "finer than 16/30," do you
6 mean larger than 16/30 --

7 A No.

8 Q -- correct?

9 A Finer. Smaller particles.

10 Q So you're saying that 12/18 mesh is smaller --

11 A I'm sorry. I had --

12 Q -- than 16/30?

13 A I had it up -- I had it backwards.

14 Q Okay.

15 A The text actually says from the top down for
16 40/60, 20/40, and 16/30 you can use quarter inch. For
17 12/18 and 8/12, you use three-eighths inch.

18 Q Well, actually, if you look at the bold figures
19 under three-eighths, the 12/18 you can use three-eighths,
20 but for 8/12 in Figure 1 --

21 A Yeah, yeah, you need something --

22 Q -- those are not bolded, correct?

1 A You need something bigger, right. Yeah. Thank
2 you.

3 Q So you would need bigger nozzles?

4 A Yeah, that's correct. For 8/12 you would need
5 bigger.

6 Q So you would agree that Hurst says for 40/60
7 and 20/40 mesh you can use either quarter inch nozzles or
8 three-eighths inch nozzles, correct?

9 A Perhaps you can draw that from there. That's
10 not how the text reads, but that's what the table bolding
11 shows if we infer that that table bolding means
12 recommended.

13 Q So why do you say that's not what the text --
14 how the text reads?

15 A Well, the text reads, "Gravel sizes up to and
16 including 16/30 can be used with quarter inch, while
17 three-eighths inch will be required to 12/18 U.S. mesh.

18 So it doesn't say in the text you can use
19 either. It says quarter inch up to 16/30 and
20 three-eighths for 12/18. If -- if we infer that from the
21 bolding, then maybe we can infer that you can use
22 three-eighths on 40/60 and 20/40, but that's not what the

1 text says.

2 Q Okay. So the text doesn't say you can't use
3 three-eighths inch with anything smaller than 16/30 mesh,
4 correct?

5 A It does not say that. It's silent --

6 THE COURT REPORTER: It's what?

7 A Silent.

8 Q (BY MR. WILSON) Okay. If we take a look at
9 Page 3 of Hurst, on the lower left you see concentric
10 versus eccentric design?

11 A Yes.

12 Q Now, you would agree that are there two basic
13 types of sand screens used in the industry as of 2018,
14 concentric versus eccentric, correct?

15 A Correct. That's two general categories,
16 correct.

17 Q Okay. At the -- the second paragraph under
18 that section says, "The key advantage of the eccentric
19 design is the increased base pipe size allowing, for
20 example, 5-and-a-half inch base pipe in an 8-and-a-half
21 inch open hole. The disadvantage of the eccentric design
22 is that the gravel pack thickness is lower on one side

1 compared to the other."

2 Did I read that correctly?

3 A Yes.

4 Q A person of ordinary skill in the art
5 understood by 2018 that there were advantages and
6 disadvantages to concentric and eccentric screens,
7 correct?

8 A Sure. Certainly.

9 If we're going to move on, I think we're
10 approaching that hour mark.

11 Q All right. Let's hang on for just a few more
12 minutes.

13 A Sure.

14 Q So take a look at Figure 3. That's on Page 12
15 of Hurst. And you can see that what Hurst is describing
16 is an eccentric two-by-two arrangement, correct?

17 A It is in Figure 3, correct.

18 Q Okay. And if we look at the top of Page 6, the
19 very top -- or actually, let's look at the bottom right
20 of Page 5, you can see we're in the section referencing
21 open hole applications?

22 A Yes, sir.

1 Q Okay. And you can see that at the top of
2 Page 6 Hurst says, "Of the 80 horizontals, seven were
3 completed with the manifold design, while the remainder
4 was with the eccentric design."

5 Did I read that correctly?

6 A You did.

7 Q Okay. Are you familiar with the manifold
8 design he's referring to?

9 A Well, I'm certainly familiar with manifold
10 designs in concentric applications. If you know where he
11 described manifold inside Hurst, I would be glad to look
12 at it.

13 Q So take a look at Page 3 --

14 A Okay.

15 Q -- on the right-hand side --

16 A Uh-huh.

17 Q -- you can see manifold design on the top
18 right.

19 A Okay.

20 Q And you can see he refers to Figure 6 there.

21 A Right. Right. Okay.

22 Q Okay. So you see that?

1 A Yes.

2 Q Okay. So you can see on the left of Figure 6
3 he refers to shunt tube exit nozzles on two out of the
4 four tubes, correct?

5 A Right. Yes.

6 Q And you can see -- even if you look at his
7 concentric design in Figure 5 there, you're still dealing
8 with a two-by-two arrangement.

9 A Two-by-two, yes, sir.

10 Q And, in fact, if you look at Figure 7, you can
11 see the concentric entrance Y-manifold that he shows
12 there, you can see the arrangement.

13 Do you see that?

14 A Yes, I do. Okay.

15 Q So in all cases we're still referring to
16 rectangular tubes, correct?

17 A It -- yes, in these figures, correct.

18 Q Okay.

19 A Right. You're manifolding the transport tubes,
20 right. Okay. I recall this now.

21 Q Okay. So if you take a look at Page 9, the
22 middle of the page below the numbered paragraphs says,

1 "Another issue."

2 Do you see that?

3 A Yes, I do.

4 Q "Another issue that must be kept in mind in
5 alternate path gravel packing treatments is the burst
6 pressure limit of the shunt tubes, which is 5000 psi."

7 Did I read that correctly?

8 A Yes, you did.

9 Q So Hurst describes the burst pressure rating of
10 rectangular tubes as 5000 psi, correct?

11 A Perhaps. I'll want to read back through Hurst
12 to make sure that that's true in all cases, but perhaps.

13 Q I'll refer you to Page 2 where he says,
14 "Introduction of larger tubes."

15 A Right.

16 Q And you can see the -- where he refers in the
17 first paragraph there to the original shunt tube design
18 with half by one-inch external dimensions?

19 A Uh-huh. Yes.

20 Q And he says, "Similarly," in the next
21 paragraph, "long open hole horizontal gravel packs may
22 limit the pump rates due to increased frictional pressure

1 losses. In both cases, the limitation is the burst
2 pressure of the shunt tubes, which is currently 5000
3 psi."

4 Do you see that?

5 A Yes. I agree with that.

6 Q And in the next paragraph he again refers to
7 larger but still rectangular tubes, correct?

8 A Yes, he does.

9 Q So you would agree that he's disclosing that
10 the burst pressure of rectangular tubes is 5000 psi?

11 A Right. In that section I agree with that.

12 MR. WILSON: That's it. I don't have any
13 further questions.

14 MR. WALTERS: Can we take a break?

15 MR. WILSON: Sure.

16 THE COURT REPORTER: Off record at
17 1:43 p.m.

18 (Break taken from 1:43 p.m. to 2:00 p.m.)

19 THE COURT REPORTER: We are back on the
20 record at 2:00 p.m.

21 CROSS-EXAMINATION

22 BY MR. WALTERS:

1 Q Welcome back, Dr. Durham.

2 Do you have a petroleum engineering
3 license?

4 A I do.

5 Q And what is a petroleum engineering license?

6 A It allows me to practice petroleum engineering
7 in the state of Oklahoma.

8 Q And who granted that license?

9 A The Oklahoma Board for Professional Engineering
10 and Land Surveyors.

11 Q And do you have to do to get a petroleum
12 engineering license?

13 A I submitted my experience to the board at the
14 time my license granted, and they determined that
15 experience was sufficient for the granting of that
16 license.

17 Q And what experience was that?

18 A Experience in doing petroleum engineering
19 reservoir have calculations, understanding formation
20 pressures, formation porosity, permeability, things that
21 affect oil and gas and production out of the reservoir.

22 Q And does that relate to oil and gas well

1 drilling completion or subsurface production operations?

2 A All three.

3 Q And when did you receive your petroleum
4 engineering license?

5 A It was the late 2000s so probably '6, '7, '8,
6 '9 time frame, somewhere in there, 2007 to 2009 would be
7 my guess.

8 Q And how much experience in oil or gas well and
9 drilling completion and/or subsurface production
10 operations did you have at the time that you received
11 your petroleum engineering license?

12 A Oh five, six, seven years, somewhere around
13 there.

14 Q And since that time, has your experience
15 increased?

16 A It has, certainly.

17 Q How many years of experience do you have today
18 in oil or gas well drilling completion and/or subsurface
19 production operations or in the technical support of such
20 operations?

21 A I've been doing that for about 23 years.

22 Q And we talked about some of the organizations

1 through which you gained some of that experience earlier
2 today. Can you identify some of those organizations?

3 A Sure. Mostly I'm active in the IEEE, petroleum
4 chemical industry committee, which deals with at least
5 production -- or a large amount of my experience there is
6 in subsurface production, and the education of that. We
7 also have drilling and completion information as well, as
8 well as being a member of the Society of Petroleum
9 Engineers and reading the articles, journal articles
10 trying to keep up with the industry in that manner.

11 Q Okay. What about your consulting or work
12 organizations --

13 A Yes. We --

14 Q -- through which -- through which you gained
15 experience in oil or gas well drilling completion and
16 subsurface production operations?

17 A Right. Well, my work experience, I gained
18 experience in drilling completion and production at
19 New Dominion, at the interface with those organizations.
20 With PEDOCS, I've gained additional experience over the
21 past 20-plus years in completion and subsurface
22 production. And then, of course, my work experience

1 directed towards subsurface production, that -- dozens of
2 different companies, dozens of different consulting
3 operations.

4 Q Earlier today you also discussed loosely and
5 unconsolidated formations.

6 Do you recall?

7 A Yes.

8 Q What is -- can you elaborate on what is a loose
9 formation and an unconsolidated formation?

10 A Yes. So a consolidated formation is one where
11 you don't have to worry about any fines intrusion, fines,
12 F-I-N-E-S, intrusion into the wellbore. So it's
13 something that's really not a concern.

14 Then you moved into unconsolidated
15 formations, which is a continuum of places where you have
16 to be concerned about fines intrusion into the well and
17 problems it creates.

18 A loosely consolidated is one that's kind
19 of more towards the less consolidated region versus a
20 firmly or a -- I'm trying to remember the term -- a more
21 consolidated. So unconsolidated is a broad continuum.
22 Loosely consolidated is a subset of that.

1 Q Do -- excuse me. Do sand control techniques
2 differ in loosely consolidated formations versus
3 unconsolidated formations?

4 A Well, loosely consolidated is a type of
5 unconsolidated. If you compare loosely consolidated with
6 completely unconsolidated, where you have no fine -- no
7 clays or binding agents, the individual calculations for
8 each well may change. The size screens or the size
9 gravel or size prepack may change, but the same
10 techniques apply. You would still use sand screens,
11 prepacks, gravel packs to control that formation. It's
12 just the particular application may change a little.

13 Q Did the use of shunt tubes -- strike that.

14 Does the -- do the techniques behind the
15 use of shunt tubes change?

16 A No. It's just your gravel size may be
17 different, so there's some different flow considerations.

18 MR. WALTERS: I don't have any further
19 questions.

20 MR. WILSON: Nothing for me.

21 THE COURT REPORTER: Really quick.

22 Mr. Walters, did you want to receive a rough draft?

1 MR. WALTERS: I don't need a transcript.

2 THE COURT REPORTER: You received

3 realtime.

4 MR. WALTERS: Okay. So you're going to

5 get an order.

6 MR. WALTERS: Okay. I don't need one.

7 THE COURT REPORTER: Off the record.

8 (Discussion off the record at 2:06 p.m.)

9 THE COURT REPORTER: Mr. Walters, I am
10 going to send you a rough draft of the transcript and

11 also the read-and-sign for the witness?

12 MR. WALTERS: Okay.

13 THE COURT REPORTER: Off record at 2:07

14 p.m.

15 (Break taken from 2:07 p.m. to 2:09 p.m.)

16 THE COURT REPORTER: So you need the

17 expedited transcript by when?

18 MR. WILSON: I would say -- it would help
19 to look at the calendar. I would say by -- let's call it
20 a week, May 22nd, five business days.

21 THE COURT REPORTER: And, Mr. Walters, did
22 you want to receive the transcript then as well?

1 MR. WALTERS: No.

2 THE COURT REPORTER: Off record at 2:09

3 p.m.

4 (End of proceedings at 2:09 p.m.)

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1 My Commission Expires:
STATE OF TEXAS)

2 I, Kelly Hassell, RPR, CLR, CSR, in and for the
3 State of Texas, do hereby certify that, pursuant to the
4 agreement hereinbefore set forth, there came before me on
5 the 15th day of May, A.D., 2025, at 8:59 a.m., at the
6 offices of Baker Botts LLP, located at 2001 Ross Avenue,
7 Suite 1100, in the City of Dallas, State of Texas, the
8 following named person, to wit:
9 ROBERT A. DURHAM, PhD, PE, who was by me duly cautioned
10 and sworn to testify the truth, the whole truth and
11 nothing but the truth, of his knowledge touching and
concerning the matters in controversy in this cause; and
that he was thereupon carefully examined upon his oath,
and his examination was reduced to writing under my
supervision; that the deposition is a true record of the
testimony given by the witness, same to be sworn to and
subscribed by said witness before any Notary Public,
pursuant to the agreement of the parties; and that the
amount of time used by each party at the deposition is as
follows:

Mr. Wilson - 3 hours, 35 minutes,

12 Mr. Walters - 9 minutes;

I further certify that I am neither attorney or
counsel for, nor related to or employed by, any of the
parties to the action in which this deposition is taken,
and further that I am not a relative or employee of any
attorney or counsel employed by the parties hereto, or
financially interested in the action.

I further certify that, before completion of the
deposition, the Deponent and/or the Plaintiff/Defendant
did request to review the transcript.

In witness whereof, I have hereunto set my hand and
affixed my seal this 20th day of May, A.D., 2025.

18
19
20
21
22


KELLY HASSELL, CSR No. 5729
Cert. Expires 10/31/26

1 Robert A. Durham, Ph.D., PE, c/o
Baker Botts

2 2001 Ross Avenue, Suite 900
3 Dallas, Texas 75201

Case: Weatherford U.S., L.P. v. Halliburton Energy Services, Inc.

4 Date of deposition: May 15, 2025

Deponent: Robert A. Durham, Ph.D., PE

5

6 Please be advised that the transcript in the above
referenced matter is now complete and ready for signature.

7 The deponent may come to this office to sign the transcript,
8 a copy may be purchased for the witness to review and sign,
9 or the deponent and/or counsel may waive the option of
10 signing. Please advise us of the option selected.

11 Please forward the errata sheet and the original signed
12 signature page to counsel noticing the deposition, noting the
13 applicable time period allowed for such by the governing
14 Rules of Procedure. If you have any questions, please do
15 not hesitate to call our office at (202)-232-0646.

16

17

18 Sincerely,

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4 SIGNATURE PAGE

Case: Weatherford U.S., L.P. v. Halliburton Energy Services, Inc.

5 Witness Name: Robert A. Durham, Ph.D., PE

Deposition Date: May 15, 2025

6

I do hereby acknowledge that I have read
7 and examined the foregoing pages
of the transcript of my deposition and that:

8

9 (Check appropriate box):

() The same is a true, correct and
10 complete transcription of the answers given by
me to the questions therein recorded.

11 () Except for the changes noted in the
attached Errata Sheet, the same is a true,
12 correct and complete transcription of the
13 answers given by me to the questions therein
14 recorded.

