



**Celebrating the
50th Anniversary
of the Clean
Water Act...
*A Job Well Done!***

**NEWEA
2023 Annual
Conference
& Exhibit**

January 22 – 25
Boston Marriott Copley Place
Boston, Massachusetts

**Using Electricity to Disinfect – Sparks May Fly when
O3 & UV combine to Purify WRF Effluent**

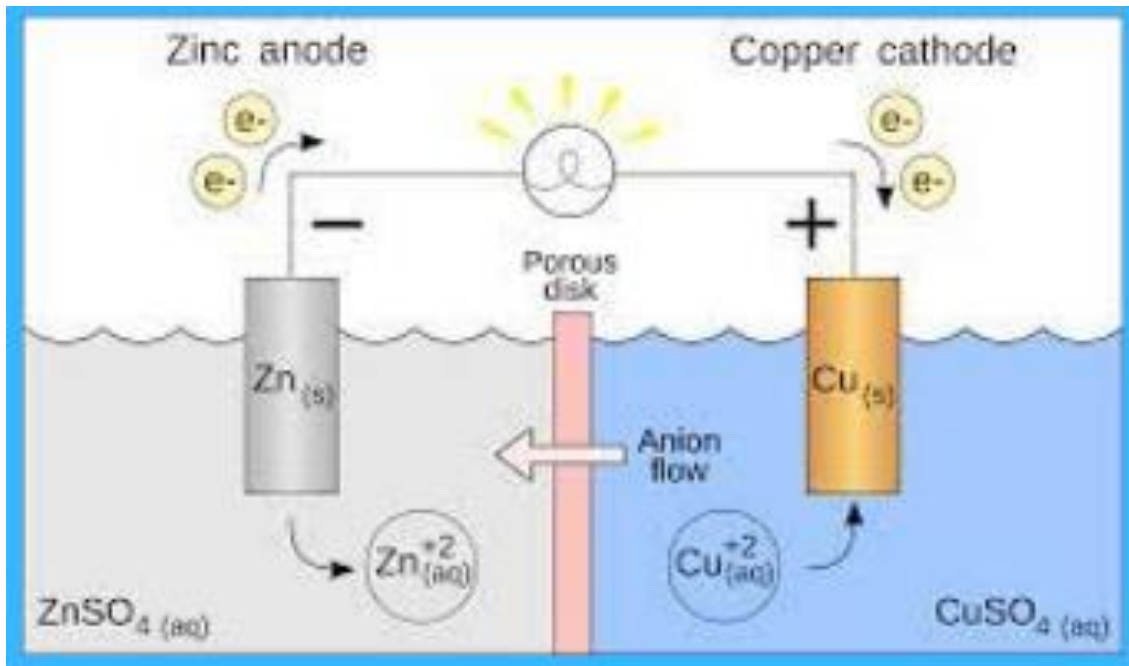
Bruce Stevens & Bill Nezgod – VEOLIA P+D TEAM

Electricity ~ Oxidizing Power from Basic Chemistry

Oxidizing species	Relative oxidation power
Chlorine	1.00
Hypochlorous acid	1.10
Permanganate	1.24
Hydrogen peroxide	1.31
Per Acetic Acid	1.38
Per Formic Acid	1.45
Ozone	1.82
Atomic oxygen	1.86
Hydroxyl radical	2.05
Positively charged hole on TiO ₂ w UV	2.35

Electricity is used to create many oxidants

- Anode and Cathode technologies help Enhance Fluid Chemistry



Anode	Cathode
The anode is the electrode where electricity moves into.	The cathode is the electrode where electricity is given out or flows out.
The anode is usually the positive side.	A cathode is a negative side.
It acts as an electron donor.	It acts as an electron acceptor.
In an electrolytic cell, oxidation reaction takes place at the anode.	In an electrolytic cell, a reduction reaction takes place at the cathode.

UV Lamps are essentially a glorified e-cell

- Electricity is pushed thru a cathode to an anode which creates a **plasma arc** that emits photons to provide energy for disrupting the RNA, DNA , proteins and cellular masses of viruses, protozoans, spores, nematodes & bacteria by breaking chemical bonds - **Inactivation aka Disinfection**
- Advanced Oxidation Processes occur when much larger power levels are forced thru the lamps into the fluid which react with oxidants to create short lived but powerful hydroxyl radicals.
- Ozone can also be mixed with Peroxide , Sulfate , NaOCL, other chemicals or UV lamps to create hydroxyl radicals too



Ozone has been favored and feared

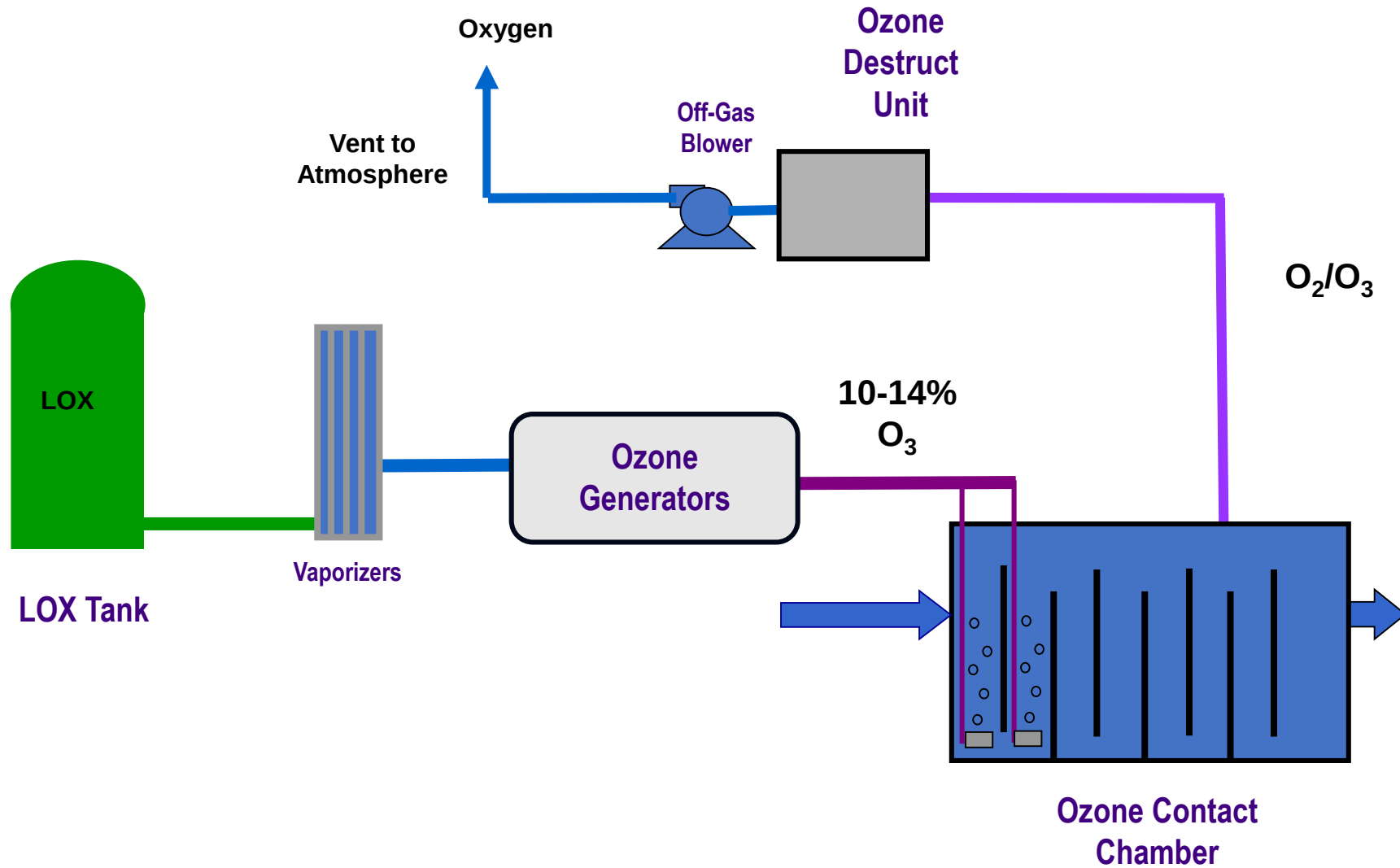
- Many years ago a wise man saw and smelled the creation of a special chemical during a lightning storm and vowed to harness nature's power for the good of all mankind

His name was Thor !

