

*Declaration of Dr. Stephen Niksa
IPR of U.S. Patent Nos. 10,343,114 and 10,596,517*

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

Berkshire Hathaway Energy Company, and
PacifiCorp,

Petitioners

v.

Birchtech Corp.

Patent Owner

Case Nos. IPR2025-00274 and IPR2025-00278 (Patent No. 10,343,114)

Case Nos. IPR2025-00280 and IPR2025-00281 (Patent No. 10,596,517)

DECLARATION OF DR. STEPHEN NIKSA

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I. Introduction

1. My name is Stephen Niksa, and I declare as follows:
2. I am a citizen of the United States and am over 18 years of age. I have personal knowledge of the matters stated in this declaration.
3. I have been asked to provide technical assistance in the *inter partes* review of U.S. Patent No. 10,343,114 (“the ’114 Patent”) and U.S. Patent No. 10,596,517 (“the ’517 Patent”).
4. I previously submitted one declaration for each of these patents, which was labeled Exhibit 1002. In my prior declarations (EX1002, which I may refer to as “Original Declaration”), some of the grounds I addressed included the following:

Ground	Patent: Claims Challenged	Prior Art
A1	'114 Patent: Claims 1-30 '517 Patent: Claims 1-15, 17-30	Obvious over Vosteen589 (EX1005) in view of Starns (EX1008)
A2	'114 Patent: Claims 1-30 '517 Patent: Claims 1-15, 17-30	Obvious over Vosteen589 (EX1005) in view of Mass-EPA (EX1009)

Since that time, I have been asked to address additional technical issues concerning the ’114 Patent and ’517 Patent that were raised by Patent Owner and its expert, Mr. Cichanowicz. I address those additional issues in this declaration.

II. Additional Chemistry Background

5. In my Original Declarations, I provided an extensive technology background and introduction to chemistry. I have been asked to supplement that

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discussion to further discuss how various chemicals containing “Br” (element 35)
relate to one another.¹

**Table 3.2
Periodic Table of the Elements**

The periodic table displays elements organized by groups (IA to VIII) and periods. Element 35, Bromine (Br), is located in Group VIIA, Period 4. The table includes atomic numbers, symbols, and names for all elements up to 118. A key for element 30 (Zinc) is provided on the left, showing its atomic number, symbol, name, and various physical and chemical properties. A legend at the bottom explains the notation for elements 104-110 and 112-118.

Element 35 in the periodic table, shown above, can be present as an atom (radical), ion, compound, or molecule. Mr. Cichanowicz was asked several chemistry questions in his deposition, and while I disagree with him on questions of obviousness, I largely agree with his understanding of basic chemistry principles. Where applicable, I also cite to Mr. Cichanowicz.

¹ EX1027 (Steam book) at 239.

6. **Atom:** An “atom” is a single unit of a chemical element, such as Hg (mercury) or Br (bromine). An atom is charge neutral. Certain chemical elements can exist by themselves in a stable state in nature, such as mercury (Hg) and gold (Au), and remain charge neutral.² Other chemical elements, particularly halogens such as chlorine (Cl) or bromine (Br), have unpaired electrons in their valence (outer electron) shell.



Atoms with unpaired electrons are called “radicals.” Though charge neutral, they are still highly reactive, combining almost instantaneously with other species in their environment.³

7. **Ion:** When an atom gains or loses electrons, it becomes an “ion.” The negative ion is often given an “-ide” suffix. Halide ions, such as bromide ions, gain

² EX1152 (Cichanowicz Dep. Tr.) at 25:14-18, 26:24-27:12.

³ EX1152 (Cichanowicz Dep. Tr.) at 27:13-28:14.

an electron that completes their outer electron shell (to have a charge of -1) and are represented as Br⁻.^{4, 5}

8. **Molecule:** two or more atoms chemically bonded together as a discrete unit.⁶ In a molecule, the two (or more) constituent atoms can be the same chemical element or different chemical elements. An example is molecular bromine (Br₂), sometimes called “bromine” for short. In Br₂, the two atoms are covalently bonded, and do not contain Br⁻ ions.⁷

9. **Compound:** A compound is a specific type of molecule, in which two or more *different* elements are chemically combined together. Exemplary compounds include NaCl (sodium bromide), NaBr (sodium bromide), KBr (potassium bromide), and HgBr₂ (mercuric bromide).⁸

10. **Bromine v. bromide:** The term “bromine” can refer either to element 35 by itself (Br) or to molecular bromine (Br₂). In molecular bromine, the two

⁴ EX1152 (Cichanowicz Dep. Tr.) at 25:23-26:19.

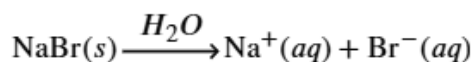
⁵ The charge is often indicated as a superscript, but for readability with the Times New Roman font, I do not use it as a superscript in this declaration (as it gets swallowed by the “r”).

⁶ EX1152 (Cichanowicz Dep. Tr.) at 28:15-29:15.

⁷ EX1152 (Cichanowicz Dep. Tr.) at 36:16-37:1.

⁸ EX1152 (Cichanowicz Dep. Tr.) at 29:16-30:19.

bromine atoms are covalently bonded to one another, without any bromide ions. The term “bromide” can refer to either a bromide ion (Br⁻) or to a bromide compound (e.g., NaBr).⁹ A “bromide ion” forms when a bromide compound is dissolved in water:

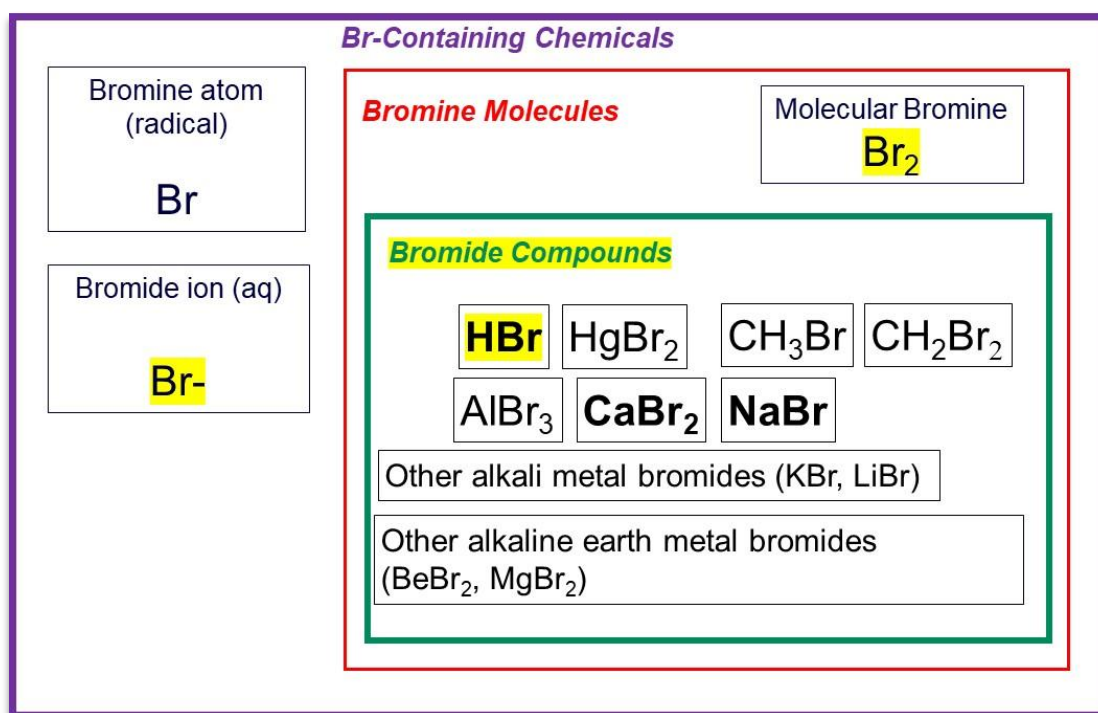


11. **Genus/species:** Molecular bromine (Br₂) is not a species of HBr, and molecular bromine is not a species of “bromide compound.”¹⁰

12. A diagram showing the various relationships and groupings of Br-containing chemicals is provided below:

⁹ EX1152 (Cichanowicz Dep. Tr.) at 32:20-34:5, 34:20-35:8, 36:3-15.

¹⁰ EX1152 (Cichanowicz Dep. Tr.) at 37:8-22.



Species are indicated in black boxes, genera have italic labels and are identified in colored boxes, and claim limitations are highlighted yellow. As can be seen above, the claims recite one genus (“bromide compound”) and three species: Br⁻, HBr, and Br₂. The above figure shows a few examples of bromide compounds, but there are countless other forms of bromide compounds.

III. Additional Discussion of Vosteen589, Starns, and Mass-EPA

13. In my Original Declarations for the '114 and '517 Patents, I addressed the reasons why a person of ordinary skill in the art would have been motivated to combine Vosteen589 with Starns (Ground A1) and Vosteen589 with Mass-EPA (Ground A2), and with reasonable expectation of success. I further discussed how the combinations disclose every limitation of the challenged claims.

14. Mr. Cichanowicz does not appear to dispute that the combinations disclose every claim limitation of the challenged claims. Rather, he devotes a section of his report to asserting that there was no motivation to combine Vosteen589 with Starns or Mass-EPA.¹¹ I address this section below.

A. VOSTEEN589 SAYS TO ADD THE CLAIMED BROMINE-CONTAINING INGREDIENTS TO THE COAL AND/OR COMBUSTION CHAMBER

15. Mr. Cichanowicz states the following:

Petitioners fail to explain why a POSITA would employ pre-combustion addition of bromine with post-combustion injection of activated carbon, as opposed to using the conventional approach of injecting brominated activated carbon.¹²

At the outset, I provided my own independent opinions in my Original Declarations. I do not intend to explain what “Petitioners” stated in their brief, but I can provide my own opinions on the technical matters.

1. Pre-combustion addition of bromine-containing ingredients

16. I will start with the first part of the question raised by Mr. Cichanowicz, namely, why a POSITA who uses “post-combustion injection of activated carbon ... would employ pre-combustion addition of bromine.”¹³ The

¹¹ EX2047 (Cichanowicz Decl.) § VI.

¹² EX2047 (Cichanowicz Decl.) ¶ 49.

¹³ EX2047 (Cichanowicz Decl.) ¶ 49.

majority of Mr. Cichanowicz's critique of Grounds 1-2 relates to his opinions as to why a POSITA would not apply a Br-containing chemical to coal. This all seems irrelevant. If the proposed combination had required modifying Vosteen589 to include bromine injection from another reference, then it might be relevant (if not technically wrong), but that is not the case. Here, Vosteen589 expressly instructs a POSITA to apply various bromine-containing ingredients to the coal and/or to the combustion chamber.

17. Vosteen589 describes adding HBr (hydrogen bromide), bromine (Br₂), and bromide compounds (such as sodium bromide, NaBr) to the coal, to the combustion chamber, or to both. Vosteen589 describes that bromine-containing ingredients are added to the combustion chamber (also referred to by Vosteen589 as a "furnace"):

The invention relates to a process for removing mercury from flue gases of high-temperature plants, in particular from power stations and waste incineration plants, in which bromine and/or a bromine compound and/or a mixture of various bromine compounds is fed to the if appropriate multistage furnace ¹⁴

Particularly preferably, an aqueous solution of hydrogen bromide [HBr] or an alkali metal bromide, in particular sodium bromide [NaBr], or an aqueous solution of the alkali metal bromide is used.¹⁵

¹⁴ EX1005 (Vosteen589) ¶[0006].

¹⁵ EX1005 (Vosteen589) ¶[0009].

The addition of a bromine compound and if appropriate a sulphur compound is made according to the invention to the furnace ...¹⁶

Vosteen589 also describes that the bromine-containing ingredients (including a “bromine compound” and hydrogen bromide)¹⁷ can be added either through injection into the pre-combustion air (upstream of the furnace) or by addition to the coal itself:

The bromine compound, for example, sodium bromide, can be added in solid form, for example as salt, or liquid form, for example as aqueous solution, to the waste mixture, coal or the like to be burnt, upstream of the furnace.¹⁸

[I]t is also possible to feed the bromine compound, for example an aqueous solution of hydrogen bromide or sodium bromide, at a fine dispersion to the combustion air and/or if appropriate to a recirculated substream, in particular recirculated flue gas, recirculated ash and recirculated fly ash.¹⁹

¹⁶ EX1005 (Vosteen589) ¶[0013].

