

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HALLIBURTON ENERGY SERVICES, INC.
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 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 1002 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.” In this Second Declaration, I incorporate the facts and opinions set forth in my Original Declaration.

II. EXPERIENCE AND QUALIFICATIONS

3. My experience, qualifications, CV, and consulting fee are set forth in my Original Declaration.

III. TASK SUMMARY AND MATERIALS REVIEWED

4. My Original Declaration addressed U.S. Patent No. 11,091,992 (Ex. 1001, “’992 Patent”). I have been informed that U.S. Well Services, LLC (“USWS” or “Patent Owner” or “PO”) has submitted a Non-Contingent Motion to Amend for the ’992 Patent (Paper 13, “Motion to Amend” or “MTA”) in Case No. IPR2024-01274 in which it has proposed “Substitute Claims” to replace the “Original Claims” of the ’992 Patent. I have been informed by counsel that the Motion to Amend was

filed as “non-contingent,” which I understand means that the Board will provide a final decision on the patentability of the Substitute Claims in place of determining the patentability of corresponding Original Claims.

5. For the purposes of this Second Declaration, I have been asked to review the 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

6. 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 and this declaration.

Ex. ¹	Description
1001	U.S. Patent No. 11,091,992 by Joel N. Broussard <i>et al.</i> 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 <i>et al.</i> entitled “Mobile, Modular, Electrically Powered System for Use in Fracturing Underground Formations” (“ Coli ”)
1005	U.S. Patent 5,606,853 by Peter H. Birch <i>et al.</i> 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 <i>et al.</i> entitled “Intelligent Pump System” (“ Rusnak ”)
1008	U.S. Patent Application Publication 2010/0038907 by Sam R. Hunt <i>et al.</i> entitled “Power Generation” (“ Hunt ”)
1009	IEEE100: THE AUTHORITATIVE DICTIONARY OF IEEE STANDARDS TERMS, 7 th ed. (IEEE Press: 2000), ISBN: 0-7381-2601-2 (“ IEEE Standards Dictionary ”)
1010	U.S. Patent No. 9,410,410 by Joel N. Broussard <i>et al.</i> 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.

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	Intentionally omitted
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, 6 th 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 March 25, 1926 and issued January 14, 1930) (“ Hall ”)
1019	Donald G. Fink, STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS, 13 th 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,” (“ <i>Broussard079</i> ”), 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,” (“ <i>Broussard601</i> ”), 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,” (“ <i>Kohlenberger</i> ”), 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,” (“ <i>Ekanayake</i> ”), 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,” (“ <i>Weiher</i> ”), filed Nov. 30, 2010, and issued Oct. 8, 2013
1029	European Patent No. 0023879 by Newman, “Engine module life tracking system,” (“ <i>Newman</i> ”), 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 <i>et al.</i> , “Fire Extinguishing System for a Casing,” (“ <i>Gensel</i> ”), 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,” (“ <i>Smith</i> ”), filed May 4, 1925, issued June 11, 1929

1036	U.S. Patent No. 3,605,919, by Bromell and Homanick, “Drilling Rig Control,” (“ <i>Bromell</i> ”), 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,” (“ <i>Thompson</i> ”), 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,” (“ <i>Discenzo</i> ”), 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,” (“ <i>McIver</i> ”), filed Oct. 23, 2012, published June 6, 2013
1040	International Publication No. WO2016/019219 by Omont et al, “Monitoring Health of Additive Systems,” (“ <i>Omont</i> ”), 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.

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 (03) (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 2005 Industry Applications Conference, 2005., 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.

V. Technical Background

7. 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 2015-2016 timeframe, and long before.

A. Types of Pumps – Fracturing Pump Chain

8. 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 rate of the fracturing jobs, the sizes of equipment and the particular proppants, chemicals, and liquids used.

9. A modern fracturing process requires multiple pumps operating together as a system to provide fracturing fluid with the suitable composition at the right flow rate², 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, tanks) to the blender or the hydration unit.

10. 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 sizes and types of pumps. These are typically relatively small horsepower

² “Flowrate,” “flow rate,” and “flow-rate” are used interchangeably in the industry and herein.

pumps operating at lower pressures, as the blender tub operates at more or less ambient pressures.

11. 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, which requires higher pressures to move the same volume of slurry. Second, the slurry is heavier than plain water, requiring additional horsepower to move the slurry (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.

12. 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].

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.

13. 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

head, creating suction that draws the slurry into the piston chamber. As the piston (plunger) moves toward the head, pressure is created, which drives the fluid out of the chamber and down the line to and 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 the pressure downstream. The result is that the flow at a particular pump speed remains relatively constant, while the pressure changes in response to changes in downstream conditions. Accordingly, as fracturing begins, reducing the downstream impedance of the fluid flow system, pressure tends to drop as flow rate stays 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 rise until some condition reduces the downstream impedance. This is typically equipment failure, such as pump seals, piping failure, or rupturing of valve bodies.

14. 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 void of the piston (plunger) must be filled by the incoming slurry. If the suction pressure gets too low, then cavitation occurs. Cavitation is the condition where bubbles form in the liquid because the vapor

pressure of the liquid is higher than the suction pressure. When the bubbles collapse, such as when the piston reaches the bottom of its stroke, noise, vibration and damaging forces are created. To avoid cavitation and the associated problems, suction pressure must be maintained higher than the fluid's vapor pressure of the fluid (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

15. 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

- The cavity areas will initially partially choke the impeller passages and reduce the pump performance. In extreme cases, total loss of pump-developed head occurs.

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

16. *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

17. 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 reduction 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.

18. 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.

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 completely 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.

19. *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.

20. 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

21. 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 completely fill based on the NPSHA.

C. Background on e-stop

22. 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 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

¹¹ Ex. 1044 (Langewis) pg. 2-3

to all or part of an installation.”¹² NFPA 79 has further taught that modern electrical machines “involve highly complex electrical control systems, including electronic and solid-state devices and equipment.” NFPA 79 at Origins. 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).”

23. 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 Emergency Shutdown Systems” specifically for “the oil, gas and process industries.”¹³ *Pearson* discusses that, for such processes that include “complex interconnected computer based systems...there are advantages from a safety view point in having a dedicated independent protection system or emergency shut down (ESD)

¹² Ex. 1046 (*NFPA 79*) §3.3.38.

¹³ Ex. 1047 (*Pearson*), at 55.

system to take action to achieve a safe plant condition in the event of plant or equipment failure or indeed control system failure.”¹⁴ *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,” 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.”¹⁵ *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.”¹⁶

24. As another example of an emergency shutdown system being in common use, *Gilson* describes initiating an ESD from a central controller.¹⁷ *Gilson* 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.”¹⁸ *Gilson* describes that the ESD is part of a “fast response stimulation package (FRSP), and that it is operated “from a

¹⁴ Ex. 1047 (*Pearson*), at 55 (Introduction).

¹⁵ Ex. 1047 (*Pearson*), at Applications

¹⁶ Ex. 1047 (*Pearson*), at Configurations.

¹⁷ Ex. 1048 (*Gilson*), see generally.

¹⁸ Ex. 1048 (*Gilson*), at Control Cabin.

central control cabin.”¹⁹ *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.”²⁰

25. *Burgos* describes using such systems, entitling his paper, “Eliminating Human Error During Coiled-Tubing Operations.”²¹ “The system also includes an emergency stop.”²² Based on 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 into a safe state, the coiled tubing system. Coiled tubing systems are one method of tool placement downhole, analogous to a pump-down plug and perf operation.

26. Such ESD systems have been regularly used in Oil and Gas applications, but are not limited to them. For example, *Sammarco*,²³ 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.

¹⁹ Ex. 1048 (*Gilson*), at Abstract.

²⁰ Ex. 1048 (*Gilson*), at 3.

²¹ Ex. 1049 (*Burgos*), Title.

²² Ex. 1049 (*Burgos*), at Modified CS.

²³ Ex. 1050 (*Sammarco*).

27. 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.²⁴ 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. 051 (*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”).

28. 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.” *NFPA 79* at 79-9 (3.3.37). 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.”²⁵ This action, coupled with opening the breakers connecting the generator to the rest of the

²⁴ Ex. 1051 (*Kurz*) at Abstract. (“Emergency shutdowns in compressor stations cause fast transients in the operating conditions”).

²⁵ *Kurz* p. 2 (left column).

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

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

VII. LEGAL STANDARDS

30. The Legal Standards provided to me were described in my Original Declaration.²⁶

31. 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 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.

VIII. OVERVIEW OF THE SUBSTITUTE CLAIMS

A. Table Correlating Original Claims to Substitute Claims

²⁶ Ex. 1003, § IV.

32. I understand that in Patent Owner's 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
<i>1</i>		<i>21</i>	
2	1	22	21
3	2	23	22
4	1	24	21
5	4	25	24
6	2	26	22
7	6	27	26
<i>8</i>		<i>28</i>	
9	8	29	28
10	9	30	29
11	9	31	29
12	9	32	29
13	9	33	29
14	8	34	28

15	9	35	29
16	15	36	35
17		37	
18	17	38	37
19	17	39	37
20	17	40	37

B. List of Substitute Claims

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

34. Substitute Claim 21:

[21p] 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:

[21a] an electric pump fluidly connected to the well, and configured to pump fluid into the wellbore; and

[21b] a centralized control unit coupled to the electric pump,

[21c] wherein the centralized control unit is configured to:

monitor the electric pump; and

[21d] a variable frequency drive that controls a speed of the electric pump;

[21e] wherein the electric pump has a maximum continuous torque of at least 11,488 lb-ft or more;

[21f] wherein the electric pump has a maximum continuous power output of at least 1750 brake horsepower or more;

[21g] wherein the centralized control unit is coupled to the electric pump via one or more of cabling, Ethernet, or wirelessly; and

[21h] wherein the centralized control unit is further configured to reset a fault occurring in the variable frequency drive.

35. Substitute Claim 22:

[22a] The system of **[claim 1] claim 21**, 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.

