IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF COLORADO

Civil Action No. 1:21-cv-02235-SKC

ENERGY ENVIRONMENTAL CORPORATION,
a Colorado corporation,

Plaintiff,

v.

THE CITY AND COUNTY OF DENVER, ACTING BY AND THROUGH ITS BOARD OF WATER COMMISSIONERS A/K/A DENVER WATER,

Defendant.

FIRST AMENDED COMPLAINT AND JURY DEMAND

Plaintiff Energy Environmental Corporation for its First Amended Complaint against Defendant The City and County of Denver, acting by and through its Board of Water Commissioners also known as Denver Water, states and alleges:

I. THE PARTIES

1. Energy Environmental Corporation ("EEC") is a Colorado corporation having a principal place of business at 8295 South Krameria Way, Centennial, Colorado 80112.

2. The City and County of Denver created the Denver Water Department to operate and maintain a municipal water works system and plant on behalf of the City and County of Denver and its inhabitants and created the Board of Water Commissioners as the governing body and policy maker of the Denver Water Department ("Denver Water"). The City and County of Denver acts by and through its Board of Water Commissioners. Denver Water, which is a municipal corporation and political subdivision of the State of Colorado, exists and operates pursuant to the

laws of Colorado and Article 10 of Charter of the City and County of Denver. Denver Water is headquartered in Denver, Colorado.

II. JURISDICTION AND VENUE

3. This action arises under the Patent Act, 35 U.S.C. §§ 101, *et seq.* The infringing acts of Denver Water, as complained of herein, were committed in this District and have caused and continue to cause EEC injury in this District. The Court has original jurisdiction over the parties and the claims asserted in this action pursuant to 28 U.S.C. §§ 1331 and 1338.

4. This Court has personal jurisdiction over Denver Water because Denver Water has committed, and continues to commit, acts of infringement in this District, has conducted business in this District, and/or has engaged in continuous and systematic activities in this District.

5. Venue is proper in this District pursuant to 28 U.S.C. § 1400 because Denver Water has a regular and established place of business in this District and has committed acts of infringement in this District.

III. THE PATENTS-IN-SUIT

6. U.S. Patent 9,410,752 ("the '752 Patent") titled "Hydronic Building Systems Control" was filed on August 16, 2013 and claims priority to Provisional Application No. 61/684,564, filed on August 17, 2012. The United States Patent and Trademark Office ("USPTO") duly and legally issued the '752 Patent on August 9, 2016. A copy of the '752 Patent is attached hereto as Exhibit 1 and incorporated herein by reference.

7. Independent claim 1 of the '752 Patent is representative of the subject matter of the '752 Patent and is set forth in its entirety below.

> 1. A method for controlling heating and cooling in a conditioned space, the method comprising the steps of:

> (a) receiving in a microprocessor controller a desired set point temperature and a desired set point humidity;
>
> (b) receiving in the microprocessor controller a plurality of sensor inputs from a plurality of sensors, wherein the plurality of sensors sense at least one temperature and at least one relative humidity;
>
> (c) processing by the microprocessor controller the plurality of sensor inputs from the plurality of sensors in light of the desired set point temperature and the desired set point relative humidity;
>
> (d) calculating and tracking by the microprocessor controller a first dew point in a fresh intake air moving into a dehumidifying device; and a second dew point in a thermally conductive structure in the conditioned space;
>
> (e) sending a plurality of digital signals from the microprocessor controller to a devices controller; and
>
> (f) sending a plurality of control signals from the devices controller to a plurality of devices, the plurality of devices selected from the group consisting of analog devices and digital devices, wherein the plurality of devices upon receiving the plurality of control signals achieve the desired set point temperature and the desired set point humidity in the conditioned space by:
>
> (i) circulating a fluid within at least one of the thermally conductive structure and the dehumidifying device, wherein the dehumidifying device is in fluid connection with the thermally conductive structure;
>
> (ii) moving the fresh intake air through the dehumidifying device and into the conditioned space;
>
> (iii) keeping a first temperature of the fluid less than the first dew point at the dehumidifying device; and
>
> (iv) keeping a second temperature of the fluid greater than the second dew point at the thermally conductive structure.

8. U.S. Patent 10,072,863 ("the '863 Patent") titled "Hydronic Building Systems Control" was filed on July 5, 2016 and claims priority to U.S. Continuation Application No. 13/969,316, filed on August 16, 2013 (the '752 Patent), and to Provisional Application No. 61/684,564, filed on August 17, 2012. The USPTO duly and legally issued the '863 Patent on September 11, 2018. A copy of the '863 Patent is attached hereto as Exhibit 2 and incorporated herein by reference.

9. Independent claim 1 of the '863 Patent is representative of the subject matter of the '863 Patent and is set forth in its entirety below.

> 1. A method for controlling heating and cooling in a conditioned space, the method comprising the steps of:
>
> (a) receiving in a microprocessor controller a desired set point temperature;
>
> (b) receiving in the microprocessor controller a plurality of sensor inputs from a plurality of sensors, wherein the plurality of sensors sense at least one temperature and at least one relative humidity;
>
> (c) processing by the microprocessor controller the plurality of sensor inputs from the plurality of sensors in light of the desired set point temperature;
>
> (d) calculating and tracking by the microprocessor controller a dew point in at least one of:
>
> (i) a fresh intake air moving into a dehumidifying device;
>
> (ii) a thermally conductive structure in the conditioned space; or
>
> (iii) the conditioned space;
>
> (e) sending a plurality of digital signals from the microprocessor controller to a device controller; and
>
> (f) sending a plurality of control signals from the device controller to a plurality of devices, wherein the plurality of devices upon receiving the plurality of control signals achieve the desired set point temperature in the conditioned space by:
>
> (i) circulating a fluid within the thermally conductive structure;
>
> (ii) keeping the temperature of the fluid greater than the dew point at the thermally conductive structure.

10. U.S. Patent 10,330,336 ("the '336 Patent") titled "Hydronic Building Systems Control" was filed on August 9, 2018 and claims priority to U.S. Continuation Application No. 15/202,370 (the '863 Patent), to U.S. Continuation Application No. 13/969,316, filed on August 16, 2013 (the '752 Patent), and to Provisional Application No. 61/684,564, filed on August 17, 2012. The USPTO duly and legally issued the '336 Patent on June 25, 2019. A copy of the '336 Patent is attached hereto as Exhibit 3 and incorporated herein by reference.

11. Independent claim 52 of the '336 Patent is representative of the subject matter of the '336 Patent and is set forth in its entirety below.

> 52. A method for controlling occupant comfort in a conditioned space, the method comprising the steps of:
>
> (a) receiving in a microprocessor controller at least one of a desired set point temperature, a desired set point relative humidity, or a desired set point dew point;

(b) receiving in the microprocessor controller a plurality of sensor inputs from a plurality of sensors, wherein the plurality of sensors sense at least one temperature;

(c) processing by the microprocessor controller the plurality of sensor inputs from the plurality of sensors in light of the desired set point temperature, desired set point relative humidity, or desired set point dew point;

(d) calculating and tracking by the microprocessor controller a dew point in at least one of:

(i) a fresh intake air moving into a dehumidifying device;

(ii) a thermally conductive structure in the conditioned space; or

(iii) the conditioned space;

(e) sending a plurality of digital signals from the microprocessor controller to a device controller; and

(f) sending a plurality of control signals from the device controller to a plurality of devices, wherein the plurality of devices upon receiving the plurality of control signals achieve the desired set point temperature, set point relative humidity, or set point dew point; in the conditioned space by:

(i) circulating a fluid within the thermally conductive structure;

(ii) keeping the temperature of the fluid greater than the dew point at the thermally conductive structure,

wherein the microprocessor controller is programmed to provide staged heating, cooling and ventilation.

12. U.S. Patent 10,907,848 ("the '848 Patent") titled "Hydronic Building Systems Control" was filed on May 14, 2019 and claims priority to U.S. Continuation Application No. 16/059,342 (the '336 Patent), to U.S. Continuation Application No. 15/202,370 (the '863 Patent), to U.S. Continuation Application No. 13/969,316 (the '752 Patent), and to Provisional Application No. 61/684,564, filed on August 17, 2012. The USPTO duly and legally issued the '848 Patent on February 2, 2021. A copy of the '848 Patent is attached hereto as Exhibit 4 and incorporated herein by reference.

13. Independent claim 1 of the '848 Patent is representative of the subject matter of the '848 Patent and is set forth in its entirety below.

1. An apparatus comprising:
a conditioned space;

a thermally conductive structure oriented below and thermally connected with the conditioned space;

at least one source process heat exchanger fluidly connected to at least one first thermal storage and at least one second thermal storage;

at least one first process heat circulator fluidly connected to the at least one source process heat exchanger and configured to circulate a first source fluid through the at least one first thermal storage;

at least one second process heat circulator fluidly connected to the at least one source process heat exchanger and configured to circulate a second source fluid through the at least one second thermal storage;

at least one hydronic-to-air circulator fluidly connected to the at least one first thermal storage;

at least one energy transfer and ventilation device comprising a dedicated outdoor air system (DOAS) and at least one hydronic coil-to-air heat exchanger, wherein the at least one hydronic coil-to-air heat exchanger is fluidly connected to the at least one hydronic-to-air circulator;

the at least one hydronic-to-air circulator is configured to circulate at least one hydronic coil supply fluid in the at least one hydronic coil-to-air heat exchanger;

the at least one energy transfer and ventilation device is configured with at least one fresh air fan fluidly connected to a fresh air supply;

wherein the at least one energy transfer and ventilation device receives the fresh air supply, and outputs into the conditioned space at least one of:

a fresh air; and

a conditioned air;

at least one fan coil unit comprising: a fan and at least one fan coil unit hydronic coil-to-air heat exchanger in fluid communication with an air in the conditioned space, wherein the at least one fan coil unit returns the air from the conditioned space and supplies the conditioned air into the conditioned space;

a radiant mixing device in fluid communication with the at least one first thermal storage, the thermally conductive structure, and the at least one fan coil unit hydronic coil-to-air heat exchanger;

