UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Berkshire Hathaway Energy Company &
PacifiCorp

Petitioners

v.

Birchtech Corp.
(d/b/a Midwest Energy Emissions Corp.)

Patent Owner

Case IPR2025-00422
Case IPR2025-00423
Case IPR2025-00424
Case IPR2025-00425
Patent 10,668,430
Patent 10,589,225

DECLARATION OF JOSEPH EDWARD CICHANOWICZ IN SUPPORT OF PATENT OWNER'S RESPONSE

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Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

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I, Joseph Edward Cichanowiscz, declare as follows:

I. INTRODUCTION

1. I am an expert in environmental control technologies for fossil fuel power plants. As further detailed below and exhibited in my *curriculum vitae* as Exhibit 2048, I have approximately 50 years of experience in the development, management, and commercialization of environmental control technologies for fossil fuel power plants. Furthermore, I am the inventor on several patents relating to environmental control technologies.

2. I have been retained as an expert witness to provide my independent opinion in regard to the matters at issue in *inter partes* reviews of U.S. Patent No. 10,668,430 ("the '430 Patent") in IPR2025-00422 and IPR2025-00423, and U.S. Patent No. 10,589,225 ("the '225 Patent") in IPR2025-00424 and IPR2025-00425. I have been retained by Birchtech Corp. ("ME2C" or "Patent Owner"). The Petitioners are Berkshire Hathaway Energy Company and PacifiCorp.

3. For my work on this case, I am being compensated for my time at my standard hourly rate. I am also being reimbursed for expenses that I incur during the course of this work. My compensation does not depend on the substance of my opinions or the outcome of any issues in this case.

4. My analysis of the materials produced in this matter is ongoing and I will continue to review any new material as it is provided. This declaration

represents only those opinions I have formed to date. I reserve the right to amend or supplement my opinions based on additional documents or evidence I am presented, including without limitation any arguments or expert declarations advanced by the Petitioners in this proceeding.

II. QUALIFICATIONS AND EXPERIENCE

5. I am qualified to be an expert in this matter as I possess the requisite knowledge, skill, experience, training, and education relating to the subject matter covered by the asserted patents.

6. In summary, I have nearly 50 years of experience in environmental control technologies for fossil fuel process equipment, mostly power plants. I spent nearly 15 years of my professional career as a Technical Project Manager at the Electric Power Research Institute ("EPRI"). In this role, I managed research projects to develop and commercialize environmental control technologies and improve plant performance. Most of my responsibilities at EPRI were directed to managing tests conducted on six pilot plants, which were similar to the test facilities used by the Energy and Environmental Research Center. The tests under my management addressed developing advanced technologies to control nitrogen oxides (NOx), sulfur dioxide (SO_2), and particulate matter emissions.

7. I am now, and have been for over 30 years, an independent power system consultant. In this role, I provide consulting services addressing the design

and application of environmental control technologies for fossil fuel process equipment, focusing on power stations. This work requires expertise in process fundamentals, capital and operating cost, applicability to a given site, and operating risk. The control technologies include burners and catalytic reactors for low emissions of NOx, desulfurization processes for SO_2, sorbents and additives for control of mercury (Hg), and carbon capture systems for carbon dioxide (CO_2). Evaluating the technical and economic feasibility of these options considers the role of fuel composition, boiler design, plant and site layout, and operating practices to improve the control technology performance while reliably generating power and steam.

8. My educational background includes a B.S. in Mechanical Engineering from Clarkson University (1972) and M.S. in Mechanical Engineering & Thermal Science from the University of California at Berkeley (1975).

9. I am an inventor on four patents, including a patent awarded for a design variant of a selective catalytic reduction reactor to increase the oxidation of elemental Hg (U.S. Patent No. 7,776,297, issued August 17, 2010).

10. In forming my opinions here, I am relying on my education and experience, including 50 years of experience in a variety of technologies involved in environmental control and fossil fuel power plants.

11. Additional information concerning my background, qualifications, publications, conferences, honors, and awards are described in my *curriculum vitae*, a copy of which is attached with this Declaration as Exhibit 2048.

III. LEGAL STANDARDS

12. I am not a lawyer, and I do not intend to offer any opinions as to the interpretation of the law. When considering the ’430 and ’225 Patents and stating my opinions, I rely on the following legal standards as described to me by the attorneys for ME2C.

A. Priority Date of Patent

13. I understand that the analysis of alleged obviousness of the ’430 and ’225 Patents should be performed from the perspective of a POSITA as of the priority date of the Patent. The “priority date” of the patent is the application filing date for the earliest identified application as shown on the face of the patent, *i.e.*, August 30, 2004, the date the provisional application was filed. Through a series of one or more continuation, divisional, and provisional applications, the ’430 and ’225 Patents claim priority to August 30, 2004. Furthermore, the inventors of the ’430 and ’225 Patents conceived the claimed invention and reduced it to practice before August 30, 2004. The inventions claimed in the ’430 and ’225 Patents were conceived and reduced to practice no later than September 2003.

14. I understand that a patent may be valid over prior art that was published or was publicly available before the priority date (but after the "critical date," which is one year before the priority date, *i.e.*, August 30, 2003) if the inventors conceived of the claimed invention before the prior art, and were diligent in reducing the claimed invention to practice.

15. I understand that the patentee must come forward with evidence corroborating an earlier conception date. I understand that a "rule of reason" analysis is applied to determine whether an inventor's prior conception or reduction to practice testimony has been corroborated. I understand that there is no single formula that must be followed in proving corroboration. I understand that an evaluation of all pertinent evidence must be made so that a sound determination of the credibility of an inventor's story may be reached. I understand that factors bearing on the inventor's credibility and on whether the inventor's testimony has been adequately corroborated include: delay between the event and the trial; interest of corroborating witnesses; contradiction or impeachment; corroborating witnesses' familiarity with details of alleged prior structure; improbability of prior use considering state of the art; impact of the invention on the industry; and relationship between witness and alleged prior user. I understand that all of the evidence put forth by the patentee, including any of the inventor's corroborated testimony, must be considered as a whole, not individually, in determining earlier

conception. In other words, an inventor can conceivably prove prior conception although no one piece of evidence in and of itself establishes the prior conception. It is sufficient if the picture painted by all of the evidence taken collectively gives "an abiding conviction" that the inventor's assertion of prior conception is "highly probable." For example, I understand that the analysis can consider whether the inventor made disclosure to others or an embodiment of the invention in some clearly perceptible form, such as drawings or model, with sufficient proof of identify in point of time. I understand that only the inventor's testimony requires corroboration, and that physical or documentary evidence offered to corroborate that testimony need not be further corroborated.

