

Filed on behalf of Weatherford U.S., L.P.

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

WEATHERFORD U.S., L.P.,
Petitioner,

v.

HALLIBURTON ENERGY SERVICES, INC.,
Patent Owner.

Case No. IPR2024-00990
U.S. Patent No. 11,333,007

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	GROUND 1: YEH DISCLOSED OR SUGGESTED THE CLAIMED SHUNT SYSTEM MODIFICATION REQUIREMENTS	2
A.	Yeh Suggested the Thicker Upstream Walls of Claim 1[e].....	3
B.	Halliburton’s Alleged Teaching Away Ignores Both the Petition and the Prior Art	7
C.	Halliburton’s Remaining Arguments Also Fail	13
D.	Claim 2	16
1.	Halliburton Agrees Yeh2 Taught Declining Slurry Flow Rate Was an Issue	16
2.	Yeh/Yeh2’s Slurry Flow Rate Disclosures Taught Tradeoffs, Not Criticisms of Increasing Nozzle Size	19
E.	Claim 4	21
F.	Claim 5	22
III.	GROUND 2: THE YEH/YEH2 COMBINATION DISCLOSED OR SUGGESTED THE CLAIMED INSTALLATION METHOD	24
IV.	GROUND 3: THE YEH/JONES COMBINATION DISCLOSED OR SUGGESTED THE CLAIMED SHUNT TUBE MATERIAL REQUIREMENTS	25
V.	GROUND 4: THE YEH/JONES/YEH2 COMBINATION DISCLOSED OR SUGGESTED THE CLAIMED SHUNT TUBE PRESSURE RATING REQUIREMENT.....	27
VI.	CONCLUSION	27

TABLE OF AUTHORITIES

	Page No(s).
<i>Cardiac Pacemakers v. St. Jude Medical</i> , 381 F.3d 1371 (Fed. Cir. 2004)	14
<i>CRFD Rsch. v. Dish DBS</i> , 876 F.3d 1330 (Fed. Cir. 2017)	5, 8, 11
<i>In re Hedges</i> , 783 F.2d 1038 (Fed. Cir. 1986)	16
<i>Honeywell Int’l v. 3G Licensing</i> , 124 F.4th 1345 (Fed. Cir. 2025)	14
<i>In re Huang</i> , 100 F.3d 135 (Fed. Cir. 1996)	10
<i>In re Kotzab</i> , 217 F.3d 1365 (Fed. Cir. 2000)	15, 16
<i>KSR Int’l v. Teleflex Inc.</i> , 550 U.S. 398 (2007)	13, 26
<i>In re Kubin</i> , 561 F.3d 1351 (Fed. Cir. 2009)	14
<i>In re Mouttet</i> , 686 F.3d 1322 (Fed. Cir. 2012)	6
<i>Nextremity Sols. v. Extremity Med.</i> , IPR2022-00802, Paper 35 (P.T.A.B. July 26, 2023)	8
<i>In re Nuvasive</i> , 841 F.3d 966 (Fed. Cir. 2016)	7
<i>Pfizer v. Sanofi Pasteur</i> , 94 F.4th 1341 (Fed. Cir. 2024)	14

Weatherford U.S. v. Halliburton
Patent No. 11,333,007 – IPR2024-00990

<i>R.J. Reynolds v. Philip Morris</i> , IPR2021-00585, Paper 36 (P.T.A.B. Sept. 8, 2022)	17
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Unless noted, all emphasis is added to quoted material in this brief.

TABLE OF EXHIBITS

Exhibit No.	Description
1001	U.S. Patent No. 11,333,007 (“’007 Patent”)
1002	File History for U.S. Patent No. 11,333,007
1003	Declaration of Michael R. Chambers Sr. (“Chambers Decl.”)
1004	CV of Michael R. Chambers Sr.
1005	U.S. Patent No. 9,797,226 (“Yeh”)
1006	IPTC 12549 (“Yeh2”)
1007	U.S. Patent No. 4,945,991 (“Jones”)
1008	U.S. Patent No. 5,113,935 (“Jones2”)
1009	L.G. Jones et al., <i>Alternate Path Gravel Packing</i> , Society of Petroleum Engineers, SPE 22796 (Oct. 1991)
1010	U.S. Patent No. 7,661,476
1011	<i>ExxonMobil Awards Alternate Path Technology License to Weatherford</i> , ExxonMobil Press Release (Aug. 27, 2013)
1012	U.S. Patent No. 5,588,487
1013	G. Hurst et al., <i>Alternate Path Completions: A Critical Review and Lessons Learned From Case Histories With Recommended Practices for Deepwater Applications</i> , Society of Petroleum Engineers, SPE 86532 (Feb. 2004) (“Hurst”)
1014	K.W. Lagrone et al., <i>A New Development in Completion Methods The Limited Entry Technique</i> , Society of Petroleum Engineers, SPE 530 (July 1963) (“Lagrone”)
1015	M.T. Hecker et al., <i>Extending Openhole Gravel Packing Capability: Initial Field Installation of Internal Shunt Alternate Path Technology</i> , Society of Petroleum Engineers, SPE 135102 (Sept. 2010) (“Hecker”)
1016	A. Bonner et al., <i>Design and Validation of an Improved Shunt Tube System</i> , Society of Petroleum Engineers, SPE-169440-MS (2014) (“Bonner”)

Exhibit No.	Description
1017	API Technical Report 5C3, published in December 2008 with an Addendum in October 2015 (excerpts)
1018	ASTM A554-16: Standard Specification for Welded Stainless Steel Mechanical Tubing (2016) (excerpts)
1019	Declaration of Christine Diedrich of the Society of Petroleum Engineers
1020	Complaint for Patent Infringement, <i>Halliburton Energy Servs. v. Weatherford U.S. L.P.</i> , Case No. 24-cv-00090 (W.D. La. Jan. 22, 2024)
1021	U.S. District Courts – Combined Civil and Criminal Federal Court Management Statistics (March 31, 2023), available at https://www.uscourts.gov/statistics-reports/federal-court-management-statistics-march-2023
1022	Shahryar Saebi, <i>The Evolution of Completion Designs Using Alternate Path (Shunt-Tubes) Technology</i> , Society of Petroleum Engineers SPE 155129 (Mar. 2012)
1023	U.S. Patent No. 5,476,143
1024	U.S. Patent No. 7,938,184
1025	Larry G. Myers et al., <i>Case History in Achieving High Rate Producers in Sub Sea Gravel Packed Completions</i> , Society of Petroleum Engineers, SPE 39433 (Feb. 1998)
1026	Raymond Tibbles, et al., <i>Design and Execution of a 3000-ft Horizontal Gravel-Packed Completion (A Kazakhstan Case History)</i> , Society of Petroleum Engineers, SPE 64410 (Oct. 2000)
1027	M.D. Barry et al., <i>Openhole Gravel Packing With Zonal Isolation</i> , Society of Petroleum Engineers, SPE 110460 (Nov. 2007)
1028	U.S. Patent No. 5,890,533
1029	ASTM A500/A500M-13: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes (2013) (excerpts)
1030	U.S. Patent No. 4,629,218
1031	Declaration of Stephen McNamee
1032	Fischer Stainless Steel Tubing - Part Number List