at least one first hydronic load circulator fluidly connected to the at least one first thermal storage and fluidly connected to the radiant mixing device, wherein the at least one first hydronic load circulator circulates a first hydronic supply fluid to the at least one first thermal storage and the radiant mixing device;

the at least one first hydronic load circulator is fluidly connected to:

the thermally conductive structure; and

the at least one fan coil unit hydronic coil-to-air heat exchanger;

the at least one first hydronic load circulator circulates a mixed radiant supply fluid from the radiant mixing device through:

the thermally conductive structure; and

the at least one fan coil unit hydronic coil-to-air heat exchanger;

wherein a temperature of the mixed radiant supply fluid is modulated by the operation of at least one of:

the radiant mixing device; and

the at least one first hydronic load circulator that modulates a mixed flow of fluid comprised of a portion of at least one of:

the first hydronic supply fluid; and

a first hydronic return fluid;

at least one second hydronic load circulator fluidly connected to:

the at least one second thermal storage that is fluidly connected to:

the thermally conductive structure that is fluidly connected to:

the at least one fan coil unit hydronic coil-to-air heat exchanger that is fluidly connected to:

at least one DOAS hydronic coil-to-air heat exchanger;

wherein the at least one second hydronic load circulator circulates a second hydronic supply fluid in:

the at least one second thermal storage; and

at least one of:

the thermally conductive structure;

the at least one fan coil unit hydronic coil-to-air heat exchanger; and

the at least one DOAS hydronic coil-to-air heat exchanger;

at least one temperature sensor in at least two of:

the conditioned space;

the thermally conductive structure; and

the at least one energy transfer and ventilation device;

at least one humidity sensor in at least two of:

the conditioned space;

the at least one energy transfer and ventilation device; and

the fresh air supply;

a plurality of sensors that send a plurality of sensor inputs to a microprocessor controller, the plurality of sensors selected from the group consisting of at least two of:

the at least one temperature sensor;

a pressure sensor;

an atmospheric pressure sensor;

the at least one humidity sensor; a relative humidity sensor;

an air velocity sensor;

a fluid velocity sensor;

a power sensor; and

a real time energy use sensor;

a building automation system configured to achieve at least one of:

at least one energy efficiency;

at least one health benefit;

at least one safety benefit; and

at least one comfort benefit;

the building automation system comprising:

a client/server architecture; and

the microprocessor controller;

a memory coupled to and readable by the microprocessor controller and storing therein a plurality of instructions that, when executed by the microprocessor controller, causes the microprocessor controller to:

receive at least one of:

a cooling set point temperature for the conditioned space;

a heating set point temperature for the conditioned space;

a temperature from the at least one temperature sensor; and

a humidity level from the at least one humidity sensor;

calculate a dew point temperature for at least one of:

a fresh air intake;

the conditioned air into the conditioned space;

a surface of the thermally conductive structure; and

the conditioned space;

in response to processing at least one of:

the cooling set point temperature for the conditioned space; and

the heating set point temperature for the conditioned space;

process:

the temperature from the at least one temperature sensor;

the humidity level from the at least one humidity sensor; and

the dew point temperature;

to achieve at least one of:

the at least one energy efficiency;

the at least one health benefit;

the at least one safety benefit; and

the at least one comfort benefit;

execute at least two of the following:

send a thermal storage temperature control signal to the at least one source process heat exchanger causing the at least one source process heat exchanger to maintain at least one of:

a set point temperature in the at least one first thermal storage; and

a set point temperature in the at least one second thermal storage;

send a hydronic-to-air circulator control signal to the at least one hydronic-to-air circulator causing the at least one hydronic-to-air circulator to circulate the at least one hydronic coil supply fluid;

send a first hydronic load circulator control signal to the at least one first hydronic load circulator causing the at least one first hydronic load circulator to circulate the mixed radiant supply fluid;

send a second hydronic load circulator control signal to the at least one second hydronic load circulator causing the at least one second hydronic load circulator to circulate the second hydronic supply fluid;

> send a hydronic supply mixing control signal to at least one of the radiant mixing device and the at least one first hydronic load circulator that modulates at least one of the temperature of the mixed radiant supply fluid and the flow rate of the mixed radiant supply fluid and maintain a temperature of the surface of the thermally conductive structure above the dew point temperature;
>
> send a DOAS temperature control signal to the at least one energy transfer and ventilation device that modulates a temperature of the conditioned air from the at least one energy transfer and ventilation device into the conditioned space;
>
> send a DOAS humidity control signal to the at least one energy transfer and ventilation device that modulates a humidity of the conditioned air from the at least one energy transfer and ventilation device into the conditioned space; and
>
> send a ventilation air fan control signal to at least one of:
> the at least one energy transfer and ventilation device; and
> the at least one fresh air fan to modulate a fan speed.

14. The '752 Patent, '863 Patent, '336 Patent and the '848 Patent are collectively referred to as "the EEC Patents" or "the Patents-in-Suit."

15. EEC owns all rights, title and interest in and to the EEC Patents.

16. The claims of the Patents-in-Suit are directed to patentable subject matter.

17. In particular, the Patents-in-Suit are directed to methods and systems for heating and cooling a building based on physical implementations of the process model, which as shown in Figure 1 of the shared specification, reproduced below, includes numerous machines.

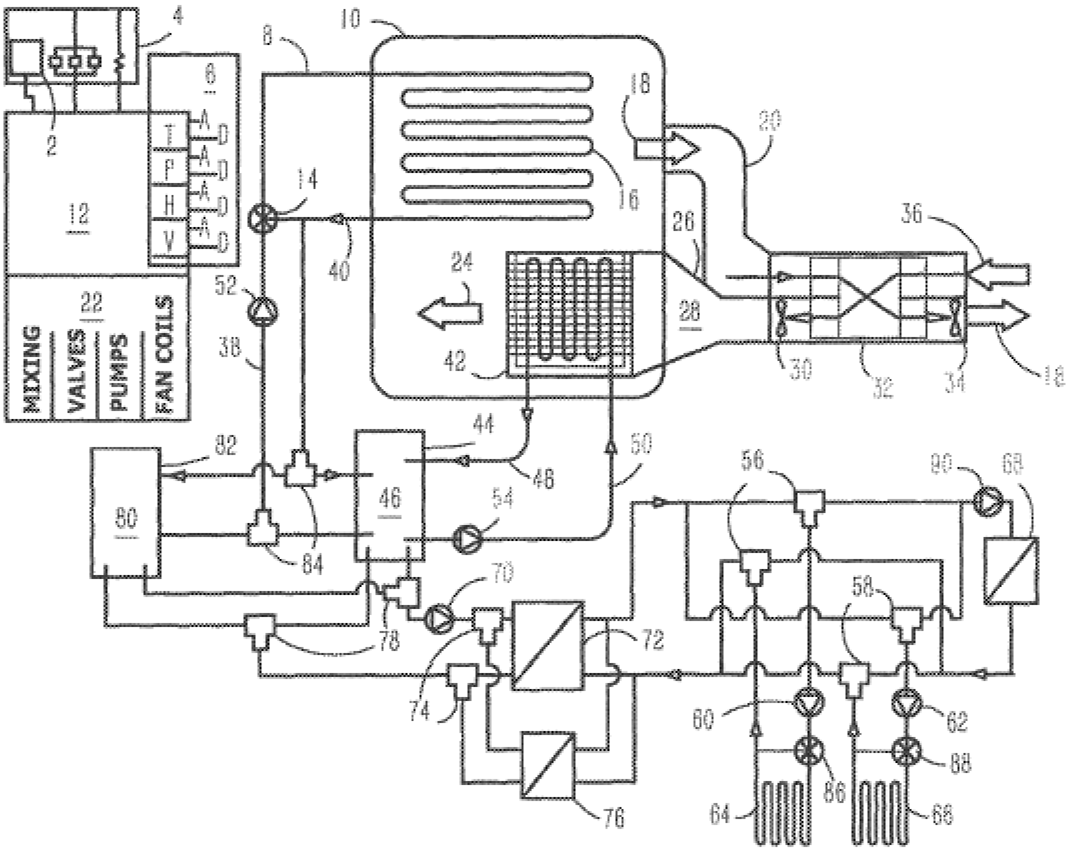


Fig. 1

18. The Patents-in-Suit require extensive specialized physical input/output (I/O) apart from the microprocessor which are not available on generic computers, and control of analog devices that are incompatible with the digital processing associated with a generic computer. As the shared specification explains, "[t]o simplify the control optimization strategy, [Hydronic Building Systems Control ("HBSC")] utilizes the explicit process model shown in FIG. 1 to determine critical parameters." *E.g.*, '752 Patent at 11:61-63.

19. The claims of the Patents-in-Suit are not directed to an abstract idea, but to a technical solution to a technical problem. As the shared specification explains, "[m]ore energy is

consumed by buildings than any other segment of the U.S. economy, including transportation or industry, with almost 41% of total U.S. energy consumption devoted to taking care of our nation's home and commercial building energy needs." *E.g.*, '752 Patent at 1:18-22. The Patents-in-Suit recognize that "[n]ext-generation building controls have the potential to produce significant energy savings in buildings," but "the potential to realize these savings via innovative building controls has been hampered by several market and industry barriers." *Id.* at 1:41-52.

20. The specification states that the invention is "related to hydronic heating and cooling applications and more specifically to software control systems for hydronic heating and cooling applications." *Id.* at 1:14-16. "Hydronic heating and cooling" refers to circulating liquid. e.g., water, through pipes and other machines to efficiently move heat from one location to another and to thus control the overall temperature of a structure in a desired and efficient manner.

21. The specification identifies specific technical problems with conventional hydronic systems, including the fact that hydronic systems were difficult to retrofit with traditional forced air systems (*i.e.*, air conditioners or heaters that use temperature-controlled forced air to control temperature) and the fact that hydronic system controllers were complex. *Id.* at 3:14-17 and 33-45.

