

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

STELLAR ENERGY AMERICA, INC.
Petitioner

v.

TAS ENERGY, INC.
Patent Owner

Patent No. RE44,815 E
Reissue Date: March 25, 2014

Title: SYSTEM AND METHOD FOR CHLLING INLET AIR FOR GAS
TURBINES

Case No. IPR2016-00294
Case No. IPR2016-00335

EXPERT DECLARATION OF GREGOR P. HENZE

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I. QUALIFICATIONS AND PROFESSIONAL EXPERIENCE

1. My name is Gregor P. Henze.
2. I have been asked to opine on the merit, if any, of Stellar Energy Americas, Inc.'s ("Stellar") arguments made in petitions for inter partes review ("IPR") that Stellar has filed with the U.S. Patent and Trademark Office on U.S. Patent No. RE44,815 (the "'815 patent"). I am being compensated in this matter at my usual and customary rate of \$350 per hour of work and \$175 per hour of nonworking travel time. My compensation is not dependent on any outcome in this matter.
3. My experience and education are detailed in my curriculum vitae, which is attached as Exhibit A to this Declaration.
4. I obtained an undergraduate degree and a Diplom-Ingenieur (Dipl.-Ing.) in energy and process engineering from the Technical University of Berlin in 1989 and 1992, respectively. In addition, I received a Master of Science in Mechanical Engineering from Oregon State University in 1991.
5. Both graduate engineering programs at TU Berlin and in Oregon State focused on thermal sciences for electrical power generation in both conventional fossil fuel as well as nuclear power plants, including the design, analysis, and assembly of turbo-machinery such as an 80 MW gas turbine for Siemens in Berlin.

6. I obtained a Ph.D. in civil engineering from the University of Colorado Boulder in 1995 with a focus on controls, optimization, and energy conservation in buildings. Particular emphasis during my doctoral studies was the analysis of control strategies for thermal energy storage systems. I have since dedicated a significant fraction of my research career to the design and control of active and passive thermal energy storage systems, in both a buildings and an industrial facilities context.

7. From 1996 to 1999, I worked in the energy services industry at Johnson Controls, a manufacturer of building automation systems. As the engineering manager, I established a business unit for energy savings performance contracting in Germany.

8. In 1999, I joined the University of Nebraska-Lincoln as an assistant and later as an associate professor and founding member of the Durham School of Architectural Engineering and Construction in the Peter Kiewit Institute in Omaha, Nebraska.

9. In 2008, I joined the University of Colorado Boulder's Department of Civil, Environmental, and Architectural Engineering as a full professor, where I remain today. My teaching focuses on thermal environmental engineering, energy

systems design, sustainable building design, and building control and automation systems.

10. In 2013, I received a joint appointment to the National Renewable Energy Laboratory's Commercial Building Research Group, where I engage in a range of research projects in the domain of building sciences including fault detection, building systems control, decision support, and building data analytics.

11. My research includes, among other things, model predictive optimal control of building energy systems and thermal energy storage systems for building-to-grid integration.

12. I am a professional mechanical engineer, a member of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), and an ASHRAE-certified high-performance building design professional (HBDP). I have published approximately 110 peer-reviewed articles, four of which have received best paper awards, three from the American Society of Mechanical Engineers (ASME) and one from the Architectural Engineering Institute (AEI).

II. TECHNOLOGY BACKGROUND

13. This section of my declaration discusses the background of the patented technology of the '815 patent, including a discussion of natural gas turbines, turbine inlet cooling, and thermal energy storage.

14. The '815 patent relates to turbine inlet cooling ("TIC"), which is a technique for improving the power output of a natural gas power plant by cooling the temperature of the air used in the plant. TIC is useful because turbines generate less power under warm or hot weather conditions, which is problematic in the electric power system context, because more power is required on warm days than on cool days, largely due to increases in air-conditioning loads for comfort cooling. The reason turbines produce less power on warm days is that warm air is less dense than cold air, which implies a reduced air mass flow rate passing through the gas turbine and thus producing less useful power.

15. Utilities can address the turbine capacity loss problem by building more turbines, often called peaker plants. However, it can be more economical to build a system to chill the air going into the turbine, increasing its density and recovering some or all of the lost turbine capacity for producing power. There are two reasons for this. First, a well-designed TIC system is generally less expensive than a new turbine. Second, the power restored by the use of a well-designed TIC system is generally several times greater than the power used to run the TIC system.

16. Because TIC systems are used to improve gas turbine power output during the warmest parts of the day, it makes sense to chill and store chilled water

during the night so that it can be used during the warm parts of the day. This is called “thermal energy storage” (“TES”). TES is usually implemented using large tanks of water or ice or some other phase change material. A TES system works as a thermal battery—storing cooling power during the night and using it during the day. A TIC system can use chilling from both the TES system and the chillers simultaneously, if so designed.

III. LEGAL PRINCIPLES

17. I have not been asked to offer an opinion on the law. However, as an expert assisting the PTAB in determining validity, I understand that I am obliged to follow existing law. I have therefore been asked to apply the following legal principles to my analysis, and I have done so.

18. For a claim to be anticipated, every limitation of the claimed invention must be found in a single prior art reference, either expressly or inherently, arranged as in the claim.

19. For a claim element to be inherently present in a prior art reference, the element must be “necessarily present” in the disclosed apparatus, system or method, not merely probably or possibly present.

20. A claim is invalid for obviousness if differences between the subject matter sought to be patented and the prior art are such that the subject matter as a

whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

21. In determining whether a claimed invention is obvious, one should consider the scope and content of the prior art, the level of ordinary skill in the relevant art, the differences between the claimed invention and the prior art, and whether the claimed invention would have been obvious to one of ordinary skill in the art in light of those differences.

22. I understand that certain objective factors, sometimes known as “secondary considerations” must, if present, be taken into account in determining whether a claimed invention would have been obvious. Such objective indicia as “commercial success, long felt but unsolved needs, [and] failures of others” may often be the most probative and cogent evidence of non-obviousness. Such evidence may often establish that an invention appearing to have been obvious in light of the prior art was not obvious.

23. The person of ordinary skill in the art is a hypothetical person who is presumed to be aware of all of the pertinent art. The person of ordinary skill is not an automaton, and may be able to fit together the teachings of multiple prior art references employing ordinary creativity and the common sense that familiar items may have obvious uses beyond their primary purposes.

24. In establishing obviousness, one must avoid the temptation to read into the prior art the teachings of the invention at issue and guard against slipping into the use of hindsight. The prior art itself, and not the applicant's achievement, must establish the obviousness of the combination. That is, a claim cannot serve as a motivation to combine prior art references.

25. To be properly applied as an obviousness or anticipation reference, the reference must predate the invention of the subject matter of the claim, unless a statutory bar applies.

26. I understand that even if all aspects of the claimed invention were individually known in the art, that is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references as arranged in the claim under consideration. On this point, I understand that mere statements to the effect that a combination was obvious are not sufficient in the absence of articulated reasoning with rational underpinning to support the conclusion of obviousness. I understand that a mere combination of references disclosing individual elements itself does not satisfy the burden of proving invalidity by a preponderance of evidence.

27. If a proposed modification to a reference would render the prior art invention being modified unsatisfactorily for its intended purpose, or if the prior art

teaches away from the proposed modification, then there is no suggestion or motivation to make the proposed modification.

28. If a proposed modification or combination of prior art references would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious.

29. I understand that being the first to actually recognize a problem can independently confirm non-obviousness. In cases where the structures are closely related, the obviousness analysis is aided by consideration of the problem facing the inventor and the improvement sought by the inventor.

IV. THE PERSON OF ORDINARY SKILL IN THE ART

30. Stellar opines that “as of the applicable priority date, the level of ordinary skill in the art of chilled water-based turbine inlet air cooling systems was high. . . . As such, a person of ordinary skill in the art of the ’815 Patent would have been a person having: (1) a Bachelor’s degree in Mechanical Engineering or a related discipline along with 4-7 years of related industry experience, or (2) an Associate’s degree focusing on HVAC&R or equivalent training with 6 to 10 years of related industry experience. In addition, he would have had at least two years of

practical experience relating to the design and operation of chilled water systems including thermal energy storage.”

31. For purposes of assessing whether Stellar has provided its case by a preponderance of evidence, I have assumed the level of ordinary skill in the art asserted by Stellar. Notably, however, a person having Stellar’s proposed level of skill would have no experience with gas turbines or TIC.

V. CLAIM CONSTRUCTION

32. I understand that the Board has not issued a claim construction ruling in this matter. I further understand that neither party has proposed constructions for any ’815 patent terms. Accordingly, I have applied the plain and ordinary meaning of the terms of the ’815 patent in connection with my analysis.

VI. RESPONSE TO CHALLENGES

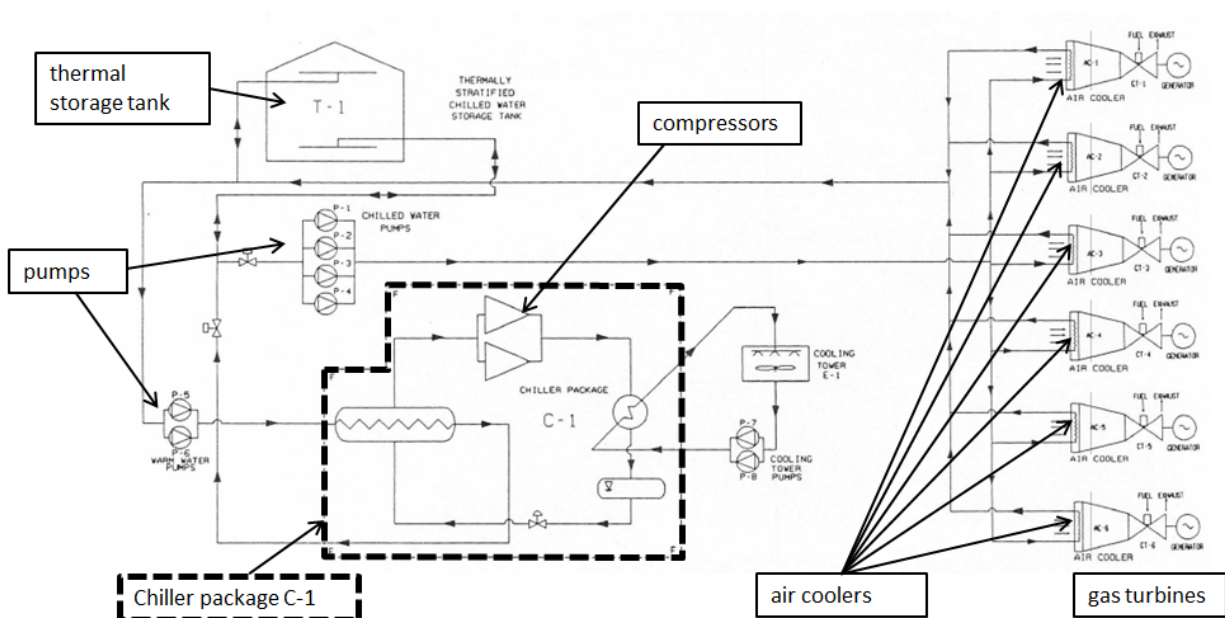
33. The following sets forth my responses to the challenges at issue in this Petition, as instituted by the Board in its Decision To Institute. In connection with my analysis in this matter, I have reviewed the ’815 patent, its prosecution history, the documents that have been submitted as exhibits in this case, Stellar’s Petitions, Dr. Reindl’s declarations, Dr. Reindl’s deposition testimony, and the Board’s Decisions to Institute. In addition to the facts cited in connection with this report, I may rely upon facts provided by any witnesses at deposition or at trial in

further support of my opinions. To the extent that it becomes necessary for me to revise or supplement this report, or file a supplemental or responsive report, based on any report submitted by Stellar and/or any additional discovery provided in this matter, I reserve the right to do so.