Exhibit No.	Description
1033	L.G. Jones et al., <i>Gravel Packing Horizontal Wellbores with Leak-Off Using Shunts</i> , Society of Petroleum Engineers, SPE 38640 (Oct. 1997)
1034	D.W. Bryant & L.G. Jones, <i>Completion and Production Results from Alternate-Path Gravel-Packed Wells</i> , SPE Drilling & Completion, SPE 27359 (Sept. 1995)
1035	U.S. Patent No. 6,588,506
1036	Halliburton Cementing Tables (1979) (excerpts)
1037	Introduction to Otis Multi-Position Gravel Pack System, Otis Engineering Corporation, Technical Manual 2004/88 (excerpts)
1038	Johnson Oil and Gas Well Screens Catalog (1991) (excerpts)
1039	U.S. Patent No. 2,905,245
1040	U.S. Patent No. 8,839,861
1041	U.S. Patent No. 5,842,516
1042	Order granting stay, <i>Halliburton Energy Servs. v. Weatherford U.S. L.P.</i> , Case No. 24-cv-00090 (W.D. La. June 17, 2024)
1043	Transcript of May 15, 2025 Deposition of Dr. Robert A. Durham
1044	Second Declaration of Michael R. Chambers Sr. (“Second Chambers’ Decl.”)

I. INTRODUCTION

Halliburton’s briefing confirms the ’007 Patent should have never issued. The Response made no effort to defend the two Claims 11 and 12 Halliburton asserted in district court, thereby conceding their unpatentability. The remaining claims are equally flawed. Halliburton devotes most of its briefing to addressing a single limitation 1[e] before swiftly canceling nearly every original ’007 Patent claim in its Contingent Motion to Amend. As explained in the Weatherford’s Opposition brief, Halliburton’s Substitute Claims 24-40 are plainly unpatentable over Halliburton’s own prior art previously cited in the Petition.

Halliburton offers no roadblock to canceling the ’007 Patent. Halliburton agrees with the Petition on claim construction and the level of ordinary skill in the art. It raises no objection that Yeh, Yeh², Jones, and Jones² are prior art. Halliburton never disputes a motivation to combine or offers any objective indicia of non-obviousness. And, the Response identifies no difference between the prior art and the original ’007 Patent claims.

Halliburton’s primary argument defending Claim 1[e] withstands no scrutiny. Halliburton concedes it won allowance by asserting the prior art did not teach “placing the higher pressure rated components at an upstream location and lower pressure rated components at a downstream location.” EX1002, 573; POR, 4. Yeh identified the same problem and taught exactly those features, as Dr. Durham and

Halliburton both admit. EX1043, 49:12-50:12; POR, 31. Halliburton’s argument that neither Yeh nor Yeh2 suggest Claim 1[e] cannot be sustained because both Halliburton and Dr. Durham conceded that Yeh’s wall-thickness disclosures were not limited to a crossover joint. Halliburton’s remaining arguments attack strawmen and ignore the prior art.

Finally, Halliburton’s claim that increasing pressure rating using well-known design parameters, such as wall thickness or tubing material, would have been non-obvious crumbles under the weight of voluminous industry-specific prior art and Mr. Chambers’ extensive discussion of it cited in the Petition.

Simply put, Claims 1-12 and 14-23 should be canceled.

II. GROUND 1: YEH DISCLOSED OR SUGGESTED THE CLAIMED SHUNT SYSTEM MODIFICATION REQUIREMENTS

Halliburton devotes most of its abbreviated Response to addressing Ground 1, asserting that Claim 1[e] is patentable. POR, 10-37. But there is hardly any dispute. Halliburton and its expert, Dr. Durham, admit that Yeh and Yeh2 “identify the same problem as the ’007 Patent.” *See* POR, 30; EX2002 ¶115. Halliburton identifies no error in the Board’s assessment that Claim 1 was obvious over Yeh as understood by one of ordinary skill in the art. *See* Paper 7 (“DI”), 28-30.

Halliburton’s assorted arguments fail because they: (1) mischaracterize or misunderstand Yeh’s and Yeh2’s teachings; (2) attack arguments Weatherford did not

make; or (3) ignore the Petition’s actual grounds. *See* POR, 10-32. The ’007 Patent claims should be canceled over Ground 1.

A. Yeh Suggested the Thicker Upstream Walls of Claim 1[e]

Halliburton principally argues that Yeh and Yeh2 did not suggest Claim 1[e], POR, 11-16, which broadly claims thicker walls upstream: “the transport tube of the first sand screen assembly has a first wall thickness and the transport tube of the second sand screen assembly has a second wall thickness, the first wall thickness being greater than the second wall thickness.” EX1001, 18:51-55.

The Board correctly found at institution that Yeh suggested Claim 1[e]. DI, 28-29. Indeed, Yeh taught that concentric screens can contain higher pressure and should be placed at the higher-pressure heel of the well. Pet., 41 (citing EX1005, 28:10-24, 30:13-26; EX1003 ¶¶291-92). Yeh expressly taught that “a certain surrounding wall thickness is required” to maintain “mechanical integrity”—i.e., to stay within the burst, bending, and collapse ratings” of the flow paths. EX1005, 28:20-24; EX1003 ¶¶295-96; Pet., 41-42.

The Response only takes issue with the last sentence, misreading Yeh at column 28:20-24 to assert that “Yeh addresses wall thickness of the crossover joint, not wall thickness of the shunt tubes.” *See* POR, 12-13 (citing EX1005, 28:20-24) (emphasis removed). That contrived interpretation did not last long.

