IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF PENNSYLVANIA

PROMIER PRODUCTS, INC., Plaintiff, v. GEAROZ, *et al.*, Defendants.	Case No. **FILED UNDER SEAL**

DECLARATION OF DORUKALP "ALP" DURMUS, Ph.D.

I, Dorukalp "Alp" Durmus, Ph.D., declare and state as follows:

1. I am over eighteen (18) years of age. I have never been convicted of a felony or any criminal offense involving moral turpitude, and I am competent to testify to the matters stated herein. If called as a witness, I could and would testify to the statements made herein.

2. I am currently an Assistant Professor at Penn State University where I am the Director of the Lighting Lab. A copy of my CV is attached hereto as Exhibit 1. My compensation for my services in this matter is $350 per hour. My compensation is in no way contingent on the outcome of this case.

3. I have been asked to opine based on my experience and expertise as to whether adverting claims for a high lumen flashlight are realistic. I understand that the lights involved in this lawsuit have advertised lumen values ranging from 500 to 5,000,000 lumens.

4. A lumen (lm) is the unit of luminous flux, which is a measure of the time rate of flow of radiant energy, evaluated in terms of a standardized visual response (photopic luminous efficiency function). Luminous flux (lumen) approximately quantifies the visible radiation coming

out of a light source in every direction; therefore, it is often used as a proxy for the brightness of a given light source and advertised in product packaging or technical datasheets.

5. The lumen output of a light source must be measured using an integrating sphere, and it is typically performed by a photometric laboratory. Commercial lighting products, including flashlights, should be ideally measured by a certified commercial photometric lab. A commercial photometric lab uses calibrated measurement equipment where a test light source is placed in an integrating sphere. Once the light source is turned on, light exiting the integrating sphere is measured. The photometric results of this measurement protocol can then be used to support the light (lumen) output claims for a product.

6. The lumen rating of a light source is based upon the integrated indirect illuminance (unit: lux) over a closed surface (i.e., integrating sphere). An integrating sphere has highly reflective, diffuse innter coatings, which causes the light bounce repeatedly. An illuminance photometer placed at the wall of the sphere then measures the bounced light exiting the integrating sphere through an aperture. The integrated illuminance over the sphere surface area (unit: m^2) gives the luminous flux value in lumens. Although there is no maximum limit to luminous flux, the luminous efficacy (unit: lm/W, lumens per watt) of a light source is theoretically limited to 683 lm/W by definition. The theoretical maximum luminous efficacy of 683 lm/W requires 100% radiant (aka, wall-plug) efficiency which is not feasible due to thermal and other losses and a spectral power distribution of a single wavelength at 555 nm (i.e., which is a green laser, not white light). The theoretical maximum luminous efficacy for a *white* light source is considered to be around 250 lm/W - 370 lm/W[1] and even lower (up to 255 lm/W)[2] for commercially available

[1] Murphy, T. W. (2012). Maximum spectral luminous efficacy of white light. *Journal of Applied Physics*, 111(10).
[2] Pattison, P. M., Hansen, M., & Tsao, J. Y. (2018). LED lighting efficacy: status and directions. *Comptes Rendus. Physique*, 19(3), 134-145.

products. For example, Cree LED, a global leader in high-performance LEDs, reported in 2024 that its most efficient high-power product — the J Series® 5050C E Class LED — achieves a luminous efficacy of 228 lm/W at 4000 K and 70 CRI, operating at 1 W.[3] This value reflects best-case conditions for industrial lighting applications, not the thermal and optical constraints of compact flashlights. Another product, the XT-E High Efficacy LED, reaches a guaranteed 164 lm/W at 85°C and 350 mA, with system-level performance estimated around 130 lm/W under real operating conditions.[4] In practice, light sources when driven at high current for maximum output, deliver lower efficacy (e.g., between 60 and 120 lm/W) due to significant thermal and electrical losses. Moreover, small form-factor LED packages cannot maintain high efficacy at high drive currents without active cooling and careful heat dissipation — neither of which is practical in handheld devices.

