

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*.

JUDGMENT
Final Written Decision
Determining Some Challenged Claims Unpatentable
35 U.S.C. § 318(a)

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I. INTRODUCTION

Halliburton Energy Services, Inc. (“Petitioner”) 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. We issued an Institution Decision (Paper 7, “Inst. Dec.”) instituting the petitioned review.

U.S. Well Services, LLC (“Patent Owner”) then filed a Patent Owner Response (Paper 11, “PO Resp.”) to the Petition. Petitioner filed a Reply (Paper 14, “Pet. Reply”) to the Patent Owner Response. Patent Owner filed a Sur-reply (Paper 15, “PO Sur-reply”) to the Reply.

An oral hearing was held on June 27, 2024. A transcript of the hearing is in the record (Paper 26, “Tr.”).

We have jurisdiction under 35 U.S.C. § 6(b)(4) and § 318(a). This Decision is a final written decision under 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73 as to the patentability of claims 1–16 of the ’870 patent. We determine Petitioner has shown claims 1–12 and 14 are unpatentable, but has not shown claims 13, 15, and 16 are unpatentable.

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 20, 1.

The parties identify *Halliburton Energy Services, Inc., et al. v. U.S. Well Services, LLC*, Case No. 6:22-cv-00906-ADA (W.D. Tex.) as involving the '870 patent. *See* Pet. 1; Paper 20, 1. That litigation has been stayed as requested by both parties, pending final resolution of this proceeding (IPR2023-00558) and two other proceedings (PGR2023-00023 and IPR2023-01319). *See* Dkt. No. 109.

Petitioner has also filed several other IPR proceedings challenging Patent Owner's patents. *See* Pet. 1–2; Paper 20, 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

Proceeding No.	U.S. Patent No.
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	10,934,824 B2
IPR2023-00557	9,650,871 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. The Board's decision in the 1033 case has been filed as Exhibit 1048 here (“the Board's '601 Patent Decision”). The parties dispute whether and how the Board's '601 Patent Decision relates to issues presented here, as discussed further below.

B. The '870 Patent Specification

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.

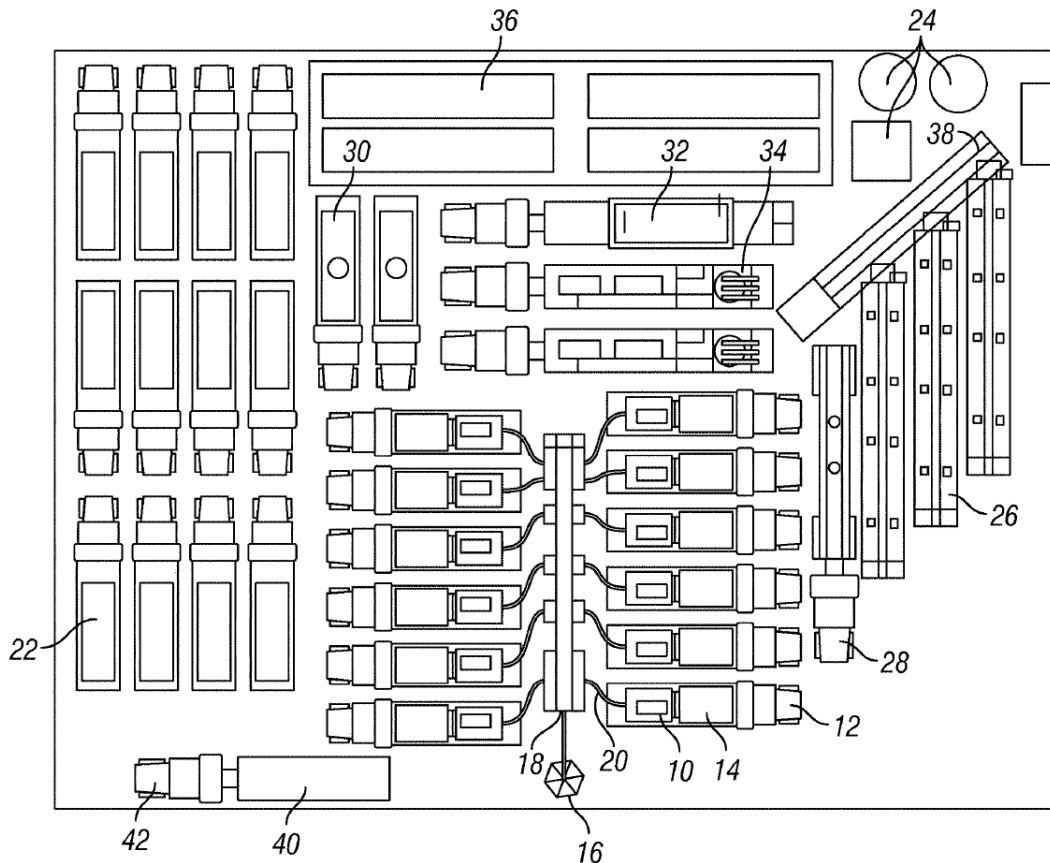


FIG. 1
Figure 1 of the '870 Patent.

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, 3:59–62, 4:8–10, 5:39–42. The VFD “can frequently 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 '870 Patent Claims

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. Claim 1 illustratively recites, with our emphasis added:

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 (emphasis added).

Independent 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.

Independent 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 (emphasis added).

Claim 13 depends from claim 7, and adds that an electric power generator, the pump, and the electric motor “are mounted on . . . a truck having at least five axles” to be ported from one well to another. *Id.* at 8:40–51.

Claim 15 depends from claim 7, and adds that “the electric motor has a maximum continuous power output of about 1750 brake horsepower or more.” *Id.* at 8:55–57.

Claim 16 depends from claim 7, and adds that “the electric motor has a maximum continuous torque of about 8750 lb-ft or more.” *Id.* at 8:58–59.

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	US 2011/0197988 A1	1010

E. Asserted Grounds

Petitioner asserts the following seven grounds of unpatentability. *See* Pet. 16.

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

¹ 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). Amendments to 35 U.S.C. § 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); PO Resp. 1 (effective filing date). Based on this common approach by the parties, we apply pre-AIA law here.

5A	14, 15	103(a)	Coli, Toshiba Manual, Gardner
5B	14, 15	103(a)	Coli, Loucks, Gardner

F. Testimonial Evidence

Petitioner relies on the expert witness testimony of Robert Durham, Ph.D. (Exhibits 1002 and 2003). Patent Owner relies on the expert witness testimony of Michael Nikolaou, Ph.D. (Exhibits 1054 and 2002).

III. PETITIONER’S GROUNDS OF UNPATENTABILITY

A. Statement of Law

1. Petitioner’s Burden of Proof

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is 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). The petitioner must prove unpatentability by a preponderance of the evidence. *See* 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d).

2. Law of Obviousness

A patent claim is unpatentable under 35 U.S.C. § 103(a) 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 same definition of a [person of ordinary skill in the art] proposed by the Petitioner.” PO Resp. 10 (citing Pet. 20).

We are satisfied that Petitioner’s undisputed 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.*

We address the construction of various claim terms below. We consider a VFD performing “electric motor diagnostics to prevent damage to the one or more electric motors” (claims 1 and 4) in Sections III.D.3(i) and III.E.2(i) below. We consider a VFD “having one or more . . . heat sinks having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat” (claim 7) in Section III.D.6(i) below. We consider “a truck having at least five axles” (claim 13) in Section III.D.7(i) below. We consider “continuous” (claims 15 and 16) in Section III.D.7(ii) below.

Apart from the foregoing limitations, and based on the arguments and evidence presented in the record before us, we determine no explicit construction of any claim term is needed to resolve the parties’ controversy. *See 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)).

D. Ground One — 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, and Petitioner's motivations for the combination as to:

(1) a VFD performing electric motor diagnostics per claims 1 and 4; and
(2) a VFD heat sink having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat per claim 7. *See* PO Resp. 1, 4–7, 12–18, 21–27, 37–44. Patent Owner also argues for the patentability of dependent claims 13, 15, and 16 separately from their common parent claim 7. *See id.* at 45–53. We conclude a preponderance of the evidence supports Petitioner's assertions as to claims 1–6, but not as to claims 7–16, for the following reasons.

1. Summary of Coli

Coli discloses a mobile hydraulic fracturing system that is electrically powered. *See* Ex. 1005, codes (54) and (57), ¶¶ 2–3. Figure 2 (reproduced below) illustrates such a system.

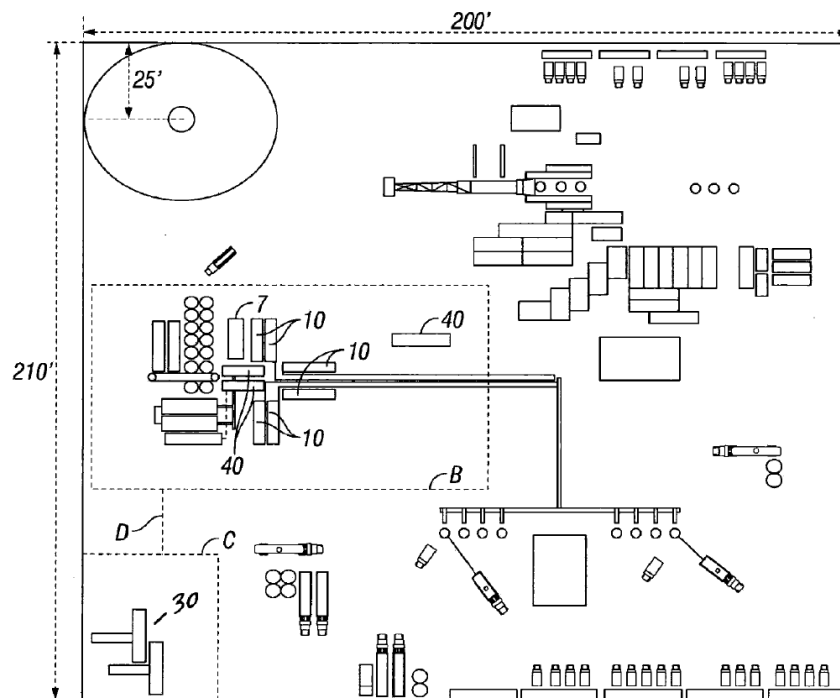


FIG. 2
Figure 2 of Coli.

Figure 2 is a schematic 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.

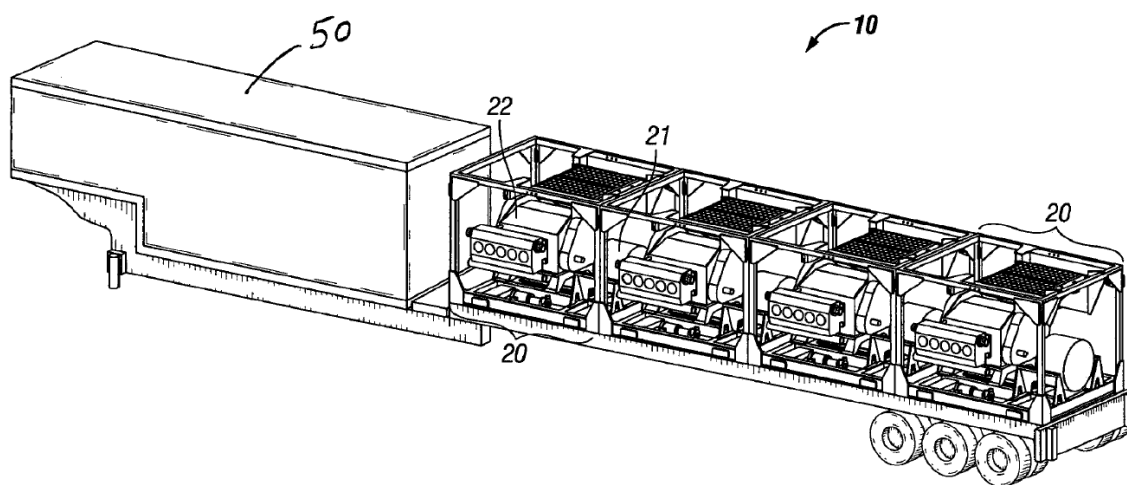


FIG. 3
Figure 3 of Coli.

Figure 3 is a schematic perspective view of trailer 10 housing four fracturing modules 20, each including an electric motor 21 coupled to a fluid pump 22. *See id.* ¶¶ 24, 40. “[A]n electrical transformer and drive unit 50 . . . step[s] down the voltage of the power from turbine generator 30 to a voltage appropriate for electric motor 21.” *Id.* ¶ 47.

A control system regulates each fracturing module 20. *See 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). *See* Ex. 1006, 1–2.² Dr. Durham and Dr. Nikolaou both testify that Toshiba Manual’s ASD is a variable frequency drive (VFD) as recited in claim 1 and as disclosed in Coli. *See* Ex. 1002 ¶¶ 56–58, 115–116, 150–151; Ex. 2002 ¶ 41.

Two aspects of the Toshiba Manual disclosure are at issue here — its current overload protection (pertinent to claims 1 and 4) and its overheat protection (pertinent to claim 7).

(i) *Toshiba Manual’s Current Overload Protection*

Toshiba Manual lists several “variable speed AC motor control concepts with which the user of [Toshiba Manual’s VFD] should become familiar,” including an “Overload Protection Adjustment.” Ex. 1006, 19. Pursuant to this adjustment, Toshiba Manual’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”).

² When citing to Toshiba Manual, 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; PO Resp. 6–7.

The default overload current “is set to the maximum rated current of [Toshiba Manual’s 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 [Toshiba Manual’s 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 FLA³ of the motor.” *Id.* at 160.

Toshiba Manual also describes enabling various protection parameters, including “Overload.” *Id.* at 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 182–184 (Table 12 lists possible Faults that may cause a Trip, including “Motor Overload” and “Output Current Protection Fault”).

³ A motor’s “FLA” is its “full-load amperage” which “may be found on the nameplate of the motor.” Ex. 1006, 47.

(ii) *Toshiba Manual's Overheat Protection*

Toshiba Manual's VFD includes a "heat sink and other components [that] may become extremely hot to the touch." Ex. 1006, 14, 204. Further, as one of its protection parameters, Toshiba Manual's VFD has a "Cooling Fan Control," and displays an alarm code if an "Overheat" condition is observed. *Id.* at 58, 163, 180. This condition occurs when the VFD's "ambient 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 contending 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, 147–168. Patent Owner opposes. *See* PO Resp. 1, 4–7, 21–27, 37–44; Ex. 2002 ¶¶ 41–45, 50–60, 76–89.

We first address the meaning of "electric motor diagnostics to prevent damage to the one or more electric motors" in claim 1. Then we discuss Petitioner's reliance on Coli, which is not opposed by Patent Owner. Next, we 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, and Patent Owner's opposition thereto. We ultimately conclude a preponderance of the evidence supports Petitioner's assertions.

(i) *Claim Construction* — “*electric motor diagnostics to prevent damage to the one or more electric motors*”

Claim 1 requires a VFD that “performs electric motor diagnostics to prevent damage to the one or more electric motors.” Ex. 1001, 7:58–61.

In the Petition, Petitioner does not address this limitation in the claim construction section. *See* Pet. 20–21. Then, in a footnote in the prior art analysis section, Petitioner asserts the “‘to prevent damage to the one or more electric motors’ element is non-limiting.” *Id.* at 30 n.5 (citing *Bristol-Myers Squibb Co. v. Ben Venue Labs., Inc.*, 246 F.3d 1368, 1376 (Fed. Cir. 2001)). Petitioner nonetheless contends Toshiba Manual discloses that element, even if it is limiting. *See id.* at 30–32.

In the Institution Decision, we concluded Toshiba Manual’s VFD performs electric motor diagnostics to prevent damage to an electric motor because it “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.” Inst. Dec. 19 (line 10) – 20 (line 20). We were not persuaded by arguments made in the Patent Owner Preliminary Response, including what we understood to be an “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.” *Id.*

The Patent Owner Response clarifies “Patent Owner does not contend that ‘electric motor diagnostics’ necessarily requires the VFD to interrogate the motor itself.” PO Resp. 10–11. Instead, Patent Owner’s position is that “the phrase ‘electric motor diagnostics’ means ‘diagnostics for an electric motor alone,’” and “Patent Owner disputes that ‘electric motor diagnostics’

can encompass ‘diagnostics’ of anything other than the ‘electric motor.’” *Id.* at 11 (citing Ex. 2002 ¶ 38). Patent Owner relies on the plain language of the claim, and on the testimony of both expert witnesses. *See* PO Resp. 11–12 (citing Ex. 2003, 35:10–15; Ex. 2002 ¶ 39). As one example, Patent Owner asserts “the intrinsic evidence distinguishes VFD faults from electric motor diagnostics.” *Id.* at 40–41 (citing Ex. 1001, 2:36–39, 5:42–46; Ex. 2002 ¶¶ 51–55, 58; Ex. 2003, 29:7–18, 34:2–6).

Petitioner replies that Patent Owner proposes “an improperly narrow construction,” and Petitioner objects to any claim construction requiring “that the electric motor is the **sole** target of the diagnostics to the **exclusion** of other components.” Pet. Reply 1, 2. Petitioner asserts such a construction is unsupported by the claim language which “does not require ‘electric motor diagnostics’ to identify problems only with the electric motor,” and is inconsistent with the ’870 patent specification which “simply states that the VFD can frequently perform electric motor diagnostics to prevent damage to the electric motor if it becomes grounded or shorted.” *Id.* (citing Ex. 1001, 2:36–39, 4:20–23). Petitioner argues Patent Owner mischaracterizes Dr. Durham’s testimony on this point as supporting Patent Owner’s view, and Dr. Durham actually agrees with Petitioner’s view. *See id.* at 1, 3–4 (citing PO Resp. 11; Ex. 2003, 34:8–35:22). Further according to Petitioner, Patent Owner’s claim construction is contradicted by the Board’s ’601 Patent Decision. *See id.* at 2 (citing Ex. 1048, 26). Finally, when applying claim 1 to Toshiba Manual, Petitioner asserts: “Nothing in the ’870 Patent indicates that VFD faults generally — or those in Toshiba Manual — cannot be ‘electric motor diagnostics.’” *Id.* at 6 (citing Ex. 1001, 2:36–39, 4:16–25, 5:42–46; Ex. 1054, 30:4–13; Ex. 2003, 34:2–6).

Patent Owner replies that “Petitioner’s arguments [applying claim 1 to Toshiba Manual] are predicated on an incorrect claim construction that fails to give ‘effect to’ the prefix ‘electric motor’ for the claimed ‘diagnostics’” because it “improperly includes ‘diagnostics of other components’ [i.e., the VFD] besides the electric motor.” PO Sur-reply 18 (citing Pet. Reply 2; *Bicon, Inc. v. Straumann Co.*, 441 F.3d 945, 950 (Fed. Cir. 2006)). Patent Owner asserts Dr. Durham’s testimony relies on the same erroneous claim construction. *See id.* at 19 & n.7 (citing Ex. 2003, 34:8–35:22). Further according to Patent Owner: “The Board’s understanding of the disputed term in [the Board’s ’601 Patent Decision] does not support [the proposition] that diagnostics are not limited to those for an electric motor.” *Id.* at 19 (citing Ex. 1048, 26–27).

Upon our review, we conclude firstly that the term “electric motor diagnostics” in claim 1 refers to diagnostics for the electric motor, and not to diagnostics for some other component in the recited system such as the VFD. This is a simple application of the claim term “electric motor diagnostics.” We discern nothing in the ’870 patent specification disclosures cited by the parties to contradict this plain reading of the claim language. *See* Ex. 1001, 2:36–39, 4:16–25, 5:42–46. Thus, we conclude claim 1 requires that the VFD perform diagnostics for the electric motor, which comports with Patent Owner’s proffered claim construction except that it omits the word “alone” at the end. *See, e.g.*, PO Resp. 11 (“[T]he phrase ‘electric motor diagnostics’ means ‘diagnostics for an electric motor alone.’”); Ex. 2002 ¶¶ 38, 50–55; Ex. 2003, 34:2–35:22. It also comports with the expert witness testimony. *See* Ex. 2002 ¶¶ 38–40; Ex. 2003, 35:10–15.

We conclude secondly that Patent Owner’s use of the word “alone” is unclear and therefore unhelpful. On one hand, Patent Owner agrees claim 1 is open to the VFD performing diagnostics for other system components such as the VFD, so long as the VFD also performs diagnostics for the electric motor too, due to the claim’s “comprising” transition term. *See* Ex. 1001, 7:49–50 (claim 1 recites “the system comprising”); PO Sur-reply 19 & n.7; Tr. 37:12–39:8; *see also Genentech, Inc. v. Chiron Corp.*, 112 F.3d 495, 501 (Fed. Cir. 1997) (“[T]he open-ended term ‘comprising’ . . . is a term of art used in claim language which means that the named elements are essential, but other elements may be added[.]”).