Neither Halliburton nor Dr. Durham could maintain the pretense: both conceded that Yeh’s disclosure was ***not*** limited to the crossover joint. The Response offeres in support only its own speculation and a few paragraphs of Dr. Durham’s disavowed testimony. *See* POR, 12-16 (citing EX1005; EX2002 ¶¶88-92). But the Response itself ultimately acknowledged that Yeh expressly taught the need “to maintain mechanical integrity” in its “shunt tube design.” POR, 15-16. On cross-examination, Dr. Durham likewise acknowledged that a skilled artisan understood that the mechanical integrity, including wall thickness, that Yeh described needing is required in “both the sand screen and crossover joint secondary flow paths.” EX1043, 63:22-64:19, 65:16-66:1; *see also* EX2002 ¶92.

Even a cursory reading of Yeh’s disclosure demonstrates that Yeh expressly states the wall thickness is necessary “to maintain the mechanical integrity... of the secondary flow paths,” not solely the crossover joint:

In order to maintain the ***mechanical integrity*** (that is, to stay within the burst, bending, and collapse ratings) ***of the secondary flow paths***, a certain surrounding ***wall thickness*** is required. This, in turn, limits the inside diameter of the crossover joint.

EX1005, 28:20-24; Pet., 41-42; EX1003 ¶¶291-93. Halliburton’s selective reading ignores the axiom that the prior art “must be considered for everything that it

teaches,” *CRFD Rsch. v. Dish DBS*, 876 F.3d 1330, 1349 (Fed. Cir. 2017), and should be rejected.

Ample evidence supports Yeh’s disclosure. The well-known need for shunt tubes to maintain mechanical integrity while withstanding high pressure only exposes the flaws in Halliburton’s strained interpretation of Yeh. *E.g.*, EX1006, 5 (“Burst strength of shunt tubes must therefore be capable of accommodating this high hydraulic pressure.”); EX1015, 2 (“In-house best practices limit the shunt friction pressure to 3,000 psi to maintain reliability in the shunt packing system.”); EX1016, 12 (“The overall testing substantiated the goal rating of 5000 psi burst pressure [for the shunt tubing].”).

Yeh plainly taught that wall thickness related to pressure containment. *Pet.*, 41-42 (citing EX1005, 28:20-24). Yeh’s teaching of a high pressure inside the secondary flow paths necessitates a high-pressure shunt tube system using a concentric sand screen, as Dr. Durham concedes. EX1043, 65:8-66:1. Halliburton’s contrary position that Yeh did not suggest thicker walls upstream, *POR*, 13, is flatly contradicted by its own decision not to defend the patentability of asserted Claims 11 and 12 over Yeh and Yeh2, *see generally* *POR* (offering no argument that Claims 11 and 12 are valid over Weatherford’s challenge). Claim 11 requires the upstream shunt system have a greater burst pressure than the downstream. *See Pet.*, 60-61; EX1001, 19:42-54 (Claim 11). Claim 12 further specifies the upstream assembly

operates at pressures between 5000-10000 psi, while the downstream operates as no more than 5000 psi. EX1001, 19:55-60. Thus, a skilled artisan understood the need for higher pressure ratings in upstream shunt tubes toward the heel of a long horizontal well.

Indeed, the experts agree on the direct relationship between wall thickness and pressure rating. Dr. Durham admitted that round shunt tube wall thickness is directly proportional to pressure rating and that wall thickness is proportional to pressure rating for rectangular tubing. EX1043, 66:21-68:14, 96:12-97:5; *see also* EX2002 ¶¶96 (“Even with some increased wall thickness, the working pressure rating of these eccentric designs was still limited to 3,000 PSI, limiting the overall length of the sand screen assembly.”), 100 (“wall thickness, and associated pressure ratings”), 103 (“Reducing the wall thickness in the downstream screens would further limit the use of the eccentric screens, as it would have reduced the pressure rating of those screens....”).

Halliburton cannot credibly assert that a skilled artisan would not have known to increase wall thickness in shunt tubes toward the heel of a horizontal well despite knowing that (1) a higher burst pressure rating was needed and (2) the pressure rating was proportional to wall thickness in shunt tubes. *In re Mouttet*, 686 F.3d 1322, 1333 (Fed. Cir. 2012) (“[T]he test for obviousness is what the combined teachings of the references would have suggested to those having ordinary skill in the art.”).

The Board should sustain its finding of unpatentability in view of Ground 1.

B. Halliburton’s Alleged Teaching Away Ignores Both the Petition and the Prior Art

Halliburton next asserts that Yeh and Yeh2 taught away by using “concentric screens, with thinner walls, upstream.” POR, 17. Because Halliburton both attacks a strawman and ignores the actual teachings of the prior art, this argument also fails.

First, Halliburton argues Ground 1 proposed that Yeh used concentric screens with round shunt tubing upstream and eccentric screens with thicker, rectangular tubing downstream. *See* POR, 16-26. That is inaccurate. In fact, the Petition identified Yeh’s disclosure of using *round tubes* in eccentric screens, as shown at right in Yeh’s Figure 8C

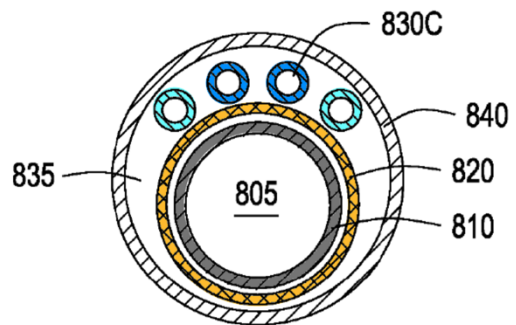


FIG. 8C

example. *See* Pet., 36-37 (Claim 1[b]); EX1005, 24:10-12; *see also id.*, 4:57-60; EX1003 ¶276. On cross-examination, Dr. Durham acknowledged that Yeh disclosed “an eccentric screen with round shunt tubes.” EX1043, 48:22-49:11; EX2002 ¶94 n.84 (“Eccentric designs with round shunt tubes were known....”).