15

16

17 _____
DATE

WITNESS SIGNATURE

18

19

20

21

22 _____
DATE

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6 ERRATA SHEET
7

8 Case: Weatherford U.S., L.P. v. Halliburton Energy Services, Inc.
9 Witness Name: Robert A. Durham, Ph.D., PE
10 Deposition Date: May 15, 2025

11	Page No.	Line No.	Change
12	31	14	energy to integer
13	33	7-8	bay to sand
14	34	3	finds to fines
15	37	10	different to difficult
16	41	13	Standard to Standards
17	67	10	than to in
18	76	4	nonconcentric to concentric
19	120	10	expressed to experienced
20	123	20	this to these
21	125	6	this to these
22	154	19	delete "have"



2025-05-26

Signature

Date

Errata 1

Final Audit Report

2025-05-27

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A				
A-L-L-A-N 4:21	additionally 30:15 36:20	allowing 85:19	applicability 124:10	151:8,12
A.D 1:14 161:3	57:9	148:19	applicable 105:4	arrow 140:8,9
161:17	address 43:19	allows 154:6	105:9 162:13	arrows 112:3,10
a.m 1:14 4:3 40:6	addressed 44:9	alternate 49:4	applicant 49:18	art 39:9 50:4
40:7,7,9 71:8,9	adjusting 85:7	133:8 152:5	50:3	64:12 65:16
71:11 107:16	138:15,16	Amend 7:12	application 115:5	79:22 80:20
107:17 161:3	Administration 15:13	amended 49:19	117:14 158:12	81:21 82:6,13
A3C 121:2,11	advantage 56:12	amount 55:21	applications 77:2	83:2 85:6 91:15
A554-16 105:3,9	148:18	72:18 93:3,7,20	105:5 149:21	92:20 94:4 96:4
105:14 106:6	advantages 149:5	115:17 127:6	150:10	96:5,10 104:6
106:19	advisable 122:10	156:5 161:10	applied 69:5	118:22 122:22
abandoned 31:10	advise 162:10	analyses 115:19	72:11 76:15	123:8 130:10
able 53:13,19	advised 162:6	116:17	120:1 121:11	131:9,21
123:3 124:14	affect 34:16 93:3	analysis 24:12,16	134:8	132:14 134:13
above-styled 1:13	93:5,6,7 154:21	24:20,21,22	apply 122:15	134:19 135:2
absent 162:21	affiliations 40:16	25:3,7,9,15,16	158:10	138:9,21
abstract 108:13	40:18	25:22 30:18	approach 73:2	139:16 144:12
108:14	affixed 161:17	39:7 68:3,3	approaching 149:10	149:4
accommodate 53:13,20	agents 158:7	69:4	appropriate 34:2	article 108:5
accomplished 21:19	aggregate 9:19	analyzed 30:17	63:4 163:9	articles 156:9,9
account 99:8	agree 47:6 51:19	and/or 155:9,18	approximately 130:21 143:12	artisan 100:21
accurate 99:13	57:6 63:15 67:4	161:16 162:9	archive 23:13	101:2 138:12
accurately 5:11	67:19 68:6 82:3	angle 56:2	area 86:22 87:1,7	aside 125:7
achieved 84:9	92:19 93:21	annular 79:12	87:19,22 95:5	asked 117:6
achieves 84:19	94:5 99:2,14	94:12	97:18 98:1,3,6	asking 23:2
acid 32:13,14	116:13,16,22	annulus 57:10,12	98:8,8,15,16,20	aspects 13:8
acknowledge 163:6	121:21 123:13	57:19 58:3	98:21,22 99:2,4	41:18
acquire 81:17	128:4 129:16	answer 29:12	99:5,6,7,9	assembled 109:14,17
Acquisitions 17:19	131:8,20	59:3 87:10	100:4,5 101:6	assemblies 49:21
acronym 28:20	132:12,18	121:18 122:21	101:10,14	50:6,10 59:9
action 161:13,15	138:3,6,8,12,18	answers 163:10	110:9,12,15,18	assembly 6:13,14
active 156:3	138:19,20	163:13	111:14,18	47:7,9 59:17
activities 32:9	139:9,15,20,21	anybody 10:10	115:17 116:6	62:7,10,12
add 94:22	139:22 140:1	anymore 14:19	117:3,4 119:3,4	71:17,18 89:4
addition 37:10	140:15,20	22:8	132:15 138:16	105:11 112:22
additional 7:1	147:6 148:12	Anyway 126:11	143:10	113:3
9:3,13,16 16:22	153:5,9,11	API 42:12,12,14	areas 25:14	asserted 50:4
19:2,12 30:16	agreed 103:12	42:15 73:9	86:19 115:19	Asset 17:19
30:20 35:12,16	agreement 1:19	apologize 102:15	116:18	associated 91:12
58:22 127:11	161:3,10	apparatus 123:22	argued 49:18	91:18,19,22
145:5 156:20	ahead 47:20	appears 5:19	arguing 49:19	92:2,3 144:15
	al 135:9	7:14 8:18 78:2	Armond 2:4 4:5	assume 59:4,5,10
	Allan 4:21		arrangement 95:3 149:16	98:10
	allow 122:11			assumed 97:20
	allowed 162:13			assuming 59:11
				59:11,13 66:21

67:14 92:18 95:16 ASTM 105:3,9 105:14 106:6 106:18 atmospheric 77:14 attached 163:11 attempt 68:1 attorney 161:12 161:14 Aus- 45:9 Austin 45:1,6,9 45:16,20 46:6,7 46:11,21 authored 132:22 authors 108:5 available 49:2 96:21 127:12 Avenue 1:17 2:14 161:4 162:2 aware 5:7 39:19 awful 13:20 23:2 29:14 42:7 59:2 89:6 103:19 axis 52:4 78:11 78:14,18,18 119:17,17 121:5,6 128:1,5 axis-offset 53:11	154:1 back-and-forth 37:14 background 28:6 29:7,9 backgrounds 20:13 27:22 28:2 backwards 6:15 48:22 146:13 Baker 1:16 2:13 4:7 10:6,8 161:4 162:1 barrel 31:13,14 129:8 barrels 32:2 78:19 128:2 129:6 130:3 base 62:10 89:17 90:7 94:12 95:2 95:16 143:17 148:19,20 based 34:3,15 60:3 79:22 81:21 82:14 83:3 86:17 96:4 96:10 123:15 144:22 145:3 basic 13:10 148:12 basis 46:10 114:21 115:1,2 bay 33:7,8 Beach 2:7 beginning 1:14 80:3 begins 83:13,21 130:18 133:17 133:21 141:5 144:22 behalf 37:12 believe 14:13 67:10 70:4 73:12 96:6 believed 86:4,10 bending 64:2,8 beneficial 144:6	144:8 benefit 84:19,21 84:22 benefits 34:18 85:7 best 91:8 better 21:11 45:8 46:15,20 115:12 beyond 123:17 bigger 136:12 138:1 142:10 147:1,3,5 bill 26:13 binding 158:7 bit 58:20 99:12 103:17 blockage 113:21 114:5 blocked 113:8,12 114:11 136:12 blue 79:6,10 119:18,22 board 1:1 154:9 154:13 bold 146:18 bolded 146:22 bolding 147:10 147:11,21 Bonner 108:6 109:11 112:1 114:22 115:1,9 116:4,13,16 118:13,17 119:9 120:17 122:2,3,8,18 125:7 Bonner's 109:6 112:5 114:12 119:1,19 121:4 121:7 122:16 123:8,16 124:5 124:8,13 bore 48:11 52:13 52:15 53:15,21 bottom 10:19 19:16 44:13	56:14,22 59:16 68:20 82:4 87:14 95:18 107:1 112:6 125:21 136:21 137:3,7,16 149:19 Botts 1:16 2:13 4:7 10:6,8 161:4 162:1 box 110:1,1,4,7,8 110:22 111:3,8 112:22 113:13 114:2,7,15,17 163:9 branched 113:9 break 40:4,7 70:17 71:1,9 107:13,17 153:14,18 159:15 breaks 63:8 broad 24:22 56:2 63:19 157:21 building 22:3,3 bulk 20:20 bulky 109:16 bullet 128:11,13 129:5 131:5,15 burst 64:2,8 72:13,14,16,21 73:1,2,4,17 74:1 75:1,2,8,9 76:20 77:2,4,6 77:9,17,17 93:21 100:22 101:3 103:5,11 104:2,7 122:4 122:10,20 124:6 143:4 152:5,9 153:1 153:10 business 15:13 22:13,16 159:20	140:1,9,17 c/o 162:1 cable 43:7,8,9 calculated 99:15 calculation 99:19 102:5,8 calculations 34:11,14,15 35:3,5 97:10,13 97:16,19 99:20 99:22 154:19 158:7 calendar 159:19 California 2:7 call 31:5 159:19 162:15 called 126:17 capability 109:13 capable 60:18 76:4 capacities 30:3 capacity 30:2 35:6 66:3 67:16 68:8 carefully 161:7 case 1:3 9:18 38:17 39:1,4,6 39:10 44:10,13 44:17 87:6 125:18 140:1,9 140:17 162:3 163:4 164:8 cases 38:15 39:17 46:21 66:20 143:3 146:1 151:15 152:12 153:1 casing 127:4 catalogue 34:1 categories 148:15 cause 1:13 84:13 161:7 cautioned 4:13 161:5 center 50:19,20 52:3,13,14 56:15 57:1
B B 51:2 119:12,15 120:1 Bachelor 12:12 12:18 14:2,7 bachelor's 15:22 16:21 17:1,4,7 29:13 back 15:4 20:22 23:2 31:11,12 37:20 39:16 48:14 56:19 63:20,21 71:10 81:20 88:7 94:4 116:11 121:18 131:4 142:17 152:11 153:19				
				C C 2:1,12 4:1 51:2

103:2,17,22 central 4:3 45:1 48:11 Cert 161:22 certain 43:19 64:3,7,10 79:4 79:4 115:9,18 certainly 14:19 14:20 22:18 32:14 58:5,6 75:13 88:5 118:17 132:12 144:8 149:8 150:9 155:16 certify 161:2,12 161:15 cetera 21:14 125:1 Chad 2:12 4:7 chad.walters@... 2:18 chair 26:5 41:11 chalk 45:1,6,13 45:14,16,21 46:7,7,11,21 Chambers 100:2 105:3,13 106:6 106:18 Chambers' 97:10 99:19 100:9 101:18 105:18 105:21 135:15 change 54:2,13 54:21 55:12,16 55:22 66:10,12 66:13,14 75:7 92:10,20 95:11 95:17 102:16 117:22 139:6 144:6 158:8,9 158:12,15 164:11 changed 22:1 92:14 103:4,6 changes 66:12,13 102:17 163:11 changing 49:20	50:5,9 94:22 96:8 116:13 channel 48:2,2,5 48:12 49:4 characteristic 118:19 characteristics 49:20 50:5,10 60:8 118:7 138:15 characterization 119:1 chart 101:11 Check 163:9 chemical 13:20 28:5 41:10 156:4 Chernicky 37:12 choice 115:17 choose 63:2 circumstances 92:6,7 citations 89:6 cite 85:22 89:4 105:22 cited 10:20,21 11:17,17 City 161:4 Civil 1:18 Claim 6:12 claims 49:19 clamshell 109:16 clarification 103:1 class 16:15,16,16 16:20 classified 45:8 clays 158:7 clear 84:8 126:2 clearly 9:13 close 85:18 closely 39:11 closer 80:11 99:3 CLR 1:15 161:2 collapse 35:10 64:2,9 74:22 76:19 77:5,10	77:13 collapsed 72:22 74:13,15 75:9 College 15:13,14 colored 112:19 column 47:19 49:1,3 52:7,9 53:6 54:7,16 56:4,14,14,22 56:22 57:8,8 60:17 63:20,21 63:22 75:18,22 85:22 86:3 126:13 130:16 135:17 136:6 137:22 com- 32:8 combination 47:9 49:20 50:4 combine 51:19 combined 145:4 combining 56:15 57:1 come 25:6 162:7 commercial 60:20,22 76:5 Commission 161:1 committee 41:10 156:4 common 62:17 115:11 commonly 145:6 companies 42:16 157:2 company 23:22 24:1 28:16 33:14 108:16 compar- 139:5 compare 140:12 158:5 compared 60:19 75:6 76:5 91:5 91:6 136:22 139:4,5 149:1 compares 52:13 100:10	comparing 140:13 comparison 140:12 complement 137:10 complete 11:9,21 14:6,9,21 15:8 16:6,10,13 17:3 17:6,14 40:15 41:5 162:6 163:10,12 completed 12:16 14:14 150:3 completely 158:6 completion 17:8 18:10,14,17 26:8,21 29:21 30:8,19 32:4 37:11 41:8,12 41:14,19 42:22 57:15 58:13 86:6,7 125:14 144:11 155:1,9 155:18 156:7 156:15,18,21 161:15 completions 14:10 41:18 133:8 143:20 complex 25:6 component 109:16 components 25:18 109:13 composition 134:7 compression 71:18 109:13 comprises 42:7 72:20 concentrating 21:4 concentration 78:19 79:2,15 103:15 134:7 142:2,5	concentrations 67:9 concentric 47:12 48:1,5,11,15 56:15 57:2 58:16 59:9,13 59:15 60:1,18 61:6 62:7 63:7 63:17 65:13 76:2 86:15 89:16 90:5,13 90:14,16,21 91:2,7 94:10 95:1,3 96:8,20 148:9,14 149:6 150:10 151:7 151:11 concept 10:4 concepts 13:3,10 13:11,15,18,21 concern 157:13 concerned 157:16 concerning 161:7 conclusion 74:19 123:19 140:6 condition 74:9 79:13,16 80:7 130:7 conditions 128:9 132:16 conduits 136:11 confident 7:6 8:3 confidentiality 70:1 configuration 61:4 68:5 71:19 75:7 77:8 86:13 89:18 104:2 123:14 124:21 configurations 66:14 79:5 124:9 confirmation 145:5 conflating 26:10 conjunction
--	---	--	---	---

15:14 connect 51:13 123:4 connected 51:17 109:22 111:15 111:19 114:19 connecting 123:1 connection 109:15 113:9 connections 115:10 connectors 114:15,18 connects 110:13 110:16 112:16 112:21 connotation 21:22 consent 162:22 consider 85:11 consideration 65:21 98:3,3 99:7 144:20 considerations 53:12 63:13 64:18 72:21,22 75:2 76:21 77:17 79:4 87:3 158:17 considered 11:10 11:22 32:1,2 74:6 consistent 88:5 91:4 135:4 consolidated 36:13 45:9,10 45:14 46:2,16 46:22 157:10 157:18,19,21 157:22 158:2,4 158:5 constrained 84:4 consult 30:11 consulted 30:15 consulting 24:11 30:14 38:11,16 39:17,21	156:11 157:2 contain 65:14,18 72:19 123:3,5 containing 81:5 containment 35:6,9 66:3 67:15 68:8 content 34:19 Contingent 7:12 continued 30:11 continuing 16:4 16:16 19:16 continuously 30:7 continuum 157:15,21 contract 20:3,19 contractor 28:8 contractors 27:20 control 13:13 14:1 26:10 28:7 33:2 34:22 35:1 36:12,17,21 37:3,16 38:4 44:6 45:16,17 127:6 133:8 158:1,11 controlled 134:5 134:8,15,21 controversy 161:7 conventional 80:1,9 91:11 123:11 conversions 21:6 conveyor 9:22 copy 5:17 8:9 162:8 Copying 162:21 Copyright 162:20 corner 103:16,17 126:13 corners 103:16 Corp 20:4,19 Corporation 9:1	19:20 24:5 Corr- 113:17 correct 4:22 5:18 6:1 7:13,16,18 8:10 11:7 12:4 12:10,14 15:6 15:13 17:12 19:17,21 24:5 24:13 28:13,17 35:14 38:6 42:11,14,19 44:11,15 46:14 47:11,17 48:3,7 48:12,16,20 49:10,15,16 50:7,11,17,22 51:3,7,10,11,14 51:18,22 52:5 52:18 53:4,8,9 53:21 54:4,18 55:1,6,8,13,20 56:7,11,12,17 57:3,21 58:4,9 58:13,18 60:20 60:21 61:2,9,13 61:20 63:1,12 63:18 64:10,16 65:1,10,14,19 66:5 67:2,17 68:11 70:9 71:20 72:5 73:18 74:2,10 74:11 76:10,17 77:7 78:1,2,5,9 78:12,16,20 79:3,7,12,13,15 79:16,18,19 80:5,8,13,15 81:5,6 82:1,9 82:15 83:6,18 84:14,20 85:9 85:10 86:1,10 86:11 88:1,3,17 89:5,6 90:9,19 91:3,17,21 92:5 93:1,5,22 94:4 94:13 96:9,11	97:4,11,16,20 98:4,5,6,18 100:12,13,18 100:19,22 101:6,22 102:3 102:4,5,6,19 103:3,4 104:10 105:7,12,16 106:19 107:6 108:3,11 109:8 110:2,3,5,6,10 110:13,14,16 110:17,20 111:4,5,9,12,16 111:20 112:6,7 112:11,14,17 112:19,20 113:1,5,6,9,16 113:19 114:2,9 114:11,15,16 114:19 115:6 116:7,14 117:20 118:3 118:15 119:5 119:12,20,21 120:1,3,9 121:2 121:8,9,12,15 121:16 123:4 123:12,18 124:6,8 125:15 125:18 126:1,7 127:15,21 128:2,6,9,10,14 128:15,16,18 128:21 129:2,6 129:9,15,16 130:3,8,12 131:6,17 132:2 132:11,17 133:5,9,11 134:16,22 135:5,12,15,16 136:18,19 137:1,2,5,9,19 138:2,17 139:2 139:13,19 140:4,10,19	142:7 144:6,16 145:14 146:8 146:22 147:4,8 148:4,14,15,16 149:7,16,17 151:4,16,17 152:10 153:7 163:9,12 corrected 6:7 9:11 correctly 11:1,19 21:7 36:14 37:1 38:13 45:4 49:7 50:1 52:16 53:1 53:16 57:16 64:5 69:9 70:2 72:6 76:7 81:18 84:10 85:20 86:8 90:1 95:7 95:15 96:22 100:7 108:19 109:4,18 115:7 115:13 116:2 120:20 122:6 122:13 131:2 134:11 136:15 141:11 143:6 143:14 144:1 145:8 149:2 150:5 152:7 corrosion 105:6 costly 96:21 counsel 4:3 161:13,14 162:9,12 couple 33:6 104:13,15 143:21 course 13:3,4,5,9 14:14 15:1,1,21 16:4 21:14 25:13 28:5 41:9 71:2 135:6 143:16 156:22 courses 12:20 13:1 14:4,9,21 15:17,19 18:17
---	---	--	--	--