7. For the lights in this lawsuit that advertise a lumen output in the range of 900,000 to 5,000,000 lumen (an extremely high lumen output), a light source would need to be connected to a power source that supplies 4,000 W, assuming a super high efficacy of 250 lm/W. For more realistic flashlights, which operate in the 60 lm/W – 120 lm/W range due to heat and drive current losses, the actual power requirement could range from 8,000 W to over 16,000 W for that same output. Generating such power would require a large battery, such as a Tesla Powerwall, and would certainly not be portable (capable of being carried in one's pocket). A Tesla Powerwall 3 — a residential stationary battery system — stores 13.5 kWh of energy, can deliver up to 11.5 kW continuous output, but it weighs around 287 pounds and is roughly the size of a compact refrigerator (43.5" x 24" x 7.6").[5] By contrast, small flashlight batteries (e.g., AA cells or 18650

[3] https://www.cree-led.com/news/awards-brightstar2024
[4] https://www.led-professional.com/products/leds_led_modules/crees-new-high-efficacy-xt-e-led-delivers-25-percent-higher-lpw
[5] https://www.tesla.com/powerwall

lithium-ion cells) simply cannot sustain such high discharge rates without overheating, rapid voltage drop, or outright failure. Driving LEDs at these extreme power levels in a confined, non-actively cooled enclosure would result in thermal runaway, as LED efficiency sharply drops with heat. The concerns discussed herein are concerns for all light sources, regardless of their lumen output.

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

Dated: April 15, 2025

Alp Durmus, Ph.D.

Dorukalp "Alp" Durmus, Ph.D., FHEA

Assistant Professor
Department of Architectural Engineering
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Pennsylvania State University, University Park, PA 16802 USA
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APPOINTMENTS

Assistant Professor — Mar. 2020 - present
Department of Architectural Engineering
Affiliate of the Institute of Energy and the Environment
Affiliate of the Institute of Computational and Data Sciences
Pennsylvania State University, USA

Joint Appointment — Jul. 2020 - present
Senior Associate Research Scientist — Sep. 2019 - Mar. 2020
Postdoctoral Research Associate — Feb. 2019 - Aug. 2019
Advanced Lighting Team
Pacific Northwest National Laboratory (PNNL), USA

Honorary Associate — Feb. 2018 - Feb. 2020
Lecturer/Adjunct academic — Feb. 2015 - Feb. 2019
Research Assistant — Feb. 2015 - Feb. 2018
School of Architecture, Design, and Planning
University of Sydney, Australia

Lighting Engineer — Aug. 2014 - Feb. 2019
SAL, Australia

Designer — Jun. 2011 - Aug. 2014
Energy Exhibition Service, Australia

Lighting Designer — May 2010 - May 2011
Lumina, Turkey

EDUCATION

Ph.D., Architectural Sciences, University of Sydney, Australia — 2018

M.S., Architectural Lighting Design, KTH Royal Institute of Technology, Sweden — 2009

B.S., Electrical Engineering, Istanbul Technical University, Turkey — 2006

SELECT PUBLICATIONS

Select Journal Articles (Total = 33)

Senyer, N., Durmus, D. (2025). An AI-driven framework for perceived display spectra: The effects of dimming, observer age, and viewing distance. *Displays*, 103024.

Wang, Y., Durmus, D. (2025). Effect of display luminance and ambient illuminance on the perceived quality of indoor environment images. *Journal of the Society for Information Display*.

Mahmoudzadeh, P., Hu. W., Davis, W., Durmus, D. (2025). The effect of center and surround luminance, visual angle, edge blur, and contrast polarity on overall brightness perception. *Building and Environment*, 112582.

Roddick, C. M., Chen, F, S., Durmus, D., Royer, M. P., Veitch, J. A., Zhao, J., Wang, L., Cao, W., Whitehead, L. A. (2024). Effects of near infrared radiation (NIR) in ambient lighting on cognitive performance, emotional state, and cardiovascular physiology. *Journal of Environmental Psychology*, 100, 102484

Kore, R., Durmus, D. (2023). Curve-Fitting Correction Method for the Nonlinear Dimming Response of Tunable SSL Devices. *Technologies*, 11(6), 162.

Select Conference Proceedings (Total = 69)

Warenda, R., Durmus, D. (2025) Effect of colour and abstract images on emotions and heart rate variability. *CIE Australia Lighting Research Conference 2025*, Brisbane: Commission Internationale de L'Eclairage.

Liu, Y., Durmus, D. (2025) The impact of narrowband spectra on visual and safety perception under low light levels. *CIE Australia Lighting Research Conference 2025*, Brisbane: Commission Internationale de L'Eclairage.

Knoechel, O., Durmus, D. (2025) Effect of melanopic equivalent daylight illuminance on human cognition. *CIE Australia Lighting Research Conference 2025*, Brisbane: Commission Internationale de L'Eclairage.

