



Connected Systems

GUV Presentation and Training

2020



Fail-Safe GUV Disinfection Solutions

Empowering Health and Safety through Germicidal UV

June 2020





In the face of the global pandemic,
now more than ever before . . .
disinfecting places, spaces, and things
is critical!



Overview / Agenda

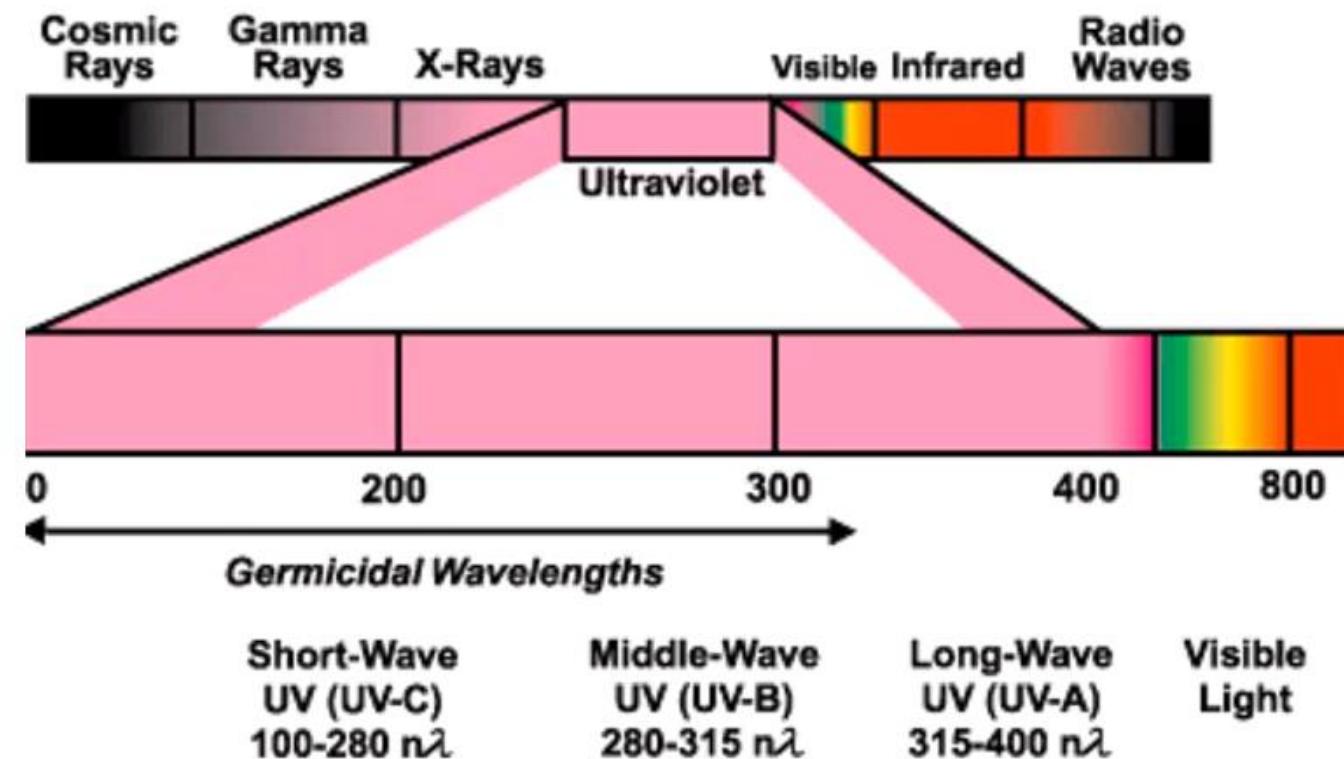


- The Science of GUV
- The Math of GUV
- How to Apply GUV Lighting
- GUV Lighting Products
- Next Steps



What is UV light?

Types of UV



Ultra-Violet (UV) is invisible to the human eye

It can be subdivided into three categories: UVA, UVB and UVC

- UV-A from 315 to 400 nm
- UV-B from 280 to 315 nm
- UV-C from 100 to 280 nm

<https://www.livescience.com/50326-what-ultraviolet-light.html>

Far UV vs. Near UV

- The difference between Near and Far-UV is simply a matter of wavelength
- The energy determines what happens when the light comes into contact with human skin as well as with dangerous pathogens.
- The shorter the wavelength the more energy there is in the light. **Near UV** is **near** the visible light range.

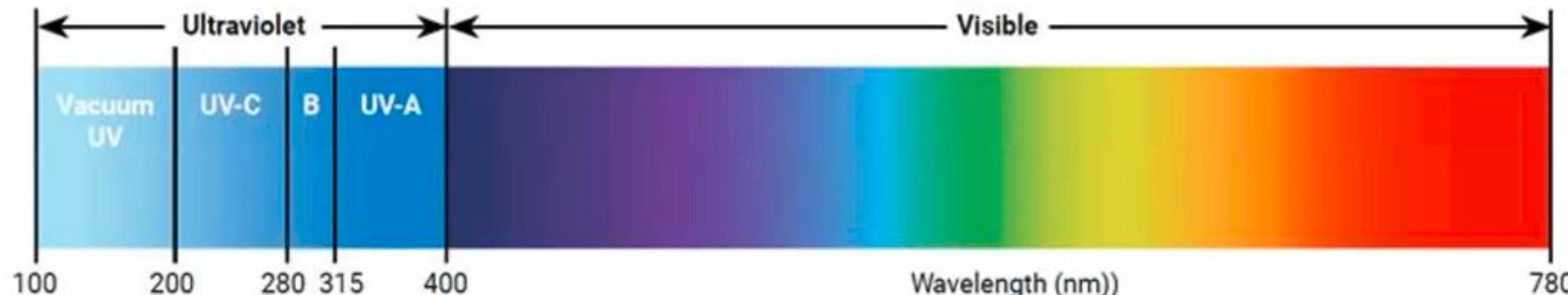
UV type **A** has wavelengths between 315 nm and 400 nm.

UV type **B** has wavelengths between 280nm and 315nm.

UV type **C** has wavelengths between 100nm to 280nm
(most energetic of UV light).

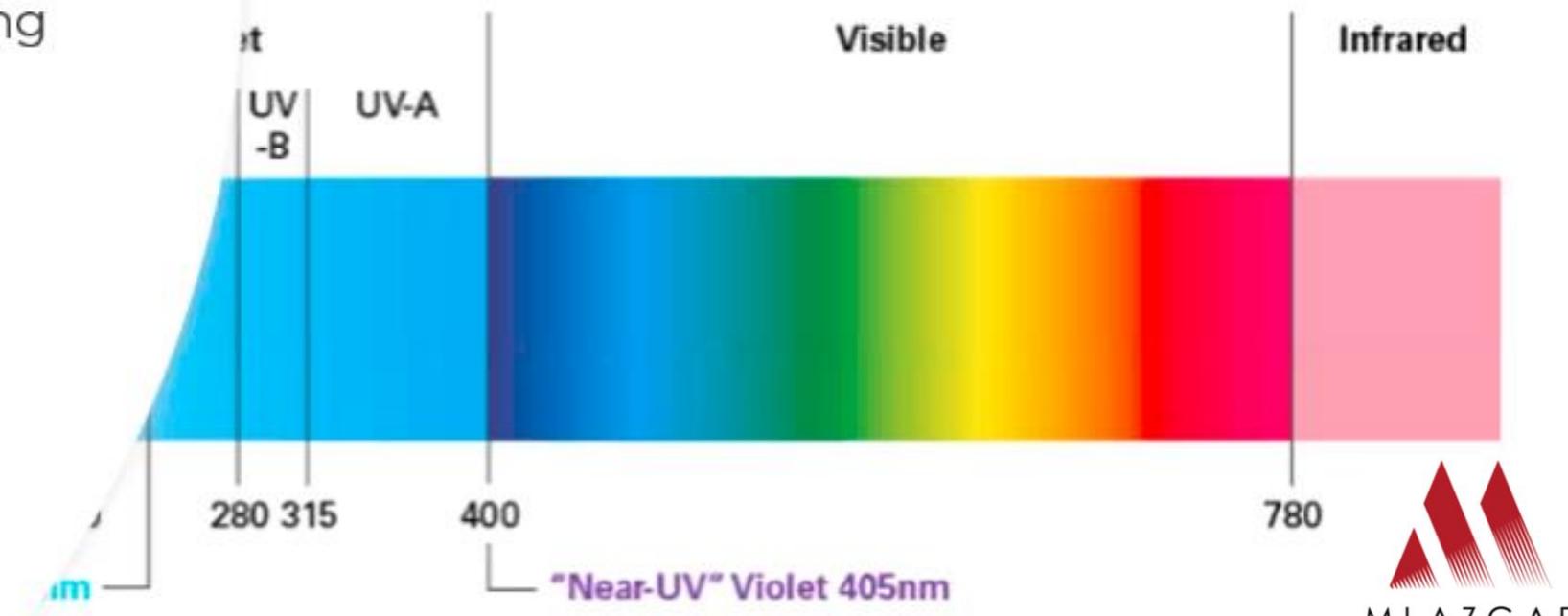
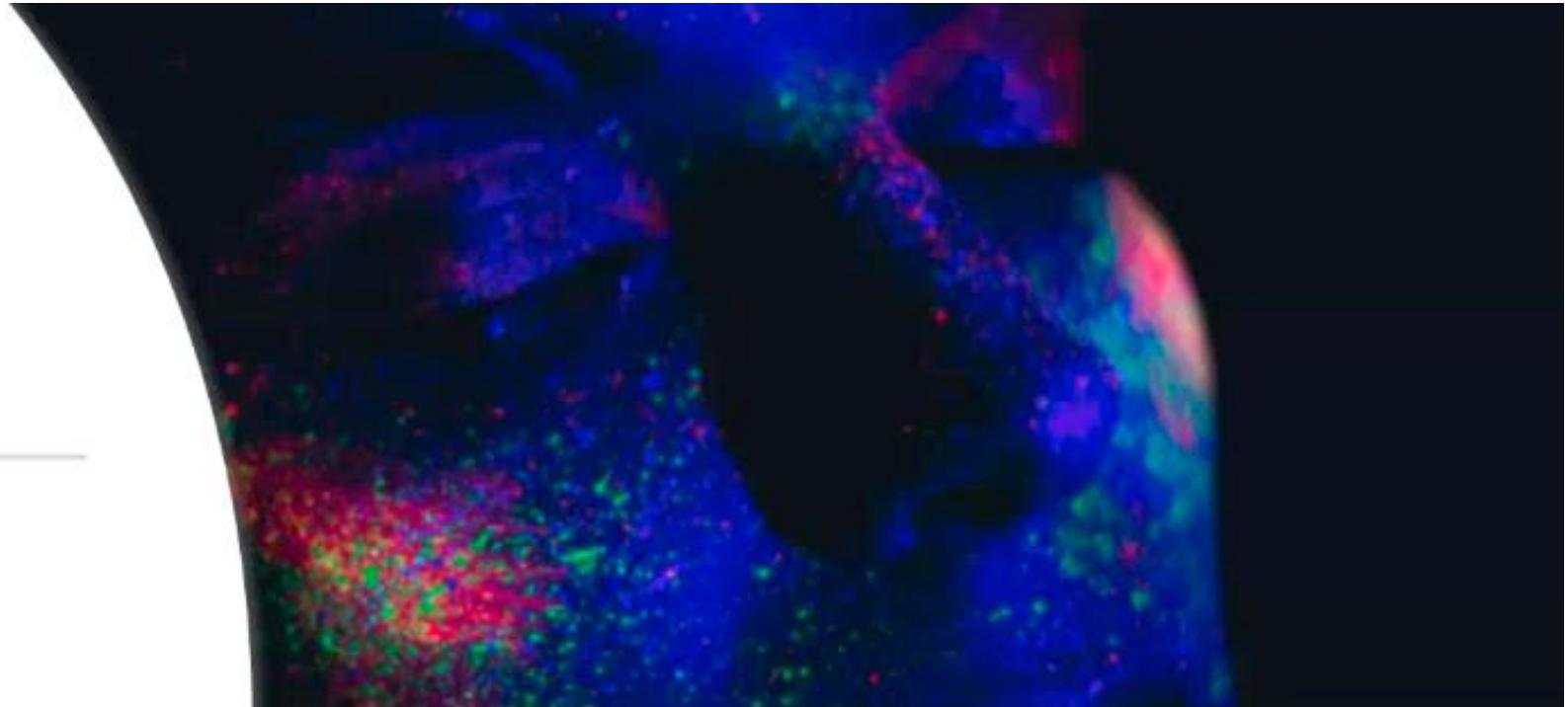
http://www.chemistryland.com/CHM107Lab/Exp08_UV/Lab/Exp08_UV.html