36. Substitute Claim 23:

[23a] The system of **[claim 2] claim 22**, wherein the generator is a turbine generator, and

[23b] wherein the centralized control unit is further configured to monitor **operating characteristics** and control the turbine generator,

[23c] **wherein the operating characteristics include at least fuel system air supply pressure transmitter failure, thermocouple input module thermistor failure, start VFD configuration failure, turbine air inlet filter transmitter 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.**

37. Substitute Claim 24

[24a] The system of [claim 1] **claim 21**, wherein the electric pump is a plurality of electric pumps,

[24b] **the system further comprising a switch gear,**

[24c] **wherein the centralized control unit is further configured to monitor operating characteristics of the switch gear,**

[24d] **wherein operating characteristics include at least the status of a fire alarm.**

38. Substitute Claim 25:

[25a] The system of [claim 4] **claim 24**, further comprising: a variable frequency drive that controls the plurality of electric pumps,

[25b] the system further comprising a hydraulic system,

[25c] wherein the system is configured to monitor operating characteristics of the hydraulic system,

[25d] wherein the operating characteristics include at least system pressure, charge pressure, temperature, hydraulic oil level, and filter status.

39. Substitute Claim 26:

[26a] The system of [claim 2] claim 22, further comprising an emergency power off unit coupled to the centralized control unit, the electric pump, and the generator,

[26b] wherein the emergency power off unit is configured to substantially immediately cut power from the generator when activated,

[26c] wherein the emergency power off unit is operated by a switch that sounds an audible alarm.

40. Substitute Claim 27:

[27a] The system of [claim 6] claim 26, the emergency power off unit comprising an auxiliary power and a switchgear, each coupled to the generator and the centralized control unit,

[27b] 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,

[27c] **wherein the signal is transmitted over armored shielded CAT5E cabling.**

41. Substitute Claim 28:

[28a] 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;

[28b] monitoring at a centralized control unit the electrically powered pump;

[28c] wherein the centralized control unit is coupled to the electrically powered pump via one or more of cabling, Ethernet, or wirelessly; and

[28d] controlling the speed of the pump with a variable frequency drive,

[28e] wherein the centralized control unit is configured to reset a fault occurring in the variable frequency drive;

[28f] **wherein the electric pump has a maximum continuous torque of at least 11,488 lb-ft or more; and**

[28g] **wherein the electric pump has a maximum continuous power output of at least 1750 brake horsepower or more.**

42. Substitute Claim 29:

[29a] The method of [claim 8] **claim 28**, further comprising:

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

[29b] monitoring compression of natural gas.

43. Substitute Claim 30:

[30a] The method of [claim 9] **claim 29**, [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**

[30b] **the operating characteristics including the status of a fire alarm.**

44. Substitute Claim 31:

[31a] The method of [claim 9] **claim 29**, further comprising controlling compression of **the liquefied** natural gas;

[31b] wherein the generator is fueled by **liquefied** natural gas,

[31c] the method further comprising monitoring operating characteristics of a hydraulic system

[31d] wherein the operating characteristics include system pressure, charge pressure, temperature, hydraulic oil level, and filter status.

45. Substitute Claim 32:

[32a] The method of [claim 9] claim 29, wherein the generator is a turbine generator; the method further comprising

[32b] monitoring operating characteristics of the turbine generator

[32c] wherein the monitored operating characteristics include at least fuel system air supply pressure transmitter failure, thermocouple input module thermistor failure, start VFD configuration failure, turbine air inlet filter transmitter 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, engine serial number, and turbine air inlet filter transmitter failure.

46. Substitute Claim 33:

[33a] The method of [claim 9] claim 29, wherein the generator is a turbine generator; the method further comprising

controlling the turbine generator **and**

[33b] **monitoring operating characteristics of the turbine generator**

[33c] **wherein the monitored operating characteristics include gas fuel main valve discharge pressure transmitter failure, and backup system relay failure.**

47. Substitute Claim 34:

[34a] The method of **[claim 8] claim 28**, further comprising resetting a fault occurring in the variable frequency drive from the centralized control unit,

[34b] **the method further comprising monitoring operating characteristics of the variable frequency drive,**

[34c] **wherein the monitored operating characteristics include motor winding temperatures, the motor RPM, the voltage, the torque, and the current (amperage).**

48. Substitute Claims 35:

[35a] The method of **[claim 9] claim 29**, 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

[35b] wherein the emergency power off unit is operated by a switch that sounds an audible alarm.

49. Substitute Claim 36

[36a] The method of [claim 15] claim 35, 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

[36b] wherein signaling is transmitted over armored shielded CAT5E cabling.

50. Substitute Claim 37

[37p] A system for centralized monitoring and control of a hydraulic fracturing operation, comprising:

[37a] 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;

[37b] a centralized control unit coupled to electric powered fracturing fleet; and

[37c] 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,

[37d] 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;

[37e] wherein the centralized control unit is coupled to the electric powered fracturing fleet via one or more of cabling, Ethernet, or wirelessly;

[37f] **wherein each electric pump has a maximum continuous torque of at least 11,488 lb-ft or more;**

[37g] **wherein each electric pump has a maximum continuous power output of at least 1750 brake horsepower or more.**

51. Substitute Claim 38

[38a] The system of **[claim 17]** **claim 37**, the emergency power off unit comprising an auxiliary power and switchgear, each coupled to the 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 turbine generators;

[38b] wherein the centralized control unit is further configured to monitor operating characteristics of the switch gear,

[38c] wherein operating characteristics include at least the status of a fire alarm.

52. Substitute Claim 39:

The system of [claim 17] claim 37, 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.

53. Substitute Claim 40:

[40a] The system of [claim 17] claim 37, wherein the centralized control unit is further configured to monitor and control the turbine generators,

[40b] wherein the turbine generators are fueled by liquefied natural gas.

54.

IX. PRIORITY DATE OF THE SUBSTITUTE CLAIMS

55. In its Motion to Amend, Patent Owner contends that “the proposed substitute claims are supported by the original non-provisional application,” and that each of the proposed substitute claims are further supported by the ’838 application” (U.S. Pat. App. No. 15/978,838, which was filed on May 14, 2018) “and/or the ’363 application” (U.S. Patent App. No. 14/884,363, which was filed on October 15, 2015).²⁷ 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

56. 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

²⁷ MTA, 13-14 (fn. 2).

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.

57. 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

58. Based upon my review of the Petition, the 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
3A	21, 22, 28, and 29	<i>Coli, Birch, Rusnak, Broussard079, Broussard601</i>
4A	23, 32	<i>Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Kohlenberger, Ekanayake, Weiher, Newman</i>
5A	24, 30, 38	<i>Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, and Gensel</i>
6A	25, 31	<i>Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Gensel, Omont</i>
7A	26, 35	<i>Coli, Birch, Rusnak, Broussard079, Broussard601, Smith, Bromell</i>
8A	27, 36	<i>Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Smith, Bromell, Thompson</i>
9A	33, 37, 40	<i>Coli, Birch, Rusnak, Hunt, Broussard079, and Broussard601</i>

10A	34	<i>Coli, Birch, Rusnak, Broussard079, Broussard601, Discenzo</i>
11A	39	<i>Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, McIver</i>

XII. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. The “continuous” language does not provide reasonable certainty as to claim scope.

59. Independent Substitute Claim Elements [21e], [21f], [28f], [28g], [37f], and [37g] are copied below:

[21e] wherein the electric pump has a maximum continuous torque of at least 11,488 lb-ft or more;

[21f] wherein the electric pump has a maximum continuous power output of at least 1750 brake horsepower or more;

[28f] wherein the electric pump has a maximum continuous torque of at least 11,488 lb-ft or more; and

[28g] wherein the electric pump has a maximum continuous power output of at least 1750 brake horsepower or more.

[37f] wherein each electric pump has a maximum continuous torque of at least 11,488 lb-ft or more;

[37g] wherein each electric pump has a maximum continuous power output of at least 1750 brake horsepower or more.

The claims, specification, and prosecution history of the ’992 Patent provide no objective standard for ascertaining the scope of “continuous.”

60. The scope of the claims with the “*continuous*” limitation is unclear, because different pumps are configured to operate in different applications for different periods of time, such that it is unclear of the particular application and duration in which a pump must operate with a particular power output and torque for such characteristics to be considered “*continuous*.” Further, there is no description in the claims, specification, or prosecution history of the ’992 Patent that elucidates the boundaries of “*continuous*.” Indeed, the ’992 Patent simply lists the values for “*maximum continuous torque*” and “*maximum continuous power output*” listed in the claims, without providing a description of the time frame for which a pump must maintain a particular torque or power output in order for such operation to be considered “*continuous*” or for the particular torque or power output to be considered “*continuous*.” A POSITA has no way of knowing the boundaries of what “*continuous*” operation is intended to represent. Thus, reasonable minds may have different views as to what is considered “*continuous*,” and the term renders the claims indefinite.

61. In fact, when asked about the meaning of the word “*continuous*”, Patent Owner’s Expert Dr. Nikolaou could provide no restrictions or bounds on the length of time that would be “*continuous*,” but instead testified that it is just “a reasonable amount of time over which a pump delivering continuous horsepower would be

required to actually deliver that horsepower in a fracturing operation.”²⁸ This provides no elucidation of the boundaries of “continuous”.

B. Ground 3A: The Combination of *Coli*, *Birch*, *Rusnak*, *Broussard079*, and *Broussard601* Renders Obvious Claims 21, 22, 28, and 29

62. In my opinion, the combination of *Coli*, *Birch*, *Rusnak*, *Broussard079*, and *Broussard601* discloses and/or suggests to a POSITA each element of Substitute Claims 21, 22, 28, and 29.

63. Substitute Claims 21 and 28 incorporate the subject matter of original claims 1 and 8, respectively, addressed in my Original Declaration, and the claims add the “*continuous*” limitations in Claim Elements [21e], [21f], [28f], and [28g].²⁹ Substitute Claims 22 and 29 incorporate the subject matter of original claims 2 and 9, respectively, addressed in my Original Declaration, and the claims add the “*liquefied natural gas*” limitation in Claim Elements [22a] and [29a].³⁰

64. Claim Elements [21e], [21f], [22a] are addressed below. Claim Element [28f] is rendered obvious for the same reasons given for Claim Element [21e]. Claim Element [28g] is rendered obvious for the same reasons given for Claim Element [21f]. Claim Element [29a] is rendered obvious for the same reasons given for Claim

²⁸ Ex. 1024 (Nikolaou Dep. Tr.), 130:14-131:5.

²⁹ See Ex. 1003 (1st *Durham Dec*), ¶¶146-170, 187-195; MTA at A-1, A-4-5.

³⁰ See Ex. 1003(1st *Durham Dec*), ¶¶171-181, 196-198; MTA at A-2, A-5.

Element [22a]. Limitations from the original claims not addressed below are addressed in my Original Declaration.

1. Status and Overview of *Broussard079*

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

66. *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 fracturing operations.³¹ *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.”³²

67. *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.”³³

68. *Broussard079* further discloses a “[p]ump control and data monitoring equipment” that “can be mounted on a control vehicle 42, and connected to the

³¹ Ex. 1024 (*Broussard079*), Abstract.