Mahmoudzadeh, P., Durmus, D. (2024). Brightness in a wider field of view: The effect of surround luminance, visual angle, and edge clarity. *CORM/CIE-USNC Joint Annual Conference.*

Song, W., Durmus, D. (2024) Impact of melanopsin and color gamut on spatial brightness. *IES Annual Conference*. New York: The Illuminating Engineering Society.

Select Professional Magazines, Book Chapters, and Technical Reports (Total = 10)

Dure, P., Mundinger, J., Durmus, D. (2023) ISO settings and LED dimming impact video quality, *LED Magazine*. https://www.ledsmagazine.com/specialty-ssl/article/14299599/video-lighting-iso-settings-and-led-dimming-impact-video-quality

Luedtke, W., Whitehead L., Durmus, D. (2023). The Lumen: What it's for, and what it's not. *LD+A*, 53(4), 24-26. https://doi.org/10.1177/03606325202305300400 8

Collier, J., Durmus, D., Davis, R. (2022). Lighting in care centers: comparing tunable LED systems to conventional lighting systems in four care centers. *(No. PNNL-30112). Pacific Northwest National Lab. (PNNL), Richland, WA (United States).*

Hu, W., Durmus, D., Davis. W. (2021) Beyond 2030: Beyond luminous efficacy. In *Visionary Challenge*, Illumination Engineering Society: New York, NY, USA.

Durmus, D. (2020). On the right wavelength. *Light Lines*, 13(5), 8-10.

INVITED TALKS

Select Conferences, Seminars, Webinars (Total = 18)

Durmus, D. (2025). Color Pop & Melanopsin: The Spatial Brightness in Architectural Lighting. *Lightfair*, LasVegas: Lightfair International.

Durmus, D. (2025). Stranger Things: The Melanopsin-Red Saturation-Brightness Connection.

LEDucation, New York.

Jägerbrand, A., Tengelin, M. N., Durmus, D. (2024) Breaking Dawn: The Challenges and Consequences of Light Pollution Remedies. *IES Annual Conference*. New York: The Illuminating Engineering Society.

Durmus, D., Tengelin, M. N., Jägerbrand, A. (2023). Light pollution and human health: how do we know what we know. *IES Annual Conference*. Chicago: The Illuminating Engineering Society.

Mahmoudzadeh, P., Hu. W., Davis, W., Durmus, D. (2023). Lighting Application Efficacy (LAE): The What, Why, and How. *LEDucation*, New York.

Academic Guest Lectures (Total = 5)

Durmus, D. (2023) Keynote: Recent developments and future of lighting research. Kongsberg Vision Meeting 2023, 23 October 2023.

Durmus, D. (2023) Language of light. Penn State, Camp Candle, 4 July 2023.

Durmus, D. (2022). Fundamentals and applications of lighting and color science. Department of Optometry, Radiography and Lighting Design, University of South-Eastern Norway, 15 November 2022.

Durmus, D. (2021). Fundamentals of lighting and color science, *Shaping Light,* School of Architecture, Carnegie Mellon University, 12 April 2021.

Durmus, D. (2020). Color basics for lighting designers, *Module: Light and Science*, KTH, Royal Institute of Technology, 23 November 2020.

SERVICE TO PROFESSION

Peer-review & editorial roles

Associate editor, Lighting Research & Technology	2024-present
Photochemical & Photobiological Sciences, Guest editor for topical collection (Polluting the darkness)	2024-present
Funding Reviewer, National Research, Development and Innovation Office, Hungary	2023
Buildings, Guest editor special issue (Lighting in Buildings)	2022-present
NIST, Manuscript reviewer (Outside technical reviewer)	2022,2023
External PhD Examiner: Svetlana Roslyakova, Automated control of artificial lighting in work organization systems for computer system users, ITMO University	2022
Reviewer, CIC Color and Imaging Conference	2021, 2023, 2024
Grant Reviewer, DOE, SBIR/STTR peer review	2020
External PhD Examiner: Svetlana Kolgushkina, Optoelectronic methods of an integrated assessment of luminance distribution in an urban environment, ITMO University	2020
PDLC 2020 review committee	2020
Reviewer Board, Sustainability Journal	2019-present