B. Level of Ordinary Skill in the Art.

16. My opinions in this declaration are based on the understandings of a person of ordinary skill in the art, as of the time of the invention. I understand that the person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. By "relevant," I mean relevant to the challenged claims of the '430 and '225 Patents.

17. I understand that various factors should be considered when determining the person of ordinary skill in the art in connection with a particular patent. I understand that these factors include, without limitation, the type of problems encountered in the art, the prior solutions to those problems found in the

prior art references, the rapidity with which innovations are made, the sophistication of the technology, the level of education of active workers in the field, and my own experience working with those of skill in the art at the time of the invention.

18. At the time of invention, a POSITA would have a bachelor's degree in mechanical engineering, chemical engineering, chemistry, or a related field of technology and at least two years of experience dealing with power plant operation, and/or pollution control equipment. Additional work experience in relevant industries could compensate for less education, or education in a different field. Similarly, advanced education and degrees could compensate for less work experience.

19. I am readily familiar with the level of ordinary skill in the art as of the priority date of the Patent. My qualifications at that time far exceeded that of a POSITA, and I had worked with, as well as supervised, many POSITA's throughout my work in the field.

C. Claim Construction

20. I understand that claims in a patent-at-issue are interpreted as they would have been interpreted by a person of ordinary skill in the art at the time of the invention, in light of the specification and the patent's prosecution history in the patent office.

D. Obviousness Legal Standard

21. I understand that a patent claim is unpatentable if the claimed invention would have been obvious to a person of ordinary skill in the art at the time of the invention.

22. I understand that an obviousness analysis involves comparing a claim to the prior art to determine whether the claimed invention would have been obvious to a person of ordinary skill in the art at the time of the invention in view of the prior art and in light of the general knowledge in the art as a whole. I also understand that obviousness is ultimately a legal conclusion based on underlying facts of four general types, all of which must be considered: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) any objective indicia of non-obviousness, including any praise of the invention. Objective indicia of non-obviousness may include, for example, commercial success of an embodiment, a long-felt need, skepticism, failure by others to find the solution provided by the claimed invention, copying by others of the subject matter of the claim invention, unexpected results of the claimed invention, acceptance of others and industry praise, and licensing of the patents.

23. I also understand that obviousness may be established under certain circumstances by combining or modifying the teachings of the prior art. However,

I have been informed that a claim is not proved obvious merely by demonstrating that each of the elements was independently known in the prior art. I have been informed that many, if not all, inventions rely on building blocks already previously known, and claimed discoveries almost of necessity will likely be combinations of what is already known. I have been informed that it is important to identify whether a reason existed at the time of the invention that would have motivated a person of ordinary skill in the art in the relevant field to combine the known elements in the way the claimed invention does. Specific teachings, suggestions, or motivations to combine any first prior art reference with a second prior art reference can be explicit or implicit but must have existed before the date of purported invention. I understand that prior art references themselves may be one source of a specific teaching or suggestion to combine features of the prior art, but that such suggestions or motivations to combine art may come from the knowledge that a person of ordinary skill in the art would have had.

24. I understand that a reference may be relied upon for all that it teaches, including uses beyond its primary purpose, but also including teachings that lead away from the invention. I understand that a reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference.

25. I further understand that whether there is a reasonable expectation of success in combining references in a particular way is also relevant to the analysis.

26. I understand that it is improper to use hindsight to combine references or elements of references to reconstruct the invention using the claims as a guide. My analysis of the prior art is made from the perspective of a person of ordinary skill in the art at the time of the invention.

27. I am not offering any legal opinions in this declaration nor am I qualified to do so. I only consider such legal standards in framing my opinions and conclusions as well as placing assertions made by Petitioner in the Petition into the proper context. Additionally, from a subject matter perspective, I understand that the petitioner always has the burden of persuasion regarding a challenge of patentability of an invention under an inter partes review.

IV. CLAIMS-AT-ISSUE

28. I understand that in IPR2025-00422 and IPR2025-00424, Petitioners have challenged claims of the ’430 and ’225 Patents under five grounds. The first ground alleges that ’430 claims 1–4 and 6–29, and ’225 claims 1, 2, 5–15, 17–20, and 22–29 are obvious based on the combination of Vosteen589 and Starns. The second ground alleges that ’430 claims 1–4 and 6–29, and ’225 claims 1, 2, 5–15, 17–20, and 22–29 are obvious based on the combination of Vosteen589 and Mass-EPA. The third ground alleges that ’430 claims 1–4, 6–9, 14–16, 18–19, 22–28 and

’225 claims 1, 2, 5, 7, 8, 14–15, 17, 19–20, 25–29 are anticipated by Down-Boiler. The fourth ground alleges that ’430 claims 1–4 and 6–29, and ’225 claims 1, 2, 5–8, 14–15, 17–20, 22–29 are obvious based on the combination of Downs-Boiler and Starns. The fifth ground alleges that ’430 claims 1–4 and 6–29, and ’225 claims 1, 2, 5–8, 11–12, 14–15, 17–20, 22–29 are obvious based on the combination of Downs-Boiler and Mass-EPA.

29. In IPR2025-00423 and IPR2025-00425, Petitioners have challenged claims of the ’430 and ’225 Patents under three grounds. The first ground alleges that ’430 claims 1–4 and 6–29, and ’225 claims 1–2, 5–8, 10–12, 14–15, 17–20, 22–29 are obvious over Sjostrom and Eckberg. The second ground alleges that ’430 claims 1–4 and 6–29, and ’225 claims 1, 2, 5–15, 17–20, and 22–29 are obvious over Sjostrom and Olson-646. The third ground alleges that ’430 claims 1, 3, 6–7, 10–29, and ’225 claims 1–2, 5–15, 17–18, 22–24, 27–29 are anticipated by Olson-235.