22. The specification particularly highlighted various technical inadequacies of existing and conventional hydronic system controllers. For example, most controllers were limited to "one device using a few sensors." *Id.* at 6:24-25. Enterprise controllers—those designed for industrial applications—were "expensive to install, program and maintain." *Id.* at 6:33-34. While such controllers could control multiple devices, they failed to provide "higher system energy efficiency." *Id.* at 37-39. Traditional hydronic controllers were also designed for steady state

operation and could not achieve energy efficiencies available from addressing dynamic conditions, including peak load, off peak load, partial load and other changing conditions (such as changing weather, changing building occupancy. etc.). *Id.* at 6:56—7:3. Further, conventional controllers did not modify the temperature of chilled fluid entering a cooling hydronic system based on changing conditions, leading to further energy inefficiencies. *Id.* at 7:4-12. Conventional hydronic systems also relied on controllers designed for older fossil fuel systems instead of heat pump systems that have more advanced capabilities. *Id.* at 7:13—8:4. The existing technology also failed to provide a controller for integrated heating and cooling systems using a single fluid circuit which improves efficiencies. *Id.* at 8:7-44.

23. The specification further explains that traditional forced air systems used "air-to-air heat exchanger[s] with one or more built-in fans," which had to be adjusted depending on the temperature and humidity of the climate. *Id.* at 3:20-34. The specification identifies several problems with traditional air conditioning technology as well, including energy inefficiency, the incubation and spread of pathogens, and vulnerability of duct work to external attack. *Id.* at 5:6-53.

24. The specification also explains technical problems with existing sensors, specifically a lack of interoperability between sensors for disparate components within the same building. *Id.* at 20:36-57.

25. The specification goes on to describe *technical* barriers to the *technical* problem of properly controlling energy use by buildings. For example, the specification spends some four columns detailing problems with existing systems, including "Poor Energy Performance Due To Distribution Ductwork," "Poor Hydronic Control Outcomes," including "inadequate controls and

equipment efficiency ratings based upon steady state conditions," and a lack of "Synergistic Design." *Id.* at 5:6—9:3. Again, these are technical problems addressed by the claimed inventions.

26. The solutions are also technical in nature. As summarized in the shared specification, the objectives of the Patents-in-Suit include:

> 1. Delivery at Speed and Scale-Commercialize a product in less than two years at a price which drives rapid market adoption.
>
> 2. Interoperability-Design interoperable solutions that improve the ease and likelihood of system energy efficiency retrofits.
>
> 3. Accelerate the implementation of affordable hydronic distribution systems.
>
> 4. Increase the market acceptance for ground source heat pumps.
>
> 5. Lower the cost and improve the solar fraction of solar thermal systems.
>
> 6. Create a control requiring minimal or no user input for optimum operation with high reliability and proven energy savings, which minimizes the soft costs attributable to installation, commissioning, and maintenance.
>
> 7. Drive the early adoption of high impact emerging technologies, which will improve the efficiency of integrated hydronic systems, including high thermal conductivity nanofluids, multifunction sensors, and self-optimizing algorithms.

Id. at 9:38-58.

27. The Patents-in-Suit thus have a technical focus and are not directed to abstract ideas. In particular, the specification explains that the above problems in conventional systems are solved with innovative and inventive building controls covering integrated systems that substantially reduce energy use. *Id.* at 2:36-36, 2:60-64. The Hydronic Building System Controls (HBSC) described and claimed by the Patents-in-Suit allows for the integration of traditional and renewable hydronic system components, including utilizing commodity hardware. *Id.* at 3:65- 4:5. The claimed invention also integrates individual sensors and controllers for an integrated whole-building system, unlike in the prior art. *Id.* at 2:53-55.

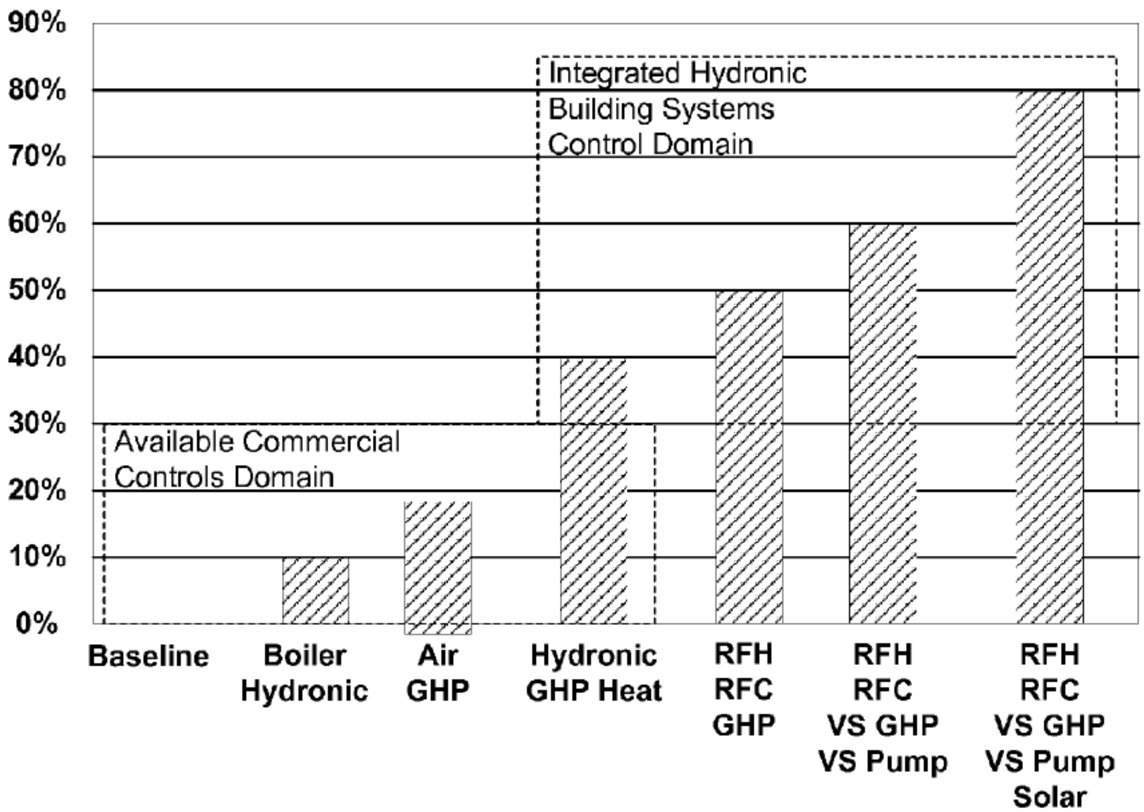
28. The Patents-in-Suit also describe integrating hydronic fan coils for heating and cooling with Dedicated Outdoor Air Systems (DOAS) for improved energy efficiency. *Id.* at 8:45-59. As the shared specification explains, using a liquid (typically water) to control the temperature of a slab (a floor) for heating and cooling while avoiding condensation issues associated with the dew point temperature requires adjusting the temperature of the fluid in the slab. *Id.* The invention allows the use of the same fluid to condition incoming air to control humidity, thus saving energy over conventional dehumidification implementations using a vapor-compression cycle air conditioner. Thus, at a minimum, the integrated system incorporates hydronic technology for heating and cooling and air flow for controlling humidity, where the overlapping fluid and air systems control both temperature and humidity with circulating fluids. *Id.* at 9:13-29, 21:28-33.

29. These technical solutions yield improvements in the technology, including lower energy costs, more efficient use of hardware (and thus longer hardware life), and an improved indoor air quality environment. *Id.* at 9:41-43, 10:1-11.

30. The claims of the Patents-in-Suit also contain inventive concepts and are not routine, conventional or well-understood. As discussed above, the shared specification includes detailed discussions of the many technical shortcomings in conventional building heating, cooling and humidity control systems. The claimed inventions provide innovative approaches to overcome these shortcomings.

31. For example, Figure 2 of the shared specification contrasts the then-prevailing state of the art (conventional system with boilers and forced air cooling) with the enhancements delivered by various embodiments of the claimed HBSC technology, including high mass radiant floor cooling and heating, variable speed pump control with water-water heat pumps, and

integration with renewable energy systems such as solar thermal process heat exchangers. While not all claims require these specific features, they are representative of the unconventional solution developed by the inventor of the Patents-in-Suit.



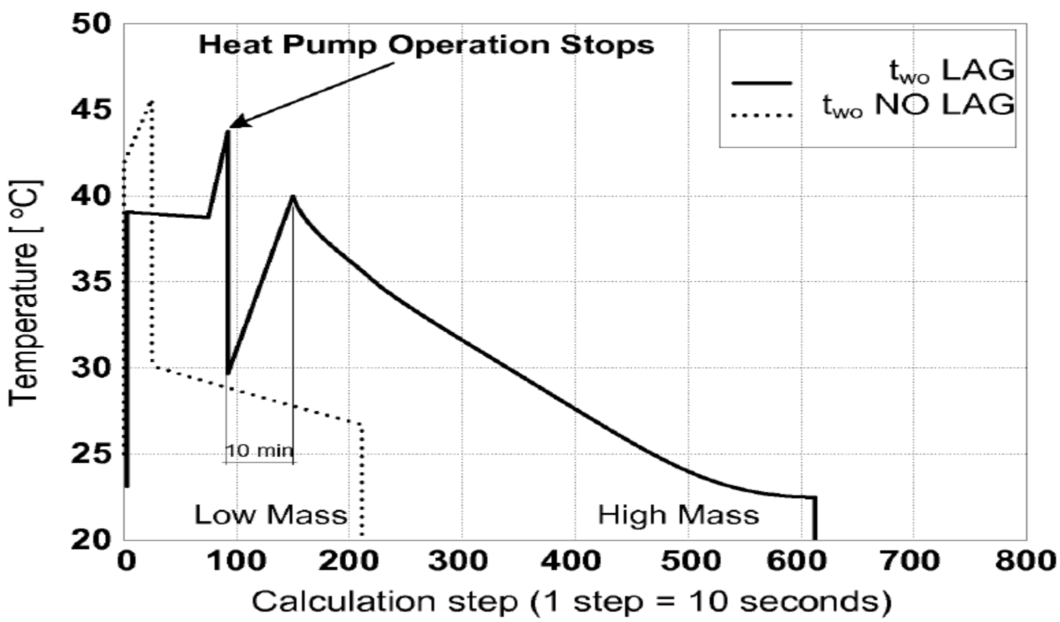
HBSC Energy Savings Potential Compared to Baseline HVAC System

Fig. 2

32. Figure 2 also illustrates the gaps in conventional technology, demonstrating how certain embodiments of the claimed HBSC technology improves energy efficiency, comfort and safety by, *e.g.*, addressing integration and performance issues involving radiant floor cooling,

cooling with hydronic fan coils (as opposed to conventional vapor compression air conditioning), optimizing heat pump operation including source pump control, passive heating and cooling with ground heat or process heat exchangers, integrating solar thermal with high efficiency conventional technologies, and splitting ground source heat exchangers for increasing solar thermal capacity and optimizing water-water heat pump performance.

