Why is Far-UVC safe for human exposure?

Far-UVC light (typically at 222 nm) is an effective disinfection technology that can inactivate microorganism without posing a hazard to human health. The safety of Far-UVC has been studied for a decade, and below we summarize some of the key findings from peer-reviewed scientific literature that explain why Far-UVC is considered safe for human exposure as well as a list of all published safety studies.

Quick Intro to TLVs

Far-UVC safety guidelines are shaped by Threshold Limit Values (TLVs)—standards that define daily exposure levels over 8 hours to ultraviolet light. For reference:

- ICNIRP (2006) TLV for 222 nm (used in Europe):
  - Combined skin and eye: 23 mJ/cm²
- ACGIH (2022) TLVs for 222 nm (used in the US):
  - Eye: 160 mJ/cm²
  - Skin: 479 mJ/cm²

These thresholds are set by scientific bodies based on available evidence and are periodically revised as new data emerges.

Far-UVC Absorbed by Protein in Dead Skin Cells

Far-UVC light is strongly absorbed by proteins in the outermost layers of the skin and eyes. Its short wavelength (222 nm) means it cannot penetrate beyond the stratum corneum (the outer dead-cell layer of skin) or the tear film and outer corneal layers of the eye. This absorption effectively blocks Far-UVC from reaching living cells where damage could occur.

Extreme Exposure Study Shows High Safety Margins

A real-world case study found that human skin can tolerate extremely high doses of filtered Far-UVC light. A volunteer exposed his forearms to doses nearly 800 times the ICNIRP TLV (23 mJ/cm²), yet experienced no burns or skin damage. Only at very high doses (above 6000 mJ/cm^2) did a faint yellowing occur, which faded within hours. Tests confirmed that the effect was superficial and did not reach living skin layers (Eadie et al., 2021)[1].

Long-Term Exposure Evidence

Multiple long-term studies in mice confirm that filtered 222 nm Far-UVC light does not cause tissue damage, even with extended exposure.

- In a 66-week study, UV-sensitive hairless mice were exposed to Far-UVC five days a week for eight hours a day at doses far above the ICNIRP TLV (23 mJ/cm²). Researchers found no increase in skin tumors, unusual growths, or tissue changes, and health outcomes were similar to unexposed control groups (Welch et al., 2022).

- Another study used both normal and UV-sensitive hairless mice known for their susceptibility to develop UV induced skin cancer. Despite their vulnerability, no tumors or inflammation developed after repeated 222 nm exposure (Yamano et al., 2020).

- A third study looked for cumulative damage from repeated high doses of Far-UVC light. It also found no skin abnormalities or DNA lesions, supporting the conclusion that filtered Far-UVC is safe for long-term use (Narita et al., 2018).

A growing body of consistent evidence points to the same conclusion: filtered 222 nm Far-UVC light can offer effective disinfection without harming skin—even over the long term.

Eye Safety: Evidence from Laboratory and Real-World Studies

One of the most common concerns about UV light is its potential to harm the eyes. However, studies show that properly filtered Far-UVC light (222 nm) poses minimal risk—even with regular exposure.

- A study using rats showed that Far-UVC only reaches the very outermost layers of the eye's surface—the layers that are naturally shed every day. The researchers found that signs of corneal damage didn't appear until exposure reached at least 3,500 mJ/cm², a level vastly higher than the TLVs. In fact, this "lowest observed adverse effect level" is over 150 times higher than the ICNIRP TLV of 23 mJ/cm^2 (Kaidzu et al., 2021).

- Another study used a lab-grown human eye model to study DNA changes at different UV wavelengths. Their findings confirm that Far-UVC only causes minor effects in the very top layers of the corneal surface. Critically, no damage was observed in the deeper, regenerative cells that are essential for long-term eye health—even without the protective tear film (Buonanno et al., 2025).

- Finally, real-world data comes from a 3-year clinical involving eye doctors working daily under filtered 222 nm Far-UVC lighting. Even after 36 months, no participants showed any signs of eye damage. Vision, corneal health, and eye cell counts remained unchanged, and no discomfort or delayed effects were observed (Sugihara et al., 2024)[7].