A. Summary of Stellar's Prior Art References

1. *Andrepont*

34. Andrepont describes a turbine system using a water chiller and a chilled water storage tank for TES to cool the turbine inlet air, as is shown below.



Ex. 1220/1320, Andrepont, at 6 (annotated). In this figure, the chiller package is marked as “C-1.” The chiller package has two compressors in parallel, as well as the other elements of a chiller. The system also has a thermal energy storage tank, air cooling coils, and pumps for distributing the water. Andrepont does not

disclose series chilling or a duplex chiller. I note that there is a statement in Andrepont that “an inherent flexibility of chilled water storage is that any water chilling technology, including absorption chilling, could be used to accomplish the recharge.” Ex. 1220/1320, Andrepont, at 5. However, this statement does not refer to series or any other arrangement of chillers. Instead, this passage is drawing the distinction between absorption chilling (which can be powered by steam) and the “conventional . . . mechanical refrigeration system” mentioned in the preceding sentence. *Id.* Andrepont included this statement to let the reader know that absorption systems can be used with chilled-water TIC/TES (which might be a surprise to the reader, since ice-based TIC/TES systems cannot use absorption chilling, as these use an aqueous solution as the refrigerant).

2. *Stewart Design Guide*

35. Stewart Design Guide is a document that provides a discussion of the design of combustion turbine inlet air cooling systems. Stewart appears to be intended as comprehensive guide of the state of the art of TIC systems. Notably, many of the techniques described and claimed in the '815 patent, such as series chilling, are not described in Stewart.

3. *Trane Manual and Trane Product Sheet*

36. The Trane Manual is an informational manual discussing various aspects of chilled-water system design. Ex 1222 & 1322. The Trane Product Sheet is an informational brochure for a product called the Trane Duplex Centrifugal Water Chiller. Exs. 1223 & 1323, Trane Product Sheet, at 1.

37. I understand that Stellar relies on the Trane Product Sheet as disclosing a motivation to combine a duplex chiller with Andrepont. *E.g.*, '294 Pet. at 13; '335 Pet. at 12.

4. *Ondryas*

38. Ondryas is an article entitled "Options in Gas Turbine Power Augmentation Using Inlet Air Chilling." Ondryas discusses gas turbine power augmentation in a cogeneration plant using inlet air chilling and various water chillers. Exs. 1224, 1330.

5. *Polimeros*

39. Polimeros is an excerpt from an Energy Cogeneration Handbook subtitled "Criteria for Central Plant Design." Exs. 1225 & 1327, Polimeros at 1. Polimeros discloses more than thirty different configurations of multiple chillers and condensers for use in refrigeration and air conditioning and "addresses the factors that influence chiller selection and arrangement." *Id.* at 3. Polimeros teaches that a "designer must strike an economic and operational balance in

arriving at the total number of machines, considering power consumption, piping and valving economy, maintainability, total installed cost, operating costs, space limitations, the extent of automatic operation of the refrigerant and water cycles, and availability and capability of operating personnel.” *Id.* at 4.

40. I understand that Stellar relies on Polimeros as disclosing systems with chillers arranged in series. ’294 Pet. at 27–58; ’335 Pet. at 53–57.

6. *Mornhed*

41. Mornhed discusses district cooling, a different field of technology from turbine inlet cooling. Whereas turbine inlet cooling is designed to cool only gas turbine inlet air—which represents a single load—district cooling is intended to cool a large number of buildings over a large geographic area, with each building having different (and varying) cooling loads. Mornhed explains that one way to get more cooling capacity out of an existing district cooling system is to add a low temperature chiller in series with an existing chiller, as shown below:

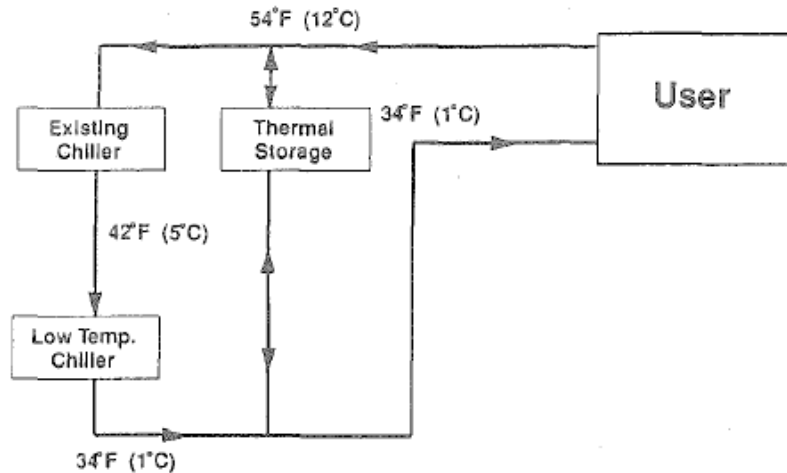


Figure 4 Typical series chilling concept.

Mornhed at 4.

42. In the figure above, an existing chiller lowers water temperatures from 54°F down to 42°F. Adding a low temperature chiller further reduces the water temperature to 34°F, effectively adding the equivalent of another 8°F of chilling power without having to pay for the cost of new pipes. As noted by Dr. Reindl, this can be significant in district cooling systems like the one in Chicago because it could potentially save millions of dollars from not having to install new pipes under the existing city streets. Ex. 2219/2319, July 16, 2014 Reindl Depo. (Reindl I), at 36:3–18; 140:6–141:4.

43. The key concept at work in Mornhed is the enlargement of the *supply* to *return* temperature differential, also called ΔT (delta-T). Mornhed used a high supply to return temperature differential so that the existing piping network could

supply more cooling capacity, meaning that more cooling power was being transferred by the district cooling system to the loads at the same flow rate for the given piping network, which can be a desirable effect in certain district cooling applications. Mornhed explains that a ΔT of 12°F (from 42 to 54°F) is a conventional value, whereas a ΔT of 20°F (from 34 to 54°F) is fairly high in the district cooling setting. Ex. 1226/1321, Mornhed, at 4.

44. I understand that Stellar contends that Mornhed discloses series chillers, and that Mornhed's discussion of series chillers' alleged benefits to district cooling applications supplies a motivation to combine the element with the Andrepont Turbine Inlet Cooling.

7. *Mornhed and Kardos Patents*

45. Mornhed Patent is U.S. Patent No. 5,465,585 to Mornhed, *et al.* Ex. 1324. Kardos Patent is U.S. Patent No. 5,104,562, to Kardos, *et al.* Ex. 1325. I understand that Stellar contends that Morned Patent and Kardos Patent disclose the use of the freezing point depressants such as sodium nitrate and potassium formate. *See, e.g.*, '335 Pet. at 11–12.

8. *Clark*

46. Clark is an article entitled “The Application of Thermal Energy Storage for District Cooling and Combustion Turbine Inlet Air Cooling.” Clark

reviews the Reedy Creek Improvement District chilled water thermal storage project.

B. Claims 50, 57, 58 and its Dependent Claims are Not Obvious

47. It is my opinion that challenged claims 50, 57, 58 and their dependent claims (claims 51–52, 59–64) would not have been obvious to a person having ordinary skill in the art at the time of the claimed invention, for the reasons set forth below.

1. *Stellar’s Asserted Prior Art References Fail to Teach the System Recited in Claim 58*

48. I understand that Stellar asserts Andrepont and Polimeros in its attempts to challenge claims 58, 59, 63, and 64, and I further understand that Stellar asserts Andrepont, Polimeros, and Trane Manual to challenge claims 60–62. ’294 Pet. at 9. The discussion below sets forth my response to the issues raised in the Petition, Dr. Reindl’s declaration in this matter, Dr. Reindl’s deposition testimony, and the Board’s Decision to Institute.

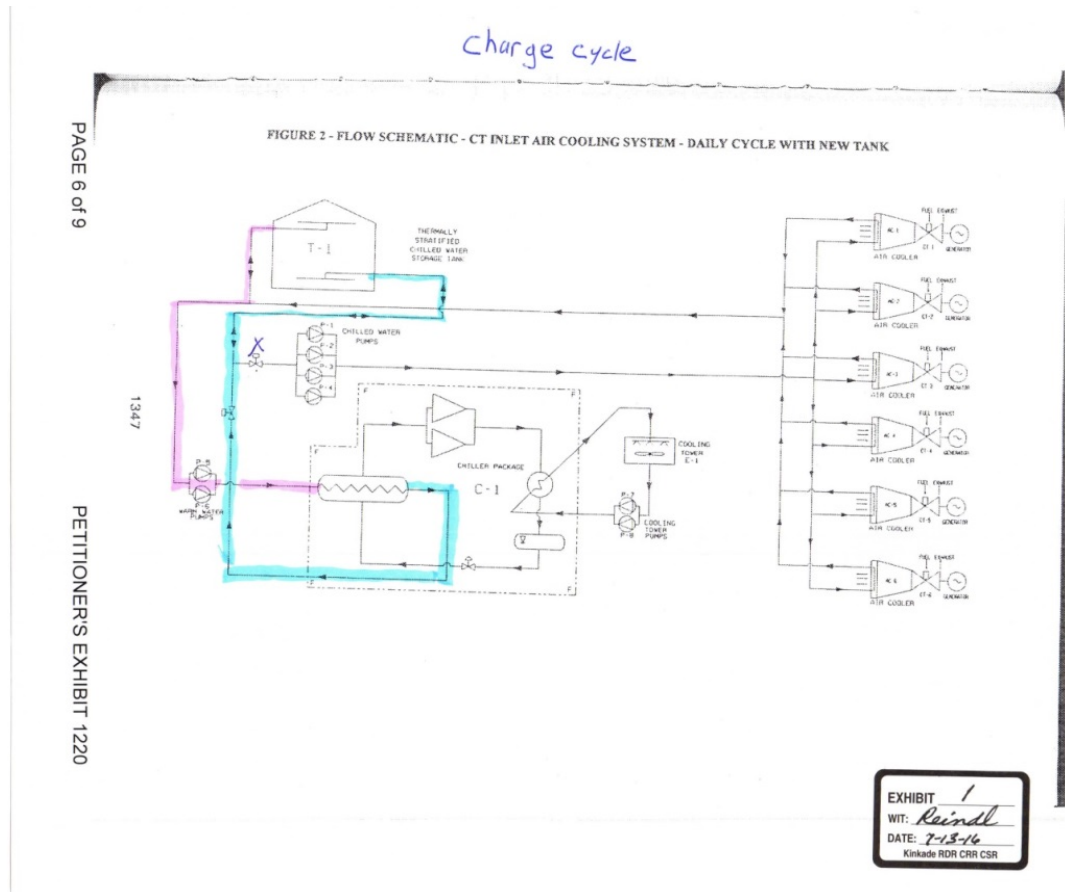
49. I disagree with Stellar’s assertion that any combination of these references renders claims 58–64 obvious. It is my opinion that the references cited by Stellar fail to disclose all of the elements recited by claim 58, and as a consequence claim 58’s dependent claims as well.

50. Relevant to this portion of my report, claim 58(c) claims a TIC system requiring that “[1] the outlet of the second water chiller evaporator is in fluid communication with the liquid water inlet of the air cooler, and [2] that the inlet of the first water chiller evaporator is in fluid communication with the water outlet of the air cooler.” Ex. 1201, ’815 patent, cl. 58(c). In each of these claim limitations, the inlet/outlet of the water chiller is in fluid communication with the respective outlet/inlet of the air cooler. The Andrepont reference does not disclose these limitations. As explained below, Andrepont has two operating modes—a “charge” mode in which the water chiller is in fluid communication with the TES tank, and a “discharge” mode in which the tank is in fluid communication with the air cooler. But Andrepont does not disclose any operating mode in which the water chiller is in fluid communication with the air cooler, as required by claim 58. Thus, it is my opinion that Stellar’s asserted references fail to teach or otherwise disclose these limitations.