³² Ex. 1024(*Broussard079*), [0020].

³³ Ex. 1024 (*Broussard079*), [0009], [0024].

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.”³⁴ *Broussard079* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

2. Status and Overview of *Broussard601*

69. *Broussard601* is a U.S. Patent that was filed on February 26, 2014, and was issued on July 29, 2014. *Broussard601* is therefore prior art to the ’992 Patent.

70. *Broussard601* 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 fracturing operations.³⁵ *Broussard601* further discloses particular power output and torque values associated with electric pumps used in its system, providing 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 ft-lb, 11,485 ft-lb, or more.”³⁶

71. *Broussard601* further discloses a “[p]ump control and data monitoring equipment” that “can be mounted on a control vehicle 42, and connected to the

³⁴ Ex. 1024 (*Broussard079*), [0027].

³⁵ Ex. 1025 (*Broussard601*), Abstract.

³⁶ Ex. 1025 (*Broussard601*), 4:20-23.

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.”³⁷ *Broussard601* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

3. Motivation to Combine

72. As discussed in my first declaration, a POSITA would have been motivated to combine *Coli* with *Birch* and *Rusnak*.³⁸ A POSITA would have been motivated to further combine the *Coli-Birch-Rusnak* system with *Broussard079* and *Broussard601*. *Coli* discloses a hydraulic fracturing system that uses electrically-powered pumps for pressurizing and pumping hydraulic fracturing fluid.³⁹ *Broussard079* and *Broussard601* disclose similar systems, and they further specify particular output power and torque figures associated with the pumps.⁴⁰ In implementing the *Coli-Birch-Rusnak* system, a POSITA would have been motivated to look to additional references that specify particular characteristics associated with electrically-powered fracturing pumps (e.g., output powers and torques), such as *Broussard079* and *Broussard601*, to ensure that the pumps are sufficiently powerful

³⁷ Ex. 1024 (*Broussard601*), 6:6-11.

³⁸ See Ex. 1003, ¶¶ 126-145.

³⁹ Ex. 1004 (*Coli*), Abstract.

⁴⁰ See Ex. 1024 (*Broussard079*), [0020]; Ex. 1025 Ex. 1025 (*Broussard601*), 4:20-23.

for fracturing operations. Incorporating fracturing pumps with the specific output power and torque figures as described by *Broussard079* and *Broussard601* would have involved the mere application of a known technique (i.e., fracturing pumps with particular output power and torque figures, as taught by *Broussard079* and *Broussard601*) to a known system (i.e., the *Coli-Birch-Rusnak* hydraulic fracturing system) ready for improvement.

73. *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 “liquid fuels.”⁴¹ *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.”⁴² 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

⁴¹ Ex. 1004 (*Coli*), [0010], [0038], [0040].

⁴² Ex. 1024 (*Broussard079*), [0009], [0024].

motivated to combine the references and would have reasonably expected success in doing so.

4. **[21e]: “wherein the electric pump has a maximum continuous torque of at least 11,488 lb-ft or more”**

74. The *Coli-Birch-Rusnak-Broussard079-Broussard601* combination renders obvious “*wherein the electric pump has a maximum continuous torque of at least 11,488 lb-ft or more.*” *Coli* discloses fracturing modules 20 that contain electric motor 21 and fluid pump 22, where the fluid pump 22 “utilize[s] electric power...to pump the fracturing fluid directly to the wellbore.”⁴³ *Broussard079* provides that “some pumps 10 can have...a maximum continuous torque of about 8750 lb-ft or more.”⁴⁴ *Broussard601* provides that “some pumps 10 can have...a maximum continuous torque of about 8750 ft-lb, 11,485 ft-lb, or more.”⁴⁵ A POSITA would have understood that a “*maximum continuous torque of at least 11,488 lb-ft or more*” falls within the ranges of “about 8750 lb-ft or more” (as provided by *Broussard079*) and “about 8750 ft-lb, 11,485 ft-lb, or more” (as provided by *Broussard601*), as these disclosed ranges do not have an upper bound such that “at least 11,488 lb-ft or more” would necessarily fall within the disclosed range. Further, 11,488 ft-lb is only 0.026% above 11,485 ft-lb, and would clearly fall within “about 11,485 ft-lb or

⁴³ Ex. 1004 (*Coli*), [0038], [0040].

⁴⁴ Ex. 1024 (*Broussard079*), [0020].

⁴⁵ Ex. 1025 (*Broussard601*), 4:20-23.

more.” The *Coli-Birch-Rusnak-Broussard079-Broussard601* combination therefore renders this limitation obvious.

5. **[21f]: “wherein the electric pump has a maximum continuous power output of at least 1750 brake horsepower or more”**

75. The *Coli-Birch-Rusnak-Broussard079-Broussard601* combination renders obvious “*wherein the electric pump has a maximum continuous power output of at least 1750 brake horsepower or more.*” In addition to their disclosures regarding torque, *Broussard079* and *Broussard601* provide particular power outputs of electric fracturing pumps. *Broussard079* provides that “some pumps 10 can have a maximum continuous power output of about 1500 BHP, 1750 BHP, or more.”⁴⁶ *Broussard601* provides that “some pumps 10 can have a maximum continuous power output of about 1500 BHP, 1750 BHP, or more.”⁴⁷ Both references disclose pumps with the precise “maximum continuous output power” claimed. Accordingly, the *Coli-Birch-Rusnak-Broussard079-Broussard601* combination therefore renders this limitation obvious.

6. **[22a]: “wherein the electric pump is powered by liquefied natural gas”**

76. The *Coli-Birch-Rusnak-Broussard079-Broussard601* combination renders obvious “*wherein the electric pump is powered by liquefied natural gas.*”

⁴⁶ Ex. 1024 (*Broussard079*), [0020]; see also Ex. 1024 (*Broussard079*), [0019] (defining “BHP” as brake horsepower).

⁴⁷ Ex. 1025 (*Broussard601*), 4:20-23.

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 “liquid fuels.”⁴⁸ *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.”⁴⁹ 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.⁵⁰ The *Coli-Birch-Rusnak-Broussard079-Broussard601* combination, therefore, renders this limitation obvious.

C. Ground 4A: The Combination of *Birch, Rusnak, Hunt, Broussard079, Broussard601, Kohlenberger, Ekanayake, Weiher, and Newman* Renders Obvious Claims 23 and 32

77. In my opinion, the combination of *Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Kohlenberger, Ekanayake, Weiher, and Newman* discloses and/or suggests to a POSITA each element of Substitute Claims 23 and 32.

78. Substitute Claims 23 and 32 incorporate the subject matter of original claims 3 and 12, respectively, addressed in my Original Declaration, and the claims

⁴⁸ Ex. 1004 (*Coli*), [0010], [0038], [0040].

⁴⁹ Ex. 1024 (*Broussard079*), [0009], [0024].

⁵⁰ Ex. 1024 (*Broussard079*), [0009], [0024].

add limitations regarding monitoring particular “*operating characteristics*” of a turbine generator in Claim Elements [23b], [23c], [32b], and [32c].⁵¹

79. Claim Elements [23b] and [23c] are addressed below. Claim Elements [32b] and [32c] are rendered obvious for the same reasons given for Claim Elements [23b] and [23c], respectively. Limitations from the original claims not addressed below are addressed in my Original Declaration.

1. Status and Overview of *Kohlenberger*

80. *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.

81. *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.”⁵² *Kohlenberger* discloses monitoring several characteristics of the turbine generator, including “sensors (not shown) within the air inlet to insure [sic.] that the air entering the turbine cabinet 48 is of constant temperature and pressure to optimize the performance of the gas turbine 42.”⁵³ *Kohlenberger* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

⁵¹ See Ex. 1003 (1st *Durham Dec*), ¶¶182-184, 202-204; MTA at A-2, A-6.

⁵² Ex. 1026 Abstract

⁵³ Ex. 1026 (*Kohlenberger*), 6:2-6.

2. Status and Overview of *Ekanayake*

82. *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.

83. *Ekanayake* relates to “filter systems for gas turbines and more particularly to systems for monitoring the degree of fouling of gas turbine filters.”⁵⁴ *Ekanayake* discloses that the system 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.”⁵⁵ *Ekanayake* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

3. Status and Overview of *Weiher*

84. *Weiher* is United States Patent no. 8,552,728 that was filed on November 30, 2010, and issued October 8, 2013. *Weiher* is therefore prior art to the '992 Patent.

85. *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.”⁵⁶ *Weiher* teaches a “ ‘stuck

⁵⁴ Ex. 1027: 1:116-19.

⁵⁵ Ex. 1027, 2:19-35.

⁵⁶ Ex. 1028 (*Weiher*) 3:58 – 66.

breaker’ condition, in which the circuit breaker fails to open”⁵⁷ 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.”⁵⁸ *Weiher* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

4. Status and Overview of Newman

86. *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.

87. *Newman* describes an “information recording system” for “recording the service life history and configuration of gas turbine engines.”⁵⁹ This system includes 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.”⁶⁰ *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

⁵⁷ Ex. 1028 (*Weiher*) 3:2-3.

⁵⁸ Ex. 1028 (*Weiher*) 9:3-8.

⁵⁹ Ex. 1029 (*Newman*) 1:3-7.

⁶⁰ Ex. 1029, [0003].

demand, to an electronic signal processor in the LTU which is mounted on or off the engine.”⁶¹ *Newman* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

5. Motivation to Combine

88. A POSITA would have been motivated to combine *Coli* with *Birch*, *Rusnak*, and *Hunt*, as described in my Original Declaration.⁶² A POSITA would have been motivated to combine *Coli* with *Broussard079* and *Broussard601*.⁶³ A POSITA would have been further motivated to combine *Coli* with *Kohlenberger*, *Ekanayake*, *Weiher*, *Hunt*, *Birch*, and *Newman* as described below.

89. *Coli* discloses a “control center 40” that includes “controls and computer monitoring for the entire fracturing operation.”⁶⁴ 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.⁶⁵ *Kohlenberger*, *Ekanayake*, *Weiher*, *Hunt*, *Birch*, and *Newman* each disclose monitoring particular aspects of turbine generator operation.

⁶¹ Ex. 1029 1:60 – 2:1.

⁶² Ex. 1003, ¶¶ 267-276.

⁶³ See Section XII.B.3 above.

⁶⁴ Ex. 1004 (*Coli*), [0072].