On the other hand, however, Patent Owner appears to argue that Toshiba Manual’s VFD does *not* perform electric motor diagnostics *because* it also performs VFD diagnostics. *See* PO Resp. 40–43; Ex. 2002 ¶ 59. Patent Owner particularly asserts that “all of these faults [detected by Toshiba Manual’s VFD] have *possible causes* . . . without any nexus to an electric motor,” which distinguishes Toshiba Manual from claim 1. PO Resp. 41 (emphasis added); Ex. 2002 ¶ 59. Yet, Patent Owner all but concedes that some of the “possible causes” of Toshiba Manual’s detected faults do have a nexus to the electric motor driven by the Toshiba Manual’s VFD. *See, e.g.*, PO Resp. 41 (stating Toshiba Manual’s VFD detects a fault when “Motor is locked” or when “Load requirement exceeds ability of the motor” (citing Ex. 1006, 184⁴)); *id.* at 42 (stating Toshiba Manual’s VFD

⁴ As Petitioner points out, the Patent Owner Response here mis-quotes Toshiba Manual as identifying an “Overload” fault, when in fact Toshiba Manual actually identifies a “Motor Overload” fault. *See* PO Resp. 41; Pet. Reply 6; Ex. 1006, 184.

detects a “Ground fault at the motor”). Patent Owner’s expert witness Dr. Nikolaou also testified on cross-examination that some of the “Possible Causes” of Toshiba Manual’s “Motor Overload” fault (Ex. 1006, 184) and other faults reflect a “state of the motor” not the VFD. Ex. 1054, 238:10–242:15; *see* Pet. Reply 6 (citing Ex. 1054, 234:6–246:22).

The import of Patent Owner’s usage of the term “alone” in its claim construction was clarified during oral argument, as Patent Owner’s counsel compared claim 1 with Toshiba Manual. *See* Tr. 39:5–40:18 (discussing Ex. 1006, 184–186). We reproduce an excerpt of Toshiba Manual’s disclosure below, with our color annotations added, to illustrate Patent Owner’s position in this regard:

Fault Screen Display	Possible Causes
Motor Overload	• V/f setting needs to be adjusted. • Motor is locked. • Continuous operation at low speed. • Load requirement exceeds ability of the motor. • Startup frequency setting adjustment required.

Toshiba Manual (page 184, color annotations added).

Here, Toshiba Manual discloses that its VFD displays a “Motor Overload” fault condition (left column) which has five different “Possible Causes” (right column). Patent Owner focuses on the two possible causes we have highlighted in yellow — “Continuous operation at low speed” and “Startup frequency setting adjustment required” — and argues those causes are VFD faults rather than motor faults. *See* PO Resp. 41–43; Ex. 2002 ¶¶ 58–59; Tr. 39:9–40:11. At the same time, Patent Owner and Dr. Nikolaou recognize that other possible causes such as the ones we have highlighted in green — “Motor is locked” and “Load requirement exceeds ability of the motor” — are motor faults. *See* Tr. 39:9–40:11; Ex. 1054, 238:10–239:16.

Patent Owner's position is that, for this disclosure in Toshiba Manual to reflect performance of electric motor diagnostics as claimed, all five of the possible causes must be electric motor faults rather than VFD faults. *See* Tr. 39:9–40:11.

We disagree. Claim 1 pertinently requires only that the VFD performs electric motor diagnostics. *See* Ex. 1001, 7:58–61. Claim 1 does not specify or limit how the results of the diagnostics are reported to the user, as Patent Owner's position suggests. *See id.* That is, even if motor diagnostics and VFD diagnostics are both reported as the same “Motor Overload” fault as in Toshiba Manual (page 184), the VFD nonetheless still performs electric motor diagnostics.

We conclude thirdly that we need not address Petitioner's assertion that the claim phrase “to prevent damage to the one or more electric motors” is non-limiting. *See* Pet. 30 n.5. For reasons provided below in Sections III.D.3(iii) and III.E.2(iii), a preponderance of the evidence establishes that Toshiba Manual and Horikoshi both disclose a VFD that performs electric motor diagnostics to prevent damage to an electric motor, regardless of whether damage prevention is actually required by claim 1. *See Realtime Data*, 912 F.3d at 1375 (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’”).

Finally, nothing in the portion of the Board's '601 Patent Decision cited by the parties here is inconsistent with our foregoing claim construction. *See* Ex. 1048, 25–27.

In summary, we conclude that the term “electric motor diagnostics” in claim 1 refers to diagnostics for the electric motor, and not to diagnostics for

some other component in the recited system such as the VFD. At the same time, claim 1 is open to the VFD performing diagnostics for other system components such as the VFD, so long as the VFD also performs diagnostics for the electric motor.

(ii) 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 for hydraulically fracturing an underground formation, 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. We find these contentions, which Patent Owner does not oppose, are supported by a preponderance of the evidence as follows.

We find 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.

We find Coli also discloses a trailer for attachment to a truck, with two or more 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 (describing Figure 1, stating “[e]ach trailer 5 is attached to a truck 6”).

We find 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.

We find 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.

(iii) Comparing Claim 1 with Toshiba Manual

Petitioner contends Toshiba Manual discloses a VFD for a motor, and the VFD “performs electric motor diagnostics to prevent damage to” the motor, as recited in claim 1. See Pet. 10–11, 22, 31–32 (citing Ex. 1006, 2, 19, 22, 23, 43, 44, 65, 71, 160–163, 165, 179, 180, 182–186); Ex. 1002 ¶¶ 115–119, 150, 166–168. Patent Owner raises two objections, which we consider in turn.

(a) Sufficiency of Explanation in the Petition

Patent Owner argues Petitioner and Dr. Durham fail to explain “how certain VFD faults [in Toshiba Manual] satisfy the claimed ‘electric motor diagnostics.’” PO Resp. 37, 38–40, 43 (citing Pet. 22, 31; Ex. 1002 ¶¶ 117,

150, 166); Ex. 2002 ¶¶ 57–60. Patent Owner argues that, at best, Petitioner and Dr. Durham “simply list[] [Toshiba Manual’s] exemplary ‘faults’ without explanation.” PO Resp. 39 (citing Ex. 1002 ¶ 117); Ex. 2002 ¶ 57. Patent Owner concludes “[t]his lack of technical detail and explanation is insufficient to show Toshiba Manual discloses ‘electric motor diagnostics.’” PO Resp. 39–40 (citing three Board decisions). Patent Owner further asserts the Institution Decision improperly “articulated a theory regarding how Toshiba Manual satisfies the claimed ‘electric motor diagnostics’ that the Petitioner never made.” *Id.* at 37, 43 (citing Inst. Dec. 19). Patent Owner suggests we would now perpetuate that error if we were to rely on this theory in the present Decision, because it “introduces a different unpatentability theory never addressed by the Petition and that is unsupported by expert testimony.” *Id.* at 43–44 (citing *SAS Inst., Inc. v. Iancu*, 138 S. Ct 1348, 1356 (2018); *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1381 (Fed. Cir. 2016)).

Petitioner replies that Patent Owner “ignores Dr. Durham’s explanation of how Toshiba Manual’s VFD faults are electric motor diagnostics” including his listing of “several examples of these diagnostics, including overload and over-current protection, and the possible causes of each fault relating to preventing damage to an electric motor.” Pet. Reply 6–7 (citing Ex. 1002 ¶¶ 117–119, 150, 166; Ex. 1006, 19, 22, 160–163, 166–168, 179, 182–186). Petitioner further asserts the Institution Decision’s consideration of Toshiba Manual in this regard “does not raise a new unpatentability theory,” and instead it “relies on the same overload (and overcurrent) protection that the Petition raises.” *Id.* at 7–8 (citing Inst.

Dec. 19; Pet. 10–11, 22, 31–32; Ex. 1002 ¶¶ 117, 150, 166; Ex. 1006, 19, 22, 160).

We conclude the Petition explains sufficiently where and how Toshiba Manual discloses a VFD that performs electric motor diagnostics. The Petition cites specific pages of the Toshiba Manual, and explains how those pages support Petitioner’s contention that Toshiba Manual’s VFD performs electric motor diagnostics. *See* Pet. 10–11, 22, 31–32 (citing Ex. 1006, 2, 19, 22, 23, 43, 44, 65, 71, 160–163, 165, 179, 180, 182–186); *see also* Inst. Dec. 20 (line 22) – 21 (line 10) (reaching same conclusion). The Petition’s analysis may be terse, but in our view, it is not fatally insufficient.

In particular, the Petition discusses how Toshiba Manual states that its VFD may perform diagnostics (at page 43) including identification of various faults (at pages 182–186) that result in alarms (at page 179). *See* Pet. 10–11, 22, 31. The Petition states “Toshiba Manual discloses performing electric motor diagnostics to prevent damage to the motor, including protecting against overload, overcurrent, overtorque, short circuit, and earth faults.” Pet. 11, 31 (citing Ex. 1006, 19, 22, 71, 160–163, 165). The Petition adds that Toshiba Manual’s electric motor diagnostics include “overload protection, over-current protection, electronic thermal protection, overheat, overcurrent stall level, motor 150% OL time limit, short circuit test, over-torque trip, and earth fault trip.” *Id.* at 22 (citing Ex. 1006, 19, 22, 160–163, 165, 180).

Further, Dr. Durham’s testimony puts meat on the bones of the contentions in the Petition, especially as to identifying particular passages of Toshiba Manual where Dr. Durham finds disclosure of the particular electric

motor diagnostics alleged by Petitioner. *See* Ex. 1002 ¶¶ 117–118, 150, 166; *see also* Pet. 22 (citing Ex. 1002 ¶¶ 117, 150); Pet. Reply 6–7 (citing Ex. 1002 ¶¶ 117–119, 150, 166).

Our summary of Toshiba Manual’s disclosures in these regards, set forth above in Section III.D.2(i), is limited to pages expressly cited by Petitioner and Dr. Durham (i.e., pages 19, 22, 71, 160, 179, and 182–184) plus one further explanatory page (i.e., page 47 which defines the “FLA” acronym mentioned on page 160). Our summary also focuses on the disclosures in those pages relating to Toshiba Manual’s potential teachings concerning *electric motor diagnostics*, which we were able to discern easily based on the Petition’s contentions and Dr. Durham’s testimony as cited and summarized above in this Section. Thus, we are not persuaded by Patent Owner’s argument that our summary improperly articulates a theory of unpatentability regarding how Toshiba Manual satisfies the claimed electric motor diagnostics that was not made in the Petition.

*(b) Whether Toshiba Manual’s VFD Performs
Electric Motor Diagnostics*

Patent Owner argues Petitioner has failed to show Toshiba Manual’s VFD performs electric motor diagnostics to prevent damage to the motor. *See* PO Resp. 1, 6–7, 37. Patent Owner asserts Toshiba Manual’s VFD monitors for VFD faults, but VFD faults are not electric motor diagnostics. *See id.* at 1, 6–7, 40–43 (citing Ex. 1006, 180–186); Ex. 2002 ¶¶ 42–43, 56–60. In particular, according to Patent Owner and Dr. Nikolaou, “all of these faults [detected by the Toshiba Manual’s VFD] have possible causes . . . without any nexus to an electric motor.” PO Resp. 41–43

(reproducing and adding emphases to portions of Ex. 1006, 180–186);
Ex. 2002 ¶¶ 58–59.

Petitioner maintains in reply that Toshiba Manual’s “VFD fault conditions satisfy ‘electric motor diagnostics.’” Pet. Reply 5. According to Petitioner, Patent Owner’s opposition that Toshiba Manual’s “faults have possible causes ‘without any nexus to an electric motor’ [ignores] the causes that are related to the motor” such as “Motor is locked,” “Motor/machine jammed,” and “Ground fault at the motor.” *Id.* at 5–6 (citing PO Resp. 41–42; Ex. 1054, 234:6–246:22).

Patent Owner replies that “Petitioner’s Reply advances a new theory” of unpatentability — that “Overload, Overcurrent, and Earth Fault satisfy the claimed ‘diagnostics’ because each may have possible ‘causes that are related to the motor’ out of other possible causes.” PO Sur-reply 17 (citing Pet. Reply 6–7). Patent Owner asserts “[n]either the Petition nor Dr. Durham’s declaration provide this explanation” so “[t]he Board should disregard” it. *Id.* at 17–18 (citing *Netflix, Inc. v. DivX, LLC*, 84 F.4th 1371, 1380 (Fed. Cir. 2023); *Parus Holdings, Inc. v. Google LLC*, 70 F.4th 1365, 1371–72 (Fed. Cir. 2023)). Patent Owner further argues Petitioner’s arguments are predicated on an improper claim construction, which “includes ‘diagnostics of other components’ besides the electric motor which fails to give effect to the claimed prefix ‘electric motor.’” *Id.* at 18 (citing Pet. Reply 2).

We conclude a preponderance of the evidence supports Petitioner’s contention that Toshiba Manual discloses a VFD that performs electric motor diagnostics to prevent damage to the motor that is driven by the VFD. As demonstrated by our summary of Toshiba Manual’s current overload

protection feature above in Section III.D.2(i), Toshiba Manual's 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, 71, 160; Ex. 1002 ¶¶ 117, 150, 166. That monitoring corresponds to performing electric motor diagnostics to prevent damage to the motor, as recited in claim 1. *See* Pet. 10–11, 22, 31–32 (citing, *inter alia*, Ex. 1006, 19, 22, 71, 160); Ex. 1002 ¶¶ 117–119, 150, 166.

We disagree with Patent Owner's assertion that the Petitioner Reply advances a new theory of unpatentability in this regard. The Petition and the Petitioner Reply both rely on Toshiba Manual as disclosing a VFD that performs electric motor diagnostics to prevent damage to the motor that is driven by the VFD. *See* Pet. 10–11, 22, 31–32; Pet. Reply 5–6. To the extent the Petitioner Reply adds analysis supporting that contention, it is a permissible response to Patent Owner's claim construction of "electric motor diagnostics" articulated in the Patent Owner Response. *See* Pet. Reply 5–7.

Also, Patent Owner does not dispute the fact that Toshiba Manual's current overload monitoring is performed *to protect the motor*. Indeed, Toshiba Manual states that "[t]he [VFD] software monitors the output current of the system and determines when an overload condition occurs," wherein "[t]he overload current level is a percentage of the rating of the motor," and "[t]his function protects the motor from overload." Ex. 1006, 19. Toshiba Manual further provides: "When using the [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.”). *Id.* at 22; *see also id.* at 47, 160 (stating that the VFD’s motor electronic thermal protection parameter specifies the motor overload current level as the motor’s full-load amperage rating). Further, “Patent Owner does not contend that ‘*electric motor diagnostics*’ necessarily requires the VFD to interrogate the motor itself to perform the diagnostics.” PO Resp. 11. Thus, we conclude Toshiba Manual’s current overload monitoring is an electric motor diagnostic, not a VFD diagnostic as Patent Owner and Dr. Nikolaou would have it, despite that the parameter being monitored is the current generated by the VFD for delivery to the motor.

Moreover, to the extent Patent Owner’s opposition relies on Patent Owner’s proffered claim construction of “electric motor diagnostics” as requiring diagnostics of the motor “alone” (*see, e.g.*, PO Resp. 41–43; Ex. 2002 ¶ 56), we have rejected that claim construction for reasons provided above in Section III.D.3(i). Thus, Patent Owner’s objections to Toshiba Manual’s disclosure in this regard rely on unclaimed subject matter, and therefore are unavailing.

Finally, although the foregoing discussion focuses on Toshiba Manual’s VFD protecting against a *current overload* being supplied to the motor as corresponding to an electric motor diagnostic, Petitioner contends and Dr. Durham testifies that Toshiba Manual’s VFD protects against *other* motor parameter faults such as short circuits and earth faults. *See* Pet. 10–11, 22, 24, 31–32 (citing Ex. 1006, 19, 22, 43, 160–163, 165, 179, 180, 182–186); Ex. 1002 ¶¶ 117–119, 150, 153, 166. We agree. *See, e.g.*, Ex. 1006, 162 (“Short Circuit Test” and “Short Circuit Test Duration”), 179 (stating that a Trip disables the VFD when one or more listed variables exceeds its normal range), 182–186 (stating that a Trip disables the VFD for

“Earth Fault” including “Ground fault at the motor”). Notably, the ’870 patent acknowledges that shorting and grounding are two causes of motor damage. *See* Ex. 1001, 2:36–39, 4:20–23. We therefore conclude Toshiba Manual teaches performance of electric motor diagnostics (plural) as recited in claim 1.

For the foregoing reasons, we conclude a preponderance of the evidence supports Petitioner’s contention that Toshiba Manual discloses a VFD that performs electric motor diagnostics to prevent damage to the motor that is driven by the VFD.

(iv) Motivation to Perform Electric Motor Diagnostics in Coli’s VFD, in light of Toshiba Manual’s VFD

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 . . . 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, 31–32 (citing Ex. 1006, 43, 179, 182–186); Ex. 1002 ¶¶ 117, 153, 155–156, 158, 166–168. “For example,” according to Petitioner, a person of ordinary skill in the art “would have been motivated to simply substitute the VFD of Coli for the VFD of Toshiba Manual that has the diagnostic functionality . . . to prevent damage, without affecting the other functionalities of Coli.” Pet. 25; Ex. 1002 ¶¶ 155, 158. Petitioner and

Dr. Durham further conclude this could have been achieved with a reasonable expectation of success. *See* Pet. 24–25; Ex. 1002 ¶¶ 157–158.

We conclude a preponderance of the evidence establishes that a person of ordinary skill in the art would have been motivated “to enhance the Coli VFD with the features taught by Toshiba Manual” (Pet. 23) including its “diagnostic functionality . . . in order to prevent damage to [Coli’s] electric motor” (*id.* at 24, 25), as the application of a known technique (i.e., the fault detection of Toshiba Manual’s VFD) to predictably improve a similar system (i.e., Coli’s VFD) in the same way (*id.* at 25).⁵ In particular, Coli recognizes that a control system may regulate various components of its electrically-powered hydraulic fracturing system, including “control software and variable frequency drives [which] calculate a maximum current available to the motors.” Ex. 1005 ¶ 65 (cited at Pet. 21–22, 30). At the same time, Toshiba Manual “discloses further details about these VFD features” (Pet. 22), such as performing electric motor diagnostics to prevent damage to an electric motor driven by a VFD (*id.* at 22–24, 31–32; *see supra* Section III.D.3(iii)). We are persuaded by Dr. Durham’s testimony that these combined disclosures would have motivated Petitioner’s combination. *See* Ex. 1002 ¶¶ 149–150, 152–153, 156, 165–168.

⁵ We do not rely on Petitioner’s “[a]lternative[.]” theory of obviousness premised on a simple substitution of Coli’s VFD for Toshiba’s VFD. Pet. 25; *see* PO Resp. 21–25 (opposing this theory); Pet. Reply 8–10 (maintaining this theory); PO Sur-reply 19–23 (opposing this theory). Thus, we need not resolve Patent Owner’s objection to Petitioner’s Demonstrative Exhibit Slide 39 (Paper 25, at 2).

Patent Owner and Dr. Nikolaou respond that Petitioner’s motivation contentions are conclusory and so should be given no weight. *See* PO Resp. 25–27; PO Sur-reply 22–23; Ex. 2002 ¶¶ 86–87. In particular, according to Patent Owner, Toshiba Manual’s “faults prevent damage to the VFD — not the ‘electric motor’ [as] required by” claim 1. PO Resp. 26; Ex. 2002 ¶ 87. However, for reasons provided above in Section III.D.3(iii), we find Toshiba Manual’s VFD performs electric motor diagnostics to prevent damage to a motor, as required by claim 1. Further, as can be seen from our summary and discussion of Petitioner’s motivation arguments and Dr. Durham’s testimony set forth above in this Section, we disagree with Patent Owner’s contention that those arguments and testimony are too conclusory to demonstrate unpatentability.

(v) *Conclusion as to Claim 1*

Thus, based on the record presented, we conclude Petitioner has shown by a preponderance of the evidence that claim 1 is unpatentable as having been obvious over Coli and Toshiba Manual.

4. *Claims 2 and 3*

Claims 2 and 3 each depend from claim 1. *See* Ex. 1001, 8:1–7.

Petitioner provides arguments and evidence in support of contending claims 2 and 3 are unpatentable as having been obvious over Coli and Toshiba Manual, relying on Coli as disclosing the limitations added to claim 1 by the dependent claims, including supporting testimony from Dr. Durham. *See* Pet. 32–33; Ex. 1002 ¶¶ 169–172. Patent Owner does not oppose those contentions, apart from arguments we have already considered above in relation to claim 1. *See* PO Resp. *generally*. For reasons provided

above in Section III.D.3 in the context of claim 1, we conclude Patent Owner's arguments are unavailing. We further adopt Petitioner's additional analysis for the obviousness of claims 2 and 3 as our own in this Decision, and we accordingly conclude Petitioner has demonstrated by a preponderance of the evidence that claims 2 and 3 are unpatentable as having been obvious over Coli and Toshiba Manual.

5. *Claims 4–6*

Claim 4 is an independent claim reciting a method of hydraulically fracturing an underground formation, comprising steps of using the system components recited in claim 1 except for the trailer, and claims 5 and 6 depend from claim 4. *See* Ex. 1001, 8:8–23.