V. TECHNOLOGY BACKGROUND

30. A POSITA would be aware of the technology explained in the remainder of this section.

31. At a high level, coal-fired power plants convert the chemical energy in coal into electrical energy which is then used to power our civilization. As shown in Figure 1, which depicts one of several embodiments of a coal-fired power plant,

coal is combusted to release heat that turns water into steam, which drives rotating steam turbines. The rotating steam turbines drive rotating electrical generators that produce electricity.

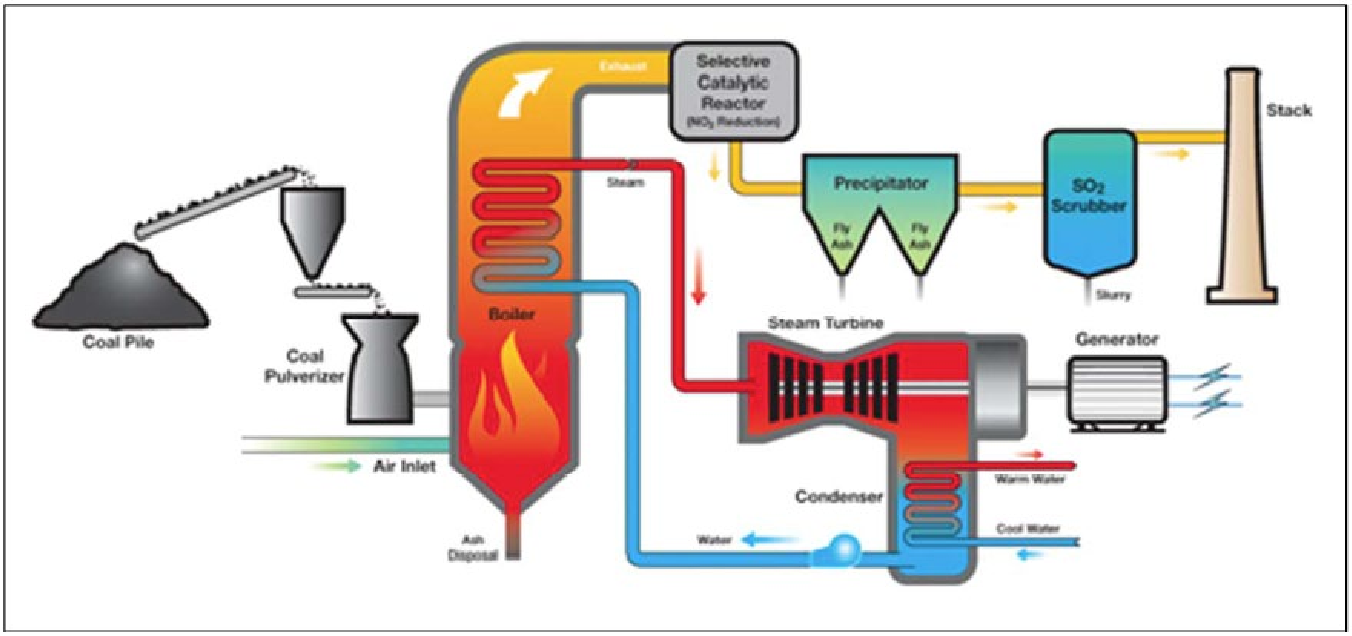


Figure 1.

32. The coal is delivered to a power plant where it is unloaded and sent by conveyors to a coal pile for long term storage. Coal is removed from the pile as needed, via a reclaim system, and moved by conveyor belts to the bunkers (coal silos). Coal is removed from the bunkers via gravity and sent to feeders. The feeders meter specific amounts of coal to the pulverizers depending on rate of combustion and steam demand. The pulverizers grind the coal into fine powder, which is conveyed by a primary air stream and conveyed up by primary air fans. The primary air fans deliver the coal-primary air mixture to the burners in the

furnace which is part of the steam generation system (often referred to as the steam generator, or boiler) of the plant. The area near the burners form a combustion chamber, the furnace section of the boiler. Downstream of the combustion chamber there are series of heat exchangers and tubes in the convective heat transfer sections of the boiler that further extract heat from flue gas that exits the furnace. Products of combustion are formed as coal is burned in the furnace. The coal carbon and hydrogen constituents are combusted to generate flue gas which will contain particulate matter from the inorganic material in the coal, mostly metal oxides, that do not burn. Flue gas leaving the furnace will retain about $4/5^{th}$ of the inorganic matter in the gas flow, as about $1/5^{th}$ falls to the furnace bottom.

33. At the burners, the coal-primary air stream is further combined with inlet or secondary air, and this mixture ignites to create a flame within the lower furnace. The radiant heat released by the flame zone heats water in surrounding waterwall tubes until it becomes saturated steam. This saturated steam is forwarded to additional heat exchangers that "superheat" the steam so as to contain higher energy.

34. An alternative to the pulverized coal boiler is a legacy design developed by Babcock and Wilcox. This design employs what is known as the cyclone furnace to burn coals that would readily form slag deposits on heat exchanger surfaces in a pulverized coal boiler. Coal is from the pile is "crushed"

and not pulverized, resulting in larger particles that are fed into a number of horizontally oriented cyclone burners along with primary and secondary air. The crushed coal and air form a whirling fireball within the cyclone burner (combustion chamber), which separates the inorganic matter by centrifugal force, forming molten "slag" which coats the cyclone burner walls. The combustion of coal is completed and flue gas leaves the furnace, containing only a small fraction (~1/5th) of the inorganic matter as the rest is rejected as molten slag. The heat generated in the cyclones and absorbed in the furnace is used to heat boiler water to saturated steam.

35. Downstream in the flue gas path of either a pulverized coal or cycle boiler furnace are superheater tubes, located in the convection section. Flue gas exiting the furnace enters the convective superheater tubes and converts the saturated steam into superheated steam, subsequently sent to the steam turbine. The superheated steam drives the turbine-generator to produce electricity. The turbine exhausts the steam into a condenser which employs cooling water to condense the expanded, low energy steam back into water. The water is then returned to the boiler to repeat the cycle.

36. Boilers also feature a "reheater" section. This heat exchanger optimizes the efficiency of the steam cycle by reheating a portion of steam

extracted from the turbine before expansion is complete, with this steam recycle step adding to thermal efficiency.

