UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LIBERTY ENERGY INC. AND LIBERTY OILFIELD SERVICES LLC
Petitioner

v.

U.S. WELL SERVICES, LLC
Patent Owner

Case No. IPR2024-01274
Patent 11,091,992

DECLARATION OF DR. ROBERT DURHAM IN SUPPORT OF PETITIONERS' OPPOSITION TO PATENT OWNER'S REVISED NON-CONTINGENT MOTION TO AMEND

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Declaration of Dr. Robert Durham

I. INTRODUCTION

1. My name is Dr. Robert A. Durham. I make this declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters contained herein.

2. I had previously authored and then signed a declaration on September 4, 2024, which I understand was submitted as Exhibit 1003 to the Patent Trial and Appeal Board ("PTAB") of the United States Patent and Trademark Office in case number IPR2024-01274. I may alternatively refer to the September 4, 2024, declaration as "Exhibit 1003" or "Original Declaration."

3. I have also previously authored and then signed a declaration on September 15, 2025, which I understand was submitted as Exhibit 1022 to the PTAB in case number IPR2024-01274. I may alternatively refer to the September 15, 2025, declaration as "Exhibit 1022" or "Second Declaration."

4. In this Third Declaration, I incorporate the facts and opinions outlined in my Original Declaration and in my Second Declaration.

II. EXPERIENCE AND QUALIFICATIONS

5. My experience, qualifications, CV, and consulting fee are outlined in my Original Declaration.

III. TASK SUMMARY AND MATERIALS REVIEWED

6. My Original Declaration addressed U.S. Patent No. 11,091,992 (Ex. 1001, "'992 Patent"). My Second Declaration addressed U.S. Well Services, LLC ("USWS" or "Patent Owner" or "PO") Non-Contingent Motion to Amend for the '992 Patent, filed June 23, 2025 (Paper 13, "Motion to Amend" or "MTA") in case number IPR2024-01274, in which it has proposed "Substitute Claims" to replace the "Original Claims" of the '992 Patent. I have been informed that PO has now submitted a revised Non-Contingent Motion to Amend for the '992 Patent (Paper 21, "Revised Motion to Amend" or "Revised MTA") in case number IPR2024-01274, in which it has proposed "Substitute Claims" to replace the "Original Claims" of the '992 Patent. Counsel has informed me that the Revised Motion to Amend was filed as "non-contingent," which I understand means that the Board will issue a final decision on the patentability of the Substitute Claims rather than determining the patentability of the corresponding Original Claims.

7. For this Third Declaration, I have been asked to review the Revised MTA filed by USWS regarding the '992 Patent, the proposed Substitute Claims, and the exhibits cited by USWS. I have been asked to provide an understanding of the technology relevant to the MTA, to review certain prior-art references, and analyze whether or not those references disclose or teach limitations of the proposed Substitute Claims. The opinions stated in this declaration are from the perspective of a person of ordinary skill in the art ("POSITA").

IV. LIST OF EXHIBITS

8. In forming my opinions, I have reviewed the ’992 Patent, its prosecution history and references cited by the Examiner, the materials cited in the List of Exhibits, and the materials cited throughout my Original Declaration, my Second Declaration, and this declaration.

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Ex.[1]	Description
1001	U.S. Patent No. 11,091,992 by Joel N. Broussard *et al.* entitled "System for Centralized Monitoring and Control of Electric Powered Hydraulic Fracturing Fleet" ("**the '992 Patent**")
1002	'992 Patent File History
1003	Declaration of Dr. Robert Durham
1004	U.S. Patent Application Publication 2012/0255734 by Todd Coli *et al.* entitled "Mobile, Modular, Electrically Powered System for Use in Fracturing Underground Formations" ("***Coli***")
1005	U.S. Patent 5,606,853 by Peter H. Birch *et al.* entitled "Gaseous Fuel Compression and Control System for Gas Turbine Engine" ("***Birch***")
1006	U.S. Patent Application Publication 2008/0236818 by Jason Dykstra entitled "Method and Apparatus for Controlling the Manufacture of Well Treatment Fluid" ("***Dykstra***")
1007	U.S. Patent Application Publication 2008/0288115 by Dennis Rusnak *et al.* entitled "Intelligent Pump System" ("***Rusnak***")
1008	U.S. Patent Application Publication 2010/0038907 by Sam R. Hunt *et al.* entitled "Power Generation" ("***Hunt***")
1009	EXCERPT OF IEEE100: THE AUTHORITATIVE DICTIONARY OF IEEE STANDARDS TERMS, 7th ed. (IEEE Press: 2000), ISBN: 0-7381-2601-2 **("IEEE Standards Dictionary")**
1010	U.S. Patent No. 9.410,410 by Joel N. Broussard et al. entitled "System for Pumping Hydraulic Fracturing Fluid Using Electric Pumps" ("**the '410 Patent**")

[1] Citations to patents are made by column and line cite; citations to patent publications are made by paragraph number; citations to Exhibit 1002 are made with reference to the Bates-stamped pagination; citations to other exhibits are made to the page number of the document itself.

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1011	U.S. Patent No. 9,970,278 by Joel N. Broussard et al. entitled "System for Centralized Monitoring and Control of Electric Powered Hydraulic Fracturing Fleet" ("**the '278 Patent**")
1012	Chart Comparing Claims of the '992 Patent and the '278 Parent Patent
1013	Intentionally omitted
1014	Intentionally omitted
1015	Intentionally omitted
1016	Lionel B. Roe, PRACTICES AND PROCEDURES OF INDUSTRIAL ELECTRICAL DESIGN (McGraw-Hill: 1972), ISBN: 0-07-053390-3 **("Roe")**
1017	John A. Camara, ELECTRICAL ENGINEERING REFERENCE MANUAL FOR THE ELECTRICAL AND COMPUTER PE EXAM, 6th ed. (Professional Publications, Inc.: 2002), ISBN: 1-888577-56-8 **("EE-Reference")**
1018	U.S. Patent No. 1,743,771 to Hall et al., entitled "System of Electric Distribution" (filed Mar. 25, 1926, and issued January 14, 1930) **("Hall")**
1019	Donald G. Fink, STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS, 13th ed. (McGraw-Hill, New York: 1993), ISBN: 0-07-020984-7 **("Fink")**
1020	U.S. Patent Publication No. 2011/0241590 to Horikoshi et al., entitled "Motor Driving Apparatus Having Fault Diagnostic Function" (filed Feb. 11, 2011 and published Oct. 6, 2011) **("Horikoshi")**
1021	IEEE Recommended Practice for Electric Power Distribution for Industrial Plants. 1986. ANSI/IEEE Std 141-1986: 1-609. ("**Red Book**")
1022	Second Declaration of Dr. Robert Durham
1023	Deposition Transcript of Dr. Michael Nikolaou in IPR2024-01274
1024	U.S. Patent Pub. No. 2014/0138079 by Broussard et al., "System for Pumping Hydraulic Fracturing Fluid Using Electric Pumps," ("***Broussard079***"), filed Nov. 16, 2012, published May 22, 2014

1025	U.S. Patent No. 8,789,601 by Broussard et al., "System for Pumping Hydraulic Fracturing Fluid Using Electric Pumps," ("***Broussard601***"), filed Feb. 26, 2014, published Jun. 26, 2014, and issued Jul. 29, 2014
1026	U.S. Patent No. 5,790,972 by Kohlenberger, "Method and Apparatus for Cooling the Inlet Air of Gas Turbine and Internal Combustion Engine Prime Movers," ("***Kohlenberger***"), filed Aug. 24, 1995, and issued Aug. 4, 1998
1027	U.S. Patent No. 8,747,533 by Ekanayake and Scipio, "Systems and Methods to Determine Fouling in a Gas Turbine Filter," ("***Ekanayake***"), Apr. 30, 2013, and issued June 10, 2014
1028	U.S. Patent No. 8,552,728 by Weiher, "Sluggish Circuit Breaker Detection System and Method," ("***Weiher***"), filed Nov. 30, 2010, and issued Oct. 8, 2013
1029	European Patent No. 0023879 by Newman, "Engine module life tracking system," ("***Newman***"), filed August 4, 1980, and published January 30, 1985
1030	Rosemount Model 3051 Transmitter Product Manual, available as of March 22, 2012, at https://web.archive.org/web/20120322124738/http://www2.emersonprocess.com/siteadmincenter/PM%20Rosemount%20Documents/00809-0100-4774.pdf
1031	Rosemount 848T High Density Temperature Transmitter Reference Manual, available as of January 18, 2012, at https://web.archive.org/web/20120118001644/http://www2.emersonprocess.com/siteadmincenter/PM%20Rosemount%20Documents/00809-0100-4697.pdf
1032	Declaration of Mina Ching, Internet Archive
1033	U.S. Patent App. Pub. No. 2009/0188682 by Gensel *et al.*, "Fire Extinguishing System for a Casing," ("***Gensel***"), filed March 31, 2009, and published July 30, 2009
1034	Whitaker, "AC Power System Handbook," 3rd Ed., CRC Press (2007)
1035	U.S. Patent No. 1,717,071, by Smith and Smith, "Shutting-down Means for Hydraulic Turbines," ("***Smith***"), filed May 4, 1925, issued June 11, 1929

1036	U.S. Patent No. 3,605,919, by Bromell and Homanick, "Drilling Rig Control," ("***Bromell***"), filed May 16, 1969, issued Sept. 20, 1971
1037	U.S. Patent App. Pub. No. 2009/0181582 by Thompson, "Enhanced Cable for Field Data Distribution System," ("***Thompson***"), filed Jan. 16, 2009, published July 16, 2009
1038	U.S. Patent No. 7,949,483 by Discenzo et al, "Integration of Intelligent Motor with Power Management Device," ("***Discenzo***"), filed Sept. 30, 2005, issued May 24, 2011
1039	U.S. Patent App. Pub. No. 2013/0142601 by McIver and Cunningham, "Fracture Sand Silo System and Methods of Deployment and Retraction of Same," ("***McIver***"), filed Oct. 23, 2012, published June 6, 2013
1040	International Publication No. WO2016/019219 by Omont et al, "Monitoring Health of Additive Systems," ("***Omont***"), filed July 31, 2015, published February 4, 2016.
1041	Gardner Denver GD-2500 Quintuplex Well Servicing Pump Operating and Service Manual, captured by the Internet Archive on Sept. 17, 2005, available at <https://web.archive.org/web/20120917102614/http:/www.quincieoilfield.com/pdf/3.0%20Gardner%20Denver/2500/GD2500Q%20Op%20&%20Service%20Manual.pdf>
1042	Tutterow, V. and McKane, A. T., "Variable Speed Pumping: A Guide to Successful Applications," Europump and Hydraulic Institute, 2004.
1043	Mark's Standard Handbook for Mechanical Engineers, Eleventh Edition, McGraw-Hill Companies, New York, 2007
1044	Langewis, Jr., C. and Gleeson, C. W., "Practical Hydraulics of Positive Displacement Pumps for High-Pressure Waterflood Installations," Society of Petroleum Engineers, February 1971.
1045	Intentionally omitted
1046	NFPA 79, "Electrical Standard for Industrial Machinery" National Fire Protection Association, Quincy, Mass, 1962-2007 (2007 ed).

1047	Pearson, "Proposed HSE guidelines on emergency shutdown systems," 1989 A First International Conference on the Use of Programmable Electronic Systems in Safety Related Applications Computers and Safety, 1989, pp. 55-58
1048	Gilson, Bill. "Fast Response System for Large-Volume Acid Stimulation." Paper presented at the Offshore Technology Conference, Houston, Texas, May 1996. doi: https://doi.org/10.4043/8096-MS
1049	Rex Burgos; Marc Allcorn; Robin Mallalieu; Jorge Vicens "Eliminating Human Error during Coiled Tubing Operations," SPE Production & Operations 22 (June 2006): 335–338. DOI: 10.2118/100164-PA
1050	J. J. Sammarco, "Programmable electronic and hardwired emergency shutdown systems: a quantified safety analysis," Fortieth IAS Annual Meeting. Conference Record of the Industry Applications Conference, 2005, pp. 210-217 Vol. 1, doi: 10.1109/IAS.2005.1518312
1051	Kurz, Rainer, and Robert C. White. "Modeling Emergency Shutdowns of Centrifugal Compressors." Paper presented at the PSIG Annual Meeting, Galveston, Texas, May 2009.
1053	Deposition Transcript of Dr. Michael Nikolaou, dated November 20, 2025, in Case No. IPR2024-01274
1054	International Application No. WO 2004/099587, published on Nov. 18, 2004 ("***Armstrong***")
1055	U.S. Patent No. 7,909,585 ("***Clancy***"), filed March 28, 2007, published November 22, 2007.
1056	WO 2016/044509 ("***Trobaugh***"), filed Sept. 17, 2015, and published Mar. 14, 2016
1057	EP 1380740 ("***Teets***"), filed December 3, 1997, published January 14, 2004.
1058	U.S. 6,576,849 ("***Bliss***"), filed December 1, 2000, published June 10, 2003.
1059	U.S. 7,455,138 ("***Delaney***"), filed November 10, 2006, published November 25, 2008.

1060	Weir SPM General Catalog (2009) ("***Weir***")
1061	Declaration of Nathaniel E. Frank-White, dated September 20, 2022
1062	U.S. Pub. No. 2016/0258267 ("***Payne***"), effectively filed March 4, 2015, published September 8, 2016.
1063	Provisional App. No. 62/128,291 ("***Payne Provisional***"), filed March 4, 2015.
1064	U.S. Patent No. 9,523,312 ("***Allam***"), filed Nov. 1, 2012, and published May 2, 2013.
1065	EXCERPT OF IEEE100: THE AUTHORITATIVE DICTIONARY OF IEEE STANDARDS TERMS, 7th ed. (IEEE Press: 2000), ISBN: 0-7381-2601-2 **("IEEE Standards Dictionary")**
1065	IEEE100: The Authoritative Dictionary of IEEE Standards Terms, 7th ed. (IEEE Press: 2000), ISBN: 0-7381-2601-2.
1066	U.S. Patent Pub. No. 2013/0306322 ("***Sanborn***"), filed December 7, 2012, and published November 21, 2013.
1067	S.V. Stephenson et al., "Fracturing Process and Control Automation: Phase 2," SPE 26220 (1993) ("***Stephenson***").
1068	U.S. Patent Pub. No. 2008/0183415 ("***Dykstra415***"), Filed January 31, 2007, and published July 31, 2008.
1069	What is LNG?, available at: https://web.archive.org/web/20040712131010/http://fossil.energy.gov/features/lng/whatisit.html
1070	Merriam Webster, Definition of "Fouling," available at: https://web.archive.org/web/20111018124705/http://www.merriam-webster.com/dictionary/fouling
1071	Tomlinson, H.L. et al., "Fracturing Process Control and Automation," SPE 17315 (1988)

1072	Excerpts from NFPA 79, "Electrical Standard for Industrial Machinery" National Fire Protection Association, Quincy, Mass, 1962-2007.

V. TECHNICAL BACKGROUND

9. In the subsections below, I describe some of the basic principles of engineering that would be used, or at least considered for use, on a hydraulic fracturing site. The principles discussed in the subsections below would have been well-known to a POSITA in the 2015-2016 timeframe, and long before.

A. TYPES OF PUMPS – FRACTURING PUMP CHAIN

10. The basics of hydraulic fracturing have not changed significantly since 1949, when Halliburton first commercialized the "hydrafrack" process. Hydraulic fracturing still involves pumping water (or another fluid) blended with a proppant (*e.g.*, sand) and other chemicals into the downhole reservoir at sufficient pressure to crack (fracture) the downhole rock. The sand-water mixture is then forced into the cracks, where the sand keeps the cracks (fractures) open to allow hydrocarbons, such as oil and natural gas, to flow out of the formation into the well bore. What has changed are the pressures and flow rates of the fracturing jobs, the sizes of the equipment, and the specific proppants, chemicals, and liquids used.

11. A modern fracturing process requires multiple pumps operating together as a system to provide fracturing fluid with the suitable composition at the

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right flow rate[2], and at a pressure sufficient to fracture the formation. At the beginning of the pumping chain are the water transfer pumps. These pumps operate at relatively low pressure to move water from storage (e.g., ponds or tanks) to the blender or hydration unit.

12. In the blender, the water is mixed with a proppant, such as sand, resin-coated sand, or ceramics, to form the fracturing slurry. Other chemicals, such as acids, gels, friction reducers, biocides, and the like, are added to the slurry. Dry products, such as sand, are transported into the blender tub using gravity, conveyors, or augers. Liquid products, such as acids, are transported into the blender tub using various pump sizes and types. These are typically relatively small-horsepower pumps operating at lower pressures, as the blender tub operates at more or less ambient pressure.

13. Once the fracturing slurry is blended to the proper makeup and consistency, it is transferred to the fracturing pumps using a blender discharge pump. This pump typically operates at a higher pressure than the water or chemical transfer pumps for several reasons. First, the viscosity of the slurry is typically higher than that of water, requiring higher pressures to move the same volume. Second, the slurry is heavier than plain water, requiring additional horsepower to move the slurry

[2] "Flowrate," "flow rate," and "flow-rate" are used interchangeably in the industry and herein.

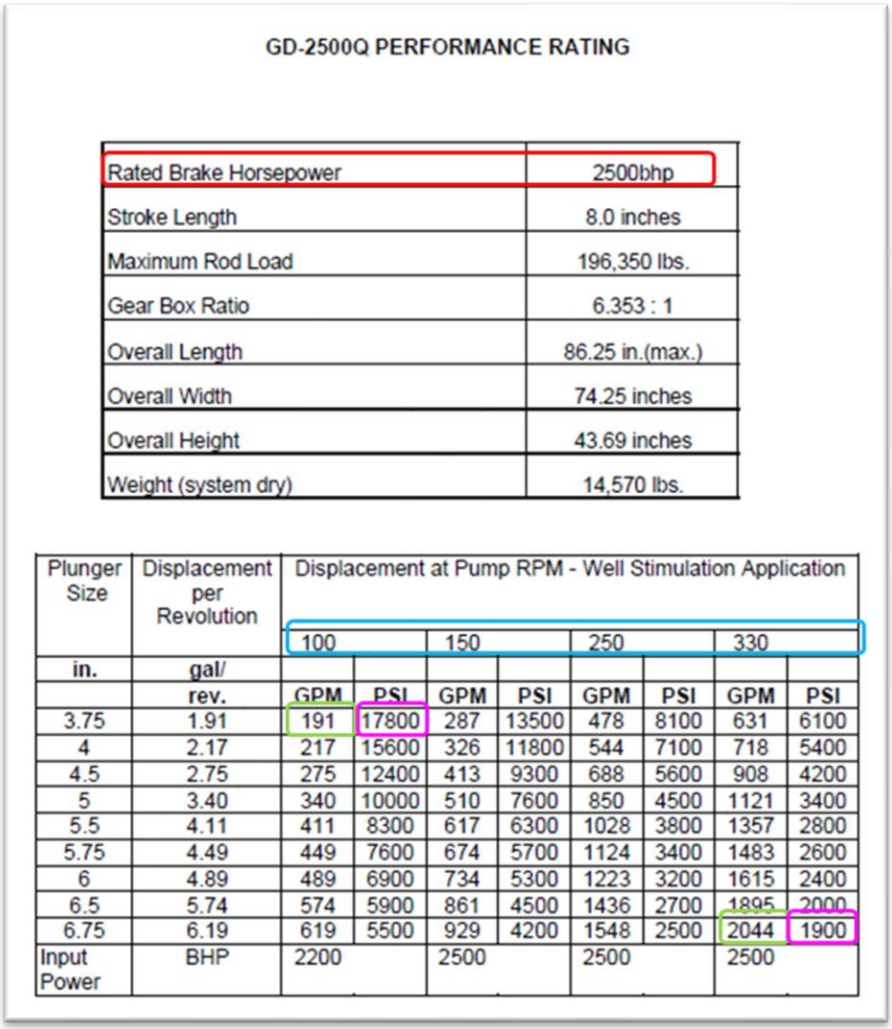
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(as compared to plain water). Finally, the large fracturing pumps are piston (or plunger) positive displacement pumps, requiring a higher suction (input) pressure to ensure a flow sufficient to prevent cavitation, as explained below.

14. Pumps have specific ranges they are designed to operate in. For example, a Gardner Denver 2500 well service pump, disclosed by *Coli* as an appropriate pump for fracturing,[3] has specified operating ranges of a maximum of 2500 brake horsepower (BHP, annotated in red), speed between 100 – 330 RPM (annotated in blue), flow between 191 and 1044 gallons per minute (GPM, annotated in green) and pressure (pounds per square inch or PSI) between 1900 and 17,800 PSI (annotated in magenta).

[3] Ex. 1004 (*Coli*), [0046].

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GD-2500Q PERFORMANCE RATING

Rated Brake Horsepower	2500bhp
Stroke Length	8.0 inches
Maximum Rod Load	196,350 lbs.
Gear Box Ratio	6.353 : 1
Overall Length	86.25 in.(max.)
Overall Width	74.25 inches
Overall Height	43.69 inches
Weight (system dry)	14,570 lbs.

Plunger Size	Displacement per Revolution	Displacement at Pump RPM - Well Stimulation Application							
		100		150		250		330	
in.	gal/ rev.	GPM	PSI	GPM	PSI	GPM	PSI	GPM	PSI
3.75	1.91	191	17800	287	13500	478	8100	631	6100
4	2.17	217	15600	326	11800	544	7100	718	5400
4.5	2.75	275	12400	413	9300	688	5600	908	4200
5	3.40	340	10000	510	7600	850	4500	1121	3400
5.5	4.11	411	8300	617	6300	1028	3800	1357	2800
5.75	4.49	449	7600	674	5700	1124	3400	1483	2600
6	4.89	489	6900	734	5300	1223	3200	1615	2400
6.5	5.74	574	5900	861	4500	1436	2700	1895	2000
6.75	6.19	619	5500	929	4200	1548	2500	2044	1900
Input Power	BHP	2200		2500		2500		2500	

EX. 1041 (Gardner) pg. 14.

15. A fracturing piston (or plunger) pump works similarly to a car engine without the step of igniting the fuel to provide energy to the shaft. In a piston (plunger) pump, the shaft is rotated by an external power source, such as an engine or electric motor. Pistons (plungers), typically 3-5, are arranged along the shaft and connected so that the rotational motion of the shaft is translated into the linear motion of the pistons. As the shaft rotates, the piston (or plunger) moves away from the

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head, creating suction that draws the slurry into the piston chamber. As the piston (plunger) moves toward the head, pressure is generated, which drives the fluid out of the chamber and down the line into the wellbore. A key characteristic of these fracturing pumps is that the same amount of liquid is discharged from the pump with every stroke, largely independent of downstream pressure. The result is that the flow at a given pump speed remains relatively constant, while the pressure changes in response to changes in downstream conditions. Accordingly, as fracturing begins and reduces the downstream impedance of the fluid flow system, pressure tends to drop while the flow rate remains relatively constant. Conversely, pressure rises with a relatively stable flow rate as downstream impedance increases. As a boundary condition, if a valve is closed downstream of a fracturing pump, the flow rate through the pump will remain relatively constant while the pressure rises extremely fast. Pressure will continue to increase until some condition reduces the downstream impedance. This is typically equipment failure, such as pump seals, piping failures, or ruptured valve bodies.

16. Because the pistons (plungers) are so large (~5" in diameter with ~8" stroke), a large amount of fluid must flow into the piston on each stroke. This tends to lower the suction pressure, as the incoming slurry must fill the piston (plunger) void. If the suction pressure gets too low, then cavitation occurs. Cavitation is the condition in which bubbles form in a liquid because its vapor pressure exceeds the

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suction pressure. When bubbles collapse, as when the piston reaches the bottom of its stroke, noise, vibration, and damaging forces are generated. To avoid cavitation and the associated problems, suction pressure must be maintained higher than the fluid's vapor pressure (e.g., slurry), even during the intake phase of the piston. This is called maintaining a Net Positive Suction Head (NPSH).

B. PUMPING AND CAVITATION

17. Cavitation in pumping, including in positive displacement (e.g., plunger) pumps, has been a well-known problem. Cavitation is described when "the incoming liquid [into a pump] is at a pressure with insufficient margin above the vapour pressure, then vapour cavities or bubbles appear [] [t]his phenomenon is known as cavitation."[4] Cavitation has at least three negative effects on a pumping system:[5]

- The collapsing cavitation bubbles can erode the vane surface, especially when pumping water-based liquids.
- Noise and vibration are increased, with possible shortened seal and bearing life.

[4] Ex. 1042 (*Tutterow*) pg 20; see also Ex. 1043 (Marks) pg. 14-2.
[5] Ex. 1042 (*Tutterow*) pg 20

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- The cavity areas will initially partially choke the impeller passages and reduce the pump performance. In extreme cases, the pump-developed head is completely lost.

Accordingly, it was known to avoid cavitation in pumping systems.

18. *Tutterow* further teaches that "[t]he amount by which the pressure in the pump inlet exceeds the liquid vapour pressure is expressed as a head of liquid and referred to as Net Positive Suction Head Available (NPSHA). This is a characteristic of the system design. The value of NPSH needed at the pump suction to prevent the pump from cavitating is known as NPSH Required (NPSHR)."[6]

19. Further, NPSHR "varies approximately with the square of speed in the same way as pump head."[7] Accordingly, a 10% reduction in pump speed would result in a 19% reduction in NPSHR, and a 10% increase in speed would require a 21% increase in NPSHR. In any given system, a decrease in pump speed would reduce the risk of cavitation. It follows then that there is a specific speed that would eliminate cavitation for any given pump system. It further follows that as speed increases, cavitation increases.

20. With specific regard to PD pumps, "a PD pump needs the incoming liquid to have a pressure margin above liquid vapour pressure to prevent cavitation

[6] Ex. 1042 (*Tutterow*) pg 20
[7] Ex. 1042 (*Tutterow*) pg. 21.

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within the suction passages or pumping chamber."[8] PD pumps also have an additional problem outlined by *Tutterow*:[9]

> The cavities [cylinders] on a positive displacement pump open and close as the pump operates, and the liquid must flow quickly enough at the pump suction to fill the cavities with liquid. If the cavities do not fill with liquid, there will be a void and apparent cavitation, resulting in a loss of both flow and pressure performance. If the speed is increased, this filling process becomes more problematical, limiting the maximum speed. With viscous liquids, [such as fracturing fluid] the effect is more severe.

21. *Langewis* describes the use of positive displacement pumps used to inject produced water into the formation in a waterflood oil & gas operation. The pumps described in Langewis are very similar in design and function to those used in hydraulic fracturing. Langewis describes "Net positive suction head (NPSH) is defined as the head, in feet of liquid above vapor pressure, required at the suction inlet of the pump to completely fill each cylinder on the suction stroke."[10] Langewis further describes NPSH required mathematically:

$$NPSH_{required} = H_a + H_g - H_{vp}$$

[8] Ex. 1042 (*Tutterow*) pg. 30.
[9] Ex. 1042 (*Tutterow*) pg. 30.
[10] Ex. 1044 (*Langewis*) pg. 2.

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22. H_g represents "minimum pressure required for acceptable pump performance". Further, Langewis teaches that "[t]he value of H_g should be obtained from the pump manufacturer. This term is a function of the diameter of the plunger, *speed of the pump*, type of valve used, valve-spring load and tolerance of the equipment; therefore, all pump manufacturers should have this value for their pumps."[11]

23. The maximum speed of operation of a positive displacement pump to prevent cavitation is the lower of the speed that keeps NPSHR below NPSHA and that speed which allows sufficient time for the cylinders to fill based on the NPSHA completely.

C. CONTROL SYSTEMS FOR HYDRAULIC FRACTURING

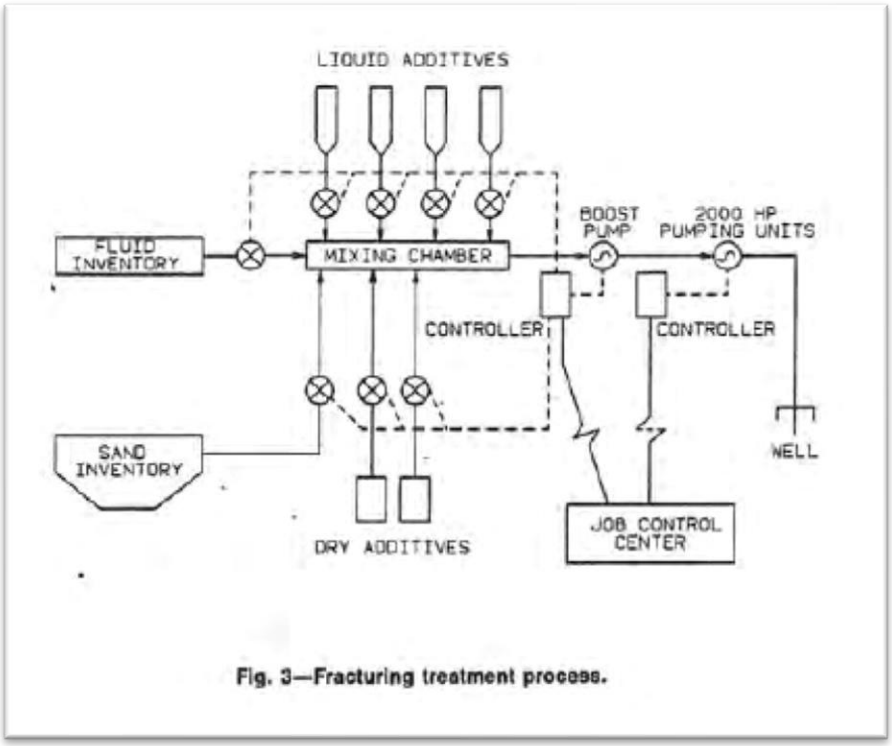
24. Computer-based control systems have been commonplace in hydraulic fracturing operations for decades before the '258 Patent. For example, *Tomlinson* describes Phase 1 of a project to "automate and remotely control the fracturing processes" as early as 1988.[12] *Tomlinson* described the goals of the project:[13]

> to automate and remotely control the fracturing process were to (1) improve execution of complex job design, (2) significantly improve quality control of chemical blends, (3) reduce operational cost, (4) improve safety, (5) provide for changes in job design during progress of the operation, and (6) improve documentation of the processes.

[11] Ex. 1044 (Langewis) pg. 2-3
[12] Ex. 1071 (*Tomlinson*) pg 371.
[13] Ex. 1071 (*Tomlinson*) pg 371.

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Fig. 3 of *Tomlinson* shows the fracturing system to which *Tomlinson* was applied:[14]



Ex. 1022 (*Tomlinson*) Fig. 3

Tomlinson further discloses a blender with control loops to "monitor and adjust liquid additives, proppant [e.g., sand] delivery, engine control, dry additives, and mixing tub level."[15] As *Tomlinson* was published more than three decades before the '258 Patent, the sensing of output rates from a sand system, water system, pumping system, and blender while controlling the rates with a controller was well-known

[14] Ex. 1071 (*Tomlinson*) pg 375.
[15] Ex. 1071 (*Tomlinson*) pg 372.

and commonly used in the oil and gas industry for hydraulic fracturing as well as other oilfield operations.

25. Phase 2 of the *Tomlinson* project is outlined in *Stephenson*, published in 1993.[16] *Stephenson* describes that "the entire automated and remote controlled fracturing stimulation system has been placed into production globally with hundreds of jobs successfully accomplished and documented."[17] *Stephenson* describes that Phase 2 of the control system involved "(1) a new design concept for a slurry processor, (2) creating software for the central computer in the control and engineering center, and (3) improving the proppant handling equipment. In addition, fluid monitoring systems were developed."[18] Fig. 1 of *Stephenson* shows the control and engineering system described.[19]

[16] Ex. 1067 (*Stephenson*) generally.
[17] Ex. 1067 (*Stephenson*) pg. 43.
[18] Ex. 1067 (*Stephenson*) pg 43.
[19] Ex. 1067 (*Stephenson*) Fig. 1.

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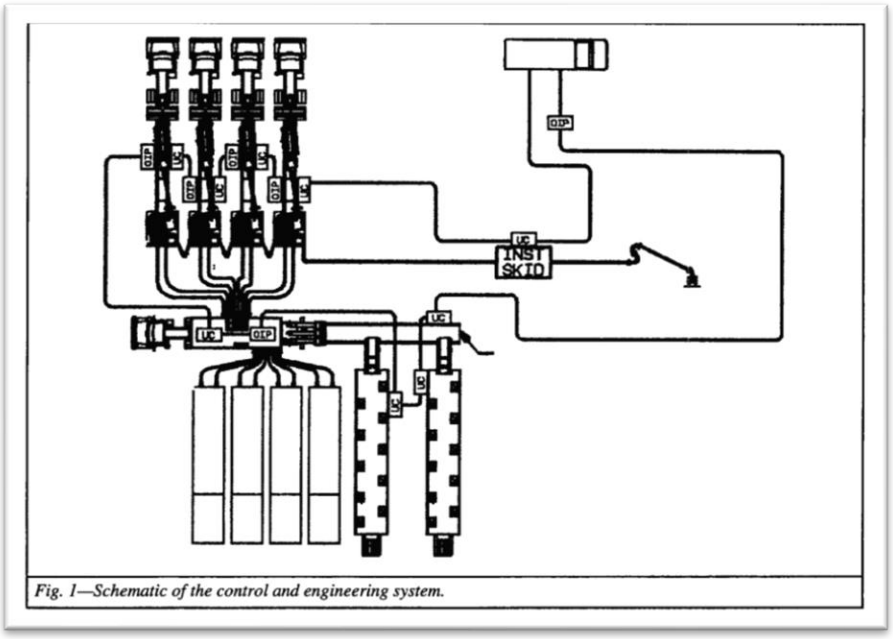


Fig. 1—Schematic of the control and engineering system.

Ex. 1067 (*Stephenson*) Fig. 1

Stephenson describes that the "control and engineering center monitors over 1,200 surface treatment parameters through the communications network" and that these "parameters consist of rates, pressures, temperatures, densities, material inventories, and equipment status."[20]

26. *Coli*, for example, describes "[a] control system can be provided for regulating various equipment and systems within the electric powered fractioning [sic, fracturing] operation."[21] *Dykstra* and *Sanborn* describe similar control

[20] Ex. 1067 (*Stephenson*) pg. 47.
[21] Ex. 1004 (*Coli*) [0065], *see also* Ex. 1004 (*Coli*) [0072] ("Suitable controls and computer monitoring for the entire fracturing operation can take place at a single central location, which facilitates adherence to pre-set safety parameters.")

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systems.[22] Further, it was well-known long before the '992 Patent to use field devices to monitor the health status of fracturing equipment. For example, *Dykstra 415* allows operators "to determine failure, or likelihood of failure" of equipment, which "provides an improved view of system health and performance, and also permits signaling to operators so that failures are prevented or caught more quickly, reducing operator error."[23] Further, *Dyktra 415* teaches its system "include[s] a plurality of subsystems (such as sensors or actuators, or combinations of parts) that can signal operation or state information. This information is used to determine if one or more subsystems are in or near failure mode."[24] *Dykstra 415* further teaches the "ability to switch control modes depending on sensor or actuator health."[25]

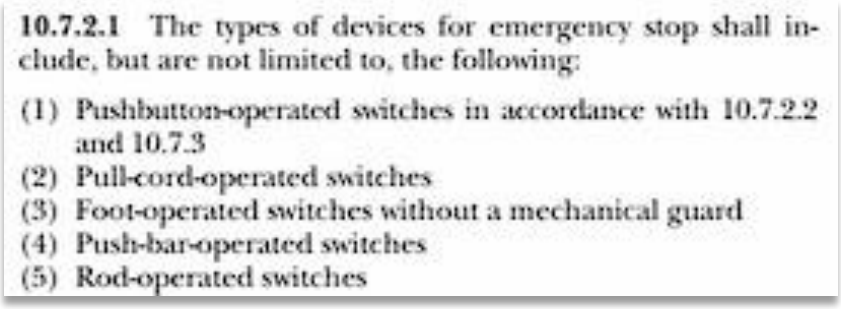
D. BACKGROUND ON E-STOP

27. An emergency stop or "e-stop" (e-kill) system has long been a common, well-known function of modern industrial systems. Such a system provides for a single human action, such as pressing a button or pulling a cord, to shut down an

[22] See, Ex. 1066 (*Sanborn*) [0030] (disclosing "an operations and control unit, usually computer-based, and containing monitoring, data-recording, and communication equipment, as well as remote pumper controls to monitor and control each stage of the fracturing process, and to record data for each phase.", *see also* [0050]. *See* Ex. 1006 (*Dykstra*) [0021], (disclosing a "central control system" that may be an "electronic computer system" for monitoring, coordinating, and controlling the "operations of the chemical storage system, proppant storage system, blending unit, pumping grid, power unit, and manifolds").
[23] Ex. 1068 (*Dykstra 415*) [0055].
[24] Ex. 1068 (*Dykstra 415*) [0007].
[25] Ex. 1068 (*Dykstra 415*) [0016].

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entire process by removing energy from the system. At least by 2007, the National Fire Protection Association (NFPA) described e-kill in NFPA 79, the "Electrical Standard for Industrial Machinery." NFPA 79 defined "Emergency Switching Off" as "An emergency operation intended to switch off the supply of the electrical energy to all or part of an installation."[26] NFPA 79 has further taught that modern electrical machines "involve highly complex electrical control systems, including electronic and solid-state devices and equipment."[27] This description encompasses an electric fracturing system. NFPA 79 requires that such systems be operated by a single human action using one of a variety of devices:



10.7.2.1 The types of devices for emergency stop shall include, but are not limited to, the following:

(1) Pushbutton-operated switches in accordance with 10.7.2.2 and 10.7.3
(2) Pull-cord-operated switches
(3) Foot-operated switches without a mechanical guard
(4) Push-bar-operated switches
(5) Rod-operated switches

Ex. 1046 (*NFPA* 79) §10.7.2.1. Article 9.2.5.4 of *NFPA 79* describes various functions of "Emergency Operations (Emergency Stop, Emergency Switching Off)."

28. Emergency stop systems are sometimes referred to as "Emergency Shutdown Systems" or ESDs. Such systems have been described in the learned literature for decades. For example, in 1989, Pearson proposed "HSE Guidelines on

[26] Ex. 1072 (*NFPA 79*) at 79-9, §3.3.38.
[27] Ex. 1046 (*NFPA 79*) at Origins.

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Emergency Shutdown Systems" specifically for "the oil, gas and process industries."[28] *Pearson* discusses that, for such processes that include "complex inter-connected computer based systems…there are advantages from a safety view point in having a dedicated independent protection system or emergency shut down (ESD) system to take action to achieve a safe plant condition in the event of plant or equipment failure or indeed control system failure."[29] *Pearson* further discusses that such "protection has traditionally been implemented using custom designed and built relay systems or more recently solid state electronic modular systems,"[30] making it clear that such systems had existed long before *Pearson. Pearson* further describes that "Emergency Shutdown (ESD) systems can be applied to any hazardous plant which has a safe state to which the plant can be directed when things go wrong for any reason."[31] Pearson's ESD system is "new," as of 1989, in that it uses multiple programmable logic controllers (PLCs) to effect the shutdown system. Pearson states, however, "[t]here are many possible configurations of shutdown systems."[32]

29. As another example of an emergency shutdown system being in common use, *Gilson* describes initiating an ESD from a central controller.[33] Gilson

[28] Ex. 1047 (*Pearson*), at 55 (Introduction).
[29] Ex. 1047 (*Pearson*), at 55 (Introduction).
[30] Ex. 1047 (*Pearson*), at 55 (Introduction).
[31] Ex. 1047 (*Pearson*), at 55 (Applications).
[32] Ex. 1047 (*Pearson*), at 56 (Configurations).
[33] Ex. 1048 (*Gilson*), see generally.

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describes an "emergency systems activation panel" for use during such stimulation activities as containing "all to neutral," "emergency kill," "emergency disconnect [ESD]," and "fixed fire system activation."[34] *Gilson* describes that the ESD is part of a "fast response stimulation package (FRSP), and that it is operated "from a central control cabin."[35] *Gilson* describes that "FRSP control hookup is accomplished quickly by centrally locating all connections for all functions to be remotely controlled at one point on each piece of equipment, which enables the use of multi-signal connectors between these single points."[36]

30. *Burgos* describes using such systems, entitling his paper, "Eliminating Human Error During Coiled-Tubing Operations."[37] "The system also includes an emergency stop."[38] Given the well-known aspects of emergency stop systems, a POSITA would have understood Burgos to be discussing a system to switch off power or otherwise put the coiled tubing system into a safe state. Coiled tubing systems are one method of tool placement downhole, analogous to a pump-down plug-and-perf operation.

[34] Ex. 1048 (*Gilson*), at 636 (Control Cabin).
[35] Ex. 1048 (*Gilson*), at 635 (Abstract).
[36] Ex. 1048 (*Gilson*), at 637.
[37] Ex. 1049 (*Burgos*), Title.
[38] Ex. 1049 (*Burgos*), at 73 (Modified CS).

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31. Such ESD systems have been regularly used in Oil and Gas applications, but are not limited to them. For example, *Sammarco*,[39] in 2005, quantifies the "safety integrity of a PLC-based ESD and a hardwired ESD" for mining operations using "continuous mining machines and conveyors", analogous to a fracturing operation using conveyors to move proppant. *Sammarco* is a result of a study performed by the National Institute for Occupational Safety and Health.

32. It was also known to use ESD in connection with compressors for turbine generators. For example, engineers at Solar (a gas turbine generator manufacturer) published an article in 2009 about how to handle gas compression during an emergency shutdown.[40] Kurz describes an emergency shutdown to kill fuel flowing to a gas turbine:

> *During emergency shutdowns, the situation is different from regular, controlled recycle. Emergency shutdowns are initiated to protect the compressor station, and require the immediate shutdown of the compressor and its driver. In gas turbine driven compressors, this is initiated by cutting off the fuel flow into the gas turbine. In electric motor driven stations, the electric power to the motor is turned off.*

Ex. 1051 (*Kurz*) p. 2 (left column); *see also* p. 4 ("After the fuel is shut off, the gas turbine will still produce power due to its thermal inertia").

[39] Ex. 1050 (*Sammarco*).
[40] Ex. 1051 (*Kurz*) at Abstract. ("Emergency shutdowns in compressor stations cause fast transients in the operating conditions").

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33. A POSITA would recognize that at a facility with on-site generation, such as with a gas turbine generator, a shutdown with an ESD system would "switch off the supply of the electrical energy to all or part of an installation."[41] One method of "switching off" the supply of electrical energy to the entire installation would be "by cutting off the fuel flow into the gas turbine."[42] This action, coupled with opening the breakers connecting the generator to the rest of the on-site equipment, would "achieve a safe plant condition" as described by *Pearson* (Introduction). Such a configuration would have been well-known to a POSITA.

VI. OVERVIEW OF THE ASSERTED PATENTS

34. See Section III.A of my Original Declaration (Ex. 1003) for an overview of the '992 Patent.

VII. LEGAL STANDARDS

35. The Legal Standards provided to me were described in my Original Declaration and in my Second Declaration.[43]

36. In addition to those legal standards, I have been informed by counsel as to a legal background on indefiniteness. I have been informed that, in order to be valid, the claims of a patent must be sufficiently definite that one skilled in the art can determine the metes and bounds of the claimed invention. I have been informed

[41] Ex. 1072 (NFPA 79), at 79-9 (3.3.37).
[42] Ex. 1051 (*Kurz*) p. 2 (left column).
[43] Ex. 1003 (Original Declaration), § IV; Ex. 1022 (Second Declaration), § VII.

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that a patent claim is deemed "indefinite" if the claim, read in light of the patent's specification and prosecution history, fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention. I understand that a claim must be precise enough to afford clear notice of what is claimed, thereby apprising the public of what is still open to them.

37. In addition to these legal standards, I have been informed by counsel as to the legal background on lack of written description. I have been informed that, in order for claims to be valid, the claims of a patent must provide written description support for each limitation of the claims. I have been informed that a patent claim lacks written description if the specification fails to convey with reasonable clarity to a POSITA that the inventor was in possession of the invention as of the filing date sought. I have been informed that this requirement relies on an objective inquiry into what is contained within the specification, and that while the precise terms appearing in the claims need not necessarily appear in the specification, there must be sufficient detail in the specification that a POSITA can clearly conclude that the invention described in the claims had been invented as of the filing date sought.

38. I have been informed that to satisfy the written description requirement, the specification must actually or inherently disclose each element of the claims.

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39. I have been informed that for the disclosure to be inherent, the missing descriptive matter must necessarily be present in or unavoidably be taught by the specification, such that a POSITA would recognize such disclosure.

40. I have been informed that subject matter that is not disclosed, but would be obvious over what is expressly disclosed, does not satisfy the written description requirement.

41. I have been further informed that a claim is not patentable if the claimed invention was otherwise available to the public before the effective filing date of the claimed invention.

VIII. OVERVIEW OF THE SUBSTITUTE CLAIMS

A. TABLE CORRELATING ORIGINAL CLAIMS TO SUBSTITUTE CLAIMS

42. I understand that in Patent Owner's Revised Motion to Amend, Patent Owner has sought to amend the independent claims by proposing new substitute claims. The table below compares the Original Claims to the Substitute Claims, with independent claims emphasized in bold italics.

Original Claim	Dependency	Substitute Claim	Dependency
1		***41***	
2	1	42	41
3	2	canceled	canceled
4	1	43	41

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5	4	44	43
6	2	45	42
7	6	46	45
8		***47***	
9	8	48	47
10	9	49	48
11	9	50	48
12	9	51	48
13	9	52	48
14	8	53	47
15	9	54	48
16	15	55	54
17		***56***	
18	17	57	56
19	17	58	56
20	17	59	56

B. LIST OF SUBSTITUTE CLAIMS

43. Patent Owner also provided annotations showing the changes it made to the claims of the ’992 Patent. This is found in Appendix A of the Revised Motion

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to Amend. Patent Owner amended all of the independent claims and all of the dependent claims. These changes are shown below.

44. Substitute Claim 41:

[41p] A system for hydraulically fracturing an underground formation in an oil or gas well to extract oil or gas from the formation, the oil or gas well having a wellbore that permits passage of fluid from the wellbore into the formation, the system comprising:

[41a] an electric pump fluidly connected to the well, and configured to pump fluid into the wellbore; and

[41b] a centralized control unit coupled to the electric pump,

[41c] wherein the centralized control unit is configured to:

monitor the electric pump; and

[41d] a variable frequency drive that controls a speed of the electric pump;

[41e] the system further comprising a generator electrically connected to the electric pump to provide power to the electric pump,

[41f] wherein the generator is a natural gas generator,

[41g] the system further comprising a gas filtration skid,

[41h] wherein the centralized control unit is further configured to monitor operating characteristics of the gas filtration skid;

[41i] wherein the monitored operating characteristics of the gas filtration skid include at least water separator status, particulate filter status, gas pressures, gas temperatures, valve statuses, and filter bypass status;

[41j] wherein the centralized control unit is further configured to control operating characteristics of the gas filtration skid;

[41k] wherein the controllable operating characteristics of the gas filtration skid include at least inlet valves, outlet valves, bypass valves, and pressure release;

[41l] the system further comprising a gas compressor,

[41m] wherein the centralized control unit is further configured to monitor operating characteristics of the gas compressor;

[41n] wherein the monitored operating characteristics of the gas compressor include at least compressor motor run status, oil pump run status, enclosure exhaust fan run status, compressor inlet pressure, compressor discharge pressure, and oil pump discharge pressure;

[41o] wherein the centralized control unit is coupled to the electric pump via one or more of cabling, Ethernet, or wirelessly; and

41[p] wherein the centralized control unit is further configured to reset a fault occurring in the variable frequency drive.

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45. Substitute Claim 42:

[42a] The system of **[claim 1]** **claim 41**, further comprising:

a generator electrically connected to the electric pump to provide power to the electric pump, wherein the generator is powered by **liquefied** natural gas, and

[22b] wherein the centralized control unit is further configured to monitor and control compression of the natural gas.

46. Substitute Claim 43

[43a] The system of **[claim 1]** **claim 41**, wherein the electric pump is a plurality of electric pumps**,**

[43b] **the system further comprising a switch gear,**

[43c] **wherein the centralized control unit is further configured to monitor operating characteristics of the switch gear,**

[43d] **wherein operating characteristics include at least the status of a fire alarm**.

47. Substitute Claim 44:

[44a] The system of **[claim 4]** **claim43**, further comprising: a variable frequency drive that controls the plurality of electric pumps**,**

[44b] **the system further comprising a hydraulic system,**

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[44c] **wherein the system is configured to monitor operating characteristics of the hydraulic system,**

[44d] **wherein the operating characteristics include at least system pressure, charge pressure, temperature, hydraulic oil level, and filter status**.

48. Substitute Claim 45:

[45a] The system of **[claim 2] claim 42**, further comprising an emergency power off unit coupled to the centralized control unit, the electric pump, and the generator,

[45b] wherein the emergency power off unit is configured to substantially immediately cut power from the generator when activated**,**

[45c] **wherein the emergency power off unit is operated by a switch that sounds an audible alarm**.

49. Substitute Claim 46:

[46a] The system of **[claim 6] claim 45**, the emergency power off unit comprising an auxiliary power and a switchgear, each coupled to the generator and the centralized control unit,

[46b] wherein the switchgear is responsive to a signal from the centralized control unit to open a breaker to substantially immediately cut power to the generator**,**

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[46c] **wherein the signal is transmitted over armored shielded CAT5E cabling**.

50. Substitute Claim 47:

[47a] A method, comprising:

pumping fracturing fluid into a well in a formation with an electrically powered pump, the fracturing fluid having at least a liquid component and a solid proppant, and inserting the solid proppant into the cracks to maintain the cracks open, thereby allowing passage of oil and gas through the cracks;

[47b] monitoring at a centralized control unit the electrically powered pump;

[47c] wherein the centralized control unit is coupled to the electrically powered pump via one or more of cabling, Ethernet, or wirelessly; and

[47d] controlling the speed of the pump with a variable frequency drive,

[47e] wherein the centralized control unit is configured to reset a fault occurring in the variable frequency drive;

[47f] the method further comprising powering the electrically powered pump with a generator,

[47g] wherein the generator is a turbine generator;

[47h] the method further comprising monitoring operating characteristics of the turbine generator; and

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[47i] wherein the monitored operating characteristics of the turbine generator include at least turbine air inlet filter transmitter failure.

51. Substitute Claim 48:

[48a] The method of **[claim 8] claim 47**, further comprising:

powering the electrically powered pump with a generator, wherein the generator is fueled by **liquefied** natural gas; and

[48b] monitoring compression of natural gas.

52. Substitute Claim 49:

[49a] The method of **[claim 9] claim 48**, **[wherein the natural gas is selected from the group consisting of field natural gas, compressed natural gas, and liquid natural gas] the method further comprising monitoring, by the centralized control unit, operating characteristics of a switch gear**

[49b] **the operating characteristics including the status of a fire alarm**.

53. Substitute Claim 50:

[50a] The method of **[claim 9] claim 48**, further comprising controlling compression of **the liquefied** natural gas;

[50b] wherein the generator is fueled by **liquefied** natural gas,

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[50c] **the method further comprising monitoring operating characteristics of a hydraulic system**

[50d] **wherein the operating characteristics include system pressure, charge pressure, temperature, hydraulic oil level, and filter status**.

54. Substitute Claim 51:

[51a] The method of **[claim 9] claim 48**, wherein the generator is a turbine generator; the method further comprising

[51b] monitoring **operating characteristics** of the turbine generator

[51c] **wherein the monitored operating characteristics of the turbine generator include at least fuel system air supply pressure transmitter failure, thermocouple input module thermistor failure, start VFD configuration failure, generator circuit breaker failure to open, gas fuel supply pressure transmitter failure, gas fuel control pressure transmitter failure, utility circuit breaker closed, generator frequency, and engine serial number.**

55. Substitute Claim 52:

[52a] The method of **[claim 9] claim 48**, wherein the generator is a turbine generator; the method further comprising

controlling the turbine generator **and**

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[52b] **monitoring operating characteristics of the turbine generator**

[52c] **wherein the monitored operating characteristics include gas fuel main valve discharge pressure transmitter failure, and backup system relay failure**.

Claim 53. (Proposed substitute for original claim 14)

[53a] The method of [claim 8] claim 47, further comprising resetting a fault occurring in the variable frequency drive from the centralized control unit,

[53b] **the method further comprising monitoring operating characteristics of the variable frequency drive,**

[53c] **wherein the monitored operating characteristics include motor winding temperatures, the motor RPM, the voltage, the torque, and the current (amperage)**.