He works for VEOLIA



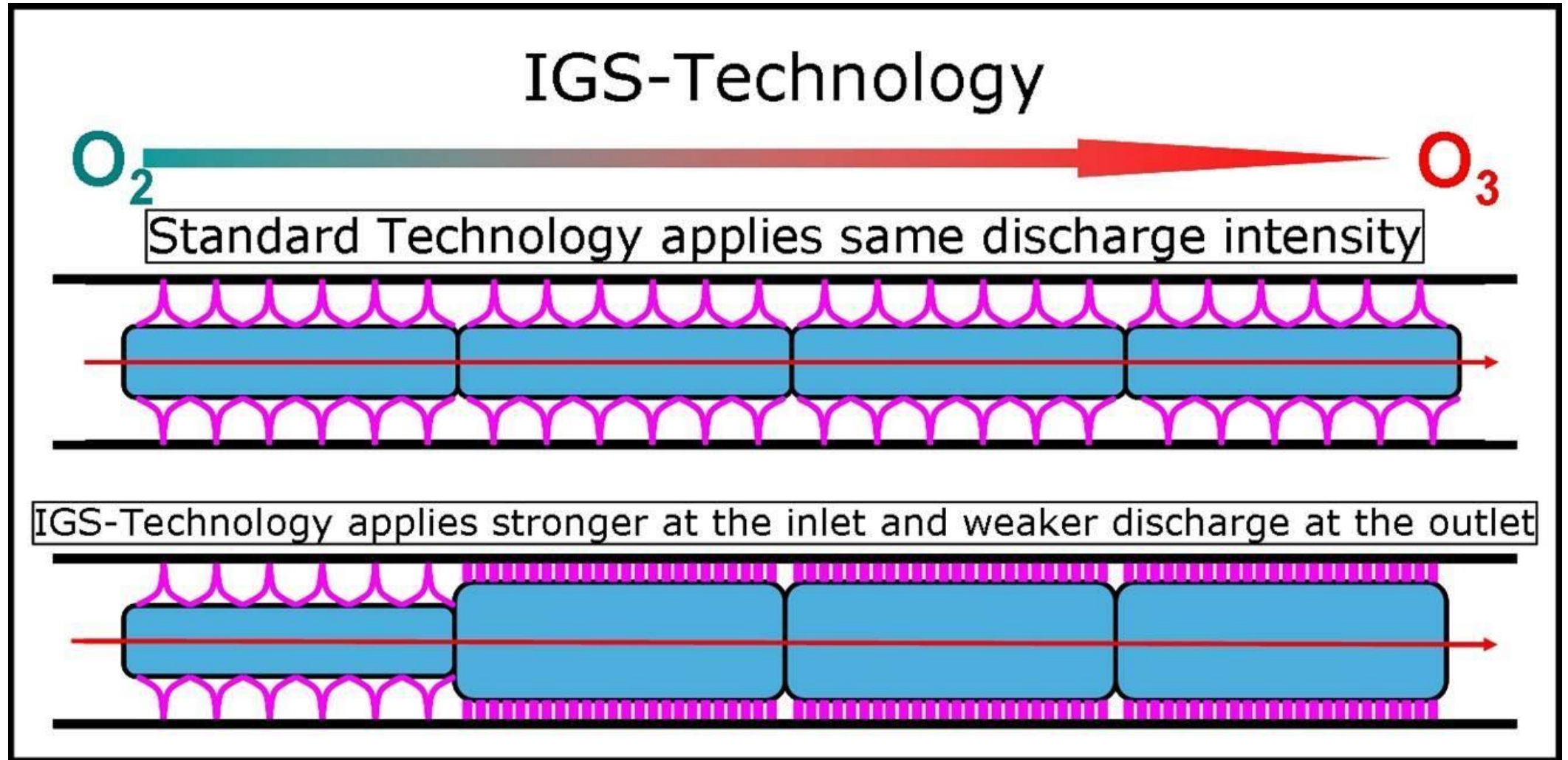
Now - Ozone Process Flow Diagram



Is Ozone the Magic Silver Bullet ?

- Ozone used as a Preliminary Oxidant can reduce other chemicals required for Coagulation/Clarification + Filtration in WTPs + WRFs
- Ozone reduces solids from NOM, lowers operating costs and is safe
- Using ozone for T&O compounds also gives disinfection credits plus it enhances particle removal by filters
- Ozone for disinfection also provides better removal of organic matter when coupled with Biofiltration GAC/ BAC processes
- CECs, PHCPs, Pesticides, NDMA & other long chain organic molecules can be broken by O₃, rendering them easier to degrade biologically

Creating Ozone Efficiently Electrically for the entire Lifecycle



Taming the power of Lightning with Gap Control



- ✓ Even higher durability, strength and efficiency
- ✓ Improved performance by (5 ~ 10 %)
- ✓ Harmonics eliminated
- ✓ Smoother power delivery
- ✓ Higher O₃ concentrations (up to 14 wt %)
- ✓ Better Oxygen utilization
- ✓ Longer Life of Components

Skid Mounted Ozone Generators



1800 lbs/day Ozone Generator @ 10% O₃ Tacoma, WA

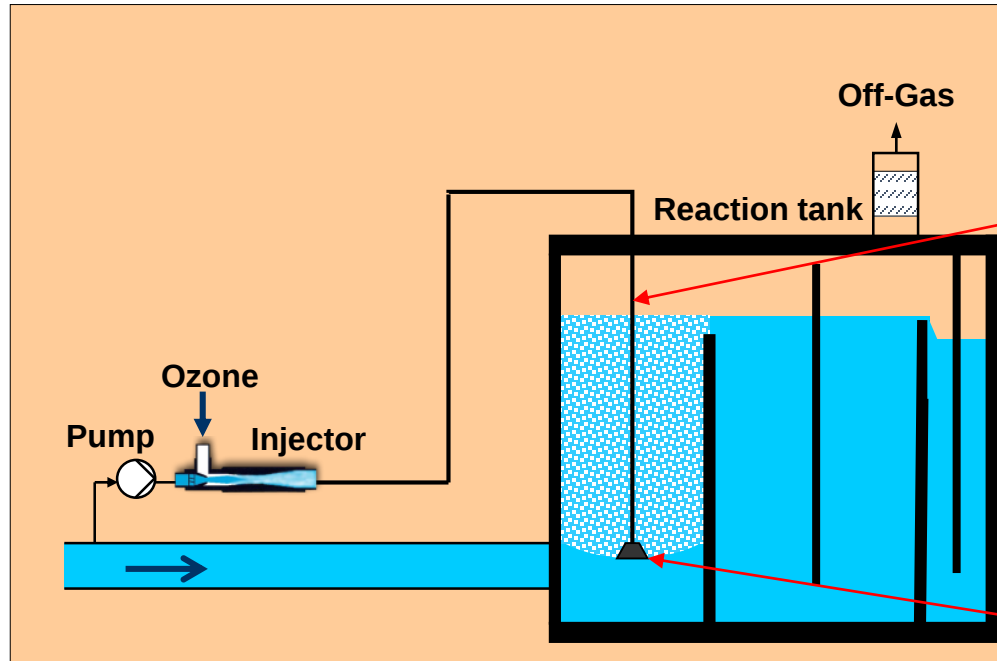
Pre-Engineered Skids – Ozone Cooling Water



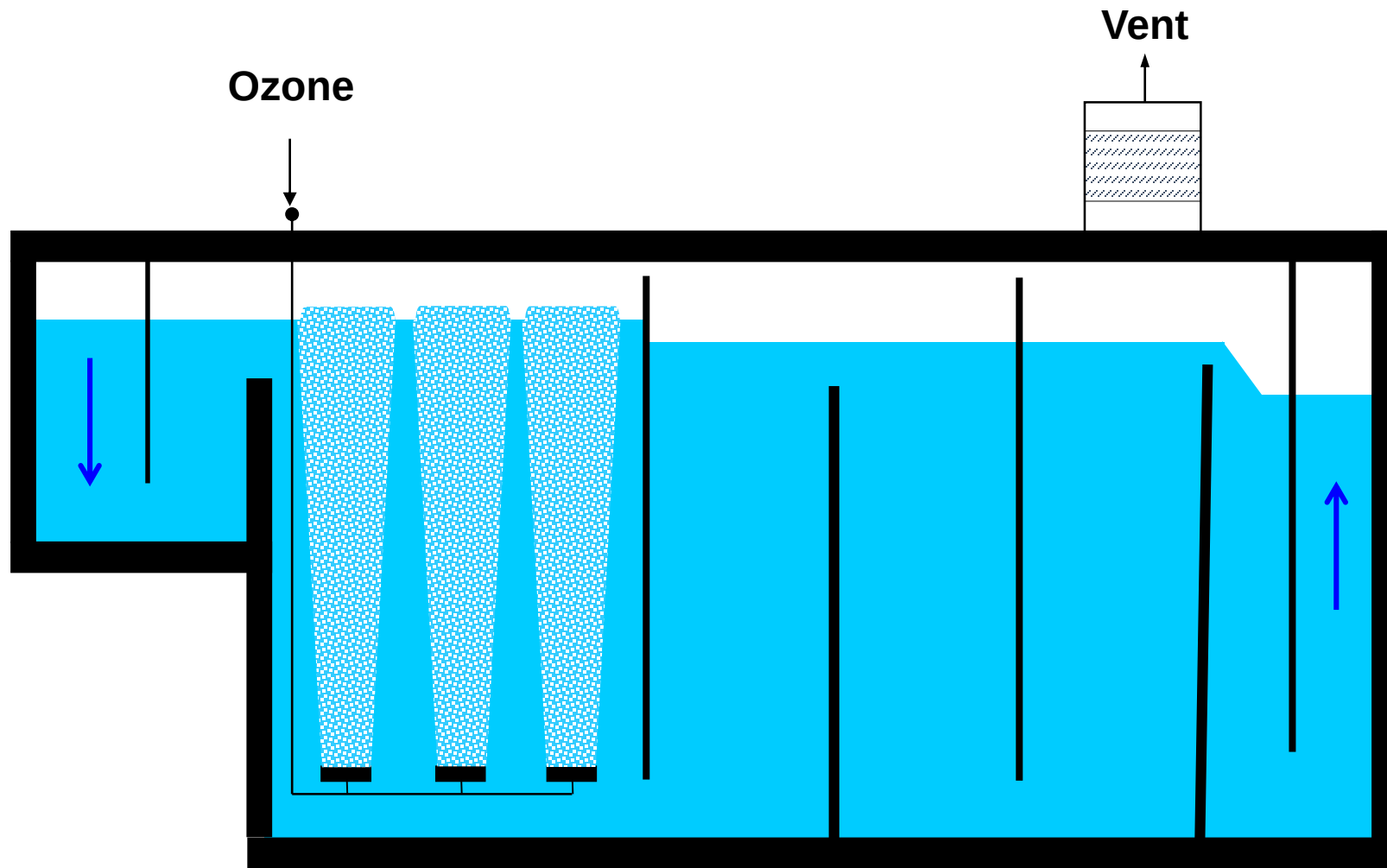
Closed Loop Cooling Water System Sky Lake WTP - Orlando, FL