coursework 14:6 16:7,10,13,22 17:3,6,9 18:16 19:11 Court 2:5 4:2,10 18:5 23:20 26:14 40:5,8 71:7,10 107:15 107:19 148:6 153:16,19 158:21 159:2,7 159:9,13,16,21 160:2 covered 13:3,9 covering 109:15 covers 28:10 create 56:16 57:2 100:3 created 103:22 creates 157:17 credit 16:17 Cross-Examin... 3:3 153:21 cross-sectional 86:19,22 87:1,7 87:19,21 95:5 97:18 98:1,6,8 98:8,15,16,20 98:21,22 99:2,4 99:6,7 100:3,5 101:6,10,13 110:9,12,15,18 111:14,18 116:6 117:3,4 119:3,4 132:15 138:16 crossover 50:15 51:2,6 52:14 53:11,13,18 54:2,3,11,12,17 54:21,22 55:7 55:11 56:7,11 57:11 58:4,6,17 59:12,14,20 60:5 61:7,8,12 61:20 62:10,11 62:14 63:10	64:15 84:15 110:1,1,4,7,8 110:22 111:3,8 111:8,11,14,19 112:14,16,22 113:13 114:2,8 CSA 87:15,17,18 97:20,21 CSAs 88:6 CSR 1:15 161:2 161:21 cubic 97:17,19,22 98:2,7,17 99:1 99:15 current 8:15 40:15 currently 20:1 28:18 29:15 143:5 153:2 curriculum 14:18 curvature 53:11 54:8,9,14 55:13 55:19 56:5 curve 56:2,3 131:6 curved 52:22 53:3,19,22 56:11 CV 8:9 cylinder 98:10,12 98:13 D D 3:1 4:1 D.C 1:21 163:2 164:3 D2 8:22 19:19 20:2,6,8,17 21:2 22:12,12 22:16 23:16,17 30:22 Dallas 1:17 2:16 161:4 162:2 darker 119:22 dashed 79:17 119:18 121:6 data 78:7 79:22	119:11 121:1 122:20 123:20 124:4 125:6 date 8:16 133:9 133:11 162:4 163:5,17,22 164:10,22 dated 6:1 7:18 49:18 Dave 37:12 day 1:14 32:2 38:21 161:3,17 days 26:11,15 159:20 deal 43:9 dealing 151:7 deals 156:4 decide 98:13 Deciding 34:1 decks 22:9 declaration 6:3 7:11 10:22 11:18 49:13 68:16 96:15 97:7,11 101:18 104:21 105:19 105:22 106:1 135:15 139:11 139:13 140:22 declarations 5:18 125:18 decrease 104:3 115:17 141:19 141:22 142:8 144:14 decreased 139:17 defendant 38:21 definitely 140:12 deformation 120:11 deformed 121:21 degree 12:12,19 14:3 15:8,11,17 16:8,19,21 17:1 17:4,7,15 degreed 16:16 degrees 12:9	29:15 dehydrate 141:15 142:12 delivering 134:6 demise 30:12 demonstrates 101:20 depend 21:18 75:2 82:19 depending 27:18 61:4 75:5 76:20 103:19 depends 46:1,4 77:1,4,15 86:13 depicted 112:9 depicts 136:17 deponent 161:16 162:4,7,9 deposed 4:22 deposition 1:6,11 6:4 7:21 8:13 9:16 71:1 161:8 161:10,13,16 162:4,12 163:5 163:7 164:10 depositions 5:5 9:14 depth 34:4 127:5 describe 21:11 24:18 92:11 described 46:15 59:13 61:10 63:6 64:14 112:6 150:11 describes 47:14 48:8 52:9 57:22 120:11 126:16 135:19 152:9 describing 58:12 144:3,5 149:15 design 23:9 24:12 24:15,19,21 25:2,7,10,11,12 25:13,21 33:17 35:18 73:8,14 73:14 84:7 89:21 90:12,13	90:14,16 91:7 109:3 114:21 115:1,2,10,12 115:18 119:19 121:8 125:4 133:15 143:11 145:4 148:10 148:19,21 150:3,4,8,17 151:7 152:17 designed 22:19 22:21,22 23:1,9 23:15 24:2 26:8 26:22 108:22 designer 63:14 74:4 93:13 designing 22:13 38:4 designs 24:19 73:13 75:10 76:20 85:17 86:20 88:16 89:2,16 90:5,18 90:21 91:2 95:22 96:7,8 115:4,22 116:20 150:10 destination 139:8 determine 37:21 68:3 determined 115:11 154:14 detriments 85:7 developed 108:16 Development 125:13 device 34:22 35:1 37:17 74:4,7 devices 33:2 34:2 36:12,17,21 37:3 38:4 44:6 diameter 56:6,9 66:11,13 95:11 102:1,11,12 134:9,10,16 135:3 141:10 143:17
---	--	---	---	---

diameters 145:6 dictated 134:3 differ 158:2 difference 73:17 different 25:14 25:17 26:6 33:6 34:6,6 37:10 52:15 60:9 67:9 74:13 93:18 100:4,5 118:20 128:9 157:2,2 158:17,17 differential 57:9 57:13,18 58:2,7 60:4 62:13 72:11 74:11,21 74:21 77:13 79:10 81:4 139:2,8,16 140:2,16,18 dig 23:13 142:17 Digital 1:20 162:19,20 163:1 164:1 dimension 101:4 dimensional 66:16 dimensions 92:13 101:15,15 104:9 134:9 143:8 144:4 152:18 direct 3:2 4:16 69:4 92:1 94:16 132:5,6 directed 50:14 157:1 direction 54:3,13 54:22 55:12,17 55:22 84:6 101:5 103:2 112:4,9 directly 14:5,8 37:18 43:18 66:4,19 67:1,20 68:8 99:4,6 131:10	disadvantage 148:21 disadvantages 149:6 disagree 55:2,3 61:22 67:5 76:11 97:15 98:19 101:8 107:8 116:8,9 131:7 145:16 145:17 disagreed 97:17 disagreements 99:18 discloses 47:6 48:9,15,18 disclosing 83:16 153:9 disclosures 123:9 discuss 18:10 70:22 144:10 discussed 92:1 95:19 97:5 100:20 157:4 discusses 48:1 73:12 108:14 discussing 49:14 Discussion 159:8 displacement 62:15 dissertation 17:22 18:2,9 distance 34:4,5 55:22 117:15 distributed 127:8 District 38:17 diverted 113:14 134:4 divesting 24:2 divided 98:4 102:7 doctors 29:1 document 108:2 135:11 doing 32:9 154:18 155:21 Dominion 30:4,9	30:12 36:21 37:4,7,9 38:5 156:19 doug.wilson@a... 2:9 Douglas 2:3 4:5 downhole 23:16 24:3 25:22 26:5 26:22 34:21 35:2,11 42:10 43:6,8,9 56:10 62:9,12 124:1 downstream 6:12 25:5 80:11 96:17 113:8 114:1,7,14,19 downward 129:20 dozen 36:8 43:10 dozens 30:18 157:1,2 Dr 4:18,21 7:11 40:10 71:12 107:21 154:1 draft 158:22 159:10 draw 123:19 125:6 128:3 140:6,11 147:9 draws 23:4 drill 43:3,11 drilled 31:9,11 31:18 drilling 14:7 17:7 18:10,13,18 26:9,21,21 29:20 30:7,18 31:16 37:12 41:8,12,13,18 41:19 42:8,22 43:5,7 155:1,9 155:18 156:7 156:15,18 drive 56:2 127:12 driving 56:3 139:17 140:16 140:18	drop 95:12 119:5 130:11 131:11 132:1,10 143:22 dropped 28:19 drops 134:5 due 56:15 57:1 89:18 109:14 143:2 152:22 duly 4:9,13 161:5 duplicate 97:19 99:20,22 124:22 duplicated 101:12 Durham 1:7,11 4:12,18,21 7:11 40:10 71:12 107:21 154:1 161:5 162:1,4 163:5 164:9 Dutcher 32:21 dynamics 13:4 13:15 14:15,16 17:2	75:5 76:5 80:1 80:11 81:14,16 81:22 82:6,13 83:4 85:17 86:5 86:14,18,20 87:22 88:12,13 88:16 89:2,21 90:12,18,22 95:2,22 96:7,18 97:3 102:21 109:3,7 114:12 123:16 148:10 148:14,18,21 149:6,16 150:4 ed 16:4,16 education 156:6 eductor 23:3,3 eductor-type 23:7 eductors 23:8 effect 101:4 effective 71:17 eight 27:17,21 eighth 44:13 either 26:22 59:1 70:14 74:12 127:4 143:19 147:7,19 elaborate 157:8 electric 9:9 17:21 30:5 43:3,4 electrical 12:13 12:19 13:12 14:3,17 19:10 20:16 21:5,10 21:12,17 25:13 26:4 28:4 29:13 42:3,5,9 electronically 162:21 electrons 21:18 21:19 element 23:3 104:4 email 69:22 embodiments 60:10,12 61:10
---	---	---	--	--

emergency-type 62:20	125:14 126:14 126:17,21	example 9:22 25:8 43:22	125:9,9,22 126:16 132:21	120:10
empirical 115:4	127:2,3	46:19 57:12	132:22 135:8	extend 86:6
employ 27:11	environment 17:21 25:19	58:18 60:10,18	139:11 140:22	extended 9:1
employed 20:1,2 36:21 161:13	69:7 82:20	62:8,10 66:10	142:15	19:20
161:14	Environments 43:2	66:14 74:5 76:3	exhibits 3:8 8:6	Extensive 109:11
employee 30:4 161:14	equal 58:10	77:11 79:5,19	10:5,11,14,21	extent 16:18
employees 27:14 27:21	68:10 101:1	80:21 81:1,6	11:5,7,11,17,22	43:14
employer 24:4	103:11,13	82:10 90:12	12:4	external 72:21
energy 1:4 21:5	132:19	93:11,15 98:9	exist 58:7,8 67:12	74:12 143:9
24:11 31:14	equipment 22:9	98:20 100:9	existing 115:3	152:18
162:3 163:4	34:21 35:2	101:19 103:10	exit 112:5 151:3	
164:8	41:20,21 42:2,3	103:13 114:13	expand 58:20	F
engagement 38:11	42:5,5,8,9 44:1	125:1 141:5,7	expect 60:5	F-I-N-E-S 157:12
engineer 29:10	109:12	148:20	expected 54:11	fabricated 123:10
engineering 12:13,19,21	erosion 112:5	examples 23:8,12	57:13 123:11	facilities 23:1
13:3,9,11,20,21	113:7	45:2 60:11 91:5	expedited 159:17	24:12,16,19
13:21 14:3,4,18	errata 162:11	excavation 142:17	expense 84:18	25:1,5 30:16
15:5,11,15,17	163:11 164:6	exceed 74:14	143:17 144:4	41:14
15:17,19,20	error 6:20	96:7	expensive 81:17	fact 39:12 64:20
16:7,8,11,11	errors 8:1 57:17	exceeded 121:22	experience 45:15	67:20 70:12
17:10 18:1 19:3	ESP-type 26:7	exceeds 72:16	120:12 154:13	82:3 99:5
19:7,9 20:15,16	ESQ 2:3,12	74:10 75:1,8	154:15,17,18	102:21 103:6
20:18 22:5	essentially 56:13	77:6	155:8,14,17	122:9 126:10
24:11 28:4,4,5	62:12 72:22	exchange 144:15	156:1,5,15,17	151:10
28:5,6 34:11,14	115:21 116:19	excuse 158:1	156:18,20,22	factor 73:6,10,14
108:16 154:2,5	117:9,11,19,20	exhaust 105:5	experienced 120:4,8 121:14	73:18,20 74:2
154:6,9,12,18	119:4 127:10	Exhibit 5:15,17	121:19	75:3 118:19
155:4,11	et 21:14 125:1	7:7,10,10,20	experiences 36:17	122:9,15
engineers 22:6	135:9	8:4,8,9,12,15	experiments 145:5	factors 66:17
40:20 41:9	evenly 127:8	9:12 10:16	Expires 161:1,22	73:8,13 74:6
156:9	evidence 1:20	11:11,13 12:1,6	explain 50:14	82:19 85:11
English 91:7	115:4 162:19	15:4 17:17,17	88:11	118:16 132:4
enhance 108:17	162:20 163:1	19:15 21:1 24:8	explained 120:17	Faculty 17:22
enjoy 115:4	164:1	36:9 40:11	explaining 55:18	failed 121:21
enlarging 84:12	exact 38:18 65:22	42:17,18 44:8	56:13	failing 120:9
ensure 109:11	exactly 13:5	44:19 47:4,16	explains 53:18	121:15
entire 142:7	15:18 26:3	47:16 49:13	54:1,20 55:10	failure 24:12,15
entitled 17:18	51:15 98:17	68:16 69:6,11	56:4,9	24:20,21,21
133:14	102:10,11	69:14,15,21	exploration 31:3	25:2,7,9,15,16
entrance 151:11	125:4	70:12 71:13	explosions 25:10	25:21 30:17
entry 18:1	examination 3:2	77:19,21 78:4	express 94:9	failures 120:18
	4:16 161:8	81:7 83:9 85:13	162:22	Fair 130:5
	examined 161:7	88:8 105:14,21	expressed 7:6 8:4	false 70:5
	163:7	106:2,5,5,10		familiar 5:4
		107:2,5,9,22		36:20 38:1,6
				46:6 73:8 74:15
				78:5 125:19

126:21 150:7,9 familiarize 68:19 far 80:16 110:5 111:11 140:8 140:13 faster 142:13 Federal 1:18 feed 43:8 feet 54:3,22 55:8 60:19,19 61:1,3 61:8 72:5 76:5 76:5 78:8,15,16 79:3 80:4,13 82:8 83:5 88:12 89:8,8 96:11 97:19 123:18 124:19 FEM 68:3 104:3 104:4 fewer 87:4 field 29:11 30:6 37:9,15,18,19 figure 23:14 49:2 49:9 51:1,5 52:2,9,18,21 53:4,15,21 54:9 54:10,11,12 55:5,7,11 78:4 78:7,22 80:1 101:17 103:1 109:21 110:5,7 110:19 111:6 111:12,22 112:3,10 119:8 119:11,13,14 119:16 120:13 120:22 121:1,4 121:4,17 122:1 127:16,20 128:8 130:18 130:20 131:4 135:5,19 136:2 136:2,5,17,20 137:8,17 139:13 140:2,7 140:17 146:20 149:14,17	150:20 151:2,7 151:10 figures 51:2 109:20 146:18 151:17 filed 96:6 files 23:13 financially 161:15 find 6:6,8 8:1 97:15 finds 34:3 fine 46:8,11,18 158:6 finer 146:4,5,9 fines 45:11,11,21 46:4 157:11,11 157:16 finite 104:4 fire 28:7,7 firm 20:18 21:4 24:11 firmly 157:20 first 4:13 6:13,15 6:17,18,18 12:12 21:1 27:6 50:14,20 51:13 51:17 71:14 89:14 91:10 114:22 115:9 120:14 122:3 136:12 138:2 140:12,18 142:9 152:17 Fischer 69:20,21 70:9 fit 84:4 five 15:9 155:12 159:20 five-eights 146:1 flexibility 60:15 flip 49:1 flow 21:18 22:22 23:4,5 34:3,16 34:17,17 35:1 48:1,2,5,11 49:4 50:16,19	50:21 51:6,9,12 51:13,16,17 52:3,4 53:12,19 55:20 56:6,16 57:2,10,19 58:3 60:8 61:19 62:13 63:10,16 64:3,9,15 65:9 65:18 79:13,18 80:7 83:17,18 84:5,12,13,18 84:19 85:8 95:11 101:6 112:4,9 113:21 114:6 115:17 115:19 116:18 118:7,10,11,19 119:5 127:11 127:12,20 128:1,8 129:4 129:17 130:2,6 130:11 131:10 131:22 132:10 132:15 134:14 134:20 136:11 136:13 138:1 138:14 139:1 140:16,18 143:10 144:4,5 144:7,8,13,14 158:17 flowing 61:18 113:12,14,15 128:15,18,20 129:2 flows 114:13 fluid 13:4,14 14:14,16 16:20 16:22 17:2 19:12 23:4 50:15 127:7 130:22 134:7 141:15 142:12 fluidly 51:12,17 114:18 fluids 45:22 focus 43:20 52:8	69:17 72:1 83:21 85:13 131:4 focused 68:18,19 folks 37:11,12 follow 54:7 65:3 followed 58:16 58:17 61:6 63:7 following 112:8 161:5 follows 4:15 161:11 foot 55:4 83:7 87:2,4 97:17,22 98:2,7,17,21 Footnote 75:17 83:13 104:22 105:2 forbidden 162:21 force 139:17 foregoing 163:7 Fork 32:20 45:2 46:21,22 47:1 form 55:14 56:18 57:5 61:21 63:11 64:17 65:2,20 66:6 67:3,18 68:13 80:6,14 82:2,16 101:7 113:18 131:13,18 139:3 140:5 145:15 formal 17:9 formation 32:18 34:4 45:7,10,14 45:19 46:13,16 81:2 127:9 154:19,20 157:9,9,10 158:11 formations 33:1 36:13 44:3,22 45:3 157:5,15 158:2,3 formed 88:13 forming 10:19	11:16 forth 1:19 136:14 161:3 forward 49:1 162:11 found 6:21 7:1 four 26:6 29:16 87:14 128:9 151:4 fourth 95:9 frac 39:13 frac-packed 143:19 fractional 31:13 31:13 fracture 39:14,15 127:8 fracturing 9:20 26:9 32:11,12 39:6,8,10 127:7 133:21 134:2 frame 36:1,2 155:6 frequency 134:10 134:21 135:4 friction 81:17 85:18 86:6,15 87:1,2,8 88:1,6 89:17,21 90:3,8 90:10,15,18,20 91:1,6 95:12 96:21 115:20 115:22 116:6 116:18,20 117:2,16 118:2 118:14,19 127:21 128:5,9 129:8,19 130:21 134:7 141:8,14,16,19 141:22 142:3,4 142:9,14 143:11,21 144:9 frictional 134:5 143:3 152:22 front 142:15
--	---	--	--	---