<https://www.hepacart.com/blog/far-uv-vs.-near-uv>



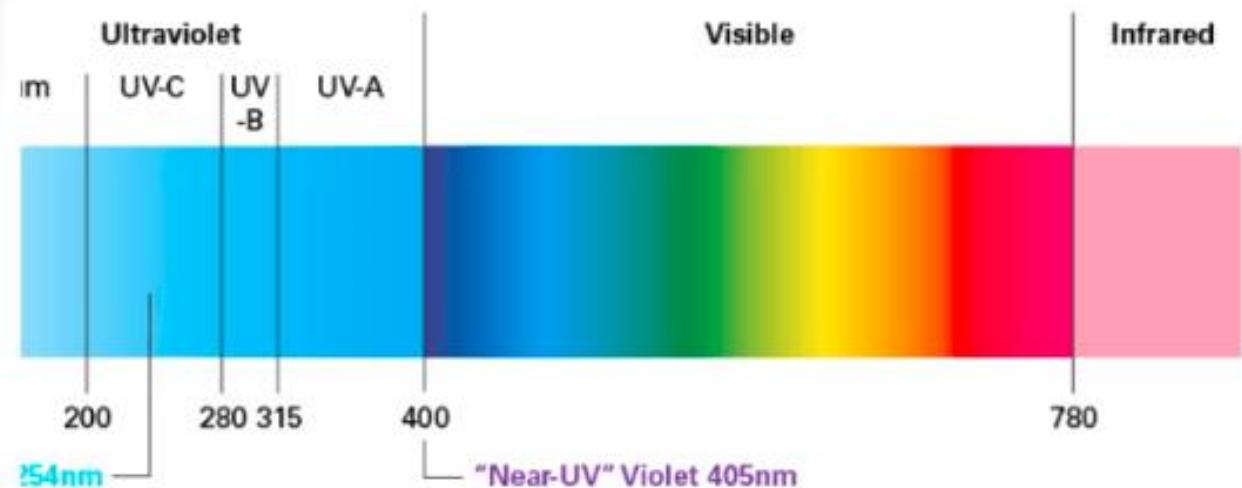
Near - UV

- 405 nm
- Visible light
- Does not inactivate viruses
- Impacts on Mold and Fungi still being researched
- Slows bacteria growth
- Requires Long Exposure time



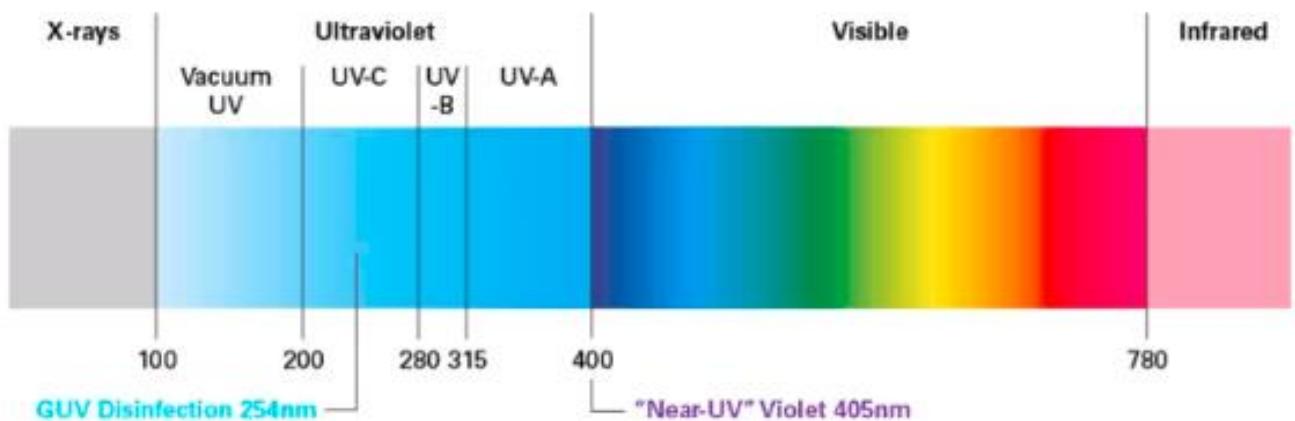
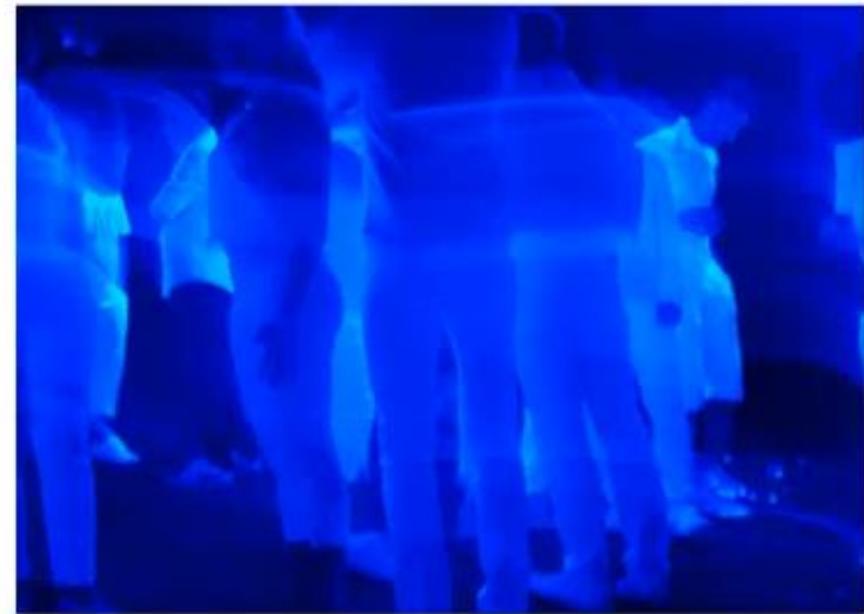
UVA/ UVB

- 315nm/365nm
- Not visible light
- Does not Inactivate viruses
- Reduces bacteria
- Exposure time is moderate
- Exposure risk
- Proven technology



FAR - UV

- 222nm
- Not visible light
- Kills bacteria (90% bacterial effective)
- Virus effect being tested
- Does not kill Mold, Fungi
- Exposure time is long
- Lower Exposure and Ozone risks
- Technology Infancy



What is GUV?



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What is germicidal UV, and what is UVGI?

Germicidal UV (GUV) refers to using ultraviolet radiant energy to inactivate bacteria, mold spores, fungi or viruses. When the process is applied in a given location, it has generally been referred to as ultraviolet germicidal irradiation (UVGI).

Is all ultraviolet considered germicidal ultraviolet (GUV)?

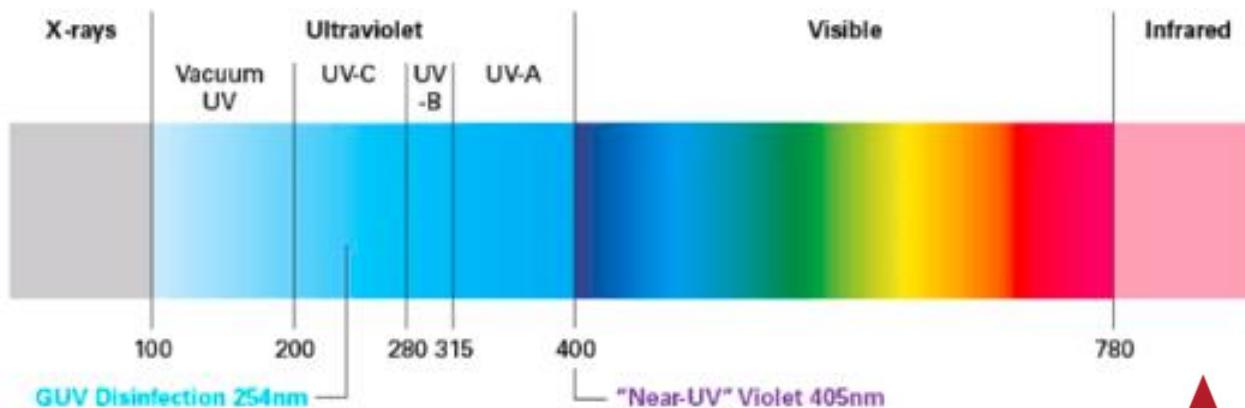
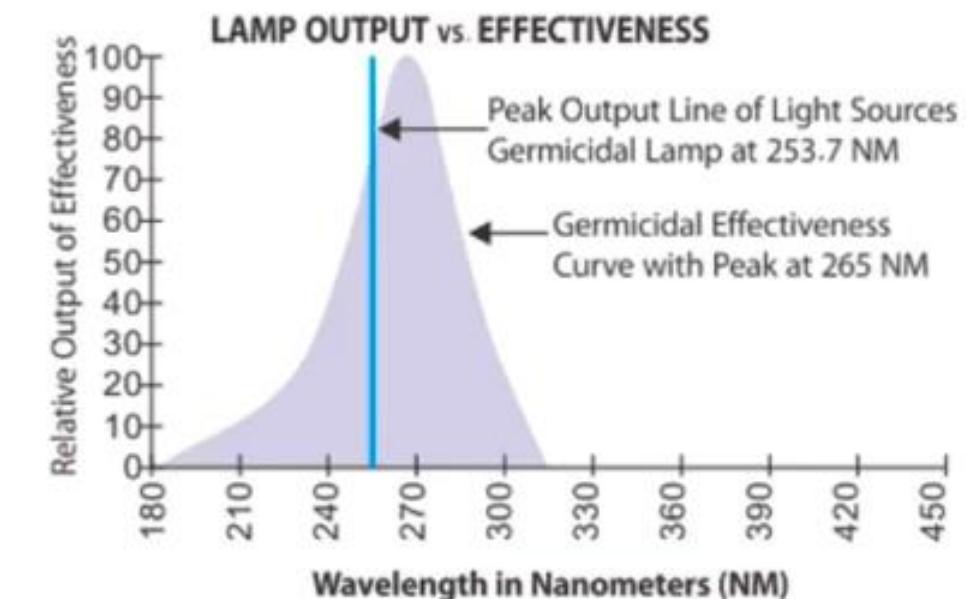
No. *Germicidal ultraviolet (GUV)* – refers to short-wavelength ultraviolet “light” (radiant energy) that has been shown to kill bacteria and spores and to inactivate viruses. Wavelengths in the photobiological ultraviolet spectral band known as the “UV-C,” from 200 to 280 nanometers (nm), have been shown to be the most effective for disinfection, although longer, less energetic UV can also disinfect if applied in much greater doses.

Can UV-C kill viruses as well as bacteria?

Yes, UV-C kills living bacteria, but viruses are technically not living organisms; thus, we should correctly say “inactivate viruses.”

Germicidal UV (GUV)

- 254nm
- Not visible light
- Kills bacteria
- Inactivates viruses
- Kills mold and fungi
- Exposure time is short
- 99.99% effective
- Proven Technology
- Exposure Risk known, "Superficial Effects"



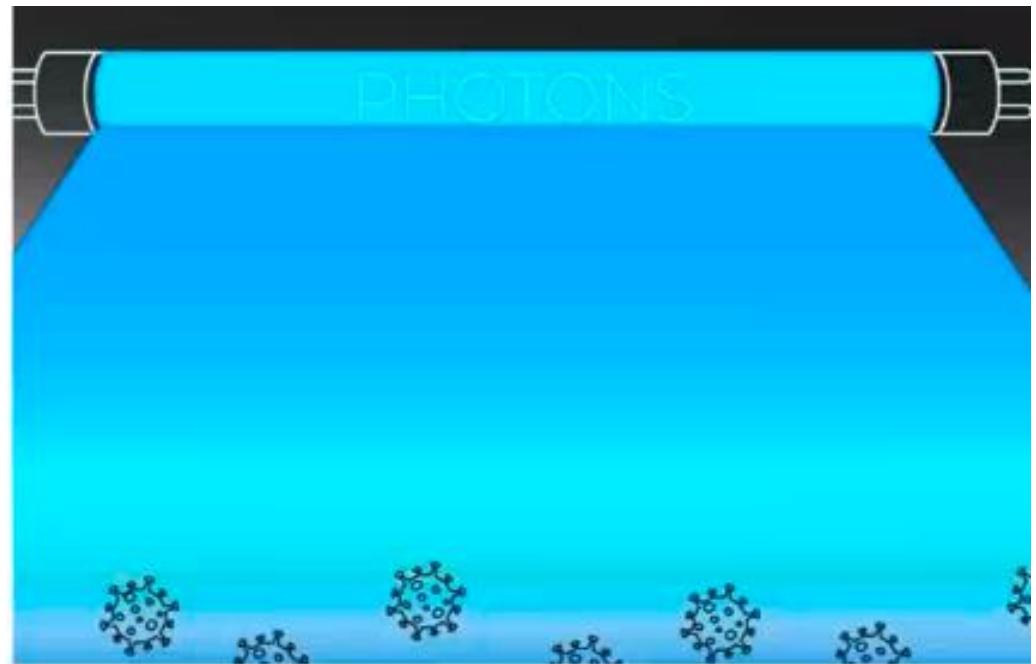
How does GUV work?

—

What is Inactivation?