⁶⁵ Ex. 1004 (*Coli*), [0038], [0040].

90. For example, *Kohlenberger* discloses sensors that monitor temperature and pressure at the “air inlet” of a gas turbine.⁶⁶ *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.⁶⁷ *Ekanayake* discloses a “filter assembly” that monitors the extent to which a gas turbine’s air inlet filter is “fouled” by filtered particulate.⁶⁸ *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.”⁶⁹ *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.⁷⁰ *Hunt* discloses a multifunction control module that is configured to “monitor the frequency of the power produced by” a turbine generator.⁷¹ *Newman* discloses a “life tracking system (LTS) for automatically identifying and recording in permanent

⁶⁶ Ex. 1026, 6:2-6.

⁶⁷ Ex. 1005, 2:30-39, 3:4-12.

⁶⁸ Ex. 1027, 1:24-27, 2:19-35.

⁶⁹ Ex. 1028 (*Weiher*) 3:58 – 66.

⁷⁰ Ex. 1028, [0006].

⁷¹ Ex. 1008, [0025], [0040], [0054].

record the configurations of a gas turbine engine by exact module type and serial number.”⁷²

91. 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* further *Coli*’s goal of providing “control and computer monitoring for the entire fracturing operation...at a single central location.”⁷³ A POSITA would be motivated to turn to references providing more detail regarding such control, such as *Kohlenberger*, *Birch*, *Ekanayake*, *Hunt*, *Weiher*, and *Newman*, which provide highly relevant details regarding 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 aspects of turbine generators and associated equipment, as taught by *Kohlenberger*, *Birch*, *Ekanayake*, *Hunt*, *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 and would have reasonably expected success in doing so. Additional motivations for each reference are discussed below.

⁷² Ex. 1029, [0003].

⁷³ Ex. 1004, [0072].

6. [23b]: “wherein the centralized control unit is further configured to monitor operating characteristics ...[of] the turbine generator”

92. For the reasons provided in the subsections below, the *Coli-Birch-Rusnak-Broussard*⁰⁷⁹-*Broussard*⁶⁰¹-*Kohlenberger-Ekanayake-Hunt-Weiher-Newman* combination renders obvious “wherein the centralized control unit is further configured to monitor operating characteristics ...[of] the turbine generator.”

7. [23c]: “wherein the operating characteristics include at least...”

a) *“fuel system air supply pressure transmitter failure”*

93. *Kohlenberger* discloses a “motor/turbine control center” that “has sensors (not shown) within the air inlet to insure [sic.] that the air entering the turbine cabinet 48 is of constant temperature and pressure to optimize the performance of the gas turbine 42.”⁷⁴ 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 that “pressure transmitters,” such as *Kohlenberger*’s air inlet pressure sensors, could

⁷⁴ Ex. 1026 (*Kohlenberger*), 6:2-6.

further transmit failure codes.⁷⁵ A POSITA would have been motivated 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.⁷⁶

94. 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,”

95. *Birch* discloses a “thermocouple 18 for monitoring the discharge (gas) temperature.”⁷⁷ It was known in the art that a thermocouple-based temperature transmitter could further transmit failure codes, including failure of the input module thermistor, which would be a hardware failure of the input block.⁷⁸ A POSITA would

⁷⁵ 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), “Electronics Failure” (condition 20), “I/O Failure” (condition 22); see also Ex. 1032 (Internet Archive Declaration), 1-126.

⁷⁶ Ex. 1024 (Nikolaou Dep. Tr.), 35:4-21.

⁷⁷ Ex. 1005 (*Birch*), 3:4-12

⁷⁸ 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

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.⁷⁹

96. 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,”

97. *Coli* discloses using “variable frequency drives” (VFDs), which “essentially ‘tell motors what they are allowed to do.’”⁸⁰ *Rusnak* discloses an external controller 30 (i.e., centralized control unit) that controls a VFD and can “automatically reset [a] faulted condition” in the VFD.⁸¹ It would have been obvious to a POSITA that one such “faulted condition” of a VFD (and perhaps the most

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.

⁷⁹ Ex. 1024 (*Nikolaou* Dep. Tr.), 35:22-37:3.

⁸⁰ Ex. 1004 (*Coli*), [0065].

⁸¹ Ex. 1007 (*Rusnak*), [0087]; see also Ex. 1007 (*Rusnak*)., [0020]-[0021].

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.⁸²

d) “turbine air inlet filter transmitter failure,”

98. *Ekanayake* discloses a “filter assembly” that filters “air entering a gas turbine for power generation application.”⁸³ 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.”⁸⁴ Thus, the module is associated with the inlet air filter and transmits (communicates) the degree of fouling, and is thus a

⁸² Ex. 1024 (Nikolaou Dep. Tr.), 37:4 – 38:7.

⁸³ Ex. 1027, 1:24-27.

⁸⁴ Ex. 1027, 2:19-35.

turbine air inlet filter transmitter. A POSITA would have been motivated to monitor for failure of the turbine air inlet filter 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. 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 wireless communication module (*i.e.*, “*turbine air inlet filter transmitter*”) 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.⁸⁵

e) “generator circuit breaker failure to open,”

99. *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.”⁸⁶ *Weiher* teaches that a “ ‘stuck breaker’ condition, in which the circuit breaker fails to open”⁸⁷ 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

⁸⁵ Ex. 1024 (Nikolaou Dep. Tr.), 38:8 – 39:17.

⁸⁶ Ex. 1028 (*Weiher*) 3:58 – 66.

⁸⁷ Ex. 1028 (*Weiher*) 3:2-3.

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.”⁸⁸ *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.”⁸⁹

100. 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 fail to open, such as preventing personnel from accessing 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.⁹⁰ Further, Patent Owner’s expert testified that monitoring for a generator

⁸⁸ Ex. 1028 (*Weiher*) 9:3-8.

⁸⁹ Ex. 1028 (*Weiher*) 5:34 – 36.

⁹⁰ See, e.g., Ex. 1028 (*Weiher*) 3:58 – 4:3.

circuit breaker failure to open was known and provided reasons why a POSITA would do so.⁹¹

f) “gas fuel supply pressure transmitter failure,”

101. *Birch* discloses a “gaseous fuel compression and control system for a turbine engine” that includes “under and over pressure electronic sensors 6a and 6b.”⁹² These sensors monitor the pressure of a “mains supply 1,” which supplies natural gas to a compressor associated with a turbine generator.⁹³ Furthermore, as discussed above, pressure sensors that could transmit failure codes were well-known in the art.⁹⁴ A POSITA would have been motivated to monitor for failure of the gas fuel 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 the turbine 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

⁹¹ Ex. 1024 (*Nikolaou Dep. Tr.*), 39:18 – 41:1.

⁹² Ex. 1005 (*Birch*), 2:30-39, Fig. 1.

⁹³ Ex. 1005 (*Birch*) 2:36-39, Fig. 1.

⁹⁴ See Section XII.C.7.a above.

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 has 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.⁹⁵

g) “gas fuel control pressure transmitter failure,”

102. *Birch* discloses a “a pressure sensor 17 for monitoring the discharge (gas) pressure” of a compressor providing “feeding gaseous fuel” to a turbine generator.⁹⁶ *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.⁹⁷ Accordingly, a POSITA would have understood *Birch*'s “pressure sensor 17” to be a “gas fuel control pressure transmitter.” And as discussed above, pressure sensors that could transmit failure codes, were well-known in the art.⁹⁸ 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

⁹⁵ Ex. 1024 (Nikolaou Dep. Tr.), 41:2 – 42:9.

⁹⁶ Ex. 1005 (*Birch*), 3:4-8, Abstract.

⁹⁷ Ex. 1005 (*Birch*) 3:37-4:12.

⁹⁸ See Section XII.C.7.a above.

transmitter, could be enacted. Operating with this transmitter in a failed condition would have led to improper operation of the turbine, such as uncontrolled operation of the turbine, 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 have monitored whether such a pressure transmitter had failed, consistent with the known functionality of such pressure transmitters and *Coli*'s control system functionality. 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.⁹⁹

h) "utility circuit breaker closed,"

103. As discussed in my Original Declaration, the combined *Coli-Birch-Rusnak-Hunt* system includes a switchgear, which comprises circuit breakers, that controls the coupling of a turbine generator bus with a utility bus.¹⁰⁰ A POSITA would have therefore understood the switchgear to teach a "utility circuit breaker."

⁹⁹ Ex. 1024 (Nikolaou Dep. Tr.), 42:10 – 43:15.

¹⁰⁰ Ex. 1003 (1st Durham Dec), ¶¶ 277-307.

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, in order 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 it would also be important 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 for a utility circuit breaker closed condition was known and provided reasons why a POSITA would do so.¹⁰¹

i) *generator frequency,*"

104. *Hunt* discloses a multifunction control module that is configured to "monitor the frequency of the power produced by generator 215."¹⁰² 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

¹⁰¹ Ex. 1024 (Nikolaou Dep. Tr.), 43:16 – 44:19.

¹⁰² 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").

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.¹⁰³

j) “and engine serial number.”

105. *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.”¹⁰⁴ *Newman*’s teachings of monitoring the serial number of a module, a component of the gas turbine engine, would have been equally applicable to monitoring the serial number of the entire engine. 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

¹⁰³ Ex. 1024 (Nikolaou Dep. Tr.), 44:20 – 46:3.

¹⁰⁴ Ex. 1029, [0003].

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.¹⁰⁵

D. Ground 5A: The Combination of *Coli*, *Birch*, *Rusnak*, *Hunt*, *Broussard079*, *Broussard601*, and *Gensel* Renders Obvious Claims 24, 30, and 38

106. In my opinion, the combination of *Coli*, *Birch*, *Rusnak*, *Hunt*, *Broussard079*, *Broussard601*, and *Gensel* discloses and/or suggests to a POSITA each element of Substitute Claims 24, 30, and 38.

107. Substitute Claims 24, 30, and 38 incorporate the subject matter of original claims 4 and 7, 10 and 15, and 17, respectively, addressed in my Original Declaration, and each adds limitations regarding monitoring particular “*operating characteristics*” of switchgear in Claim Elements [24c], [24d], [30a], and [30b] and [38b]-[38c].¹⁰⁶

108. Claim Elements [24c]-[24d] are addressed below. Claim Element [30a] and [30b] are rendered obvious for the same reasons given for Claim Elements [24b] and [24c], and Claim Element [30b] is rendered obvious for the same reasons given for Claim Elements [24d]. Claim Elements [38b] and [38c] are rendered obvious for

¹⁰⁵ Ex. 1024 (Nikolaou Dep. Tr.), 46:4 – 48:8.