56. Substitute Claims 54:

[54a] The method of **[claim 9] claim 48**, further comprising:

providing an emergency power off unit coupled to the centralized control unit, the electrically powered pump and the generator; and

substantially immediately cutting power to the generator by activating the emergency power off unit

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[54b] **wherein the emergency power off unit is operated by a switch that sounds an audible alarm**.

57. Substitute Claim 55

[55a] The method of **[claim 15] claim 54**, the emergency power off unit comprising an auxiliary power and switchgear, each coupled to the generator and the centralized control unit, the method further comprising

55[a] signaling the switchgear from the centralized control unit to open a breaker to substantially immediately cut power to the generator

[55b] **wherein signaling is transmitted over armored shielded CAT5E cabling**.

58. Substitute Claim 56

[56p] A system for centralized monitoring and control of a hydraulic fracturing operation, comprising:

[56a] an electric powered fracturing fleet, the electric powered fracturing fleet comprising:

a combination of one or more of: electric powered pumps, **electric motors,** turbine generators, blenders, sand silos, chemical storage units, conveyor belts, manifold trailers, hydration units, variable frequency drives, switchgear, transformers, compressors;

[56b] a centralized control unit coupled to electric powered fracturing fleet; and

[56c] an emergency power off unit coupled to the centralized control unit, the electric powered pumps and the turbine generators, the emergency power off unit configured to substantially immediately cut power to the turbine generators when activated,

[56d] wherein the centralized control unit is configured to:

monitor one or more operating characteristics of the electric powered fracturing fleet; and control one or more operating characteristics of the electric powered fracturing fleet;

[56e] wherein the centralized control unit is coupled to the electric powered fracturing fleet via one or more of cabling, Ethernet, or wirelessly;

[56f] **the system further comprising one or more generators electrically connected to the electric pump to provide power to the electric pump;**

[56g] **wherein the one or more generators are turbine generators, and;**

[56h] **wherein the centralized control unit is further configured to monitor operating characteristics and control the one or more turbine generators, and**

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[56i] **wherein the monitored operating characteristics of the one or more turbine generators include at least turbine air inlet filter transmitter failure.**

59. Substitute Claim 57

[57a] The system of **[claim 17] claim 56**, the emergency power off unit comprising an auxiliary power and switchgear, each coupled to the **one or more turbine** generators and the centralized control unit, the switchgear responsive to a signal from the centralized control unit to open a breaker to substantially immediately cut power to the one or more turbine generators**;**

[57b] **wherein the centralized control unit is further configured to monitor operating characteristics of the switch gear,**

[57c] **wherein operating characteristics include at least the status of a fire alarm**.

60. Substitute Claim 58:

The system of **[claim 17] claim 56**, wherein the centralized control unit is further configured to monitor and control **all of the following:** compression of natural gas**, electric motors, switchgear, transformers, mobile turbines, rate and pressure of the overall system, vertical sand silos, and electrical conveyor belt**.

61. Substitute Claim 59:

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[59a] The system of **[claim 17]** **claim 56**, wherein the centralized control unit is further configured to monitor and control the **one or more** turbine generators,

[59b] **wherein the turbine generators are fueled by liquefied natural gas**.

IX. PRIORITY DATE OF THE SUBSTITUTE CLAIMS

62. In its Revised Motion to Amend, Patent Owner contends that "a POSITA would have understood, based on the disclosures of the '838 application and the '363 application, that the inventor possessed proposed Substitute Claims 41-49 as of October 15, 2025.[44] Notably, Patent Owner does not provide any evidence that the Substitute Claims have support in U.S. Patent App. No. 13/679,689 (the "'689 Application"). At least according to the cover of the '992 Patent, the '992 Patent purports to claim priority to the '689 Application. As a result, it is my opinion that the Substitute Claims do not have support in the '689 Application and consequently do not gain the benefits of the priority date of the '689 Application. The priority date of the substitute claims is no earlier than the filing date of the '363 Application, which is October 15, 2015.

X. CLAIM CONSTRUCTION

[44] Revised MTA, pg. 20.

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63. I understand that "claim construction" is the process of determining a patent claim's meaning. I also understand that, during an *inter partes* review, a claim construction analysis begins with the plain meaning of the claim term, which is the ordinary and customary meaning given to the term by those of ordinary skill in the art at the time of the invention. I also understand that the claims of a patent must be interpreted in light of the specification—that is, the claim language itself, the written description, and the figures in the patent—as well as the patent's prosecution history and/or any reexamination history.

64. In my opinion, and for the purposes of this declaration, the claim terms of the '992 Patent do not require a construction.

XI. SUMMARY OF CONCLUSIONS AND GROUNDS FOR CHALLENGE

65. Based upon my review of the Petition, the Revised Motion to Amend, the materials cited in my Original Declaration and my Second Declaration, and the materials listed in the LIST OF EXHIBITS above, it is my opinion that Substitute Claims 21-40 of the '992 Patent are rendered obvious by the Grounds listed in the table below:

Ground	'992 Claims (Substitute)	Basis for Challenge
12A	41, 42	*Coli*, *Birch*, *Rusnak*, *Armstrong, Clancy, Trobaugh, Teets,* and *Broussard079*
12B	41, 42	*Coli*, *Birch*, *Rusnak*, *Armstrong, Clancy, Trobaugh, Teets, Broussard079* and what was otherwise available to the public

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13A	43	*Coli*, *Birch*, *Rusnak*, *Armstrong, Clancy, Trobaugh, Teets, Hunt, Gensel*
13B	43	*Coli*, *Birch*, *Rusnak*, *Armstrong, Clancy, Trobaugh, Teets, Hunt, Gensel,* and what was otherwise available to the public
14A	45, 46	*Coli*, *Birch*, *Hunt*, *Rusnak*, *Armstrong, Clancy, Trobaugh, Teets, Smith, Bromell,* and *Thompson*
14B	45, 46	*Coli*, *Birch*, *Hunt*, *Rusnak*, *Armstrong, Clancy, Trobaugh, Teets, Smith, Bromell, Thompson,* and what was otherwise available to the public
15A	47-49, 52, 54, 56-57, 59	*Coli, Birch, Rusnak, Ekanayake, Bliss, Broussard079, Gensel*
15B	47-49, 52, 54, 56-57, 59	*Coli, Birch, Rusnak, Ekanayake, Bliss, Broussard079, Gensel* and what was otherwise available to the public
16A	50	*Coli, Birch, Rusnak, Ekanayake, Bliss, Broussard079, Allam*
16B	50	*Coli, Birch, Rusnak, Ekanayake, Bliss, Broussard079, Allam,* and what was otherwise available to the public
17A	51	*Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss, Broussard079, Kohlenberger, Weiher, Newman*
17B	51	*Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss, Broussard079, Kohlenberger, Weiher, Newman*, and what was otherwise available to the public
18A	53	*Coli, Birch, Rusnak, Ekanayake, Bliss, Discenzo*
18B	53	*Coli, Birch, Rusnak, Ekanayake, Bliss, Discenzo,* and what was otherwise available to the public
19A	55	*Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss, Groussard709, Thompson*
19B	55	*Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss, Groussard709, Thompson,* and what was otherwise available to the public
20A	44	*Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, Hunt, Gensel, Delaney, Weir*

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20B	44	*Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, Hunt, Gensel, Delaney, Weir,* and what was otherwise available to the public
21A	58	*Coli, Birch, Rusnak, Hunt, Bliss, McIver*
21B	58	*Coli, Birch, Rusnak, Hunt, Bliss, McIver,* and what was otherwise available to the public

66. It is further my opinion that Substitute Claims 45-46 and 54-59 are invalid as indefinite because a POSITA lacks reasonable certainty as to the scope of "substantially immediately" as recited in those claims.

67. It is additionally my opinion that Substitute Claim 44 is invalid for lack of written description because the specification of the '992 Patent does not reasonably convey to a POSITA that the inventor had possession of "a hydraulic system" as recited in limitation [44b].

68. Further, it is my opinion that Claim 50 is invalid for lack of written description because the specification of the '992 Patent does not reasonably convey to a POSITA that the inventor had possession of "controlling compression of the liquefied natural gas" as recited in limitation [50a].

XII. CERTAIN SUBSTITUTE CLAIMS ARE INVALID AS INDEFINITE AND/OR LACKING WRITTEN DESCRIPTION

A. A POSITA LACKS REASONABLE CERTAINTY AS TO THE SCOPE OF "SUBSTANTIALLY IMMEDIATELY" AS RECITED IN SUBSTITUTE CLAIMS 45-46 AND 54-59

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69. Substitute Claim 45 recites in limitation [45b] "wherein the emergency power off unit is configured to substantially immediately cut power from the generated when activated."

70. Substitute Claim 46 depends from Substitute Claim 45, and so recites this limitation by dependence. Substitute Claim 46 also recites in limitation [46b] "wherein the switchgear is responsive to a signal from the centralized control unit to open a breaker to substantially immediately cut power to the generator."

71. Substitute Claim 54 recites in [54a] "substantially immediately cutting power to the generator by activating the emergency power off unit."

72. Substitute Claim 55 depends from Substitute Claim 54, and so recites this limitation by dependence. Substitute Claim 55 also recites in limitation [55a] "signaling the switchgear from the centralized control unit to open a breaker to substantially immediately cut power to the generator."

73. Substitute Claim 56 recites in limitation [56c] "the emergency power off unit configured to substantially immediately cut power to the turbine generators when activated."

74. Substitute Claims 57-59 depend from Substitute Claim 56 and so recite this limitation by dependence. Substitute Claim 57 also recites in limitation [57a] "the switchgear responsive to a signal from the centralized control unit to open a

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breaker to substantially immediately cut power to the one or more turbine generators."

75. Substitute Claims 45-46 and 54-59 recite that power is cut "substantially immediately." The claims, specification, and prosecution history of the '992 Patent do not provide an objective standard for ascertaining the scope of "substantially immediately." In other words, there is no objective standard provided for determining how quickly the power must be cut off for it to be considered "substantially immediately."

76. The scope of "substantially immediately" is unclear, because it is not clear what within what amount of time power needs to be cut off for it to be "immediately," let alone "substantially immediately." There is no description in the claims, specification, or prosecution history of the '992 Patent that elucidates the boundaries of "substantially immediately." None of the Substitute Claims provide further limitation that provide reasonable certainty as to the scope of "substantially immediately."

77. The specification does not provide any objective baseline or guideposts to enable a POSITA to differentiate "substantially immediately" from other durations, such as "immediately." The phrase "substantially immediately" does not appear in the specification of the '992 Patent. Rather, for the switchgear, the '992 Patent states that "[u]on activation of the EPO 43, breakers open in the switchgear

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47, cutting power to the generator 22. The gas compression will turn off, cutting fuel to the turbine(s) 23," without providing a description of within what duration of time the power must be cut for it to be "substantially immediately."[45] For the emergency off unit, the '992 Patent merely states that "[t]he monitor/control data van 40 further includes an Emergency Power Off (EPO) 43 functionality, which allows for the entire site to be shut off completely," without providing a description of within what duration of time the power must be cut for it to be "substantially immediately."[46] The claims do not simply recite that the switchgear or emergency power off unit cuts the power, or even that the power is cut off "immediately," they recite that the power is cut "substantially immediately."

78. The prosecution history for the '992 Patent also does not contain any guidance as to the scope of "substantially immediately."

79. A POSITA accordingly has no way of knowing the boundaries of what "substantially immediately" is intended to represent. Thus, reasonable minds may differ as to what is considered "substantially immediately," and the term renders Substitute Claims 45-46 and 54-59 indefinite.

80. When asked about the meaning of "substantially immediately," Patent Owner's Expert Dr. Nikolaou could provide no restrictions or bounds on the length

[45] Ex. 1001 ('992 Patent) at 7:38-41.
[46] Ex. 1001 ('992 Patent) at 5:50-68.

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of time that would be "substantially immediately," but instead testified that it is a matter of "engineering judgment" and "[t]here is no specific number assigned to it."[47] Dr. Nikolaou testified it would depend on "the configuration of the system, the risk for letting power continue before it gets shut off," on "how this is handled," "on the particular situation . . . the design of the unit and so forth," and that "'substantially' is used in the context of the specific system."[48] This further confirms that the scope of "substantially immediately" is subjective (subject to "engineering judgment") and that reasonable minds may have different views on its scope. It also confirms that what is "substantially immediately" may be different in other contexts, and yet nothing in the claims, specification, or prosecution history provides any guidance on how to determine what duration of time is considered "substantially immediately" in any given context. A POSITA accordingly lacks reasonable certainty as to the scope of "substantially immediately" as recited in these Substitute Claims.

B. THE '992 PATENT DOES NOT REASONABLY CONVEY TO A POSITA THAT THE INVENTOR HAD POSSESSION OF A HYDRAULIC SYSTEM AS RECITED IN [44B]

[47] Ex. 1053 (Nikolaou Dep Tr.), at 91:6-18.
[48] Ex. 1053 (Nikolaou Dep. Tr.), at 84:14-95:15.

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81. The ’992 Patent specification does not reasonably convey to a POSITA that the inventor had possession of “the system further comprising a hydraulic system,” as recited in limitation [44b].

82. Patent Owner identifies ¶¶ 44-46 and 59 of the ’363 and ’838 Applications as alleged written description support, which correspond to 9:4-18 and 10:30-34 of the ’992 Patent.[49] None of these discloses a “hydraulic system” or describes what components comprise “a hydraulic system.” Rather, they at best disclose monitored operating characteristics of a hydraulic motor, and do not provide written description support for “a hydraulic system” itself.

83. When asked, Dr. Nikolaou was not able to identify where the specification described the components of the “hydraulic system.”[50] Rather, Dr. Nikolaou admits that “there is no detailed description of the hydraulic system” as claimed in [25b], which corresponds to [44b] in the Subst. Claims.[51]

84. In his second deposition, Dr. Nikolaou testified that the hydraulic system includes a “hydration unit.”[52] I do not agree with Dr. Nikolaou that a hydration unit is a hydraulic system. A POSITA would have understood a hydraulic system as one in which water, or another fluid with a low viscosity, is used to convey

[49] Revised MTA, pg. 22; Ex. 2005 (’363 Application), ¶¶ 44-46; Ex. 1001 (’992 Patent), 9:4-18, 10:30-34.
[50] Ex. 1023 (Nikolaou Dep. Tr.), 100:8-19.
[51] Ex. 1023 (Nikolaou Dep. Tr.), 100:8-101:19.
[52] Ex. 1053 (Nikolaou Dep. Tr.), 81:18-83:22.

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power and do mechanical work. For example, the Authoritative Dictionary of IEEE Standards Terms (IEEE Standards Dictionary) defines "hydraulic operation" as "[p]ower operation by movement of a liquid under pressure."[53] A POSITA would have understood a "hydration unit" to instead refer to a component that adds water to rehydrate a dried chemical, typically a dry powder, to create a gel, or other chemical. I accordingly do not agree that any reference to a "hydration unit" in the '992 Patent sufficiently discloses to a POSITA the "hydraulic system" as recited in limitation [44b] of the Substitute Claims, such that a POSITA would have reasonably understood that the inventor had possession of a "hydraulic system."

85. While the '992 Patent specification does reference a "hydration unit 32," it does not disclose that the "hydration unit 32" is a component of a "hydraulic system." Rather, it describes "monitoring at the hydraulic motor of the hydration unit" can include the following:

> In an embodiment, pressure monitoring at the hydration unit can be accomplished via, for example, a suction pressure transducer or a discharge pressure transducer.
>
> In an embodiment, monitoring at the hydraulic motor of the hydration unit can include soft starter, motor winding temperatures, motor RPM, voltage, torque, current (amperage), and control can include both running and disabling the motor.

[53] Ex. 1065 (*IEEE Standards Dictionary*), pg. 527 .

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> In an embodiment, monitoring at the hydraulic motor of the hydration unit can include vibration monitoring of the hydraulic motor, the fluid pumps, and discharge manifold and hoses.
>
> In an embodiment, monitoring at the hydraulic motor of the hydration unit can include hydraulic system monitoring, including of operating characteristics such as system pressure, charge pressure, temperature, hydraulic oil level, and filter status.
>
> In an embodiment, monitoring at the hydraulic motor of the hydration unit can include electrical power monitoring, including of operating characteristics such as total kilowatt consumption, system voltage, current draw (both per power cable and total). In an embodiment, monitoring at the hydraulic motor of the hydration unit can include tub paddle speed monitoring.
>
> In an embodiment, monitoring at the hydraulic motor of the hydration unit can include fluid rate monitoring (though fluid rate is mostly controlled by the blender), including operating characteristics such as measured clean rate, via a turbine flow meter or magnetic flow meter.
>
> In an embodiment, monitoring at the hydraulic motor of the hydration unit can include monitoring the valve status, including inlet, outlet, and crossover. In an embodiment, monitoring at the hydraulic motor of the hydration unit can include tub level, measured by, for example, a float, radar, laser, or capacitive sensor(s).[54]

86. These passages do not disclose a "hydraulic system" or components of a "hydraulic system" as recited in limitation [44b]. Rather, these passages at best describe that the hydration unit has a monitored hydraulic motor These passages do not reasonably convey to a POSITA that the inventor had possession of a "hydraulic system" as recited in limitation [44b].

C. THE '992 PATENT DOES NOT REASONABLY CONVEY TO A POSITA THAT THE INVENTOR HAD POSSESSION OF CONTROLLING

[54] Ex. 1001 ('992 Patent), 10:18-52.

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COMPRESSION OF THE LIQUEFIED NATURAL GAS AS RECITED IN [50A]

87. The specification contains no support for "controlling compression of the liquefied natural gas". Although the specification does contain disclosures of compressors and compression of natural gas, these disclosures always refer to compression of natural gas in its gaseous state, i.e., "gas compression".[55] Liquefied natural gas is not a gas; it is a liquid, as the name suggests.

88. Further, the only reference to liquefied natural gas in the specification is a single paragraph that cites "For example, the generators can be powered by liquefied natural gas. The liquefied natural gas can be converted into a gaseous form in a vaporizer prior to use in the generators."[56] A "vaporizer" is precisely the opposite of a compressor, and "vaporizing" liquefied natural gas into a "gaseous form" is the opposite of the "compression" of the liquefied natural gas.

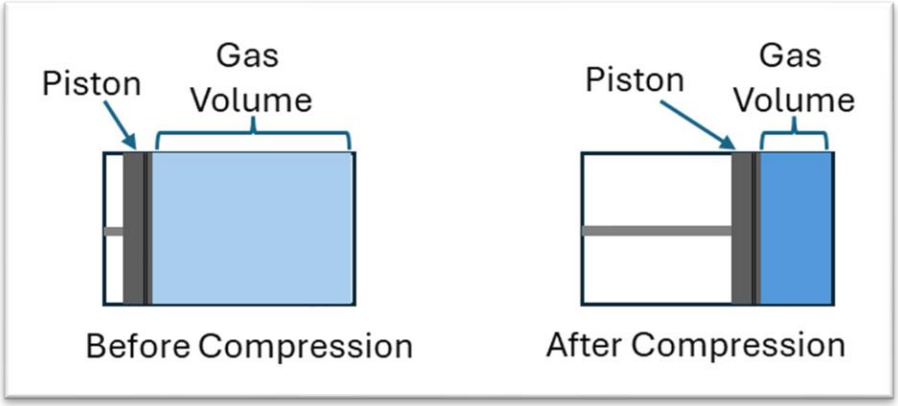
89. Liquefied natural gas is natural gas that has been cooled "to approximately 260 degrees Fahrenheit below zero (or minus 162 degrees Centigrade) at atmospheric pressure. When natural gas condenses, it takes up about 1/600th of the volume it did when it was in its gaseous state."[57] Before it can be used as a fuel, "it must be warmed and turned back into a gas."[58] The role of an LNG

[55] Ex. 1001 (*'992 Patent*) 1:53-56, 5:31-33, 5:58-61; 7:26-29; 7:40-41.
[56] Ex. 1001 (*'992 Patent*) 4:34-37.
[57] Ex. 1069 (*DOE*) pg 1.
[58] Ex. 1069 (*DOE*) pg. 1.

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vaporizer is to expand, by heating, the LNG so that it can be used, increasing the volume of the LNG to 600 times the volume of the liquid. LNG has 600 times as many natural gas molecules per unit volume as natural gas in its gaseous form.

90. A compressor performs the exact opposite function as a vaporizer. A compressor increases the pressure of the natural gas so that it is at a higher pressure (in the same volume). In a piston-type compressor, for example, the figure on the left shows the cylinder full of natural gas before the compression cycle.



91. The compression cycle comprises extending the piston and compressing the same quantity of natural gas into a smaller volume. The right side of the above figure shows the gas after compression, with the molecules closer together. Natural gas largely follows the ideal gas law as follows

$$PV = nRT$$

Where

P is Pressure

V is volume

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n is the number of moles (amount) of natural gas present

R is the ideal gas constant

T is Temperature

92. In a compressor, the volume decreases while the amount of gas remains constant, resulting in higher pressure.[59]

$$(\uparrow P)\ (V \downarrow) = nRT$$

Accordingly, a compressor *decreases* the volume required for a fixed number of natural gas molecules, while a vaporizer *increases* the volume required for that number. There is no support in the specification for "controlling compression of the liquefied natural gas," as there is no support for compression of liquid natural gas at all.

XIII. GROUND 12A: THE COMBINATION OF *COLI, BIRCH, RUSNAK, ARMSTRONG, CLANCY, TROBAUGH, TEETS, AND BROUSSARD079* RENDERS SUBSTITUTE CLAIMS 41 AND 42 OBVIOUS.

93. In my opinion, the combination of *Coli*, *Birch*, *Rusnak, Armstrong, Clancy, Trobaugh* and *Teets* discloses and/or suggests to a POSITA each element of Substitute Claim 41. The combination of *Coli, Birch*, *Rusnak, Armstrong, Clancy, Trobaugh, Teets, and Broussard079* discloses and/or suggests to a POSITA each element of Substitute Claim 42.

[59] There is also an increase in temperature due to friction of the piston and the molecules with each other.

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94. Substitute Claim 41incorporates the subject matter of original claims 1 and 8, respectively, addressed in my Original Declaration, and the claims add language regarding a natural gas generators, a gas filtration skid and monitoring and controlling the gas filtration skid, and a gas compressor and monitoring operating characteristics of the gas compressor. These additional limitations are set out in Claim elements [41e]–[41n]. Claim Elements [41e] – [41n] are addressed below. Claim elements [41p] – [41d] and [41o] – [41q] would have been obvious over the combination of *Coli*, *Birch*, and *Rusnak* as described in my original declaration.[60]

A. STATUS AND OVERVIEW OF *ARMSTRONG* (EX. 1054)

95. *Armstrong* is an International Publication of a PCT Patent Application, publication No. WO 2004/099587. *Armstrong* was filed on March 24, 2004, and published on November 18, 2004, and is therefore prior art to the '992 Patent.

96. *Armstrong* discloses a "fuel conditioning skid for an engine" that "deliver[s] a flow of fuel that is substantially free of undesirable compounds."[61] *Armstrong* discloses that the skid comprises "an inlet cleaner [that] is in fluid communication with the inlet and is operable to remove a portion of the undesirable compounds,"[62] and a "purifier [that] is in fluid communication with the inlet cleaner to receive the flow of fuel. The purifier is operable to remove substantially all of the

[60] Ex. 1003 (*Original Declaration*) Sections XI.A.1, XI.A.2.a, XI.A.2.d.
[61] Ex. 1054 (*Armstrong*), Abstract.
[62] Ex. 1054 (*Armstrong*), Abstract.

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remaining undesirable compounds from the flow of fuel."[63] *Armstrong* teaches monitoring operating parameters of the fuel conditioning skid, including water separator status,[64] particulate filter status,[65] gas pressures,[66] gas temperatures,[67] and valve statuses.[68] *Armstrong* also discloses control of operating characteristics of the fuel conditioning skid including inlet valves,[69] outlet valves,[70] bypass valves,[71] and pressure releases.[72]

97. *Armstrong* further discloses use of a gas compressor "in fluid communication with the inlet cleaner to receive the flow of fuel at a first pressure and discharge the flow of fuel at a second pressure."[73] *Armstrong* discloses monitoring operating characteristics of the gas compressor, including compressor motor run status,[74] and compressor discharge pressure.[75]

98. *Armstrong* teaches the use of the fuel conditioning skid and compressor to prepare fuels for use "in an engine to generate electricity and heat. These fuels

[63] Ex. 1054 (*Armstrong*), Abstract.
[64] Ex. 1054 (*Armstrong*) 9:24-10:14.
[65] Ex. 1054 (*Armstrong*) 11:13-15, 12:4-6.
[66] Ex. 1054 (*Armstrong*) 9:15-16, 10:21-24, 19:10-25.
[67] Ex. 1054 (*Armstrong*) 19:24-20:1, 13:7-14.
[68] Ex. 1054 (*Armstrong*) 9:16-19, 10:17-19, 12:15-21.
[69] Ex. 1054 (*Armstrong*), 10:16-19, 9:16-19.
[70] Ex. 1054 (*Armstrong*), 16:10-15.
[71] Ex. 1054 (*Armstrong*), 12:15-21, 16:20-23.
[72] Ex. 1054 (*Armstrong*), 12:2-4.
[73] Ex. 1054 (*Armstrong*), Abstract.
[74] Ex. 1054 (*Armstrong*), 10:20-24, 19:10-25.
[75] Ex. 1054 (*Armstrong*), 10:20-24, 19:10-25.

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can be combusted either in a gas turbine engine (Brayton cycle), an internal combustion engine (Otto cycle), or other prime-mover engines (e.g., Sterling engines). Any of these engines can be connected to an electric generator to generate electricity or a shaft to provide shaft power for a variety of applications."[76]

99. *Armstrong* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

B. STATUS AND OVERVIEW OF *CLANCY* (EX. 1055)

100. *Clancy* is a publication of a U.S. Patent Application that was filed on March 28, 2007 and was published on November 22, 2007. *Clancy* is therefore prior art to the '992 Patent.

101. *Clancy* discloses a "natural gas compressor and a system for operating the same."[77] *Clancy* describes "a power engine natural gas compressor system to optimize the extraction of natural gas from a reservoir and related gathering systems. The system is controlled by a distributed control system (DCS), which is a computer readable program, and allows for (HMI) humane [*sic. human*] machine interface. The DCS is integrated with a power engine computer system, which allows for diagnostics, control and data logging."[78] Like *Armstrong*, *Clancy* discloses "a separator, receiving the supply of gas and liquids flow under pressure by a first

[76] Ex. 1054 (*Armstrong*), 1:11-15, 4:11-15.
[77] Ex. 1055 (*Clancy*) at (54).
[78] Ex. 1055 (*Clancy*) [0003].

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piping line and separating the natural gas and liquids flow into a gas flow and a liquids flow, the liquids flow directed to a drain and the gas flow directed to a second piping line."[79] Also, like *Armstrong*, *Clancy* discloses "a compressor receiving the gas flow from the separator by the second piping line and compressing the gas."[80] *Clancy* further discloses the use of the conditioned gas in an engine to generate power.[81] *Clancy* further discloses, like *Armstrong*, that the separator and compressor are mounted on skids.[82]

102. *Clancy* discloses monitoring operating characteristics of the skid, including water separator status,[83] gas pressures,[84] gas temperatures,[85] and valve statuses.[86] *Clancy* further discloses controlling operating characteristics of the skid including inlet valves[87] and outlet valves.[88] Further still, *Clancy* discloses monitoring operating characteristics of the gas compressor, including enclosure exhaust fan status,[89] compressor inlet status[90] and compressor discharge pressure.[91]

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[79] Ex. 1055 (*Clancy*) [0009].
[80] Ex. 1055 (*Clancy*) [0009].
[81] Ex. 1055 (*Clancy*) [0009].
[82] Ex. 1055 (*Clancy*) [0028] – [0031].
[83] Ex. 1055 (*Clancy*) [0032], [0046].
[84] Ex. 1055 (*Clancy*) [0033], [0038], claim 9.
[85] Ex. 1055 (*Clancy*) [0037], [0041].
[86] Ex. 1055 (*Clancy*) [0031].
[87] Ex. 1055 (*Clancy*) [0031].
[88] Ex. 1055 (*Clancy*) [0042], [0044].
[89] Ex. 1055 (*Clancy*) [0039].
[90] Ex. 1055 (*Clancy*) [0038].
[91] Ex. 1055 (*Clancy*) [0038].

103. *Clancy* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

C. STATUS AND OVERVIEW OF TROBAUGH (EX. 1056)

104. *Trobaugh* is an International Publication of a PCT Patent Application, publication No. WO 2016/044509. *Trobaugh* was filed on September 17, 2015, and published on March 24, 2016, and is therefore prior art to the ’992 Patent.

105. *Trobaugh* discloses “A natural gas fueling system supplies methane gas to an engine and includes a filter assembly. The filter assembly includes a gas inlet configured to receive inlet gas and a methane permeable filter configured to separate methane gas and first contaminant gases from the inlet gas.”[92] *Trobaugh* teaches monitoring the status of the filter assembly (e.g., is working improperly and/or is being repaired or serviced),[93] and engage a bypass assembly to bypass the filter.[94] *Trobaugh* teaches monitoring the status of the bypass assembly, such as using sensors.[95]

106. *Trobaugh* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

D. STATUS AND OVERVIEW OF *TEETS* (EX. 1057)

[92] Ex. 1056(*Trobaugh*), Abstract.
[93] Ex. 1056(*Trobaugh*) [0031], [0032].
[94] Ex. 1056(*Trobaugh*) [0031], [0032].
[95] Ex. 1056(*Trobaugh*) [0031], [0032]

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107. *Teets* is a publication of European Patent Application 03090245.6 (publication no. EP 1 380 740). Teets was filed December 3, 1997, and published January 14, 2004, and is therefore prior art to the ’992 Patent.

108. *Teets* discloses a “Fuel supply system for an electricity generating system.”[96] *Teets* further teaches “a reliable electricity generating system that can operate intermittently with consistent reliability.”[97] *Teets* discloses that bearings support the drive shaft for a compressor, [98] and that a lubrication oil pump lubricates these bearings.[99] *Teets* discloses monitoring the oil pump's status, including whether it is running or has failed, using sensors.[100]

109. *Teets* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

E. STATUS AND OVERVIEW OF *BROUSSARD079* (EX. 1024)

110. *Broussard079* is a U.S. Patent Application Publication that was published on May 22, 2014. *Broussard079* is therefore prior art to the ’992 Patent.

111. *Broussard079* discloses a “system for hydraulically fracturing an underground formation in an oil or gas well to extract oil or gas from the formation,” and that the system “includes a plurality of electric pumps” for pressurizing fluid for

[96] Ex. 1057 (*Teets*) at (054), (57).
[97] Ex. 1057 (*Teets*) [0009].
[98] Ex. 1057 (*Teets*) [0028].
[99] Ex. 1057 (*Teets*) [0057], [0058], [0061].
[100] Ex. 1057 (*Teets*) [0058], [0061].

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fracturing operations.[101] *Broussard079* further discloses specific power output and torque values associated with the electric pumps used in its system, stating that "some pumps 10 can have a maximum continuous power output of about 1500 BHP, 1750 BHP, or more, and a maximum continuous torque of about 8750 lb-ft or more."[102]

112. *Broussard079* further discloses a "natural gas powered generator, which can be a turbine generator," and that "the generators can be powered by liquefied natural gas."[103]

113. *Broussard079* further discloses a "[p]ump control and data monitoring equipment" that "can be mounted on a control vehicle 42, and connected to the pumps 10, electric motors 14, blenders 34, and other down hole sensors and tools (not shown) to provide information to an operator, and to allow the operator to control different parameters of the fracturing operation."[104] *Broussard079* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

F. MOTIVATION TO COMBINE

[101] Ex. 1024 (*Broussard079*), Abstract.
[102] Ex. 1024(*Broussard079*), [0020].
[103] Ex. 1024 (*Broussard079*), [0009], [0024].
[104] Ex. 1024 (Broussard079), [0027].

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114. As discussed in my first declaration, a POSITA would have been motivated to combine *Coli* with *Birch* and *Rusnak*.[105] A POSITA would have been motivated to further combine the *Coli-Birch-Rusnak* system with *Armstrong, Clancy, Trobaugh* and *Teets*. *Coli* discloses a hydraulic fracturing system that uses electrically powered pumps to pressurize and pump hydraulic fracturing fluid, powered by a gas turbine generator.[106] *Coli* discloses a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation."[107] In implementing the *Coli-Birch-Rusnak* system, a POSITA would have been motivated to look to additional references that specify monitoring and control of particular characteristics associated with the gas turbine generator, and the supply of natural gas to the turbine generator, such as *Armstrong, Clancy, Trobaugh*, and *Teets*, to ensure that the generator(s) operate reliably and with properly conditioned gas. Incorporating gas conditioning equipment with the monitoring and control characteristics defined by *Armstrong, Clancy, Trobaugh*, and *Teets* would have involved the mere application of a known technique (i.e., monitoring and control of particular operating parameters, as taught by *Armstrong, Clancy, Trobaugh*, and *Teets*) to a known system (i.e., the *Coli-Birch-Rusnak* hydraulic fracturing system using natural gas generators) ready for improvement.

[105] See Ex. 1003 (*Original Declaration*), ¶¶ 126-145.
[106] Ex. 1004 (*Coli*), Abstract.
[107] Ex. 1004 (*Coli*), [0072].

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115. *Coli* discloses the use of "[o]ne or more natural gas-powered turbine generators 30" for providing electric power to several fracturing modules, and that the turbine generators can be driven by "natural gas."[108] *Armstrong* discloses a skid for conditioning natural gas supplied to a gas turbine generator.[109] *Armstrong* teaches that conditioning includes "removing unwanted elements or undesirable compounds in the fuel stream (e.g., solid particulates, water, heavier hydrocarbons that can condense in fuel lines, hydrogen sulfide and other halogenated compounds, siloxanes, and the like)."[110] *Armstrong* further discloses that, when these unwanted elements or undesirable compounds are not removed, both short-term and long-term damage can occur to the turbine and other components downstream of the skid.[111] *Armstrong* discloses conditioning the gas using several known filter components including a "strainer 2 to remove large particulates, including rust, weld slag, filings, and other debris,"[112] and "[a]n inlet liquid separator and filter tank 10 [that] removes (i.e., knocks out) at least a portion of the liquid components from the incoming gas, and also filters out particulates, typically in the 1 to 10 micron size range,"[113] and a "a coalescer filter … for liquid separation".[114]

[108] Ex. 1004 (*Coli*), [0010], [0038], [0040].
[109] Ex. 1054 (*Armstrong*) 8:18-20, 8:13-17, 9:1-5.
[110] Ex. 1054 (*Armstrong*) 8:13-17.
[111] Ex. 1054 (*Armstrong*) 8:9-12.
[112] Ex. 1054 (*Armstrong*) 9:10-12.
[113] Ex. 1054 (*Armstrong*) 9:20-22.
[114] Ex. 1054 (*Armstrong*) 9:22-23.

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116. *Armstrong* further teaches using a "compressor 20 [that] boosts the fuel pressure to a predetermined level suitable for engine operation."[115] *Armstrong* continues to disclose that "most engine combustion systems [including gas turbine engines] react fuel and air at elevated pressures. Thus, the fuel gas must be compressed to a higher pressure to be admitted into the engine for combustion."[116]

117. A POSITA would have been motivated to incorporate the teachings of *Armstrong* to condition the gas, provide fuel at a pressure level suitable for engine operation and remove undesirable elements and unwanted compounds to help prevent damage to the turbine. *Armstrong* expressly teaches using its techniques to condition natural gas "from oil and gas wells"… in an engine to generate electricity and heat."[117] Using *Armstrong's* techniques, including monitoring and control of specific operating parameters, to condition natural gas (including filtering, liquid separation, compression, etc.) to power turbine generators, as described by *Coli* and *Armstrong*, would have involved the mere application of a known technique (i.e., the monitoring and control techniques of gas conditioning taught by *Armstrong*) to a known system (i.e., *Coli*'s overall control system) ready for improvement. Such a combination would further *Coli's* goal of a "control center 40" that includes

[115] Ex. 1054 (*Armstrong*) 10:15-20.
[116] Ex. 1054 (*Armstrong*) 1:20-23.
[117] Ex. 1054 (*Armstrong*) 1:10-12.

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"controls and computer monitoring for the entire fracturing operation."[118] A POSITA would, therefore, have been motivated to combine the references and would have a reasonable expectation of success in the combination. This is further consistent with Dr. Nikolaou's testimony that "[i]f one used a gas filtration system, would one – would it make sense for one to monitor the operating characteristic of the system. My answer is, yes, it would make sense to monitor these characteristics of that system."[119] It is additionally consistent with Dr. Nikolaou's testimony that "[i]f one used the gas filtration system, would they have available the technology and would there be an incentive to use that technology for monitoring that system? Yes."[120]

118. Similar to *Armstrong*, *Clancy* discloses a "natural gas compressor" that supplies fuel to "an engine [that] generates power".[121] *Clancy* discloses that its system "is controllable by a distributed control system" that monitors and controls multiple operating parameters.[122] Also similar to *Armstrong, Clancy* discloses using a liquid separator and a compressor as part of the gas compressor system.[123] As with

[118] Ex. 1004 (*Coli*), [0072].
[119] Ex. 1053 (Nikolaou Dep. Tr.), 43:10-22.
[120] Ex. 1053 (Nikolaou Dep. Tr.), 44:16-19.
[121] Ex. 1055 (*Clancy*) [0027].
[122] Ex. 1055 (*Clancy*) [0003], [0028], [0033], [0037] – [0039], [0041], [0067], [0072], [0074], [0076].
[123] Ex. 1055 (*Clancy*) [0032], [0046], [0027].

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Armstrong,[124] *Clancy* discloses a "shelter structure" or "enclosure".[125] This enclosure contains louvres that operate to bring in fresh air into the enclosure and exhaust (discharge) air from the enclosure.[126] These louvers are linked to *Clancy's* overall control system (DCS), discussed below.[127] *Clancy* teaches that the design of these louvers, along with exhaust fan 37, is designed "to minimize the effects of sound pollution which is generated from moving high volumes of air."[128] Such design features would further *Coli's* goal of producing "no greater than about 80 decibels of sound … which meets OSHA requirements for noise emissions."[129]

119. Further, similar to the disclosure of *Coli*, *Clancy* teaches "[t]hrough the use of an integrated control system the present invention achieves a precise control of the overall operation of the system, which would be impossible to achieve through manual manipulation."[130] A POSITA would have been motivated to incorporate *Clancy's* teachings of monitoring and control of "the overall operation of the system" of the gas compressor with *Coli's* "control center 40" that includes "controls

[124] See, e.g., Ex. 1054 (*Armstrong*) 20:20-23 teaching that "the fuel-conditioning skids 60 ', 60' ', 60'" may include weatherproof enclosures for outdoor use. The fuel-conditioning skids 60 ', 60' ', 60'" may include weatherproof enclosures for outdoor use."
[125] Ex. 1055 (*Clancy*) [0040], [0071].
[126] Ex. 1055 (*Clancy*) [0039], [0040], claim 12.
[127] Ex. 1055 (*Clancy*)
[128] Ex. 1055 (*Clancy*) [0039], see also [0040].
[129] Ex. 1004 (*Coli*) [0080].
[130] Ex. 1055 (*Clancy*) [0008].

and computer monitoring for the entire fracturing operation."[131] Such a combination would have involved the mere application of a known technique (i.e., the monitoring and control of a gas compressor as taught by *Clancy*) to a known system (i.e., the *Coli/Armstrong* overall control system) ready for improvement. Such a combination would further *Coli's* goal of a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation."[132] A POSITA would, therefore, have been motivated to combine the references and would have a reasonable expectation of success in the combination.

120. Like *Armstrong* and *Clancy, Trobaugh* discloses "[a] natural gas fueling system [that] supplies methane gas to an engine".[133] Also like *Armstrong*, *Trobaugh* discloses the use of an "inlet filter".[134] *Trobaugh* also discloses a "filter bypass assembly which includes a bypass conduit or line 106 and a bypass valve 108."[135] *Trobaugh* teaches that the "[b]ypass valve 108 and sensors 105, 107, 109 may be operably coupled to a computer or other device (not shown) for receiving information from sensors 105, 107, 109."[136] *Trobaugh* discloses that "when engine 150 is continuously operated, it is necessary to provide an uninterrupted flow of

[131] Ex. 1004 (*Coli*), [0072].
[132] Ex. 1004 (*Coli*), [0072].
[133] Ex. 1056(*Trobaugh*), Abstract.
[134] Ex. 1056(*Trobaugh*), Abstract.
[135] Ex. 1056(*Trobaugh*), [0031].
[136] Ex. 1056(*Trobaugh*), [0031].

natural gas to engine 150 to maintain such operation. However, when filter assembly 120 is not working properly and/or is being serviced, the filter bypass assembly may be activated by opening filter bypass valve 108 to provide unfiltered natural gas fuel to engine 150 through bypass conduit 106 to continue operation of engine 150, rather than stopping engine 150 while filter assembly 120 is being serviced. As such, the filter bypass assembly allows engine 150 to maintain a continuous operation even when filter assembly 120 is not operating."[137] A POSITA would have recognized the benefits of bypassing the filter assembly "when filter assembly 120 is not working properly and/or is being serviced," to "allow[] engine 150 to maintain a continuous operation when filter assembly 120 is not operating" as beneficial to improving the uptime of the engine (turbine generator) and allowing fracturing operations in the *Coli/Armstrong/Clancy* system to continue without interruption due to a filter not in operation. This would avoid unnecessary stoppages of the fracturing system and increase the system's overall availability. As *Coli* discloses, in hydraulic fracturing systems, "downhole hydrodynamics are dependent upon constant flow (rate and pressure) of the delivered fluids, and that there should not be any interruption in fluid flow during delivery to the well bore if the fracture is to propagate as desired."[138] A POSITA would have been motivated, based on this express teaching of *Coli*, to

[137] Ex. 1056(*Trobaugh*) [0032], see also [0031].
[138] Ex. 1004 (*Coli*) [0036].

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ensure that electricity is continuously available to the electric motor driven fracturing pumps. To ensure continuous delivery of electricity, a continuous supply of fuel to the turbines would be required. Such a combination would have involved the mere application of a known technique (i.e., the monitoring and control of a gas compressor filter bypass assembly) to a known system (i.e., the *Coli/Armstrong/Clancy* overall control system) ready for improvement. Such a combination would further *Coli's* goal of a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation."[139] A POSITA would, therefore, have been motivated to combine the references and would have a reasonable expectation of success in the combination.

121. *Teets* expands on the teachings of *Armstrong, Clancy, and Trobaugh* regarding a "fuel supply system for an electricity generating system,"[140] that includes a compressor. *Teets* teaches, as was known, that the drive shaft for a compressor is supported by bearings, [141] and that a lubrication oil pump lubricates these bearings.[142] *Teets* discloses monitoring the oil pump's status, including whether it is running or has failed, using sensors.[143] A POSITA would have been motivated to incorporate monitoring of an oil pump used to lubricate bearings of various equipment, including

[139] Ex. 1004 (*Coli*), [0072].
[140] Ex. 1057 (*Teets*) (54), (57), Abstract.
[141] Ex. 1057 (*Teets*) [0028].
[142] Ex. 1057 (*Teets*) [0017], [0057], [0058], [0061].
[143] Ex. 1057 (*Teets*) [0017], [0058], [0061].

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the compressor, to further *Coli's* goal of a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation."[144] Further, such a combination would have involved the mere application of a known technique (i.e., the monitoring and control of a lubricating oil pump) to a known system (i.e., the *Coli/Armstrong/Clancy/Trobaugh* overall control system) ready for improvement. A POSITA would, therefore, have been motivated to combine the references and would have a reasonable expectation of success in the combination.

122. A POSITA would have been motivated to further combine the *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets* system with *Broussard079*. *Coli* discloses a hydraulic fracturing system that uses electrically-powered pumps for pressurizing and pumping hydraulic fracturing fluid.[145] *Broussard079* discloses similar systems that further specify the particular fuels used in the turbine generators.[146]

123. *Coli* discloses the use of "[o]ne or more natural gas-powered turbine generators 30" for providing electric power to several fracturing modules, and that one way to drive the turbine generators is with "liquid fuels."[147] *Broussard079* elaborates on this known element and discloses a "natural gas powered generator,

[144] Ex. 1004 (*Coli*), [0072].
[145] Ex. 1004 (*Coli*), Abstract.
[146] See Ex. 1024 (*Broussard079*), [0020].
[147] Ex. 1004 (*Coli*), [0010], [0038], [0040].

which can be a turbine generator," and that "the generators can be powered by liquefied natural gas."[148] It would have been obvious to use "liquefied natural gas" for powering turbine generators, as taught by *Broussard079*, in view of *Coli*'s disclosure regarding the use of liquid fuels. Using liquefied natural gas to power turbine generators, as described by *Broussard079*, would have involved the mere application of a known technique (i.e., using liquefied natural gas to power turbine generators, as taught by *Broussard079*) to a known system (i.e., *Coli*'s natural gas-powered turbine generators) ready for improvement. Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

124. Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so. Additional motivations for each reference are discussed below.

G. CLAIM 41

125. The *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets* combination renders Claim 41 obvious. *Coli, Birck, Rusnack, Armstrong, Clancy* and/or *Broussard079* discloses each and every limitation of 42. Additionally, Patent Owner's expert Dr. Nikolaou testified that the "point of novelty" in the '992 Patent

[148] Ex. 1024 (*Broussard079*), [0009], [0024].

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is that it describes a "centralized system for monitoring fracturing operations," which is disclosed in *Coli*.[149]

126. Substitute Claim 41incorporate the subject matter of original claims 1 and 8, respectively, addressed in my Original Declaration, and the claims add language regarding a natural gas generators, a gas filtration skid and monitoring and controlling the gas filtration skid, and a gas compressor and monitoring operating characteristics of the gas compressor. These additional limitations are set out in Claim elements [41e]–[41n]. Claim Elements [41e] – [41n] are addressed below. Claim elements [41p] – [41d] and [41o] – [41q] would have been obvious over the combination of *Coli, Birch,* and *Rusnak* as described in my original declaration.[150]

1. [41p] – [41d]

127. Limitations [41p] – 41[d would have been obvious over the combination of *Coli, Birch* and *Rusnak* for the same reasons as those described regarding limitations 1[p] – 1[d] discussed in Sections XI.A.2.a) – XI.A.2.d) of my original declaration, and incorporated herein by reference.

2. [41e] & [41f]: "the system further comprising a generator electrically connected to the electric pump to provide power to the electric pump, wherein the generator is a natural gas generator,"

[149] Ex. 1053 (Nikolaou Dep. Tr.), 8:8-9:9.
[150] Ex. 1003 (*Original Declaration*) XI.A.1, XI.A.2.a, XI.A.2.d.

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128. As discussed regarding Claim 2 in Section XI.A.3 of my original declaration, and incorporated herein by reference, *Coli* discloses this limitation. For example, *Coli* discloses the use of "[o]ne or more natural gas-powered turbine generators 30" for providing electric power to several fracturing modules, and that the turbine generators can be driven by "natural gas."[151] The natural gas may be "either supplied to the site or produced on-site" and "can be used to drive a dedicated source of electrical power, such as a turbine generator, for hydrocarbon-producing wellbore completions."[152] *Coli* further discloses that each "fracturing module 20 is operatively associated with turbine generator 30 to receive electric power therefrom."[153]

129. Figure 2 of *Coli* illustrates the plurality of generators:

[151] Ex. 1004 (*Coli*), [0010], [0038], [0040].
[152] Ex. 1004 (*Coli*), [0036].
[153] Ex. 1004 (*Coli*) [0040], *see also, e.g.*, [0043].

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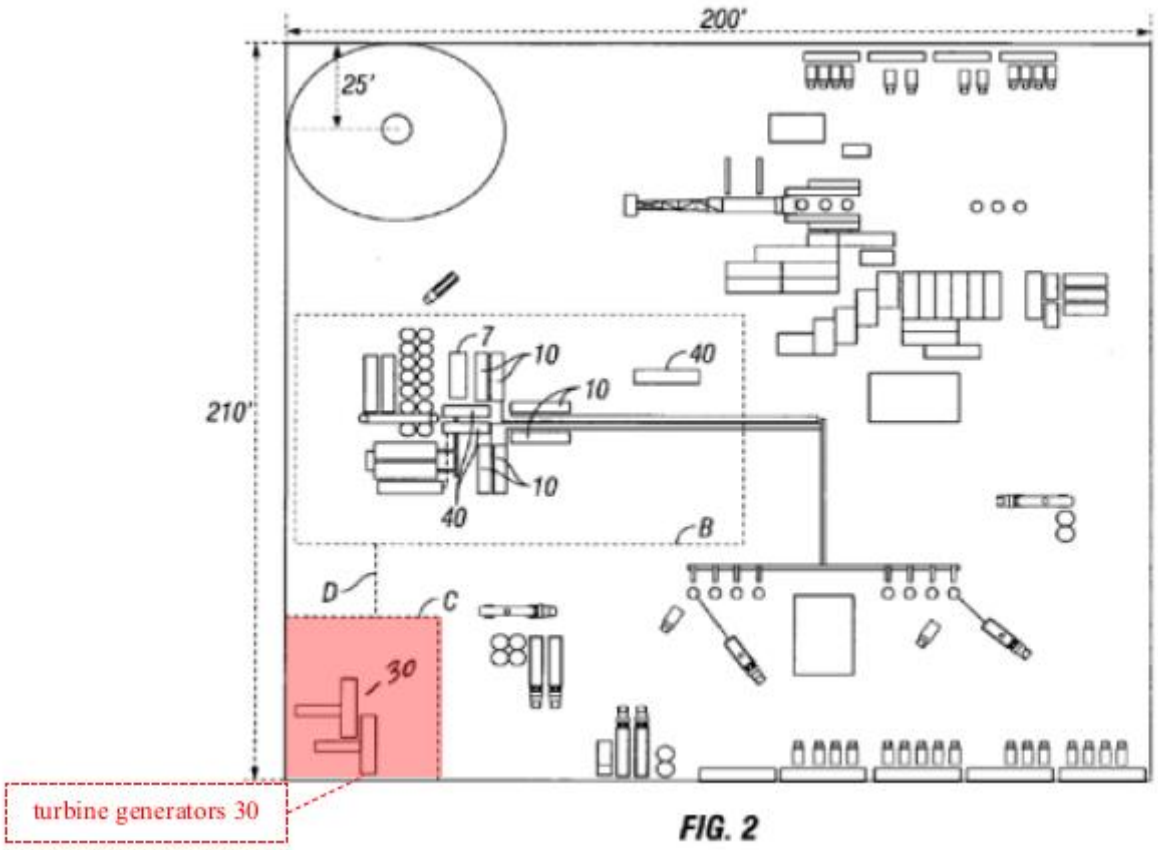


FIG. 2

Ex. 1004 (*Coli*), Fig. 2 (annotated).

130. Accordingly, *Coli* discloses limitations [41e] & [41f] and the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh and Teets* renders Limitations [41e] & [41f] obvious.