Because neither Halliburton nor Dr. Durham offers any response to the Petition’s actual ground, the Board may find the claims unpatentable over Ground 1 on this basis. *E.g., In re Nuvasive*, 841 F.3d 966, 974 (Fed. Cir. 2016) (no findings

required when patent owner “did not present arguments about those limitations to the Board”); *Nextremity Sols. v. Extremity Med.*, IPR2022-00802, Paper 35 at 26 (P.T.A.B. July 26, 2023) (canceling claims and adopting factual statements about the prior art when “Patent Owner does not identify any error in Petitioner’s foregoing arguments”).

Weatherford now addresses Halliburton’s scattershot arguments for Claim 1[e] in the event the Board decides to entertain them. POR, 16-26. Claim 1[e] expansively claims the concept of using thicker walls upstream and thinner walls downstream, EX1001, 18:51-55, which is plainly suggested by Yeh, *supra* §II.A. Halliburton’s selective criticism of specific prior art designs ignores the teachings of the prior art as a whole and should be rejected. *CRFD Rsch.*, 876 F.3d at 1349 (“A reference must be considered for everything that it teaches, not simply the described invention or a preferred embodiment.”).

Halliburton’s first error is assuming that rectangular tubes always have a greater wall thickness than round tubes. POR, 17. But Yeh never specifies the wall thickness for any shunt tubes and thus provides no basis for Halliburton’s assumption. *See generally* EX1005. Halliburton asserts that Mr. Chambers explains that rectangular tubes used in eccentric screens were 2.4 mm thick while concentric screens round tubes were 2 mm thick. POR, 17 (citing EX1003 ¶162). But those are just two examples from the Hurst and Barry prior art, EX1003 ¶162, and

Halliburton notably omits Hurst's other rectangular tube example with a 0.0625" (1.6-mm) wall thickness, which constitutes a thinner eccentric tube wall than Barry's 2 mm, EX1003 ¶162.

Halliburton next asserts that "the wall thickness required to contain pressure in concentric screens with smaller, round tubes is demonstrably less than the wall thickness required for eccentric screens using larger, rectangular tubes," but fails to explain why the concentric screens in Yeh's design necessarily use smaller tubes or why the eccentric screens use rectangular tubes at all, much less larger, rectangular tubes. POR, 17. In fact, as Dr. Durham conceded, Yeh discloses that both concentric and eccentric screens use "two or more shunt tubes," EX1043, 47:19-48:21, meaning that they could have the same number of transport tubes and thus could require approximately the same cross-sectional flow area in those tubes. Additionally, if the eccentric screen used round tubes as Yeh discloses, EX1043, 49:3-11; Pet., 36-37, the wall thickness in the concentric shunt tubes would necessarily be greater than the wall thickness in the eccentric screens because burst pressure is directly proportional to wall thickness in round tubes, EX1003 ¶235; EX1043, 66:21-67:4 (Dr. Durham agreeing). Yeh expressly teaches higher pressure in the heel and "a certain surrounding wall thickness is required" to maintain the mechanical integrity of the flow path. EX1005, 28:20-23; *see also* EX1006, 5 ("Burst strength of shunt tubes must therefore be capable of accommodating this high hydraulic pressure.").

The mere optimization of wall thickness in the absence of unexpected results is not patentable. *In re Huang*, 100 F.3d 135, 139 (Fed. Cir. 1996) (“Because Huang does not contend that he has achieved unexpected results by increasing the thickness of the polyurethane layer, the Board properly concluded that the prior art grips in combination with Lau created a *prima facie* case of obviousness.”).

Second, Halliburton argues that Yeh2 taught “achiev[ing] higher pressure ratings by changing numerous design parameters other than shunt tube wall thickness.” POR, 18. But Yeh2 says nothing about tubing wall thickness at all. Yeh2’s sole statement about shunt tube pressure containment is: “Round shunt tubes were chosen to increase the mechanical strength and pressure integrity required for extreme length gravel packing.” EX1006, 4. Dr. Durham agrees: “None of these design factors relates to shunt tube wall thickness and there is no teaching in *Yeh2* that does.” EX2002 ¶109. Halliburton’s passing claim that Yeh2 “actually thins shunt tube walls,” POR, 19, provides no citation, nor could it, because Yeh2 does not disclose wall thickness. *See generally* EX1006; EX2002 ¶109. Yeh2 does not discourage a skilled artisan from adjusting wall thickness to achieve desired pressure ratings.

Third, Halliburton claims the Petition “offers no reason” for increasing “wall thickness of the upstream concentric screen.” POR, 19-20. As discussed, the undisputed teachings of Yeh and knowledge of a skilled artisan show that: (1) a

higher burst pressure rating was needed in heel shunt tubes, and (2) burst pressure is proportional to wall thickness. *Supra* §II.A; Pet., 41-43 (citing EX1005, 28:10-24, 30:13-26; EX1003 ¶¶292, 295).

Fourth, Halliburton claims that the Petition never addresses “balanc[ing] shunt tube wall thickness with other design considerations in concentric screens.” POR, 20-21. Yeh expressly taught that wall thickness was a design need to maintain mechanical integrity of the flow path: “[A] certain surrounding wall thickness is *required*.” EX1005, 28:20-23.

Fifth, Halliburton argues that one of skill would not be motivated to use concentric tubes that exceed a “0.095-inch wall thickness of eccentric tubes.” POR, 22. Halliburton’s reference to a few specific examples in Mr. Chambers’ background discussion do not address Yeh’s broader teachings about shunt tube design. POR, 22 (citing EX1003 ¶162); *CRFD Rsch.*, 876 F.3d at 1349 (“A reference must be considered for everything that it teaches, not simply the described invention or a preferred embodiment.”).

Finally, Halliburton disputes the Petition’s showing that one of skill would have been motivated to decrease downstream tube wall thickness. POR, 22-24. Decreasing eccentric screen shunt tube wall thickness would not downgrade its pressure rating below 3,000 psi or limit the maximum packing length to less than 3,000 feet, as Halliburton claims. POR, 22-25. Bonner and Hurst disclosed that

unmodified rectangular shunt tubes “substantiated the goal rating of 5000 psi burst pressure.” EX1016, 12; EX1013, 2 (Hurst: rectangular tube burst pressure “is currently 5,000 psi”). There was room to reduce wall thickness in Bonner or Hurst, because neither of their shunt tubes was at its pressure design limit at 3,000 psi.