¹⁰⁶ See Ex. 1003 (1st *Durham Dec*), ¶¶ 185, 199-200, 295-308; MTA at A-2-3, A-5, A-9-10.

the same reasons given for Claim Elements [24c] and [24d]. Limitations from the original claims not addressed below are addressed in my Original Declaration, Ex. 1003.

1. Status and Overview of Gensel

109. *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.

110. *Gensel* discloses “a fire extinguishing system” that is suited “in particular for casings for electronics, or switchgear cabinets”.¹⁰⁷ *Gensel* discloses that “a switchgear cabinet with a smoke detecting device is known. ... The smoke detecting device sets off the alarm.”¹⁰⁸ *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.”¹⁰⁹ Further, *Gensel* teaches that the alarms are monitored by separate monitoring systems. *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.”¹¹⁰ *Gensel* is therefore

¹⁰⁷ Ex. 1033 (*Gensel*) [0001]-[0002].

¹⁰⁸ Ex. 1033 (*Gensel*) [0004].

¹⁰⁹ Ex. 1033 (*Gensel*) [0031].

¹¹⁰ Ex. 1033 (*Gensel*) [0031].

in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

2. Motivation to Combine

111. A POSITA would have been motivated to combine *Coli*, *Birch*, *Rusnak*, and *Hunt*, and further combine these references with *Broussard079*, and *Broussard601*, as discussed above in Section XII.C.5.¹¹¹ A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601* system with *Gensel*.

112. As discussed in my Original Declaration, the combined *Coli-Birch-Rusnak-Hunt* system teaches a switchgear that operates as an emergency power off unit.¹¹² *Gensel* discloses “a fire extinguishing system” that is suited “in particular for casings for electronics, or switchgear cabinets”.¹¹³ *Gensel* discloses that “a switchgear cabinet with a smoke detecting device is known. ... The smoke detecting device sets off the alarm.”¹¹⁴ *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.”¹¹⁵ Further, *Gensel* teaches that the alarms are monitored by separate monitoring systems. For example, *Gensel* discloses that “[a]larms and

¹¹¹ See Section XII.C.5 above.

¹¹² Ex. 1003 (1st *Durham Declaration*), ¶¶ 277-307.

¹¹³ Ex. 1033 (*Gensel*) [0001]-[0002].

¹¹⁴ Ex. 1033 (*Gensel*) [0004].

¹¹⁵ 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.”¹¹⁶

113. It was well-known in the art that switchgear (and the rooms housing switchgear) were prone to fires due to the high currents and voltages associated with switchgear.¹¹⁷ Thus, a POSITA implementing the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601* 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) 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.

3. [24b]: “the system further comprising a switchgear”

114. The *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-Gensel* combination renders obvious “the system further comprising a switchgear.” As discussed in my Original Declaration, the *Coli-Birch-Rusnak-Hunt* combination discloses a system that includes a switchgear.¹¹⁸

¹¹⁶ Ex. 1033 (*Gensel*) [0031].

¹¹⁷ See, e.g., Ex. 1034 (*Whitaker*), 342.

¹¹⁸ Ex. 1003, ¶¶ 277-307.

4. [24c] and [24d]: “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”

115. *Gensel* discloses “a fire extinguishing system” that is suited “in particular for casings for electronics, or switchgear cabinets”.¹¹⁹ *Gensel* discloses that “a switchgear cabinet with a smoke detecting device is known. ... The smoke detecting device sets off the alarm.”¹²⁰ *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.”¹²¹ Further, *Gensel* teaches that the alarms are monitored by separate monitoring systems. *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.”¹²²

116. It would have been obvious to also monitor a fire alarm associated with the switchgear, in that switchgear were known to have a risk of fire, 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

¹¹⁹ Ex. 1033 (*Gensel*) [0001]-[0002].

¹²⁰ Ex. 1033 (*Gensel*) [0004].

¹²¹ Ex. 1033 (*Gensel*) [0031].

¹²² Ex. 1033 (*Gensel*) [0031].

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.¹²³

E. Ground 6A: The Combination of Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Gensel, and Omont Renders Obvious Claims 25 and 31

117. In my opinion, the combination of *Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Gensel, and Omont* discloses and/or suggests to a POSITA each element of Substitute Claims 25 and 31.

118. Substitute Claims 25 and 31 incorporate the subject matter of original claims 5 and 11, respectively, addressed in my Original Declaration, and each adds limitations regarding monitoring particular “operating characteristics” of a hydraulic system in Claim Elements [25b] - [25d] and 31[c] - 31[d].¹²⁴ Claim 31 also incorporates the “liquefied natural gas” limitation in Claim Elements [31a] and [31b]; these elements are rendered obvious for the same reasons discussed above with reference to Claim Elements [22a].¹²⁵

119. Claim Elements [25b]-[25d] are addressed below. Claim Elements [31c] and [31d] are rendered obvious for the same reasons given for Claim Elements

¹²³ Ex. 1024 (Nikolaou Dep. Tr.), 52:2 – 53:5.

¹²⁴ Ex. 1003, ¶¶ 186, 201; MTA at A-3, A-5-6.

¹²⁵ See Section XII.B.6 above.

[25b]-[25d]. Limitations from the original claims not addressed below are addressed in my Original Declaration.

1. Status and Overview of *Omont*

120. *Omont* is an International Patent Application Publication that was filed on July 31, 2015, and was published on February 4, 2016. *Omont* is prior art to the '992 Patent.

121. *Omont* discloses a system for “monitoring health of additive systems” in “oilfield operations.”¹²⁶ The additive systems of *Omont* may include “several pumps ... connected in parallel” for “inject[ing] additives or other material into a wellbore.”¹²⁷ This would be recognized by a POSITA as a hydraulic fracturing system. *Omont* further discloses a “control and monitoring system” that enables estimating the functional life of oilfield components and facilitates maintenance.¹²⁸ *Omont*’s “control and monitoring system” may also “receive information generated” by sensors and “control operational parameters” associated with system components.¹²⁹ *Omont*’s system includes sensors associated with oilfield components that are “operable to generate information related to an operational parameter” of each component.¹³⁰ For example, *Omont* describes “sensors” “for

¹²⁶ Ex. 1005 (*Omont*) Title, [0002].

¹²⁷ Ex. 1005 (*Omont*) Title, [0002].

¹²⁸ Ex. 1005 (*Omont*) Figs. 1-3, [00139]- [00140], [00168]- [00169].

¹²⁹ Ex. 1005 (*Omont*) [0026], [0038], Figs. 2-3.

¹³⁰ Ex. 1005 (*Omont*) Abstract, [0030].

generating information related to operation parameters” of a pump.¹³¹ *Omont* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

2. Motivation to Combine

122. A POSITA would have been motivated to combine *Coli*, *Birch*, *Rusnak*, and *Hunt*, and further combine these references with *Broussard079*, and *Broussard601*.¹³² A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601* system with *Omont*.

123. *Coli* discloses a “control center 40” that includes “controls and computer monitoring for the entire fracturing operation.”¹³³ *Omont* discloses a system for “monitoring health of additive systems” in “oilfield operations.”¹³⁴ The additive systems of *Omont* may include “several pumps ... connected in parallel” for “inject[ing] additives or other material into a wellbore.”¹³⁵ This would be recognized by a POSITA as a hydraulic fracturing system. *Omont* further discloses a “control and monitoring system” that enables estimating the functional life of oilfield components and facilitates maintenance.¹³⁶ *Omont*’s “control and monitoring

¹³¹ Ex. 1005 (*Omont*) [0051]- [0052], Fig. 3.

¹³² Section XII.C.5 above.

¹³³ Ex. 1004, [0072].

¹³⁴ Ex. 1005 (*Omont*) Title, [0002].

¹³⁵ Ex. 1005 (*Omont*) Title, [0002].

¹³⁶ Ex. 1005 (*Omont*) Figs. 1-3, [00139]- [00140], [00168]- [00169].

system” may also “receive information generated” by sensors and “control operational parameters” associated with system components.¹³⁷ *Omont*’s system includes sensors associated with oilfield components that are “operable to generate information related to an operational parameter” of each component.¹³⁸ For example, *Omont* describes “sensors” “for generating information related to operation parameters” of a pump.¹³⁹ *Omont* discloses monitoring particular aspects and components of a hydraulic fracturing system, such as equipment temperature, oil level, and filter status.¹⁴⁰ A POSITA would have been motivated to incorporate such monitoring into the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601* as such parameters would enable proper control and operation of the fracturing system.

124. A POSITA would have been motivated to combine the system taught by *Coli* and the monitoring techniques taught by *Omont* to further *Coli*’s goal of providing “control and computer monitoring for the entire fracturing operation...at a single central location.”¹⁴¹ Overall, such a combination represents the mere application of known techniques (*i.e.*, monitoring particular aspects of a hydraulic fracturing system, as taught by *Omont*) to a known system (*e.g.*, *Coli*’s hydraulic fracturing system) ready for improvement (*i.e.*, to improve the breadth of *Coli*’s

¹³⁷ Ex. 1040 (*Omont*), [0026], [0038], Figs. 2-3.

¹³⁸ Ex. 1040 (*Omont*), Abstract, [0030].

¹³⁹ Ex. 1040 (*Omont*), [0051]- [0052], Fig. 3.

¹⁴⁰ Ex. 1040 (*Omont*), [0050], [0120].

¹⁴¹ Ex. 1004 (*Omont*), [0072].

system monitoring functionality). Thus, a POSITA would have been motivated to combine the references and would have reasonably expected success in doing so.

3. **[25b]: “the system further comprising a hydraulic system”**

125. *Coli* discloses a hydraulic fracturing system for pressurizing fluid for injection into a wellbore, thereby effectuating hydraulic fracturing.¹⁴² *Coli* therefore discloses “the system further comprising a hydraulic system.”

4. **[25c] and [25d]: “wherein the system is configured to monitor operating characteristics of the hydraulic system, wherein the operating characteristics include at least...”**

126. For the reasons discussed below in Sections XII.E.4.a-e regarding Substitute Claim Limitation [31d], the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-Gensel-Omont* combination renders obvious “wherein the system is configured to monitor operating characteristics of the hydraulic system.”

a) **“system pressure,”**

127. *Coli* discloses monitoring and controlling pressure at the pumps to avoid exceeding a maximum pressure value.¹⁴³ And as discussed above, the system generally discloses monitoring pressures at different points of the fracturing system, including pressures associated with the turbine generator.¹⁴⁴ Similarly, *Omont* discloses monitoring pressure at the “material transfer device” (e.g., pump).¹⁴⁵ For

¹⁴² Ex. 1004 (*Coli*), Abstract.