3. [41g]: "the system further comprising a gas filtration skid,"

131. *Armstrong* discloses a gas filtration skid for use in conditioning gas for a natural gas turbine generator, such as the one disclosed in *Coli*. For example, *Armstrong* discloses "[a] fuel-conditioning skid 60', illustrated schematically in Fig. 3, conditions the fuel as described above and increases the delivery pressure of the

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fuel to a level suited to the particular engine to which the fuel skid is supplying fuel."[154]

132. *Armstrong* further teaches that the fuel "can be used in an engine to generate electricity and heat," and can be "combusted either in a gas turbine engine (Brayton cycle), an internal combustion engine (Otto cycle), or other prime-mover engines (e.g., Sterling engines). Any of these engines can be connected to an electric generator to generate electricity or a shaft to provide shaft power for a variety of applications. The electric generator would produce electricity, which could either be exported to the electric utility grid (grid-parallel) or used locally to power various on-site electrical loads."[155]

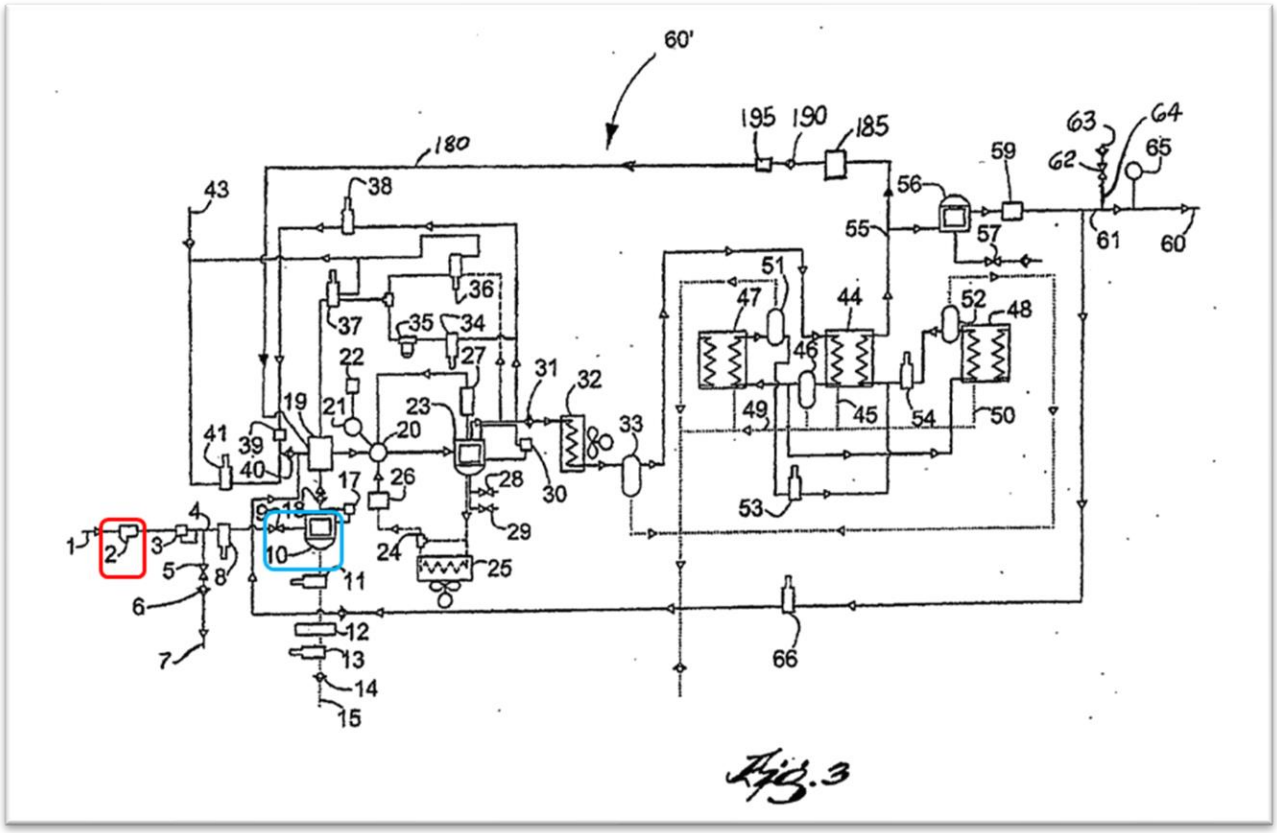
133. *Armstrong* makes it clear that the fuels include *"gas"*, like the on-site produced gas disclosed by *Coli*,[156] as *Armstrong* discloses using the conditioning skid to filter "[h]ydrocarbon-based fuels [which] are available from a variety of sources including biogas from landfills, wastewater treatment plants, agricultural and other digesters, light hydrocarbon gases from oil and gas wells, and various heavier hydrocarbon gases from processes such as refinery processing."[157] *Armstrong* further teaches that these sources of gas "contain constituents and

[154] Ex. 1054 (*Armstrong*) 8:18-20.
[155] Ex. 1054 (*Armstrong*) 1:11-19.
[156] Ex. 1004 (*Coli*) [0036].
[157] Ex. 1054 (*Armstrong*) 1:8-11, emphasis added.

contaminants that can cause problems in the fuel system, and/or the engine. In addition, most engine combustion systems react fuel and air at elevated pressures. Thus, the fuel gas must be compressed to a higher pressure to be admitted into the engine for combustion."[158] A POSITA would have been motivated to use the teachings of *Armstrong* in the system of *Coli* to remove these contaminants before the fuel is delivered to *Coli's* gas turbines, and to deliver the fuels at the elevated pressure required. *Coli* teaches the use of gas turbines fueled by on-site gas production. *Armstrong* teaches techniques to condition and filter the on-site produced gas for delivery to the turbine generators of *Coli.* A POSITA would have had a reasonable expectation of success in the combination as it involves the mere application of known techniques (i.e., gas filtration and conditioning of produced gas taught by *Armstrong*) to a known system (e.g., a hydraulic fracturing system, including gas turbines fueled by produced gas, with a control system for all components of the system) ready for improvement (i.e., to condition and filter the produced gas, remove contaminants, and monitor the complete fracturing system).

[158] Ex. 1054 (*Armstrong*) 1:20-23.

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Ex. 1054 (Armstrong) Fig. 3.

134. Further, Patent Owner's expert Dr. Nikolaou testified that a gas filtration skid "is a system that is used to remove impurities from natural gas that will be fed into . . . a gas generator . . . to make sure that the gas is suitable . . . to be used as a fuel in the generator" and provided reasons a POSITA would use a gas filtration skid in hydraulic fracturing to remove impurities and make sure the gas is suitable to be used as a fuel.[159] He also testified that a gas filtration was a known and available technology by the time of the '992 Patent.[160]

[159] Ex. 1053 (Nikolaou Dep. Tr.), 9:19-10:14, 12:21-13:12.
[160] Ex. 1053 (Nikolaou Dep. Tr.), 10:20-11:2, 11:11-17, 12:13-20.

135. *Armstrong* discloses that the conditioning skid comprises an "inlet strainer 2 [annotated in red above] to remove large particulates, including rust, weld slag, filings, and other debris,"[161] as well as an "inlet liquid separator and filter tank 10 [annotated in blue above] [that] removes (i.e., knocks out) at least a portion of the liquid components from the incoming gas, and also filters out particulates."[162] *Armstrong* also discloses the use of a "coalescer filter … for liquid separation if desired,"[163] and a "final filter" used to capture carbon particulates.[164] Accordingly, *Armstrong's* "conditioning skid" is a "gas filtration skid".

136. Therefore, Limitation [41g] is disclosed by *Anderson,* and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders Limitation [41g] obvious.

4. [41h]: "wherein the centralized control unit is further configured to monitor operating characteristics of the gas filtration skid;"

137. *Coli* discloses a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation."[165] Included in *Coli*'s fracturing operation are "[o]ne or more natural gas-powered turbine generators 30"

[161] Ex. 1054 (*Armstrong*) 9:6-12.
[162] Ex. 1054 (*Armstrong*) 9:20-23, claim 2, claim 27.
[163] Ex. 1054 (*Armstrong*) 9:22-23.
[164] Ex. 1054 (*Armstrong*) 15:17-21.
[165] Ex. 1004 (*Coli*), [0072].

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that generate electric power for use in the fracturing operation."[166] As discussed above in Section XIII.F, and incorporated herein by reference, both *Coli* and *Armstrong* teach powering turbine generators with produced gas (i.e., produced from an oil and gas well). *Armstrong* teaches filtering the produced gas, and, as discussed in the sections below, monitoring certain aspects of the gas filtration (conditioning) skid disclosed by *Armstrong*. Accordingly, it would have been obvious for *Coli*'s control center 40 to monitor and control operating characteristics of Armstrong's fuel conditioning skid (gas filtration skid). The other references that I discuss below provide details on monitoring specific operating characteristics of the gas filtration skid. It would have been obvious to a POSITA to monitor these operating characteristics in view of *Coli*'s disclosure of centralized monitoring for "the entire fracturing operation" and because it was known in the prior art and/or obvious to monitor these operating characteristics, as shown below and as conceded by Dr. Nikolaou.

138. For the reasons provided in the subsections below, the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders Limitation [41h] obvious.

5. [41i]: "wherein the monitored operating characteristics of the gas filtration skid include at least…

[166] Ex. 1004 (*Coli*), [0038], [0040].

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a) "water separator status,"

139. *Armstrong* discloses this limitation. *Armstrong* discloses that "[a]n inlet separator and filter tank 10 removes (i.e., knocks out) at least a portion of the liquid components from the incoming gas, and also filters out particulates, typically in the 1 to 10 micron size range."[167] For example, *Armstrong* discloses "conditioning involves … removing unwanted elements or undesirable compounds in the fuel stream (e.g., solid particulates, water, heavier hydrocarbons that can condense in fuel lines…"[168] and that these heavier compounds (liquid components) are removed in liquid separators.[169]

140. This is consistent with Patent Owner's expert Dr. Nikolaou's testimony that a water separator in 2015 as used in hydraulic fracturing was "a general piece of equipment that would be applied in any application that required removing moisture from a stream that would be fed to a downstream piece of equipment that would require a gas – a dry – a dry stream to bed fed."[170]

141. *Armstrong* also teaches monitoring the status (e.g., liquid level) of the water separator. *Armstrong* discloses "[a] liquid drain arrangement consisting of two solenoid valves 11, 13 and a liquid reservoir 12 can be used to drain liquid from the

[167] Ex. 1054 (*Armstrong*) 9:20-22.
[168] Ex. 1054 (*Armstrong*) 8:13-17.
[169] Ex. 1054 (*Armstrong*) 13:15-21, 14:19-23.
[170] Ex. 1053 (Nikolaou Dep. Tr.), 21:14-22.

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sub-atmospheric separator tank 10."[171] *Armstrong* further discloses that "[a] float switch and/or a pressure switch 17 may be used to send an alarm or stop signal to the FCS [fuel conditioning skid] control to reduce the likelihood of liquid slipping past the separator 10 in the event that the drain system fails to remove sufficient moisture from the separator tank 10."[172] A POSITA would have been motivated to monitor the status of the water separator to help ensure that the separator sufficiently removes moisture or liquid, based on *Armstrong*'s express teachings. When combined with the teaching of *Coli* to "monitor and control the entire fracturing operation", it would have been obvious to monitor, and perform the control function, of the liquid level in the separator using *Coli's* central monitoring and control.

142. This is consistent with Patent Owner's expert Dr. Nikolaou testimony that monitoring the water separator status would include monitoring the liquid level of the water separator[173]:

> Q. If there were a system, a potentially infringing system, that monitored the liquid level of the water separator, would that satisfy this limitation 41(a) requiring monitoring the water separator status?
>
> A. So water separator status is left as such. Namely, it is a general description that refers to what is the status of the water separator. And that could be any – that would include any variables that

[171] Ex. 1054 (*Armstrong*) 9:24-10:2.
[172] Ex. 1054 (*Armstrong*) 10:11-14.
[173] Ex. 1053 (Nikolaou Dep. Tr.), 20:5-22; *see also* Ex. 1053 (Nikolaou Dep. Tr.), 15:9-16:4.

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would be appropriate for characterizing the status of the water separator.

Q. Did that include the liquid level of the water separator?

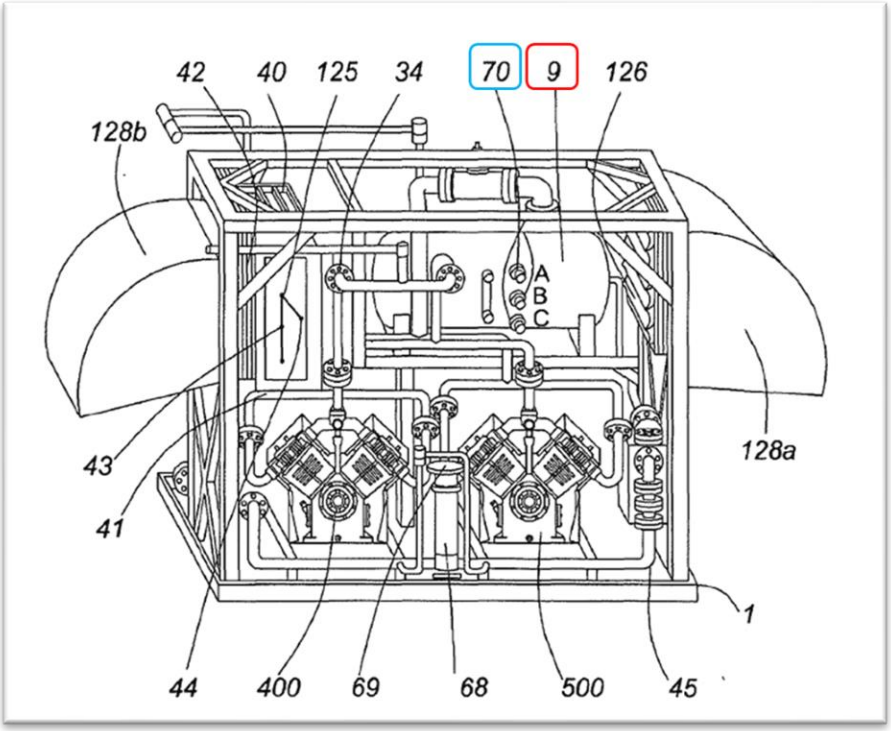
A. Yeah, a POSITA would understand that as one possible thing to monitor.

143. *Clancy* also discloses monitoring water separator status. *Clancy* discloses a water separator: "Once past the second 311 valve the flow proceeds into a separator (9) [annotated in red], which is preferably a pressure vessel, see FIG. 6a, which is used to separate the gas and liquids in the flow. The liquids are directed to the drain (63) in the base of the pressure vessel (9) through the use of gravity and the gas is allowed to escape through the top of the separator."[174] *Clancy* discloses that the liquid separated in the separator includes water.[175] *Clancy* then teaches monitoring the level of the separator (separator status) through a series of level switches (annotated in blue): "The middle-level switch (70b) is the initiating action for starting the pump, the lowest-level switch (70c) is used to turn the pump off. The highest-level switch (70a) is used for initiating an ESD of the system in the event of a high level situation."[176] When combined with the teaching of *Coli* to "monitor and control the entire fracturing operation", it would have been obvious to monitor, and perform the control function, of the liquid level in the separator using *Coli's* central

[174] Ex. 1055 (*Clancy*) [0032].
[175] *See* Ex. 1055 (*Clancy*) [0044] – [0048],
[176] Ex. 1055 (*Clancy*) [0046].

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monitoring and control. A POSITA would have been motivated to monitor the water separator status in order to perform the control function as taught by the *Coli-Clancy* combination and to ensure that the water separator is functioning properly.



Ex. 1055 (*Clancy*) Fig. 6A (annotated)

144. This is additionally consistent with Dr. Nikolaou's testimony regarding a water separator and monitoring a water separator, and that monitoring water separator status was a known and available technology.[177] Patent Owner's expert Dr. Nikolaou also testified as to reasons a POSITA would be motivated to monitor water separator status.[178] I agree with the motivations stated by Dr. Nikolaou.

[177] Ex. 1053 (Nikolaou Dep. Tr.), 20:5-22, 21:14-22, 22:20-23:2.
[178] Ex. 1053 (Nikolaou Dep. Tr.), 21:1-13.

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145. Accordingly, *Armstrong* and *Clancy* each disclose this limitation, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

b) "particulate filter status"

146. As discussed above regarding limitation [41g], and incorporated herein by reference, *Armstrong* teaches several examples of particulate filters. Further, *Armstrong* discloses monitoring filter status, including filter fouling levels.[179] For instance, *Armstrong* discloses that a "pressure switch 30 could also be used to determine and monitor the extent of coalescer filter fouling."[180] Regarding filters, "fouling" refers to the deposition of filtered particles on the filter surface.[181] As fouling increases, the pressure drop across the filter increases. Thus, *Armstrong* discloses using a pressure switch to detect the level of fouling. A POSITA would have understood *Armstrong's* teaching of monitoring the extent of filter fouling to apply to any filter, as any filter would experience fouling as it filters undesirable materials from the fluid stream. Accordingly, *Armstrong* teaches monitoring particulate filter status.

[179] As used in *Armstrong*, "filter fouling" is synonymous with "filter plugging".
[180] See, e.g., Ex. 1054 (*Armstrong*) 12:4-6.
[181] See, e.g., Ex. 1070 (Merriam Webster), https://web.archive.org/web/20111018124705/http://www.merriam-webster.com/dictionary/fouling

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147. This is consistent with Patent Owner's expert Dr. Nikolaou's testimony that the extent of filter fouling would be an example of particulate filter status, and that filter fouling refers to "deposit" on surfaces that degrade operation.[182] This is also consistent with Dr. Nikolaou's testimony that monitoring particulate filter status was known and available by the time of the '992 Patent.[183]

148. A POSITA would have been motivated to monitor particulate filter status to determine if the filter needs replacement, maintenance, or repair, and to ensure that the filter is working properly to remove particulates.

149. Accordingly, the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh and Teets* renders this limitation obvious.

c) "gas pressures"

150. *Armstrong* teaches monitoring gas pressures. For example, *Armstrong* discloses that a "pressure gauge may be attached to the FCS 60' downstream of the pressure regulator 3 to indicate the gas pressure."[184] *Armstrong* further discloses that "electric motor 21 [driving a gas compressor] is driven by a variable frequency drive (VFD) 22, sometimes also referred to as a variable speed drive. The VFD 22 varies

[182] Ex. 1053 (Nikolaou Dep. Tr.), 23:7-24:19.
[183] Ex. 1053 (Nikolaou Dep. Tr.), 25:11-18.
[184] Ex. 1054 (*Armstrong*) 9:15-16.

the motor speed in response to **a *measured parameter, such as a fuel pressure***, to maintain the parameter (fuel delivery pressure) within a desired range."[185]

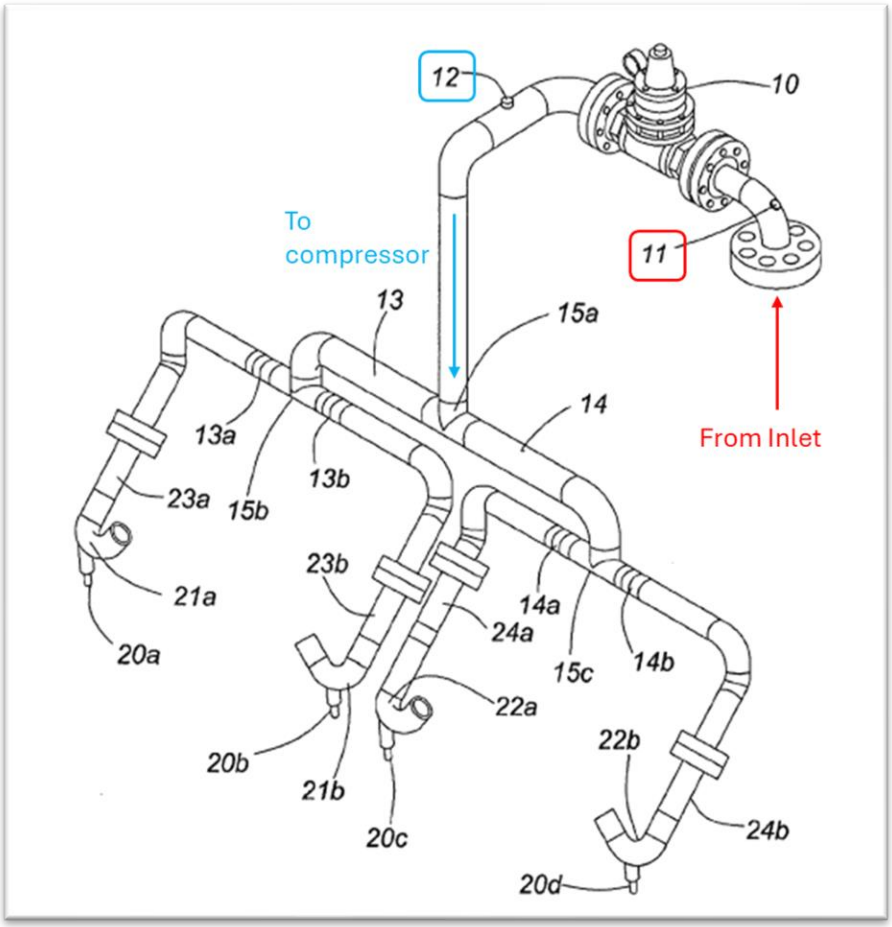
151. In light of *Armstrong*'s express teachings, a POSITA would have been motivated to monitor gas pressure to ensure that the pressure is within the appropriate range. This is important to ensure proper function of the gas filtration skid and avoid, for example, over-pressuring the system, which may cause damage to equipment.

152. *Clancy* also discloses monitoring gas pressures. For example, *Clancy* discloses "[t]wo pressure sensors (11) and (12) are located upstream and downstream respectively of the first back-pressure valve (10). The sensor (11) on the upstream side sends a pressure value to the DCS [digital control system, in the combination, *Coli's* central monitoring and control] which is used to determine whether the compressors need to speed up or slow down to maintain the targeted pressure. Additionally, the pressure can be trended to determine performance and activate the ESD of the system in the event of a high pressure or low pressure. Also, alarm set points can be set to alert the operator to the potential of an impending shut down allowing for alternative measures to be taken."[186]

[185] Ex. 1054 (*Armstrong*) 10:21-24 emphasis added; see also 19:10-25.
[186] Ex. 1055 (*Clancy*) [0033].

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153. In light of *Clancy*'s express teachings, a POSITA would have been motivated to monitor gas pressure of the gas filtration skid, to determine whether adjustments to other parameters of the system need to be made to keep pressure within the appropriate range, such as speeding up or slowing down the compressors to maintain the appropriate pressure.



Ex. 1055 (*Clancy*) Fig. 2 (annotated)

154. Patent Owner's expert Dr. Nikolaou testified as to why a POSITA would be motivated to monitor gas pressure of a gas filtration skid: "[t]o make sure

that pressure is within safe bounds, safe operation, to prevent damage of the equipment, to maintain good performance, to make sure, again, overall that the operation proceeds as intended."[187] I agree with the motivations stated by Dr. Nikolaou. Dr. Nikolaou also testified that it was known and the technology was available to monitor gas pressure of a gas filtration skid.[188]

155. Accordingly, *Armstrong* and *Clancy* each disclose monitoring gas pressure, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

d) "gas temperatures,"

156. *Armstrong* discloses monitoring gas temperatures. For example, *Armstrong* discloses that "fuel temperature sensors and/or switches measure and ensure proper gas conditions from the compressor."[189]

157. *Clancy* also discloses monitoring gas temperatures. *Clancy* discloses that "gas flows are passed by first and second temperature sensors (31) and (32) for monitoring the discharge gas flow temperature, see FIG. 4. The temperature can be used to alert the operator of faulty valves or other anomalies associated with the

[187] Ex. 1053 (Nikolaou Dep. Tr.), 34:2-10.
[188] Ex. 1053 (Nikolaou Dep. Tr.), 34:21-35:5, 35:17-36:7, 39:16-40:15.
[189] Ex. 1054 (*Armstrong*) 19:24-20:2; see also, 13:7-14.

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compression process. Again the sensors communicate to the DCS which can provide graphing details, high temperature alarms, and shut downs."[190]

158. In light of *Armstrong* and *Clancy*'s express teachings, a POSITA would be motivated to monitor gas temperatures of the gas compression skid. For example, such monitoring would ensure that gas temperatures stay within the appropriate range, and to determine whether the system components are operating properly or whether anomalies may occur, such as anomalies in the compressor or faulty valves.

159. Patent Owner's expert Dr. Nikolaou testified as to why a POSITA would be motivated to monitor gas temperature of a gas filtration skid: "[t]o make sure that the system operates as intended and to avoid any operating problems that might jeopardize the integrity of the system itself or the integrity of a systems downstream from that."[191] I agree with the motivations stated by Dr. Nikolaou. Dr. Nikolaou also testified that it was known and the technology was available to monitor gas temperature of a gas filtration skid.[192]

160. Accordingly, *Armstrong* and *Clancy* each disclose monitoring gas temperatures. Therefore, the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

e) "valve statuses,"

[190] Ex. 1055 (*Clancy*) [0037]; *see also* [0041].
[191] Ex. 1053 (Nikolaou Dep. Tr.), 40:3-10.
[192] Ex. 1053 (Nikolaou Dep. Tr.), 46:18-47:5.

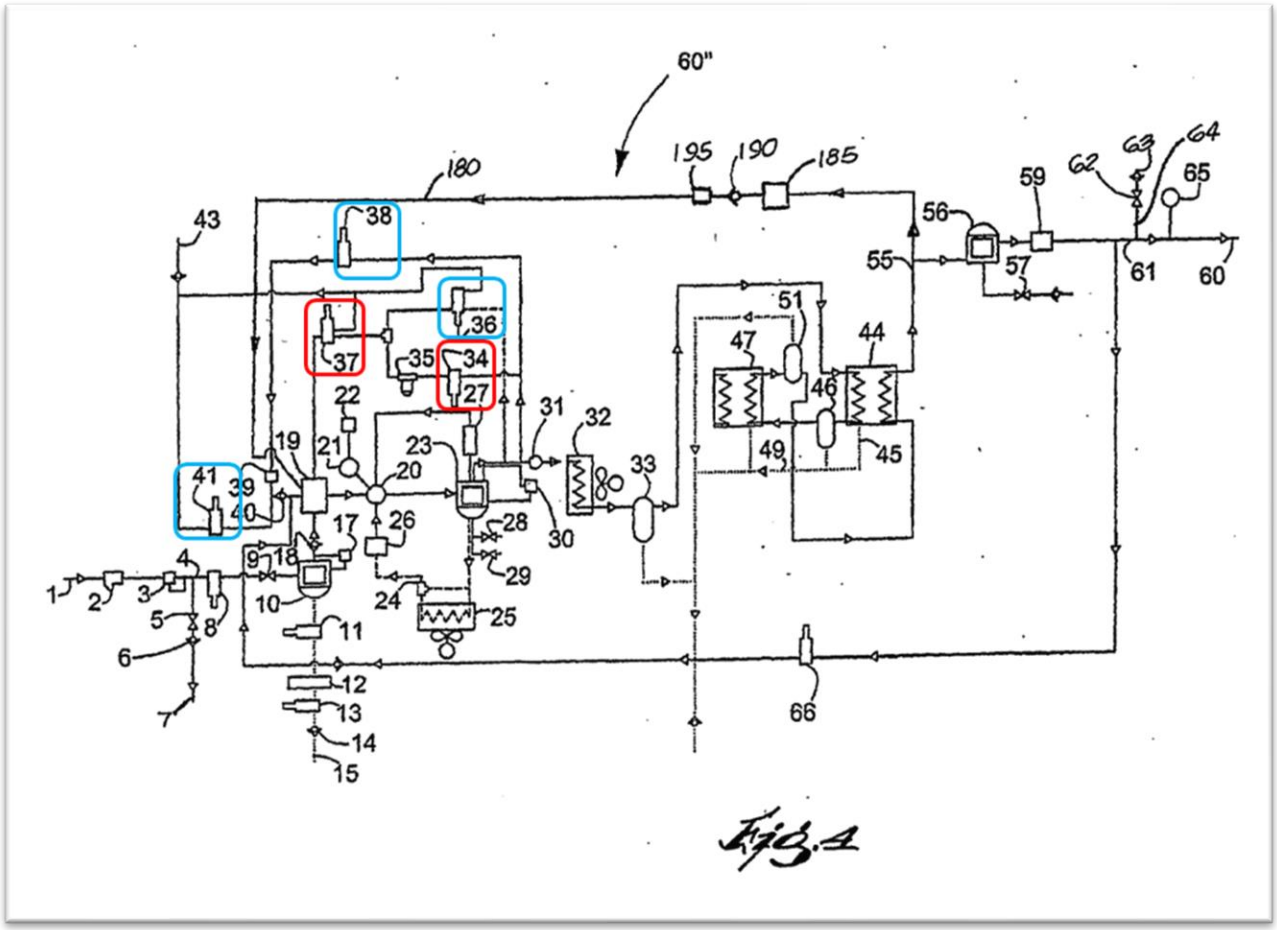
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161. *Armstrong* renders obvious monitoring valve statuses. For example, *Armstrong* discloses that, in response to monitoring separator status, as discussed above in section XIII.F.5.b), "[d]uring a drain cycle, valve 11 would be opened to permit liquid to fill the reservoir 12. Valve 11 then closes and valve 13 opens to drain liquid out through a check valve 14 to the drain system 15. This system reduces the amount of air that is admitted into the separator tank 10 during a drain cycle. Valve 13 then closes and the cycle is repeated periodically to keep the inlet separator liquid level below a predetermined level."[193] By disclosing that valve 13 opens after valve 11 closes, *Armstrong* is teaching monitoring the status of at least valve 11 to determine when it closes so that valve 13 will open.

162. As another example, *Armstrong* discloses that "[a] fuel bypass control system may be employed to further reduce the fuel flow rate. The fuel bypass control system uses bypass fuel to control and reduce the fuel flow rate. To reduce the fuel flow rate, the bypass line with solenoid valves 34 and 37 [annotated in red] is opened, while valves *36, 38, and 41* [annotated in blue] *are closed*."[194]

[193] Ex. 1054 (*Armstrong*) 10:2-6.
[194] Ex. 1054 (*Armstrong*) 12:15-21.

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Ex. 1054 (Armstrong) Fig. 4 (annotated)

163. *Armstrong*, accordingly, discloses monitoring valve states so that solenoid valves 34 and 37 are opened "while valves 36, 38 and 41 are closed".

164. It would, therefore, have been obvious to a POSITA, and a POSITA would have been motivated, to monitor valve statuses (e.g., open or closed) to determine when to proceed to the next step (i.e., open another valve).

165. As another example, *Armstrong* discloses that "the modulating valve 35 partially or fully opens the inlet valve 19 using recirculated fuel 20 pressure. The

inlet valve then 'throttles' the inlet fuel flow going to the inlet side of the gas compressor 20. By effectively reducing the inlet pressure to the compressor 20, the amount of flow pumped to the rest of the PCS 60' is reduced."[195] It would have been obvious, and a POSITA would have been motivated, to monitor the position of valve 19 so that the amount of "throttling" was known, and to control the amount of fuel going to the inlet side of the gas compressor.

166. *Clancy* also renders obvious monitoring valve status. *Clancy* discloses "[f]rom the check valve the flow passes through a second 311 valve (6), which has an electric 120-volt actuator (7) attached to the valve stem (not shown). This actuator is used to open the second 311 valve (6) for initial start up and closes the second 311 valve (6) in the event of an emergency shut down (ESD)."[196]

167. It would have been obvious, and a POSITA would have been motivated, to monitor the status of at least valve (6) to determine whether it was open and whether it was safe to complete additional steps of "initial startup." For example, starting a compressor (one of the components of *Clancy*) with the inlet valve closed would cause high vacuum on the inlet seals and piping, potentially leading to damage of the compressor, gauges, sensors or valves.

[195] Ex. 1054 (*Armstrong*) 12:18-22.
[196] Ex. 1055 (*Clancy*) [0031].

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168. This is consistent with the testimony of Patent Owner's expert, Dr. Nikolaou, who stated that monitoring valve status would include whether the valve is open or closed, among other issues.[197]

169. Patent Owner's expert, Dr. Nikolaou, testified as to why a POSITA would be motivated to monitor valve status of a gas filtration skid: "to make sure that the system operates as intended and perhaps catch and try to prevent potential malfunctions either to this – the filtration system itself or downstream operations to which the filter – the filtration system is connected to."[198] I agree with the motivations stated by Dr. Nikolaou. Dr. Nikolaou also testified that it was known to monitor the valve status for a gas filtration system, and it would be reasonable to do so.[199]

170. Accordingly, *Armstrong* and *Clancy* each disclose and render obvious monitoring valve status, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

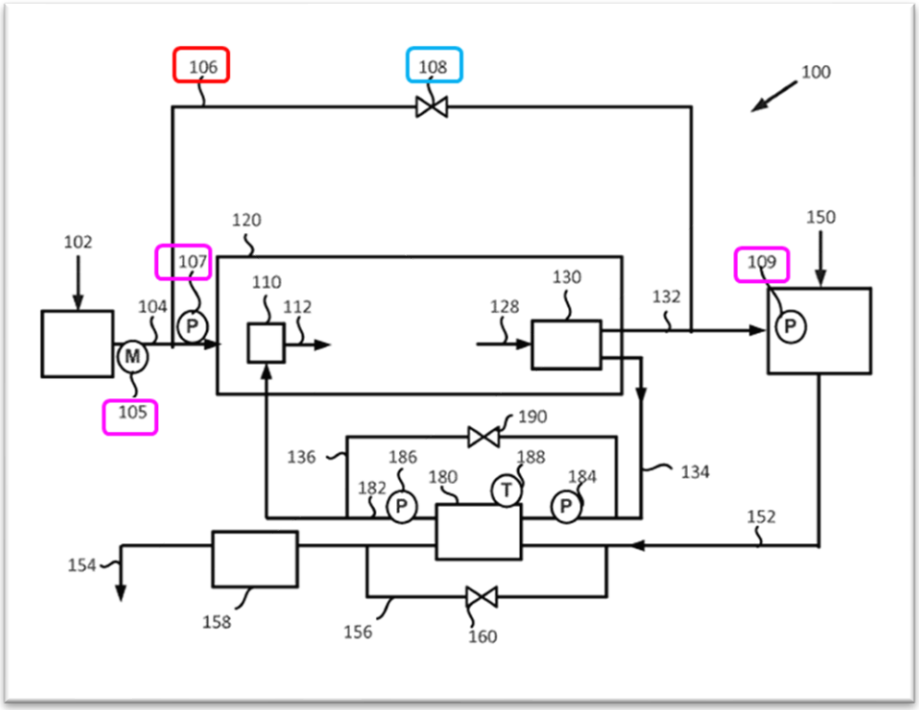
f) "and filter bypass status;"

171. *Trobaugh* discloses monitoring filter bypass status. *Trobaugh* discloses a "filter bypass assembly which includes a bypass conduit or line 106 [annotated in red] and a bypass valve 108 [annotated in blue]. The filter bypass assembly is

[197] Ex. 1053 (Nikolaou Dep. Tr.), 47:18-48:7.
[198] Ex. 1053 (Nikolaou Dep. Tr.), 47:6-17.
[199] Ex. 1053 (Nikolaou Dep. Tr.), 49:4-12.

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operably coupled to a methane gas sensor 105 and a natural gas pressure sensor 107 on conduit 104 and a methane gas pressure sensor 109 on engine 150 [sensors annotated in magenta]."[200] *Trobaugh* further discloses that "[b]ypass valve 108 and sensors 105, 107, 109 may be operably coupled to a computer or other device (not shown) for receiving information from sensors 105, 107, 109. The computer then outputs information to other components of natural gas fueling system 100 and engine 150 based on the information from sensors 105, 107, 109. *Trobaugh* further describes that "the filter bypass assembly may be activated … when filter assembly 120 is working improperly and/or is being repaired or serviced."[201]



[200] Ex. 1056 (*Trobaugh*) [0031].
[201] Ex. 1056 (*Trobaugh*) [0031].

Ex. 1056 (*Trobaugh*) Fig. 1 (annotated)

172. A POSITA would have understood, based on *Trobaugh's* disclosure, that the "output[] information to other components" includes the status of the filter bypass, for example, when there is fuel pressure at sensor 109 with valve 108 opened, and/or while the filter assembly is working improperly and/or is being repaired or serviced.

173. This is consistent with the testimony of Patent Owner's expert, Dr. Nikolaou regarding a filter bypass and that monitoring filter bypass status refers to "[w]hether that line is also available and operating as intended," including whether the bypass is activated or inactivated,[202] and that a flow sensor is one way to perform such monitoring.[203]

174. It would have been further obvious to monitor filter bypass status, based on the disclosure of *Trobaugh*, as *Coli* teaches monitoring the entire fracturing operation, which would have included the status of the filter bypass (i.e., valve 108 opened, filter bypass activated).

175. A POSITA would have been motivated to monitor filter bypass status to know whether the filter is operating appropriately, whether the filter bypass is activated, and whether the filter bypass is operating appropriately.

[202] Ex. 1053 (Nikolaou Dep. Tr.), 49:14-52:8.
[203] Ex. 1053 (Nikolaou Dep. Tr.), 55:1-12.

176. Patent Owner's expert Dr. Nikolaou testified as to why a POSITA would be motivated to monitor filter bypass of a gas filtration skid: "to know what is going on with the filter bypass and to make sure that the filter bypass is operable and it can work as intended if needed," and "[i]f they were using a filter and a bypass, it would be reasonable for them to monitor filter bypass status and the technology would be available."[204] I agree with the motivations stated by Dr. Nikolaou. He also testified that the technology to monitor filter bypass status would have been available by the time of the '992 Patent.[205]

177. Accordingly, *Trobaugh* discloses and renders obvious monitoring valve status. Therefore, the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

6. [41j]: "wherein the centralized control unit is further configured to control operating characteristics of the gas filtration skid,"

178. *Coli* discloses a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation," which would have included *Armstrong*'s FCS (gas filtration skid) in the combination[206] *Armstrong* discloses that a "programmable logic controller (PLC) or other microprocessor-based control unit performs protective functions (alarms, trips,

[204] Ex. 1053 (Nikolaou Dep. Tr.), 52:2-15.
[205] Ex. 1053 (Nikolaou Dep. Tr.), 52:9-15, 53:7-18, 54:14-22.
[206] Ex. 1004 (*Coli*), [0072].

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interlock/permissives), control functions (sequencing, logic, PID control), and information functions (operator interface, interface to other systems). Once started, the PLC controls the FCS exhaust flow rate and pressure."[207]

179. Additionally, *Clancy* discloses that its "system is controlled by a distributed control system (DCS), which is a computer readable program, and allows for (HMI) humane [*sic.* Human] machine interface. The DCS is integrated with a power engine computer system, which allows for diagnostics, control and data logging."[208]

180. The other references provide details on controlling specific components of the gas filtration skid, as I discuss in more detail below with respect to limitation [41k]. It would have been obvious for Coli's control center 40 to control the operating characteristics of [41k] in light of Coli's disclosure for centralized monitoring and control "for the entire fracturing operation" and because it was known in the prior art and/or obvious to monitor these operating characteristics, as shown below and as conceded by Dr. Nikolaou.

181. Accordingly, *Armstrong* and *Clancy* each disclose controlling operating characteristics of the filtration skid. For the reasons set forth in the

[207] Ex. 1054 (*Armstrong*), 19:19-22.
[208] Ex. 1055 (*Clancy*), [0003].

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subsections below, the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, and Teets* renders Limitation [41o] obvious.

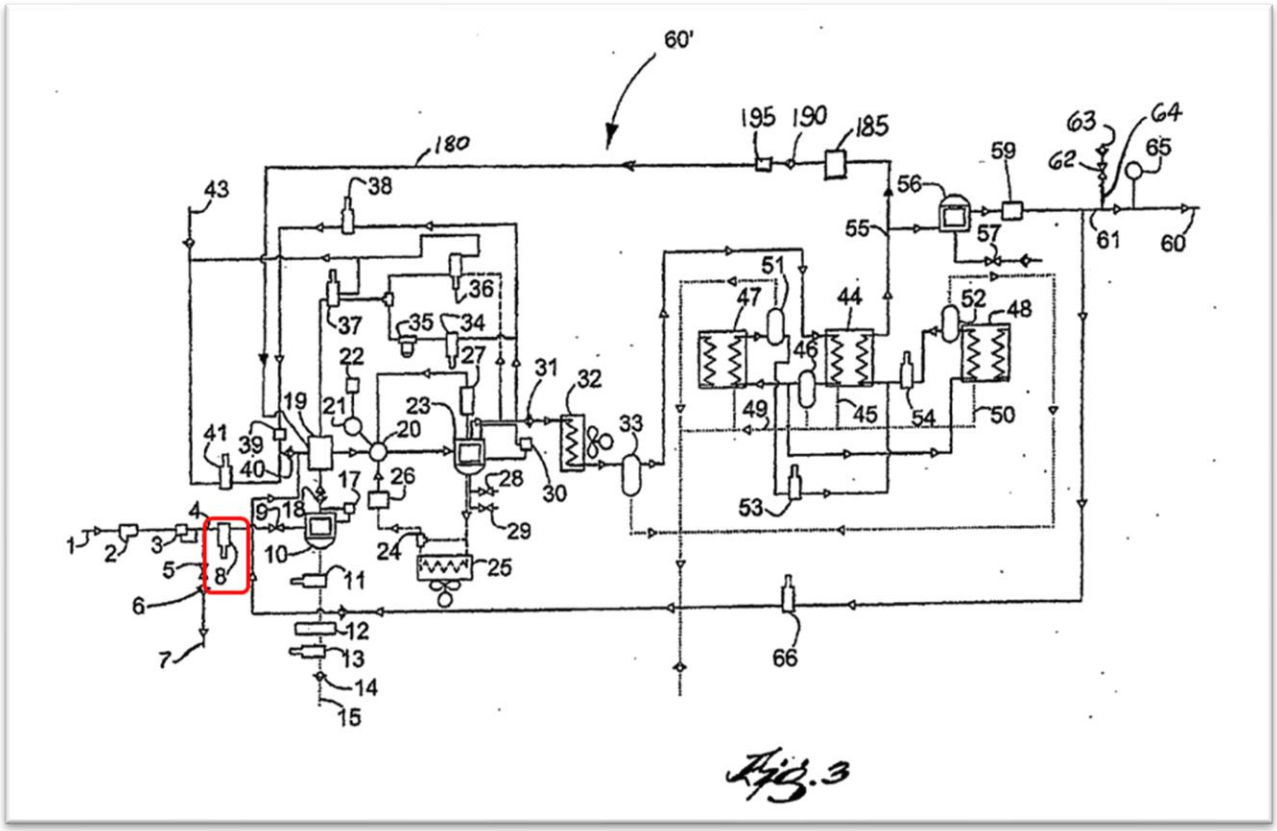
7. [41k]: "wherein the controllable operating characteristics of the gas filtration skid include at least…

a) "inlet valves,"

182. *Armstrong* discloses that fuel feeds "into an inlet valve 19 that controls the flow rate to a compressor such as an oil-flooded screw-type compressor 20."[209] Further, as discussed above, *Armstrong* discloses that inlet valve 19 ""'throttles" the inlet fuel flow going to the inlet side of the gas compressor 20."[210] "Further still, *Armstrong* discloses that "[a]n inlet solenoid valve 8 may be used to externally shut off the gas and isolate the FCS 60'.[211] A solenoid valve would be controlled by *Armstrong*'s FCS. Accordingly, *Armstrong* discloses controlling multiple inlet valves (inlet valve 19 and inlet solenoid valve 8), as claimed.

[209] Ex. 1054 (*Armstrong*) 10:16-19.
[210] Ex. 1054 (*Armstrong*) 12:18-22.
[211] Ex. 1054 (*Armstrong*) 9:16-19.

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Ex. 1054 (*Armstrong*) Fig. 3 (annotated)

183. *Clancy* also discloses controlling inlet valves. *Clancy* discloses "In the compressor skid (1) of the preferred embodiment of this invention, as seen in FIG. 1, a natural gas and liquids flow is provided to the skid via a 311 300 ANSI connection (2) passing through a 311 ball valve (3). See FIG. 1. The ball valve is used to isolate the skid in the event of maintenance or if manual isolation is required. A check valve (4) is located next in the pipeline (5) which is used to prevent any reversal of flow backwards toward the source of suction. From the check valve the flow passes through a second 311 valve (6), which has an electric 120-volt actuator (7) attached to the valve stem (not shown). This actuator is used to open the second

311 valve (6) for initial start up and closes the second 311 valve (6) in the event of an emergency shut down (ESD)."[212] The actuator would have been controlled by *Clancy*'s control system, and the central monitoring and control system in the combination with *Coli*.

184. A POSITA would have been motivated to control the inlet valves in accordance with Clancy's express instructions to isolate the gas compression skid during maintenance or shutdown, and to control the flow of gas through the system.

185. This is consistent with the testimony of Patent Owner's expert, Dr. Nikolaou, that an inlet valve is "any kind of valve that one would use for a gas flow," that controlling the inlet valve means "adjust[ing] the opening of the valve."[213]

186. Dr. Nikolaou further testified that a POSITA would be motivated to control the inlet valve "[t]o make sure that flow rate is as desired," to "adjust flow rate of the gas," "adjust what is the pressure downstream of the valve, what is the flow rate, and the . . . other operating characteristics of the system," and "[t]o make sure that flow rate is as desired, the operating characteristics overall are as desired."[214] I agree with the motivations stated by Dr. Nikolaou.

[212] Ex. 1055 (*Clancy*) [0031].
[213] Ex. 1053 (Nikolaou Dep. Tr.), 55:13-21, 56:10-57:1.
[214] Ex. 1053 (Nikolaou Dep. Tr.), 55:13-21, 56:10-57:8.

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187. Accordingly, *Armstrong* and *Clancy* each disclose and render obvious controlling inlet valves. Therefore, the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

b) "outlet valves,"

188. *Armstrong* discloses that a "receiver tank would preferentially be located between the FCS outlet 60 and the microturbine(s) 10' or other engines that use the fuel. A fuel solenoid could be used to ensure that when the FCS 60' is depressurized for service or maintenance, the receiver tank remains pressurized."[215] The "fuel solenoid" is an outlet valve, as it is located "between the FCS outlet 60 and the microturbines". The PLC programmable logic controller would have controlled a solenoid valve, and the central monitoring and control system in the combination with *Coli*.[216] To the extent the limitation claims controlling outlet "valves", a POSITA would have understood that Armstrong's PLC programmable logic controller controls multiple outlet valves because control of multiple outlet valves would be involved in controlling "the FCS exhaust flow rate and pressure," and to inform the protective, control, and information functions disclosed by *Armstrong*.[217] It would have been further obvious to control multiple outlet valves to achieve the same benefits as controlling one outlet valve. There is no

[215] Ex. 1054 (*Armstrong*) 16:10-15.
[216] Ex. 1054 (*Armstrong*) 19:19-20:7.
[217] Ex. 1054 (*Armstrong*) 19:19-20:7.

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inventiveness in applying Armstrong's teachings to multiple outlet valves, and a POSITA would be motivated to do so to enable the PLC to perform its disclosed control functions.

189. *Clancy* also discloses controlling outlet valves. *Clancy* discloses that "[t]he cooled gas flow is then led from discharge pipe (46) to three different directions. A first flow is directed through a gas fuel line (60) in which fuel gas flows. The fuel gas flow is piped then to the engine skid to power the engine (300). The fuel line is equipped with a first manual valve (49) for starting and stopping the flow of gas at the operator's discretion. In FIG. 8, downstream from the manual valve, a second ball valve (50) is located with an electric actuator (51), which is used to open the fuel supply during start-up and close the fuel supply in the event of an ESD situation."[218] Valves 49 and 50 are discharge valves of the compressor skid as they are downstream of the "discharge pipe (46). Valve 50 is coupled with an electric actuator, which, in combination with *Coli*, would have been controlled by *Coli's* central monitoring and control system.

190. A POSITA would have been motivated to control the outlet valves in light of the express teachings of *Armstrong* and *Clancy* to control the flow and pressure of gas through the system, including to direct the flow of gas or start and stop the flow of gas in certain directions, or to maintain pressure.

[218] Ex. 1055 (*Clancy*) [0042].

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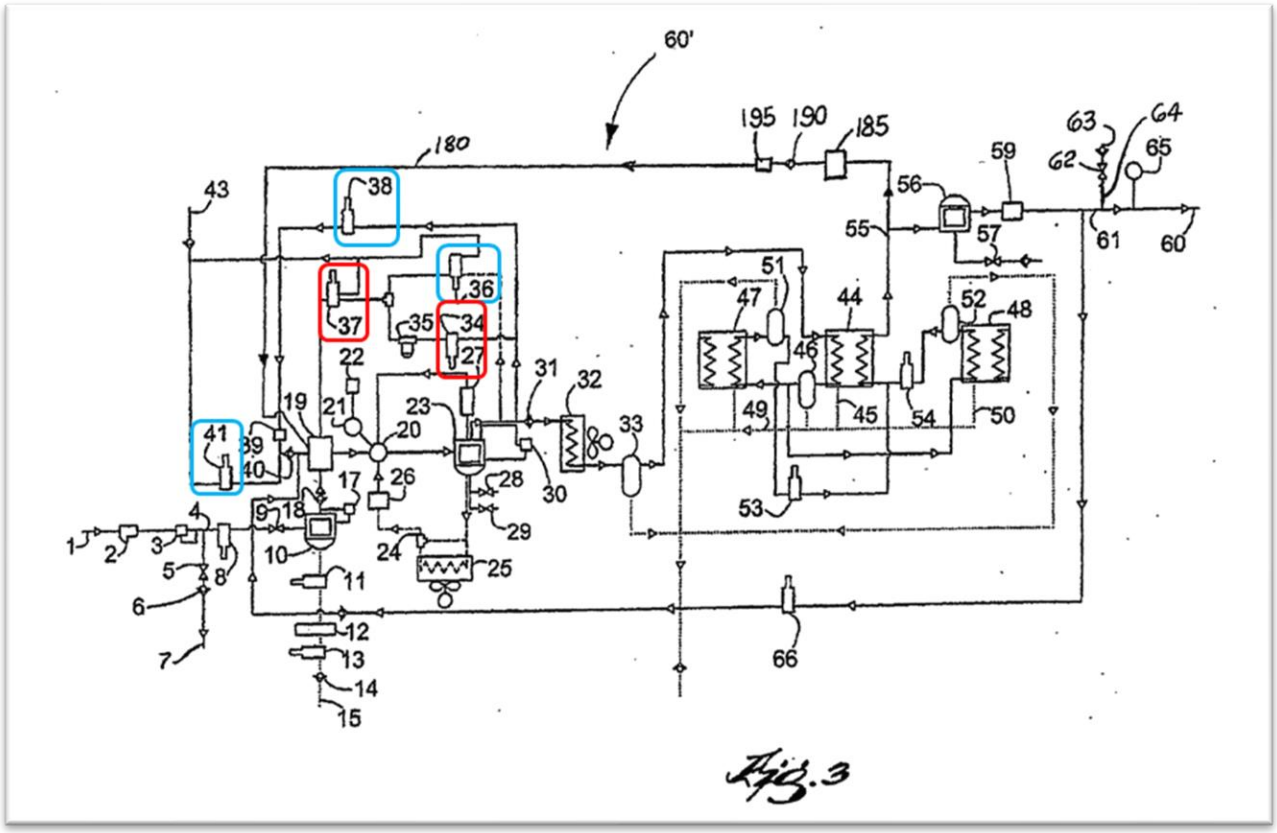
191. Accordingly, *Armstrong* and *Clancy* each disclose and render obvious controlling outlet valves. Therefore, the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

c) "bypass valves,"

192. *Armstrong* discloses a "fuel bypass control system [which] uses bypass fuel to control and reduce the fuel flow rate. To reduce the fuel flow rate, the bypass line with solenoid valves 34 and 37 [annotated in red] are opened, while valves 36, 38, and 41 [annotated in blue] are closed."[219] Accordingly, *Armstrong* discloses controlling bypass valves (solenoid valves 34 and 37). Solenoid valves would have been controlled by *Armstrong*'s PLC and the central monitoring and control system in the combination with *Coli*.

[219] Ex. 1054 (*Armstrong*) 12:15-21.

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193. This is consistent with Patent Owner's expert Dr. Nikolaou's testimony that "bypass valves" of a gas filtration system are "the valves that adjust the flow rate of the bypass stream – regulate the flow rate of the bypass stream."[220]

194. A POSITA would have been motivated to control the bypass valves to manage the gas flow rate and pressure through the system, for example, by activating or deactivating bypass lines.

[220] Ex. 1053 (Nikolaou Dep. Tr.), 60:11-16.