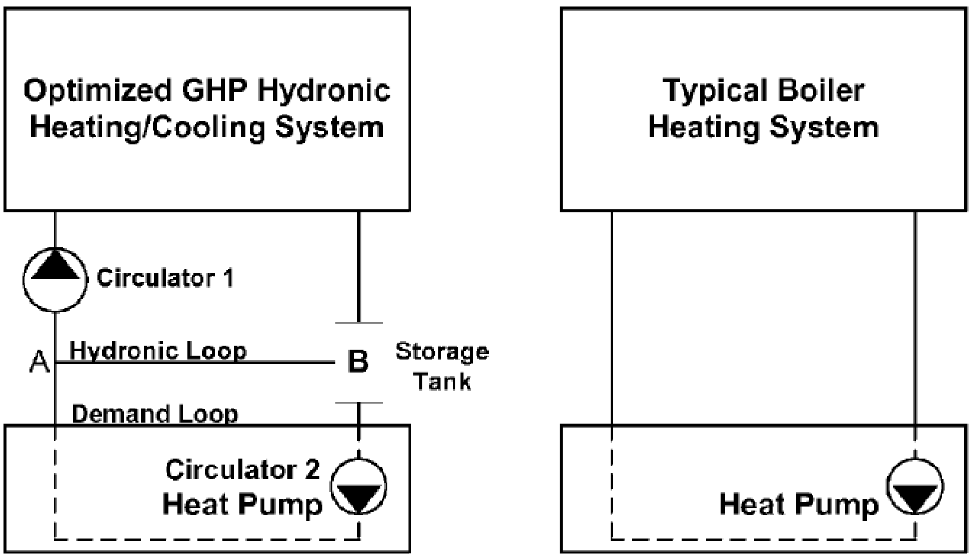
33. Figure 6 of the shared specification demonstrates the unconventional approach of controlling compressor shut-off time to take advantage of high mass thermal lag in order to increase the system efficiency. The area under the solid line graph represents the significant energy recovery of HBSC controls for high mass systems contrasted with the dotted line representing conventional controls for low mass systems with energy recovery.



Comparison of temperature levels for a radiator system with no lag time and 10 minutes lag time. Fixed speed GHP operating at 100% with DOAT at 48 degrees F.

Fig. 6

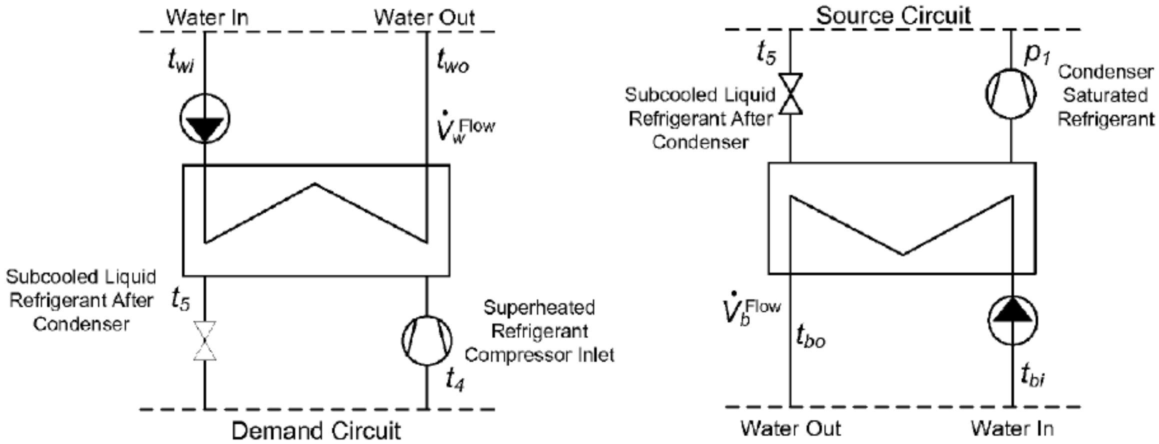
34. Figure 8 of the shared specification demonstrates how, in some embodiments, the HBSC fluid flow configuration and rate differs from traditional, conventional boilers in a series configuration, and shows that the HBSC heat pumps in a parallel configuration optimize pumping to reduce overall energy use.



GHP Parallel Piping Design versus Serial Boiler Connection to Hydronic System

Fig. 8

35. Figure 9 of the shared specification shows the atypical installation of ground source heat pumps controlled by HBSC in some embodiments to optimize load and source pumping to increase efficiency 17% over conventional piping and pumping implementations.



Boundaries for Optimizing the Demand and Source Systems

Fig. 9

36. As these figures illustrate, the inventions claimed in the Patents-in-Suit improve the functioning of building control systems by replacing conventional building environmental control technology with innovative HBSC technology and, as a result, achieve improved performance of the system operating technology and incorporated machines (e.g., hydronic heating and cooling structures, hydronic fan coils, ground source heat pumps, among others). The Patents-in-Suit are thus directed to an improved system, specifically an improved building environmental control system and incorporated machines.

37. EEC's process models and related components are innovative and unconventional and consist of devices beyond mere conventional software running on a generic computer. While the claimed inventions utilize software and microprocessors, these are components that help control an innovative, unconventional architecture of components to achieve a technical improvement over existing building control systems. As detailed in the shared specification, the

myriad of problems in conventional prior art building control systems confirm that the claimed HBSC approach was neither routine nor well-understood.

38. Additional passages from the shared specification confirm that the Patents-in-Suit are directed to specific components arranged to achieve an innovative technical solution. As the specification explains, "[t]he primary function is to control cooling in a thermally-conductive structure, such as RFC or chilled beams." '752 Patent at 23:5-6. In order to control RFC (radiant floor cooling), a building must be constructed with a thermally conductive structure and a collection of components configured as an improvement over the state of the art.

39. The specification further explains:

> The Hydronic Building Systems Control is a *temperature and humidity control apparatus* for air and temperature variable fluid in an air space, comprising a *thermally-conductive structure*, such as a building floor, wall, or ceiling; *hydronic coil-to-air heat exchanger*; a *source of liquid coolant* at a temperature below or above the temperature of the air space; controllable means for applying a temperature variable liquid at a temperature higher than the dew point of the air space to the thermally-conductive structure and for applying a temperature variable liquid coolant at a temperature lower than the dew point to the hydronic coil-to-air heat exchanger; means for sensing at least the air temperature in the air space, a relative humidity of the air space, a temperature of the thermally-conductive structure, and liquid source temperatures; a controller coupled to the sensing means and to the controllable means.

Id. at 9:13-29 (emphasis added). The claimed invention thus requires several discrete structural components beyond algorithms and processors. *See also id.* at 12:13-19 ("HBSC is based on a model consisting of a combination of *analog devices* using a circulating fluid to heat or cool a Conditioned Space 10, such as a room in a home or an office in a building, or multiple conditioned spaces, in a *Thermally-Conductive Structure 16, such as radiant floors, walls, and ceilings, or chilled beams*") (emphasis added).

40. The specification also highlights specific improvements over conventional systems, such as HVAC forced air systems:

> HBSC provides interoperability between legacy and new HVAC equipment, and is designed using a process model which incorporates hydronic fan coils and high mass radiant floor hydronic heating and cooling incorporating ground source heat pumps source circulator control, process heat and solar thermal sources, ground heat exchanger passive cooling, and dew point tracking for high mass radiant cooling applications.

Id. at 11:46-53. Thus, the claimed invention explicitly improves upon prior art found in conventional HVAC systems by improving the operation of the component technologies and enabling the integration of renewable energy sources. This consists of an improvement in the functioning of a machine, which has been consistently recognized as a patent-eligible invention.

41. The claimed inventions thus go beyond a generic computer running conventional software. The claimed solutions are non-abstract, and are not routine, conventional, or well-understood.

42. These innovations are embodied in the claims. The following table sets forth exemplary, non-limiting illustrations of how the innovations described in the specification are embodied in specific claim limitations of the '752 Patent.

