

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.

IPR2023-00558
Patent 11,136,870 B2

Before LYNNE H. BROWNE, GEORGE R. HOSKINS, and
SEAN P. O'HANLON, *Administrative Patent Judges*.

HOSKINS, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

Halliburton Energy Services, Inc. (“Petitioner”) has filed a Petition (Paper 1, “Pet.”) pursuant to 35 U.S.C. §§ 311–319 to institute an *inter partes* review of U.S. Patent No. 11,136,870 B2 (Ex. 1001, “the ’870 patent”), claims 1–16. U.S. Well Services, LLC (“Patent Owner”) has filed a Preliminary Response (Paper 6, “Prelim. Resp.”) opposing institution of review.

The Petition, to justify institution of review, must demonstrate a reasonable likelihood that Petitioner would prevail with respect to at least one challenged claim. *See* 35 U.S.C. § 314(a). Applying that standard on behalf of the Director (37 C.F.R. § 42.4(a)), we institute an *inter partes* review to determine whether Petitioner demonstrates by a preponderance of the evidence that the challenged claims are unpatentable, considering all grounds in the Petition.

II. BACKGROUND

A. *Real Parties-in-Interest and Related Proceedings*

Petitioner identifies itself (i.e., Halliburton Energy Services, Inc.), Halliburton Co., and Halliburton Holdings LLC as real parties-in-interest. *See* Pet. 1. Patent Owner identifies itself (i.e., U.S. Well Services, LLC), USWS Holdings, LLC, U.S. Well Services, Inc., and ProFrac Holding Corporation as real parties-in-interest. *See* Paper 5, 1.

The parties identify one district court litigation involving the ’870 patent: *Halliburton Energy Services, Inc., et al. v. U.S. Well Services, LLC*, Case No. 6:22-cv-00906-ADA (W.D. Tex.). *See* Pet. 1; Paper 5, 1.

Petitioner has also filed several other IPR proceedings to challenge patents owned by Patent Owner. *See, e.g.*, Pet. 1–2. They are:

Proceeding No.	U.S. Patent No.
IPR2021-01032	9,410,410 B2
IPR2021-01033	8,789,601 B2
IPR2021-01034	10,337,308 B2
IPR2021-01035	9,970,278 B2
IPR2021-01036	9,611,728 B2
IPR2021-01037	9,745,840 B2
IPR2021-01038	10,408,030 B2
IPR2021-01065	9,840,901 B2
IPR2021-01066	10,020,711 B2
IPR2021-01238	10,526,882 B2
IPR2021-01315	9,893,500 B2
IPR2021-01316	10,280,724 B2
IPR2021-01538	10,408,031 B2
IPR2021-01539	10,648,311 B2
IPR2022-00074	10,254,732 B2
IPR2022-00610	11,136,870 B2
IPR2023-00557	9,659,871 B2

Petitioner identifies IPR2021-01032, IPR2021-01033, and IPR2021-01034 as “involv[ing] substantially similar subject matter” as the ’870 patent.

Pet. 1. Those proceedings resulted in Final Written Decisions, all of which were appealed to the Federal Circuit. Two of those appeals (1032 and 1034) have been dismissed per the agreement of the parties, and the third (1033) remains pending at the Federal Circuit.

B. The ’870 Patent

The ’870 patent provides a system for hydraulically fracturing an underground formation to extract oil or gas. *See* Ex. 1001, codes (54) and (57). The system employs electric pumps to pump the fracturing fluid

down into the formation at a high pressure to fracture the formation. *See id.*; *id.* at 1:21–26. Figure 1 (reproduced below) illustrates such a system.

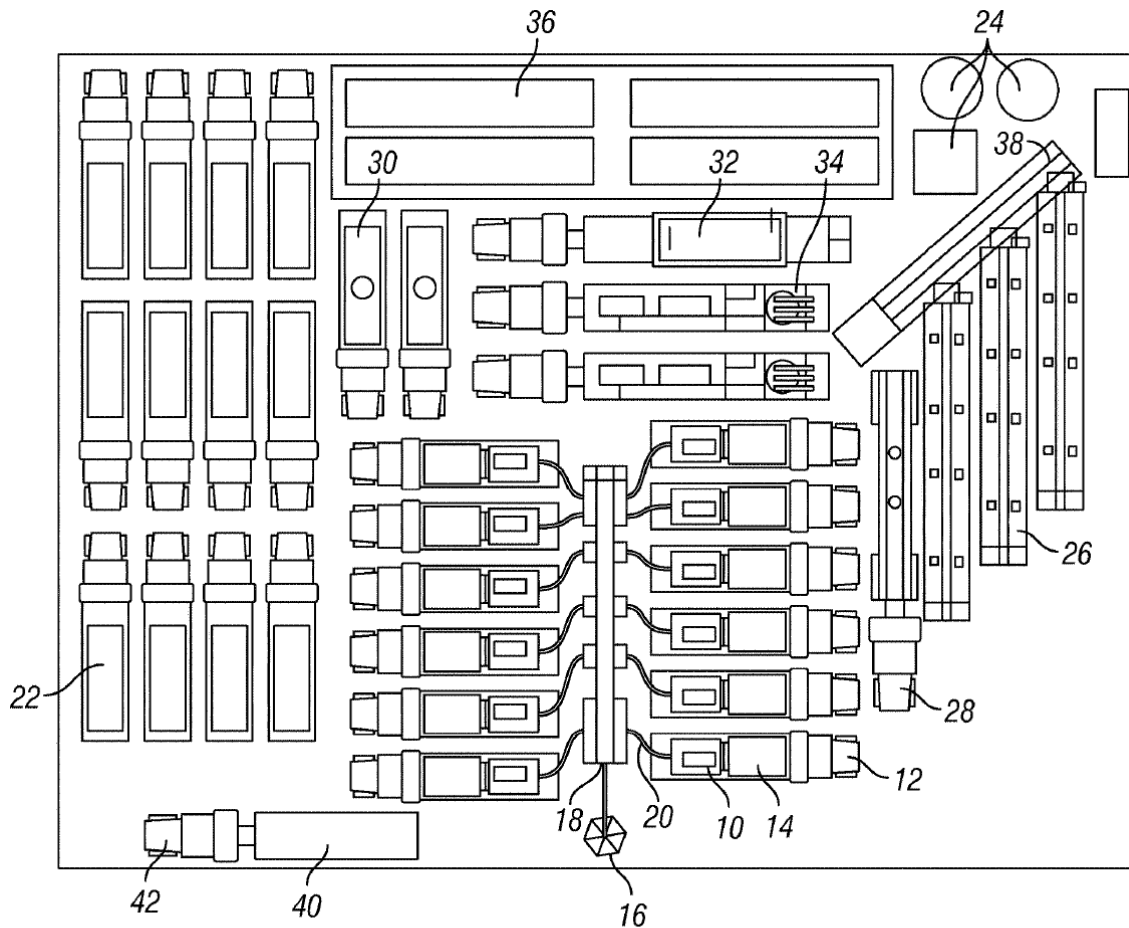


FIG. 1
Figure 1 of the '870 Patent.

Figure 1 is a schematic plan view of equipment used in a hydraulic fracturing operation, including several pumps 10 powered by electric motors 14, mounted on vehicles 12 such as trucks. *See id.* at 3:16–18, 3:38–44. Pumps 10 deliver pressurized fracturing fluid to wellhead 16 via fluid lines 20 and missile 18. *See id.* at 3:44–50.

A variable frequency drive (VFD), not shown in Figure 1, controls the speed of motors 14 and thereby the speed of pumps 10. *See id.* at 2:5–7, 2:21–22, 2:58–60, 4:8–10, 5:39–42. The VFD can “perform electric motor

diagnostics to prevent damage to the electric motor if it becomes grounded or shorted.” *Id.* at 2:36–39, 4:16–23. The VFD also “can include power semiconductor heat sinks having one or more thermal sensors monitored by a microprocessor to prevent semiconductor damage caused by excessive heat.” *Id.* at 2:39–42, 4:10–16.

C. The Claims of the '870 Patent

The '870 patent includes sixteen claims, all of which are challenged here. *See* Ex. 1001, 7:45–8:60; Pet. 4, 16. Claims 1, 4, and 7 are independent, and claim 1 illustratively recites:

1. 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:
 - a trailer for attachment to a truck;
 - two or more pumps attached to the trailer and fluidly connected to the well, the pumps configured to pump fluid into the wellbore;
 - one or more electric motors attached to the pumps to drive the pumps, the electric motors attached to the trailer; and
 - a variable frequency drive connected to the electric motor to control the speed of the motor, wherein the variable frequency drive performs electric motor diagnostics to prevent damage to the one or more electric motors.

Ex. 1001, 7:46–61.

Claim 4 recites a method of hydraulically fracturing an underground formation, comprising steps of using the system components recited in claim 1, but without requiring any of those components to be attached to a trailer. *See id.* at 8:8–19.

Claim 7 recites a system for hydraulically fracturing an underground formation, comprising essentially the same components as claim 1 except for the trailer. *See id.* at 8:24–36. Claim 7 does not require the VFD to perform electric motor diagnostics, and instead requires the VFD to have “one or more power semiconductor heat sinks having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat.” *Id.* at 8:32–36.

D. Asserted Prior Art

Petitioner relies principally on the following six prior art references, listed in alphabetical order. *See* Pet. 16.

Name	Reference	Exhibit No.
Coli	US 2012/0255734 A1	1005
Gardner	Gardner Denver, Inc., <i>Well Servicing Pump, Model GD-2500Q Quintuplex, Operating and Service Manual</i> , 300FWF996 Rev. C (Aug. 2005)	1011
Horikoshi	US 2011/0241590 A1	1008
Loucks	US 2010/0312415 A1	1009
Toshiba Manual	Toshiba Int’l Corp., <i>G7 Adjustable Speed Drive Operation Manual</i> , Doc. No. 51546-009 (Mar. 2005)	1006
Vliet ¹	US 2011/0197988 A1	1010

¹ Although the first-named inventor is “J. Todd Van Vliet” (Ex. 1010, code (75)), the parties refer to Exhibit 1010 as “Vliet” (*see, e.g.*, Pet. 15; Prelim. Resp. 11). We adopt the parties’ nomenclature for consistency and ease of reference.