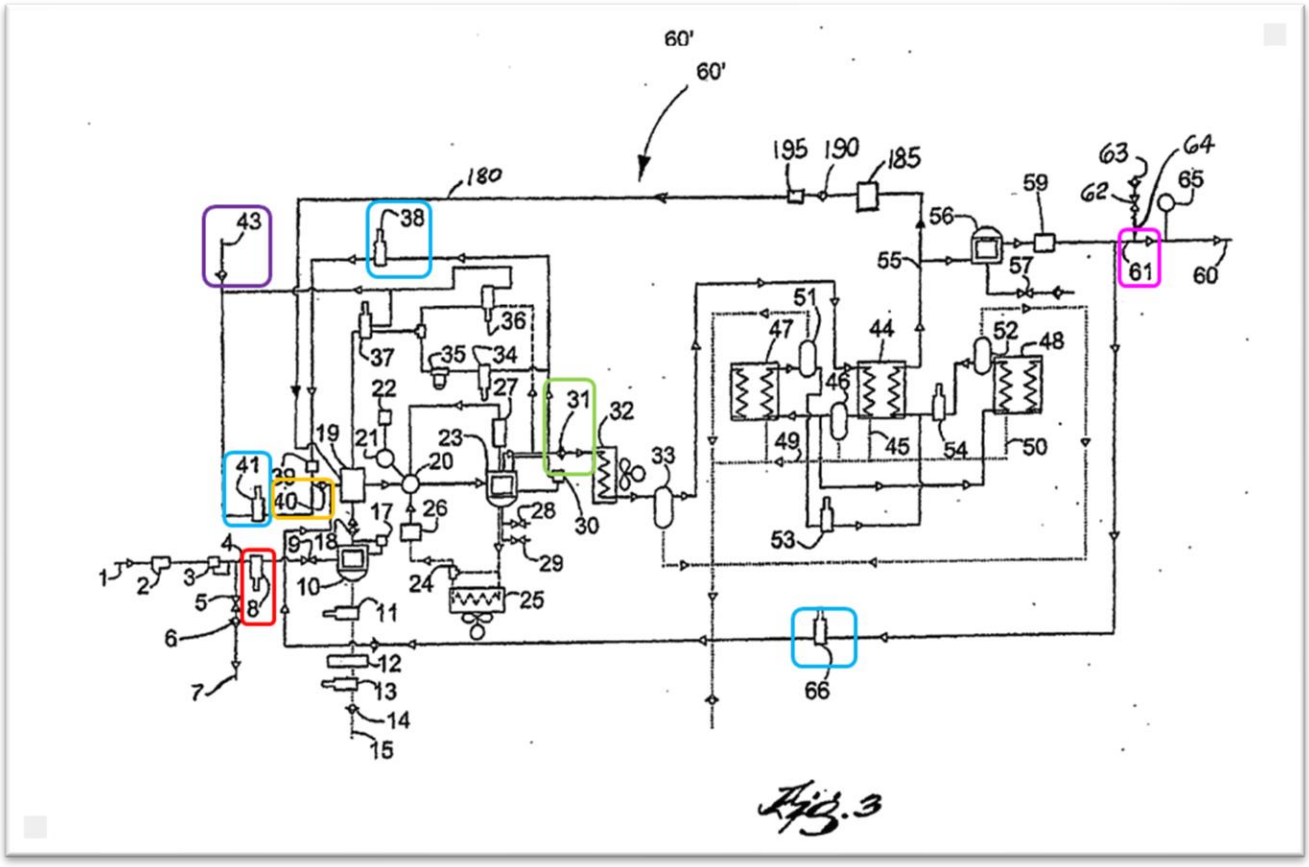
195. Therefore, *Armstrong* discloses and renders obvious controlling outlet valves, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

d) "pressure release,"

196. *Armstrong* teaches that "[t]o purge the skid 60' of high-pressure gas [i.e., release pressure], solenoid valve 8 [annotated in red] closes, and valves 66, 38 and 41 [annotated in blue] open ... The high-pressure fuel downstream of the minimum pressure check valve 31 [annotated in green] flows through the skid 60' to location 61 [annotated in magenta]. The dry, clean gas then flows back to the entrance of the inlet valve 40 [annotated in orange] through the line with valve 66. The gas then flows from the inlet valve 40, through the compressor 20, separator tank 23, out to the bypass line 38, and eventually out of the vent 43[annotated in purple]."[221] *Armstrong* further teaches that at least valve 38 is a solenoid valve,[222] and valves 8, 41 and 66 use the same "solenoid valve" symbol and would have been understood by a POSITA to be solenoid valves, based on Armstrong's teachings. These valves, therefore, would have been controlled by the PLC, and the central monitoring and control system in the combination with *Coli*.

[221] Ex. 1054 (*Armstrong*) 17:17-23.
[222] Ex. 1054 (*Armstrong*) 13:5-6.

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Ex. 1054 (*Armstrong*) Fig. 3 (annotated)

197. A POSITA would have been motivated to control the pressure release to maintain gas pressure within the appropriate range. For example, releasing pressure helps prevent over-pressurization, which can damage equipment or become a safety concern.

198. This is consistent with Patent Owner's expert Dr. Nikolaou's testimony regarding the meaning of "pressure release" and that a POSITA would be motivated to be able to release pressure to "avoid damage to the system" from excessive

pressure and "void problems in the operation and health of the equipment."[223] Dr. Nikolaou also testified that "[i]f a gas filtration skid were used, it would be reasonable to see these pressure release – this pressure release capability there."[224] I agree with the motivations stated by Dr. Nikolaou.

199. Accordingly, *Armstrong* discloses and renders obvious controlling pressure release, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

8. [41l]: "the system further comprising a gas compressor,"

200. *Armstrong's* fuel conditioning skid (FCS) comprises a gas compressor. *Amrstrong* discloses that "[g]aseous fuel exits the inlet filter/separator 10 and passes through a check valve 18 which ensures that gas, which could potentially be at a higher pressure than the source gas, does not flow backward into the fuel supply lines. The fuel then feeds into an inlet valve 19 that controls the flow rate to a compressor such as an oil-flooded screw-type compressor 20. The compressor 20 boosts the fuel pressure to a predetermined level suitable for engine operation."[225]

201. *Clancy* also discloses a gas compressor. *Clancy* discloses that "[t]he present invention seeks to provide a natural gas compressor for optimizing the extraction of natural gas from a reservoir or associated gathering system, comprising

[223] Ex. 1053 (Nikolaou Dep. Tr.), 60:17-61:8.
[224] Ex. 1053 (Nikolaou Dep. Tr.), 61:1-22.
[225] Ex. 1054 (*Armstrong*) 10:15-22.

in combination: a natural gas and liquids flow under pressure supply from a source; a separator, receiving the supply of gas and liquids flow under pressure by a first piping line and separating the natural gas and liquids flow into a gas flow and a liquids flow."[226]

202. Accordingly, *Armstrong* and *Clancy* each disclose and render obvious using a gas compressor, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders Limitation [41l] obvious.

9. [41m]: "wherein the centralized control unit is further configured to monitor operating characteristics of the gas compressor;

203. *Coli* discloses a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation," which would have included the gas compressor in the combination.[227] Included in *Coli*'s fracturing operation are "[o]ne or more natural gas-powered turbine generators 30" that generate electric power for use in the fracturing operation."[228] As discussed above in Section XIII.F.3, and incorporated herein by reference, both *Coli* and *Armstrong* teach powering turbine generators with produced gas (i.e., produced from an oil and gas well). *Armstrong* and Clancy teach compressing the produced gas, and, as discussed in the sections below, controlling certain aspects of the gas compressor

[226] Ex. 1055 (*Clancy*), [0009].
[227] Ex. 1004 (*Coli*), [0072].
[228] Ex. 1004 (*Coli*), [0038], [0040].

disclosed by *Armstrong* and *Clancy*. The other references provide details on controlling specific components of the gas compressor skid. It would have been obvious to a POSITA to monitor the "*operating characteristics*" listed in [41n], in view of *Coli*'s disclosure of centralized monitoring of the entire fracturing operation and because it was known in the prior art and/or obvious to monitor these operating characteristics, as shown below and as conceded by Dr. Nikolaou.

204. Patent Owner's expert, Dr. Nikolaou, further testified as to reasons that a POSITA would want to monitor operating characteristics of a gas compressor in a fracturing system: "[t]o make sure that the performance is as intended and also to make sure that there are no impending problems in case something abnormal would be detected."[229] I agree with the motivations stated by Dr. Nikolaou.

205. For the reasons outlined in the subsections below, the combination of Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, *and Teets* renders Limitation [41m] obvious.

10. [41n]: "wherein the monitored operating characteristics of the gas compressor include at least…"

a) "compressor motor run status,"

206. *Armstrong* discloses monitoring compressor motor run status. For example, *Armstrong* discloses a "programmable logic controller (PLC) or other

[229] Ex. 1053 (Nikolaou Dep. Tr.), 62:2-63:4.

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microprocessor-based control unit performs protective functions (alarms, trips, interlock/permissives), control functions (sequencing, logic, PID control), and information functions (operator interface, interface to other systems). Once started, the PLC controls the FCS exhaust flow rate and pressure. A pressure sensor 65 located near the outlet 60 of the FCS 60', 60'', 60''' senses the FCS outlet pressure. A proportional-integral-derivative (PID) control algorithm is used to adjust the gas compressor speed by adjusting the variable frequency drive device 22."[230] As monitoring is part of controlling, such as in a feedback loop,[231] *Armstrong* teaches controlling and monitoring compressor motor run status (i.e., compressor speed). If motor speed is zero, the motor is not running. If the speed is non-zero, the motor is running. This monitoring would have been with the central monitoring and control system in combination with *Coli*.

207. This is consistent with Patent Owner's expert Dr. Nikolaou's testimony that compressor motor run status of a gas compressor includes whether the motor is running or not,[232] and a sensor is one way to measure the compressor motor's run status by measuring its speed, and such a sensor "typically would be provided by the manufacturer of the compressor."[233]

[230] Ex. 1054 (*Armstrong*) 19:19-25, see also 10:20-24.
[231] See Section V.D above.
[232] Ex. 1053 (Nikolaou Dep. Tr.), 64:3-10.
[233] Ex. 1053 (Nikolaou Dep. Tr.), 64:11-65:5.

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208. A POSITA would have been motivated to monitor compressor motor run status to determine if the compressor is activated and ensure proper function of the compressor motor.

209. Patent Owner's expert, Dr. Nikolaou, testified as to why a POSITA would be motivated to monitor the compressor motor run status of the gas compressor: "[t]o make sure that the operation is satisfactory and also catch potential impending problems that might jeopardize the operation or the health of the equipment, either the compression system itself or downstream systems,"[234] and that it would be common to monitor the compressor motor's status in 2015 if a compressor were used.[235] I agree with the motivations stated by Dr. Nikolaou.

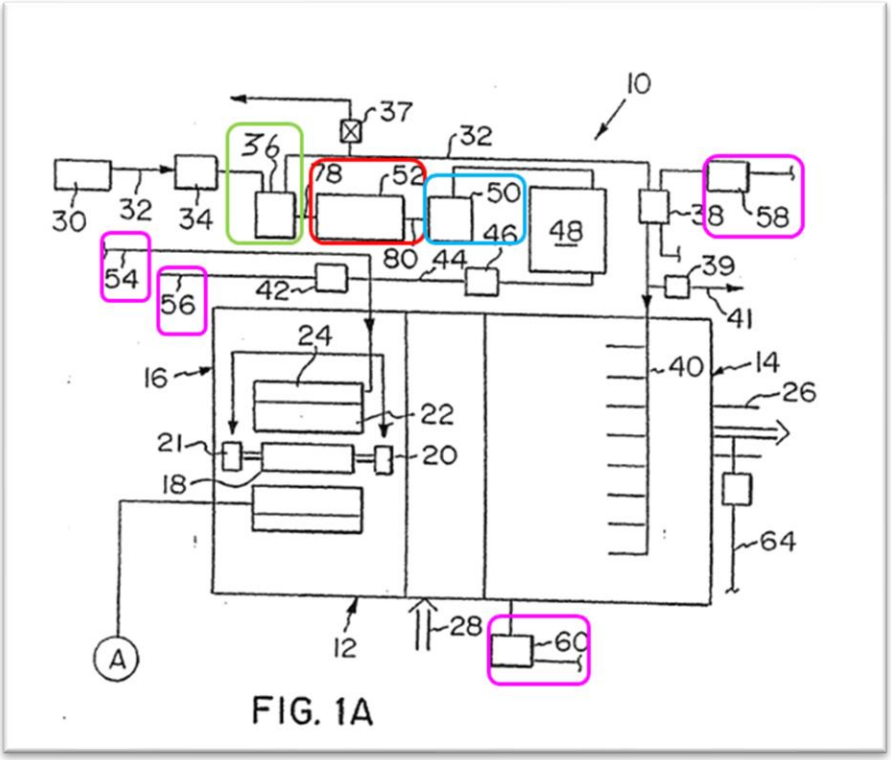
210. Accordingly, *Armstrong* discloses and renders obvious monitoring a gas compressor run status, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, and Teets* renders this limitation obvious.

b) "oil pump run status,"

211. *Teets* discloses monitoring oil pump run status. For example, *Teets* states that "bearings 20 and 21" support the compressor rotor.[236] Further, *Teets* discloses that "the rotor bearings are lubricated by lubricating oil and the lubricating

[234] Ex. 1053 (Nikolaou Dep. Tr.), 65:6-17.
[235] Ex. 1053 (Nikolaou Dep. Tr.), 65:18-22.
[236] Ex. 1057 (*Teets*) [0028].

oil and fuel are provided through pumps driving by one motor."[237] *Teets* further teaches that "electric motor 52 is energized. This motor drives the lubricating oil pump 50 and fuel pump 36."[238]



Ex. 1057 (*Teets*) Fig. 1A (annotated)

212. Still further, *Teets* discloses that "[t]ransducers 54, 56, 58 and 60 [each annotated in magenta] are provided for measuring lubricating oil temperature, lubricating oil pressure, fuel pressure and the compressor exit gas pressure, respectively. Transducers 54, 56, 58 and 60 are electrically coupled to a

[237] Ex. 1057 (*Teets*) [0055].
[238] Ex. 1057 (*Teets*) [0057].

microprocessor controlled engine controller 62."[239] By monitoring lubricating oil pressure, *Teets* is disclosing monitoring oil pump run status, i.e., if pressure is zero, the oil pump is not running. If pressure is above zero, the pump is running.

213. As another example, *Teets* discloses that "the engine controller monitors the system to determine whether there has been a failure of the fuel pump, the oil pump or the electric motor 52 driving these pumps."[240] *Teets*, therefore, teaches monitoring the oil pump's run status (failure or no failure). This monitoring would have been with the central monitoring and control system in the combination with *Coli*.

214. A POSITA would have been motivated to monitor the oil pump run status to determine whether the oil pump is operating correctly and within proper ranges, and whether it is running. This is important to ensure the appropriate lubricating oil for the gas compressor, which allows the compressor to function correctly.

215. Accordingly, *Teets* discloses and renders obvious monitoring an oil pump run status, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

c) "enclosure exhaust fan run status,"

[239] Ex. 1057 (*Teets*), [0017].
[240] Ex. 1057 (*Teets*), [0061].

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216. *Armstrong* discloses that the fuel conditioning skid (FCS), which includes a compressor as discussed above, "include[s] weatherproof enclosures for outdoor use."[241] Similarly, *Clancy* discloses that its compressor skid is contained in an "enclosure,"[242] "room,"[243] or "shelter structure."[244] *Clancy* further teaches that "a cooler fan (37) is powered by a hydraulic motor," which directs air into and out of a series of louvers.[245] These louvers are "controlled from the DCS."[246] *Clancy* discloses that "[i]n the event that the room temperature falls, the electric actuator is sent a signal to open the two recycle louvers and as a result ***the outlet louver*** begins to close as the recycle and outlet louvers are interconnected by the linkage. This system is designed to maintain a set temperature as input by the field operator."[247] Further, *Clancy* discloses that the "shelter structure of the compressor skid includes louvers (126), located on the wall at the opposite side of the ducting, which draws fresh cool air into the shelter."[248] Accordingly, since cooler fan (37) directs air out of the outlet louver, it is an enclosure exhaust fan.

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[241] Ex. 1054 (*Armstrong*) 20:20-23.
[242] Ex. 1055 (*Clancy*) [0071]
[243] Ex. 1055 (*Clancy*) [0039], Claim 30.
[244] Ex. 1055 (*Clancy*) [0040].
[245] Ex. 1055 (*Clancy*) [0039]-[0040].
[246] Ex. 1055 (*Clancy*) [0039].
[247] Ex. 1055 (*Clancy*) [0039], emphasis added.
[248] Ex. 1055 (*Clancy*) [0040].

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217. *Clancy* discloses that "the system is controlled by a distributed control system (DCS), which is a computer readable program, and allows for (HMI) humane [*sic—human*] machine interface. The DCS is integrated with a power engine computer system, which allows for diagnostics, control and *data logging*."[249] Combined with *Coli's* centralized control and monitoring system which comprises "controls and computer monitoring for the entire fracturing operation," it would have been obvious to monitor all parameters of the fracturing operation, including the enclosure exhaust fan run status. For example, it would be obvious, and a POSITA would have been motivated to monitor the fan run status so that the DCS would know whether operating the louvers, as described in *Clancy*, would have any significant impact on temperature, or whether the exhaust fan required service or maintenance. This monitoring would have been with the central monitoring and control system in the combination with *Coli*.

218. This is consistent with Patent Owner's expert Dr. Nikolaou's testimony regarding an enclosure exhaust fan status, monitoring an enclosure exhaust fan status, and why a POSITA would be motivated to monitor enclosure exhaust fan status.[250] I agree with the motivations stated by Dr. Nikolaou.

[249] Ex. 1055 (*Clancy*) [0003], *see also* [0028].
[250] Ex. 1053 (Nikolaou Dep. Tr.), 66:1-68:7.

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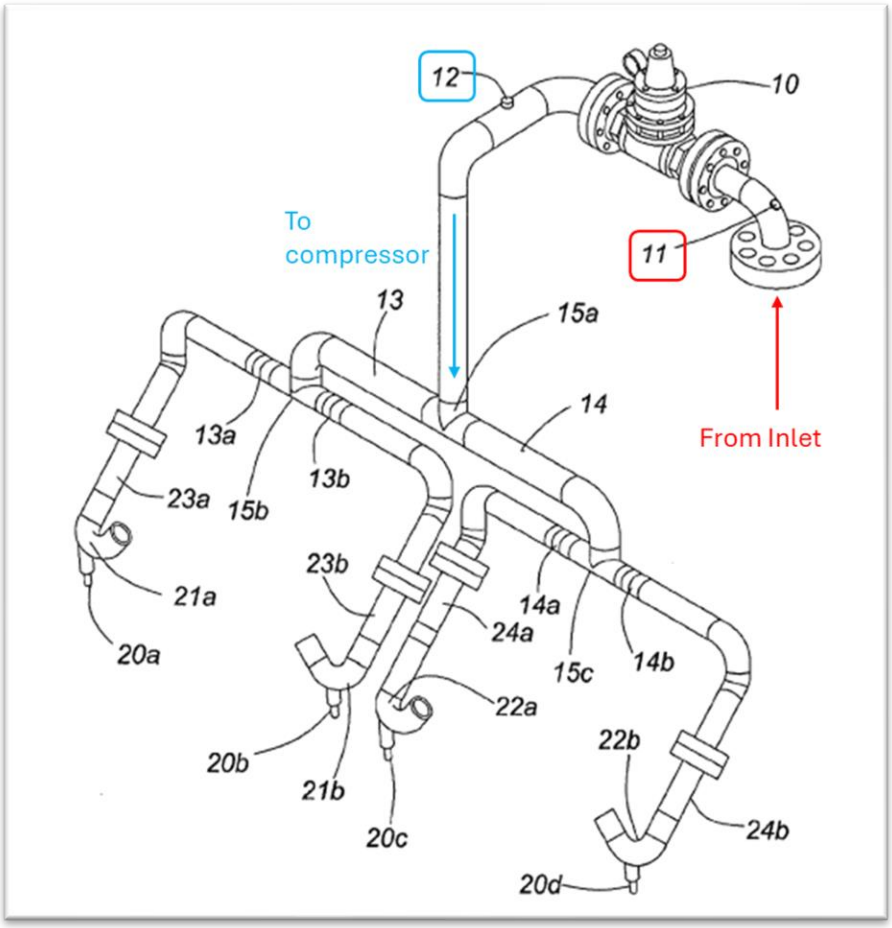
219. Accordingly, *Clancy* discloses and renders obvious monitoring the run status of an enclosure exhaust fan, and the combination of Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, *and Teets* renders this limitation obvious.

d) "compressor inlet pressure,"

220. *Clancy* discloses monitoring compressor inlet pressure. *Clancy* discloses that inlet gas to the compressor "pass[] from the top of the pressure vessel through a first back-pressure valve (10), as represented in FIG. 2, which is placed in the flow line to regulate the downstream pressure which must be maintained at a pressure no greater than 15 psi which is the ***max suction pressure allowed for this selected compressor***. Two pressure sensors (11) [annotated in red] and (12) [annotated in blue] are located upstream and downstream respectively of the first back-pressure valve (10)."[251] This monitoring would have been with the central monitoring and control system in the combination with *Coli*. The pressure sensor "downstream" of back-pressure valve 10 is also the "suction pressure" for the selected compressor, as shown by the blue arrow, and described by *Clancy*.

[251] Ex. 1055 (*Clancy*) [0033], emphasis added; see also [0034] teaching that the gas flow continues from sensor 11 to the compressors.

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Ex. 1055 (*Clancy*) Fig. 2 (annotated)

221. A POSITA would have been motivated to monitor the inlet pressure of the gas compressor to ensure that it stays within the appropriate ranges, so that there is sufficient pressure for the gas compressor to function properly and efficiently, while avoiding over-pressurization that can cause damage to the gas compressor and compromise the safety of the system.

222. Patent Owner's expert Dr. Nikolaou testified as to why a POSITA would be motivated to monitor compressor inlet pressure of a gas compressor: "[t]o

make sure that it is within the specifications for which the compressor has been designed," because "[t]here is a further wide but nonetheless finite range of pressures over which compressor works well," and that it would be common to monitor the pressure if one was using a gas compressor.[252] Dr. Nikolaou also testified that it was common to monitor compressor inlet pressure of a gas compressor by the time of the '992 Patent.[253] I agree with the motivations stated by Dr. Nikolaou.

223. Accordingly, *Clancy* discloses and renders obvious monitoring compressor inlet pressure via pressure sensor 12, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

e) "compressor discharge pressure, and"

224. *Armstrong* discloses monitoring compressor discharge pressure. *Armstrong* discloses that a "programmable logic controller (PLC) or other microprocessor-based control unit performs protective functions (alarms, trips, interlock/permissives), control functions (sequencing, logic, PID control), and information functions (operator interface, interface to other systems). Once started, the PLC controls the FCS exhaust flow rate and pressure. A pressure sensor 65 located near the outlet 60 of the FCS 60', 60", 60"' senses the FCS outlet pressure. A proportional-integral-derivative (PID) control algorithm is used to adjust the gas

[252] Ex. 1053 (Nikolaou Dep. Tr.) 68:15-17, 68:19-69:1.
[253] Ex. 1053 (Nikolaou Dep. Tr.) 69:2-7.

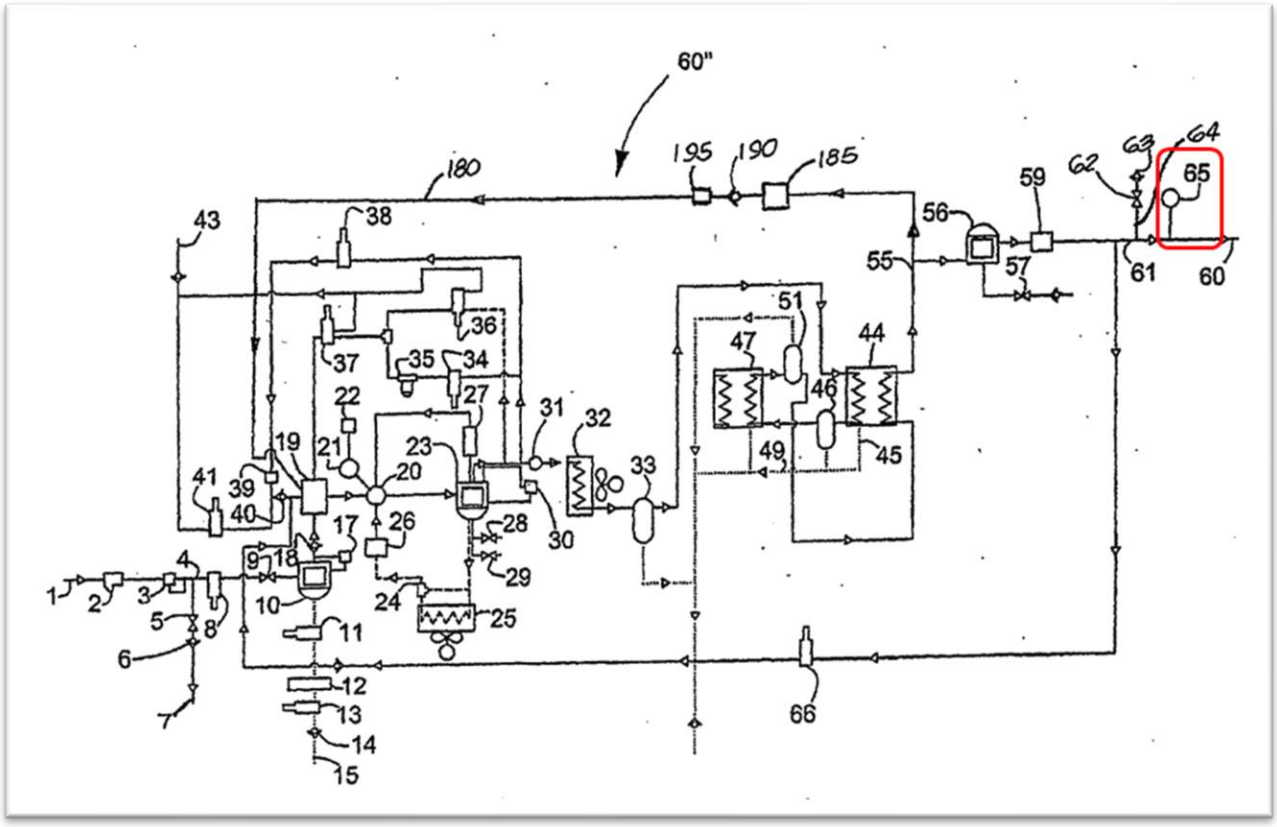
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compressor speed by adjusting the variable frequency drive device 22."[254] By disclosing monitoring of an "FCS Outlet pressure", *Armstrong* discloses and renders obvious monitoring of a compressor discharge pressure, as the "FCS Outlet pressure" is controlled by the speed of the compressor. This monitoring would have been with the central monitoring and control system in the combination with *Coli*.

225. This is consistent with the testimony of Patent Owner's expert Dr. Nikolaou that "the gas filtration skid provides gas at a certain pressure, that is what the compressor has to work with . . . []they are – the two are related and one impacts the other," and that one would monitor the compressor discharge pressure to adjust the speed of the compressor.[255]

[254] Ex. 1054 (*Armstrong*) 19:10-25, see also 10:20-24.
[255] Ex. 1053 (Nikolaou Dep. Tr.), 70:13-21, 71:14-72:5.

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Ex. 1055 (*Clancy*) Fig. 1 (annotated)

226. *Clancy* additionally teaches monitoring compressor discharge pressure. *Clancy* discloses "gas flows … coming from the two compressors are then combined back into one common fifth 211 pipe (33) which leads the combined gas flow to an after-cooler (34) see FIG. 6. The combined gas flow will first pass by a third pressure sensor (35) which again communicates to the DCS and provides protection from over pressuring the system in the event of some form of blockage happening down stream of the compressors."[256] As the third pressure sensor (35) is measuring

[256] Ex. 1055 (*Clancy*) [0038].

pressure between the compressor and the after cooler, it is measuring compressor discharge pressure. This monitoring would have been with the central monitoring and control system in the combination with *Coli*.

227. This is consistent with the testimony of Patent Owner's expert, Dr. Nikolaou, that the compressor discharge pressure refers to the gas flowing out of the compressor in the downstream direction.[257]

228. A POSITA would have been motivated to monitor compressor discharge pressure to ensure it remains within appropriate ranges, providing sufficient pressure for the system to function properly and efficiently while avoiding over-pressurization that can damage system equipment and compromise safety. Monitoring the outlet pressure of the gas compressor can also inform whether parameters, such as compressor speed, need to be adjusted.

229. Patent Owner's expert, Dr. Nikolaou, testified as to why a POSITA would be motivated to monitor compressor discharge pressure of the gas compressor to make sure the compressor works as intended, to prevent higher pressure than intended or over-pressurization, and to evaluate whether the speed of the compressor needs to be adjusted.[258] I agree with the motivations stated by Dr. Nikolaou. Dr.

[257] Ex. 1053 (Nikolaou Dep. Tr.), 70:7-21.
[258] Ex. 1053 (Nikolaou Dep. Tr.), 69:8-72:5.

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Nikolaou additionally testified that it was common to monitor compressor discharge pressure in 2015.[259]

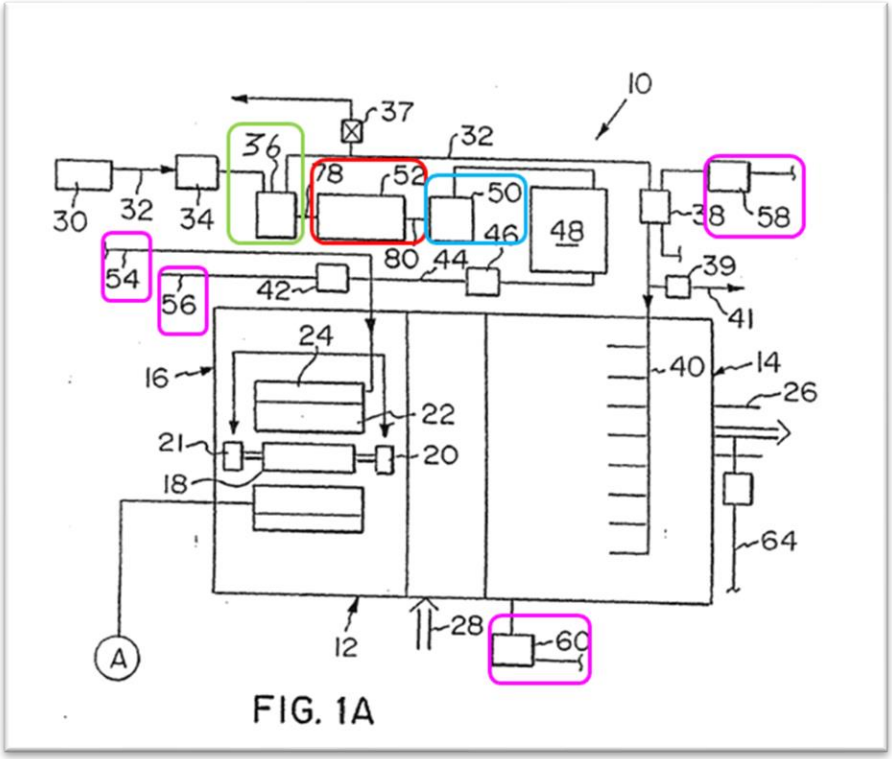
230. Accordingly, *Armstrong* and Clancy each disclose and render obvious monitoring a compressor discharge pressure, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders this limitation obvious.

f) "oil pump discharge pressure."

231. *Teets* discloses monitoring oil pump discharge pressure. As discussed above in section XIII.F.10.b) incorporated herein by reference, *Teets* discloses that an oil pump pressurizes lubricating oil. *Teets* discloses "[t]ransducers 54, 56, 58 and 60 are provided for measuring lubricating oil temperature, ***lubricating oil pressure***, fuel pressure and the compressor exit gas pressure, respectively. Transducers 54, 56, 58 and 60 [each annotated in magenta] are electrically coupled to a microprocessor controlled engine controller 62."[260] This monitoring would have been with the central monitoring and control system in the combination with *Coli*.

[259] Ex. 1053 (Nikolaou Dep. Tr.), 72:3-5.
[260] Ex. 1057 (*Teets*) [0017].

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Ex. 1057 (*Teets*) Fig. 1A (annotated)

232. A POSITA would have understood, based on the teachings of Teets, that "lubricating oil pressure" is "oil pump discharge pressure" as *Teets* teaches, as discussed in Section XIII.G.10.b), that the oil pump pumps lubricating oil. A POSITA would have been motivated to monitor oil pump discharge pressure to ensure proper oil pump operation and that the compressor receives the proper levels of lubricating oil, allowing it to function efficiently and avoid unnecessary wear. Accordingly, *Teets* discloses and renders obvious monitoring of an oil pump discharge pressure, and the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh,* and *Teets* renders this limitation obvious.

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11. [41o] & [41q]: "wherein the centralized control unit is coupled to the electric pump via one or more of cabling, Ethernet, or wirelessly; and wherein the centralized control unit is further configured to reset a fault occurring in the variable frequency drive.

233. Limitations [41o] & [41q] are rendered obvious by the combination of *Coli, Birch, Rusnak* & *Dykstra* for the same reasons as those discussed in Sections XI.A.2.f and XI.A.2.g in my original declaration. Accordingly, the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh and Teets* renders Limitations [41o] & [41q] obvious.

H. CLAIM 42

234. The *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets-Broussard079* combination renders Claim 42 obvious. Claim 42 depends from Claim 41. In addition to the discussion regarding Claim 41 above, incorporated herein by reference, *Armstron*g, *Clancy* and/or *Broussard079* discloses each and every limitation of 42.

1. [42a]: "The system of [claim 1] claim 41, further comprising: a generator electrically connected to the electric pump to provide power to the electric pump, wherein the generator is powered by liquefied natural gas, and"

235. The *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets-Broussard079* combination renders obvious "*wherein the generator is powered by liquefied natural gas*." *Coli* discloses the use of "[o]ne or more natural gas-powered turbine generators 30" for providing electric power to several fracturing modules,

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and that one way to drive the turbine generators is with "liquid fuels."[261] *Broussard079* elaborates on this known element and discloses a "natural gas powered generator, which can be a turbine generator," and that "the generators can be powered by liquefied natural gas."[262] It would have been obvious to a POSITA that *Coli*'s natural gas-powered turbine generator would have been powered by liquefied natural gas, as such a fuel source was known in the art as indicated by *Broussard079*, and would be a "liquid fuel" that *Coli* teaches powered a turbine generator.[263]

2. [42b]: "wherein the centralized control unit is further configured to monitor and control compression of the natural gas."

236. Limitation [48b] is contained within the limitations of original limitation 2[b]. It would have been obvious over the teachings of *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets-Broussard079*for the same reasons as those discussed in Section XI.A.3 of my original declaration.

237. Additionally, as discussed above in Section XIII.G.10 regarding limitation [41n], the *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets-Broussard079* renders obvious *"the centralized control unit is further configured to monitor … compression of the natural gas."* The combination also renders obvious

[261] Ex. 1004 (*Coli*), [0010], [0038], [0040].
[262] Ex. 1024 (*Broussard079*), [0009], [0024].
[263] Ex. 1024 (*Broussard079*), [0009], [0024].

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"*control compression of natural gas*." As discussed above in Sections XIII.G, incorporated herein by reference, *Coli* teaches a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation."[264] *Armstrong* and *Clancy* each teach control, which would have been included in *Coli's* "control center 40".

238. For example, *Armstrong* teaches "A programmable logic controller (PLC) or other microprocessor-based control unit performs protective functions (alarms, trips, interlock/permissives), control functions (sequencing, logic, PID control), and information functions (operator interface, interface to other systems). … A proportional-integral-derivative (PID) control algorithm is used to adjust the gas compressor speed by adjusting the variable frequency drive device 22."[265] Accordingly, *Armstrong* discloses control of the gas compression.

239. *Clancy* also discloses control of gas compression. *Clancy* discloses that "[t]his invention relates to a power engine natural gas compressor system to optimize the extraction of natural gas from a reservoir and related gathering systems. The system is controlled by a distributed control system (DCS), which is a computer readable program, and allows for (HMI) humane [*sic. human*] machine interface. The DCS is integrated with a power engine computer system, which allows for

[264] Ex. 1004 (*Coli*), [0072].
[265] Ex. 1054 (*Armstrong*) 19:10-25.

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diagnostics, control and data logging."[266] This control would have been with the central monitoring and control system in the combination with *Coli*.

XIV. GROUND 12B: THE COMBINATION OF *COLI, BIRCH, RUSNAK, ARMSTRONG, CLANCY, TROBAUGH, TEETS, BROUSSARD079* AND WHAT WAS OTHERWISE AVAILABLE TO THE PUBLIC, RENDERS SUBSTITUTE CLAIMS 41 AND 42 OBVIOUS.

A. MOTIVATION TO COMBINE

240. The motivation to combine *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, and Broussard079* is the same as that discussed above in Section XIII.F, included herein by reference. It would have been obvious to combine these references with what was known and otherwise available to the public for the same reasons. Such known and available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation of success in the combination for the same reasons, and because such a combination would have involved the mere application of known techniques (those otherwise available to the public) to a known system (the *Coli/Birch/Rusnak/Armstrong/Clancy/Trobaugh/Teets/Broussard079 system*), ready for improvement.

B. SUBSTITUTE CLAIM 41

1. [41p]-[41d]

[266] Ex. 1055 (*Clancy*) [0003].

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241. Limitations [41p] – 41[d] would have been obvious over the combination of *Coli, Birch* and *Rusnak* for the same reasons as those described regarding limitations 1[p] – 1[d] discussed in Sections XI.A.2.a) – XI.A.2.d) of my Original Declaration, and incorporated herein by reference. Further, limitations [41p]-[41d] recite what was already known and available to the public before the time of the '992 Patent. I have been aware of each of these limitations since at least the early 2000s.

2. [41e] & [41f]: "the system further comprising a generator electrically connected to the electric pump to provide power to the electric pump, wherein the generator is a natural gas generator,"

242. Limitations [41e] and [41f] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, and Broussard079* for the same reasons discussed with respect to these limitations in Ground 12A, incorporated herein by reference. Further, limitations [41e] and [41f] recite what was already known and available to the public before the time of the '992 Patent. For example, I have been familiar with natural gas generators since at least the early 1990s. These generators powered various equipment, including electric motor-driven pumps (i.e., electric pumps).

3. [41g]: "the system further comprising a gas filtration skid,"

243. Limitation [41g] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh,* and *Teets* for the same reasons

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discussed above with respect to this limitation in Ground 12A, incorporated herein by reference. What was otherwise known and available to the public further renders this limitation obvious.

244. It is my opinion that a gas filtration skid was known and available to the public before the time of the '992 Patent. I have been familiar with natural gas filtration equipment, including skid-mounted equipment, since at least the 1990s. These gas filtration equipment were used to remove particles and liquids from the natural gas stream before use by on-site equipment, or sale into a natural gas sales line.

245. Patent Owner's expert, Dr. Nikolaou, admits that gas filtration skids were known in hydraulic fracturing in 2015, and were "an available technology":

> Q. Sure. Were gas filtration skids commonly used in hydraulic fracturing in 2015?
>
> A. Gas filtration skids were known as a technology. . . .
>
> Q. Sure. And that's not my question. My question was: Were gas filtration skids used in hydraulic fracturing in 2015?
>
> A. As a technology, gas filtration was used, and it was known at the time. It was an available technology that one could use in any setting desirable.[267]

[267] Ex. 1053 (Nikolaou Dep. Tr.), 10:20-11:2, 11:11-17; *see also* Ex. 1053 (Nikolaou Dep. Tr.), 12:13-13:12.

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246. Patent Owner's expert, Dr. Nikolaou, also testified as to why a POSITA would have been motivated to use a gas filtration skid in hydraulic fracturing. I agree with the motivations stated by Dr. Nikolaou.[268]

247. Therefore, limitation [41g] is rendered obvious by the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, and *Teets* and technology otherwise available to the public, as acknowledged by Dr. Nikolaou.

4. [41h]: "wherein the centralized control unit is further configured to monitor operating characteristics of the gas filtration skid;"

248. Limitation [41h] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, and *Teets* for the same reasons discussed with respect to this limitation in Ground 12A, incorporated herein by reference. It is my opinion that monitoring characteristics of gas filtration skid was known and available to the public before the time of the '992 Patent, as I discuss further for limitation [41i] below. I have been familiar with monitoring operating characteristics of gas filtration equipment since at least the early 2000s.

5. [41i]: "wherein the monitored operating characteristics of the gas filtration skid include at least…

249. Limitation [41i] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, and *Teets* for the same reasons

[268] Ex. 1053 (Nikolaou Dep. Tr.), 12:21-13:12.

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discussed above with respect to this limitation in Ground 12A, incorporated herein by reference, in combination with what was known and otherwise available to the public, as discussed below.

a) Water separator status

250. Monitoring water separator status of a gas filtration skid was known and publicly available before the time of the ’992 Patent. I have been familiar with monitoring the status of water and liquid separators since at least the early 2000s.

251. Patent Owner’s expert, Dr. Nikolaou, admits that in 2015, “the technology for monitoring water separator status was available and known. A POSITA would know that technology.”[269]

252. Patent Owner’s expert, Dr. Nikolaou, also testified as to the reasons a POSITA would be motivated to monitor the water separator's status.[270] I agree with the motivations stated by Dr. Nikolaou.

b) Particulate filter status

253. Monitoring particulate filter status was known and publicly available before the ’992 Patent. I have been familiar with monitoring the status, such as the level of fouling of a particulate filter, since at least the 1990s.

[269] Ex. 1053 (Nikolaou Dep. Tr.), 22:20-23:2.
[270] Ex. 1053 (Nikolaou Dep. Tr.), 21:1-13.

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254. Patent Owner's expert Dr. Nikolaou admits that in 2015, "[t]he technology for monitoring particular filter status was available."[271] Dr. Nikolaou also admitted that monitoring particulate filter status is a "generic" technology that was available in 2015 for fracking systems:

> Q. Were implementers of fracking systems in 2015 monitoring particulate filter status?
>
> A. The technology for doing that was available. It's a generic technology. And to what extent -- to whatever extent one wanted to use that technology, that would be available at the time.[272]

255. Dr. Nikolaou also testified that "[t]he technology of monitoring filter status, as I already mentioned, should one select to use it, it was available," "was definitely available," and was "certainly available in 2015."[273] Dr. Nikolaou also testified about motivations to monitor a water separator's status.[274] I agree with the motivations stated by, Dr. Nikolaou, who testified as to the reasons a POSITA would be motivated to monitor the water separator's status.[275]

c) Gas pressures

[271] Ex. 1053 (Nikolaou Dep. Tr.), 24:20-25:2, 25:11-18.
[272] Ex. 1053 (Nikolaou Dep. Tr.), 25:11-18.
[273] Ex. 1053 (Nikolaou Dep. Tr.), 27:7-9, 27:22-28:3, 29:7-10, 30:11-14, 30:21-31:1, 32:21-33:1.
[274] Ex. 1053 (Nikolaou Dep. Tr.), 21:1-13.
[275] Ex. 1053 (Nikolaou Dep. Tr.), 21:1-13.

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256. Monitoring gas pressures was known and publicly available before the '992 Patent. I have been familiar with monitoring gas pressures in natural gas generators, including those in gas turbine generator systems, since the early 1990s.

257. Patent Owner's expert, Dr. Nikolaou, admits that in 2015, "the technology was known" for monitoring gas pressure of a gas filtration skid[276]:

> Q. My question is: Was it known in 2015 to monitor gas pressure of a gas filtration skid in a hydraulic fracturing operation?
>
> A. So if you're asking whether the technology was known for how to do that, yes, the technology was known.

258. Patent Owner's expert, Dr. Nikolaou, also admits that in 2015, implementers of fracking sites with gas filtration skids "would certainly have availability of the technology for monitoring pressure"[277]:

> Q. Okay. So you don't know whether, in 2015, implementers of fracking sites were monitoring gas pressure of a gas filtration skid?
>
> A. If they have a gas filtration skid, they would certainly have availability of the technology for monitoring pressure.
>
> Q. Does that mean they would have been monitoring pressure?
>
> A. If they chose to do so, the technology would be there, yes.

[276] Ex. 1053 (Nikolaou Dep. Tr.), 34:21-35:5.
[277] Ex. 1053 (Nikolaou Dep. Tr.), 35:17-36:7 (objection omitted); *see also* Ex. 1053 (Nikolaou Dep. Tr.), 37:6-17 (admitting "[t]hey were not technologies that would have to be invented from scratch"), 38:20-39:6 (admitting "the technology would definitely be there"), 40:11-15 (admitting "[t]he technology was available"), 43:5-6 ("Was it known how to do that? It was absolutely known, yes.").

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259. Dr. Nikolaou also admits that in 2015, "[i]f a gas filter operating was used in fracturing, how to monitor gas pressure would be known, yes."[278]:

> Q. I'm asking whether or not known to use -- whether or not it was known to monitor gas pressure of a gas filtration skid in a fracturing operation in 2015?
>
> A. If -- if a gas filtering operation was used in fracturing, how to monitor gas pressure would be known, yes.

260. Dr. Nikolaou also admits the following[279]:

> Q. Okay. Would it surprise you if implementers of fracking sites in 2015 were monitoring gas temperatures of gas filtration skids?
>
> A. No.
>
> Q. Why not?
>
> A. Because it's a technology that -- that was available and it's reasonable to monitor this to ensure proper operation.

261. Dr. Nikolaou also testified about the reasons a POSITA would be motivated to monitor the gas pressure on a gas filtration skid.[280] I agree with the motivations stated by Dr. Nikolaou.

d) Gas temperatures

262. Monitoring gas temperatures was known and publicly available before the '992 Patent. I have been familiar with monitoring gas temperatures, including those in a gas turbine generator system, since the early 1990s.

[278] Ex. 1053 (Nikolaou Dep. Tr.), 39:16-40:1 (objection omitted).
[279] Ex. 1053 (Nikolaou Dep. Tr.), 46:18-47:5.
[280] Ex. 1053 (Nikolaou Dep. Tr.), 34:2-10.

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263. Patent Owner's expert, Dr. Nikolaou, admits that in 2015, the technology was available to monitor gas temperatures of a gas filtration skid[281]:

> Q. Was it known to monitor gas temperature of a gas filtration skid in 2015 in a fracturing operation?
>
> A. The technology was available. . . .

264. Dr. Nikolaou also testified about the reasons a POSITA would be motivated to monitor the gas temperature of a gas filtration skid.[282] I agree with the motivations stated by Dr. Nikolaou.

e) Valve statuses

265. Monitoring valve statuses was known and publicly available before the '992 Patent. I have been aware of monitoring valve statuses of gas filtration equipment since the 1990s.

266. Patent Owner's expert, Dr. Nikolaou, admits that in 2015, "was it known to monitor the valve status for such a system, assuming a filtration system was used, yes, one would know what the technology would be, and it would be reasonable to monitor valve status."[283]

f) Filter bypass status

[281] Ex. 1053 (Nikolaou Dep. Tr.), 40:11-15 (objection omitted).
[282] Ex. 1053 (Nikolaou Dep. Tr.), 40:3-10.
[283] Ex. 1053 (Nikolaou Dep. Tr.), 48:21-49:12.

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267. Monitoring filter bypass status was known and publicly available before the time of the '992 Patent. I have been aware of monitoring filter bypass statuses of gas filtration equipment since the 1990s.

268. Patent Owner's expert, Dr. Nikolaou, admits that in 2015, "the technology would be available" for implementation at fracking sites to monitor filter bypass status[284]:

> Q. In 2015, were implementers of fracking sites monitoring filter bypass status?
>
> A. If they were using a filter and a bypass, it would be reasonable for them to monitor filter bypass status, and the technology would be available.

269. Dr. Nikolaou also admits that the technology was available for filter and filter bypasses in a fracking system using a generator in 2015[285]:

> Q. My -- my question is: In 2015, were implementers of fracking systems using filters and filter bypasses for the gas?
>
> A. For gas fed to a generator?
>
> Q. Yes.
>
> A. For gas fed to a generator, the technology was there. So if they were using a generator, they would know how to use a filter and a filter bypass.

[284] Ex. 1053 (Nikolaou Dep. Tr.), 52:9-15; *see also* Ex. 1053 (Nikolaou Dep. Tr.), 53:7-18.
[285] Ex. 1053 (Nikolaou Dep. Tr.), 54:14-22.

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270. Patent Owner's expert, Dr. Nikolaou, also testified as to why a POSITA would be motivated to monitor filter bypass on a gas filtration skid.[286] I agree with the motivations stated by Dr. Nikolaou.

6. [41j]: "wherein the centralized control unit is further configured to control operating characteristics of the gas filtration skid"

271. Limitation [41i] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh,* and *Teets* for the same reasons discussed with respect to this limitation in Ground 12A, incorporated herein by reference, in combination with the public availability of controlling each of the operating characteristics of the gas filtration skid, as I discuss further below. I have been familiar with controlling gas filtration equipment since at least the early 2000s.

7. [41k]: "wherein the controllable operating characteristics of the gas filtration skid include at least…"

272. Limitation [41k] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh,* and *Teets* for the same reasons discussed with respect to this limitation in Ground 12A, incorporated herein by reference, in combination with the public availability of each limitation, as I discuss further below.

a) Inlet valves

[286] Ex. 1053 (Nikolaou Dep. Tr.), 52:2-15.

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273. Controlling inlet valves of a gas filtration skid was known and publicly available before the time of the ’992 Patent. I have been familiar with controlling inlet valves to gas filtration equipment since at least the early 2000s.

b) Outlet valves

274. Controlling outlet valves of a gas filtration skid was known and publicly available before the time of the ’992 Patent. I have been familiar with controlling outlet valves of gas filtration equipment since at least the early 2000s.

c) Bypass valves

275. Controlling bypass valves of a gas filtration skid was known and publicly available before the time of the ’992 Patent. I have been familiar with controlling bypass valves of gas filtration equipment since at least the early 2000s.

d) Pressure release

276. Controlling pressure release of a gas filtration skid was known and publicly available before the time of the ’992 Patent. I have been familiar with controlling the pressure release of gas filtration equipment since at least the early 2000s.

277. Patent Owner’s expert, Dr. Nikolaou, admits that it was not novel to control pressure release of gas filtration skids in 2015[287]:

> Q. Were implementers of fracking systems in 2015 controlling pressure releases of gas filtration skids?

[287] Ex. 1053 (Nikolaou Dep. Tr.), 61:11-22 (objection omitted).

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A. If a gas filtration skid were used, it would be reasonable to see these pressure release -- this pressure release capability there.

Q. Controlling pressure releases of gas filtration skids was not novel in 2015?

A. As to -- as a technology, no.

8. [41l]: "the system further comprising a gas compressor,"

278. Limitation [41l] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh,* and *Teets* for the same reasons discussed with respect to this limitation in Ground 12A, incorporated herein by reference, in combination with the public availability of gas compressors.

279. Gas compressors used with gas turbine generators were known and publicly available before the time of the '992 Patent. I have been familiar with such compressors since the 1990s.

9. [41m]: "wherein the centralized control unit is further configured to monitor operating characteristics of the gas compressor;

280. Limitation [41m] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh,* and *Teets* for the same reasons discussed with respect to this limitation in Ground 12A, incorporated herein by reference, in combination with the public availability of monitoring operating characteristics of the gas compressor, as I discuss further below.

10. [41n]: "wherein the monitored operating characteristics of the gas compressor include at least…"

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281. Limitation [41n] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh,* and *Teets* for the same reasons discussed with respect to this limitation in Ground 12A, incorporated herein by reference, in combination with the public availability of monitoring each of the operating characteristics of the gas compressor, as I discuss further below.

a) Motor run status

282. Monitoring motor run status of a gas compressor was known and publicly available before the time of the ’992 Patent. I have been familiar with monitoring the “run status” of compressor motors since the early 1990s.

283. Patent Owner’s expert, Dr. Nikolaou, admits that in 2015, it was common to monitor the status of the compressor motor[288]:

> Q. Was it common to monitor the status of the compressor motor in 2015?
>
> A. If -- if a compressor were to be used, yes, it would be common to monitor the status.

b) Oil pump run status

284. Monitoring the oil pump run status of a gas compressor was known and publicly available before the ’992 Patent. I have been aware of monitoring oil pump status for compressor lubricating oil since the 1990s.

c) Enclosure exhaust fan run status

[288] Ex. 1053 (Nikolaou Dep. Tr.), 65:18-22.

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285. Monitoring enclosure exhaust fan run status of a gas compressor was known and publicly available before the time of the ’992 Patent. I have been familiar with monitoring the “run status” of exhaust fans for gas compression equipment enclosures since at least the early 2000s.

286. Patent Owner’s expert, Dr. Nikolaou, admits that in 2015, it was common to monitor the status of an enclosure exhaust fan of a gas compressor[289]:

> Q. Okay. Was it common to monitor the status of an enclosure exhaust fan of a gas compressor in 2015?
>
> A. If a gas compressor were used, yes, one would monitor that. It would be reasonable to monitor.

287. Dr. Nikolaou also testified as to why a POSITA would have been motivated to monitor the run status of the enclosure exhaust fan.[290] I agree with the motivations stated by Dr. Nikolaou.

d) Compressor inlet pressure

288. Monitoring compressor inlet pressure of a gas compressor was known and publicly available before the time of the ’992 Patent. I have been familiar with monitoring compressor inlet pressure since the early 1990s.

289. Patent Owner’s expert, Dr. Nikolaou, admits that in 2015, it was common to monitor the compressor inlet pressure of a gas compressor[291]:

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[289] Ex. 1053 (Nikolaou Dep. Tr.), 68:2-7.
[290] Ex. 1053 (Nikolaou Dep. Tr.), 67:14-68:12.
[291] Ex. 1053 (Nikolaou Dep. Tr.), 69:2-7.

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> Q. Was it common to monitor compressor inlet pressure of a gas compressor in 2015?
>
> A. If one was using a gas compressor, yes, it would be common to monitor the pressure.

