

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LIBERTY ENERGY, INC. AND LIBERTY OILFIELD SERVICES LLC
Petitioners

v.

U.S. WELL SERVICES, LLC
Patent Owner

Case No. IPR2025-00031
Patent 10,655,435

PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 1-19 OF
U.S. PATENT NO. 10,655,435

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LIST OF EXHIBITS

1001	U.S. Patent No. 10,655,435, Jared Oehring et al., “Smart Fracturing System and Method” (the “’435 Patent”), filed October 25, 2018, issued on May 19, 2020.
1002	File History for U.S. Patent No. 10,655,435.
1003	Declaration of Dr. Robert Durham
1004	PCT International Patent Publication No. 2017/040921 to Norris et al., “Pump Synchronization and Method” (“Norris”), filed September 2, 2016 and published on March 9, 2017.
1005	PCT International Patent Publication No. 2016/019219 to Omont et al., “Monitoring Health of Additive Systems” (“Omont”), filed July 31, 2015, published February 4, 2016.
1006	U.S. Patent Publication No. 2009/0053072 to Borgstadt et al., “Integrated ‘One Pump’ Control of Pumping Equipment” (“Borgstadt”), filed on August 21, 2007 and published on February 26, 2009.
1007	U.S. Patent Publication No. 2008/0236818 to Dykstra, “Method and Apparatus for Controlling the Manufacture of Well Treatment Fluid” (“Dykstra”), filed March 27, 2007, published October 11, 2012.
1008	U.S. Provisional Patent Application 62/577,056, Jared Oehring et al., “Automated Fracturing Pump System”, filed October 25, 2017.
1009	Complaint, <i>U.S. Well Services, LLC et al. v. Liberty Energy, Inc. et al.</i> , No. 4:24-cv-00839 (S.D. Tex. March 6, 2024)
1010	Plaintiff’s Motion for Leave to File the Second Amended Complaint, <i>U.S. Well Services, LLC et al. v. Liberty Energy, Inc. et al.</i> , No. 4:24-cv-00839 (S.D. Tex. September 19, 2024)
1011	<i>Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation</i> (June 21, 2022)
1012	Federal Court Management Statistics (Mar. 31, 2022), available at < https://www.uscourts.gov/sites/default/files/data_tables/fcms_na_apppr_ofile1231.2023.pdf >
1013	PCT International Patent Publication No. 2014/0379300 to Devine et al., “Pump Efficiency Determining System and Related Method for Determining Pump Efficiency,” filed February 1, 2013 and published on December 25, 2014.
1014	Claim Listing for Claims of U.S. Patent No. 10,655,435, Jared Oehring et al., “Smart Fracturing System and Method” (the “’435 Patent”), filed October 25, 2018, issued on May 19, 2020.

1015	Michael Morton, “Unlocking the Earth: A Short History of Hydraulic Fracturing,” GEO ExPro, Vol. 10, No. 6, December 2013 (https://geoexpro.com/unlocking-the-earth-a-short-history-of-hydraulic-fracturing/) (last accessed November 30, 2023)
1016	B.A. Wells and K.L. Wells. “Shooters – A “Fracking” History.” American Oil & Gas Historical Society, (https://aoghs.org/technology/hydraulic-fracturing) (last accessed November 30, 2023)
1017	Carl T. Montgomery and Michael B. Smith, “Hydraulic Fracturing: History of an Enduring Technology,” <i>Journal of Petroleum Technology</i> , Vol. 62, Issue 12 (Dec. 2010)
1018	Bourgoyne, A. T., Jr., K. K. Millheim, M. E. Chenevert and F. S. Young, Jr. (1986). <u>Applied Drilling Engineering</u> , Society of Petroleum Engineers,
1019	Vassiliou, M. S. (2018), <u>Historical Dictionary of the Petroleum Industry</u> , Rowman & Littlefield,
1020	U.S. Patent Application Publication No. 2013/0306322 to Sanborn <i>et al.</i> entitled “System and Process for Extracting Oil and Gas by Hydraulic Fracturing” (“ <i>Sanborn</i> ”),
1021	U.S. Patent Publication No. 2012/0255734 to Coli <i>et al.</i> entitled “Mobile, Modular, Electrically Powered System for Use in Fracturing Underground Formations” (“ <i>Coli</i> ”),
1022	Tomlinson, Hl, Ac Byrd, And Cf Vanberg. 1988. Spe 17315 "Fracturing Process Control And Automation." In Permian Basin Oil And Gas Recovery Conference, Onepetro.
1023	Stephenson, SV, EL Woodall, CD Donaghe, and RE Dant. 1993. "Fracturing process control and automation: Phase 2." In Petroleum Computer Conference. OnePetro.
1024	U.S. Patent Application Publication No. 2008/0236818 to Dykstra <i>et al.</i> entitled “Method and Apparatus for Controlling the Manufacture of Well Treatment Fluid.” (“ <i>Dykstra 818</i> ”)
1025	U.S. Patent Application Publication No. 2008/0183415 to Dykstra <i>et al.</i> entitled “methods to Monitor System Sensor and Actuator Health and Performance.” (“ <i>Dykstra 415</i> ”)
1026	<i>Modbus over Serial Line Specification and Implementation Guide V1.02</i> , Dec. 20, 2006, available at https://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf
1027	<i>IEEE Standard for Ethernet</i> , IEEE Std 802.3™-2018, IEEE Computer Society, approved June 14, 2018 (excerpted).

I. MANDATORY NOTICES

Real Party in Interest: Liberty Energy, Inc., Liberty Oilfield Services LLC (“Liberty” or “Petitioners”), and Liberty Advanced Equipment Technologies LLC are the real parties in interest.

Related Matters: The ’435 Patent is involved in a pending lawsuit between Petitioners and U.S. Well Services, LLC (“Patent Owner,” or “PO”) entitled *U.S. Well Services, LLC, et al v. Liberty Energy, Inc. et al*, 4:24-cv-00839-KPE (S.D. Tex.) (“Liberty Litigation”).

Lead Counsel and Back-Up Counsel: Petitioners designate lead and back-up counsel as noted below. A Power of Attorney is filed concurrently herewith under 37 C.F.R. §42.10(b).

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II. STANDING AND FEES

Standing: Petitioners certify under 37 C.F.R. §42.104(a) that the '435 Patent is eligible for *inter partes* review and Petitioners are not barred or estopped from requesting *inter partes* review on the grounds herein.

Fees: The Office is authorized to charge the fee in 37 C.F.R. §42.15(a) to Deposit Account No. 02-0384 as well as any additional fees that might be due in connection with this Petition.

III. OVERVIEW OF THE '435 PATENT

A. Subject Matter

The '435 Patent relates to a “smart fracturing system” “for assessing flow rates in hydraulic fracturing.” EX1001, Title, 1:40-43. The '435 system includes multiple “pumps” to pressurize fracturing fluid from a blender. EX1001, 1:44-46, 3:29-40, Fig. 1. The system also includes a “distribution system fluidly coupled to receive and consolidate fracturing fluid” from the pumps “for injection into a wellhead.” EX1001, 1:46-48, 3:46-55.

The '435 Patent states that prior art fracturing components were “individually controlled by operators,” requiring “a large amount of operator intervention” “for

taking measurements” and “control[ing] operating conditions.” *Id.* To address these problems, the ’435 Patent introduces “a control system” having “sensing devices” that measure operating “parameters”, “processing devices” that “generate control instructions” based on measured parameters, and “control devices” that receive control instructions and control aspects of the system, including the pumps and distribution system. EX1001, 1:48-60.

B. Prosecution History

Application 16/170,695 leading to the ’435 Patent was filed October 25, 2018. The Patent Office issued a first Non-Final Office Action February 12, 2019, rejecting claims 1-7, 11, 12, and 14-18 as being anticipated by PCT Patent Publication 2017/0226842 (“*Omont*”) and rejecting claims 8-10, 19, and 20 as obvious based on *Omont* in view of PCT Patent Publication No. 2014/0379300 (“*Devine*”). EX1002, 1426-1434; EX1013. In response, Applicant amended independent claims 1, 7, and 14 to include additional limitations: e.g., “detecting that a first parameter of the one or more parameters is outside of an acceptable threshold” and “automatically adjusting” functions of system components. EX1002, 1312-1317; EX1003, §VI.C. Applicant canceled claim 8 and added new claim 21. *Id.*, 1309.

The Patent Office issued a first Final Office Action on June 7, 2019, rejecting claims 1-12 and 14-20 as obvious over PCT Patent Publication 2017/0226842 (“*Omont*”) in view of PCT Patent Publication No. 2014/0379300 (“*Devine*”) and

rejecting claim 13 as obvious based on *Omont*, *Devine*, and U.S. Patent Publication No. 2014/0095114 (“*Thom*”). EX1002, 1130-1139. The Final Office Action allowed claim 21. *Id.*, 1140. In response, Applicant amended the independent claims to include the subject matter of “allowable” dependent claim 21, including “transmitting the first parameter from a first device of the plurality of pumps, the distribution system, or the wellhead to a second device of the plurality of pumps, the distribution system, or the wellhead”; “generating the automated instructions at the second device; and automatically adjusting one or more functions of the second device based on the automated instructions.” *Id.*, 991-999, 1317.

The Patent Office issued a second Non-Final Office Action September 25, 2019 allowing claims 1-7 and 9-13 and objecting to claims 14-20 for antecedent basis errors. *Id.*, 969. Following Applicant’s amendment to address antecedent basis, the Patent Office issued a notice of allowance January 13, 2020. *Id.*, 912, 943.

C. Priority Date

The ‘435 Patent (EX1001) claims priority to provisional application 62/577,056 (EX1008) filed October 25, 2017. Petitioners rely on prior art pre-dating that provisional application. EX1003, §VI.D.

IV. SUMMARY OF PRIOR ART & GROUNDS

A. Norris (EX1004)

Norris is an International Patent Application Publication published March 9, 2017. EX1004. *Norris* is prior art to the ‘435 Patent at least under 35 U.S.C.

§§102(a)(1)-(2). *Norris* describes a “pump management system” that manages “multiple positive displacement pumps ... to provide desired flow rates and operational pressures.” EX1004, Title, [0002]. *Norris* is from the same field as the ‘435 Patent, describes similar multiple-pump systems, and addresses deficiencies in the same multiple-pump prior art systems that the ‘435 Patent purportedly improves. *See* EX1003, §X.A.2.

B. *Omont (EX1005)*

Omont is an International Patent Application Publication published February 4, 2016. EX1005. *Omont* is thus prior art to the ‘435 Patent at least under 35 U.S.C. §§102(a)(1)-(2). *Omont* discloses “several pumps ... connected in parallel” for “inject[ing] additives or other material into a wellbore.” EX1005, Title, [0002]. *Omont* describes a “control and monitoring system” that “receive[s] information generated” by sensors and “control[s] operational parameters.” *Id.*, [0026], [0038], Figs. 2-3. *Omont* is from the same field as the ‘435 Patent, describes similar multiple-pump systems, and provides for controlling multiple-pump systems. *See* EX1003, §X.B.2.

C. *Borgstadt (EX1006)*

Borgstadt is a U.S. Patent Application Publication published on February 26, 2009. *Borgstadt* is prior art to the ‘435 Patent at least under 35 U.S.C. §§102(a)(1)-(2). *Borgstadt* discloses “controlling a pumping process” having

multiple pumps. Ex.1006, [0001]-[0002]. *Borgstadt* states prior art “pumps are manually adjusted” and lack an “intelligent control system,” causing “wear and tear” and “pump failure.” *Id.*, [0003]-[0004]. *Borgstadt* “control[s] the operation of the pumps involved based on certain parameters characterizing the pump.” EX1006, [0009]. *Borgstadt* is in the same field as the ‘435 Patent: sensing and control of multiple-pump systems. *See* EX1003, §X.C.2.

D. Dykstra (EX1007)

Dykstra is a U.S. Patent Application Publication published on October 2, 2008. *Dykstra* is prior art to the ‘435 Patent at least under 35 U.S.C. §§102(a)(1)-(2). *Dykstra* describes “a method for controlling the production of well treatment fluid.” EX1007, [0005]. In *Dykstra*, “operations of the chemical storage system, proppant storage system, pumping grid ... and manifolds are controlled, coordinated, and monitored by a central control system” that “may use all of the sensor data from all units” to control fluid delivery. *Id.*, [0021]. *Dykstra* thus discloses control of blending and fluid delivery in multiple-pump systems. *See* EX1003, §X.D.2.

E. Grounds

Ground	Claims	Basis (35 U.S.C. §)	Prior Art
1	1-5, 7, 13-14, 16-17	102	<i>Norris</i>
2	1-5, 7, 13-14, 16-17	103	<i>Norris</i>
3	1-7, 10-17	103	<i>Norris, Omont</i>
4	1-5, 7-19	103	<i>Norris, Borgstadt</i>
5	1-7, 13-17	103	<i>Norris, Dykstra</i>

EX1003, §IV; EX1014 (listing challenged claim elements).

V. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art (“POSITA”) would have either (1) a Bachelor of Science in Mechanical, Electrical, or Petroleum Engineering or an equivalent field, and at least 2 years of academic or industry experience in the oil and gas industry, including well drilling, completion, or production, or (2) at least four years of oil and gas industry experience including well drilling, completion, or production. EX1003, §V.A.

VI. CLAIM CONSTRUCTION

Claim terms in IPR are construed according to their “ordinary and customary meaning” to a POSITA. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*); 37 C.F.R. §42.100(b). Constructions are proposed “only to the extent necessary.” *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). For this proceeding and the grounds presented herein, Petitioners do not present any constructions. EX1003, §VIII.

VII. INSTITUTION IS PROPER

A. The Fintiv Factors Favor Institution under § 314(a)

The factors described in *Apple, Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (PTAB May 13, 2020) (Precedential) (“*Fintiv-I*”) favor institution. Notably, the merits of this Petition are particularly strong, with compelling art and arguments.

The Liberty Litigation is just beginning. Just over three weeks ago, plaintiffs sought to amend the complaint and in doing so described the case as “in its infancy” with “ample time” for “Defendants to request a continuance.” EX1010, 6. Thus the *Fintiv* factors favor institution. EX1011, p.3, 8-9; EX1012, p.36 (showing median 30-month time-to-trial); *Samsung Elecs. Co. v. Staton Techiya, LLC*, IPR2022-00324, Paper 13, at 12 (P.T.A.B. July 11, 2022) (applying the median).

A stay motion has not yet been filed in the Liberty Litigation, but Petitioners may file one in the event of IPR institution. The Board has treated related factors as neutral after declining to speculate on the outcome of a stay motion. *See, e.g., HP Inc. v. Slingshot Printing LLC*, IPR2020-01084, Paper 13 at 9 (PTAB Jan. 14, 2021).

“[I]t is often reasonable for a petitioner to wait to file its petition until it learns which claims are being asserted against it in the parallel proceeding.” *Fintiv-I* at 11. Here, Petitioners promptly filed this Petition against all ‘435 Patent claims less than three months after receiving infringement contentions. This “diligent” filing favors institution. *See, e.g., Corning v. Dali Wireless*, IPR2021-00762, Paper 8 at 9-10 (P.T.A.B. October 31, 2021) (crediting petitioner’s diligent filing approximately four months after receiving infringement contentions). Due to Petitioner’s diligence, it would be premature at this time to argue regarding timing of milestones in this proceeding versus the Liberty Litigation. If PO raises 314(a) arguments in a Preliminary Response, Petitioners respectfully request opportunity to reply prior to

institution to address expected schedules and whether a prior art stipulation would be appropriate.