E. Asserted Grounds

Petitioner proposes the following seven grounds of unpatentability.
See Pet. 16.

Ground	Claims Challenged	35 U.S.C. § ²	References
1	1–16	103	Coli, Toshiba Manual
2	1–6	103	Coli, Horikoshi
3	7–16	103	Coli, Loucks
4A	12, 13	103	Coli, Toshiba Manual, Vliet
4B	12, 13	103	Coli, Loucks, Vliet
5A	14, 15	103	Coli, Toshiba Manual, Gardner
5B	14, 15	103	Coli, Loucks, Gardner

F. Testimonial Evidence

Petitioner relies on the proffered expert witness testimony of Robert Durham, Ph.D. (Exhibit 1002). Patent Owner does not rely on opposing expert witness testimony at this time.

III. PETITIONER’S GROUNDS OF UNPATENTABILITY

A. Legal Standards

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is

² The ’870 patent issued from an application filed in June 2019, claiming continuation benefits to a parent application filed in November 2012. *See* Ex. 1001, codes (22) and (63). The amendments to 35 U.S.C. § 102 and § 103 enacted by the Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (“AIA”) took effect in March 2013. Both parties apply pre-AIA law. *See* Pet. 6 (priority date), 7 (Coli), 8–9 (Gardner), 9–10 (Toshiba Manual), 12 (Horikoshi), 14 (Loucks), 15 (Vliet); Prelim. Resp. 3. Based on this common approach and lack of disagreement, we apply pre-AIA law in this Decision.

unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to the patent owner. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

A patent claim is unpatentable under 35 U.S.C. § 103 if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness, if made available in the record, which has not happened here. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. Level of Ordinary Skill in the Art

Petitioner contends a person having ordinary skill in the art pertaining to the ’870 patent “would have either (1) a Bachelor of Science in Mechanical Engineering, Electrical Engineering, Petroleum Engineering or an equivalent field as well as at least two years of academic or industry experience in the oil and gas industry, including well drilling, completion, or production; or (2) at least four years of industry experience in the oil and gas industry, including well drilling, completion, or production.” Pet. 20.

Patent Owner “applies the skill level proposed by Petitioner.” Prelim. Resp. 11 (citing Pet. 20).

For purposes of this Decision, we are satisfied that Petitioner’s formulation of ordinary skill generally comports with the level of skill necessary to understand and implement the teachings of the ’870 patent and the asserted prior art, so we apply that formulation here.

C. Claim Construction

We interpret the ’870 patent claims “using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b).” 37 C.F.R. § 42.100(b). This “includ[es] construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” *Id.*

1. Claim 1 — “to prevent damage to the one or more electric motors”

The Petition initially states “Petitioner does not propose any constructions.” Pet. 20–21. However, the Petition later asserts “Petitioner believes that ‘to prevent damage to the one or more electric motors’ element [in claim 1] is non-limiting,” even though this element is recited in the body of the claim. *Id.* at 30 n.5.

We need not address that assertion, because for reasons provided in Sections III.D.3(ii) and III.E.3(ii) below, the present record sufficiently supports Petitioner’s further contention that Toshiba Manual and Horikoshi both disclose preventing damage to their electric motors, to justify institution on that basis regardless of whether this is actually required by claim 1. *See id.* at 30 n.5, 31–32, 48–50; *Realtime Data, LLC v. Iancu*, 912 F.3d 1368,

1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’”) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

2. *Claim 1 — “perform[] electric motor diagnostics”*

The Preliminary Response initially states: “[A]t this stage . . . no terms require a construction.” Prelim. Resp. 12. However, the Preliminary Response later asserts “[t]he claimed ‘*diagnostics*,’ . . . determine the underlying cause of the problem or error to prevent damage to a motor.” *Id.* at 17. We address this assertion in Section III.D.3(ii) below, as part of considering the pertinent disclosures of Toshiba Manual.

D. *Ground 1 — Obviousness over Coli and Toshiba Manual*

Petitioner asserts claims 1–16 of the ’870 patent are unpatentable as having been obvious over Coli and Toshiba Manual. *See* Pet. 7–8, 9–11, 16, 21–45. Patent Owner disagrees, focusing on Petitioner’s reliance on Toshiba Manual. *See* Prelim. Resp. 1–2, 6–9, 12–28.

We have reviewed the preliminary record, and we conclude Petitioner has demonstrated a reasonable likelihood of prevailing on its assertions as to at least claim 1, but not as to claim 7. First we summarize the disclosures of Coli and Toshiba Manual, then we consider the parties’ opposing contentions concerning claims 1 and 7.

1. *Summary of Coli*

Coli discloses a mobile, electrically powered, hydraulic fracturing system. *See* Ex. 1005, codes (54) and (57), ¶¶ 1–2. Figure 2 (reproduced below) illustrates such a system.

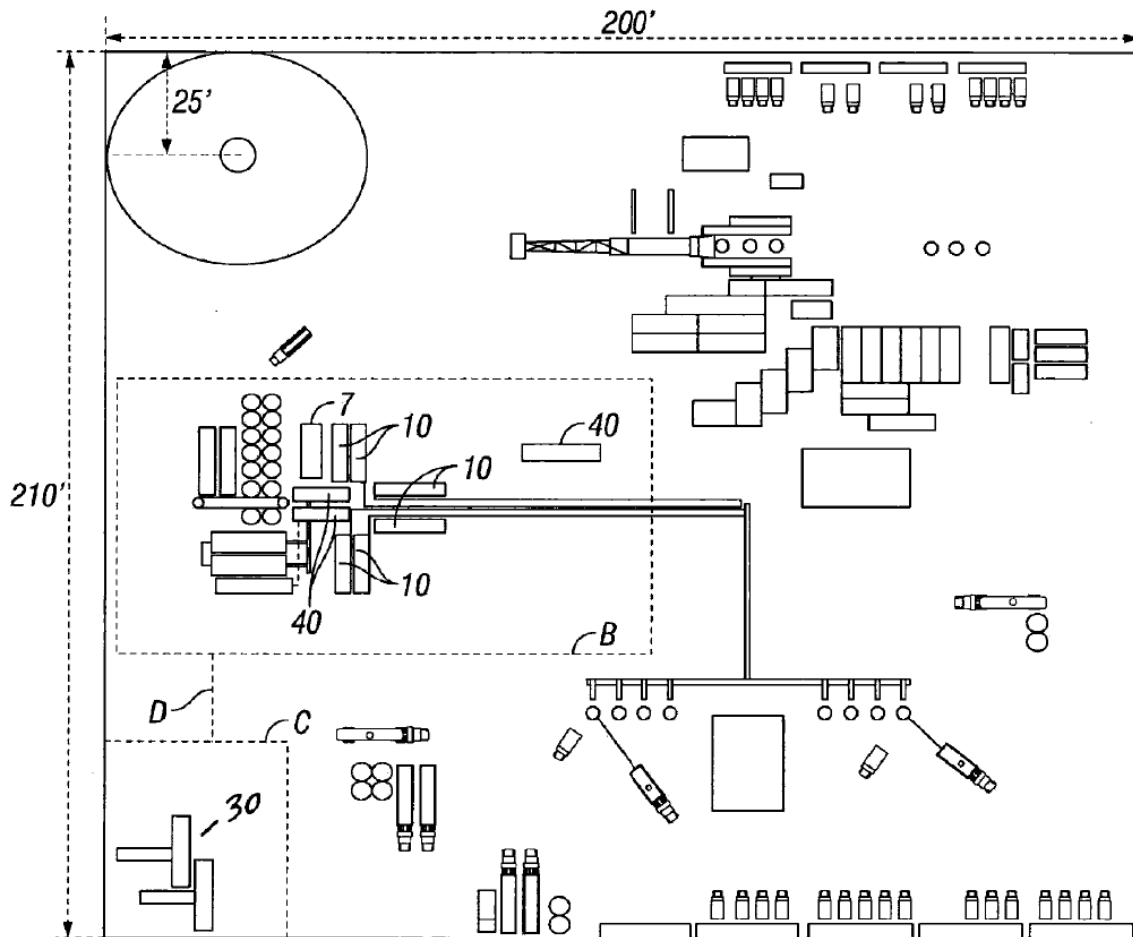


FIG. 2

Figure 2 of Coli.

Figure 2 is a schematic plan view of a fracturing site, including a site plan for an electrically powered fracturing operation. *See id.* ¶¶ 23, 38. This operation includes trailers 10, each housing one or more fracturing modules 20 (shown in Figure 3), which are powered by electricity generated by on-site turbine generators 30 using natural gas. *Id.* ¶ 38.

Figure 3 of Coli is reproduced below.

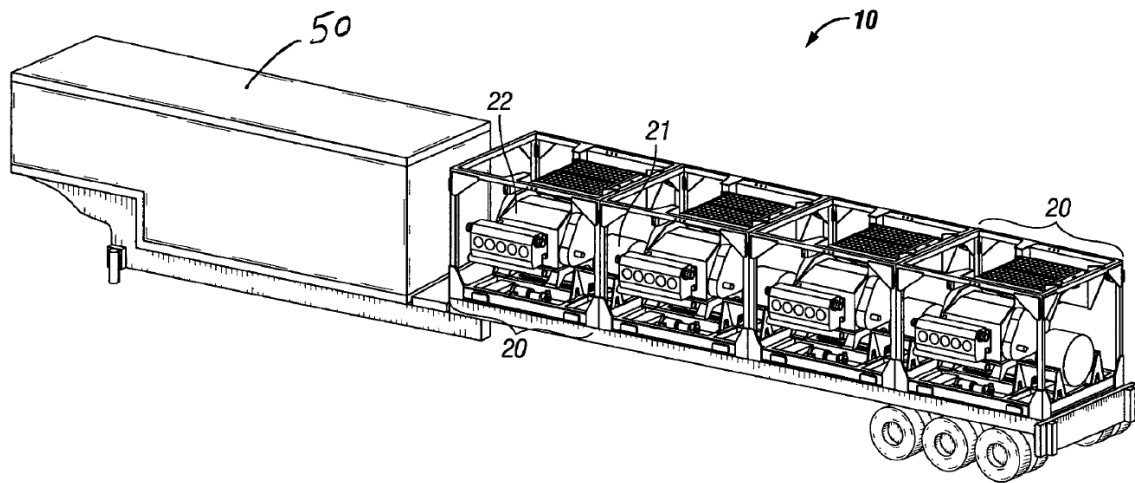


FIG. 3

Figure 3 of Coli.