Halliburton’s claim that reducing wall thickness would *not* increase cross-sectional flow area thus reducing friction pressure drop and extending packable lengths, POR, 23-24, is unsupported. Dr. Durham contradicts Halliburton’s claim, explaining that “*decreas[ing]* the cross-sectional area of the shunt tubes[would] lead[] to undesirable higher friction, which would limit the available length for gravel pack....” EX2002 ¶¶98, 113 (“Increasing tube thickness without any change to outer diameter would restrict the flow path of the shunt tubes, increasing friction pressure drop....”). Contrary to Halliburton’s assertion, POR, 24-25, there is no dispute that one of skill understood how to optimize wall thickness and cross-sectional flow area. *See* EX1013, 2 (increasing shunt tube dimensions “of course was at the expense of a reduced base pipe diameter, which in many instances does not impact well productivity”); EX1043, 144:3-20 (Durham: one of skill would be aware of tradeoffs between optimizing performance metrics, friction loss, and tool size). In fact, Halliburton’s own Bonner reference modified and improved conventional eccentric screens. *See* EX1016.

C. Halliburton’s Remaining Arguments Also Fail

Halliburton’s admission that both Yeh/Yeh2 and the ’007 Patent identified the same problem means the only remaining question is whether the ’007 Patent’s solution in Claim 1[e] would have been obvious. *See* POR, 30-31. That is indisputable. First, Yeh taught tubing wall thickness achieved “mechanical integrity.” EX1005, 28:20-23; EX1043, 63:22-64:19, 65:16-66:1 (Dr. Durham agreeing). Second, it is undisputed that a skilled artisan understood that tubing wall thickness was proportional to burst pressure. EX1003 ¶235 (“[B]urst pressure is roughly directly proportional to the... tubing wall thickness.”), 291 (“wall thickness being one of three parameters (wall thickness, tubing material, and tubing outside diameter) that could be adjusted to meet pressure containment requirements”); EX1043, 66:21-68:14, 96:12-97:5; EX2002 ¶¶96, 100, 103.

Where the prior art discloses a combination of familiar elements (high- and low-pressure screens) according to known methods (adjusting wall thickness) to achieve predictable results, the combination is obvious. *KSR Int’l v. Teleflex Inc.*, 550 U.S. 398, 416 (2007); *see also id.* at 419-20 (Obviousness shown when “there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent’s claims.”).

Halliburton next alleges a skilled artisan would not have known to increase shunt tube wall thickness over modifying other design parameters, *see* POR, 26-29,

but that ignores the straightforward teachings to increase pressure rating in upstream tubes using tubing wall thickness discussed above. *Honeywell Int’l v. 3G Licensing*, 124 F.4th 1345, 1356 (Fed. Cir. 2025) (To show obviousness, “the claimed modification needed only to be desirable in light of the prior art and not the ‘best’ or ‘preferred’ approach....”). Unlike the situation described *In re Kubin*, where prior art did not provide an “indication of which parameters were critical or no direction as to which of many possible choices is likely to be successful,” 561 F.3d 1351, 1359 (Fed. Cir. 2009) (citation omitted), “[m]uch has been learned about tube design, manifolds, and number of and placement of orifices along the tube, as well as number of tubes required,” EX1003 ¶236. A skilled artisan would have understood the relationships between the various design parameters, and thus optimization was not patentable. *See Pfizer v. Sanofi Pasteur*, 94 F.4th 1341, 1348 (Fed. Cir. 2024) (“A routine optimization analysis generally requires consideration whether a person of ordinary skill in the art would have been motivated, with a reasonable expectation of success, to bridge any gaps in the prior art to arrive at a claimed invention.”).

Halliburton’s reliance on *Cardiac Pacemakers v. St. Jude Medical* is also misplaced because, unlike here, the solution to the problem “had not previously been achieved.” 381 F.3d 1371, 1377 (Fed. Cir. 2004).

Halliburton’s attempt to limit Yeh’s concentric screens to “a higher number of small, round tubes,” POR, 30-31, is contradicted by Yeh itself, which describes both

concentric and eccentric screens as containing “two or more shunt tubes,” EX1005, 16:26-35; EX1043, 47:19-48:21, and eccentric screens that use round tubes, EX1005, 24:1-2, 24:10-12; EX1043, 49:3-11; Pet., 36-37; EX1044 ¶168. Similarly, concentric screens with rectangular tubes were also known to a skilled artisan, as shown in Figure 7, reproduced below. EX1013, 3 (describing a “concentric entrance” as an “improvement of the alternate path system” for eccentric screens).

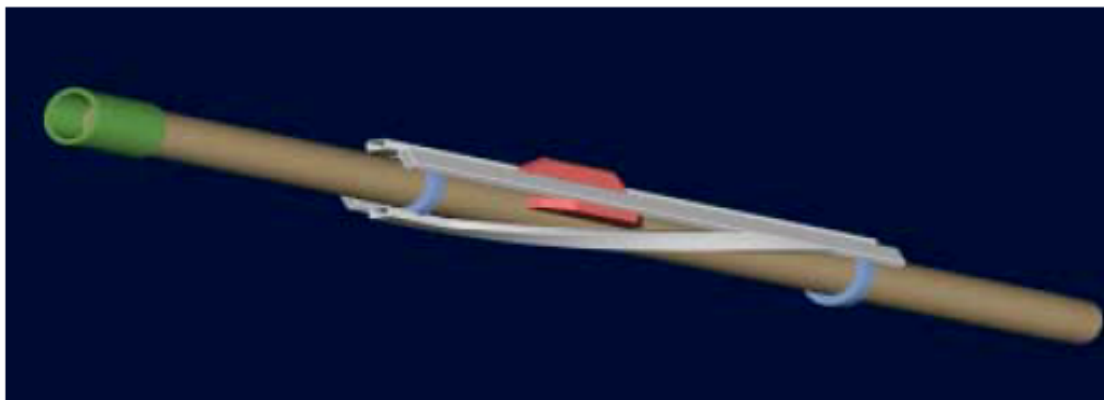


Figure 7 – Concentric Entrance (Y-manifold).

EX1013, Fig. 7; EX1043, 151:10-17 (Dr. Durham agreeing that Hurst discloses a concentric design with rectangular tubes); EX1044 ¶168. Thus, whether a screen is concentric or eccentric does not determine how it achieves its pressure containment.