B. Institution is Proper under § 325(d)

Although *Dykstra* is listed on the face of the ‘435 Patent, it was not used to reject claims. EX1001, item (56), 2-3. The Board has declined to deny institution where Petitioner relied upon prior art cited on the face of the challenged patent but “not applied by the examiner ... in any rejection of claims.” *Comcast Cable Communs., LLC v. Promptu Sys. Corp.*, Case No. IPR2018-00342, Paper 13 at 17 (PTAB July 19, 2018).

Further, although the Examiner relied on *Omont* during prosecution of the ‘435 Patent, the Examiner did not consider *Omont* in combination with *Norris*. The Petition relies on *Omont* for elements for which the Examiner also relied on *Omont* (e.g., at least those elements of claims 1-7 and 10-17 that the Examiner found *Omont* disclosed or taught, as described in the February 12, 2019 and June 7, 2019 rejections). See EX1002, 1130-1138, 1425-1434. Applicant did not contest the Examiner’s reliance on *Omont*, instead amending in response to final rejection. *Id.*, 998-999.

Applicant amended independent claims to include the subject matter of then-dependent claim 21—“transmitting the first parameter from a first device of the plurality of pumps, the distribution system, or the wellhead to a second device of the

plurality of pumps, the distribution system, or the wellhead,” “generating the automated instructions at the second device,” and “automatically adjusting one or more functions of the second device based on the automated instructions”—after this subject matter was identified as “allowable” in view of *Omont*. See *supra* §III.B; EX1002, 968-970, 991-999. At no point was *Norris*’s disclosure of these claim elements discussed by Applicant or Examiner. See *generally* EX1002. However, as explained below in Section VIII, *Norris* discloses these elements, and the teachings of *Norris*, *Omont*, *Borgstadt*, and *Dykstra* render these elements obvious.

Moreover, each Ground herein relies on *Norris* (EX1004), which was not before the Patent Office during examination. The Board has found the *Becton* factors favor institution where even a single noncumulative secondary reference distinguished the prior-art ground, regardless of other overlapping references. *Oticon Medical AB et al. v. Cochlear Limited*, IPR2019-00975, Paper 15 at 9-20 (PTAB Oct. 16, 2019) (precedential).

VIII. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. Ground 1: Norris Anticipates Claims 1-5, 7, 13-14, and 16-17

Norris discloses each element of claims 1-5, 7, 13-14, and 16-17, and thus anticipates those claims under 35 U.S.C. §102. EX1003, §XI.

1. Claim 1

- a) 1[p]: A hydraulic fracturing system, comprising:

Norris describes a “wellbore servicing system coupled to a wellhead” for performing “fracturing formation.” EX1004, [0020], Figs. 1-2, Claim 1; *See* EX1003, §XI.A.1.

b) 1[a]: a plurality of pumps positioned at a wellsite and configured to pressurize a fracturing fluid;

The ‘435 Patent admits that “hydraulic fracturing” requires multiple “pumps that inject fracturing fluid down the wellbore.” EX1001, 1:17-25. *Norris* also discloses “multiple positive displacement pumps ... to provide desired flow rates and operational pressures.” EX1004, [0002], [0024]-[0026]; *see* EX1003, §XI.A.2.

Additionally, Figure 2 illustrates **multiple pumps** in *Norris*’s system at a **wellhead**:

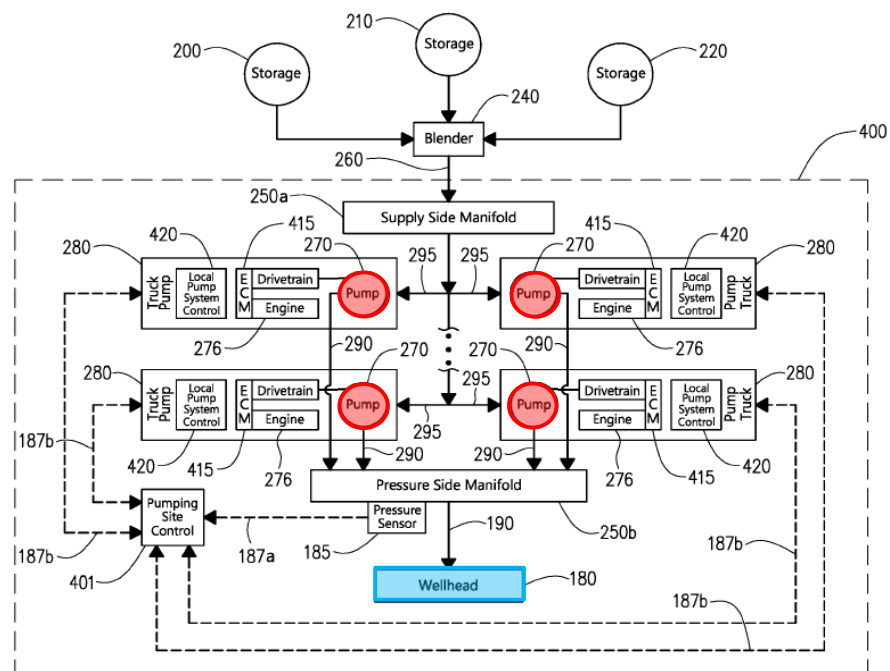


FIG. 2

EX1004, Fig. 2 (annotated).

c) 1[b]: a distribution system fluidly coupled to receive and consolidate fracturing fluid from the plurality of pumps for injection into a wellhead; and

Norris discloses that pumps “force[] the wellbore service fluid into a pressure-side manifold 250b” and “from pressure-side manifold 250b to wellhead 180.” EX1004, [0022]. Figure 2 illustrates a distribution system in the **pressure-side manifold** delivering fluid consolidated from multiple pumps to a **wellhead**:

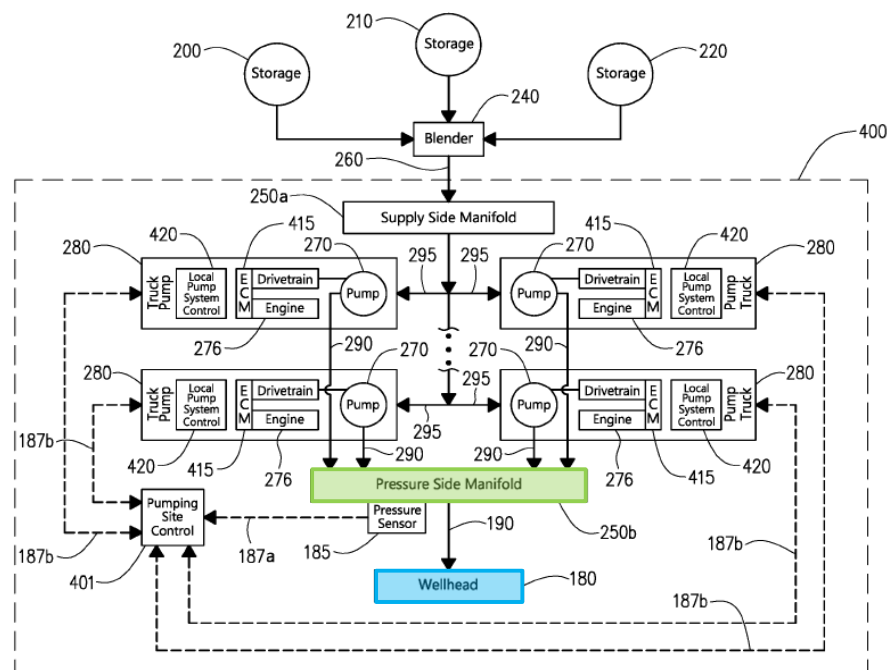


FIG. 2

EX1004, Fig. 2 (annotated), [0004], [0025]-[0026]; see EX1003, §XI.A.3.

d) 1[c]: a control system comprising:

Norris discloses a “pump management system” that “provides overall operational control.” EX1004, [0028], Figs. 2-4; see EX1003, §XI.A.4. The “pump management system” contains an application controller that “manages the overall

pumping operation” and performs “centralized” control. EX1004, [0029], [0046], Figs. 3-4. The pump management system further includes “local pump control system 420” that controls local pump operation. EX1004, [0032], Figs. 2-4. Local pump control may include a “local pump controller” and “local drivetrain controller” for monitoring, communicating, and controlling pump operating parameters. *Id.*, [0032]-[0037], Figs. 3-4.

e) 1[d]: a plurality of sensing devices configured to measure one or more parameters of the plurality of pumps and the distribution system;

Norris’s system “receives real time data ... from sensors and data processors monitoring fluid pressure and pump operations.” EX1004, [0029]-[0030], Figs. 3-4; *see* EX1003, §XI.A.5. Sensors “associated with pump trucks 280, pressure-side manifold 250b, and other monitored operations” measure pump and distribution-system operating parameters. EX1004. For example, “pressure sensor 185 monitors fluid pressure within pressure-side manifold 250b.” *Id.*, [0030]. Similarly, “sensors at wellhead 180 ... measure fluid pressure.” *Id.*, [0037]. Sensor data exchanged includes pump “piston position, engine RPM, and pressure”; “pressure data from ... pressure-side manifold”; manifold and wellhead “outlet flow rates, outlet pressure”; and “supply pressure at [the] wellhead.” *Id.*, [0034]-[0035].

Norris also discloses a “DAQ ... monitoring vibrations in pressure flowlines.” EX1004, [0049], Fig. 4. Each pump’s DAQ may also “receive data”—such as

“RPM,” “outlet pressure,” and “piston position”—from “pressure sensor[s],” “flow sensors,” “piston position sensors,” and “transmission sensors.” EX1004, [0047], Fig. 4.

Norris further discloses that electronic control module (ECM) sensors “monitor[] engine parameters,” including “engine piston position,” “throttle position,” and “common engine management operations.” *Id.*, [0032]. Moreover, each pump truck collects sensor data including “RPM,” “outlet pressure,” “piston position,” engine “power,” “outlet flow,” and “supply pressure.” *Id.*, Figs. 3-4.

f) 1[e][i] one or more processing devices configured to receive a first parameter from a first device of the plurality of pumps, the distribution system, or the wellhead, and transmit the first parameter to a second device of the plurality of the plurality [sic] of pumps, the distribution system, or the wellhead, and

Norris discloses “data processors” that “monitor[] fluid pressure and pump operations” and send monitored data to other devices in the pump management system. EX1004, [0029]. *Norris*’s “application controller” and “local pump control system[s]” also contain processors that implement algorithms, communications, and control. *See, e.g., id.*, [0029], [0040]-[0043]; EX1003, §XI.A.6. Controllers and sensors in *Norris* also communicate over data links requiring a processor. *Id.*, [0029], Figs. 3A, 4A; EX1003, §XI.A.6. In sum, a POSITA would understand that *Norris*’s sensors, processors, and controllers all contain “processing devices.” EX1003, §XI.A.6.

Norris also discloses transmission and reception of operating parameters between “sensors,” “data processors,” and “controller[s].” EX1004, [0029], Figs. 2-4; EX1003, §XI.A.6. *Norris*’s “pump management system” is “configured to receive and transmit data,” including sensor data. EX1004, [0004]. *Norris* also discloses numerous examples of transmitting and receiving sensor data between specific devices. *See, e.g.*, EX1004, [0029]-[0036], Figs. 2-4. For example, “data links ... provide data from sensors and other data processors associated with pump trucks 280, pressure-side manifold 250b, and other monitored operations to application controller 401” and to local “pump system control 420.” *Id.*, [0029], Figs. 2-4. And the application controller and local controllers communicate parameters over “two-way data links.” *Id.*, [0034]-[0037], Figs. 2-4. *Norris* also discloses numerous parameters sensed, transmitted, and received. *See supra* §VIII.A.1(e).

Norris also illustrates parameters communicated from pump truck components to local pump control. EX1004, Fig. 3B, 4B. “Additional datalinks” communicate parameters from sensors and processors to local “pump system control.” *Id.*, [0029]. As another example, ECM 415 receives “engine parameters” from the engine or drivetrain. *Id.*, [0032], Figs. 3-4; EX1003, §XI.A.6. DAQ 413 also receives sensor data and “provides the received data directly to local pump controller 410.” *Id.*, [0047], Fig. 4. Local pump control also provides received data to application controller 401, including “piston position, engine RPM, and pressure

data.” EX1004, [0034], [0036], Figs. 3-4. And “each local pump controller 410 is also in data communication with all other local pump controllers 410 via data link 187c.” *Id.*, [0044].

Norris’s sensors and data processors are “of the plurality of pumps, the distribution system, or the wellhead” because they are co-located with and “associated with” those components. EX1004, [0029], Figs. 2-4. Similarly, *Norris*’s controllers are “of the plurality of pumps, the distribution system, or the wellhead” because they are co-located with and manage operation of those components. *Id.*, Figs. 2-4.

Norris also discloses numerous examples of receiving a “first parameter” from a “first device” and transmitting a “first parameter” to a “second device” (including from and to one or more “processors”), as discussed further in Section VIII.A.1(j) below collectively addressing multiple claim limitations. To the extent PO argues that element 1[e][i] requires “one or more processing devices” that are devices separate and distinct from a “first device” and a “second device,” Examples 1A-1C below disclose those elements. To the extent that PO argues that the “first device” and “second device” may be “processing devices,” each of examples 1A-1C below discloses at least one “first device” and one “second device” that contain “processing devices.”

g) 1[e][ii] detect that the first parameter is outside of an acceptable threshold; and

Norris discloses that the application controller compares measured parameters to desired “operational parameters” and controls system (and component) operation based on the comparison. EX1004, [0037]. “Operational parameters input into application controller 401 determine the desired pressure and flow rates,” and “upon variation from the desired settings,” the application controller signals “to increase or decrease pumping operations.” *Id.*

Accordingly, *Norris*’s application controller “detects that the first parameter is outside of an acceptable threshold” by comparing measured and desired operational parameters. EX1003, §XI.A.7. *Norris* similarly discloses that local pump control manages local pump operation by comparing measured and “desired rate[s],” and thus “detect[s] that the first parameter is outside of an acceptable threshold.” EX1004, [0035], [0038], Fig. 3B.

h) 1[e][iii] generate automated control instructions at the second device based at least in part on the first parameter; and;

Norris’s control system “generate[s] automated control instructions” by controlling pumping operations—both globally and locally—based on measured parameters. §EX1003, XI.A.8. Control instructions provide both “overall operational control” (at the application controller) and “local control” (at local pump control). EX1004, [0028]; *see also* [0036]-[0037]. For example, the “pump management system” uses a “pressure signal to manage operation of each prime mover” (i.e., pump). EX1004, [0004]. *Norris* further implements control by

communicating control instructions over various data links. EX1004, [0004], [0036], Figs. 2-4. And each local pump controller generates control instructions at each pump. *Id.*, [0038]-[0039], Figs. 3-4. Each local controller may also act as an application controller and “assume overall control” in “backup operational modes.” EX1004, [0044].

Norris also discloses numerous examples of a “second device” receiving a “first parameter” and “generate[s] automated control instructions at the second device” based on the first parameter, as discussed in further detail in Section VIII.A.1(j) below.

- i) 1[f] one or more control devices configured to receive the automated control instructions and automatically adjust one or more aspects of the second device based on the control instructions.

As discussed in Section VIII.A.1(d), *Norris* describes numerous control devices that receive instructions and adjust operations accordingly. Each pump truck (and components therein) receives control from the application controller and adjusts local pump operation. *E.g.*, EX1004, [0035]-[0036], [0041]-[0042]. Within each pump truck, the ECM receives control instructions from local pump control and adjusts engine, drivetrain, and pump operation. *Id.*, [0035], [0038], Figs. 3B, 4B.