290. Dr. Nikolaou also testified as to why a POSITA would have been motivated to monitor compressor inlet pressure.[292] I agree with the motivations stated by Dr. Nikolaou.

e) Compressor discharge pressure

291. The monitoring of compressor discharge pressure for a gas compressor was known and publicly available before the time of the '992 Patent. I have been familiar with monitoring compressor discharge pressure since the early 1990s.

292. Patent Owner's expert, Dr. Nikolaou, admits that in 2015, it was common to monitor compressor discharge pressure[293]:

> Q. Was it common to monitor compressor discharge pressure in 2015?
>
> A. Over all of compressors, yes.

293. Dr. Nikolaou also testified as to why a POSITA would have been motivated to monitor compressor discharge pressure.[294] I agree with the motivations stated by Dr. Nikolaou.

f) Oil pump discharge pressure

[292] Ex. 1053 (Nikolaou Dep. Tr.) 68:15-17, 68:19-69:1.
[293] Ex. 1053 (Nikolaou Dep. Tr.), 72:3-5.
[294] Ex. 1053 (Nikolaou Dep. Tr.), 69:8-72:5.

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294. Monitoring oil pump discharge pressure of a gas compressor system was known and publicly available before the time of the ’992 Patent. I have been familiar with monitoring the discharge pressure of a lubricating oil pump since at least the 1990s.

11. [41o] & [41q]: “wherein the centralized control unit is coupled to the electric pump via one or more of cabling, Ethernet, or wirelessly; and wherein the centralized control unit is further configured to reset a fault occurring in the variable frequency drive.

295. Limitations [41o] & [41q] are rendered obvious by the combination of *Coli, Birch, Rusnak* & *Dykstra* for the same reasons as those discussed in Sections XI.A.2.f and XI.A.2.g in my original declaration, in combination with the public availability of these limitations. Limitation [41o] and [41q] recite what was known and otherwise available to the public before the time of the ’992 Patent. I have been familiar with coupling VFDs to central control units via cabling, Ethernet or wirelessly since the early 1990s. Further, I have been familiar with resetting a fault in the VFD from a central control unit since at least the early 2000s.

296. Accordingly, the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, and Teets, together with the public availability of these limitations,* renders Limitations [41o] & [41q] obvious.

C. CLAIM 42

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297. Claim 42 depends from Claim 41. I incorporate by reference my discussion of Claim 41 in Ground 12B.

1. [42a]: "The system of [claim 1] claim 41, further comprising: a generator electrically connected to the electric pump to provide power to the electric pump, wherein the generator is powered by liquefied natural gas, and"

298. Limitation [42a] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, and Broussard079* for the same reasons discussed above with respect to this limitation in Ground 12A, incorporated herein by reference, in combination with what was known and otherwise available to the public

299. Generators powered by liquefied natural gas (LNG) were known and publicly available before the time of the '992 Patent. LNG is a technology for transporting natural gas to its use location, where it is vaporized into gaseous natural gas and used in applications that combust natural gas. I have known of LNG since at least the early 2000s.

300. Patent Owner's expert, Dr. Nikolaou admits that as of 2015, generators were powered by liquefied natural gas[295]:

> Q. As of 2015, were there generators that were powered by liquefied natural gas?
>
> A. Yes.

[295] Ex. 1023 (Nikolaou Dep. Tr.), 31:7-9.

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301. Therefore, limitation [42a] is rendered obvious by the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets*, and *Broussard079* and technology otherwise available to the public, as acknowledged by Dr. Nikolaou.

2. [42b]: "wherein the centralized control unit is further configured to monitor and control compression of the natural gas."

302. Limitation [42b] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets,* and *Broussard079* for the same reasons discussed with respect to this limitation in Ground 12A, incorporated herein by reference, in combination with what was known and otherwise available to the public. Monitoring and controlling compression of natural gas was known and publicly available before the time of the '992 Patent. I have been familiar with monitoring and controlling compression of natural gas since the 1990s.

XV. GROUND 13A: THE COMBINATION OF *COLI, BIRCH, RUSNAK, ARMSTRONG, CLANCY, TROBAUGH, TEETS, HUNT* AND *GENSEL* RENDERS SUBSTITUTE CLAIM 43 OBVIOUS.

A. STATUS AND OVERVIEW OF *GENSEL* (EX. 1033)

303. *Gensel* is United States Patent Application Publication that was filed on March 31, 2009, and was published on July 30, 2009. *Gensel* is prior art to the '992 Patent.

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304. *Gensel* discloses "a fire extinguishing system" that is suited "in particular for casings for electronics, or switchgear cabinets".[296] *Gensel* discloses that "a switchgear cabinet with a smoke detecting device is known. … The smoke detecting device sets off the alarm."[297] *Gensel* also discloses that "fire detection is made by means of sensors adapted to the fire parameters, which are technically denoted as automatic fire alarms." [298] Further, *Gensel* teaches that separate monitoring systems monitor the alarms. *Gensel* discloses that "[a]larms and disorders are transferred by means of potential-free contacts [i.e., dry contacts] or via a data bus to higher-order monitoring or guiding devices."[299] *Gensel* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

B. MOTIVATION TO COMBINE

305. The motivation to combine *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh,* and *Teets* is the same as that discussed above in Section XIII.F, included herein by reference. The motivation to combine Hunt is the same as that discussed in my original declaration. Nothing in *Hunt* teaches against the combination with Armstrong, *Clancy, Trobaugh,* and *Teets.* A POSITA would have been motivated to

[296] Ex. 1033 (*Gensel*) [0001]-[0002].
[297] Ex. 1033 (*Gensel*) [0004].
[298] Ex. 1033 (*Gensel*) [0031].
[299] Ex. 1033 (*Gensel*) [0031].

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further combine the *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets* system with *Gensel*.

306. As discussed in my Original Declaration, the combined *Coli-Birch-Rusnak-Hunt* system teaches a switchgear that operates as an emergency power off unit.[300] *Gensel* discloses "a fire extinguishing system" that is suited "in particular for casings for electronics, or switchgear cabinets".[301] *Gensel* discloses that "a switchgear cabinet with a smoke detecting device is known. … The smoke detecting device sets off the alarm."[302] *Gensel* also discloses that "fire detection is made by means of sensors adapted to the fire parameters, which are technically denoted as automatic fire alarms." [303] Further, *Gensel* teaches that separate monitoring systems monitor the alarms. For example, *Gensel* discloses that "[a]larms and disorders are transferred by means of potential-free contacts [dry contacts] or via a data bus to higher-order monitoring or guiding devices."[304]

307. It was well known in the art that switchgear (and the rooms housing it) were prone to fire due to the high currents and voltages associated with it.[305] Thus, a POSITA implementing the *Coli-Birch-Rusnak-Hunt-Armstrong-Clancy-*

[300] Ex. 1003 (Original Declaration), ¶¶ 277-307.
[301] Ex. 1033 (*Gensel*) [0001]-[0002].
[302] Ex. 1033 (*Gensel*) [0004].
[303] Ex. 1033 (*Gensel*) [0031].
[304] Ex. 1033 (*Gensel*) [0031].
[305] See, e.g., Ex. 1034 (*Whitaker*), 342.

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Trobaugh-Teets system would have been motivated to incorporate *Gensel's* teachings of a switchgear fire alarm being monitored by a "higher-order" monitoring system to *Coli*'s site-wide monitoring system. Overall, such a combination represents the mere application of known techniques (i.e., switchgear fire alarm monitoring, as taught by *Gensel*) to a known system (e.g., a hydraulic fracturing system with centralized control and monitoring) that is ready for improvement (i.e., to enhance the overall system's safety). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

C. CLAIM 43

308. The *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets-Hunt-Gense1* combination renders Claim 43 obvious. Claim 43 depends from Claim 41. In addition to the discussion regarding Claim 41 above, incorporated herein by reference, the references disclose each and every limitation of Claim 43, as discussed in the subsections below.

1. [43a]: "The system of [claim 1] claim 41, wherein the electric pump is a plurality of electric pumps,"

309. *Coli* discloses limitation [43a] for the same reasons as those discussed in Section XI.A.5 of my original declaration, incorporated herein by reference.

2. [43b]: "the system further comprising a switch gear,"

310. The *Coli-Birch-Rusnak-Hunt-Armstrong-Clancy-Trobaugh-Teets-Gense1* combination renders obvious "the system further comprising a switchgear."

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As discussed in my Original Declaration, the *Coli-Birch-Rusnak-Hunt* combination discloses a system that includes a switchgear.[306] Further, *Gensel* also discloses switchgear.[307]

3. [43c] and [43d]: "wherein the centralized control unit is further configured to monitor operating characteristics of the switch gear, wherein operating characteristics include at least the status of a fire alarm."

311. *Gensel* discloses "a fire extinguishing system" that is suited "in particular for casings for electronics, or switchgear cabinets".[308] *Gensel* discloses that "a switchgear cabinet with a smoke detecting device is known. … The smoke detecting device sets off the alarm."[309] *Gensel* also discloses that "fire detection is made by means of sensors adapted to the fire parameters, which are technically denoted as automatic fire alarms." [310] Further, *Gensel* teaches that separate monitoring systems monitor the alarms. *Gensel* discloses that "[a]larms and disorders are transferred by means of potential-free contacts [dry contacts] or via a data bus to higher-order monitoring or guiding devices."[311]

312. It would also have been obvious, and a POSITA would have been motivated to monitor a fire alarm associated with the switchgear, given that

[306] Ex. 1003 (Original Declaration), ¶¶ 277-307.
[307] Ex. 1033 (*Gensel*) [0001]-[0002].
[308] Ex. 1033 (*Gensel*) [0001]-[0002].
[309] Ex. 1033 (*Gensel*) [0004].
[310] Ex. 1033 (*Gensel*) [0031].
[311] Ex. 1033 (*Gensel*) [0031].

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switchgear was known to pose a fire risk, as discussed above. In combination with *Coli*'s control system, it would have been obvious to monitor the status of such a first alarm in view of *Coli*'s teaching that its control system monitors all equipment of a hydraulic fracturing site, and *Gensel's* teaching of monitoring switchgear fire alarms with a "higher order" system, such as *Coli's* sitewide monitoring system. Further, Patent Owner's expert testified that monitoring for a switchgear fire alarm status was known and provided reasons why a POSITA would do so.[312]

XVI. GROUND 13B: THE COMBINATION OF *COLI, BIRCH, RUSNAK, ARMSTRONG, CLANCY, TROBAUGH, TEETS, HUNT GENSEL*, AND TECHNOLOGY OTHERWISE AVAILABLE TO THE PUBLIC RENDERS SUBSTITUTE CLAIM 43 OBVIOUS.

A. MOTIVATION TO COMBINE

313. The motivation to combine *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, Hunt,* and *Gensel* is the same as that discussed above in Section XV.B, included herein by reference. It would have been obvious to combine these references with known technology otherwise available to the public for the same reasons. Such available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation of success in the combination for the same reasons, and because such a combination would have involved the mere application of known techniques (those

[312] Ex. 1023 (Nikolaou Dep. Tr.), 52:2 – 53:5.

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otherwise available to the public) to a known system (the *Coli/Birch/Rusnak/Armstrong/Clancy/Trobaugh/Teets/Hunt/Gensel system*) ready for improvement.

B. CLAIM 43

314. Claim 43 depends from Claim 41. I incorporate by reference my discussion of Claim 41 in Ground 12B.

1. [43a]: "The system of [claim 1] claim 41, wherein the electric pump is a plurality of electric pumps,"

315. Limitation [43a] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Hunt*, and *Gensel* for the same reasons discussed with respect to these limitations in Ground 14A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

2. [43b]: "the system further comprising a switch gear,"

316. Limitation [43b] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Hunt*, and *Gensel* for the same reasons discussed with respect to these limitations in Ground 14A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

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317. The use of switchgear was known and publicly available before the '992 Patent. I have been familiar with switchgear used to switch power to electric motor-driven pumps (i.e., electric pumps) since the 1980s.

3. [43c] & [43d]: "wherein the centralized control unit is further configured to monitor operating characteristics of the switch gear, wherein operating characteristics include at least the status of a fire alarm."

318. Limitations [43c] and [43d] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak, Armstrong, Clancy, Trobaugh, Teets, Hunt,* and *Gensel* for the same reasons discussed with respect to these limitations in Ground 14A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

319. Monitoring the status of a fire alarm associated with a switch gear before the time of the '992 Patent. I have been familiar with monitoring fire alarm status in switchgear since the early 1990s.

320. Patent Owner's expert, Dr. Nikolaou, admits that as of 2015, the technology of monitoring the status of a fire alarm associated with a switchgear was known[313]:

> Q. As of the time of the 992 patent application in 2015, was it known to monitor the status of a fire alarm associated with a switchgear?

[313] Ex. 1023 (Nikolaou Dep. Tr.), 52:16-53:5 (objections omitted).

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> A. The technology of monitoring the status of a fire alarm was known at the time.
>
> Q. And it was known to monitor status of fire alarm of switchgear at the time?
>
> A. It was known for any application that would require that for which the fire alarm would be relevant.

321. Therefore, limitations [43c] and [43d] are rendered obvious by the combination of *Coli*, *Birch*, *Rusnak, Armstrong*, *Clancy*, *Trobaugh, Teets*, *Hunt*, and *Gensel* and technology otherwise available to the public, as acknowledged by Dr. Nikolaou.

XVII. GROUND 14A: THE COMBINATION OF *COLI, BIRCH, HUNT, RUSNAK, ARMSTRONG, CLANCY, TROBAUGH, TEETS, SMITH BROMELL, AND THOMPSON* RENDERS OBVIOUS SUBSTITUTE CLAIMS 45 AND 46.

322. In my opinion, the combination of *Coli*, *Birch*, *Rusnak, Armstrong, Clancy, Trobaugh, Teets*, *Smith,* and *Bromell* discloses and/or suggests to a POSITA each element of Substitute Claim 45. In my opinion, the combination of *Coli*, *Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets*, *Smith, Bromell, and Thompson* discloses and/or suggests to a POSITA each element of Substitute Claim 46.

A. STATUS AND OVERVIEW OF *SMITH* (EX. 1035)

323. *Smith* is a U.S. Patent that was filed on May 4, 1925, and was issued on June 11, 1929. *Smith* is prior art to the ’992 Patent.

324. *Smith* discloses a “means for shutting down large hydraulic turbines and connected generators … from a switchboard or some other point distant from the

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said actuator or governor" which "enable[s] a switch board operator, through electrical connections and elements, to shut down a turbine unit in an emergency by simply closing a switch to energize and actuate a movable electrical part, which effects the result sought through the governor mechanism."[314] *Smith* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

B. STATUS AND OVERVIEW OF *BROMELL* (EX. 1036)

325. *Bromell* is a U.S. Patent filed on May 16, 1969, and issued on September 20, 1971. *Bromell* is prior art to the '992 Patent.

326. *Bromell* discloses "drilling rig control" that includes the "determination of off-normal operation upon the deviation of one of three variables from individually established levels."[315] When such "off-normal operation" is detected, *Bromell* discloses "sound[ing] an alarm."[316] *Brommel* further teaches that the audible alarm is initiated with a switch (relay). For example, *Brommel* discloses "alarm controller 50 energizes the relay 54, thereby closing a contact 54-1 in series with an indicating light 60 shown in FIG. 2. The light 60 will be connected to a source of voltage at the terminals 62 and 64 through a contact 66. The contact 66 has previously been closed in the normal sequence of operation. In addition to turning

[314] Ex. 1035 (*Smith*), 1:1-3, 1:23-29.
[315] Ex. 1036 (*Bromell*), 1:33-36.
[316] Ex. 1036 (*Bromell*), 1:19-21.

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on the light 60 by closing the contact 54-1, energizing the relay 54 closes a contact 54-2 to energize a horn 68 to *produce an audible alarm*."[317]

327. Further, *Bromell* discloses that the alarm condition indicates an automatic shutdown due to the "off-normal" condition. *Bromell* teaches that "[i]n addition to giving a visual and audible indication of a change in drill string weight, energizing the relay 54 also opens a contact 54-3 which de-energizes a relay 70, thereby shutting down the drilling rig."[318] *Bromell* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

C. STATUS AND OVERVIEW OF *THOMPSON* (EX. 1037)

328. *Thompson* is U.S. Patent Application Publication No. 2009/0181582, filed on January 16, 2009, and published on July 16, 2009. *Thompson*, therefore, is prior art to the '992 Patent.

329. *Thompson* discloses an "enhanced cable assembly for [a] field data distribution system formed by a plurality of twisted conductor pair bundled within a conductive shield and an insulative sheath."[319] *Thompson* further teaches that "[t]he conductor pairs, in cooperation with the cable connector, are configured to comply with Category 5E specifications, often referred to as Cat 5E."[320] *Thompson* further

[317] Ex. 1036 (*Bromell*) 4:29-37 emphasis added.
[318] Ex. 1036 (*Bromell*) 4:38-41.
[319] Ex. 1037 (*Thompson*) Abstract.
[320] Ex. 1037 (*Thompson*) [0015].

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explains that the cable "may also include an outer "armor" layer (not shown) to reduce damage to the cable member 77 from contact with rough objects in the field, such as rocks, branches, exposed tree roots, and the like, being run over by vehicles, or being chewed by animals."[321] *Thompson* further teaches that the cable is "for carrying computer network signals, such as Ethernet type signals."[322] *Thompson*'s disclosures regarding the deployment of durable, resilient communication means are reasonably pertinent to the problem addressed by the '992 Patent—controlling and/or monitoring industrial equipment from a centralized location.

D. MOTIVATION TO COMBINE.

330. A POSITA would have been motivated to combine *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Trobaugh*, and *Teets*, and to further combine these references with *Broussard079*.[323] Further, a POSITA would have been motivated to combine *Hunt* for the same reasons as those described in Section XI.C.1 of my original declaration. Nothing in Hunt teaches against the combination. A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Hunt-Armstrong-Clancy-Trobaugh-Teets-Broussard079* system with *Smith* and *Bromell*.

331. The combined *Coli-Birch-Rusnak-Hunt-Armstrong-Clancy-Trobaugh-Teets-Broussard079* system teaches a switchgear that operates as an emergency

[321] Ex. 1037 (*Thompson*) [0049], *see also* [0015].
[322] Ex. 1037 (*Thompson*) [0008].
[323] Section XIII.B above.

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power off unit for shutting down a turbine generator.[324] *Smith* discloses a "means for shutting down large hydraulic turbines and connected generators," "by simply closing a switch."[325] *Bromell* discloses "drilling rig control" that "sound[s] an alarm" when "off-normal" operation is detected.[326] As discussed above in Section XVII.B, the alarm condition indicates an automatic shutdown due to an "off-normal" condition. A POSITA would have been motivated to incorporate *Bromell's* teaching of an audible alarm indicating a shutdown because of an "off-normal" condition, with *Smith's* teaching of an emergency shutdown simply by closing operating a switch. A POSITA would have recognized that both *Smith* and *Bromell* teach taking actions for shutdown using a switch (a relay is a type of switch). A POSITA would have been motivated to incorporate an audible alarm for safety, so that personnel on the site would be immediately notified that an emergency condition existed, necessitating the emergency shutdown. Further, as discussed above in Section V.D, a POSITA would have been motivated to meet industry standards, including NFPA 79, which states that a switch was one of the methods recognized for use in an e-stop system.[327]

[324] Ex. 1003 (Original Declaration), ¶¶ 267-307.
[325] Ex. 1035 (*Smith*), 1:1-3, 1:23-29.
[326] Ex. 1036 (*Bromell*), 1:19-21, 1:33-36.
[327] See Section V.D above.

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332. I further understand that Patent Owner's expert Dr. Nikolaou testified that a POSITA would want to implement an emergency power off unit in a fracturing system as "a way to stop the operation if continuation would create problems for the equipment or for humans," that "[p]ower off units were used in 2015," and that the technology for using power off units operated by a switch that sounds an audible alarm were "definitely available" and "indeed, used, yes."[328]

333. Incorporating *Smith* and *Bromell* into the combined *Coli-Birch-Rusnak-Hunt-Armstrong-Clancy-Trobaugh-Teets-Broussard079* system, such that the emergency power off unit may be controlled by a switch (as taught by *Smith*) that triggers an audible alarm (as taught by *Bromell*) represents the mere application of known techniques (*i.e.*, *Smith*'s switch-controlled technique for shutting down an turbine generator and *Bromell*'s teachings of an audible alarm) to a known system (*e.g.*, a hydraulic fracturing system) ready for improvement (*i.e.*, to improve the safety of the overall system). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

334. A POSITA would have been motivated to combine *Coli*, *Birch*, *Rusnak*, and *Hunt*, and further combine these references with *Broussard079*, *Smith*, and

[328] Ex. 1053 (Nikolaou Dep. Tr.), 72:6-73:8.

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Bromell.[329] A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Hunt-Broussard079* system with *Thompson.*

335. A POSITA would have been motivated to use shielded, armored CAT 5E Ethernet cables, such as those disclosed in *Thompson*, for transmitting signals to and from *Coli*'s control system.[330] *Thompson* discloses the use of a cable comprised of "a plurality of twisted conductor pair[s] bundled within a conductive shield and an insulated sheath" which also comprises "an outer 'armor' layer (not shown) to reduce damage to the cable member 77 from contact with rough objects in the field, such as rocks, branches, exposed tree roots, and like, being run over by vehicles, or being chewed by animals."[331] *Thompson* further teaches that the cable is "for carrying computer network signals, such as Ethernet type signals."[332] A POSITA would have understood that, at a hydraulic fracturing site, "rough objects" are present, including at least rocks and edges of equipment, such as pumps and transports, and would have appreciated the benefits of protecting the cable from such rough objects. A POSITA would also have understood the benefits of protecting the cables from "being run over by vehicles", as there are numerous vehicles at a fracturing site that pose a hazard to cables that communicate between locations,

[329] See Section XII.F.3. above
[330] Ex. 1003 (*Original Declaration*), ¶¶ 165-168.
[331] Ex. 1037 (*Thompson*) Abstract, [0049].
[332] Ex. 1037 (*Thompson*) [0008].

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including switchgear and gas turbines. Further, *Thompson* teaches that conductors "carrying data between computers may be shielded separately from the other conductor pairs to minimize possible interference to and from other signals on other conductor pairs."[333] A POSITA would have recognized the benefits of avoiding interference between on data signals. Further, a POSITA implementing the *Coli-Birch-Rusnak-Hunt-Broussard079-Smith-Bromell* system would have been motivated to look to additional references that provide details and specific types of Ethernet cables, such as *Thompson*, as *Coli* makes it at least obvious to use Ethernet communications at a fracturing site.

336. Overall, such a combination represents the mere application of known techniques (*i.e.*, a shielded CAT5e with an outer "armor" layer, as taught by *Thompson*) to a known system (*e.g.*, *Coli*'s hydraulic fracturing system, which uses Ethernet cables) ready for improvement (*i.e.*, to gain the benefits of shielded CAT5e cabling, such as more resilient communication cables). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

E. CLAIM 45

337. The *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets-Smiteh-Bromell* combination renders Claim 45 obvious. Claim 45 depends from Claim 42.

[333] Ex. 1037 (*Thompson*) [0013], [0046].

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In addition to the discussion regarding Claim 42 above, incorporated herein by reference, *Smith* and/or *Bromell* discloses each and every limitation of 42.

1. [45a] The system of claim 42, further comprising an emergency power off unit coupled to the centralized control unit, the electric pump, and the generator,

338. Limitation [45a] is disclosed by the combination of *Coli*, *Birch*, *Rusnak* and *Hunt* for the same reasons as those discussed in Section XI.C.2 of my original declaration.

2. [45b] wherein the emergency power off unit is configured to substantially immediately cut power from the generator when activated,

339. Limitation [45b] is disclosed by the combination of *Coli*, *Birch*, *Rusnak* and *Hunt* for the same reasons as those discussed in Section XI.C.2 of my original declaration.

3. [45c]: "*wherein the emergency power off unit is operated by a switch that sounds an audible alarm.*"

340. The *Coli-Birch-Rusnak-Hunt-Armstrong-Clancy-Trobaugh-Teets-Broussard079-Smith-Bromell* combination renders obvious "*wherein the emergency power off unit is operated by a switch that sounds an audible alarm*." *Smith* discloses a "means for shutting down large hydraulic turbines and connected generators," which enables an operator to "shut down a turbine unit in an emergency by simply closing a switch to energize and actuate a movable electrical part, which effects the

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result sought through the governor mechanism."[334] *Bromell* discloses "drilling rig control" that includes the "determination of off-normal operation upon the deviation of one of three variables from individually established levels."[335] When such "off-normal operation" is detected, *Bromell* discloses "sound[ing] an alarm."[336]

341. It would have been obvious to effectuate the "emergency power-off" functionality of the *Coli-Birch-Rusnak-Hunt-Armstrong-Clancy-Trobaugh-Teets-Broussard079-Smith-Bromell* system via a "switch," as taught by *Smith*. And it further would have been obvious to sound an alarm when triggering such a switch, as it was well-known in the art to "sound an alarm" to notify an oil and gas site about "off-normal operation," as taught by *Bromell*, which a POSITA would have understood to include an "emergency power off" scenario. Further, Patent Owner's expert testified that an emergency power off unit powered by a switch that sounds an audible was not only known, but "that capability ***should be there*** should emergency arise for quick and safe powering off of the unit to avoid both damage to the equipment and worse injuries or even loss of life [of] humans a switch would be used along with an audible alarm to alert everybody around that the emergency

[334] Ex. 1035 (*Smith*), 1:1-3, 1:23-29.
[335] Ex. 1036 (*Bromell*), 1:33-36.
[336] Ex. 1036 (*Bromell*), 1:19-21.

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power off has been activated."[337] Further, Dr. Nikolaou testified that this would have been implemented without undue experimentation.[338]

342. Accordingly, limitation [26c] is disclosed by the *Coli-Birch-Rusnak-Hunt-Armstrong-Clancy-Trobaugh-Teets-Broussard079-Smith-Bromell* combination.

F. CLAIM 46:

343. The *Coli-Birch-Rusnak-Armstrong-Clancy-Trobaugh-Teets-Smiteh-Bromell-Thompson* combination renders Claim 46 obvious. Claim 46 depends from Claim 45. In addition to the discussion regarding Claim 42 above, incorporated herein by reference, *Thompson* discloses each and every limitation of 46.

1. [46a] The system of claim 45, the emergency power off unit comprising an auxiliary power and a switchgear, each coupled to the generator and the centralized control unit,

344. Limitation [46a] is disclosed by the combination of *Coli, Birch, Rusnak* and *Hunt* for the same reasons as those discussed in Section XI.C.2 of my original declaration.

2. [46b] wherein the switchgear is responsive to a signal from the centralized control unit to open a breaker to substantially immediately cut power to the generator,

[337] Ex. 1023 (Nikolaou Dep. Tr.), 63:9-19 emphasis added.
[338] Ex. 1023 (Nikolaou Dep. Tr.), 72:19-73:4.

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345. Limitation [46a] is disclosed by the combination of *Coli, Birch, Rusnak* and *Hunt* for the same reasons as those discussed in Section XI.C.2 of my original declaration.

3. [46c] wherein the signal is transmitted over armored shielded CAT5E cabling.

346. *Thompson* discloses the use of a "cable assembly for [a] field data distribution system formed by a plurality of twisted conductor pair bundled within a conductive shield and an insulative sheath" which is "configured to comply with Category 5E specifications, often referred to CAT 5E" and has "an outer 'armor' layer (not shown) to reduce damage to the cable member 77 from contact with rough objects in the field such as rocks, branches, exposed tree roots, and the like, being run over by vehicles or being chewed by animals".[339]

347. It would have been obvious to a POSITA that the cabling used by *Coli*'s control system for transmitting signals, including an emergency power off signal as recited in Substitute Claim 46, would have been armored, shielded CAT5E cabling, as this particular type of cabling was known for Ethernet transmissions as taught by *Thompson*, and provides benefits such as protection of the cable from physical damage and prevention of interference with data signals. As Dr. Nikolaou testified, and I agree, armored shielded cabling was known at the time of the '992

[339] Ex. 1037 (*Thompson*) Abstract, [0015], [0049].

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Patent.[340] Thompson discloses armored, shielded Cat 5E cabling, along with the benefits of such cable. Thus, the *Coli-Birch-Rusnak-Hunt-Broussard079-Smith-Bromell-Thompson* combination renders this limitation obvious.

XVIII. GROUND 14B: THE COMBINATION OF *COLI, BIRCH, HUNT, RUSNAK, ARMSTRONG, CLANCY, TROBAUGH, TEETS, SMITH, BROMELL, THOMPSON,* AND WHAT WAS OTHERWISE AVAILABLE TO THE PUBLIC RENDERS OBVIOUS SUBSTITUTE CLAIMS 45 AND 46.

A. MOTIVATION TO COMBINE

348. The motivation to combine *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Smith*, *Bromell*, and *Thompson* is the same as that discussed above in Section XVII.D, included herein by reference. It would have been obvious to combine these references with known technology otherwise available to the public for the same reasons. Such available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation of success in the combination for the same reasons, and because such a combination would have involved the mere application of known techniques (those otherwise available to the public) to a known system (the *Coli/Birch/Rusnak/Armstrong/Clancy/Trobaugh/Teets/Smith/Bromell/Thompson system*) ready for improvement.

B. CLAIM 45

[340] Ex. 1023 (Nikolaou Dep. Tr.), 78:7-80:4; Ex. 1053 (Nikolaou Dep. Tr.), 95:16-96:8.

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349. Claim 45 depends from Claim 42. I incorporate by reference my discussion of Claim 42 in Ground 12B.

1. [45a]: The system of claim 42, further comprising an emergency power off unit coupled to the centralized control unit, the electric pump, and the generator,

350. Limitation [45a] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Smith*, and *Bromell* for the same reasons discussed with respect to these limitations in Ground 14A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

351. An emergency power off unit was known and publicly available before the time of the '992 Patent. I have been familiar with emergency power off units that cut power to generators since the 1990s.

352. The emergency power-off unit would be coupled to a centralized control unit, an electric pump, and a generator.

2. [45b]: wherein the emergency power off unit is configured to substantially immediately cut power from the generator when activated,

353. Limitation [45b] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Smith*, and *Bromell* for the same reasons discussed with respect to these limitations in Ground 14A,

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incorporated herein by reference, in combination with what was publicly available before the time of the ’992 Patent.

354. An emergency power-off unit that substantially immediately cuts power to the generator when activated was known and publicly available before the ’992 Patent. I have been familiar with emergency power off units that immediately cut power to the generator since the 1990s.

3. [45c]: “wherein the emergency power off unit is operated by a switch that sounds an audible alarm.”

355. Limitation [45c] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak, Armstrong, Clancy*, *Trobaugh*, *Teets*, *Smith*, and *Bromell* for the same reasons discussed with respect to these limitations in Ground 14A, incorporated herein by reference, in combination with what was publicly available before the time of the ’992 Patent.

356. An emergency power-off unit operated by a switch that sounded an audible alarm was known and publicly available before the time of the ’992 Patent. I have been familiar with emergency power off units that sound audible alarms since the 1990s.

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357. Patent Owner's expert admits that in 2015 it was common to implement emergency power off units and that the technology for power off units operated by a switch that sounds an audible alarm was "definitely available"[341]:

> Q. Okay. What is an emergency power off unit operated by a switch that sounds an audible alarm?
>
> A. So if -- if there is an emergency, then there would be a switch that would be activated and there would be an alarm so that people around the area would be alerted about the problem that has emerged.
>
> Q. Why would one -- why would one want to implement such a -- an emergency power off unit in a fracturing system?
>
> A. An emergency power off unit is a way to stop the operation if continuation would create problems for the equipment or for humans.
>
> Q. Was it common to implement such an emergency power off unit in 2015?
>
> A. Power off units were used in 2015, yes, in various contexts, yes. Yeah.
>
> Q. Power off units that are operated by a switch of that sounds an audible alarm?
>
> A. The technology for doing this was definitely available and such units were, indeed, used, yes.

358. Dr. Nikolaou also testified that a POSITA would "consider these as a reasonable safety measure."[342] I agree with the motivations stated by Dr. Nikolaou.

[341] Ex. 1053 (Nikolaou Dep. Tr.), 72:6-73:8.
[342] Ex. 1053 (Nikolaou Dep. Tr.), 73:13-14.

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359. Therefore, limitation [45c] is rendered obvious by the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Smith*, and *Bromell*, and technology otherwise available to the public, as acknowledged by Dr. Nikolaou.

C. CLAIM 46

360. Claim 46 depends from Claim 45. I incorporate by reference my discussion of Claim 45 above.

1. [46a]: The system of claim 45, the emergency power off unit comprising an auxiliary power and a switchgear, each coupled to the generator and the centralized control unit,

361. Limitation [46a] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Smith*, *Bromell*, and *Thompson* for the same reasons discussed with respect to these limitations in Ground 14A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

362. Auxiliary power and a switchgear in an emergency power off unit that were coupled to a generator were known and publicly available before the time of the '992 Patent. I have been familiar with such systems since the 1990s.

363. In an electric-driven hydraulic fracturing system, the auxiliary power and switchgear would be coupled to the generator and centralized control unit.

2. [46b]: wherein the switchgear is responsive to a signal from the centralized control unit to open a breaker to substantially immediately cut power to the generator,

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364. Limitation [46b] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, Smith, Bromell,* and *Thompson* for the same reasons discussed with respect to these limitations in Ground 14A, incorporated herein by reference, in combination with what was publicly available before the time of the ’992 Patent.

365. Switchgear opening a breaker to immediately cut power to the generator in response to a signal from a centralized control unit was known and publicly available before the time of the ’992 Patent. I have been familiar with such systems since the 1990s.

3. [46c]: “wherein the signal is transmitted over armored shielded CAT5E cabling.”

366. Limitation [46a] would have been obvious over the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, Smith, Bromell,* and *Thompson* for the same reasons discussed with respect to these limitations in Ground 14A, incorporated herein by reference, in combination with what was publicly available before the time of the ’992 Patent.

367. Transmitting signals over armored, shielded CAT5E cabling was known and publicly available before the ’992 Patent. I have been familiar with such cable since the 2000s.

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368. Patent Owner's expert, Dr. Nikolaou, admits that in 2015 "[t]he technology was definitely available" for signals to switchgears to be transmitted over armored shielded CAT5E cabling[343]:

> Q. Was it common in 2015 for signals to switchgears to be transmitted over armored shielded Cat5e cabling?
>
> A. The technology was definitely available at the time, yes.

369. Therefore, limitation [46c] is rendered obvious by the combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, Smith, Bromell,* and *Thompson* and technology otherwise available to the public, as acknowledged by Dr. Nikolaou.

XIX. GROUND 15A THE COMBINATION OF *COLI, BIRCH, RUSNAK, EKANAYAKE, BLISS, BROUSSARD079, AND GENSEL* RENDERS SUBSTITUTE CLAIMS 47-49, 52, 54, 56-57 AND 59 OBVIOUS

A. STATUS AND OVERVIEW OF *EKANAYAKE* (EX. 1027)

370. *Ekanayake* is a U.S. Patent that was filed on April 30, 2013, and was issued on June 10, 2014. *Ekanayake* is therefore prior art to the '992 Patent.

371. *Ekanayake* relates to "filter systems for gas turbines and more particularly to systems for monitoring the degree of fouling of gas turbine filters."[344] *Ekanayake* discloses that the system includes "a fouling detection instrument" for detecting the extent to which the filter assembly has been "fouled" (dirty) and "a

[343] Ex. 1053 (Nikolaou Dep. Tr.), 96:4-8.
[344] Ex. 1027 (*Ekanayake*), 1:16-19.

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wireless communication module" for "wirelessly communicating the degree of fouling."[345] *Ekanayake* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

B. STATUS AND OVERVIEW OF BLISS (EX. 1058)

372. Bliss is United States Patent No. 6,576,849. The application that led to Bliss was filed on December 1, 2000 and was published on June 6, 2002. *Bliss* was granted on June 10, 2003. *Bliss* is prior art to the '992 Patent.

373. *Bliss* discloses a "weighing apparatus" comprising load cells. *Bliss* further discloses failure modes of load cells and "designs and methods for load cell failure prediction."[346] *Bliss* teaches "a weighing apparatus which has the capability to perform diagnostics and communication data including load cell failure prediction."[347] Further, *Bliss* discloses that its teachings are "to be understood as being a broad, teaching disclosure directed to persons of skill in the appropriate arts, and not as limiting upon the present invention."[348] *Bliss* further discloses methods and techniques to "makes periodic tests to determine the health of the load cells in the system, producing a log file to record events such as any detected failure, suspicious reading, overload condition, or any user defined parameter".[349]

[345] Ex. 1027 (*Ekanayake*), 2:19-35.
[346] Ex. 1058 (*Bliss*) 1:19-21.
[347] Ex. 1058 (*Bliss*) 4:66-5:2.
[348] Ex. 1058 (*Bliss*) 5:9-12.
[349] Ex. 1058 (*Bliss*) Abstract, 2:41–46.

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374. *Bliss* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

C. MOTIVATION TO COMBINE

375. The motivation to combine *Coli*, *Birch* and *Rusnak* is the same as that discussed in Section XI.A.1 of my original declaration, which is incorporated herein by reference. A POSITA would have been further motivated to combine *Coli* with *Ekanayake* and *Bliss* as described below.

376. *Coli* discloses a “control center 40” that includes “controls and computer monitoring for the entire fracturing operation.”[350] Included in *Coli*’s fracturing operation are “[o]ne or more natural gas-powered turbine generators 30” that generate electric power for use in the fracturing operation.[351] *Ekanayake* discloses monitoring particular aspects of turbine generator operation, while Bliss provides further details regarding monitoring Ekanayake’s load cells (i.e., transmitters) for failure.

377. For example, *Ekanayake* discloses a “filter assembly” that monitors the extent to which a gas turbine’s air inlet filter is “fouled” or dirtied by filtered particulate.[352] *Ekanayake* discloses a “filter assembly” that filters “air entering a gas

[350] Ex. 1004 (*Coli*), [0072].
[351] Ex. 1004 (*Coli*), [0038], [0040].
[352] Ex. 1027, 1:24-27, 2:19-35.

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turbine for power generation application."[353] The filter assembly further "includes a fouling detection instrument" for detecting the extent to which the filter assembly has been "fouled" and "a wireless communication module" for "wirelessly communicating the degree of fouling."[354] *Ekanayake* discloses that an air inlet filter for a gas turbine "provide[s] a safe and efficient operation" of the gas turbine. *Ekanayake* discloses "methods and systems that may determine the location of dirty air filters" so that the dirty (fouled or loaded) air filters can be cleaned or otherwise maintained.[355] *Ekanayake*'s techniques also "permit an operator to make appropriate adjustments for proactive compliance with filtered air specifications rather than being notified after-the-fact by a differential pressure or other warning."[356]

378. *Ekanayake* discloses that, in its "smart" filter assembly, "[e]ach section of filters may have a device that measures weight, such as a compression type strain gauge load cell 415 or a tension type strain gauge load cell 410."[357] *Ekanayake* further teaches that "load cells may be applied to loads from 0-500,000 pounds with accuracy of 0.03% to 0.25% full scale. With this in mind an appropriate load cell for the load range application may be selected along with the appropriate secondary auxiliary components to determine the incremental weight of the group of filters

[353] Ex. 1027, 1:24-27.
[354] Ex. 1027 (*Ekanayake*), 2:19-35.
[355] Ex. 1027 (*Ekanayake*), 3:21-26.
[356] Ex. 1027 (*Ekanayake*), 3:35-39.
[357] Ex. 1027 (*Ekanayake*), 4:13-19.

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attributable to the filters increased dust loading."[358] *Ekanayake* further discloses that "strain gauge load cells, as discussed herein, convert the load acting on them into electrical signals."[359] Accordingly, load cells are transmitters, as they transmit the measured weight via electrical signals.

379. *Bliss* includes techniques for monitoring load cell failures, like those used in *Ekanayake*. As *Bliss* teaches, "load cells can fail catastrophically … but more often, the failure is by degrees over a period of time."[360] *Bliss* further discloses that "failure of a load cell in a weighing apparatus can cause a company to lose money and goodwill due to downtime and possible inaccurate readings, being able to predict this failure and to plan around it would be extremely valuable."[361] To accomplish this goal, *Bliss* teaches "a weighing apparatus which has the capability to perform diagnostics and communication data including load cell failure prediction."[362] Bliss further discloses methods and techniques *Bliss* further discloses methods and techniques to "makes periodic tests to determine the health of the load cells in the system, producing a log file to record events such as any detected failure, suspicious reading, overload condition, or any user defined parameter".[363] Further, *Bliss*

[358] Ex. 1027 (*Ekanayake*), 4:34-40.
[359] Ex. 1027 (*Ekanayake*) 11:56-57.
[360] Ex. 1058 (*Bliss*) 1:23-25.
[361] Ex. 1058 (*Bliss*) 2:14-18.
[362] Ex. 1058 (*Bliss*) 4:66-5:2.
[363] Ex. 1058 (*Bliss*) 2:41–46.

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discloses that its teachings are "to be understood as being a broad, teaching disclosure directed to persons of skill in the appropriate arts, and not as limiting upon the present invention."[364]

380. A POSITA would have been motivated to monitor for failure of the turbine air inlet filter transmitter to know whether appropriate action, including maintenance or replacement of the transmitter, is needed. Operating this transmitter in a failed condition would have led to improper turbine operation, such as starving it of air. It would have been obvious to a POSITA that *Coli*'s control system would have monitored the status of *Ekanayake*'s filter assembly and associated load cells (*i.e.*, "*turbine air inlet filter transmitter*") using *Bliss's* teachings to ensure that these components are operating correctly and have not failed. Further, Patent Owner's expert testified that monitoring for a turbine air inlet filter transmitter failure was known and provided reasons why a POSITA would do so.[365]

381. Overall, such a combination represents the mere application of known techniques (*i.e.*, *Ekanayake's* techniques of monitoring for dirty air inlet filters using load cells, and *Bliss'* techniques for monitoring for a failure of the load cells (i.e. transmitters) to a known system (*e.g.*, *Coli*'s hydraulic fracturing system, which uses a turbine generator) ready for improvement (*i.e.*, to gain the benefits of filtered air

[364] Ex. 1058 (*Bliss*) 5:9-12.
[365] Ex. 1023 (Nikolaou Dep. Tr.), 38:8 – 39:17.

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and proper maintenance of the air filters). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

382. A POSITA would have been motivated to add *Broussard079* to the *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss* combination for the same reasons as those discussed in Sections XIII.F and XV above and incorporated herein by reference. Nothing in *Broussard079* teaches against the combination.

383. The motivation to combine *Gensel* into the combination is the same as that discussed above in Section XV.B and incorporated herein by reference. Nothing in *Gensel* teaches against the combination.

D. CLAIM 47

384. The *Coli-Birch-Rusnak-Ekanayake-Bliss* combination renders Claim 47 obvious. As discussed in the subsections below, *Coli*, *Birch*, *Rusnak*, *Ekanayake*, and/or *Bliss* disclose and render obvious each and every limitation of Claim 47.

1. [47a][i]: "A method, comprising: pumping fracturing fluid into a well in a formation with an electrically powered pump,

385. *Coli* describes a "system [] for hydraulic stimulation of underground hydrocarbon-bearing formations."[366] The title of *Coli* is "Mobile, Modular, Electrically Powered System for Use in Fracturing Underground Formations."[367]

[366] Ex. 1004 (*Coli*), [0009].
[367] Ex. 1004 (*Coli*), Cover.

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Coli describes "a system for use in delivering pressurized fluid to a wellbore."[368] Accordingly, *Coli* discloses hydraulically fracturing a formation in an oil or gas well, and that the well has a wellbore that permits passage of fluid from the wellbore into the formation.

386. *Coli* further teaches that its system is intended to extract oil or gas from the formation. *Coli* teaches that fracturing is designed to assist in the "recover[y] of unconventional oil and gas resources" including "natural gas production from shale formations."[369]

387. The '992 Patent admits that pumps used in hydraulic fracturing were known. To wit, "[h]ydraulic fracturing has been used for decades to stimulate production from oil and gas wells. The practice consists of pumping fluid into a wellbore at high pressure. Inside the wellbore, the fluid is forced into the formation being produced. When the fluid enters the formation, it fractures, or creates fissures, in the formation. Water, as well as other fluids, and some solid proppants, are then pumped into the fissures to stimulate the release of oil and gas from the formation."[370]

388. *Coli* also discloses hydraulic fracturing pumps, and that these pumps are powered using electricity (i.e. an "electric pump"). *Coli* discloses "one or more

[368] Ex. 1004 (*Coli*), [0013].
[369] Ex. 1004 (*Coli*), [0006]
[370] Ex. 1001 ('992 Patent), 1:22–36.

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fracturing modules 20 [annotated in red]," each containing an electric motor 21 (annotated in blue) and a fluid pump 22 (annotated in green) that "utilize electric power...to pump the fracturing fluid directly to the wellbore" (i.e., an electric pump).[371] These pumps act to pressurize the fluid for "fracturing the wellbore" (i.e., configured to pump fluid into the wellbore at high pressure so that the fluid passes from the wellbore into the formation, and fractures the formation).[372] Fig. 3 of *Coli* shows the trailer 10 containing the fracturing modules 20, pumps 22, motors 21 and drive unit 50.

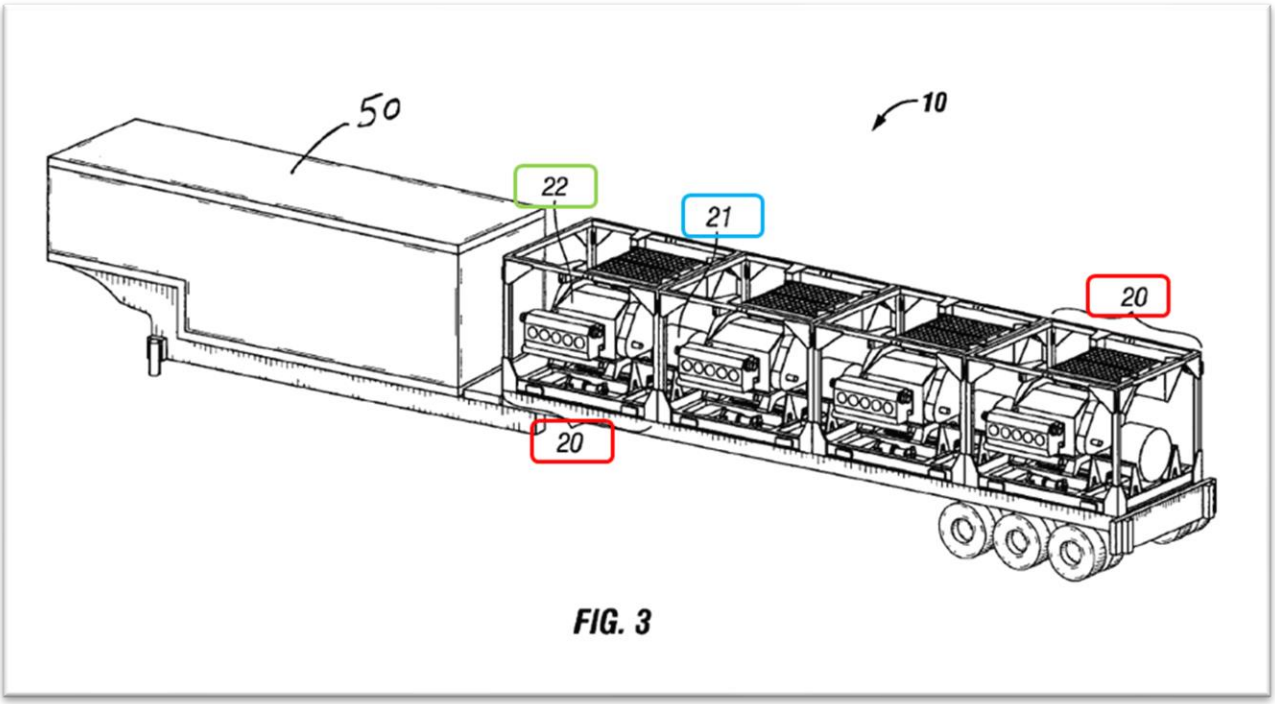
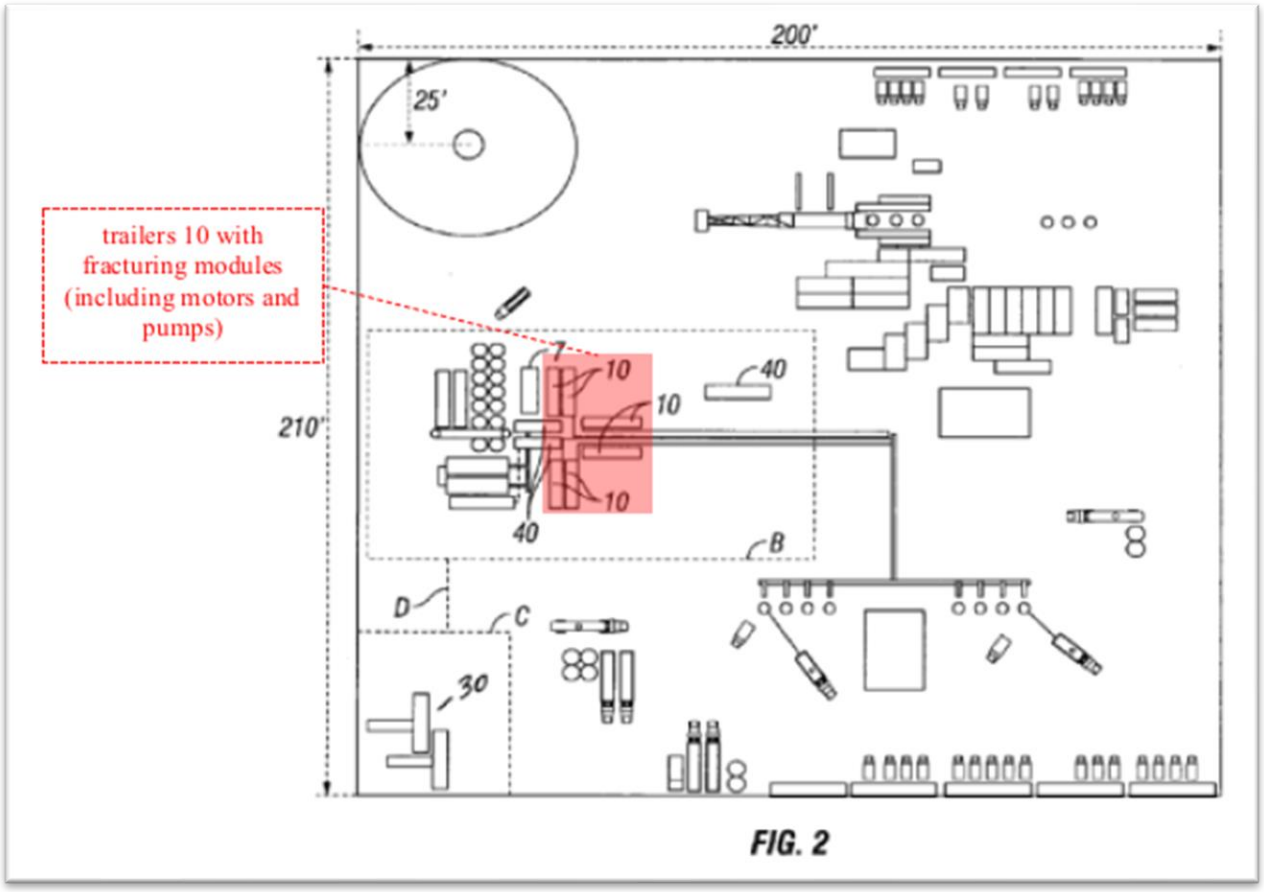


FIG. 3

389. Figure 2 illustrates the location of trailer 10 at the fracturing site.

[371] Ex. 1004 (*Coli*), [0040].
[372] Ex. 1004 (*Coli*), [0005]; *see also* [0083], Claim 12.

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Ex. 1004 (*Coli*), Fig. 2 (annotations added).

390. Accordingly, *Coli* discloses limitation [47a][i].

2. [47a][ii]: "the fracturing fluid having at least a liquid component and a solid proppant, and inserting the solid proppant into the cracks to maintain the cracks open, thereby allowing passage of oil and gas through the cracks;"

391. First, the '992 Patent admits and explains that "[f]racturing rock in a formation *requires* that the slurry be pumped into the wellbore at very high pressure. This pumping is typically performed by large diesel-powered pumps. Such pumps are able to pump fracturing fluid into a wellbore at a high enough pressure to crack

the formation".[373] Further, "[w]ater, as well as other fluids, and some solid proppants, are then pumped into the fissures to stimulate the release of oil and gas from the formation."[374] These two references are in the "Background of the Invention" section of the '992 Patent, indicating that such teachings were well known prior to the '992 Patent, as they were.