37. The last set of tube bundles (heat exchangers) in the boiler are referred to as the economizer. The economizer is located downstream of the superheater tubes (heat exchangers) in the convective pass of the boiler. The economizer further extracts energy from the flue gas to heat up water and condensed steam that is returned to the boiler, thereby "economizing" the process by using heat exiting the boiler.

38. As noted previously, the inorganic matter in the coal—mostly metal oxides (predominantly silica and aluminum)—is denoted as fly ash and retained in the flue gas as it moves through the furnace and convective section. As previously explained, about 1/5th of the inorganics are rejected from a pulverized coal furnace while about 4/5th of the inorganics are rejected by the action of a cyclone boiler. For both types of boilers the coal composition and combustion conditions also determine the amount of inorganics rejected and the composition of the fly ash. The remaining fly ash in the flue gas is transported through the convective pass of the boiler and any other components, and ultimately removed by a particulate removal device such as an electrostatic precipitator (ESP) or baghouses. A small amount of fly ash is removed in a hopper at the economizer as the flue gas makes a

right angle turn upon leaving the economizer. Fly ash collected in the boiler and economizer hoppers is removed on an ongoing basis.

39. Depending on the NOx compliance strategy, flue gas leaving the economizer may enter a selective catalytic reduction (SCR) unit for NOx control. The SCR process, if present in the flue gas stream as shown in Figure 1, can significantly impact Hg oxidation and the propensity of Hg to be removed in downstream equipment. Flue gas leaving the SCR reactor or (in absence of SCR) the boiler convective section enters one or more air heaters.

40. The air heater (not shown in Figure 1) is the last device to utilize flue gas heat from the boiler before entering the remaining environmental controls. This "low quality" heat—described as such due to a modest temperature of 550-650ºF—is used to preheat incoming air for combustion and the primary air to transport pulverized coal.

41. Flue gas exiting the air heater can enter several process steps to control emissions of particulate matter, SO_2, and Hg. If Hg is controlled by carbon sorbent, injection of sorbent into the ductwork immediately following the air heater is a typical option. The injected carbon sorbent is suspended in the gas flow stream and then enters a series of emissions control equipment. In one common arrangement, this first process step is an electrostatic precipitator (ESP) or baghouse to remove fly ash and any carbon sorbent laden with Hg. Subsequent to

the ESP or baghouse, as shown in Figure 1, flue gas enters a wet desulfurization step to remove SO_2, before entering the stack for discharge to the atmosphere.

42. The specific emissions control equipment at a plant can have a significant impact on mercury removal from the flue gas. For example, using a baghouse to collect particulate matter in lieu of an ESP will increase the effectiveness of the carbon sorbet to remove Hg. Also, "wet" scrubbers can remove Hg but only in oxidized state.

43. ESPs operate by imposing an electrical charge on entering fly ash particles, which then migrate to a collecting plate. A baghouse removes fly ash by passing the flue gas through fabric filters, the latter resembling 30 foot long "tube socks" hanging within a plenum chamber. At the base of the ESP or baghouse, an array of hoppers collect the fly ash from the flue gas. The collected ash is removed from the hoppers, and in some cases, is sold to be used to make cement products.

44. The "wet" scrubbers previously cited primarily remove SO_2 (some fly ash is removed but is incidental to the process, and can undesirably affect the sulfur chemistry). The wet FGD process completely saturates the flue gas with water – it essentially "rains" water in the scrubber vessel. The water contains a calcium material such as lime or limestone which reacts with SO_2 as the spray droplets disperse through the flue gas. A typical wet scrubber features three to six levels of spray nozzles within a vessel to optimize contact of the alkaline slurry

and flue gas. The SO2 is washed out as calcium sulfite or sulfate, which is thickened into a paste or solid for storage.

45. A competing desulfurization step is the "dry" scrubber. In contrast to the wet scrubber, in which the SO_2 absorber follows the particulate control step, the dry scrubber absorber precedes the particulate control step. Dry scrubbers use a water and lime slurry which is dispersed as a fine spray, but utilizing only a fraction of the water of a wet scrubber. As a result, SO_2 is captured as a sulfur-laden particle that can be collected by a particulate control device along with fly ash in the flue gas. The particulate control device used with dry scrubbers is almost exclusively a baghouse.

46. Coal is classified into four main ranks: anthracite, bituminous, subbituminous and lignite. These different types of coal have different heating values, meaning that a pound of bituminous coal, for example, can produce more heat than a pound of lignite. This heating values often measured in pounds per million British thermal units or lbs/MBtu. Coals may also be graded based on sulfur and inorganic content. The composition of coal varies widely with rank, and includes large variations in sulfur and Hg content.

47. Power plants may also blend coals of different ranks, or coals of the same rank from different mines. Coals of different ranks, from different mines, and even from different seams in a mine may differ by heating value and also by

chemical composition. Accordingly, power plants must consider the heating value and chemical composition of the coal being combusted when designing and operating pollution control equipment. A power plant must also be permitted to burn a particular type of coal. The type of coal burned can significantly impact mercury speciation, emissions, and the technology required to control emissions.

VI. OPINIONS

A. IPR2025-00422/IPR2025-00424 Grounds 1 and 2: No Motivation for a POSITA to Combine Vosteen589 with Starns or Mass-EPA

48. 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.

1. Petitioners Do Not Provide Evidence of a Motivation to Combine Vosteen with Starns and Mass-EPA.

49. 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. At the very least, Petitioners do not address the known concerns of reaction time and corrosion that would have been fundamental to the decision making of a POSITA. Take corrosion as an example. Corrosion is a significant

concern particularly for boilers equipped with state-of-the-art burners designed to minimize emissions of NOx. The flame structure to minimize NOx if exposed to boiler water tubes can induce corrosion. Boiler manufacturers can alter materials of construction used for boiler tubes in the near-burner region due to corrosion potential as determined by fuel type and firing conditions. Boilers equipped with low NOx burners and designed for bituminous coals with high chlorine in the coal could have different materials of construction vs subbituminous coals with low chlorine values.

2. Petitioners Do Not Account for the Differences Between Power Plants that Prevented POSITA From Mixing and Matching Techniques.