Norris also discloses numerous examples of a control device receiving control instructions and adjusting aspects of a second device. EX1003, §XI.A.9. Section VIII.A.1(j) below details a few examples.

j) Examples of elements 1[e]-1[f]

Each example below is compatible with the other examples, but explained separately for clarity:

Example 1A:

1[e][i] – *Norris*’s pressure-side manifold is a “first device,” and *Norris*’s pump trucks are each a “second device.” The pressure-side manifold is “of the ... distribution system” because it is the distribution system that delivers fluid to the wellhead. *See* EX1004, Figs. 2-4. Each pump truck is “of the plurality of pumps” because the pump trucks contain and operate the pumps. EX1004, Figs. 1, 3B, 4B.

The application controller (a “processing device”) receives data “via data link 187a” from pressure sensor 185, which “monitors fluid pressure within pressure-side manifold 250b.” EX1004, [0030]; *see also supra* VIII.A.1(f), EX1003, §XI.A.10(a). Accordingly, *Norris* discloses a processing device (application controller 401) configured to receive a first parameter (pressure) from a first device of the distribution system (pressure side manifold 250b via pressure sensor 185). EX1003, §XI.A.10(a).

The application controller also sends data to pump trucks via local pump system control on each pump truck. As shown in Fig. 3, data links 187b and 187c connect application controller 401 to local pump controller 410 and local drivetrain controller 405 and deliver data (pressure) from pressure side manifold 250b.

EX1004, Fig. 3, [0035] (“Additionally, local drivetrain controller 405 receives data via data links 187b from pressure side manifold 250b and/or wellhead 180 as well as data from multiple drivetrain controller 402 via data link 187b, local pump controller 410 and from multiple pump controller 403 via data link 187c.”); EX1003, §XI.A.10(a).

Norris thus discloses a processing device (application controller 401) that receives a first parameter (pressure) and transmits the first parameter to a second device (e.g. the pump truck).

I[e][ii] – As discussed above in Section VIII.A.1(g), both *Norris*’s application controller and local pump system control compare parameters to an acceptable (or “desired”) threshold. EX1003, §XI.A.7, ¶¶178-180.

I[e][iii] – *Norris*’s pump truck is a “second device” that receives operating parameters and generates control instructions based on received parameters. First, the pump truck receives control instructions from the application controller. EX1004, [0036]-[0037], [0039]. Second, local pump system control on the pump truck generates control instructions for controlling pump truck operation. *Id.*, [0038]-[0039]. These control instructions are based on a first parameter (pressure) because the application controller signals to “increase or decrease pumping operations” based on deviation of the first parameter from a desired setting. *See, e.g.*, EX1004, [0037]. *Norris* thus discloses “generating automated control instructions at

the second device based at least in part on the first parameter.” EX1003, §XI.A.10(a).

1[f] – In the pump truck, local drivetrain controller 405 and ECM 415 may each act as a “control device” that receives automated control instructions from the local pump controller and adjusts pump truck operation. Once local pump system control receives instructions to change pumping operation, it “transmits a throttle change command to local drivetrain controller 405 and local drivetrain controller 405 signals a throttle change to ECM 415.” EX1004, [0038], Fig. 3B. In a “second path,” “local pump controller 410 transmits an RPM change command to ECM 415.” *Id.* “In this path, ECM 415 changes engine RPM,” and “[e]ither path provides control over PD pump 270 speed through change in engine RPM.” *Id.* *Norris* thus discloses “control devices” (local drivetrain control or ECM) that receive control instructions and automatically adjust operation of a second device (the pump truck) based on received control instructions. EX1003, §XI.A.10(a).

Example 1B:

1[e]/[i] – In *Norris*, a pump truck (labeled pump truck 2) is a “first device,” and a separate pump truck (labeled pump truck 1) is a “second device.” *Norris* discloses “backup operational modes” in which a local pump controller may assume functions of the application controller. EX1004, [0044], [0048]; EX1003, §XI.A.10(b). Accordingly, pump truck 1 (a “second device”), with a local pump

controller acting as the application controller (a “processing device”), may receive parameters from pump truck 2 (a “first device”). *Id.* Each pump truck is “of the plurality of pumps” because pump trucks contain and operate pumps. EX1004, Figs. 1, 3B, 4B.

“Thus, in this mode,” local pump truck 2 receives operational parameters—including “pressure data, piston position data, or ... pump flow rate”—from sensors at a pump, ECM, DAQ, engine, manifold, or wellhead. EX1004, [0044], *see also id.*, [0029]-[0031], [0034]-[0035], Figs. 3-4. Pump truck 2 transmits received parameters to the local pump controller of pump truck 1 (a “second device”), which receives the parameters “in the same manner” as the application controller.¹ EX1004, [0034]-[0036], [0044].

1[e]/[ii] – As discussed in Section VIII.A.1(g), both *Norris*’s local pump controller of pump truck 1 (acting as an application controller) and other local pump controllers compare received parameters to an acceptable (or “desired”) threshold. EX1003, §XI.A.7, ¶¶178-180.

¹ *Norris* also states parameters may be received “directly or indirectly,” that is, from sensors, data processors, or another local pump control. EX1004, [0030], EX1003, §§XI.A.6,10(a).

1[e][iii] –Norris’s pump truck 1 is a “second device” in a backup operational mode because a local pump controller on pump truck 1 receives operating parameters (from pump truck 2) and generates control instructions based on the received parameters “in the same manner as” the application controller. EX1004, [0044], [0048], Figs. 2-4; EX1003, §XI.A.10(b). The local pump controller (acting as an application controller) “utilizes all of the data received to manage ... all pumping operations,” and specifically “uses ... pressure data, piston position data, or other data input, e.g. pump flow rate, ... to determine when to” control pump operations, including operations of its local pump. EX1004, [0030], [0041]. The local pump controller on pump truck 1 may also manage pumping operations by generating and communicating instructions to other pump trucks. *Id.*, [0036]-[0037].

1[f] – In a backup operational mode, a local drivetrain control and an ECM each act as a “control device” by receiving control instructions from pump truck 1 (via local pump control acting as the application controller) and adjusting aspects of pump truck 1 (a “second device”) or its components accordingly. In this mode, one or more components of pump truck 1, such as local drivetrain control or the ECM (either directly from the local pump controller or indirectly through local drivetrain control), may receive control instructions from the local pump controller that is acting as the application controller and adjust operation of pump truck 1. EX1004, [0038], [0044], [0048]; EX1003, §XI.A.9,10(b).

Example 1C:

l[e]/[i] – *Norris*’s pump trucks are each a “first device,” and *Norris*’s local pump system controls are each a “second device.” Devices on *Norris*’s pump truck can send parameters to local “pump system control” through a communications processor implementing a connection or data link (*e.g.*, Ethernet, fieldbus, CANbus, Modbus, or other industrial communications protocols). EX1004, [0029]; EX1003, §XI.A.10(c). *Norris* also illustrates sensor data—including “RPM,” “outlet pressure,” “piston position,” “power,” “outlet flow,” “outlet pressure,” and “supply pressure”—transmitted from pump truck sensors to local pump controller 410 and local drivetrain controller 405. EX1004, Figs. 3-4. EX1003, §XI.A.5.

Norris also discloses that each pump truck’s local pump control may receive measured parameters from the ECM. “[E]ach engine of drivetrain 276 includes an associated electronic control module (ECM)” that “monitors engine parameters” such as “engine RPM,” “engine piston position, spark management, throttle position and management and other common engine management operations.” EX1004, [0032], [0035]. The ECM may receive these parameters from pump truck sensors or other data processors. EX1004, [0029], [0032]; EX1003, ¶139. For example, *Norris* explains that sensors provide information on piston position and RPM, engine parameters monitored by the ECM. *Id.* The ECM then transmits monitored parameters to local pump control. EX1004, [0035]. *Norris*’s ECM also contains at

least one “processing device” to monitor and manage engine operations and communicate with local pump control. EX1004, [0032], [0035], Fig. 3B; EX1003, ¶¶139, 146.

I[e][ii] – As discussed above in Section VIII.A.1(g), both *Norris’s* application controller and local pump system control compare parameters to an acceptable (or “desired”) threshold. EX1003, ¶¶178-180.

I[e][iii] – *Norris’s* local pump system control is a “second device” that receives operating parameters (from the pump truck) and generates control instructions based on received parameters. Each pump truck’s local pump control receives RPM, outlet pressure, piston position, power, outlet flow, and supply pressure parameters. EX1004, Figs. 3-4. And local pump control “transmits a throttle change command” or “an RPM change command” to control pump operation. *Id.*, [0038]. In this feedback loop, the pump truck controls operating parameters based on measured parameters. EX1004, [0029], [0035], [0038], Figs. 3-4; EX1003, §XI.A.10(c), ¶¶190-94. Local pump control may also generate control instructions based on communications received from the application controller, which receives the same measured parameters. EX1004, [0036], [0039].

I[f] – *Norris’s* ECM is a “control device” that receives control instructions from the local pump controller or local drivetrain controller (each a part of local pump system control) and automatically adjusts aspects of local pump truck

operation. EX1003, §XI.A.10(c). Local pump control on the pump truck “transmits a throttle change command” or “an RPM change command” to the ECM. EX1004, [0038], Figs. 3B, 4B. The ECM then “changes engine RPM,” which “directs a change in drivetrain 276 operation.” *Id.* The ECM automatically adjusts aspects of pump-truck and local-pump-control operation as it signals changes to the local pump control and changes pump truck drivetrain operating parameters that are fed back to local pump control. EX1004, [0035] (describing how local pump control “receives RPM and power data from ECM”), [0038], Fig. 3B (illustrating ECM communicating changes to engine RPM to local pump system control), 4B.

2. Claim 2

- a) The system of claim 1, wherein the plurality of sensing devices are installed on the plurality of pumps and the distribution system, and selected from a group including flow sensors, accelerometers, pressure transducer, and tachometers.

See Element 1[d]; supra §VIII.A.1(e). *Norris* discloses at least the following sensors: “pressure sensor[s]” ([0004]), “position sensors” including “rotary encoder-type sensor[s]” ([0033]), and “flow sensors” ([0047]). *See also* EX1004, Claim 2. *Norris* also discloses sensing the following data: “engine RPM, piston position,” “outlet pressure,” “supply pressure,” “flow,” “RPM,” and “power data.” *Id.*, [0035], Figs. 2-4. As discussed above, *Norris* discloses sensors “associated with pump trucks 280, pressure-side manifold 250b, and other monitored operations.” *Id.*, [0029], Figs. 3-4. *Norris* also illustrates and describes these sensors installed on monitored

components. EX1004, [0030] (“[P]ressure sensor 185 monitors fluid pressure within pressure-side manifold 250b”), [0032] (describing “piston monitoring sensor” that determines “position of each piston in PD pump”), Figs. 3-4 (illustrating sensor data received from sensors on “pump truck 280”); EX1003, §XI.B.

3. Claim 3

- a) The system of claim 1, wherein the plurality of pumps or the distribution system includes at least one device selected from a group include a gate, valve, actuator, motor, suction pipe, discharge pipe, engine, transmission, and temperature regulation device, controllable via the one or more control devices.

Norris discloses numerous “supply” and discharge “flow lines,” and a “conduit” delivering fluid to a wellhead, as part of a “distribution system” that a POSITA would understand to contain the claimed “suction pipe” and “discharge pipe.” EX1004, [0026], Fig. 2; EX1003, §XI.C. Pressure and flow in the “flow lines” and “conduit” is controllable via overall control of the pump management system and local pump control. EX1004, [0035], [0039]. *Norris* also discloses an “engine,” “gear shift,” and “drivetrain” controllable by “ECM 415,” “local pump system control,” and “application controller 401.” *Id.*, [0038]-[0039], Figs. 2-4.

4. Claim 4

- a) The system of claim 1, further comprising: a suction line through which fracturing fluid is supplied, and

See supra §§VIII.A.3. *Norris* discloses suction and discharge lines. EX1004, Fig. 2; EX1003, §XI.D.

b) a discharge line through which fracturing fluid is discharged, wherein the plurality of sensing devices includes one or more flow sensors configured to measure flow through the suction line and the discharge line.

See supra §VIII.A.4(a). A POSITA also would have understood *Norris*'s disclosure of sensors monitoring “flow rates” to include sensors measuring flow through the suction and discharge lines. EX1003, §XI.D.

5. Claim 5

a) 5[a] The system of claim 1, further comprising: one or more blenders configured to mix together one or more materials to form the fracturing fluid, wherein the fracturing fluid is provided from the blender to the plurality of pumps via a manifold,

Norris illustrates a “blender” delivering fluid to a “supply-side manifold” that directs the fluid to multiple “pumps.” EX1004, [0021], Fig. 2. In the blender, “water is mixed with various other components ... to form a wellbore servicing fluid.” *Id.*

b) 5[b] wherein the plurality of sensing devices includes one or more pressure or flow sensors for measuring flow conditions at the one or more blenders, the manifold, the plurality of pumps, or the distribution system.

See Elements 1[d], 2; supra §§VIII.A.1(e), VIII.A.2(a). *Norris* discloses that “pressure sensor 185 monitors fluid pressure within pressure-side manifold 250b.” EX1004, [0030]. *Norris* also discloses “pressure or flow sensors” downstream from the pump ([0047]) and sensors for “pump 270 outlet pressure” ([0035]). EX1004.

6. Claim 7

a) 7[p]

See supra §§VIII.A.1(a)-(c).

b) 7[a]

See supra §§VIII.A.1(a)-(c). *Norris* further discloses that fluid flows from “supply-side manifold 250a to the PD pumps 270 via supply flowlines.” EX1004, [0021].

c) 7[b]

See supra §§VIII.A.1(a)-(c).

d) 7[c]

See supra §§VIII.A.1(a)-(c).

e) 7[d]

See Element 1[d]; supra §§VIII.A.1(e), VIII.A.2(a).

f) 7[e]

See Element 1[e][ii]; supra §VIII.A.1(g).

g) 7[f]

See Elements 1[c], 1[e][iii]-1[f]; supra §§VIII.A.1(d),(h)-(i).

h) 7[g]

See Element 1[c], 1[e][iii]-1[f]; supra §VIII.A.1(d),(h)-(i).

i) 7[h]

See Element 1[e][i]; supra §VIII.A.1(f).

j) 7[i]

See supra §VIII.A.1(h).

k) 7[j]

See supra §VIII.A.1(i).

7. Claim 13

a) 13[p]

See supra §§VIII.A.1(a)-(c).

b) 13[a]

See supra §§VIII.A.1(a)-(c).

c) 13[b]

See Element 1[d]; supra §VIII.A.1(e).

d) 13[c]

See Element 1[e]/[i]; supra §VIII.A.1(f).

e) 13[d]

See supra §VIII.A.1(g).

f) 13[e]

See supra §VIII.A.1(h).

g) 13[f]

See Element 1[f]; supra §VIII.A.1(i).

8. Claim 14

a) The method of claim 13, wherein the distribution system receives and consolidates the fracturing fluid from the plurality of pumps for injection into a wellhead.

See Element 1[b]; supra §VIII.A.1(a)-(c).

9. Claim 16

- a) The method of claim 13, wherein the first parameter includes measurements of one or more of the plurality of pumps.

See Element 1[d]; supra §VIII.A.1(e), VIII.A.2(a).