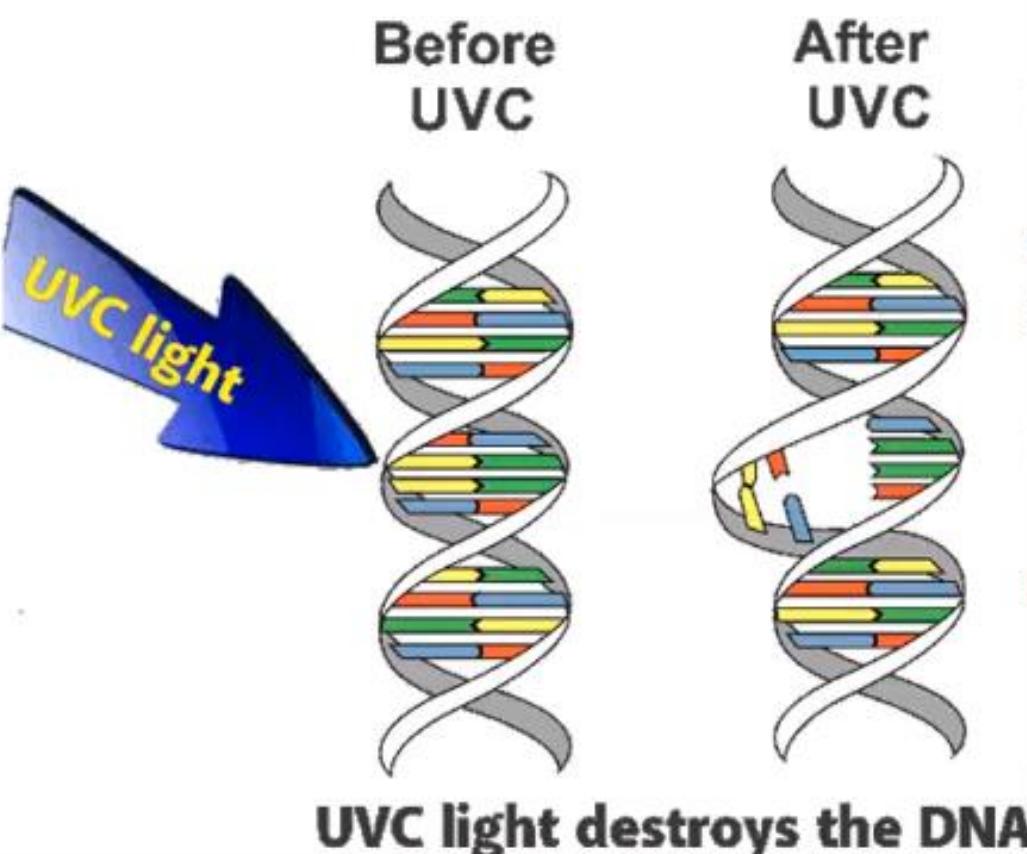
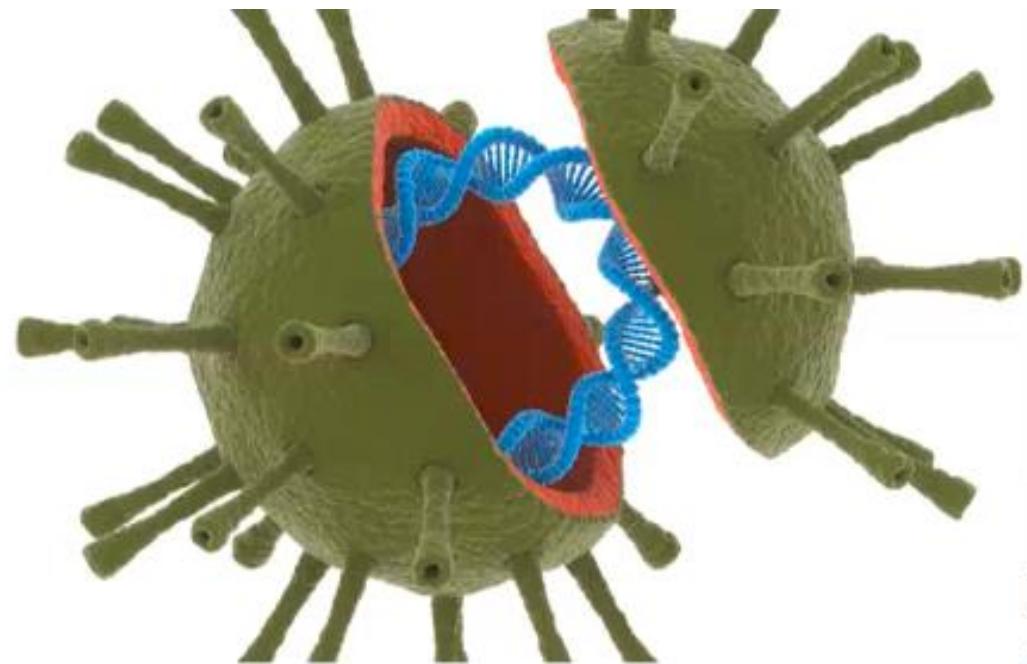
- For mold and bacteria, doses of UVC energy may not cause immediate cell death but the microbe will be "inactivated".
- While some biological activity may still exist, cell replication is impossible and no longer viable and is harmless.
- Small doses of UV-C over time hasten cell death. As viral particles are not a life form, we depend solely on inactivation to rid ourselves of their impending harm.

<http://www.uvresources.com/resources/faqs>



How does Germicidal UV (GUV) work?

- Microorganisms are simple organic structures that readily absorb the UVC wavelength, causing photo-disassociation (destruction).
- A microbes DNA (deoxyribonucleic acid), is adversely effected due to its weaker molecular bonds. In hundredths of a second it suffers irreparable damage. The loss of genetic instructions causes cell death and/or the inability to replicate, rendering them harmless.
- Continuous exposure to UVC causes uninterrupted degradation, similar to exposure to the sun, only significantly faster.





Bacteria vs. Viruses

- Bacteria and viruses differ in their structure and their response to medication.
- Bacteria are single-celled, living organisms.
- Viruses are not considered to be “living”. They require a host cell to survive long-term.
- Less than 1% of bacteria cause disease. Most are beneficial for our good health and the health of Earth’s ecosystem. Most viruses cause disease.
- Antibiotics may be used to treat some bacterial infections, but they do not work against viruses.
- Vaccination is the primary way to prevent viral infections. Antivirals are not effective against bacteria.

What type of lamps?

Available Lamp Technologies for GUV

- Low-and medium-pressure mercury vapor lamps in a fused quartz envelope
- Pulsed xenon arc lamps.
- LED's can provide ultraviolet light germicidal wavelengths of 100nm to 280nm, but are not currently able to provide the intensity of light needed to disinfect surfaces.
- Light emitting diodes (LEDs) and krypton-chlorine excimer lamps, which emit in narrow bands in the germicidal range (UV-C), are emerging technologies.



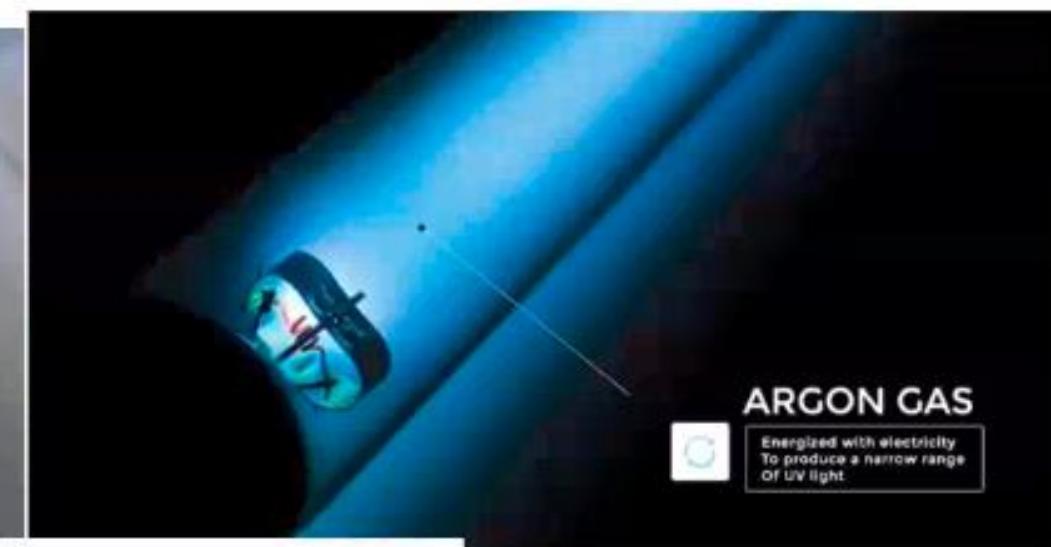
LED Lamp



Xenon Arc Lamp



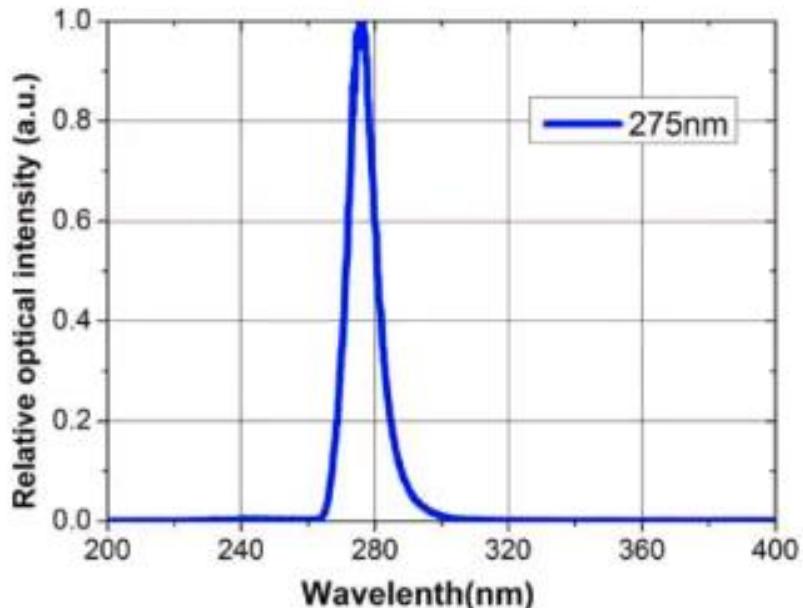
Excimer Lamp



Mercury UVC
Lamp

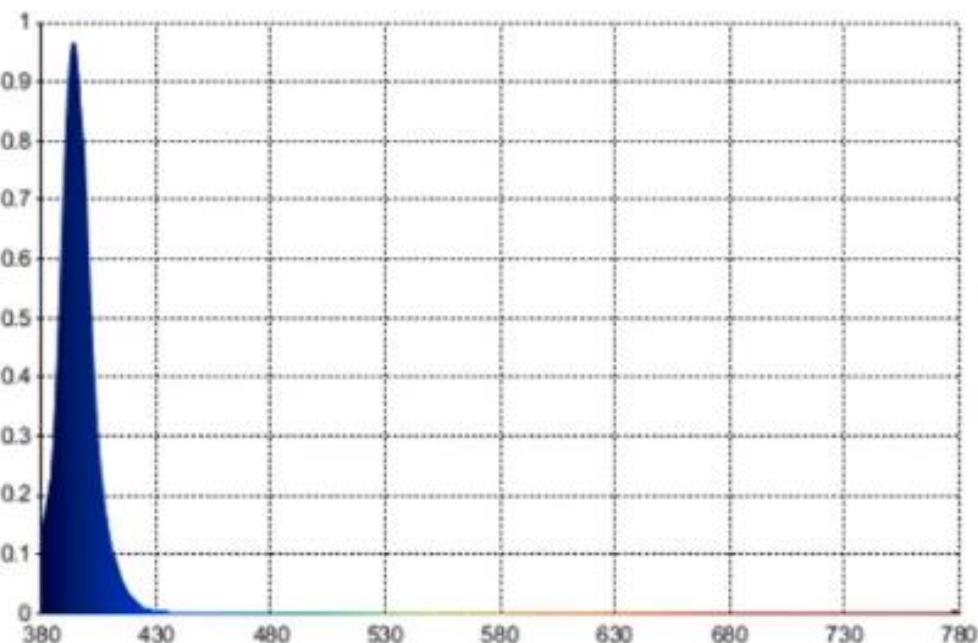
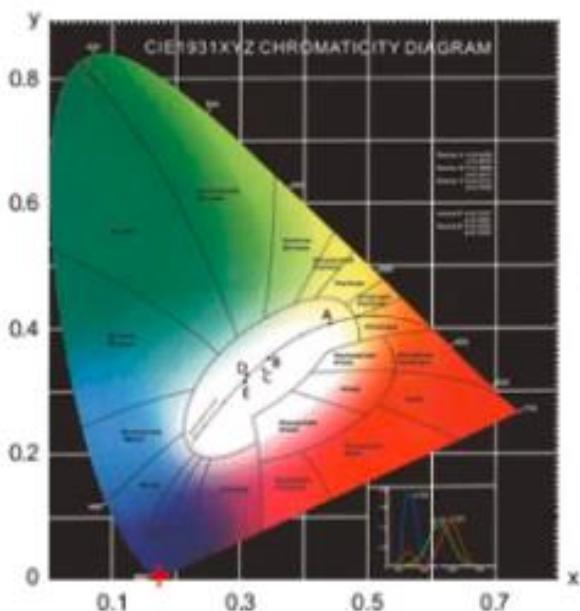
Available Lamp Technologies for GUV

- LEDs have been developed that emit in the UVC range around 265-280 nm
- Operation at 274 -280 nm increases the risk of skin and eye damage over that of 253.7 nm mercury emission
- Many products can be found in the marketing advertising LEDs for germicidal use; most such advertising is false as they emit in the UVA range
- Current efficiency of UVC LEDs is below 1% i.e. very low, but progress likely will come quickly



Mis-information

CIE1931 Chroma Figure



Model: 390nm UV lamp

Test Cond:Tg=24.2Cels Ta=24.6Cels RH=60%

Test Date: 2020-3-30

Manufacturer:

Measure Device: Volnic X10 Series CCD Spectrum System

Operator(Sign): _____



<https://hackaday.com/2020/04/15/buyer-beware-this-led-bulb-sold-as-germicidal-doesnt-emit-uv-c/>

How long does GUV take to work?

