UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ADB Safegate Sweden AB,
ADB Safegate BV, and
ADB Safegate Americas, LLC

Petitioner,

v.

Honeywell International Inc.,

Patent Owner.

Case PGR2023-00053
U.S. Patent No. 11,538,349

EXHIBIT 1044
DECLARATION OF MARK CAMPBELL, PH.D.

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I. INTRODUCTION

1. My name is Mark Campbell. I am an expert in sensor fusion and planning in autonomous systems such as self-driving cars, robotics, UAVs, and spacecraft. I have been retained as an expert witness to provide my independent opinion regarding certain matters at issue in post grant review of U.S. Patent No. 11,538,349 ("the '349 patent"). I have been retained by ADB Safegate Sweden AB, the Petitioner in these proceedings ("Petitioner" or "Safegate"). Patent Owner is Honeywell International Inc. ("Patent Owner" or "Honeywell").

2. For my work on this case, I am being compensated at my typical consulting rate of $500 per hour. I am also being reimbursed for reasonable expenses that I incur during the course of this work. My compensation does not depend on the substance of my opinions or the outcome of any issues in this case.

3. My analysis of the materials produced in this matter is ongoing and I will continue to review any new material as it is provided. This declaration represents only those opinions I have formed to date. I reserve the right to amend or supplement my opinions based on additional documents or evidence I am presented, including without limitation any arguments or expert declarations advanced by Patent Owner in this case.

4. I am not a legal expert and offer no opinions on the law. However, I have been informed by counsel of the various legal standards that apply, and I have applied those standards in arriving at my conclusions.

II. QUALIFICATIONS

5. I am currently a Professor of Mechanical & Aerospace Engineering at Cornell University in Ithaca, New York. At the same institution since 2001, I have served in several faculty and administrative positions, including as an Assistant Professor and Associate Professor of Mechanical Engineering, Member of the Graduate Fields of Electrical and Computer Engineering and Computer Science, Director (Chair) of the Sibley School of Mechanical & Aerospace Engineering, and as the John A. Mellowes `60 Professor of Mechanical & Aerospace Engineering.

6. I graduated from Carnegie Mellon University, Pittsburgh PA in 1990 with a Bachelor of Science (B.S.) in the field of Mechanical Engineering. I graduated from Massachusetts Institute of Technology in Cambridge MA in 1993 with a Masters of Science (M.S.) degree in Aeronautics and Astronautics and in 1996 with a Doctor of Philosophy (Ph.D.) degree in Control and Estimation.

7. I teach several courses related to the estimation, sensor fusion, and autonomous control of systems including robotics and aircraft. My research interests include most aspects of autonomous systems including sensor fusion,

perception, machine learning, control and planning. The research has included both algorithmic development, as well as experimental prototypes of self-driving cars, autonomous aircraft, and autonomous satellites. I have given and occasionally continue to give seminars and presentations worldwide to academia and to industry including broader keynotes such as to the National Academy of Sciences and National Academy of Engineering.

8. I have received research funding from the National Science Foundation (NSF), the Defense Advanced Research Projects Agency (DARPA), the U.S. Air Force Office of Scientific Research (AFOSR), the Office of Naval Research (ONR), Army Research Office (ARO) and a number of private companies, including major technology companies.

9. I have authored and co-authored more than 200 peer-reviewed articles and advised over 70 PhD student and Postdoctoral Research Associates. A partial list of my publications appears in my *curriculum vitae* attached as Appendix 1.

10. In recognition to the significance of my research contributions, I was elected to Fellow status (highest distinction) in three societies: American Institute of Aeronautics and Astronautics (AIAA), American Society of Mechanical Engineers (ASME), and Institute of Electrical and Electronic Engineering (IEEE).