10. Claim 17

- a) The method of claim 16, further comprising: controlling one or more of the plurality of pumps individually based on the automated instructions.

See Element 1[f]; supra §VIII.A.1(i). Norris discloses “local pump system control” “manage[s] the operation of each positive displacement pump/drivetrain assembly.” *See, e.g.,* EX1004, [0005], Figs. 2-4. Each “individual local pump control system ... make[s] adjustments” to individual pumps to preclude coincidental operation. *Id.*, [0041], [0047].

B. Ground 2: Norris Renders Obvious Claims 1-5, 7, 13-14, and 16-17

Norris also renders obvious Claims 1-5, 7, 13-14, and 16-17 under 35 U.S.C. §103. EX1003, §XI. Ground 2 relies on *Norris*’s teaching, as described in Ground 1, of these claim limitations. *Supra* §VIII.A. In addition, for Ground 2 Petitioners explain that *Norris* also renders obvious element 1[e][i], as discussed below. EX1003, §XI.A.6.

1. Claim 1

- a) 1[e][i]

Ground 1 describes *Norris*'s disclosure of processing devices that receive a first parameter from a first device and transmit the first parameter to a second device. To the extent PO argues that *Norris*'s disclosure of this element (in Ground 1) is insufficient, it would have been obvious to implement processing devices in *Norris*'s system that receive measured parameters from a first device and transmit received parameters to a second device. A POSITA would have known to establish communications interfaces or networks containing "processing devices" to receive communications from sensors or pumping operations and transmit those communications (including measured parameters) to control devices. *See, e.g.*, EX1002, [0029] (describing networks and communications interfaces for implementing data links); EX1003, §XI.A.6; EX1004, Fig. 2 (illustrating sensors communicating with controllers and controllable devices through networks and communication interfaces containing processors). A POSITA would also have known that controllers—whether local or central—contain processing devices to communicate with sensors, network nodes, and other controllers. *Id.* Accordingly, a POSITA would have configured a "first device," such as a sensor, communication interface, or pumping component (e.g., a pump, valve, or engine), to communicate measured parameters to "second device," such as a controller, communication interface, or other pumping component, via processors in a communications interface or network.

C. Ground 3: The Combination of Norris and Omont Renders Obvious Claims 1-7 and 10-17

Norris discloses to a POSITA each limitation of claims 1-5, 7, 13-14, and 16-17. *Supra* §VIII.A. *Norris* combined with *Omont* renders obvious dependent claims 4, 6, 10-12, and 15 (in addition to those claims in Ground 1) under 35 U.S.C. §103. EX1003, §XII.

1. Motivation to Combine

A POSITA would have been motivated to combine *Norris* and the teachings of *Omont*. EX1003, §XII.A. *Norris* discloses a multi-pump fracturing system shown in Figure 2:

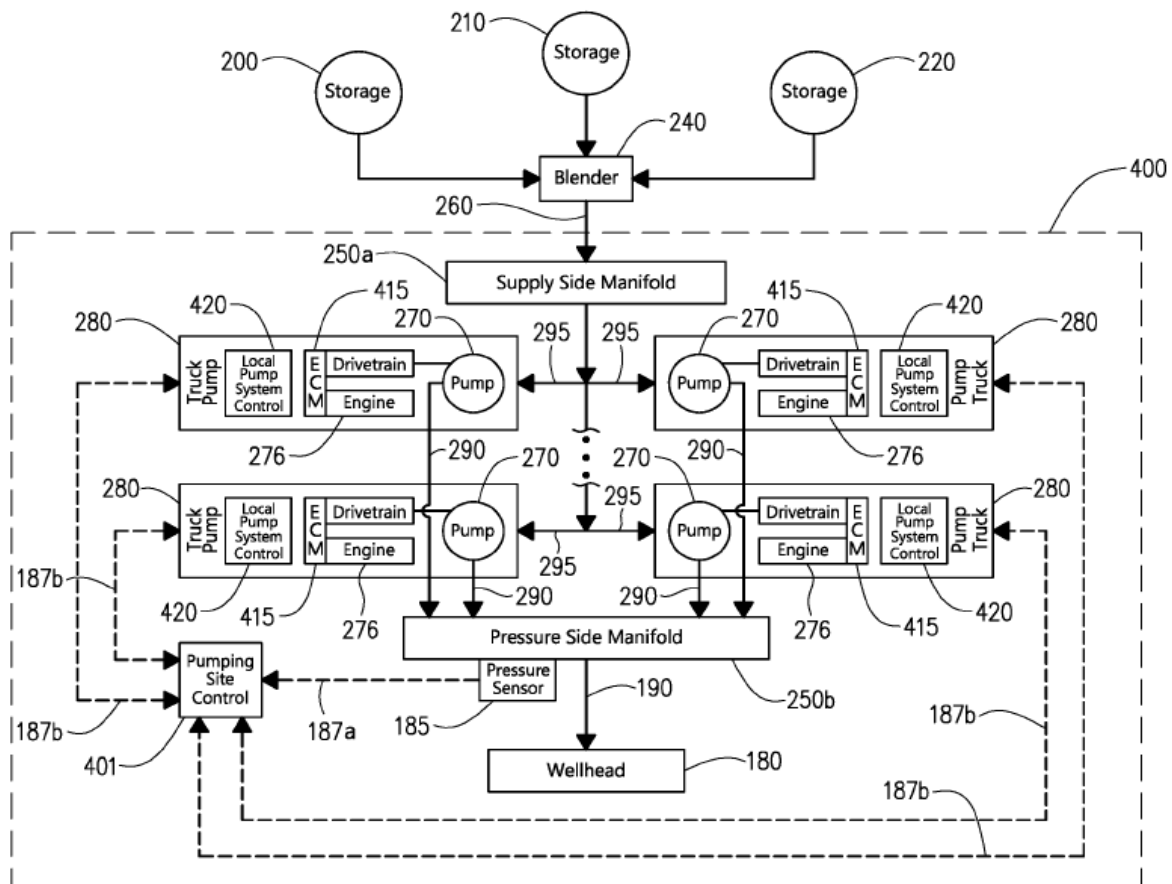


FIG. 2

Norris states that “coincidental operation” of multiple pumps causes “pressure spikes” and “high and low pressure stresses leading to metal fatigue and failure of components.” EX1004, [0002], [0027]. *Norris*’s “pump management system” eliminates coincidental operation. Figure 3A illustrates an example:

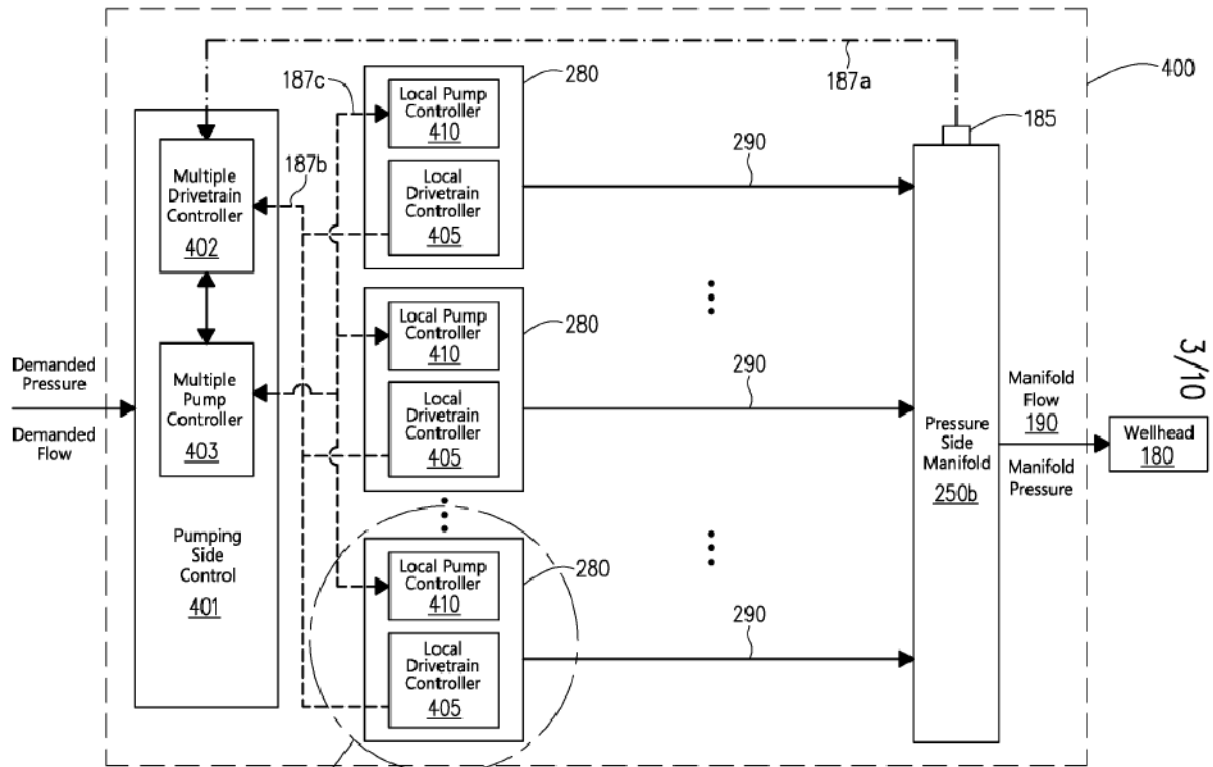


FIG. 3B

FIG. 3A

Norris's “pump management system” contains both sensors and controllers for controlling fracturing operations. EX1004, [0035]. *Norris* uses sensed data to manage operations and “reduce stress and fatigue.” *Id.*, [0028], [0035].

Omont similarly discloses a multi-pump fracturing system, shown in Figure 1:

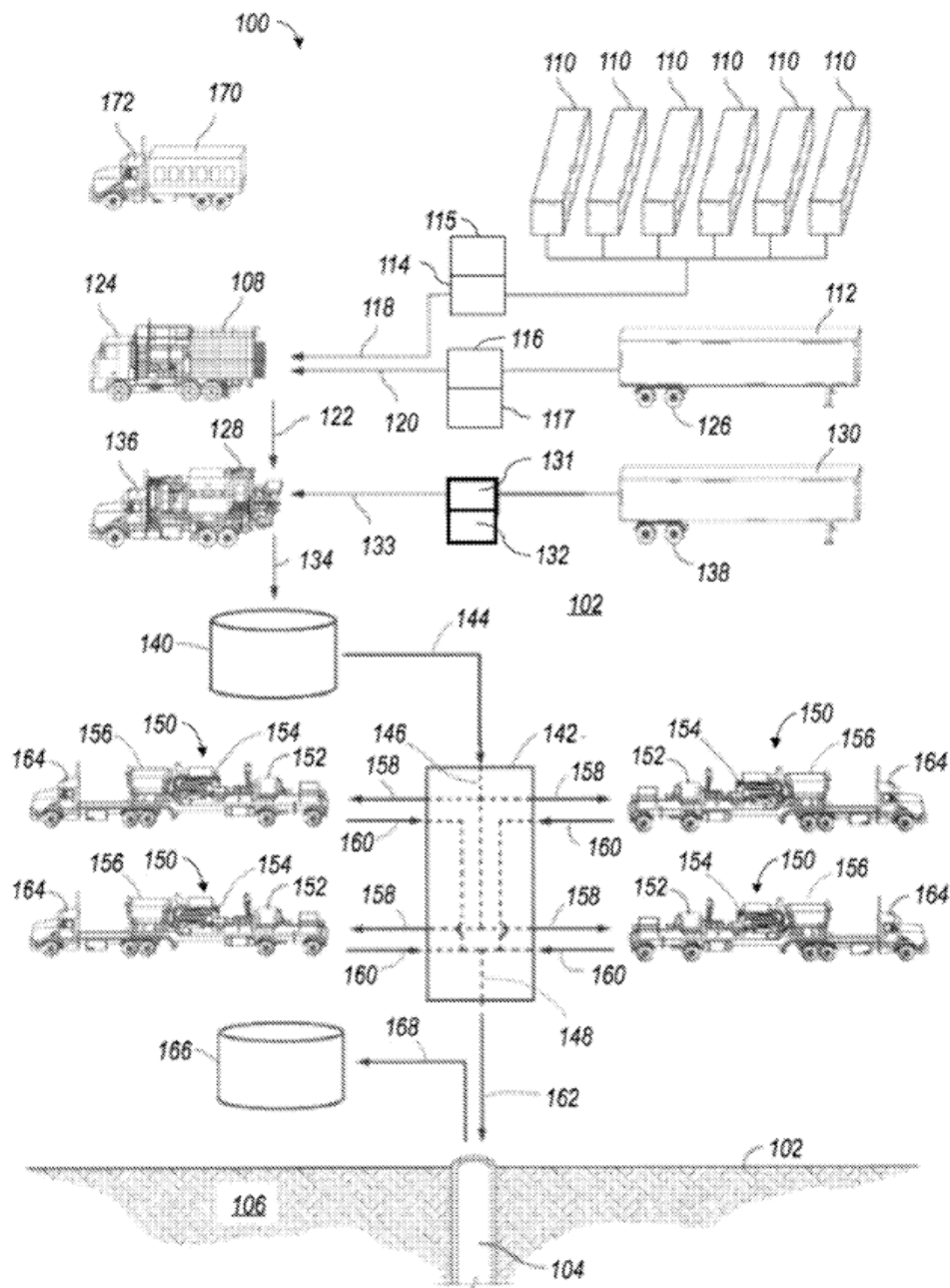


FIG. 1

Like *Norris*, *Omont*'s fracturing system contains "mixers," multiple pumps, and manifolds distributing fluid. EX1005, Fig. 1. *Omont* identifies wear and tear, causing "operation stoppages and severe damage," as an operational challenge. *Id.*,

[0002]-[0003]. *Omont* introduces “control and monitoring” to fracturing operations, shown for example in Figure 2:

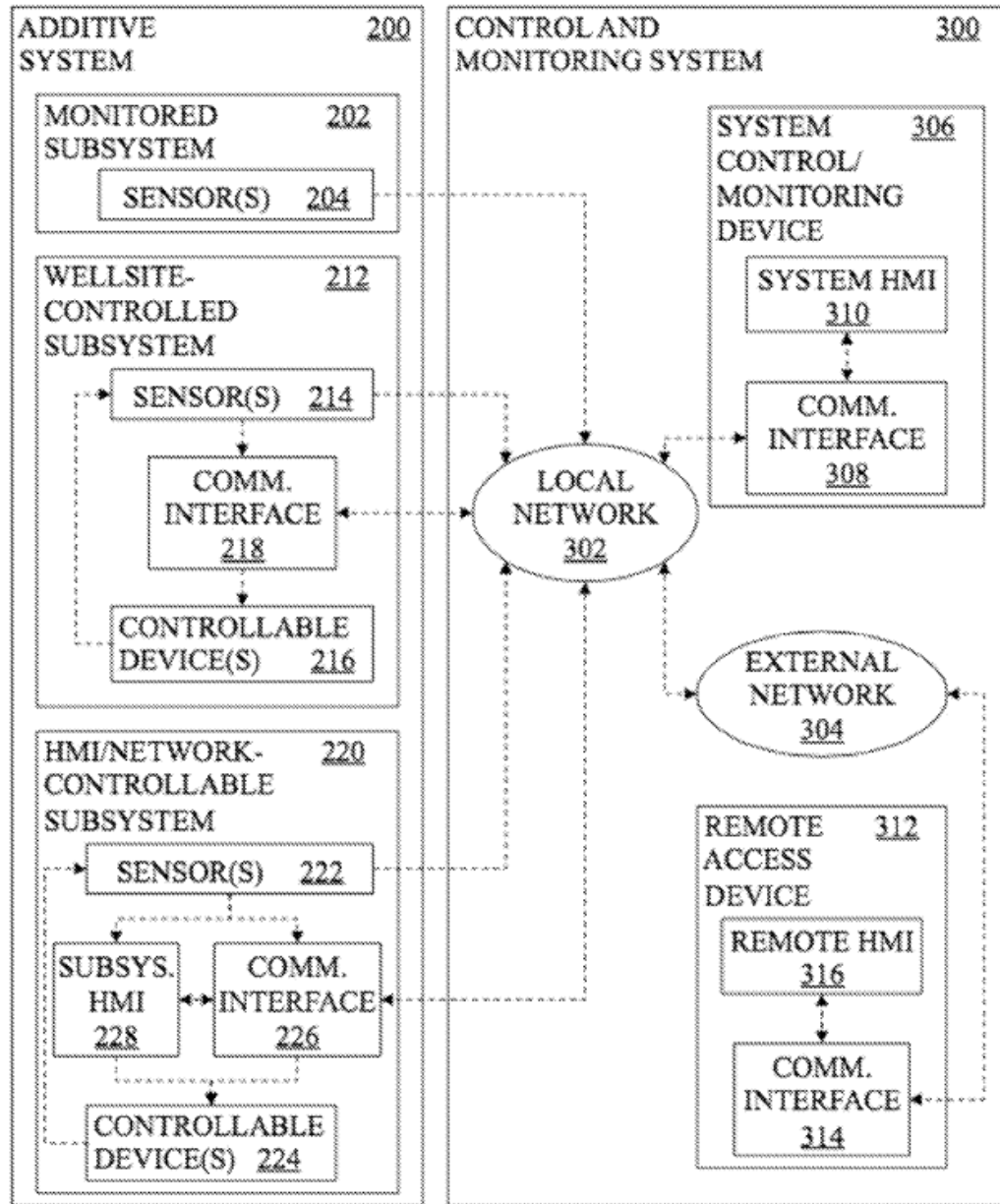


FIG. 2

Norris and *Omont* are thus from the same field (multiple-pump fracturing), identify similar problems (component fatigue and failure), and address problems

with similar solutions (sensing, monitoring, and control). A POSITA would have considered whether known solutions from one reference could be applied in the other. EX1003, §XII.A.

Moreover, a POSITA would reasonably expect *Omont*'s monitoring and control techniques to improve *Norris*'s control system. Applying elements of *Omont* (e.g., *Omont*'s diagnostic tool) to *Norris* would enable logging and storing operational parameters, generating alerts for predictive maintenance, and extending control to blenders and material-handling systems, all while maintaining *Norris*'s approach to avoiding coincidental operation. *See infra* §§VIII.C.5-6, VIII.C.9-11; EX1003, §XII.A.

Systems and techniques in *Norris* and *Omont* are compatible and combining elements of *Norris* and *Omont* leads toward the same system configuration as in *Norris* with desirable operating results. For example, *Omont* teaches control devices deployed locally with components or separately (EX1005, [0061], Figs. 2-3), and *Norris* similarly discloses both local and system-wide control (EX1004, Figs. 3-4). A POSITA would have understood that features of *Omont*'s local pump control could be implemented in *Norris*'s local pump control, that features of *Omont*'s central control could be implemented in *Norris*'s central control, or vice versa. EX1003, §XII.A. *Norris* also discloses that non-coincidental pump operation reduces stress and fatigue (EX1004, [0028], [0049]), and *Omont* describes predictive

maintenance techniques, compatible with *Norris*, that extend component lifetime and avoid costly failures (EX1005, [00118]).

Omont also identifies known techniques to improve similar devices in the same way that *Norris* improved fracturing operations. For example, *Norris* describes pump sensing and control (EX1004, [0029]), and *Omont* extends similar sensing and control to blenders and material conduits (EX1005, [0026], [0051]-[0054], [0059]). Accordingly, a POSITA would naturally apply *Omont*'s monitoring and control techniques—highly similar to those in *Norris*—to *Norris*'s control system, pumps, blender, and flowlines. *See, e.g.*, EX1003, §XII.A.

A POSITA would also have combined *Norris* and *Omont* according to known methods to yield predictable results. For example, *Norris* discloses sensors measuring “operational parameters.” EX1004, [0032], [0037], [0041]. *Omont* discloses logging sensor data—including the same types of operational data measured in *Norris*—for use in predictive maintenance. EX1005, [0005], [0052]. A POSITA would have known that sensor types in *Omont* could also be used, with predictable results, with components in *Norris*. EX1003, §XII.A. A POSITA would also have known that data obtained from *Norris*'s sensors could be predictably logged for predictive maintenance, as taught in *Omont*. EX1003, §XII.A.

Finally, design incentives and market forces in multi-pump fracturing would have led a POSITA to combine *Norris* and *Omont*. *Norris* teaches that coincidental

pump operation causes fatigue and failure. EX1004, [0002]-[0003]. *Omont* teaches that “operation stoppages” and “severe damage” to components introduce “monetary costs and loss of production time.” EX1005, [0003]. A POSITA seeking to extend component life, maximize production time, or reduce expensive manual interventions in operations would naturally look to *Norris* and *Omont* together. *Omont*’s teachings require little variation for use with *Norris*, and variations in sensing, monitoring, and control techniques would have been predictable to a POSITA. EX1003, §XII.A.

All these reasons would have motivated a POSITA to combine the teachings of *Norris* and *Omont*.

2. Claim 1

a) 1[p]:

See supra §VIII.A.1(a). *See also* EX1005, [0017], Fig. 1.

b) 1[a]:

See supra §VIII.A.1(b). *See also* EX1005, [0023], Fig. 1.

c) 1[b]:

See supra §§VIII.A.1(c), VIII.C.2(b). *See also* EX1005, [0025].

d) 1[c]:

See supra §VIII.A.1(d). *Omont* also teaches “a control and monitoring (CAM) system” and “control hardware,” containing processors for implementing control

and implemented in “additive systems” or “CAM system 300.” EX1005, [0029], [0060]-[0065], Figs. 2-4.

Omont thus teaches local and system-wide control like *Norris*, and a POSITA would have combined elements and functions of *Omont* with *Norris*’s control system. For example, a POSITA would have implemented aspects of *Omont*’s “control and monitoring (CAM) system” in *Norris*’s “application controller” and aspects of *Omont*’s “control hardware” in *Norris*’s “local pump system control.” EX1003, §XII.B.2. Similarly, a POSITA would have known to program *Norris*’s sensors, controllers, and processors to perform methods performed by *Omont*’s sensors, controllers, and processors (e.g., *Omont*’s “diagnostic tool”). *Id.*

e) 1[d]:

See supra §VIII.A.1(e). *Omont* also teaches various sensors (e.g., “sensor 204,” “sensor 214,” “sensor 222”) that “monitor ... parameters” associated with fracturing “subsystem[s],” including “pump assemblies.” EX1005, [0030]-[0033], [0037], Fig. 2. *Omont*’s “sensors” gather numerous “operational parameters” from various components, including the distribution system. EX1005, [0050]-[0052], [0054] Figs. 1, 3; EX1003, §XII.B.3. A POSITA would have known to implement *Omont*’s sensors in *Norris*’s system. EX1003, §XII.B.3.

Omont’s sensors may also be “implemented as an instance of the control hardware,” which contains processors. EX1005, [0061]-[0063]; EX1003, §XII.B.3.

A POSITA would also have known to use *Omont*'s control hardware to implement "sensors and data processors" monitoring operations in *Norris*. EX1003, §XII.B.3.

f) 1[e][i]

See supra §§VIII.A.1(f), VIII.C.2(d)-(e). *Omont* further teaches "components of each subsystem" (including sensors) and "components of the SCM device" (or "system control/monitoring device") may be "implemented as ... control hardware" having "one or more processors." EX1005, [0060]-[0062], Figs. 2-4. A POSITA would have known to implement sensors, data processors, and controllers in *Norris* using *Omont*'s control hardware. EX1004, [0029]; EX1005, [0062]-[0063]; EX1003, §XII.B.4. Both references also teach use of processors from standard industrial communication protocols to send and receive operating parameters. *Id.* Similarly, a POSITA would have implemented aspects of *Omont*'s SCM device in *Norris*'s application controller, and *Omont* teaches that the SCM may be "implemented as ... control hardware." *See* EX1003, §XII.B.4; EX1005, [0060]-[0061].

Omont also teaches control hardware implemented in communication interfaces between sensors, controllers, and other subsystem components. *See* EX1005, [0032], [0061], Fig. 2. A POSITA would have implemented communication via communication interfaces containing "processing devices." EX1003, §XII.B.4.

Omont further teaches processors transmit and receive operational parameters. For example, “control hardware 400 may receive information generated by the sensors.” EX1005, [0065]. *Omont*’s sensors also transmit operational parameters “to the CAM system” via a local network or communication interface. *Id.*, [0038], [0050], Figs. 2-3.

Accordingly, *Omont* teaches receiving a “first parameter” from a “first device” and transmitting a “first parameter” to a “second device,” directly or indirectly through a “processing device.” Section VIII.C.2(j) below further describes detailed examples collectively addressing multiple claim limitations.

g) 1[e][ii]

See supra §§VIII.A.1(g), VIII.C.2(f). PO amended elements 1[e]-1[f] to obtain allowance, as shown below:

one or more processing devices configured to receive ~~and the one or more parameters~~ a first parameter from a first device of the plurality of pumps, the distribution system, or the wellhead, and transmit the first parameter to a second device of the plurality of the plurality of pumps, the distribution system, or the wellhead, and detect that ~~[[a]] the first parameter of the one or more parameters~~ is outside of an acceptable threshold; and generate automated control instructions at the second device based at least in part on the first parameter ~~one or more parameters~~; and

one or more control devices configured to receive the automated control instructions and automatically adjust one or more aspects of the second device ~~the plurality of pumps or the distribution system~~ based on the control instructions.

EX1002, 991. But as explained above, *Norris* discloses the amended elements. *See supra* §§VIII.A.1(f)-(i). And as the Examiner explained, *Omont* teaches unamended claim limitations, including “detect[ing] that the first parameter is outside of an acceptable threshold.” EX1002, 1130-1131.

Omont teaches that “SCM device 306” or another “portion of the CAM system” (e.g., control hardware 400) may implement “diagnostic tools.” EX1005, [0075], Fig. 5. “Diagnostic tool[s]” compare a “parameter associated with the sensor to a predetermined threshold” to identify defects and issue warnings. *Id.*, [0093]. Similarly, “diagnostic tools” monitor “sensor data and/or other process parameter[s]” to “confirm that such values meet predetermined thresholds or are within predetermined ranges.” *Id.*, [0094]. Accordingly, both the SCM and control

hardware detect that a first parameter is outside of an acceptable threshold. *Omont* further teaches operational control based on comparing parameters to thresholds. EX1005, [00143].

A POSITA would have compared operational parameters to thresholds, as taught in *Omont*, throughout *Norris*'s system. *Norris* already teaches comparing actual operating parameters to desired parameters. EX1004, [0037]. A POSITA would understand, from *Omont*, the benefits of this threshold comparison for sensors and components throughout *Norris*'s system, including at pumps, manifolds, conduits, valves, actuators, and blenders. EX1003, §XII.B.5.

A POSITA would also have implemented *Omont*'s “diagnostic tool” and related methods in *Norris*'s system. *Norris* describes monitoring pumps, comparing operating and desired parameters, and avoiding component fatigue. EX1004, [0027]-[0028]. *Omont*'s “diagnostic tool” could implement and improve these functions. EX1003, §XII.B.5. Further, a POSITA would have been encouraged to implement a diagnostic tool in *Norris*'s system by *Omont*'s and *Norris*'s suggestion to combine aspects of *Omont*'s control hardware and SCM—which implement the diagnostic tool—into *Norris*'s sensors and controllers. *See* EX1003, §XII.B.2; EX1005, [0075].

h) 1[e][iii]

Both the SCM and control hardware in *Omont* generate automated control instructions based on the first parameter. EX1005, [0038], [0065]; EX1003,

§XII.B.6. Section VIII.C.2(j) below further details two examples of the SCM and control hardware generating automated control instructions.

i) 1[f]

See supra §§VIII.A.1(i); VIII.C.2(d),(f)-(h). *Omont* teaches “controllable devices” that receive instructions from control hardware and/or the SCM. “[E]xecuted instructions and/or generated output information” from control hardware “may be for controlling the controllable devices,” including “by another instance of the control hardware.” EX1005, [0065], Fig. 2. Similarly, “[t]he SCM” may “generate and send control signals to the controllable devices.” *Id.*, [0038]. As examples, a “common manifold,” “valve,” “actuator,” “material transfer device,” or “prime mover” “may be implementations of the controllable devices.” *Id.*, [0050]-[0052], [0059]. *Omont* accordingly teaches control devices receiving control instructions.

As discussed above, a POSITA would have combined functions of *Omont*’s controllers into *Norris*’s controllers. *See supra* §§VIII.C.1; VIII.C.2(d),(f)-(g). Both *Omont* and *Norris* describe multiple pumps, manifolds, conduits, blenders, and wellheads. *See supra* §§VIII.A.1(a)-(c), §§VIII.C.2(a)-(c). A POSITA would also have readily recognized benefits of *Omont*’s controllable devices and implemented those devices at (or as) components in *Norris*. EX1003, §XI.B.7.

Omont also teaches that controllable devices adjust “aspects of the second device” based on received control. Section VIII.C.2(j) below provides two examples for control received from the SCM and control hardware.

j) Examples of elements 1[e]-1[f]

Both the SCM and control hardware in *Omont* generate automated control instructions based on the first parameter, and controllable devices automatically adjust operations based on those instructions. EX1003, §XII.B.7. Example 3A below addresses the SCM generating instructions and Example 3B addresses control hardware generating instructions. These two examples are compatible:

Example 3A:

1[e][i] – *Omont*’s sensors are a “first device” and *Omont*’s SCM device is a “second device.” Both sensor and SCM contain “processing devices.” EX1005, [0061]-[0063]; EX1003, §XII.B.3-4. And *Omont*’s sensors communicate parameters to the SCM through a communication interface or network also containing “processing devices.” EX1005, [0032], [0061], Fig. 2.

The “SCM device” “receive[s] information generated by the sensors 204, 214, 222.” EX1005, [0038], Figs. 2-3. Sensors “generate ... information related to operational parameters” or “monitor one or more parameters” communicated to the “CAM system” (i.e., the SCM). *Id.*, [0030]-[0035], Figs. 2-3.

Sensors installed at and monitoring the pumps and distribution system are “of the plurality of pumps, the distribution system, or the wellhead.” For example, sensor 222 is part of “HNC subsystem 220,” which may include “pump assemblies.” EX1005, [0037], Figs. 1-2. The “common manifold” also includes “sensors” that “generate a signal or information related to operational parameters” and “communicate such signal or information” to the SCM. *Id.*, [0059], Fig. 3.

The SCM device is “of the plurality of pumps, the distribution system, or the wellhead” because it controls and monitors pump and distribution system operations. The SCM “receive[s]” operational parameters of the pumps and distribution system and “generate[s] and sends control signals to the controllable devices” that control pump and distribution-system operation. EX1005, [0038], [0050]-[0052], Fig. 3.