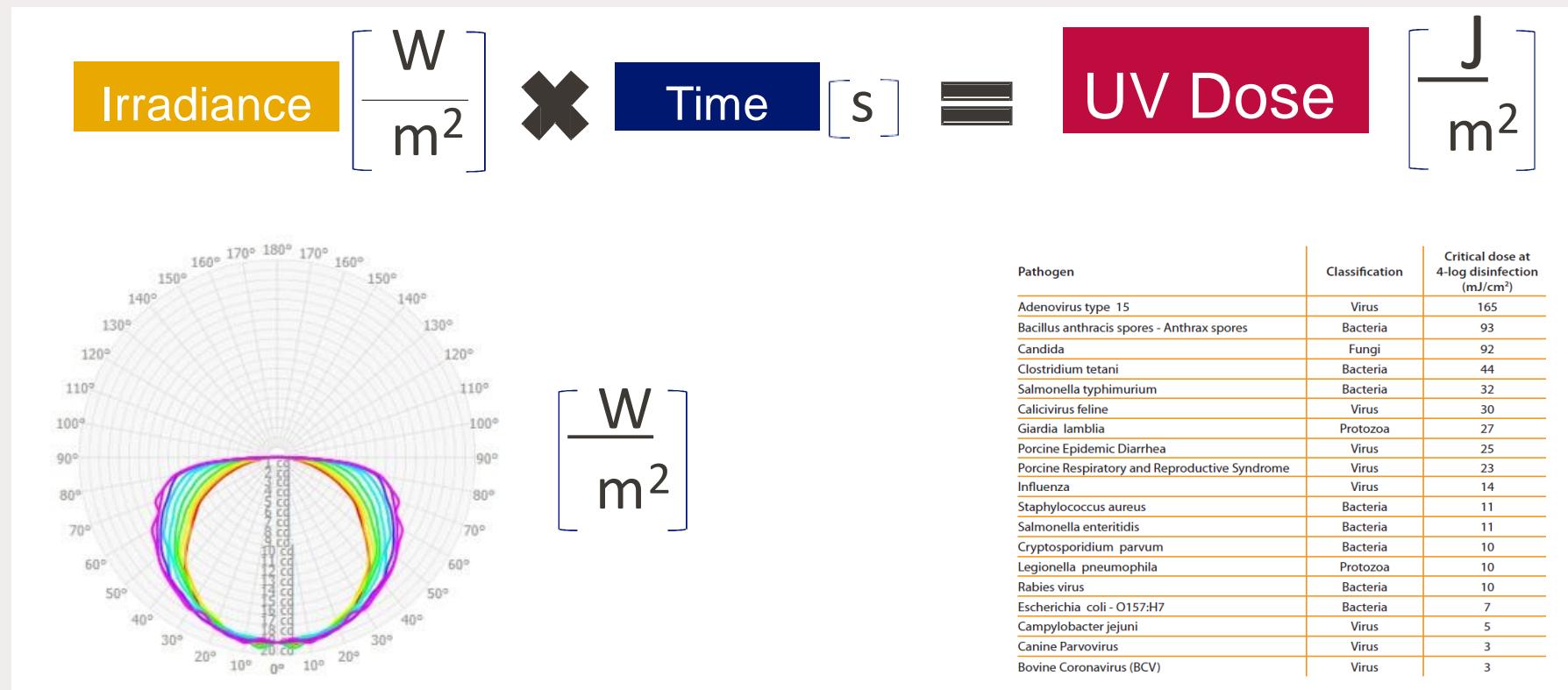


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Complex Math, Simple Solution

Dose based on Intensity and Time



Irradiance ~ Luminance

Known Pathogen Dosages
99.99% effective

Confidently determine the time required to eliminate pathogens

- Breaking News:*
- Up to now, we have reported the Covid-19 coronavirus was being tested without results
 - As of June 16, Signify and National Emerging Infectious Diseases (NEIDL) at Boston University have validated Signify UV-C light sources inactivate SARS-CoV-2
 - As of June 16 the dosing has been determined and is lower than expected – 22mJ/cm² is the dose required to inactivate SARS-CoV-2 to a 6-log kill which is 99.9999% effective. A 99.99% effective dose is just over 15mJ/cm².



Log Reduction or Log “Kills”

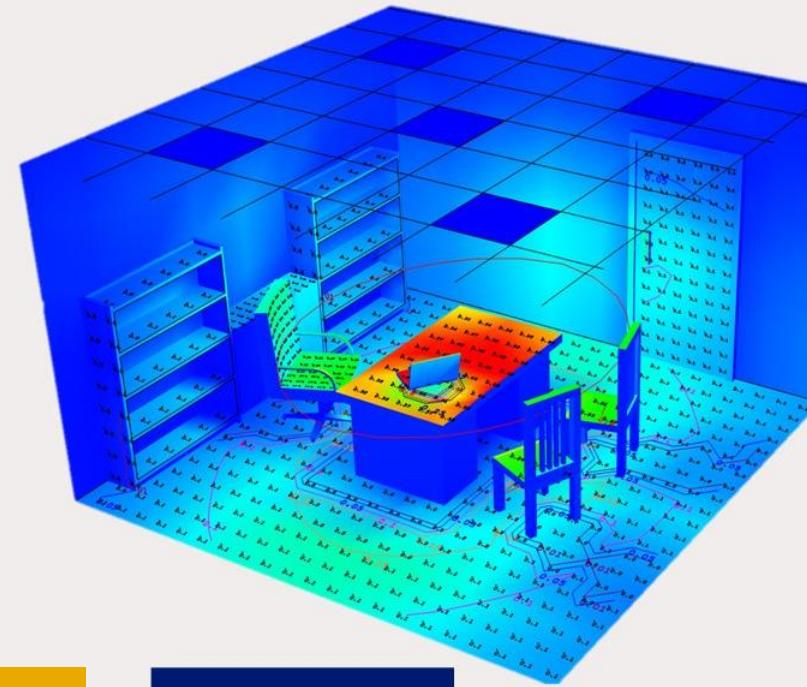
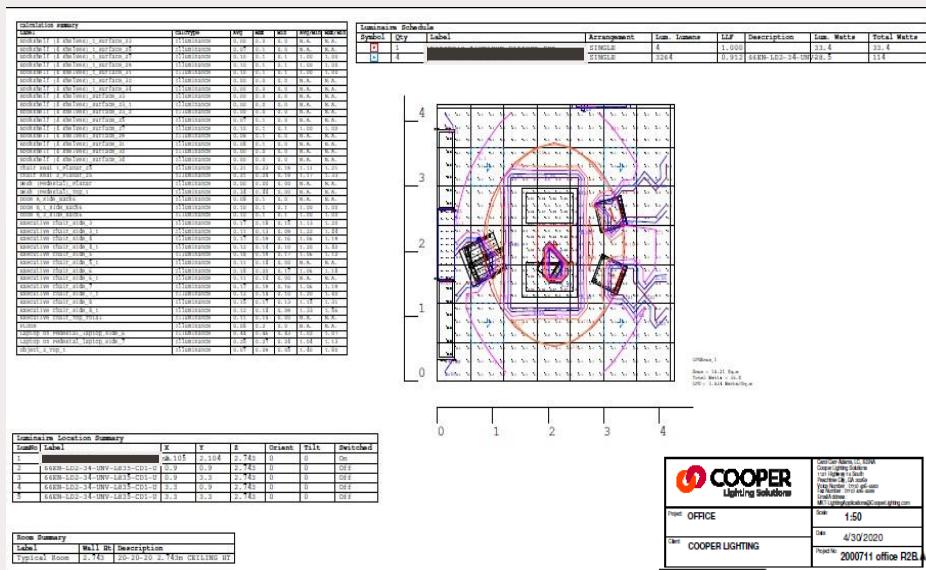


- If a certain UV exposure kills 90% of a bacterial population (frequently referred to as "one-log kill"), doubling the exposure time or intensity can kill only 90% of the residual 10%, for an overall germicidal efficacy of 99% ("two-log kill"). Likewise, a 50% decrease in dose or exposure time decreases germicidal efficacy only from 99% to 90%.
- In practice a GUV dose of interest is 3 or 4 log-kills, corresponding to 99.9% or 99.99% inactivation, respectively. To be effective in practice, achieving two log-kills (99% inactivation) is frequently accepted.

How do we plan spaces with GUV?

Disinfectant Layouts

Product type and GUV quantity layouts are based on proximity to GUV, exposure time and target pathogen



Planning

UV Dose

Irradiance

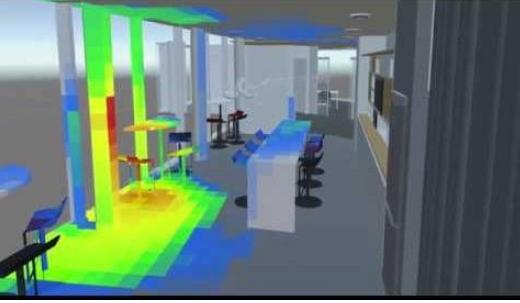
Time

We are building tools to enable clarity in applications and confidence in results to provide solutions and service



Applications Tools

GUV Power Guidance (coming in July)



Sample Application – Private Office

The screenshot shows two tables from the software's interface:

Luminaire Summary	Model	X	Y	Z	Orient	Tilt	Total Watts
...

Luminaire Schedule	Symbol	Qty	Label	Arrangement	Size	Lum.	Description	Lum. Watts	Total Watts
...	SINGLE

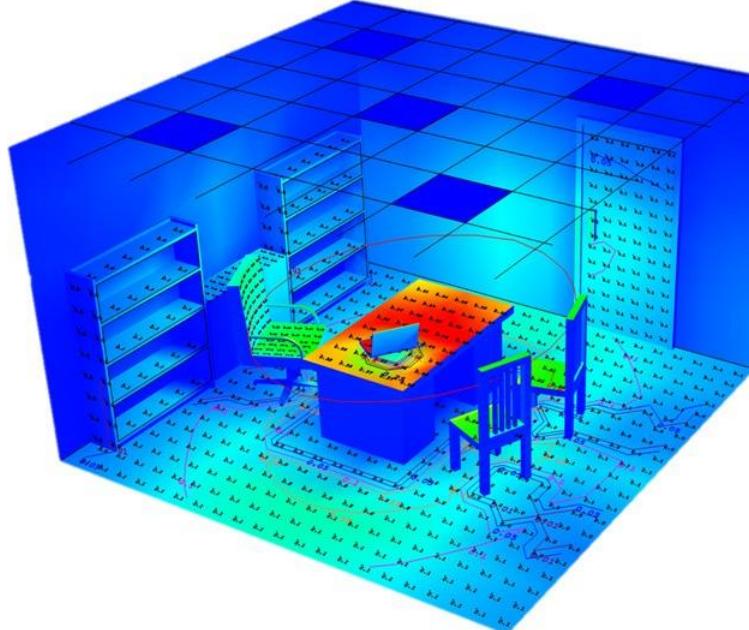
Below the tables is a 2D floor plan of an office layout with luminaire placement indicated by purple circles. A legend at the bottom right defines symbols for 'Single' and 'Dual' arrangements.

Luminaire Location Summary	X	Y	Z	Orient	Tilt	Switched
...

Room Summary	Wall	Height	Description
Typical Room	0.743	2.0-2.0-2.0	2.4m Ceilings 81

At the bottom is a small logo for COOPER Lighting Solutions and some project details:

Project: OFFICE Date: 1-50
Client: COOPER LIGHTING Date: 4/30/2020
Design: 2000711 office R2B.GI



Dosing calculations on next pages are based on log₄ Kill for each pathogen.

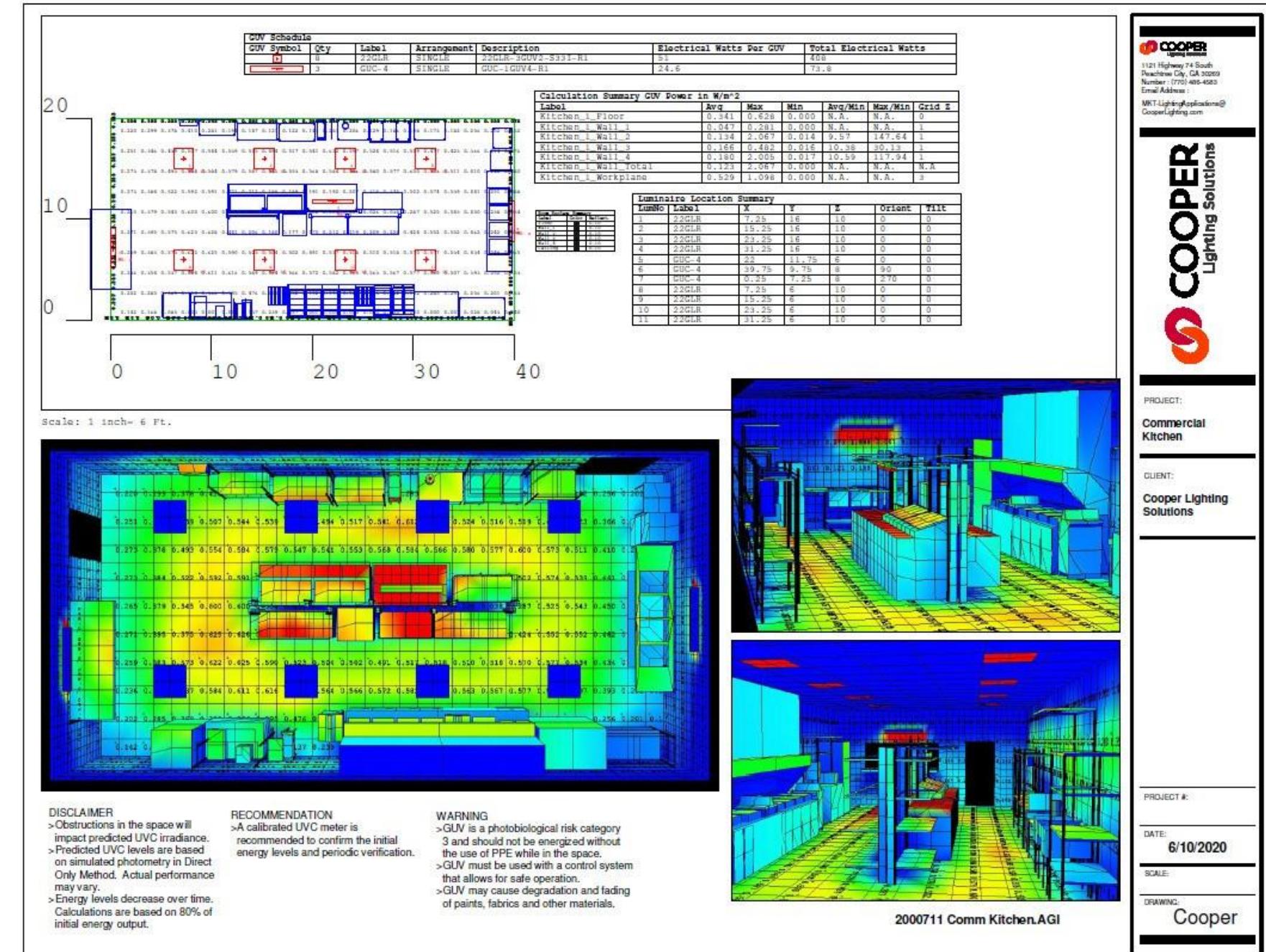
$$\text{UV Dose} \left[\frac{\text{J}}{\text{m}^2} \right] \div \text{Irradiance} \left[\frac{\text{W}}{\text{m}^2} \right] = \text{Time} \left[\text{s} \right]$$

Calculated life is based on lamp life of 9000 hours.