11. In addition to my academic experience, I spent a sabbatical in 2005 working with a small autonomous airplane company (The Insitu Group, subsequently purchased by Boeing) developing and integrating sensor fusion and tracking algorithms for gimballing cameras in the nose cone, tracking ground objects such as cars. In 2019-20, I spent a sabbatical working at Draper Labs sensor fusion using cameras and lidar to localize and navigate aircraft without the need for GPS.

12. I was also a member of the U.S. Air Force Science Advisory Board from 2016-20, a group composed of academics, industry leaders, and retired U.S. Air Force leaders whose goal is to advise Air Force leadership on science, technology and investments. As a member, I participated and led reviews of research at the Air Force Research Labs. In addition, I also took part in several in-depth science and technology studies in the areas of Test and Evaluation, Sensor Fusion, and Unintended Behaviors of Autonomy; the latter study I led and gave briefings to the leadership of the U.S. Air Force. For my work with the Air Force Science Advisory Board, I received the U.S. Air Force Chief of Staff Award for Exceptional Public Service, the highest-level award granted by the U.S. Air Force to non-employee civilians.

13. I have served as Editor and Associate Editor for major conferences and journal publications including the AIAA Journal of Guidance, Control and

Dynamics, the IEEE Transactions on Aerospace and Electronics, and the International Conference on Robotics and Automation (ICRA) among others. I currently serve on the Board of Directors of the AIAA Journal of Guidance, Control and Dynamics.

14. I am qualified by education and experience to testify as an expert with respect to subject matter in the fields of sensor fusion, estimation, machine learning, and planning and control related to robotics, self-driving cars, aircraft and spacecraft.

15. I have attached a current copy of my curriculum *vitae* as Appendix 1, which includes a list of my publications.

III. LEGAL STANDARDS

16. I am not a lawyer, and I do not intend to offer any opinions as to the interpretation of the law. When considering the ’349 patent and stating my opinions, I rely on the following legal standards as described to me by the attorneys for Petitioner.

A. Priority Date

17. I understand that the analysis of alleged obviousness of the Patent should be performed from the perspective of a person of ordinary skill in the art (POSITA) as of the priority date of the Patent. The ‘349 Patent claims priority to

August 3, 2020. My opinions in this matter are from the perspective of a POSITA as of that date.

B. Level Of Ordinary Skill In The Art.

18. My opinions in this declaration are based on the understandings of a person of ordinary skill in the art, as of the time of the invention. I understand that the person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. By "relevant," I mean relevant to the challenged claims of the '349 patent.

19. I understand that various factors should be considered when determining the person of ordinary skill in the art in connection with a particular patent. I understand that these factors include, without limitation, the type of problems encountered in the art, the prior solutions to those problems found in the prior art references, the rapidity with which innovations are made, the sophistication of the technology, the level of education of active workers in the field, and my own experience working with those of skill in the art at the time of the invention.

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

21. Based upon my knowledge of this field, I conclude that a POSITA at the time of the alleged invention of the ’349 patent, and for that matter, at all subsequent times through the present, would have held at least a degree in electrical engineering, computer engineering, computer science or a similar discipline, with at least two years of relevant industry or research experience, including experience designing, planning, or implementing sensor networks using LIDAR, radar and/or cameras and corresponding data analysis. Additional work or research experience can substitute for less or different education, and vice-versa.

22. Based on my experience, education, and training, I meet the definition of a POSITA as of the priority date of the ’349 Patent. My qualifications at that time far exceeded that of a POSITA. My opinions concerning the ’349 Patent claims and the prior art are from the perspective of a POSITA, as set forth above.

23. As further discussed below, my opinions as stated in this declaration are valid even if the Board adopts a slightly different level of ordinary skill in the art.

C. Claim Construction.

24. I understand that claims in a patent-at-issue in a PGR are generally interpreted according to the district court-type claim construction.