Petitioner provides arguments and evidence in support of contending claims 4–6 are unpatentable as having been obvious over Coli and Toshiba Manual, relying principally on its analysis of claim 1 in relation to claim 4, and relying on Coli as disclosing the limitations added by claims 5 and 6, including supporting testimony from Dr. Durham. *See* Pet. 33–35; Ex. 1002 ¶¶ 173–179. Patent Owner does not oppose those contentions, apart from arguments we have already considered above in relation to claim 1. *See* PO Resp. *generally*. For reasons provided above in Section III.D.3 in the context of claim 1, we conclude Patent Owner's arguments are unavailing. We further adopt Petitioner's additional analysis for the obviousness of claims 4–6 as our own in this Decision, and we accordingly conclude Petitioner has demonstrated by a preponderance of the evidence that claims 4–6 are unpatentable as having been obvious over Coli and Toshiba Manual.

6. *Claim 7*

Claim 7 recites a system for hydraulically fracturing an underground formation, including a VFD “having one or more power semiconductor heat sinks having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat.” Ex. 1001, 8:24–36.

Petitioner relies on Toshiba Manual (Exhibit 1006), in combination with a collection of other documents relating to the Toshiba G7 VFD(s) (Exhibit 1007), as disclosing or teaching a VFD heat sink having thermal sensors. *See* Pet. 11, 22–23, 36–38; Pet. Reply 14–17; Ex. 1002 ¶¶ 120–124, 151, 154, 184–186. Petitioner asserts it would have been obvious, in light of those combined Toshiba disclosures and teachings, to utilize a heat sink having thermal sensors in Coli’s VFD. *See* Pet. 21–25, 36–38; Pet. Reply 8–11, 14–17; Ex. 1002 ¶¶ 147–158, 184–186.

Patent Owner opposes, on the bases that: (1) Toshiba Manual (Exhibit 1006) does not support Petitioner’s contentions; (2) Petitioner’s reliance on the other Toshiba G7 VFD documents (Exhibit 1007) is untimely because it was not articulated in the Petition; and (3) Petitioner’s alleged motivations for combining Coli with Toshiba Manual are not supported by a preponderance of the evidence. *See* PO Resp. 1, 6–7, 12–18, 21–27, 36–37; PO Sur-reply 2–6; Ex. 2002 ¶¶ 41–43, 62–70, 76–89.

We first address the meaning of a VFD “having one or more . . . heat sinks having thermal sensors” as recited in claim 7. Then we explain why we are persuaded by Patent Owner’s first and second arguments, such that we conclude a preponderance of the evidence does not support Petitioner’s assertions of obviousness.

(i) *Claim Construction — a VFD “having one or more . . . heat sinks having thermal sensors”*

Claim 7 requires a VFD “having one or more power semiconductor *heat sinks having thermal sensors* monitored by a microprocessor to prevent damage caused by excessive heat.” Ex. 1001, 8:32–36 (emphasis added).

In the Petition, Petitioner does not address the scope of this limitation directly. *See* Pet. 20–21, 36–38.

Prior to institution, Patent Owner argued the Petition is deficient for failing to establish Toshiba Manual’s VFD has a heat sink having thermal sensors, because Toshiba Manual does not “say[] that the internal thermistor [of its VFD] is *located on* the heat sink as required by’ claim 7.” Inst. Dec. 24–25 (our emphasis in the Institution Decision) (quoting Paper 6, 24–25). When instituting review, we were “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).” *Id.* at 24–26. “Instead, based on the [preliminary] record, we [found] that the Toshiba Manual does *not specify a particular location* within the VFD for the thermal sensors to be located.” *Id.* at 26 (emphasis added). We then explained why we were not persuaded by Petitioner’s contention that Toshiba Manual’s heat sink would inherently (that is, necessarily) have thermal sensors, in part because Loucks discloses “*various locations* for thermal sensors within electronic equipment.” *Id.* at 26–28 (emphasis added). In short, we implicitly construed the claim limitation reciting a “heat sink[] *having thermal sensors*” (Ex. 1001, 8:34–35 (emphasis added)) to require the thermal sensors to be *located on* the heat sink.

Patent Owner accepts the Institution Decision’s implicit construction of claim 7 as requiring thermal sensors “**located on the heat sink.**”

PO Resp. 12. Patent Owner then maintains Toshiba Manual does not disclose that claim limitation. *See, e.g., id.* at 13 (“Petitioner identifies no evidence that Toshiba’s thermistor is located on the heat sink.”), 14 (“[T]he Toshiba Manual disclosures relied on by Petitioner never explain that the internal thermistor is located on the heat sink as required by the claim.”); Ex. 2002 ¶¶ 43, 63–70.

Petitioner argues in reply that “Toshiba Manual discloses ‘heat sinks having thermal sensors’ (*i.e.*, thermal sensors *associated with* the heat sink).” Pet. Reply 1 (emphasis added). Petitioner asserts that construing claim 7 to require the thermal sensors to be located on the heat sink “goes too far” because “[c]laim 7 does not state that the thermal sensors are located ***on*** the heat sink.” *Id.* at 14. According to Petitioner, the Institution Decision “did not construe claim 7 to require that location,” and instead it “states that Toshiba Manual did not ‘inherently ***associate***[] its heat sinks with its thermal sensors.’” *Id.* (citing Inst. Dec. 26). Petitioner further asserts no intrinsic evidence supports construing claim 7 to require the thermal sensors to be located on the heat sink, because the ’870 patent specification’s “only description of a heat sink having thermal sensors parrots the claim language.” *Id.* at 14 n.5 (citing Ex. 1001, 2:39–42). Petitioner moreover asserts Patent Owner’s expert witness “Dr. Nikolaou did not consider whether claim 7 requires the thermal sensor to be located on the heat sink, and interpreted it more broadly.” *Id.* (citing Ex. 1054, 44:13–19).

Patent Owner replies that Petitioner’s “associated with” construction is inconsistent with the language of claim 7 requiring a heat sink “*having*”

thermal sensors, because claims must be interpreted with an eye toward giving effect to all terms in the claim. PO Sur-reply 4–5 (citing *Bicon*, 441 F.3d at 950). Patent Owner asserts Petitioner mischaracterizes Dr. Nikolaou’s testimony in this regard. *See id.* at 5 n.2 (citing Ex. 1054, 39:7–18, 44:13–19).

Upon our review, we begin our analysis with the claim language, which recites “one or more . . . heat sinks *having* thermal sensors.” Ex. 1001, 8:33–36 (emphasis added). It is unclear to us, and Petitioner does not explain persuasively, how a heat sink may be found to “have” a thermal sensor without the thermal sensor being located on the heat sink. In a plain application of the claim language, if the thermal sensor is located on some other system component, then it is the other component (not the heat sink) that “has” the thermal sensor. The ’870 patent specification’s discussion of heat sinks having thermal sensors does not add anything to the claim language in this regard. *See* Ex. 1001, 2:39–42, 4:8–16.

Petitioner’s “associated with” claim construction is vague. It fails to “define the precise scope of” claim 1 to serve the public notice function of claiming, thereby “render[ing] the scope of the patent ambiguous,” which the Federal Circuit has instructed us not to do. *Bicon*, 441 F.3d at 950. We understand Petitioner’s construction is based on a statement we made in the Institution Decision (at page 26). Nonetheless, as already discussed above, the overall thrust of the Institution Decision (at pages 24–28) focused on the location of the thermal sensors and not their association(s).

Finally, Dr. Nikolaou’s testimony is more consistent with our claim construction than Petitioner’s proffered claim construction. *See* Ex. 1054, 39:7–18, 43:11–45:1.

For the foregoing reasons, we construe the claim limitation reciting a heat sink *having* a thermal sensor to require the thermal sensor to be *located on* the heat sink.

(ii) *Petitioner’s Reliance on Toshiba Documents for
a Heat Sink Having Thermal Sensors*

(a) *The Petition*

In the Petition, Petitioner argues Toshiba Manual discloses a VFD having a heat sink having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat. *See* Pet. 11, 22–23, 36–37 (citing Ex. 1006, 2, 14, 36, 42–43, 58, 163, 174, 180, 183, 184–185, 204); Ex. 1002 ¶¶ 120–124, 151, 154, 185–186. Petitioner particularly asserts Toshiba Manual VFD’s “*heat sinks have thermal sensors*, e.g., an ‘internal thermistor’ that protects against overheating.” Pet. 11 (emphasis added) (citing Ex. 1006, 180, 185, 163); *id.* at 37 (“*The heat sinks have thermal sensors* (e.g., thermistors) monitored by a microprocessor to prevent damage caused by excessive heat.” (emphasis added)); Ex. 1002 ¶¶ 122, 186. Petitioner also asserts 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. 37–38 (emphasis added) (citing Ex. 1006, 163, 185); Ex. 1002 ¶¶ 122–123, 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).

Moreover, the Petition appears to rely on Exhibit 1007 in two regards. *See* Pet. 10, 31. Exhibit 1007 is a 298 page omnibus collection of a witness

declaration and various documents relating to the commercially sold Toshiba G7 Adjustable Speed Drive(s), at least one of which is the VFD that is the subject of Toshiba Manual (Exhibit 1006). Exhibit 1007 consists of:⁶

- the Declaration of Nathaniel Frank-White of the Internet Archive (pages 1–3, 17), attesting to the Wayback Machine source of the documents collected in Exhibit 1007;
- a web page identifying various “Industrial Systems” manufactured by Toshiba including “Motors,” “Drives,” and “EQP Global” (pages 4–5);
- web pages describing the Toshiba GX7 Series drive(s), including “Standard Specifications” (pages 6–13);
- a web page listing “GX7 Standard Specifications” (pages 14–16);
- a Toshiba “Adjustable Speed Drives GX7 Series” brochure (pages 18–24);
- the Toshiba Manual (pages 25–246), included in the record separately as Exhibit 1006;
- various technical drawings for the Toshiba GX7 600VAC drive(s) (pages 247–274);
- various technical drawings for the Toshiba GX7E/HX7E 690VAC drive(s) (pages 275–289); and
- a Toshiba “Adjustable Speed Drives Product Offering” brochure (pages 290–298).

First, the Petition relies on Exhibit 1007 as establishing that the Toshiba Manual is prior art to the ’870 patent. *See* Pet. 10 (lines 4–12) (citing Ex. 1007, 1, 25); Ex. 1002 ¶ 114.

⁶ When citing to Exhibit 1007, 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, 31; PO Resp. 39.

Second, the Petition on its face cites Exhibit 1007 as establishing that Toshiba Manual’s VFD performs “electric motor diagnostics” as recited in claim 1 of the ’870 patent. *See* Pet. 31 (lines 1–10). However, it is clear from context and the page numbers cited in the Petition that Petitioner meant to cite Exhibit 1006 not Exhibit 1007 here. *See id.* (citing Ex. 1007, 43, 162, 182–186; Ex. 1002 ¶¶ 117, 150, 166); *compare* Ex. 1006, 43, 162, 182–186, *with* Ex. 1007, 43, 162, 182–186.

The Petition does not rely on Exhibit 1007 in relation to the limitation in claim 7 requiring a VFD heat sink having thermal sensors. *See* Pet. 21–25 (discussing motivations to combine Coli and Toshiba Manual), 36–38 (discussing limitation 7[d]). Nonetheless, Dr. Durham’s Declaration cites Exhibit 1007 as including photographs showing “[h]eat sinks are located so as to dissipate heat ‘out-the-back’ of the cabinet of the VFD, which also includes a ‘Long Life 1200 cfm Front-Removable Heatsink Fan.’” Ex. 1002 ¶ 120 n.2 (citing Ex. 1007, 20).

(b) The Institution Decision

In the Institution Decision, we concluded based on the preliminary record that “Petitioner’s contentions seeking to establish that [Toshiba Manual’s] VFD includes a heat sink having thermal sensors [are] not sufficiently supported by the evidence to justify institution of review.” Inst. Dec. 28; *see also id.* at 24–28 (supporting analysis). We nonetheless instituted the petitioned review as to claim 7. *See id.* at 23–24 (citing 37 C.F.R. § 42.108(a); *SAS, supra*).

(c) The Patent Owner Response

Patent Owner concedes “Toshiba Manual includes both a heat sink and thermistor (i.e., temperature sensor)” in its VFD, but Patent Owner nonetheless maintains “nothing in Toshiba Manual describes the thermistor as located on the heat sink” as required by claim 7. PO Resp. 7 (citing Ex. 1006, 14, 180, 204); *see also id.* at 12 (arguing Toshiba Manual “does not disclose that the **thermistor is located on the heat sink**”) (citing Ex. 1006, 2, 14, 42–43, 180–186, 204). Patent Owner asserts Dr. Durham’s testimony on behalf of Petitioner is conclusory and unpersuasive of an inherent disclosure being found in Toshiba Manual in this regard. *See id.* at 12, 13–16 (citing Ex. 1002 ¶¶ 124, 186). Further according to Patent Owner, Dr. Nikolaou’s testimony directly contradicts Dr. Durham’s unsupported opinion, and is supported by Loucks which discloses that “thermal sensors in a system like that described in Toshiba Manual may be placed in various other internal locations of an electrical component, not necessarily on the heat sink.” *Id.* at 14, 16–18 (citing Ex. 2002 ¶¶ 64–70; Ex. 1009 ¶ 3).

(d) The Petitioner Reply

Petitioner replies that “Toshiba Manual discloses ‘heat sinks having thermal sensors’ (i.e., thermal sensors associated with the heat sink),” applying Petitioner’s claim construction of claim 7. Pet. Reply 1, 15. Petitioner further asserts Dr. Durham’s testimony establishes that “because the heat sink is the main heat dissipating device in the Toshiba VFD, protecting against an ‘overheat’ condition in that VFD must involve

measuring the heat sink's temperature.” *Id.* at 14 (citing Ex. 1002 ¶¶ 122–123, 186).

Petitioner argues Exhibit 1007 supports that assertion, in two ways. *See id.* First, Petitioner cites Exhibit 1007 as providing “the ‘standard specifications’ for Toshiba Manual’s GX7 VFD” that “expressly refer to the only ‘Overheat’ function of that system as ‘**Heatsink** Overheat.’” *Id.* at 14–15 (citing Ex. 1007, 1, 15, 23; Ex. 1002 ¶¶ 122, 186; Ex. 1054, 84:19–85:18). Second, Petitioner argues Exhibit 1007 provides “the drawings and equipment list for Toshiba’s VFD [that] refer to the only thermistor in that device as the ‘**heatsink** thermistor.’” *Id.* at 15–16 (citing Ex. 1007, 251, 264, 279–280; Ex. 1002 ¶ 120).

Petitioner then contends “[t]o the extent the Board maintains that Toshiba Manual does not disclose that its heat sink has thermal sensors, a [person of ordinary skill in the art] would have deemed that obvious.” Pet. Reply 16. Here, Petitioner characterizes the Petition as asserting “that monitoring the temperature of heat sinks in VFDs was known in the art.” *Id.* (citing Pet. 38; Ex. 1002 ¶¶ 87–95); *cf.* Pet. 38 (stating only that “heat sinks and temperature monitoring using sensors were well-known long before the ’870 Patent”). Petitioner then adds that Dr. Durham’s Declaration refers to “general engineering knowledge regarding the operation of ASDs, power semiconductors[, heat sinks, CPUs, and control interfaces” in concluding that “Toshiba Manual discloses a power semiconductor heatsink having thermal sensors.” Ex. 1002 ¶ 124; Pet. Reply 16. Petitioner further asserts “Dr. Nikolaou . . . conceded that a [person of ordinary skill in the art] would have understood that Toshiba Manual’s thermistor could be located on the heat sink . . . but does not identify anywhere else the thermistor would be

located.” Pet. Reply 16 (citing Ex. 2002 ¶ 63). Petitioner finally cites Exhibit 1007 as demonstrating that locating the thermistor of Toshiba Manual’s VFD on its heat sink would have been “an obvious design choice” based on “the limited number of locations in Toshiba Manual’s VFD cabinet where the thermistor could be located.” *Id.* at 16–17 (citing Ex. 1007, 20; Ex. 1002 ¶ 236; *Uber Techs., Inc. v. XOne, Inc.*, 957 F.3d 1334, 1340 (Fed. Cir. 2020)).

(e) *The Patent Owner Sur-reply*

Patent Owner responds that the Petitioner Reply “offers no further explanation demonstrating *inherency*,” which was the only theory presented in the Petition. PO Sur-reply 1 (emphasis added), 2–3. Patent Owner also argues the Petitioner Reply relies on new evidence (i.e., Exhibit 1007) and new theories of obviousness (i.e., express disclosure by Toshiba Manual, and obviousness over the Toshiba Manual and Exhibit 1007), which the Board should reject as untimely. *See id.* 1, 2–4 (citing Pet. 37–38; Pet. Reply 14–16; Ex. 1002 ¶ 186). Patent Owner asserts that considering these new arguments would “deprive Patent Owner the opportunity to cross examine Petitioner’s expert on such theories, at great prejudice to Patent Owner.” *Id.* at 4 (citing *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1370 (Fed. Cir. 2016)).

Patent Owner moreover argues Petitioner’s contentions fail on their merits, as relying on an incorrect claim construction, and because “[a]n assertion that something **could be done** does not articulate a reason **why** something would be done . . . rais[ing] a specter of impermissible hindsight bias.” *Id.* at 5–6.

(f) *Analysis and Conclusion*

The parties' disputes focus on the limitation in claim 7 requiring a VFD having a heat sink having one or more thermal sensors. As discussed above in Section III.D.6(i), we have construed that claim limitation as requiring a thermal sensor located on the heat sink.

It is undisputed that Toshiba Manual's 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[.]"); Ex. 1002 ¶¶ 120, 186; Ex. 2002 ¶¶ 43, 63. It is also undisputed that Toshiba Manual's VFD has a thermal sensor to monitor the temperature of the VFD and thereby prevent overheating. *See* Ex. 1006, 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"); Ex. 1002 ¶¶ 121–124, 186; Ex. 2002 ¶¶ 43, 63.

Thus, the issues presented are whether Petitioner has shown that: (1) Toshiba Manual expressly discloses the thermal sensor is located on the heat sink; (2) Toshiba Manual inherently discloses the thermal sensor is located on the heat sink; or (3) it would have been obvious based on the combination of Toshiba Manual (Exhibit 1006) and other Toshiba documents (Exhibit 1007) to utilize a thermal sensor located on a heat sink in a VFD. We consider each issue in turn.

*Whether Toshiba Manual Expressly Discloses
a Thermal Sensor Located On a Heat Sink*

Toshiba Manual's express disclosure concerning the location of its thermal sensor is meager. It most pertinently indicates an "Overheat" fault is determined when the VFD's "ambient temperature [is] excessive," as measured by an "[i]nternal thermistor." Ex. 1006, 180, 185; *see* Pet. 11, 23 (arguing Toshiba Manual's "heat sinks have thermal sensors") (citing Ex. 1006, 180, 184–185). There is nothing there to indicate the thermistor is located on the heat sink of the VFD, rather than some other component of the VFD that would allow the thermistor to monitor the VFD's ambient temperature.

Toshiba Manual further describes how the VFD's "heat sink and other components may become extremely hot to the touch," and for example "the heat generated by the [Dynamic Braking Resistor] will affect the cooling capacity of the heatsink." Ex. 1006, 14, 204; *see* Pet. 23, 37 (arguing Toshiba Manual's VFD includes a heat sink having a thermal sensor) (citing Ex. 1006, 14, 204). But again, there is nothing there to indicate the thermistor is located on the heat sink of the VFD, rather than any of the other VFD components that may become extremely hot. *See also* Pet. 23 (arguing Toshiba Manual "detect[s] an 'elevated temperature' *of the VFD*" using its thermal sensor (emphasis added)).

Exhibit 1007 does not aid Petitioner's effort to establish Toshiba Manual expressly discloses a thermal sensor located on a heat sink. The issue of what Toshiba Manual discloses is distinct from the issue of whether the *commercial VFD product(s)* that were *actually sold* had a thermal sensor located on a heat sink, even though Toshiba Manual was prepared as an

operation manual for such commercial VFD products. Petitioner’s challenge is premised on Toshiba Manual’s disclosure as a “printed publication” per 35 U.S.C. § 102(a)–(b), not on the corresponding commercial product demonstrating a “public use or . . . sale” per 35 U.S.C. § 102(b). *See* Pet. 9–11, 36–38; *see also* 35 U.S.C. § 311(b) (*inter partes* review may be requested “only on the basis of prior art consisting of patents or printed publications”).

We have considered Dr. Durham’s testimony concerning the location of Toshiba Manual’s thermal sensor in relation to its heat sink. *See* Ex. 1002 ¶¶ 120 & n.2, 122–123, 151, 186. To the extent Dr. Durham relies on an express disclosure by Toshiba Manual in this regard, we are not persuaded for the reasons provided above.