O3 Dissolution Systems

Sidestream Injection with Radial Dispersion Unit



Ozone Reactivity and Contact Time



Various Diffuser systems have been employed over the years to reduce Ozone off-gas

Pre Engineered Skids – Ozone Destruct



Ozone Destruct Units 3 x 300 CFM Sky Lake WTP

Complete Ozone System Controls and Monitoring Components



Master Ozone Control Panel (MOCP)

- PLC Based Graphical Operator Interface Panel
- Communication with Plant Control System

Power Supply Side Component Options



IGBT Based

(Insulated Gate Bipolar Transistor)

Power Supply Unit

Ozone Generator

1335 ppd @10% O₃

Complete Packaged Ozone Generation Skid



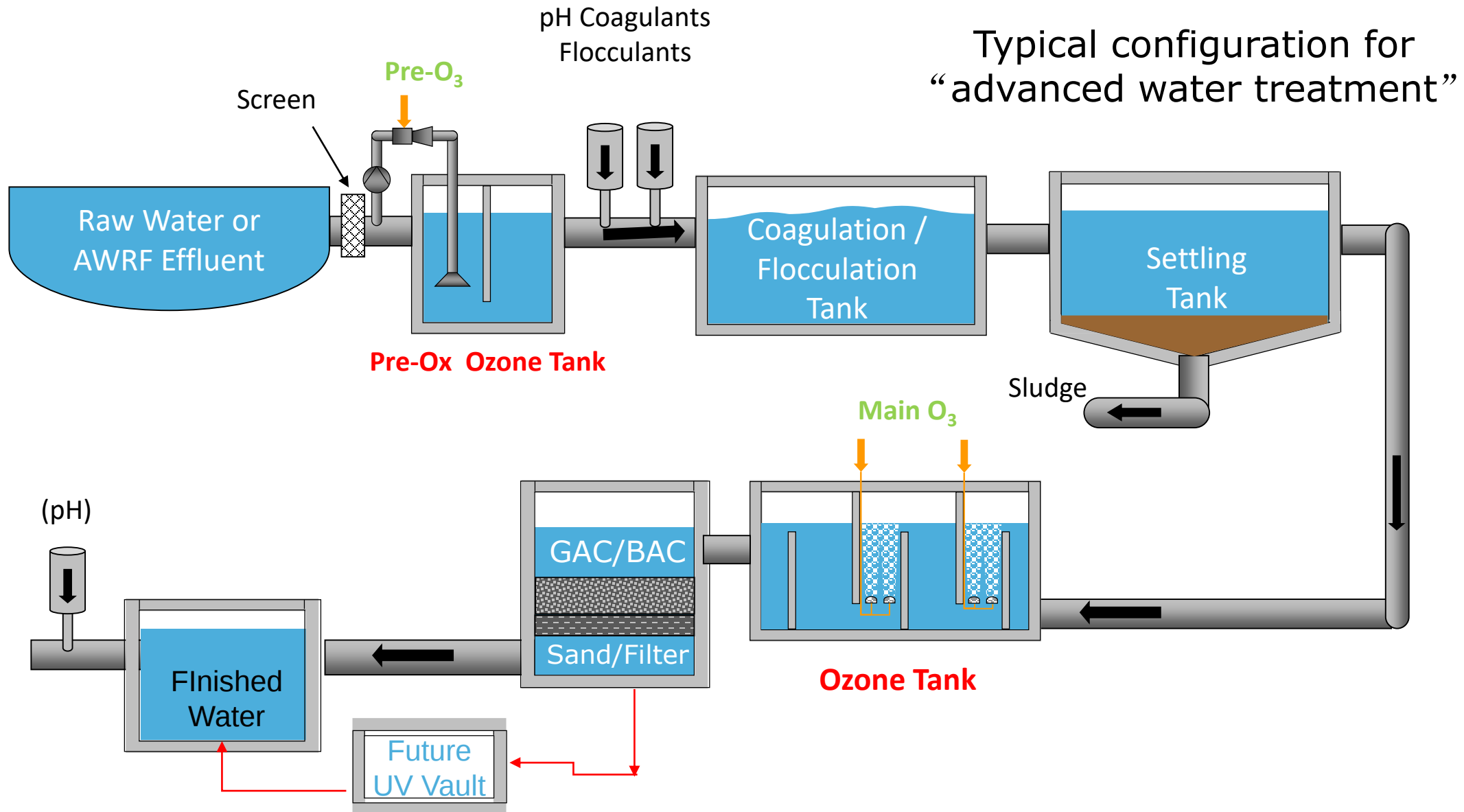
CFV-10 w CW system - 350 lbs/day @ 10%

Electrical Efficiency of Ozone has improved with pure Oxygen

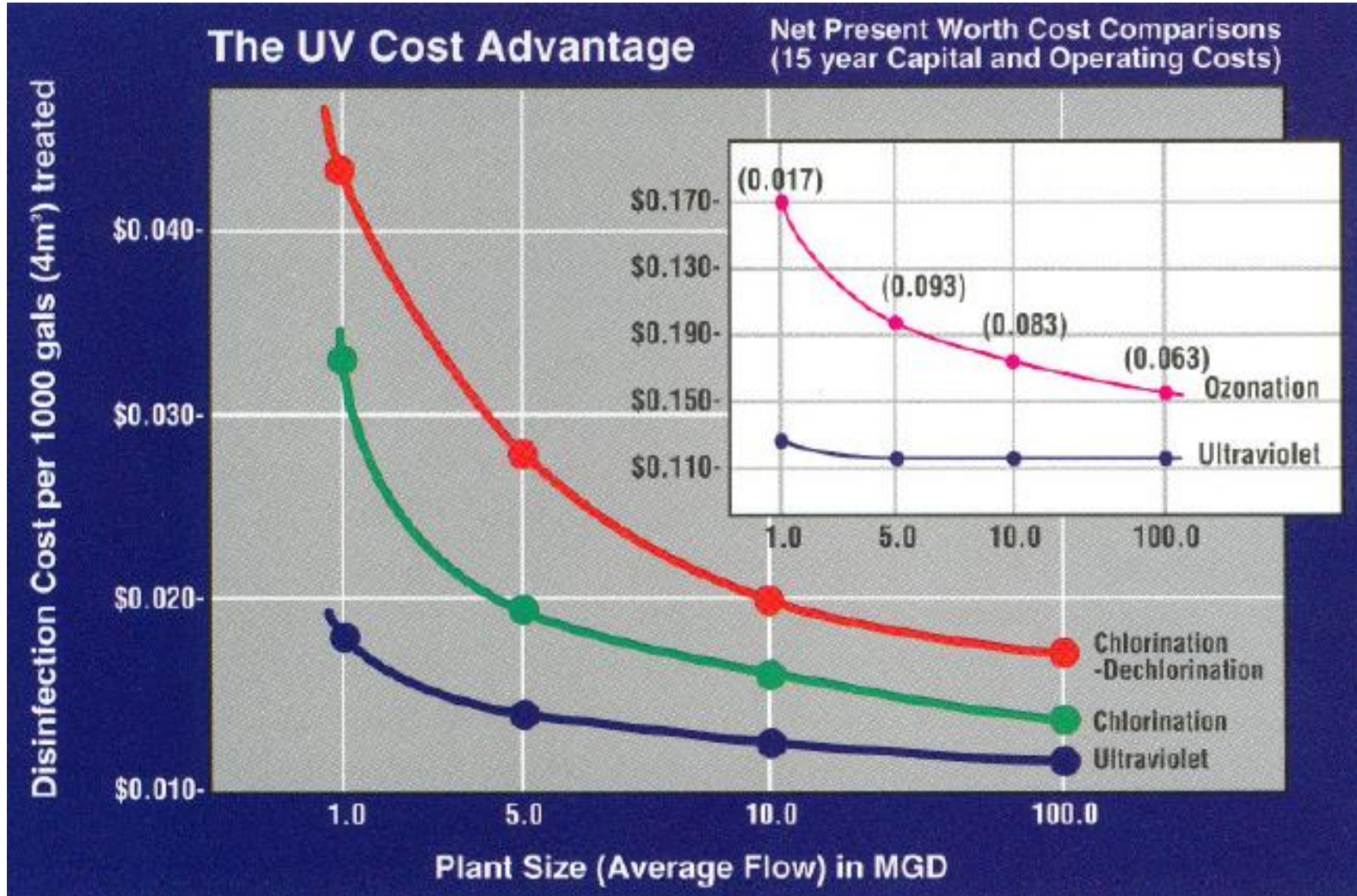


LOX System – Fort Worth, TX – Rolling Hills WTP

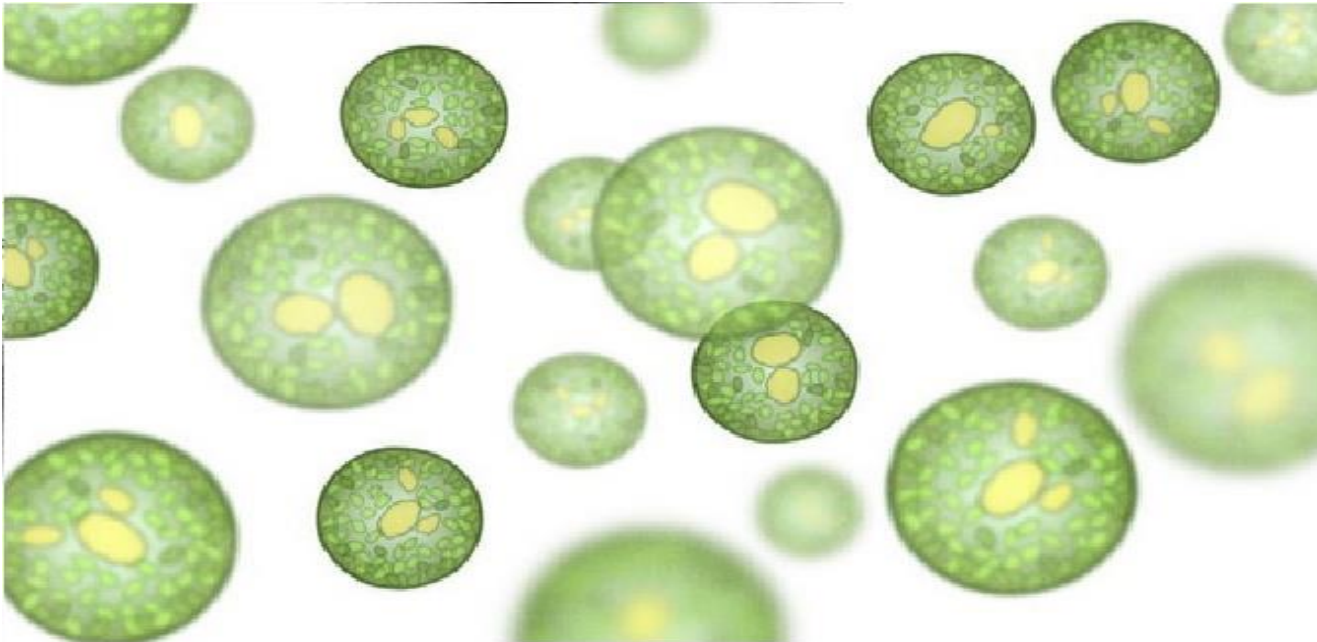
ADVANCED WTP WITH OZONE BAC & UV OPTION



Focus on UV ~ metaphorically, not physically

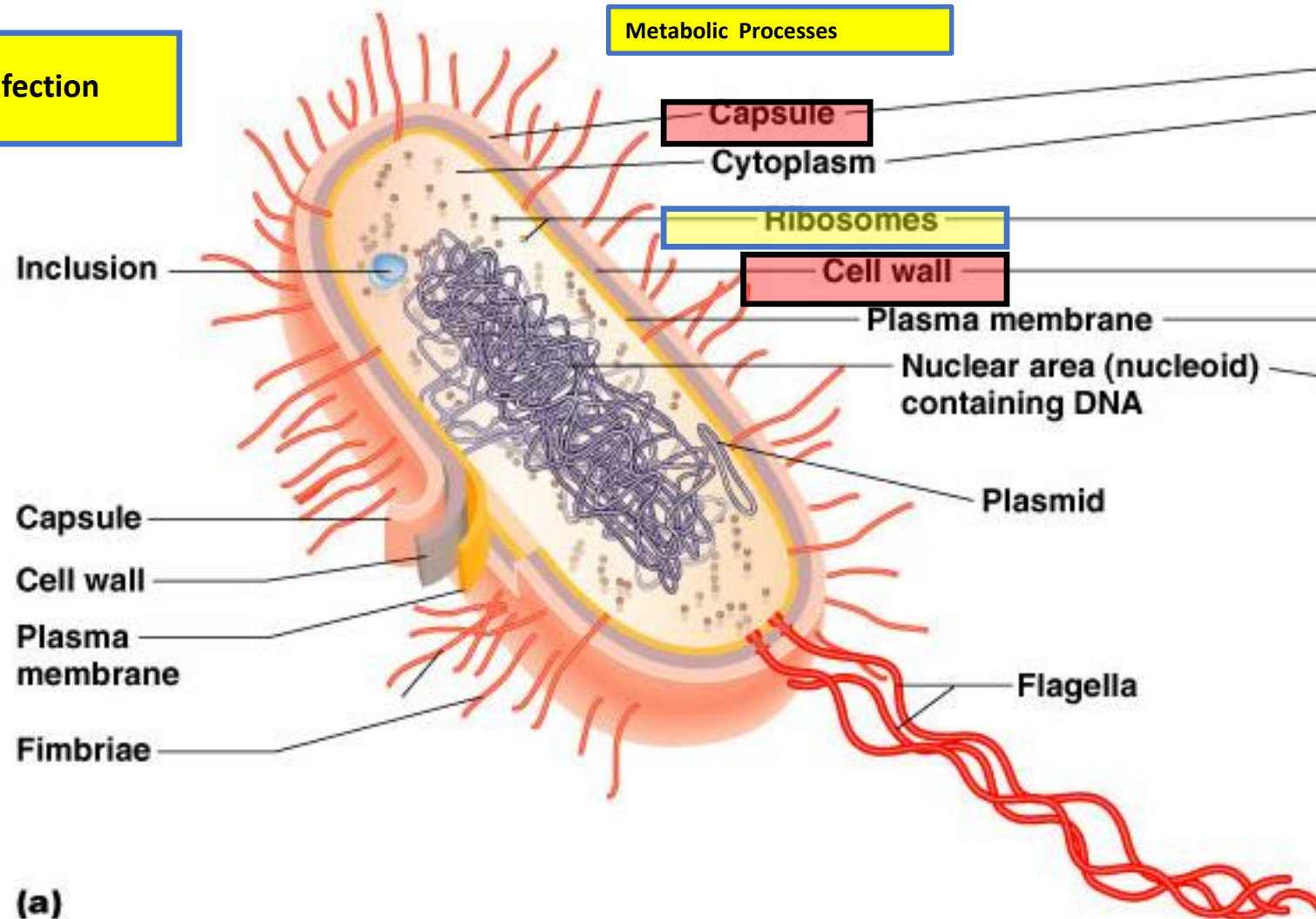


UV Energy is harnessed for disruption of RNA , DNA and metabolic damage to the cellular bonds in biocontaminants

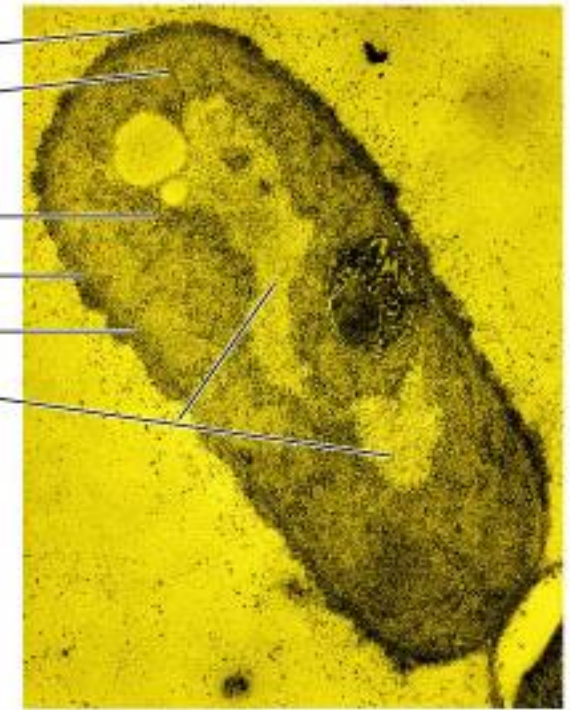


Microbes - Chemical vs UV Disinfection

UV Disinfection



(a)