51. Andrepont describes its “charge” mode or “charge cycle” as follows: “During off-peak periods, warm water is removed from the top of the tank, pumped to and chilled by the refrigeration system, and returned to the bottom of the tank for use during the next on-peak period.” Ex. 1220/1320, Andrepont, at 5. In other words, during this charge cycle, water is chilled and stored for use at a

later time for air cooling. During charging, the water chiller is *not* in fluid communication with the air coolers, as illustrated below.

52. I understand that during his July 2016 deposition, Dr. Reindl illustrated the water flow for the charge cycle taught by Andrepont.



Ex. 2204/2304 (7/13/16 Reindl) at 20:21-22:1. Ex. 2217/2317 (Reindl Ex. 1). In this annotation (which I agree with), chilled water flows directly from the chiller package to the TES tank, and warm water is returned directly from the TES tank to the chiller package. Notably, Dr. Reindl has marked an “X” over one of the valves

in this drawing. This “X” illustrates that during the charge cycle, there is no fluid communication between the outlet of the water chiller and the inlet of the air cooler, because the path is blocked by the closed valve. *See* Ex. 2204/2304 (7/13/16 Reindl) at 23:8–15, 22:21–24, 25:7–13; Reindl Exs. 1, 2. Consequently, there also would be no fluid communication between the outlet of the air cooler and the inlet of the water chiller, as required by claim 58. In fact, the air cooler is not even operating to cool air during Andrepont’s charge cycle.

53. Similarly, Andrepont discloses that for its discharge cycle, “[d]uring the on-peak operation of the CT’s, cold water is pumped from the bottom of the thermally stratified chilled water storage tank to the air coolers. The cold water cools the hot, humid air approaching the CT; warm water is returned to the top of the tank while cool air enters the CT, increasing CT output and performance.” Ex. 1220/1320, Andrepont, at 5. During this discharge cycle, cool water stored for TES is used for air cooling, and warm water is returned from the air coolers and stored for later chilling. Here again, during the discharge cycle, there is no fluid communication between the water chiller and the air cooler.

54. During his deposition, Dr. Reindl illustrated the water flow for the charge cycle taught by Andrepont.

discharge cycle

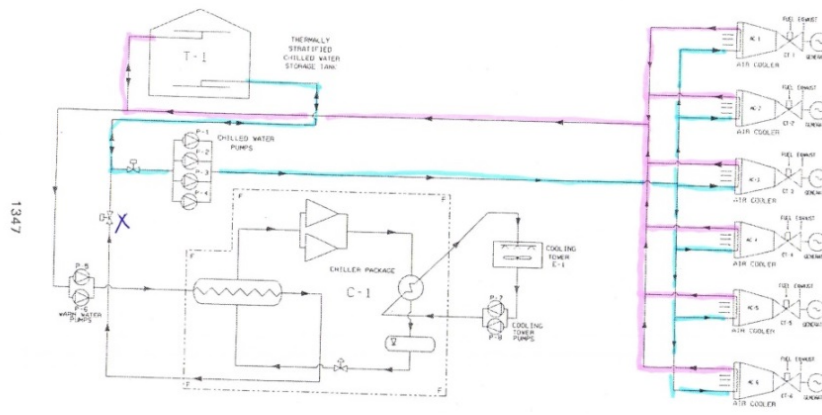


EXHIBIT 2
WIT: Reindl
DATE: 7-13-14
Kinkade RDR CRR CSR

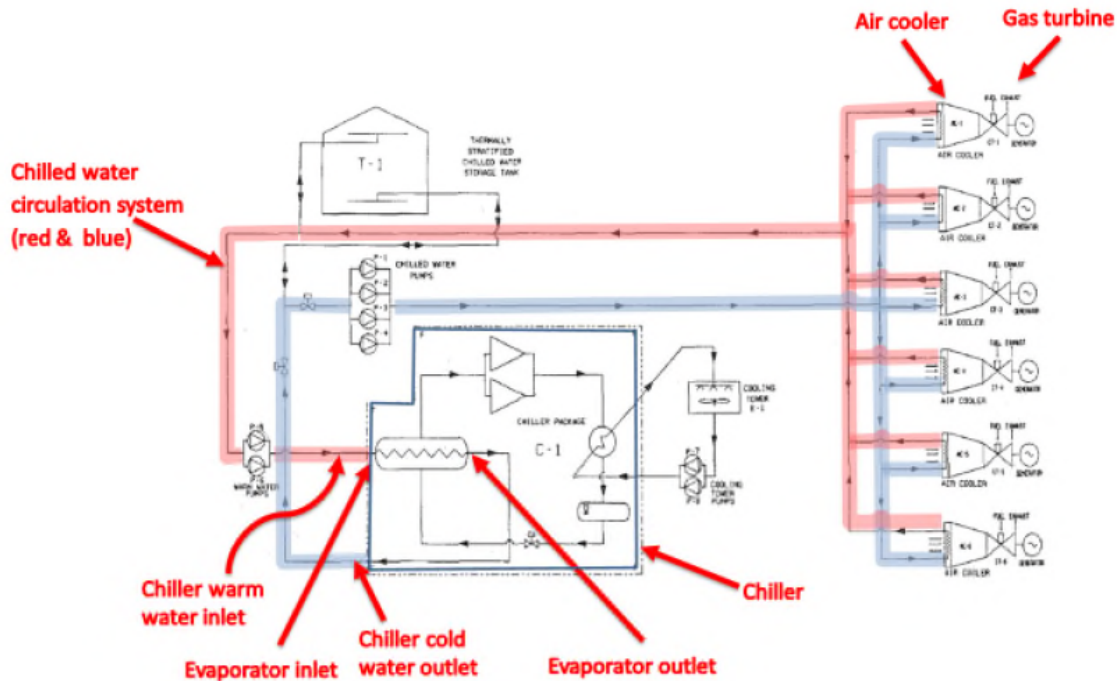
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Reindl) at 23:8–15, 22:21–24, 25:7–13; Ex. 2217-2218/2317-2318 (Reindl Dep. Ex. 1 and 2).

55. I understand that during deposition, Stellar’s expert stated that the charge and discharge cycles are the only modes of operation described for Andrepont Figure 2. *See* Ex. 2204/2304, Reindl Depo., at 26:3–7. I agree that the charge and discharge cycles are the only modes of operation described for Andrepont Figure 2. Neither of these operating modes include the claimed fluid communications between the chiller and the air cooler.

56. Because the charge and discharge cycles are the only modes of operation for Andrepont Figure 2, and neither mode involves the water chiller being in fluid communication with the air cooler, the Andrepont reference does not disclose the elements of [1] that “the outlet of the second water chiller evaporator is in fluid communication with the liquid water inlet of the air cooler, and [2] that the inlet of the first water chiller evaporator is in fluid communication with the water outlet of the air cooler.”

57. At the end of paragraph 59 of Dr. Reindl’s declaration for Stellar’s ’294 Petition, Dr. Reindl includes an annotated version of Andrepont Figure 2 that shows the flow paths for warm and cold water in a hypothetical system design that omits the use of TES and uses direct chilling.



Annotated Figure 2 of Andrepont.

Ex. 1218, Reindl '294 Dec. ¶ 59; *see also* Ex. 1318, Reindl '335 Dec. ¶ 58 (similar figure for claim 57). This annotated figure describes a use of Andrepont Figure 2 that is not disclosed in the Andrepont reference. Dr. Reindl's annotations purport to show warm and chilled running water, but this is not how Andrepont's system was designed to work. This water paths through the Andrepont system is not described in the Andrepont reference itself. Dr. Reindl's annotations do not reflect the flow of water during either of Andrepont's two operating modes (charge/discharge). Dr. Reindl's report does not explain how, or more importantly, why and under what circumstances, a POSITA would have modified Andrepont to work in the manner described in his annotated Figure 2. Instead, his annotated

Figure 2 seems to incorrectly assert that it describes one of Andrepont's operating modes, when it does not.

58. A modification of Andrepont to work in the manner described by Dr. Reindl, and to therefore include the claimed fluid communication between the chiller package and air coolers, would drastically change Andrepont's system and undermine the basic purpose of the article. A primary focus of Andrepont is to analyze different system designs using TES and to determine their relative benefits. Ex. 1220/1320, Andrepont, at 7–9. These benefits include, for example, the ability to use smaller chillers due to stored chilling capacity through TES. *Id.* at 4. If TES was not used in Andrepont, the size of the chiller would need to be increased, and the electrical demand associated with running that larger chiller would greatly increase. This would largely defeat the purpose of the Andrepont article itself, namely, analyzing the benefits of TES, such as the use of smaller chillers and avoiding parasitic power consumption during times of peak power demand. *Id.*

59. I have reviewed the sections of Stellar's '294 Petition and Stellar's related expert declaration concerning claim 58(c). This Petition and declaration included no argument or evidence, persuasive or otherwise, showing that the fluid

communication recited in claim 58 is taught by Andrepont. *See* '294 Petition at 29–30; *see also* Ex. 1218, Reindl Decl. ¶ 59.

60. In Stellar's petition, Stellar does not show the necessary fluid connections between the chiller package and the air coolers for claim 58(c). Stellar does not depict the air coolers in the figure included in that section of its Petition. *See* '294 Petition at 29–30. The declaration of Stellar's expert similarly fails to assert that Andrepont teaches a direct chilling system. Ex. 1218, Reindl Decl. ¶ 59. The only figure included in the relevant portion of Dr. Reindl's declaration simply shows the same flow paths as in Reindl Exhibit 3, which I understand Dr. Reindl admitted that Exhibit 3 illustrates a system that is not disclosed in Andrepont. *See* Ex. 2204/2304 (7/13/16 Reindl), at 279:10–19. I agree that the system illustrated in Reindl Exhibit 3 is not disclosed in Andrepont.

61. Thus, it is my opinion that claim 58 is not obvious because Stellar's asserted prior art references do not disclose the "fluid communication" limitations.

62. Finally, Stellar also asserts that claims 59–64 are obvious. For the reasons discussed above, it is my opinion that these claims are nonobvious over Stellar's asserted prior art. As previously explained, it is my opinion that Stellar's asserted references do not disclose all elements of claim 58. Because claims 59 through 64 depend on claim 58, it is my opinion that for the reasons previously

discussed, Stellar's asserted references also fail to disclose the necessary elements to render these claims obvious.

2. *Stellar's Asserted Prior Art References Fail to Teach the System Recited in Claims 50 and 57*

63. For similar reasons, Stellar's prior art fails to disclose the system recited in claims 50 and 57.

64. Claim 50 discloses a TIC system requiring, e.g., that “[1] the outlet of the third chiller is in fluid communication with the water inlet of the air cooler, and [2] the inlet of the first chiller is in fluid communication with the water outlet of the air cooler.” ’815 patent, cl. 50(c). Similarly, claim 57 recites that “the outlet of the second chiller is in fluid communication with the air cooler.” Thus, claims 50 and 57 recite a fluid communication path for chilled water from the chiller package to the air cooler, and claim 50 recites a fluid communication path for warm water from the air cooler back to the chiller package. Stellar has not shown that claims 50 or 57 are obvious, because its asserted references fail to disclose these claimed fluid communications between the chiller package and air cooler.

65. As explained above for claim 58, Andrepont does not disclose the claimed fluid communication between its water chiller and its air coolers. As a result, replacing the chiller arrangement from either Polimeros or Mornhed in place of Andrepont's chiller C-1 would not have the modified chiller package in “fluid

communication” with the air cooler. Thus, Stellar has not shown that claims 50 or 58 would have been obvious to a POSITA at the time of the claimed invention.