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

D. Patent Eligibility Legal Standard.

26. I understand that a claimed invention maybe patent-eligible if it is a new and useful process, machine, manufacture, or composition of matter, but that this includes exceptions, i.e., laws of nature, natural phenomena, and abstract ideas are not patentable. I understand that the patent eligibility analysis follows a twostep framework. I understand that the first step of that inquiry is to ask whether the claim at issue is directed to a patent-ineligible concept, such as an abstract idea. I understand that this inquiry requires looking at the focus of the claims, which may be informed by analyzing the specification to understand the problem facing the inventor.

27. If a claim is directed to an abstract idea, I understand that the second step in the inquiry requires an examination of the claim elements to determine whether they contain an inventive concept sufficient to transform the claimed abstract idea into a patent-eligible application. I also understand that merely appending conventional steps, specified at a high level of generality, is not enough to supply an inventive concept.

28. I have been informed that the U.S. Patent and Trademark Office ("USPTO") has issued guidance ("Guidance") for applying the two-part test described above. I understand that, at Step 1 of the Guidance, the USPTO looks to whether the claimed subject matter falls within the four statutory categories of patentable subject matter: process, machine, manufacture, or composition of matter. I further understand that Step 2 of the Guidance is divided into multiple parts. I understand that Step 2A, Prong 1 of the Guidance asks whether a claim recites a judicial exception, i.e., whether a law of nature, natural phenomenon, or abstract idea is set forth or described in the claim. I further understand that, at Step 2A, Prong 2 of the Guidance, one determines whether the claim as a whole integrates the recited judicial exception into a practical application of the exception. Finally, I understand that Step 2B of the Guidance asks whether the claim recites additional elements that amount to significantly more than the judicial exception.

E. Anticipation Legal Standard.

29. I understand that, once the claims of a patent have been properly construed, determining anticipation of a patent claim requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

30. I understand that in order for a claim to be anticipated, each and every requirement of the claim must be found, expressly or inherently, in a single prior art reference as recited in the claim.

31. I understand that a prior art reference "inherently" discloses a limitation if that limitation is necessarily present in the prior art reference.

32. I understand that it is impermissible for anticipation to combine multiple, separate embodiments, even if they are described in a single prior art reference.

F. Obviousness Legal Standard.

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

34. I understand that an obviousness analysis involves comparing a claim to the prior art to determine whether the claimed invention would have been obvious to a person of ordinary skill in the art at the time of the invention in view of the prior art and in light of the general knowledge in the art as a whole. I also understand that obviousness is ultimately a legal conclusion based on underlying facts of four general types, all of which must be considered: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) any objective indicia of

non-obviousness, including any praise of the invention. Objective indicia of non-obviousness may include, for example, commercial success of an embodiment, a long-felt need, skepticism, failure by others to find the solution provided by the claimed invention, copying by others of the subject matter of the claim invention, unexpected results of the claimed invention, acceptance of others and industry praise, and licensing of the patents.

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

but that such suggestions or motivations to combine art may come from the knowledge that a person of ordinary skill in the art would have had.

36. I understand that a reference may be relied upon for all that it teaches, including uses beyond its primary purpose, but also including teachings that lead away from the invention. I understand that a reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, although the mere disclosure of alternative designs does not teach away.

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

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

39. I am not offering any legal opinions in this declaration nor am I qualified to do so. I only consider such legal standards in framing my opinions and conclusions. Additionally, from a subject matter perspective, I understand that Petitioner always has the burden of persuasion regarding a challenge of patentability of an invention under a post grant review.

IV. COMBINING CAMERA WITH LIDAR/RADAR DATA IS WELL-UNDERSTOOD, ROUTINE, AND CONVENTIONAL

40. The Mr. Wilson's Declaration (EX2002) relied upon in the Patent Owner Response ("POR") indicates that "A POSITA reading Berkmo would not understand that the 2D camera data is to be combined with the 3D radar/LIDAR data, nor how that would be done." EX2002, ¶100. As an expert research and educator in the field familiar with the understanding of a POSITA, I fundamentally disagree with this statement.