I[e][ii] – As discussed above in Section VIII.C.2(g), a POSITA would have combined *Omont* and *Norris* to compare operational parameters to thresholds throughout the fracturing system.

I[e][iii] – *Omont*’s SCM device is a “second device” that “generate[s] automated control instructions at the second device” based on receiving a first parameter. The “SCM device” may “receive information generated by the sensors” and based “on such information, generate and send control signals.” EX1005, [0038]. The “SCM device” uses “information generated by the sensors” to “execute coded machine-readable instructions” to perform methods and processes disclosed

in *Omont* (e.g. *Omont*'s "diagnostic tool"). EX1005, [0038]. The SCM generates control instructions "at the second device" because instructions are contained at the SCM and the SCM itself generates and sends instructions. *Id.*

I[f] – *Omont*'s controllable devices are "control devices" that adjust aspects of SCM operation based on received control instructions. Controllable devices adjust operation of oilfield components and subsystems that are fed back to adjust operation of the SCM (a "second device"). EX1005, [0037]-[0038], [0075]-[0077], Fig. 5. For example, the SCM monitors components and subsystems and generates output signals such as "alarms, visual indicators, error codes, and/or other diagnostic information." EX1005, [0075], [0094]; EX1003, §XII.I-J. As another example, "automation diagnostics" provide status information, calibration information, and diagnostic messaging via the SCM during automation of various oilfield operations. EX1005, [0099]-[00101].

Example 3B:

I[e][i] – *Omont*'s sensors are a "first device" and *Omont*'s subsystems are "second device[s]." Both sensors and subsystems contain "processing devices." EX1005, [0061]-[0063]; EX1003, §XII.B.2-4. Sensors may also communicate parameters to subsystems through a communication interface containing a "processing device." *E.g.*, EX1005, [0061]-[0063], Fig. 2.

Omont's subsystems receive a first parameter from one or more sensors. The subsystems—such as “wellsite-controlled (WC) subsystem 212,” “HMI/network-controllable subsystem 220,” “subsystem 242,” “subsystem 252,” and “subsystem 262”—have “portions” implemented as “control hardware” that “receive[s] information generated by the sensors.” EX1005, [0060]-[0065], Figs 2-3.

Subsystems are “of the plurality of pumps, the distribution system, or the wellhead”: the subsystems contain (and may be) the pumps, the distribution system, the wellhead, or components thereof. For example, “WC subsystem 212” may include “material transfer devices” and “prime movers”—such as pumps, motors, engines, and actuators—as well as “other components.” EX1005, [0018], [0021], [0033]. Similarly, “HNC subsystem 220” may include “mixers” and “pump assemblies.” *Id.*, [0037], Fig. 1.

1[e][ii] – As discussed above in Section VIII.C.2(g), a POSITA would have combined *Omont* and *Norris* to compare operational parameters to thresholds throughout the fracturing system.

1[e][iii] – *Omont*'s subsystems contain control hardware that “generate[s] automated control instructions at the second device” (i.e., the subsystem) based on receiving a first parameter. “[C]ontrol hardware may receive information generated by the sensors” and “execute programs, routines, and/or other coded instructions based on such information,” resulting “in the generation of output information ...

for controlling the controllable devices.” EX1005, [0065]-[0067]. And control hardware implements methods described in *Omont* for controlling components based on operational parameters. *Id.*, [0065], [00137]-[00143]. Control hardware generates instructions “at a second device” because the control hardware may be in or at the controlled subsystem (a “second device”). *See* EX1005, [0061]-[0065], Figs. 2-3.

1[f] – *Omont*’s controllable devices automatically adjust aspects of subsystem operation based on received control instructions. EX1005, [0037]-[0038], [0061]-[0065]. For example, valves and actuators in “subsystem 242” or “subsystem 262” are controllable to adjust subsystem operations. *Id.*, [0050], [0057], Fig. 3. Similarly, material transfer devices and prime movers in “subsystem 252” are controllable to adjust subsystem 252 operation. *Id.*, [0052], Fig. 3. The “common manifold” and “mixing device[s]” are controllable in the same manner. *Id.*, [0059].

3. Claim 2

See Element 1[d]; supra §§VIII.A.2(a), VIII.C.2(e). *Omont* teaches “pressure sensors,” “flow meters,” and sensors that measure “pressure,” “rotational position,” and “operating speed,” among others. EX1005, [0048], [0052], [00131]. A POSITA would have understood these sensors are installed on pumps, the distribution system, and wellhead. *Id.*, Fig. 2; EX1003, §XII.C.

4. Claim 3

See Element 1[f]; supra §§VIII.A.3(a), VIII.C.2(h); EX1003, §XII.D. *Omont* further teaches pumps include a “prime mover” with a controllable motor or engine. EX1005, [0051].

5. Claim 4

a) 4[a]

Norris teaches both a “supply-side manifold” and “pressure-side manifold” with associated sensors. *See Elements 1[b], 3; supra* §§VIII.A.1(c), VIII.A.4. *Omont* similarly teaches both suction and discharge lines in a manifold monitored by flow sensors. EX1005, [0023]; *see supra* §VIII.C.2(e).

b) 4[b]

See supra §VIII.C.5(a). *Omont* also teaches a “material sensor,” such as a “flow meter,” that “generate[s] information relat[ing] to the flow rate of material being transferred” to and from the manifolds via “material conduits.” EX1005, [0053]-[0054]. *Omont* further teaches that the “common manifold” may include “sensors” and “actuators” to both monitor and “control ... flow” through the manifold. *Id.*, [0059]. A POSITA would have applied *Omont*’s sensors, actuators, and controllers for monitoring and controlling suction and discharge manifolds to like components in *Norris* to achieve monitoring and control. *See supra* §§VIII.C.1, VIII.C.2(d)-(e); EX1003, §XII.E.

6. Claim 5

a) 5[a]

See supra §VIII.A.5(a). *Omont* teaches multiple “mixers” that mix “fracturing fluid” provided to a “common manifold” feeding multiple pumps. EX1005, [0018]-[0021], [0023], Fig. 1.

b) 5[b]

See Elements 1[d], 4; supra §§VIII.A.5(b), VIII.C.2(e), VIII.C.5. *Omont* teaching sensing and control of blending, considered alongside *Norris*’s blender, would have motivated a POSITA to apply sensing and control techniques taught in *Norris* and *Omont* at blenders (in addition to pumps and manifolds) to control fluid delivery. EX1003, §§XII.F-G; *see supra* §VIII.C.1.

7. Claim 6

a) The system of claim 5, wherein the one or more control device is configured to control the one or more blenders, the manifold, the plurality of pumps and the distribution system based on the flow and/or pressure conditions,

See Elements 1[c]-1[d], 1[f]; supra §§VIII.A.5, VIII.C.2(d)-(e),(h), VIII.C.6. *Omont* further teaches “control” of “operational parameters” associated with “first and second mixers,” including “production rate of the mixture.” EX1005, [0026]. A POSITA would have understood that controllers were available to control blending, mixing, and fluid-delivery systems (as well as the manifold, pumps, and distribution

system) and would have controlled these components based on *Norris* and *Omont*.

EX1003, §§XII.F-G .

8. Claim 7

a) 7[p]

See supra §§VIII.A.1(a)-(c), VIII.C.2(a)-(c).

b) 7[a]

See supra §§VIII.A.1(a)-(c), VIII.C.2(a).

c) 7[b]

See supra §§VIII.A.1(a)-(c), VIII.C.2(b).

d) 7[c]

See supra §§VIII.A.1(a)-(c), VIII.C.2(c).

e) 7[d]

See Element 1[d]; supra §§VIII.A.1(e), VIII.C.2(e).

f) 7[e]

See supra §§VIII.A.1(g), VIII.C.2(g).

g) 7[f]

See Elements 1[c], 1[e][ii]-1[f]; supra §§VIII.A.1(d),(h)-(i); VIII.C.2(d),(h)-

(i).

h) 7[g]

See Element 1[f]; supra §§VIII.A.1(d),(h)-(i), VIII.C.2(d),(h)-(i).

i) 7[h]

See Element 1[e][i]; supra §§VIII.A.1(f), VIII.C.2(f).

j) 7[i]

See supra §§VIII.A.1(h), VIII.C.2(h).

k) 7[j]

See supra §§VIII.A.1(i), VIII.C.2(i).

9. Claim 10

a) 10[a] The method of claim 7, further comprising: determining that the one or more parameters are indicative of a potential failure condition; and

See supra §§VIII.C.1, VIII.C.8(a). *Omont's* diagnostic tool monitors sensors and detects “problems that are sensor related, mechanical in nature, and/or process related.” EX1005, [00102]. The diagnostic tool also detects “errors and/or faults” in communications, automatic operations, or calibrations. *Id.*, [0096], [0099]. A “predictive maintenance tool” also uses monitored parameters to generate “functional life profiles” for various components, “preventing failures before they occur.” *Id.*, [00118]-[00119]. As discussed above, a POSITA would have been motivated to combine aspects of *Omont's* diagnostic tool into *Norris's* pumping system, including these methods for identifying potential failure. EX1003, §§XII.A,I; *See Element 1[e][ii]; supra* §VIII.C.2(g).

b) 10[b] determining a source of the potential failure condition.

See supra §§VIII.C.1, VIII.C.9(a). *Omont*'s diagnostics identify the “reason for an abort of automation or failure” and communicate “the reason for or a description of the abort or failure” when a failed process occurs. EX1005, [0099]-[00101]. *Omont*'s “predictive maintenance tool” also identifies “parameters that have greater affect on the functional life” of components (i.e., parameters causing failure conditions). *Id.*, [00119].

10. Claim 11

- a) The method of claim 10, further comprising: generating an alert or notification indicative of the potential failure condition and the source.

See supra §§VIII.C.1, VIII.C.9; EX1003, §§XII.A,J. *Omont* teaches control hardware initiating “alarms, visual indicators, error codes, and other diagnostic indicators.” EX1005, [0075]. Components “generate various error codes” containing “a meaningful message” for an operator to “facilitate understanding of the problem.” *Id.*, [00104]. Triggered alarms may include potential “root causes.” *Id.*, [0094], [00107].

11. Claim 12

- a) 12[a] The method of claim 7, further comprising: logging operation data including a number of strokes and pumping hours performed by a pump of the plurality of pumps; and

In *Omont*, a “logging tool” logs “various operational parameters,” including pump parameters. EX1005, [00114]-[00120]. Logged information includes “engine speeds,” “linear position, “rotational position,” operating rate or frequency,”

“operating time,” and “operating hours” (i.e., pumping hours). EX1005, [00120], [00129].

As discussed above, a POSITA would have combined aspects of *Omont*’s diagnostic tool into *Norris*’s pumping system, including these methods for logging data. EX1003, §§XII.A,I,K; *See Element 1[e]/[ii]; supra* §§VIII.C.1, VIII.C.2(g). Moreover, a POSITA would have recognized logging data would enable predictive maintenance and manual intervention, as taught in *Omont*, to maintain and evaluate both pumping operations and monitoring and control systems disclosed in *Norris*. EX1003, §§XII.A,I,K.

- b) 12[b] determining a maintenance schedule based at least in part on the operation data.

See supra §VIII.C.11(a). *Omont* teaches a “predictive maintenance tool” using “logged parameter values” to create a “historical database of functional life profiles.” EX1005, [00118]-[00119]. The predictive maintenance tool informs operators “of a predetermined maintenance schedule” and a “remaining functional life” of fracturing components. *Id.*

12. Claim 13

- a) 13[p]:

See supra §§VIII.A.1(a)-(c), VIII.C.2(a).

- b) 13[a]

See supra §§VIII.A.1(a)-(c), VIII.C.2(b)-(c).

c) 13[b]

See Element 1[d]; supra §§VIII.A.1(e), VIII.C.2(e).

d) 13[c]

See Element 1[e][i]; supra §§VIII.A.1(f), VIII.C.2(f).

e) 13[d]

See supra §§VIII.A.1(g), VIII.C.2(g).

f) 13[e]

See supra §§VIII.A.1(h), VIII.C.2(h).

g) 13[f]

See Element 1[f]; supra §§VIII.A.1(i), VIII.C.2(i).

13. Claim 14

See Element 1[b]; supra §§VIII.A.8(a), VIII.C.2(b)-(c).

14. Claim 15

a) The method of claim 14, further comprising: controlling one or more functions of the distribution system based on the automated instructions.

See Element 1[f]; supra §§VIII.A.1(f)-(i), VIII.C.1, VIII.C.2(h), VIII.C.5,7,13. A POSITA would have understood that controlling both suction and discharge lines, as taught in *Omont*, would improve control of pumping operations in *Norris* to achieve desired wellhead parameters. *See, e.g.*, EX1003, XII.N.

15. Claim 16

See Element 1[d]; supra §§VIII.C.12(a), VIII.C.2(e). *Omont* also teaches monitoring and individually controlling “pump assemblies 150.” EX1003, §§XII.O-P.

16. Claim 17

See Element 1[f]; supra §§ VIII.C.2(h)-(i), VIII.C.15. *Omont* also teaches that “subsystem 220” contains “controllable device 224,” which may control an individual “material transfer device” or “prime mover.” EX1005, [0037]-[0038], [0051]-[0052], Fig. 2. The controllable device 224 receives “control signals” “based at least in part on” “information generated by the sensors.” *Id.*

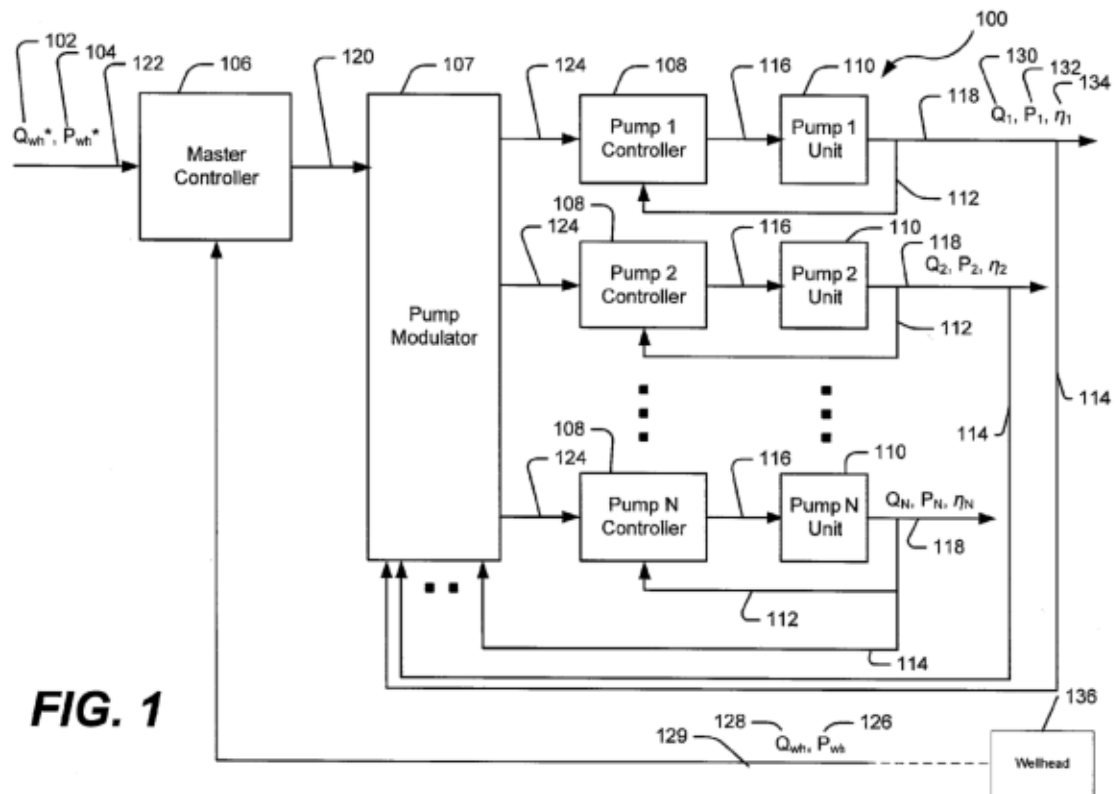
D. Ground 4: The Combination of Norris and Borgstadt Renders Obvious Claims 1-5 and 7-19.