66. Finally, claims 51 and 52, are also patentable because they depend from claim 50.

C. Claim 1 and its Dependent Claims are Not Obvious

67. It is my opinion that challenged claim 1 and its dependent claims (claims 2–4) would not have been obvious to a person having ordinary skill in the art at the time of the claimed invention, for the reasons set forth below.

1. *Stellar’s Asserted Prior Art References Fail to Teach TIC System Control and Maintaining of Leaving Air Temperature*

68. Stellar asserts Andrepont and Stewart Design Guide in its attempts to challenge claim 1. I disagree with Stellar’s contention that claim 1 is obvious. In particular, it is my opinion that Andrepont does not disclose controlling and maintaining of leaving air temperature. Accordingly, it is my opinion that claim 1 is nonobvious over Stellar’s contentions, and that by extension claims 2–4, which depend on claim 1, are also nonobvious.

69. Claim element 1(f) claims a TIC system and further requires “controlling the leaving air temperature off the cooling coil to maintain a leaving air temperature slightly above the dew point temperature of the ambient air to maintain high efficiency on the power plant.”

70. Stellar asserts that Andrepont discloses the limitation of “*controlling* the leaving air temperature off the cooling coil to *maintain* a leaving air temperature.” *See* Petition at 19–22 (emphases added). However, Andrepont does not disclose “controlling . . . to maintain a leaving air temperature” at any level, let alone at a level slightly above the dewpoint.

71. Stellar’s ’294 Petition makes two statements asserting that Andrepont discloses the “controlling” or “maintain[ing]” of air temperature. It is my opinion that each of these arguments is incorrect, and therefore Stellar has not proven that claim 1 is obvious.

72. Stellar’s first assertion for the “controlling/maintaining” limitation of element 1(f) is that “Andrepont quantifies ‘on-peak increases in CT power and efficiency’ of the chilled water system in Table 1. Ex. 1220/1320 at 7, 8, Table 1.” ’294 Pet. at 20. This statement from Andrepont does not refer to any type of “controlling” of the leaving air temperature to “maintain” it above the dew point. Instead, Andrepont Table 1 and the associated text are discussing the net electrical power capacity enhancement (in MW) that would be provided by his proposed TIC systems during on-peak operation. Table 1 does not explicitly or implicitly show either (1) controlling or maintaining the air temperature or (2) maintaining the efficiency of the power plant in his proposed system. The

“controlling/maintaining” air temperature elements are completely absent from this discussion.

73. Stellar’s second assertion is that

Andrepoint further illustrates the effects of inlet air chilling on the gas turbine plant’s operation efficiency (heat rate) to ensure high efficiency is maintained. See Ex. 1220 at 4, Fig. 1. Accordingly, Andrepoint maintains a high efficiency on the power plant. See Ex. 1218 at ¶47.

’294 Pet. at 20. Like Stellar’s first statement, this passage also does not concern or otherwise show any disclosure by Andrepoint of “controlling leaving air temperature off the cooling coil” or “maintain[ing] a leaving air temperature.”

With respect to “maintain[ing] high efficiency on the power plant,” Figure 1 does correctly show the benefits of TIC from the perspective of the capacity and efficiency of a combustion turbine alone. However, as previously stated, this principle does not relate to “controlling leaving air temperature off the cooling coil to maintain a leaving air temperature,” and Andrepoint does not otherwise disclose it.

74. In performing my analysis, I also reviewed the ’815 patent specification. That specification also confirms that Andrepoint does not disclose the “controlling” and “maintain[ing]” limitations of claim 1(f). The specification states that

efficiency degradation can be mitigated through the use of a special control algorithm whereby the inlet air dry bulb temperature and relative humidity are precisely measured and the dew point calculated. By controlling the leaving air temperature off the cooling coil to maintain a temperature slightly above the dew point temperature, the coil can be prevented from producing condensate which will greatly reduce the parasitic power associated with the mechanical inlet chilling system.

'815 Patent at 28:66–29:7.

75. This passage discusses the use of a dedicated control algorithm for controlling and maintaining leaving air temperature, including the use of active measurements and calculations to control system operability. *See id.* A system that utilizes such a feedback control mechanism does not simply relate to a recitation of basic principles of efficiency and thermodynamics, as Stellar appears to assert in its Petition. Accordingly, the '815 patent specification's discussion of this algorithm further confirms that “controlling” and “maintain[ing]” are absent from any disclosure in Andrepont.

76. It is my understanding that during deposition, Dr. Reindl also confirmed during deposition that Andrepont fails to disclose the “controlling” and “maintain[ing]” limitations of claim 1(f). For example, regarding Andrepont's statement that “ambient inlet air, at temperatures of 90 to 100°F or more, is

desireably cooled to the 40 to 50°F range,” Stellar’s expert admitted that no control or maintaining is disclosed: Ex. 2204/2304 (7/13/16 Reindl), 31:19–25; 32:1–8; 33:1–34:2. That section of Andrepont discusses a broad and approximate temperature range that may be desireable for a TIC system. *See id.* Such a broad disclosure cannot be transformed into the specific concept of “controlling” or “maintain[ing]” leaving air temperature at a particular level relative to the dewpoint.

77. It is my understanding that Stellar’s expert acknowledged during deposition that no other portions of Andrepont disclosed “controlling” or “maintain[ing]” of leaving air temperature. For example, it is my understanding that when asked about Andrepont’s selection of its baseline system “by analysis of the overall process as several major subsystems plus controls and instrumentation and auxiliary systems,” Dr. Reindl agreed that “this passage of Andrepont . . . does not expressly descibe[] the controls that he’s [i.e., Andrepont] referring to.” *Id.* at 35:17–20. It is also my understanding that Stellar’s expert further agreed that Andrepont “doesn’t describe that detail, the actual how-to implement” of “a control system for maintaining the turbine inlet air temperature at a particular level.” *Id.* at 35:21–36:1. And finally, it is also my understanding that Dr. Reindl

stated that Andrepont, “didn’t really provide much in the way of details on controls and instrumentation.” Ex. 2206/2306, at 268:1:5.

78. It is similarly my opinion that Andrepont does not disclose controls or instrumentation that meet the “controlling” or “maintain[ing]” of leaving air temperature limitation recited in claim 1(f). It is my opinion that claim 1 is nonobvious over Stellar’s asserted combination for these reasons, as well as the reasons previously discussed.

79. Finally, Stellar asserts that claims 2–4 are also obvious. It is my opinion that this assertion fails by its virtue of their dependency on Stellar’s challenge for claim 1, for which Stellar has failed to meet its burden of proving obviousness.

D. Stellar Has Failed to Explain Why a POSITA Would Have Selected the Andrepont Reference for Modification

80. Stellar has not provided a valid reason why a POSITA would have selected Andrepont for combination with the other references asserted by Stellar. It is my opinion that a POSITA, including the POSITA with the background and experience described by Stellar, would not have selected the Andrepont reference for modification and combination with other references.

81. It is my understanding that Stellar has described its asserted POSITA as one having no experience in the relevant art of TIC systems. ’294 Pet. at 11.

Stellar's POSITA is someone having experience only in "chilled water systems including thermal energy storage." '294 Pet. at 11. Stellar's description of its asserted POSITA does not mention TIC systems or require its POSITA to have any experience with them. It is my understanding that Dr. Reindl also acknowledged that Stellar's POSITA need not have any experience in TIC systems. Ex. 2204/2304 (7/13/16 Reindl) at 91:6–13. Accordingly, Stellar's POSITA would have no experience in what the '815 patent identifies as "the field of the invention"— "cooling inlet air to a gas turbine." Ex. 1201/1301 at 1:27–28; Ex. 2204/2304 (7/13/16 Reindl) at 88:23–25.

82. Andrepont discloses a TIC design that was never actually built prior to the '815 patent invention. At the time of the invention, the TIC industry was focused on three types of TIC systems: evaporative cooling systems (i.e., systems with no chilled water), online chilled water systems (i.e., systems with no thermal energy storage), and ice-based systems (i.e., systems with ice-based thermal energy storage but not chilled-water storage). This is illustrated in the TICA database. Ex. 2209/2309. The TIC industry was capable and knowledgeable at building these conventional types of systems (many of which were also designed by Mr. Pierson). It is my opinion that a POSITA would have selected one of these three types of systems for any possible modifications.

83. By contrast, Andrepont was unconventional and thus untested at the time, as it focused on systems with a chiller package and chilled water TES. I disagree with Stellar's apparent assertion that a POSITA would have selected a system that was unprecedented and thus untested at the time, let alone have combined such a system with series chilling from Polimeros to arrive at the claimed invention.

E. Stellar Has Not Shown that the Series Chilling Claims Challenged in the '294 IPR Would Have Been Obvious to a POSITA

84. Stellar asserts that the series claims of the '815 patent are invalid. It is my opinion that for the reasons set forth below, Stellar has not presented a valid rationale for combining Andrepont and Polimeros to arrive at the inventions claimed in the series chilling claims (i.e., claims 58, 65, 76, and dependents). The discussion below sets forth my response to the issues raised in the Petition, Dr. Reindl's declaration in this matter, Dr. Reindl's deposition testimony, and the Board's Decision to Institute.

1. *Stellar's "Costs Savings" Rationale Fails Because Stellar's Proposed Combination Would Not Have Resulted in the Alleged Savings*

85. I understand that Stellar asserts "costs savings" as a rationale for combining its references. In particular, I understand that Stellar asserts "it would have been obvious to one of ordinary skill in the art to use a series arrangement of

chillers, as disclosed by Polimeros, with the system of Andrepont in order to achieve the costs savings explained by Polimeros.” ’294 Pet. at 32 (claim 58); *see also* Pet. at 41 (claim 65), and 49 (claim 76). I disagree that purported costs savings would have motivated a POSITA to combine Andrepont with the series chilling of Polimeros.

86. I understand that Stellar’s discussion for its “costs savings” argument, Stellar cites a passage of Polimeros that states “at the higher temperature differentials . . . the series arrangement effects operating costs savings because less chilled water need be circulated.” Ex. 1225 at 7. ’294 Pet. at 31, 48 (quoting Polimeros, Ex. 1225 at 7). Polimeros’ alleged “costs savings” stem from an application of series chilling in which “less chilled water need be circulated,” because “higher temperature differentials” are being used. The higher temperature differentials allow for cost savings because they permit a smaller amount of chilled water to provide the same amount of chilling to a load. Because less water is being circulated, operational costs are lower due to less pumping power required to circulate that water. In other words, the combination of a higher temperature differential and a lower flow rate permits the same cooling load to be met using less pumping power.

87. Stellar's Petition is silent about changing either the flow rate or the temperature differential through Andrepont. Moreover, it is my understanding that during deposition, Dr. Reindl stated that Stellar's proposed combination does not change either the flow rate or the temperature differential through the Andrepont system. Ex. 2204 at 197:8–17; *see also* Ex. 2206 (7/14/16 Reindl) at 218:16–219:4. Because Stellar is not changing Andrepont's flow rate or temperature differential, it is circulating the same amount of water at the same temperature differential serving the same chilled water cooling load as the original Andrepont system. This prevents Stellar's proposed combination from achieving the alleged "operating costs savings" as described by Polimeros, because the flow rate remains the same even in Stellar's proposed modified system.

88. In fact, A POSITA would understand that operational costs are actually likely to increase through Stellar's proposal to use of series chilling with Andrepont. This is because the chilled water must be pumped through two evaporators in series during the charge cycle, which requires significantly more pumping power than the use of one chiller.

89. Thus, a POSITA would understand that Stellar's "costs savings" argument is not valid combination rationale, because Stellar's proposed combination would not achieve the benefits recited by Polimeros.