¹⁴³ Ex. 1003 (1st *Durham Declaration*), ¶¶ 158-161.

¹⁴⁴ See Section, XII.C.7 above.

¹⁴⁵ Ex. 1040 (*Omont*) [0051] – [0052].

example, *Omont* describes “sensors” “for generating information related to operation parameters” of a pump.¹⁴⁶ Sensed operational parameters (e.g., “temperature, pressure,” among others) may be “communicated to the CAM [control and monitoring] system.”¹⁴⁷ It would have been obvious to a POSITA, especially in light of the teachings of *Coli*, to monitor the “system pressure” as well as the pressure of each pump. Accordingly, a POSITA would have understood that the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-Gensel-Omont* combination renders this limitation obvious. Further, Patent Owner’s expert testified that monitoring system pressure of a hydraulic system was known and provided reasons why a POSITA would do so.¹⁴⁸

b) “charge pressure”

128. “Charge pressure”, sometimes referred to as boost pressure, simply refers to the pressure at an input to a hydraulic system pump, to prevent cavitation of the pump, as described above in Sections V.A & V.B. For the hydraulic fracturing system of *Coli*, the charge pressure is provided by the blender. *Omont* discloses measuring the charge pressure, as *Omont* discloses that “[o]ne or more instances of the material sensors 260 may also include one or more pressure transducers operable

¹⁴⁶ Ex. 1040 (*Omont*) [0051]- [0052], Fig. 3.

¹⁴⁷ Ex. 1040 (*Omont*) [0051]- [0052], Fig. 3.

¹⁴⁸ Ex. 1024 (Nikolaou Dep. Tr.), 53:6 – 58:13.

to monitor suction and discharge pressure within the additive system.”¹⁴⁹ As discussed above, the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-Gensel-Omont* combination teaches monitoring pressure at various points of the fracturing system, such that a POSITA would have understood that the system’s “charge pressure” is also monitored, consistent with *Coli*’s teaching that the control system monitors all aspects of the fracturing site, and *Omont*’s teaching of monitoring suction pressure of the pump. Further, Patent Owner’s expert testified that monitoring charge pressure of a hydraulic system was known and provided reasons why a POSITA would do so.¹⁵⁰

c) “temperature”

129. *Omont* discloses using sensors to monitor the temperature of a “material transfer device” (e.g., pump) and a “prime mover” (e.g., a motor).¹⁵¹ The *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-Gensel-Omont* combination therefore renders this limitation obvious. Further, Patent Owner’s expert testified that monitoring temperature of a hydraulic system was known, and provided reasons why a POSITA would do so.¹⁵²

d) “hydraulic oil level,”

¹⁴⁹ Ex. 1040 (*Omont*) [00133].

¹⁵⁰ Ex. 1024 (Nikolaou Dep. Tr.), 58:14 – 59:11.

¹⁵¹ Ex. 1040 (*Omont*), [0052].

¹⁵² Ex. 1024 (Nikolaou Dep. Tr.), 59:11.– 60:15.

130. *Omont* discloses monitoring “dates of engine oil, transmission fluid, and other fluid changes” associated with a prime mover (*e.g.*, a motor).¹⁵³ *Omont* also discloses monitoring different levels of fluids, including a “tub level” of the fracturing fluid¹⁵⁴ and the level of material (additives to the fracturing fluid) in a container.¹⁵⁵ A POSITA would have understood that it would have been obvious that such monitoring would also have included an oil/fluid level (*i.e.*, “hydraulic oil level”), particularly when the pump uses hydraulic fluid, such as a hydraulic pump driven by an electric motor on a blender. The *Coli-Birch-Rusnak-Hunt-Broussard*079-*Broussard*601-*Gensel-Omont* combination, therefore, renders this limitation obvious. Further, Patent Owner’s expert testified that monitoring the hydraulic oil level in a hydraulic system was known and provided reasons why a POSITA would do so.¹⁵⁶

e) “and filter status.”

131. *Omont* discloses monitoring “service of filters” associated with a prime mover (*e.g.*, a motor).¹⁵⁷ A POSITA would have understood that such monitoring would indicate a “*filter status*” such as time since install or time in service. For

¹⁵³ Ex. 1040 (*Omont*), [0120].

¹⁵⁴ Ex. 1040 (*Omont*), [0099].

¹⁵⁵ Ex. 1040 (*Omont*) [0048].

¹⁵⁶ Ex. 1024 (Nikolaou Dep. Tr.), 60:16.– 61:11.

¹⁵⁷ Ex. 1040 (*Omont*), [0120].

example, *Omont* teaches monitoring “operating time” of the prime mover.¹⁵⁸ The *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-Gensel-Omont* combination, therefore, renders this limitation obvious. Further, Patent Owner’s expert testified that monitoring the hydraulic oil level in a hydraulic system was known and provided reasons why a POSITA would do so.¹⁵⁹

F. Ground 7A: The Combination of *Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Smith, and Bromell* Renders Obvious Claims 26 and 35

132. In my opinion, the combination of *Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Smith, and Bromell* discloses and/or suggests to a POSITA each element of Substitute Claims 26 and 35.

133. Substitute Claims 26 and 35 incorporate the subject matter of original claims 6 and 15, respectively, addressed in my Original Declaration, and each adds limitations regarding the emergency power unit being operated by a switch that sounds an audible alarm in Claim Elements [26c] and [35b].¹⁶⁰

134. Claim Element [26c] is addressed below. Claim Element [35b] is rendered obvious for the same reasons given for Claim Element [26c]. Limitations from the original claims not addressed below are addressed in my Original Declaration.

¹⁵⁸ Ex. 1040 (*Omont*), [0120].

¹⁵⁹ Ex. 1024 (Nikolaou Dep. Tr.), 61:12.– 62:13.

¹⁶⁰ Ex. 1003, ¶¶ 277-294, 308, 309; MTA at A-3, A-7.

1. Status and Overview of *Smith*

135. *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.

136. *Smith* discloses a “means for shutting down large hydraulic turbines and connected generators ... from a switchboard or some other point distant from the 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.”¹⁶¹ *Smith* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

2. Status and Overview of *Bromell*

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

138. *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.”¹⁶² When such “off-normal operation” is detected, *Bromell* discloses “sound[ing] an alarm.”¹⁶³ *Bromell* further teaches that the audible

¹⁶¹ Ex. 1035 (*Smith*), 1:1-3, 1:23-29.

¹⁶² Ex. 1036 (*Bromell*), 1:33-36.

¹⁶³ Ex. 1036 (*Bromell*), 1:19-21.

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 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*.”¹⁶⁴

139. Further, *Brommell* discloses that the alarm condition is indicative of an automatic shutdown because of the “off-normal” condition. *Brommell* teaches that “In 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.”¹⁶⁵ *Bromell* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

3. Motivation to Combine.

140. A POSITA would have been motivated to combine *Coli*, *Birch*, *Rusnak*, and *Hunt*, and further combine these references with *Broussard079* and *Broussard601*.¹⁶⁶ A POSITA would have been further motivated to combine the

¹⁶⁴ Ex. 1036 (*Brommell*) 4:29-37 emphasis added.

¹⁶⁵ Ex. 1036 (*Brommell*) 4:38-41.

¹⁶⁶ Section XII.C.5 above.

*Coli-Birch-Rusnak-Hunt-Broussard*079-*Broussard*601 system with *Smith* and *Bromell*.

141. The combined *Coli-Birch-Rusnak-Hunt* system teaches a switchgear that operates as an emergency power off unit for shutting down a turbine generator.¹⁶⁷ *Smith* discloses a “means for shutting down large hydraulic turbines and connected generators,” “by simply closing a switch.”¹⁶⁸ *Bromell* discloses “drilling rig control” that “sound[s] an alarm” when “off-normal” operation is detected.¹⁶⁹ As discussed above in Section XII.F.2, 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 the audible alarm for safety reasons, such that personnel on the site would be immediately notified that an emergency condition existed, which necessitated the emergency shutdown. Further, as discussed above in Section V.C, a POSITA would have been motivated to meet industry standards, including NFPA

¹⁶⁷ Ex. 1003, ¶¶ 267-307.

¹⁶⁸ Ex. 1035, 1:1-3, 1:24-29.

¹⁶⁹ Ex. 1036, 1:19-21, 1:33-36.

79, which states that a switch was one of the methods recognized for use in an e-stop system.¹⁷⁰

142. Incorporating *Smith* and *Bromell* into the combined *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601* 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 the implementation 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.

4. **[26c]: “wherein the emergency power off unit is operated by a switch that sounds an audible alarm”**

143. The *Coli-Birch-Rusnak-Broussard079-Broussard601-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 result sought through the

¹⁷⁰ See Section V.C above.

governor mechanism.”¹⁷¹ *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.”¹⁷² When such “off-normal operation” is detected, *Bromell* discloses “sound[ing] an alarm.”¹⁷³

144. It would have been obvious to effectuate the “emergency power-off” functionality of the *Coli-Birch-Rusnak-Broussard079-Broussard601-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 power off has been activated.”¹⁷⁴ Further, Dr.

¹⁷¹ Ex. 1035 (*Smith*), 1:1-3, 1:24-29.

¹⁷² Ex. 1036 (*Bromell*), 1:33-36.

¹⁷³ Ex. 1036 (*Bromell*), 1:19-21.

¹⁷⁴ Ex. 1024 (Nikolaou Dep. Tr.), 63:9-19 emphasis added.

Nikolaou testified that this would have been implemented without undue experimentation.¹⁷⁵

G. Ground 8A: The Combination of Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Smith, Bromell, and Thompson Renders Obvious Claims 27 and 36

145. In my opinion, the combination of *Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, Smith, Bromell, and Thompson* discloses and/or suggests to a POSITA each element of Substitute Claims 27 and 36.

146. Substitute Claims 27 and 36 incorporate the subject matter of original claims 7 and 16, respectively, addressed in my Original Declaration, and each adds limitations regarding the signal being transmitted “*over armored shielded CAT5E cabling*” in Claim Elements [27c] and [36b].¹⁷⁶

147. Claim Element [27c] is addressed below. Claim Element [36b] is rendered obvious for the same reasons given for Claim Element [27c]. Limitations from the original claims not addressed below are addressed in my Original Declaration.