Figure 3 is a schematic perspective view of trailer 10 housing four fracturing modules 20, with each module including an electric motor 21 coupled to a fluid pump 22. *See id.* ¶¶ 24, 40. “Typically, each fracturing module 20 will be associated with a drive housing for controlling electric motor 21 and pumps 22, as well as an electrical transformer and drive unit 50 . . . to step down the voltage of the power from turbine generator 30 to a voltage appropriate for electric motor 21.” *Id.* ¶ 47.

“A control system can be provided for regulating” each fracturing module 20. *Id.* ¶¶ 64–65. Thus, “electric motors are controlled by variable frequency drives,” which “essentially ‘tell’ the motors what they are allowed to do.” *Id.* ¶ 65. For example: “When the system operator sets a maximum pressure for the treatment, the control software and variable frequency drives calculate a maximum current available to the motors.” *Id.* Further: “Electric motors controlled via variable frequency drive are far safer and easier to control than conventional diesel powered equipment.” *Id.* ¶ 66.

2. *Summary of Toshiba Manual*

Toshiba Manual is an operation manual for the Toshiba G7 Adjustable Speed Drive (ASD), which Dr. Durham testifies is a variable frequency drive (VFD) as recited in claim 1 and as disclosed in Coli. *See* Ex. 1006³, 1–2; Ex. 1002 ¶¶ 56–58, 115–16, 150–51, 155–56, 166. Patent Owner does not presently disagree with this testimony from Dr. Durham. *See, e.g.*, Prelim. Resp. 7–8, 18–19 (discussing “the VFD (also referred to as an ASD in Toshiba)”). We will therefore refer hereafter to the Toshiba G7 VFD.

Two aspects of the Toshiba Manual disclosure are at issue here — the Toshiba G7 VFD’s overload protection (pertinent to claim 1) and its overheat protection (pertinent to claim 7). We discuss each separately.

(i) *Toshiba Manual’s Overload Protection*

Toshiba Manual lists several “variable speed AC motor control concepts with which the user of the [Toshiba G7 VFD] should become familiar,” including an “Overload Protection Adjustment.” Ex. 1006, 19. Pursuant to this adjustment, the Toshiba G7 VFD’s “software monitors the output current of the system and determines when an overload condition occurs,” where “[t]he overload current level is a percentage of the rating of the motor” powered by the VFD, in order to “protect[] the motor from overload.” *Id.*; *see also id.* at 22 (similarly referring to “Over-current Protection”).

³ When citing to Exhibit 1006, we follow the convention used by both parties, and refer to the page numbering added by Petitioner at the bottom right corner of each page. *See, e.g.*, Pet. 10–11; Prelim. Resp. 7–9.

The default overload current “is set to the maximum rated current of the [Toshiba G7 VFD] at the factory,” but “[t]his setting will have to be adjusted to match the rating of the motor with which the [VFD] is to be used.” *Id.* at 19; *see also id.* at 22 (“When using the [Toshiba G7 VFD] for an application that controls a motor which is rated significantly less than the maximum current rating of the [VFD], the over-current limit (Thermal Overload Protection) setting will have to be changed to match the application.”). Thus, Toshiba Manual provides instructions for setting an “Electronic Thermal Protection #1” parameter, specifying “the motor overload current level . . . as either a percentage of the full load rating of the [VFD] or as the FLA⁴ of the motor.” *Id.* at 160.

Toshiba Manual also describes a “Program Menu Navigation” in which various protection parameters, including “Overload”, may be adjusted and enabled or disabled. *Id.* at 58, 71. As described in Toshiba Manual, setting the overload parameter protects against motor overload. *Id.* Thus: “If a user setting or [a VFD] parameter has been exceeded . . . a condition that is referred to as a **Fault** is incurred” and “[a]n **Alarm** is an indication that a **Fault** is imminent if existing operating conditions continue unchanged.” *Id.* at 179. “In the event that the condition that caused the **Alarm** does not return to its normal operating level within a specified time, the [VFD] **Faults** and a **Trip** is incurred . . . that disables the [VFD] system in the event that a subsystem of the [VFD] is malfunctioning,” including when the “Current” “exceeds its normal range.” *Id.*; *see also id.* at 182–84

⁴ Toshiba Manual describes the “Motor Current Rating” as a parameter that “allows the user to input the full-load amperage (FLA) of the motor” which “may be found on the nameplate of the motor.” Ex. 1006, 47.

(Table 12 lists possible Faults that may cause a Trip, including “Motor Overload” and “Output Current Protection Fault”).

(ii) *Toshiba Manual’s Overheat Protection*

Toshiba Manual describes how the Toshiba G7 VFD includes a “heat sink and other components [that] may become extremely hot to the touch.” Ex. 1006, 14, 204. Thus, as one of its protection parameters, Toshiba Manual identifies a “Cooling Fan Control,” and indicates an alarm code may be displayed by the Toshiba G7 VFD if an “Overheat” condition is observed. *Id.* at 58, 163, 180. This condition occurs when the VFD’s “temperature [is] excessive,” as measured by an “[i]nternal thermistor.” *Id.* at 180, 185.

3. *Claim 1*

Petitioner provides arguments and evidence in support of its contention that claim 1 is unpatentable as having been obvious over Coli and Toshiba Manual. *See* Pet. 7–8, 9–11, 21–32; Ex. 1002 ¶¶ 105–119, 148–168. Patent Owner opposes, on the basis that the evidence does not support Petitioner’s contention that the Toshiba G7 VFD performs electric motor diagnostics to prevent damage to a motor. *See* Prelim. Resp. 1–2, 6–9, 12–24.

We first address Petitioner’s reliance on Coli, which is not opposed by Patent Owner at this time. We then turn to Petitioner’s reliance on Toshiba Manual, and Patent Owner’s opposition thereto. We finally address Petitioner’s contentions as to the motivation(s) for combining Coli and Toshiba Manual, which are not opposed by Patent Owner at this time. We ultimately conclude Petitioner has demonstrated a reasonable likelihood of prevailing on its assertions for claim 1.

(i) *Comparing Claim 1 with Coli*

Petitioner argues Coli discloses the subject matter of claim 1, including a VFD to control the speed of an electric motor, except Coli's VFD is not disclosed as "perform[ing] electric motor diagnostics to prevent damage to" the electric motor, as claimed. *See* Pet. 7–8, 25–32; Ex. 1002 ¶¶ 107–110, 159–165. For the following reasons, we conclude these contentions, which Patent Owner does not oppose at the present time, are sufficiently supported by the evidence of record to justify institution of review.

Coli discloses a system for hydraulically fracturing an underground formation in an oil or gas well to extract oil or gas from the formation, wherein the well has a wellbore that permits passage of fluid from the wellbore into the formation, per the claim preamble (assuming it is limiting). *See* Pet. 25–26 (citing Ex. 1005, code (54), ¶¶ 6, 9, 13); Ex. 1002 ¶ 159. In particular, Coli's Figure 2 illustrates a site plan for a fracturing operation, which Coli describes as "hydraulic stimulation of underground hydrocarbon-bearing formations" by "delivering fracturing fluid to a wellbore" in order to "fracture[]" the formation(s) surrounding the wellbore. Ex. 1005, Fig. 2, ¶¶ 9, 13, 38.

Coli also discloses a trailer for attachment to a truck, with four pumps attached to the trailer and fluidly connected to the well to pump fluid into the wellbore. *See* Pet. 26–28 (citing Ex. 1005, Fig. 3, ¶¶ 7, 37–38, 40); Ex. 1002 ¶¶ 160–162. In particular, Coli's Figure 3 illustrates trailer 10 for attachment to a truck, and carrying four pumps 22. *See* Ex. 1005, Fig. 3, ¶¶ 38, 40; *see also id.* ¶ 37 (in describing Figure 1, stating "[e]ach trailer 5 is attached to a truck 6").

Coli further discloses electric motors attached to the pumps to drive the pumps, and also attached to the trailer. *See* Pet. 28–29 (citing Ex. 1005, Figs. 4A–4B, ¶¶ 25, 40, 46, 52); Ex. 1002 ¶¶ 163–164. In particular, Coli describes how each pump 22 is coupled to an electric motor 21 to form a fracturing module 20, which is attached to trailer 10. *See* Ex. 1005, Figs. 3 and 4A, ¶¶ 40, 46.

Coli moreover discloses a VFD connected to the electric motor to control the speed of the motor. *See* Pet. 30 (citing Ex. 1005 ¶¶ 11, 47, 65); Ex. 1002 ¶ 165. In particular, Coli states its “electric motors are controlled by variable frequency drives.” Ex. 1005 ¶¶ 65–66.

(ii) *Comparing Claim 1 with Toshiba Manual*

Petitioner contends Toshiba Manual discloses a VFD for a motor, which “performs electric motor diagnostics to prevent damage to” the motor, as recited in claim 1. *See* Pet. 10–11, 31–32 (citing Ex. 1006, 2, 19, 22, 23, 43, 44, 65, 71, 160–63, 165, 179, 182–86); Ex. 1002 ¶¶ 115–119, 150, 166–168.