**2. *Stellar Has Failed to Show that “Efficiency” Improvements
Would Have Guided a POSITA to Series Chilling***

90. I understand that Stellar also asserts in its Petition “efficiency” improvements as a rationale for combining its references. Stellar asserts that “[a]s known to one of ordinary skill in the art, and as evidenced by Ondryas (*see* Ex. 1224 at 4–5), for a given load, two chillers arranged in series will operate more efficiently than a single chiller.” ’294 Pet. at 31, 40, 48. I disagree with Stellar’s assertion that “efficiency” improvements in Ondryas would have motivated a POSITA to combine Andrepont with the series chilling of Polimeros.

91. In particular, the cited pages of Ondryas fail to support this “efficiency” rationale. The cited pages discuss various types of water chillers, with an emphasis on absorption cooling. But they do not discuss series chilling, let alone an efficiency rationale for using series chilling. Ex. 1224/1330 at 4-5.

92. It is my understanding that Dr. Reindl admitted during deposition that the cited pages of Ondryas do not support Stellar’s “efficiency” rationale:

Q. [O]n pages 4 and 5 [of Ondryas] do you see anything that expressly illustrates that, for a given load, two chillers arranged in series will operate more efficiently than a single chiller?

A. It doesn’t say that expressly.

Ex. 2204/2304 (7/13/16 Reindl) at 58:3–7.

93. I agree with Dr. Reindl that the cited pages of Ondryas do not support the argument that chillers operate more efficiently in series compared with a single chiller.

94. Page 4 of Ondryas refers to efficiency gains associated with a device called a “two-stage lithium bromide” chiller. However, this is not a series water chiller arrangement as claimed in the ’815 patent. In a two-stage lithium bromide absorption chiller, the chilled water still enters and leaves a single evaporator. The chemical compression process in a double-effect or two-stage absorption chiller involves two stages akin to a multi-stage compression of a mechanical vapor compression system. However, this is not series chilling since the chilled water is only chilled in a single evaporator. It is my understanding that Dr. Reindl agrees. Ex. 2204/2304 (7/13/16 Reindl) at 54:2-5 (“Q. You wouldn't regard a two-stage lithium bromide chiller as a series chiller, would you? A. Not in the context that we've discussed previously.”).

95. Accordingly, I disagree with Stellar’s proffered “efficiency” argument as a possible motivation to combine Andrepont with the series chilling of Polimeros. Note that for the reasons explained below, this argument also applies to the ’335 Petition, in which Stellar made the same arguments regarding pages 4 and 5 of Ondryas.

3. *Stellar’s Reliance on “Flexibility” of the Prior Art, as Well as Similarly Vague Statements, is Not a Motivation to Combine References*

96. Stellar’s Petition also contains various references to “flexibility” and “factors” that impact its analysis. However, none of these factors are matters that would have motivated a POSITA to modify Andrepont to use series chilling. Instead, the factors identified by Stellar are merely *characteristics* of the prior art, not considerations that would have *motivated* a POSITA to modify Andrepont to use series chilling.

97. For example, Stellar repeatedly recites Andrepont’s statement that “an inherent flexibility of chilled water storage is that any water chilling technology, including absorption chilling, could be used to accomplish the recharge.” ’294 Pet. at 13, 15, 30, 32, 33, 34, 39, 41, 42, 43, 47, 48, 50, and 51. It is my opinion that this statement would not have motivated a POSITA to combine Andrepont with series chilling.

98. Stellar misstates the significance of Andrepont’s language concerning “inherent flexibility.” Andrepont’s language merely states that different water chilling technologies can be used with chilled water storage. But this language would not point a POSITA to use any particular chilling technology with Andrepont, let alone motivate a POSITA to implement a chiller configuration such

as series chilling. In fact, this statement does not refer to series or any other arrangement of chillers. Instead, this passage is drawing the distinction between absorption chilling (which can be powered by steam) and the “conventional . . . mechanical refrigeration system” mentioned in the preceding sentence. *Id.* Andrepont included this statement to let the reader know that absorption systems can be used with chilled-water TIC/TES (which might be a surprise to the reader, since ice-based TIC/TES systems cannot use absorption chilling, as these use an aqueous solution as the refrigerant).

99. Stellar also relies on Polimeros’s discussion of generic characteristics of series chilling without explaining why any of those characteristics would have motivated changes to Andrepont’s system. For example, Stellar cites the section of Polimeros that states that since “[c]entral cooling plants have more than one chiller . . . the justification for more than one chiller and the determination of the final number of chillers *depend on a variety of factors*. ”294 Pet. at 31, 48 (emphasis added). Stellar then cites design characteristics of specific series chillers arrangements, such as “eliminating the overchilling problem of the parallel arrangement (Ex. 1225 at 6), whether water flow will be constant or variable (Ex. 1225 at 6), suction temperature and number of passes (Ex. 1225 at 7), and required temperature drop/load across the chillers (Ex. 1225 at 7, 10).” ’294 Pet. at 31, 40,

48. For claim 65 only, Stellar also referenced a “counterflow principle”¹ in connection with that claim. Pet. at 40. But Stellar does not explain why any of these factors or characteristics would have motivated a POSITA to modify Andrepont to use series chilling. And in fact, the matters identified by Stellar such as flow rate, suction temperature, number of passes, counterflow, and temperature drop are simply *characteristics* of specific series chilling implementations, not considerations that would have *motivated* the use of series chilling.

100. The one possible exception to this is the use of series chilling to avoid an overchilling problem that can arise under certain circumstances. However, this is not a consideration that would have motivated the use of series chilling with

¹ The “counterflow principle” refers to a modification to series chilling in which the chiller condensers are also in series and in which the condenser and evaporator water flow in opposite directions to one another. Series chillers (i.e., evaporators) are a necessary but not sufficient condition for a series-counterflow arrangement. For claim 65, Stellar mentions the “counterflow principle” but does not explain why this principle would have motivated the use of chillers (i.e., evaporators) in series. ’294 Pet. at 32, 41, 49.

Andrepoint. In fact, I understand that during his deposition, Dr. Reindl admitted that overchilling was not a risk in Andrepoint:

Q. Does Andrepoint have any characteristics that suggest to you that it suffers from the overchilling problem of the parallel arrangement?

A. This particular -- no, the C-1 chiller package would not have -- I would not expect it to have overchilling. It's a parallel arrangement issue.

Ex. 2204/2304 (7/13/16 Reindl) at 179:9-16. I agree that overchilling was not a risk in Andrepoint, since this problem only arises in the context of multiple chillers arranged in parallel. In other words, avoiding overchilling would not have motivated a POSITA to modify Andrepoint to use series chilling, because Andrepoint could not even have an overchilling problem.

101. Thus, it is my opinion that none of the factors identified in Stellar's Petition, including the alleged "overchilling problem," would have guided a POSITA to Stellar's proposed combination.

4. *Stellar's conclusory paraphrasing of KSR does not provide a valid combination rationale*

102. I have reviewed the portion of Stellar's Petition that I understand to offer paraphrases from *KSR v. Teleflex*. Pet. at 32, 42, 49. I have reviewed these sections and they do not appear to offer any new technical arguments other than

those addressed above. They also do not provide any arguments for me to respond to regarding the alleged “simple substitution” or “ready for the improvement” combination rationales. I found no explanation of the basis for these arguments in either the Petition or Dr. Reindl’s declaration.

103. Thus, in my opinion, Stellar has not shown that any of the challenged claim are unpatentable because it has not shown why a POSITA would have selected Andrepont for modification.

F. Stellar Has Not Shown that claim 50 would have been obvious to a POSITA

104. In my opinion, Stellar has also failed to show that claim 50 and its dependents are obvious over Andrepont and Polimeros.

105. Claim 50 differs from the other series chilling claims because it requires three chillers in series. Stellar’s argument for claim 50 points to Figure 3-8 of Polimeros, which shows three chillers, and then quotes a passage asserting that “Polimeros explains that ‘[o]ne chiller is used for low loads, two chillers for normal loads and *three chillers for high loads.*’ Ex. 1327 at 10” Pet. at 55 (emphasis added). Stellar uses the passage as the basis for its combination rationale, by asserting that “it would have been obvious to implement Andrepont *using the series arrangement of three water chillers of Polimeros for high loads*, as explained by Polimeros.” ’335 Pet. at 55-56 (emphasis added). Stellar does not

argue that cost or efficiency considerations would have provided a rationale for combining Andrepont and Polimeros. '335 Pet. at 55-56.

106. In my opinion, fails to explain why a POSITA would view Polimeros as benefiting Andrepont. Stellar identifies nothing in Andrepont suggesting that it lacks the ability to meet “high loads,” or that using three chillers in series would somehow enhance its ability to meet the load that it was designed for. The ability to meet a load under design conditions is a property of all chiller systems, including Andrepont. Adding three chillers in series would not change Andrepont’s ability to meet its existing load.

107. There is no indication in either Andrepont or Polimeros that three chillers in series would lead to lower capital or operating costs. Stellar points to Polimeros Figure 3-10 as another example of a system with three chillers in series. '335 Pet. at 55. But Polimeros expressly disclaims any assertion that Figure 3-10 is economically beneficial, stating that “[a]lthough the arrangements are possible, they are not necessarily advantageous unless shown to be so by analysis. No attempt has been made to discover the superiority or inferiority of any of these arrangements.” Ex. 1225/1327, Polimeros at 13. Thus, Stellar has not relied on and cannot rely on an economic rationale for this combination.

108. Stellar also uses “flexibility” arguments for claim 50. As explained above, the fact that the prior art was “flexible” would not have guided a POSITA in the direction of series chillers or duplex chillers. The same is true of three chillers in series, and thus I incorporate the portion of my report above regarding flexibility, because those opinions are also true for Stellar’s arguments for claim 50 (because Stellar uses similar language to describe its “flexibility” argument for all of the challenged claims. In addition, Stellar brief states that “Polimeros explains that this arrangement [Figure 3-8] ‘possesses much flexibility in refrigeration load handling and some variation in chilled water flow by employing more or fewer pumps as the circumstances demand.’ 1327 at 10,12.” ’335 Pet. at 55. This statement asserts that the arrangement of Figure 3-8 can be used in different scenarios. It does not provide any indication that a POSITA would perceive that it is beneficial to the Andrepont reference, or that it ought to be used in an Andrepont-style system. In other words, “flexibility” may be a characteristic of Figure 3-8 of Polimeros, but it is not an independent reason to use it with Andrepont.

109. Stellar also asserts that claims 51 and 52 are obvious. These challenges fail by virtue of their dependence on Stellar’s challenge for claim 50

G. Stellar Has Not Shown That Claims 5 and 57 Are Unpatentable

110. In my opinion, claims 5 and 57 and their dependents are patentable over the Andrepont/Mornhed theory presented by Stellar. Stellar has not shown that a POSITA would have been guided to modify Andrepont to use series chilling from Mornhed, for the following three reasons.

1. *A Person of Ordinary Skill in the Art Would Not Be Motivated By Mornhed To Perform Stellar's Proposed System Modification*

111. Stellar also asserts that a person of ordinary skill in the art would have been motivated to modify the Andrepont system to use series chilling so that they could achieve certain alleged economic benefits such as “doubl[ing] the capacity of existing distribution piping or, alternatively, reduc[ing] pumping power to a fraction.” ’335 Pet. at 20, 26. It is my opinion that the alleged benefits either would not exist, or they would be vastly outweighed by the costs required to obtain those benefits.