full 4:20 44:22 120:14 fully 5:11 function 53:5 functionally 115:3 further 69:3 80:11 85:17 87:17 93:13 96:17 153:13 158:18 161:12 161:14,15	17:19 geological 37:21 geology 14:12 16:14,15 18:21 37:13 43:17,19 43:22 getting 87:16 105:1 127:8 give 60:10,11 73:9 102:7 given 66:16 87:3 130:11 131:9 131:22 132:11 134:6 139:7 142:3 145:6 161:9 163:10 163:13 gives 102:8 glad 54:5 105:17 105:18 150:11 glasses 126:2 Glenpool 45:2 go 23:2 34:7 39:13 47:20 48:22 66:17 71:5 88:7 114:3 126:11 131:4 goal 122:4,19 124:5 goes 53:6 59:2 62:2 91:20,21 92:4,5,8,9,14 92:15 93:1,2 127:7 132:10 132:11 143:8 143:16 144:9 going 5:14 7:9 8:8 34:15 37:22 40:1 52:8 63:14 67:16 69:13 70:16 76:1 82:18 85:13 87:9 93:15 94:1 100:17 107:21 108:21 112:8 117:2 125:8 129:20 132:20	135:7 149:9 159:4,10 golly 23:1 good 4:18,19 13:6 62:8 107:12 146:3 governing 162:13 grammatical 57:17 granted 154:8,14 granting 154:15 graph 52:13 78:16 80:17 81:20 gravel 38:10,15 38:22 39:2,4,7 39:9,12,18,20 44:10 57:14,14 57:20 60:18 61:15,18 62:8 63:5 65:10 69:7 71:18 72:4 76:3 76:4 78:8,14,19 79:1,14 84:20 85:19 86:7 89:15,19,22 91:1 108:17,22 112:4,9 113:12 113:21 114:5 114:13 123:17 124:18 133:22 134:2,7 136:9 136:10 137:22 138:14 139:17 142:5 143:2,13 145:6,20 147:15 148:22 152:5,21 158:9 158:11,16 gravel-packed 143:19 gravel-packing 115:6 gray 112:19 Great 107:14 greater 74:17 76:19 81:2 95:1	100:15 green 121:10 Group 1:20 162:19,20 163:1 164:1 groups 26:6 guess 19:6 35:9 84:22 129:10 137:10 155:7 guy 30:6 37:9 guys 37:17,19	115:1 126:13 142:20 heat 13:14 heater 23:10 heel 47:8 57:13 57:20 60:4 63:17 64:22 65:10 78:15 80:4,13 82:8 83:6 89:20 height 98:13 101:19,20 102:10,16 103:2 help 159:18 hereinafter 1:19 hereinbefore 161:3 hereto 161:14 hereunto 161:17 hesitate 162:15 hey 13:19 heyday 31:12 high 39:13 57:9 57:18 58:2,6 62:13 65:8,14 high-pressure 47:7 48:6 64:21 65:13 higher 47:13 89:18,19 95:13 96:21 100:22 103:5 104:9 142:5,14 highest 103:19 129:4 hinges 109:16 hire 22:6 history 8:16,22 19:17 49:14 hold 41:3 102:14 102:16 103:5 103:13 holding 22:9 62:9 hole 128:17,20 129:1 130:22 131:1 143:1
G G 4:1 132:22 gained 34:18 156:1,14,17,20 gamut 28:10 gas 9:10 14:7 17:7 18:10,13 18:17,21 23:1 23:10,19,22 28:15,16 29:21 30:16,18 41:8 42:22 43:13,14 43:17 44:3,6 154:21,22 155:8,18 156:15 gauge 100:14,16 100:17,17 102:2,2 gauges 13:16 gear 41:22 general 62:1 64:18 69:5 75:14 76:22 82:12 84:16 88:4,5 92:2 94:5 148:15 generalizations 63:19 generally 32:1,2 50:22 71:20 73:19 75:7,14 87:12 88:5 94:1 103:12 133:10 Generating			H Hailey 108:6 half 15:18,18 17:16 36:8 102:10,11 130:7 152:18 half-inch 128:11 128:13 129:5 129:22 130:7 130:22 131:5 131:15 Halliburton 1:4 4:8 10:10,13 38:19 44:10 108:6 162:3 163:4 164:8 hand 5:14 7:9 8:8 47:15 69:13 107:22 125:8 132:20 135:7 161:17 handing 105:20 handle 62:19 77:8,10 124:14 124:17 handling 9:19 hang 149:11 hard 82:18,18 Hassell 1:15 161:2,21 hat 26:12,16,17 26:18,19 hate 27:15 HDPE 77:12 head 23:6 26:19 heading 11:6	

148:21 149:21 152:21 hole-size 145:1,3 honors 12:13 hope 62:1 horizontal 47:8 47:11 57:14,20 58:12 59:21 60:6 63:8 65:1 65:10 78:15 79:3 80:3,21 82:1,7 86:5 109:1 119:18 121:6 123:17 143:2,13,19 152:21 horizontals 150:2 Hostile 43:1 hour 40:2 70:17 149:10 hours 161:11 hundred 30:9 Hurst 132:22 133:4,7,13 134:2,14,20 138:9,13 142:16 143:8 143:16 144:3 144:18 145:11 145:12 147:6 148:9 149:15 149:15 150:2 150:11 152:9 152:11 Hurst's 135:3 hydrocarbon 34:17 hydrocarbons 31:15 hypothetical 58:19 61:5 63:6	117:11,19,20 119:5 identified 51:6 51:10 identify 31:3 156:2 identifying 119:18 121:7 IEEE 156:3 illustrate 51:2 illustrated 113:1 illustrates 78:7 78:22 112:3 127:20 illustrating 135:19 illustrative 49:4 image 110:19 impact 55:19 56:5 101:16 143:18 144:10 144:10 impacts 44:1 implementation 23:9 implemented 33:2,5 133:9 implementing 13:16 implies 132:5,6 important 53:12 improve 54:1,20 improved 108:14 109:6 126:16 In- 142:1 inch 99:1,15 102:2 128:17 128:20 129:1 129:19 130:1,6 131:1 145:13 145:14,21,21 146:3,16,17 147:7,8,16,17 147:19 148:3 148:20,21 inches 97:17,19 97:22 98:2,7,9	98:17,20 99:1 99:15,16 incidents 30:18 include 22:2 43:3 43:5 includes 28:6 75:11 113:3 including 62:18 64:13 109:12 138:16 145:20 147:16 162:21 incomplete 58:19 inconsequential 117:22 incorrect 102:8 increase 23:5 56:6 89:15 91:6 92:22 93:2,3,9 93:14,14,16,19 95:4 101:3,12 103:10 104:1,2 116:6 117:13 117:16 132:15 141:8,9,14,16 142:1,2,3 144:7 increased 20:21 56:9 88:14 89:1 101:14 103:14 103:21 104:8 143:3 148:19 152:22 155:15 increases 93:22 103:12 142:2 increasing 86:22 95:10,12 100:21 132:14 141:7,10,13 144:3,7,13 individual 42:16 134:3 158:7 industrial 19:6,9 industry 41:10 69:5 115:12 148:13 156:4 156:10 industry-proven 115:3	infect 34:16 infer 147:11,20 147:21 inference 129:12 information 69:20 156:7 infrastructure 30:5 injected 130:22 injection 139:17 inside 65:9 150:11 insignificant 117:14 installations 24:13,16 25:2 installed 80:3,12 102:21,22 instance 1:12 instances 143:18 instrument 13:22 instrumentate 13:13 instrumentation 13:2,9 15:1 instruments 13:17 integral 109:15 Integrated 17:20 integrity 64:1,8 64:13,19 65:17 65:22 84:7,8 109:12 intellectual 9:20 interaction 25:17 25:17 interest 29:18 143:12 interested 161:15 interface 37:11 156:19 interfaced 30:7 interior 101:11 internal 56:6 72:19,20,21 74:12,12 75:8 77:14 79:11	101:6 123:3 124:14,17 143:10 interruptions 59:8 interval 57:15 78:15 79:3 82:1 82:7 123:17 124:18 intervals 58:22 76:3 108:18 introduced 39:21 introduction 13:11 38:7 142:20 152:14 intrusion 157:11 157:12,16 invention 135:20 investigation 28:8 involve 39:18 involved 29:20 30:7,17,21 31:3 31:16 32:4 33:17 36:7 39:1 involving 36:17 44:10 63:7 IPR 5:18 8:10 10:6 IPR2024-00990 1:3 IPTC 77:22 isolation 133:15 134:18 issue 152:1,4 item 17:18 51:6
I				
i.e 115:10 ID 84:5 idea 127:10 identical 115:21 116:19 117:9				

56:7,11 57:11 58:6,17 60:5 61:7,8,12,20 64:15 109:15 110:7 joints 58:4 Jones 135:9,15 135:16 137:21 138:10,13 journal 156:9 judged 122:10 jumbles 16:5 jumper 112:17 112:19,21 113:13,22 114:7,14,17 115:10 116:5,5 116:14,14 117:8 119:1,6,6 119:11 120:4,8 120:17 123:1 justify 93:14	122:18 124:2,2 124:20 126:10 126:11,11 136:5 138:3 140:6,11 150:10 knowledge 161:6 known 60:18 72:2 73:21 85:7	left 43:4 52:5 78:11,16 101:20 109:21 110:5 112:8,10 112:13,16 140:13 148:9 151:2 length 49:21 50:6 50:11 54:12 62:19,22 71:17 72:5 76:14,17 78:14 79:2 86:7 89:3,16 95:14 98:4,21 99:8 101:16 134:9 139:18 141:9 141:18,20 142:7 145:22 lengthening 54:3 54:22 55:4,21 lengths 85:19 125:1 let's 10:16 11:13 12:6 19:15 27:5 27:5 36:9 40:10 44:19,20 47:3 47:19 48:22,22 49:12 50:13 52:7 57:7 59:4 69:2 75:22 83:9 85:12 86:3 88:7 97:6 98:10 104:20 109:20 111:22 114:21 115:16 119:8 120:22 127:16 133:13 135:17 139:10 140:21 142:19 145:10 149:11,19 159:19 license 154:3,5,8 154:12,14,16 155:4,11 lightning 25:10 lime 45:10,14 limestone 45:11	limit 93:12 96:17 143:2 152:6,22 limitation 143:4 153:1 limited 21:14 69:7 71:17 72:3 72:4,10 73:22 80:2 84:9 88:12 88:16 89:3 93:12 94:11 96:1 113:15 125:14 126:13 126:17,21 127:2,3 limiting 84:5 89:3 line 49:3 52:3,9 52:12,15,20,20 52:21 53:6,7,10 53:10 54:7,8,10 54:16 56:4 57:1 57:8,8 60:17 63:22 76:2 79:6 79:10,14,17 86:4 95:9 103:2 119:18,22 121:6,10 131:5 131:16,16 135:18 136:7 164:11 linear 67:11 131:6 lines 47:19 48:10 48:18 56:15 75:18 76:1 85:22 87:14 136:7 list 10:20 11:6,9 11:16,17,21,22 12:4 20:5 24:5 40:15 70:8 listed 11:6 12:3 17:18 lists 12:9 19:17 42:18 literally 99:16 little 58:20 70:17	103:17 158:12 LLC 30:4 36:22 37:4,7 164:1 LLP 1:16 2:4 4:6 161:4 loading 21:15,20 22:3,8,9 27:18 located 1:17 19:5 59:21 60:5 61:8 89:17 90:7 161:4 location 9:20 34:2 48:13 93:8 139:7 locations 23:1,10 30:19 31:4 43:19 46:3 long 15:8 54:4 55:1,8,11 56:20 65:10 76:3 103:18 108:17 123:18 125:20 143:1,13 152:21 longer 34:7 35:2 85:19 87:5 96:20 124:18 longitudinal 52:14 look 10:16,17 11:13 17:17 19:15 36:9 40:10 44:8,19 44:20 47:3,19 48:9 49:12 50:13 51:1 52:2 52:7 54:6,16 57:7 63:21 68:15 69:14 71:22 75:22 77:18 78:3 80:16 81:7 83:9 83:20 85:12 86:3 87:13 88:10 89:12 91:9 94:7 95:18 96:12 97:6
joint 58:4 Jones 135:9,15 135:16 137:21 138:10,13 journal 156:9 judged 122:10 jumbles 16:5 jumper 112:17 112:19,21 113:13,22 114:7,14,17 115:10 116:5,5 116:14,14 117:8 119:1,6,6 119:11 120:4,8 120:17 123:1 justify 93:14	known 60:18 72:2 73:21 85:7	length 49:21 50:6 50:11 54:12 62:19,22 71:17 72:5 76:14,17 78:14 79:2 86:7 89:3,16 95:14 98:4,21 99:8 101:16 134:9 139:18 141:9 141:18,20 142:7 145:22 lengthening 54:3 54:22 55:4,21 lengths 85:19 125:1 let's 10:16 11:13 12:6 19:15 27:5 27:5 36:9 40:10 44:19,20 47:3 47:19 48:22,22 49:12 50:13 52:7 57:7 59:4 69:2 75:22 83:9 85:12 86:3 88:7 97:6 98:10 104:20 109:20 111:22 114:21 115:16 119:8 120:22 127:16 133:13 135:17 139:10 140:21 142:19 145:10 149:11,19 159:19 license 154:3,5,8 154:12,14,16 155:4,11 lightning 25:10 lime 45:10,14 limestone 45:11	limit 93:12 96:17 143:2 152:6,22 limitation 143:4 153:1 limited 21:14 69:7 71:17 72:3 72:4,10 73:22 80:2 84:9 88:12 88:16 89:3 93:12 94:11 96:1 113:15 125:14 126:13 126:17,21 127:2,3 limiting 84:5 89:3 line 49:3 52:3,9 52:12,15,20,20 52:21 53:6,7,10 53:10 54:7,8,10 54:16 56:4 57:1 57:8,8 60:17 63:22 76:2 79:6 79:10,14,17 86:4 95:9 103:2 119:18,22 121:6,10 131:5 131:16,16 135:18 136:7 164:11 linear 67:11 131:6 lines 47:19 48:10 48:18 56:15 75:18 76:1 85:22 87:14 136:7 list 10:20 11:6,9 11:16,17,21,22 12:4 20:5 24:5 40:15 70:8 listed 11:6 12:3 17:18 lists 12:9 19:17 42:18 literally 99:16 little 58:20 70:17	located 1:17 19:5 59:21 60:5 61:8 89:17 90:7 161:4 location 9:20 34:2 48:13 93:8 139:7 locations 23:1,10 30:19 31:4 43:19 46:3 long 15:8 54:4 55:1,8,11 56:20 65:10 76:3 103:18 108:17 123:18 125:20 143:1,13 152:21 longer 34:7 35:2 85:19 87:5 96:20 124:18 longitudinal 52:14 look 10:16,17 11:13 17:17 19:15 36:9 40:10 44:8,19 44:20 47:3,19 48:9 49:12 50:13 51:1 52:2 52:7 54:6,16 57:7 63:21 68:15 69:14 71:22 75:22 77:18 78:3 80:16 81:7 83:9 83:20 85:12 86:3 87:13 88:10 89:12 91:9 94:7 95:18 96:12 97:6
joint 58:4 Jones 135:9,15 135:16 137:21 138:10,13 journal 156:9 judged 122:10 jumbles 16:5 jumper 112:17 112:19,21 113:13,22 114:7,14,17 115:10 116:5,5 116:14,14 117:8 119:1,6,6 119:11 120:4,8 120:17 123:1 justify 93:14	known 60:18 72:2 73:21 85:7	length 49:21 50:6 50:11 54:12 62:19,22 71:17 72:5 76:14,17 78:14 79:2 86:7 89:3,16 95:14 98:4,21 99:8 101:16 134:9 139:18 141:9 141:18,20 142:7 145:22 lengthening 54:3 54:22 55:4,21 lengths 85:19 125:1 let's 10:16 11:13 12:6 19:15 27:5 27:5 36:9 40:10 44:19,20 47:3 47:19 48:22,22 49:12 50:13 52:7 57:7 59:4 69:2 75:22 83:9 85:12 86:3 88:7 97:6 98:10 104:20 109:20 111:22 114:21 115:16 119:8 120:22 127:16 133:13 135:17 139:10 140:21 142:19 145:10 149:11,19 159:19 license 154:3,5,8 154:12,14,16 155:4,11 lightning 25:10 lime 45:10,14 limestone 45:11	limit 93:12 96:17 143:2 152:6,22 limitation 143:4 153:1 limited 21:14 69:7 71:17 72:3 72:4,10 73:22 80:2 84:9 88:12 88:16 89:3 93:12 94:11 96:1 113:15 125:14 126:13 126:17,21 127:2,3 limiting 84:5 89:3 line 49:3 52:3,9 52:12,15,20,20 52:21 53:6,7,10 53:10 54:7,8,10 54:16 56:4 57:1 57:8,8 60:17 63:22 76:2 79:6 79:10,14,17 86:4 95:9 103:2 119:18,22 121:6,10 131:5 131:16,16 135:18 136:7 164:11 linear 67:11 131:6 lines 47:19 48:10 48:18 56:15 75:18 76:1 85:22 87:14 136:7 list 10:20 11:6,9 11:16,17,21,22 12:4 20:5 24:5 40:15 70:8 listed 11:6 12:3 17:18 lists 12:9 19:17 42:18 literally 99:16 little 58:20 70:17	located 1:17 19:5 59:21 60:5 61:8 89:17 90:7 161:4 location 9:20 34:2 48:13 93:8 139:7 locations 23:1,10 30:19 31:4 43:19 46:3 long 15:8 54:4 55:1,8,11 56:20 65:10 76:3 103:18 108:17 123:18 125:20 143:1,13 152:21 longer 34:7 35:2 85:19 87:5 96:20 124:18 longitudinal 52:14 look 10:16,17 11:13 17:17 19:15 36:9 40:10 44:8,19 44:20 47:3,19 48:9 49:12 50:13 51:1 52:2 52:7 54:6,16 57:7 63:21 68:15 69:14 71:22 75:22 77:18 78:3 80:16 81:7 83:9 83:20 85:12 86:3 87:13 88:10 89:12 91:9 94:7 95:18 96:12 97:6