Patent Owner objects that, although Toshiba Manual does disclose a VFD for a motor, it does not disclose that the VFD performs *electric motor diagnostics* to prevent damage to the motor. *See* Prelim. Resp. 1, 7–8, 12, 13–24 (citing Ex. 1006, 1, 2, 36, 42, 43, 180–86). In particular, according to Patent Owner, the Toshiba G7 VFD provides “monitoring features includ[ing] alarms and . . . fault codes,” but “none of the fault codes or alarms disclosed in Toshiba satisfy the claimed ‘*electric motor diagnostics*.’” *Id.* at 8 (citing Ex. 1006, 180–86). Patent Owner emphasizes that claim 1 separately recites a VFD and an electric motor, and then

requires electric motor diagnostics to prevent damage to the motor, not VFD diagnostics or other system diagnostics. *See id.* at 13–15. This distinction is supported by the '870 patent specification, according to Patent Owner. *See id.* at 14–15 (citing Ex. 1001, 2:36–39, 5:42–46). Patent Owner then asserts the Toshiba Manual's "VFD faults . . . have no nexus to an '*electric motor*'" because those faults instead "represent errors in the VFD." *Id.* at 15, 16–17.

Patent Owner further asserts that Table 12 of Toshiba Manual, which lists "Fault Screen Display" identifications and "Possible Causes," fails to include "a fault directed toward an '*electric motor*' only" and instead includes "VFD faults" having "possible causes . . . unrelated to the motor." *Id.* at 20–22 (paraphrasing excerpts of Ex. 1006, 182–86, with various emphases added). Patent Owner concludes "[t]he Petition fails to show how any of Toshiba's VFD faults [in Table 12] satisfy performing the claimed '*electric motor diagnostics*,' . . . and the Petition lacks any explanation regarding **how** any of [those] faults satisfy the claimed '*electric motor diagnostic*.'" *Id.* at 22–23.

Patent Owner moreover argues that, even if Toshiba Manual does disclose determining a fault condition of the motor, it does not disclose performing motor "*diagnostics*" as claimed. *Id.* at 17. Patent Owner asserts "[t]he claimed '*diagnostics*,' . . . determine the underlying cause of the problem or error to prevent damage to a motor." *Id.* (citing Ex. 1001, 4:20–23; Ex. 2001, 406). Patent Owner suggests this claim construction distinguishes Toshiba Manual from claim 1, because Toshiba Manual discloses only determining whether "[f]ault conditions" exist, rather than determining the underlying cause of the fault condition. *Id.* In particular, Patent Owner contends Toshiba Manual mentions "diagnostics" only twice,

and neither reference relates the diagnostics to a motor. *Id.* at 17–18 (citing Ex. 1006, 42, 43).

Patent Owner finally addresses the testimony of Dr. Durham that Toshiba Manual discloses the electric motor diagnostics limitation. *See id.* at 23–24 (citing Pet. 31; Ex. 1002 ¶¶ 117, 150, 166). Patent Owner asserts this “expert testimony provides no additional explanation and rehashes the same evidence” as in the Petition, and “merely parrots the Petition,” which is “insufficient” to support obviousness. *Id.* (citing *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 12 at 5 (PTAB Feb. 10, 2023) (precedential)).

We conclude the present preliminary record sufficiently supports Petitioner’s contentions to justify institution of review. As demonstrated by the summary of Toshiba Manual’s overload protection feature in Section III.D.2(i) above, the Toshiba G7 VFD monitors the electric current being delivered to a motor by the VFD, to determine whether that current exceeds a pre-set percentage of the current rating of the motor, in order to protect the motor from overload. *See, e.g.*, Ex. 1006, 19, 22, 47, 58, 160. Therefore, the present record supports Petitioner’s contention that the Toshiba G7 VFD performs electric motor diagnostics to prevent damage to the motor, as recited in claim 1. *See* Pet. 10–11, 22, 31–32 (citing, *e.g.*, Ex. 1006 at pages 19, 22, 160).

Patent Owner’s present opposition relies on an implicit claim construction of the term “electric motor diagnostics” that would require the VFD to interrogate the motor itself in order to perform the diagnostics. This implicit claim construction is not supported by the “electric motor diagnostics” claim language or the supporting specification, which essentially just repeats the claim language. *See* Ex. 1001, 2:36–39, 4:16–25,

7:59–61. Based on the present record, we conclude the Toshiba G7 VFD’s monitoring of the electric current being delivered to a motor in order to protect the motor from overload is the performance of electric motor diagnostics, as claimed.

Patent Owner cites a dictionary definition of “diagnostics” as meaning “a routine for testing a piece of hardware or for locating an error in a program,” to contend claim 1 requires “determin[ing] the underlying cause of the problem or error.” Prelim. Resp. 17 (quoting Ex. 2001, 406). Patent Owner’s claim construction is not supported by the cited dictionary definition, which equates a “diagnostic” to either “testing” or “locating an error.” Ex. 2001, 406. Based on the present record, we conclude Toshiba Manual discloses both of those alternative meanings. The Toshiba G7 VFD’s monitoring of the electric current being delivered to a motor is a testing, per the first alternative. The Toshiba G7 VFD also notifies a user when the monitored current exceeds a pre-set percentage of the current rating of the motor, which is locating an error, per the second alternative. *See* Ex. 1006, 19, 22, 43, 160, 179, 184; *see also* Pet. 10–11, 22, 31 (citing these pages of Ex. 1006 in support of Petitioner’s contention that Toshiba Manual performs electric motor diagnostics); *supra* Section III.D.2(i) (summarizing the pertinent Toshiba Manual disclosures).

We further are not presently persuaded by Patent Owner’s contention that Petitioner fails to show where Toshiba Manual discloses performing “electric motor diagnostics.” *See* Prelim. Resp. 22–23. As discussed above, the Petition cites specific pages of the Toshiba Manual, and explains how those pages disclose the performance of electric motor diagnostics. *See* Pet. 10–11, 22, 31. The corresponding testimony of Dr. Durham is similarly

explained and accompanied by citations to Toshiba Manual. *See* Ex. 1002 ¶¶ 117–119, 150, 166. Thus, the Board’s decision and the Director’s affirmance in *Xerox* does not aid Patent Owner here. *See Xerox*, Paper 9 at 15–16 (Board decision according “little weight” to an expert declaration that “merely repeats, *verbatim*, the conclusory assertion for which it is offered to support” and that “does not cite to any additional supporting evidence,” “particularly . . . where, like here, expert testimony is offered not simply to provide a motivation to combine prior-art teachings, but rather to supply a limitation missing from the prior art”); *Xerox*, Paper 12 at 4–5 (Director affirmance).

Finally, although the foregoing discussion focuses on protecting against an *overcurrent* being supplied to the motor as corresponding to an electric motor diagnostic, Petitioner and its expert Dr. Durham further contend the Toshiba G7 VFD protects against *other* motor parameter faults such as overheat, overtorque, short circuit, and earth faults. Pet. 10–11, 22, 24, 31 (citing Ex. 1006, 19, 22, 43, 160–63, 165, 179, 180, 182–86); Ex. 1002 ¶¶ 117–119, 150, 153, 166. Based on the present record, Toshiba Manual supports these contentions. *See, e.g.*, Ex. 1006, 162 (“Short Circuit Test” and “Short Circuit Test Duration”), 163 (“Overtorque Trip” with associated “Alarm Level[s],” and “Cooling Fan Control”), 179 (stating that a Trip disables the VFD when one or more listed variables exceeds its normal range), 180 (stating that an Alarm may result from “Overheat”), 182–86 (stating that a Trip disables the VFD for “Earth Fault”, “Overheat”, and “Over Speed”). We therefore presently conclude that Toshiba Manual teaches performance of electric motor diagnostics (plural) as recited in claim 1.

For the foregoing reasons, we conclude Petitioner’s contentions seeking to establish that Toshiba Manual discloses a VFD for a motor, which performs electric motor diagnostics to prevent damage to the motor, are sufficiently supported by the evidence to justify institution of review.

(iii) Motivation to Perform Electric Motor Diagnostics in Coli, in light of Toshiba Manual

Petitioner contends and Dr. Durham testifies that a person of ordinary skill in the art “would have been motivated to use the VFD described in Toshiba Manual as the variable frequency drive in Coli, or to enhance the Coli VFD with the features taught by Toshiba Manual.” Pet. 23; Ex. 1002 ¶ 152. In particular, according to Petitioner and Dr. Durham, “Toshiba Manual’s express disclosure of VFD control and monitoring of parameters of the electric motor in Coli, such as current, voltage, speed, temperature, torque, and load” would have motivated “use [of] the diagnostic functionality of Toshiba Manual (e.g., the alarms and fault trips) in order to prevent damage to the electric motor” in Coli. Pet. 24–25 (citing Ex. 1006, 179, 182–85); Ex. 1002 ¶¶ 153, 155–156, 158. Petitioner and Dr. Durham further conclude this could have been achieved with a reasonable expectation of success. See Pet. 24; Ex. 1002 ¶¶ 157–158.

We conclude Petitioner’s contentions as to the motivation for combining Coli and Toshiba Manual to practice the invention of claim 1, which are not presently opposed by Patent Owner, are sufficiently supported by the evidence to justify institution of review.

(iv) *Conclusion as to Claim 1*

Based on the present record, we conclude Petitioner has provided sufficient argument and evidence in relation to the proposed obviousness of claim 1 over Coli and Toshiba Manual, to demonstrate a reasonable likelihood that Petitioner would prevail with respect to this challenge at trial.

4. *Claim 7*

Petitioner provides arguments and evidence in support of its contention that claim 7 is unpatentable as having been obvious over Coli and Toshiba Manual. *See* Pet. 7–8, 11, 21–25, 35–38; Ex. 1002 ¶¶ 105–110, 120–124, 148–158, 180–186. Patent Owner opposes, on the basis that the evidence does not support Petitioner’s contention that the Toshiba G7 VFD has power semiconductor heat sinks having thermal sensors to prevent damage caused by excessive heat. *See* Prelim. Resp. 1–2, 6–9, 12, 15–16, 24–28.