As described in Ground 1, *Norris* discloses to a POSITA each limitation of claims 1-5, 7, 13-14, and 16-17. *Norris* combined with *Borgstadt* further renders obvious dependent claims 4, 8-11, 15, and 18-19 (in addition to those claims addressed in Ground 1) under 35 U.S.C. §103. EX1003, §XIII.

1. Motivations to Combine

For similar reasons as in Ground 3, a POSITA would have been motivated to combine *Norris* with teachings of *Borgstadt*. *See supra* §VIII.C.1; EX1003, §XIII.A.

As discussed in Ground 3, *Norris* discloses a pump management system for monitoring and controlling multiple pumps. *Supra* §VIII.C.1. *Borgstadt* Figure 1 illustrates a similar multi-pump system:



EX1006, Fig. 1.

Borgstadt identifies several issues in multiple-pump systems, including (1) “the pumps are manually adjusted,” (2) “wear and tear” leads to “pump failure [that] can be very costly” and “halt[s] the operations,” and (3) when pumps fail, operators “have no idea” which pumps can “compensate for the dropped pump load.” EX1006, [0003]-[0008]. To address these issues, *Borgstadt* “control[s] the operation of the

pumps involved based on certain parameters characterizing the pump.” EX1006, [0001].

Norris and *Borgstadt* are thus from the same field (multiple-pump fracturing), identify similar problems (component fatigue, stress, and failure), and address problems with similar solutions (pump sensing and control). A POSITA would have considered whether known solutions from one reference could be applied in the other. EX1003, §XIII.A.

Moreover, a POSITA would reasonably expect *Borgstadt*’s techniques to improve *Norris*’s system. For example, *Norris* states pump, sensor, or controller failure may inhibit control system operation, prevent non-coincidental operation, or require redistributing pumping load across remaining pumps. EX1004, [0044], [0048]. *Borgstadt* teaches diagnosing potential failure conditions, issuing “warning conditions” during abnormal operation, and “intelligently” distributing pumping load to compensate for component failure. EX1006, [0025]-[0026], [0033]-[0035]. A POSITA would understand that *Borgstadt*’s techniques for preventing failures and redistributing pumping load would improve *Norris*’s system by improving efficiency, facilitating preventative maintenance, avoiding pump use beyond capacity, protecting against cavitation, and minimizing system downtime. EX1003, §XIII.A.

Systems and techniques in *Norris* and *Borgstadt* are compatible, and combining elements of *Norris* and *Borgstadt* leads toward a similar system configuration as in *Norris* with desirable operating results. For example, *Borgstadt* teaches both local and top-level control of the pumping system (EX1006, [0022]-[0025], Fig. 1) as does *Norris* (EX1004, Figs. 3-4). A POSITA would have understood that features of *Borgstadt*'s local pump control could be implemented in *Norris*'s local pump control and features of *Borgstadt*'s central control could be implemented in *Norris*'s central control. EX1003, §XIII.A. *Norris* also discloses maintaining non-coincidental pump operation to reduce stress and fatigue on components (EX1004, [0028], [0049]), and *Borgstadt* similarly addresses stress and fatigue by diagnosing pump underperformance or defects, balancing pumping load across pumps, and providing warnings to operators (EX1006, [0025]-[0026], [0031]-[0034]).

A POSITA would also have combined *Norris* and *Borgstadt* according to known methods to yield predictable results. For example, *Norris* discloses sensors measuring “operational parameters” of various components. EX1004, [0032], [0037], [0041]. *Borgstadt* discloses sensors measuring the same types of pressure and flow parameters measured in *Norris* and using that data to diagnose pump underperformance or failure. EX1006, [0025], Figs. 1-2. A POSITA would have

known that sensor types and monitoring techniques in *Borgstadt* could be used, with predictable results, with components in *Norris*. EX1003, §XIII.A.

Design incentives and market forces in the field of multi-pump fracturing would also have led a POSITA to combine *Norris* and *Borgstadt*. *Norris* teaches that coincidental pump operation causes fatigue and failure. EX1004, [0002]-[0003]. *Borgstadt* teaches that “wear and tear” leads to a “shortened lifespan” and that “pump failure can be very costly” due to halts in operations. EX1006, [0004]. *Borgstadt* also explains that “manually adjusted” pumps exacerbate these problems, motivating a POSITA to consider automated control systems, as in *Norris*. *See id.*, [0003]. A POSITA seeking to extend component life, maximize production time, or reduce expensive manual interventions would naturally look to *Norris* and *Borgstadt* together. *Borgstadt*’s teachings require little to no variation for use with *Norris*, and variations in sensing, monitoring, and control techniques would have been predictable to a POSITA. EX1003, §§IX.E, XII.B.2, XIII.B.2.

Finally, express teachings in *Norris* and *Borgstadt* motivate combining the references. *Borgstadt* describes methods for compensating for “dropped pump load”: intelligently redistributing load among remaining pumps. EX1006, [0008], [0031]-[0034]. *Norris* describes “backup operational modes”—including taking a pump truck “off-line” and having “pumping operations handled by the remaining pump trucks”—to account for component failures. EX1004, [0044], [0048]. A POSITA

would recognize the need, disclosed in *Norris*, to maintain system pumping capacity when taking a pump off-line and would naturally apply *Borgstadt*'s solution, intelligently redistributing pumping load to maintain overall pumping capacity. EX1003, §XIII.A.

All these reasons would have motivated a POSITA to combine *Borgstadt*'s teachings with *Norris*'s system.

2. Claim 1

a) 1[p]:

See supra §VIII.A.1(a). *See also* EX1006, [0001]-[0002], [0006]; EX1003, §XI.B.1.

b) 1[a]:

See supra §§VIII.A.1(b), VIII.D.2(a). *See also* EX1006, Fig. 1.

c) 1[b]:

See supra §VIII.A.1(c). *See also* EX1006, [0037], Fig. 4.

d) 1[c]:

See supra §VIII.A.1(d). *Borgstadt* further teaches a “master controller,” “pump modulator,” and local “pump controller[s]” at each pump unit. EX1006, Fig. 1, [0021]-[0029]. *Borgstadt*, like *Norris*, teaches local and system-wide control, and a POSITA would have been motivated to combine elements and functions of *Borgstadt*'s control system with *Norris*'s control system. For example, a POSITA would have understood that aspects of *Borgstadt*'s “master controller” or “pump

modulator” may be implemented in, operated with, or performed by *Norris’s* “application controller,” aspects of *Borgstadt’s* local “pump controllers” would improve *Norris’s* “local pump system control,” and aspects of *Borgstadt’s* pump units could be implemented in *Norris’s* pump trucks. EX1003, §XIII.B.1-2.

Borgstadt also teaches pump controllers monitoring pump efficiency and providing efficiency parameters to the pump modulator, and a POSITA would understand the benefit of *Norris’s* system performing the same functions. EX1003, §XIII.A; EX1006, [0022]-[0025]. Similarly, a POSITA would have understood how to program *Norris’s* sensors, controllers, and processors to perform functions performed by *Borgstadt’s* sensors, processors, and controllers (e.g., *Borgstadt’s* “diagnostic tool”). EX1003, §XIII.B.2.

e) 1[d]:

See supra §VIII.A.1(e). *Borgstadt* also teaches sensors, located with measured components, measuring parameters of pumps and the distribution system. For example, “individual pump controllers ... measure information regarding the performance of the pump,” including “flow rate,” “output pressure,” and “output efficiency.” EX1006, [0023], Fig. 1. A POSITA would understand the benefits of implementing *Borgstadt’s* sensors (or functions thereof) in *Norris’s* system. EX1003, §XIII.A,B.3.

f) 1[e][i]

See supra §§VIII.A.1(f); VIII.D.2(d)-(e). *Borgstadt*’s “master controller,” “pump modulator,” and “local controllers” contain processors that implement algorithms, communications, and control. *See, e.g.*, EX1006, [0023]-[0025], [0037]-[0038], Figs. 2-3; EX1003, §XIII.B.2,4. Controllers and sensors in *Borgstadt* also signal each other over data links, and a POSITA would have understood that processing devices implement these data links. EX1006, [0011], [0026]-[0027], Figs. 1, 4; EX1003, §XIII.B.4.

Borgstadt Figure 1 illustrates measured parameters transmitted from “pump unit[s]” to “pump controller[s]” and a “pump modulator.” EX1006, Fig. 1. *Borgstadt* teaches that “output 118 parameters of each pump unit” are “fed into the pump modulator.” EX1006, [0025]. *Borgstadt* also describes a pump modulator “receiv[ing] a pump unit’s current efficiency value” or “other pump parameters” for diagnostics. *Id.*, [0033], Fig. 3.

Accordingly, *Borgstadt* teaches receiving a “first parameter” from a “first device” and transmitting a “first parameter” to a “second device,” whether directly or indirectly. Section VIII.D.2(i) below provides one example, collectively addressing multiple claim limitations, of a first device transmitting a first parameter to a second device.

g) 1[e][ii]

See supra §§VIII.A.1(g), VIII.D.1, VIII.D.2(f). *Borgstadt* teaches comparing measured parameters to a threshold. For example, *Borgstadt* teaches comparing a pump's efficiency with a "threshold efficiency value" in diagnostics. EX1006, [0033], Fig. 2. A POSITA would have been motivated to compare operational parameters to thresholds, as taught in *Borgstadt*, throughout *Norris*'s system. *Norris* already teaches comparing actual operating parameters to desired parameters. EX1004, [0037]. *Borgstadt*'s teaching would have motivated a POSITA to perform its threshold comparison in *Norris*'s pumping system locally based on pump parameters and globally based on wellhead parameters. EX1003, §XIII.B.5.

h) 1[e][iii]

See supra §§VIII.A.1(h), VIII.D.1, VIII.D.2(f). *Borgstadt* teaches generating automated control instructions at the second device based on the first parameter. *See, e.g.,* EX1006, [0010], [0022]-[0026], Fig. 1 (illustrating generation and communication of automated control instructions at each of master controller, pump modulator, and local pump controllers). Section VIII.D.2(i) below, collectively addressing multiple claim limitations, provides a detailed example of generating automated control instructions at a local pump controller. A POSITA would understand, however, that *Borgstadt*'s system also generates automated control instructions at the master controller and at the pump modulator. EX1003, §XIII.B.6.

Moreover, a POSITA would have been motivated to generate and execute automated control instructions in the manner taught by *Borgstadt* in *Norris*'s control system. For example, a POSITA would have applied *Borgstadt*'s teaching of monitoring pump efficiency, and intelligently distributing pumping load based on pump efficiency, to *Norris*'s system. EX1003, §XIII.A; EX1006, [0023]-[0025].

i) 1[f]

See supra §§VIII.A.1(i), VIII.D.1, VIII.D.2(d). *Borgstadt*'s local pump units, pump controllers, pump modulator, and master controller are each “control devices.” Section VIII.D.2(i) below provides an example of a pump unit receiving automated control instructions and automatically adjusting operation of a second device, but a POSITA would understand that the pump controllers, pump modulator, or master controller may also act as control devices adjusting aspects of a second device. EX1003, §XIII.B.2,7.

j) Example 4 of elements 1[e]-1[f]

1[e][i] – *Borgstadt*'s sensors at pump units are “first devices” and *Borgstadt*'s local pump controllers are “second devices.” As explained in Section VIII.D.2(f), *Borgstadt*'s sensors and local pump controllers both contain “processing devices.” EX1003, §XIII.B.4. Sensors at each pump transmit “to the pump controller,” via “feed back loop 112,” a “measured parameter ... of the pump unit 110, for example output pressure 132 or output flow rate.” EX1006, [0024], Fig. 1. The sensors and

pump controllers are “of the plurality of pumps, the distribution system, or the wellhead” because they are located at and monitor pump units. *Id.*

1[e][ii] – As discussed above in Section VIII.D.2(g), a POSITA would have combined *Omont* and *Norris* to compare operational parameters to thresholds throughout the fracturing system.

1[e][iii] – *Borgstadt*’s local pump controllers are “second devices” that “generate[s] automated control instructions at the second device” based on receiving a first parameter. *Borgstadt* teaches that local pump controllers “may use different measured parameters ... to adjust the performance of the pump unit.” EX1006, [0024], Fig. 1. The “pump controller 108 may use a measured parameter ... to adjust the driving signal 116 sent to the pump unit.” *Id.*

1[f] – *Borgstadt*’s local pump unit is a “control device” that “receive[s] the automated control instructions” and adjust aspects of local pump operation and control. The “pump unit” may “run at a particular level of operation” based on signals received from the “pump controller.” EX1006, [0022], Figs. 1. The “pump unit” may adjust a level of operation by controlling “output pressure, output flow rate, and the gear RPM” of the pump. *Id.*; *see also* EX1004, Fig. 3B (illustrating

ECM in a pump unit adjusting RPM and throttle).² Pump unit operating parameters feed back to the local pump controller to adjust its operation. EX1006, [0023]-[0024], Fig. 1. The pump unit thus receives control instructions from the local pump controller and adjusts aspects of both the local pump controller and its own operation.

3. Claim 2

See Element 1[d]; supra §§VIII.A.2(a), VIII.D.2(e). *See also* EX1006, [0023], Fig. 1; EX1003, §XIII.C.

4. Claim 3

See supra §VIII.A.3(a). *Borgstadt* further teaches controllable “pump units” operate an engine or motor having “gear RPM” and “horse power.” EX1006, [0022], [0031]-[0032], Fig. 1. *Borgstadt* also teaches a controllable “manifold” with valves, suction pipe(s), and discharge pipe(s). *Id.*, [0037], [0043], Figs. 4-5; EX1003, §XIII.D.

5. Claim 4

a) 4[a]

See Elements 1[b], 3; supra §§ VIII.D.2(c), VIII.D.4(a).

b) 4[b]

² As taught in *Norris*, a POSITA would have known the local pump unit may control operation via local drivetrain control or ECM. EX1003, §XIII.B.7.

See supra §VIII.D.4(a). *Borgstadt* teaches a “manifold” with suction and discharge lines (which a POSITA would have known were needed to deliver fluid to and consolidate fluid from pumps), as well as measurement of “output parameters” “at any point in the system,” including suction and discharge. EX1006, [0043], Fig. 1; EX1003, §XIII.E.

6. Claim 5

a) 5[a]

See supra §VIII.A.5(a).

b) 5[b]

See Elements 1[d], 4; supra §VIII.A.5(b).