'752 Patent, Claim 1	**'752 Patent Specification**
1. A method for controlling heating and cooling in a conditioned space, the method comprising the steps of:	"The Hydronic Building Systems Control (HBSC) described in this disclosure is a low-cost standards-compliant software-based control that integrates traditional and renewable hydronic system components for building heating, cooling, and hot water." '752 Patent at 2:65—3:2. "HBSC is based on a model consisting of a combination of analog devices using a circulating fluid to heat or cool a Conditioned Space **10**, such as a room in a home or an

	office in a building, or multiple conditioned spaces, in a Thermally-Conductive Structure **16**, such as radiant floors, walls, and ceilings, or chilled beams." *Id.* at 12:14-19.
(a) receiving in a microprocessor controller a desired set point temperature and a desired set point humidity;	"Microprocessor Controller **12** hosts the software algorithms containing system functionality. This compact embedded microprocessor system accepts digital input from User Interface **2** and digital/analog input from Sensor Inputs **6**, and generates digital output to User Interface **2**, Communications Module **4**, digital and analog components within the Devices Controller **22**." *Id.* at 15:14-20. "The primary function is to control cooling in a thermally-conductive structure, such as RFC or chilled beams… Zone sensors provide temperature, atmospheric pressure …, and relative humidity data to determine a system dew point, and to set a supply water temperature which prevents condensation within the structure." *Id.* at 23:5-13. "The controller selects an active or passive source based on set point heat and cooling source temperatures to meet building loads." *Id.* at 24:59-61.
(b) receiving in the microprocessor controller a plurality of sensor inputs from a plurality of sensors, wherein the plurality of sensors sense at least one temperature and at least one relative humidity;	"Microprocessor Controller **12** hosts the software algorithms containing system functionality. This compact embedded microprocessor system accepts digital input from User Interface **2** and digital/analog input from Sensor Inputs **6**, and generates digital output to User Interface **2**, Communications Module **4**, digital and analog components within the Devices Controller **22**." *Id.* at 15:14-20. "In one embodiment, Microprocessor Controller **12** processes sensor data, applies algorithms to extract control outputs, and

	communicates those outputs via standard architectures, such as a BACnet link in one embodiment." *Id.* at 15:28-32. "Sensor Inputs **6** provide analog and digital input for system control. Control devices contain at least one member of the group consisting of sensor inputs for temperature, pressure, relative humidity, air and fluid velocity, and real time energy use." *Id.* at 15:48-52.
(c) processing by the microprocessor controller the plurality of sensor inputs from the plurality of sensors in light of the desired set point temperature;	"Microprocessor Controller **12** hosts the software algorithms containing system functionality. This compact embedded microprocessor system accepts digital input from User Interface **2** and digital/analog input from Sensor Inputs **6**, and generates digital output to User Interface **2**, Communications Module **4**, digital and analog components within the Devices Controller **22**." *Id.* at 15:14-20. "In one embodiment of the device controlling HBSC system as shown in **FIG. 1**, temperature sensors are located in: Conditioned Space **10**; Thermally-Conductive Structure **16**; the outside air; the input and output of Radiant Mixing Device **14;** Source Mixing Device One **86**; Source Mixing Device Two **88**; Thermal Storage One **46**; Thermal Storage Two **80**; Source 3-Way Control Valves One **56**; Source 3-Way Control Valves Two **58**; Bypass 3-Way Control Valves **74**; Thermal Storage Source 3-Way Control Valves **78** Thermal Load 3-Way Control Valves **84**; Hydronic Supply Fluid **38**; Hydronic Return Fluid **40**;" *Id.* at 15:57—16:7.

(d) calculating and tracking by the microprocessor controller a first dew point in a fresh intake air moving into a dehumidifying device; and a second dew point in a thermally conductive structure in the conditioned space;	"The dew point is the temperature below which the water vapor in a volume of humid air at a given constant barometric pressure will condense into liquid water at the same rate at which it evaporates." *Id.* at 4:12-16. "The Hydronic Building Systems Control is a temperature and humidity control apparatus for air and temperature variable fluid in an air space, comprising a thermally-conductive structure, such as a building floor, wall, or ceiling; hydronic coil-to-air heat exchanger; a source of liquid coolant at a temperature below or above the temperature of the air space; controllable means for applying a temperature variable liquid at a temperature higher than the dew point of the air space to the thermally-conductive structure and for applying a temperature variable liquid coolant at a temperature lower than the dew point to the hydronic coil-to-air heat exchanger; means for sensing at least the air temperature in the air space, a relative humidity of the air space, a temperature of the thermally-conductive structure, and liquid source temperatures; a controller coupled to the sensing means and to the controllable means." *Id.* at 9:13-29.
(e) sending a plurality of digital signals from the microprocessor controller to a devices controller; and	"Devices Controller 22 accepts Microprocessor Controller 12 output to affect control of digital or analog devices including mixing (Radiant Mixing Device 14, Source Mixing Device One 86, and Source Mixing Device Two 88); 3-way valves (Source 3-Way Control Valves One 56, Source 3-Way Control Valves Two 58, Bypass 3-Way Control Valves 74, Thermal Storage Source 3-Way Control Valves 78, and Thermal Load 3-Way Control Valves 84); Heat Pump 72; Hydronic Coil-to-Air Heat Exchanger 42, Fresh Air Fan 30, and components which lack digital onboard input capabilities. Devices

	Controller 22 provides binary (on/off) control signals, or variable control signals (such as a 01-10 volt signal)." *Id.* at 16:47-59.
(f) sending a plurality of control signals from the devices controller to a plurality of devices, the plurality of devices selected from the group consisting of analog devices and digital devices, wherein the plurality of devices upon receiving the plurality of control signals achieve the desired set point temperature and the desired set point humidity in the conditioned space by:	"When Heat Pump **72** cools Thermal Storage One **46** below the temperature required for air coil condensation, HBSC activates Hydronic-to-Air Circulator **54** to circulate Hydronic Coil Supply Fluid **50**. If the energy transfer and ventilation is not already operating, HBSC turns on Hydronic-to-Air Circulator **54** to the lowest fan setting which provides sufficient ventilation and maximum dehumidification across the fan coil. As Fresh Intake Air **28** passes through Hydronic Coil-to-Air Heat Exchanger **42**, the resultant Conditioned Air **24** will be cooled and have less humidity than Fresh Air Supply **36**. With continuous operation, this process will lower the relative humidity and calculated dew point in Conditioned Space **10**. The lower dew point in Thermally-Conductive Structure **16** will enable a lower Mixed Radiant Supply Fluid **8** temperature making Thermally-Conductive Structure **16** more effective as a cooling heat exchanger." *Id.* at 18:28-43.
(i) circulating a fluid within at least one of the thermally conductive structure and the dehumidifying device, wherein the dehumidifying device is in fluid connection with the thermally conductive structure;	"In cooling mode, the Mixed Radiant Supply Fluid **8** is circulated at a temperature above dew point to prevent condensation in Thermally-Conductive Structure **16**. Chilled fluid below dew point contained in Thermal Storage One **46**, and used to dehumidify air in Hydronic Coil-to-Air Heat Exchanger **42**, is mixed to a temperature above dew point to circulate in Thermally-Conductive Structure **16**." *Id.* at 13:5-11. "A radiant floor cooling system has the ability to directly extract infrared heat gains from the thermally conductive structure to prevent overheating in this scenario. Heat extracted for cooling is utilized in the integrated system

	to provide immediate heating or stored for future use." *Id.* at 23:33-37.
(ii) moving the fresh intake air through the dehumidifying device and into the conditioned space;	"Energy Transfer and Ventilation Device **32** uses two or more fans, such as Fresh Air Fan **30** and Exhaust Air Fan **34**, to bring Fresh Air Supply **36** into Conditioned Space **10** while removing Stale Exhaust Air **18**. Typical implementations utilize ventilation comprising Air Duct Intake **26** and Air Duct Exhaust **20**. In this process, Energy Transfer and Ventilation Device **32** exchanges energy between the air flows (Fresh Air Supply **36** and Stale Exhaust Air **18**), which includes water vapor in the air, causing a change in humidity." *Id.* at 12:33-41.
(iii) keeping a first temperature of the fluid less than the first dew point at the dehumidifying device; and	"In these applications, the control must provide chilled water below dew point to the W-A coil for dehumidification, while mixing RFC water to an offset temperature above dew point for use in the high mass thermally-conductive structure." *Id.* at 23:20-22.
(iv) keeping a second temperature of the fluid greater than the second dew point at the thermally conductive structure.	"In these applications, the control must provide chilled water below dew point to the W-A coil for dehumidification, while mixing RFC water to an offset temperature above dew point for use in the high mass thermally-conductive structure." *Id.* at 23:20-22.

43. The innovations are embodied in the dependent claims as well. Claim 2 of the '752 Patent specifies an additional "energy transfer and ventilation device" that further enhances the claimed integrated control system. Claims 3 and 4 specify an improved user interface to enhance the utility and reliability of the claimed control system. Claims 5 and 6 require "thermal storage" components that provide further enhancements of the integrated control system. Claim 10 recites additional calculating and tracking functions for the microprocessor. Claim 12 recites more detail

concerning achieving the desired set point humidity. And Claim 13 specifies a set of dehumidifying devices to choose from, establishing more particularity to the claimed invention.

44. The following table sets forth exemplary, non-limiting illustrations of how the innovations described in the specification are embodied in specific claim limitations of the '863 Patent.

'863 Patent, Claim 1	**'863 Patent Specification**
1. A method for controlling heating and cooling in a conditioned space, the method comprising the steps of:	[0013] The Hydronic Building Systems Control (HBSC) described in this disclosure is a low-cost standards-compliant software-based control that integrates traditional and renewable hydronic system components for building heating, cooling, and hot water. "HBSC is based on a model consisting of a combination of analog devices using a circulating fluid to heat or cool a Conditioned Space **10**, such as a room in a home or an office in a building, or multiple conditioned spaces, in a Thermally-Conductive Structure **16**, such as radiant floors, walls, and ceilings, or chilled beams." '863 Patent at 12:28-34.
(a) receiving in a microprocessor controller a desired set point temperature;	"Microprocessor Controller **12** hosts the software algorithms containing system functionality. This compact embedded microprocessor system accepts digital input from User Interface **2** and digital/analog input from Sensor Inputs **6**, and generates digital output to User Interface **2**, Communications Module **4**, digital and analog components within the Devices Controller **22**." *Id.* at 15:36-42. "The primary function is to control cooling in a thermally-conductive structure, such as RFC or chilled beams… Zone sensors provide temperature, atmospheric pressure …, and relative humidity data to determine a system dew point, and to set a supply water temperature

’863 Patent, Claim 1	**’863 Patent Specification**
	which prevents condensation within the structure.” *Id.* at 23:38-46. “The controller selects an active or passive source based on set point heat and cooling source temperatures to meet building loads.” *Id.* at 24:28-30.
(b) receiving in the microprocessor controller a plurality of sensor inputs from a plurality of sensors, wherein the plurality of sensors sense at least one temperature and at least one relative humidity;	“Microprocessor Controller **12** hosts the software algorithms containing system functionality. This compact embedded microprocessor system accepts digital input from User Interface **2** and digital/analog input from Sensor Inputs **6**, and generates digital output to User Interface **2**, Communications Module **4**, digital and analog components within the Devices Controller **22**.” *Id.* at 15:36-42. “In one embodiment, Microprocessor Controller **12** processes sensor data, applies algorithms to extract control outputs, and communicates those outputs via standard architectures, such as a BACnet link in one embodiment.” *Id.* at 15:50-54. “Sensor Inputs **6** provide analog and digital input for system control. Control devices contain at least one member of the group consisting of sensor inputs for temperature, pressure, relative humidity, air and fluid velocity, and real time energy use.” *Id.* at 16:3-7.
(c) processing by the microprocessor controller the plurality of sensor inputs from the plurality of sensors in light of the desired set point temperature;	“Microprocessor Controller **12** hosts the software algorithms containing system functionality. This compact embedded microprocessor system accepts digital input from User Interface **2** and digital/analog input from Sensor Inputs **6**, and generates digital output to User Interface **2**, Communications Module **4**, digital and analog components within the Devices Controller **22**.” *Id.* at 15:36-42.