Finally, Halliburton’s assertion that the Petition poses a “mere assumption that a POSITA knew to thicken shunt tube walls to increase pressure rating,” POR, 31, is contradicted by Yeh and the knowledge of a POSITA as well as its own expert, EX1043, 66:21-68:14, 96:12-97:5; EX2002 ¶¶96, 100, 103. In *In re Kotzab*, “there was no finding as to the specific understanding or principle within the knowledge of

a skilled artisan that would have motivated one with no knowledge of Kotzab's invention to make the combination in the manner claimed.” 217 F.3d 1365, 1371 (Fed. Cir. 2000). Similarly, the prior art in *In re Hedges* suggested lower temperatures for a chemical reaction in contrast to the claimed higher temperatures. 783 F.2d 1038, 1041 (Fed. Cir. 1986).

D. Claim 2

1. Halliburton Agrees Yeh2 Taught Declining Slurry Flow Rate Was an Issue

Claim 2 requires “a cross-sectional flow area of the packing tube nozzle opening in the *first sand screen assembly* is less than a cross-sectional flow area of the packing tube nozzle opening in the *second sand screen assembly*.” EX1001, 18:56-60.

Halliburton argues that Yeh and Yeh2 did not “teach that declining flow rate near the toe is a significant problem that a POSITA should address,” but then asserts that Yeh2 addressed declining flow rate “with a different solution than nozzle size” by using closed-ended packing tubes. *See* POR, 32-33; EX2002 ¶120 (“Although the '007 Patent solves the same problem (decreasing slurry flow out of the tubes) as Yeh2....”).

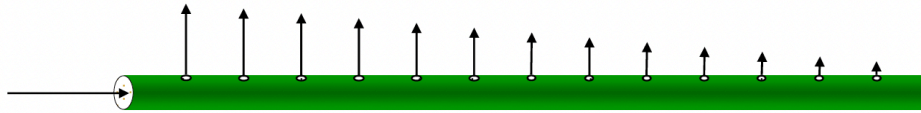
In fact, Yeh2 disclosed that gravel slurry pressure dropped from over 5,000 psi to near zero from heel to toe, as shown in Figure 15. *See* EX1006, Fig. 15; Pet.,

43-45; EX1003 ¶¶298-301. It is undisputed that a skilled artisan understood that flow is proportional to pressure drop across a nozzle. EX1014, Fig. 3 (showing proportional relationship of flow and pressure drop); EX1003 ¶304; EX1043, 131:4-132:7 (Dr. Durham agreeing that they are “somewhat proportional”). Thus, as the available pressure to drive flow across a nozzle decreases toward the toe, the flow necessarily decreases also, motivating manipulation of nozzle size to improve flow. EX1003 ¶305. Hurst confirms that a skilled artisan understood this relationship. EX1013, 3-4 (“[F]riction and thus the pressure applied to each zone can be controlled through... nozzle diameter and frequency.”). Routine optimization is not patentable. *R.J. Reynolds v. Philip Morris*, IPR2021-00585, Paper 36 at 47 (P.T.A.B. Sept. 8, 2022) (“[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” (citation omitted)).

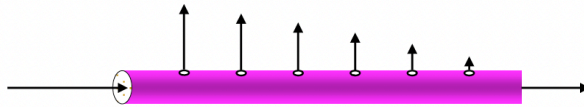
Yeh2’s closed-end packing tubes partially addressed the declining flow rate problem only across a single packing tube in a horizontal interval in its “Figure 7 Flow diversion in a single shunt” but did not address the declining pressure from heel to toe:

1 bpm slurry flow through a 16 mm ID shunt tube with 6 ft porthole spacing

Case A Open-End Shunt with 6 mm Portholes over 80 ft Interval



Case B Open-End Shunt with 6 mm Portholes over 40 ft Interval



Case C Closed-End Shunt with 6 mm Portholes over 40 ft Interval

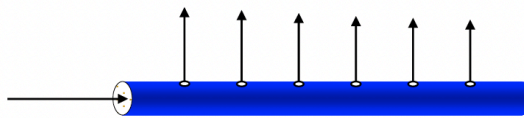


Figure 7 Flow diversion in a single shunt

EX1006, Fig. 7; EX1003 ¶302.

Increasing nozzle diameter had understood tradeoffs. It offset the pressure loss and facilitated a better gravel pack towards the toe. *See* EX1043, 132:13-19 (agreeing increased diameter increased flow out of nozzle), 133:13-135:6 (agreeing Hurst disclosed slurry flow out of nozzles could be controlled by modifying nozzle diameter or nozzle frequency). And it would have minimal impact on shunt tube friction pressure loss. *See, e.g.*, EX1043, 138:20-139:9 (agreeing that larger nozzle diameter increases flow while decreasing pressure drop), 141:16-142:14 (agreeing that adding more nozzles would initially reduce friction pressure drop but would “tend towards a higher pressure—friction loss” as the slurry dehydrates).

2. Yeh/Yeh2's Slurry Flow Rate Disclosures Taught Tradeoffs, Not Criticisms of Increasing Nozzle Size

Halliburton's position that Yeh and Yeh2 discouraged increasing nozzle size is unsupported. *See* POR, 33-34. Halliburton's assertion that "as Petitioner recognizes, greater nozzle diameter would *increase* friction pressure drop" is incorrect. *Compare* POR, 33 (citing Pet., 45; EX1003 ¶¶303-04), *with* Pet., 45 ("Lagrone's Figure 3 shows that flow through a hole in the pipe is roughly directly proportional to the pressure drop (*i.e.*, driving force) across that hole."). Lagrone contradicts this assertion as well. EX1014, Fig. 3 (showing that for a given flow rate of 2.4 bbls/min, pressure drop decreases from about 1050 to about 250 for oil and sand through a $\frac{3}{8}$ " hole versus a $\frac{1}{2}$ " hole).

