

■ UVC LED Disinfection – Session Summary

This presentation outlines the rapid emergence of UVC LED disinfection technology and its potential to replace traditional mercury-based systems in healthcare. Andy explains how UVC works by damaging DNA/RNA in microorganisms, a method used for over a century but historically reliant on mercury lamps. Mercury is a WHO-listed neurotoxin and subject to global elimination under the UN Minamata Convention, with mining due to end in 2032 and regulatory exemptions expiring from 2027.

LED technology now provides a mercury-free alternative, benefiting from major improvements in output, cost and efficiency. Modern UVC LED cabinets use multiple chips and highly reflective chambers to overcome shadowing and deliver faster, lower-energy disinfection that meets BS 8628 standards. Examples include medical device reprocessing and large-scale water purification, where LEDs are already widely adopted.

Andy concludes that LED systems now match or outperform mercury equivalents, making continued reliance on mercury unjustifiable.

Purpose of the Presentation

- Introduces **UVC disinfection using LED technology** and its emerging role in healthcare.
- Focuses on how LED-based UVC can help eliminate **mercury**, one of the world's most harmful pollutants.
- Provides examples from medical device reprocessing and large-scale water purification.

What UVC Disinfection Is

- UVC is a form of **radiation between visible light and X-rays**.
- Works by **penetrating organic cells**, damaging DNA/RNA and preventing replication. *“rendering them incapable of reproduction”*
- Used in healthcare for decades, historically generated via **mercury-based lamps**.

Why LED UVC Matters

- Traditional UVC lamps rely on **mercury vapour**, a WHO-listed **top-10 chemical of public health concern**.
- Mercury causes severe neurological harm and is subject to global elimination efforts.

- LED chips now provide a **mercury-free alternative**, emerging ~20 years after LEDs transformed general lighting.

Global Policy & Regulatory Drivers

- **ROHS regulations** currently ban mercury except for germicidal UV (temporary exemption).
- Exemption expires **early 2027**; consultation underway on whether it should continue.
- **UN Minamata Convention** aims to eliminate mercury globally.
- **Primary mercury mining ends in 2032**, reducing long-term availability of mercury-based lamps.

Technology Shift: LED vs Mercury

- LED performance follows **Haitz's Law**:
 - 30× increase in output per decade
 - 10× reduction in cost per decade
- Mercury lamp costs expected to rise as regulations tighten.
- First LED-ready applications now emerging:
 - Water treatment (since 2017)
 - BS 8628-compliant medical device disinfection (since 2022)
 - LED cabinets now **outperform mercury equivalents**

Medical Device Disinfection Examples

- LED UVC cabinets use **50–108 LEDs** arranged around reflective chambers (>90% reflectivity).
- Overcome historical issues of **shadowing** by distributing light and using reflective surfaces.
- Achieve **BS 8628** requirements in **5 minutes**, with:
 - **Lower energy use** (115 watts for 5 minutes)
 - **Higher dose delivery**
 - **35% faster disinfection** than mercury systems
 - **50 watts less energy consumption**
- Certified as **Class IIa medical devices**.

BS 8628 Standard (2022)

- Defines testing for UVC surface disinfection.
- Requires log-reduction performance against **five resistant pathogens**, including Enterococcus and E. coli. *“known photo-reactivable pathogens”*
- Ensures reliable, reproducible, safe disinfection.

Water Purification Examples

- LED UVC already deployed at scale in:
 - Pharmaceutical water systems
 - Drinking water (e.g., Las Vegas)
 - Data-centre cooling water
 - Wastewater treatment
- Tens of thousands of LEDs used in industrial systems.
- Drivers include:
 - Mercury mining ban
 - Lower operational costs (OPEX)
 - Higher reliability and flexibility

Key Takeaway

- LED UVC systems now **match or outperform mercury-based systems** in several applications.
- Continuing mercury exemptions for device-level UVC disinfection is **no longer justified**.
- Engineering guidance increasingly states that **mercury-free options must be considered**.
- LED UVC represents a scalable, sustainable, regulatory-aligned future for medical device disinfection.