112. The benefits described in Mornhed are unique to the specific problem Mornhed was trying to solve, which concerned serving an increasing total cooling load using an existing district cooling piping network. Mornhed addresses the field of district cooling, with the use of a common water distribution system to heat and cool multiple buildings in a city or college campus. Indeed, in district cooling

applications using chilled water TES, chilled water is often used to supply potentially hundreds of air-conditioning systems for buildings spread across a large geographic area. Mornhed describes the classic district cooling scenario being “campus systems,” and this is an apt example.

113. The typical purpose of a district cooling facility is to sell cooling to users. The value of such a service is that it allows building owners to avoid the cost of building and maintaining their own chiller plants, and instead simply purchase the cooling from the district cooling provider. Occasionally, a district cooling plant will produce electrical power in addition to cooling. Plants that provide district cooling, district heating, and electrical power are referred to as district energy plants.

114. In contrast to district cooling and district energy applications, a utility scale power plant of the type that was the basis for Andrepont has no need for any large-scale cooling capacity. Utility scale gas turbine power plants are designed solely to provide large amounts of electrical power for sale to the grid. Therefore, when technology providers look for ways to cool the inlet air of a utility scale gas turbine power plant, they are designing a completely separate and dedicated cooling system with the singular goal of being to cool the inlet air for that gas

turbine. This allows TIC/TES designers to freely utilize whatever cooling technology they believe to be the most cost effective.

115. District cooling systems typically involve chilled water pipes that are buried underneath the ground. The maximum cooling power output of these systems is limited by several factors, including the flow rate of chilled water that can be pumped through the pipes. If a district cooling system is running at maximum capacity, then it cannot serve any new load customers that may be added to the system, because adding more water to the pipes would increase pressure to levels that would be dangerous to the system. However, the excavation and subsequent construction of a new district cooling piping network is likely to be prohibitively expensive, thus creating a dilemma for a district cooling operator who wants to service the cooling needs of a new building.

116. In Mornhed, the problem presented was to increase capacity without increasing the number or size of the existing pipes. Mornhed resolves this dilemma by adding a low temperature chiller in series with the existing chiller—in other words, by making the temperature of the chilled water particularly cold (34°F instead of the previous temperature of around 42°F) by *adding* another chiller downstream of the existing chillers. This new lower-temperature downstream chiller worked in this particular application because the extra-cold water could be

used to cool more buildings while still returning at the same temperature to the district cooling plant as before series chillers were installed. The result was a higher chilled water ΔT (supply to return water temperature differential) with series chillers that allowed for both a growth in the number of district cooling customers served and more cooling revenue from the existing piping distribution network. This allows Mornhed to get more chilling out of the existing piping network without the need for excavation. Mornhed also notes that this design could be used to reduce pumping power (in lieu of increasing piping network capacity). Ex. 1226/1321, Mornhed, at 4.

117. However, unlike a high ΔT in the TIC context, the high ΔT achieved in Mornhed reflected the fact that the only reasonable way to make the supply water extra cold was to add another chiller downstream of the existing chiller. By adding the extra downstream chiller, Mornhed took on substantial costs, both capital and operating costs, the most notable of the latter was that the installation of series chilling had the undesirable effect of making the downstream chiller less efficient and thus more expensive to operate compared to a chiller serving the same ΔT at higher temperatures. In Mornhed, the costs associated with the installation and operation of the new chiller (despite its diminished efficiency) were justified in light of the extreme cost of modifying the underground piping network. Thus,

series chillers were the most cost-effective solution to the unique needs in Mornhed.

118. Mornhed also notes that series chilling could be used to decrease pumping power. This would occur if a district cooling operator increased ΔT using a series chiller, without increasing the chilling load. Under such conditions, the district cooling operator could reduce the chilled water flow rate being pumped in an amount proportional to the increase in ΔT . In this district cooling setting the energy savings from lower pumping power can be substantial (since a district cooling pumping system typically uses many megawatts of electricity).

119. However, the considerations motivating Mornhed's use of series chilling simply do not apply to Andrepont. Andrepont does not have an existing underground piping system, so he does not need to modify that (nonexisting) underground piping system to provide additional energy without excavation. Besides, Andrepont is working in the TIC field, where excavation is not an issue since the pipes typically run aboveground. *See, e.g.*, Ex. 2219/2319, Reindl I, at 22–36.

120. Similarly, Andrepont's pumping requirements are far smaller than what is typical in the field of district cooling. District cooling systems have to pump water through miles of pipe to reach their destinations. This requires pumps

that have thousands of horsepower and use megawatts of electricity. *Id.* For example, the district cooling pump at the University of Wisconsin, where Dr. Reindl works, is a 10,000 horsepower pump. Given the approximate rate of 1 MW per 1341 horsepower, this pump would require around 7.46 MW to operate. In contrast, TIC systems such as Andrepont typically have a short distance to travel between the chillers, the tank, and the cooling coil. This requires *kilowatts*, rather than megawatts as in Mornhed (for example, Andrepont example B requires no more than 250 kW for the chilled water pumps and 127 kW for the warm water pumps). Thus, the motivation to save pumping power would be a far more significant consideration for Mornhed and district cooling than it would be for a person of skill in the art considering whether Mornhed's techniques make sense for Andrepont. Moreover, as noted above, the use of series chilling in a system like Andrepont would actually *increase* the pumping energy required to send water through the chillers by 3.5 times as compared to other options, assuming the same chilled water flow rate. Ex. 2212/2312, Trane 1977, at 5.

121. In short, the economic considerations that motivated series chilling in Mornhed's district cooling environment simply do not transfer over to Andrepont's TIC environment. This is one reason why a POSITA would not have been motivated to modify Andrepont to use series chilling from Mornhed.

2. A POSITA Would View Stellar's Combination As Harming Andrepont

122. I note that Stellar asserted that its combination of Andrepont and Mornhed would “provide the predictable result of lower temperature water in order to achieve the benefits of improving thermal capacity, increased temperature differential, increased storage tank heat capacity, or decreased storage tank volume.” ’335 Pet. at 26.

123. Stellar suggests that a POSITA would have been motivated to change the temperature differential in its Andrepont/Mornhed combination. I note that this is different than for Stellar's Andrepont/Polimeros combination. Nevertheless, Stellar is incorrect in suggesting that a POSITA would have been motivated by Mornhed to change the temperature differential. To a POSITA, the proper selection of system settings such as chilled water temperature and flow rates is critical in ensuring that a modification would actually benefit a system, and therefore that a POSITA would be motivated to perform the modification. This is explained in Polimeros:

Selection of chilled water primary flow rates and temperature differentials is extremely important. If not established on the best available information, the result can be an improperly balanced system with excessive first or operating costs, or both. This is the area in which most misconceptions persist and where most arbitrary

decisions are made. Few studies have been made and little actual operating data have been accumulated. . . . Depending on the supposition, the plant will be economical or wasteful.

Ex. 2213/2313, Polimeros at 42. I note that Stellar’s Petition fails to account for this important principle.

124. Stellar instead asserts that a POSITA would be motivated to increase temperature differential in order to increase system capacity. Pet. at 35. I note that Andrepont does not express a need for increased system capacity, and I see no such need in Andrepont.

125. I have analyzed Stellar’s proposed modifications to Andrepont that would involve using the techniques of Mornhed to allegedly “almost double the capacity” of the Andrepont system. ’335 Pet. at 20, 26 (quoting Ex. 1221/1321, Mornhed at 4. Absent some unforeseen scenario that Stellar has not articulated, such a system would use almost the same flow rate, but use low temperature water to achieve a higher temperature differential, and thus achieve a higher capacity. Such changes would have at least the following consequences to the Andrepont system:

- (1) increased chilling power required;
- (2) increased pumping power required; and
- (3) significantly increased cost and complexity of the overall system.

126. The reasons for these consequences are explained below.

127. The first consequence of Stellar's proposed use of a low temperature chiller is a significant increase in the amount of chilling power required in the system. For example, Andrepont's chiller C-1 chilled water down to 40 °F using approximately 5.7 MW of electricity. Ex. 1220/1320, Andrepont, at 5. A lower temperature chiller included in series with Andrepont's C-1 chiller would require many additional megawatts of electricity to lower the temperature at the given flow rate of water down to 34 °F, as was done in Mornhed. *See, e.g.*, Ex. 2211/2311, '886 Reindl, at 91:22–93:5. Moreover, the operating costs of a low temperature chiller are higher relative to a comparable chiller serving conventional higher chilled water temperature differences, all else being equal.

128. The second consequence of Stellar's proposed modification is increasing the amount of system pumping power required on the warm water pumps. Andrepont states that 127 kW of pumping power is needed to pump the water through chiller C-1. However, if an additional chiller was placed in series, then far more pumping power would be required. This is illustrated in an article that was submitted in an IPR brought by Trane against the '815 patent. There, the energy required to pump in series was 3.5 times higher than the pumping energy required by an alternative system using parallel chillers. Ex. 2212/2312, Trane

1977, at 5. As in Trane, additional pumping power would be required by the use of the series chilling in Stellar's proposed combination (assuming the same flow rate).

129. The third consequence of the second chiller is added expense and complexity. I understand that Dr. Reindl estimates that the Andrepont system required 5 MW of power and had approximately 7,500 to 10,000 tons of cooling power. I further understand that Stellar's expert estimated that such a chiller would cost in the range of three to five million dollars. It is my opinion that if a second chiller were added in series, it would likely cost a comparable amount of money and require even more power (since it requires more power to cool water to even lower temperatures).

130. Finally, even if Mornhed's alternative technique of lowering the flow rate and adding a lower temperature chiller in series were considered, a POSITA would still see the proposed modification as undesirable. First, the downstream chiller in the series configuration, which would be operating with water at lower temperatures, would use much more power per ton of chilling than the existing chiller, thereby decreasing system efficiency. The reason for this is that refrigerant that is used to take water to a very low temperature will leave an evaporator at a low pressure. This refrigerant must then be compressed back to a high pressure. Compressing from a low pressure to a high pressure requires more power than

compressing from an intermediate pressure to a high pressure. The net result of this is a less efficient system. For example, in Mornhed, the series chilling arrangement involved (1) an existing chiller; and (2) a low temperature chiller. In that arrangement, the existing chiller had the same efficiency (kW/ton) both before and after the addition of a second chiller. The second chiller had a lower efficiency (because low temperature chillers are less efficient). As a result, the total chiller system average efficiency (in kW/ton) for Mornhed was actually *worse* for the series chiller arrangement than it was for the system without series chilling. Mornhed was willing to accept these inefficiencies only because he had no other good option, as explained above.

3. Stellar's Ondryas-based "Efficiency" Arguments Would Not Have Motivated A POSITA To Make The Combination

131. The third problem with Stellar's Andrepont/Mornhed combination is that it once again relies on Ondryas, pp. 4-5 as evidence of some type of efficiency gain to be had from series chilling. '335 Pet. at 20-21, 26. As explained above in Section VI(e)(2), which I incorporate by reference in its entirety, Ondryas says no such thing. Therefore, it is my opinion that a POSITA would not have been motivated by any type of efficiency considerations.

4. “Flexibility” would not have motivated the combination

132. Stellar also argues that “flexibility” would have motivated its combination. Stellar cites this “flexibility” in at least twelve pages of its brief. *See* ’335 Pet. at 11, 12, 15, 20, 21, 25, 26, 27, 34, 35, 54, 55. These “flexibility” statements are inadequate to prove obviousness for the reasons described in Section VI(E)(3) (¶¶ 96-101) above. Based on the above, it is my opinion that a POSITA would not have been motivated to modify Andrepont with series chilling in Mornhed in the manner described in Stellar’s Petition. Thus, it is my opinion that claims 5, 57, and their dependents are valid over Stellar’s challenge.

H. The Duplex Chiller Claims are Patentable

133. It is my opinion that Stellar has not presented a valid rationale for combining Andrepont and Trane References to arrive at the inventions claimed in the duplex chilling claims (i.e., claims 34–49, 60–61, 68–70, and 77–82), for the reasons set forth below.