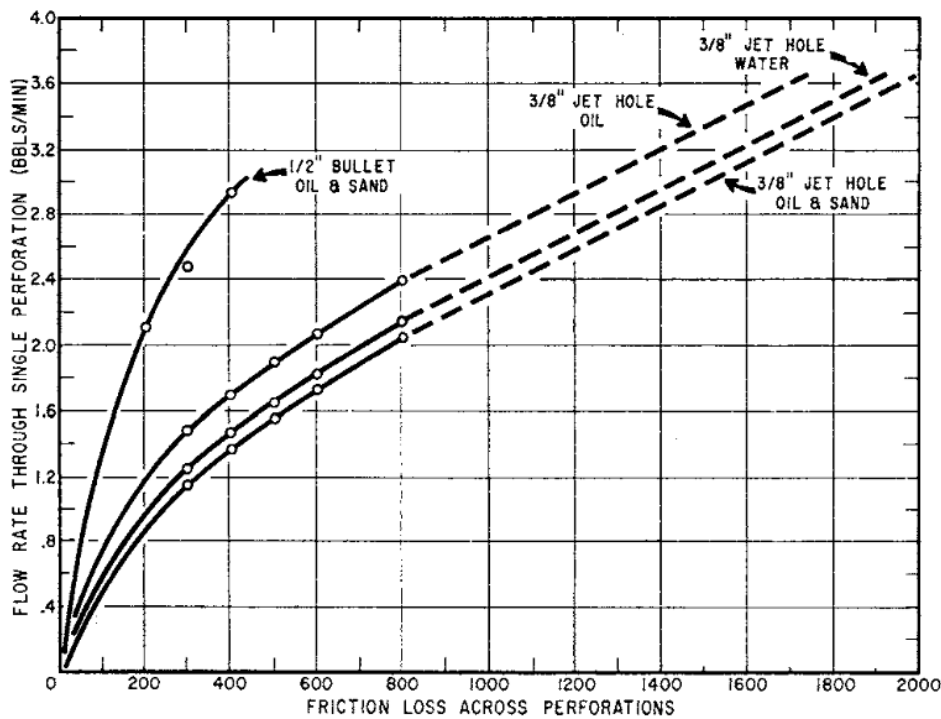


Fig. 3—Flow rate vs friction loss, laboratory measured (courtesy of The Halliburton Co.).

EX1014, Fig. 3; EX1003 ¶304; EX1043, 127:20-130:14. Dr. Durham agreed that when other conditions remained the same, larger nozzle cross-sectional flow area resulted in increased slurry flow. EX1043, 132:13-19; *see also id.*, 125:8-132:12; EX2002 ¶¶118-19.

Halliburton’s assertion that Yeh2 capped nozzle size at “10 times the gravel size” is contradicted by the reference. POR at 33. Yeh2 recommended larger nozzles (ratio 10 or greater): “Larger portholes, ratio 10 or greater, were found to facilitate the discharge of concentrated slurry and prevent plugging in a horizontal ported

shunt tube.” EX1006, 2. Yeh2 later states without quantifying “larger portholes” that:

Although larger portholes could prevent plugging by a concentrated slurry, a different shunt plugging mechanism was observed after the annulus was packed as shown in Figure 4b.

EX1006, 2, Fig. 4b. Yeh2 provides no quantification of porthole size to avoid this phenomenon. But Hurst recommended nozzle sizes for various gravel types and recommended $\frac{3}{8}$ ” (9.6-mm) nozzles for both 40/60 and 20/40 mesh gravel, which is larger than Yeh2’s 6-mm portholes, showing there is room to increase nozzle diameter. EX1013, Table 1 (showing recommended nozzle-to-mean gravel diameter ratios much larger than 10); *see also* EX1043, 147:6-12 (Dr. Durham agreeing).

Additionally, Halliburton’s concerns with increasing fluid leakoff due to increased nozzle size, POR at 33, have far less significance when the slurry is already near the toe and the pressure driving fluid leakoff is much diminished.

E. Claim 4

Halliburton’s arguments fail for the same reasons as its arguments for Claim 2. *See supra* §II.D. Claim 4 requires “the number of packing tube nozzles in the first sand screen assembly is less than the number of packing tube nozzles in the second sand screen assembly.” EX1001, 19:7-10.

Contrary to Halliburton’s assertion, Yeh2 did not teach that the acceptable minimum nozzle spacing was six feet. *See* POR, 34-35 (citing EX1006, 2). Dr. Durham bases this assertion on Yeh2’s page 5 and Figure 14, which both describe “the distance between the manifold and the first porthole,” not nozzle spacing in general. EX2002 ¶129 (citing EX1006, 5, Fig. 14). Dr. Durham’s assertion that multiple examples using 6-foot spacing constitutes a “suggest[ion]” that spacing “could not be decreased” is wishful thinking. *Id.*

F. Claim 5

Claim 5 requires “the cross-sectional flow areas of the passageway in the first and second transport tubes is the same.” EX1001, 19:11-13.

Halliburton’s Response ignores Yeh’s disclosures and Mr. Chambers’ opinions. *See* POR, 35-37. Halliburton contends that using Yeh’s concentric screen with a “common” 6×3 shunt system and eccentric screen with a “common” 2×2 shunt system “demonstrate[s] different cross-sectional flow areas of the passageways in the two tubes.” *See* POR, 35-37. But that ignores Yeh’s broader disclosure.

Yeh disclosed that its concentric and eccentric screens included “two or more shunt tubes.” *See* EX1005, 16:26-34. Yeh also disclosed that the eccentric screen shunt tubes could be round. EX1005, 24:10-12, Fig. 8C; *see also id.*, 4:57-60; EX1003 ¶276; *supra* §II.B. Dr. Durham agreed. EX1043, 48:15-21, 49:3-11. In the

screens Yeh disclosed with the same number of transport tubes and round tubes in both, the shunt tubes would necessarily be approximately the same size to accommodate the same flow. EX1044 ¶¶165-71.

Halliburton and Dr. Durham criticize Mr. Chambers' supposedly improper comparison of round to round and rectangular to rectangular shunt tubing in his cross-sectional flow calculations. *See* POR, 35-37 (citing EX1003 ¶¶160, 162); EX2002 ¶139 (citing EX1003 ¶331). However, this ignores the prior art's teachings and his opinions regarding the same, *see* EX1003 ¶¶161 (quoting EX1041: "While the conduit forming shunt tube 25 has been illustrated as having a rectangular cross-section, it should be recognized that conduits having other cross-sections (e.g. circular, etc.) can be used without departing from the present invention."), 276-77 (describing Yeh's disclosure of eccentric screens with round shunt tubes and obviousness of the same); *see also* Pet., 36-37 (asserting that Yeh disclosed eccentric screens with round tubes, and even if it had not, that such use would have been obvious). Further, Halliburton already recognized that round tubes with a smaller cross-sectional area could have the same pressure drop compared to rectangular tubes with a larger cross-sectional area due to the nature of flow in round versus rectangular tubes. EX1016, 16-17, Fig. 36; EX1043, 117:1-11; *see also id.*, 115:15-116:22, 117:13-22.