Finally, to the extent Petitioner’s reliance on Toshiba Manual applies Petitioner’s proffered claim construction which would require that the heat sink and the thermal sensor are “associated with” each other (*see, e.g.*, Pet. Reply 1, 14–16), we have rejected that claim construction for reasons provided above in Section III.D.6(i). Thus, Petitioner’s argument in this regard relies on unclaimed subject matter, and therefore is unavailing.

We find Toshiba Manual does not expressly disclose a thermal sensor located on a heat sink.

*Whether Toshiba Manual Inherently Discloses
a Thermal Sensor Located On a Heat Sink*

An inherent disclosure may be found only if it “is necessarily present” in the reference, and “may not be established by probabilities or possibilities.” *In re Montgomery*, 677 F.3d 1375, 1379–80 (Fed. Cir. 2012). 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. *See Cont'l Can Co. USA, Inc. v. Monsanto Co.*, 948 F.2d 1264, 1268–69 (Fed. Cir. 1991).

Petitioner correspondingly argues and Dr. Durham testifies that Toshiba Manual's "heat sink would necessarily have sensors (e.g., thermistors)." Pet. 37–38 (citing Ex. 1006, 2, 42–43, 180, 163, 185); Ex. 1002 ¶¶ 120–124, 186. Dr. Durham most pertinently testifies as follows:

A [person of ordinary skill in the art] would further understand that in order to protect against overheat, the heatsink would necessarily have sensors which would report temperature data to the CPU (microprocessor). By performing a "protective function" of "heatsink overheat," Toshiba Manual is disclosing that the purpose of the heatsink, and the monitoring of the heat sink by temperature sensors connected to the CPU, is to prevent damage cause[d] by excessive heat.

Ex. 1002 ¶¶ 122, 186; *see* Pet. 38. Although Dr. Durham's testimony uses the quoted phrase "heatsink overheat," he does not identify the source of the quoted phrase. *See* Ex. 1002 ¶¶ 122, 186. The Petition suggests the quoted phrase may be found in Toshiba Manual at page 163 or page 185. *See* Pet. 38. However, we are unable to find it there. *See* Ex. 1006, 163 (discussing "Cooling Fan Control" settings), 185 (discussing an "Overheat" fault). Further, as already discussed above, we find Toshiba Manual does not expressly disclose a thermal sensor located on a heat sink. This leaves very little evidentiary support for Dr. Durham's testimony that Toshiba Manual's thermal sensor necessarily would be located on its heat sink.

Indeed, other prior art of record — Loucks, cited in Petitioner's Ground Three — suggests that measuring the temperature of electrical equipment 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. We are persuaded by Dr. Nikolaou’s testimony that Loucks directly contradicts Dr. Durham’s testimony that Toshiba Manual’s heat sink, specifically, must have a thermal sensor. *See* Ex. 2002 ¶¶ 43, 63–70.

Dr. Durham does not offer any additional explanation that might support finding Toshiba Manual’s thermal sensor necessarily is located on the heat sink. *See* Ex. 1002 ¶¶ 120–124, 151, 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 thermal sensor possibly might be located on the heat sink, not that it is located there necessarily. Further, Loucks’s disclosure of various locations for thermal sensors in electronic equipment belies any such necessity.

For all of the foregoing reasons, we conclude Dr. Durham’s testimony that Toshiba Manual inherently discloses a thermal sensor located on a heat sink is not supported persuasively by the evidence of record.

Petitioner also cites the Board’s ’601 Patent Decision as supporting Petitioner’s case here. *See* Pet. 36 (citing Ex. 1048, 23–29). However, the Board’s ’601 Patent Decision concerned the combination of Coli and Horikoshi (Ground Two in the present proceeding), not the combination of Coli and Toshiba Manual (Ground One in the present proceeding). *See* Ex. 1048, 23–29. Our prior Decision does not relate to Petitioner’s

contention here that Toshiba Manual's VFD necessarily includes a thermal sensor located on a heat sink. *See id.*

Petitioner further cites expert testimony provided by Mr. Robert Schaaf on behalf of Patent Owner in other proceedings 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, Mr. Schaaf's 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 thermal sensors being located on heat sinks (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, 1027). However, Dr. Durham does not proffer any explanation for why Hilbert might thereby support a finding that Toshiba Manual's thermal sensor necessarily is located on the heat sink. *See id.*

Finally, Exhibit 1007 does not aid Petitioner's effort to establish Toshiba Manual inherently discloses a thermal sensor located on a heat sink. First, Petitioner's reliance on Exhibit 1007 in this regard was untimely presented in the Petitioner Reply. *See, e.g., Netflix*, 84 F.4th at 1378–79 (holding that a petitioner reply improperly exceeded the scope of a petition

in relying on Pyle’s new manifest disclosures as teaching a filtering limitation, where the petition had cited only Pyle’s pre-existing manifest disclosures as teaching the filtering limitation). The Petition asserts only that Toshiba Manual (Exhibit 1006) is a printed publication that *discloses* a VFD with a heat sink having a thermal sensor, and the Petition cites only to Toshiba Manual (Exhibit 1006) and Dr. Durham’s related testimony in support. *See* Pet. 11, 22–23, 36–38. The Petition does not cite to Exhibit 1007 at all in that regard, much less the specific page numbers 15, 23, 251, 264, and 279–280 of Exhibit 1007 that are cited in the Petitioner Reply as relating to that assertion. *See* Pet. Reply 14–15.

During oral argument, Petitioner’s counsel argued the Petition and Dr. Durham’s Declaration both “cited to Exhibit 1007 profusely,” so Petitioner’s reliance on Exhibit 1007 in the Petitioner Reply was not untimely. Tr. 23:11–24:8 (discussing Paper 23, Slides 62–64). Petitioner’s counsel relied on pages 10 and 31 of the Petition. *See id.*; Paper 23, Slides 63–64. However, as already discussed above in Section III.D.6(iii)(a), the Petition at page 10 cites Exhibit 1007 only as establishing that Toshiba Manual is prior art, and the Petition at page 31 on its face cites Exhibit 1007 only as establishing that Toshiba Manual’s VFD performs electric motor diagnostics. The Petition does not rely on Exhibit 1007 in relation to the limitation in claim 7 requiring a VFD heat sink having thermal sensors. *See* Pet. 21–25, 36–38. Indeed, counsel’s citation to page 31 of the Petition is especially specious, because it is clear from context that Petitioner actually meant to cite Exhibit 1006 not Exhibit 1007 there. *See supra* Section III.D.6(iii)(a). The Durham Declaration testimony cited by counsel similarly does not relate to the limitation in claim 7

requiring a VFD heat sink having thermal sensors. *See* Paper 23, Slides 62–64 (citing Ex. 1002 ¶¶ 113–114, 116–117, 150).⁷

Moreover, Petitioner’s reliance on Exhibit 1007 is not persuasive on the merits. Even if the *commercial VFD product(s)* that were *actually sold* had a thermal sensor located on a heat sink,⁸ that does not establish such a sensor location *necessarily follows* from the disclosures in Toshiba Manual. Petitioner’s challenge is premised on Toshiba Manual’s disclosure as a “printed publication” per 35 U.S.C. § 102(a)–(b), not on the corresponding commercial product demonstrating a “public use or . . . sale” per 35 U.S.C. § 102(b). *See* Pet. 9–11, 36–38; *see also* 35 U.S.C. § 311(b) (*inter partes* review may be requested “only on the basis of prior art consisting of patents or printed publications”). Moreover, at best for Petitioner, Exhibit 1007 establishes only that locating thermal sensors on a heat sink was one possible implementation of the Toshiba Manual disclosures. Exhibit 1007 does not establish that such a location was necessary, particularly when Loucks suggests measuring the temperature of electrical equipment to provide a controlled cooling of the equipment may be done on various components of the equipment (not just the heat sink), as discussed above.

We find Toshiba Manual does not inherently disclose a thermal sensor located on a heat sink.

⁷ Patent Owner objected to Petitioner’s Slide 62 as containing a new legal proposition and case citation (*see* Paper 25, 3), and objected to Petitioner’s Slide 64 as citing to Exhibit 1002 ¶ 116 for the first time (*see* Paper 25, 4). We do not reach those specific objections, but we do conclude Slides 62 and 64 reflect arguments first raised in the Petitioner Reply, relying on Exhibit 1007 in relation to a VFD heat sink having thermal sensors.

⁸ *See* Ex. 1007, 15, 23, 251, 264, 279–280 (referring to “Heatsink Overheat” and “HEATSINK THERMISTOR”); Pet. Reply 14–15.

*Whether It Would Have Been Obvious To Utilize
a Thermal Sensor Located On a Heat Sink in a VFD*

Finally, we conclude Petitioner's assertions of the obviousness of locating a thermal sensor on a heat sink, based on either Toshiba Manual alone or on Toshiba Manual in combination with Exhibit 1007, improperly present a theory of unpatentability that is not articulated in the Petition.

As an initial matter, the Petition's obviousness analysis confusingly addresses the electric motor diagnostics of claim 1 and the heat sink having thermal sensors of claim 7 together in one section. *See* Pet. 21–25. This complicates determining exactly what Petitioner asserts in relation to claim 7. Yet, “[a] petitioner may not rely on a vague, generic, and/or meandering petition and later fault the Board for failing to understand what the petition really meant” because “it is the petitioner’s burden to present a clear argument.” *Netflix*, 84 F.4th at 1377. Further: “While the Board should review a petition holistically, it is not obligated to ‘cobble together assertions from different sections of a petition or citations of various exhibits in order to infer every possible permutation of a petitioner’s argument[.]’” *Id.* at 1379 (alteration in original).

We conclude the Petition's obviousness analysis as it relates to claim 7 is limited to asserting motivations for utilizing a heat sink having thermal sensors in Coli's VFD, in light of Toshiba Manual allegedly disclosing a VFD including a heat sink having thermal sensors. *See* Pet. 21–25, 36–38; Ex. 1002 ¶¶ 147–158, 184–186. The Petition does not posit Toshiba Manual might fall short of disclosing a VFD including a heat sink having a thermal sensor, nor does the Petition provide any reasoning for why it would have been obvious to include a heat sink having a thermal sensor in

a VFD absent Toshiba Manual’s alleged disclosure in that regard. *See* Pet. 21–25, 36–38; Ex. 1002 ¶¶ 147–158, 184–186. Therefore, the “obvious design choice” argument in the Petitioner Reply, which was provided only “[t]o the extent the Board maintains that Toshiba Manual does not disclose that its heat sink has thermal sensors” (Pet. Reply 16–17), improperly presents a new theory of unpatentability not asserted in the Petition, so we do not consider it in this Decision. *See Intelligent Bio-Sys.*, 821 F.3d at 1369–70 (holding that a petitioner reply was improper for presenting “an entirely new rationale to explain” combining the prior art including “a modification of Zavgorodny” that was not presented in the petition).

The Petition does assert that “heat sinks and temperature monitoring using sensors were well-known long before the ’870 Patent.” Pet. 38 (citing Ex. 1002 ¶¶ 87–95) (cited at Pet. Reply 16). Dr. Durham also refers to “*general engineering knowledge* regarding the operation of [VFDs], power semiconductors (IGBTs), heat sinks, CPUs and control interfaces” as part of concluding “Toshiba Manual discloses a power semiconductor heatsink having thermal sensors.” Ex. 1002 ¶ 124 (emphases added) (cited at Pet. Reply 16). However, the Petition does not assert and Dr. Durham’s supporting testimony does not propose the obviousness of including a heat sink having a thermal sensor in a VFD, absent Toshiba Manual’s alleged disclosure in that regard. *See* Pet. 38; Ex. 1002 ¶¶ 87–95.

We further conclude that Petitioner’s reliance on Exhibit 1007 as supporting a conclusion of obviousness in relation to including a heat sink having a thermal sensor in Coli’s VFD was untimely presented in the Petitioner Reply, for reasons provided above in our analysis of Toshiba Manual’s alleged inherent disclosure.

In short, Petitioner’s assertion of the obviousness of including a heat sink having a thermal sensor in Coli’s VFD absent Toshiba Manual’s alleged disclosure in that regard is an unpatentability theory not presented in the Petition, so we do not consider that assertion here.

(iii) Conclusion as to Claim 7

Thus, based on the record presented, we conclude Petitioner has not shown by a preponderance of the evidence that claim 7 is unpatentable as having been obvious over Coli and Toshiba Manual.

7. Claims 8–16

Claims 8–16 each depend from claim 7. *See* Ex. 1001, 8:37–59.

Petitioner’s additional analysis for these dependent claims does not cure the deficiencies in Petitioner’s case for the parent claim 7, discussed above in Section III.D.6. *See* Pet. 38–45. Therefore, for the reasons provided above in relation to claim 7, we conclude Petitioner has not shown by a preponderance of the evidence that claims 8–16 are unpatentable as having been obvious over Coli and Toshiba Manual.

Nonetheless, we discuss further here Patent Owner’s arguments for the patentability of claims 13, 15, and 16 over Coli and Toshiba Manual separately from claim 7, because these arguments also apply to other Grounds discussed below. *See* PO Resp. 45–53.

(i) Claim 13

Claim 13 depends from claim 7, and adds that an electric power generator, the pump, and the electric motor “are mounted on . . . *a truck*

having at least five axles” to be ported from one well to another. Ex. 1001, 8:40–51 (emphasis added).

Petitioner argues “Figure 3 of Coli clearly depicts a trailer 10 with three axles” for carrying pumps 22 and motors 21. Pet. 41–42 (citing Ex. 1005 ¶ 40); Ex. 1002 ¶ 198. Figure 3 of Coli, as annotated by Petitioner to illustrate this argument, is reproduced below.

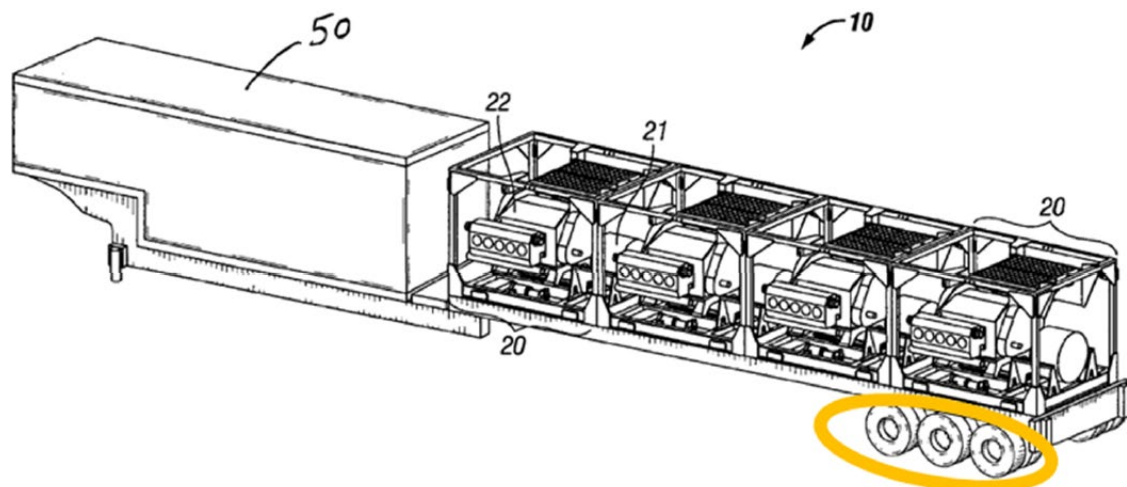


FIG. 3

Figure 3 of Coli (annotated at Pet. 42).

Figure 3 is a schematic perspective view of trailer 10, which Petitioner has annotated with a yellow oval to identify three axles of the trailer, wherein the trailer carries motors 21 and pumps 22. See Ex. 1005 ¶¶ 24, 40, 47.

Petitioner further argues Figure 1 of Coli “discloses ‘[e]ach trailer 5 is attached to a truck 6.’” Pet. 42 (citing Ex. 1005 ¶¶ 7, 37, 39, 78); Ex. 1002 ¶ 198. Dr. Durham testifies a person of ordinary skill in the art “would have understood that any truck pulling the trailer in Coli would have at least two axles,” thereby providing “a vehicle that is *[a] truck-trailer configuration with a total of 5 axles.*” Pet. 42 (emphasis added); Ex. 1002 ¶ 198.

“Additionally,” according to Petitioner and Dr. Durham, it would have been obvious to employ “a ‘unitary’ truck with five axles . . . in view of

[Coli's] disclosure of a three axle semi-trailer intended to be attached to and pulled by a tractor (commonly referred to collectively as a 'tractor-trailer truck,' a 'semi-trailer truck,' and a 'semi-truck')." Pet. 42; Ex. 1002 ¶ 199. This is "because a [person of ordinary skill in the art] would have known that the semi-trailer portion could be permanently attached to the tractor portion of the truck instead of as a detachable trailer, as is done with many commercial trucks." Pet. 42; Ex. 1002 ¶ 199. "Furthermore, a [person of ordinary skill in the art] would have understood that the number of axles used on a vehicle is a simple design choice, with the number of axles to use being determined based on the amount of load that is supported by the axles." Pet. 42–43; Ex. 1002 ¶ 200.

Patent Owner responds that claim 13 requires a "truck" having five axles, not Petitioner's alleged "truck-trailer configuration" having five axles. PO Resp. 45 (citing Pet. 42; Ex. 1001, 8:50–51); Ex. 2002 ¶ 103. Patent Owner asserts the claimed "truck" is distinct from a "trailer," as demonstrated by claim 1 which requires "a trailer for attachment to a truck." PO Resp. 45 (citing Ex. 1001, 7:51, 8:51–52); Ex. 2002 ¶ 106. Patent Owner asserts Dr. Durham's cross-examination testimony to the contrary violates basic principles of claim construction, pursuant to which "[t]he same claim term in different claims of the same patent nearly always has the same meaning" with only "rare exception[s]." PO Resp. 46–47 (citing Ex. 2003, 53:15–54:2, 54:9–13, 55:10–56:4) (case law citations omitted); Ex. 2002 ¶ 107. Therefore, Patent Owner concludes, we should dismiss Dr. Durham's testimony that Coli discloses a truck having at least five axles. PO Resp. 47.

Patent Owner further argues Petitioner’s “‘unitary’ truck” obviousness rationale is insufficient, because “[e]vidence of what could be done is not evidence of obviousness.” PO Resp. 47–48 (citing Pet. 42; Ex. 1002 ¶¶ 198–199; *Polaris Indus., Inc. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1069 (Fed. Cir. 2018); *InTouch Techs., Inc. v. VGo Commc’ns, Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014)). Patent Owner asserts Petitioner’s “simple design choice” obviousness rationale also fails because Petitioner’s “only evidence are conclusory statements from” Dr. Durham. *Id.* at 48–49 (citing Pet. 43; Ex. 1002 ¶ 200). Patent Owner adds that Dr. Durham’s “testimony should be entitled to no weight, especially given his misunderstanding of the claim term ‘truck’” and also because it “provides little to no probative value beyond Petitioner’s attorney argument.” *Id.* at 49 (citing *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 12, at 5 (PTAB Feb. 10, 2023) (Director Review) and other Board decisions).

Petitioner maintains in reply that “Coli discloses a truck-trailer with five axles.” Pet. Reply 22 (citing Ex. 1005 ¶¶ 7, 37, 39, 78). According to Petitioner, Patent Owner “has not asserted that ‘truck’ needs to be construed . . . so the plain meaning applies,” and “[t]he ’870 Patent does not illustrate a truck differently from a truck-trailer.” *Id.* (citing Ex. 2002 ¶ 104). Petitioner then relies on Dr. Durham’s testimony that “Coli’s truck-trailer [falls] within the plain and ordinary meaning of a truck,” and Dr. Nikolaou’s cross-examination testimony “that ‘truck’ is readily understood” without “provid[ing] any defining characteristics of a ‘truck’ other than its ‘size’ and ‘ability to carry things.’” *Id.* (citing Ex. 1002 ¶ 198; Ex. 1054, 259:16–260:10). According to Petitioner, “Coli’s truck-trailer has both the ‘size’ and ‘ability to carry things’ necessary for the pumps to be

‘mounted on [the] vehicles,’ *i.e.*, trucks.” *Id.* (citing Ex. 1001, 2:7–10). Petitioner asserts Patent Owner’s reliance on claim 1 of the ’870 patent is “another red herring — accusing Dr. Durham of construing ‘truck’ differently in different claims” by taking his testimony out of context. *Id.* at 22–23 (citing Ex. 2003, 53:15–54:2, 54:9–13, 55:10–56:8).

Petitioner also maintains that, “[e]ven if Coli does not disclose a truck carrying the claimed equipment,” a person of ordinary skill in the art “would have found it obvious that Coli’s three-axle semi-trailer could be attached to and pulled by a tractor (‘tractor-trailer truck’), and the number of axles on the tractor trailer is simply a design choice.” *Id.* at 23 (citing Ex. 1002 ¶¶ 199–200). Petitioner asserts that “[l]ike the truck-trailer, a ‘tractor trailer’ also reads on to the plain and ordinary meaning of a ‘truck.’” *Id.* (citing Ex. 1002 ¶ 199; Ex. 2003, 57:3–8). Petitioner further argues Dr. Durham’s testimony provides a persuasive explanation in support of Petitioner’s “simple design choice” obviousness rationale. *See id.* (citing Ex. 1002 ¶¶ 161, 198–200; *Uber*, 957 F.3d at 1340).