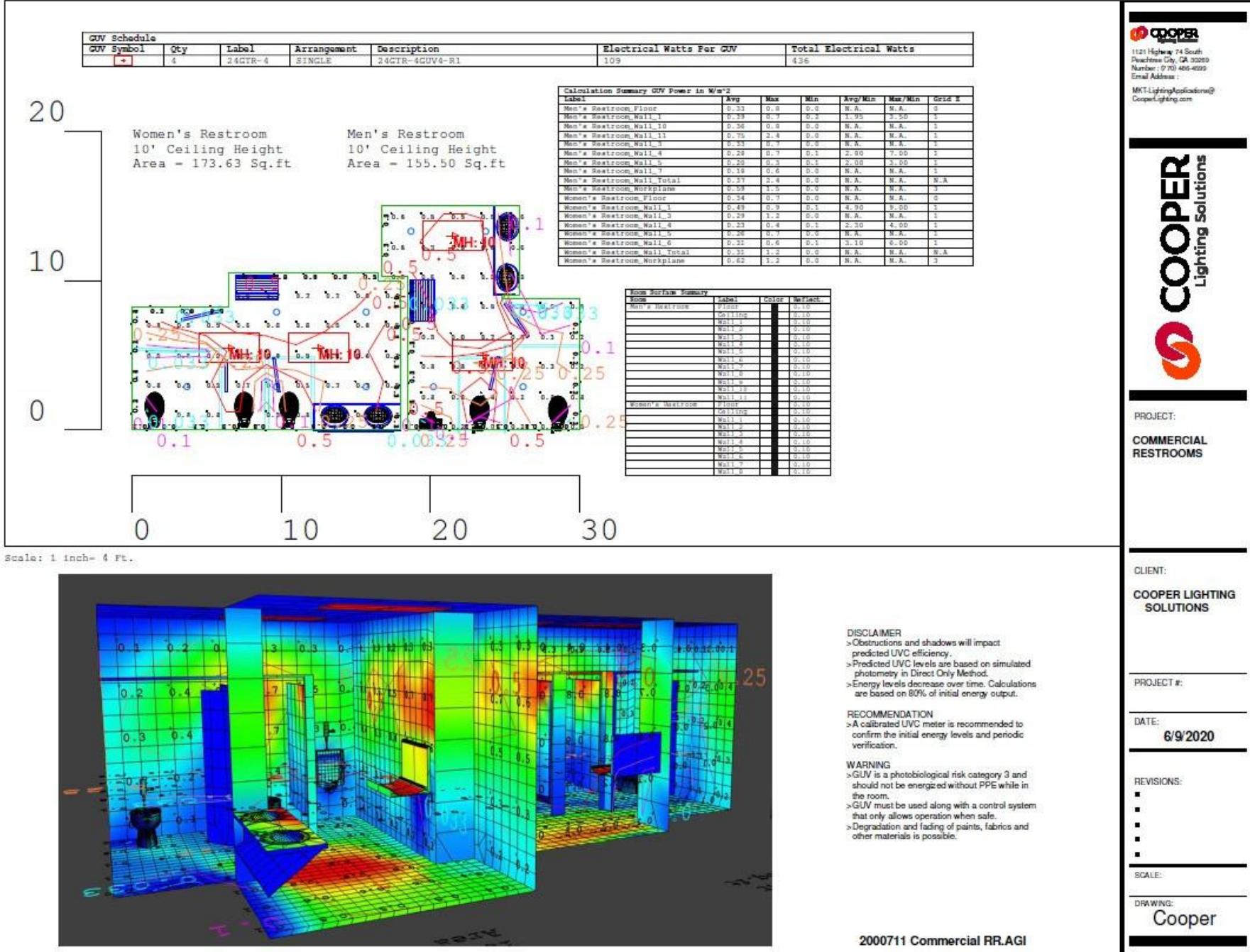
Dosing Calculations – Typical Applications



- Private Office
- Restroom
- Kitchen (Large Commercial)
- Classroom
- Large High Ceiling Space (Foyer, Showroom, Warehouse)
- Janitor Closet



Application – Bathroom



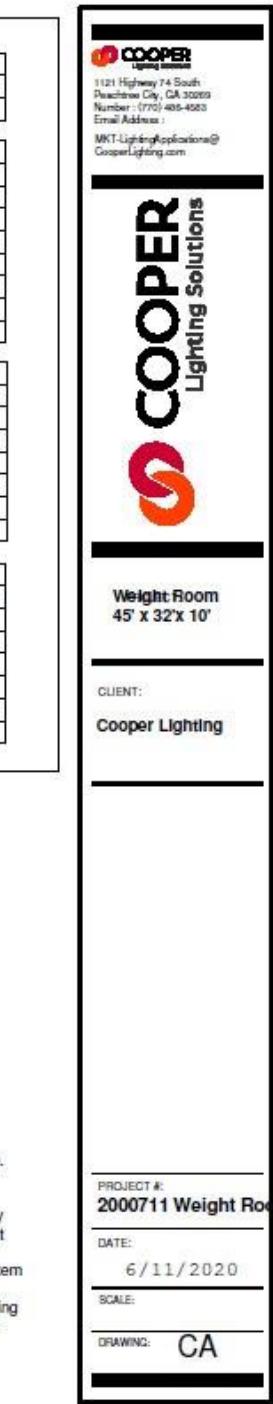
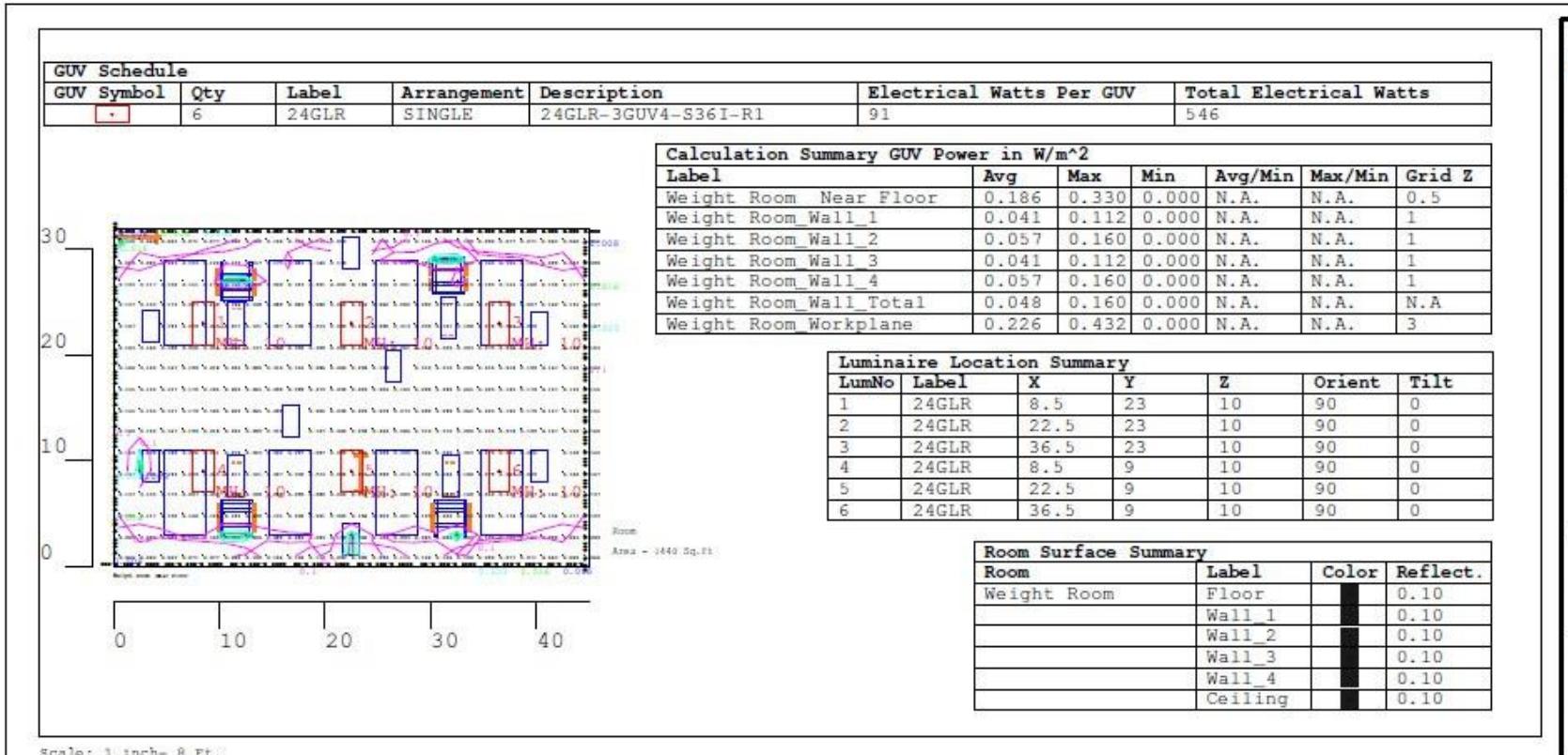
Two 2x4 GTR 4 lamp