101:17 104:20 105:17,18 106:4,9 108:12 109:10,20 111:22 114:21 115:8,16 119:8 120:22 127:16 129:17 130:15 133:13 135:17 136:6 139:10 140:21 142:19 144:21 145:10 146:18 148:8 149:14,18,19 150:11,13 151:6,10,21 159:19 looked 99:21 looking 12:7 41:2 49:3 81:10,20 83:11 87:14 96:14 102:13 102:15 104:22 111:6 122:2 126:12 looks 40:1 41:4 43:12 70:16 124:21 loose 157:8 loosely 36:13 45:9,9,14 46:2 46:15,21 157:4 157:18,22 158:2,4,5 loss 87:2,2 115:20 116:1,7 116:18,21 117:2,8,17 118:2,14,20 127:21 128:5,9 129:8,19 141:8 141:14,16,19 141:22 142:3,4 142:9,14 losses 143:3 153:1 lost 87:4	lot 13:20 23:2 29:13,14 42:7 59:2 66:17 89:6 103:19 122:20 lots 89:11 low-pressure 47:10 64:22 lower 65:4 66:15 81:15,17 86:15 87:8,22 89:20 89:21 91:1 95:2 116:5 130:17 133:14 148:9 148:22 lowers 138:22 lowest 140:2 Lunch 107:17 M M 1:21 163:1 164:2 MacArthur 2:5 magnitude 143:13 main 115:2 maintain 63:22 84:7 maintained 66:1 maintaining 101:5,13 major 108:16 109:13 majors 31:11 making 55:10 56:1,2 103:22 management 15:5,12 17:11 manager 30:5 manifold 78:8 150:3,7,9,11,17 manifolding 151:19 manipulated 138:15,19 manner 130:14 141:9 156:10 manufacturer 73:15,15	manufacturing 122:12 March 6:1 7:18 mark 149:10 marked 3:8 5:15 7:10 47:15 69:14 77:22 105:21 107:22 125:9 132:21 135:8 married 15:9 Master 15:5 master's 15:11 15:16,22 16:8 16:11 matching 50:16 material 104:9 materials 10:20 10:21 11:10,16 11:17,22 12:3 13:15 14:22 15:2 17:4 19:13 76:21 mathematically 73:3 matter 9:8,17,21 162:6 matters 161:7 maximize 82:13 83:16 maximizing 84:5 maximum 86:7 87:3 McDonald 10:9 mean 9:13 16:3 21:10,21 23:12 23:18 24:17 31:7 72:7 74:8 82:17 86:16 88:20 91:19 92:3 93:15 95:2 104:4 117:9,10 118:5 146:6 meaning 21:13 means 113:11 117:10 135:19 147:11	meant 51:12,16 124:22 measured 127:21 measurement 129:4 measurements 130:2 mechanical 12:21 13:3,8,11 13:20 15:20 16:7 19:2 20:15 21:5,9,12,12 22:2,3,7,13,17 22:20 28:4 64:1 64:7,13,19 65:17,22 84:7,8 105:6 mechanics 14:22 16:21,22 17:4 19:12,13 mechanism 127:9 medial 61:3 82:11 medical 5:10 member 42:14 156:8 membership 42:15,16 memberships 40:13 41:1,7 mentioned 19:19 28:11,12 37:8 mesh 145:12,12 145:20,22 146:10 147:7 147:17 148:3 method 126:17 methods 34:6 44:6 125:14 middle 15:9 23:4 24:1 36:10 59:1 81:12 83:12 94:21 110:19 122:2 133:21 137:1 141:4 151:22	midway 49:17 mind 35:20 146:2 152:4 minute 78:19 128:2 129:6,9 130:3 minutes 104:13 104:15 149:12 161:11,12 missing 8:19 mistake 6:8,20 7:5 mistakes 6:6 8:1 mitigate 55:19 56:5 model 68:1 modeling 104:5 modified 143:9 modify 127:3 modifying 134:15,21 moment 96:13 morning 4:18,19 5:8 8:13 Motion 7:12 motors 41:22 43:1,3,5,8,11 mounted 109:3 move 27:5 31:12 56:1 93:13 149:9 moved 31:10 157:14 movement 53:14 53:20 moves 52:5,14 Multi-zone 133:15 multiple 78:8 N N 2:1 3:1 4:1 name 4:20 163:5 164:9 named 161:5 nature 65:5 115:22 116:20 118:1,14
---	--	--	---	--

near 57:13 60:4 63:17 81:16 93:12 necessarily 46:18 46:19 103:6 107:10 necessary 32:7 105:10 need 13:22 22:6 58:21 59:7,12 59:14 60:4 65:12 68:19 76:17 91:11 122:20 146:21 147:1,3,4 159:1 159:6,16 needed 36:7 58:18 64:8,14 65:9,17 105:6 needing 64:14 needs 6:7 9:11 64:19 neither 161:12 never 87:10 nevertheless 26:20 84:17 new 30:4,9,11 36:21 37:4,7,9 38:4 115:2,18 125:13 156:19 Newport 2:7 Nine 104:18 non-technical 23:8 nonconcentric 76:4 nonsensical 93:17 noon 104:14,16 Nope 117:18 normal 62:1 63:5 63:13,14 Northwards 5:3 Notary 161:9 163:22 Note 145:19 noted 163:11	notice 108:5 122:8 noticing 162:12 noting 162:12 nozzle 134:10,15 134:21 135:3 138:15,16,22 139:1,6 140:3 140:17,19 141:10 142:4,9 145:4,6,22 nozzles 6:14 110:1 113:16 134:15,20 138:17 140:3 141:8,13,17,21 145:13,14,21 147:3,7,8 151:3 number 36:16 39:20 70:8 72:15 73:9 82:18,18 90:11 127:4 135:9 138:17 140:14 140:14 141:7 141:13 number's 28:18 numbered 1:13 151:22 numbers 99:22 NW 1:21 163:1 164:2 O O 4:1 oath 4:15 5:7 161:7 Objection 55:14 56:18 57:5 61:21 63:11 64:17 65:2,20 66:6 67:3,18 68:13 80:6,14 82:2,16 101:7 113:18 131:13 131:18 139:3 140:5 145:15 obligation 69:22	obvious 7:1 occur 57:9 October 49:18 OD 84:5 101:14 102:9 offered 15:12 office 1:1 28:1 162:7,15 offices 1:16 161:4 offset 34:18 50:20 56:15 57:1 offshore 39:2 oftentimes 37:16 39:12 oh 48:14 94:17 106:13 121:7 155:12 oil 9:10 14:6 17:7 18:10,13,17,21 22:22 23:10,11 23:19,22 28:15 28:16 29:21 30:16,18 41:7 42:22 43:13,14 43:17 44:3,6 128:12,14,15 128:18 129:2,5 142:17 154:21 154:22 155:8 155:18 156:15 okay 5:4,7,14 6:1 6:6,9,11,16,20 7:3,9,15 8:12 8:15,21 9:11,16 10:3,5,8,16,18 11:9,21 12:6,8 12:9 13:8 14:2 14:17,21 15:4 15:16 16:2,6,20 17:3,10,17 18:4 18:7,9,16 19:1 19:8,11,11,15 20:5,13,22 21:9 22:11,16,19 23:15 24:4,7,15 25:1,21 27:2,11	27:21 28:2,9,11 28:12,19,20 29:2,17 30:20 31:2,7,16,19 32:4,8,15 33:4 33:9,15,17 34:9 35:5,16 36:6,20 37:3,6 38:3,9 38:15,22 39:17 40:3,12,13 41:1 41:6,17 42:10 42:14,17 43:16 43:21 44:16 45:12,18,20 46:17 47:3,5,19 47:22 48:9,15 50:9 51:1,21 54:16 55:6 58:11,15 59:4,5 59:6,20 60:3,17 61:5,12,15 62:4 62:21 63:5,16 66:8,21 67:14 68:6,15,17 69:2 69:2,3,13,16,18 70:11,15,19 71:3,5,12 72:17 73:3,16,21 74:8 74:15,19 75:11 75:22 76:12,16 77:3,18 78:3,7 78:11,18 79:14 79:21 81:4,9,10 81:13,20 82:22 83:9,11 84:3 85:12,15 87:6 87:13,17,18,21 88:7,9,22 89:12 89:13,14 90:10 90:17 91:19 92:11,16 93:18 94:3,7,8,9,20 97:8 98:10 99:10,14,18 100:1,17 101:17 102:18 103:8 104:20	105:1,2,13 106:3,4,9,21 107:12,21 108:9,12 110:4 110:22 111:22 112:2,8 114:12 116:16 117:1 117:12,21 119:8,10,14,16 120:4,13,22 121:1 122:1 123:7 125:7,21 126:6,6,9,12 127:16 128:5,8 129:4,8,13,17 130:5,10,15 131:8,15,20 132:8,13,20 133:4,7,11,13 133:16,20 134:2 135:7,17 136:1,4,6,21 137:21 138:6 138:20 139:10 140:1,15,21 141:3,6,22 142:6,11,15,17 142:19 144:12 144:21,22 146:14 148:2,8 148:17 149:18 150:1,7,14,19 150:21,22 151:2,14,18,20 151:21 156:11 159:4,6,12 Oklahoma 24:9 28:17 45:2 154:7,9 one's 26:13 one-inch 152:18 ones 43:6 142:13 open 136:14 139:22 143:1 148:21 149:21 152:21 opening 111:1,4
--	---	--	---	--

138:22 139:6 openings 110:9 operate 23:7 80:10 operated 30:10 operating 23:22 28:16 74:9 operation 136:9 144:11 operations 23:11 30:8 36:4 39:6 41:12 62:1 63:6 63:14 155:1,10 155:19,20 156:16 157:3 operators 30:16 30:20 35:13,17 opine 71:15 72:2 81:14 96:16 97:2 100:1 opinion 46:10,17 81:10 94:9 96:4 118:9 124:8 opinions 7:6 8:3 10:20 11:16 opposite 111:7 optimization 145:3 option 162:9,10 ORAL 1:6,11 orange 112:11 order 13:12,22 21:19 63:22 115:4 122:11 127:6 143:13 159:5 ordered 24:3 ordinary 58:1 64:12 65:16 66:2 79:21 80:19 81:21 82:5,12 83:2 85:5 91:15 92:19 94:3 96:5 104:6 118:22 122:22 123:7 130:10 131:9	131:21 132:13 134:13,19 135:2 138:8,21 139:15 144:12 149:4 organizations 155:22 156:2 156:12,19 original 125:18 143:11 152:17 162:11 ornamental 105:4 outer 66:10,12 94:13 95:11 outside 23:5 79:12 102:1,10 102:11 overall 72:4 85:18 86:6 89:3 95:4 122:3 overcome 56:17 57:3 Overseen 17:20 oversimplified 138:4 owing 115:22 116:20 118:1 owned 29:22 30:9 31:2 Owner 1:5 2:11 4:8 Owner's 7:12 Oxygenic's 23:6	39:2,4,7,9,12 39:13,14,18,20 44:10 61:16 62:8 65:10 71:18 72:5 85:19 87:5 89:15,19,22 123:17 124:18 136:9 148:22 packable 95:13 packed 59:1 62:7 packers 58:22 59:4,5,12 61:7 63:9 packing 6:13 57:14,20 60:19 63:5 69:8 76:3 76:4 78:8,14 84:20 86:7,20 108:17,22 109:2,22 110:16,19 112:5 113:4,7 113:15,16 114:1,8 125:4,5 133:22 134:3 136:19,22 137:5,8,9,10,11 137:17,18 139:18 140:3 140:19 141:8 152:5 packs 143:2,13 152:21 158:11 page 3:2,3 5:20 7:15,16 8:21 10:19 12:7,9 17:18 19:16,16 20:22 24:7 40:11 41:3 43:1 44:8,14,21,22 68:21 75:16 78:4 81:11 83:22 85:14 87:14 90:5 95:21 96:15,15 100:10 102:22	104:22 106:15 106:17,22 108:13 109:21 112:1,6 114:22 115:1 118:18 119:9 120:13 120:14,22 121:17 122:2 125:22,22 126:12 127:17 130:15,16,16 133:13 139:12 142:19 143:1 144:21 145:11 145:19,19 148:9 149:14 149:18,20 150:2,13 151:21,22 152:13 162:12 163:4 164:11 pages 42:17 163:7 paper 43:2,2,20 108:10,14 125:9,17,19 papers 26:3 43:9 43:20 paragraph 6:10 7:5 10:17,18 11:6,14,15 21:1 36:10,10 38:9 44:20,21 47:3 49:12,13,17 50:13 58:6 68:16,20,22 69:15 71:13,14 71:22 81:7,12 82:4 83:10,12 83:20 85:12 87:13 88:7,11 88:11 89:12 91:9 94:7,21 95:9,19,21 96:12 97:6,9 100:1 104:21 104:21 106:1,5	106:8,9,17,21 107:1 108:13 109:10 115:8 115:15 120:14 122:3 130:17 133:17,21 136:1 139:10 139:11 140:21 141:2,5 142:20 144:22 148:17 152:17,21 153:6 paragraphs 151:22 parameters 66:21 67:15 68:9 92:18 paraphrase 50:18,22 94:15 Pardon 96:13 part 12:18 14:2,7 14:17 15:16 16:7,11,21 18:12,16 19:1 19:11 23:15,17 30:21 35:13 70:8 125:17 partial 62:15 particles 146:9 particular 23:10 60:8,9,12 61:4 61:10 68:4 73:9 73:13 77:9 79:19 80:7 81:1 82:10,19,20,20 86:13 93:7 121:20 127:7 158:12 particularly 24:21 25:18 36:12 71:19 84:15 parties 29:17 38:19 161:10 161:13,14 partner 30:13 partners 37:9
--	--	--	--	--