Patent Owner replies that Petitioner’s alleged “plain and ordinary meaning of a truck” as encompassing “Coli’s truck-trailer” “runs contrary to the plain language of claims 1 and 13” which distinguishes between a “truck” and a “trailer.” PO Sur-reply 23 (citing Pet. Reply 22–23; Ex. 1001, 7:51, 8:51–52; Ex. 2002 ¶¶ 104, 107).

We conclude Petitioner has not satisfied its burden to establish by a preponderance of the evidence that Coli renders obvious an electric power generator, a pump, and a motor being mounted on *a truck having at least five axles*, as recited in claim 13. First, we agree with Patent Owner’s claim construction that the ’870 patent distinguishes between a truck and a trailer.

For example, claim 1 recites “a trailer for attachment to a truck.” Ex. 1001, 2:47–48, 7:51; *see also* Ex. 1005 ¶ 37 (Coli describes its Figure 1 as showing “[e]ach trailer 5 is attached to a truck 6”). The ’870 patent specification similarly describes a trailer as being distinct from a truck, rather than a trailer being part of a truck as Petitioner would have it, in describing how pumps and motors can be “load[ed] . . . directly onto a truck body” as shown in Figure 1, or “[a]lternatively . . . trailers 112 can be used to transport the pumps 110 and electric motors 114” as shown in Figure 2. Ex. 1001, 6:36–55; *see also id.* at 3:38–44 (stating Fig. 1 shows pumps 10 and motors 14 “mounted to pump vehicles 12” which “can be trucks having at least five axles”), 5:49–50 (describing Fig. 2 as “an alternate embodiment”). Thus, we conclude a truck is distinct from a trailer, based on the evidence presented in this proceeding.

We are not persuaded otherwise by Petitioner’s and Dr. Durham’s bewildering array of terms seeking to blur the distinction between trucks and trailers, under the guise of plain and ordinary meaning. Dr. Durham refers to a “semi-trailer” attached to a “tractor” to form a “tractor-trailer truck,” a “semi-trailer truck,” and a “semi-truck.” Ex. 1002 ¶¶ 198–199. However, Dr. Durham does not cite any intrinsic or extrinsic evidence that actually uses those terms, nor does he provide any meaningful explanation of why those combinations would be viewed as a “truck” per claim 13. *See id.*

Second, in light of our claim construction that a truck is distinct from a trailer, we determine Petitioner has not established Coli discloses a truck having at least five axles. Instead, Figure 3 of Coli illustrates trailer 10. *See* Ex. 1005, Fig. 3, ¶¶ 24, 40. It may very well be that trailer 10 is attached to a truck (not shown in Figure 3) to transport the trailer to various locations.

See, e.g., id. ¶¶ 37, 39 (Figs. 1 and 2 show “[m]ultiple trailers 5” where “[e]ach trailer 5 is attached to a truck 6”). Nonetheless, because a truck is distinct from a trailer, the truck being attached to the trailer does not result in a “truck having at least five axles” as required by claim 13.

Third, we determine Petitioner has not established the obviousness of modifying Coli’s system to provide an electric power generator, a pump, and a motor mounted on a truck having at least five axles. Petitioner posits and Dr. Durham testifies that a person of ordinary skill in the art “would have known that the semi-trailer portion [of Coli] *could* be permanently attached to the tractor portion of the truck instead of as a detachable trailer, as is done with many commercial trucks.” Pet. 42–43 (emphasis added); Ex. 1002 ¶ 199. However, the fact that Coli would have allowed for the claimed invention, or possibly could be modified to reach the claimed invention, is not a sufficient reasoning to support obviousness. *See Personal Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 991–92 & 993–94 (Fed. Cir. 2017); *InTouch*, 751 F.3d at 1351–52. Dr. Durham’s testimony, at best, establishes Coli could have been modified predictably to reach the claimed invention, and does not provide a rational underpinning for why this would have been done. *See, e.g., InTouch*, 751 F.3d at 1348–49 (“[The expert witness’s] testimony was nothing more than impermissible hindsight; she opined that all of the elements of the claims disparately existed in the prior art, but failed to provide the glue to combine these references.”).

Petitioner’s “simple design choice” rationale similarly is lacking in evidentiary support, apart from Dr. Durham’s conclusory testimony. Pet. 42–43 (citing Ex. 1002 ¶ 200). Indeed, Dr. Durham does not even cite any evidence that might suggest trucks having at least five axles were known

to be used for any particular purpose prior to the '870 patent. *See* Ex. 1002 ¶¶ 199–200. This conclusory testimony does not provide a preponderance of the evidence upon which we might find such a large number of axles on one truck was, indeed, a simple design choice to support the weight of the elements required by claim 13 to be mounted on the truck. *See* 37 C.F.R. § 42.65(a) (“Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.”); *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9, at 15–16 (PTAB Aug. 24, 2022) (precedential). The case before us, unlike the *Uber* decision cited by Petitioner, does not involve picking between only two possible solutions. *See* 957 F.3d at 1340–41.

Dr. Durham does refer to the Board’s ’601 Patent Decision, which he says “found a substantially similar claim of the ’601 Patent to be disclosed by Coli.” Ex. 1002 ¶ 200 (citing Ex. 1048, 43). However, the pertinent claim limitation of the ’601 patent recited “wherein *the trailer* has *three* axles.” Ex. 1048, 43 (emphases added). This is hardly substantially similar to a truck having at least five axles, as discussed above.

In summary, we conclude Petitioner has not shown by a preponderance of the evidence that claim 13 is unpatentable as having been obvious over Coli and Toshiba Manual, due to deficiencies in Petitioner’s reliance on Toshiba Manual for the heat sinks having thermal sensors recited in parent claim 7, and deficiencies in Petitioner’s reliance on Coli for the truck having at least five axles recited in claim 13.

(ii) *Claim 15*

Claim 15 depends from claim 7, and adds that “the electric motor has a maximum *continuous* power output of about 1750 brake horsepower or more.” Ex. 1001, 8:55–57 (emphasis added).

Petitioner argues “Coli discloses that the motor ‘can deliver a true 2500 hp directly to each pump 22 because pump 22 is directly coupled to electric motor 21.” Pet. 44 (citing Ex. 1005 ¶ 49); Ex. 1002 ¶ 203.

Dr. Durham testifies that a person of ordinary skill in the art “would have recognized that Coli discloses the ‘electric motor has a maximum continuous power output of about 1750 horsepower or more.’” Pet. 44; Ex. 1002 ¶ 203.

Patent Owner responds that Petitioner has not shown Coli discloses a motor having a maximum *continuous* power output of about 1750 brake horsepower or more, as required by claim 15. *See* PO Resp. 49–52. Patent Owner asserts Petitioner and Dr. Durham present only “a cursory explanation of how [Coli] supposedly discloses claim 15,” which is deficient. *Id.* at 49–50 (citing Pet. 44; Ex. 1002 ¶ 203). Patent Owner argues and Dr. Nikolaou testifies that the Coli paragraph quoted by Petitioner and Dr. Durham “does not disclose the ‘maximum *continuous* power’ of Coli’s motor, but rather only the maximum *instantaneous* power, or *peak power*.” *Id.* at 50 (emphases modified); Ex. 2002 ¶ 109.

Dr. Nikolaou testifies in support that “[t]he word ‘continuous’ is not present in the [Coli] sentence, and there is a difference between maximum horsepower and maximum *continuous* horsepower.” Ex. 1009 ¶¶ 109–114; *see* PO Resp. 60. Patent Owner asserts Dr. Durham agrees with Dr. Nikolaou on this point. *See* PO Resp. 50–52 (citing Ex. 2003, 42:4–43:1, 43:19–21, 44:9–18, 46:8–18, 88:10–16).

Petitioner maintains in reply that Coli's motor has a maximum continuous power output of about 1750 brake horsepower or more. *See* Pet. Reply 23–25. Petitioner asserts that “to invalidate this system claim, Coli need not disclose a method where a specific ‘maximum continuous power output’ is achieved,” and instead “a [person of ordinary skill in the art] need only understand Coli to disclose a system in which the motor could achieve the claimed maximum continuous power output.” *Id.* at 5, 24 (citing *Hewlett-Packard Co. v. Bausch & Lomb Inc.*, 909 F.2d 1464, 1468 (Fed. Cir. 1990) (“[A]pparatus claims cover what a device *is*, not what a device *does*.”)).

Petitioner then argues Patent Owner's opposition is based on the “implicit and incorrect claim construction” that “would exclude Coli's ‘true 2500 hp’ because Coli does not state that it is maintained during the entire fracturing operation.” *Id.* at 24. Petitioner asserts Patent Owner “fails to clarify how long ‘continuous’ requires,” and “Dr. Nikolaou testified that a fracturing pump need not operate at a single horsepower throughout the entire operation” which “confirm[s] that [Patent Owner's] interpretation is too narrow.” *Id.* (citing Ex. 1054, 264:1–16).

Petitioner next cites Coli's claim 28, as “describ[ing] a motor ‘capable of operating at 2500 hp **during fracturing operation**,’ *i.e.*, continuously, even under [Patent Owner's] interpretation.” Pet. Reply 24. Petitioner asserts “Coli also discloses that conventional diesel systems typically ‘only provide 1800 hp’ to pumps after parasitic losses,” whereas Coli's system “reduces those losses, such that it ‘can deliver a true 2500 hp directly to each pump.’” *Id.* (citing Ex. 1005 ¶ 49). Petitioner concludes a person of

ordinary skill in the art “would have understood that Coli’s motor can output its full 2500-hp rating.” *Id.* at 24–25 (citing Ex. 1002 ¶ 203).

Patent Owner replies that it is insufficient for Coli to disclose “only a system that *could* achieve” the required maximum continuous power output, because Petitioner’s burden is “to show each limitation is disclosed, not that there is a mere possibility that a system could meet the limitations.”

PO Sur-reply 23 (citing Pet. Reply 24; *Dynamic Drinkware*, 800 F.3d at 1378–79; *Nautilus Hyosung Inc. v. Diebold, Inc.*, IPR2016-00633, Paper 9, at 21 (PTAB Aug. 22, 2016)). Patent Owner then asserts Petitioner has not shown Coli’s motor can achieve the required maximum continuous power output, even if only the capability to do so is required. *See id.* at 24.

We conclude Petitioner has not satisfied its burden to establish by a preponderance of the evidence that Coli discloses a motor having a maximum continuous power output of about 1750 brake horsepower or more, as recited in claim 15. As a matter of claim construction, Dr. Durham and Dr. Nikolaou appear to agree that the term “continuous” in claim 15 requires that the motor can output at least 1750 horsepower for *some minimum amount of time* (albeit unspecified in the record presented), not just *at one moment in time*. *See* PO Resp. 50–52 (discussing Ex. 2002 ¶¶ 108–114 and Ex. 2003, 42:4–43:1, 43:19–21, 44:9–18, 46:8–18, 88:10–16). For example, Dr. Durham testified on cross-examination as follows:

Q. Does an electric motor have a limit on its input current for continuous operation that is different than a limit for [an] instantaneous or short time period operation?

A. Yes, sir, it does.

- Q. Okay. · So using those different limits applied to the same electric motor, *would there be a difference in horsepower at the continuous limit and the limit for a shorter period of time?*
- A. All else being equal, *those are likely to be different horsepower.* · It would really depend on the particular motor design and the protection scheme in place.

Ex. 2003, 46:8–20 (emphases added).

Petitioner does not materially dispute this understanding of the expert testimony as to the meaning of the term “continuous.” *See* Pet.

Reply 23–25. Petitioner only states that the experts do not “clarify how long ‘continuous’ requires.” *Id.* at 24. That is true, but it overlooks that Petitioner bears the burden to demonstrate unpatentability. *See* 35 U.S.C. § 316(e); *Dynamic Drinkware*, 800 F.3d at 1378. Thus, our Rules require a petition must set forth “[h]ow the challenged claim is to be construed” as well as “[h]ow the construed claim is unpatentable under the statutory grounds.” 37 C.F.R. § 42.104. As applied here, Petitioner must establish how Coli discloses a motor having a maximum continuous power output of about 1750 brake horsepower or more. To the extent there is lack of clarity in the minimum amount of time required to determine a “maximum *continuous* power output,” this is a problem for Petitioner not Patent Owner. The expert witness testimony cited by Petitioner does not aid Petitioner in this regard. *See* Pet. Reply 24; Ex. 1054, 264:1–16 (Dr. Nikolaou was asked whether “a fracturing pump has to operate continuously throughout the entire fracturing operation,” and he answered it “is not one size fits all”); Ex. 2003, 88:4–89:3 (Dr. Durham’s testimony concerning whether the Toshiba GX7 VFD could power pumps of varying horsepower ratings either “for a period of time” or “continuously”).

Now turning to the prior art, Coli states “the present system can *deliver a true 2500 hp* directly to each pump 22.” Ex. 1005 ¶ 49 (emphasis added). Dr. Durham provides no persuasive explanation for his bare conclusion that a person of ordinary skill in the art would have understood from this disclosure that Coli’s motor has a maximum *continuous* power output of about 1750 brake horsepower or more. *See* Ex. 1002 ¶ 203. In particular, he does not discuss how Coli’s described “true 2500 hp” informs a person of ordinary skill in the art that Coli’s motor might be capable of outputting 1750 horsepower or more for any particular minimum amount of time. *See id.* Thus, on the record presented, Petitioner has not established paragraph 49 of Coli describes a motor that satisfies the requirement of claim 15.

Petitioner cites the Board’s ’601 Patent Decision as previously deciding Coli’s paragraph 49 discloses a similar limitation to the one at issue here. *See* Pet. 44 (citing Ex. 1048, 41); Pet. Reply 25 (arguing “the Board previously decided that Coli discloses a similar limitation based on this disclosure”). The pertinent claim limitation of the ’601 patent was indeed similar, in reciting “the electric motor has a maximum continuous power output of about 1500 horsepower or more.” Ex. 1048, 41. However, “Patent Owner [did] not contest this aspect of the Petition,” so we concluded that “on this record, Coli supports Petitioner’s contentions.” *Id.* (citing Coli’s paragraph 49). In the present case, by contrast, Patent Owner does contest this aspect of the Petition’s reliance on Coli’s paragraph 49, with supporting expert witness testimony. *See* Ex. 2002 ¶¶ 108–115.

The Petitioner Reply additionally cites claim 28 of Coli, which states Coli’s “motor is capable of *operating at 2500 hp during fracturing*

operations.” Ex. 1005, claim 28 (emphasis added). However, Dr. Durham’s testimony does not address claim 28 at all. *See* Ex. 1002 ¶ 203. Further, Petitioner’s conclusory assertion that “claim 28 describes a motor ‘capable of operating at 2500 hp *during fracturing operation*,’ *i.e.*, continuously”⁹ does not explain why claim 28 informs a person of ordinary skill in the art that Coli’s motor might be capable of outputting 1750 horsepower or more for any particular minimum amount of time. Thus, on the record presented, Petitioner has not established claim 28 of Coli describes a motor that satisfies the requirement of claim 15.

In summary, we conclude Petitioner has not shown by a preponderance of the evidence that claim 15 is unpatentable as having been obvious over Coli and Toshiba Manual, due to deficiencies in Petitioner’s reliance on Toshiba Manual for the heat sinks having thermal sensors recited in parent claim 7, and deficiencies in Petitioner’s reliance on Coli for the motor recited in claim 15.

(iii) *Claim 16*

Claim 16 depends from claim 7, and adds that “the electric motor has a maximum *continuous* torque of about 8750 lb-ft or more.” Ex. 1001, 8:58–59 (emphasis added).

Petitioner argues “Coli discloses that the ‘electric motor can be capable of operation in the range of up to 1500 rpms and up to 20,000 ft/lbs of torque.” Pet. 44 (citing Ex. 1005 ¶ 11); Ex. 1002 ¶ 204. Dr. Durham

⁹ Petitioner asserts Patent Owner’s “implicit” construction of claim 15 is that the motor must maintain the specified horsepower output “during the entire fracturing operation.” Pet. Reply 24. We do not discern this implicit construction in Patent Owner’s analysis of claim 15. *See* PO Resp. 49–52.

testifies that “the unit of torque is ft-lb, as recited in” claim 16, whereas Coli’s disclosure contains “a typo . . . insofar as it expresses torque in ft/lbs, as opposed to ft-lbs.” Pet. 44 n.6; Ex. 1002 ¶ 108 n.1, ¶ 204 n.4.

Dr. Durham further testifies that a person of ordinary skill in the art “would have recognized that Coli discloses an ‘electric motor has a maximum continuous torque of about 8750 ft-lb or more’” as claimed. Pet. 44–45; Ex. 1002 ¶ 204.

Patent Owner responds that Petitioner has not shown Coli discloses a motor having a maximum *continuous* torque of about 8750 lb-ft or more, as required by claim 16. See PO Resp. 52–53; Ex. 2002 ¶¶ 116–121. Patent Owner’s reasoning is substantially the same as discussed above in relation to claim 15’s recitation of a maximum continuous power output, re-cast to claim 16’s recitation of a maximum continuous torque. See PO Resp. 52–53. The ensuing arguments are cast in the same mold. See Pet. Reply 25; PO Sur-reply 23–24.

For substantially the same reasons discussed above in Section III.D.7(ii) in connection with claim 15, we conclude Petitioner has not satisfied its burden to establish by a preponderance of the evidence that Coli discloses a motor having a maximum *continuous* torque of about 8750 lb-ft or more, as recited in claim 16. Therefore, Petitioner has not shown claim 16 is unpatentable as having been obvious over Coli and Toshiba Manual, due to deficiencies in Petitioner’s reliance on Toshiba Manual for the heat sinks having thermal sensors recited in parent claim 7, and deficiencies in Petitioner’s reliance on Coli for the motor recited in claim 16.

E. Ground Two — 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 disagrees, focusing on Petitioner’s reliance on Horikoshi. *See* PO Resp. 1, 4–6, 7–8, 37–38, 44. We conclude a preponderance of the evidence supports Petitioner’s assertions as to all challenged claims 1–6, for the following reasons.

1. Summary of Horikoshi

Horikoshi describes a “motor driving apparatus” that provides an AC power supply to a motor. Ex. 1008, code (54), ¶ 4. Horikoshi’s 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, on the next page) illustrates such an apparatus.

Fig.5

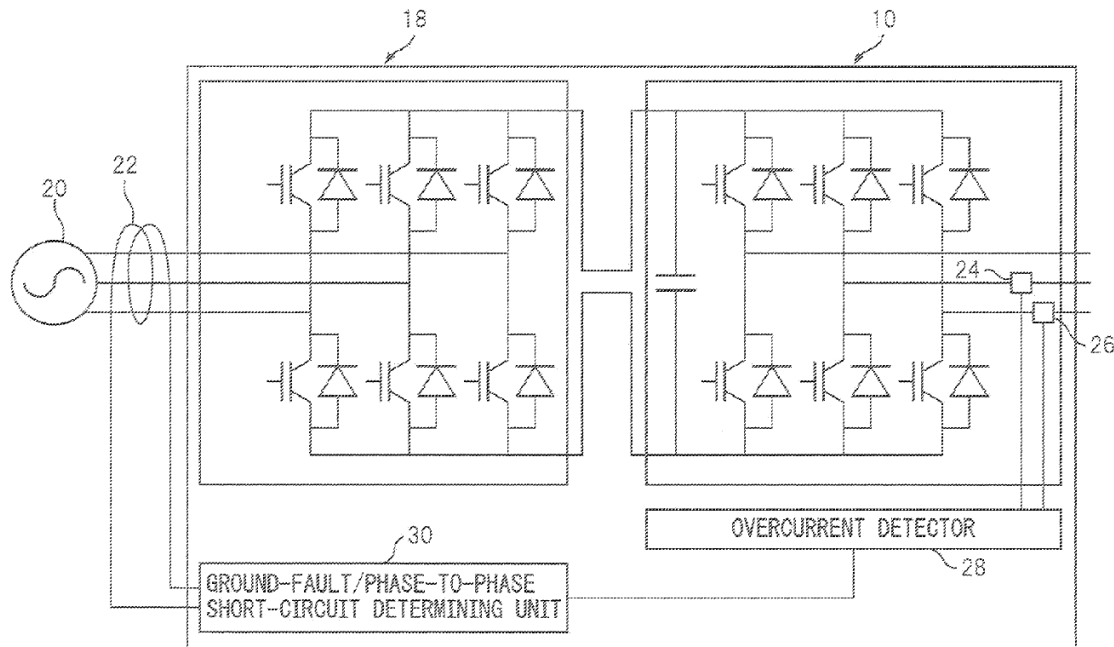


Figure 5 of Horikoshi.