¹⁷ Vosteen589 refers to a “fine dispersion” of the hydrogen bromide, meaning that he is using an aqueous solution of hydrogen bromide. EX1005 (Vosteen589) ¶[0014].

¹⁸ EX1005 (Vosteen589) ¶[0013].

¹⁹ EX1005 (Vosteen589) ¶[0014].

Similar disclosures can be found in claims 1 and 2 of Vosteen589, highlighted below, which recite adding a bromine compound or mixture of compounds (including hydrogen bromide) to the combustion chamber (furnace):²⁰

1. Process for removing mercury from flue gases of high-temperature plants, in particular from power stations and waste incineration plants, characterized in that

bromine and/or a bromine compound and/or a mixture of various bromine compounds is fed to the if appropriate multistage furnace and/or to the flue gas in a plant section downstream of the furnace, the temperature during the contact of the bromine compound with the flue gas being at least 500° C., preferably at least 800° C.,

the combustion taking place in the presence of a sulphur compound, in particular sulphur dioxide, with or without the addition of sulphur and/or a sulphur compound and/or of a mixture of various sulphur compounds,

and then the flue gas being subjected to an if appropriate multistage cleanup for removing mercury from the flue gas, which cleanup comprises a wet scrubber and/or a dry cleanup.

2. Process according to claim 1, characterized in that the bromine compound is an aqueous solution of hydrogen bromide and/or an alkali metal bromide, in particular sodium bromide, and/or an aqueous solution of alkali metal bromide.

I note that hydrogen bromide (HBr) by itself is a toxic gas at room temperature. However, Vosteen589 discloses applying the hydrogen bromide in an aqueous solution (i.e., hydro-bromic acid), such that inhalation is less of a concern.

²⁰ EX1005 (Vosteen589) at claims 1-2.

2. Post-combustion use of injection of activated carbon

18. I will now continue with the second part of the question raised by Mr. Cichanowicz, namely, why a POSITA “would employ post-combustion injection of activated carbon.”²¹ The short answer is that Vosteen589 strongly suggests (though does not outright use the words “injection” for activated carbon) that the activated carbon should be injected downstream of the combustion chamber. The inventors, Mr. Cichanowicz, and Starns/Mass-EPA are all in agreement that activated carbon injection (ACI) was the most mature and thoroughly researched method at the time for capturing mercury.

19. Vosteen589 discloses a “dry emission control system” as part of the “flue gas emission control system,” which he also refers to as “cleanup of the flue gas” or as “dry cleanup.”²² Vosteen589 describes that the sorbent is introduced to the mercury-containing flue gas, downstream of the combustion chamber, and even states: “removal of mercury from the flue gases in a flue gas emission control system downstream of the combustion”²³ The flue gas was formed as a result of combustion of coal in the combustion chamber.

²¹ EX2047 (Cichanowicz Decl.) ¶ 49.

²² EX1005 (Vosteen589) ¶¶[0017]-[0019].

²³ EX1005 (Vosteen589) ¶[0007].

20. Vosteen589 refers to using the invention in plants “which do not have a wet flue gas emission control system, but solely have a dry emission control system having a mercury sorption stage.”²⁴ The processes that Vosteen589 repeatedly describes as being performed by the dry-emission control system—“adsorption” or “sorption”—are ones in which an adsorbate (e.g., atoms, ions, or molecules) in a fluid (typically a gas) become bound to the surface of the sorbent. The processes performed by the dry-emission control system is “based on the adsorption of ionic mercury compounds.”²⁵

21. Vosteen589 discloses that two types of mercury will be present in the flue gas—“metallic mercury” (i.e., elemental mercury, or Hg⁰) and “ionic mercury.”²⁶ Vosteen589 repeatedly refers to binding mercury to “adsorbents,” another term for “sorbents,”²⁷ and provides as an exemplary sorbent “finely pulverulent slaked lime/activated carbon.”²⁸

²⁴ EX1005 (Vosteen589) ¶[0019].

²⁵ EX1005 (Vosteen589) ¶[0019].

²⁶ EX1005 (Vosteen589) ¶[0022].

²⁷ EX1005 (Vosteen589) ¶¶[0003], [0007], [0019].

²⁸ EX1005 (Vosteen589) ¶[0019].

22. The adsorbate (e.g., mercury) in the mercury-containing flue gas is being adhered to the sorbent (e.g., activated carbon), and the activated carbon is thus contacting mercury in the mercury-containing gas to form a mercury/sorbent composition, which can then be separated from the gas stream before it is released to the atmosphere. For the coal-fired power plants, Vosteen589 discloses that a “dry electrostatic precipitator (ESP) is used.”²⁹

23. Therefore, Vosteen589 provides explicit instructions to add bromine-containing ingredients to coals and/or furnaces and then to capture mercury in both elemental and oxidized forms on activated carbon sorbents in conventional particle collection devices (such as ESPs).

B. CORROSION FROM BROMINE-CONTAINING INGREDIENTS WAS NOT A KNOWN CONCERN IN 2004, AND WOULD HAVE BEEN OUTWEIGHED BY OTHER TRADEOFFS

24. Despite the explicit instructions in Vosteen589 to add bromine-containing ingredients (such as sodium bromide, NaBr) to coal, Mr. Cichanowicz ignores the teachings of Vosteen589 and instead asserts, “Petitioners do not address the known concerns of ... corrosion that would have been fundamental to the decision making of a POSITA.”³⁰ Later, he states the following:

²⁹ EX1005 (Vosteen589) ¶[0034].

³⁰ EX2047 (Cichanowicz Decl.) ¶ 49.

POSITA would understand that bromine is a corrosive material. When used as an additive, bromine in the fuel—similar to the native chlorine—has the potential to corrode the metal components of the power plant. However, the pre-treatment of carbon with bromine bounds the bromine to the carbon and removes or at least minimizes the corrosion concern.³¹

He concludes, based on this, that a POSITA would use “pre-treated brominated carbon that is injected downstream of the boiler” to avoid these corrosion issues,³² despite the fact that Vosteen589 expressly states to apply Br-containing ingredients to the coal or combustion chamber.

25. I agree that, long before 2004, utilities knew that so-called high-Cl coals could cause corrosion near burner belts in furnaces and also on some air preheaters. But there would be no reason for a POSITA to suppose that similar problems would arise with the Br of Vosteen589, particularly since the concentrations were so much lower.