A. My Relevant Experience

41. I led a team in 2007 to develop a self-driving car in the 2007 DARPA Urban Challenge (DUC). The car we developed for the DUC combined radar, lidar, and image data to provide 6D tracking of moving objects. *See* EX1014; EX1019. All teams that finished the 2007 DUC race combined multiple sensors for tracking, and each team published their approaches in a 2008 Special Issue on the DUC.

42. The research (algorithms and using the combined/merged camera+lidar+radar data) from the 2007 DUC seeded many of the approaches that companies started to use in 2008. For example, companies that started using these approaches include Google (which became Waymo) and General Motors with Cruise, among others. All self-driving car companies, starting with Google in 2008, combine multiple sensors including camera+lidar+radar to detect and understand the

environment. For airport operations, Thapkula in 2017 (EX1013) specifically teaches fusing multiple sensors, including radar, lidar, camera, and infrared, to create 3D object detectors. Thus, in my opinion, any POSITA, whether a student or industry researcher, working in the self-driving car area would fully understand how to combine/merge camera+lidar+radar data since at least the 2007 DUC.

B. Cameras provide more than 2D pixel/color data

43. The POR's contention, in reliance on Mr. Wilson's declaration, incorrectly assert that a POSITA would not know how to use 2D pixel data from cameras to create 3D information. I fundamentally disagree with this statement.

44. Educationally, Cornell undergraduate computer vision courses have taught "3D reconstruction," which creates 3D point clouds from 2D images, since at least 2010. Similarly, first year graduate courses in computer vision have been taught "depth estimation," which enables creating point clouds from image data since at least 2010 as well. That "depth estimation" has been updated to include deep learning depth estimation since 2016. The undergraduate computer vision course also teaches how to work data from stereo cameras to create 3D data and how to create object detection and classification algorithms using machine learning algorithms using 2D or 3D data. *See also* EX1045, 33:15-34:1 (Mr. Wilson recognizing that a POSITA would be familiar with using machine learning with camera data to detect and identify objects).

45. Cornell, where I am a professor, started using Kinect sensors (RGB-D data) in undergraduate robotics classes around 2008. RGB-D sensors use two cameras to combine/merge RGB color data with a depth D estimate for each data point. As noted in my original declaration, these sensors have been available for over 20 years. *See also* EX1045, 33:15-34:1 (Mr. Wilson recognizing that 2D camera images can be used to generate 3D information when the camera is a known position and the detected and identified object has a known scale and orientation).

46. The Point Cloud Library ("PCL"), which was started in 2010, is an open-source library of software functions for working with point clouds. The ICP algorithm in the '349 patent is one of the most common tools in this library. As noted in EX1024 cited in my original declaration, a key reason to use the PCL is for camera data: "Very recently… 3D sensors have become available that change the game. For example, the Kinect sensor for the Microsoft XBox 360 game system, based on underlying technology from PrimeSense, can be purchased for under $150, and provides real time point clouds as well as 2D images. As a result, we can expect that most robots in the future will be able to 'see' the world in 3D." EX1024, 2.

C. Combining 2D Camera Data with 3D LIDAR/RADAR

47. A POSITA would have known one or more specific algorithmic approaches for combining/merging 2D camera data with 3D LIDAR/RADAR data. In one such approach, given an aligned camera and a LIDAR/RADAR sensor (e.g.,

embodiment 200 in Berkmo), one can merge the "range from LIDAR/RADAR" with the "RGB color from camera" by simply combining the two to create RGB+D data. This approach is a well-understood, routine, and conventional approach known to a POSITA. *See also* EX1045, 136:21-137-14 (camera image data with depth information can be correlated with a 3D point claim of radar or LIDAR data).