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. Claim 1

Petitioner provides arguments and evidence in support of contending 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 opposes. *See* PO Resp. 1, 4–6, 7–8, 37–38, 44; Ex. 2002 ¶¶ 46, 61.

We first address the meaning of “electric motor diagnostics” in claim 1. Then we discuss Petitioner’s reliance on Coli, which is not opposed by Patent Owner. Next, we turn to Petitioner’s reliance on Horikoshi, and Patent Owner’s opposition thereto. We finally address Petitioner’s contentions as to the motivation(s) for combining Coli and Horikoshi, which are not opposed by Patent Owner. We ultimately conclude a preponderance of the evidence supports Petitioner’s assertions.

(i) *Claim Construction — “electric motor diagnostics”*

Claim 1 requires a VFD that “performs electric motor diagnostics to prevent damage to the one or more electric motors.” Ex. 1001, 7:58–61.

We have construed this limitation above in Section III.D.3(i), when addressing Petitioner’s reliance on Toshiba Manual in Ground One, to refer to diagnostics for the electric motor and not to some other component in the system. Now, to address Petitioner’s reliance on Horikoshi in Ground Two, we additionally consider the meaning of the term “diagnostics” (plural).

Patent Owner argues “Horikoshi discloses only one ‘electric motor diagnostic’ — not the multiple ‘diagnostics’ required by the claim.” PO Resp. 1, 38 (“[T]he Board [in the Institution Decision] never considered that [Horikoshi] discloses only a single, ‘electric motor diagnostic.’”); Ex. 2002 ¶¶ 46, 61. Patent Owner asserts the Institution Decision applied this understanding of the claim term “diagnostics” as “requiring more than one diagnostic.” PO Resp. 44 (citing Inst. Dec. 21).

Petitioner argues Patent Owner “fails to clarify what it means by ‘more than one diagnostic’ or how Horikoshi fails to disclose it.” Pet. Reply 4. Petitioner also asserts “the record does not support [Patent Owner’s] narrow interpretation” that claim 1 “requires multiple different types of diagnostics simply because the word ‘diagnostics’ is plural.” *Id.* Petitioner maintains Horikoshi “discloses ‘plural’ ‘electric motor diagnostics’ because it discloses performing its electric motor diagnostic multiple times.” *Id.* at 5. Petitioner adds that the Board’s ’601 Patent Decision “already found Horikoshi discloses ‘electric motor diagnostics.’” *Id.* at 5 & n.3 (citing Ex. 1048, 23–29).

Patent Owner replies that the Petitioner Reply improperly advances a new patentability theory by contending that Horikoshi teaches diagnostics “because it performs a single ‘fault diagnostic **more than once over the life of the VFD.**’” PO Sur-reply 15 (citing Pet. Reply 5; Pet. 45–50; *Intelligent Bio-Sys.*, 821 F.3d at 1370; *Netflix*, 84 F.4th at 1381). In particular, according to Patent Owner, Petitioner’s “new claim construction” that “the claimed ‘diagnostics’ do not require different types of diagnostics, but rather performing the same diagnostic multiple times” should not be considered. *Id.* at 16 (citing Pet. Reply 4–5). Patent Owner concludes “[t]he Board should maintain that ‘diagnostics’ requires more than one diagnostic.” *Id.* (citing Inst. Dec. 21).

Patent Owner also maintains on the merits that Petitioner’s claim construction is inconsistent with the intrinsic evidence, “which refers to multiple ‘*diagnostics*’ that can be performed or disabled.” *Id.* Patent Owner cites the ’870 patent specification disclosures that “motor diagnostics can be performed frequently” and “[t]he electric motor diagnostics can be disabled.” Ex. 1001, 4:20–23; *see* PO Sur-reply 16. Patent Owner adds that Petitioner’s claim construction is unsupported by expert testimony. *See id.* at 16 n.6 (citing Ex. 1002 ¶¶ 86, 129, 215–217; Ex. 1054, 255:21–258:9). Patent Owner also argues the Board’s ’601 Patent Decision “never considered the argument that Horikoshi does not disclose the claim ‘diagnostics’ (plural) because Patent Owner never made the argument.” *Id.* at 17 (citing Ex. 1048, 23–29).

We hold that the plural term “diagnostics” requires more than one diagnostic to be performed, per its plain and ordinary meaning. *See Apple Inc. v. MPH Techs. Oy*, 28 F.4th 254, 261–62 (Fed. Cir. 2022) (“In

accordance with common English usage, we presume a plural term refers to two or more items.” (citations omitted)).

We disagree with Patent Owner’s contentions that would either: (1) limit the plural “diagnostics” to require performing more than one type of diagnostic; or (2) exclude from the plural “diagnostics” the performing of one type of diagnostic multiple times.¹⁰ The ’870 patent specification pertinently discloses only that “motor diagnostics can be performed frequently (e.g., on the application of power, or with each start)” and “[t]he electric motor diagnostics can be disabled.” Ex. 1001, 4:20–25. Read in a light most favorable to Patent Owner’s position, the plural term “diagnostics” in that description may refer to performing multiple types of diagnostics each time the diagnostics are performed, rather than equating the plural term “diagnostics” to performing a single diagnostic frequently. Nonetheless, “[w]e depart from the plain and ordinary meaning of claim terms based on the specification in only two instances: lexicography and disavowal,” both of which require meeting “exacting” standards. *Hill-Rom*

¹⁰ We also reject Patent Owner’s position that Petitioner’s raising of this second issue in the Petitioner Reply was improper. In the Petition, Petitioner relied on Horikoshi as disclosing the performance of electric motor diagnostics. *See* Pet. 44–50. The Petitioner Reply then explained in more detail why that is so, including a rebuttal of Patent Owner’s limiting claim construction. *See* Pet. Reply 4–5. This is not a new theory of unpatentability. By contrast, in the *Intelligent Bio-Systems* decision cited by Patent Owner, the petitioner reply had relied on an entirely new rationale to explain a motivation for obviousness. *Intelligent Bio-Sys.*, 821 F.3d at 1369–70. Patent Owner asserts the court there stated “Petitioners ‘cannot raise new claim construction issues that were not previously raised in its petition’” (PO Sur-reply 16), but we were unable to find that statement or anything similar in the decision.

Servs., Inc. v. Stryker Corp., 755 F.3d 1367, 1371 (Fed. Cir. 2014). We find “no words of manifest exclusion or restriction” in the ’870 patent specification so as to result in lexicography or disavowal in this case. *Id.*

In the Institution Decision, we concluded Toshiba Manual’s VFD performs the claimed electric motor diagnostics (plural) by performing multiple types of diagnostics, and we have maintained that conclusion in the present Decision. *See* Inst. Dec. 21; *supra* Section III.D.3(iii)(b). However, we did not then and we do not now hold that claim 1 is *limited to require* performing multiple types of diagnostics, as Patent Owner asserts.

In summary, we conclude claim 7 requires more than one electric motor diagnostic to be performed. In exemplary embodiments, this might be achieved by performing more than one type of diagnostic, or by performing one type of diagnostic multiple times.

(ii) *Comparing Claim 1 with Coli*

The disclosure of Coli as it compares with the subject matter of claim 1 is discussed above in Section III.D.3(ii) in relation to Ground One. *See* Pet. 45, 48 (for Ground Two, referring back to Ground One for the disclosure of Coli pertinent to claim 1). In particular, we find Coli discloses the subject matter of claim 1, except Coli’s VFD is not disclosed as “perform[ing] electric motor diagnostics to prevent damage to” the electric motor as claimed.

(iii) *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, 223–227.

Specifically, according to Petitioner and Dr. Durham, Horikoshi’s VFD “can reliably detect any overcurrent occurring in the DC/AC converter” of the VFD, which “is a potential source of damage to an electric motor” driven by the VFD. Pet. 46 (citing Ex. 1008 ¶ 4); Ex. 1002 ¶¶ 210–211. Petitioner asserts and Dr. Durham testifies that Horikoshi’s VFD then “protect[s] the motor from damage” by employing “a fault diagnostic function capable of detecting during operation a ground fault and a phase-to-phase short circuit by distinguishing one from the other” as the cause of the detected overcurrent. Pet. 46, 48–50 (citing Ex. 1008 ¶¶ 2, 4, 6, 8, 10, 11); Ex. 1002 ¶¶ 211–213, 225–226.

Patent Owner responds and Dr. Nikolaou testifies that “Horikoshi discloses only one ‘electric motor diagnostic’ — not the multiple ‘diagnostics’ required by” claim 1. PO Resp. 1, 38 (“[T]he Board [in the Institution Decision] never considered that [Horikoshi] discloses only a single, ‘electric motor diagnostic.’”); Ex. 2002 ¶¶ 46, 61. Patent Owner and Dr. Nikolaou rely on Horikoshi’s description stating that “[t]he present invention relates to a motor driving apparatus having a *fault diagnostic* function” and “a motor driving apparatus *having a fault diagnostic* function capable of detecting during operation a ground fault and a phase-to-phase short circuit by distinguishing one from the other.” Ex. 1008 ¶¶ 2, 11 (emphasis by Patent Owner at PO Resp. 44); Ex. 2002 ¶ 61 (stating Horikoshi “discloses only a single, electric motor diagnostic to detecting a ground fault and a phase-to-phase short circuit by distinguishing one from the other”); *see also* PO Resp. 7–8 (summarizing Horikoshi’s fault diagnostic function).

Petitioner replies that “the Board already found Horikoshi discloses ‘electric motor diagnostics’” in the Board’s ’601 Patent Decision, “and should do the same here.” Pet. Reply 5 & n.3 (citing Ex. 1048, 23–29). Petitioner further maintains that “Horikoshi also discloses ‘plural’ ‘electric motor diagnostics’ because it discloses performing its electric motor diagnostic multiple times . . . ‘during operation,’” “so *Horikoshi* must perform the fault diagnostic more than once over the life of the VFD.” *Id.* at 5 (citing Ex. 1008 ¶ 11). Petitioner asserts the expert witnesses agree on this point. *See id.* (citing Ex. 1002 ¶¶ 86, 129, 215–217; Ex. 1054, 255:21–258:9).

Patent Owner responds that the Board’s ’601 Patent Decision “never considered the argument that Horikoshi does not disclose the claim ‘diagnostics’ (plural) because Patent Owner never made the argument.” PO Sur-reply 17 (citing Ex. 1048, 23–29). Patent Owner also asserts “Petitioner’s theory that the claimed ‘diagnostic[s]’ is satisfied by a single diagnostic being performed repeatedly is unsupported by” testimony from the expert witnesses. PO Sur-reply 16 n.6 (citing Ex. 1002 ¶¶ 86, 129, 215–217; Ex. 1054, 255:21–258:9). Patent Owner concludes “None of [Petitioner’s] citations show Horikoshi’s diagnostic performed more than once, but rather the fault diagnostic continuously monitors the system.” *Id.*

We conclude a preponderance of the evidence supports Petitioner’s contention that Horikoshi discloses a VFD that performs electric motor diagnostics to prevent damage to the motor that is driven by the VFD. Specifically, Horikoshi discloses a motor driving apparatus (i.e., a VFD) that provides an AC power supply to a motor, and also implements a fault diagnostics function that detects an overcurrent being supplied to the motor

and determines 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, 210–213, 223–226. This matches 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).

As to the claim requirement for “diagnostics” (plural), we agree with Petitioner’s contention that Horikoshi performs more than one diagnostic because it performs its fault diagnostic function multiple times “during operation.” Ex. 1008 ¶ 11; Pet. Reply 5. Dr. Durham correspondingly explains that “Horikoshi describes the system monitoring *a fault that occurs momentarily*, in operation on only part of a cycle *and then clears.*” Ex. 1002 ¶¶ 86, 129 (emphases added) (citing Ex. 1008, Figs. 2 and 4). That is, each time Horikoshi’s overcurrent detector 28 detects an overcurrent, Horikoshi’s determining unit 30 determines whether the overcurrent was caused by a short circuit or a ground fault. *See* Ex. 1008, Fig. 5, ¶¶ 28–29. Horikoshi’s determination then “clears” (Ex. 1002 ¶ 86) and continues to monitor the current being supplied to a motor “during operation” (Ex. 1008 ¶ 11), waiting for a second overcurrent to be detected at which time Horikoshi determines whether the second overcurrent is caused by a short circuit or a ground fault. In this way, we are persuaded by Dr. Durham’s testimony that Horikoshi performs its fault diagnostic function multiple times during operation.

Moreover, to the extent Patent Owner’s opposition relies on Patent Owner’s proffered claim construction of “electric motor diagnostics” to require performing more than one type of diagnostic (*see* PO Sur-reply 15;

Ex. 2002 ¶ 61), we have rejected that claim construction for reasons provided above in Section III.E.2(i). Thus, Patent Owner’s objection to Horikoshi’s disclosure in this regard relies on unclaimed subject matter, and therefore is unavailing.

For the foregoing reasons, we conclude a preponderance of the evidence supports Petitioner’s contention that Horikoshi discloses a VFD that performs electric motor diagnostics to prevent damage to the motor that is driven by the VFD.

(iv) Motivation to Perform Electric Motor Diagnostics in Coli’s VFD, in light of Horikoshi’s VFD

Petitioner contends and Dr. Durham testifies that “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, 222. 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 short circuit or a ground fault per Horikoshi. See Pet. 46, 48–49 (citing Ex. 1008 ¶¶ 2, 4, 6); Ex. 1002 ¶¶ 210–213. According to Petitioner, this would have been done in order to protect the motor from damage, as disclosed by Horikoshi. See Pet. 46–48, 49–50 (citing Ex. 1008 ¶¶ 4, 8, 10–11; Ex. 1001, 2:36–39); Ex. 1002 ¶¶ 209, 211–214, 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 agree with Petitioner’s foregoing contentions, which we conclude are supported by a preponderance of the evidence cited by Petitioner, as summarized here. Patent Owner’s sole opposition to these contentions is Patent Owner’s objection to Petitioner’s reliance on Horikoshi’s disclosure, which we have determined is unavailing for reasons provided above in Section III.E.2(iii).

(v) *Conclusion as to Claim 1*

Thus, based on the record presented, we conclude Petitioner has shown by a preponderance of the evidence that claim 1 is unpatentable as having been obvious over Coli and Horikoshi.

3. *Claims 2–6*

For claims 2–6, Petitioner relies on its analysis of overlapping subject matter in claim 1 as discussed above in Section III.E.2, and further asserts all other elements in claims 2–6 are disclosed or rendered obvious by Coli as explained in Ground One. *See* Pet. 45. Patent Owner does not oppose those contentions, apart from arguments we have already considered above in relation to claim 1. *See* PO Resp. *generally*. For the reasons provided above in Section III.E.2 in the context of claim 1, we conclude Patent Owner’s arguments are unavailing. We further adopt Petitioner’s additional analysis for the obviousness of claims 2–6 as our own in this Decision, and we accordingly conclude Petitioner has demonstrated by a preponderance of the evidence that claims 2–6 are unpatentable as having been obvious over Coli and Horikoshi.

F. Ground Three — 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 disagrees, focusing on Petitioner's reliance on Loucks, and Petitioner's motivations for the combination. *See* PO Resp. 1, 4–6, 8–10, 13, 18–21, 28–37. Patent Owner also argues for the patentability of dependent claims 13, 15, and 16 separately from their common parent claim 7. *See id.* at 45–53. We conclude a preponderance of the evidence supports Petitioner's assertions as to claims 7–12 and 14, but not as to claims 13, 15, and 16, for the following reasons.

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.

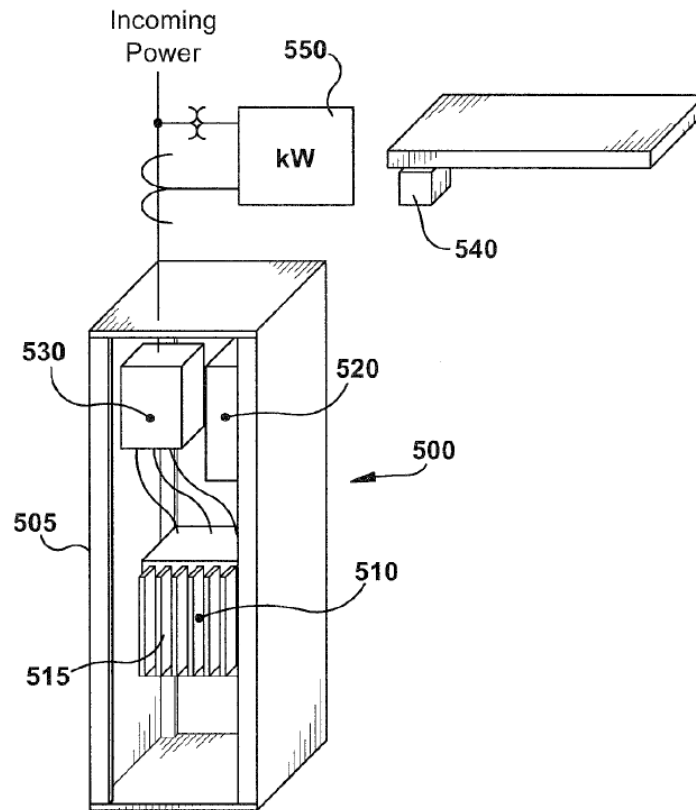


Fig. 5

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 of an electrical equipment cooling system. *See id.* ¶¶ 4, 63.

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

(i) *Statement of Law*

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 Deutschland GmbH v. Mylan Pharms. Inc.*, 66 F.4th 1373, 1377–78 (Fed. Cir. 2023).

Petitioner bears the burden of persuasion to establish Loucks is analogous art to the '870 patent. *See Sanofi-Aventis*, 66 F.4th at 1377 (“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.* at 1378–79 (“We have routinely held that the petitioner has the burden of proving unpatentability.”).

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

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* PO Resp. 28, 29 (citing Ex. 1001, 1:23–26); Ex. 2002 ¶ 100. In particular, the '870 patent describes its “Field” as “hydraulic fracturing in oil and gas wells.” Ex. 1001, 1:21–26. Petitioner does not dispute this determination. *See* Pet. Reply 17–19 (Petitioner’s argument concerning analogous art).

Patent Owner also argues and Dr. Nikolaou testifies that “Loucks is drawn to the [different] field of endeavor of measuring changes in cooling

performance for server IT equipment.” PO Resp. 29 (citing Ex. 1009, Fig. 1, code (57)); Ex. 2002 ¶ 100. We disagree. We conclude 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. Petitioner does not dispute this determination. *See* Pet. Reply 17–19 (Petitioner’s argument concerning analogous art).

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

Patent Owner argues Loucks is not reasonably pertinent to the particular problem facing the inventors of the ’870 patent. *See* PO Resp. 29–32. Patent Owner asserts and Dr. Nikolaou testifies that “the only problem[s] identified by the inventors of the 870 patent” are “‘the problems associated with diesel pumps,’ which are addressed by using a ‘pump system for hydraulic fracturing fluid’ that includes a VFD and electric motor.” PO Resp. 30 (citing Ex. 1001, 1:23–26, 1:44–54; Ex. 1002 ¶ 40); Ex. 2002 ¶ 101. Further according to Patent Owner and Dr. Nikolaou, “any additional problem would be limited to those problems when *implementing a portable VFD*.” PO Resp. 30 (emphasis added) (citing Ex. 1001, Fig. 1, 1:40–51, 3:38–63); Ex. 2002 ¶ 101.

Patent Owner then argues and Dr. Nikolaou testifies that “Loucks is not reasonably pertinent to either problem described above.” PO Resp. 30; Ex. 2002 ¶ 102. This is because “Loucks addresses the problem of detecting cooling problems in the environment in room and/or data centers” and

“Loucks does not describe any portable equipment.” PO Resp. 30–31 (citing Ex. 1009 ¶¶ 18, 24, 26); Ex. 2002 ¶ 102.

Patent Owner objects to our conclusion in the Institution Decision that Loucks is reasonably pertinent to a problem facing the inventors of the ’870 patent, because the “only nexus between the problem [the Board] defined and [Loucks’s] disclosures is that [Loucks] includes a VFD — nothing more.” PO Resp. 31 (citing Inst. Dec. 42); Tr. 45:14–46:4 (Patent Owner’s counsel stating this argument should have referred to “Loucks” not “Coli”). Patent Owner maintains that “[u]sing a VFD is insufficient to show prior art is analogous given VFDs are ubiquitous” and that “[n]othing in these disclosures [of the ’870 patent] mentions that the VFD needs to be cooled.” PO Resp. 31–32 (citing Ex. 1001, 1:24–26, 1:52–54, 2:5–7, 2:21–22, 4:8–25; Ex. 2003, 7:16–13:8; *Sanofi-Aventis*, 66 F.4th at 1378). Indeed, according to Patent Owner, “the ’870 Patent’s only mention of temperature is that [the] VFD needs to be monitored against ‘excessive heat’ — not to be kept cool” and “nothing in the ’870 Patent would have conveyed to a [person of ordinary skill in the art] that the VFDs described in the ’870 Patent . . . need to be cooled.” *Id.* at 32 (citing Ex. 1001, 4:1–3, 4:10–16).