’863 Patent, Claim 1	’863 Patent Specification
	“In one embodiment of the device controlling HBSC system as shown in **FIG. 1**, temperature sensors are located in: Conditioned Space **10**; Thermally-Conductive Structure **16**; the outside air; the input and output of Radiant Mixing Device **14**; Source Mixing Device One **86**; Source Mixing Device Two **88**; Thermal Storage One **46**; Thermal Storage Two **80**; Source 3-Way Control Valves One **56**; Source 3-Way Control Valves Two **58**; Bypass 3-Way Control Valves **74**; Thermal Storage Source 3-Way Control Valves **78**; Thermal Load 3-Way Control Valves **84**; Hydronic Supply Fluid **38**; Hydronic Return Fluid **40**;” *Id.* at 16:13-30.
(d) calculating and tracking by the microprocessor controller a dew point in at least one of: (i) a fresh intake air moving into a dehumidifying device; (ii) a thermally conductive structure in the conditioned space; or (iii) the conditioned space;	“The dew point is the temperature below which the water vapor in a volume of humid air at a given constant barometric pressure will condense into liquid water at the same rate at which it evaporates.” *Id.* at 4:23-26. “The Hydronic Building Systems Control is a temperature and humidity control apparatus for air and temperature variable fluid in an air space, comprising a thermally-conductive structure, such as a building floor, wall, or ceiling; hydronic coil-to-air heat exchanger; a source of liquid coolant at a temperature below or above the temperature of the air space; controllable means for applying a temperature variable liquid at a temperature higher than the dew point of the air space to the thermally-conductive structure and for applying a temperature variable liquid coolant at a temperature lower than the dew point to the hydronic coil-to-air heat exchanger; means for sensing at least the air temperature in the air

’863 Patent, Claim 1	’863 Patent Specification
	space, a relative humidity of the air space, a temperature of the thermally-conductive structure, and liquid source temperatures; a controller coupled to the sensing means and to the controllable means.” *Id.* at 9:26-41.
(e) sending a plurality of digital signals from the microprocessor controller to a device controller; and	“Devices Controller 22 accepts Microprocessor Controller 12 output to affect control of digital or analog devices including mixing (Radiant Mixing Device 14, Source Mixing Device One 86, and Source Mixing Device Two 88); 3-way valves (Source 3-Way Control Valves One 56, Source 3-Way Control Valves Two 58, Bypass 3-Way Control Valves 74, Thermal Storage Source 3-Way Control Valves 78, and Thermal Load 3-Way Control Valves 84); Heat Pump 72; Hydronic Coil-to-Air Heat Exchanger 42, Fresh Air Fan 30, and components which lack digital onboard input capabilities. Devices Controller 22 provides binary (on/off) control signals, or variable control signals (such as a 01-10 volt signal).” *Id.* at 17:3-16.
(f) sending a plurality of control signals from the device controller to a plurality of devices, wherein the plurality of devices upon receiving the plurality of control signals achieve the desired set point temperature in the conditioned space by:	“When Heat Pump **72** cools Thermal Storage One **46** below the temperature required for air coil condensation, HBSC activates Hydronic-to-Air Circulator **54** to circulate Hydronic Coil Supply Fluid **50**. If the energy transfer and ventilation is not already operating, HBSC turns on Hydronic-to-Air Circulator **54** to the lowest fan setting which provides sufficient ventilation and maximum dehumidification across the fan coil. As Fresh Intake Air **28** passes through Hydronic Coil-to-Air Heat Exchanger **42**, the resultant Conditioned Air **24** will be cooled and have less humidity than Fresh Air Supply **36**. With continuous operation, this process will lower the relative humidity and calculated dew point in Conditioned Space **10**. The lower dew point in Thermally-Conductive Structure **16** will enable a lower Mixed Radiant Supply Fluid **8** temperature making Thermally-Conductive

’863 Patent, Claim 1	’863 Patent Specification
	Structure **16** more effective as a cooling heat exchanger.” *Id.* at 18:54—19:3.
(i) circulating a fluid within the thermally conductive structure;	“In cooling mode, the Mixed Radiant Supply Fluid **8** is circulated at a temperature above dew point to prevent condensation in Thermally-Conductive Structure **16**. Chilled fluid below dew point contained in Thermal Storage One **46**, and used to dehumidify air in Hydronic Coil-to-Air Heat Exchanger **42**, is mixed to a temperature above dew point to circulate in Thermally-Conductive Structure **16**.” *Id.* at 21-28. “A radiant floor cooling system has the ability to directly extract infrared heat gains from the thermally conductive structure to prevent overheating in this scenario. Heat extracted for cooling is utilized in the integrated system to provide immediate heating or stored for future use.” *Id.* at 23:67—24:5.
(ii) keeping the temperature of the fluid greater than the dew point at the thermally conductive structure.	

45. The innovations are embodied in the dependent claims as well. Claims 2 and 19 of the ’863 Patent specify a dehumidification device or dehumidifying device of a particular type. Claim 3 specifies additional steps in the air circulation process. Claims 4 and 6-8 specify an additional advantage discussed in the specification, namely, the ability to control a building remotely. And Claims 17 and 18 recite additional calculating and tracking functions for the microprocessor.

46. The following table sets forth exemplary, non-limiting illustrations of how the innovations described in the specification are embodied in specific claim limitations of the ’336 Patent.

'336 Patent, Claim 52	**'336 Patent Specification**
52. A method for controlling occupant comfort in a conditioned space, the method comprising the steps of:	"The Hydronic Building Systems Control (HBSC) described in this disclosure is a low-cost standards-compliant software-based control that integrates traditional and renewable hydronic system components for building heating, cooling, and hot water." '336 Patent at 3:6-9. "HBSC is based on a model consisting of a combination of analog devices using a circulating fluid to heat or cool a Conditioned Space **10**, such as a room in a home or an office in a building, or multiple conditioned spaces, in a Thermally-Conductive Structure **16**, such as radiant floors, walls, and ceilings, or chilled beams." *Id.* at 12:7-13.
(a) receiving in a microprocessor controller at least one of a desired set point temperature, a desired set point relative humidity, or a desired set point dew point;	"Microprocessor Controller **12** hosts the software algorithms containing system functionality. This compact embedded microprocessor system accepts digital input from User Interface **2** and digital/analog input from Sensor Inputs **6**, and generates digital output to User Interface **2**, Communications Module **4**, digital and analog components within the Devices Controller **22**." *Id.* at 15:14-20. "The primary function is to control cooling in a thermally-conductive structure, such as RFC or chilled beams… Zone sensors provide temperature, atmospheric pressure …, and relative humidity data to determine a system dew point, and to set a supply water temperature which prevents condensation within the structure." *Id.* at 23:17-25. "The controller selects an active or passive source based on set point heat and cooling source temperatures to meet building loads." *Id.* at 24:6-8.
(b) receiving in the microprocessor controller a plurality of sensor inputs from a plurality of	"Microprocessor Controller **12** hosts the software algorithms containing system

'336 Patent, Claim 52	**'336 Patent Specification**
sensors, wherein the plurality of sensors sense at least one temperature;	functionality. This compact embedded microprocessor system accepts digital input from User Interface **2** and digital/analog input from Sensor Inputs **6**, and generates digital output to User Interface **2**, Communications Module **4**, digital and analog components within the Devices Controller **22**." *Id.* at 15:14-20. "In one embodiment, Microprocessor Controller **12** processes sensor data, applies algorithms to extract control outputs, and communicates those outputs via standard architectures, such as a BACnet link in one embodiment." *Id.* at 15:28-32. "Sensor Inputs **6** provide analog and digital input for system control. Control devices contain at least one member of the group consisting of sensor inputs for temperature, pressure, relative humidity, air and fluid velocity, and real time energy use." *Id.* at 15:48-52.
(c) processing by the microprocessor controller the plurality of sensor inputs from the plurality of sensors in light of the desired set point temperature, desired set point relative humidity, or desired set point dew point;	"Microprocessor Controller **12** hosts the software algorithms containing system functionality. This compact embedded microprocessor system accepts digital input from User Interface **2** and digital/analog input from Sensor Inputs **6**, and generates digital output to User Interface **2**, Communications Module **4**, digital and analog components within the Devices Controller **22**." *Id.* at 15:14-20. "In one embodiment of the device controlling HBSC system as shown in **FIG. 1**, temperature sensors are located in: Conditioned Space **10**; Thermally-Conductive Structure **16**; the outside air; the input and output of Radiant Mixing Device **14**; Source Mixing Device One **86**; Source Mixing Device Two **88**;