“When instituting *inter partes* review, the Board will authorize the review to proceed on all of the challenged claims and on all grounds of unpatentability asserted for each claim.” 37 C.F.R. § 42.108(a). Thus, pursuant to USPTO rules and policy implementing *SAS Inst., Inc. v. Iancu*, 138 S. Ct. 1348 (2018), we “either (1) institute as to all claims challenged in the petition and on all grounds in the petition, or (2) institute on no claims and deny institution.” Patent Trial and Appeal Board Consolidated Trial Practice Guide (“CTPG”) 5–6, 64 (Nov. 2019).⁵ We “will not institute on fewer than all claims or all challenges in a petition.” *Id.* at 5, 64; *see also* *PGS Geophysical AS v. Iancu*, 891 F.3d 1354, 1359–60 (Fed. Cir. 2018)

⁵ Available at <https://www.uspto.gov/TrialPracticeGuideConsolidated>.

(stating a decision to institute is “a simple yes-or-no institution choice respecting a petition, embracing all challenges included in the petition”).

Thus, because we have decided to grant institution on claim 1, we do the same for claim 7. Nonetheless, we will address Patent Owner’s arguments concerning claim 7 separately from claim 1, to provide guidance to the parties for the upcoming trial. *See* CTPG 6, 64.

Petitioner contends in part that Toshiba Manual discloses a VFD “having one or more power semiconductor heat sinks having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat,” as recited in claim 7. *See* Pet. 11, 23–24, 36–38 (citing Ex. 1006, 2, 14, 42–43, 36, 180, 184–85, 163, 204; Ex. 1048, 23–29; Ex. 1050 ¶ 63; Ex. 1052, 175:10–176:11); Ex. 1002 ¶¶ 120–124, 151, 154–156, 158, 185–186. Petitioner particularly asserts the Toshiba G7 VFD’s “heat sinks have thermal sensors,” on the basis that a person of ordinary skill in the art “would have understood that the heat sink would necessarily have sensors (e.g., thermistors) to report the temperature measurements to the CPU (i.e., microprocessor).” Pet. 11, 37–38 (citing Ex. 1006, 180, 185); Ex. 1002 ¶¶ 120–123, 186. Petitioner adds: “Furthermore, as explained in Dr. Durham’s declaration, heat sinks and temperature monitoring using sensors were well-known long before the ’870 Patent.” Pet. 38 (citing Ex. 1002 ¶¶ 87–95 (citing Exs. 1030–1035); Ex. 1050 ¶ 63; Ex. 1052, 175:10–176:11).

Patent Owner objects that, although the Toshiba G7 VFD does have power semiconductor(s), heat sinks(s), and thermal sensor(s), Toshiba Manual does not disclose that its VFD includes “*a heat sink having thermal sensors*” as recited in claim 7 (emphasis added). *See* Prelim. Resp. 1–2, 8–9,

12, 15–16, 24–28 (citing Ex. 1006, 2, 14, 42–43, 180–86, 204). Patent Owner asserts that the Toshiba G7 VFD “[a]t most . . . includes a heat sink . . . and an internal thermistor,” without “say[ing] that the internal thermistor is *located on* the heat sink as required by” claim 7. *Id.* at 24–25 (emphasis added). In response to Petitioner’s assertions of an inherent disclosure in this regard, Patent Owner argues the evidence of record “show[s] that thermal sensors may be placed in multiple locations internally—not just on the heat sink,” so Dr. Durham’s testimony on behalf of Petitioner “that the heat sinks ‘would necessarily have sensors (e.g., thermistors) to report the temperature measurements’” is unsupported and incorrect. *Id.* at 16, 25–27 (quoting Pet. 37–38; citing Ex. 1002 ¶ 186). Patent Owner particularly cites Loucks as “showing that thermal sensors typically have a variety of internal locations in a system.” *Id.* at 26 (citing Ex. 1009 ¶ 3). Patent Owner finally asserts that “the Petition includes no rationale explaining why a [person of ordinary skill in the art] would have found it obvious to place a thermistor on a heat sink.” *Id.* at 16, 24, 28.

Based on the present record, we agree with Patent Owner’s argument. The Toshiba G7 VFD has a heat sink. *See* Ex. 1006, 14 (“The heat sink and other components may become extremely hot to the touch.”), 204 (“[T]he heat generated by the [Dynamic Braking Resistor] will affect the cooling capacity of the heatsink[.]”). The Toshiba G7 VFD also has an internal thermistor to monitor the temperature of the VFD and thereby prevent overheating. *See id.* at 58 (describing a “Cooling Fan Control”); *id.* at 180, 185 (identifying an “Overheat” control parameter and fault condition that determine when the VFD’s ambient temperature is excessive, as might be caused by the VFD “operating at an elevated temperature” or when an

“[i]nternal thermistor is disconnected”). However, we are unable to discern any express disclosure in the Toshiba Manual pages cited by Petitioner of “*heat sinks having thermal sensors*,” as recited in claim 7 (emphasis added). See Ex. 1006, 2, 14, 42–43, 36, 180, 184–85, 163, 204. Instead, based on the present record, we find that the Toshiba Manual does not specify a particular location within the VFD for the thermal sensors to be located. See *id.*

Petitioner nonetheless asserts “the heat sink would necessarily have sensors (e.g., thermistors).” Pet. 11, 37–38 (citing Ex. 1006, 180, 185); Ex. 1002 ¶¶ 120–123, 186. Thus, Petitioner appears to rely on an inherent disclosure in this regard. See, e.g., *In re Montgomery*, 677 F.3d 1375, 1379–80 (Fed. Cir. 2012) (an inherent disclosure may be found if it “is necessarily present” in the reference). However, inherency “may not be established by probabilities or possibilities,” and the fact that a certain characteristic *may* be, but is not *necessarily*, present in the prior art is not sufficient to establish the inherency of that characteristic. *Id.*; *Cont’l Can Co. USA, Inc. v. Monsanto Co.*, 948 F.2d 1264, 1268–69 (Fed. Cir. 1991).

In this case, Loucks suggests that measuring the temperature of electrical equipment in order to provide a controlled cooling of the equipment may be accomplished by “measuring the temperature of inlet air, exhaust air, heat sinks, or other areas of” the equipment. Ex. 1009 ¶¶ 1–3. Thus, based on the present record, Petitioner’s assertion that Toshiba Manual inherently associates its heat sinks with its thermal sensors is not supported by the evidence.

Further, Dr. Durham’s testimony does not offer any additional explanation that might support a finding of inherency. See Ex. 1002

¶¶ 120–123, 186. He does state that a person of ordinary skill in the art “would understand that the heatsink is the main heat dissipating device in the [VFD] cabinet” so “[a]n overheat condition would, therefore, be based on heatsink temperature as well as ambient temperature.” *Id.* ¶ 123. However, that testimony at best establishes that Toshiba Manual’s heat sink might possibly have an associated thermal sensor, not that it necessarily does. Further, Loucks’s disclosure of various locations for thermal sensors within electronic equipment belies any such necessity.

Petitioner cites the Board’s final written decision in *Halliburton Energy Services, Inc. v. U.S. Well Services, LLC*, IPR2021-01033, Paper 41 at 23–29 (PTAB Jan. 4, 2023), as supporting Petitioner’s case in the present proceeding.⁶ *See* Pet. 36. However, that decision concerned the combination of Coli and Horikoshi (Ground 2 in the present proceeding), not the combination of Coli and Toshiba Manual (Ground 1 in the present proceeding). Thus, it does not relate to Petitioner’s contention here that the Toshiba G7 VFD includes a heat sink having a thermal sensor.

Petitioner also cites expert testimony provided by Mr. Robert Schaaf on behalf of Patent Owner in *U.S. Well Services, LLC v. Tops Well Services, LLC et al.*, Case No. 3:19-cv-00237 (S.D. Tex.), as supporting Petitioner’s case in the present proceeding. *See* Pet. 23–24, 38 (citing Ex. 1050 ¶ 63; Ex. 1052, 175:10–176:11). However, this testimony at best establishes that heat sinks and thermal sensors are familiar components in the industry to prevent damage to a VFD caused by excessive heat; it does not relate to heat

⁶ Petitioner has submitted this decision as Exhibit 1048 in the present proceeding.

sinks having thermal sensors (specifically) as recited in claim 7. *See* Ex. 1050 ¶ 63; Ex. 1052, 175:10–176:11.

Dr. Durham’s testimony at paragraphs 87–95 of his declaration is to a similar, limited effect. *See* Pet. 38 (citing Ex. 1002 ¶¶ 87–95). This testimony most pertinently states that Hilbert (Exhibit 1034) “monitored the internal temperature of the heat sink by use of a . . . thermocouple located inside a hole drilled into the solder interface between the chip and heat sink at the center of the heat sink base . . . to monitor the internal temperature of the heat sink.” Ex. 1002 ¶ 93 (citing Ex. 1034, at 1027). However, Dr. Durham does not proffer any motivation for using a heat sink having thermal sensors in a VFD, as recited in claim 7, to support a case for obviousness in this regard. *See id.*

Thus, we conclude based on the present record that Petitioner’s contentions seeking to establish that the Toshiba G7 VFD includes a heat sink having thermal sensors is not sufficiently supported by the evidence to justify institution of review.

5. *Claims 2–6 and 8–16*

As to dependent claims 2–6 and 8–16, because we have decided to grant institution on claim 1, we do the same for these claims. *See* Section III.D.4 *supra*; 37 C.F.R. § 42.108(a); CTPG 5–6, 64. We note further that Patent Owner does not address claims 2–6 and 8–16 apart from arguments we have already considered above in connection with claim 1 or claim 7, so there is nothing further for us to address with respect to the dependent claims at this time. *See* CTPG 5–6, 64.

E. Ground 2 — Obviousness over Coli and Horikoshi

Petitioner asserts claims 1–6 of the ’870 patent are unpatentable as having been obvious over Coli and Horikoshi. *See* Pet. 7–8, 12–14, 16, 45–51. Patent Owner opposes, on the sole basis that Horikoshi is non-analogous art to the ’870 patent. *See* Prelim. Resp. 2, 9–10, 28–33.

We have reviewed the preliminary record, and we conclude Petitioner has demonstrated a reasonable likelihood of prevailing on its assertions as to at least claim 1. First, we summarize the disclosure of Horikoshi, then we consider the parties’ contentions.