Petitioner responds: “As the Board has already found, Loucks is reasonably pertinent to the problem addressed in the ’870 Patent’ of “implementing VFDs and electric motors in the field of hydraulic fracturing.” Pet. Reply 17 (citing Ex. 1001, 1:24–26, 2:5–7, 4:8–25; Ex. 1002 ¶¶ 40–41). According to Petitioner, “[n]othing in the ’870 Patent requires the VFD to be ‘portable’” as Patent Owner would have it. *Id.* at 18 (citing Ex. 1054, 120:8–121:3).

Petitioner maintains that “techniques for implementing VFDs and electric motors in other fields, including those of Loucks, would have been reasonably pertinent to that problem,” and cites Dr. Durham’s testimony in support. *Id.* at 17 (citing Ex. 1002 ¶¶ 132, 234–235). Petitioner asserts “Loucks states that its methods ‘may be used on *any* device that consumes electrical energy and exhausts waste heat.’” *Id.* at 17–18 (quoting Ex. 1009 ¶ 60 (emphasis by Petitioner)). Petitioner moreover disagrees with Patent Owner’s alleged distinction between preventing damage to electrical equipment caused by excessive heat as described in the ’870 patent, and cooling of electrical equipment as described in Loucks. *See id.* at 18–19 (citing PO Resp. 32; Ex. 1002 ¶¶ 87–95; Ex. 1009, code (54), ¶ 60; Ex. 1054, 36:17–37:7; Ex. 2002 ¶ 102).

Patent Owner replies that “Loucks is non-analogous art according to Dr. Nikolaou’s unrebutted testimony,” because Petitioner “fail[s] to provide expert testimony of Loucks addressing” a problem faced by the inventors of the ’870 patent, and Petitioner advances only unsworn attorney argument that cannot rebut admitted evidence. PO Sur-reply 1–2, 6–7 & n.4 (citing Pet. 14–15, 51–57; Ex. 1002 ¶ 40; *Gemtron Corp. v. Saint-Gobain Corp.*, 572 F.3d 1371 (Fed. Cir. 2009)); *see also* PO Resp. 32 (“[T]he only evidence of record conclusively demonstrates that Loucks is non-analogous art.” (citing Ex. 2002 ¶¶ 100–102)). This allegedly includes the “portable VFD” aspect of Patent Owner’s assertions. PO Sur-reply 10 (citing Ex. 1054, 120:1–2, 179:14–19). Patent Owner similarly asserts that the Institution Decision “identified another problem that [is] not supported by expert testimony,” so that problem “cannot fix Petitioner’s failure to satisfy its burden.” PO Sur-reply 8 (citing Inst. Dec. 34; Ex. 1002 ¶ 73).

Patent Owner further argues that Petitioner’s identification of the problem addressed by the ’870 patent being “implementing VFDs and electric motors in the field of hydraulic fracturing” is not supported by the testimony of Dr. Durham cited by Petitioner. *See id.* at 8–9 (citing Pet. Reply 17; Ex. 1002 ¶¶ 40–41).

Patent Owner moreover asserts that even if Loucks does disclose cooling techniques, Loucks does not describe any techniques for implementing VFDs or electric motors. *See id.* at 9 (citing Pet. Reply 17; Ex. 1002 ¶¶ 132, 234–235). Patent Owner disagrees with Petitioner’s argument that Loucks is relevant to any electrical device that exhausts waste heat, because it “broadens the scope Loucks can be applied to without addressing” whether Loucks is reasonably pertinent to the problem faced by the ’870 patent inventors. *Id.* at 9–10 (citing Pet. Reply 17). Patent Owner further asserts “Loucks does not monitor **temperature** (i.e., against excessive heat) but rather a **cooling efficiency**, which itself is not derived from temperature but rather a **temperature differential**,” so Loucks “does not teach ‘heat sinks having thermal sensors . . . to prevent damage caused by excessive heat’ as required by” claim 7 of the ’870 patent. *Id.* at 10–11 (citing Ex. 1009, code (54); Ex. 1001, 8:35–37).

We conclude Loucks is reasonably pertinent to a particular problem facing the inventors of the ’870 patent. First, we maintain our finding from the Institution Decision, that 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* Inst. Dec. 34, 42; 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.”); Ex. 1002 ¶ 40; Ex. 2002 ¶¶ 30–32, 101. We further maintain our finding that one particular aspect of that problem was using a VFD to drive the electric motors. *See* Inst. Dec. 34–35, 42;¹¹ Ex. 1001, 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; Ex. 2002 ¶ 32 (discussing how the ’870 patent’s hydraulic fracturing system utilizes VFDs); *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)).

We are not persuaded by Patent Owner’s and Dr. Nikolaou’s more narrow characterization of the problem facing the inventors of the ’870 patent as being limited to “problems associated with diesel pumps” (Ex. 1001, 1:52–2:4). That characterization presumes the “problems” of the analogous art test refer only to “problems” that are described expressly in

¹¹ Petitioner adopted this finding in the Petitioner Reply. *See* Pet. Reply 17 (stating that “[a]s the Board has already found, Loucks is reasonably pertinent to the problem addressed in the ’870 Patent,” which “addresses implementing VFDs and electric motors in the field of hydraulic fracturing”); *Sanofi*, 66 F.4th at 1379–80 (“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.’” (citations omitted)).

the '870 patent as being a problem. *See, e.g.*, PO Resp. 30 (referring to “*the only problem[s] identified by the inventors of the 870 patent*” and arguing “any additional problem would be *limited to those problems*” (emphasis added)); Ex. 2002 ¶ 101. Patent Owner does not cite any legal authority for this alleged limitation on the scope of analogous art, and we are not aware of any. Instead: “The problems to which the claimed invention and reference at issue relate must be identified and compared from the perspective of a person having ordinary skill in the art.” *Donner*, 979 F.3d at 1360 (citing *Sci. Plastic Prods., Inc. v. Biotage AB*, 766 F.3d 1355, 1360 (Fed. Cir. 2014)).

We also reject Patent Owner’s argument that prior art can be analogous to the '870 patent only if the prior art concerns a “portable” VFD. *See* PO Resp. 30–31; Ex. 2002 ¶¶ 101–102. No doubt, portability was one of the problems facing the inventors of the '870 patent. *See* Ex. 1001, 1:39–47, 2:5–10, 3:38–50 (describing Fig. 1). However, as discussed above, it was not the only problem facing the inventors of the '870 patent, as another problem was using a VFD to drive electric motors. *See, e.g.*, *Donner*, 979 F.3d at 1361 (recognizing that a challenged patent can pertain to “one or more . . . problems”).

Next, we find Loucks is reasonably related to the problem of using a VFD to drive electric motors, because Loucks discusses the need to cool VFDs and provides methods (i.e., a heat sink with thermal sensors) for doing so. *See* Ex. 1009, Fig. 5, ¶¶ 60–63; *infra* Section III.F.3(ii) (discussing various disputes between the parties comparing claim 7 with Loucks’s disclosure). As discussed further below in Section III.F.3(ii), Loucks focuses on using heat sink temperature data to calculate a cooling efficiency

indicator reflecting changes in equipment cooling performance.

Nonetheless, it does so with the ultimate goal of protecting electrical equipment (including a VFD) from damage caused by excessive heat. *See* Ex. 1009, Fig. 5, ¶¶ 60–63; *infra* Section III.F.3(ii).

We disagree with Patent Owner’s argument that Loucks cannot be reasonably pertinent to the problem facing the inventors of the ’870 patent because “VFDs are ubiquitous.” PO Resp. 31. Presumably, the reasoning here is that using a VFD could not have been a “problem” facing the inventors of the ’870 patent so as to be analogous art per *Bigio* due to their ubiquity. However, Patent Owner cites no legal authority for that reasoning,¹² which would lead to the incongruous result of excluding any ubiquitous technology from the scope of prior art available to a party who desires to challenge a patent for obviousness. Thus, for example, the court in *In re ICON Health & Fitness, Inc.*, 496 F.3d 1374 (Fed. Cir. 2007), held that analogous art “may come from any area describing hinges, springs, latches, counterweights, or other similar mechanisms,” despite the ubiquity of such structures in the prior art. *Id.* at 1379–80.

¹² Although not cited by Patent Owner, the court in *Donner* criticized the Board for stating that the “purpose” of the challenged patent was “to mount guitar effects on a pedal board,” where the challenged patent “readily disclose[d]” that “guitar effects had already been mounted on a pedalboard,” because “with respect to the analogous art inquiry, the relevant purposes of an invention are those relating to solving a problem.” 979 F.3d at 1360. However, Patent Owner here does not cite any equivalent disclosures in the ’870 patent. *See* PO Resp. 2–3 (“[T]he ’870 Patent teaches a novel fracturing system and method that uses electric motors controlled by a VFD.”), 29–32.

We also disagree with Patent Owner’s argument that Loucks cannot be reasonably pertinent to the problem facing the inventors of the ’870 patent because the ’870 patent does not mention that VFDs need to be cooled. *See* PO Resp. 31–32; PO Sur-reply 10–11. We do not discern any meaningful difference between the ’870 patent’s description of utilizing a heat sink in a VFD to prevent semiconductor damage caused by excessive heat (Ex. 1001, 2:39–42, 4:8–16), and Loucks’s description of the need to cool electrical equipment that generates heat such as a VFD (Ex. 1009 ¶¶ 18, 60). Further, even if we are missing some subtle distinction here, Loucks’s indicated disclosure still is “reasonably pertinent” to the problem facing the inventors of the ’870 patent for analogous art purposes, even if the respective problems are not identical.

Finally, we agree with Patent Owner’s point that Dr. Durham’s testimony as cited in the Petitioner Reply does not address the analogous art issue directly, whereas Dr. Nikolaou’s testimony does. *See* Ex. 1002 ¶¶ 40–41, 132, 234–235; Ex. 2002 ¶¶ 100–102. Nonetheless, for the reasons provided above, we conclude Petitioner has satisfied its burden to establish Loucks is analogous art, despite Dr. Nikolaou’s testimony to the contrary.

We conclude Loucks is analogous art to the ’870 patent by virtue of the second prong of the *Bigio* test.

(iv) *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 contending 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 opposes. *See* PO Resp. 1, 4–6, 8–10, 13, 18–21, 32–37; Ex. 2002 ¶¶ 47, 71–75, 90–102.

We first address Petitioner’s reliance on Coli, which is not opposed by Patent Owner. Next, we turn to Petitioner’s reliance on Loucks, and Patent Owner’s opposition thereto. We finally address Petitioner’s contentions as to the motivation(s) for combining Coli and Loucks, and Patent Owner’s opposition thereto. We ultimately conclude a preponderance of the evidence supports Petitioner’s assertions.

(i) Comparing Claim 7 with Coli

The disclosure of Coli as it compares with the subject matter of claim 7 is discussed above in Section III.D.3(ii) in relation to Ground One and substantially identical subject matter in claim 1. *See* Pet. 51, 56 (for Ground Three, referring back to Ground One for the disclosures of Coli pertinent to claim 7). In particular, we find Coli discloses the subject matter of claim 7, except Coli’s VFD is not disclosed as “having 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, 54, 56–57 (citing Ex. 1009, code (57), Figs. 4–6, ¶¶ 3, 5, 8, 18, 36, 57, 60–61, 63, 66–70, 72); Ex. 1002 ¶¶ 131–133, 231, 234–236, 239–242. Petitioner relies on Loucks’s power electronics heat sink temperature sensor 510, which monitors the temperature of a heat sink, and Loucks’s use of that temperature data to calculate an operating cooling efficiency for the electrical equipment. *See* Pet. 15, 53, 54, 56 (citing Ex. 1009, Fig. 5, ¶¶ 8, 63, 66–70, 72); Ex. 1002 ¶¶ 133, 234–236, 240–241.

Petitioner also asserts “Loucks teaches the importance of ‘detect[ing] problems before temperatures reach alarm limits’ because ‘electrical or electronic equipment can malfunction due to over-temperature.’” Pet. 52 (quoting Ex. 1009 ¶ 18); Ex. 1002 ¶¶ 132, 234–235, 242. Moreover, “Loucks further teaches that without such protections in place, ‘the consequences of not cooling equipment properly may result in accelerated equipment degradation and early failure.’” Pet. 52 (quoting Ex. 1009 ¶ 18); Ex. 1002 ¶¶ 132, 234–235, 242. Petitioner thus concludes “Loucks teaches a cooling efficiency monitoring technique that ‘detect[s] problems before temperatures reach alarm limits’ to prevent equipment damage, accelerated degradation, and early failure.” Pet. 56–57 (quoting Ex. 1009 ¶ 18); Ex. 1002 ¶ 235.

Patent Owner responds that Loucks fails to disclose or teach a VFD having thermal sensors monitored to prevent damage caused by excessive heat. *See* PO Resp. 1, 8–10, 13, 18–20 (citing Ex. 1009, code (57), Figs. 1, 2, and 5, ¶¶ 6, 36, 60–61, 63); Ex. 2002 ¶¶ 47, 71–72. Patent Owner argues “Loucks has the same fatal deficiency as [Toshiba Manual]: it separately

discloses a VFD and a ‘power electronics heat sink temperature sensor 510,’ **but does not disclose that the VFD includes such a sensor** as the claim requires.” PO Resp. 13, 18 (citing Ex. 1009, Fig. 5, ¶¶ 61, 63); Ex. 2002 ¶¶ 71–72. In particular, Patent Owner asserts “nothing in the description of Figure 5 (or in the figure itself) mentions or illustrates a VFD” and “Loucks provides only two disclosures about a VFD, but neither discloses that the VFD includes a heat sink.” PO Resp. 18–19 (citing Ex. 1009, Fig. 5, ¶¶ 36, 60, 63); Ex. 2002 ¶¶ 71–72.

Patent Owner further argues that “even assuming that Loucks discloses a VFD ‘*having one or more power semiconductor heat sinks having thermal sensors,*’ those thermal sensors are not ‘*monitored by a microprocessor to prevent damage caused by excessive heat*’ as” claimed. PO Resp. 19; Ex. 2002 ¶¶ 73–75. In particular, Patent Owner asserts “Loucks’s cooling efficiency monitoring technique does not even use heat sink thermal sensors or alarm limits.” PO Resp. 13, 19–20 (citing Ex. 1009, Fig. 2, ¶¶ 18, 48–49); Ex. 2002 ¶¶ 73–74. According to Patent Owner, Petitioner’s expert witness Dr. Durham “admitted under cross-examination that Loucks[’s] high temperature limits and alarms are not part of its ‘cooling efficiency monitoring technique’ as shown in Figure 2 and incorporated into its VFD.” PO Resp. 20 (citing Ex. 2003, 59:8–15, 65:4–20); Ex. 2002 ¶ 75.

Petitioner replies that “even if Loucks does not disclose sensor 510 in a VFD” as Patent Owner asserts, still “at minimum, a [person of ordinary skill in the art] would have found it obvious to implement Loucks’ system to include sensor 510 in a VFD, e.g., the VFD of Coli” as asserted in the

Petition. Pet. Reply 11 (citing Pet. 52–55; Ex. 1002 ¶¶ 120 n.2, 235–237, 242; Ex. 1007, 20; Ex. 1009, Fig. 5).

Petitioner also asserts Loucks actually does disclose using its power electronics heat sink temperature sensor in a VFD. *See id.* (citing Ex. 1009, Fig. 5, ¶¶ 15, 60). Petitioner argues that Patent Owner’s opposition “interprets Figure 5 in a vacuum, assuming (incorrectly) that it is a complete depiction of the equipment where the system is installed,” whereas in fact “Figure 5 is a generic ‘functional block diagram’ of the cooling efficiency monitoring system” which “would not enumerate details of the equipment on which it is installed.” *Id.* at 11–12. Petitioner asserts a person of ordinary skill in the art “would have understood that Figure 5 describes the cooling efficiency monitoring system — including its heat sink having thermal sensors — in a generic piece of ‘equipment’, which expressly includes VFDs.” *Id.* at 12 (citing Ex. 1002 ¶¶ 233–236; Ex. 1054, 169:17–170:9).

Concerning the claim recitation of monitoring thermal sensors to prevent damage caused by excessive heat, Petitioner argues Patent Owner misconstrues Petitioner’s case as relying on “Loucks’ high temperature limits and alarms described in paragraph 18” for this recitation. *See id.* at 12 (citing PO Resp. 19–20). Petitioner agrees with Patent Owner’s position to the extent that Loucks’s paragraph 18 “describes the problems in **conventional** systems that Loucks’ methods avoid,” but Petitioner nonetheless maintains “Loucks discloses monitoring sensor 510 to calculate a ‘cooling efficiency indicator’ *and triggering a notification if that indicator is outside a specified range.*” *Id.* at 12–13 (second emphasis added) (citing Ex. 1009, Fig. 2, ¶¶ 18, 49, 63; Ex. 1002 ¶¶ 132–133, 241–242). Petitioner

further argues Dr. Durham explains that “Loucks’ methods improve cooling to *avoid* excessive heat that could trigger the temperature alarms or limits described in paragraph 18,” and “paragraph 18 simply confirms that Loucks’ methods monitor the sensor 510 to prevent damage that could result from excessive heat if the alarms or limits were reached.” *Id.* at 13 (citing Ex. 2003, 69:22–71:10).

Patent Owner responds that the Petitioner Reply improperly pursues a new theory of unpatentability to address the claim recitation of monitoring thermal sensors to prevent damage caused by excessive heat — that “Loucks teaches this limitation by describing a triggered notification if the cooling efficiency indicator is outside a range to help avoid excessive heat.” PO Sur-reply 14 (citing Pet. Reply 12–13; *Intelligent Bio-Sys.*, 821 F.3d at 1370). According to Patent Owner: “The Petition never makes this argument, cites this evidence, nor explains how the notification and range help ‘prevent damage caused by excessive heat.’” *Id.* Indeed, Patent Owner asserts Loucks’s “notification and range keep its system at a ‘baseline cooling efficiency’” and do not “prevent damage caused by excessive heat.” *Id.* (citing Ex. 1009 ¶ 49).

We conclude a preponderance of the evidence supports Petitioner’s contention that Loucks discloses a VFD heat sink having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat. First, we find Loucks discloses a VFD having a heat sink having thermal sensors monitored by a microprocessor. Specifically, Loucks’s Figure 5 illustrates cooling efficiency monitoring system 500 employing several sensors, including power electronics heat sink temperature sensor 510, mounted in enclosure 505 “containing a variety of heat producing electrical

devices.” Ex. 1009 ¶¶ 61–63; *see* Pet. 14–15, 52–53, 54; Ex. 1002 ¶¶ 131–133, 234–236, 240–242. Loucks states “[t]he cooling efficiency techniques and systems described herein may be used on any device that consumes electrical energy and exhausts waste heat,” examples of which are “variable or adjustable frequency drives” — i.e., VFDs. Ex. 1009 ¶ 60; *see* Pet. 14–15, 52–53, 54; Ex. 1002 ¶¶ 131–133, 234–236. In this way, Loucks discloses a VFD heat sink having thermal sensors monitored by a microprocessor, arranged or combined in the same way as in claim 7. *See Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1369–71 (Fed. Cir. 2008). Patent Owner’s and Dr. Nikolaou’s attempt to divorce paragraph 60 from paragraphs 61–63 simply is not a fair or unbiased reading of the Loucks disclosure.

Second, we find Loucks discloses that its VFD heat sink having thermal sensors functions to prevent damage to the VFD caused by excessive heat, as recited in claim 7. Dr. Durham correspondingly testifies that a person of ordinary skill in the art would have understood that the function of a “power electronics heat sink” (Ex. 1009 ¶ 63, Fig. 5) is to dissipate heat away from the power electronics. *See* Ex. 1002 ¶¶ 87–90 (“It has long been known that power semiconductor devices generate substantial heat that must be dissipated (i.e., the devices must be cooled) in order to prevent damage to the devices” and “it was generally understood that heatsinks were needed.”) (citing Exs. 1030, 1031, 1032); *id.* ¶ 234 (referring back to ¶¶ 87–95 in discussing the Loucks disclosure); Pet. 57. Thus, the heat sink alone (without any sensors) functions to prevent damage to the VFD caused by excessive heat.