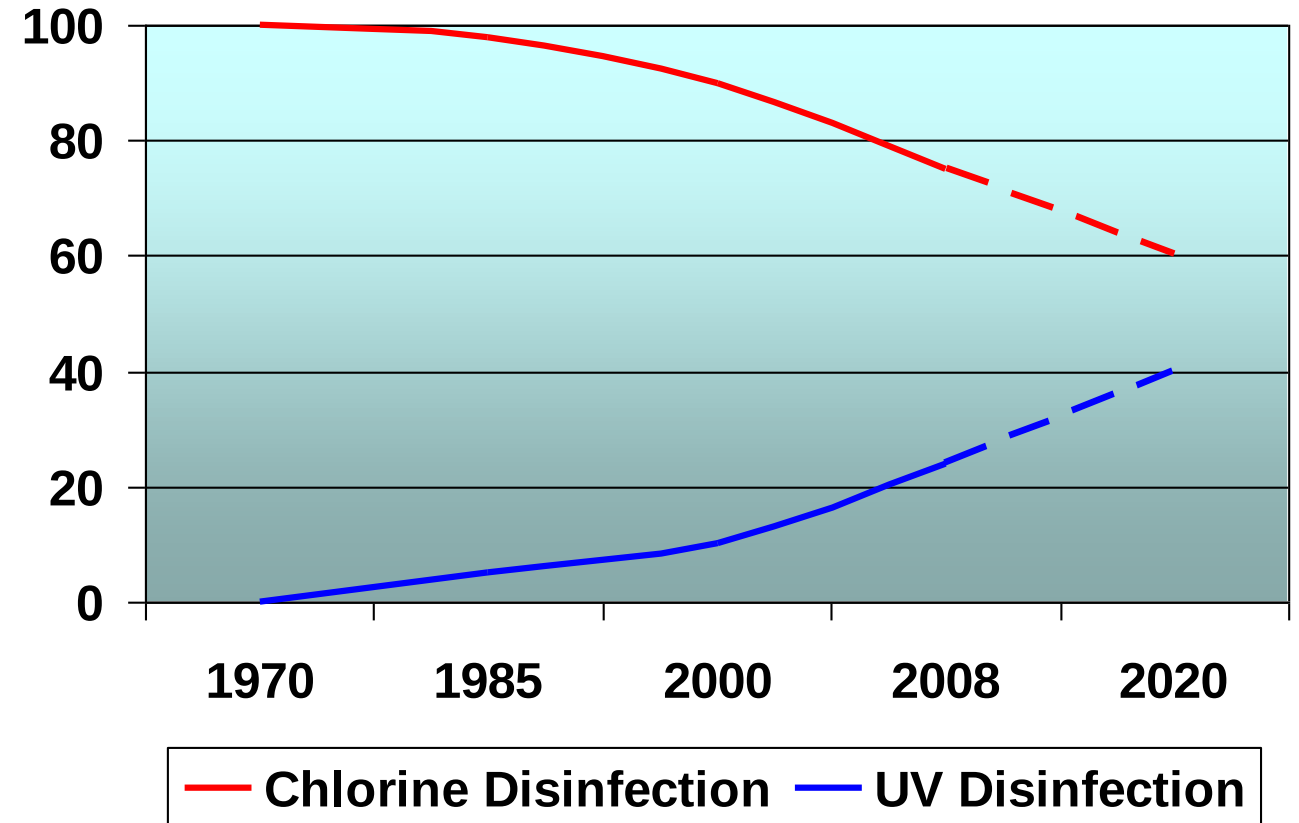


(b)

Chlorine Disinfection

Disinfection Chemistry or UV Separate vs. Together Can't we all work together ?

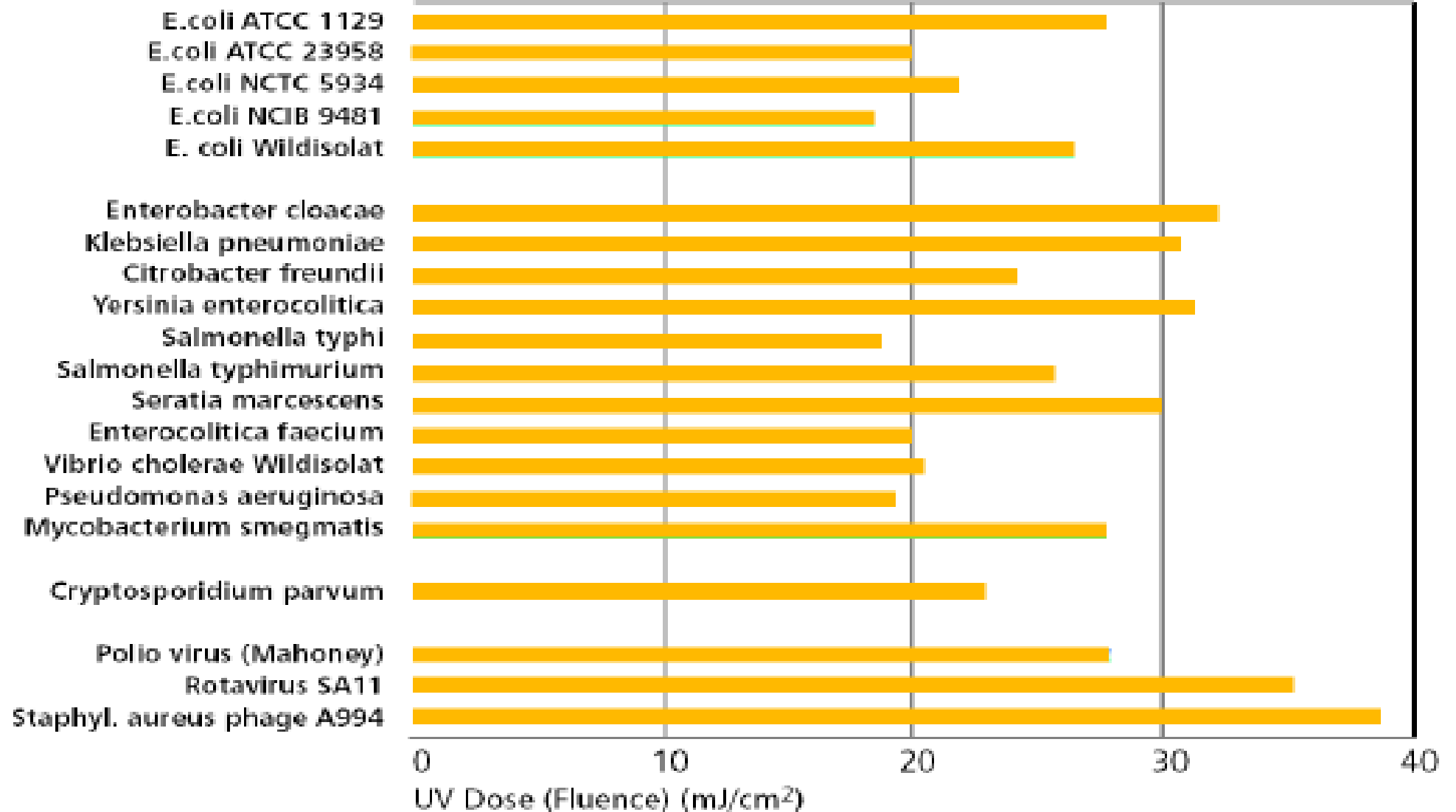
- Concerns about chloraminated byproducts are driving WTPs back toward Enhanced Coagulation and Free CL₂
- Innovative Oxidants like PAA, Ferrate + CLO₂ are coming into vogue to avoid DBP FP from organics.
- Ozone has it's place and could be used more when combined and controlled by advanced WTPs for Reuse



- UV is Very Effective against **Chlorine Resistant Pathogens**, e.g. Cryptosporidium, Giardia Lamblia, Staphylococcus, Clostridium, Micrococcus, Bacillus & Aeromonus !
- Responsible water treatment strategy; WW of upstream communities ultimately becomes DW of downstream communities - so essentially Indirect Potable Reuse (IPR) has been practiced for decades.