Mr. Chambers explained that for Claim 5 he “provided an example” calculation showing two round tubes of the same material and the same cross-sectional flow area but different outer diameters had burst ratings within the design parameters for Yeh’s 5,000-foot interval example. *See* EX1003 ¶331; *see also id.* ¶184. Halliburton and Dr. Durham also criticize Mr. Chambers’ burst pressure calculation results “exceeding 15,000 psi” but do not argue that they are incorrect. *See* POR, 22. Dr. Durham also seems to acknowledge Mr. Chambers was providing an example and does not challenge its accuracy. *See* EX2002 ¶139 (“What Mr. Chambers actually shows is that it is *possible* to create two round tubes with the same cross-sectional area and different wall thicknesses....”); EX1043, 97:9-99:22.

III. GROUND 2: THE YEH/YEH2 COMBINATION DISCLOSED OR SUGGESTED THE CLAIMED INSTALLATION METHOD

Claim 14[c] requires “determining a shunt tube system operating pressure associated with the distal end of the production zone and selecting a low pressure shunt tube system based on the distal end determined pressure.” EX1001, 20:14-17.

Halliburton argues that this limitation requires selecting “a low pressure shunt tube system based on that distal end determined pressure” and that the Petition’s challenge fails because it “admits that the proposed combination selects the downstream screen based on pressure ‘3,000 feet from the toe.’” *See* POR, 37-38.

But Halliburton ignores that the Petition states that “one of skill would have implemented Yeh’s teachings to use eccentric screens toward the toe at any point *at which the slurry pressure dropped below the pressure capacity of the eccentric screen shunt tubes*, which is about 3,000 feet from the toe.” Pet., 66. Dr. Durham admitted as much. EX1043, 80:9-83:8 (agreeing that the differential pressure at the toe is about 100 psi and that Yeh and Yeh2 taught using eccentric screens anywhere the pressure was less than 3,000 psi).

IV. GROUND 3: THE YEH/JONES COMBINATION DISCLOSED OR SUGGESTED THE CLAIMED SHUNT TUBE MATERIAL REQUIREMENTS

Contrary to Halliburton’s assertion, Yeh did *not* “actively teach[] against further reducing the pressure rating and packing length of the downstream eccentric screen.” See POR, 40. Yeh taught to use its crossover tool to fluidly connect “less-expensive eccentric screens on the toe or lower-pressure side of the interval during gravel-packing operations, and to use the concentric screens on the heel or higher-pressure side of the interval during the gravel-packing operations.” EX1005, 30:20-25; see Pet., 41; EX1003 ¶¶185, 292. Yeh taught a skilled artisan to reduce overall cost of completion by using less expensive and more readily available eccentric screens where possible in place of more costly concentric screens. Pet., 41; EX1003 ¶¶185, 292. Dr. Durham agreed Yeh’s teachings would have motivated a skilled artisan “to maximize the use of eccentric screens, relative to concentric screens, in

order to reduce overall job cost and friction losses.” *See* EX2002 ¶170. Yeh’s teachings are not limited to a specific eccentric screen, nor do they preclude further modifications based on the prior art and knowledge of a skilled artisan. *KSR*, 550 U.S. at 421 (“A person of ordinary skill is also a person of ordinary creativity, not an automaton.”).

As stated in the Petition, a skilled artisan looking to maximize cost savings would use lower tensile strength materials in eccentric screen shunt tubes that were subjected to lower pressures near the toe based on the “finite number of options for reducing burst pressure.” *See* Pet., 77-78; EX1003 ¶436; *see also id.* at ¶232. While Dr. Durham took issue with Mr. Chambers’ use of ASTM standard A554-16 (EX1018) for his tensile strength calculations, *see* EX2002 ¶ 107 n.115, Dr. Durham did not challenge the accuracy of Mr. Chambers’ yield and tensile strength values, EX1043, 104:20-107:11.

Moreover, as noted above, eccentric screen shunt tubes, which had a 5,000-psi burst rating, were not generally the limiting factor in pressure containment for eccentric screens. EX1013, 2 (“[T]he burst pressure of the shunt tubes... is currently 5,000 psi.”); *see also supra* §II.B. Consequently, weaker tensile strength could be used before reaching the 3,000-psi operating limit of conventional sand screens.

V. GROUND 4: THE YEH/JONES/YEH2 COMBINATION DISCLOSED OR SUGGESTED THE CLAIMED SHUNT TUBE PRESSURE RATING REQUIREMENT

Halliburton has no rebuttal for Ground 4's obviousness challenge. Halliburton mistakenly refers to Claim 22 being challenged in Ground 4, when Ground 4 challenged Claim 23. *Compare* POR, 41-42 (citing Pet., 78-79), *with* Pet., 79. Nevertheless, Halliburton's responses to Weatherford's obviousness challenge for Claim 23 are based only on Claim 21[e]. *See* POR, 38-41 (arguing Grounds 3-4 fail as to Claims 21-23 because the Yeh/Yeh2/Jones and Yeh/Yeh2/Jones2 combinations do not render obvious Claim 21[e]); EX2002 ¶¶170-75. Moreover, Weatherford's obviousness arguments for Claim 23 based on its arguments provided in Claims 7 and 21[d] are entirely unrebutted. *See* Pet., 79; *see generally* POR.

Halliburton's arguments also fail for the same reasons as its arguments for Claim 1[e]. *See supra* §II.A.

VI. CONCLUSION

For at least the foregoing reasons, Weatherford respectfully requests that the Board cancel the challenged claims as unpatentable.

Weatherford U.S. v. Halliburton
Patent No. 11,333,007 – IPR2024-00990

ARMOND WILSON LLP

Dated: May 30, 2025

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CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that foregoing **PETITIONER’S REPLY TO PATENT OWNER’S REESPONSE**, exclusive of the parts exempted as provided in 37 C.F.R. § 42.24(c), contains 5,458 words and therefore complies with the type-volume limitations of 37 C.F.R. § 42.24(a).

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CERTIFICATE OF SERVICE

The undersigned certifies that pursuant to 37 C.F.R. § 42.6(e), a true copy of the foregoing **PETITIONER’S REPLY TO PATENT OWNER’S REESPONSE** and **EXHIBITS 1043-1044** are being served electronically on May 30, 2025 to the following counsel for Patent Owner to the following email addresses:

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