partners' 30:6	people 27:19	13:12 37:21	162:11,14	66:13,16,18,22
parts 115:9,18,18	28:1	pertains 9:8	plug 62:9,12	67:15 68:1,4,8
115:20 116:11	percent 130:9	petition 135:14	point 39:21 54:5	71:16 72:2,7,9
116:17,19	perforation	Petitioner 1:3,12	59:22 60:7 61:3	72:10,11,13,14
117:8	127:4,7 128:6	2:2 4:6	63:3 82:11 83:5	72:14,16,16,17
party 161:10	128:11,13,16	petroleum 13:21	90:3 103:22	72:18,19,20,21
passage 52:8	129:5,19 130:1	14:4 16:10 19:2	129:22	72:22 73:1,2,4
58:11	130:2,7,12,21	28:6 40:20 41:9	pointed 97:18	73:4,17,17,22
passed 30:13	131:5,10,11,16	41:10 154:2,5,6	points 103:15	74:1,3,10,10,11
patent 1:1,1,4,5	131:22 132:1	154:11,18	pool 23:7	74:12,13,16,21
2:11 4:8 6:17	132:11,15,16	155:3,11 156:3	porosity 154:20	74:21,22 75:1,2
7:12 49:14	137:1	156:8	port 112:5	75:8,9,9 76:9
71:16 72:3 96:6	perforations	Ph.D 1:7 162:1,4	portion 85:13	76:13,15,19,20
135:9	127:5,5,6,11,13	163:5 164:9	89:19 110:5	77:1,2,4,4,6,9
path 50:19,21	127:14 128:2	PhD 1:11 4:12	111:12	77:10,15,17
51:6,9,12,16	129:18 136:12	17:10 18:2,12	portions 89:22	78:11 79:1,7,9
52:3,4 53:12,19	136:13,18,21	18:16,20 19:1	POSITA 69:4	79:10,11,12,22
55:20 56:6,17	137:3,4,7,8,12	19:11 29:10	positive 62:15	80:2,5,10,12,20
57:3 61:19	137:16,18	161:5	possibility 16:3	81:2,4,15 82:15
63:10 65:9,18	138:2,7	phrase 87:15	possible 82:1,7	83:5 87:4 88:15
83:17 84:6,14	perform 35:5,17	pick 26:12,15,16	100:2 124:21	88:19,20 89:2
84:19 95:11	performed 35:13	piece 103:18	potentially	89:18,19,20,21
101:6 133:8	performing	pin 111:8,11,14	144:14	91:12,16,21
136:10 137:22	34:10	111:18 112:13	power 25:14	92:5,9,13,14,15
144:4,5,8 152:5	period 38:2	112:16 114:15	PPA 78:19	92:22 93:6,9,9
paths 50:16	162:13	114:17	practice 154:6	93:16,22 95:12
51:13,17 57:10	permeability	pins 109:17	prefer 74:3	95:13,22 96:7
57:19 58:3	154:20	pipe 62:10 77:12	premise 86:17,18	96:18 97:3
63:16 64:3,9,15	Permian 43:22	89:17 90:8	prepack 34:7	100:22 101:3
83:18 84:13,18	permitted 70:21	94:12 95:3,16	158:9	103:5,11 104:2
85:8 144:8,13	person 29:6 58:1	143:17 148:19	prepacks 33:7,8	104:7 115:20
144:14	64:12 65:16	148:20	33:13,18 34:12	115:22 116:7
PD 43:1	66:2 79:21	pipes 34:21	36:1 37:5,7	116:18,21
PE 1:7,11 4:12	80:19 81:21	piping 21:13 22:8	38:2 158:11	117:2,8,13,17
29:1 161:5	82:5,12 83:2	22:22 25:15	preparing 8:6	118:2,14,20
162:1,4 163:5	85:5 91:15	62:18 105:10	10:5,11 11:10	119:5,12,16
164:9	92:19 94:3 96:5	place 56:1 119:3	12:1	120:1,2,4,8,19
pedantic 99:12	104:6 118:22	placed 48:10	present 50:4	121:2,5,11,15
PEDOCS 23:19	122:22 123:7	places 58:7 68:1	97:10 135:20	122:5,10,16,20
26:11 27:3	130:10 131:8	89:7 157:15	Presented 17:22	123:3,6,15
28:13,20 29:2	131:21 132:13	plaintiff 38:20	pressure 35:6,8,9	124:6,15,17
29:18,22 31:2,3	134:13,19	Plaintiff/Defen...	35:10 39:14	127:11 129:14
31:16,21 32:4	135:2 138:8,20	161:16	47:13 57:9,13	130:11 131:11
32:15 34:12	139:15 144:12	platforms 22:9	57:18 58:2,7	132:1,10 134:5
36:1 38:8	149:4 161:5	play 86:21	60:4 62:9,13,22	134:8 139:2,8
156:20	personnel 25:11	please 4:4,20	64:22 65:4,9,14	139:16 140:2
PEDOT 23:20	perspective	18:6 162:6,10	65:18 66:3,11	140:16,18

142:14 143:3,4 143:22 152:6,9 152:22 153:2 153:10 pressure-related 77:9 pressures 123:10 143:12 154:20 pressurized 105:10 pretty 13:6 25:16 35:3 126:5 previously 5:15 7:10 44:9 47:15 69:14 77:22 95:19 107:22 125:8 132:21 133:4 135:8,11 primarily 108:22 primary 50:16 50:19,21 51:6 51:12,13 52:3,4 53:12,19 55:20 56:6,16 57:2 83:17 84:5,13 84:19 85:8 144:4,5,14 principal 20:3,6 20:20 21:2 23:18 24:8 27:6 27:8 28:12 principals 20:8 29:2 principle 94:5 principles 43:2 prior 6:3 39:9 50:4 72:3 89:7 96:4 probably 9:14 26:12 28:19 36:3,5 42:9 43:10 45:8 50:22 70:16 73:14 75:5 91:8 103:19 129:12 142:8 155:5 problem 32:20	32:21,21 33:1 47:1 problems 47:2 157:17 Procedure 1:18 162:14 proceed 4:11 proceedings 160:4 process 25:12 127:3 processes 13:13 13:14 produce 45:10 produced 1:12 produces 87:8 producing 32:16 45:22 production 23:11 24:1 26:21 28:15,16 29:21 30:8,19 36:12 41:11 43:12,13 43:15 49:22 50:7,11 108:18 154:21 155:1,9 155:19 156:5,6 156:16,18,22 157:1 productivity 143:18 144:10 professional 27:19 40:13,16 40:18 41:1,6 154:9 profile 52:22 53:3,7 79:7,9 79:22 profiles 52:15 ProFrac 38:19 program 16:19 programs 109:11 properly 13:12 properties 105:6 property 9:21 proportional 66:4,19 67:1,17	67:19,20 68:7,8 68:10 91:17,20 130:12,13,14 131:11 132:1,4 132:5,6 proportionality 132:5,6 proppant 39:15 prosecution 49:14 50:3,5 protection 25:10 25:11 28:7 36:7 46:3 provide 84:6 provided 53:7 69:21 provides 24:12 119:11 121:1 133:7 providing 25:2 psi 57:12 60:4 61:13,20 63:10 63:17 72:4 74:1 74:5,14,18,20 77:12,13 78:12 80:3,5,10 81:1 81:2,5 82:15,18 83:4 87:4 88:16 89:3,7,8 93:15 93:16,16 96:1,8 96:11 119:16 119:18,19 120:5,9,12,18 120:19 121:5,7 121:15,19,22 122:4 123:10 123:11,15 124:6,14,17 125:6 129:9,10 129:14 143:5 152:6,10 153:3 153:10 Public 161:9 publication 8:19 8:19 9:3,6 publications 42:18,21 43:16	44:2,5 published 8:20 9:4 108:10 126:1,7 pull 77:12 pump 62:14 143:2 152:22 pumping 61:15 62:6 pumps 9:10 21:13 26:4 34:21 35:2 39:13 41:22 62:16 purchase 33:13 purchased 162:8 purchasing 34:22 purple 101:17 pursuant 161:2 161:10 put 36:5 39:15 74:5	R R 2:1,3 4:1 radial 50:19,20 101:5,16 103:1 radially 48:11 range 27:17,18 54:8,9,10 ranging 130:2 rate 54:2,13,21 55:12,15,16 78:19 79:2,18 119:5 127:20 128:1,8 129:4 130:11 131:10 131:22 132:10 134:3 rated 72:16 80:10 rates 34:3 129:17 130:2,6 143:2 143:12 152:22 rathole 59:19 rating 35:10 47:13 62:19,22 65:4 66:11,13 66:16,22 68:4 71:16 72:2,7,10 72:14,17 73:1,4 73:17,22 74:3,6 74:10,16,20 75:1 76:10,13 76:19,20 77:1,4 77:4,5,6,9,16 83:5 88:15,19 88:20 89:2,18 89:20 91:17,21 92:5,9,13,15,22 93:6,9,10,14 95:13,22 96:7 96:19 97:3 104:8 120:19 122:4,16,19 124:6 152:9 ratings 64:2,9 68:1 75:9,10 91:13 93:16 rationale 69:4
---	--	--	---	---

re- 39:11 41:10	36:4 41:2	117:3 118:2,11	refers 76:12	remember 13:7
read 11:1,19 21:7	105:18 151:20	118:15,21	87:18 106:6,18	38:18,20 39:19
36:14 37:1	157:6	119:4 121:2,11	118:14 122:8	157:20
38:13 45:4	receive 155:3	121:14 123:9	150:20 151:3	remind 95:20
47:20 49:7 50:1	158:22 159:22	125:5 151:16	152:16 153:6	removal 46:8,11
52:16 53:1,16	received 15:4	152:10 153:7	refineries 25:20	46:18
56:19 57:16	17:10 155:10	153:10	refinery 25:8,9	remove 45:21
58:12 64:5	159:2	red 32:20 45:1	refining 25:5	rephrase 137:6
68:18 69:9 70:2	recited 15:2	46:21,22 47:1	reflects 79:10	report 37:20
72:6 76:7 81:18	recognized 65:3	79:17 112:3,9	regard 6:17	reported 116:4
84:10 85:20	65:6	121:6	regarding 18:17	REPORTER 4:2
86:8 90:1 94:17	recollection 50:8	reduce 54:2,21	37:6 38:12	4:10 18:5 23:20
95:7,15 96:22	51:20	55:15 85:18	region 157:19	26:14 40:5,8
100:7 108:19	recommendation	86:6 87:2 88:6	regular 14:17	71:7,10 107:15
109:4,18 115:7	58:15	89:17 90:3,8,10	34:8 37:10	107:19 148:6
115:13 116:2	recommended	91:6 93:9 141:8	regularly 32:6	153:16,19
120:20 122:6	145:5,13	reduced 89:21	Regulated 17:19	158:21 159:2,7
122:13 129:7	147:12	90:18,20 96:18	rejections 49:19	159:9,13,16,21
130:4 131:2	recomplete 32:6	143:17 161:8	relate 41:7 42:22	160:2
134:11 136:15	32:8	reduces 55:12	43:10,16 44:2,5	representative
137:21 141:11	reconnecting	87:1 90:15	154:22	69:20 70:8
143:6,14 144:1	50:15	reducing 34:18	related 14:6,9,21	represents 79:6
145:8,18 146:2	record 4:3,4 40:5	54:13 96:16	15:19 16:13	79:14,17
149:2 150:5	40:8 71:6,7,10	143:11,11	17:4,7 18:13	119:22 120:2
152:7,11 163:6	107:15,19	144:9	28:3 39:8,11	121:10
read-and-sign	153:16,20	reduction 34:17	67:21 68:14	reproduce 97:9
159:11	159:7,8,13	55:5 84:13 93:8	72:14 73:4	139:13
readily 96:21	160:2 161:8	95:5	76:14 77:17	request 161:16
reading 18:6	recorded 163:10	refer 76:9 90:18	78:7 86:15 97:3	requested 69:20
119:1 138:9,13	163:14	91:11 95:20,21	97:21 98:19	70:8
156:9	rectangular 49:5	105:2 106:1	99:4 132:3,9	require 34:6
reads 6:12 48:14	66:15 67:6,10	152:13	161:13	45:16,21 46:3,7
147:10,14,15	67:13,14,16	reference 39:9	relates 41:10,12	46:18 146:4
ready 162:6	68:2,9 75:4,12	47:16 107:1	99:4	required 64:4,10
real 124:11 125:1	75:14 77:7 87:6	136:1	relation 84:15	96:19 145:22
really 22:7 25:12	91:22 92:4,8,21	referenced 162:6	relationship	147:17
68:2 157:13	93:19,20,22	references 73:12	67:11 68:7 79:1	requirement
158:21	100:4,9,11,11	75:20 91:4	92:1	119:19 121:8
realtime 159:3	101:4,18 103:3	referencing	relative 52:14	requires 6:12
reason 5:10 43:7	103:15 104:8	105:3 149:20	90:10,20 91:2	46:11
70:4 87:22	104:10 110:9	referred 16:20	161:14	requiring 95:13
97:15 107:8	110:12,15,18	35:12 77:22	relatively 119:6	requote 89:10
118:13	111:15,15,20	105:14 135:14	relay 37:17	research 18:13
reasonable	112:10,13	referring 36:18	remain 136:14	18:20
129:12	113:4,4 115:12	72:13,18 73:16	remainder 150:3	reserving 84:17
recall 15:21 19:4	115:21 116:1,4	90:5 150:8	remained 132:16	reservoir 143:21
33:14 35:19,20	116:14,20,21	151:15	remaining 31:15	143:22 154:19

154:21 residential 25:4 resistance 105:6 136:10 138:1 response 49:18 69:21 responsible 34:10 38:3 rest 43:12 124:20 145:18 restrict 95:11 restricting 127:10 restriction 35:1 56:16 57:2 138:22 result 139:1 resulted 100:22 results 37:20 100:18 review 6:3 7:20 8:12 69:11 91:10 97:13 133:7 161:16 162:8 reviewed 10:20 11:5,16 12:3 96:5,10 108:2 125:17 133:4 135:11 right 7:9 10:19 12:18 16:19 17:13 18:8 24:10 27:4 41:2 46:15 52:5 53:22,22 55:21 56:2 57:22 61:17 69:2 75:13,20 76:18 78:18 79:6 80:17 83:8,12 85:1,2,5,15 86:3 87:17,19 90:6 92:16 97:5 99:16 102:13 104:19 105:20 111:6,12 112:8	112:14,20,21 113:1,3 114:4 120:10 126:4 130:17 133:14 140:8 142:10 144:21 145:10 147:1 149:11 149:19 150:18 150:21,21 151:5,19,20 152:15 153:11 156:17 right-hand 126:13 130:16 150:15 rigs 41:13,22 42:7,8 Robert 1:7,11 4:12,21 7:11 161:5 162:1,4 163:5 164:9 robust 76:3 role 30:5,6 33:22 34:13 37:6 38:11,16 39:7 39:21 roles 37:10 rolling 90:4 139:12 room 83:17 94:11 Ross 1:17 2:14 161:4 162:2 rough 158:22 159:10 roughly 83:6 round 49:5,10 66:12 67:4 74:22 75:11,13 77:6 87:7 89:18 96:9 100:3 111:4,20 112:17 115:11 116:1,5,14,21 117:4 118:2,9 118:15,20,21 119:3	Rounds 118:6 RPR 1:15 161:2 rule 75:14 rules 1:18 5:4 162:14 run 27:15 56:10 82:8 104:3 S S 2:1 4:1 S2.1 107:2 safety 73:10,13 73:14,18,20 74:2 75:3 122:9 122:15 sample 119:12,15 120:1 121:2,11 121:20,21 sand 6:13,14 26:9 32:15,21 33:2,9 34:8,18,22,22 35:6,8,17 36:7 36:11,13,17,21 37:3,16 38:4 39:15 44:6 45:2 45:16,17,19 47:7,9 48:2,2,5 48:12,16 49:5 51:21 58:4,8,16 58:16 59:9,16 64:15 70:13 71:17 76:2 80:9 85:8 89:4 105:10 108:17 109:3,7 123:2,2 123:12 128:12 128:14,15 129:2,5 133:8 148:13 158:1 158:10 sand-producing 32:18 saw 99:18 saying 8:21 9:22 77:5 90:22 99:5 103:8,9 117:1,7 146:10 says 8:17 10:19	11:15 21:2 24:7 24:8 27:6 36:11 44:22 49:4 52:12,20 53:9 53:10 54:7,15 57:8 60:17 63:22 69:19 75:17 76:1 78:13 79:8 83:16 86:4,10 102:4 108:14 108:21 109:11 115:1,9,16 116:11,16 118:1,14 121:20 130:20 134:2 136:9 137:21 138:3,5 141:7 143:1 145:3 146:15 147:6,19 148:1 148:18 150:2 151:22 152:13 152:20 scale 27:20,20 scenario 61:13 61:15 62:4,6 92:11 scenarios 104:4 school 13:19 17:22 Science 12:12,19 14:2,7 scientist 20:3,20 24:9 27:7 scientists 27:8 screen 6:13,14 33:9 34:8 35:17 37:16 47:7,9 48:2,3,5,12,16 48:19 49:9 51:22 59:9,16 60:1,1,8,22 64:15 69:8 71:17 72:10,12 80:10,12 81:15 86:14,15 89:4	90:22 94:10 102:21 105:11 109:7,16 123:2 123:3 screens 33:7,8,12 33:18 34:11 35:7,8,22 39:3 39:4,15 47:12 47:13 49:5 58:4 58:8,16,17 60:18,20 61:6,6 63:3,7,8,9,17 65:4,14 70:13 72:3 73:22 76:2 76:4,6 80:1 81:16,22 82:6 82:13 83:4 85:8 86:5,18 87:22 88:12 96:17,18 96:19,20 97:3 108:17 109:3 123:12,16,16 148:13 149:6 158:8,10 screens' 88:13 seal 161:17 second 6:14,15 7:11 17:18 24:4 41:3 50:21 51:13,18 72:1 102:5,14,16 108:13 109:10 115:8,16 142:20 148:17 secondary 51:9 51:16,17 57:10 57:19 58:3 61:19 63:10,16 64:2,9,15 65:9 65:18 83:18 84:12,18 85:8 144:8,13 seconds 119:17 121:5 section 15:2 62:7 114:22 133:14 148:18 149:20
--	---	--	--	---