Author	Title	Year
Barnard et al.	Further Evidence that Far-UVC for Disinfection is Unlikely to Cause Erythema or Pre-Mutagenic DNA Lesions in Skin	2020
Buonanno et al.	Exposure of Human Skin Models to KrCl Excimer Lamps: The Impact of Optical Filtering	2021
Buonanno et al.	Germicidal Efficacy and Mammalian Skin Safety of 222-nm UV Light	2017
Buonanno et al.	Wavelength-dependent DNA damage in human cornea model	2025
Duncan et al.	Ocular and Facial Far-UVC Doses from Ceiling-Mounted 222 nm Far-UVC Fixtures	2022
Eadie et al.	Computer Modeling Indicates Dramatically Less DNA Damage from Far-UVC Krypton Chloride Lamps	2021
Eadie et al.	Extreme Exposure to Filtered Far-UVC: A Case Study	2021
Finlayson et al.	Depth Penetration of Light into Skin as a Function of Wavelength from 200 to 1000 nm	2021
Fukui et al.	Exploratory Clinical Trial on the Safety and Bactericidal Effect of 222-nm Ultraviolet C in Humans	2020
Fukui et al.	Safety of 222 nm UVC Irradiation to the Surgical Site in a Rabbit Model	2022
Glaab et al.	Skin Tolerant Inactivation of Multiresistant Pathogens Using Far-UVC LEDs	2021
Gutierrez-Bayona et al.	Extending the Acute Skin Response Spectrum to Include the Far-UVC	2024
Hanamura et al.	Viability evaluation of layered cell sheets after ultraviolet light irradiation of 222 nm	2020
Hickerson et al.	Minimal, superficial DNA damage in human skin from filtered far-ultraviolet C	2021
Ivanova et al.	Improved Spectral Purity of 222-nm Irradiation Eliminates Detectable CPD	2022
Kaidzu et al.	Safety evaluation of far-UVC irradiation on epithelial basal cells in the corneal limbus	2023
Kousha et al.	222 nm Far-UVC does not cause eye irritation when deployed in office environment	2023
Narita et al.	Chronic irradiation with 222-nm induces neither DNA damage nor epidermal lesions in mouse skin	2018
Narita et al.	Effect of ultraviolet C emitted from KrCl excimer lamp with or without bandpass filter to mouse epidermis	2022

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Kaidzu et al.	Re-Evaluation of Rat Corneal Damage by Short-Wavelength UV Revealed Extremely Less Hazardous Property	2021
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Narita et al.	Effect of ultraviolet C emitted from KrCl excimer lamp with or without bandpass filter to mouse epidermis	2022
Sugihara et al.	Interventional human ocular safety experiments for 222-nm far-ultraviolet-C	2024
Sugihara et al.	Ocular safety of 222-nm far-ultraviolet-c full-room germicidal irradiation: A 36-month clinical observation	2024
Sugihara et al.	One-Year Ocular Safety Observation of Workers and Estimations of Microorganism Inactivation Efficacy	2022
Tavares et al.	Different biological effects of exposure to 222 and 254 nm	2023
Welch et al.	Film dosimetry for occupant exposure monitoring within Far-UVC installations	2024
Welch et al.	No Evidence of Induced Skin Cancer or Other Skin Abnormalities after Long-Term Exposure	2022
Welch et al.	Wavelength-dependent DNA Photodamage in a 3-D human Skin Model over the Far-UVC	2022
Woods et al.	The effect of 222-nm UVC phototesting on healthy volunteer skin: a pilot study	2014
Wu et al.	Modeling of ultraviolet propagation from air to human epidermis with wavelength range of 200–300 nm	2022
Yamano et al.	Evaluation of acute reactions on mouse skin irradiated with 222 and 235 nm UV-C	2021
Yamano et al.	Long-term effects of 222-nm ultraviolet radiation C sterilizing lamps on mice susceptible to UV radiation	2020
Yamano et al.	Repetitive irradiation with 222nm UVC noncarcinogenic, safe for sterilizing human skin	2020