50. At the time of invention, a POSITA would have believed the following:

- The mercury present in coal combustion gas can exist in particulate form (entrapped on particles of fly ash) or gaseous form. In gaseous form, the mercury may be present in "metallic" or "elemental" form (Hg^0) or "oxidized" or "ionic" form (Hg^{2+}). Ex. 1009 at 4.
- Particulate mercury can be readily captured in particulate pollution control devices that were already present on many coal-fired power plants, i.e., ESPs and fabric filters or baghouses. Ex. 1009 at 6.
- Gaseous mercury (including oxidized and elemental forms) can be captured on sorbents, e.g., activated carbon. Once this gaseous form of mercury is trapped on a sorbent, it is particulate bound and can be

readily captured in a particulate pollution control device. Ex. 1009 at 6.

- When high amounts of halogens such as chlorine are present in the combustion chamber, they can potentially convert some elemental mercury to oxidized mercury.
- Oxidized mercury can be readily captured in wet and dry scrubbers. Ex. 1009 at 7.

51. 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 ¶ 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. To the contrary, there 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 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. There would simply be no motivation for a power plant to do that if the activated carbon were not providing some benefit of other known pollution control techniques.

52. For power plants that lacked a wet or dry scrubber, Petitioners fail to show that using additives to convert elemental mercury to oxidized mercury would meaningfully improve mercury capture. Instead, these power plants would be motivated to focus on techniques that can capture both elemental and oxidized mercury at the same time, as opposed to introducing a new step, such as bromine addition, that merely converted elemental mercury to oxidized mercury.

53. Even if a POSITA did want to use bromine and activated carbon at these plants, the conventional approach would be to use pre-treated carbon. This is because gaseous mercury (both elemental and ionic) binds much better to carbon impregnated with halogens. Experimental evidence had shown that under certain conditions, it may take several minutes for bromine to bond with carbon sorbent in processing conventional carbon to a halogenated sorbent. Ex. 1026 at 349. This action can only be practically carried out "….outside the presence of boiler gases." *Id.* But when activated carbon injection is used, upon injection into the boiler ductwork the carbon only has a few *seconds* to react with Hg in the flue gas.

54. Thus, a POSITA would expect to achieve better results by utilizing halogenated activated carbon—requiring the pre-treatment of the carbon with bromine external to the boiler for several minutes—and then injecting that pre-treated carbon into the flue gas to react with the mercury.

3. Petitioners Fail to Show That a POSITA Would Combine the Asserted References in Light of Prior Art Concerns About Corrosion.

55. A 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.

56. Thus, if bromine is used at all, there is a strong incentive to bind the bromine to carbon before exposing metal surfaces of the power plant—both the boiler water tubes and ductwork near the injection location—to the bromine. In fact, pre-treated brominated carbon that is injected downstream of the boiler would not expose boiler water tubes to corrosion potential, isolating exposure to lower temperature flue gas ductwork.

B. IPR2025-00422/IPR2025-00424 Grounds 3–5: The Inventors Conceived Their Invention and Reduced It to Practice Before the Priority Date of Downs-Boiler.

57. Petitioners contend that Downs-Boiler qualifies as prior with a priority date of March 22, 2004. However, the inventors reduced the claimed invention to practice by at least September 2003.

1. The Results of Inventors Testing of NaBr is Sufficient to Teach Other Species Including Bromine.

58. The inventors demonstrated that pre-combustion bromine, in the form of NaBr added to the coal, can effectively react with injected activated carbon. This observation of success is despite the limited residence time of activated carbon with flue gas once injected into the ductwork. From this demonstration, it would have been clear to a POSITA that other forms of bromine can produce the same results.

59. This is because, regardless of the form of bromine added to coal or a combustion chamber (*e.g.*, Br_2, HBr, bromide/BR^-), combustion flame temperatures of nominally 3,000 F are adequate to dissociate those compounds to form bromine atoms. As the combustion gases leave the combustion chamber and cool down, the Br atoms form HBr. This HBr reacts with activated carbon to capture mercury. *See generally* '430 patent at fig. 2.

60. Accordingly, the inventors' reduction to practice using NaBr is sufficient to teach the claimed bromine species recited in the claims.

2. The Inventors Actually Reduced the Claims to Practice Before the Asserted Priority Date for Downs-Boiler.

61. Inventor Dr. John Pavlish of the ’430 and ’225 Patents has testified that the inventors conceived of the invention at least by August 2002, and, after obtaining DOE funding for testing, they reduced the challenged claims to practice at least as early as September 2003. *See* Ex. 2018 (declarations of inventors John Pavlish, Edwin Olson, and Michael Holmes); Ex. 2046 (declaration of inventor John Pavlish). These dates are corroborated by contemporaneous meeting presentations, testing logbooks, and post-testing reports. *See generally* Exs. 2013–15, 2017, 2024–33.

62. As explained above, the inventors actually reduced the claims of the ’430 and ’225 Patents to practice through pilot scale testing conducted in September 2003, December 2003, and February 2004. This reduction to practice is confirmed by testimony from all three inventors (Exs. 2003, 2018, 2046) and corroborated by non-inventor testimony (Ex. 2017), logbook entries (Ex. 2017), and DOE reports (Exs. 2012–2014). Additional documentation (Exs. 2027–2032, 2015, 2033) from the inventors’ meetings and development efforts confirms that the inventors had conceived and reduced to practice their invention. As a test engineer for three years on-site at similar pilot plant facilities and managing analogous tests on at least six similar pilot plants for fifteen years, I can attest the

logbook entries include information I would expect to be recorded during the testing of environmental control technologies for a power plant.