’336 Patent, Claim 52	’336 Patent Specification
	Thermal Storage One **46**; Thermal Storage Two **80**; Source 3-Way Control Valves One **56**; Source 3-Way Control Valves Two **58**; Bypass 3-Way Control Valves **74**; Thermal Storage Source 3-Way Control Valves **78**; Thermal Load 3-Way Control Valves **84**; Hydronic Supply Fluid **38**; Hydronic Return Fluid **40**;” *Id.* at 15:57—16:7.
(d) calculating and tracking by the microprocessor controller a dew point in at least one of: (i) a fresh intake air moving into a dehumidifying device; (ii) a thermally conductive structure in the conditioned space; or (iii) the conditioned space;	“The dew point is the temperature below which the water vapor in a volume of humid air at a given constant barometric pressure will condense into liquid water at the same rate at which it evaporates.” *Id.* at 4:23-26. “The Hydronic Building Systems Control is a temperature and humidity control apparatus for air and temperature variable fluid in an air space, comprising a thermally-conductive structure, such as a building floor, wall, or ceiling; hydronic coil-to-air heat exchanger; a source of liquid coolant at a temperature below or above the temperature of the air space; controllable means for applying a temperature variable liquid at a temperature higher than the dew point of the air space to the thermally-conductive structure and for applying a temperature variable liquid coolant at a temperature lower than the dew point to the hydronic coil-to-air heat exchanger; means for sensing at least the air temperature in the air space, a relative humidity of the air space, a temperature of the thermally-conductive structure, and liquid source temperatures; a controller coupled to the sensing means and to the controllable means.” *Id.* at 9:9-24.
(e) sending a plurality of digital signals from the microprocessor controller to a device controller; and	“Devices Controller 22 accepts Microprocessor Controller 12 output to affect control of digital or analog devices including mixing (Radiant Mixing Device 14, Source Mixing Device One

'336 Patent, Claim 52	**'336 Patent Specification**
	86, and Source Mixing Device Two 88); 3-way valves (Source 3-Way Control Valves One 56, Source 3-Way Control Valves Two 58, Bypass 3-Way Control Valves 74, Thermal Storage Source 3-Way Control Valves 78, and Thermal Load 3-Way Control Valves 84); Heat Pump 72; Hydronic Coil-to-Air Heat Exchanger 42, Fresh Air Fan 30, and components which lack digital onboard input capabilities. Devices Controller 22 provides binary (on/off) control signals, or variable control signals (such as a 01-10 volt signal)." *Id.* at 16:48-60.
(f) sending a plurality of control signals from the device controller to a plurality of devices, wherein the plurality of devices upon receiving the plurality of control signals achieve the desired set point temperature, set point relative humidity, or set point dew point; in the conditioned space by:	"When Heat Pump **72** cools Thermal Storage One **46** below the temperature required for air coil condensation, HBSC activates Hydronic-to-Air Circulator **54** to circulate Hydronic Coil Supply Fluid **50**. If the energy transfer and ventilation is not already operating, HBSC turns on Hydronic-to-Air Circulator **54** to the lowest fan setting which provides sufficient ventilation and maximum dehumidification across the fan coil. As Fresh Intake Air **28** passes through Hydronic Coil-to-Air Heat Exchanger **42**, the resultant Conditioned Air **24** will be cooled and have less humidity than Fresh Air Supply **36**. With continuous operation, this process will lower the relative humidity and calculated dew point in Conditioned Space **10**. The lower dew point in Thermally-Conductive Structure **16** will enable a lower Mixed Radiant Supply Fluid **8** temperature making Thermally-Conductive Structure **16** more effective as a cooling heat exchanger." *Id.* at 18:32-49.
(i) circulating a fluid within the thermally conductive structure;	"In cooling mode, the Mixed Radiant Supply Fluid **8** is circulated at a temperature above dew point to prevent condensation in Thermally-Conductive Structure **16**. Chilled fluid below dew point contained in Thermal Storage One **46**, and used to dehumidify air in Hydronic Coil-to-Air Heat Exchanger **42**, is mixed to a temperature above dew point to circulate in
(ii) keeping the temperature of the fluid greater than the dew point at the thermally conductive structure, wherein the microprocessor controller is programmed to provide staged heating, cooling and ventilation.	

’336 Patent, Claim 52	’336 Patent Specification
	Thermally-Conductive Structure **16**.” *Id.* at 12:67—13:7. “A radiant floor cooling system has the ability to directly extract infrared heat gains from the thermally conductive structure to prevent overheating in this scenario. Heat extracted for cooling is utilized in the integrated system to provide immediate heating or stored for future use.” *Id.* at 23:46-51. “HBSC is programmed with staged priority cooling and ventilation set to multiple stages, *e.g.*, Stage 1 – Energy Transfer and Ventilation Device **32**; Stage 2 – radiant floor cooling through Thermally-Conductive Structure **16**; and Stage 3 – forced air cooling through Hydronic Coil-to-Air Heat Exchanger **42**.” *Id.* at 17:17-22. “Using historic data, climate data, or real time weather data, the staging and set points of these options can be adjusted to predict set points for optimal comfort, or stage processes for optimal system energy efficiency.” *Id.* at 18:50-53.

47. The innovations are embodied in the dependent claims as well. Claim 53 of the ’336 Patent specifies a particular class of microprocessor controller, *i.e.* a software algorithm. Claim 54 specifies an additional advantage discussed in the specification, namely, the ability to control a building remotely. Claims 55 and 56 specify yet another advantageous method of control, *i.e.* a client/server architecture. Claims 60 and 61 specify an improved user interface to enhance the utility and reliability of the claimed control system. Claim 65 specifies a dehumidification device of a particular type. And Claims 73-77 specify the use of variables in determining control parameters, which is discussed as an advantage in the specification.

48. Finally, Claim 1 of the ’848 Patent is directed to an apparatus consisting of several non-abstract components arranged in a manner that embodies the inventive concepts of the ’848 Patent. *See* ¶ 13, *supra*.

49. The claims discussed above are merely exemplary, and numerous other independent and dependent claims of the Patents-in-Suit embody the inventive concepts of the Patents-in-Suit.

IV. GENERAL ALLEGATIONS

A. EEC

50. EEC was formed by Albert R. Wallace in 2006 and is a leading designer and installer of high-performance heating, cooling and ventilating systems for commercial and residential spaces. EEC's systems intelligently control hydronic radiant heating and cooling with dehumidification to achieve high efficiency and cost savings.

51. Mr. Wallace is a member of the American Society of Heating and Refrigeration and Air Conditioning Engineers (ASHRAE); a Certified Geo-Exchange Designer (CGD) and Certified Energy Manager (CEM) by the Association of Energy Engineers; a Certified Trainer and Installer by the International Ground Source Heat Pump Association; and certified and permitted by the Colorado Division of Water Resources for geo-exchange systems. Mr. Wallace has earned the LEED for Homes Accredited Professional designation from the U.S. Green Building Council. He is a former Associate Member of the American Institute of Architects, served as past President of the Colorado Heat Pump Association, and as a HERS rater and Director of E*Star Colorado. Mr. Wallace holds Advanced Building Science Master's Certification and is a certified contractor for Tridium's NiagaraAX enterprise control software. He served on the technical committee

creating the 2015 Uniform Solar, Hydronics and Geothermal Code from the International Association of Plumbing and Mechanical Officials.

52. Mr. Wallace holds a Bachelor of Science degree in Aeronautical Engineering from the U.S. Air Force Academy in Colorado Springs, a Master's degree in Business Administration from Golden Gate University in California, and dual Master's degrees in Architecture and Landscape Architecture with Certificates in Design/Build and Historic Preservation from the University of Colorado at Denver.

53. As part of its business, EEC provides professional engineering consulting in the area of radiant heating and cooling, geothermal heat pumps, building science, ventilation systems and controls.

B. EEC's Prior Relationship with M.A. Mortenson Company and Heating & Plumbing Engineers, Inc.

54. In 2013, EEC was engaged by and provided consulting engineering services to RMH Group, a mechanical and electrical consultant hired to design a radiant heating and cooling system to be installed as part of new barracks being constructed at Fort Carson in Colorado Springs, Colorado for the 13th Combat Aviation Brigade. The general contractor for the Fort Carson construction project was M.A. Mortenson Company ("Mortenson"). The lead mechanical contracting company for the Fort Carson barracks construction project was Heating & Plumbing Engineers, Inc. ("HPE"). Upon information and belief, RMH Group engaged EEC as a consultant because Mortenson, the general contractor, expressed concerns regarding the adequacy of RMH Group's radiant heating and cooling system design for the barracks.

55. In an August 27, 2013 meeting, Mr. Wallace, on behalf of EEC, reported to Mortenson, RMH Group and HPE that the RMH Group design would not meet the specifications

of the U.S. Army for the Fort Carson 13th Combat Aviation Brigade barracks and identified needed enhancements for the radiant heating and cooling system design to meet the Army's specifications. At the August 27 meeting, Mr. Wallace disclosed his original pending patent application (Application Serial No. 13/969,316, now the '752 Patent) to Mortenson, HPE and RMH Group, and provided a diagram directly from his pending patent application of a viable radiant heating and cooling system that would satisfy the Army's specifications.

56. On September 11, 2013, Mr. Wallace met with RMH Group engineers to discuss his concerns specific to the faulty design of the radiant heating and cooling system for the barracks.

57. On September 13, 2013, Mr. Wallace met with Mr. William Green, a Principal and President of RMH Group, and Mr. Hung Dang, Senior VP of Engineering at RMH Group, in a final attempt to remedy the faults in the RMH design for the barracks. At that meeting, Mr. Dang explained to Mr. Wallace that the design was 90 percent complete and had already been approved by the U.S. Army Corps of Engineers. He explained to Mr. Wallace that RMH Group was a long standing business with qualified engineers and advised Mr. Wallace to focus on issues unrelated to the identified potential system failures. After this meeting and following delivery of EEC's report commenting on the RMH Group design, RMH Group chose not to follow Mr. Wallace's advice and terminated EEC's consulting involvement. The hydronic heating and cooling system was built according to RMH Group's design and subsequently failed. Litigation ensued between HPE and RMH Group over the failure of RMH Group's design. In connection with the litigation, HPE hired Mr. Wallace as an expert in the area of radiant heating and cooling system design and operation. Upon information and belief, the lawsuit settled favorably to HPE and the radiant

heating and cooling system in the Fort Carson barracks was retrofitted to incorporate the changes suggested by Mr. Wallace and as described in his then-pending patent application.