153:11	85:16 88:10,22	128:5,8 130:18	sigmoid 53:5	48:8,14,21 49:8
sections 81:15	89:14 90:17	130:20 147:11	sign 162:7,8	49:16 50:2
see 40:13 51:5	91:10 95:21	151:11	signature 5:21	52:11,17 53:2
52:3,10,11 53:3	96:14 109:11	shrink 95:3	7:16 162:6,12	53:17 66:7
54:17 58:11	114:22 115:9	shrinking 144:5	163:4,17	69:10 70:3,6,10
61:12,20 62:2	115:15 130:18	shroud 94:13	164:22	71:2,4 72:6
62:13 63:9,17	133:20 141:5	109:15	signed 162:11	75:21 76:8 78:2
69:2 75:17,19	sentences 83:21	shunt 39:3,5 47:7	signing 162:10	78:6,10,21 79:5
80:17 83:14	separated 66:19	47:10 48:6,10	silent 148:5,7	80:7 81:19 82:3
84:1 87:15	separation 23:11	48:16,19 49:5	similar 65:21	83:19 86:9
91:13 93:13	September 8:20	49:10,21 50:6	66:16 74:13	87:20 90:2
96:2 101:21	9:4	50:10 61:18,19	141:9	91:14 93:6 95:8
102:21 106:6	sequence 114:3	62:18 63:1	Similarly 143:1	95:16 97:1
106:22 107:3	serve 20:3 24:8	64:21,22 65:13	152:20	100:8 106:20
108:7,9 109:21	26:5	65:18 66:4,22	simply 69:3 72:9	107:7,10 108:4
111:7 119:12	service 108:16	70:12 72:19	124:3	108:8,20 109:5
125:11,21	Services 1:4	74:16 78:8 79:1	simulation	109:19 111:13
126:2,19	44:11 162:3	79:11,12 80:20	126:17	112:15 113:2,6
127:19 130:1	163:4 164:8	81:4 84:3,6	simulators	115:7,14 116:3
130:17 131:5	set 1:19 125:7	88:13 89:16	143:21	120:21 122:14
132:21 133:2	161:3,17	90:7,12 91:1,5	Sincerely 162:18	125:12 126:8
133:14,17,21	setting 53:14,20	94:10,12 95:12	single 58:17 61:7	127:14 128:22
135:18,21	setup 124:22	96:9 105:11	61:8 111:4	131:3 133:6
136:2 141:4	setups 124:22	108:15 109:7	128:1 136:19	134:12,17
144:22 145:11	seven 150:2	112:4,22 113:3	136:19	135:13 139:14
148:9 149:15	155:12	114:12,13,14	single-flow 79:16	143:7,15
149:20 150:1	sheet 162:11	114:18,19	sir 5:1,6,9,13,19	149:22 151:9
150:17,20,22	163:11 164:6	115:5 120:19	5:22 6:2,5 7:8	sit 5:12
151:2,6,11,12	short 59:2 117:8	121:1,14	7:14,22 8:2,5	situation 34:20
151:13 152:2	117:14 119:6	122:16 123:1,2	8:11 9:2,5,7,9	87:9
152:16 153:4	shorter 34:5	123:4,9 124:13	10:7,12,15 11:2	situations 24:2
seeing 37:15	140:13	134:6,9,15,21	11:4,8,12,20	62:20 82:21
seeking 82:13	show 53:7	135:19 136:17	12:2,11,15 14:5	six 90:13 91:5,6
seen 54:8	shower 23:6	136:22 137:4	14:8,13 15:7,14	155:12
segments 53:8	showing 124:1	138:14,17	16:9,12 17:2,9	size 34:3 66:16
selected 162:10	shown 16:18	139:18 140:9	18:11,19,22	85:7 86:22 95:4
selection 44:1	52:18 54:8,10	141:18,20	19:7,18,22 20:7	124:2 125:1
send 159:10	69:6 70:12 79:9	142:7 143:4	20:10 21:8 24:6	127:4,5 130:12
sense 87:18 91:20	101:11 107:1	144:3 151:3	24:14 28:14,18	131:10,22
106:14	110:4,7,19	152:6,17 153:2	30:1 31:1,5	132:11 148:19
sentence 10:18	111:11 136:20	158:13,15	32:6,10,12 33:3	158:8,9,16
11:15 36:11	140:9	shunting 33:10	33:11,19 34:13	sizes 145:6,20
38:9 44:22	shows 49:9 78:11	sic 16:21	35:15 36:15,19	147:15
50:14 68:20,22	78:14,18 100:2	side 25:12 52:4,5	37:2 38:14	skill 58:1 64:12
69:17,19 71:14	101:19 110:8	78:16 109:21	40:14,17 42:20	65:16 66:2
72:1 75:16	112:10 119:16	111:6 112:21	44:7,12,15 45:5	79:21 80:19
81:11 83:11	121:5,19 128:1	148:22 150:15	46:9 47:18 48:4	81:21 82:5,12

83:2 85:5 91:15 92:20 94:3 96:5 104:6 118:22 122:22 123:7 130:10 131:9 131:21 132:13 134:13,19 135:2 138:9,21 139:15 144:12 149:4 skilled 100:20 101:2 138:12 skimmers 23:7 slightly 74:13 slow 18:6 slowed 15:10 slurry 61:18 78:18 79:2,15 79:17 91:1 112:4,9 113:12 113:21 114:6 114:13 134:4,6 134:14,20 136:10 137:22 138:14 139:17 142:2,4 small 93:3 127:17 smaller 54:9 55:16 90:15 109:2 110:15 117:3 119:2 129:18 139:1,6 146:9,10 148:3 smallest 140:9 Society 40:20 41:9 156:8 solely 75:2 solid 79:6,10,14 119:22 121:10 solution 89:15 Solutions 8:22 19:19 20:2,6,9 20:17 21:2 22:12,13,16 23:16,17 30:22 somewhat 132:4	soon 70:18 sooner 141:15 sorry 6:18 11:11 18:7 22:11 23:20 26:14 40:11 42:18 46:5 48:13,22 55:6 57:6 62:15 63:21,21 75:8 94:15 106:5,11 106:13 111:1 120:7 121:7 128:12 130:15 136:7 137:13 138:10 146:11 sort 28:21 29:6 33:2 34:11 35:5 36:7 45:21 46:18 sorts 24:3 25:20 sounds 17:13 source 139:7 south 25:19 45:1 space 84:4,9,18 94:12 space-constrai... 69:7 SPE 40:21 42:12 108:10 SPE-169440 108:1 SPE-86532 132:22 speak 10:13 118:17 speaking 73:19 75:7 94:1 133:10 specialized 22:5 specific 21:22 46:7 69:6 specifically 10:8 26:2 33:4,22 41:21 62:21 78:22 90:4 specification 33:18 35:17	119:19 121:8 specifications 33:19,21 specified 24:3 27:1 36:11 specify 37:16 specifying 38:4 speculate 46:5 spent 20:19 spot 103:14 130:1 square 98:9 99:16 stainless 70:9 105:15 106:7 stand 28:22 107:10 standard 35:4 41:13,17 73:7,9 109:3 standards 26:6,6 41:13,18,19 42:6,10,13 43:9 start 76:2 82:8 135:18 138:11 started 36:4 starting 52:8,20 86:4 133:20 state 1:16 4:4,20 95:10 154:7 161:1,2,4 statement 11:3 62:1 70:5 76:22 88:4 89:5 107:11 138:4 states 1:1 122:3 statics 13:4 15:21 16:6 stay 64:1,8 66:21 67:15 92:18 staying 68:9 stays 92:15 steel 70:9 88:14 steels 105:16 106:7 stick 35:20 74:3 stimulation 32:9	32:13 stop 40:2 stopped 62:12 stormy 25:18 straight 53:7 131:16 strain 13:16 strange 25:16 59:6 Street 1:21 163:1 164:2 strength 15:2 104:9 105:15 106:7 107:6 strengths 13:15 106:18 107:9 stress 13:16 67:9 68:3 93:7,8,12 93:13 103:19 103:22 stresses 67:12,12 103:15 strike 8:7 22:11 31:20 34:9 83:1 111:1 118:8 120:7 128:12 138:7,10 158:13 stripper 31:5,7,9 31:19,21 32:3 stripping 31:14 structural 21:15 21:20,22 22:5,6 28:5 105:4 structured 27:16 structures 25:16 studied 26:8 27:1 38:10,15 studies 25:17 stuff 35:4 style 38:18 subcommittee 41:11,13,17 subject 9:8,17 subjected 80:12 submersible 9:10 26:4	submitted 5:18 8:9 154:13 subscribed 161:9 subsequent 38:8 142:13 subset 157:22 substance 6:22 70:22 substantiate 124:5 substantiated 122:4,19 substantive 6:8 subsurface 155:1 155:9,18 156:6 156:16,21 157:1 successful 115:5 sufficient 154:15 Suite 1:17,21 2:6 2:15 161:4 162:2 163:1 164:2 sum 83:13,16 supervision 161:8 support 7:12 89:5 155:19 supported 122:19 supporting 120:18 Sur- 42:2 sure 4:21 13:5 21:11 24:18 26:11,15 29:12 29:15 35:19 40:3 47:22 56:21 58:21 70:19,20 114:4 120:11 124:12 126:5 135:6 149:8,13 152:12 153:15 156:3 surface 42:2 surprise 70:11
--	--	--	--	---

surprised 70:14	14:3 15:8,17,19	50:9 89:15	113:7 114:10	67:17 68:10
surrounding	16:22 17:14,17	teaches 57:18	114:16 119:2	88:15 89:1
57:11 64:3,10	18:17 19:2,5,12	62:21 63:2 64:7	119:12 121:2	91:12,16,20
Surveyors	19:15 23:13	81:14 85:17	121:22 123:14	92:4,8,14,21,21
154:10	36:9 40:3 44:8	91:3 96:20	123:22 124:3,9	92:22 93:20
switch 41:22 63:3	44:19,20 47:3	teaching 56:21	124:22,22	94:22 95:10
Switches 23:21	49:12 50:13	60:3 65:7,8,12	testified 4:15	96:16 97:2
switching 116:4	51:1 52:7 57:7	82:14 85:6	38:12 39:22	99:21 100:4,6
sworn 4:9,13	63:20 68:15	teachings 81:22	44:9	100:15,21
161:6,9	69:14 70:17	83:3 88:6 135:3	testify 4:13 5:11	101:3,12
system 9:20 10:1	71:22 75:22	135:4	44:16 161:6	103:11 148:22
23:7 24:13,16	77:18 78:3 81:7	Tech 8:22 19:19	testifying 9:18	thicknesses 104:1
25:1,14,18	83:20 85:12	20:2,6,8,17	39:17	thin-walled
27:16,17 47:8	87:13 89:12	21:2 22:12,12	testimony 70:22	88:14
47:10 48:6 63:1	91:9,10 94:7	22:16 23:16,17	161:9	thing 70:19
64:21,22 65:13	95:18 98:12	30:22	testing 22:17	things 15:10
78:9 80:21	99:8 104:20	technical 27:19	43:1 120:18	21:16,17,19
85:19 89:19,22	106:4,9 108:12	27:22 28:2 29:6	122:4	22:10 25:20
108:15,22	109:20 111:22	29:9 155:19	tests 145:4	33:6 58:10
109:1,7,14	114:21 119:8	technically 20:14	Texas 1:16,17	85:10 103:20
112:4 114:12	120:22 127:16	technique 125:14	2:16 25:19	125:2 134:17
114:13,14,18	129:17 133:13	126:18,22	38:18 45:1	134:18 135:1
114:19 115:2	135:17 136:6	127:2,3 133:18	161:1,2,4 162:2	154:20
120:17,19	136:10 137:22	techniques	text 120:13	think 6:7,22 9:14
122:11,17	139:10 140:21	126:14 158:1	121:17 122:1	9:19 16:17,19
123:9 124:14	142:19 144:21	158:10,14	128:4 145:18	19:14 28:10
142:7	145:10 148:8	technologies	146:15 147:10	41:4,16 42:8
systems 21:5,10	149:14 150:13	38:10,16 39:11	147:13,14,15	43:18 45:6 46:1
21:12,12,13,17	151:21 153:14	39:18	147:18 148:1,2	46:12 61:14
22:2,3,4,8,14	taken 1:13 16:15	technology 15:5	Thank 4:10 5:16	62:3 65:7 73:13
22:17,19,20,20	40:7 71:9	15:12 28:3	47:22 107:14	76:12 102:9
22:22 23:3,10	107:17 144:19	38:12,22 39:3	119:14 137:14	105:22 114:4
24:19,20 25:13	153:18 159:15	44:10 45:21	147:1	117:1,5,7 118:8
25:15 26:7,7,9	161:13	115:6	Thanks 77:20	118:13,16,18
26:9,9,10,20,22	takes 99:8	technology-rel...	THEWAY 8:22	121:20 123:19
28:7 39:7,8,9	talked 26:4 36:16	21:4	19:20 20:3,19	124:10,13,16
39:10,12 62:18	89:7 155:22	tend 118:6,9	24:5,9 26:11	128:3 138:4
62:18 91:1	talking 27:3 58:5	136:11 138:1	27:3,6,9,11	140:14 149:9
	74:1 77:16,16	142:13	30:22 31:1	thinking 16:15
T	120:14 124:3	tendency 118:10	35:13	third 109:10
T 108:6	141:17,18	tensile 104:9	thicker 100:18	115:15
table 106:22	tall 75:6	105:15 106:7	103:5	three 20:12,12
107:2 145:7,10	tank 25:10	106:18 107:5,9	thicker-walled	129:6,18
145:12 146:2	tanks 21:13	tension 109:12	94:10	143:10 155:2
147:10,11	taught 58:2	term 27:15 45:12	thickness 64:3,10	three-dimensio...
tailing 36:4	64:21 84:12,17	132:6 157:20	64:14 66:5,11	99:12
take 8:17 10:16	teach 49:20 50:5	test 109:11 112:5	66:14,15 67:1	three-eights
11:13 12:20				

128:17,20	59:15,20 62:11	111:16,20	112:17,17,19	117:8 118:2,3,6
129:1,19 130:1	62:11,14 84:16	112:11,13,16	112:21,22	118:9,11,15,15
130:6 131:1	86:22 95:4	113:4,8,11,14	113:3,4,5,7,8	118:20 119:6,7
145:13,21	101:14 103:2	113:22 114:1,6	113:11,13,14	122:12 123:4
146:4,17,19,19	124:2 125:1	114:7,8 151:19	113:15,16,22	138:14 141:18
147:8,17,20,22	tool's 63:10	treatments 152:5	113:22 114:1,1	142:21 143:4
148:3	tools 24:3 25:22	trial 1:1 44:16	114:6,7,7,8,9	151:4,16,19
three-quarters	42:11 50:16	tried 33:6,7,7	114:14,17,18	152:6,10,14
102:2	51:14,18 56:10	true 11:3 16:18	114:19 115:5	153:2,7,10
throw 81:8	56:16 57:2	23:18 58:3 66:9	115:22 116:20	158:13,15
thumb 75:15	top 21:1 56:14,22	67:5 75:5,13	117:3,4 119:1,3	tubing 69:5 70:9
time 4:2,3 20:18	81:11 83:21	76:22 77:11	119:4 120:4,8	70:9,12,13
20:20 30:10	106:17 108:9	84:16 86:12	120:19 121:1	72:19 91:16
36:1,2 49:1	119:13,14	87:11,12 88:3,5	121:14 122:11	94:10 97:10
65:5 66:7 71:15	137:4,9,18	94:2 114:10	122:16 123:1,2	100:11,11,18
71:20 74:16	139:12 144:21	131:17 142:6	123:2,9 124:13	101:3,4,19
77:1,3,5,8	146:15 149:18	152:12 161:8	125:5,5 134:9	102:1 103:18
91:10 96:6	149:19 150:1	163:9,11	134:15,21	104:8,10 105:4
104:13 107:12	150:17	truth 4:14,14,14	136:17,19,22	119:11
119:17 120:1,3	torque 109:12	161:6,6,6	136:22 137:4,5	Tulsa 12:14,20
121:5,11	total 20:12 23:5	truthfully 5:11	137:8,9,11,11	15:6 24:9
154:14 155:6	touching 161:6	try 93:18 94:18	137:17,18	Tulsa's 15:13
155:10,14	trade-off 85:3	120:7	138:17 139:18	turbulent 118:7
161:10 162:13	144:18	trying 19:4	139:22 140:4,9	118:10
times 5:2 143:10	trade-offs 124:3	156:10 157:20	140:19 141:20	turn 5:20 7:15
title 9:6,7 30:4	125:2 144:15	tube 6:13 47:7,10	142:3,7 143:8	12:6 20:22
titled 125:13	144:19,19	48:6 49:21 50:6	144:3 151:3	71:13 72:4
today 5:12 6:4	TRADEMARK	50:10 62:18	152:17	106:21 134:4
7:21 8:15 20:21	1:1	63:1 64:21,22	tubes 39:3,5	turning 95:9
23:6 71:3	trading 34:20	65:13 66:12,15	48:10,16,19	106:22
155:17 156:2	traditional	66:22,22 67:2,4	49:6,10 61:19	turnover 25:11
157:4	108:15 109:6	67:6,10,13,14	61:19 65:19	twice 54:11 55:10
Today's 17:20	trans- 112:11	67:16 68:9,11	66:4,18 68:2	130:21
toe 47:10 61:1,8	transcript 159:1	74:12,22 75:10	74:16 75:4,12	two 16:1 17:16
65:1,6 80:11,17	159:10,17,22	76:14,20 77:12	75:14 76:15	20:12 28:1 30:3
80:21 81:16	161:16 162:6,7	79:1 80:4,20	77:7 78:12,20	30:3 48:10,16
82:9 86:5 89:22	163:7	84:6 87:7,7	79:11,12 81:5	48:19 50:15
tolerance 80:2	transcription	89:16 91:1,22	84:4 86:19,20	52:15 83:21
123:15	163:10,12	92:4,8,14,21	88:13 90:7,12	85:4 90:12,15
tolerate 123:10	transfer 13:14	93:1,19,20,22	90:13,14 91:5	91:6,7 100:3,4
tool 23:16 26:5	transition 59:22	95:10 101:15	92:13 94:12	102:7 103:15
33:14 50:15,20	60:7,13,15 61:1	103:3,16	95:1,2,6,12	109:1,2 110:8
50:21 51:6,21	transport 78:12	105:11 108:15	96:9 100:3,5	125:18 148:12
52:15 53:14,14	78:20 80:4	109:7,22,22	102:20 109:2,2	148:15 151:3
53:20,20 54:2	86:19 90:13,13	110:13,16,19	115:10,11,12	two-by-two
54:21 55:16,17	95:1,2 109:2,22	111:8,16,20	116:1,1,5,5,14	109:7 149:16
55:22 56:1	110:13 111:7	112:4,5,11,13	116:14,21,21	151:8,9