7. Claim 7

a) 7[p]

See supra §§VIII.A.1(a)-(c), VIII.D.2(a).

b) 7[a]

See supra §§VIII.A.1(a)-(c), VIII.D.2(b).

c) 7[b]

See supra §§VIII.A.1(a)-(c), VIII.D.2(c).

d) 7[c]

See supra §§VIII.A.1(a)-(c), VIII.D.2(c).

e) 7[d]

See Element 1[d]; supra §§VIII.A.1(e), VIII.D.2(e).

f) 7[e]

See supra §§VIII.A.1(g) , VIII.D.2(g).

g) 7[f]

See Elements 1[c], 1[e][ii]-1[f]; supra §§VIII.A.1(d),(h)-(i), VIII.D.2(d),(h)-(i).

h) 7[g]

See Element 1[f]; supra §§VIII.A.1(d),(h)-(i), VIII.D.2(d),(h)-(i).

i) 7[h]

See Element 1[e][i]; supra §§VIII.A.1(f), VIII.D.2(f).

j) 7[i]

See supra §§VIII.A.1(h), VIII.D.2(h).

k) 7[j]

See supra §§VIII.A.1(i), VIII.D.2(i).

8. Claim 8

a) 8[a] The method of claim 7, further comprising: detecting that a first pump of the plurality of pumps is underperforming; and

Borgstadt teaches receiving “information regarding the performance of each pump,” including pump efficiency, to determine whether the pump is “performing poorly.” EX1006, [0033]-[0034], Figs. 2-3. As explained above, a POSITA would have modified *Norris*’s system to monitor efficiency, as taught in *Borgstadt*, and a POSITA would have recognized degraded efficiency indicates pump

underperformance. *See supra* §§VIII.D.2(e),(g); EX1003, §XIII.A,H,J. A POSITA would also have known pressure or flow-rate monitoring could be used to detect underperformance. *See* EX1006, [0031], [0033], [0042]-[0043].

b) 8[b] adjusting one or more of the pumps in the plurality of pumps to compensate for the first pump.

In *Norris*, when a pump is taken offline, pumping is “handled by the remaining pump trucks.” EX1004, [0048]. *Borgstadt* teaches that “pump modulator 107 can redistribute the load among the remaining pump units” to compensate for an underperforming pump. EX1006, [0034]-[0035]. Accordingly, a POSITA would have been motivated to use *Borgstadt*’s intelligent system for redistributing pumping load to *Norris*’s system when a pump underperforms or goes offline. EX1003, §XIII.A,H,J. Moreover, it was standard practice in fracturing operations to take underperforming pumps offline and redistribute pumping load to the remaining pumps to continue operations, and a POSITA would have done so with *Borgstadt*’s intelligent redistribution techniques. EX1003, §XIII.H.2.

9. Claim 9

a) The method of claim 8, further comprising: selecting the one or more of the other pumps to adjust based at least in part on the conditions of the other pumps as indicated by one or more of the one or more parameters.

Borgstadt teaches that the “pump modulator” can “redistribute the load” among pumps “according to the specified system pumping requirements, individual pump specifications, and existing operating conditions of the pump units.” EX1006,

[0034]-[0035]. The “pump modulator” may “determine which pump or pumps can pick up the load” and “take into account the current state of performance” of each pump (e.g., by reference to pumping efficiency) “as opposed to equally increasing the load on all pump units.” EX1006, [0025]-[0026]. And as discussed just above, a POSITA would combine *Borgstadt*’s intelligent load redistribution into *Norris*’s system to maintain pumping capacity, and avoid operation beyond local pump capacity, when a pump goes offline. *See supra* §VIII.D.8; EX1003, §XIII.I.

10. Claim 10

a) 10[a]

In *Borgstadt*, “a diagnostic tool” uses pump-unit efficiency or other parameters for “diagnosing a pump failure.” EX1006, [0033]. “[L]ower efficiency value may be an indication of a cavitation,” worn seals, or complete failure. *Id.* If too many pumps in *Norris*’s system fail or go offline, “pump control may no longer be effective.” EX1004, [0044]. A POSITA would accordingly have looked to *Borgstadt* to detect and diagnose potential pump failures before they occur to avoid coincidental operation and maintain pump control as taught in *Norris*. EX1003, §XIII.A,H,J.

b) 10[b]

See supra §VIII.D.10(a). *Borgstadt*’s “diagnostic tool” may implement various processes (e.g., reducing pump speed) for diagnosing “system defects,”

including pump cavitation, worn seals, sensor failure, and pump controller failure. EX1006, [0033]-[0034].

11. Claim 11

See supra §§VIII.D.1, VIII.D.10. *Borgstadt* also teaches issuing a “pump warning condition” when a pump “has encountered an abnormal operating condition.” EX1006, [0033]-[0034], Fig. 3. A POSITA would understand “a pump warning condition,” or a diagnosis of “sensor or pump controller failure,” would indicate the pump at issue. *Id.*; EX1003, §XIII.K. Moreover, a POSITA would have added *Borgstadt*’s warnings of abnormal pump operation to *Norris*’s system to prevent failures, which could damage components or result in costly downtime. EX1003, §XIII.A,K; EX1006, [0004]. Similarly, *Norris* teaches that sensor or pump-controller failures degrade operation of *Norris*’s control system to maintain non-coincidental operation, and a POSITA would accordingly implement *Borgstadt*’s warning conditions, including identification of the source, to enable preventative maintenance before failure. EX1003, §XIII.A,J; EX1006, [0004]; EX1004, [0044], [0048].

12. Claim 12

See supra § VIII.D.1. *Borgstadt* also teaches “capability to develop a pattern on how long each part in a pumping unit can last ... and potentially replace them right before they fail.” EX1006, [0013]. A POSITA would have combined runtime

(hours) with RPM data and recorded the number of strokes a pump is run, along with hours, so an operator can determine potential failure and replace the part “right before they fail.” EX1003, §XIII.L. Accordingly, it would have been obvious to a POSITA to record (log) not only number of hours run, but also the speed and strokes at which the pump was run.

13. Claim 13

a) 13[p]

See supra §§VIII.A.1(a)-(c), VIII.D.2(a)-(c).

b) 13[a]

See supra §§VIII.A.1(a)-(c), VIII.D.2(a)-(c).

c) 13[b]

See Element 1[d]; supra §§VIII.A.1(e), VIII.D.2(e).

d) 13[c]

See Element 1[e][i]; supra §§VIII.A.1(f), VIII.D.2(f).

e) 13[d]

See supra §§VIII.A.1(g), VIII.D.2(g).

f) 13[e]

See supra §§VIII.A.1(h), VIII.D.2(h).

g) 13[f]

See Element 1[f]; supra §§VIII.A.1(i), VIII.D.2(i).

14. Claim 14

See Element 1[b]; supra §§VIII.A.8, VIII.D.2(c).

15. Claim 15

See Element 1[f]; supra §§VIII.A.1(f)-(i), VIII.A.8, VIII.D.2(d), VIII.D.2(h).

Borgstadt teaches a “manifold observer” for sensing “at any point in a system” (including the distribution system) and operating at a “desired value of a parameter at that point in the system.” EX1006, [0042]-[0043], Figs. 4-5. A POSITA would have implemented sensing and control at suction and discharge lines of the distribution system, as suggested in *Borgstadt*’s manifold observer, to achieve desired wellhead parameters in *Norris*. EX1003, §XIII.O.

16. Claim 16

See Element 1[d]; supra §§VIII.A.9; VIII.D.2(e)-(f), VIII.D.3.

17. Claim 17

See Element 1[f]; supra §§VIII.A.10, VIII.D.2(g)-(h), VIII.D.4.

18. Claim 18

a) 18[a] The method of claim 17, further comprising: detecting that a measurement associated with a first pump of the plurality of pumps is outside of an acceptable threshold; and

See Element 1[e][ii]; supra §§VIII.D.1, VIII.D.2(g), VIII.D.8-9; EX1003, §XIII.R. Borgstadt teaches a “diagnostic tool” comparing pump efficiency “with a threshold efficiency value” and warning when outside the threshold. EX1006, [0033], Fig. 3. A POSITA would also have understood to perform diagnostics by

comparing multiple parameters—such as pressure, flow rate, and efficiency—to acceptable thresholds. EX1006, [0031], [0033]; EX1003, §XIII.R.

- b) 18[b] automatically taking the first pump offline in response to the detection.

See supra §§VIII.D.18(a); EX1003, §§XIII.R-S. *Borgstadt*’s pump modulator “may completely take a pump unit 110 offline” when a “lower efficiency value” (or similar pressure or flow rate value outside a threshold) indicates “a pump has failed completely.” EX1006, [0033]-[0034].

19. Claim 19

- a) The method of claim 18, further comprising: adjusting one or more of the other pumps in the plurality of pumps to compensate for taking the first pump offline.

See supra §§VIII.D.8-9, VIII.D.18. *Norris* and *Borgstadt* both teach that when a pump goes offline, pumping load must be redistributed among remaining pumps. EX1004, [0048]; EX1006, [0025], [0034]. *Borgstadt* teaches intelligently redistributing pumping load across remaining pumps, and a POSITA would have used intelligent redistribution in *Norris*’s system to cope with pump, sensor, or controller failures and maintain pump control and non-coincidental operation. EX1003, §XIII.S. Moreover, it was standard practice in fracturing operations to take failed pumps offline and redistribute pumping load to remaining pumps to continue operations, and a POSITA would have done so with *Borgstadt*’s intelligent redistribution techniques. EX1003, §§XIII.R-S.

E. Ground 5: The Combination of Norris and Dykstra Renders Obvious Claims 1-7, 13-17.

As described in Grounds 1-2, *Norris* discloses or renders obvious claims 1-5, 7, 13-14, and 16-17. Ground 5 relies on *Norris*'s teaching, described in Grounds 1-2, of these claims. *Supra* §VIII.A. *Norris* combined with *Dykstra* also renders obvious under 35 U.S.C. §103 each limitation of claims 5-6 and 15 (in addition to those claims addressed in Ground 1). EX1003, §XIV.

1. Motivations to Combine

For similar reasons as in Grounds 3-4, a POSITA would have been motivated to combine *Norris* with *Dykstra*. EX1003, §XIV.A. *Dykstra* discloses controlling manufacture of well-treatment fluid. EX1007, [0002]. *Dykstra* identifies fluid production as “critical” in pumping operations and notes subsystems often operate independently, causing systems to run “ahead or behind” and leading to “fluid that does not comply with the needs of a well formation.” *Id.*, [0003]-[0005]. *Dykstra* proposes “controlling the production of well treatment fluid” to resolve these issues. *Id.* *Dykstra*'s “central control system” uses “sensor data” to control blending operations and ensure pumping and fluid-delivery systems operate together at required rates. EX1007, [0021], [0025]-[0027], Fig. 3. *Norris* and *Dykstra* are thus from related fields (pumping and fluid production), identify similar problems (lack of control), and address problems with similar solutions (monitoring and control). A

POSITA would have considered whether known solutions from one reference could be applied in the other. EX1003, §XIV.A.

Moreover, a POSITA would reasonably expect *Dykstra*'s techniques for controlling fluid manufacture to improve pumping operations. Although *Norris* focuses on a "pump management system" for non-coincidental operation, *Norris* also describes a "fluid delivery system" including blender and manifolds for delivering fluid to and from pumps. EX1004, [0021], Fig. 2. Adding *Dykstra*'s fluid control techniques to *Norris*'s fluid-delivery system would improve fluid composition, permit adjusting fluid properties in response to changing well-treatment needs, match fluid-delivery rate to pumping or well-formation needs, and enable control over the whole well-treatment system, without modifying *Norris*'s non-coincidental pump operation. EX1003, §XIV.A; EX1007, [0007].

Systems and techniques in *Norris* and *Dykstra* are compatible and combining their elements leads toward the same system configuration as in *Norris* with desirable operating results. For example, *Dykstra* teaches "subcontrollers" control fluid-delivery components and a "central control system" controls, coordinates, and monitors fluid delivery as a whole. EX1007, [0021]. *Norris* similarly discloses both local and system-wide control. EX1004, Figs. 3-4. A POSITA would thus understand *Dykstra*'s local control of fluid-delivery subsystems—blenders, storage systems, and manifolds—could be implemented alongside *Norris*'s local pump

control. EX1003, §XIV.A. A POSITA would also understand that features of *Dykstra*'s central control could be implemented in or alongside *Norris*'s application controller without affecting *Norris*'s system. EX1003, §XIV.A.

Dykstra also identifies known techniques to improve similar devices in the same way that *Norris* proposed to improve fracturing operations. For example, *Norris* describes pump sensing and control (EX1004, [0029]), while *Dykstra* extends similar sensing and control to blenders and fluid delivery (EX1007, [0021], Fig. 3). Accordingly, a POSITA aware of *Norris* and *Dykstra* would naturally apply *Dykstra*'s monitoring and control techniques—similar to those in *Norris*—to *Norris*'s blender, manifolds, and fluid-delivery systems. EX1003, §XIV.A.

A POSITA would also combine *Norris* and *Dykstra* according to known methods to yield predictable results. *Norris* discloses sensors measuring “operational parameters” including flow rates. EX1004, [0030], [0035]. *Dykstra* similarly discloses sensing and controlling fluid-delivery rates. EX1007, [0021]-[0022], [0025], [0028]. A POSITA would have used the types of sensors in *Dykstra* and *Norris*, with predictable results, at *Norris*'s blender and manifold. EX1003, §XIV.A.

All these reasons would have motivated a POSITA to combine *Dykstra*'s monitoring and control system with *Norris*'s pump management system.

2. Claim 5

a) 5[a]

See supra §§VIII.A.5(a). *See also* EX1007, [0018].

b) 5[b]

See Element 1[d], 4; supra §VIII.A.5(b), VIII.E.1. *Dykstra* teaches “pressure sensors or pump sensors at the well pump or pumps” and flow sensors that “indicate the rate of water entering the blender tub.” EX1007, [0028]. A POSITA would have measured pressure and flow at *Norris*’s pumps, blenders, manifold, and distribution system based on *Dykstra*’s monitoring and controlling pressure and flow for both fluid-delivery and pumping systems. *Id.*, [0021]-[0022], [0025]; EX1003, §XIV.B.

3. Claim 6

See Elements 1[c]-1[d], 1[f]; supra §§VIII.E.1-2. *Dykstra* teaches that the “blending unit, pumping grid, power unit, and manifolds are controlled, coordinated, and monitored by a central control system.” EX1007, [0021], [0028]. *Dykstra*’s “central control system may use all the sensor data from all units ... to determine subsystem trajectories. For example, control over the manufacture [and] pumping ... of proppant by the control system can be driven by well formation needs such as flow rate.” *Id.* Based on this teaching in *Dykstra*, a POSITA have improved *Norris* to automatically control the pumps, blender, supply-side manifold, and pressure-side manifold based on measured pressure and flow. EX1003, §XIV.C-D.

4. Claim 15

See Claim 6; supra §VIII.E.3.

IX. CONCLUSION

Petitioners respectfully request that *inter partes* review of the '435 Patent be instituted and that the challenged claims be cancelled as unpatentable under 35 U.S.C. §318(b).

Respectfully submitted,

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CERTIFICATE OF SERVICE

The undersigned hereby certifies on this 11th day of October 2024, that true and correct copies of the foregoing PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 10,655,435, Exhibits 1001-1027, and Petitioner's power of attorney were served in their entirety to Patent Owner via FedEx Express® or Express Mail:

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**CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME
LIMITATION, TYPEFACE REQUIREMENTS, AND TYPE STYLE
REQUIREMENTS**

1. This Petition complies with the type-volume limitation of 14,000 words, comprising 13,994 words, excluding the parts exempted by 37 C.F.R. §42.24(a).
2. This Petition complies with the general format requirements of 37 C.F.R. §42.6(a) and has been prepared using Microsoft® Word in 14-point Times New Roman.

Respectfully submitted,

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