C. The Denver Water Administration Building

58. In 2016, construction started on redevelopment of the operational complex for Denver Water, a municipal entity empowered by the City and County of Denver, Colorado to operate and maintain a water works system on behalf of the City and County of Denver. The operational complex included construction of a new Administration building at 1600 West 12th Avenue, Denver, Colorado ("the Administration Building"). Construction of the Administration Building is complete. Mortenson was the general contractor for construction of the Administration Building. HPE was the mechanical installation contractor responsible for construction of the Denver Water Administration Building mechanical systems.

59. The Administration Building incorporates a hydronic radiant system together with a ventilation system (collectively, "the Accused System") that is used for heating, cooling and conditioning the air within the building. Upon information and belief, HPE designed and installed the Accused System. Publicly available engineering drawings, labeled Denver Water Operations Complex Redevelopment, 01 Administration, Construction Documents, Volume 2, Food Service/Fire/MEP/Lighting/Technology/Acoustics, and dated March 24, 2017, disclose relevant details of the Accused System. A copy of these construction drawings is attached hereto as Exhibit 5 and incorporated by reference in its entirety.

60. At least as early as December 7, 2017, EEC provided written notice to Denver Water of the '752 Patent and EEC's then pending patent application Serial No. 15/202,370 (which issued as the '863 Patent). A copy of the notice is attached as Exhibit 6 and is incorporated herein

by reference in its entirety. The notice was sent by certified mail and, upon information and belief, was received by Denver Water. Shortly thereafter, EEC was contacted by William Eustace, President of HPE, who acknowledged having received a copy of the December 7, 2017 notice from Denver Water. Upon information and belief, Mr. Eustace was acting on behalf and at the request of Denver Water. Mr. Eustace expressed to EEC his displeasure with the notice and, upon information and belief, also caused Uponor Corporation, a piping supplier who worked with EEC, to threaten legal action against EEC due to the notice.

61. By letter dated November 6, 2019 to James Lochhead, Chief Executive Officer of Denver Water, counsel for EEC notified Denver Water that the heating, ventilating and cooling system installed and operating in the Denver Water Administration Building infringed EEC's '752 Patent, '863 Patent and '336 Patent. At this point in time, the '848 Patent had not issued. A copy of this letter is attached as Exhibit 7 and is incorporated herein by reference in its entirety.

62. Counsel for Denver Water acknowledged receipt of the November 6, 2019 letter by email on November 20, 2019 and stated that the letter had been forwarded to its general contractor, Mortenson, and architect, Stantec Inc. A copy of this email is attached as Exhibit 8 and is incorporated herein by reference in its entirety.

63. Subsequently, in late February or early March, 2020, counsel for Mortenson contacted counsel for EEC by telephone and advised that Mortenson had tendered defense of EEC's patent infringement claims to HPE and that Mortenson and its subcontractor would be following up with a response to the infringement claims. A copy of an email confirming the telephone conversation is attached as Exhibit 9 and is incorporated herein by reference in its entirety.

64. To date, no response has been provided to EEC from Denver Water, Mortenson, HPE or any other Mortenson subcontractor.

D. Patent Infringement by Denver Water

65. Operation of the Accused System directly infringes one or more of the '752 Patent claims without authority of EEC. More specifically and without limitation, Denver Water has been and is directly infringing, either literally or under the doctrine of equivalents, at least Claims 1-6, 10, 12 and 13 of the '752 Patent by operation of the Accused System. A claim chart further detailing infringement of these claims of the '752 Patent is attached as Exhibit 10 and incorporated herein by reference in its entirety.

66. Denver Water directly infringes one or more of the '863 Patent claims without authority of EEC. More specifically and without limitation, Denver Water has been and is directly infringing, either literally or under the doctrine of equivalents, at least Claims 1-4, 6-8, 17-19 and 36-39 of the '863 Patent by operation of the Accused System. A claim chart further detailing infringement of these claims of the '863 Patent is attached as Exhibit 11 and incorporated herein by reference in its entirety.

67. Denver Water directly infringes one or more of the '336 Patent claims without authority of EEC. More specifically and without limitation, Denver Water has been and is directly infringing, either literally or under the doctrine of equivalents, at least Claims 52-56, 60, 61, 65 and 73-77 of the '336 Patent by operation of the Accused System. A claim chart further detailing infringement of these claims of the '336 Patent is attached as Exhibit 12 and incorporated herein by reference in its entirety.

68. Denver Water directly infringes one or more of the '848 Patent claims without authority of EEC. More specifically and without limitation, Denver Water has been and is directly infringing, either literally or under the doctrine of equivalents, at least Claims 1-80 of the '848 Patent by operation of the Accused System. A claim chart further detailing infringement of these claims of the '848 Patent is attached as Exhibit 13 and incorporated herein by reference in its entirety.

V. FIRST CLAIM FOR RELIEF
(Patent Infringement Under 35 U.S.C. § 271(a) – U.S. Patent No. 9,410,752)

69. The allegations set forth in paragraphs 1 through 68 are hereby realleged and incorporated herein by reference.

70. With knowledge of the '752 Patent, Denver Water, directly and literally, or in the alternative under the doctrine of equivalents, infringes one or more claims of the '752 Patent, in violation of 35 U.S.C. § 271(a), in this district by operating the Accused System.

71. The infringement of the '752 Patent by Denver Water has been willful since the Accused System was first operated and continues to be willful.

72. Because of Denver Water's infringement of the '752 Patent, EEC has suffered and will continue to suffer damages.

73. Because of Denver Water's infringement of the '752 Patent, EEC has suffered and will continue to suffer irreparable harm in this District.

VI. SECOND CLAIM FOR RELIEF
(Patent Infringement Under 35 U.S.C. § 271(a) – U.S. Patent No. 10,072,863)

74. The allegations set forth in paragraphs 1 through 68 are hereby realleged and incorporated herein by reference.

75. With knowledge of the '863 Patent, Denver Water, directly and literally, or in the alternative under the doctrine of equivalents, infringes one or more claims of the '863 Patent, in violation of 35 U.S.C. § 271(a), in this district by operating the Accused System.

76. The infringement of the '863 Patent by Denver Water has been willful at least since Denver Water received the November 6, 2019 letter (Exhibit 7) and continues to be willful.

77. Because of Denver Water's infringement of the '863 Patent, EEC has suffered and will continue to suffer damages.

78. Because of Denver Water's infringement of the '863 Patent, EEC has suffered and will continue to suffer irreparable harm in this District.

VII. THIRD CLAIM FOR RELIEF
(Patent Infringement Under 35 U.S.C. § 271(a) – U.S. Patent No. 10,330,336)

79. The allegations set forth in paragraphs 1 through 68 are hereby realleged and incorporated herein by reference.

80. With knowledge of the '336 Patent, Denver Water, directly and literally, or in the alternative under the doctrine of equivalents, infringes one or more claims of the '336 Patent, in violation of 35 U.S.C. § 271(a), in this district by operating the Accused System.

81. The infringement of the '336 Patent by Denver Water has been willful at least since Denver Water received the November 6, 2019 letter (Exhibit 7) and continues to be willful.

82. Because of Denver Water's infringement of the '336 Patent, EEC has suffered and will continue to suffer damages.

83. Because of Denver Water's infringement of the '336 Patent, EEC has suffered and will continue to suffer irreparable harm in this District.

VIII. FOURTH CLAIM FOR RELIEF
(Patent infringement Under 35 U.S.C. § 271(a) – U.S. Patent No. 10,907,848)

84. The allegations set forth in paragraphs 1 through 68 are hereby realleged and incorporated herein by reference.

85. Denver Water, directly and literally, or in the alternative under the doctrine of equivalents, infringes one or more claims of the '848 Patent, in violation of 35 U.S.C. § 271(a), in this district by operating the Accused System.

86. Because of Denver Water's infringement of the '848 Patent, EEC has suffered and will continue to suffer damages.

87. Because of Denver Water's infringement of the '848 Patent, EEC has suffered and will continue to suffer irreparable harm in this District.

88. Denver Water's continued infringement of the '848 Patent by operation of the Accused System is willful.

IX. PRAYER FOR RELIEF

WHEREFORE, EEC prays for judgment in its favor and against Denver Water as follows:

a. That Denver Water has infringed one or more claims of the EEC Patents;

b. That Denver Water, its officers, directors, agents, servants, employees, privies, representatives, attorneys, parent and subsidiary corporations or other related entities, successors, assigns, licensees, retail distributors, and all persons in active concert or participation with any of them, be enjoined from infringing the EEC Patents or, in the alternative, be compelled to enter into a patent license with EEC authorizing the continued operation of the Accused Systems relative to the EEC Patents;

c. That EEC be awarded damages in an amount to be determined at trial for Denver Water's infringing activities, which are no less than a reasonable royalty;

d. That EEC be awarded treble damages by reason of any willful, wanton and deliberate infringement found under 35 U.S.C. § 284;

e. That EEC be awarded its pre-judgment and post-judgment interest;

f. That EEC be awarded its costs and expenses of suit, including expert witness fees;

g. That EEC be awarded its attorneys' fees should this case be found to be exceptional under 35 U.S.C. § 285;

h. That Denver Water be required to account for all gains, profits, advantages, and unjust enrichment derived from its violations of law; and

j. That EEC be awarded other and further relief as the Court deems appropriate and just.

X. JURY DEMAND

EEC demands a trial by jury on all issues so triable.

DATED: November 5, 2021

Respectfully submitted,

By: s/ Todd P. Blakely

Todd P. Blakely
tblakely@sheridanross.com
Paul Sung Cha
pscha@sheridanross.com
Maria V. Spiridonova
mspiridonova@sheridanross.com
SHERIDAN ROSS P.C.
1560 Broadway, Suite 1200
Denver, Colorado 80202-5141
Telephone: 303-863-9700
Facsimile: 303-863-0223
E-mail: litigation@sheridanross.com

ATTORNEYS FOR PLAINTIFF
ENERGY ENVIRONMENTAL
CORPORATION