392. *Coli* discloses "a method of delivering fracturing fluid to a wellbore."[375] *Coli* discloses it was known, even before *Coli*, that "various fluids (along with additives, proppants, gels, cement, etc . . . .) can be delivered to the wellbore under pressure and injected into the wellbore."[376] *Coli* further explains "[i]n a conventional fracturing operation, a 'slurry' of fluids and additives is injected into a hydrocarbon bearing rock formation at a wellbore to propagate fracturing. *Low pressure fluids* are mixed with chemicals, *sand*, and, if necessary, acid, and then transferred at medium pressure and high rate to vertical and/or deviated portions of the wellbore via multiple high pressure, plunger style pumps driven by diesel fueled prime movers. The majority of the fluids injected will be flowed back through the wellbore and recovered, *while the sand will remain in the newly created fracture, thus 'propping' it open and providing a permeable membrane for hydrocarbon fluids and*

[373] Ex. 1001 ('992 Patent) 1:32-36.
[374] Ex. 1001 ('992 Patent) 1:28-32.
[375] Ex. 1004 (*Coli*), [0009].
[376] Ex. 1004 (*Coli*), [0005].

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gases to flow through so they may be recovered." [377] Accordingly, it is my opinion that a POSITA would have understood from *Coli*'s disclosure that the sand is a "proppant," as it "props open" the fractures created during the hydraulic fracturing operation and allows hydrocarbons to flow into the wellbore.[378] Further, *Coli* discloses both a liquid component (i.e., fluids) and a solid component (i.e., proppants) and further discloses a "slurry" which a POSITA would have understood to be a mixture of liquid and solid components. *Coli* specifically discloses the use of a liquid fluid, such as water: "the fluid from fluid source 48 can be, for example, water, oils or methanol blends, and the fluid additive from fluid additive source 44 can be, for example, friction reducers, gellents, gellent breakers or biocides."[379]

393. Accordingly, *Coli* discloses limitation 47[a][ii] and the combination of *Coli*, *Birch*, and *Rusnak* renders 47[a][ii] obvious.

3. [47b] monitoring at a centralized control unit the electrically powered pump;

394. As discussed in my original declaration regarding original Limitation 1[b], *Coli* discloses "a control system" that "can be provided for regulating various equipment and systems within the electric powered fractioning operation" and that "absolute control of all equipment on location can be maintained from one central

[377] Ex. 1004 (*Coli*), [0035] (emphasis added).
[378] *See, e.g.*, Ex. 1006 (*Dykstra*), [0022] ("the terms sand and proppant are used synonymously").
[379] Ex. 1004 (*Coli*) [0055].

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point."[380] *Coli* further discloses "the control system can regulate fracturing module 20 in delivery of treatment fluid from blender module 30 to pumps 22 for delivery to the wellbore,"[381] and "[e]xamples of operations that can be controlled and monitored remotely from control center 40 via communications link 41 can be the power generation function in Area B, or the delivery of treatment fluid from blender module 40 to pumps 22 for delivery to the wellbore."[382] A POSITA would have understood that "regulating" fracturing module 20 (which includes the electric pump) and monitoring "delivery of treatment fluid from blender module 40 to pumps 22 for delivery to the wellbore" discloses "monitor[ing] the electric pump," as recited by Limitation 1[c]. A POSITA would understand that the specific disclosures above are only examples and not limitations of *Coli's* teaching. Accordingly, to the extent that *Coli* does not explicitly disclose monitoring the "electric pump," such a configuration would have been obvious to facilitate *Coli*'s goals of regulating fracturing module 20 and controlling and monitoring delivery of fluid to pumps 22 for delivery to the wellbore.

[380] Ex. 1004 (*Coli*), [0065]; *see also* [0071] – [0072].
[381] Ex. 1004 (*Coli*), [0065].
[382] Ex. 1004 (*Coli*), [0072]. As discussed above, it is my opinion that *Coli*'s discussion of the power generation function in Area B is an obvious typographical error, and it is understood that *Coli*'s power generation functions take place in Area C.

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395. *Coli* also explains that to prevent accidental over-pressures, "[a] maximum pressure value [can be] set at the beginning of the operation [via the control system]."[383] This value corresponds to the "maximum amount of power that can be sent" to the electric motors for the pumps from the generators.[384] It is my opinion that a POSITA would understand that, to set and effectuate a maximum pressure value of the pumps, the control system would monitor the pressure of the pumps (i.e., to determine and respond when pressure meets or exceeds the "maximum pressure value"), and control the power sent to the pumps [via the VFDs and electric motors] so that this maximum pressure is not exceeded. That is, a POSITA would have understood that the control system would monitor the pressure of the pumps in order to determine when the pressure value meets or exceeds the "maximum pressure value," and to take appropriate action. To the extent that *Coli* does not explicitly disclose monitoring pressure at the pumps, such monitoring would have been an obvious implementation, at least because, as just discussed, it would have allowed for improved detection and response to dangerous overpressure situations, thereby improving overall system safety.

396. As *Coli* explains, "[a]ccidental over-pressures are quite common."[385] It is my opinion that a POSITA would have understood that it would be advantageous

[383] Ex. 1004 (*Coli*), [0069].
[384] Ex. 1004 (*Coli*), [0069].
[385] Ex. 1004 (*Coli*), [0067].

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to monitor and control pump pressure to avoid potentially catastrophic overpressure situations that, as *Coli* explains, could cause the entire operation to be shut down for over a week.[386] Accordingly, it is my opinion that a POSITA would have understood, or at least found it obvious, that the control system in *Coli* would monitor the pumps.

397. Accordingly, *Coli* discloses, or at least renders obvious, Limitation [47c], and the combination of *Coli*, *Birch*, *Rusnak*, *Ekanayake* and *Bliss* renders Limitation [47c] obvious.

4. [47c] wherein the centralized control unit is coupled to the electrically powered pump via one or more of cabling, Ethernet, or wirelessly; and

398. As I discussed above, *Coli* teaches a "control center 40" from which "power generation" and pump functions "can be controlled and monitored."[387] The "control center 40" includes "controls and computer monitoring for the entire fracturing operation."[388] The "control center 40" may facilitate control and monitoring "at a single central location," including a location that is remote from the operation.[389] Specifically, as discussed above, the "control system" disclosed in *Coli* is coupled to fracturing modules (electric pumps), or it would have at least been

[386] Ex. 1004 (*Coli*), [0068].
[387] Ex. 1004 (*Coli*) [0072].
[388] Ex. 1004 (*Coli*) [0072].
[389] Ex. 1004 (*Coli*), [0072].

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obvious to do so. *Coli* discloses that control "can be managed via communications link 41. Examples of operations that can be controlled and monitored remotely from control center 40 via communications link 41 can be the power generation function in Area B, or the delivery of treatment fluid from blender module 40 to pumps 22 for delivery to the wellbore."[390]

399. It is my opinion that a POSITA would have understood that communication link 41 would be achieved via "cabling, Ethernet, or wirelessly." For example, *Coli* explains that prior art systems (i.e., a diesel pump control system and a fracturing site) include signals that communicate operational characteristics, which "are typically sent via hardwired cable to an operator console controlled by the pump driver."[391] It is my further opinion that a POSITA would have found it obvious to use the same hardwired cables to couple the control system in an electrified system to the various components throughout the well site. Furthermore, a POSITA would have found that using cables (e.g., Ethernet cables) or without cables (i.e., wirelessly) in an electrical fracturing system would have been no more than an obvious design choice between a predictable, finite number of design possibilities (i.e., with wires or wirelessly), and thus would have been obvious to try.

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[390] Ex. 1004 (*Coli*), [0072]. As discussed above, it is my opinion that *Coli*'s discussion of the power generation function in Area B is an obvious typographical error, and it is understood that *Coli*'s power generation functions take place in Area C.

[391] Ex. 1004 (*Coli*), [0066].

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400. It is my opinion that a POSITA would have recognized that there would have been a limited number of available options for coupling or electronically connecting the control unit to the pumps and generators. That is, a POSITA would have recognized that there were only wired or wireless options. As to wired options, a POSITA would have recognized that coupling or electronically connecting the various components would have required "cables" capable of the transmission of signals, such as Ethernet, and that Ethernet had been known as early as the 1980s[392]. Accordingly, it is my opinion that using cables (or, more specifically, Ethernet cables) or not using cables (wirelessly) would have been obvious design choices.

401. Accordingly, *Coli* discloses, or at least renders obvious, Limitation 47[c] and the combination of *Coli*, *Birch*, *Rusnak, Ekanayake* and *Bliss* renders Limitation 4[e] obvious.

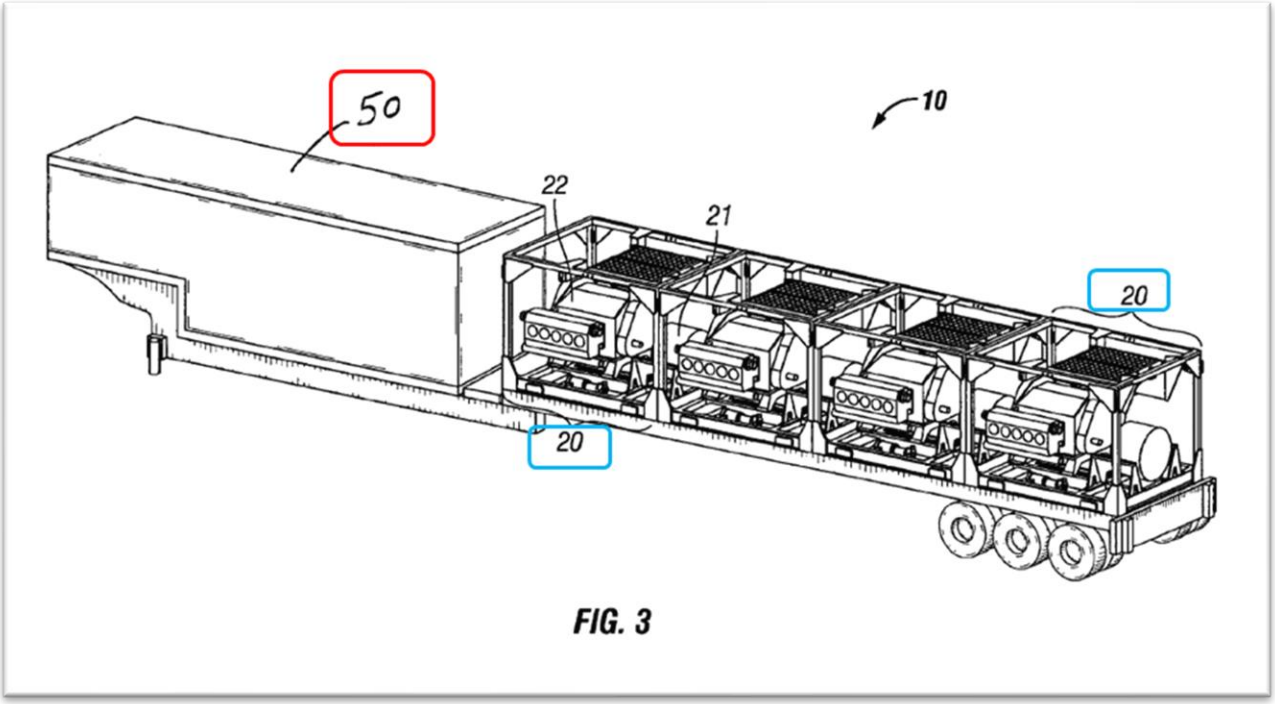
5. [47d] controlling the speed of the pump with a variable frequency drive,

402. *Coli* teaches the use of a "variable speed motor" within the fracturing module 20, and further teaches that the electric motors used in the system are "controlled by variable frequency drives" that "essentially 'tell' the motors what they are allowed to do."[393] A POSITA would have understood this description to

[392] Ethernet protocol is governed by the IEEE 802.3 Standard, which originally published in 1983.
[393] Ex. 1004 (*Coli*), [0011], [0065].

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disclose "at least one variable frequency drive connected to the electric motors to control the speed of the motors." Fig. 3 of *Coli* shows drive 50 (VFD, annotated in red) and fracturing modules 20 (annotated in blue, containing motor 21 and pump 22) mounted on the same trailer.



Ex. 1004 (*Coli*) Fig. 3 (annotated)

403. These motors, in turn, are "coupled directly" to the pumps. Accordingly, by controlling the speed of the motor, *Coli*'s VFD controls the speed of the pump (i.e., a change in the power input to the motors from the variable frequency drive would cause a change in the motor drive shaft rotational speed, which would cause the speed at which the pump is pumping to change).[394] As

[394] Ex. 1004 (*Coli*), [0052], [0069].

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discussed in Section VII.K of my original declaration, controlling the speed of an electric motor (including an attached pump) is one function of VFDs, and VFDs were known to control speeds of motors for decades before the '992 Patent.

404. Accordingly, *Coli* discloses, Limitation 47[d] and the combination of *Coli*, *Birch* and *Rusnak* renders Limitation 47[d] obvious.

6. [47e]: "wherein the centralized control unit is configured to reset a fault occurring in the variable frequency drive;"

405. *Rusnak* discloses an external controller 30 (i.e., centralized control unit) that controls a VFD and "automatically reset[s] [a] faulted condition" in the VFD (i.e., configured to reset a fault occurring in the variable frequency drive).[395] A POSITA would have recognized the benefits of applying *Rusnak*'s teaching of automatically resetting a fault and retrying to start the pump or attempting to re-establish normal operation to the VFD system of *Coli* to remove the need for a POSITA to enter the red zone where the VFD would be located to reset a fault. This would result in increased pump uptime and enhanced system safety.

406. Accordingly, *Rusnak* discloses, or at least renders obvious, Limitation [47e] and the combination of *Coli*, *Birch*, *Rusnak*, *Ekanayake* and *Bliss* renders Limitation [47e] obvious.

7. [47f] the method further comprising powering the electrically powered pump with a generator,

[395] *See, e.g.*, Ex. 1007 (*Rusnak*), [0080]; *see also* Ex. 1007 (*Rusnak*), [0020]-[0021].

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407. *Coli* discloses a plurality of generators powered by natural gas in the form of "[o]ne or more natural gas-powered turbine generators 30."[396] *Coli* teaches that each "fracturing module 20 is operatively associated with turbine generator 30 to receive electric power therefrom."[397] As discussed above, each fracturing module comprises a pump and an electric motor to power the pump.

408. Figure 2 of *Coli* illustrates the plurality of generators:

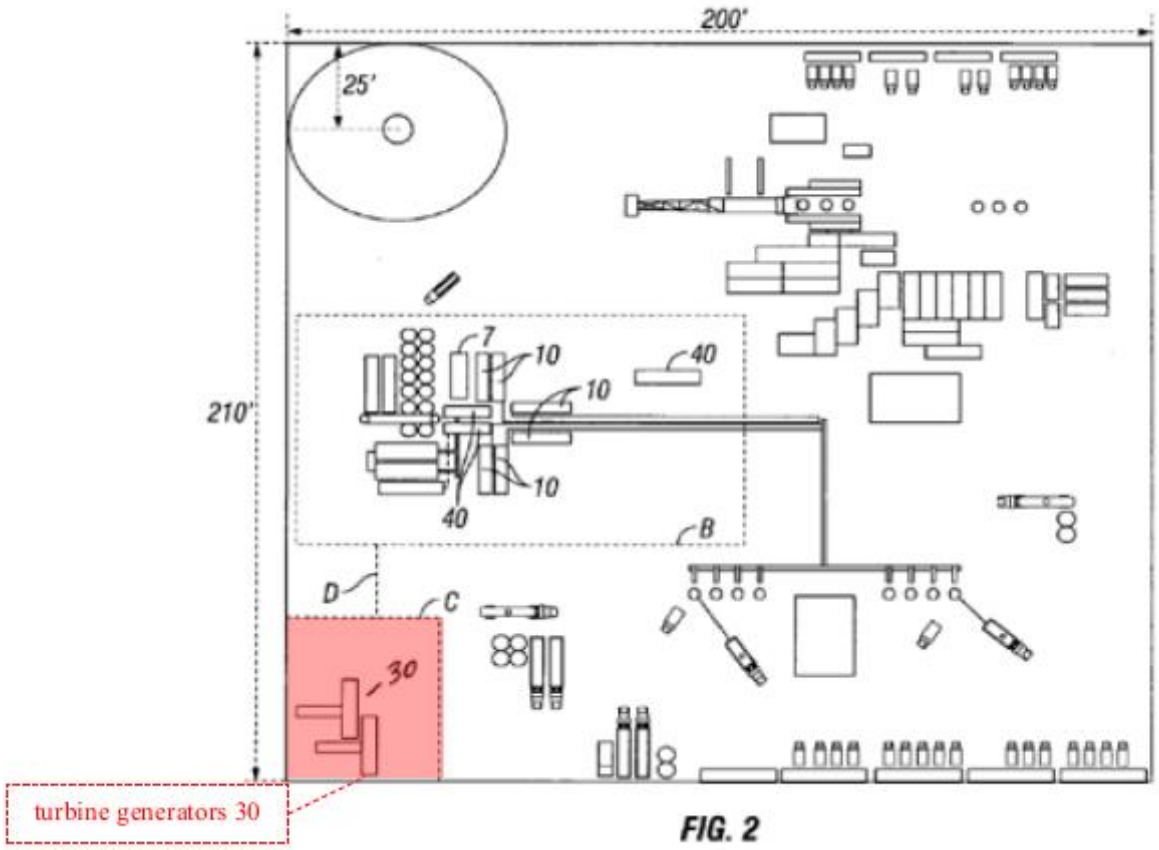


FIG. 2

Ex. 1004 (*Coli*), Fig. 2 (annotated).

[396] Ex. 1004 (*Coli*), [0038].
[397] Ex. 1004 (*Coli*), [0040], *see also, e.g.*, [0043].

409. Accordingly, *Coli* discloses Limitation [47f] and the combination of *Coli*, *Birch*, and *Rusnak* renders Limitation [47f] obvious.

8. [47g] wherein the generator is a turbine generator;

410. As discussed above in Sections XIII.F and XIV.B.7, incorporated herein by reference, *Coli* discloses the use of "[o]ne or more natural gas-powered turbine generators 30"[398] to power the hydraulic fracturing pumps.

411. Accordingly, *Coli* discloses Limitation [47g] and the combination of *Coli*, *Birch*, and *Rusnak* renders Limitation [47f] obvious.

9. [47h] the method further comprising monitoring operating characteristics of the turbine generator; and

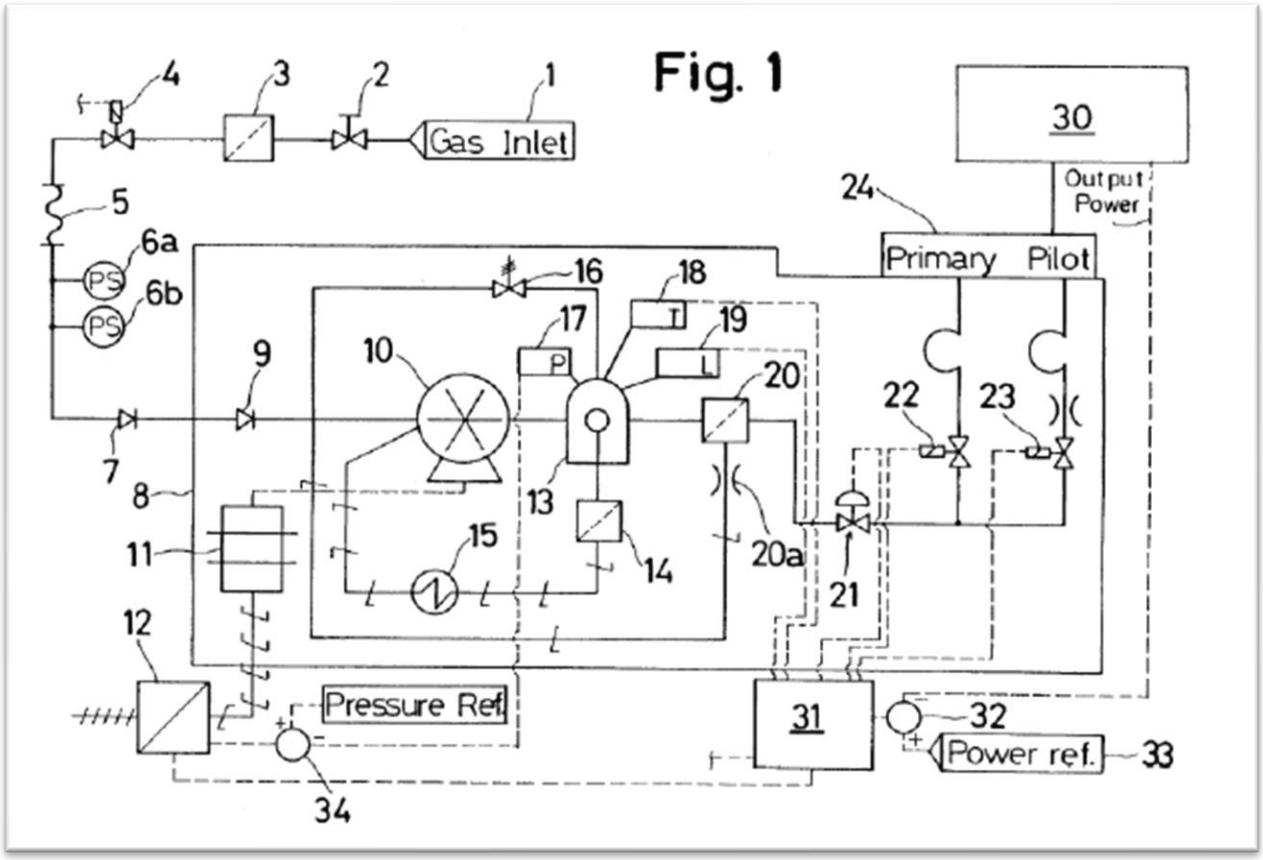
412. *Birch* discloses a gaseous fuel compression control system for a gas turbine that comprises:[399]

> a screw compressor driven by an electric motor for compressing gaseous fuel for supply to the gas turbine engine, a power sensor for sensing the output power of the gas turbine engine, and modulating means for controlling the frequency of electrical power supplied to the electric motor, so as to control speed of the motor, in response to a control signal derived directly or indirectly from the power sensor.

[398] Ex. 1004 (*Coli*), [0038].
[399] Ex. 1005 (*Birch*), 1:60-67.

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Figure 1 illustrates a schematic view of the "gaseous fuel compression and control system supplying a gas turbine:"



Ex. 1005, Fig. 1.

413. It is my opinion that a POSITA would have understood that the controller disclosed in *Birch* monitors and controls the compression and pressure of the natural gas flowing into the gas turbine of the generator. *Birch*'s control system monitors and controls a "compressor driven by an electric motor for compressing gaseous fuel for supply to the gas turbine engine."[400] Control of the compressor is

[400] Ex. 1005 (*Birch*), 1:60–67.

accomplished by using a "modulating means for controlling the frequency of electrical power supplied to the electric motor".[401] After the gas turbine in *Birch* is started, "the gas fuel control system operates continuously in pressure feedback mode."[402] *Birch*'s control system uses a "power reference" or output power setpoint. When the engine's output power exceeds the power reference, the control system slows the motor, reducing the compression and flow of natural gas to the turbine and thereby reducing output power. When the engine's output power is below the power reference, the control system accelerates the compressor motor, increasing compression and supplying more natural gas to the turbine, thereby increasing output power.[403]

414. It is my opinion that a POSITA would have been motivated and found it obvious to implement the central control monitoring features taught by *Birch* into *Coli* so that the control system of *Coli* controls and monitors the compression of natural gas flowing into the gas turbines, to control the power output from the turbine generators and so that "the control of fuel flow to a gas turbine" is simplified. This

[401] Ex. 1005 (*Birch*), 1:60–67.
[402] Ex. 1005 (*Birch*), 4:46-47.
[403] *See* Ex. 1005 (*Birch*), 4:46-67.

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would have furthered *Coli*'s goal of "control and monitoring for the entire fracturing operation can take place at a single central location."[404]

415. The compression (as well as flow rate and output power) are merely additional operating characteristics that would have been monitored and controlled by *Coli*'s control center 40.

416. To the extent that the "power generation" in Fig. 2 is in Area C rather than Area B as specifically disclosed by *Coli*, a POSITA would have found it obvious to apply the same teaching to power generation functions elsewhere on the site. *Coli* teaches that "*[e]xamples* of operations that can be controlled and monitored remotely from control center 40 via communications link 41 can be the power generation function in Area B, or the delivery of treatment fluid from blender module 40 to pumps 22 for delivery to the wellbore."[405] As discussed above, it is my opinion that *Coli*'s discussion of the power generation function in Area B is an obvious typographical error, and it is understood that *Coli*'s power generation functions take place in Area C. Further, a POSITA would understand that the specific disclosures are only examples and not limitations of the teaching. A POSITA would have found it obvious to, when moving the generation function (i.e.,

[404] Ex. 1004 (*Coli*), [0072]. *See also* [0038] "the natural gas powered supply of electricity can be monitored and regulated remotely such that, if desired, no personnel are required to be within region C during operation."
[405] Ex. 1004 (*Coli*), [0072] emphasis added.

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turbine generators) to a new area (i.e., Area C or any other area), move the communication link 41 with the generation function and continue to monitor and control the generation function in the same way.

417. *Coli* teaches coordinated control of the entire system, which would include at least pump modules, blenders and the turbine generator. *Coli* explains that "[i]f a rate change is required, the system will increase the rate of the entire system with a single command."[406] Further, *Birch* teaches control of gas turbine engines using a "power reference" (i.e., a power output setpoint). In the combined system of *Coli* and *Birch*, the "power reference" would come from the control center 40 via communication link 41.[407]

418. Accordingly, the combination of *Coli, Birch, and Rusak* renders Limitation [47h] obvious.

10. [47i] wherein the monitored operating characteristics of the turbine generator include at least turbine air inlet filter transmitter failure.

419. *Ekanayake* discloses a "filter assembly" that filters "air entering a gas turbine for power generation application."[408] The filter assembly further "includes a fouling detection instrument" for detecting the extent to which the filter assembly

[406] Ex. 1004 (*Coli*), [0071], see also [0072] ("Suitable controls and computer monitoring for the entire fracturing operation can take place at a single central location.")
[407] *See* Ex. 1005 (*Birch*), 4:46-67
[408] Ex. 1027, 1:24-27.

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has been "fouled" and "a wireless communication module" for "wirelessly communicating the degree of fouling."[409] Thus, the module is associated with the inlet air filter and transmits (communicates) the degree of fouling, and is therefore a turbine air inlet filter transmitter. *Ekanayake* teaches that when the load cells determine the weight of a filter exceeds a "threshold", it determines that the filter is dirty and needs to be cleaned or otherwise maintained.[410] This is consistent with Dr. Nikolaou's testimony that an air inlet filter transmitter is "[a]nything that could be used to transmit a signal" and "[t]here are many options that one can use, either wired or wireless or anything that one can think of" and "lots of technologies for doing that."[411]

420. Various methods would have been available to detect "the degree of fouling" disclosed by *Ekanayake*. *Ekanayake* teaches a mechanism using "load cells" to measure the weight of the filters. *Ekanayake* teaches that "load cells may be applied to load from 0 – 500,000 pounds with accuracy of 0.03% to 0.25% full scale."[412] *Ekanayake* further discloses that "strain gauge load cells, as discussed herein, convert the load acting on them into electrical signals."[413] Accordingly, load

[409] Ex. 1027 (*Ekanayake*), 2:19-35; *see also* Ex. 1053 (Nikolaou Dep. Tr.), 24:5-19, 80:21-81:1.
[410] Ex. 1027 (*Ekanayake*), 1:55-2:3, 3:21-26.
[411] Ex. 1053 (Nikolaou Dep. Tr.), 74:8-14.
[412] Ex. 1027 (*Ekanayake*), 4:34-35.
[413] Ex. 1027 (*Ekanayake*) 11:56-57.

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cells are transmitters, as they transmit the measured weight via electrical signals. This is consistent with the testimony of Patent Owner's expert Dr. Nikolaou, who stated that load cells measure the weight of the filter and then transmit that measurement.[414]

421. As *Bliss* teaches, "load cells can fail catastrophically … but more often, the failure is by degrees over a period of time."[415] *Bliss* further discloses that "failure of a load cell in a weighing apparatus can cause a company to lose money and goodwill due to downtime and possible inaccurate readings, being able to predict this failure and to plan around it would be extremely valuable."[416] In order to plan maintenance, which is also a disclosed goal of *Ekanayake, Bliss* teaches "a weighing apparatus which has the capability to perform diagnostics and communication data including load cell failure prediction."[417] *Bliss* teaches a technique that "makes periodic tests to determine the health of the load cells in the system, producing a log file to record events such as any detected failure, suspicious reading, overload condition, or any user defined parameter".[418] Further, *Bliss* discloses that its teachings are "to be understood as being a broad, teaching disclosure directed to persons of skill in the appropriate arts, and not as limiting upon the present

[414] Ex. 1053 (Nikolaou Dep. Tr.), 73:15-74:14, 75:11-22, 80:6-15, 80:21-81:1..
[415] Ex. 1058 (*Bliss*) 1:23-25.
[416] Ex. 1058 (*Bliss*) 2:14-18.
[417] Ex. 1058 (*Bliss*) 4:66-5:2.
[418] Ex. 1058 (*Bliss*) Abstract, 2:41–46.

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invention."[419] Accordingly, it was known well before the '992 Patent to monitor for failure of load cells, which are used in the teachings of *Ekanayake* as an air inlet filter transmitter, for failures, and to use that monitored data to enhance maintenance of the system as a whole. This is consistent with Dr. Nikolaou's testimony regarding failure.[420]

422. A POSITA would have been motivated to monitor for failure of the turbine air inlet filter transmitter, so that appropriate action, including planning for maintenance or replacement of the transmitter, could be enacted. Operating this transmitter in a failed condition would have led to improper turbine operation, such as starving it of air. It would have been obvious to a POSITA that *Coli*'s control system would have monitored the status (i.e., failure) of *Ekanayake*'s filter assembly and associated wireless communication module (*i.e.*, "*turbine air inlet filter transmitter*") using *Bliss's* teachings to ensure that these components are operating properly and have not failed. Further, Patent Owner's expert testified that monitoring for a turbine air inlet filter transmitter failure was known and provided reasons why a POSITA would do so.[421]

E. SUBSTITUTE CLAIM 48:

[419] Ex. 1058 (*Bliss*) 5:9-12.
[420] Ex. 1053 (Nikolaou Dep. Tr.), 78:11-79:11.
[421] Ex. 1023 (Nikolaou Dep. Tr.), 38:8 – 39:17.

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423. The *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss-Broussard079* combination renders Claim 48 obvious. In addition to the discussion regarding Claim 47 above, incorporated herein by reference, the *Broussard079* discloses each and every additional limitation of Claim 48.

1. [48a] The method of claim 47, further comprising: powering the electrically powered pump with a generator, wherein the generator is fueled by liquefied natural gas; and

424. Limitation [48a] is essentially similar to limitation [42a] and is disclosed by *Coli* for the same reasons as those discussed in Section XIII.H.1 above.

2. [48b] monitoring compression of natural gas.

425. Limitation [48b] is contained within the limitations of original limitation 2[b] and would have been obvious over the teachings of *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss-Broussard079* for the same reasons as those discussed in Section XI.A.3 of my original declaration.

F. SUBSTITUTE CLAIM 49:

426. The combination of *Coli*, *Birch*, *Rusnak*, *Hunt*, *Ekanayake*, *Bliss*, *Broussard079*, and *Gensel* renders Claim 49 obvious. In addition to the discussion of Claim 48 discussed above, and incorporated herein by reference, the combination discloses each and every additional limitation of Claim 49.

1. [49a] & [49b]: "The method of claim 48, the method further comprising monitoring, by the centralized control unit, operating characteristics of a switch gear the operating characteristics including the status of a fire alarm."

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Limitations [49a] & [49b] are contained within those of [43c] and [43d] and are rendered obvious by the combination of Coli, *Birch, Rusnak, Hunt, Ekanayake, Bliss, Broussard079,* and *Gensel* for the same reasons as those discussed in Sections XV.B and XIX.C above.

G. SUBSTITUTE CLAIM 52:

427. The *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss-Broussard079* combination renders Claim 52 obvious. In addition to the discussion regarding Claim 48, incorporated herein by reference, *Broussard079* discloses each and every additional limitation of Claim 52.

1. [52a] The method of claim 48, wherein the generator is a turbine generator; the method further comprising controlling the turbine generator and

428. Limitation [52a] is obvious over the *Coli-Birch-Rusnak-Ekanayke-Bliss-Broussard079* combination for the same reasons as those discussed in Section XI.A.3 of my original declaration, which is incorporated herein by reference.

2. [52b] & [52c]monitoring operating characteristics of the turbine generator, wherein the monitored operating characteristics include…

429. For the reasons discussed below, the *Coli-Birch-Rusnak-Ekanayake-Bliss-Broussard079* combination renders obvious "*monitoring operating characteristics of the turbine generator, wherein the monitored operating characteristics include…* ." *Coli* discloses a "control center 40" that includes "controls and computer monitoring ***for the entire fracturing operation***," which

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includes turbine generators.[422] It would have been obvious to a POSITA to monitor the "*operating characteristics*" listed in [52c], in view of *Coli*'s disclosure and because it was known in the prior art and/or obvious to monitor these operating characteristics, as shown below and as conceded by Dr. Nikolaou.[423]

a) gas fuel main valve discharge pressure transmitter failure, and

430. *Birch* discloses a "gaseous fuel compression and control system for a turbine engine" that includes "under and over pressure electronic sensors 6a and 6b."[424] These sensors monitor the pressure of a "mains supply 1," which supplies natural gas to a compressor associated with a turbine generator.[425] A POSITA would have understood *Birch*'s "under and over pressure electronic sensors 6a and 6b," to be a "gas fuel main valve discharge pressure transmitter," because these sensors monitor pressure of a gas fuel mains supply 1, which includes a solenoid isolating valve 4 just prior to the location of the sensors.[426] Thus, a POSITA would have understood that the sensors monitor a "gas fuel main valve discharge pressure." Furthermore, it was well known for pressure sensors to transmit failure codes.[427]

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[422] Ex. 1004 (Coli), [0010], [0072].
[423] Ex. 1023 (Nikolaou Dep. Tr.), 80:5-82:20.
[424] Ex. 1005 (Birch), 2:30-39, Fig. 1.
[425] Ex. 1005 (Birch), 2:30-39, Fig. 1.
[426] Ex. 1005 (*Birch*), 2:30-39, Fig. 1.
[427] See, e.g., Ex. 1030, (*Rosemount 3051 PT*) C-4-5, listing several error codes that a pressure transmitter is capable of transmitting, including "Output Failure" (condition 8), "Memory Failure" (condition 9), "General Error" (condition 17),

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Accordingly, for the same reasons discussed in my second declaration with reference to Limitation [23c], *Birch* renders monitoring for a gas fuel main valve discharge pressure failure limitation obvious. A POSITA would have been motivated to monitor for failure of the gas fuel main valve discharge pressure transmitter to improve the safety and reliability of the system as a whole, and to determine when the pressure transmitter required maintenance or replacement. Further, Patent Owner's expert testified that monitoring gas fuel main valve discharge pressure transmitter failure was known and provided reasons why a POSITA would do so.[428] I agree with the motivations stated by Dr. Nikolaou.

b) backup system relay failure.

431. *Hunt* discloses a power distribution system in which utility power may be used to power a load (e.g., pumps) if a generator must be disconnected from the load (e.g., due to overheating or fuel starvation).[429] *Hunt* further discloses a "[s]witchgear 221 [that] is coupled to generator power bus 240 and utility power bus 260" and a "[s]witchgear control relay 229 [that] is connected to engage or disengage switchgear 221, thus coupling or decoupling power buses 240 and 260."[430] A POSITA would have understood switchgear control relay 229 to be a "backup

"Electronics Failure" (condition 20), "I/O Failure" (condition 22); see also Ex. 1032 (Internet Archive Declaration), 1-126.
[428] Ex. 1023 (Nikolaou Dep. Tr.), 79:12 - 81:15.
[429] Ex. 1008 (*Hunt*), [0033]-[0035], [0046], [0075]-[0076]
[430] Ex. 1008(*Hunt*), [0046].

system relay" because it controls the engagement of utility power bus 260 (*i.e.*, the "backup system"). It would have been obvious to monitor the status of this relay, including whether it has failed, given *Coli*'s teaching that its control system monitors all equipment at the fracturing site, of which the switchgear control relay is part in the *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss-Broussard079* system. Further, a failure of such a relay would indicate that backup power was unavailable, and it would have been obvious for a POSITA to monitor it to determine whether operations could continue. Further, Patent Owner's expert testified that monitoring backup system relay failure was known and provided reasons why a POSITA would do so.[431] I agree with the motivations stated by Dr. Nikolaou.

H. CLAIM 54

432. The *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss-Broussard079* combination renders Claim 54 obvious. In addition to the discussion regarding Claim 48 above, incorporated herein by reference, the *combination* discloses each and every additional limitation of Claim 48.

1. [54a] The method of claim 48, further comprising:

a) providing an emergency power off unit coupled to the centralized control unit, the electrically powered pump and the generator; and

[431] Ex. 1023 (Nikolaou Dep. Tr.), 81:16-82:20.

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433. This limitation is disclosed by the combination of *Coli, Birch, Rusnak* and *Hunt* for the same reasons as those discussed in Section XI.C.2 of my original declaration.

b) substantially immediately cutting power to the generator by activating the emergency power off unit

434. This limitation is disclosed by the combination of *Coli, Birch, Rusnak* and *Hunt* for the same reasons as those discussed in Section XI.C.2 of my original declaration.

2. [54b] wherein the emergency power off unit is operated by a switch that sounds an audible alarm.

435. This limitation would have been obvious for the same reasons as those discussed regarding limitation [45c] in Section XVIII.B.3 above, which is included herein by reference.

I. SUBSTITUTE CLAIM 56

436. The combination of *Coli*, *Birch*, *Rusnak*, *Ekanayake*, and *Bliss* renders Claim 56 obvious. As discussed in the subsections below, the combination discloses each and every additional limitation of Claim 56.

1. [56p] A system for centralized monitoring and control of a hydraulic fracturing operation, comprising:

437. The limitations of the preamble are encompassed in those of original Claim 1's preamble, and limitations 1[b] – 1[c]. As discussed in Sections XI.A.2.(a),

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(c)-(d) of my original declaration, the combination of *Coli*, *Birch*, and *Rusnak* discloses and suggests to a POSITA each limitation of claim 56[p].

2. [56a] an electric powered fracturing fleet, the electric powered fracturing fleet comprising: a combination of one or more of: electric powered pumps, electric motors, turbine generators, blenders, sand silos, chemical storage units, conveyor belts, manifold trailers, hydration units, variable frequency drives, switchgear, transformers, compressors;

438. Limitation 56[a] would have been obvious for the same reasons as those discussed in Section XI.C.6.b) of my original declaration.

3. [56b] a centralized control unit coupled to electric powered fracturing fleet; and

439. Limitation 56[b] would have been obvious for the same reasons as those discussed in Section XI.C.6.c) of my original declaration.

4. [56c] an emergency power off unit coupled to the centralized control unit, the electric powered pumps and the turbine generators, the emergency power off unit configured to substantially immediately cut power to the turbine generators when activated,

440. Limitation 56[c] would have been obvious for the same reasons as those discussed in Section XI.C.6.d) of my original declaration.

5. [56d] wherein the centralized control unit is configured to: monitor one or more operating characteristics of the electric powered fracturing fleet; and control one or more operating characteristics of the electric powered fracturing fleet;

441. Limitation 56[d] would have been obvious for the same reasons as those discussed in Section XI.C.6.e) of my original declaration.

6. [56e] wherein the centralized control unit is coupled to the electric powered fracturing fleet via one or more of cabling, Ethernet, or wirelessly;

442. Limitation 56[e] would have been obvious for the same reasons as those discussed in Section XI.C.6.f) of my original declaration.

7. [56f] the system further comprising one or more generators electrically connected to the electric pump to provide power to the electric pump;

443. *Coli* discloses this limitation for the same reasons as those discussed in Sections XIII.G.2 above. For example, *Coli* discloses the use of "[o]ne or more natural gas-powered turbine generators 30" for providing electric power to several fracturing modules, and that the turbine generators can be driven by "natural gas."[432]

8. [56g] wherein the one or more generators are turbine generators, and;

444. *Coli* discloses this limitation for the same reasons as those discussed in Section XIX.D.8 above. For example, *Coli* discloses the use of "[o]ne or more natural gas-powered turbine generators 30" for providing electric power to several fracturing modules, and that the turbine generators can be driven by "natural gas."[433]

9. [56h] wherein the centralized control unit is further configured to monitor operating characteristics and control the one or more turbine generators, and

[432] Ex. 1004 (*Coli*), [0010], [0038], [0040].
[433] Ex. 1004 (*Coli*), [0010], [0038], [0040].

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445. As discussed in Sections XIX.D.9, XIX.D.10, and XIX.G.1-2 above, incorporated herein by reference, the combination of *Coli* and *Hunt* discloses monitoring operating characteristics and controlling one or more turbine generators.

10. [56i] wherein the monitored operating characteristics of the one or more turbine generators include at least turbine air inlet filter transmitter failure.

446. Limitation [56i] would have been obvious for the same reasons as those discussed in Section XX.B.2 regarding limitation [47i].

J. CLAIM 57

1. [57a]: "The system of claim 56, the emergency power off unit comprising an auxiliary power and switchgear, each coupled to the one or more turbine generators and the centralized control unit, the switchgear responsive to a signal from the centralized control unit to open a breaker to substantially immediately cut power to the one or more turbine generators"

447. Limitation 57[a] would have been obvious for the same reasons as those discussed in Section XI.C.3 of my original declaration. To the extent that Claim 57 depends from Claim 56 which comprises "one or more generators", and Claim 57 immediately cuts power to "on or more turbine generators", it would have been obvious to immediately cut power to all of the generators on the fracturing site. As discussed above, *Coli* discloses the use of "[o]ne or more natural gas-powered turbine generators 30" for providing electric power to several fracturing modules,

and that the turbine generators can be driven by "natural gas."[434] In an emergency, such as those described by *Hunt*,[435] a POSITA would have understood, from the combined teachings of *Coli* and *Hunt* that all of *Coli's* "one or more" turbine generators would have been disconnected to remove electrical energy from the emergency condition.

2. [57b] and [57c]: "wherein the centralized control unit is further configured to monitor operating characteristics of the switchgear wherein the monitored operating characteristics of the switchgear include at least the status of the fire alarm"

448. *Gensel* discloses "a fire extinguishing system" that is suited "in particular for casings for electronics, or switchgear cabinets".[436] *Gensel* discloses that "a switchgear cabinet with a smoke detecting device is known. … The smoke detecting device sets off the alarm."[437] *Gensel* also discloses that "fire detection is made by means of sensors adapted to the fire parameters, which are technically denoted as automatic fire alarms." [438] Further, *Gensel* teaches that separate monitoring systems monitor the alarms. *Gensel* discloses that "[a]larms and

[434] Ex. 1004 (*Coli*), [0010], [0038], [0040].
[435] Ex. 1008 (*Hunt*), [0067].
[436] Ex. 1033 (*Gensel*) [0001]-[0002].
[437] Ex. 1033 (*Gensel*) [0004].
[438] Ex. 1033 (*Gensel*) [0031].

disorders are transferred by means of potential-free contacts [dry contacts] or via a data bus to higher-order monitoring or guiding devices."[439]

449. It would also have been obvious to monitor a fire alarm associated with the switchgear, given that switchgear was known to pose a fire risk, as discussed above. In combination with *Coli*'s control system, it would have been obvious to monitor the status of such a first alarm in view of *Coli*'s teaching that its control system monitors all equipment of a hydraulic fracturing site, and *Gensel's* teaching of monitoring switchgear fire alarms with a "higher order" system, such as *Coli's* sitewide monitoring system. Further, Patent Owner's expert testified that monitoring for a switchgear fire alarm status was known and provided reasons why a POSITA would do so.[440]

K. CLAIM 59

450. The *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss-Broussard079* combination renders Claim 59 obvious. In addition to the discussion regarding Claim 46 above, incorporated herein by reference, *Broussard079* discloses each and every additional limitation of Claim 59.

1. [59a] The system of claim 56, wherein the centralized control unit is further configured to monitor and control the one or more turbine generators,

[439] Ex. 1033 (*Gensel*) [0031].
[440] Ex. 1024 (Nikolaou Dep. Tr.), 52:2 – 53:5.

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451. This limitation would have been obvious for the same reasons as those discussed above in Section XIX.I.9 regarding limitation 56[h].

2. [59b] wherein the turbine generators are fueled by liquefied natural gas.

452. Broussard079 discloses this limitation for the same reasons as those discussed above in Section XIII.H.1 regarding limitation [42a].

XX. GROUND 15B THE COMBINATION OF *COLI*, *BIRCH*, *RUSNAK*, *EKANAYAKE*, *BLISS*, *BROUSSARD079*, *AND GENSEL* AND WHAT WAS OTHERWISE AVAILABLE TO THE PUBLIC RENDERS SUBSTITUTE CLAIMS 47-49, 52, 54, 56-57 AND 59 OBVIOUS

A. MOTIVATION TO COMBINE

453. The motivation to combine *Coli*, *Birch*, *Rusnak, Ekanayake, Bliss, Broussard079, and Gensel* is the same as that discussed above in Section XIX.C, included herein by reference. It would have been obvious to combine these references with known technology otherwise available to the public for the same reasons. Such available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation of success in the combination for the same reasons, and because such a combination would have involved the mere application of known techniques (those otherwise available to the public) to a known system (the *Coli/Birch/Rusnak/Ekanayake/Bliss/Broussard079/Gensel* system) ready for improvement.

B. CLAIM 47

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1. [47a] – [47h]

454. Limitations [47a] – [47h] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak, Ekanayake*, and *Bliss* for the same reasons discussed with respect to these limitations in Ground 15A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

455. Limitations [47a]-[47h] recite what was known and publicly available before the time of the '992 Patent. I have been aware of each of these limitations since at least the early 2000s.

2. [47i]: "wherein the monitored operating characteristics of the turbine generator include at least turbine air inlet filter transmitter failure"

456. Limitation [47i] would have been obvious over the combination of *Coli, Birch, Rusnak, Ekanayake,* and *Bliss* for the same reasons discussed above with respect to this limitation in Ground 15A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

457. Monitoring turbine air inlet filter transmitter failure of a turbine generator was known, or at least obvious, and publicly available before the time of the '992 Patent. I have been familiar with monitoring turbine air inlet filter transmitters, such as differential pressure transmitters that convey the level of filter fouling, since at least the 2000s. I have also been familiar with monitoring for failure

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of differential pressure transmitters since the early 1990s. It is my opinion that monitoring for failure of a differential pressure transmitter associated with a turbine air inlet filter was obvious to a POSITA at least since the early 2000s.

458. Patent Owner's expert Dr. Nikolaou admits that in 2015 the technology was available to monitor for a failure of an air inlet filter transmitter both for turbines and in general[441]:

> Q. Was it common to monitor for a failure of a turbine air inlet filter transmitter in 2015?
>
> A. For -- for turbines, yes. In general, yes.

459. Dr. Nikolaou further admits that in 2015 the technology for monitoring failure of a turbine generator's air inlet filter transmitter was available[442]:

> Q. As of the time of the 992 patent application in 2015, was it known to monitor for failure of a turbine generator's air inlet filter transmitter?
>
> A. The technology of doing this, yes, it was available.

460. Therefore, limitation [47i] is rendered obvious by the combination of *Coli*, *Birch*, *Rusnak*, *Ekanayake*, and *Bliss* and technology otherwise available to the public, as acknowledged by Dr. Nikolaou.

C. CLAIM 48

461. Claim 48 would have been obvious over the combination of *Coli*, *Birch*, *Rusnak, Hunt, Ekanayake, Bliss, and Broussard079* for the same reasons discussed

[441] Ex. 1053 (Nikolaou Dep. Tr.), 79:12-16.
[442] Ex. 1023 (Nikolaou Dep. Tr.), 39:13-17.

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with respect to these limitations in Ground 15A, incorporated herein by reference. Claim 48 depends from Claim 47. I incorporate by reference my discussion of Claim 47 in Ground 15B by reference.

D. CLAIM 49

1. [49a] & [49b]: "The method of claim 48, the method further comprising monitoring, by the centralized control unit, operating characteristics of a switch gear the operating characteristics including the status of a fire alarm."

462. Limitations [49a] and [49b] would have been obvious over the combination of *Coli, Birch*, *Rusnak, Bliss, Broussard079,* and *Gensel* for the same reasons discussed above with respect to this limitation in Ground 15A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent, for the same reasons as those discussed with respect to limitations [43c] and [43d] in Ground 14B, incorporated herein by reference. Claim 48 depends from Claim 48. I further incorporate by reference my discussion of Claim 48 in Ground 15B.

E. CLAIM 52

463. Claim 52 depends from Claim 48. I incorporate by reference my discussion of Claim 48 in Ground 15B.

1. [52a]: The method of claim 48, wherein the generator is a turbine generator; the method further comprising controlling the turbine generator and

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464. Limitation [52a] would have been obvious over the combination of *Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss, and Broussard079* for the same reasons discussed with respect to these limitations in Ground 15A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

465. Controlling a turbine generator was known and publicly available before the time of the '992 Patent. I have been familiar with controlling a turbine generator since the 1990s.

2. [52b] & [52c]: monitoring operating characteristics of the turbine generator wherein the monitored operating characteristics include…

466. Limitations [52b] and [52c] would have been obvious over the combination of *Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss, and Broussard079* for the same reasons discussed above with respect to this limitation in Ground 15A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

467. Monitoring the operating characteristics of the turbine generator was known and publicly available before the '992 Patent, as I discuss further below.

a) Gas fuel main valve discharge pressure transmitter failure

468. Monitoring gas fuel main valve discharge pressure transmitter failure of a turbine generator was known and publicly available before the time of the '992

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Patent. I have been aware of monitoring the status of a turbine generator gas fuel main valve discharge pressure transmitter failure since at least the early 2000s.

469. Patent Owner's expert, Dr. Nikolaou, admits that as of 2015, it was known to monitor for failure of a turbine generator's gas fuel main valve discharge pressure transmitter[443]:

> Q. Okay. As of the time of the 992 patent application in 2015 was it known to monitor for failure of a turbine generators gas fuel main valve discharge pressure transmitter?
>
> THE WITNESS: The technology for doing that was available at the time that is correct.

b) Backup system relay failure

470. Monitoring backup system relay failure in a turbine generator was known and publicly available before the '992 Patent. I have been aware of monitoring the status, including failure, of a backup system relay since the 1990s.

471. Patent Owner's expert Dr. Nikolaou admits that as of 2015, it was known to monitor for failure of a turbine generator's backup system relay[444]:

> Q. As of the time of the 992 patent application in 2015, was it known to monitor for failure of a turbine generator's backup system relay?
>
> A. The technology for doing this was available at the time, yes.

F. CLAIM 54

[443] Ex. 1023 (Nikolaou Dep. Tr.), 81:9-15 (objection omitted).
[444] Ex. 1023 (Nikolaou Dep. Tr.), 82:11-16 (objection omitted).

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472. Claim 54 would have been obvious over the combination of *Coli*, *Birch, Rusnak, Hunt, Ekanayake, Bliss, and Broussard079* for the same reasons discussed with respect to these limitations in Ground 15A, incorporated herein by reference. Claim 54 depends from Claim 48. I incorporate by reference my discussion of Claim 48 in Ground 15B. Additionally, limitation [54b] recites what was known and otherwise available to the public for the same reasons as those discussed above with respect to limitation [45c] in Ground 14B, which I hereby incorporate by reference. Accordingly, Claim 54 would have been obvious over the combination of *Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss,* and *Broussard079*, in combination with what was publicly available before the time of the '992 Patent.

G. CLAIM 56

1. [56a] – [56h]

473. Limitations [56a] – [56h] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak, Ekanayake*, and *Bliss* for the same reasons discussed with respect to these limitations in Ground 17A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

474. Limitations [56a]-[56h] recite what was known and publicly available before the time of the '992 Patent. I have been aware of limitations [56a], [56b], [56f], and [56h] since at least the early 2000s. I have been aware of emergency power

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off units that immediately cut power to turbine generators as claimed in [56c] since at least the early 2000s. I have been aware of centralized control units monitoring and controlling fracturing fleets, and centralized control units coupled to the monitored equipment via one or more of cabling, Ethernet or wirelessly, as claimed in [56d] and [56e] since at least the early 2000s. I have also been aware of centralized control units monitoring and controlling electric equipment, including motors, and connected as claimed since the early 1990s. In my opinion, it would have been obvious to a POSITA to combine the well-known methods of centralized control of electrical equipment and fracturing fleets to implement the claimed limitations on an electric fracturing fleet long before the '992 Patent.