48. In another approach, a depth estimation algorithm for single or stereo cameras, which is taught to and understood by a POSITA, is used to create image + depth RGB-D data. This RGB-D data corresponds to a point cloud that can be aligned and merged using tools from the PCL, such as averaging depths or pixel-to-pixel weighted averages as described in Berkmo (*see*, *e.g.*, EX1004, ¶¶0022-0025).

49. It is also known to a POSITA to detect the aircraft and/or other objects within the raw data by adding machine learning object detectors for each sensor and combining/merging these sensor measurements with a Kalman Filter. This approach is described in Berkmo (¶137) and EX1019 by which the camera provides angular (2D) information, and the LIDAR/RADAR provide 3D-location information. Thus, 2D and 3D information from different sensors is naturally combined in the Kalman Filter framework, which I teach to first year graduate students in my Estimation course. *See also* EX1045, 22:9-23-18 (Mr. Wilson recognizing that Kalman filtering is with the ability of a POSITA and that combining camera with LIDAR and radar had been done well before the priority date of the '349 Patent).

50. Yet another approach is to use a 3D-template model and machine learning algorithm to estimate the projection of a 6D pose of the aircraft into the 2D image. *See*, *e.g.*, EX1005, EX1025-1027. Point clouds are created by sampling the model surface. The point clouds can then be combined/merged using PCL tools such as averaging depths or pixel-to-pixel weighted averages as described in Berkmo.

51. Finally, Cornell's robotics classes taught to undergraduates, which I am very familiar with, regularly teach combining lidar and camera data in order to create occupancy grids of the environment and to track moving objects. Similarly, in my Estimation class for first year graduate students, I teach fusing camera+radar+lidar data for tracking moving objects using tools such as the Kalman Filter.

V. DISPLAYING GUIDANCE AND MERGED DATA

52. In my opinion, Patent Owner takes an overly narrow view of the meaning of "directional guidance" and "speed guidance." The overly narrow view overlooks, at least, Berkmo's teaching of "pilot maneuvering guidance information." According to Berkmo, "pilot maneuvering guidance information … [is] for aiding a pilot of the approaching aircraft towards [a] parking position." EX1004, Abstract, claim 31. To provide "maneuvering guidance" to a particular destination, a POSITA would have understood the need to provide instructions that would get the aircraft from its current position to the destination and such instructions would necessarily include "directional guidance" such as, left, right, continue, or go toward. In fact,

the term "maneuvering" itself is well known to a POSITA as providing directional and speed information. For example, robotics classes teach about "maneuvering" a robot around objects from point A to point B. I also note that, with respect to "directional guidance," these opinions are consistent with my deposition testimony that a POSITA would understand that "directional guidance" provides the pilot with information indicating "which direction to go." EX2003, 29:6-17.

53. I also disagree with Patent Owner that "stop the aircraft" is not "speed guidance." When a moving aircraft is instructed to "stop," that instruction necessarily provides speed guidance because it is instructing the pilot to change the speed of the aircraft. Even the '349 Patent describes an instruction to change speed as "speed guidance." In particular, the '349 Patent explicitly describes "speed guidance" as including to "slow down." EX1001, 10:16-20. Since both "stop the aircraft" and "slow down" instruct the pilot to change speed, a POSITA would have understood both instructions to be "speed guidance."

54. Moreover, a POSITA would have understood the instructions to "continue approaching the stand" (as "directional guidance") and "stop the aircraft" (as "speed guidance") as examples of "maneuvering guidance" but not the only possible types of "maneuvering guidance." While including these examples, a POSITA would have understood "maneuvering guidance" as not limited to just these examples, but rather is also inclusive of other types of instructions that provide

"maneuvering guidance" that enable a pilot to maneuver and guide the aircraft from its current position to the destination. Accordingly, to ensure the aircraft arrives at the destination, such as a parking position, and to do so safely, a POSITA would have known that "maneuvering guidance" includes directional and speed guidance.