26. As an illustration, I previously determined the range of Br concentrations in flue gas during one of the example tests in Vosteen589, such as in my Original Declaration for claims 4 and 29 of the '114 Patent. As I described in my earlier declarations, Vosteen589 discloses two values for the concentration of bromine in the flue gas: 43 and 75 mg/M³ S.T.P. db. Vosteen589 also discloses “the

³¹ EX2047 (Cichanowicz Decl.) ¶ 55.

³² EX2047 (Cichanowicz Decl.) ¶ 55.

flue gas volume flow rate” of $110 \times 10^3 \text{ m}^3 \text{ S.T.P. db/hr.}$ ³³ These Br concentrations can be converted into units of ppm in flue gas (not on coal) by dividing by the density of dry flue gas of 1340 g/m^3 (based on an estimated dry flue gas molecular weight of 30 g/mol), according to

$$43 \frac{\text{mg-Br}}{\text{m}^3} = 43 \frac{\text{mg-Br}}{\text{m}^3} \times \left(\frac{1 \text{ g}}{1000 \text{ mg}} \right) \times \left(\frac{1}{1340 \frac{\text{g}}{\text{m}^3}} \right) = 3.21 \times 10^{-5} \frac{\text{g-Br}}{\text{g-flue gas}}$$

Applying the same conversion to $75 \text{ mg/m}^3 \text{ S.T.P}$ gives $5.60 \times 10^{-5} \text{ g-Br/g-flue gas}$. Once these values are multiplied by $10^6 \text{ ppm per g-Br/g-flue gas}$, the calculations show that a range for typical Br concentrations in flue gas that includes the Br addition taught by Vosteen589 is only 32 - 56 ppm.

27. This range of ppm Br in the flue gas can be converted to ppm Br in coal by using the nominal conversion factor of roughly 8 g flue gas per 1 g low rank coal,³⁴ which gives a range of 265 – 450 ppm Br in coal. For the Br additions recommended by Vosteen589, the equivalent Br loadings on coal are not excessive compared to the range of native-Cl levels in coal and therefore give little, if any, basis for acute corrosion concerns.

³³ EX1005 (Vosteen589) ¶[0048].

³⁴ Vosteen589 describes “lignite-fired power stations.” EX1005 (Vosteen589) ¶[0008]. Lignite is a type of low-ranked coal.

28. The view that a POSITA would not have been concerned with corrosion caused by addition to coal of bromine-containing ingredients was shared by Mr. Pavlish:

Q. Didn't you have the same concerns about corrosion with bromine that you just described for chlorine?

A. Not nearly the same level of concern, much lower level. We were using less amounts as well, so the concern with bromine was quite diminished.³⁵

29. Field test experience from 2004 onward confirmed the expectation that corrosion potentials with Br additions would be manageable. The first wave of tests to evaluate Br additions were conducted by many testing teams at various coal-fired furnaces and gas cleaning systems. These were short-term parametric test campaigns that generally lasted only about one week. So it is not surprising that no corrosion episodes were reported. However, once long-term testing lasting a few months began in 2006 or so, corrosion was reported in the air preheaters at some sites (but not in furnaces and not at all sites).

30. Soon after, EPRI began a comprehensive research program on Br-based corrosion both at lab-scale and in actual plants. This program ultimately identified which types of air preheaters, and which coals could be affected by Br-based corrosion. However, the first presentation or publication from EPRI on Br-based

³⁵ EX2004 (Trial Transcript) at 253:11-15.

corrosion in coal plants was as the 2008 MEGA symposium.³⁶ But again, this paper was not published until 2008, many years after Vosteen589.

31. Consequently, in 2004, a POSITA would not have had any basis to avoid Br additives on coal—the approach described by Vosteen589—due to the potential for Br-based corrosion. It was not until 2008 and later that corrosion associated with Br additions was taught in the power plant community. Those teachings also included effective mitigation strategies, so concerns about Br-based corrosion never substantially impeded the penetration of Br-based Hg control technologies in the commercial marketplace.

32. Of course, implementation and installation of any process or system into a coal-fired power plant carried with it a learning curve—whether new technology or old technology—that must be traversed with tradeoffs considered. The corrosion potential of bromine-containing ingredients (if considered at all in 2004) would have been compared against the cost savings and ease of implementation in the teachings of Vosteen589 combined with Starns and Mass-EPA: barrels of aqueous sodium bromide solutions (salt water), flexible hoses, spray nozzles

³⁶ Dombrowski K, et al. The balance of plant impacts of calcium bromide injection as a mercury oxidation technology in power plants. AWMA/EPA/EPRI/ DOE Combined Power Plant Air Pollution Control MEGA Symp, Baltimore MD, August 19-22, 2008

positioned above coal conveyers, ordinary liquid metering systems, and widely available ACI systems and monitors (for which Starns even shows pictures). The capital costs of such standard equipment pales in comparison to bringing online other technologies to help with mercury removal.

33. I also note that the claims of the '114 Patent recite injecting halogens at more than two points in the system, such as: (a) “the coal,” “the combustion chamber,” “or a combination thereof” (claim 1); (b) halogens also downstream of the combustion chamber (claims 8-9); and (c) as part of the activated carbon (claim 14). Thus, to the extent Br-caused corrosion was a concern in 2004 (it was not), then the '114 Patent and the '517 Patent say nothing about how to solve that concern.

**C. THE PRESENCE OR ABSENCE OF A SCRUBBER WOULD NOT HAVE
DETERRED FROM ACTIVATED CARBON INJECTION**

34. Despite the explicit instructions in Vosteen589 to add bromine-containing ingredients (such as sodium bromide) to coal and to use downstream activated carbon, Mr. Cichanowicz ignores the teachings of Vosteen589 and instead asserts:

At most, for power plants that had a wet or dry scrubber installed, the power plant could improve mercury capture by using bromine additives to convert elemental mercury into oxidized mercury that can be captured in the scrubber as done in Vosteen. *See, e.g.*, Ex. 1005 at ¶ 47 (Vosteen primarily focuses on examples at waste incineration plants but example 5 discusses a power plant with a scrubber). Petitioners offer no basis for such a power plant to use the two-part approach of the claims. After

all, if a POSITA believed that bromine additives could effectively oxidize the mercury, and that this oxidized mercury can be captured in a scrubber, then there would be no reason to undertake the additional expense and potential problems of using activated carbon injection.³⁷

35. I see no reason why this observation precludes a POSITA from contemplating the combination of Br addition and ACI for the much larger portion of the power-plant population that had no scrubbers at the time that Vosteen589 was published. Both Vosteen589 and Downs-Boiler are directed at plants firing low-rank coals. The Br addition/ACI combination is explicitly focused on lignites and subbituminous coals, because these coals tend to contain much lower sulfur levels than bituminous coals, and therefore operators could often meet compliance goals without dedicated sulfur scrubbing.³⁸ Moreover, low-rank coals are naturally deficient in inherent halogens and also produce relatively little unburned carbon in their flyash. In concert, these three factors—few scrubbers, few halogens, and little unburned carbon—make Hg emissions control with low-rank coals much more challenging than with bituminous coals. The Br addition/ACI combination is a highly effective and economical match for this challenge.