Coronavirus Expected Run Time = 90 sec

GUV source life expectancy > 25 years



Application – Fitness Center



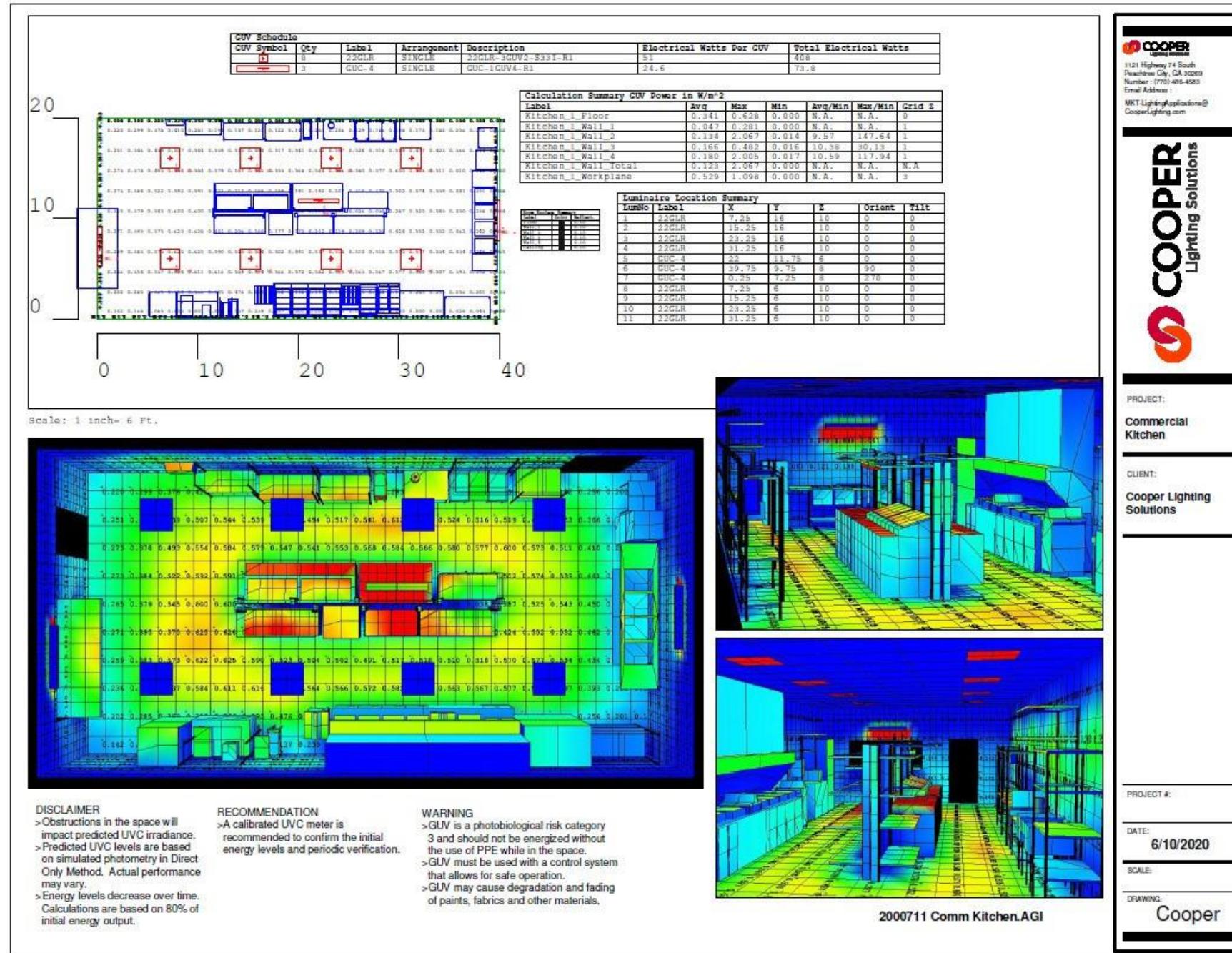
Six 2x4 GLR

Influenza Expected Run
Time = 11 min

GUV source life
expectancy > 25 years



Application - Kitchen



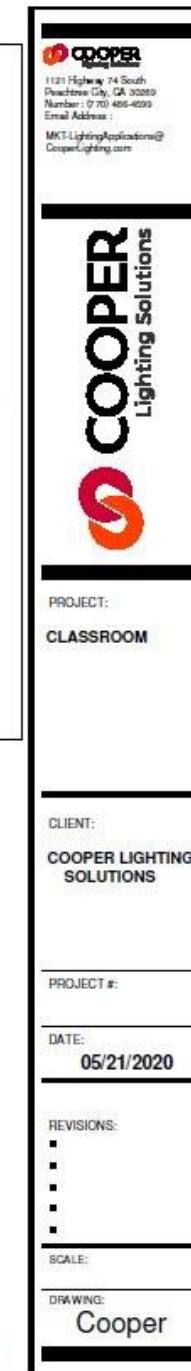
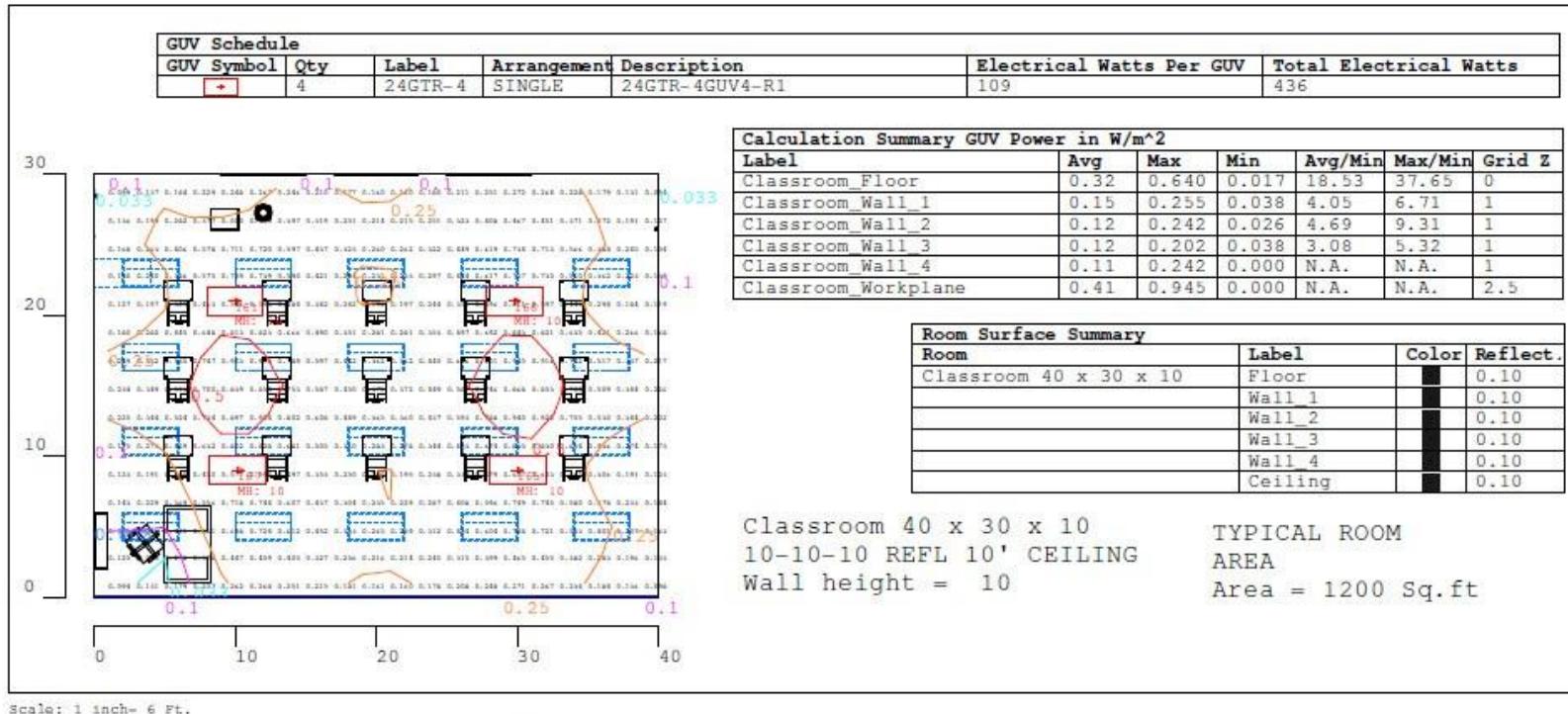
Eight 2x2 GLR

Salmonella Expected
Run Time = 10 min

GUV source life
expectancy > 25 years



Application – Classroom



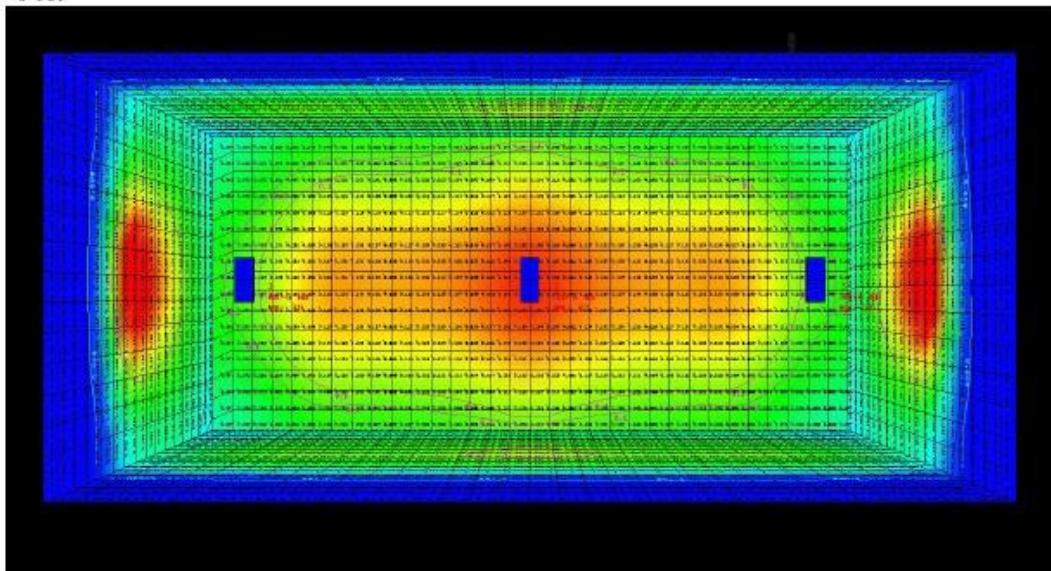
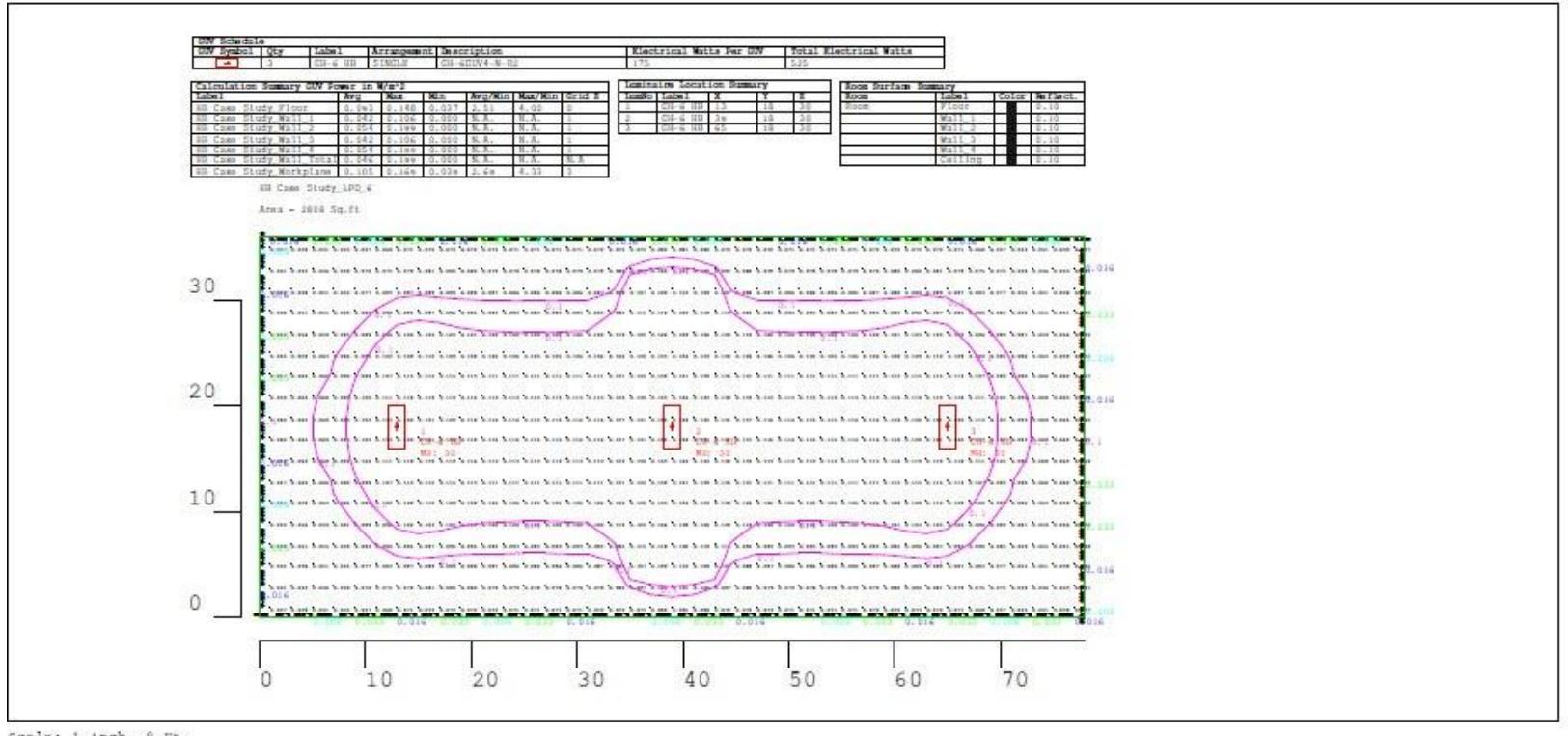
Four 2x4 GTR 4 lamp