2. [56i]: "wherein the monitored operating characteristics of the one or more turbine generators include at least turbine air inlet filter transmitter failure."

475. Limitation [56i] would have been obvious over the combination of *Coli, Birch, Rusnak, Ekanayake,* and *Bliss* for the same reasons discussed above with respect to this limitation in Ground 17A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent, for the same reasons discussed with respect to limitation [47i] in Ground 17B, incorporated herein by reference.

H. CLAIM 57

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476. Claim 57 depends from Claim 56. I incorporate by reference my discussion of Claim 56 above.

477. Claim 57 would have been obvious over the combination of *Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss, Gensel* for the same reasons discussed with respect to these limitations in Ground 15A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent, for the same reasons as those discussed above with respect to limitations [43c] and [43d] discussed in Ground 13B and incorporated herein by reference, which recite the same limitations as limitations [57b] and [57d], respectively.

I. CLAIM 59

478. Claim 59 is rendered obvious by the combination of *Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss, and Broussard079* for the same reasons discussed with respect to these limitations in Ground 15A, incorporated herein by reference. Claim 59 depends from Claim 56. I hereby incorporate by reference my discussion of Claim 56 from Ground 15B. Additionally Claim 59 is obvious for the same reasons as limitation [42a] in Ground 12B, which I incorporate by reference.

XXI. GROUND 16A: THE COMBINATION OF *COLI, BIRCH, RUSNAK, EKANAYAKE BLISS, BROUSSARD079* AND *ALLAM* RENDERS CLAIM 50 OBVIOUS

A. STATUS AND OVERVIEW OF ALLAM

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479. *Allam* is United States Patent No. 9,523,312. *Allam* was filed on November 1, 2012, and published on May 2, 2013. Therefore, *Allam* is prior art to the '992 Patent.

480. *Allam* discloses "an integrated power generating system and method and liquefied natural gas (LNG) vaporization system and method."[445] *Allam* further discloses a "power generation system [which] comprises a combustor 1 that combusts the natural gas fuel with oxygen" and "the combustion product stream 6 enters a power turbine 2 driving a turbine electrical generator 3 producing an electrical output 4."[446] *Allam* further discloses that "if desired, the natural [for combustion] gas can be derived from the LNG supply, and the fuel natural gas stream can be provided using a second LNG pump."[447]

481. *Allam* teaches that this second LNG Pump provides compressed LNG to the turbine for combustion: "[t]he natural gas fuel for the power system combustor can be taken from the discharge of a high pressure LNG pump and compressed to the required pressure for combustion in a second LNG pump."[448]

[445] Ex. 1064 (*Allam*) at Abstract.
[446] Ex. 1064 (*Allam*) 14:46-54.
[447] Ex. 1064 (*Allam*) 13:51-56.
[448] Ex. 1064 (*Allam*) 8:30-33.

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482. Further, *Allam* teaches controlling this compression cycle. For example, *Allam* discloses that "[f]low of the compressed LNG stream 32 can be controlled as desired.

483. For example, first control valve 29 and second control valve 49 can be used to determine the routing of the LNG. These, in combination with a variety of further pumps and water bath heaters in the LNG facility (not illustrated), can be used to alternate the flow path of the LNG stream to ensure continuous supply of LNG to the power generation system."[449]

B. MOTIVATION TO COMBINE

484. A POSITA would have been motivated to combine *Coli*, *Birch*, *Rusnak, Ekanayake, Bliss and Broussard079*.[450] A POSITA would have been further motivated to combine the teachings of *Allam* with *Coli*, *Birch*, *Rusnak, Ekanayake, Bliss and Broussard079*. As discussed above in Section XIX.E.1, the combination of *Coli* and *Broussard079* teaches powering turbine generators with liquefied natural gas. *Allam* teaches a method of compressing and vaporizing LNG "to ensure continuous supply of LNG to the power generation system."[451] When using LNG as a fuel for gas turbine generators, as taught by *Coli* and *Broussard079*, a POSITA would desire a continuous supply of LNG to the gas turbine generators.

[449] Ex. 1064 (*Allam*) 15:39-46.
[450] See Section XXV.A above.
[451] Ex. 1064 (*Allam*) 15:39-46.

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485. As *Coli* discloses, in hydraulic fracturing systems, "downhole hydrodynamics are dependent upon constant flow (rate and pressure) of the delivered fluids, and that there should not be any interruption in fluid flow during delivery to the well bore if the fracture is to propagate as desired."[452] A POSITA would have been motivated, based on this express teaching of *Coli*, to ensure that electricity is continuously available to the electric motor driven fracturing pumps. To ensure continuous delivery of electricity, a continuous supply of natural gas (including LNG) to the turbines would be required. A POSITA would have been motivated to look for teachings, such as those in *Allam*, that ensure a continuous supply of LNG to the turbine generator(s). This would include controlling the valves and pumps associated with compression of the LNG, as disclosed by *Allam*.[453]

486. Overall, such a combination represents the mere application of known techniques (*i.e.*, *Allam's* techniques of controlling compression of LNG) to a known system (*e.g.*, *Coli*'s & *Broussard079's* hydraulic fracturing system, which uses a turbine generator fueled by LNG) ready for improvement (*i.e.*, to ensure a continuous supply of LNG to the turbine generators). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

[452] Ex. 1004 (*Coli*) [0036].
[453] Ex. 1064 (*Allam*) 8:30-33; 15:39-46.

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C. SUBSTITUTE CLAIM 50

487. The combination of *Coli*, *Birch*, *Rusnak, Ekanayake, Bliss, Broussard079 and Allam* renders Claim 50 obvious. In addition to the discussion of Claim 48 discussed above, and incorporated herein by reference, the combination discloses each and every additional limitation of Claim 50.

1. [50a] The method of claim 48, further comprising controlling compression of the liquefied natural gas;

488. *Allam* discloses "an integrated power generating system and method and liquefied natural gas (LNG) vaporization system and method."[454] *Allam* further discloses a "power generation system [which] comprises a combustor 1 that combusts the natural gas fuel with oxygen" and "the combustion product stream 6 enters a power turbine 2 driving a turbine electrical generator 3 producing an electrical output 4."[455] *Allam* futher discloses that "if desired, the natural [for combustion] gas can be derived from the LNG supply, and the fuel natural gas stream can be provided using a second LNG pump."[456] *Allam* teaches that this second LNG Pump provides compressed LNG to the turbine for combustion: "[t]he natural gas fuel for the power system combustor can be taken from the discharge of a high pressure LNG pump and compressed to the required pressure for combustion in a

[454] Ex. 1064 (*Allam*) at Abstract.
[455] Ex. 1064 (*Allam*) 14:46-54.
[456] Ex. 1064 (*Allam*) 13:51-56.

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second LNG pump."[457] Further, *Allam* teaches controlling this compression cycle. For example, *Allam* discloses that "[f]low of the compressed LNG stream 32 can be controlled as desired. For example, first control valve 29 and second control valve 49 can be used to determine the routing of the LNG. These, in combination with a variety of further pumps and water bath heaters in the LNG facility (not illustrated), can be used to alternate the flow path of the LNG stream to ensure continuous supply of LNG to the power generation system."[458]

489. Accordingly, *Allam* discloses controlling compression of the liquefied natural gas, and the *Coli-Birch-Rusnak-Ekanayake-Bliss-Broussard079-AllamAllam* combination renders the limitation obvious.

2. [50b] wherein the generator is fueled by liquefied natural gas,

490. *Broussard079* discloses limitation [50b] for the same reasons as those discussed in Section XIII.H.1 regarding limitation [42a]. Accordingly, the *Coli-Birch-Rusnak-Ekanayake-Bliss-Broussard079-Allam* combination renders the limitation obvious.

3. [50c] the method further comprising monitoring operating characteristics of a hydraulic system

491. Limitation [50c] is disclosed by *Broussard079* for the same reasons as those discussed in Section XXIX.D.3 regarding limitation [44c]. Accordingly, the

[457] Ex. 1064 (*Allam*) 8:30-33.
[458] Ex. 1064 (*Allam*) 15:39-46.

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Coli-Birch-Rusnak-Ekanayake-Bliss-Broussard079-Allam combination renders the limitation obvious.

4. [50d] wherein the operating characteristics include system pressure, charge pressure, temperature, hydraulic oil level, and filter status.

492. Limitation [50d] is disclosed by *Delaney* and *Weir* for the same reasons as those discussed in Section XXIX.D.4 regarding limitation [44d]. Accordingly, the *Coli-Birch-Rusnak-XXXX-Broussard079-Allam* combination renders the limitation obvious.

XXII. GROUND 16B: THE COMBINATION OF *COLI, BIRCH, RUSNAK, EKANAYAKE BLISS, BROUSSARD079* AND *ALLAM* AND WHAT WAS OTHERWISE AVAILABLE TO THE PUBLIC RENDERS CLAIM 50 OBVIOUS

A. MOTIVATION TO COMBINE

493. The motivation to combine *Coli*, *Birch*, *Rusnak, Ekanayake, Bliss, Broussard079*, and *Allam* is the same as that discussed above in Section XXI.B, included herein by reference. It would have been obvious to combine these references with known technology otherwise available to the public for the same reasons. Such available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation of success in the combination for the same reasons, and because such combination would have involved the mere application of known techniques (those otherwise available to the public) to a known system (the

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Coli/Birch/Rusnak/Ekanayake/Bliss/Broussard079/Allam system) ready for improvement.

B. CLAIM 50

1. [50a] – [50c]

494. Limitations [50a] - [50c] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Ekanayake*, *Bliss*, *Broussard079*, and *Allam* for the same reasons discussed with respect to these limitations in Ground 16A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

495. Limitations [50a]-[50c] recite what was known and publicly available before the time of the '992 Patent.

2. [50d]

496. Limitation [50d] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Ekanayake*, *Bliss*, *Broussard079*, and *Allam* for the same reasons discussed above with respect to this limitation in Ground 16A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent, for the same reasons as those discussed with respect to limitation [44d] in Ground 20B, which recites the same limitation. Claim 50 depends from Claim 48. I further incorporate by reference my discussion of Claim 48 in Ground 15B by reference.

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XXIII. GROUND 17A: THE COMBINATION OF *COLI*, *BIRCH*, *RUSNAK*, *HUNT*, *EKANAYAKE*, *BLISS*, *BROUSSARD079*, *KOHLENBERGER*, *WEIHER*, AND *NEWMAN* RENDERS CLAIMS 51 OBVIOUS

A. STATUS AND OVERVIEW OF *KOHLENBERGER* (EX. 1026)

497. *Kohlenberger* is a U.S. Patent that was filed on August 24, 1995, and was issued on August 4, 1998. *Kohlenberger* is therefore prior art to the '992 Patent.

498. *Kohlenberger* discloses a "method and apparatus for cooling the inlet air of internal combustion engine and gas turbine prime movers" for various applications, including "to produce electricity or useful work from the prime mover application."[459] *Kohlenberger* discloses monitoring several characteristics of the turbine generator, including "sensors (not shown) within the air inlet to insure [sic. ensure] that the air entering the turbine cabinet 48 is of constant temperature and pressure to optimize the performance of the gas turbine 42."[460] *Kohlenberger* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

B. STATUS AND OVERVIEW OF WEIHER (EX. 1028)

499. *Weiher* is United States Patent No. 8,552,728, filed on November 30, 2010, and issued on October 8, 2013. *Weiher* is therefore prior art to the '992 Patent.

[459] Ex. 1026 (*Kohlenberger*) Abstract
[460] Ex. 1026 (*Kohlenberger*), 6:2-6.

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500. *Weiher* is titled "Sluggish Circuit Breaker Detection System and Method" and discloses a "circuit breaker electronic trip unit" that "provide[s] an appropriate indication or alarm, and also trip an upstream circuit breaker, if a sluggish operation or a stuck breaker is detected."[461] *Weiher* teaches that a " 'stuck breaker' condition, in which the circuit breaker fails to open,"[462] would be one case in which an alarm would be generated. *Weiher* further teaches that the electronic tripping unit can be used with "low voltage circuit breakers (e.g., 600 V class)" but that it "can also be used with any higher voltage class circuit breaker requiring a trip unit, such as medium voltage circuit breakers, for example."[463] *Weiher* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

C. STATUS AND OVERVIEW OF *NEWMAN* (EX. 1029)

501. *Newman* is a European Patent that was filed on August 4, 1980, and was published on January 30, 1985. *Newman* is therefore prior art to the '992.

502. *Newman* describes an "information recording system" for "recording the service life history and configuration of gas turbine engines."[464] This system includes a "life tracking system (LTS) for automatically identifying and recording

[461] Ex. 1028 (*Weiher*) 3:58–66.
[462] Ex. 1028 (*Weiher*), 3:1-3.
[463] Ex. 1028 (*Weiher*), 9:3-8.
[464] Ex. 1029 (*Newman*), 1:3-8.

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in permanent record the configurations of a gas turbine engine by exact module type and serial number."[465] *Newman* further discloses that the "LTS includes a life tracking unit (LTU) and a plurality of engine mounted module identifier units, one for each engine module, each providing module identification signal data, on demand, to an electronic signal processor in the LTU which is mounted on or off the engine."[466] *Newman* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

D. MOTIVATION TO COMBINE

503. A POSITA would have been motivated to combine *Coli* with *Birch* and *Rusnak*, as described in my Original Declaration.[467] A POSITA would have been motivated to combine *Coli* with *Broussard079*.[468] Nothing in any of *Kohlenberger*, *Ekanayake*, *Weiher*, *Hunt*, *Birch*, or *Newman* teaches against the combinations. A POSITA would have been further motivated to combine *Coli* with *Kohlenberger*, *Ekanayake*, *Weiher*, *Hunt*, *Birch*, and *Newman* as described below.

504. *Coli* discloses a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation."[469] Included in *Coli*'s fracturing operation are "[o]ne or more natural gas-powered turbine generators 30"

[465] Ex. 1029 (*Newman*), 1:50-58.
[466] Ex. 1029 (*Newman*) 1:60–2:1.
[467] Ex. 1003 (*Original Declaration*), ¶¶ 267-276.
[468] See Section XII.F above.
[469] Ex. 1004 (*Coli*), [0072].

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that generate electric power for use in the fracturing operation.[470] *Kohlenberger, Ekanayake, Weiher, Hunt, Birch*, and *Newman* each disclose monitoring particular aspects of turbine generator operation.

505. For example, *Kohlenberger* discloses sensors that monitor temperature and pressure at the "air inlet" of a gas turbine.[471] *Birch* discloses a "thermocouple" for monitoring the temperature of discharge gas exiting a turbine generator's compressor, pressure sensors for monitoring the pressure at a turbine generator's natural gas mains supply line, and a pressure sensor for monitoring the pressure of discharge gas exiting a turbine generator's compressor.[472] *Ekanayake* discloses a "filter assembly" that monitors the extent to which a gas turbine's air inlet filter is "fouled" by filtered particulate.[473] *Weiher* discloses a "circuit breaker electronic trip unit" that "provide[s] an appropriate indication or alarm, and also trip an upstream circuit breaker, if a sluggish operation or a stuck breaker is detected."[474] *Weiher* discloses a system for monitoring the status of a circuit breaker, including whether the circuit breaker's opening/closing mechanism is not operating properly.[475] *Hunt* discloses a multifunction control module that is configured to "monitor the

[470] Ex. 1004 (*Coli*), [0038], [0040].
[471] Ex. 1026 (*Kohlenberger*), 6:2-6.
[472] Ex. 1005 (*Birch*), 2:30-39, 3:4-12.
[473] Ex. 1027 (*Ekanayake*), 1:24-27, 2:19-35.
[474] Ex. 1028 (*Weiher*), 3:58–66.
[475] Ex. 1028 (*Weiher*), 2:56-3:5, 4:39-67, 5:22-42.

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frequency of the power produced by" a turbine generator.[476] *Newman* discloses a "life tracking system (LTS) for automatically identifying and recording in permanent record the configurations of a gas turbine engine by exact module type and serial number."[477]

506. A POSITA would have been motivated to combine the control system taught by *Coli* with the monitoring techniques taught by *Kohlenberger*, *Birch*, *Ekanayake*, *Hunt*, *Weiher*, and *Newman*, furthering *Coli*'s goal of providing "control and computer monitoring for the entire fracturing operation…at a single central location."[478] A POSITA would be motivated to consult references that provide more detail on such control, such as Kohlenberger, Birch, Ekanayake, Hunt, Weiher, and Newman, which offer highly relevant details on the monitoring of various aspects of turbine generators and associated equipment. Overall, such a combination represents the mere application of known techniques (i.e., monitoring of various elements of turbine generators and associated equipment, as taught by *Kohlenberger*, *Birch*, *Ekanayake*, *Weiher*, and *Newman*) to a known system (e.g., a hydraulic fracturing system, including gas turbines, with a control system for all components of the system) ready for improvement (i.e., to monitor gas turbines and associated equipment). Thus, a POSITA would have been motivated to combine the references

[476] Ex. 1008 (*Hunt*), [0025], [0040], [0054].
[477] Ex. 1029 (*Newman*), 1:50-58.
[478] Ex. 1004 (*Coli*), [0072].

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and would have reasonably expected success in doing so. Additional motivations for each reference are discussed below.

E. SUBSTITUTE CLAIM 51:

507. The combination of *Coli*, *Birch*, *Rusnak*, *Bliss*, *Broussard079*, *Kohlenberger*, *Ekanayake*, *Weiher*, and *Newman* renders Claim 51 obvious. In addition to the discussion of Claim 48 discussed above, and incorporated herein by reference, the combination discloses each and every additional limitation of Claim 51.

1. [51a] The method claim 48, wherein the generator is a turbine generator; the method further comprising

508. *Coli* discloses limitation [51a] for the same reasons as those discussed above in Section XXIX.D.8 regarding limitation [47g]. Accordingly, the combination of *Coli*, *Birch*, *Rusnak*, *Bliss*, *Broussard079*, *Kohlenberger*, *Ekanayake*, *Weiher*, and *Newman* renders limitation [51a] obvious.

2. [51b] monitoring operating characteristics of the turbine generator

509. Limitation [51b] is obvious for the same reasons as those discussed above in Section XXIX.D.9 regarding limitation [47h]. Accordingly, the combination of *Coli*, *Birch*, *Rusnak*, *Bliss*, *Broussard079*, *Kohlenberger*, *Ekanayake*, *Weiher*, and *Newman* renders limitation [51b] obvious.

510. *Coli* discloses a "control center 40" that includes "controls and computer monitoring ***for the entire fracturing operation***," which includes turbine

generators.[479] It would have been obvious to a POSITA to monitor the "*operating characteristics*" listed in [51c], in view of *Coli*'s disclosure of centralized monitoring for the entire fracturing operation and because it was known in the prior art and/or obvious to monitor these operating characteristics, as shown below and as conceded by Dr. Nikolaou.

3. [51c] wherein the monitored operating characteristics of the turbine generator include at least…

a) "fuel system air supply pressure transmitter failure"

511. *Kohlenberger* discloses a "motor/turbine control center" that "has sensors (not shown) within the air inlet to insure [*sic*., ensure] that the air entering the turbine cabinet 48 is of constant temperature and pressure to optimize the performance of the gas turbine 42."[480] In combination with *Coli*, it would have been obvious that *Kohlenberger*'s monitoring pressure at the gas turbine's air inlet (*i.e.*, the "*fuel system air supply pressure*") would have been incorporated into *Coli*'s control system, as such monitoring falls within the control system's general functionality of monitoring all equipment of a hydraulic fracturing site. It was known in the art for "pressure transmitters," such as *Kohlenberger*'s air inlet pressure sensors, to transmit failure codes.[481] A POSITA would have been motivated

[479] Ex. 1004 (Coli), [0010], [0072].
[480] Ex. 1026 (*Kohlenberger*), 6:2-6.
[481] See, e.g., Ex. 1030, (*Rosemount 3051 PT*) C-4 – C-5, listing several error codes that a pressure transmitter is capable of transmitting, including "Output Failure"

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to monitor for failure of the fuel system air supply pressure transmitter, so that appropriate action, including maintenance or replacement of the transmitter, could be enacted. Operating with this transmitter in a failed condition would have led to improper operation of the turbine, such as starving it of air. Further, Patent Owner's expert testified that monitoring for a fuel system air supply pressure transmitter failure was known and provided reasons why a POSITA would do so.[482] I agree with the motivations stated by Dr. Nikolaou.

512. Accordingly, it would have been obvious to a POSITA that *Coli*'s control system would have monitored whether a "*fuel system air supply pressure transmitter*" had failed.

b) "thermocouple input module thermistor failure,"

513. *Birch* discloses a "thermocouple 18 for monitoring the discharge (gas) temperature."[483] It was known in the art for a thermocouple-based temperature transmitter to transmit failure codes, including failure of the input module thermistor, which would be a hardware failure of the input block, which would have included a thermistor for monitoring "cold junction" temperature of the

(condition 8), "Memory Failure" (condition 9), "General Error" (condition 17), "Electronics Failure" (condition 20), "I/O Failure" (condition 22); see also Ex. 1032 (Internet Archive Declaration), 1-126.

[482] Ex. 1023 (Nikolaou Dep. Tr.), 35:4-21.

[483] Ex. 1005 (*Birch*), 3:4-12

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transmitter.[484] A POSITA would have been motivated to monitor for failure of the thermocouple input module thermistor, so that appropriate action, including maintenance or replacement of the transmitter, could be enacted. Operating with this transmitter in a failed condition would have led to improper operation of the turbine, such as overheating or losing the benefits of cooled air. Further, Patent Owner's expert testified that monitoring for a thermocouple input module thermistor failure was known and provided reasons why a POSITA would do so.[485] I agree with the motivations stated by Dr. Nikolaou.

514. Accordingly, it would have been obvious to a POSITA that *Coli*'s control system would have monitored whether a "*thermocouple input module thermistor*" had failed.

c) "start VFD configuration failure,"

515. *Coli* discloses using "variable frequency drives" (VFDs), which "essentially 'tell motors what they are allowed to do."[486] *Rusnak* discloses an external controller 30 (i.e., centralized control unit) that controls a VFD and

[484] See, e.g., Ex. 1031, (*Rosemount 848T*) D-5, listing several error codes that a pressure transmitter is capable of transmitting, including "Output Failure" (condition 8), "Memory Failure" (condition 9), "General Error" (condition 17), "Electronics Failure" (condition 20), "I/O Failure" (condition 22); see also Ex. 1032 (Internet Archive Declaration), 1-2, 127-241.
[485] Ex. 1023 (Nikolaou Dep. Tr.), 35:22-37:3.
[486] Ex. 1004 (*Coli*), [0065].

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"automatically reset[s] [a] faulted condition" in the VFD.[487] It would have been obvious to a POSITA that one such "faulted condition" of a VFD (and perhaps the most fundamental "faulted condition") is that the VFD fails to start. It would have been obvious to monitor a failure of the VFD to start so that appropriate action could be enacted, such as attempting a restart of the VFD or performing maintenance/replacement of the VFD. In combination with *Coli*, it would have been obvious that *Rusnak*'s external controller for monitoring faulted conditions of a VFD, including whether the VFD has failed to start (i.e., "start VFD configuration failure") would have been incorporated into *Coli*'s control system, as such when monitoring falls within the control system's general functionality of monitoring all equipment in a fracturing site. Further, Patent Owner's expert testified that monitoring for a start VFD configuration failure was known and provided reasons why a POSITA would do so.[488] I agree with the motivations stated by Dr. Nikolaou.

d) "turbine air inlet filter transmitter failure,"

516. This limitation would have been obvious for the same reasons as those discussed above in Section XXIX.D.10 regarding limitation 47[i]

e) "generator circuit breaker failure to open,"

[487] Ex. 1007 (*Rusnak*), [0087]; see also Ex. 1007 (*Rusnak*)., [0020]-[0021].
[488] Ex. 1023 (Nikolaou Dep. Tr.), 37:4 – 38:7.

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517. *Weiher* discloses a "circuit breaker electronic trip unit" that "provide[s] an appropriate indication or alarm, and also trip an upstream circuit breaker, if a sluggish operation or a stuck breaker is detected."[489] *Weiher* teaches that a " 'stuck breaker' condition, in which the circuit breaker fails to open"[490] would be one case in which an alarm would be generated. *Weiher* further teaches that the electronic tripping unit can be used with "low voltage circuit breakers (e.g., 600 V class)" but that it "can also be used with any higher voltage class circuit breaker requiring a trip unit, such as medium voltage circuit breakers, for example."[491] *Weiher* further teaches that "when a sluggish breaker operation is detected, a remote alarm can be triggered by a contact closure from the alarm/upstream breaker trip output 36."[492]

518. In combination with *Coli*, it would have been obvious that *Weiher's* circuit breaker electronic trip unit would have been incorporated into *Coli*'s control system for monitoring whether a generator circuit breaker has failed to open, as this would have been an obvious mechanism for improving the safety of the overall fracturing system. For example, by monitoring such a condition, a POSITA would have recognized that operational decisions would have been made in the case of a circuit breaker failing to open, such as preventing personnel from accessing

[489] Ex. 1028 (*Weiher*) 3:58 – 66.
[490] Ex. 1028 (*Weiher*) 3:1-3.
[491] Ex. 1028 (*Weiher*) 9:3-8.
[492] Ex. 1028 (*Weiher*) 5:34 – 36.

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switchgear or other downstream equipment that may still be energized. Further, a POSITA would have recognized that energizing backup power (such as utility power) with the generator circuit breaker still closed would cause the generator to "motor", or spin the turbine, which would cause damage and create a safety hazard. Additionally, maintenance crews would have been dispatched to diagnose and/or repair the breaker.[493] Further, Patent Owner's expert testified that monitoring for a generator circuit breaker failure to open was known and provided reasons why a POSITA would do so.[494] I agree with the motivations stated by Dr. Nikolaou.

f) "gas fuel supply pressure transmitter failure,"

519. *Birch* discloses a "gaseous fuel compression and control system for a turbine engine" that includes "under and over pressure electronic sensors 6a and 6b."[495] These sensors monitor the pressure of a "mains supply 1," which supplies natural gas to a compressor associated with a turbine generator.[496] Furthermore, as discussed above, pressure sensors capable of transmitting failure codes were well known in the art.[497] A POSITA would have been motivated to monitor for failure of

[493] See, e.g., Ex. 1028 (*Weiher*) 3:58 – 4:3.
[494] Ex. 1023 (Nikolaou Dep. Tr.), 39:18 – 41:1.
[495] Ex. 1005 (*Birch*), 2:30-39, Fig. 1.
[496] Ex. 1005 (*Birch*) 2:30-39, Fig. 1.
[497] See, e.g., Ex. 1030, (*Rosemount 3051 PT*) C-4 – C-5, listing several error codes that a pressure transmitter is capable of transmitting, including "Output Failure" (condition 8), "Memory Failure" (condition 9), "General Error" (condition 17), "Electronics Failure" (condition 20), "I/O Failure" (condition 22); see also Ex. 1032 (Internet Archive Declaration), 1-126.

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the gas fuel supply pressure transmitter, so that appropriate action, including maintenance or replacement of the transmitter, could be enacted. Operating this transmitter in a failed condition would have led to improper turbine operation, such as starving it of fuel. In combination with *Coli*, it would have been obvious that *Birch*'s "under and over pressure electronic sensors" monitoring pressure of mains supply that provides natural gas to a turbine generator's compressor (i.e., the "gas fuel supply pressure transmitter") would have been monitored by *Coli*'s control system, as such monitoring falls within the control system's general functionality of monitoring all equipment of a hydraulic fracturing site. Further, it would have been obvious that *Coli*'s control system would have monitored whether such a pressure transmitter had failed, consistent with the well-known functionality of such pressure transmitters and *Coli*'s control system functionality, as discussed above. Further, Patent Owner's expert testified that monitoring for a gas fuel supply pressure transmitter failure was known and provided reasons why a POSITA would do so.[498] I agree with the motivations stated by Dr. Nikolaou.

g) "gas fuel control pressure transmitter failure,"

520. *Birch* discloses a "a pressure sensor 17 for monitoring the discharge (gas) pressure" of a compressor providing "feeding gaseous fuel" to a turbine

[498] Ex. 1023 (Nikolaou Dep. Tr.), 41:2 – 42:9.

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generator.[499] *Birch* explains that the pressure measurements generated by pressure sensor 17 control the operation of the compressor, which ultimately dictates how much compressed gas (*i.e.*, "*fuel*") is provided to the turbine generator.[500] Accordingly, a POSITA would have understood *Birch*'s "pressure sensor 17" to be a "gas fuel control pressure transmitter." As discussed above, pressure sensors that transmit failure codes, were well known in the art.[501] A POSITA would have been motivated to monitor for failure of the gas fuel control pressure transmitter, so that appropriate action, including maintenance or replacement of the transmitter, could be enacted. Operating this transmitter in a failed condition would have led to improper turbine operation, such as uncontrolled operation, starving the turbine of gas, or running the turbine too rich in fuel. In combination with *Coli*, it would have been obvious that *Birch*'s "pressure sensor 17" for monitoring the discharge pressure of a compressor (*i.e.*, the "*gas fuel control pressure transmitter*") would have been incorporated into by *Coli*'s control system, as such functionality falls within the control system's general functionality of monitoring all equipment of a hydraulic fracturing site. Further, it would have been obvious that *Coli*'s control system would

[499] Ex. 1005 (*Birch*), 3:4-8, Abstract.
[500] Ex. 1005 (*Birch*) 3:37-4:12.
[501] See, e.g., Ex. 1030, (*Rosemount 3051 PT*) C-4 – C-5, listing several error codes that a pressure transmitter is capable of transmitting, including "Output Failure" (condition 8), "Memory Failure" (condition 9), "General Error" (condition 17), "Electronics Failure" (condition 20), "I/O Failure" (condition 22); see also Ex. 1032 (Internet Archive Declaration), 1-126.

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have monitored whether such a pressure transmitter had failed, consistent with the known functionality of such pressure transmitters and *Coli*'s control system. Further, Patent Owner's expert testified that monitoring for a gas fuel control pressure transmitter failure was known and provided reasons why a POSITA would do so. I agree with the motivations stated by Dr. Nikolaou.[502]

h) "utility circuit breaker closed,"

521. As discussed in my Original Declaration, the combined *Coli-Birch-Rusnak-Hunt* system includes a switchgear, comprising circuit breakers that controls the coupling of a turbine generator bus to a utility bus.[503] A POSITA would have therefore understood the switchgear to teach a "utility circuit breaker." Further, a POSITA would have understood that *Coli*'s control system would have monitored the status of the "utility circuit breaker," including whether it is open or closed, to determine whether or not power was available from the utility, consistent with the control system's general functionality of monitoring all equipment of a hydraulic fracturing site. Not only would it be important from an operational perspective (utilizing utility power instead of on-site generation), but also from a safety perspective, ensuring that personnel do not interact with an energized system, even when the generators are off. Further, Patent Owner's expert testified that monitoring

[502] Ex. 1023 (Nikolaou Dep. Tr.), 42:10 – 43:15.
[503] Ex. 1003 (Original Declaration), ¶¶ 277-307.

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for a utility circuit breaker closed condition was known and provided reasons why a POSITA would do so.[504] I agree with the motivations stated by Dr. Nikolaou.

i) generator frequency,"

522. *Hunt* discloses a multifunction control module that is configured to "monitor the frequency of the power produced by generator 215."[505] In combination with *Coli*, it would have been obvious that *Hunt*'s teachings regarding monitoring generator frequency would have been incorporated into *Coli*'s control system, as such monitoring falls within the control system's general functionality of monitoring all equipment of a hydraulic fracturing site. A POSITA would have been motivated to monitor generator frequency to control frequency, and to ensure, for example, that frequency matches the frequency expected by the downstream equipment (e.g., VFDs, motors without VFDs, etc.). Further, Patent Owner's expert testified that monitoring generator frequency was known and provided reasons why a POSITA would do so.[506] I agree with the motivations stated by Dr. Nikolaou.

j) "and engine serial number."

523. *Newman* discloses a "life tracking system (LTS) for automatically identifying and recording in permanent record the configurations of a gas turbine

[504] Ex. 1023 (Nikolaou Dep. Tr.), 43:16 – 44:19.
[505] Ex. 1008, [0040]; see also Ex. 1008, [0054] (disclosing a "supervisory relay 1120A" that is "capable of sensing, for example, voltage, current, frequency, and/or phase of the power produced by generator 1115").
[506] Ex. 1023 (Nikolaou Dep. Tr.), 44:20 – 46:3.

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engine by exact module type and serial number."[507] *Newman's* teachings on monitoring the serial number of a module, a component of the gas turbine engine, would have been equally applicable to monitoring the entire engine's serial number. A POSITA would have been motivated to monitor the serial number of the engine to ensure, for example, that maintenance activities would occur consistent with the monitored characteristics of the correct engine and to operate the engine the operator intended. It would have been obvious to a POSITA that implementing *Coli*'s system of monitoring various operating characteristics of a turbine generator, as discussed above, would have also monitored an "*engine serial number*" associated with the turbine generator to keep such monitoring organized (*i.e.*, such that the monitored operating characteristics are associated with the relevant turbine generator engine) as taught by *Newman*. Further, Patent Owner's expert testified that monitoring generator frequency was known and provided reasons why a POSITA would do so.[508] I agree with the motivations stated by Dr. Nikolaou.

XXIV. GROUND 17B: THE COMBINATION OF *COLI*, *BIRCH*, *RUSNAK*, *HUNT*, *EKANAYAKE*, *BLISS*, *BROUSSARD079*, *KOHLENBERGER*, *WEIHER*, *NEWMAN*, AND WHAT WAS OTHERWISE AVAILABLE TO THE PUBLIC RENDERS SUBSTITUTE CLAIM 51 OBVIOUS

A. MOTIVATION TO COMBINE

[507] Ex. 1029 (*Newman*), 1:50-58.
[508] Ex. 1023 (Nikolaou Dep. Tr.), 46:4 – 48:8.

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524. The motivation to combine *Coli*, *Birch*, *Rusnak, Hunt, Ekanayake, Bliss, Broussard079, Kohlenberger, Weiher,* and *Newman* is the same as that discussed above in Section XXIII.D, included herein by reference. It would have been obvious to combine these references with known technology otherwise available to the public for the same reasons. Such available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation of success in the combination for the same reasons, and because such combination would have involved the mere application of known techniques (those otherwise available to the public) to a known system (the *Coli/Birch/Rusnak/Hunt/Ekanayake/Bliss/Broussard079/Kohlenberger/Weiher/Newman system*) ready for improvement.

B. CLAIM 51

525. Claim 51 depends from Claim 48. I incorporate by reference my discussion of Claim 48 in Ground 17B.

1. [51a] – [51b]

526. Limitations [51a] – [51b] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak, Hunt, Ekanayake, Bliss*, *Broussard079, Kohlenberger, Weiher,* and *Newman* for the same reasons discussed with respect to

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these limitations in Ground 17A, incorporated herein by reference, , in combination with what was publicly available before the time of the ’992 Patent.

527. Limitations [51a]-[51b] recite what was known and publicly available before the time of the ’992 Patent. I have been aware of each of these limitations since the 1990s.

2. [51c]: wherein the monitored operating characteristics of the turbine generator include at least…

528. Limitation [51c] would have been obvious over the combination of *Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss, Broussard079, Kohlenberger, Weiher,* and *Newman* for the same reasons discussed with respect to these limitations in Ground 17A, incorporated herein by reference, in combination with what was publicly available before the time of the ’992 Patent, as I discuss further below.

a) Fuel system air supply pressure transmitter failure

529. Monitoring fuel system air supply pressure transmitter failure of a turbine generator was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring for a fuel system air supply pressure transmitter failure since at least the early 2000s.

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530. Patent Owner's expert Dr. Nikolaou admits that as of 2015, it was known to monitor for failure of a turbine generator's fuel system air supply pressure transmitter[509]:

> Q. Sure. At the time of the 992 patent application in 2015, was it known to monitor failure of a turbine generator's fuel system air supply pressure transmitter?
>
> A. Are you asking whether that technology was known at the time?
>
> Q. Yes.
>
> A. Yes, it was.

b) Thermocouple input module thermistor failure

531. Monitoring thermocouple input module thermistor failure was known and publicly available before the '992 Patent. The thermocouple input module thermistor provides a "cold junction" reference point for measuring temperatures with thermocouples. I have been aware of monitoring for thermistor failure in the thermocouple input module since at least the early 1990s.

532. Patent Owner's expert Dr. Nikolaou admits that as of 2015, it was known and available to monitor for failure of a turbine generator's thermocouple input module thermistor[510]:

> Q. At the time of the 992 patent application in 2015, was it known to monitor failure of a turbine generator's thermocouple input module thermistor?

[509] Ex. 1023 (Nikolaou Dep. Tr.), 35:14-21.
[510] Ex. 1023 (Nikolaou Dep. Tr.), 36:20-37:3.

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> A. Again, I understand your requestion to be was that technology available – known at the time. The technology was, in general, known at the time yes.

c) Start VFD configuration failure

533. Monitoring start VFD configuration failure was known and publicly available before the time of the '992 Patent. I have been aware of monitoring for VFD configuration failures as they start since at least the 1990s.

534. Patent Owner's expert Dr. Nikolaou admits that as of 2015, it was known and available to monitor for failure of a turbine generator's start VFD configuration[511]:

> Q. As of 2015, at the time of the 992 patent, was it known to monitor for failure of a turbine generator's start VFD configuration?
>
> A. The technology was available at the time, correct.
>
> Q. The technology to monitor for that failure was known?
>
> A. Yes, that's what is stated there, right.

d) Generator circuit breaker failure to open

535. Monitoring generator circuit breaker failure to open was known and publicly available before the time of the '992 Patent. I have been aware of monitoring for generator circuit breaker failure to open since at least the 1990s.

[511] Ex. 1023 (Nikolaou Dep. Tr.), 37:22-38:7.

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536. Patent Owner's expert Dr. Nikolaou admits that as of 2015, it was known and available to monitor for failure of a turbine generator circuit breaker to open[512]:

> Q. As of the time of the 992 patent application in 2015, was it known to monitor for failure of a turbine generator circuit breaker to open?
>
> A. The technology for monitoring this was available.
>
> Q. And known?
>
> A. Known as meaning how to do it? Yes, it was known how to do it.

e) Gas fuel supply pressure transmitter failure

537. Monitoring gas fuel supply pressure transmitter failure system was known and publicly available before the time of the '992 Patent. I have been aware of monitoring for gas-fuel supply transmitter failures since the 1990s.

538. Patent Owner's expert Dr. Nikolaou admits that as of 2015, it was known to monitor for failure of a turbine generator's gas fuel supply transmitter[513]:

> Q. As of the time of the 992 patent application in 2015 was it known to monitor for failure of a turbine generators gas fuel supply transmitter?
>
> THE WITNESS: The technology of doing this was known.

f) Gas fuel control pressure transmitter failure

[512] Ex. 1023 (Nikolaou Dep. Tr.), 40:15-41:1.
[513] Ex. 1023 (Nikolaou Dep. Tr.), 42:4-9 (objection omitted).

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539. Monitoring gas fuel control pressure transmitter failure was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring for gas-fuel control pressure transmitter failures since the 1990s.

540. Patent Owner’s expert Dr. Nikolaou admits that as of 2015, the technology was available to monitor for failure of a gas fuel control pressure transmitter[514]:

> Q. As of the time of the 992 patent application in 2015 was it known to monitor for failure of a gas fuel control pressure transmitter?
>
> THE WITNESS: The technology for how to monitor this was available at the time.

g) Utility circuit breaker closed

541. Monitoring utility circuit breaker closed was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring the status (e.g., open/closed) of a utility circuit breaker since at least the early 1990s.

542. Patent Owner’s expert, Dr. Nikolaou, admits that as of 2015, the technology was available to monitor for a closed status of a turbine generator’s utility circuit breaker[515]:

> Q. Okay. As of the time of the 992 patent application in 2015 was it known to monitor for a closed status of a turbine generators utility circuit breaker?

[514] Ex. 1023 (Nikolaou Dep. Tr.), 43:10-15 (objection omitted).
[515] Ex. 1023 (Nikolaou Dep. Tr.), 44:13-19 (objection omitted).

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THE WITNESS: The technology was available at the time.

h) Generator frequency

543. Monitoring generator frequency was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring generator frequency since at least the early 1990s.

544. Patent Owner’s expert, Dr. Nikolaou, admits that as of 2015, it was known and the technology was available to monitor a turbine generator’s frequency[516]:

> Q. As of the time of the 992 patent application in 2015 was it known to monitor a turbine generator's frequency?
>
> A. The technology was available at the time.
>
> Q. So it was known to do that?
>
> THE WITNESS: The technology for how to do generator frequency monitoring was available at the time; it was known.

i) Engine serial number

545. Monitoring engine serial number of a turbine generator was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring a turbine generator serial number since the 1990s.

546. Patent Owner’s expert Dr. Nikolaou admits that as of 2015, it was known to monitor a turbine generator’s engine serial number[517]:

[516] Ex. 1023 (Nikolaou Dep. Tr.), 45:17-46:3 (objection omitted).
[517] Ex. 1023 (Nikolaou Dep. Tr.), 48:3-8 (objection omitted).

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> Q. As of the time of the 992 patent application in 2015 was it known to monitor a turbine generators engine serial number?
>
> THE WITNESS: The technology for how to do that was known, yes.

XXV. GROUND 18A THE COMBINATION OF *COLI, BIRCH, RUSNAK, EKANAYAKE, BLISS* AND *DISCENZO* RENDERS SUBSTITUTE CLAIM 53 OBVIOUS

A. STATUS AND OVERVIEW OF *DISCENZO (EX. 1038)*

547. *Discenzo* is U.S. Patent No. 7,949,483, filed on September 30, 2005, and granted on May 24, 2011. *Discenzo* is prior art to the '992 Patent.

548. *Discenzo* relates "generally to motors, motor diagnostics and motor control."[518] *Discenzo* teaches that "[v]ariable frequency drives may continually monitor motor current or current and voltage to a motor to adjust the power to the motor."[519] *Discenzo* teaches the connected motor's sensors also "sample[] three phases of voltage, load end and fan end bearing temperatures, winding temperature, and vibration."[520] *Discenzo* further teaches that this sensor information is used to "determine the condition of the windings, the bearings, the rotor, out of balance condition, torque, or the health of a pump connected to the motor,"[521] or "to predict a motor failure, such as a winding failure, that may occur in the near future."[522]

[518] Ex. 1038 (*Discenzo*) 1:6-7.
[519] Ex. 1038 (*Discenzo*) 6:35-39.
[520] Ex. 1038 (*Discenzo*) 6:40-41.
[521] Ex. 1038 (*Discenzo*) 8:65–9:1.
[522] Ex. 1038 (*Discenzo*) 9:10-13.

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Discenzo is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

B. MOTIVATION TO COMBINE.

549. A POSITA would have been motivated to combine *Coli*, *Birch*, *Rusnak*, *Ekanayake* and *Bliss*.[523] A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Ekanayake-Bliss* system with *Discenzo*.

550. The combined *Coli-Birch-Rusnak* system discloses a control system that controls and monitors all equipment of a fracturing site, including electric motors and VFDs that drive the electric motors.[524] *Discenzo* discloses that the VFD monitors various performance characteristics of the associated motor, including “[v]ariable frequency drives may continually monitor motor current or current and voltage to a motor to adjust the power to the motor.”[525] *Discenzo* also teaches monitoring “three phases of voltage, load end and fan end bearing temperatures, winding temperature, and vibration.”[526] *Discenzo* further teaches that this sensor information is used to “determine the condition of the windings, the bearings, the rotor, out of balance condition, torque, or the health of a pump connected to the motor,”[527] or “to predict a motor failure, such as a winding failure, that may occur in

[523] Section XIX.C above.
[524] Ex. 1003 (Original Declaration), ¶¶ 126-170.
[525] Ex. 1038 (*Discenzo*) 6:35-37.
[526] Ex. 1038 (*Discenzo*) 6:40-41.
[527] Ex. 1038 (*Discenzo*) 8:65–9:1.

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the near future."[528] A POSITA would have understood the benefits of monitoring winding temperature to determine the condition of the windings and of being able to predict a motor failure, so that preventive maintenance/replacement of the motor could take place.

551. *Rusnak* further teaches monitoring various aspects of electric motors and the VFDs that control them, including the VFD "provid[ing] speed and torque measurements".[529] A POSITA would have understood that, in a hydraulic fracturing system using VFDs to control positive displacement pumps, the speed of the motor is driving by the frequency of the power delivered to the motor A POSITA would have been motivated to monitor operating characteristics of the motor, such as voltage, speed, torque, and current to determine whether the VFD is operating correctly, and that the motor/pump is operating within design limits. A POSITA would have been motivated to combine the system taught by *Coli* monitoring techniques taught by *Discenzo* and *Rusnak* to further *Coli*'s goal of providing "control and computer monitoring for the entire fracturing operation…at a single central location."[530] Overall, such a combination represents the mere application of known techniques (*i.e.*, techniques for monitoring electric motors and VFDs, as taught by *Discenzo* and *Rusnak*) to a known system (*e.g.*, *Coli*'s hydraulic fracturing

[528] Ex. 1038 (*Discenzo*) 9:10-13.
[529] Ex. 1007 (*Rusnak*), [0002].
[530] Ex. 1004 (*Coli*), [0072].

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system, which includes electric motors and VFDs that control the electric motors) ready for improvement (*i.e.*, to improve the breadth of *Coli*'s system monitoring functionality). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

C. SUBSTITUTE CLAIM 53:

552. The combination of *Coli*, *Birch*, *Rusnak*, *Ekanayake*, *Bliss*, and *Discenzo* renders Claim 53 obvious. In addition to the discussion of Claim 47 discussed above, and incorporated herein by reference, the combination discloses each and every additional limitation of Claim 53.

1. [53a] The method of claim 47, further comprising resetting a fault occurring in the variable frequency drive from the centralized control unit,

553. *Rusnak* discloses an external controller 30 (i.e., centralized control unit) that controls a VFD and "automatically reset[s] [a] faulted condition" in the VFD (i.e., configured to reset a fault occurring in the variable frequency drive.).[531] To the extent that *Rusnak* does not explicitly disclose resetting a fault in a VFD "from the centralized control unit", a POSITA would have recognized the benefits of applying *Rusnak*'s teaching of automatically resetting a fault and retrying to start the pump or attempt to re-establish normal operation to the VFD system of *Coli* to remove the need for a POSITA to enter the red zone where the VFD would be located to reset a

[531] *See, e.g.*, Ex. 1007 (*Rusnak*), [0080]; *see also* Ex. 1007 (*Rusnak*), [0020]-[0021].

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fault. As *Coli* discloses a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation,"[532] it would have been obvious to reset the fault, using *Rusnak's* techniques, from *Coli's* "control center 40", the claimed centralized control unit. This would result in increased pump uptime and enhances system safety.

554. Accordingly, *Rusnak* and *Coli* render Limitation [53a] obvious and the combination of *Coli, Birch,* and *Rusnak* renders Limitation [53a] obvious.

2. [53b] & [53c] the method further comprising monitoring operating characteristics of the variable frequency drive, wherein the monitored operating characteristics include…

555. For the reasons discussed below in subsection XXV.C.2.a) through XXV.C.2.e), the *Coli-Birch-Rusnak-Ekanayake-Bliss-Discenzo* combination renders obvious "*the method further comprising monitoring operating characteristics of the variable frequency drive, wherein the monitored operating characteristics include...*"

556. *Coli* discloses a "control center 40" that includes "controls and computer monitoring ***for the entire fracturing operation***," which includes the variable frequency drive.[533] It would have been obvious to a POSITA to monitor the "*operating characteristics*" listed in [53c], in view of *Coli*'s disclosure of centralized

[532] Ex. 1004 (*Coli*), [0072].
[533] Ex. 1004 (Coli), [0010], [0072].

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monitoring for the entire fracturing operation and because it was known in the prior art and/or obvious to monitor these operating characteristics, as shown below and as conceded by Dr. Nikolaou.

a) "motor winding temperatures"

557. *Discenzo* teaches that the connected motor's sensors also "sample[] three phases of voltage, load end and fan end bearing temperatures, winding temperature, and vibration."[534] *Discenzo* further teaches that this sensor information is used to "determine the condition of the windings, the bearings, the rotor, out of balance condition, torque, or the health of a pump connected to the motor,"[535] or "to predict a motor failure, such as a winding failure, that may occur in the near future."[536] Accordingly, the *Coli-Birch-Rusnak-Ekanayake-Bliss-Discenzo* system renders this limitation obvious.

558. Further, Patent Owner's expert testified that monitoring motor winding temperature was known and provided reasons why a POSITA would do so.[537]

b) "the motor RPM"

559. *Rusnak* discloses that it "is known in the prior art to use of a VFD and an external processor to control a centrifugal pump. **The VFD is used to vary pump**

[534] Ex. 1038 (*Discenzo*) 6:40-41.
[535] Ex. 1038 (*Discenzo*) 8:66 – 9:1.
[536] Ex. 1038 (*Discenzo*) 9:10-13.
[537] Ex. 1023 (Nikolaou Dep. Tr.), 83:10-84:6.

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speed and provide speed and torque measurements."[538] *Rusnak* further provides that "[m]otor speed and torque values from a VFD are supplied to a processor" to further processing.[539] Accordingly, a POSITA would have understood that the "speed and torque measurements" taken by the VFD correspond to motor speed and torque. A POSITA would have understood that a motor's speed may be measured in revolutions per minute (RPM), such that *Rusnak*'s disclosure of measuring a motor's speed discloses monitoring "*the motor RPM*." Accordingly, the *Coli-Birch-Rusnak-Ekanayake-Bliss-Discenzo* system renders this limitation obvious. Further, Patent Owner's expert testified that monitoring motor RPM was not only known but a "classic measurement" and provided reasons why a POSITA would monitor rpm.[540]

c) "the voltage,"

560. *Rusnak* discloses a "method of controlling operation of a centrifugal pump in a fluid pumping system having a variable frequency drive powering an alternating current (AC) motor which turns said centrifugal pump," which "comprises internally monitoring automatically output current and voltage of the VFD to the AC motor without the need for an external sensor."[541] Further, Discenzo discloses that "[v]ariable frequency drives may continually monitor motor current

[538] Ex. 1007 (*Rusnak*), [0002] emphasis added.
[539] Ex. 1007 (*Rusnak*), [0003].
[540] Ex. 1023 (Nikolaou Dep. Tr.), 84:7-20.
[541] Ex. 1007 (*Rusnak*), [0005].

or current and voltage to a motor to adjust the power to the motor."[542] Accordingly, the *Coli-Birch-Rusnak-Ekanayake-Bliss-Discenzo* system renders this limitation obvious. Further, Patent Owner's expert testified that monitoring a VFD's voltage was known and provided reasons why a POSITA would do so.[543] I agree with the motivations stated by Dr. Nikolaou.

d) "the torque,"

561. As discussed above, *Rusnak* discloses providing "[m]otor speed and torque values" of a motor "from a VFD" to a processor further processing.[544] Accordingly, the *Coli-Birch-Rusnak-Ekanayake-Bliss-Discenzo* system renders this limitation obvious. Further, Patent Owner's expert testified that monitoring a VFD's torque was known, and provided reasons why a POSITA would do so.[545] I agree with the motivations stated by Dr. Nikolaou.

e) "and the current (amperage)."

562. *Rusnak* discloses "internally monitoring automatically output current and voltage of the VFD to the AC motor without the need for an external sensor."[546] Further, Discenzo teaches that "[v]ariable frequency drives may continually monitor

[542] Ex. 1038 (*Discenzo*) 6:35-39.
[543] Ex. 1023 (Nikolaou Dep. Tr.), 84:21-85:11.
[544] Ex. 1007 (*Rusnak*), [0003]; Section XII.I.4.b.
[545] Ex. 1023 (Nikolaou Dep. Tr.), 85:12-86:3.
[546] Ex. 1007, [0005].

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motor current or current and voltage to a motor to adjust the power to the motor."[547] Accordingly, the *Coli-Birch-Rusnak-Ekanayake-Bliss-Discenzo* system renders this limitation obvious. Further, Patent Owner's expert testified that monitoring a VFD's current (amperage) was known and provided reasons why a POSITA would do so.[548] I agree with the motivations stated by Dr. Nikolaou.