C. IPR2025-00423/IPR2025-00425 Grounds 1-3: The Asserted Prior Art References Post-Date the Priority Date of the Claims.[1]

63. All of the asserted grounds in IPR2025-00423 and IPR2025-00425 assume that the claims of the ’430 and ’225 Patents, respectively, cannot claim the priority date of the provisional application. Petitioners do not identify any differences between the claims that impact their priority date analysis. The analysis below focuses on ’430 claim 1 as a representative claim:

1. A method of separating mercury from a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, to provide the mercury-containing gas, wherein

the coal comprises an additive comprising Br2, HBr, a bromide compound, or a combination thereof, wherein the additive is added to the coal before the coal enters the combustion chamber, or

[1] In this section, citations to Petitioners’ Exs.1023–1025, 1033-1035, 1063-1069 will include the IPR numbers to distinguish between the different documents assigned the same exhibit number in different petitions. For example, Ex. 1025 from IPR2025-00423 will be cited as “IPR2025-00423, Ex. 1025” and Ex. 1025 from IPR2025-00425 will be cited as “IPR2025-00425, Ex.1025.”

the combustion chamber comprises an additive comprising Br2, HBr, a bromide compound, or a combination thereof or

a combination thereof

injecting a sorbent comprising activated carbon into the mercury-containing gas downstream of the combustion chamber;

contacting mercury in the mercury-containing gas with the sorbent; and

separating the sorbent contacted with the mercury from the mercury-containing gas.

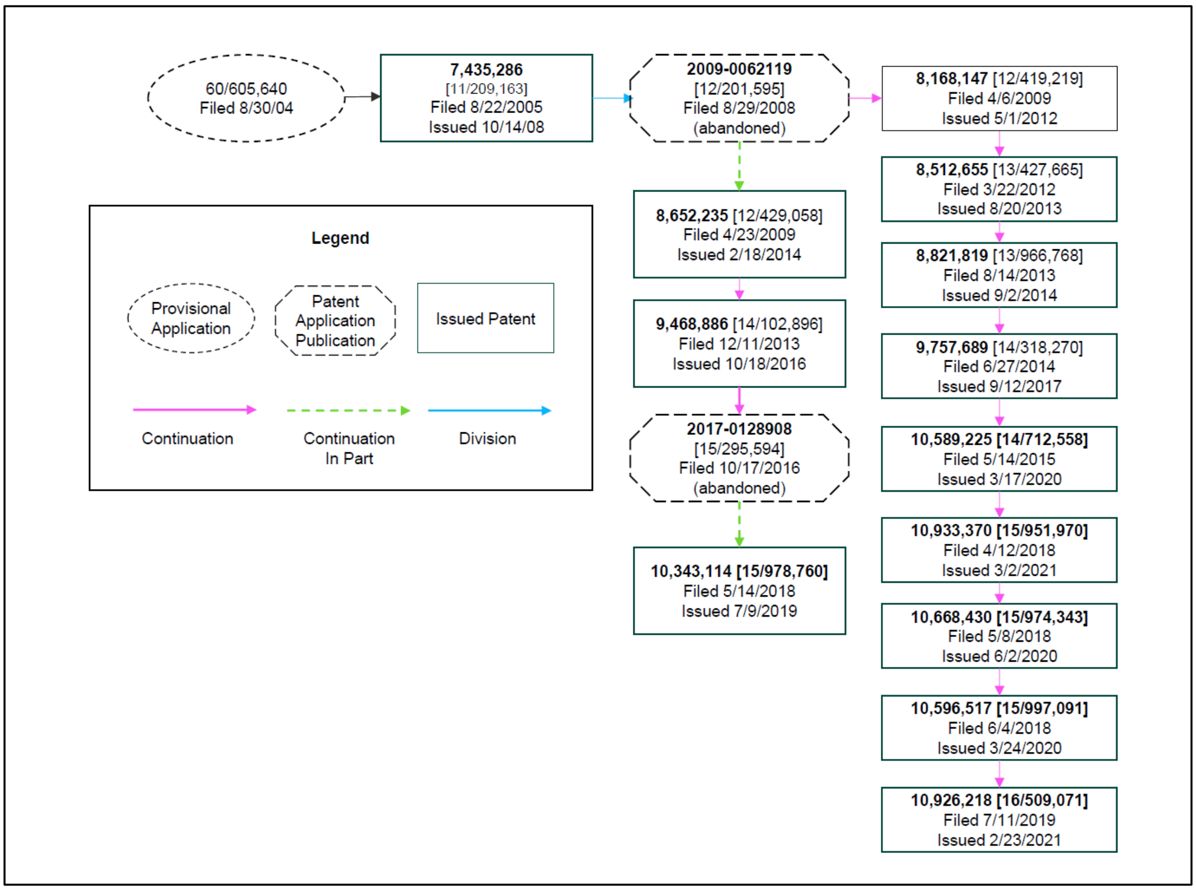
The provisional application and all intervening applications provide written description support for this claim.

64. The chain of applications connecting the provisional application to the ’430 and ’225 Patents includes a number of applications with identical specifications:

- The provisional application (Ex. 1020);
- The ’595 Application, which is representative of the ’163 application (Exs. 1021–1022) (the “Pre-CIP Applications”);
- The ’558 Application, which ultimately issued as the ’225 Patent and is representative of the ’270, ’768, ’665, and ’219 applications (IPR2025-00423, Ex. 1025; Exs. 1033-1035; IPR2025-00423, Ex. 1067);

- The ’343 Application which ultimately issued as the ’430 Patent (IPR2025-00423, Ex. 1066; Ex. 2044) (together with the ’270, ’768, ’665, ’219, and ’558 applications).

65. In general, the applications leading to the ’430 and ’225 Patents all include the same disclosure and they all incorporate the provisional application by reference. For reference, the relevant portion of the patent family tree is reproduced below:



Ex. 1004.

66. I understand that because all of the above identified applications incorporate the provisional application by reference, if the provisional application supports the claims, then they are entitled to the priority date of the provisional application. I have also reviewed the Pre-CIP applications and the other applications leading to the ’430 and ’225 Patents and find that they also support the claims.