Influenza Expected
Run Time = 14 min

GUV source life
expectancy > 25 years



Application – Foyer, Showroom, Warehouse



2000711 Small Warehouse.AGI



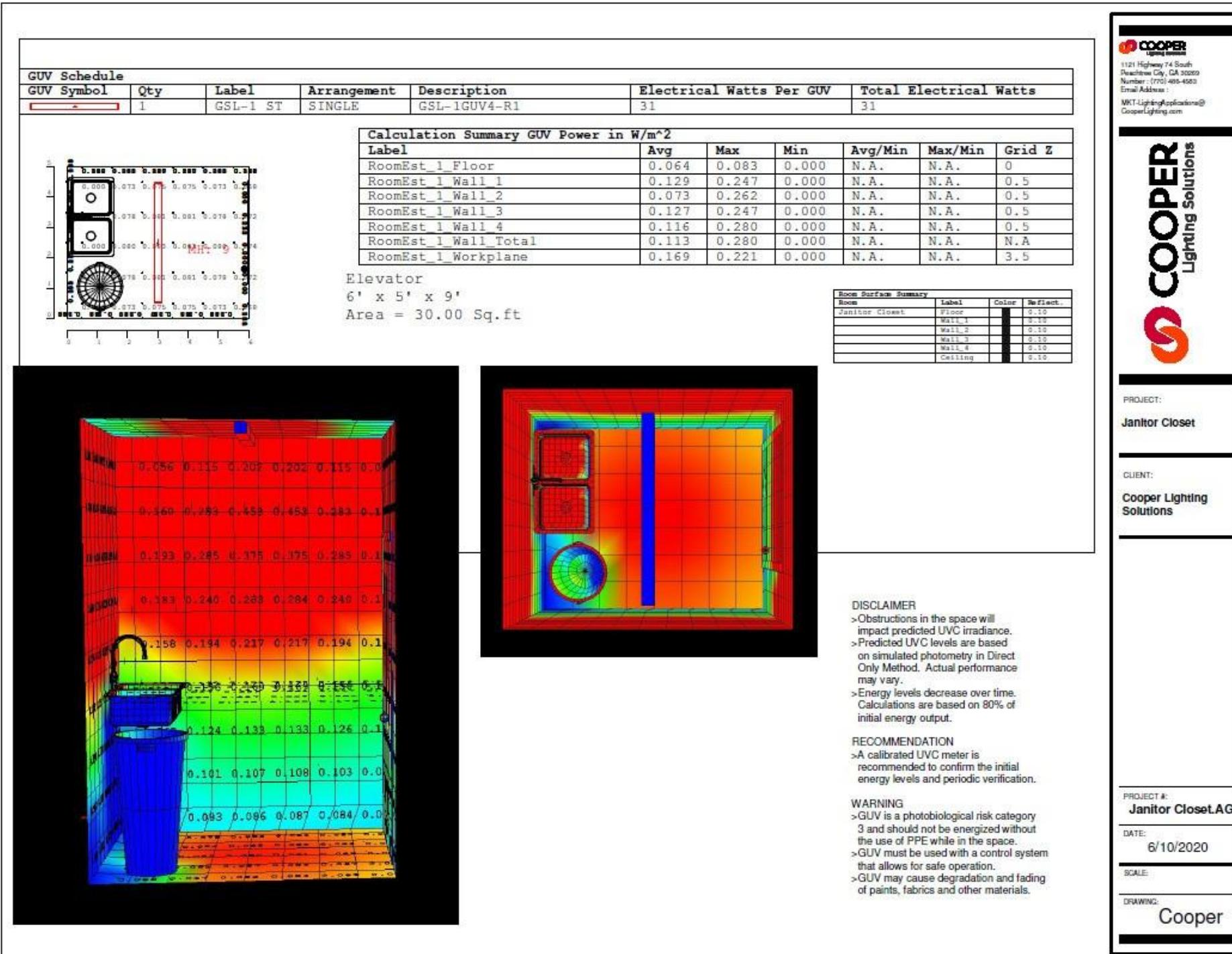
Three 2x4 GH 6 lamp

Coronavirus Expected
Run Time = 15 min

GUV source life
expectancy > 25 years



Application – Janitor Closet



One 4' GSL

Anthrax Expected Run
Time = 1.5 hours

GUV source life
expectancy > 16 years



What about controls for GUV lighting?

UL1598, it's new! But it's not.



Examples of current germicidal UVC devices



Products that UL will certify for safety.



Products that UL is unwilling to certify for safety due to high risk.

Type of UVC Device	Sample Image	Environment	Assessing the risks	Safety Certification(s)
Home use portable sterilizer Marketed to clean a room in the home		Consumer	UVC is NOT contained - not safe for a home setting There is too great a risk that people and pets could accidentally be exposed to UVC and be injured, and ozone may be emitted. The exposure dose to people can be far above accepted levels and can cause injury. Integral timers or proximity and orientation sensors pose concerns with accuracy and reliability of these safeguards, as well as opportunities for misuse or bypass	NOT eligible for certification for consumer use
Personal portable sterilizer/wand Marketed to be hand held and moved over surfaces to sterilize		Consumer	UVC is contained	NOT eligible for certification for consumer use; for commercial and healthcare applications contact UL to discuss
Home use air cleaners with internal (contained) UVC Marketed to homes and offices		Consumer	UVC is contained The UVC source is inside the product enclosure and a safeguard disables the UVC when an access door is opened	UL 507 for electrical investigation; standard includes personal injury requirements for UVC based on ANSI RP-27 for photobiological assessment
Portable and stationary UVC sterilization boxes		Consumer and Commercial	UVC is contained The UVC source is inside the enclosure; opening the door will disable the UV source. Testing would ensure that any 'UV leakage' will be within safe exposure dose limits	UL 73 for electrical investigation; includes personal injury requirements for UVC based on ANSI RP-27 for photobiological assessment. UL 62368-1 (or 60950-1) may also apply.
Upper room (UVGI) Mounted out of easy reach typically 2.1m (7 feet) from floor		Commercial	UVC containment is achieved based on product design features plus site safeguards Unlike typical luminaires, these have construction features that direct UV energy away from the occupied space	UL 1598 for electrical investigation IEC 62471 for photobiological assessment
Commercial/industrial heating & ventilation May also be found in home settings		Commercial	UVC is contained inside the air duct and not visible Access is restricted to qualified personnel during installation and service. The design also includes other product safeguards such as ON/ OFF switch and interlock switch	UL 1598 (or UL 153) and UL 1995 for electrical investigation; UL 1995 includes personal injury requirements for UVC based on ANSI RP-27 for photobiological assessment
Water treatment UVC disinfects the water as an alternative to chlorination		Commercial	UVC is contained inside a water vessel and not visible Access is restricted to qualified personnel during installation and service	UL 979 for water treatment equipment ANSI RP-27 for photobiological assessment
Mobile UVC sterilizer/equipment sterilization		Healthcare and Commercial	UVC containment is achieved by limiting access to the space so people are not present during operation In addition, the equipment includes reliable safeguards and is operated by staff with training for its proper use	In healthcare settings - UL 61010 for electrical investigation; the standard references IEC 62471 for photobiological assessment to address personal injury concerns for UVC In commercial settings - UL 73 for electrical investigation; standard includes personal injury requirements for UVC based on ANSI RP-27 for photobiological assessment
Permanently installed/hybrid lighting systems Have UVC or UVC and regular lights		Healthcare and Commercial	UVC containment is achieved based on product safeguards, trained staff and site safeguards	UL 1598 for electrical investigation IEC 62471 for photobiological assessment
UVC mobile units Used to decontaminate surgical equipment between procedures		Healthcare	UVC containment is achieved based on product safeguards, trained staff and site safeguards	UL 61010 for electrical investigation; the standard references IEC 62471 for photobiological assessment to address personal injury concerns for UVC
UVClamps and components Ballasts, LED drivers, UVC sources, controls, sensors, etc.		Components	Components for use in UV devices and lamps (bulbs) can be certified; contact UL to discuss the specific use and design, and intended operation (within luminaires or only within equipment designed specifically for germicidal applications)	Multiple, as applicable

Always follow device labeling and manufacturer recommendations for appropriate settings, use restrictions, recommended PPE (if applicable), and required training. Don't see your product type here? We can help. Contact us today.

Consumer

Commercial

Health Care

"Containment"

UL Certified System



Germicidal UV
System



1. Control Panel



1. Control Panel

- Available in medium (16 inputs) and large (24 inputs).
 - An input is a pushbutton wired back to the control panel.
- One User Station can be wired into the control panel.
- Integrated timer mechanism
 - Maximum 6 hours.
- 120-277VAC
 - 120V- 1900W max
 - 277V- 4400W max

2. User Station



2. User Station



- Fits in double gang wallbox

1. Selector switch- provides power to pushbuttons and magnetic sensors
2. START LED- indicator to show if power is being supplied
3. READY LED- to show the user all pushbuttons and magnetic sensors are in the closed position.
4. Keyed momentary switch- to turn the GUV fixtures on. allows authorized personnel to operate the system
5. GO LED- letting the user know the GUV fixtures are on

3. Clearance Pushbutton



3. Clearance Pushbutton



- Placed inside and outside the room to be disinfected.
- Ensures the user walks the space and checks for occupants.
- Illuminates when the button is engaged.
- IP65 rating
- Fits into standard single gang wallbox
- Fits in single gang wallbox

4. Magnetic Sensors



4. Magnetic Sensor

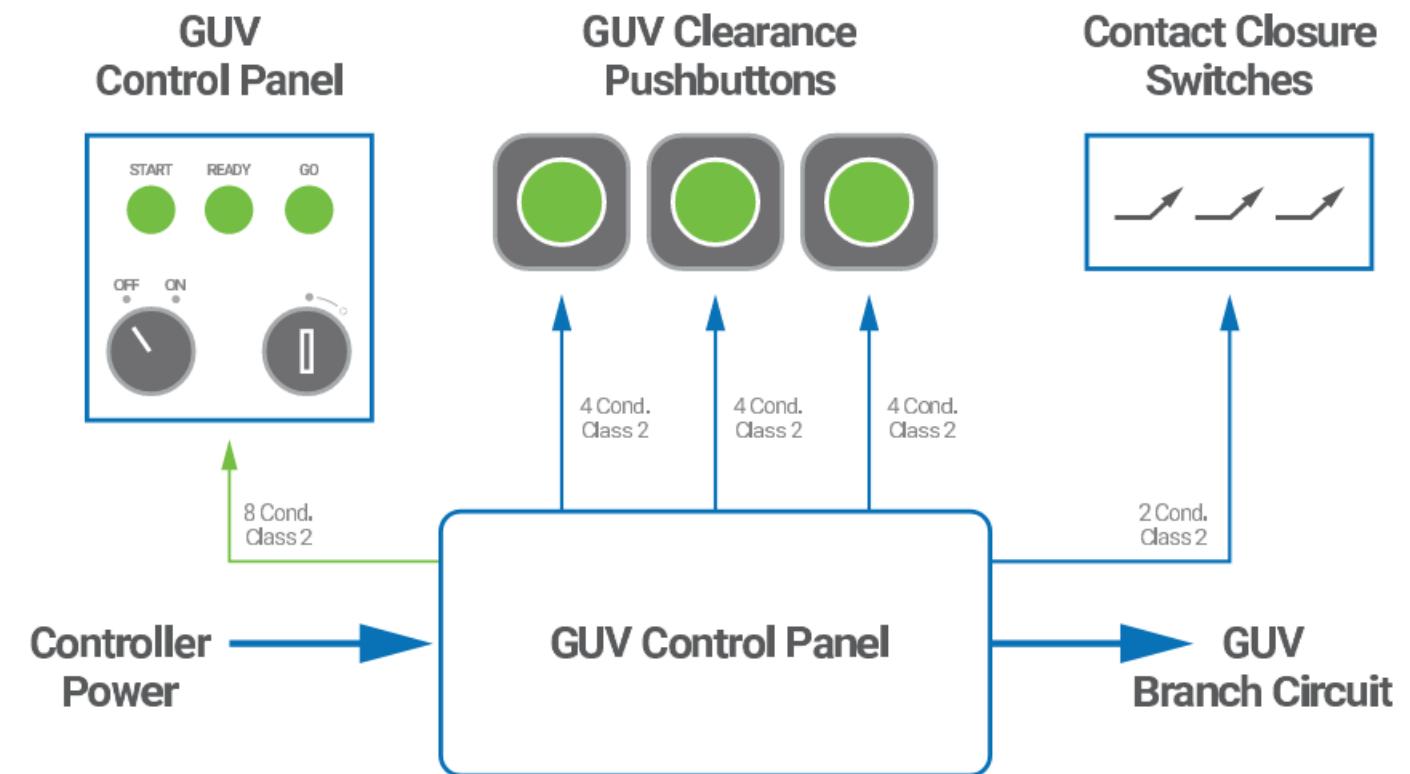


- Placed on any point of entry including doors and windows
- UL508 rated built in triple redundancy
- Coded magnetic actuator cannot be defeated
- IP67 rating

How it all connects...



Block Diagram:



Essential Safeguards - Generic Example

Open space – areas not enclosed completely on all sides if all doors and windows are closed. Not suitable for GUV luminaires.

Closed space – areas that can be completely enclosed and a boundary defined.

Doors - reliable enclosures with common door materials such as wood, metal, opaque plastics.

Windows – standard window glass blocks UVC emissions

Openings – openings that are not for doors/windows with an example of a food service window opening.

Partitions - a wall feature potentially creating an alcove.

Gates – interlocked areas without a door (not commonly used – special cases only)

Alcoves – Areas not easily seen when verifying no one is present in the cleaning zone

Hallways – open areas connecting rooms

Startup zone – location outside of enclosed, radiated area

Cleaning zone – radiated area while GUV luminaires are powered and interlocks are closed

Trained user – Person trained the exposure risks, operating the system, verifying upon cleaning no one is in the cleaning zone and is responsible for deactivating the system when done cleaning.