XXVI. GROUND 18B THE COMBINATION OF *COLI, BIRCH, RUSNAK, EKANAYAKE, BLISS, DISCENZO* AND WHAT WAS OTHERWISE AVAILABLE TO THE PUBLIC *RENDERS SUBSTITUTE CLAIM 53 OBVIOUS*

A. MOTIVATION TO COMBINE

563. The motivation to combine *Coli*, *Birch*, *Rusnak, Ekanayake, Bliss*, and *Discenzo* is the same as that discussed above in Section XXV.B, included herein by reference. It would have been obvious to combine these references with known technology otherwise available to the public for the same reasons. Such available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation of success in the combination for the same reasons, and because such a combination would have involved the mere application of known techniques (those otherwise

[547] Ex. 1038 (*Discenzo*) 6:35-39.
[548] Ex. 1023 (Nikolaou Dep. Tr.), 86:4–19.

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available to the public) to a known system (the *Coli/Birch/Rusnak/Ekanayake/Bliss/Discenzo system*) ready for improvement.

B. CLAIM 53

564. Claim 53 depends from Claim 47. I incorporate by reference my discussion of Claim 47 in Ground 17B.

1. [53a]: The method of claim 47, further comprising resetting a fault occurring in the variable frequency drive from the centralized control unit,

565. Limitation [53a] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Ekanayake*, *Bliss*, and *Discenzo* for the same reasons discussed with respect to these limitations in Ground 18A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

566. Resetting a fault in a variable frequency drive was known and publicly available before the '992 Patent. I have been aware of resetting a fault occurring in a VFD from the centralized control unit since at least the early 2000s.

2. [53b] & [53c]: the method further comprising monitoring operating characteristics of the variable frequency drive, wherein the monitored operating characteristics include…

567. Limitations [53b] – [53c] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Ekanayake*, *Bliss*, and *Discenzo* for the same reasons discussed with respect to these limitations in Ground 18A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent, as I discuss further below.

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a) Motor winding temperatures

568. Monitoring motor winding temperatures was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring motor winding temperatures since at least the early 1990s.

569. Patent Owner’s expert, Dr. Nikolaou, admits that as of 2015, it was known and the technology was available to monitor a VFD’s motor winding temperature[549]:

> Q. As [of] the time of the 992 patent application in 2015, was it known to monitor a VFD’s motor winding temperature?
>
> A. The technology for doing that was available at the time.
>
> Q. And it was known to do that?
>
> A. It was known how to do this kind of temperature monitoring.

b) The motor RPM

570. Monitoring motor RPM of a variable frequency drive was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring motor RPM from a VFD since at least the early 1990s.

571. Patent Owner’s expert Dr. Nikolaou admits that as of 2015, it was known to monitor a VFD’s motor RPM[550]:

> Q. As of the time of the 992 patent application in 2015 was it known to monitor a VFDs motor RPM?

[549] Ex. 1023 (Nikolaou Dep. Tr.), 83:19-84:6 (objections omitted).
[550] Ex. 1023 (Nikolaou Dep. Tr.), 84:17-20.

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> A. The technology for doing this was known it's a classic measurement actually.

c) The voltage

572. Monitoring the voltage of a variable frequency drive was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring VFD voltage since at least the early 1990s.

573. Patent Owner’s expert, Dr. Nikolaou, admits that as of 2015, it was known to monitor a VFD’s voltage[551]:

> Q. As of the time of the 992 patent application in 2015 was it known to monitor a VFD's voltage?
>
> THE WITNESS: The technology for measuring voltage on a VFD was known at the time, yes.

d) The torque

574. Monitoring the torque of a variable frequency drive was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring VFD output torque since at least the early 2000s.

575. Patent Owner’s expert, Dr. Nikolaou, admits that as of 2015, the technology was available to monitor a VFD’s torque[552]:

> Q. As of the time of the 992 patent application in 2015 was it known to monitor a VFD's torque?

[551] Ex. 1023 (Nikolaou Dep. Tr.), 85:7-11 (objection omitted).
[552] Ex. 1023 (Nikolaou Dep. Tr.), 85:21-86:3 (objection omitted).

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THE WITNESS: The technology for doing this was available at the time.

e) The current (amperage)

576. Monitoring the current (amperage) of a variable-frequency drive was known and publicly available before the '992 Patent. I have been aware of monitoring VFD current since at least the early 1990s.

577. Patent Owner's expert, Dr. Nikolaou, admits that as of 2015, it was known and the technology was available to monitor a VFD's current (amperage)[553]:

Q. As of the time of the 992 patent application in 2015 was it known to monitor a VFD's current?

THE WITNESS: The technology for doing this was available at the time.

Q. (By Mr. Walters) And it was known to do this?

THE WITNESS: It was known how to do this.

Q. (By Mr. Walters) And were those skilled in the art monitoring VFD's current in 2015?

THE WITNESS: If they would need to do that they would have technology available for doing this.

XXVII. GROUND 19A THE COMBINATION OF *COLI*, *BIRCH*, *RUSNAK*, *HUNT*, *EKANAYAKE*, *BLISS* AND *BROUSSARD079* AND *THOMPSON* RENDERS SUBSTITUTE CLAIM 55 OBVIOUS

A. STATUS AND OVERVIEW OF *THOMPSON (EX. 1037)*

[553] Ex. 1023 (Nikolaou Dep. Tr.), 86:12-87:2 (objection omitted).

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578. *Thompson* is a U.S. Patent Application Publication No, 2009/0181582, filed on January 16, 2009, and published on July 16, 2009. *Thompson*, therefore, is prior art to the ’992 Patent.

579. *Thompson* discloses an “enhanced cable assembly for [a] field data distribution system formed by a plurality of twisted conductor pair bundled within a conductive shield and an insulative sheath.”[554] *Thompson* further teaches that “[t]he conductor pairs, in cooperation with the cable connector, are configured to comply with Category 5E specifications, often referred to as Cat 5E.”[555] *Thompson* further explains that the cable “may also include an outer "armor" layer (not shown) to reduce damage to the cable member 77 from contact with rough objects in the field, such as rocks, branches, exposed tree roots, and the like, being run over by vehicles, or being chewed by animals.”[556] *Thompson* further teaches that the cable is “for carrying computer network signals, such as Ethernet type signals.”[557] *Thompson*’s disclosures regarding deploying durable and resilient communication means are reasonably pertinent to the problem addressed by the ’992 Patent—controlling and/or monitoring industrial equipment from a centralized location.

B. MOTIVATION TO COMBINE.

[554] Ex. 1037 (*Thompson*) Abstract.
[555] Ex. 1037 (*Thompson*) [0015].
[556] Ex. 1037 (*Thompson*) [0049].
[557] Ex. 1037 (*Thompson*) [0008].

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580. A POSITA would have been motivated to combine *Coli, Birch, Rusnak, Hunt, Ekanayake, Bliss* and *Broussard079l*.[558] A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss-Broussary079* system with *Thompson.*

581. A POSITA would have been motivated to use shielded, armored CAT 5E Ethernet cables, such as those disclosed in *Thompson*, for transmitting signals to and from *Coli*'s control system.[559] *Thompson* discloses the use of a cable comprised of "a plurality of twisted conductor pair[s] bundled within a conductive shield and an insulated sheath" which also comprises "an outer 'armor' layer (not shown) to reduce damage to the cable member 77 from contact with rough objects in the field, such as rocks, branches, exposed tree roots, and like, being run over by vehicles, or being chewed by animals."[560] *Thompson* further teaches that the cable is "for carrying computer network signals, such as Ethernet type signals."[561] A POSITA would have understood that, at a hydraulic fracturing site, "rough objects" are present, including at least rocks and edges of equipment, such as pumps and transports, and would have appreciated the benefits of protecting the cable from such rough objects. A POSITA would also have understood the benefits of protecting the

[558] See Section XVIII.A above
[559] Ex. 1003 (Original Declaration), ¶¶ 165-168.
[560] Ex. 1037 (*Thompson*) Abstract, [0049].
[561] Ex. 1037 (*Thompson*) [0008].

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cables from "being run over by vehicles", as there are numerous vehicles at a fracturing site that pose a hazard to cables that communicate between locations, including switchgear and gas turbines. Further, *Thompson* teaches that conductors "carrying data between computers may be shielded separately from the other conductor pairs to minimize possible interference to and from other signals on other conductor pairs."[562] A POSITA would have recognized the benefits of avoiding interference between on data signals. Further, a POSITA implementing the *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss-Broussary079* system would have been motivated to consult additional references that teach particular types of Ethernet cables, such as *Thompson,* as *Coli* makes it at least obvious to use Ethernet communications at a fracturing site.

582. Overall, such a combination represents the mere application of known techniques (*i.e.*, a shielded CAT5e with an outer "armor" layer, as taught by *Thompson*) to a known system (*e.g.*, *Coli*'s hydraulic fracturing system) ready for improvement (*i.e.*, to gain the benefits of shielded CAT5e cabling, such as more resilient communication cables). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

C. SUBSTITUTE CLAIM 55

[562] Ex. 1037 (*Thompson*) [0013], [0046].

583. The combination of *Coli*, *Birch*, *Rusnak*, *Hunt*, *Ekanayake*, *Bliss* *Broussard079* and *Thompson* renders Claim 55 obvious. In addition to the discussion of Claim 54 discussed above, and incorporated herein by reference, the combination discloses each and every additional limitation of Claim 55.

1. [55a] The method of claim 54, the emergency power off unit comprising an auxiliary power and switchgear, each coupled to the generator and the centralized control unit, the method further comprising signaling the switchgear from the centralized control unit to open a breaker to substantially immediately cut power to the generator

584. Limitation [55a] would have been obvious for the same reasons as those disclosed in Section XI.C.3 of my original declaration, which is incorporated herein by reference.

2. [55b] wherein signaling is transmitted over armored shielded CAT5E cabling.

585. *Thompson* discloses the use of a "cable assembly for [a] field data distribution system formed by a plurality of twisted conductor pair bundled within a conductive shield and an insulative sheath" which is "configured to comply with Category 5E specifications, often referred to CAT 5E" and has "an outer 'armor' layer (not shown) to reduce damage to the cable member 77 from contact with rough objects in the field such as rocks, branches, exposed tree roots, and the like, being run over by vehicles or being chewed by animals".[563]

[563] Ex. 1037 (*Thompson*) Abstract, [0015], [0049].

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586. It would have been obvious to a POSITA that the cabling used by *Coli*'s control system for transmitting signals, including an emergency power off signal as recited in Substitute Claim 27, would have been armored, shielded CAT5E cabling, as this particular type of cabling was known for Ethernet transmissions as taught by *Thompson*, and provides benefits such as protection of the cable from physical damage and prevention of interference with data signals. Ethernet has been known since at least the 1980s. As Dr. Nikolaou testified, and I agree, armored shielded cabling was known at the time of the '992 Patent.[564] *Thompson* discloses armored, shielded Cat 5E cabling, along with the benefits of such cable. Thus, the *Coli-Birch-Rusnak-Hunt-Ekanayake-Bliss-Broussary079-Thompson* combination renders this limitation obvious.

XXVIII. GROUND 19B THE COMBINATION OF *COLI*, *BIRCH*, *RUSNAK*, *HUNT*, *EKANAYAKE*, *BLISS*, *BROUSSARD079*, *THOMPSON*, AND WHAT WAS OTHERWISE AVAILABLE TO THE PUBLIC RENDERS SUBSTITUTE CLAIM 55 OBVIOUS

A. MOTIVATION TO COMBINE

587. The motivation to combine *Coli*, *Birch*, *Rusnak, Hunt, Ekanayake*, *Bliss*, *Broussard079*, and *Thompson* is the same as that discussed above in Section XXVII.B, included herein by reference. It would have been obvious to combine these references with known technology otherwise available to the public for the

[564] Ex. 1023 (Nikolaou Dep. Tr.), 78:7-80:4.

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same reasons. Such available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation success in the combination for the same reasons, and because such combination would have involved the mere application of known techniques (those otherwise available to the public) to a known system (the *Coli/Birch/Rusnak/Hunt/Ekanayake/Bliss/Broussard079/Thompson* system) ready for improvement.

B. CLAIM 55

588. Claim 55 depends from Claim 54. I incorporate by reference my discussion of Claim 54 in Ground 15B.

1. [55a]: The method of claim 54, the emergency power off unit comprising an auxiliary power and switchgear, each coupled to the generator and the centralized control unit, the method further comprising signaling the switchgear from the centralized control unit to open a breaker to substantially immediately cut power to the generator

589. Limitations [55a] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Hunt*, *Ekanayake*, *Bliss*, *Broussard079*, and *Thompson* for the same reasons discussed with respect to these limitations in Ground 19A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

590. Limitation [55a] recites what was known and publicly available before the time of the '992 Patent I have been aware of emergency power off units with

auxiliary power and switchgear that signal a breaker to immediately cut power to the generator since at least the early 2000s.

2. [55b]: "wherein signaling is transmitted over armored shielded CAT5E cabling."

591. Limitations [55a] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Hunt*, *Ekanayake*, *Bliss*, *Broussard079*, and *Thompson* for the same reasons discussed with respect to these limitations in Ground 19A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent, for the same reasons discussed above with respect to limitation [46c] in Ground 14B.

XXIX. GROUND 20A THE COMBINATION OF *COLI*, *BIRCH*, *RUSNAK*, *ARMSTRONG*, *CLANCY*, *TROBAUGH*, *TEETS*, *HUNT*, *GENSEL*, *DELANEY*, *AND WEIR* RENDERS CLAIM 44 OBVIOUS.

A. OVERVIEW AND DISCLOSURE OF *DELANEY* (EX. 1059)

592. *Delaney* is United States Patent no. 7,455,138. *Delaney* is titled "Integrated Hydraulic System for Motor Vehicles". *Delaney* was filed on November 10, 2006, published on March 29, 2007 and granted on November 25, 2008. *Delaney* is prior art to the '992 Patent.

593. *Delaney* discloses the basics of a hydraulic system which include "[p]ower for an auxiliary hydraulic system is converted from engine output by an engine driven hydraulic pump. The hydraulic pump draws working fluid from a tank

and supplies fluid to a hydraulic valve manifold which can divert the working fluid to a cylinder or impeller used to move a target load."[565]

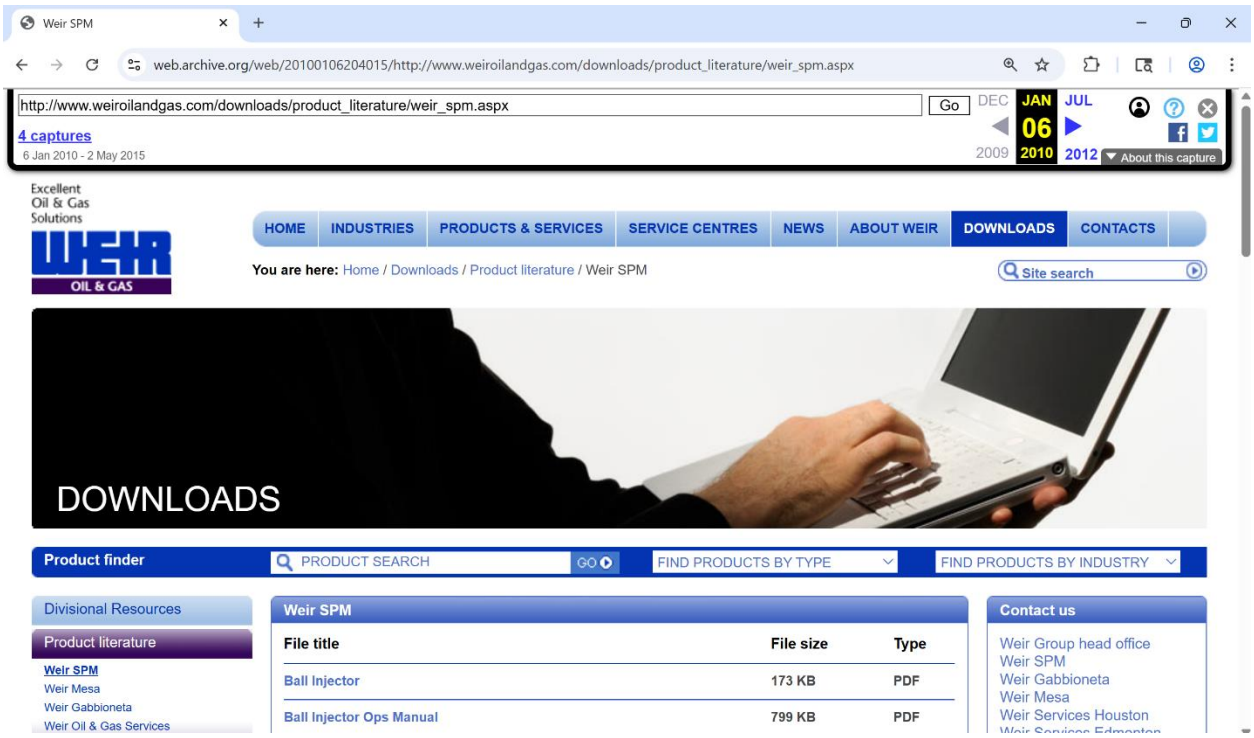
594. *Delaney* discloses monitoring several well-known aspects of the hydraulic system, including system pressure, temperature, hydraulic oil level and filter status.[566] *Delaney* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

B. STATUS AND OVERVIEW OF *WEIR* (*EX. 1060*)

595. *Weir* is a "General Catalog" of products available from Weir SPM. *Weir* contains information regarding "Well Service Pumps, Flow Control Products, Manifold Trailers, Safety Products, Post Sale Services."[567] *Weir* has a copyright date of 2009. Further, I accessed *Weir* from the Internet Archive at https://web.archive.org/web/20100106204015/http://www.weiroilandgas.com/downloads/product_literature/weir_spm.aspx.

[565] Ex. 1059 (*Delaney*) 1:19-24.
[566] *See* Ex. 1059 (*Delaney*) 2:64-66, 3:21-28, 4:51-62, 5:26-40, Fig. 6
[567] Ex. 1060 (*Weir*) pg. 1.

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596. I am familiar with the Internet Archive and use it regularly to determine when websites were updated and when printed material was publicly available. I understand that the Internet Archive displays the date the website was captured on the display page. I also understand that the URL of the Internet Archive records when the page was captured.[568] In this case, I understand from the Internet Archive URL that *Weir* was publicly available at least by January 6, 2010 as indicated by the ”20100106” portion of the URL. Further still, I reviewed the declaration of Nathaniel E Frank-White, which additionally confirms that Weir was publicly available on the

[568] Ex. 1061 (Frank-White Affidavit), ¶¶ 5, 7.

internet as of at least January 6, 2010.[569] Accordingly, *Weir* is prior art to the '992 Patent.

597. *Weir* discloses a variety of equipment useful for oil and gas, and hydraulic fracturing, operations that were commercially available prior to the '992 Patent, Included in *Wier's* offerings are "Manifolds, Frac Head and Cement Heads"[570] as well as "Manifold Trailers"[571], "Well Service Pumps"[572] of the type and style used for fracturing applications, as well as "Pump Monitoring Device" for the well service pumps.[573] *Weir* discloses that its well service pumps "range from 250 BHP to 3500 BHP with pressure capabilities up to 20,000 psi," and "can be configured to a variety of well service needs" including " fracturing." *Weir's* pumps, then, are hydraulic fracturing pumps, and are compatible with *Coli's* teachings of *Coli's* electric driven fracturing system. Thus, *Weir* is in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

C. MOTIVATION TO COMBINE

598. The motivation to combine *Coli*, *Birch*, *Rusnak, Armstrong, Clancy, Trobaugh, Teets, Hunt* and *Gensel* is the same as that described above in Section XIV.B, and incorporated herein by reference. A POSITA would have been

[569] Ex. 1061 (Frank-White Affidavit), ¶¶ 5, 7 & Ex. B.
[570] Ex. 1060 (*Weir*) pg. 13.
[571] Ex. 1060 (*Weir*) pg 17.
[572] Ex. 1060 (*Weir*) pg 20.
[573] Ex. 1060 (*Weir*) pg. 34.

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motivated to combine *Delaney* with *Coli*, *Birch*, *Rusnak, Armstrong, Clancy, Trobaugh, Teets,* and *Gensel.*

599. *Clancy* discloses the use of a hydraulic system on its compression skid. For example, *Clancy* discloses that "[a]s known by those skilled in the art, some gas compressors use a hydraulic drive."[574] Further, *Clancy* describes the hydraulic system in one embodiment as "hydraulic liquids supply from a source; a hydraulic pump, connected to the hydraulic liquids supply and to the engine, receiving power from the engine and transferring hydraulic pressure to the a seventh piping line; a hydraulic motor, connected to the hydraulic liquids supply, to the hydraulic pump, to the engine and controlled by an actuated valve, receiving hydraulic pressure from the hydraulic pump by the seventh piping line and power from the engine; transferring power to the compressor, to the after-cooler and to the water pump by a hydraulic pumping system."[575] While *Coli* teaches replacing diesel driven hydraulic systems on fracturing pumps and blenders, *Clancy's* system is different in that it employs a hydraulic system to power its gas compressor system. *Clancy* teaches that "[t]he hydraulics employed in this system allow for multiple functions to be undertaken at one time. This allows for a uniquely designed process which can accommodate a multitude of operational conditions."[576] *Clancy* also discloses an

[574] Ex. 1055 (*Clancy*) [0004].
[575] Ex. 1055 (*Clancy*) [0009]; *see also* [0027].
[576] Ex. 1055 (*Clancy*) [0061].

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electric motor used to drive the hydraulic system, making it compatible with *Coli's* electric driven fracturing system.[577]

600. *Clancy* further discloses a "hydraulic pump (111), which supplies the pressure to run the hydraulic motors and a hydraulic pilot pump (112), used to actuate the valve assembly…Multiple Filters (not Shown) are fitted in the tank on the discharge line, return line and pilot pump, together with high temperature shut downs (90), low level shut downs (91) and a sight glass for level indication (92)."[578] A POSITA would have been motivated to incorporate *Clancy's* hydraulic system into *Coli's* hydraulic fracturing system to obtain power to drive the compressors and pumps disclosed by *Clancy*. Doing so would have merely involved applying known techniques (hydraulic systems) to known systems (hydraulic fracturing systems) ready for improvement (powering components).

601. Further still, *Clancy* discloses a "distributed control system (DCS), which is a computer readable program, and allows for (HMI) humane [*sic. human*] machine interface. The DCS is integrated with a power engine computer system, which allows for diagnostics, control and data logging,"[579] and that the "DCS (110) is located in the engine skid and provides a way by which all the information

[577] See Ex. 1055 (*Clancy*) [0067].
[578] Ex. 1055 (*Clancy*) [0073].
[579] Ex. 1055 (*Clancy*) [0003], *see also* [0028].

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gathered from the different sensors, meters and devices could be managed."[580] While *Clancy* discloses details of monitoring and controlling specific operating characteristics of the gas compressor , as discussed above in Section XII.F, *Clancy* provides little detail about monitoring the hydraulic system, including pumps, tanks, filters, etc. A POSITA would have been motivated to look to other references regarding what characteristics of the hydraulic system should be monitored by *Clancy's* DCS, and, in the combination, *Coli's* central monitoring and control.

602. *Delaney's* hydraulic system, similar to the hydraulic system of *Clancy*, consists of a "hydraulic pump. The hydraulic pump draws working fluid from a tank and supplies fluid to a hydraulic valve manifold which can divert the working fluid to a cylinder or impeller used to move a target load."[581] *Delaney* discloses a "electrical system controller (ESC) which "manages the assorted vocational controllers (e.g. valve system controller 40 and 50 ECU 58) connected to bus 60 as nodes."[582] One of these nodes, valve controller 40, "monitors the hydraulic fluid level in reservoir 30 and the system oil pressure and temperature from manifold 34. Return filter 36 condition is indicated by the pressure drop across the filter which is reported by a sensor to valve system controller 40, which reports the need for

[580] Ex. 1055 (*Clancy*) [0077].
[581] Ex. 1059 (*Delaney*) 1:19-24.
[582] Ex. 1059 (*Delaney*) 3:49-51.

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maintenance to ESC 62."[583] *Delaney's* ESC provides similar overall control as provided by *Clancy's* DCS and *Coli's* central monitoring control. While *Delaney's* hydraulic system is mounted on a vehicle, and *Clancy's* compression system is mounted on a skid, a POSITA would have recognized that both systems are designed to be transported from location to location, and the teachings of *Delany*, known long before the '992 Patent, would have been equally applicable to *Clancy's* disclosure of a hydraulic system. *Delaney* teaches monitoring basic operating characteristics generally applicable to any hydraulic system.

603. A POSITA would have recognized that *Delaney's* monitoring functions would have been implemented in *Coli's* "control center 40" that includes "controls and computer monitoring for the entire fracturing operation."[584] *Coli* teaches monitoring the entire fracturing operation, while *Delaney* provides details of specific operating characteristics of the hydraulic system, part of *Clancy's* hydraulic system, which is a part of the "entire fracturing operation.

604. Such a combination represents the mere application of known techniques (*i.e.*, techniques for monitoring hydraulic systems as taught by *Delaney*) to a known system (*e.g.*, *Coli*'s hydraulic fracturing system, incorporating *Clancy's* teachings of a gas compressor hydraulic system) ready for improvement (*i.e.*, to

[583] Ex. 1059 (*Delaney*) 3:21-28.
[584] Ex. 1004 (*Coli*), [0072].

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improve the breadth of *Coli*'s system monitoring functionality). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

605. A POSITA would further have been motivated to combine the teachings of *Weir* with *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Hunt* , *Gensel* and *Delaney.*

606. As discussed above in Section XXVII.B, *Weir* discloses that "Weir SPM's Pump Monitoring Device was developed to allow the user to continually monitor the status of their well service pumps with real time data in an easy to read format. The PMD allows the operator to make the necessary changes during operation to minimize or prevent costly damage to pumping equipment and increase longevity of their pumps."[585] *Weir* further discloses that "[t]hrough various sensors installed on the pump, the PMD provides a unique opportunity to diagnose problems such as insufficient charge pressure, discharge and suction valve failure, cavitation, as well as other issues by displaying 'alarms' to notify the user of any problems as they occur."[586]

607. A POSITA would have been motivated to incorporate *Weir's* teaching of monitoring and alarming various operating characteristics of the hydraulic

[585] Ex. 1060 (*Weir*) pg. 34.
[586] Ex. 1060 (*Weir*) pg. 34.

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fracturing pumps (well service pumps) to gain the benefits of "to minimize or prevent costly damage to pumping equipment and increase longevity of their pumps,"[587] and "alarms [that] notify the user of any problems as they occur"[588] as taught by Weir to improve the effectiveness and efficiency of the operation. Monitoring the specific operating characteristics of the hydraulic pumps taught by *Weir* would support *Coli's* goal of a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation."[589]

608. Implementing the disclosure of *Weir* represents the mere application of known techniques (*i.e.*, techniques for monitoring hydraulic pumps as taught by *Weir*) to a known system (*e.g.*, *Coli*'s hydraulic fracturing system) ready for improvement (*i.e.*, to improve the breadth of *Coli*'s system monitoring functionality). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

D. CLAIM 44

609. The combination of *Coli, Birch, Rusnak, Armstrong, Clancy, Trobaugh, Teets, Gensel, Delaney and Weir* renders claim 44 obvious. In addition to the discussion of Claim 43 discussed above, and incorporated herein by reference,

[587] Ex. 1060 (*Weir*) pg. 34.
[588] Ex. 1060 (*Weir*) pg. 34.
[589] Ex. 1004 (*Coli*), [0072].

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the combination discloses each and every additional limitation of Claim 4, as discussed in the subsections below.

1. [44a] The system of claim 43, further comprising: a variable frequency drive that controls the plurality of electric pumps,

610. As discussed in my original declaration, *Coli* discloses a variable frequency drive that controls the speed of the motors providing power to the pumps (i.e., "electric pumps").[590] *Broussard079* contains a similar disclosure.[591]

2. [44b] the system further comprising a hydraulic system,

611. A POSITA would understand the ordinary meaning of a "hydraulic system" as a system in which water, or another fluid with a low viscosity, is used to convey power and do mechanical work. For example, the *Authoritative Dictionary of IEEE Standards Terms (IEEE Standards Dictionary*) defines "hydraulic operation" as "Power operation by movement of a liquid under pressure".[592]

612. *Clancy* discloses a hydraulic system. *Clancy* discloses "an engine generates power and transfers the power generated using a hydraulic system. The hydraulic system is used to drive two natural gas compressors, a natural gas after-cooler and a water pump, all of them controlled by a valve assembly."[593]

[590] Ex. 1003 (*Original Declaration*) ¶¶162 – 164.
[591] Ex. 1024 (*Broussard079*) [0008].
[592] Ex. 1065 (*IEEE Standards Dictionary*), pg. 527.
[593] Ex. 1055 (*Clancy*) [0027]; *see also* [0004], [0005], [0007], *generally*.

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613. In his second deposition, Dr. Nikolaou testified that the hydraulic system includes a "hydration unit."[594] I do not agree with Dr. Nikolaou that a hydration unit is a hydraulic system. A hydration unit "generally functions to mix water and chemical additives to make the frac fluid."[595]Nonetheless, hydration units were not novel and were well-known before the time of the '992 Patent. For example, *Payne* discloses hydration unit. *Payne* describes "a blender unit and a hydration unit,"[596] a "chemical hydration unit"[597] and a "hydration unit 900A …[which] "generally functions to mix water and chemical additives to make the frac fluid."[598] Accordingly, *Payne* discloses a hydration unit.

3. [44c] wherein the system is configured to monitor operating characteristics of the hydraulic system,

614. *Delaney* discloses monitoring operating characteristics of the hydraulic system. For example, *Delaney* discloses a hydraulic valve "system controller 40", which "monitors the hydraulic fluid level in reservoir 30 and the system oil pressure and temperature from manifold 34. Return filter 36 condition is indicated by the

[594] Ex. 1053 (Nikolaou Dep. Tr.), 81:18-83:22.
[595] Ex. 1068 (*Payne*) [0088];
[596] Ex. 1068 (*Payne*), Abstract; Ex. 1069 (*Payne Provisional*) pg. 9; ppg.11-12.
[597] Ex. 1068 (*Payne*) [0006]; Ex. 1069 (*Payne Provisional*) pg. 9; ppg.11-12.
[598] Ex. 1068 (*Payne*) [0088]; Ex. 1069 (*Payne Provisional*) ppg.11-12.

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pressure drop across the filter which is reported by a sensor to valve system controller 40, which reports the need for maintenance."[599]

615. *Weir* also disclosed monitoring operating characteristics of the hydraulic system. As discussed in more detail in Section XXVI.D.4.b) below, *Weir* discloses a "Pump Monitoring Device" that monitors multiple functions of the hydraulic system.

616. *Coli* discloses a "control center 40" that includes "controls and computer monitoring ***for the entire fracturing operation***," which includes the hydraulic system.[600] It would have been obvious to a POSITA to monitor the "*operating characteristics*" listed in [44d], in view of *Coli*'s disclosure of centralized monitoring for the entire fracturing operation and because it was known in the prior art and/or obvious to monitor these operating characteristics, as shown below and as conceded by Dr. Nikolaou.

4. [44d] wherein the operating characteristics include at least…

a) system pressure,

617. As discussed above in Section XXVIII.D.3, *Delaney* discloses monitoring hydraulic "system oil pressure and temperature."

b) charge pressure,

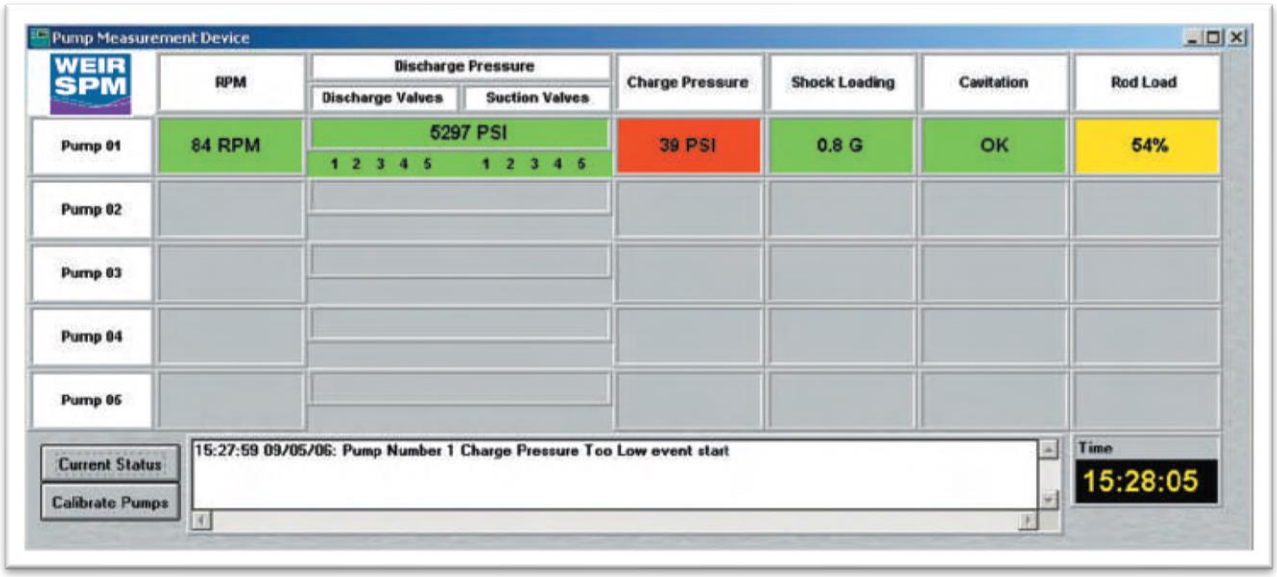
[599] Ex. 1059 (*Delaney*) 3:21-28; see also 2:64-66, 4:51-62, 5:26-40, Fig. 6
[600] Ex. 1004 (Coli), [0010], [0072].

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618. *Weir* discloses monitoring for charge pressure in a hydraulic system. *Weir* discloses a "Pump Monitoring Device (PMD)" for monitoring a well service pump (which would have been configured as a hydraulic fracturing pump, as described above in Section XXVI.B).[601] Such a pump would be a "hydraulic pump" and used in a "hydraulic system," like the hydraulic fracturing system of *Coli*.[602] *Weir* discloses that the PMD, "Through various sensors installed on the pump, the PMD provides a unique opportunity to diagnose problems such as ***insufficient charge pressure***, discharge and suction valve failure, cavitation, as well as other issues by displaying 'alarms' to notify the user of any problems as they occur."[603] *Weir* also discloses an "Actual Screenshot" from the PMD, which shows "Charge Pressure" as one of the operating characteristics monitored.

[601] Ex. 1060 (*Weir*) pg 34.
[602] Ex. 1060 (*Weir*) pgs. 21, 23-28.
[603] Ex. 1060 (*Weir*) pg 34.

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EX. 1060 (*Weir*) pg. 34

Accordingly, *Weir* discloses monitoring a "charge pressure" of a hydraulic system.

c) temperature,

619. As discussed above in Section XXVIII.D.3, *Delaney* discloses monitoring hydraulic "system oil pressure and temperature."

d) hydraulic oil level,

620. As discussed above in Section XXVIII.D.3, *Delaney* discloses monitoring hydraulic "hydraulic fluid [i.e., oil] level in reservoirs 30."

e) and filter status.

621. As discussed above in Section XXVIII.D.3, *Delaney* discloses monitoring filter status: "[r]eturn filter 36 condition is indicated by the pressure drop across the filter, which is reported by a sensor to valve system controller 40, which reports the need for maintenance."

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XXX. GROUND 20B THE COMBINATION OF *COLI*, *BIRCH*, *RUSNAK*, *ARMSTRONG*, *CLANCY*, *TROBAUGH*, *TEETS*, *HUNT*, *GENSEL*, *DELANEY*, *WEIR*, AND WHAT WAS OTHERWISE AVAILABLE TO THE PUBLIC RENDERS SUBSTITUTE CLAIM 44 OBVIOUS.

A. MOTIVATION TO COMBINE

622. The motivation to combine *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Hunt*, *Gensel*, *Delaney*, and *Weir* is the same as that discussed above in Section XXIX.C, included herein by reference. It would have been obvious to combine these references with known technology otherwise available to the public for the same reasons. Such available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation success in the combination for the same reasons, and because such combination would have involved the mere application of known techniques (those otherwise available to the public) to a known system (the *Coli/Birch/Rusnak/Armstrong/Clancy/Trobaugh/Teets/Hunt/Gensel/Delaney/Weir system*) ready for improvement.

B. CLAIM 44

623. Claim 44 depends from Claim 43. I incorporate by reference my discussion of Claim 43 in Ground 14B.

1. [44a] - [44c]

624. Limitations [44a] - [44c] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Hunt*,

Gensel, *Delaney*, and *Weir* for the same reasons discussed with respect to these limitations in Ground 20A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

625. Limitations [44a]-[44c] recite what was known and publicly available before the time of the '992 Patent. I have been aware of each of these limitations since at least the 1990s.

2. [44d]: wherein the operating characteristics include at least system pressure, charge pressure, temperature, hydraulic oil level, and filter status.

626. Limitations [44d] would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Armstrong*, *Clancy*, *Trobaugh*, *Teets*, *Hunt*, *Gensel*, *Delaney*, and *Weir* for the same reasons discussed with respect to these limitations in Ground 20A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent.

a) System pressure

627. Monitoring system pressure of a hydraulic system was known and publicly available before the time of the '992 Patent. I have been aware of monitoring system pressure of a hydraulic system since at least the 1990s.

628. Patent Owner's expert Dr. Nikolaou admits that as of 2015, the technology for monitoring the pressure of a hydraulic system was known[604]:

[604] Ex. 1023 (Nikolaou Dep. Tr.), 58:7-13 (objection omitted).

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> Q. Okay. As of the time of the 992 patent application in 2015, was it known to monitor the system pressure of a hydraulic system?
>
> A. The technology [f]or monitoring the pressure of a hydraulic system was known at the time, yes.

b) Charge pressure

629. Monitoring charge pressure of a hydraulic system was known and publicly available before the time of the ’992 Patent. I have been aware of monitoring the charge pressure of a hydraulic system since at least the 1990s.

630. Patent Owner’s expert, Dr. Nikolaou, admits that as of 2015, the technology for monitoring the charge pressure of a hydraulic system was known[605]:

> Q. As of the time of the 992 patent application in 2015, was it known to monitor the charge pressure of a hydraulic system?
>
> A. The technology for monitoring charge pressure in a hydraulic system was known at the time, yes.

c) Temperature

631. Monitoring the temperature of a hydraulic system was known and publicly available before the ’992 Patent. I have been aware of monitoring the temperature of a hydraulic system since at least the 1990s.

632. Patent Owner’s expert Dr. Nikolaou admits that as of 2015, the technology for monitoring the temperature of a hydraulic system was known[606]:

> Q. As of the time of the 992 patent application in 2015, was it known to monitor the temperature of a hydraulic system?

[605] Ex. 1023 (Nikolaou Dep. Tr.), 59:5-11 (objection omitted).
[606] Ex. 1023 (Nikolaou Dep. Tr.), 59:21-60:15 (objections omitted).

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A. The technology for doing this was available at the time.

Q. And was it known how to monitor the temperature of a hydraulic system?

A. It was known how to monitor the temperature of a hydraulic system.

Q. And those in the industry were monitoring temperatures of a hydraulic system at the time?

A. Overall, people in various industries, yeah, were monitoring temperatures of hydraulic systems.

d) Hydraulic oil level

633. Monitoring hydraulic oil level of a hydraulic system was known and publicly available before the time of the '992 Patent. I have been aware of monitoring the hydraulic oil level of a hydraulic system since at least the 1990s.

634. Patent Owner's expert, Dr. Nikolaou, admits that as of 2015, the technology for measuring hydraulic oil level was known at the time[607]:

Q. As of the time of the 992 patent application in 2015, was it known to monitor the hydraulic oil level of a hydraulic system?

A. The technology for measuring hydraulic oil level was known at the time.

e) Filter status

635. Monitoring filter status of a hydraulic system was known and publicly available before the time of the '992 Patent. I have been aware of monitoring filter status of a hydraulic system since at least the 1990s.

[607] Ex. 1023 (Nikolaou Dep. Tr.), 61:6-11 (objection omitted).

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636. Patent Owner's expert, Dr. Nikolaou, admits that as of 2015, the technology for monitoring the filter status of a hydraulic system was known and used[608]:

> Q. As of the time of the 992 patent application in 2015, was it known to monitor the filter status of hydraulic systems?
>
> A. The technology for doing this was known at the time.
>
> Q. And it was known to actually do this?
>
> A. To actually do what? To monitor the filter status?
>
> Q. Yes.
>
> A. There was technology was used – that was known and could be used to monitor filter status, yes.

XXXI. GROUND 21A THE COMBINATION OF *COLI, BIRCH, RUSNAK, HUNT, BLISS AND McIVER RENDERS CLAIM 58 OBVIOUS*

A. STATUS AND OVERVIEW OF *MCIVER (EX. 1039)*

637. *McIver* is U.S. Patent Application Publication 2013/0142601, filed on October 23, 2012, and published on June 6, 2013. *Benson* is prior art to the '992 Patent.

638. *McIver* relates to "transportable silo systems for storage of materials," which include "self-erecting silo storage systems for use in the oil and natural gas mining and drilling industries."[609] The silos are used to store various materials "usable in fracking applications," including "water, sand, proppant or an acid

[608] Ex. 1023 (Nikolaou Dep. Tr.), 61:22-62:13 (objections omitted).
[609] Ex. 1039 (*Mciver*) Abstract, [0002].

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solution."[610] *McIver* discloses a system that will "monitor the level of sand in each silo" in its configuration, wherein each silo may be positioned vertically.[611] *McIver* further teaches that a "dual belt conveyor system" is used to "move material, such as sand or other solid or semi-solid material used in fracking applications, horizontally."[612] *McIver* explains that the dual belt conveyor has a "Variable Frequency Drive" that controls the conveyor's speed.[613] *McIver* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

B. MOTIVATION TO COMBINE.

639. A POSITA would have been motivated to combine *Coli, Birch, Rusnak, Hunt, Ekanayake,* and *Bliss*.[614] A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Hunt-Broussard079* system with *McIver*.

640. The combined *Coli-Birch-Rusnak-Hunt* system discloses a control system that controls and monitors all equipment of a fracturing site.[615] *Coli* discloses the use of "blender units," "to blend fluids with proppant, sand, chemicals, acid, etc., prior to delivery to the wellbore."[616] *McIver* discloses "silo storage systems for use

[610] Ex. 1039 (*Mciver*) [0047]. See also [0005].
[611] Ex. 1039 (*Mciver*), [0017], [0056].
[612] Ex. 1039 (*Mciver*), [0044]-[0045], [0054].
[613] Ex. 1039 (*Mciver*), [0056].
[614]Section, XXIV.A above.
[615] Ex. 1003 (Original Declaration), ¶¶ 268-276.
[616] Ex. 1004 (*Coli*), [0053]-[0054].

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in the oil and natural gas mining and drilling industries," wherein silos are used to store and deliver proppant material for use in fracturing operations.[617] *McIver* further discloses monitoring silos and other equipment (e.g., monitoring levels and using VFDs to monitor and control the speed of the dual-belt conveyor system) used for the storage and transportation of proppant material.[618] POSITA would have been motivated to combine the system taught by *Coli,* containing proppant, with *McIver's* teachings of monitoring levels of proppant silos, as well as monitoring the speed of belt conveyors transporting the proppant, in order to ensure that there is sufficient proppant available and being delivered to facilitate the proppant blending operations as described in *Coli*. A POSITA further would have been motivated to incorporate the monitoring functionality taught by *McIver* to further *Coli*'s goal of providing "control and computer monitoring for the entire fracturing operation…at a single central location."[619] Overall, such a combination represents the mere application of known techniques (*i.e.*, monitoring proppant storage and transport equipment and the monitoring thereof, as taught by *McIver*) to a known system (*e.g.*, *Coli*'s hydraulic fracturing system, which includes a blender unit for mixing proppant for fracturing operation), ready for improvement. Thus, a POSITA would have been

[617] Ex. 1039 (*Mciver*), Abstract, [0005], [0047].
[618] Ex. 1039 (*Mciver*), [0044]-[0045], [0054].
[619] Ex. 1004 (*Coli*), [0072].

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motivated to combine the references and would have reasonably expected success in doing so.

C. SUBSTITUTE CLAIM 58: THE SYSTEM OF CLAIM 56, WHEREIN THE CENTRALIZED CONTROL UNIT IS FURTHER CONFIGURED TO MONITOR AND CONTROL ALL OF THE FOLLOWING…

641. The combination of *COLI, BIRCH, RUSNAK, HUNT, BLISS AND MCIVER* renders Claim 58 obvious. In addition to the discussion of Claim 56 discussed above, and incorporated herein by reference, the combination discloses each and every additional limitation of Claim 58.

642. As discussed above in Section XII.F.4, incorporated herein by reference, *Coli* discloses a "control center 40" that includes "controls and computer monitoring for the entire fracturing operation," which includes the components and characteristics recited in Claim 58 below[620] Further, as discussed in the subsections below, it would have been obvious to apply *Coli's* teaching and monitor and control each of the functions or structures claimed.

1. "compression of natural gas,"

643. As discussed in my Original Declaration, *Coli*, in view of Birch, renders obvious monitoring and controlling the compression of natural gas.[621]

2. "electric motors,"

[620] Ex. 1004 (*Coli*), [0072].
[621] Ex. 1003 (Original Declaration), ¶¶ 175-181.

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644. *Coli* discloses that the electric motors used in the system are "controlled by variable frequency drives" that "essentially 'tell' the motors what they are allowed to do," which a POSITA would have understood to disclose controlling electric motors via a VFD.[622] In addition to controlling the electric motors in this manner, *Coli* discloses monitoring "the entire fracturing operation…at a central location" (*i.e.*, *Coli*'s control system).[623] A POSITA would have understood that such functionality includes monitoring the electric motors, which are part of the fracturing operation.

3. "switchgear,"

645. The combined *Coli-Birch-Rusnak-Hunt* system comprises a switchgear that operates as an emergency power off unit.[624] Because *Coli* teaches a control system that "controls" and "monitor[s]" an "entire fracturing operation," a POSITA would have understood that the switchgear, which is part of the fracturing operation taught by the *Coli-Birch-Rusnak-Hunt-Broussard079-McIver* system, would have been control and monitored by *Coli*'s control system.

4. "transformers,"

646. *Coli* discloses that its fracturing system includes "an electrical transformer and drive unit 50 (see FIG. 3) to step down the voltage of the power

[622] Ex. 1004 (*Coli*), [0011], [0065]; Ex. 1003 (Original Declaration), ¶¶95-99, 162.
[623] Ex. 1004 (*Coli*), [0072].
[624] Ex. 1003 (Original Declaration), ¶¶ 267-307.

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from turbine generator 30 to a voltage appropriate for electric motor 21."[625] Because *Coli* teaches a control system that "controls" and "monitors " an "entire fracturing operation," a POSITA would have understood that the transformer, which is part of the fracturing operation taught by Coli, would have been controlled and monitored by *Coli*'s control system.

5. "mobile turbines,"

647. *Coli*, in view of Birch, discloses monitoring and controlling gaseous fuel compression for a gas turbine generator.[626] *Broussard079* teaches that turbine generators "can be mounted on vehicles, and can be ported from one well to another."[627] When implementing the gas turbine generators of the *Coli-Birch-Rusnak-Hunt-Broussard079-McIver* system in the manner taught by *Broussard079* (*i.e.*, such that the turbine generators "can be mounted on vehicles, and can be ported from one well to another"), a POSITA would have understood the turbine generators to be "*mobile*."

6. "rate and pressure of the overall system,"

648. *Coli* discloses that "[i]f a rate change is required, the system will increase the rate of the entire system with a single command. This means that if pumps 22 are told to increase rate, then blender module 40, along with the chemical

[625] Ex. 1004 (*Coli*), [0047].
[626] Ex. 1003 (Original Declaration), ¶¶ 235-244.
[627] Ex. 1024 (*Brouassard079*), [0008].

units and even ancillary equipment like sand belts, will increase rates to compensate automatically."[628] A POSITA would have understood that controlling the rates of pumps 22, the blender module 40, and the chemical units and ancillary equipment would constitute controlling the rate of the overall system. Further, *Coli*'s teaching of a "rate change [being] required" indicates that the system's rate is being monitored, thereby allowing the need for a rate change to be detected in the first place. *Coli* therefore discloses monitoring and controlling rate of the overall system.

649. *Coli* discloses monitoring and controlling pressure at the pumps to avoid exceeding a maximum pressure value.[629] And as discussed above, the combined *Coli-Birch* system generally discloses monitoring pressures at different points of the fracturing system, including pressures associated with the turbine generator (see Substitute Claims 51 and 52) and pressures associated with "the hydraulic system" (see Substitute Claim Limitation 44[d]).[630] And because *Coli* teaches a control system that "controls" and "monitor[s]" an "entire fracturing operation," a POSITA would have understood that the various pressures throughout the fracturing system that are monitored (as discussed above) would also have been "controlled," consistent with *Coli*'s teachings.

7. <u>vertical sand silos,</u>

[628] Ex. 1004 (*Coli*), [0071].
[629] Ex. 1003 (Original Declaration), ¶ 158-161.
[630] See Sections, XII.C.7, XII.E.4.

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650. *McIver* discloses a system that monitors "the level of sand in each silo" in its configuration, wherein each silo may be positioned vertically.[631] *McIver*'s system further controls "the rate at which the sand or other proppant is being removed from the silo."[632] Accordingly, the *Coli-Birch-Rusnak-Hunt-Broussard079-McIver* system renders obvious controlling and monitoring of "*vertical sand silos*."

8. <u>and an electrical conveyor belt.</u>

651. *McIver* discloses the use of a "dual belt conveyor system" that is used to "move material, such as sand or other solid or semi-solid material used in fracking applications, horizontally."[633] *McIver* explains that the dual belt conveyor has a "Variable Frequency Drive" that controls the conveyor's speed.[634] A POSITA would have recognized that this means that the dual belt conveyor system is "electrical," because a VFD controls the electrical inputs into a load (*e.g.*, the dual belt conveyor system) to control the load's speed. Further, a POSITA would have understood that, as taught by McIver, to control the dual belt conveyor's speed, the system would need to monitor the speed in the first place. When incorporating *McIver*'s dual belt conveyor system into the *Coli-Birch-Rusnak-Hunt-Broussard079* system, a

[631] Ex. 1039 (*Mciver*), [0017], [0056].
[632] Ex. 1039 (*Mciver*), [0056].
[633] Ex. 1039 (*Mciver*), [0044]-[0045], [0054].
[634] Ex. 1039 (*Mciver*), [0056].

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POSITA would have understood that *Coli*'s control system would have controlled and monitored *McIver*'s dual belt conveyor system, consistent with *Coli*'s teaching that the control system monitors all equipment of the fracking site.

XXXII. GROUND 21B THE COMBINATION OF *COLI*, *BIRCH*, *RUSNAK*, *HUNT*, *BLISS*, *McIVER*, AND WHAT WAS OTHERWISE AVAILABLE TO THE PUBLIC RENDERS CLAIM 58 OBVIOUS

A. MOTIVATION TO COMBINE

652. The motivation to combine *Coli*, *Birch*, *Rusnak*, *Hunt*, *Bliss*, and *McIver* is the same as that discussed above in Section XXXI.B, included herein by reference. It would have been obvious to combine these references with known technology otherwise available to the public for the same reasons. Such available technology is in the same field of endeavor—controlling and/or monitoring industrial equipment. A POSITA would have had a reasonable expectation of success in the combination for the same reasons, and because such a combination would have involved the mere application of known techniques (those otherwise available to the public) to a known system (the *Coli/Birch/Rusnak/Hunt/Bliss/McIver* system) ready for improvement.

B. CLAIM 58

653. Claim 58 would have been obvious over the combination of *Coli*, *Birch*, *Rusnak*, *Hunt*, *Bliss*, and *McIver* for the same reasons discussed with respect to these limitations in Ground 21A, incorporated herein by reference, in combination with what was publicly available before the time of the '992 Patent, for the same reasons

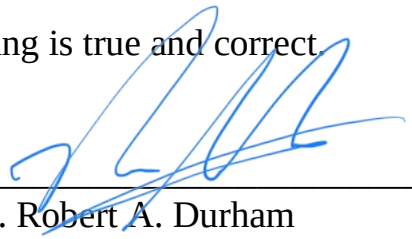
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as those discussed above with respect to Claim 56 in Ground 15B, incorporated herein by reference.

XXXIII. CONCLUSION

654. All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true. I further understand that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code. I declare under penalty of perjury that the foregoing is true and correct.

Executed on December 1, 2025.



Dr. Robert A. Durham

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