1. Summary of Horikoshi

Horikoshi describes a “motor driving apparatus” that provides an AC power supply to a motor. Ex. 1008, code (54), ¶ 4. This apparatus includes “a fault diagnostic function” that detects an “overcurrent” being supplied to the motor, and then determines whether the overcurrent was caused by a phase-to-phase short circuit or a ground fault. *See id.* at code (57), ¶¶ 11–12. Figure 5 (reproduced below) illustrates such an apparatus.

Fig.5

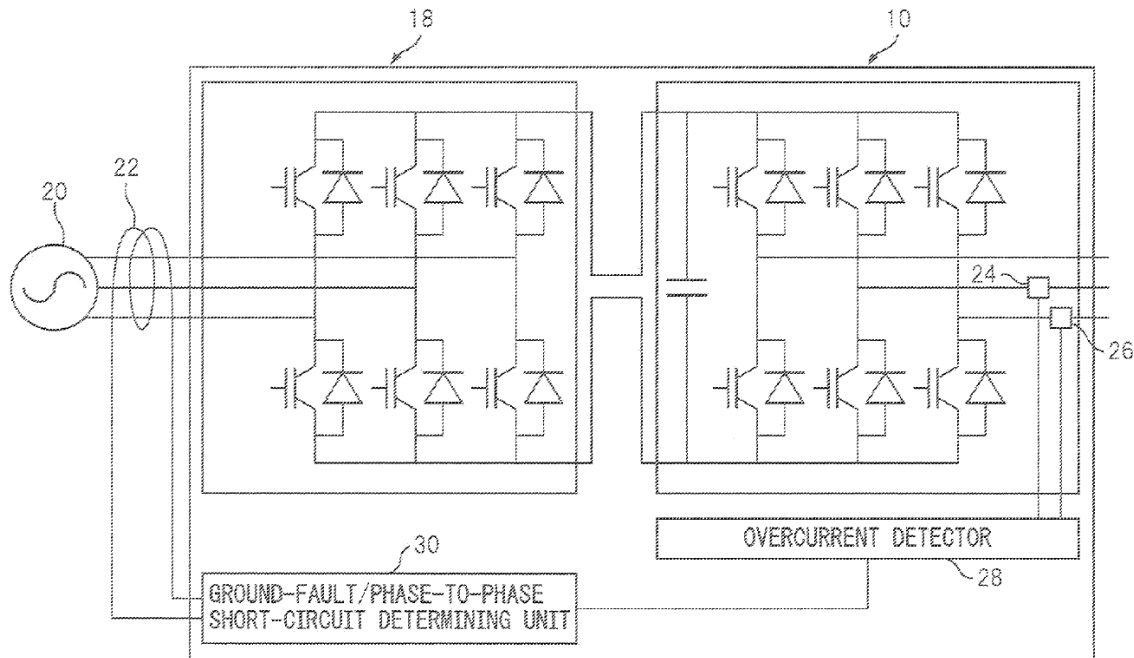


Figure 5 of Horikoshi.

Figure 5 is a diagram showing a motor driving apparatus that receives a three-phase AC power supply 20, converts it to DC power with AC / DC converter 18, and then converts the DC power to a three-phase AC power supply with DC / AC converter 10 to be outputted (at the right in the figure) to a motor (not shown). *See id.* ¶¶ 19, 27. The outputted AC power supply is “frequency variable,” so the illustrated apparatus can be used to vary the motor’s operation. *Id.* ¶ 27.

Overcurrent detector 28 monitors current sensors 24 and 26 on two of the three phases of the AC power supply outputted to the motor, to detect an overcurrent in the outputted power supply. *See id.* ¶ 28.

If an overcurrent is detected, then determining unit 30 determines whether the overcurrent was caused by a phase-to-phase short circuit or a ground fault, by monitoring zero phase current detector 22. Specifically, detector 22 detects the sum of the three-phase AC currents 20 inputted to the

motor driving apparatus. *See id.* If detector 22 detects no current or so small a current as to be judged equal to zero, then unit 30 determines the overcurrent was caused by a phase-to-phase short circuit. *See id.* ¶ 29. If detector 22 detects a larger amount of current, then unit 30 determines the overcurrent was caused by a ground fault. *See id.*

According to Horikoshi, its motor driving apparatus improved upon prior devices by utilizing only two (not three) current detectors at the AC power supply outputted to the motor, while still being able to determine the cause of overcurrent by using current detector 22 at the inputted AC power supply 20. *See id.* ¶¶ 4–7, 11–14.

2. *Whether Horikoshi is Analogous Art to the '870 Patent*

(i) *Legal Standards, including Petitioner's Burden as to Analogous Art*

Patent Owner suggests the Petition is facially deficient for failing to address whether Horikoshi is analogous art to the '870 patent, because this is an issue on which Petitioner bears the burden of persuasion. *See Prelim. Resp.* 28–30.

We agree with Patent Owner's position that Petitioner bears the burden of persuasion to establish that Horikoshi is analogous art. *See Sanofi-Aventis Deutschland GmbH v. Mylan Pharms. Inc.*, 66 F.4th 1373, 1377 (Fed. Cir. 2023)⁷ (“We agree with [the patent owner] that [the petitioner] did not carry its burden to argue that de Gennes is analogous to the [challenged] patent.”); *id.* (“In evaluating whether a reference is analogous, we have consistently held that a patent challenger must compare

⁷ This decision issued on May 9, 2023, thirteen days before the Preliminary Response was filed on May 22, 2023.

the reference to the challenged patent.”); *id.* at 1378–79 (“We have routinely held that the petitioner has the burden of proving unpatentability.”).

However, we disagree with Patent Owner’s position that a petition is facially deficient for failing to address whether the cited prior art references are analogous art to the challenged patent. Instead, the Federal Circuit has stated: “A petitioner is not required to anticipate and raise analogous art arguments in its petition; instead a petitioner can use its reply to ‘respond to arguments raised in the corresponding opposition, patent owner preliminary response, patent owner response, or decision on institution.’” *Sanofi-Aventis*, 66 F.4th at 1379–80 (citing 37 C.F.R. § 42.23).

Therefore, we turn to the merits of the analogous art arguments asserted in the Preliminary Response in relation to Horikoshi. Only “analogous” prior art references may be used to support an obviousness determination. *In re Bigio*, 381 F.3d 1320, 1325 (Fed. Cir. 2004) (citing *In re Clay*, 966 F.2d 656, 658 (Fed. Cir. 1992)). A prior art reference is analogous to a challenged patent if: (1) it is from the same field of endeavor as the challenged patent; or (2) it is reasonably pertinent to the particular problem with which the inventor(s) of the challenged patent were involved. *Id.*; *Sanofi-Aventis*, 66 F.4th at 1377–78.

(ii) *Whether Horikoshi is From the Same Field of Endeavor as the '870 Patent*

Based on the present record, we agree with Patent Owner’s position that the field of endeavor of the ’870 patent is hydraulic fracturing operations in oil and gas wells. *See* Prelim. Resp. 31 (citing Ex. 1001, 1:23–26). In particular, the ’870 patent describes its “Field” as “hydraulic fracturing in oil and gas wells.” Ex. 1001, 1:21–26.

We likewise presently agree with Patent Owner’s position that “Horikoshi is drawn to the field of endeavor of ‘a motor driving apparatus having a fault diagnostic function.’” Prelim. Resp. 31 (quoting Ex. 1008 ¶ 2). Thus, we conclude the first prong of the *Bigio* test is not satisfied, based on the present record.

(iii) *Whether Horikoshi is Reasonably Pertinent to a Particular Problem Facing the Inventors of the ’870 Patent*

Patent Owner argues Horikoshi is not reasonably pertinent to a particular problem facing the inventors of the ’870 patent. *See* Prelim. Resp. 31–33. According to Patent Owner, “[t]he specification and claims of the ’870 patent are drawn to ‘the problems associated with diesel pumps,’ which are addressed by using a ‘pump system for hydraulic fracturing fluid’ that includes a variable frequency drive and electric motor.” *Id.* at 31–32 (citing Ex. 1001, 1:23–26, 1:44–54). Patent Owner argues Horikoshi addresses the different “problem of detecting, during the operation of an electric motor, a ground fault and phase-to-phase short circuit and distinguishing between these faults,” which is not reasonably pertinent to the “diesel pumps” problem addressed by the ’870 patent. *Id.* at 32 (citing Ex. 1008 ¶ 2). Patent Owner particularly contends “ASDs [i.e., VFDs] and electric motors have broad applications in various industries outside fracturing operations or the petrochemical industry,” and “given the harsh environment” and power requirements posed by well fracturing operations, “an inventor would have . . . looked to electric motor references specific to fracturing operations” rather than generic electric motor references such as Horikoshi. *Id.* at 33 (citing Ex. 1001, 3:51–4:7).

Patent Owner also asserts “the Petition fails to identify any problem addressed by the ’870 patent addressed by Horikoshi.” *Id.* at 31 (citing Pet. 12–14, 45–51). Patent Owner acknowledges the Petition’s statement that “Horikoshi is in a field of art—variable frequency drives—that is highly relevant to the ’870 Patent, which describes the use of variable frequency drives to control electric-motor driven pumps.” Pet. 13–14 (citing Ex. 1002 ¶¶ 126–129); *see* Prelim. Resp. 30. Patent Owner dismisses that statement, however, on the basis that it does not specify a problem reasonably pertinent to the diesel pumps problem addressed by the ’870 patent. *See* Prelim. Resp. 30–31.