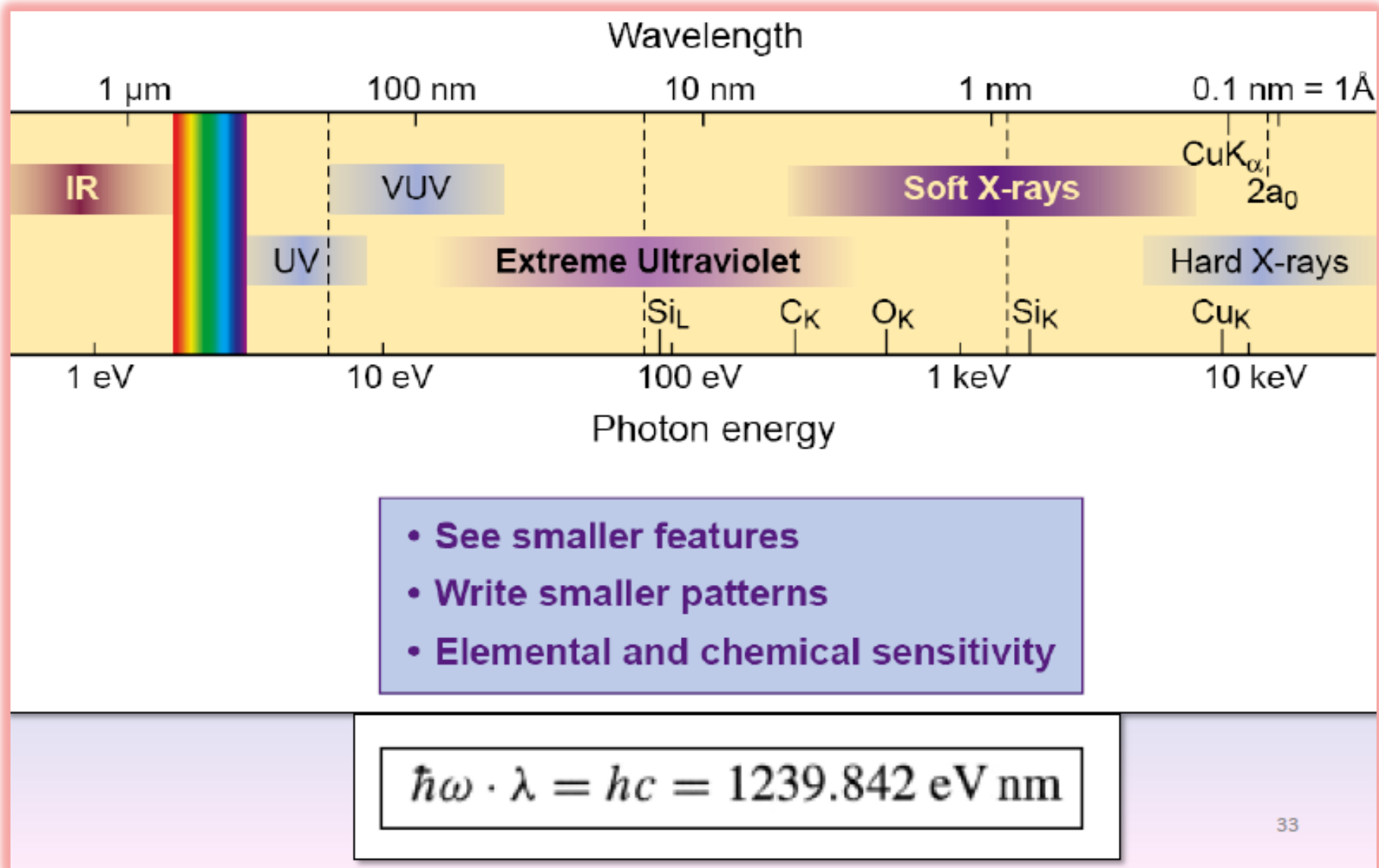
UV Action Spectrum

UV Dose
for
4 log
(99.99%)
Inactivation

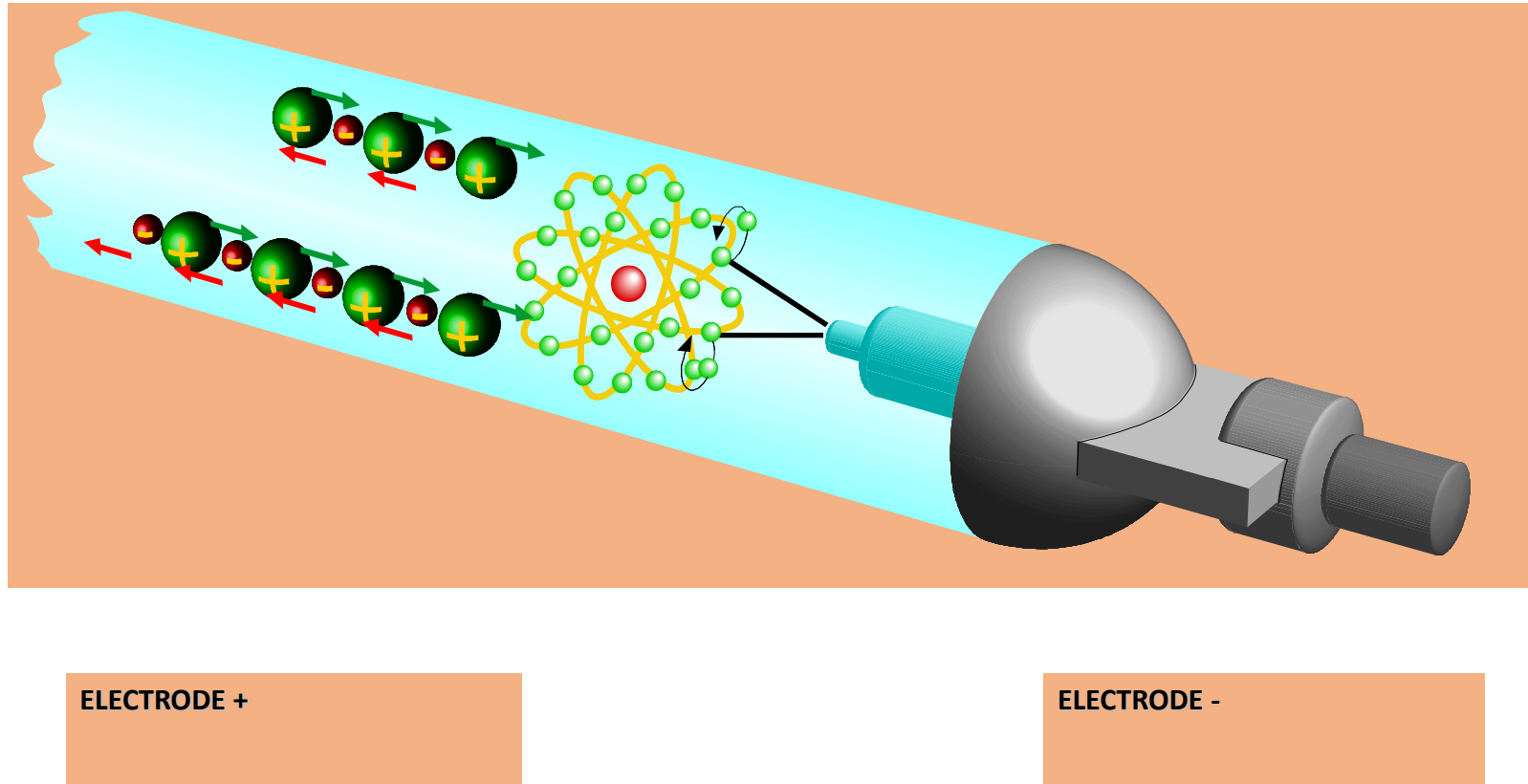


This is why many state regulators want 40 mJ/cm² regardless

Energy Level Increases as Wavelength decreases



LPHO Amalgam UV vs MP HI Lamps



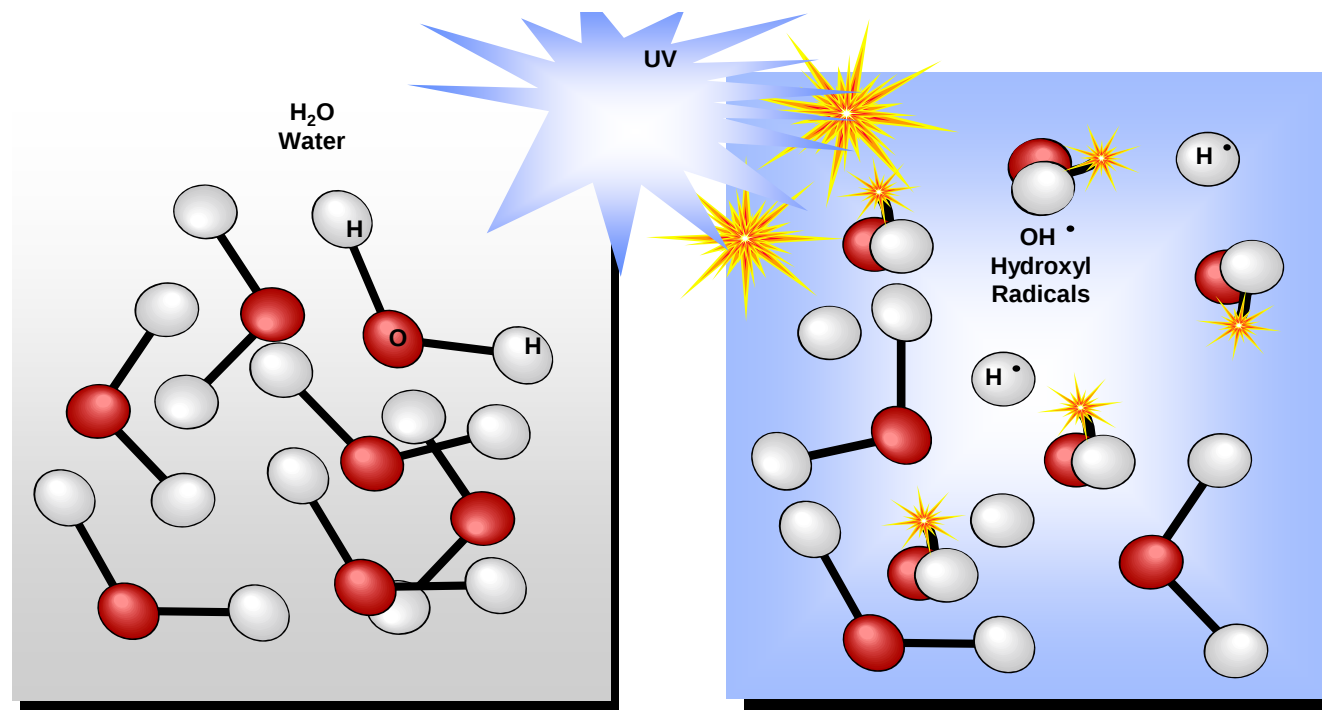
- Electrode materials & termination designs have improved with R&D
- ELDs now use soft start technology from VFDs to reduce sputter of metal filaments