³⁷ EX2047 (Cichanowicz Decl.) ¶ 51.

³⁸ EX1005 (Vosteen589) ¶¶[0006],[0008].

36. In the 2004-time frame, the vast majority of plants firing low-rank coals did not have scrubbers in their gas cleaning systems, which is why Vosteen589 teaches that conventional particle collection devices such as electrostatic precipitators (ESPs) and fabric filters (FFs)³⁹ can be used to remove Hg bound to PAC at the end of a cleaning system. These teachings strongly encourage a POSITA to consult both Starns and Mass-EPA for guidance on how to actually implement the Br addition/ACI combination that Vosteen589 recommends.

37. Vosteen589 also recognizes that some plants firing low-rank coals, and therefore likely to benefit from Br addition, either already used scrubbers or could adopt scrubbers as SO_x emissions standards were tightened in the future. Claim 1, the only independent claim in Vosteen589, stipulates that “the flue gas being subjected to an if appropriate multistage cleanup for removing mercury from the flue gas, which cleanup comprises a wet scrubber and/or a dry cleanup.”⁴⁰ Clearly, both wet scrubbers and dry cleanup are suitable for Hg removals, according to Vosteen589.

³⁹ EX1005 (Vosteen589) ¶¶[0019], [0033], [0037], [0039], [0042], [0047]-[0049], claim 8 (discussing use of an ESP).

⁴⁰ EX1005 (Vosteen589) at claim 1.

38. The contingency with scrubbers was also recognized by the patent holders as early as the Provisional. Figure 2 in the Provisional is a diagram of the main unit operations in a coal-fired power plant.⁴¹ It includes sites for additive injection, sorbent injection, an ESP or FF as well as a scrubber. Even the claims of the patents contemplate using activated-carbon injection together with a scrubber:

18. The method of claim 1, wherein the injection of the sorbent material into the mercury-containing gas occurs upstream of a particulate separator *or a scrubber*.⁴²

25. The method of claim 1, wherein the injection of the sorbent into the mercury-containing gas occurs upstream of a particulate separator *or a scrubber*.⁴³

Thus, even the patentee disagrees with Mr. Cichanowicz and recognized that a POSITA would be inclined to implement the Br addition/ACI combination in gas cleaning systems with scrubbers.

**D. FLY ASH CONTAMINATION WOULD NOT HAVE DETERRED FROM
ACTIVATED CARBON INJECTION**

39. In more general terms, Mr. Cichanowicz also states:

[T]here is a strong disincentive to inject carbon sorbent. Many power plants collect the fly ash resulting from coal combustion and sell it for use in making concrete. However, even small amounts of activated carbon can alter the makeup of the fly ash

⁴¹ EX1020 (Provisional) at Figure 2.

⁴² '114 Patent at Claim 1.

⁴³ '517 Patent at Claim 25.

rendering it unfit for use in concrete. Thus, employing activated carbon could deprive the power plant of a significant revenue source, and create a need for fly ash disposal.⁴⁴

A POSITA would not look at flyash sales in isolation. Rather, this opportunity cost would be combined with all costs associated with Hg emissions control for a variety of technological options to arrive at the best control technology for a given utility operation.⁴⁵ Lost sales of fly ash, if any, would not be a basis for outright rejection of an otherwise promising candidate such as the Br addition/ACI combination. As I described in my Original Declarations, ACI was the “most mature, retrofit technology” available by 2002,⁴⁶ and Mass-EPA referred to ACI as the “most likely technology to be commercialized for mercury control.”⁴⁷ Obviously, failure to comply with Hg emissions regulations would be very expensive in short order, and smaller financial advantages may need to be sacrificed to ensure compliance.

⁴⁴ EX2047 (Cichanowicz Decl.) ¶ 51.

⁴⁵ I also note that the same concerns Mr. Cichanowicz expresses regarding lost sales of fly ash would be equally applicable to what he calls the “conventional” technology of injecting B-PAC.

⁴⁶ EX1008 (Starns) at 2.

⁴⁷ EX1009 (Mass-EPA) at 32.

40. I also note that, to the extent fly-ash contamination was a concern in 2004, then the '114 Patent and the '517 Patent say nothing about how to solve that concern.

E. PRE-COATING OF FABRIC FILTERS

41. I have been asked to further describe the particle collection devices (PCDs) in Vosteen589, which would have further motivated the combination with Starns and with Mass-EPA. Claim 8 of Vosteen589 recites:

Process according to one of claims 1 to 7, characterized in that the flue gas emission control system comprises at least one dry or semi-dry absorption-based emission control stage, in particular using electrostatic or filtering dust separators.⁴⁸

Vosteen589 teaches that a “dry or semi-dry absorption-based” process can continuously remove Hg from flue gas as it collects particles in the flue gas stream. It gives two examples of such a unit, an ESP and FF,⁴⁹ which are the most common flyash collectors in coal-fired power plants. In ¶[0019] of Vosteen589, this Hg removal scheme is described in more detail as follows:

[0019] The flue gas emission control system can also comprise a dry emission control system based on the adsorption of ionic mercury compounds. Such a cleanup can be carried out, for example, by semi-dry desulphurization in a spray-dryer which is impinged with a milk of lime/carbon suspension, or using fixed-bed adsorbers, for example based on granulated activated carbon

⁴⁸ EX1005 (Vosteen589) at claim 8.