Loucks’s use of thermal sensors located on the heat sink improves the function of the heat sink to prevent damage to the VFD caused by excessive heat. Specifically, Loucks uses the heat sink temperature data to calculate a “cooling efficiency indicator” reflecting “[c]hanges in equipment cooling performance.” Ex. 1009, code (57), ¶¶ 5, 66–69; *see* Pet. 14–15, 53, 54, 56–57; Ex. 1002 ¶¶ 131–133, 234–235, 240–242. The parties agree that Loucks does not use the cooling efficiency indicator as part of triggering a high temperature limit alarm. *See* PO Resp. 13, 19–20 (discussing Ex. 1009 ¶ 18); Pet. Reply 12–13 (discussing Ex. 1009 ¶ 18); Tr. 19:3–20:16, 25:13–27:19, 50:11–22. Nonetheless, Loucks states that “[a] change in the cooling efficiency indicator may be used to detect changes to the cooling system performance . . . long before over-temperature limits are reached.” Ex. 1009 ¶ 60; *see* Pet. 14, 52 (discussing Ex. 1009 ¶ 60). A person of ordinary skill in the art would have understood, upon reading that disclosure, that the ultimate goal of calculating a cooling efficiency indicator in Loucks was to prevent damage to electrical equipment caused by excessive heat,¹³ even if Loucks does not expressly disclose *how* its calculated cooling efficiency indicator is used in that regard. Patent Owner’s contentions to the contrary strain credulity. For example, although we understand Petitioner bears the burden to demonstrate unpatentability, neither Patent Owner nor

¹³ Indeed, as noted in the Petitioner Reply, Loucks discloses *notifying a user* of its monitoring system 500 in the event that a determined cooling efficiency indicator drops too far below a baseline value. *See* Ex. 1009, Fig. 2 (step 260), ¶ 49; Pet. Reply 12–13. Patent Owner does not dispute this finding. *See* Tr. 25:3–28:12. Instead, Patent Owner argues it was raised only belatedly in the Petitioner Reply, but we conclude Patent Owner opened the door for this new argument by introducing Loucks’s Figure 2 into the dispute via the Patent Owner Response. *See* PO Resp. 13, 19–20.

Dr. Nikolaou offers any reason other than preventing damage to electrical equipment caused by excessive heat for why Loucks calculates its cooling efficiency indicator. *See* PO Resp. 18–21; PO Sur-reply 14; Ex. 2002 ¶¶ 47, 71–75. Moreover, the ’870 patent similarly to Loucks does not disclose *how* monitored temperature data is used to prevent damage to the VFD caused by excessive heat. *See* Ex. 1001, 2:39–42, 4:8–20, 8:32–36 (claim 7).

For the foregoing reasons, we conclude a preponderance of the evidence supports Petitioner’s contention that Loucks discloses a VFD heat sink having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat.

(iii) Motivation to Utilize a Heat Sink Having Thermal Sensors in Coli’s VFD, 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. 51–56, 57 (citing Ex. 1009 ¶¶ 8, 18, 36, 60, 63, 66, 68–70, 72); Ex. 1002 ¶¶ 234–237, 240–242. In support, Petitioner asserts “Loucks teaches the importance of ‘detect[ing] problems before temperatures reach alarm limits’ because ‘electrical or electronic equipment can malfunction due to over-temperature.’” Pet. 52 (quoting Ex. 1009 ¶ 18); Ex. 1002 ¶¶ 132, 234–235, 242. Moreover, “Loucks further teaches that without such protections in place, ‘the consequences of not cooling equipment properly may result in accelerated equipment degradation and early failure.’” Pet. 52 (quoting Ex. 1009 ¶ 18); Ex. 1002 ¶¶ 132, 234–235, 242. Thus, Petitioner and Dr. Durham conclude a person of ordinary skill in the art “would have

been motivated to look to Loucks’ heat sinks and temperature sensors and employ Loucks’ cooling efficiency monitoring techniques to ‘detect problems’ with Coli’s VFD ‘before temperatures reach alarm limits’ and to ensure that it does not ‘malfunction’ or suffer from ‘accelerated equipment degradation and early failure.’” Pet. 53–54 (quoting Ex. 1009 ¶ 18); Ex. 1002 ¶ 235. Petitioner and Dr. Durham further conclude this could have been achieved with a reasonable expectation of success. *See* Pet. 51, 54; Ex. 1002 ¶¶ 236, 238.

Patent Owner responds that “Petitioner provides no reason why a [person of ordinary skill in the art] would have combined the prior art to arrive at the invention described in claim 7.” PO Resp. 1, 32; Ex. 2002 ¶¶ 90–95. This is because, according to Patent Owner and Dr. Nikolaou, “Coli teaches away from using implementing a cooling system, like that described in Loucks, in its system.” PO Resp. 32–33 (citing Ex. 1005 ¶ 39); Ex. 2002 ¶¶ 94–95. Dr. Nikolaou explains that Petitioner’s combination of Coli and Loucks “would require a larger on-site footprint and more infrastructure,” which “Coli specifically warns against.” Ex. 2002 ¶ 95 (citing Ex. 1005 ¶ 39); *see* PO Resp. 33 (citing *Allergan, Inc. v. Sandoz Inc.*, 796 F.3d 1293, 1305 (Fed. Cir. 2015)).

Even absent a teaching away, Patent Owner argues Petitioner’s motivation contentions are flawed. *See* PO Resp. 33–36; Ex. 2002 ¶¶ 90–93. Patent Owner asserts and Dr. Nikolaou testifies that “Loucks does not disclose that the ‘power semiconductor heat sink temperature sensor 510’ is, as claim 7 requires, ‘monitored by a microprocessor to prevent damage caused by excessive heat.’” PO Resp. 34; Ex. 2002 ¶ 91. Instead, according to Patent Owner and Dr. Nikolaou, Loucks uses temperature data “in its

cooling efficiency monitor system to ‘calculate the cooling efficiency indicator.’” PO Resp. 34 (citing Ex. 1009 ¶ 63); Ex. 2002 ¶ 91. This falls short of the claim requirement, according to Patent Owner and Dr. Nikolaou, because “[t]he cooling efficiency indicator is not the ‘alarm’ or ‘high temperature limit’ mentioned in Coli [sic “Loucks”] that ‘may result in equipment damage’ if reached.” PO Resp. 34–36 (quoting Ex. 1009 ¶ 18; Ex. 2003, 59:8–15, 65:4–20); Ex. 2002 ¶¶ 91–93.

Patent Owner moreover argues that the Board’s ’601 Patent Decision undermines Petitioner’s motivation contentions here. *See* PO Resp. 36–37. Patent Owner asserts that the Decision “supports how claim 7 is not obvious over . . . Coli and Loucks” because “[t]he Board found that Petitioner failed to show claim 16 [of the ’601 patent] was unpatentable over four prior art references, including Coli.” *Id.* at 36 (citing Ex. 1048, 45, 77–78).

Petitioner replies that Coli does not teach away from Petitioner’s combination of Coli and Loucks. *See* Pet. Reply 19–20 (citing Ex. 1005 ¶ 19; Ex. 1002 ¶¶ 82, 87–95). Further according to Petitioner, obviousness here “do[es] not require ‘adding a cooling system’ to Coli’s VFD” as Patent Owner would have it (PO Resp. 33), and instead Loucks “describes the components of a cooling system (*e.g.*, heat sinks) and monitoring system that could be used in [Coli’s] VFD.” Pet. Reply 20 (citing Ex. 1002 ¶¶ 233–237). Petitioner dismisses the remainder of Patent Owner’s opposition as “simply reiterat[ing] that Loucks does not disclose” the subject matter of claim 7, as already addressed above in Section III.F.3(ii). Pet. Reply 21 (citing PO Resp. 33–35). Petitioner further asserts the Board’s ’601 Patent Decision “is not relevant to combining Coli with Loucks.” *Id.* at 21 (section heading format modified) (citing Ex. 1048, 17, 48).

Patent Owner responds that Dr. Nikolaou’s testimony as to Coli teaching away is un rebutted by contrary expert testimony, and Petitioner’s attorney argument should be given no weight. *See* PO Sur-reply 11–12 (citing *Gemtron*, 572 F.3d at 1380); *id.* at 12–13 (discussing Ex. 1002 ¶¶ 82, 87–95, 233–237). Patent Owner also argues Petitioner’s proposed modification of Coli involves adding Loucks’s “cooling system” despite Petitioner’s protestation to the contrary. *Id.* at 12 (citing Pet. Reply 30 [sic “20”]; Pet. 51–55; Ex. 1002 ¶¶ 232–237). Finally, Patent Owner maintains the Board’s ’601 Patent Decision confirms that a person of ordinary skill in the art would not have combined Coli and Loucks in the fashion proposed by Petitioner here. *See id.* at 13–14 (citing Ex. 1048, 48).

We conclude a preponderance of the evidence establishes that a person of ordinary skill in the art would have been motivated to add power semiconductor heat sinks having thermal sensors to Coli’s VFD in light of Loucks, in order to prevent damage to the VFD caused by excessive heat, as Dr. Durham testifies. *See* Ex. 1002 ¶¶ 87–95 (discussing power semiconductor heat sinks generally); *id.* ¶¶ 232–238, 242 (discussing combination of Coli and Loucks specifically).

Coli does not teach away from this combination. In order to teach away, a reference must criticize, discredit, or otherwise discourage the claimed solution. *See In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004). Even in the absence of a teaching away, general preferences as stated in the prior art are still relevant to determining whether a skilled artisan would be motivated to combine the prior art in the manner claimed. *Polaris*, 882 F.3d at 1067–70. Thus, “a reference ‘must [be] considered for all it taught, disclosures that diverged and taught away from the invention at hand as well

as disclosures that pointed towards and taught the invention at hand.” *Id.* (quoting *Ashland Oil, Inc. v. Delta Resins & Refractories, Inc.*, 776 F.2d 281, 296 (Fed. Cir. 1985)).

Coli pertinently states that “the setup of FIG. 2 requires significantly less infrastructure [and physical footprint] than the setup shown in FIG. 1, while providing comparable pumping capacity . . . due to the lack of need for a constant diesel fuel supply” by instead employing electrical power. Ex. 1005 ¶ 39; *see also id.* ¶¶ 37–38 (discussing Figs. 1 and 2). “Also, *by removing diesel prime movers, all associated machinery necessary for power transfer can be eliminated*, such as the transmission, torque converter, clutch, drive shaft, hydraulic system, etc. . . . , and *the need for cooling systems, including circulating pumps and fluids, is significantly reduced.*” *Id.* ¶ 39 (emphases added).

In stating that the need for cooling systems is merely “significantly reduced,” as opposed to the beneficial “eliminat[ion]” of associated diesel power machinery, Coli expressly recognizes the need for some cooling of its electrically powered equipment (albeit lesser versus a diesel system). That is not a teaching away from adding a heat sink having thermal sensors to Coli’s VFD to prevent damage to the VFD caused by excessive heat, to achieve the cooling that Coli expressly recognizes still is needed after converting from diesel to electric power. Loucks similarly recognizes the need to cool electrically powered equipment, as Dr. Durham testifies. *See* Ex. 1009 ¶¶ 18, 60; Ex. 1002 ¶¶ 234–235.

Moreover, we conclude that although adding a heat sink, thermal sensors, and a monitoring microprocessor to Coli will to some extent increase the infrastructure and footprint of Coli’s hydraulic fracturing

system, that is outweighed by the cooling functionality achieved by the addition of those components. *See In re Urbanski*, 809 F.3d 1237, 1243–44 (Fed. Cir. 2016) (persons of ordinary skill in the art may be motivated to pursue desirable properties of one prior art reference, even at the expense of foregoing a benefit taught by another prior art reference). Dr. Nikolaou testifies that “implement[ing] a cooling system, like the one in Loucks, in Coli’s fracturing operations . . . would require a larger on-site footprint and increased infrastructure . . . similar to the one that Coli specifically warns against.” Ex. 2002 ¶ 95 (citing Ex. 1005 ¶ 39). However, he does not provide any supporting explanation for that conclusion. *See id.* We find that the heat sink, thermal sensors, and microprocessor of Petitioner’s combination represents far less infrastructure and footprint within Coli’s system than the diesel power machinery (transmission, torque converter, clutch, drive shaft, and hydraulic system) rendered useless by Coli’s conversion to electric power. *See* Ex. 1005 ¶ 39.

Further, for the reasons provided above in Section III.F.3(ii), we find Loucks discloses a VFD heat sink having thermal sensors monitored by a microprocessor to prevent damage caused by excessive heat, despite Patent Owner’s contrary arguments.

Finally, our foregoing conclusions are not inconsistent with the Board’s ’601 Patent Decision. In that Decision, we concluded Petitioner had failed to show claim 16 of the ’601 patent would have been obvious over Coli and three other references which did not include Loucks. *See* Ex. 1048, 45. One of those other references was Stark (US Patent No. 6,116,040), which Petitioner cited for the VFD heat sink and thermal sensor requirements of claim 16 of the ’601 patent. *See id.* at 6, 45–47. We were

not persuaded, because “inclusion of these components [from Stark] necessitates inclusion of the remaining refrigeration cycle equipment and a refrigerant flowing through flow channels formed in the heat sink,” and “neither Petitioner nor Dr. Durham explains how this equipment would be incorporated into Coli’s modified variable frequency drive.” *Id.* at 48–49. There are no such refrigeration system difficulties in Petitioner’s combination of Coli and Loucks in the present case, where Loucks provides an air-cooled (not liquid-cooled) heat sink. *See* Ex. 1009, Fig. 5, ¶¶ 2, 18–25, 63.

(iv) Conclusion as to Claim 7

Thus, based on the record presented, we conclude Petitioner has shown by a preponderance of the evidence that claim 1 is unpatentable as having been obvious over Coli and Loucks.

4. Claims 8–16

Claims 8–16 each depend from claim 7. *See* Ex. 1001, 8:37–59.

As to claims 8–12 and 14, Petitioner provides arguments and evidence in support of contending the claims are unpatentable as having been obvious over Coli and Loucks, relying on Coli as disclosing or rendering obvious the limitations added to claim 7 by the dependent claims, including supporting testimony from Dr. Durham. *See* Pet. 32–33, 38–41, 43–44 (Ground One, discussing claims 8–12 and 14); *id.* at 51 (Ground Three, “[a]ll other elements of claims 7–16 are disclosed or at least rendered obvious by Coli as described above in Ground 1”); Ex. 1002 ¶¶ 171–172, 187–197, 201–202, 231. Patent Owner does not oppose those contentions, apart from arguments we have already considered above in relation to claim 7. *See* PO Resp.

generally. For the reasons provided above in Section III.F.3 in the context of claim 7, we conclude Patent Owner’s arguments are unavailing. We further adopt Petitioner’s additional analysis for the obviousness of claims 8–12 and 14 as our own in this Decision, and we accordingly conclude Petitioner has demonstrated by a preponderance of the evidence that those claims are unpatentable as having been obvious over Coli and Loucks.

As to claims 13, 15, and 16, Petitioner relies on Coli as disclosing or rendering obvious the limitations added to claim 7 by the dependent claims, as discussed above in Section III.D.7 in relation to Ground One. *See* Pet. 51 (in Ground Three, arguing “[a]ll other elements of claims 7–16 are disclosed or at least rendered obvious by Coli as described above in Ground 1”); Ex. 1002 ¶ 231. Patent Owner opposes those contentions, as discussed above in Section III.D.7. *See* PO Resp. 45–53. For the reasons provided above in Section III.D.7, we conclude Petitioner has not shown by a preponderance of the evidence that claims 13, 15, and 16 are unpatentable as having been obvious over Coli and Loucks, due to deficiencies in Petitioner’s reliance on Coli for the truck having at least five axles recited in claim 13 and for the motors recited in claims 15 and 16.

G. Grounds Four-A and Four-B — Obviousness over Coli, either Toshiba Manual or Loucks, and Vliet

In Ground Four-A, Petitioner asserts claims 12 and 13 of the ’870 patent are unpatentable as having been obvious over Coli, Toshiba Manual, and Vliet. *See* Pet. 7–8, 9–11, 15, 16, 57–60. Here, Petitioner relies on Ground One, and further cites Vliet as teaching “*mounting generators on a trailer* just as the pumps, motors, and related equipment of

Coli are mounted.” *Id.* at 58 (emphasis added); *see also id.* at 59 (stating Ground Four-A is offered “to the extent the Board determines that Coli does not expressly disclose or render obvious *the mounting of a generator on a vehicle (i.e., trailer)* with the pump and electric motor” (emphasis added)).

Ground Four-B is the same as Ground Four-A, except that the predicate ground for the subject matter of parent claim 7 is Ground Three (Coli and Loucks) rather than Ground One (Coli and Toshiba Manual). *See* Pet. 60–61.

As to claim 12, we have concluded it is unpatentable as having been obvious Coli and Loucks in Ground Three, even without the addition of Vliet in Grounds Four-A and Four-B. *See supra* Section III.F.4. Therefore, we do not reach Grounds Four-A and Four-B as to claim 12.

As to claim 13, we have concluded there are deficiencies in Petitioner’s reliance on Toshiba Manual for heat sinks having thermal sensors as recited in parent claim 7 (Ground Four-A), and deficiencies in Petitioner’s reliance on Coli for a truck having at least five axles as recited in claim 13 (Grounds Four-A and Four-B). *See supra* Sections III.D.6–7 and III.F.4. Grounds Four-A and Four-B rely on Vliet only in connection with mounting an electric generator on a trailer, so they do not cure those deficiencies in the predicate Grounds One and Three. Thus, we conclude Petitioner has not shown by a preponderance of the evidence that claim 13 is unpatentable in Ground Four-A or Ground Four-B.

H. Grounds Five-A and Five-B — Obviousness over Coli, either Toshiba Manual or Loucks, and Gardner

In Ground Five-A, Petitioner asserts claims 14 and 15 of the ’870 patent are unpatentable as having been obvious over Coli, Toshiba

Manual, and Gardner. *See* Pet. 7–11, 16, 61–63. Here, Petitioner relies on Ground One, and further cites Gardner as teaching the limitation in claim 14 reciting that “the pump is a triplex or a quinteplex pump rated at about 2250 horsepower or more.” Ex. 1001, 8:52–54 (claim 14); *see* Pet. 8–9 (summarizing Gardner’s disclosure), 61–63 (obviousness analysis of claim 14).

Ground Five-B is the same as Ground Five-A, except that the predicate ground for the subject matter of parent claim 7 is Ground Three (Coli and Loucks) rather than Ground One (Coli and Toshiba Manual). *See* Pet. 63–64.

As to claim 14, we have concluded it is unpatentable as having been obvious Coli and Loucks in Ground Three, even without the addition of Gardner in Grounds Four-A and Four-B. *See supra* Section III.F.4. Therefore, we do not reach Grounds Five-A and Five-B as to claim 14.

As to claim 15, we have concluded there are deficiencies in Petitioner’s reliance on Toshiba Manual for heat sinks having thermal sensors as recited in parent claim 7 (Ground Five-A), and deficiencies in Petitioner’s reliance on Coli for the motor recited in claim 15 (Grounds Five-A and Five-B). *See supra* Sections III.D.6–7 and III.F.4. Grounds Five-A and Five-B do not address claim 15 separately from claim 14, so they do not cure those deficiencies in the predicate Grounds One and Three. *See* Pet. 61–64.¹⁴ Thus, we conclude Petitioner

¹⁴ We acknowledge that the Petitioner Reply asserts Patent Owner “fails to dispute that Gardner discloses claim 15.” Pet. Reply 23 (citing Pet. 9, 16, 61, 63; Ex. 1002 ¶¶ 18, 109, 146, 254). We have reviewed the cited passages of the Petition and Dr. Durham’s testimony, and we conclude they

has not shown by a preponderance of the evidence that claim 15 is unpatentable in Ground Five-A or Ground Five-B.

IV. SUMMARY OF CONCLUSIONS

In summary, we determine a preponderance of the evidence establishes claims 1–12 and 14 of the ’870 patent are unpatentable, but does not establish claims 13, 15, and 16 of the ’870 patent are unpatentable, as shown in the following table:¹⁵

Claim(s)	35 U.S.C. §	Reference(s)/ Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
1–16	103(a)	Coli, Toshiba Manual	1–6	7–16
1–6	103(a)	Coli, Horikoshi	1–6	
7–16	103(a)	Coli, Loucks	7–12, 14	13, 15, 16

do not rely on Gardner as disclosing the limitation in claim 15 reciting “the electric motor has a maximum *continuous* power output of about 1750 brake horsepower or more.” Ex. 1001, 8:55–57 (emphasis added).

¹⁵ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

12, 13	103(a)	Coli, Toshiba Manual, Vliet ¹⁶		13
12, 13	103(a)	Coli, Loucks, Vliet ¹⁶		13
14, 15	103(a)	Coli, Toshiba Manual, Gardner ¹⁷		15
14, 15	103(a)	Coli, Loucks, Gardner ¹⁷		15
Overall Outcome			1–12, 14	13, 15, 16

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–12 and 14 of the '870 patent have been proven by a preponderance of the evidence to be unpatentable;

FURTHER ORDERED that claims 13, 15, and 16 of the '870 patent have not been proven by a preponderance of the evidence to be unpatentable; and

¹⁶ We do not reach these two Grounds as to claim 12, because we have concluded claim 12 is unpatentable over Coli and Loucks without Vliet. *See supra* Sections III.G and III.H.

¹⁷ We do not reach these two Grounds as to claim 14, because we have concluded claim 14 is unpatentable over Coli and Loucks without Gardner. *See supra* Sections III.G and III.H.

FURTHER ORDERED that, because this is a final written decision, parties to this proceeding seeking judicial review of our Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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