LPHO Systems are approaching the MP UV range
with 800-1500 watt lamps now common



Using 185 nM Low Wavelength LP
HO photons to create $\text{OH}^\bullet$

Generating Hydroxyl Radicals



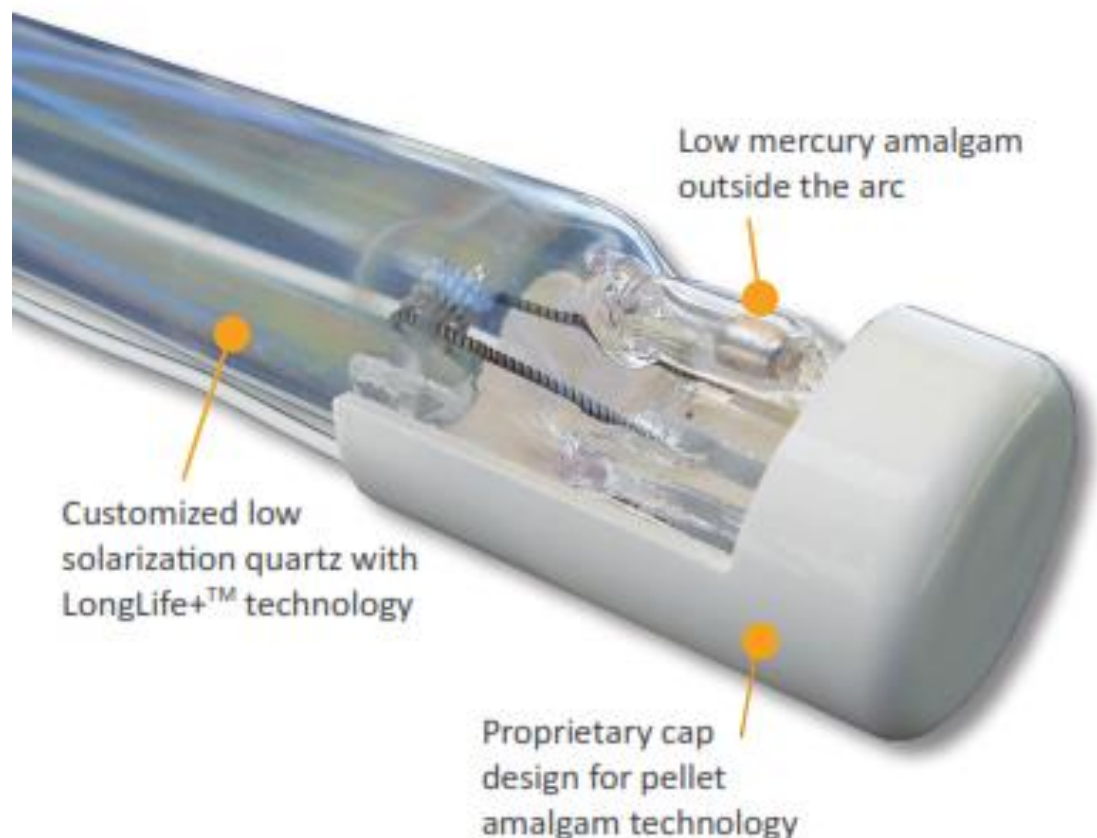
There are two pathways to produce $\bullet\text{OH}$ radicals:

1. Through water absorbing wavelength below 190nm.
2. Oxygen molecules absorbing at wavelengths below 240nm.

MP UV lamps can do the same with
many wavelengths under 254 nM

Pellet Amalgam Lamps

Cutting edge technology for your future success!

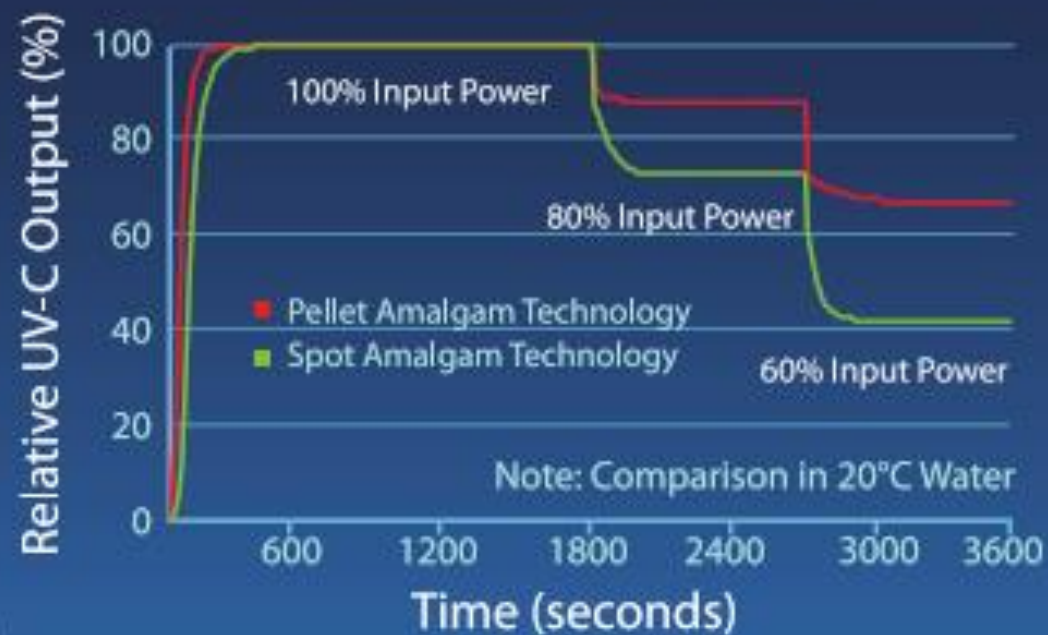


Cost Savings Compared to Spot Amalgam Lamps



- Increased output
- Greater efficiency
- Operation in more extreme ambient environments
- Up to 16,000 operating hours
- Maintaining up to 90% UVC output at end of life
- Provided with high efficiency electronic ballast-lamp package

Energy Savings with Pellet Amalgam Lamps in Reduced Power Operation



LightTech

LightSources

Pellet Amalgam Long Life+™ Technology



Power Transmission Efficiency thru Electronic Lamp Drivers considering other system factors

Impact of high mains voltage/current distortion (THD):



Califor
Output
360 /
50Hz
THD_u



☆ **More Energy losses**

Harmonics cause additional losses in conductors and equipment.

☆ **Higher subscription costs**

Harmonic currents can cause higher subscribed power level and consequently higher costs. Utilities will be charging customers.

☆ **Oversizing of equipment**

Conductors/equipment must be (over)sized taking into account the flow of harmonic currents. Due to skin effect, resistance increases with frequency. So even more oversizing needed for harmonics. Also neutral conductor needs to be oversized as well.

☆ **Reduced service life equipment**

At $THD_u > 10\%$, service life of equipment is significantly reduced. Reduction estimated at:

- 32.5% for single-phase machines
- 18% for three-phase machines
- 5% for transformers

To maintain the service lives, equipment must be oversized.

☆ **Overload, tripping and shutdown**

Circuit-breakers are subjected to current peaks caused by harmonics and nuisance tripping could occur resulting in down-time.

☆ **Disturbance of sensitive devices**

Transients can cause failures or damage to sensitive equipment.



led testbox.

System Installation + Power Analysis Recommendations

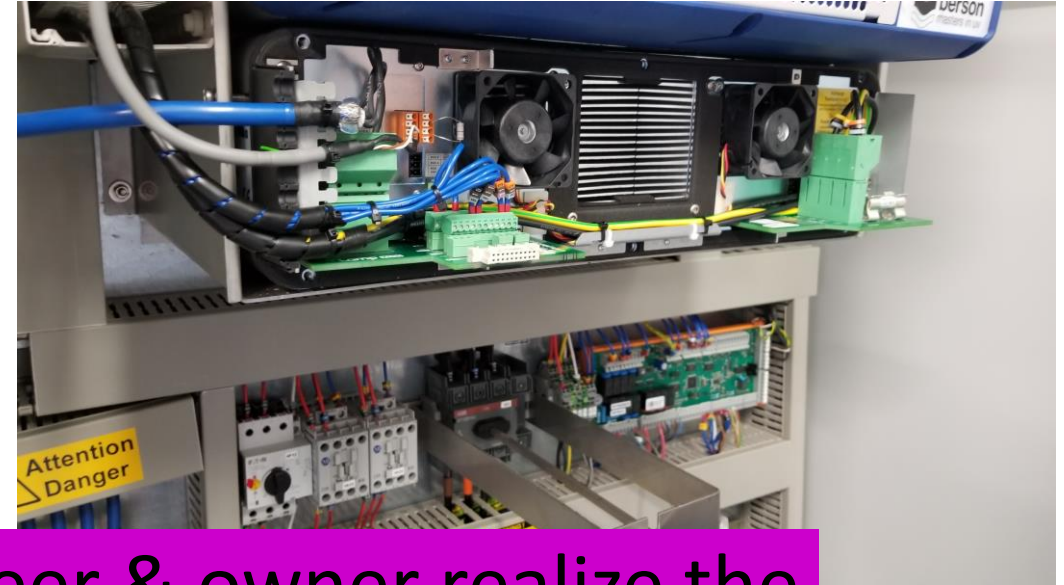


Cooling and Nema rating of cabinets for long life expectancy

Fans in climate controlled environment or A/C if not managed



UPS Sizes - Design for PLCs / HMI programs ~ Component Ratings for SCCR



Make sure that your engineer & owner realize the importance of electrical infrastructure and stability