⁴⁹ EX1005 (Vosteen589) ¶¶[0018], [0019], [0034].

or oven coke or mixtures of such adsorbers with granular lime, or using pneumatic adsorbers, for example electrostatic precipitators (ESPs), or using cloth filters which are impinged with a blown-in finely pulverulent slaked lime/activated carbon or slaked lime/oven coke mixture.⁵⁰

42. Vosteen589 [0019] first states that this version of Hg removal is based on “adsorption of ionic mercury compounds,” which necessarily refers to the chemical binding of Hg onto a substrate or sorbent. It then describes three example configurations of suitable sorbents: (1) a slurry in a spray drier absorber (SDA) that contains both carbon and lime; (2) a fixed bed of activated carbon or activated carbon/lime mixtures; and (3) a suspension of lime and carbon injected into the flue gas.

43. For both the first and third configurations, Vosteen589 uses the term “impinge” to describe a continuous contacting between the mercury-containing flue gas and the sorbent. The phrase “cloth filters which are impinged with a blown-in finely pulverulent slaked lime/activated carbon or slaked lime/oven coke mixture” does not mean that the filters are pre-coated with a pulverized lime/carbon mixture as some measure that protects the filter in an unspecified way.

44. First, Vosteen589 does not contain the terms “pre-coating” or “protect,” or in any other way describe any proactive protective measure for fabric filters,

⁵⁰ EX1005 (Vosteen589) ¶[0019].

because protecting fabric filter material is well outside the scope of Vosteen589. Vosteen589 recommends “using pneumatic adsorbers, for example electrostatic precipitators (ESPs), or using cloth filters...”⁵¹ because both ESPs and FFs are units that effectively remove Hg adsorbed on activated carbon. Since ESPs have no fabric filter materials to protect, it is incorrect to interpret “cloth filters which are impinged with a blown-in finely pulverulent slaked lime/activated carbon or slaked lime/oven coke mixture” as some unspecified protective measure, rather than a clear instruction to continuously inject a lime/carbon suspension directly into a FF to remove adsorbed Hg from flue gas.

45. Second, the term “impinge” must have the same meaning for sorbent configurations (1) and (3) because of the way that ¶[0019] is written. A spray drier absorber (in configuration (1)) continuously contacts flue gas with a lime/carbon slurry by continuously injecting fresh slurry into the top of an absorber column, and by continuously drawing away the dried suspension of lime in scrubbed flue gas into a downstream fabric filter. Similarly, when Vosteen589 refers to “cloth filters which are impinged with a blown-in finely pulverulent slaked lime/activated carbon” (configuration 3) it can only be describing a suspension of lime and carbon that is continuously injected into flue gas as it moves into a fabric filter. This suspension

⁵¹ EX1005 (Vosteen589) ¶[0019].

accumulates with flyash into a filter cake that is periodically removed by pulsed air jets, which is the typical mode of operation of all fabric filters. Third, Vosteen589 teaches a process for removing Hg from flue gas produced at coal-fired power plants. The “process” that is explicit in Claim 8 and all other claims of Vosteen589 is necessarily continuous because coal-fired power plants continuously produce high-volume streams of flue gas; whenever these plants are operating, they have to generate flue gas. And the mercury in that flue gas must be continuously removed. No isolated pre-coating of a fabric filter with any sorbent in a gas cleaning system could continuously remove Hg from flue gas at the same efficiency and thereby meet compliance regulations.

46. A POSITA would have understood that the same process of injecting activated-carbon into the flue gas of Vosteen589 using a fabric filter would also be useful with an ESP, as Vosteen589 discloses fabric filters and ESPs as alternative PCDs. Thus, Vosteen discloses activated carbon and teaches adding the activated carbon to the system in a continuous process (i.e., rather than batch), and he then ultimately removes it using an ESP or a FF. As I described in my Original Declarations, Starns and Mass-EPA also disclose adding activated carbon in a continuous process, specifically calling out activated carbon injection (ACI), and further disclose implementation details for the ACI control schemes and hardware that are interoperable with Vosteen589.

F. THE PURPORTEDLY “CONVENTIONAL” APPROACH OF B-PAC AND TRADEOFFS IN USING IT

47. Mr. Cichanowicz states the following:

Power plant pollution control systems are comprised of complex process steps that rarely can be replaced or substituted with alternative controls. That is particularly true here given that the conventional approaches taught away from the patented approach of combining pre-combustion bromine additives with post-combustion activated carbon injection.⁵²

Mr. Cichanowicz does not exactly define what he means by “conventional approaches” or explain how they “taught away.” I have certainly not seen anything in Vosteen⁵⁸⁹ or Starns/Mass-EPA that criticizes a two-part process or instructs a POSITA to not use it—quite to the contrary, as I explain above. Nevertheless, I assume that Mr. Cichanowicz is referring to “injecting brominated activated carbon” as what he calls the “conventional” approach.⁵³ He states that “known concerns of reaction time and corrosion [discussed above] that would have been fundamental to the decision making of a POSITA.”⁵⁴ Later, he refers to “the limited residence time of activated carbon with flue gas once injected into the ductwork.”⁵⁵ He apparently

⁵² EX2047 (Cichanowicz Decl.) ¶ 48.

⁵³ EX2047 (Cichanowicz Decl.) ¶ 49.

⁵⁴ EX2047 (Cichanowicz Decl.) ¶ 49.

⁵⁵ EX2047 (Cichanowicz Decl.) ¶ 58.

suggests that a POSITA would choose brominated powdered activated carbon (B-PAC) and that this somehow teaches away from using ACI in the two-part process.

48. First, Mr. Cichanowicz cites no basis or evidentiary support for his discussion of reaction times or residence time. Mr. Cichanowicz assumes that a POSITA would care, or even know, about how pretreated brominated sorbents (or B-PAC) were manufactured, of which both options are implausible.

49. A POSITA would not care about the manufacturing conditions of B-PAC because it was available for purchase as a commercial product (such as from Sorbtech). The people who operate power plants certainly do not know how every component in their operations are manufactured or care to take the time to investigate these conditions. They are focused on B-PAC's performance as a Hg removal technology and its cost, and little else. And, the performance that matters is under the conditions in full-scale gas cleaning systems. Moreover, a POSITA would probably not even be able to ascertain the conditions for B-PAC manufacture or how long the PAC was exposed to Br (to create B-PAC), as suppliers of environmental control products closely guard these conditions.