Commissioner – person who verifies system is operational and validates all push-buttons and interlocks operate as intended upon installation

Maintenance – Lamp replacement (from FL instructions)

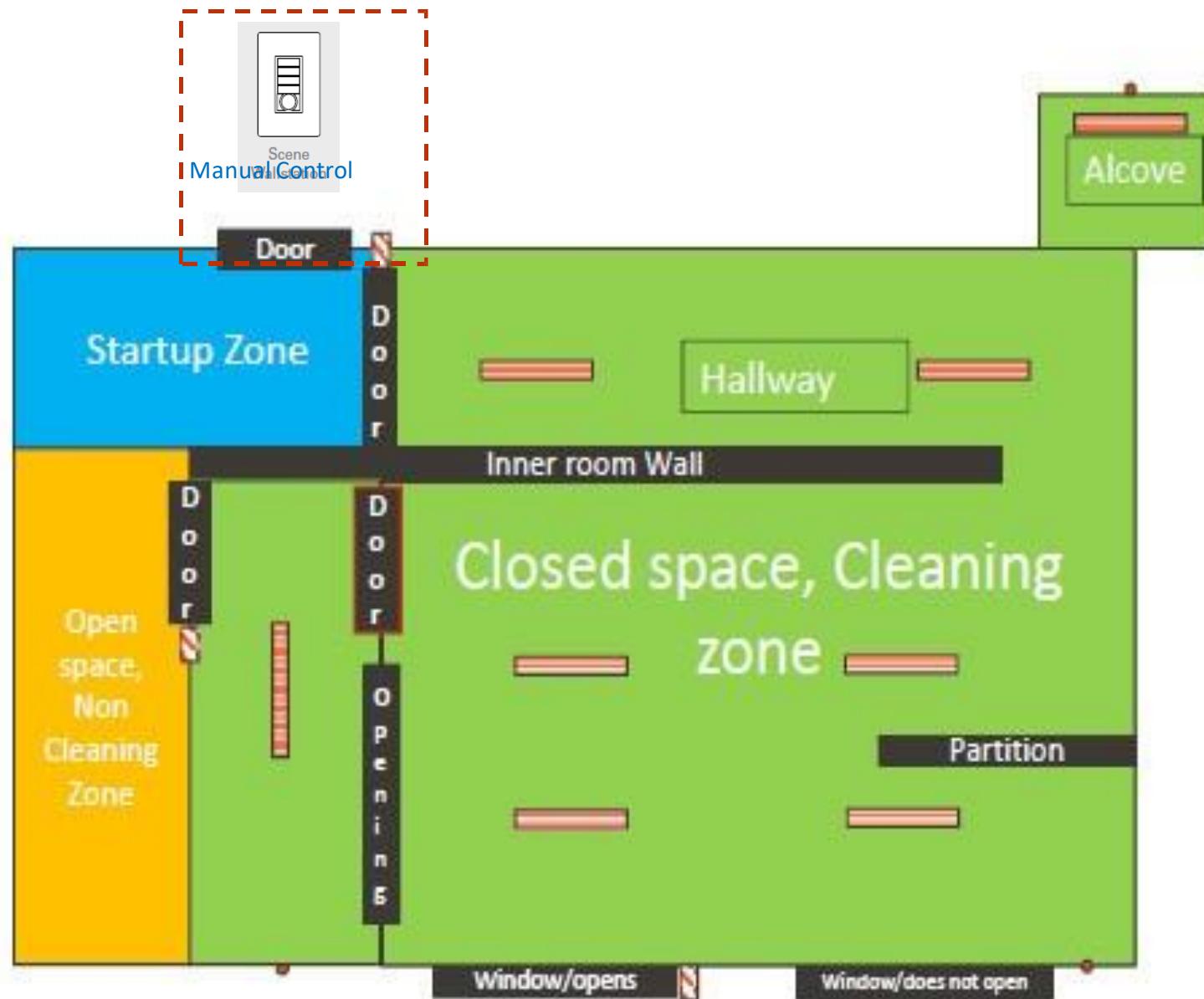
Interlocks – essential safety component for the system.

Push buttons – Push button switches when pushed latch the cleaning circuit relays

GUV Luminaire – Germicidal Luminaire

Design requirements –

- All doors and windows into closed space cleaning zone have interlocks
- Openings are considered in terms of creating open spaces and closed spaces
- Startup zone is outside of the closed space and behind an interlocked door
- Windows that can open are interlocked
- Any areas that create an alcove or nook shall have push button activator places
- Consider the cleaner's inspection of the space for adding additional push button switches (permanently placed furniture or equipment)
- For bathrooms place a push button in all stalls or partitioned areas, if it's an area where water could splash such as a shower we require a wet rated switch
- For rooms that experience high levels of humidity we require Damp rated interlocks/Push buttons
- All Interlocks must be closed, all switches must be activated for the system to activate. Consider labeling the interlocks and switches for local instructional purposes or developing a training guide for cleaners



Initial Product Offering



Introducing Fail-Safe GUV Disinfection Solutions

Fail-Safe Disinfection Solutions are Germicidal UV enabled fixtures that can be used to Disinfect surfaces, things, and spaces.



The 254nm GUV Engine



Fail-Safe

GTR Germicidal UV Troffer

Germicidal UV Disinfection Troffer
2' x 4'

Typical Applications

Retail • Industrial • Commercial • Education



Product Certification



Product Features



Top Product Features

- Designed to use the latest in Germicidal UV lamp technology
- Available in 4 and 6 lamp configurations
- Open design to maximize Germicidal UV Disinfection distribution
- Wireguard optional on all fixtures
- Compatible with standard grid ceilings
- Drywall kit available



Fail-Safe

GLR Germicidal UV Louvered Recessed

Germicidal UV Disinfection
2' x 2' and 2' x 4'

Typical Applications

Retail • Commercial • Education • Hospitality



Product Certification



Product Features



Top Product Features

- Designed to use the latest in Germicidal UV lamp technology
- Available in 2x2 and 2x4 sizes
- Open design to maximize Germicidal UV Disinfection distribution
- Louvered design for aesthetic appeal
- Compatible with standard grid ceilings
- Drywall kit available



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Fail-Safe

GUC Germicidal UV Undercabinet

Germicidal UV Disinfection Undercabinet
2' and 4'

Typical Applications

Commercial • Industrial • Education • Retail



Product Certification



Product Features



Top Product Features

- Designed to use the latest in Germicidal UV lamp technology
- Available in 2' and 4' lengths
- Front face to keep germicidal energy on workspace
- Low profile unobtrusive design
- Specially designed reflector to maximize germicidal energy output



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COOPER
Lighting Solutions

Fail-Safe

GSL Germicidal UV StripLight

Germicidal UV Disinfection StripLight
1 or 2 lamps, 4'

Typical Applications

Retail • Industrial • Commercial • Education



Product Certification



Product Features



Top Product Features

- Designed to use the latest in Germicidal UV lamp technology
- Available in 1-lamp and 2-lamp configurations
- Can be surface mounted or suspended
- Optional Wireguard to protect lamps from damage
- Narrow design for size-restricted applications



Fail-Safe

GH Germicidal UV High Bay

Germicidal UV Disinfection High Bay
6 or 8 lamps

Typical Applications

Retail • Industrial • Custom Chambers • Large Open Spaces



Product Certification



Product Features



Top Product Features

- Ideal solution for large area UV Disinfection
- Designed to use the latest in GUV lamp technology – will accommodate 6 or 8 germicidal lamps
- Can be used at lower mounting heights for rapid disinfection
- Can be used at higher mounting to disinfect a larger surface area
- Excellent solution for use in disinfecting Retail and custom enclosures



Once BioShift Pass-Thru



- *Maximizes bio-security protocols*
- *Kills a majority of viruses in a recommended five-minute disinfection cycle*
- *Rugged shelving supports heavy items*
- *Provides an effective disinfection option where no other methods exist*
- *Digital LCD display with count-down timer and lamp maintenance log*
- *Pass-through lockout protects against accidental exposure*
- *Heavy-duty stainless-steel chamber*
- *Easy-to-use, one button operation*
- *Chemical-free disinfection*

I keep hearing about
222nm?



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What's all the hype about 222nm?

Topic	254nm	222nm Concept	So what?
Proven?	In use for 30+ years	Theoretical – 1 published study	Proven vs. unproven technology
Power Needed	Uses 40% of the power to generate disinfection radiation	Uses 4% of the power to generate disinfection radiation	You need 10x the power to get the same disinfection levels
Energy Consumption	A (6) lamp fixture consumes 216W or 0.072kWh over a 20 min period	A comparable fixture consumes 450W to 2250W , or 0.15kWh to 0.75kWh	You need to spend 2x to 10x on energy to get the same disinfection levels
Price	Average sell price for a (6) lamp fixture: \$300	Average sell price for an equivalent fixture: \$3,000 to \$10,000	Price to value does not make financial sense
Availability	You can buy a 254nm fixture TODAY	Far-UV 222nm fixtures not available for sale yet	You need to serve your customer NOW
Safety	Not safe to use while people are present unless it's indirect (upper air)	Claims that it's safe but many studies point its ability to penetrate moles, freckles, etc. and cause harm	Both unsafe unless used with safeguards

So What Do I Do Next?



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Next Steps

- Educate Yourself
- Engage the Market - talk to customers, determine market need
- Qualify Opportunities - curiosity verses real desire to implement
- Quantify Applications - gather information, contact your Cooper Lighting representative for help.

Fail-Safe GUV Micro-Site

cooperlighting.com/guv

About Us | Cooper +Signify Greater Together

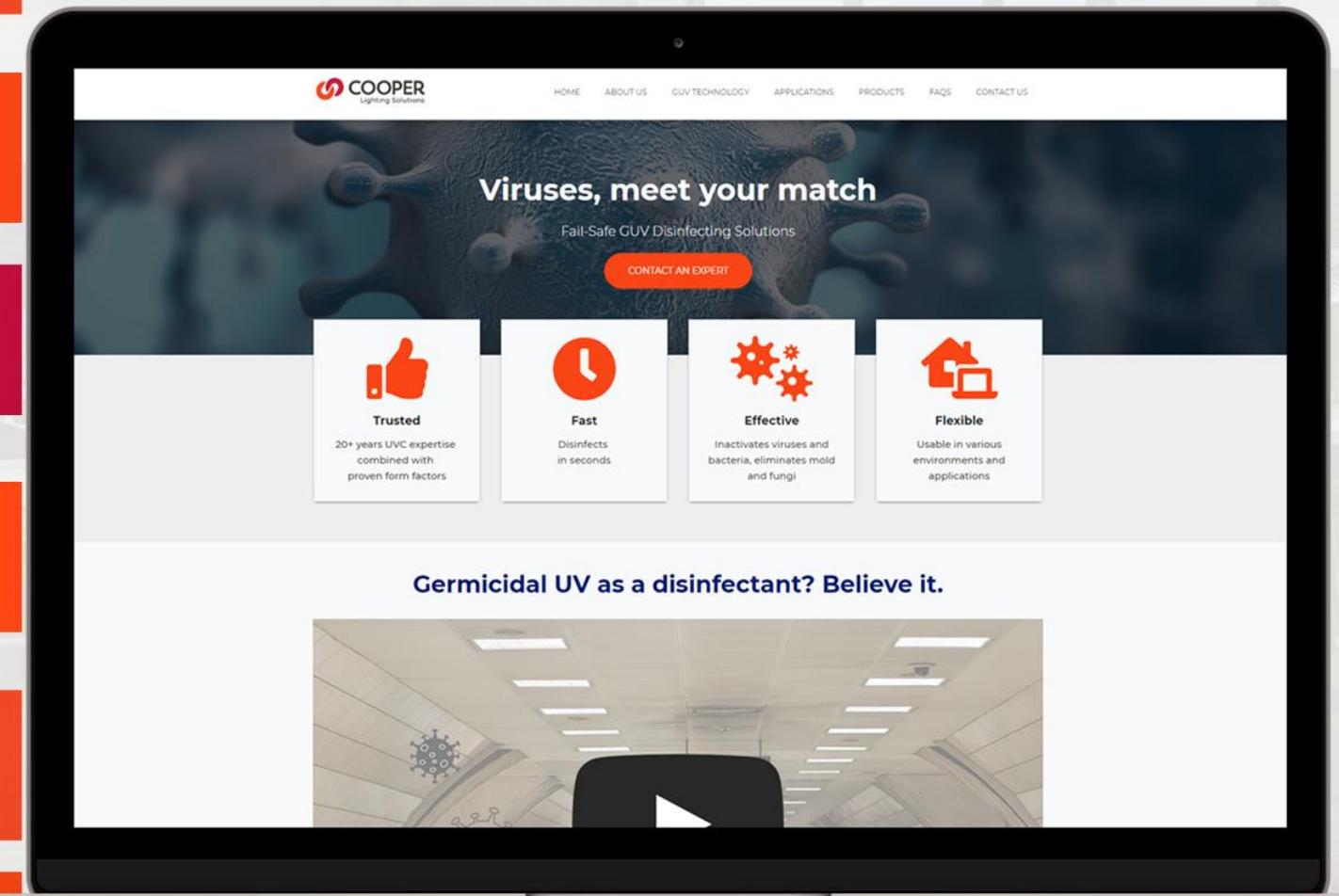
GUV Technology | What is GUV Simplified

Applications | Use Case Scenarios

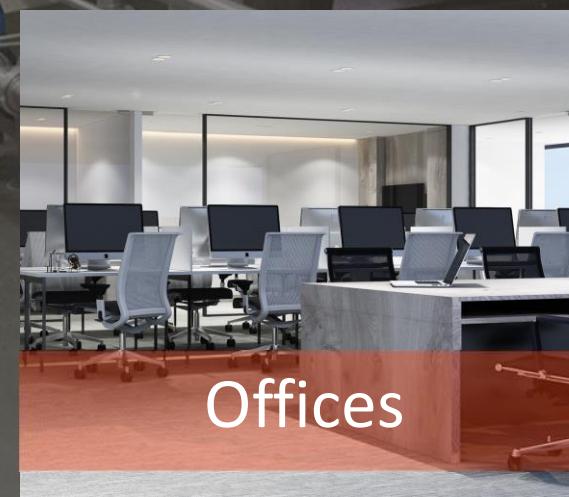
Products | Phase I Initial!

FAQs | IES – GUV, Cooper Solutions

Contact Us | Lead Capture Opportunities



Real-world Applications



If you have an application for GUV technology, you should take the following steps

1

Gather as much information as you can

1

Identify what you want to disinfect – air / surfaces / things

2

Identify what viruses / bacteria / etc you are targeting

3

In the case of air or surfaces, obtain a drawing of the space as well as a RCP

2

Contact your local rep agent to start the application team rolling

The best results come through proper application design!

Questions?



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