99:11,11 type 10:4 19:4 26:20 37:13 38:22 73:8 158:4 types 37:3 148:13 typical 45:15,20 73:10 typically 75:1 86:18 88:13 113:20 114:5 typos 7:1,1	101:2 104:7 119:2 123:1 130:11 131:9 131:22 132:14 134:14,20 135:3 138:21 139:16 144:13 144:15,17 149:5 unfortunately 30:13 32:17 UNITED 1:1 units 99:15,16 129:13,14,14 University 12:13 12:20 15:6,12 17:11 18:1 unofficial 30:5 upper 62:7 95:1 95:6 upstream 6:14 6:18,19 59:13 113:13,21 114:6,18 upwards 62:14 use 27:15 71:20 81:22 82:6,13 82:14 85:17 86:5 89:16,20 96:17,19 104:13 105:4 119:2 124:1,18 146:16,17,19 147:7,18,21 148:2 158:10 158:13,15 useable 84:22 uses 44:5 usually 72:15,15 Utilities 17:20 Utility 17:21	121:8 variations 122:11 varies 73:14 various 75:4 105:15 vast 20:20 Veit 108:6 verified 143:20 verify 115:19 116:17 version 108:14 109:6 versus 34:22 56:2 90:15 99:11 116:1,21 118:2 118:10,15 120:3 127:21 128:8 148:10 148:14 157:19 158:2 vertical 34:5 vertically 17:20 129:20 vessels 21:13 vibration 21:18 volume 98:2,4,12 99:22 101:13	65:2,20 66:6 67:3,18 68:13 77:20 80:6,14 82:2,16 101:7 104:15,18 113:18 131:13 131:18 139:3 140:5 145:15 153:14,22 158:18,22 159:1,4,6,9,12 159:21 160:1 161:12 want 10:17 60:7 60:13,15 69:17 72:1 77:18 81:22 83:20 88:10 93:13 95:20 108:12 135:18 152:11 158:22 159:22 wanting 82:6 wants 63:15 Washington 1:21 163:2 164:3 water 23:11 128:21 way 25:4 41:7 54:1,20 55:19 56:5 63:14 67:12,19,21 68:2,10,14 70:14 82:9 93:12,18 114:1 114:14 117:6 129:7,11 132:3 we'll 127:19 we're 24:1 27:3 31:14 40:8 77:16 104:13 149:9,9,20 151:15 we've 22:22 23:1 25:9,12 32:12 32:20,20,21 33:7,7,8 36:16 40:1 70:16	77:22 100:20 103:4,14 weak 103:14 Weatherford 1:2 4:6 69:19 70:7 162:3 163:4 164:8 Weatherford's 70:13 week 159:20 Welcome 154:1 well-known 71:15 wellbore 50:15 50:20,21 51:14 51:18,21 57:11 57:12,19 81:15 143:21 157:12 wells 9:10 28:16 29:21 30:9 31:2 31:4,6,8,11,13 31:14,15,17,18 31:19,21,22 32:5,6,9,15,19 34:5,5 35:10,11 35:22 36:6,12 38:19 44:3,6 45:11,16,20 46:6,7,22 47:1 109:1 went 118:17 139:18 weren't 38:3 Western 17:11 18:1 38:17 whereof 161:17 wide 75:6 widely 72:2 73:21 77:15 wider 104:1 width 102:10,11 102:17 103:4 103:14,18,21 Wilcox 32:22 Wilson 2:3,4 3:2 4:5,5,6,17 5:17 18:7,9 24:4
U U.S 1:2,4 38:19 44:11 135:8 145:22 147:17 162:3 163:4 164:8 Uh-huh 21:3 98:11,14 120:16 126:15 127:18 129:21 135:10 136:8 142:22 150:16 152:19 unclear 27:2 137:13 unconsolidated 27:16 44:3 45:3 45:7 46:13 157:5,9,14,21 158:3,5,6 understand 13:14 70:7,21 79:22 80:20 83:3 92:16 102:20 105:13 119:7 123:8 138:10,14 understanding 45:12 154:19 understands 92:20 understood 58:1 64:13 65:17 66:3 85:6 91:16 94:4 100:21	V v 1:3 162:3 163:4 164:8 vacuum 77:12 85:10 value 119:19	W Wait 102:5 waive 162:9 wall 64:3,10,13 66:4 67:1,17 88:15 89:1 91:12,16,20 92:4,7,20,21,22 93:19 94:22 96:16 97:2 99:21 100:4,6 100:15,21 101:3,12,18 walls 68:11 100:18 Walters 2:12 3:3 4:7,7 5:16 10:9 55:14 56:18 57:5 61:21 63:11 64:17	W Wait 102:5 waive 162:9 wall 64:3,10,13 66:4 67:1,17 88:15 89:1 91:12,16,20 92:4,7,20,21,22 93:19 94:22 96:16 97:2 99:21 100:4,6 100:15,21 101:3,12,18 walls 68:11 100:18 Walters 2:12 3:3 4:7,7 5:16 10:9 55:14 56:18 57:5 61:21 63:11 64:17	

40:3,10 55:18 56:21 57:7 62:4 63:12 64:20 65:8 66:2,8 67:5 68:6,15 71:5,12 77:18 77:21 80:9,16 82:5,22 101:9 104:20 107:12 107:21 113:20 131:15,20 139:5 140:8 145:17 148:8 153:12,15 158:20 159:18 161:11 wisdom 91:11 wit 161:5 withstand 125:5 witness 1:12 4:9 18:8 26:16,18 104:12,17,19 107:14 159:11 161:9,9,17 162:8 163:5,17 164:9 words 117:13 118:18 work 8:16,21 10:6,10 18:12 18:20 19:1,17 25:4 30:21 35:13,18 36:2 37:4 127:19 156:11,17,22 working 26:6 30:13 88:15,19 89:2 95:22 122:10 works 32:5 world 124:11 125:1 worry 35:11 157:11 wouldn't 70:14 122:18 142:6 Wow 13:2	wraps 96:14 writing 161:8 written 162:22 wrong 48:13 102:14,15 wrote 50:8 X X 3:1 78:14 119:17 121:6 128:5 Y Y 78:11,18 119:16 121:5 128:1 Y-manifold 151:11 yeah 6:18 18:8 19:9 33:16 41:3 41:3 63:4 68:14 73:19 82:17,21 85:3 92:17 106:13 130:4 135:6 137:13 137:15 138:19 146:21,21 147:1,4 year 8:20 years 13:6 15:9 17:14 20:21 22:1 23:2 29:14 30:3,14 38:8 39:20 115:5 155:12,17,21 156:21 Yeh 47:6,12,16 48:1,8,9,15,18 49:3 50:9,14,18 51:2,5 52:2,6,7 52:12,20 53:6 53:10,18 54:1 54:20 55:10,18 56:4,9,13,21 57:8,18 58:2,12 59:14 60:10,10 60:17 62:21 63:20,22 64:7	64:14,20 65:8 75:17,22 76:1,9 76:12 81:14 82:14 83:3,16 84:4,6,8,12,17 85:6,17,22 86:3 86:4,10 88:6 89:14 91:3 96:20 103:1 144:18 Yeh's 48:5 58:15 60:3,14 81:21 Yeh2 60:11 78:1 78:5 80:22 81:8 89:15 139:13 140:17 Yeh2's 80:1 81:20 82:14 83:3 140:2 yellow 79:14 Yep 26:16 84:3 yield 105:15 106:6 107:9 yielding 143:10 you-all 18:5 Z zero 78:15 zone 49:22 50:7 50:11 134:3,4,6 134:8 0 0.75 143:9 007 6:17 49:14 71:16 72:3 96:6 1 1 108:13 125:22 126:12 145:7 145:10,12 146:2,20 1.25 102:7 1.3 130:4 1.31-inch 143:10 1.33 122:9,15 1.4 130:3 1.5-inch 143:9	1.6 130:3 1.7 130:4 1:43 153:17,18 10 27:17,21 32:2 36:8,10,10 38:9 49:3 51:1 100:14,16,17 102:2 10-gauge 100:10 10/31/26 161:22 10:00 40:7,9 10:49 71:8,9 100 5:3 81:5 91:9 93:15 100-ish 81:3 1000 51:3 53:11 53:13 1003 105:21 106:2,5,10 1005 47:16,16 51:7,12 53:15 53:21 1006 77:19,21 78:4 1008 135:8 1012 52:4 1013 132:21,22 142:15,18 1014 52:5 125:9,9 125:22 126:16 1016 107:22 108:1 1018 105:14 107:2,5,9 102 87:13 1020 51:10,16,19 103 96:12 1030 51:19 1031 69:6,11,14 69:15 70:12 107 104:21,22 10A 51:2 52:2 11,333,007 1:4 11:01 71:9,11 11:57 107:16,17 110 94:7,14,21 1100 1:17 161:4	1100C 52:13 54:17 1110B 52:20,21 1115 53:7 112 81:11 1120A 54:8 1120B 54:10 113 95:9 115 5:20 104:22 105:2 117 139:10,11 11A 54:9,11 55:5 55:7 11B 52:21 54:10 54:12 55:11 11C 52:9,18 53:4 12 27:18 42:17 121:1,17 122:2 149:14 12/18 145:22 146:10,17,19 147:17,20 12:41 107:18,20 123 106:15,17 140:21 141:1,2 12549 77:22 126 6:10 7:5 13 44:8,14 78:4 100:14,17 102:2 13-gauge 100:11 138 97:6,9 139 100:1 14 10:17,18 11:6 57:8,8 15 1:8 75:18 76:1 77:13 78:4,7,22 80:1 162:4 163:5 164:10 153 3:3 15th 1:13 161:3 16 47:19 55:7 76:2 119:9 120:13 16-foot 55:16 16/30 145:20 146:3,4,5,6,12
--	--	--	---	--

146:16 147:16 147:19 148:3 167 106:1,5 17 11:14,15 60:17 170 81:8,12 172 104:22 1730 1:21 163:1 164:2 181 106:22 19 112:6 1963 126:1,3 1968 126:2,6,7 1992 12:16 1997 15:6	11:11,11 36:9 40:11,22 42:18 44:19 47:4 49:13 68:16 71:13 81:7 83:9 85:13 88:8 139:11 140:22 2003 8:8,9,12,15 9:12 12:6 15:4 17:17 19:15 21:1 24:8 40:11 40:12 42:18 44:9 20036 1:21 163:2 164:3 2004 7:10,10,20 8:4,6 10:6 11:13 12:1 17:11 133:11 2007 155:6 2008 36:3 2009 155:6 2014 108:10 2017 69:21,22 2018 94:4 96:6 100:21 104:7 123:1,8 131:21 132:14 134:14 135:2 138:9,13 139:16 144:13 148:13 149:5 202 1:22 163:2 202)-232-0646 162:15 202)232-0646 164:4 2020 30:12 36:3 2021 49:18 2022 8:17 2024 9:4 2025 1:8,14 6:1 7:18 8:17 9:1 19:20 161:3,17 162:4,20 163:5 164:10 20th 161:17 214 2:17	22nd 159:20 23 120:22 121:1,4 121:17 122:1 155:21 231 106:9,12,13 106:17 232-0646 1:22 163:2 24 49:1,3 85:22 86:3 26 47:19 27 52:7,9 53:6,10 54:7,16 56:14 56:22 28 48:10 56:14,22 57:8,8 63:22	120:13 121:4 325 135:19 137:11 326 136:18 326a 136:21 137:3,7,16 326b 137:1 326c 137:5,9,11 137:12,18 33 48:18 331 106:21 107:1 34 48:18 35 47:20 161:11 390 2:6	135:18 500 77:11 5000 119:18,18 120:18,19 121:7,7 122:4 122:19,20 123:10,15 124:5,14,17 125:5 143:5 152:6,10 153:2 153:10 53 52:9,11 55 52:12 54:16 56 68:21,22 143:9 57 86:1,4 5729 161:21 58 52:20 59 86:1 136:7,7
2		3	4	6
2 20:22 24:7 114:22 115:1 130:15,16 135:15,16 138:10,13 142:19 143:1 144:21 145:19 152:13 2- 48:14 2,000 80:4 82:8 83:5 106:11 2,001 106:13 2.9 129:7,8 2:00 153:18,20 2:06 159:8 2:07 159:13,15 2:09 1:14 159:15 160:2,4 20 30:15,20 35:12 36:5 63:20,21 63:22 75:18 76:1 112:1 20-plus 156:21 20/40 145:12 146:16 147:7 147:22 2000 80:13 2000s 155:5 2001 1:17 2:14 161:4 162:2 2002 5:15,17 7:7 8:6 10:5,16		3 8:21 12:7,9 19:16 40:22 127:16,20 128:8 130:18 130:20 131:4 133:13 135:5 135:19 136:2,2 136:5,17,20 137:8,17 148:9 149:14,17 150:13 161:11 3,000 60:19 61:1 61:3,8 76:5 88:12 89:8 96:11 3,200 72:5 89:8 30 22:1 30:16,20 35:12 48:10 60:17 75:18,22 30-plus 13:6 3000 72:4 74:1,5 74:14,18,20 80:2,5,10 82:15 82:17 83:4 88:16 89:3,7,8 93:16 96:1,8,11 123:11,17 124:19 3002 93:16 32 119:8,10,11,16	4 3:2 6:12 19:16 40:11 69:15 135:17 136:6 137:22 40/60 145:12 146:16 147:6 147:22 400 129:9,10,14 129:20 41 44:21 42 49:12,13 111:22 112:3 112:10 44 7:16 45 50:13 4685 2:5	6 17:18 49:18 69:22 109:21 140:14 149:18 150:2,20 151:2 155:5 60 29:14 53:6 83:22 6000 121:15,19 121:22 61 85:14 62 53:10 64 95:21 65 90:5 130:9 65- 121:19 6500 57:12 60:4 61:12,20 62:14 63:10,17 66 54:7 90:5 675 102:8 68 87:14 96:15 69 96:15 695 125:22 696 130:16 697 127:17
			5	7
			5 42:17 56:4 140:14 149:20 151:7 5-and-a-half 148:20 5,000 60:19 76:4 78:8 79:3 83:7 5,000-foot 57:14 58:12 59:21 60:6 5,000-foot-long 63:8 5,113,935 135:9 50 28:16,19 31:2	7 43:1 107:2 139:13 140:2,7

140:17 151:10	932-0778 2:8			
155:5	94 71:13,15 85:12			
71 44:20,21	949 2:8			
75 102:7	953-6500 2:17			
750 53:14,21	96 71:22 88:7,11			
7500 120:5,9,12	88:11 95:19,21			
75201 2:16 162:2	99 47:3 89:12			
77 83:13				
79 84:2 139:12				
7C 53:15,21				
7th 6:1 7:18				
8				
8 54:3,22 55:4				
56:4 109:20,21				
111:6 126:5				
155:5				
8-and-a-half				
148:20				
8-foot 54:17				
55:17				
8-foot-long 55:11				
8/12 146:17,20				
147:4				
8:59 1:14 4:3				
161:3				
80 150:2				
800A 49:5				
800C 49:5				
812 1:21 163:1				
164:2				
86 68:16,22				
88 75:17				
8A 103:1				
8C 49:2,9				
9				
9 10:19 109:20				
110:5,7,19				
111:12 151:21				
155:6 161:12				
9:47 40:6,7				
900 2:15 162:2				
90s 16:5				
91 83:10				
92 83:20 102:22				
92660 2:7				
93 100:10				