Based on the present record, we conclude Horikoshi is reasonably pertinent to a particular problem facing the inventors of the ’870 patent. The overall problem faced by the inventors of the ’870 patent was how to implement a hydraulic fracturing operation using electric motors to drive the fracturing fluid pumps, rather than diesel pumps. *See* Ex. 1001, 1:24–26 (“[T]his technology relates to pumping fracturing fluid into an oil or gas well using pumps powered by electric motors.”), 1:52–54 (“What is needed therefore, is a pump system for hydraulic fracturing fluid that overcomes the problems associated with diesel pumps.”). One particular aspect of that problem was how to use a VFD to drive the electric motors. *See id.* at 2:5–7 (“In one embodiment, the system further includes an A/C console and a variable frequency drive that controls the speed of the pumps.”), 2:21–22, 4:8–25; *see also* *Donner Tech. v. Pro Stage Gear, LLC*, 979 F.3d 1353, 1361 (Fed. Cir. 2020) (stating that if a prior art reference and a challenged patent “have ‘pertinent similarities’ such that [the prior art reference] is reasonably

pertinent to *one or more* of the problems to which the [challenged] patent pertains, then [the reference] is analogous art” (emphasis added)).

Horikoshi is reasonably pertinent to those problems facing the inventors of the ’870 patent, because it provides a motor driving apparatus to supply electrical power to an electric motor. *See* Ex. 1008 ¶¶ 2–4.

Dr. Durham testifies, and Patent Owner does not presently dispute, that a person of ordinary skill in the art would have known that Horikoshi’s motor driving apparatus is a “variable frequency drive” as that term is used in the ’870 patent. *See* Ex. 1002 ¶¶ 126–128, 207–208.

Patent Owner’s opposition, based on the present record, unpersuasively defines the problems addressed by the ’870 patent “so narrowly as to collapse [the two separate analogous art] inquiries and only consider art within the inventor’s field of endeavor,” by limiting the problems to the field of hydraulic well fracturing. *Sanofi-Aventis*, 66 F.4th at 1377 (citing *Donner*, 979 F.3d at 1360; *In re ICON Health & Fitness, Inc.*, 496 F.3d 1374, 1378 (Fed. Cir. 2007)). Moreover, Patent Owner’s suggestion that a person of ordinary skill in the art would not have considered electric motors and associated VFDs to be suitable for hydraulic well fracturing operations is presently unsupported by expert witness testimony, and is belied by Coli’s disclosure of using electric motors and associated VFDs in hydraulic well fracturing operations. *See* Section III.D.1 *supra* (summarizing Coli’s disclosures).

Thus, we conclude Horikoshi is analogous art to the ’870 patent by virtue of the second prong of the *Bigio* test, based on the present record.

(iv) *Conclusion*

We conclude Horikoshi is analogous art to the '870 patent, because it is reasonably pertinent to a particular problem with which the inventors of the '870 patent were involved.

3. *Claim 1*

Petitioner provides arguments and evidence in support of its contention that claim 1 is unpatentable as having been obvious over Coli and Horikoshi. *See* Pet. 7–8, 12–14, 45–50; Ex. 1002 ¶¶ 105–110, 125–129, 205–228. Patent Owner's sole opposition is that Horikoshi is non-analogous art to the '870 patent, which as discussed in Section III.E.2 above is not persuasive based on the present record.

We further determine, for the following reasons, that Petitioner has demonstrated a reasonable likelihood of prevailing on its assertion that claim 1 is unpatentable as having been obvious over Coli and Horikoshi.

(i) *Comparing Claim 1 with Coli*

The pertinent disclosures of Coli as they compare with the subject matter of claim 1 are discussed in Section III.D.3(i) above in relation to Ground 1 and claim 1. *See* Pet. 45 (for Ground 2, referring back to Ground 1 for the disclosures of Coli pertinent to claim 1). In particular, based on the present record, Coli discloses the subject matter of claim 1, except that Coli's VFD is not disclosed as “perform[ing] electric motor diagnostics to prevent damage to” the electric motor, as claimed.

(ii) *Comparing Claim 1 with Horikoshi*

Petitioner contends Horikoshi discloses a VFD for a motor, which “performs electric motor diagnostics to prevent damage to” the motor, as recited in claim 1. *See* Pet. 12–14, 45, 46, 48–50 (citing Ex. 1008, Fig. 5, ¶¶ 2, 4, 6, 8, 10–12, 27); Ex. 1002 ¶¶ 126–129, 206–214, 222–227. We conclude this contention, which Patent Owner does not oppose at the present time, is sufficiently supported by the evidence of record to justify review. Specifically, Horikoshi discloses a motor driving apparatus (i.e., a VFD) that provides an AC power supply to a motor, and also detects an overcurrent being supplied to the motor in order to determine whether the overcurrent was caused by a phase-to-phase short circuit or a ground fault. *See* Ex. 1008, Fig. 5, ¶¶ 2, 11–12, 27–28; Ex. 1002 ¶¶ 126–129, 207–208, 223–226. This appears to match the description in the ’870 patent specification that its VFD “perform[s] electric motor diagnostics to prevent damage to the electric motor *if it becomes grounded or shorted.*” Ex. 1001, 2:36–39 (emphasis added).

(iii) *Motivation to Perform Electric Motor Diagnostics in Coli, in light of Horikoshi*

Petitioner asserts “Coli explains that because ‘electric motors are controlled by variable frequency drives . . . the control software and variable frequency drives [‘VFD’] calculate a maximum current available to the motors.” Pet. 45–46, 48 (citing Ex. 1005 ¶¶ 40, 65); Ex. 1002 ¶ 210. Petitioner then contends and Dr. Durham testifies that a person of ordinary skill in the art would have been motivated to perform electric motor diagnostics in Coli, by monitoring the electric current supplied to the motor by the VFD to determine whether it exceeds Coli’s identified maximum

current and, if so, then determine whether the overcurrent is associated with a phase-to-phase short circuit or a ground fault, per Horikoshi. *See* Pet. 46 (citing Ex. 1008 ¶ 4); Ex. 1002 ¶¶ 207, 211–214. According to Petitioner, this would have been done in order to protect the motor from damage, as disclosed by Horikoshi. *See* Pet. 46–50 (citing Ex. 1008 ¶¶ 2, 8, 4, 6, 10–11; Ex. 1001, 2:36–39); Ex. 1002 ¶¶ 211–212, 214, 218–219. Petitioner and Dr. Durham further conclude this could have been achieved with a reasonable expectation of success. *See* Pet. 47; Ex. 1002 ¶¶ 218–221.

We conclude Petitioner’s contentions as to the motivation for combining Coli and Horikoshi to practice the invention of claim 1, which are not presently opposed by Patent Owner, are sufficiently supported by the evidence to justify institution of review.

(iv) Conclusion as to Claim 1

Based on the present record, we conclude Petitioner has provided sufficient argument and evidence in relation to the proposed obviousness of claim 1 over Coli and Horikoshi, to demonstrate a reasonable likelihood that Petitioner would prevail with respect to this challenge at trial.

4. Claims 2–6

As to dependent claims 2–6, because we have decided to grant institution on claim 1, we do the same for these claims. *See* Section III.D.4 *supra*; 37 C.F.R. § 42.108(a); CTPG 5–6, 64. We note further that Patent Owner does not address claims 2–6 apart from arguments we have already considered above in connection with claim 1, so there is nothing further for us to address with respect to the dependent claims at this time. *See* CTPG 5–6, 64.

F. Ground 3 — Obviousness over Coli and Loucks

Petitioner asserts claims 7–16 of the '870 patent are unpatentable as having been obvious over Coli and Loucks. *See* Pet. 7–8, 14–15, 16, 51–57. Patent Owner opposes, on the sole basis that Loucks is non-analogous art to the '870 patent. *See* Prelim. Resp. 2, 10–11, 28–31, 34–35.

We have reviewed the preliminary record, and we conclude Petitioner has demonstrated a reasonable likelihood of prevailing on its assertions as to at least claim 7. First we summarize the disclosure of Loucks, then we consider the parties' contentions.

1. Summary of Loucks

Loucks describes systems and methods for cooling electrical equipment. *See* Ex. 1009, code (54), ¶¶ 1–3, 5. Loucks illustrates its methods by focusing on cooling IT equipment 115 such as servers, routers, switches, and circuit protection devices, located in data center 100. *See id.* at Fig. 1, ¶¶ 25–26. However, Loucks indicates its methods may be applied to other electrical equipment, including variable frequency drives. *See id.* ¶¶ 36, 60.

Figure 5 of Loucks is reproduced below.

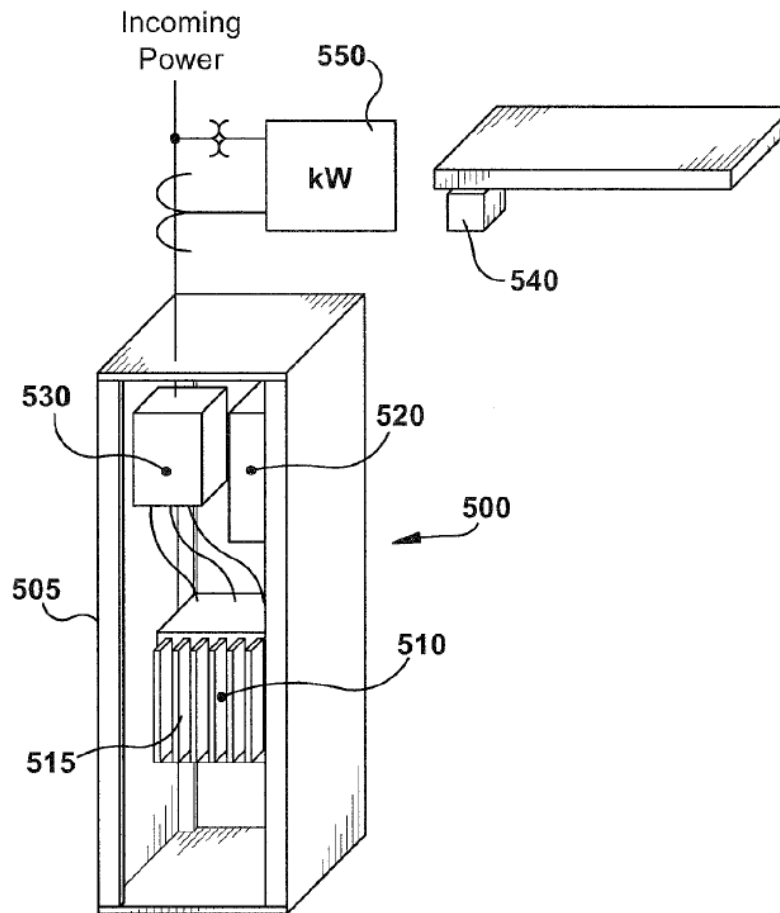


Fig. 5

Figure 5 of Loucks.