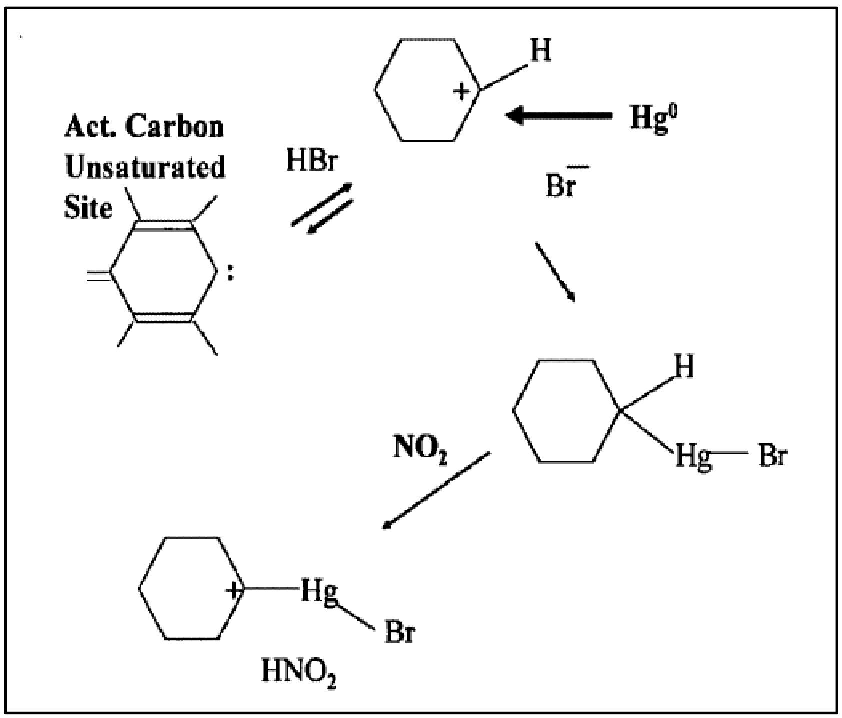
1. The Provisional Application Supports the Claims.

67. The provisional application explains the chemistry behind the invention. It states:

> We now teach that the formation of the new bromide compound with carbon increases the reactivity of the carbon forms toward mercury and other pollutants. The resulting bromide compound is uniquely suited to facilitate oxidation of the mercury. The effectiveness of the oxidation results from the promotion effect of the halide exerted on the developing positive charge on the mercury during the oxidation, known in the chemical art as a specific catalytic effect. ***Thus, as the mercury electrons are drawn toward the positive carbon, the halide anion electrons are pushing in from the other side, which stabilizes the positive charge developing on the mercury and lowers the energy requirement for the oxidation process. Bromide is especially reactive, owing to the highly polarizable electrons in the outer 4p orbitals of the ion. Thus, adding HBr or Br_2 to the carbon forms a similar carbon***

bromide, in which the positive carbon oxidizes the mercury with the assistance of the bromide ion.

Ex. 1020 at 9 (emphasis added). 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 Br_2 (all of which contain Br-) to the carbon. This is further illustrated in the diagram below:



Ex. 1020, fig. 1. This diagram depicts reactions that occur when combustion gases formed from burning coal and bromine additives react with un-brominated activated carbon. As shown above, activated carbon is mixed with HBr. This results in carbon bonded with the hydrogen atom, and a Bromine ion Br-. When these components are mixed in a mercury-containing gas, the mercury (Hg) is drawn toward the carbon, and the Bromine ion is drawn toward the mercury, creating a stable bond.

68. Thus, the inventors explained that mercury is captured by intermixing activated carbon and bromine ions with the mercury. It also provides examples of chemicals that can supply the bromine ion, Hydrogen Bromide (HBr) and Bromine gas (Br_2). Of course, the chemical model described above demonstrates that other sources of Bromine ions (i.e., bromides) may be used.

69. The provisional application also describes the use of "an optional second component." This component is a halogen or a compound from a halogen such as HBr. Ex. 1020 at 10; *see also id.* at 3 (sample claim 1E describing various bromine and other halogen additives). Thus, the inventors describe the use of an activated carbon sorbent with a source of bromine ions, and, optionally, another source of halogen ions, which could also be bromine ions:

> It has been demonstrated that addition of an optional second component, in addition to the bromine, results in improved reactivity and capacity for the sorbent, exceeding that of both the untreated carbon and the brominated carbon. The second compound comprises either a second halogen or a compound from a second halogen, such as HBr.

Id. at 10. Having described the chemistry behind their invention, the inventors also described various implementations of their theory, including the example provided below:

> FIG. 2 is a block diagram illustrating the use of the invention in a coal fueled facility. Of course, the invention can also be used in any other desired type of facility. FIG. 2 shows a boiler for burning pulverized coal. The facility utilizes various devices to clean the exhaust of the boiler. In this example, a baghouse or ESP is used to collect particulates in the exhaust. A scrubber and sorbent bed are also used to remove undesired constituents from the flue gas stream, before being fed to the stack. ***In the example shown, the sorbent is injected into the flue gas after the boiler. The additive can be injected where desired (e.g., before, after, or within the boiler).***

Id. And as illustrated below:

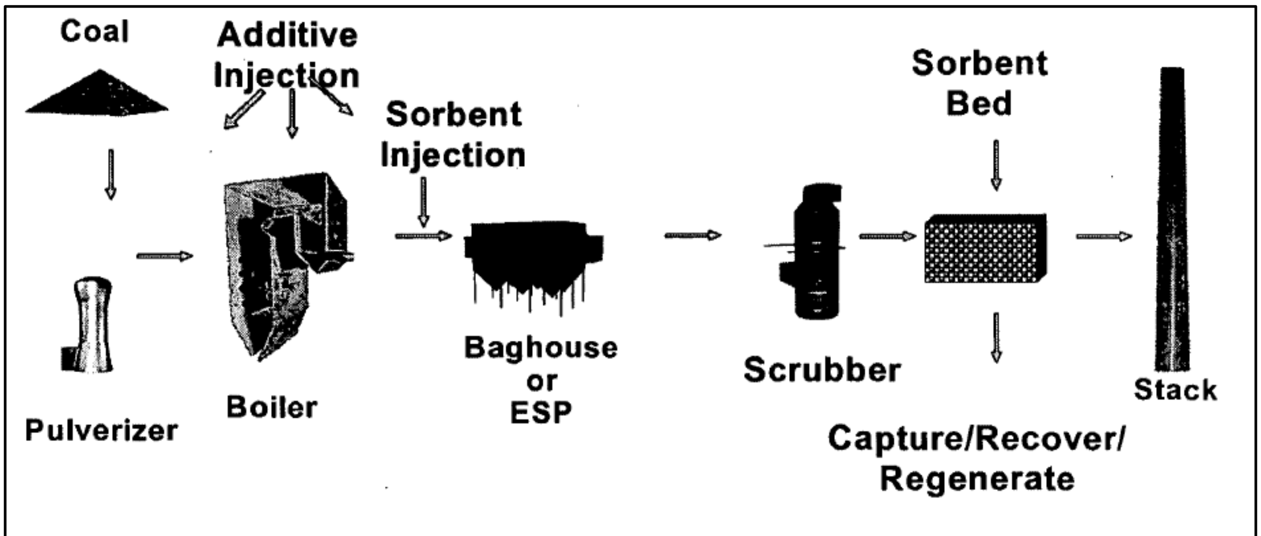


FIG. 2

Id., fig. 2. In this example, a bromine-containing additive is shown being added to the coal, to the boiler, or after the boiler, and the activated carbon sorbent is shown being added after the boiler. These components mix and contact the mercury in the gas exiting the boiler and then the combined bromine, mercury, carbon particles are captured in the baghouse or ESP to produce a cleaned gas. Thus, the provisional application provides full written description support for each of the claims of the '430 and '225 Patents.