50. Second, as I described in my Original Declarations regarding Claims 13 and 14 of the '114 Patent (and Claims 23 and 24 of the '517 Patent), Vosteen589 does not characterize the sorbent as having been pre-brominated or otherwise impregnated with a halogen promoter prior to injection, and a person of ordinary

skill in the art would have understood the disclosure of Vosteen589 to refer to plain activated carbon (not pre-brominated). As I also explained for those claims, Starns and Mass-EPA each disclose Norit Darco activated carbon that is not pre-brominated.

At each site, at least two sorbents are evaluated during the parametric tests. A standard powdered activated carbon (FGD), which is a lignite-derived sorbent supplied by Norit Americas Inc., is tested in all cases as the benchmark sorbent.⁵⁶

For Ground A2, the same activated carbon was used: “Norit FGD,” specifically “Norit America’s ‘Darco FGD.’”⁵⁷

51. As I also explained, there are tradeoffs between using the plain ACI, taught by Starns and Mass-EPA, and using the B-PAC (what Mr. Cichanowicz suggests is the “conventional” approach). A POSITA would have selected halogen-free sorbent (as in Vosteen589, Starns, and Mass-EPA) due to its lower cost (compared to pre-brominated PAC), particularly for applications (e.g., types of coal) that do not require the enhanced removal properties of B-PAC. For coals with higher native mercury content (or lower native halogen content and/or lower unburned carbon in fly ash) where a greater percentage of elemental mercury makes removal more troublesome, or for systems that did not employ a scrubber, a POSITA may

⁵⁶ EX1008 (Starns) at 3.

⁵⁷ EX1009 (Mass-EPA) at 73, 74.

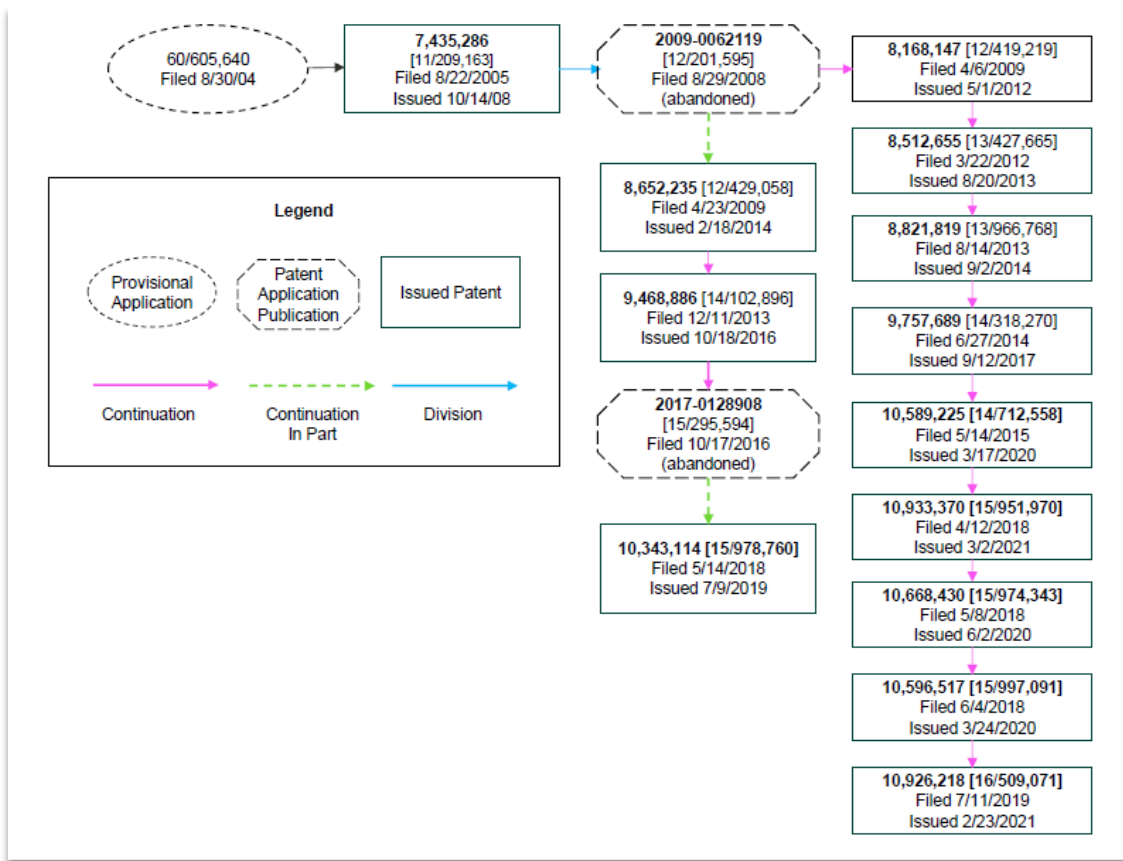
have also tried the B-PAC (in conjunction with upstream Br-addition). These are economic tradeoffs that depend on the types of coal, and both were obvious.

IV. Evolution of the Reaction Chemistry Model

52. I have been asked to comment on the reaction chemistry model shown in Figure 2 of the Provisional (EX1020) and how it evolved within the patent family tree. I have been asked to compare the figure shown in the Provisional (shown in the oval below) and how it compares to a parallel figure shown in Application No. 12/201,595 (shown in the top octagon below).⁵⁸

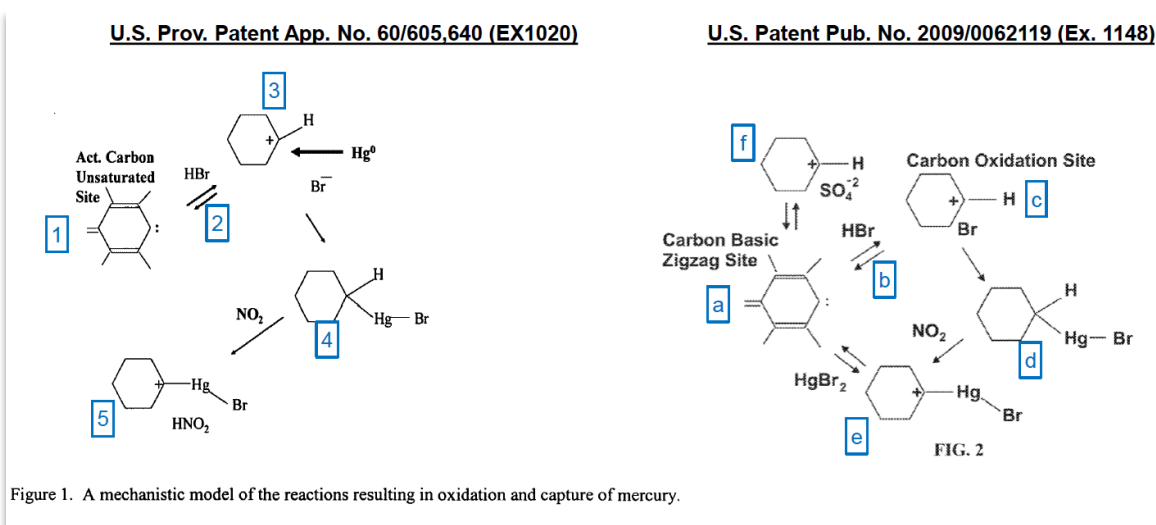
⁵⁸ EX1004 (family tree); EX1020 (Provisional); EX1148 (12/201,595).