Peer-Reviewer for 32 scientific journals	2018-present

Advisory & committee work

Advisory Board /Stakeholder, MELIDOS Metrology for wearable light loggers and optical radiation dosimeters	2024-present
Chair, Division 1: Vision and Color session, CORM/CIE-USNC Joint Annual Conference	2024
Member, JTC20 Wearable alpha-opic dosimetry and light logging methods, limitations, device calibration and data schemes (CIE)	2023-present
Member, RF-05 Implementation of CIE 2006 Cone Fundamentals in Photometric and Colorimetric Measurements	2023-present
Advisory Member, Outdoor Nighttime Environments Committee, Illuminating Engineering Society (IES)	2023-present
U.S. Department of Energy, Lighting Physiology Interest Group (LPIG)	2023-present
Advisor, PNNL Life cycle inventory (LCI) focus group	2023
Chair, Lighting Applications (VL) technical group, Optica (former OSA)	2022-present
Judge, IES PA Student Chapter, Luminaire design competition	2022
Society of Hispanic Professional Engineers (SHPE) National Convention 2021, Graduate Track Peer Review, Writing room mentor	2021
Merit Judge, 2021 IES Illumination Awards	2021
Member, PVLED 2022 Conference organization committee, Optica	2021-2022
Member, Nominating Committee, Illuminating Engineering Society (IES)	2021-2023
Advisory Member, Color Committee, Illuminating Engineering Society (IES)	2021-present
Advisory Member, Museum Lighting Committee, Illuminating Engineering Society (IES)	2021-present
Australian Representative (Division 8: Image Technology), International Commission on Illumination (CIE)	2018-2021
Committee Member, EL-041 Lamps and Related Equipment Standards Australia	2017-2019

SELECT SERVICE TO DEPARTMENT

Member, Industry Research Partnerships Faculty Working Group, Penn State	2022-2023
Member, Technology Advisory Committee, Penn State	2021-present
Member, Qualifying Exam Committee, Penn State	2021-present
Micro-Credentials Organizer, Penn State	2021-2023
Member, Graduate Studies & Recruitment Committee, Penn State	2020-2021, 2023-present

PROFESSIONAL MEMBERSHIPS

Member, International Society for Optics and Photonics (SPIE)	2021-present
Member, Optica (formerly OSA)	2019-present
Member, Illuminating Engineering Society (IES)	2016-present
Member, International Commission on Illumination (CIE)	2014-present

TEACHING

RISE 597E Research Integrity & Scholarly Ethics (co-instructor), Penn State	2025-present
AE 461 Illumination Systems and Design, Penn State	2023-present
AE 497-012 Lighting Design Applications, Penn State	2023
AE 482 Senior Thesis Project II, Penn State	2022-2024
AE 481W Senior Thesis Project I, Penn State	2021-2024
AE 597-008 Human Factors and Lighting, Penn State	2021-present
AE 466 Computer-Aided Lighting Design, Penn State	2021-present
AE 564 Color Science, Penn State	2020-present
Light and Vision, University of Sydney	2018
Empirical Thinking, University of Sydney	2017
Light and Sound, University of Sydney	2016-2018
Indoor Environmental Quality, University of Sydney	2015-2018
Introduction to Architectural Science, University of Sydney	2015-2018
Photometry and Colorimetry, University of Sydney	2015-2018

SUPERVISION

3 post-doctorate, 7 Ph.D., 10 masters, and 11 undergraduate research, and 15 undergraduate senior thesis students (2015-present)

Post-doctorate: Merve Oner, Nurettin Senyer, J. Mundinger

Graduate research (Ph.D.): Zora Yue Lie, Parisa Mahmoudzadeh, Wangyang Song, Eunice Wang, Rugved Kore, Mariana Papa, Jo Elliot

Graduate research (Masters): Sandra Ling, Sanjana Adavi, Jumanah Alawadhi, Naser Shehab, Tina Wang, Astra Goldie, Jo Reed, Dianna Abdalla, Aaron Duis, Jiawei Fu

Undergraduate research: Reagan Warenda, Gianna Gilfert, Alvaro Campos, Vincent Boyer, Thomas Mihalko, Osama Aljamal, George Zhu, Olivia Knoechel, Christie Gonzalez, Sela Plummer, Yonger Chen

Undergraduate (Senior thesis): Samantha Schur, Ashley Anthowiak, Lisa Han, Luiza Siqueira, Iman Alawadi, Sela Plummer, Aaron Zimmerman, Sanjana Adavi, Christie Gonzalez, Alexa Parks, Yuxin Li, Kyra Flood, Madelyn Seidel, Jennifer Downs, Samuel George