Power
Transfer
Monitoring
Electronics



Surge
Suppression
and
Harmonic
Noise
Filtration



Electronic Lamp Drivers aka Ballasts

(Fans under each power center to circulate and cool)



**Ballast Replacement
without removing
equipment from channel**

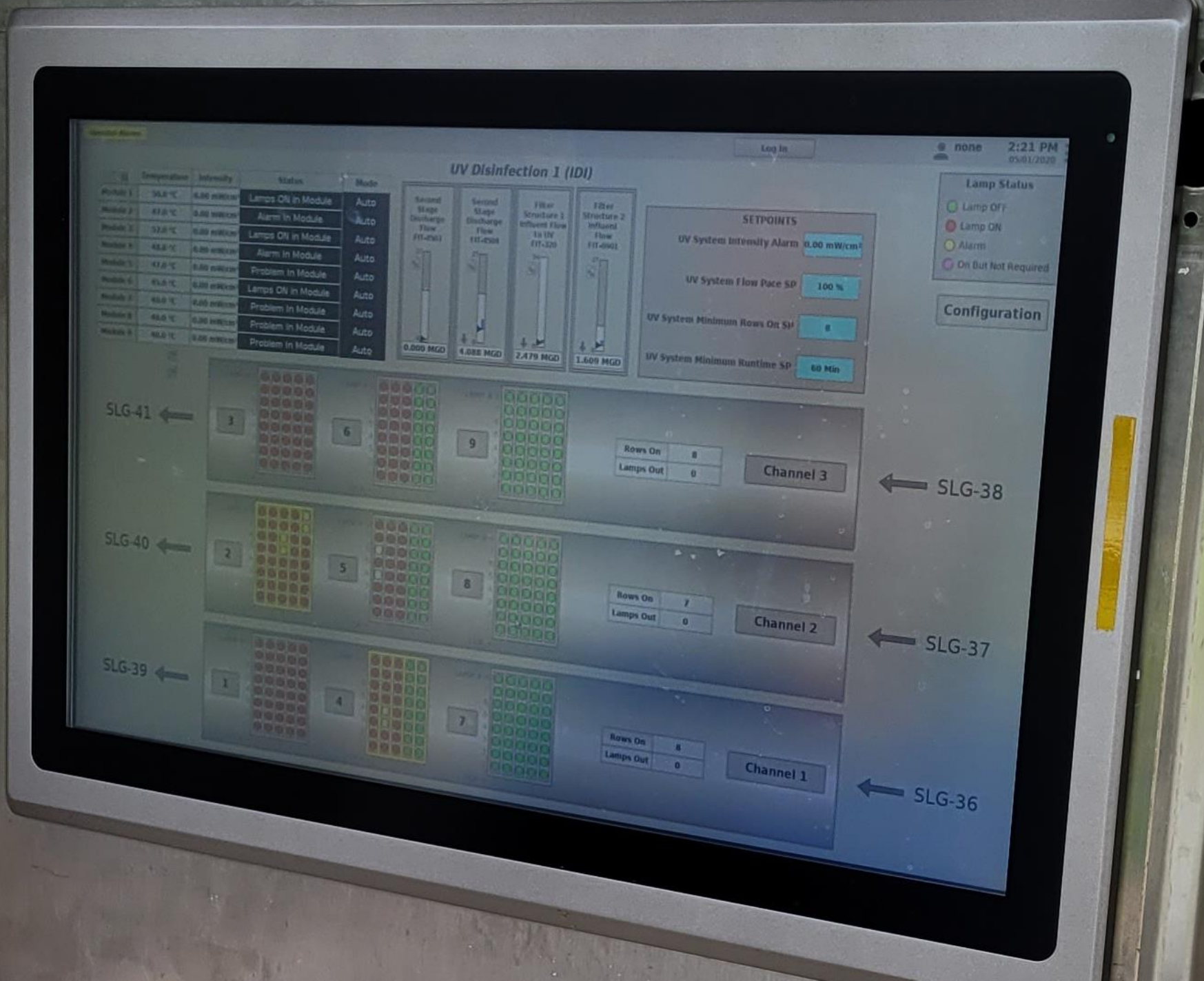
AC systems, PSUs and MCC



NEMA 12 cabinets inside temp
controlled environment

Who picked that color ???





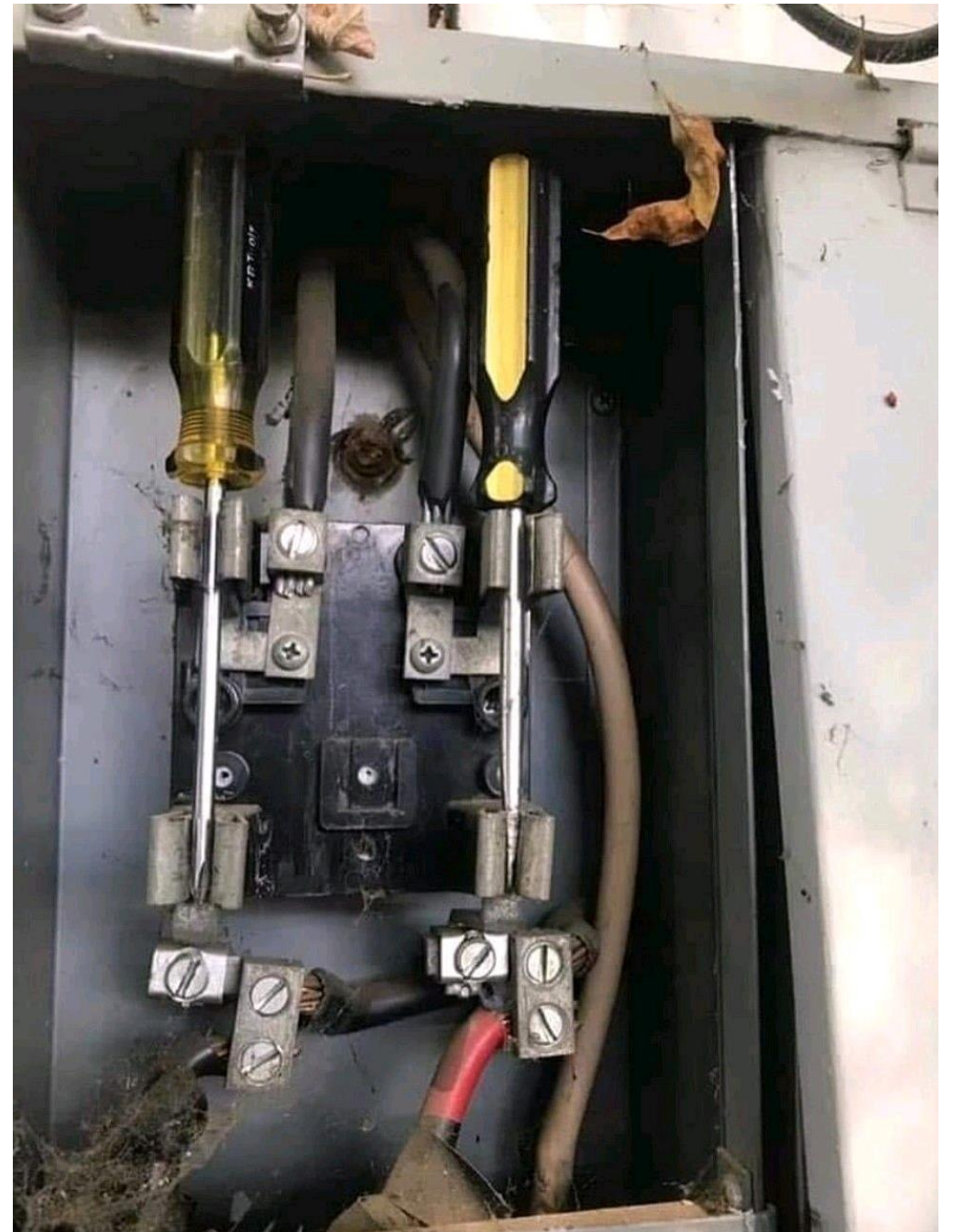
Safety is so important – Lock out and Tag out !

Sometimes you have to improvise in the field to make things work

Please take all safety precaution before using non insulated tools

No mixing / matching fuses in those breaker panels

Either use a Philips head or a Flat head , over ?



- Any questions ----- Now is the time
- email for a pdf copy of this ppt
- bruce.stevens@veolia.com
- or text me 678-707-6957



UV System O&M Cost for Disinfection and Advanced Treatment Techniques

Parameter	Low Pressure – LP	Amalgam – LPHO	Medium Pressure - MP
Germicidal UV Light	Monochromatic @ 254 nm	Monochromatic @ 254 nm	Polychromatic (185 – 315 nm)
Typical Lamp Output (W)	40 - 150	150 – 1000	500 – 10,000
Germicidal UV Output (W/cm)	0.2	0.5 - 3.5	5 - 30
# of Lamps for Given Dose	High	Relative	Low
Lifetime (hrs)	8,000 – 12,000	12,000 – 16,000	4,000 – 10,000