1. Status and Overview of Thompson

¹⁷⁵ Ex. 1024 (Nikolaou Dep. Tr.), 72:19-73:4.

¹⁷⁶ Ex. 1003, ¶¶ 295-307, 310; MTA, A-3, A-8.

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

149. *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.”¹⁷⁷ *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.”¹⁷⁸ *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.”¹⁷⁹ *Thompson* further teaches that the cable is “for carrying computer network signals, such as Ethernet type signals.”¹⁸⁰ *Thompson*’s disclosures regarding deploying durable and resilient communications means is reasonably pertinent to the problem addressed the by '992 Patent—controlling and/or monitoring industrial equipment from a centralized location.

2. **Motivation to Combine.**

¹⁷⁷ Ex. 1037 (*Thompson*) Abstract.

¹⁷⁸ Ex. 1037 (*Thompson*) [0015].

¹⁷⁹ Ex. 1037 (*Thompson*) [0049].

¹⁸⁰ Ex. 1037 (*Thompson*) [0008].

150. A POSITA would have been motivated to combine *Coli*, *Birch*, *Rusnak*, and *Hunt*, and further combine these references with *Broussard079*, *Broussard601*, *Smith*, and *Bromell*.¹⁸¹ A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601* system with *Thompson*.

151. 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.¹⁸² *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."¹⁸³ *Thompson* further teaches that the cable is "for carrying computer network signals, such as Ethernet type signals."¹⁸⁴ 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 protect the

¹⁸¹ See Section XII.F.3. above

¹⁸² Ex. 1003 (1st *Durham Dec*), ¶¶ 165-168.

¹⁸³ Ex. 1037 (*Thompson*) Abstract, [0049].

¹⁸⁴ Ex. 1037 (*Thompson*) [0008].

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.”¹⁸⁵ A POSITA would have recognized the benefits of avoiding interference between on data signals. Further, a POSITA implementing the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-Smith-Bromell* system would have been motivated to look to additional references that teach particular types of Ethernet cables, such as *Thompson*, as at least *Coli* teaches using Ethernet communications at a fracturing site.

152. 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.

¹⁸⁵ Ex. 1037 (*Thompson*) [0013].

3. [27c]: “wherein the signal is transmitted over armored shielded CAT5E cabling.”

153. *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”.¹⁸⁶

154. It would have been obvious to a POSITA that the Ethernet 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. As Dr. Nikolaou testified, and I agree, armored shielded cabling was known at the time of the ’992 Patent.¹⁸⁷ *Thompson* discloses armored, shielded Cat 5E cabling, along with the benefits of such cable. Thus, the *Coli-Birch-Rusnak-Hunt-Broussard*079-

¹⁸⁶ Ex. 1037 (*Thompson*) Abstract, [0015], [0049].

¹⁸⁷ Ex. 1024 (*Nikolaou* Dep. Tr.), 78:7-80:4.

Broussard601-Smith-Bromell-Thompson combination renders this limitation obvious.

H. Ground 9A: The Combination of *Coli, Birch, Rusnak, Hunt, Broussard079, and Broussard601* Renders Obvious Claims 33, 37, and 40

155. In my opinion, the combination of *Coli, Birch, Rusnak, Hunt, Broussard079* and *Broussard601* discloses and/or suggests to a POSITA each element of Substitute Claims 33, 37, and 40.

156. Substitute Claims 33, 37, and 40 incorporate the subject matter of original claims and 13, 17, and 20, respectively, addressed in my Original Declaration.¹⁸⁸ Substitute Claim 33 adds limitations regarding monitoring particular “operating characteristics” of a turbine generator in Claim Element [33b]-[33c].¹⁸⁹ Substitute Claim 37 adds the “continuous” limitations in Claim Elements [37f] and [37g].¹⁹⁰ Substitute Claim 40 adds the “liquefied natural gas” limitation in Claim Element [40b].¹⁹¹

157. Claim Elements [33b] and [33c] are addressed below. Claim Elements [37f] and [37g] are rendered obvious for the same reasons given for Claim Elements [21e] and [21f].¹⁹² Claim Element [40b] is rendered obvious for the same reasons

¹⁸⁸ Ex. 1003, ¶¶ 205-207, 311-327, 330;

¹⁸⁹ MTA, A-2, A-6-7.

¹⁹⁰ MTA, A-9.

¹⁹¹ MTA, A-10.

¹⁹² See Section XII.B.4-5 above.

given for Claim Element [22a].¹⁹³ Limitations from the original claims not addressed below are addressed in my Original Declaration.

1. Motivation to Combine.

158. A POSITA would have been motivated to combine *Coli*, *Birch*, *Rusnak*, and *Hunt*, and further combine these references with *Broussard079*, *Broussard601* for the same reasons as those described in Section XII.C.5 above.¹⁹⁴

2. [33b]: “monitoring operating characteristics of the turbine generator, wherein the monitored operating characteristics include...”

159. For the reasons discussed below in Section XII.H.3 regarding Substitute Claim Limitation [33c], the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601* combination renders obvious “*monitoring operating characteristics of the turbine generator, wherein the monitored operating characteristics include...*”

3. 33[c]

a) “gas fuel main valve discharge pressure transmitter failure”

160. A POSITA would have understood *Birch*’s “under and over pressure electronic sensors 6a and 6b,” discussed above with reference to Substitute Claim Limitation [23c], to be a “gas fuel main valve discharge pressure transmitter,”

¹⁹³ See Section XII.B.6 above.

¹⁹⁴ Section, XII.C.5 above.

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.¹⁹⁵ Thus, a POSITA would have understood that the sensors monitor a “gas fuel main valve discharge pressure.” Accordingly, for the same reasons discussed above with reference to Limitation [23c], *Birch* renders monitoring for a gas fuel main valve discharge pressure failure limitation obvious. 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.¹⁹⁶

b) “backup system relay failure”

161. *Hunt* discloses a power distribution system wherein utility power may be utilized to power a load (*e.g.*, pumps) should a generator need to be disconnected from the load (*e.g.*, due to temperature overheat or fuel starvation).¹⁹⁷ *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.”¹⁹⁸ A POSITA would have understood switchgear control relay 229 to be a “backup system relay” because it controls the engagement of utility power bus 260

¹⁹⁵ Ex. 1005 (*Birch*), 2:30-39, Fig. 1.

¹⁹⁶ Ex. 1024 (Nikolaou Dep. Tr.), 81:4-15.

¹⁹⁷ Ex. 1008 (*Hunt*), [0033]-[0035], [0046], [0075]-[0076]

¹⁹⁸ Ex. 1008(*Hunt*), [0046].

(i.e., the “backup system”). And it would have been obvious to monitor the status of this relay, including whether this relay has failed, in view of *Coli*’s teaching that its control system monitors all equipment of the fracturing site, of which the switchgear control relay is a part in the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601* system. Further, a failure of such a relay would be an indication that backup power was not available, 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.¹⁹⁹

I. Ground 10A: The Combination of *Coli*, *Birch*, *Rusnak*, *Broussard079*, *Broussard601*, and *Discenzo* Renders Obvious Claim 34

162. In my opinion, the combination of *Coli*, *Birch*, *Rusnak*, *Broussard079*, *Broussard601*, and *Discenzo* discloses and/or suggests to a POSITA each element of Substitute Claim 34.

163. Substitute Claim 34 incorporates the subject matter of original claim 14, addressed in my Original Declaration, and adds limitations regarding monitoring particular operating characteristics of a variable frequency drive in Claim Element [34c].²⁰⁰

¹⁹⁹ Ex. 1024 (Nikolaou Dep. Tr.), 81:16-82:20.

²⁰⁰ Ex. 1003 (*1st Durham Declaration*), ¶ 208; MTA, A-7.

164. Claim Elements [34b] and [34c] are addressed in the following sections. Limitations from the original claims not addressed below are addressed in my Original Declaration.

1. Status and Overview of *Discenzo*

165. *Discenzo* is U.S. Patent no. 7,949,483 that was filed on September 30, 2005, and was granted on May 24, 2011. *Discenzo* is prior art to the '992 Patent.

166. *Discenzo* relates “generally to motors, motor diagnostics and motor control.”²⁰¹ *Discenzo* teaches that “Variable frequency drives may continually monitor motor current or current and voltage to a motor to adjust the power to the motor.”²⁰² *Discenzo* teaches sensors on the connected motor also “sample[] three phases of voltage, load end and fan end bearing temperatures, winding temperature, and vibration.”²⁰³ *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,”²⁰⁴ or “to predict a motor failure, such as a winding failure, that may occur in the near future.”²⁰⁵ *Discenzo* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the '992 Patent.

²⁰¹ Ex. 1038 (*Discenzo*) 1:6-7.

²⁰² Ex. 1038 (*Discenzo*) 6:35-39.

²⁰³ Ex. 1038 (*Discenzo*) 6:40-41.

²⁰⁴ Ex. 1038 (*Discenzo*) 8:66 – 9:1.

²⁰⁵ Ex. 1038 (*Discenzo*) 9:11-13.

2. Motivation to Combine.

167. A POSITA would have been motivated to combine *Coli*, *Birch*, and *Rusnak*, and further combine these references with *Broussard079* and *Broussard601*.²⁰⁶ A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Broussard079-Broussard601* system with *Discenzo*.

168. The combined *Coli-Birch-Rusnak* system discloses a control system and controls and monitors all equipment of a fracturing site, including electric motors and VFDs that drive the electric motors.²⁰⁷ *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.”²⁰⁸ *Discenzo* also teaches monitoring “three phases of voltage, load end and fan end bearing temperatures, winding temperature, and vibration.”²⁰⁹ *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,”²¹⁰ or “to predict a motor failure, such as a winding failure, that may occur in

²⁰⁶ Section XII.B.3 above.

²⁰⁷ Ex. 1003, ¶¶ 126-170.

²⁰⁸ Ex. 1038 (*Discenzo*) 6:35-37.

²⁰⁹ Ex. 1038 (*Discenzo*) 6:40-41.

²¹⁰ Ex. 1038 (*Discenzo*) 8:66 – 9:1.

the near future.”²¹¹ 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.

169. *Rusnak* further teaches monitoring various aspects of electric motors and the VFDs that control the electric motors. Including the VFD “provid[ing] speed and torque measurements”.²¹² 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 in order 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.”²¹³ 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

²¹¹ Ex. 1038 (*Discenzo*) 9:11-13.

²¹² Ex. 1007 (*Rusnak*), [0002].

²¹³ Ex. 1004 (*Coli*), [0072].

fracturing 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.