Figure 5 illustrates cooling efficiency monitoring system 500 including multiple temperature sensors. *See id.* ¶ 63. These sensors include power electronics heat sink temperature sensor 510, microprocessor temperature sensor 520, and breaker trip unit temperature sensor 530, all installed within enclosure 505. *See id.* They also include ambient temperature sensor 540, installed outside of enclosure 505. *See id.* Loucks uses data from all of these sensors to calculate a cooling efficiency indicator in relation to a forced air cooling system, to detect problems with the cooling system before temperatures reach alarm limits. *See id.* ¶¶ 2–3, 18.

2. *Whether Loucks is Analogous Art to the '870 Patent*

Patent Owner suggests the Petition is facially deficient for failing to address whether Loucks is analogous art to the '870 patent. *See* Prelim. Resp. 28–30. As discussed in Section III.E.2(i) above, we are not persuaded by this argument, based on the present record. Therefore, we turn to the merits of the analogous art arguments asserted in the Preliminary Response in relation to Loucks.

(i) *Whether Loucks is From the Same Field of Endeavor as the '870 Patent*

Based on the present record, we agree with Patent Owner's position that the field of endeavor of the '870 patent is hydraulic fracturing operations in oil and gas wells. *See* Prelim. Resp. 34; Section III.E.2(ii) *supra*.

Patent Owner also argues that “Loucks is drawn to the field of endeavor of measuring changes in cooling performance for server IT equipment.” Prelim. Resp. 34 (citing Ex. 1009, Fig. 1, code (57)). Based on the present record, we disagree, because Loucks is directed more generally to the field of cooling electrical equipment (not just IT equipment), including variable frequency drives. *See* Ex. 1009 ¶¶ 1–3, 36, 60. Nonetheless, this is not the same field of endeavor as the '870 patent, so we conclude the first prong of the *Bigio* test is not satisfied, based on the present record.

(ii) *Whether Loucks is Reasonably Pertinent to a Particular Problem Facing the Inventors of the '870 Patent*

Patent Owner argues Loucks is not reasonably pertinent to a particular problem facing the inventors of the '870 patent. *See* Prelim. Resp. 34–35. According to Patent Owner, “[t]he specification and claims of the '870 patent are drawn to ‘the problems associated with diesel pumps,’ which are addressed by using a ‘pump system for hydraulic fracturing fluid’ that includes a variable frequency drive and electric motor.” *Id.* at 34 (citing Ex. 1001, 1:23–26, 1:44–54). Patent Owner argues Loucks addresses the different “problem of detecting cooling problems in server rooms and/or data centers,” which is not reasonably pertinent to the “diesels pumps” problem addressed by the '870 patent. *Id.* at 34–35 (citing Ex. 1009 ¶¶ 18, 24, 26).

Based on the present record, we conclude Loucks is reasonably pertinent to a particular problem facing the inventors of the '870 patent. As discussed in Section III.E.2(iii) above, the overall problem faced by the inventors of the '870 patent was how to implement a hydraulic fracturing operation using electric motors to drive the fracturing fluid pumps rather than diesel pumps, and one particular aspect of that problem was how to use a VFD to drive the electric motors. *See* Ex. 1001, 1:24–26, 1:52–54, 2:5–7, 2:21–22, 4:8–25. Loucks is reasonably pertinent to those problems, because it discusses the need to cool VFDs and provide methods for doing so. *See* Section III.F.1 *supra* (summarizing Loucks’s disclosures).

Patent Owner’s opposition, based on the present record, unpersuasively defines the problems addressed by the '870 patent “so narrowly as to collapse [the two separate analogous art] inquiries and only

consider art within the inventor’s field of endeavor,” by limiting the problems to the field of hydraulic well fracturing. *Sanofi-Aventis*, 66 F.4th at 1377. Specifically, Patent Owner’s argument would limit Loucks’s applicability to “server IT equipment,” as being not pertinent to the “diesel pumps” and “fracturing operations” addressed by the ’870 patent. Prelim. Resp. 34–35.

Thus, we conclude Loucks is analogous art to the ’870 patent by virtue of the second prong of the *Bigio* test, based on the present record.

(iii) *Conclusion*

We conclude Loucks is analogous art to the ’870 patent, because it is reasonably pertinent to a particular problem with which the inventors of the ’870 patent were involved.

3. *Claim 7*

Petitioner provides arguments and evidence in support of its contention that claim 7 is unpatentable as having been obvious over Coli and Loucks. *See* Pet. 7–8, 14–15, 51–57; Ex. 1002 ¶¶ 105–110, 130–133, 230–242. Patent Owner’s sole opposition is that Loucks is non-analogous art to the ’870 patent, which as discussed in Section III.F.2 is not persuasive based on the present record.

We further determine, for the following reasons, that Petitioner has demonstrated a reasonable likelihood of prevailing on its assertion that claim 7 is unpatentable as having been obvious over Coli and Loucks.

(i) Comparing Claim 7 with Coli

The pertinent disclosures of Coli as they compare with the subject matter of claim 7 are discussed in Section III.D.3(i) above in relation to Ground 1 and claim 1. *See, e.g.*, Pet. 51 (for Ground 3, referring back to Ground 1 for the disclosures of Coli pertinent to claim 7). In particular, based on the present record, Coli discloses the subject matter of claim 7, except that Coli’s VFD does not have “one or more power semiconductor heat sinks having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat,” as claimed.

(ii) Comparing Claim 7 with Loucks

Petitioner contends Loucks discloses “one or more power semiconductor heat sinks having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat,” as recited in claim 7, in order to improve cooling efficiency and to protect the monitored electrical equipment from malfunctions that result from overheating. *See* Pet. 14–15, 51–53, 56–57 (citing Ex. 1009, code (57), ¶¶ 3, 5, 8, 18, 36, 57, 60, 63, 66–70, 72); Ex. 1002 ¶¶ 131–133, 231, 234–236, 239–242. We conclude this contention, which Patent Owner does not oppose at the present time, is sufficiently supported by the evidence of record to justify review.

Specifically, Loucks discloses systems and methods for calculating a “cooling efficiency indicator” (Ex. 1009, code (57), ¶¶ 5, 66–69) as applied to an air cooling of electrical equipment such as VFDs (*see id.* ¶¶ 18, 36, 60), and then using the calculated indicator to improve cooling efficiency and to protect the monitored electrical equipment from malfunctions that result from overheating (*see id.* ¶¶ 18, 60). Loucks’s cooling efficiency

indicator is calculated in part by using data from several temperature sensors that monitor different portions of the electrical equipment, including the “inlet air, exhaust air, heat sinks, or other areas of equipment.” *Id.* ¶¶ 3, 8, 63. One such sensor is a “power electronics heat sink temperature sensor 510,” which appears to correspond to the claimed “one or more power semiconductor heat sinks having thermal sensors.” *Id.* at Fig. 5, ¶ 63.

(iii) *Motivation to Employ Power Semiconductor Heat Sinks Having Thermal Sensors in Coli, in light of Loucks*

Petitioner contends and Dr. Durham testifies that a person of ordinary skill in the art would have been motivated to add power semiconductor heat sinks and associated thermal sensors to Coli’s VFD, in light of Loucks, in order to prevent damage to the VFD caused by excessive heat. *See* Pet. 51–55 (citing Ex. 1009 ¶¶ 8, 18, 36, 60, 63, 66, 68–70, 72); Ex. 1002 ¶¶ 235–237. Petitioner and Dr. Durham further conclude this could have been achieved with a reasonable expectation of success. *See* Pet. 51, 54; Ex. 1002 ¶ 238.

We conclude Petitioner’s contentions as to the motivation for combining Coli and Loucks to practice the invention of claim 7, which are not presently opposed by Patent Owner, are sufficiently supported by the evidence to justify institution of review.

(iv) *Conclusion as to Claim 7*

Based on the present record, we conclude Petitioner has provided sufficient argument and evidence in relation to the proposed obviousness of claim 7 over Coli and Loucks, to demonstrate a reasonable likelihood that Petitioner would prevail with respect to this challenge at trial.

4. *Claims 8–16*

As to dependent claims 8–16, because we have decided to grant institution on claim 7, we do the same for these claims. *See* Section III.D.4 *supra*; 37 C.F.R. § 42.108(a); CTPG 5–6, 64. We note further that Patent Owner does not address claims 8–16 apart from arguments we have already considered above in connection with claim 7, so there is nothing further for us to address with respect to the dependent claims at this time. *See* CTPG 5–6, 64.

G. *Grounds 4A, 4B, 5A and 5B*

As to the remaining Grounds 4A, 4B, 5A, and 5B, because we have decided to grant institution as to Ground 1, we do the same for the remaining Grounds. *See* Section III.D.4 *supra*; 37 C.F.R. § 42.108(a); CTPG 5–6, 64. We note further that Patent Owner does not address the remaining Grounds separately from Grounds 1–3 considered above, so there is nothing further for us to address with respect to the remaining Grounds. *See* CTPG 5–6, 64.

IV. CONCLUSION

For the above reasons, we determine the information presented in the record establishes there is a reasonable likelihood that Petitioner would prevail with respect to at least one claim of the '870 patent challenged in the Petition. We, therefore, institute an *inter partes* review of all challenged claims 1–16 on all grounds presented in the Petition. *See* 35 U.S.C. § 314(a); 37 C.F.R. § 42.108(a).

At this preliminary stage, the Board has not made a final determination with respect to the patentability of the challenged claims or any underlying factual or legal issue. The Board's final determination will

be based on the record as developed during the *inter partes* review. Any arguments not raised by Patent Owner in a timely-filed response may be deemed waived.

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review is instituted for claims 1–16 of the '870 patent on all grounds presented in the Petition; and

FURTHER ORDERED that pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is hereby given of the institution of a trial, which commences on the entry date of this decision.

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