1. The Trane References Would Not Have Provided a POSITA With a Motivation to Modify Andrepont’s System To Use Duplex Chilling Technology

134. Stellar asserts in its Petition that the Trane documentation would have guided a POSITA to use duplex chillers “in order to achieve the advantages explained by the Trane Manual and Trane Product Sheet.” ’294 Pet. at 51–52.

Stellar recites similar factors in the ’335 Petition at page 35. I have analyzed the

factors identified in Stellar's Petition as allegedly providing a motivation to combine. It is my opinion that none of the factors raised by Stellar would have motivated a POSITA to implement duplex chillers with Andrepont. I discuss each of Stellar's stated factors and my assessment of those factors below.

135. **Multi-stage design for efficiency:** Stellar's first identified factor is "Multi-stage design for efficiency." This is a statement that appears in the Trane Product Sheet for its duplex chillers. Similar statements appear in Trane's non-duplex product literature. *See* Ex. 2208/2308 at 2 (non-duplex Trane document referring to "Multi-stage compressor for efficiency.")

136. These statements regarding multiple stages refer to the type of compressor that Trane favors for use in compressing refrigerant gas. In Trane chillers (both duplex and non-duplex), the compressor is a "multi-stage" compressor, meaning that it compresses the refrigerant gas in multiple steps, using two or three impellers on a common shaft, rather than a single impeller. I understand that during deposition, Dr. Reindl acknowledged that Trane chillers have multi-stage compressors. Ex. 2204/2304 (7/13/16 Reindl) at 131:17–132:14.

137. Compressing gas in multiple steps is not a unique operation of a "duplex" chiller; it is a generic mechanism that can apply to any chiller. As an example, I understand that Trane also identifies multi-stage compression as a

benefit of its non-duplex chillers. Ex. 2208/2308 at 2 (referring to a “Multi-stage compressor for efficiency” in a non-duplex chiller). Thus, for a POSITA, a “multi-stage design for efficiency” does not distinguish duplex chillers from non-duplex chillers. It therefore cannot provide a motivation for a POSITA to use duplex chilling technology with the system of Andrepont.

138. In addition, a POSITA reading the Trane documentation would understand that Trane’s claims about a “multi-stage design for efficiency” relate to marketplace competition between Trane and other equipment manufacturers. Some of Trane’s competitors argued that their single-stage compressor products were actually more efficient than Trane’s multi-stage compressor products. For example, I understand that McQuay, who made a competing chiller product in the relevant time period, claimed that single-stage compressors had the superior efficiency characteristics compared with multi-stage compressors:

The primary advantage to multi-stage centrifugal operation, in the pressure and volume ranges characteristic of typical air conditioning systems, is the expansion of impeller head coefficients at reduced volumetric flows or cooling loads. The McQuay back ward inclined SINGLE STAGE IMPELLER, combined with the patented movable diffuser at the impeller discharge, provides a stable operating range superior to multi-stage systems.

Ex. 2207/2307 (McQuay) at p.10.

139. At this time I state no opinion as to which party a POSITA would have viewed as correct in its efficiency claims—Trane or McQuay. Nevertheless, it is my opinion that a POSITA would view any benefits of multiple compression stages as (1) not a distinguishing feature of duplex chillers; and (2) subject to debate among industry-leading equipment manufacturers. Thus, the Trane documentation’s comment about a “multi-stage” design, when viewed through the lens of a POSITA, would not have offered a POSITA with a motivation to use duplex chilling technology.

140. **Factory-assembled for lower jobsite costs:** The next factor identified by Stellar is the statement in the Trane documentation regarding “[f]actory-assembled for lower jobsite costs.” Ex. 1223/1323 at 1. This statement refers to the fact that factory-assembled chillers do not require costs associated with assembly in the field, such as the labor costs needed to erect the chillers from their constituent parts. As explained below, this statement was used by Trane to describe all of its factor-assembled chillers, and thus is not a distinguishing feature of duplex chilling technology.

141. The fact that duplex chillers are assembled in a factory does not distinguish them from other common types of chillers (or, for that matter, from any other type of factory-assembled product). For example, Trane describes its non-

duplex chillers as having “[c]omplete factory assembly of the CenTraVac™ options for reduced jobsite assembly labor and expense.” Ex. 2208/2308 at 2. Similarly, McQuay also touted its chiller products as being factory-assembled and tested. Ex. 2207/2307 at 13 (“The chillers are shipped assembled from the factory.”) (note that McQuay did not sell a duplex chiller product). It is therefore my opinion that this statement in the Trane documentation regarding factory assembly would not have motivated a POSITA to use duplex chilling technology.

142. Reliability/Standby capacity with two independent refrigerant circuits: Stellar’s third factor is “[s]tandby capacity with two independent refrigerant circuits.” Ex. 1223/1323 at 1. This factor is mentioned in the Trane Product Sheet. The Trane Manual contains a similar statement regarding reliability in duplex chillers:

“A single large chiller may be built as a duplex machine. The evaporator and condenser water circuits are common to both halves of the duplex. Increased efficiency² comes from the separation of the compressors and refrigerant circuits. Thus, each half is redundant for increased system reliability.”

² Stellar does not elaborate on this efficiency point, but it appears to be the same point addressed above in the context of the series chilling claims. Stellar is not

Ex. 1222 at 65. These statements from the Trane Product Sheet and Trane Manual are included on page 51 of Stellar's '294 Petition as providing an alleged combination rationale for using duplex chilling technology with Andrepont.

143. Although it is true that multiple smaller chillers can provide increased system reliability over a single large chiller, that consideration would not have motivated a modification to Andrepont. Andrepont's system used a chiller having two compressors. Compressors are the moving parts in a water chiller, and are the most likely point of failure. By using two compressors, Andrepont was able to achieve increased system reliability. Using a duplex chiller would not have appreciably increased the reliability of Andrepont's system, as the evaporator and condenser components are unlikely to fail.³ Thus, the need for increased system reliability would not have motivated a POSITA to use duplex chilling technology

arguing that this statement provides a separate efficiency justification for using duplex chiller technology.

³ Evaporators and condensers may need service, but that would occur during regularly scheduled maintenance periods (i.e., in the winter months when the TIC system is not used).

with Andrepont, because Andrepont already had the benefit of increased system reliability.

144. A POSITA considering a TIC/TES system like Andrepont's would not regard complete redundancy as a high priority design criterion, because the thermal energy storage system provides redundancy. However, assuming, for sake of argument, that a POSITA was interested in complete redundancy, they would not adopt duplex chilling technology. Rather, for true redundancy, two *separate* chillers, along with the necessary bypass circuits, would be required. This is another reason why the Trane documentation would not have motivated a POSITA to use duplex chilling technology.

145. **Significant first cost and operating cost advantages compared to field assembled very large chillers:** The fourth factor identified by Stellar are alleged "first cost" and "operating cost" advantages over field-assembled very large chillers. It is my opinion that these alleged advantages would not have guided a POSITA to modify Andrepont to use duplex chilling technology.

146. Many types of chillers claim various cost advantages. For example, I understand that Trane also describes its non-duplex chillers as having the identical "significant first cost and operating cost advantages compared to field-assembled very large chillers." Ex. 2208/2308 at 26. It is not clear what advantages Trane is

referring to with this statement; however, because the statement appears in *both* its duplex and its non-duplex literature, the statement cannot refer to any distinguishing characteristic of duplex chilling technology. It is therefore my opinion that this statement in the Trane documentation would not have motivated a POSITA to modify Andrepont to use duplex chilling technology.

2. Dr. Reindl Also Fails to Provide a Rationale that Would Have Guided a POSITA to Use Duplex Chillers with Andrepont in His Declaration

147. In addition to the factors expressly identified in the Petition, I understand that Dr. Reindl listed a number of other factors from the Trane documentation that would have allegedly guided a POSITA to use duplex chillers with Andrepont/Polimeros. Ex. 1218 at ¶ 88; Ex. 1318 at ¶ 70. It is my understanding that because these factors were not presented in Stellar’s Petition, they may not be considered in the Board’s final written decision. Nonetheless, for completeness I turn to these factors now.

148. **Direct drive for reliability and simplicity:** Dr. Reindl’s first additional factor is “direct drive for reliability and simplicity.” Ex. 1218/1318 at ¶ 88. Direct drive refers to the type of compressor mechanism used in Trane chillers. Trane uses this type of drive mechanism in both its duplex and in its non-duplex chillers. Ex. 2208/2308 at 2 (discussing “direct drive for reliability” for

non-duplex chillers). Thus, as with the other non-distinguishing features recited in the Trane documentation, the direct drive feature would not have prompted a POSITA to modify Andrepont to use duplex chilling technology.

149. In addition, the Trane documentation must be read in light of the debate between Trane and other chiller manufacturers regarding the relative superiority of direct drive vs. other types of drives as they impact chiller performance. Ex. 2207/2307 at 8 (“Gear Drive Offers Greater Operating Efficiency Than Direct Drive.”). This existence of this debate makes it even less likely that a POSITA would have been prompted to modify Andrepont based on the “direct drive” statement on the face of the Trane documentation.

150. **Evaporator and condenser design for maximum efficiency:** Dr. Reindl’s second additional factor refers to the design of the Trane evaporator and condenser in a duplex chiller. Ex. 1218/1318 at ¶ 88. Notably, these marketing claims are unrelated to any distinguishing features of a duplex chiller and not unique to duplex chilling technology. Every chiller manufacturer makes claims about the relative efficiency of its products. For example, I understand that Trane describes its non-duplex products as having an “[e]vaporator and condenser designed to maximize efficiency and reduce operating costs.” Ex. 2208/2308 at 2. Similarly, I understand that McQuay describes its products as having “superior

efficiency in many applications” and “[i]ndustry leading efficiency when teamed with Dual⁴ Compressor Chillers.” Ex. 2207/2307 at 3. Thus, it is my opinion that these statements in the Trane documents amount to little more than marketing claims that for this particular product, both evaporators and condensers were designed for optimum efficiency, and not that optimum efficiency was somehow a result of using duplex chilling technology. Of course, a POSITA would understand that for practically any product in any industry, a manufacturer will praise the design and features of its product in marketing materials. It is therefore my opinion that unsubstantiated efficiency claims in the Trane documentation would not have guided a POSITA to utilize duplex chilling technology specifically, since all chiller manufacturers claim to have designs for maximum efficiencies for a range of chiller components and technologies.

151. **Single pass evaporator and condenser for low pressure drops:** Dr. Reindl’s third additional factor refers to the number of passes in the evaporator and condenser. Ex. 1218/1318 at ¶ 88. However, although duplex chillers use single pass evaporators/condensers, these are merely characteristics of duplex chillers. Many other types of chillers also have one or more of these characteristics. For

⁴ i.e., non-duplex.

example, the non-duplex Trane documentation refers to a chiller having a single-pass evaporator. Ex. 2208/2308 at 9. Similarly, the McQuay documentation refers to various types of one, two, three, and four-pass evaporator and condenser systems. Ex. 2207/2307 at 34–45. Moreover, as explained in the Polimeros reference, single-pass evaporators are undesirable because they “are less efficient in heat transfer than multiple-pass” and require “either . . . increased horsepower . . . or greater initial investment.” Ex. 1225/1327 at 7–8. It is therefore my opinion that statements in the Trane documentation regarding a single pass evaporator would not have motivated a POSITA to modify Andrepont to use duplex chilling technology.