3. **[34b]: “the method further comprising monitoring operating characteristics of the variable frequency drive, wherein the monitored operating characteristics include...”**

170. For the reasons discussed below in Sections XII.I.4 regarding Substitute Claim Limitation [34c], the *Coli-Birch-Rusnak-Broussard*079-*Broussard*601-*Discenzo* combination renders obvious “the method further comprising monitoring operating characteristics of the variable frequency drive, wherein the monitored operating characteristics include...”

4. **[34c]**

a) **“motor winding temperatures”**

171. *Discenzo* teaches sensors on the connected motor also “sample[] three phases of voltage, load end and fan end bearing temperatures, winding temperature, and vibration.”²¹⁴ *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,”²¹⁵ or “to predict

²¹⁴ Ex. 1038 (*Discenzo*) 6:40-41.

²¹⁵ Ex. 1038 (*Discenzo*) 8:66 – 9:1.

a motor failure, such as a winding failure, that may occur in the near future.”²¹⁶ Accordingly, the *Coli-Birch-Rusnak-Broussard079-Broussard601-Discenzo* system renders this limitation obvious.

172. Further, Patent Owner’s expert testified that monitoring motor winding temperature was known and provided reasons why a POSITA would do so.²¹⁷

b) “the motor RPM”

173. *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 speed and provide speed and torque measurements.**”²¹⁸ *Rusnak* further provides that “[m]otor speed and torque values from a VFD are supplied to a processor” to further processing.²¹⁹ 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-Broussard079-Broussard601-Discenzo* system renders this limitation obvious. Further, Patent Owner’s expert testified that monitoring motor RPM was not only

²¹⁶ Ex. 1038 (*Discenzo*) 9:11-13.

²¹⁷ Ex. 1024 (Nikolaou Dep. Tr.), 83:10-84:6.

²¹⁸ Ex. 1007 (*Rusnak*), [0002] emphasis added.

²¹⁹ Ex. 1007 (*Rusnak*), [0003].

known but a “classic measurement” and provided reasons why a POSITA would monitor rpm.²²⁰

c) “the voltage,”

174. *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.”²²¹ Further, *Discenzo* discloses that “[v]ariable frequency drives may continually monitor motor current or current and voltage to a motor to adjust the power to the motor.”²²² Accordingly, the *Coli-Birch-Rusnak-Broussard079-Broussard601-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.²²³

d) “the torque,”

175. As discussed above, *Rusnak* discloses providing “[m]otor speed and torque values” of a motor “from a VFD” to a processor further processing.²²⁴ Accordingly, the *Coli-Birch-Rusnak-Broussard079-Broussard601-Discenzo* system

²²⁰ Ex. 1024 (*Nikolaou Dep. Tr.*), 84:7-20.

²²¹ Ex. 1007 (*Rusnak*), [0005].

²²² Ex. 1038 (*Discenzo*) 6:35-39.

²²³ Ex. 1024 (*Nikolaou Dep. Tr.*), 84:21-85:11.

²²⁴ Ex. 1007 (*Rusnak*), [0003]; Section XII.I.4.b.

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.²²⁵

e) “and the current (amperage).”

176. *Rusnak* discloses “internally monitoring automatically output current and voltage of the VFD to the AC motor without the need for an external sensor.”²²⁶ Further, *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.”²²⁷ Accordingly, the *Coli-Birch-Rusnak-Broussard079-Broussard601-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.²²⁸

J. Ground 11A: The Combination of *Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, and McIver* Renders Obvious Claim 39

177. In my opinion, the combination of *Coli, Birch, Rusnak, Hunt, Broussard079, Broussard601, and McIver* discloses and/or suggests to a POSITA each element of Substitute Claim 39.

²²⁵ Ex. 1024 (Nikolaou Dep. Tr.), 85:12-86:3.

²²⁶ Ex. 1007, [0005].

²²⁷ Ex. 1038 (*Discenzo*) 6:35-39.

²²⁸ Ex. 1024 (Nikolaou Dep. Tr.), 86:4–19.

178. Substitute Claim 39 incorporates the subject matter of original claim 19, addressed in my Original Declaration, and adds limitations regarding monitoring and controlling several pieces of equipment in.²²⁹ Substitute Claim 39 is addressed below. Limitations from the original claim not addressed below are addressed in my Original Declaration.

1. Status and Overview of *McIver*

179. *McIver* is U.S. Patent Application Publication not 2013/0142601 that was filed on October 23, 2012, and was published on June 6, 2013. *McIver* is prior art to the '992 Patent.

180. *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.”²³⁰ The silos are used to store various materials “usable in fracking applications,” including “water, sand, proppant or an acid solution.”²³¹ *McIver* discloses a system that will “monitor the level of sand in each silo” of its configuration, wherein each silo may be positioned to stand vertically.²³² *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,

²²⁹ See Ex. 1003, ¶ 329; MTA, A-10.

²³⁰ Ex. 1039 (*Mciver*) Abstract.

²³¹ Ex. 1039 (*Mciver*) [0047]. See also [0005].

²³² Ex. 1039, [0017], [0056].

horizontally.”²³³ *McIver* explains that the dual belt conveyor has a “Variable Frequency Drive” that controls the conveyor’s speed.²³⁴ *McIver* is therefore in the same field of endeavor—controlling and/or monitoring industrial equipment—as the ’992 Patent.

2. Motivation to Combine.

181. A POSITA would have been motivated to combine *Coli*, *Birch*, and *Rusnak*, and *Hunt*, and further combine these references with *Broussard079* and *Broussard601*.²³⁵ A POSITA would have been further motivated to combine the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601* system with *McIver*.

182. The combined *Coli-Birch-Rusnak-Hunt* system discloses a control system that controls and monitors all equipment of a fracturing site.²³⁶ *Coli* discloses the use of “blender units,” “to blend fluids with proppant, sand, chemicals, acid, etc., prior to delivery to the wellbore.”²³⁷ *McIver* discloses “silo storage systems for use 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.²³⁸ *McIver* further discloses monitoring the silos and other equipment (*e.g.*, monitoring level, using

²³³ Ex. 1039, [0044]-[0045], [0054].

²³⁴ Ex. 1039, [0056].

²³⁵ Section, XII.C.5 above.

²³⁶ Ex. 1003, ¶¶ 268-276.

²³⁷ Ex. 1004, [0053]-[0054].

²³⁸ Ex. 1039, Abstract, [0005], [0047].

VFDs that monitor and control the speed of dual belt conveyor system) used in the storage and transportation of the proppant material.²³⁹ 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."²⁴⁰ 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 motivated to combine the references and would have reasonably expected success in doing so.

3. **Substitute Claim 39: "wherein the centralized control unit is further configured to monitor and control all of the following:..."**

²³⁹ Ex. 1039, [0044]-[0045], [0054].

²⁴⁰ Ex. 1004, [0072].

183. For the reasons discussed below in Sections VII.J.3.a-h regarding Substitute Claim Limitation [33c], the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-McIver* combination renders obvious Substitute Claim 39.

a) “compression of natural gas,”

184. As discussed in my Original Declaration, *Coli* in view of *Birch* renders obvious monitoring and controlling the compression of natural gas.²⁴¹

b) “electric motors,”

185. *Coli* discloses that the electric motors used in the system can be “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.²⁴² 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).²⁴³ A POSITA would have understood that such functionality includes monitoring the electric motors, which are part of the fracturing operation.

c) “switchgear,”

186. The combined *Coli-Birch-Rusnak-Hunt* system comprises a switchgear that operates as an emergency power off unit.²⁴⁴ Because *Coli* teaches a control

²⁴¹ Ex. 1003, ¶¶ 175-181.

²⁴² Ex. 1004, [0011], [0065]; Ex. 1003, ¶¶ 95-99, 162.

²⁴³ Ex. 1004, [0072].

²⁴⁴ Ex. 1003, ¶¶ 267-307.

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-Broussard601-McIver* system, would have been control and monitored by *Coli*’s control system.

d) “transformers,”

187. *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 from turbine generator 30 to a voltage appropriate for electric motor 21.”²⁴⁵ 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.

e) “mobile turbines,”

188. *Coli* in view of *Birch* discloses monitoring and controlling gaseous fuel compression for a gas turbine generator.²⁴⁶ *Broussard079* teaches that turbine generators “can be mounted on vehicles, and can be ported from one well to another.”²⁴⁷ When implementing the gas turbine generators of the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-McIver* system in the manner taught by

²⁴⁵ Ex. 1004, [0047].

²⁴⁶ Ex. 1003, ¶¶ 235-244.

²⁴⁷ Ex. 1024 (*Broussard079*), [0008].

*Broussard*⁰⁷⁹ (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*.”

f) “rate and pressure of the overall system,”

189. *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 units and even ancillary equipment like sand belts, will increase rates to compensate automatically.”²⁴⁸ A POSITA would have understood that controlling the rate of pumps 22, blender module 40, and the chemical units and ancillary equipment, *Coli* discloses 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.

190. *Coli* discloses monitoring and controlling pressure at the pumps to avoid exceeding a maximum pressure value.²⁴⁹ 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

²⁴⁸ Ex. 1004, [0071].

²⁴⁹ Ex. 1003, ¶ 158-161.

generator (see Substitute Claim Limitation 23[c]) and pressures associated with “the hydraulic system” (see Substitute Claim Limitation 23[c]).²⁵⁰ 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.

g) vertical sand silos,

191. *McIver* discloses a system that monitors “the level of sand in each silo” of its configuration, wherein each silo may be positioned to stand vertically.²⁵¹ *McIver*’s system further controls “the rate at which the sand or other proppant is being removed from the silo.”²⁵² Accordingly, the *Coli-Birch-Rusnak-Hunt-Broussard079-Broussard601-McIver* system renders obvious controlling and monitoring of “vertical sand silos.”

h) and electrical conveyor belt.

192. *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.”²⁵³ *McIver* explains that the dual belt conveyor has a

²⁵⁰ See Sections, XII.C.7, XII.E.4.

²⁵¹ Ex. 1039, [0017], [0056].

²⁵² Ex. 1039, [0056].

²⁵³ Ex. 1039, [0044]-[0045], [0054].

“Variable Frequency Drive” that controls the conveyor’s speed.²⁵⁴ 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 to control the dual belt conveyor’s speed, as taught by *McIver*, 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-Broussard601* system, a 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.

XIII. CONCLUSION

193. 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 September 15, 2025.



Dr. Robert A. Durham

²⁵⁴ Ex. 1039, [0056].