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The two models have been annotated below with the blue boxes.⁵⁹

⁵⁹ EX1149 (showing figures from EX1020 and EX1148).



I note that the figure on the right (EX1148) is generally similar to the figures shown in the Olson-646 and Olson-235 references I discussed in my Original Declarations. As I explain below, the figure on the right from EX1148 is different than the figure on the left from EX1020. EX1148, Olson-646 and Olson-235 have additional disclosures not present in the Provisional.

53. Mr. Cichanowicz states the following regarding Figure 1 of the Provisional:

Here, the inventors explained that the benefits of the claimed promoted sorbent are obtained by forming a carbon bromide out of activated carbon and a negative Bromine ion, i.e., Br⁻. They further explain that this Br⁻ ion may be supplied by adding bromide, HBr or Br₂ (all of which contain Br⁻) to the carbon.⁶⁰

⁶⁰ EX2047 (Cichanowicz Decl.) ¶68.

At the outset, I note that Br₂ does not “contain Br-.” Rather, Br₂ has two Br atoms covalently bonded together, with no ionization or transfer of electrons.

54. There are several other incorrect aspects of Mr. Cichanowicz’s assertion. First, Figure 1 of the Provisional is little more than a cartoon. It does not convey any information at all about where any Br species are added in a coal-fired power plant. That is because it illustrates a microscopic view of the surface of a carbon particle while it sustains partial Hg oxidation by Br species. This view has no information about: where any Br species was added; the nature of the specific Br-containing compound that was added; whether the addition was as a solid, liquid, or gas; whether or not the added Br-containing ingredient had to be converted into other species prior to contacting the carbon surface; the origin of the carbon in the cartoon; and how and where that carbon came into contact with Hg containing flue gas from the furnace.

55. In addition, there are very significant changes to the figure among different versions in this patent family, which can be seen when comparing the figure on the left (EX1020) with the figure on the right (EX1148). Both figures try to depict stages in postulated chemistry for heterogeneous (solid-gas reaction) oxidation of elemental mercury (Hg⁰) by Br species at zigzag site defects on an activated carbon surface. The primary Hg oxidation sequence is indicated as steps 1-2-3-4-5 in the Provisional and as a-b-c-d-e-a in the ’119 Publication. Both sequences begin with

the unpaired electrons on a zigzag site (also referred to as a “carbene”), which is a Lewis base (i.e., it can donate electrons). In both sequences this basic site attracts the acid-gas HBr onto the surface (steps 2 and b), and then disintegrates it to form a carbocation, which is indicated with the positive ring site bonded to a H atom (steps 3 and c). Whereas the Provisional version shows the carbocation in close proximity to a Br anion (Br⁻) on the surface, the ’119 version shows only a bound Br atom on the surface, which is problematic because of the imperative to maintain charge neutrality.

56. The next step is also muddled. In the Provisional, elemental Hg⁰ is stabilized by the carbocation as it bonds with the surface Br⁻ anion to form a bound HgBr species (step 4). But in the ’119 version, even though no Hg⁰ is indicated, the same bound HgBr species (step d) is formed; the Hg atom in this bond appears from nowhere. The surface species (steps 4 and d) carry no charge. The final step in the Provisional version is the elimination of an H atom near the bound HgBr to restore the carbocation to the surface (step 5), which is now presumably stabilized by the nitro group (NO₂) within the nitrous acid (HNO₂) bound to the surface. Note that the sequence in the Provisional ends with a bound HgBr species stabilized by a carbocation (step 5) instead of the ultimate oxidation product of HgBr₂(g) (step e of ’119 Publication). Consequently, it is inaccurate to assert that the Provisional reaction sequence even covers Hg oxidation because it omits the ultimate Hg

oxidation product. This crucial step is depicted in the '119 version as the conversion of the reconstituted carbocation (step e) into the original basic zigzag site (step a) with the release of HgBr_2 as a gas. The cartoon leaves the source of the additional Br atom needed to form HgBr_2 from adsorbed HgBr (step e) to the reader's imagination.

57. Both primary reaction sequences illustrate a role for $\text{NO}_2(\text{g})$ in flue gas (steps 5 and e). However, only the '119 version shows a competing reaction that forms a different carbocation from the basic zigzag site, which is labeled as (step f). This alternate carbocation represents poisoning by adsorbed sulfate species from both SO_2 and SO_3 in flue gas. This poisoning channel is only coarsely sketched in the '119 cartoon, but is completely absent from the Provisional cartoon.

58. In sum, there are substantial differences between the reaction sequences in these two versions of the reaction cartoon, only one year apart. The various versions document the evolution of the ME2C inventors' insights into this surface chemistry as they clearly demonstrate their thinking had certainly not reached its final form at the time of the Provisional Application and even for years afterward. Even crucial aspects, including the production of the ultimate Hg oxidation product, were unresolved in the Provisional Application. For these reasons, it is inappropriate to claim that an evolving cartoon conveys any information at all about where or what Br compound is added to coal-fired power plants to reduce Hg emissions.

V. CONCLUSION

59. I, Stephen Niksa, do hereby declare and state, that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code. I declare under penalty of perjury that the foregoing is true and correct.

Executed this 13th of March, 2026 in California.

A handwritten signature in black ink, appearing to be 'Stephen Niksa', written in a cursive style.

Dr. Stephen Niksa