Field Study of Early Implementation of UV Sources and their Relative Effectiveness for Public Health and Safety

Supplemental Materials

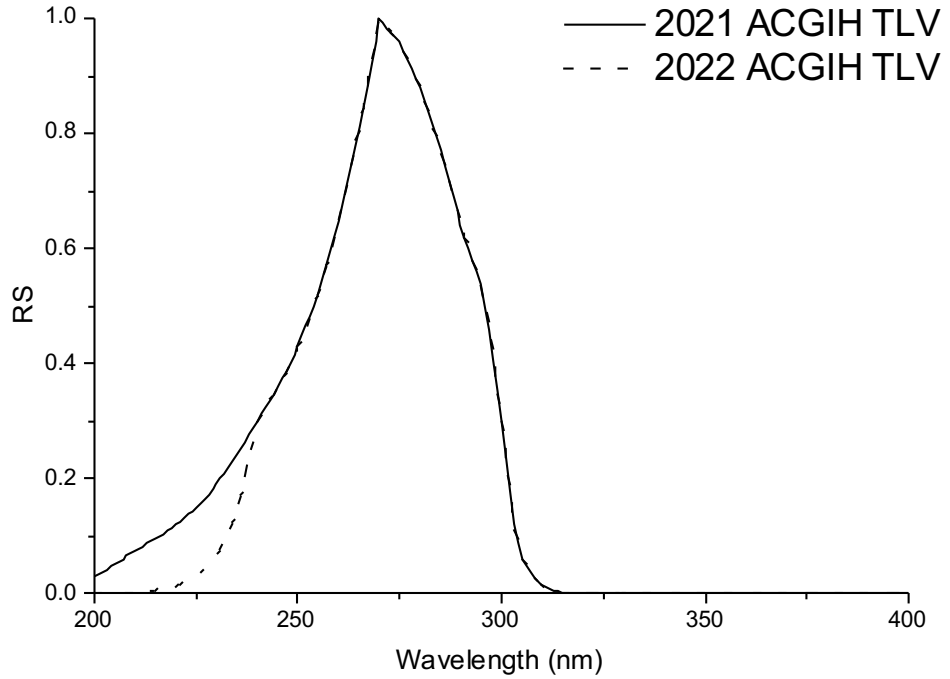

Figure S1. Hazardous relative spectral effectiveness for UV radiation from 200 to 400 nm (data extracted from ACGIH 2021).

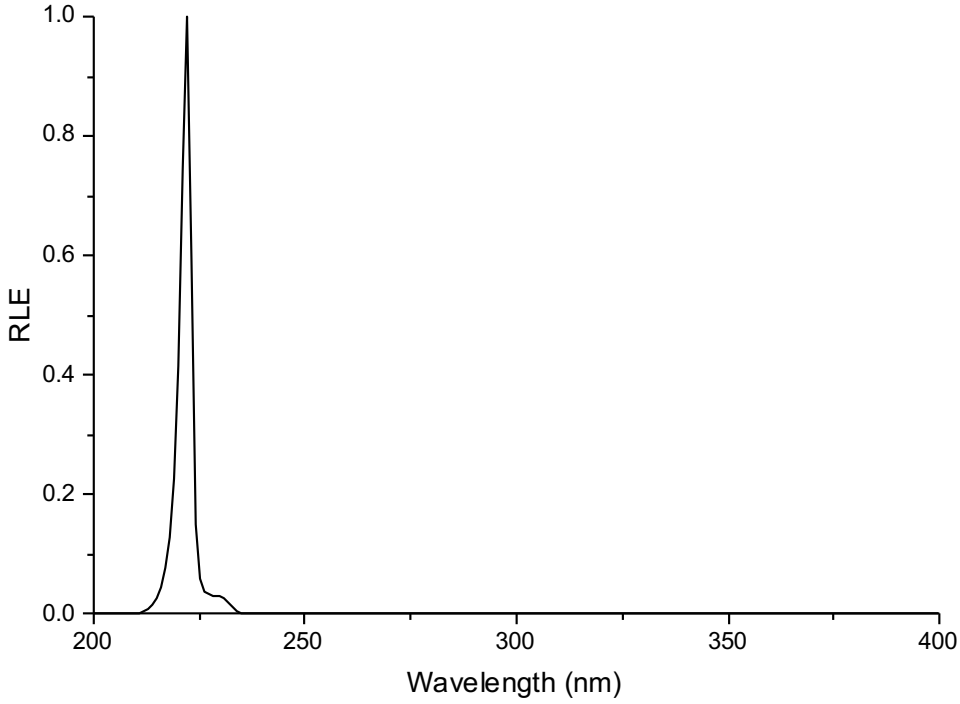

Figure S2. Relative lamp emission (RLE) of a filtered Ushio KrCl* lamp

February 2, 2022

After closing the Space Needle due to the COVID-19 Pandemic in March of 2020, we designed a plan to re-open and safely re-employ our Team Members. Our goal was to add technologies and processes that were both safe as well as efficacious relative to COVID-19.

We worked closely with City, County, and State government officials on re-opening as safely as possible, employing a redundant "Swiss cheese" safety approach with improvements in surface cleanliness, Team Member health screening, air quality monitoring and treatment with proper filtration and germicidal UVC in the 222 nm and 254 nm wavelengths.

While we trusted the representations from the various companies that we purchased air and surface quality disinfectant technologies, we wanted a third party to validate the marketing claims.

We reached out to Martin Cohen and Jennifer Hendersen at the University of Washington to validate the efficacy and safety of our hardware installations and were grateful they were willing to do a field study in this regard. After some early analysis and collaboration with Karl Linden and Ben Ma of the University of Colorado, Boulder, we felt comfortable that many of our improvements were both safe and effective. We also felt that emerging far UVC technology (specifically in the 222 nm wavelength) could be incorporated into our overall approach to COVID and future health concerns, and continually sought out the best performing germicidal UV bulbs and fixtures.

Shortly after the initial testing was completed, we reached out to the manufacturer of the UVC 222 nm equipped hardware with our concerns regarding performance and a desire for a safer bulb without the rogue "tails" observed in the field study. We subsequently received a newer version of the krypton chloride excimer bulbs. This newer generation of 222 nm UVC bulb was also equipped with a quartz filter over the lens, eliminating the tails outside of 222 nm that were measured onsite by the team, and through our own onsite testing using an ILT2400-UV light meter/radiometer.

With further data in hand, we decided that the time needed for effective sanitation of surfaces via far UVC was operationally not feasible in our portals and had them removed. Stated log reductions of aerosolized pathogens and the fluence/output of the bulbs, as advertised by the manufacturer, were not able to be verified by our internal team and external advisors. These bulbs were subsequently repurposed as static downlights and upper air germicidal units throughout the property, and implemented in a fashion (upper room UVGI) that studies had proven to be more effective in the prevention of aerosol transmission of SARS-COVID-2 and other infectious particles.

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Research continued into possible alternative vendors for our far UVC approach. Our goal was to simultaneously improve efficacy of the bulbs (fluence and log rates), while also improving the safety (ensuring that the UVC TLVs were never exceeded, and testing to validate the absence of UVC tails with more harmful UVC radiance).

We're pleased to share our learnings for others to learn and hopefully benefit from. A special thank you to Jennifer Henderson, Ben Ma, Martin Cohen, John Scott Meschke, and Karl Linden for their commitment to science in advancing safe indoor environments during a pandemic.

Sincerely,

Ron Sevart
President, CEO
Space Needle, LLC