152. **Fixed orifice system to ensure proper refrigerant flow at all load conditions:** Dr. Reindl’s fourth factor is a “fixed orifice.” Ex. 1218/1318 at ¶ 88. This refers to a structural feature that is also present in Trane non-duplex chillers. Ex. 2208/2308 at 2 (non-duplex literature describing a “Trane patented fixed orifice system for ensuring proper refrigerant flow at all load conditions.”) Thus, a “fixed orifice” would not have prompted a POSITA to modify Andrepont to use duplex chilling technology, because a fixed orifice is not a distinguishing feature of that technology.

153. In addition, the Trane documentation must be read in light of the debate between Trane and other chiller manufacturers regarding the relative superiority of fixed orifice versus other technology options as they impact chiller performance. Ex. 2207/2307 at 71 (“Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions.”). This existence of this debate makes it even less likely that a POSITA would have been prompted to modify Andrepont based on the “fixed orifice” statement on the face of the Trane documentation.

154. **“Low maintenance costs – no gear inspections or maintenance”:** Dr. Reindl’s fifth factor is a statement regarding low maintenance costs due to a lack of gear inspections. Ex. 1218/1318 at ¶ 88. This statement in the Trane documentation is another reference to Trane’s “direct drive” feature (which does not use any gears). As previously discussed, “direct drive” is not a distinguishing feature of duplex chillers because Trane also used it in its non-duplex chillers. Ex. 2208/2308 at 4 (“The Trane CenTraVac chiller has . . . no gear boxes.”). Additionally, Trane competitors such as McQuay argued that the gear box mechanism was superior because it offers greater efficiency. Ex. 2207/2307 at 8 (“Gear Drive Offers Greater Operating Efficiency Than Direct Drive.”). Thus, it is

my opinion that this statement in the Trane documentation would not have guided a POSITA to modify Andrepont to use duplex chilling technology.

155. **Reduced refrigerant emissions:** Dr. Reindl's final additional factor relates to reduced refrigerant emissions. Ex. 1218/1318 at ¶ 88. This factor does not relate to duplex chilling, and indeed, Trane does not explain what the reduced emissions are being compared to. In other words, this statement in the Trane documentation is an environmental and regulatory necessity for all chillers, not a distinguishing feature of duplex chilling technology. Moreover, Trane has made nearly the same marketing statement about its non-duplex chillers. Ex. 2208/2308 at 2 ("The Trane EarthWise CenTraVac has a proven track record as literally the world's most efficient, lowest emissions chiller.") Similarly, the McQuay packaged chillers also boast of low refrigerant emissions. Ex. 2207/2307 at 7 ("No periodic emissions of refrigerant into the atmosphere."). Thus, in my opinion, this factor would not have led a POSITA to modify Andrepont to use duplex chilling technology.

156. In short, none of the reasons that Stellar identifies from the Trane documentation for using duplex chillers would have actually guided a POSITA to modify Andrepont to use duplex chilling technology. Thus, it is my opinion that the duplex chilling claims are all patentable over Stellar's obviousness arguments

VII. Objective Evidence Shows That A Person Of Skill In The Art Would Not Have Combined Andrepont With Series Chilling From Polimeros In The Manner Claimed

157. In forming my opinions, I have also considered the development of TIC as an industry. My analysis in this regard was aided by a database maintained by the Turbine Inlet Cooling Association (“TICA”), which is discussed below. The TICA Database” shows a list of TIC projects (including evaporatively cooled and fogging projects). This list was compiled by members of the Turbine Inlet Cooling Association (TICA), an industry trade association that includes all the major TIC providers. Notably, John Andrepont is identified as the person responsible for maintaining the TICA database. Ex. 2209/2309.

158. The objective evidence in this case supports a finding of non-obviousness. The first TIC/TES system that was designed specifically for a standalone utility gas turbine power plant and which used chilled-water TES was the Calpine Clear Lake facility, designed by patentee Mr. Pierson in 1999 and which embodies several claims of his invention, including the claims relating to series chilling with chilled-water TES. Ex. 2210/2310, Pierson, ¶ 1. The innovations in Mr. Pierson’s invention allowed for more efficient and more economical TIC/TES systems than those available in the prior art.

159. Before the Calpine Clear Lake facility, *every* TIC/TES project for a standalone utility gas turbine power plant used ice as the thermal storage medium, as evidenced by Exhibit 2209/2309 (“TICA Database”). I understand that the TICA Database is compiled by members of TICA. Ex. 2210/2310, Pierson Dec. ¶ 3-5. A summary of relevant portions of the TICA database is found as the TICA Summary. Ex. 2205/2305.

160. The TICA Summary (as well as the TICA Database) shows all the “actively cooled” turbine inlet chilling projects from the TICA Database from the very first known TIC project in 1987 through 1999. “Actively cooled” projects refer to systems where some type of *chilling* technology was used, but it does not include the “passive” evaporative *cooling* projects, which were popular but could not restore most of the power lost during the heat of the day. Ex. 2205/2305. It is notable that more than 80% of the chilled water systems in the TICA Database before 1999 (20 out of 23 through 1998, including the very first turbine inlet chilling project done in 1987) were designed by Patent Owner TAS Energy or by the patentee, Mr. Pierson.

161. The TICA Database shows that prior to 1999, 100% of the nine utility-scale TIC/TES systems used *ice* for the thermal storage medium, such as the Lincoln Electric system built in 1991. Ex. 2205/2305 & Ex. 2209/2309. Three

other systems used water storage, but those were all district energy systems whose primary purpose was to chill enough water to cool other building facilities (Disneyworld, the World's Fair in Portugal, or a hospital in Norwalk, California), and they only incidentally used a small part of their chilled water to also chill the inlet air to a turbine. *Id.* This is evidenced by the fact that their chillers have far more chilling capacity than was used by the TIC cooling coil load, indicating that most of the chilling was being used for other purposes, such as district cooling and any TIC cooling is relatively incidental to the primary purpose of the district cooling facility. This contrasts with the use of Mr. Pierson's invention for power plants where the *sole purpose* of the chilling facility is *specifically* for cooling these large gas turbines, and which save money by having *lower* capacity chillers than what is required for cooling the turbines, while using a TES tank to make up the difference. Notably, four of the systems in Exhibit 2009 were developed by Trigen, who employed the authors of the Mornhed paper. Of those four Trigen systems, three of them used ammonia to operate the cooling coil to provide turbine inlet cooling, in spite of the fact that they also had chilled water (for district cooling) that they could have used for TIC purposes. *See* Ex. 2013, TICA; Ex. 2004, Energy Tech, at 5–6. District cooling plants were precluded from using ammonia direct refrigeration, which had been commonly preferred in TIC, because

of the health and safety concerns of circulating large amounts of ammonia/refrigerant around a city or college campus.

162. The TICA database shows that the *first* TIC/TES system that was designed specifically for a public utility power plant and which used chilled water storage was the Calpine-Clear Lake facility, designed by Mr. Pierson in 1999. Ex. 2007; Ex. 2013. Following Mr. Pierson's initial system, *all* of the TIC/TES systems built for power plants have used *water* for their TIC and the TES component rather than *ice* and *ammonia* refrigeration, as shown in Exhibits 2007 and 2013. To cause this complete shift in the commercially employed technology, Mr. Pierson's TIC/TES system must provide for more efficient and economical operation than the prior art ice and ammonia systems.

163. In addition to the information maintained in the TICA Database, it is my understanding that TAS Energy is aware of five standalone utility gas turbine power plant TIC/TES projects from 2007–2015, 100% of which use chilled water as the storage medium, series chillers, and high temperature change in the circulating water/inlet air:

Initial Year of Operation	CT Plant Owner/Operator	CT Plant Location	TICA Provider with Primary Involvement
2007	SDGE Palomar	San Diego, CA	GE
2013	Frontera Energy Center	Mission, TX	Stellar
2014	Calpine Baytown	Baytown, TX	TAS
2015	Dominion Greensville County	Greensville County, VA	TAS
2015	Duke Hines	Bartow, FL	Stellar

Ex. 2210/2310 (Pierson Dec.) at 9.

164. When the information in the TICA Database is combined with my understanding of these standalone utility gas turbine power plant TIC/TES projects from 2007–2015, the success of Mr. Pierson’s claimed inventions is apparent:

CHILLED WATER TIC/TES FOR USE WITH STANDALONE UTILITY GAS TURBINE POWER PLANTS	
Pre-Invention (1988-1999)	Post-Invention (1999-2015)
0 of 9	12 of 12

As this table shows, before 1999, *none*, and after the invention, *all* of the TIC/TES systems dedicated for use by electrical power utilities used chilled water. This objectively shows the real-world impact of Mr. Pierson’s inventions on the marketplace.

165. Based on the above, it is my opinion that Mr. Pierson's patented technology has been commercially successful, particularly because it has displaced the prevailing alternative designs for utility-scale TIC/TES systems.

166. The fact that people in the field had elected not to build a system like Andrepont's (i.e., a dedicated TIC/TES system using chilled water for the thermal energy storage) prior to the invention (despite the Andrepont reference being presented in 1994 at the Annual Meeting of the American Power Conference, *see* Ex. 1220, Andrepont, at 1) makes it less likely that a person having ordinary skill in the art would seek to modify Andrepont's system. This is particularly true for Stellar's theory, which argues that a POSITA would have modified Andrepont's system, even though that person had no experience with TIC.

167. I disagree with Stellar's apparent assertion that a POSITA would modify a theoretical system to arrive at a desirable outcome, particularly when real people in the field did not. The fact that actual, highly skilled design engineers in the field never built a system like Andrepont's shows that Stellar's hypothetical POSITA would not have modified Andrepont's system in the manner claimed.

168. I understand that Stellar's own expert provided a paper that reemphasizes this point. Dr. Reindl was a coauthor of a paper in 1995 which specifically looked at trying to optimize a TIC/TES system. Ex. 2203/2303 at 1.

Dr. Reindl's paper examined ice storage systems, chilled water storage systems, as well as a hybrid of these two systems. *Id.* The Reindl/Cross chilled water system would have driven the water temperature down to 40°F, just as Andrepont's system did. *Id.* at 3.

169. Moreover, just like Andrepont, the Reindl system used a single chiller rather than series chillers. *Id.* Additionally, Dr. Reindl used a cooling coil that only increased the water temperature from 40°F to 53°F which resulted in a 13°F ΔT for his chilled water system. *Id.* Thus, Dr. Reindl himself did not see the absolute need to drive the return water temperature to a very high temperature in the cooling coil, which is necessary if series chilling were to have any chance of being beneficial. In other words, in the chilled water system of Dr. Reindl's hybrid TIC/TES system using series chilling with a 13°F ΔT would not have been desirable and he would have had no motivation to make the combination. This is yet another strong indication that many of the things that Dr. Reindl now says are obvious (i.e., using series chilling in a chilled water TIC/TES system, obviousness of temperature ranges, etc.), 16 years after the invention, were in fact not obvious without the benefit of hindsight.

170. The development of chilled water storage in the TIC field is an objective consideration that is relevant to obviousness. Andrepont proposed a

chilled-water storage TIC system that was never built in the five years between the paper's publication and the disclosure of the invention, as shown by its absence the TICA database that Mr. Andrepont himself maintained. Chilled water storage systems dedicated to TIC for utilities, such as was proposed by Andrepont, were not built prior to Mr. Pierson's invention. The fact that design engineers in the field had elected not to make a system like Andrepont's prior to the invention makes it less likely that a person having ordinary skill in the art would seek to *modify* Andrepont's system.

171. In short, these objective facts, when compared with Stellar's proposed hypothetical combinations, demonstrate both the commercial success of the claimed invention and that the challenged claims are not obvious. At the very least, Stellar has failed to show by a preponderance of the evidence that the challenged claims are obvious in view of the proposed combinations.

VIII. Conclusion

172. For the foregoing reasons, it is my opinion that the challenged claims are patentable over the asserted prior art.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on August 9, 2016



Gregor P. Henze, Ph.D., P.E.