For example, claim 1 states:

1. A method of separating mercury from a mercury-containing gas, the method comprising:

combusting coal in a combustion chamber, to provide the mercury-containing gas, wherein

the coal comprises an additive comprising Br2, HBr, a bromide compound, or a combination thereof, wherein the additive is added to the coal before the coal enters the combustion chamber, or

the combustion chamber comprises an additive comprising Br2, HBr, a bromide compound, or a combination thereof or

a combination thereof

injecting a sorbent comprising activated carbon into the mercury-containing gas downstream of the combustion chamber;

contacting mercury in the mercury-containing gas with the sorbent; and

separating the sorbent contacted with the mercury from the mercury-containing gas.

70. This claim language merely requires combusting coal where the coal being combusted also includes bromine additive. The claim goes on to say that the bromine additive can be introduced somewhere upstream of the combustion chamber, or directly into the combustion chamber, or a combination thereof. This claim structure follows the disclosure in the provisional application. The bromine additive introduced "before" the boiler (and the arrow pointing before the boiler) correspond to the claim language "added to the coal upstream of the combustion chamber". Using Dr. Niksa's terminology, this also corresponds to adding bromine additive to "primary air." The bromine added "to" the boiler (and the arrow pointing to the boiler) corresponds to the claim language "the combustion chamber comprises added" bromine additive. Using Dr. Niksa's terminology, this also corresponds to adding bromine to "secondary air."

71. I understand that Dr. Niksa has argued that this distinction between primary and secondary air demonstrates some difference between the disclosure in the provisional application and the scope of the claims, but I disagree. The distinction between primary and secondary air is minor. The volume of primary air is a fraction of that of secondary air and is pre-heated to a higher temperature to

assist in drying of coal and is exposed to coal particles for several seconds preceding introduction to the burner. But both enter the burner at nearly identical locations. A POSITA would understand that the provisional application discloses adding bromine to primary or secondary air, and the claims match that description.

2. The Pre-CIP Applications and the Applications Leading to the ’430 and ’225 Patents Support the Claims.

72. The Pre-CIP Applications and all of the applications leading to the ’430 and ’225 Patents at least contain the disclosures described below. All of these applications also stated that the provisional application is “hereby incorporated by reference in its entirety,” “hereby incorporated herein by reference in their entirety for all purposes,” or “incorporated herein by reference.” Ex. 1021 at 236; Ex. 1022 at 256; IPR2025-00423, Ex. 1025 at 578; IPR2025-00423, Ex. 1033 at 1:14–16; IPR2025-00423, Ex. 1034 at 1:15–17; IPR2025-00423, Ex. 1035 at 1:17–19; IPR2025-00423, Ex. 1067 at 1:11–13; IPR2025-00423, Ex. 1066 at 1:21–23; Ex. 2044 at 11. Even absent this incorporation by reference, these applications support the ’430 and ’225 Patent claims. The ’595 Application discloses the same chemical model as the provisional application (Ex. 1022 at 265, 296), the use of a “promoter” that supplies Br- such as HBr or Br_2 (Ex. 1022 at 265, 268, 285), and the practice of adding the promoter and sorbent at one or multiple locations (Ex. 1022 at 266).

73. The ’595 Application does not contain provisional figure 2, but it does provide a similar disclosure of bromine species being added to coal. Specifically, it describes an experimental test setup at an actual coal-fired power plant. In that example, the promoter and sorbent were both injected downstream of the boiler. However, the inventors explained that these components could be added before, after, or within the boiler. *Id.* at 280 (“In this example, the halogen/halide promoted carbon sorbent was injected into the flue gas after the boiler. In general, however, the inventive sorbent can be injected where desired (e.g., before, after, or within the boiler)”).

74. Because a halogen/halide promoted sorbent necessarily includes a halogen/halide such as Br_2, HBr, or Br-, a POSITA would recognize that adding this material before the boiler necessarily results in the claim elements at issue in the ’430 and ’225 Patent. In addition, the ’595 Application also states: “For clarity, single injection points 116 or 119 are shown in Figure 3, although one skilled in the art will understand that multiple injection points are within the scope of the present invention.” Ex. 1022 at 266. While that sentence occurs during the description of figure 3, the fact that the applications disclose the use of multiple injection points and that those injection points may be before, after, or within the boiler is sufficient to support the claims. Stated differently, Petitioners have failed

to show that a POSITA would understand these applications as teaching that bromine and carbon must be injected at a single point.

VII. CONCLUSION

75. For the reasons provided above, the Petitioners have failed to show a POSITA would have been motivated to combine the references in grounds 1–2 of IPR2025-00422 and IPR2025-00424. Furthermore, the inventors of the ’430 and ’225 Patents conceived of their invention and reduced it to practice before the priority dates of the references in grounds 3–5 of IPR2025-002422 and IPR2025-00424.

76. In addition, because the applications leading up to the ’430 and ’225 Patents support the claims, Petitioners have failed to show that the prior art asserted in IPR2025-00423 and IPR2025-00425 qualifies as prior art.

I hereby declare that all statements made herein of my own knowledge are true and all statements made herein on information and belief were and are believed by me to be true, and that all statements herein were and are 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 and that any such willful false statements may jeopardize the validity of the application or any patents issued thereon.

January 16, 2025 SIGNED: ______________________

J. Edward Cichanowicz