55. Regarding Patent Owner's construction of "displaying … with the merged data set," it is my opinion that a POSITA would have understood the "maneuvering guidance" in Berkmo as including the merged data. A POSITA also would have been motivated to display at least some of the merged data according to teachings in Berkmo; indeed, Richman expressly teaches displaying such data (*see* EX1005, 2:7-24, 4:50-58, 5:1-37). At ¶0080 and ¶0136, Berkmo teaches using the combined sensor data to determine both the speed and direction of the aircraft and the speed and direction of nearby objects. Given that Berkmo teaches making this determination to ensure the aircraft and objects do not collide (*see*, *e.g.*, EX1004, ¶¶0134-0136), a POSITA would have understood that "maneuvering guidance" can include and would be motivated to include the aircraft and objects' speed and direction to ensure the safe arrival of the aircraft to the stand. This speed and direction information also provides the pilot with information to enable the pilot to adjust its path to the parking stand that avoids a potential collision.

VI. IN THE HUMAN MIND OR BY MATHEMATICAL ALGORITHMS WITHOUT MORE

56. I completely disagree that the steps recited in the claims could not be done in the human mind or by pen and paper using mathematical algorithms. As any POSITA with knowledge of cameras, LIDAR, and radar would understand, the outputs of these sensors are simply numbers. A POSITA would also understand that these numbers are generated in a predetermined format that defines what each value means. In my opinion, not only would these numbers be understandable to a human, but they must be so. Otherwise, a human would not be able to configure a connected device, such as a display, to take the outputs from these sensors and configure the connected device to perform a function based on their outputs. For example, cameras are well-known as producing data in an RGB format, with each RGB value (or set of values, with one value each for R, G, and B) corresponding to one pixel in a particular location. The RGB values typically range between 0 and 255, i.e., just numbers. In addition, a POSITA would have to understand these numbers in order to design algorithms such as object detectors and depth estimation. While LIDAR and radar may have more variance in the amount of processing performed within each sensor, that processing still produces data values in a format that can be received and understood by a human. In addition, LIDAR and RADAR typically

provide range and angular information for each datapoint, which also would be well understood to a human.

57. The merging of data from these sensors is also well within the ability of a human, as I explained in Section IV.C *supra*, by using mathematical algorithms. In fact, I have been teaching merging of camera, LIDAR, and radar data in the context of navigation and tracking to undergraduate and graduate students since 2008. For example, the RGB camera data can be simply combined with depth D data from LIDAR/RADAR data to create merged RGB-D data. Or, machine learning object detections (2D from cameras and 3D from LIDAR/RADAR) can be fused together using the Kalman Filter estimation framework; these are all mathematical algorithms that can be written on a piece of paper.

58. Determining speed and orientation from the merged data can be easily calculated by hand, on a piece of paper using two consecutive measurements from an obstacle (such as range and bearing measurements from object detections).

59. Displaying messages to provide directional and speed guidance with the merged data is also straightforward and well known to a POSITA, such as combining guidance (e.g., an arrow, or desired distance or speed), along with data such as the range to the stop point, current speed, lateral distance to the lead in line, distance to closest object, etc. Additional data simply provides context to the pilot,

if desired by the designer. A POSITA would have many options for creating such a display for the directional and speed guidance with the merged data.

VII. CONCLUSION

60. For the foregoing reasons, based on my expertise and experience and the record of this case that I have reviewed, it is my opinion that the challenged claims are not shown to be disclosed or obvious.

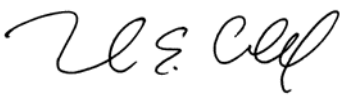
61. I understand that my opinions discussed above support a legal conclusion that the challenged claims are nonobvious.

In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required, I will appear for cross-examination within the United States during the time allotted.

I hereby declare that all statements made herein of my own knowledge are true and all statements made herein on information and belief were and are believed by me to be true, and that all statements herein were and are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code and that any such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Respectfully Submitted,

August 28, 2024



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Mark Campbell, Ph.D.