

# Enaqua - UV Technology



## UV MADE SIMPLE

DRY

SIMPLE

INTELLIGENT

ENERGY EFFICIENT

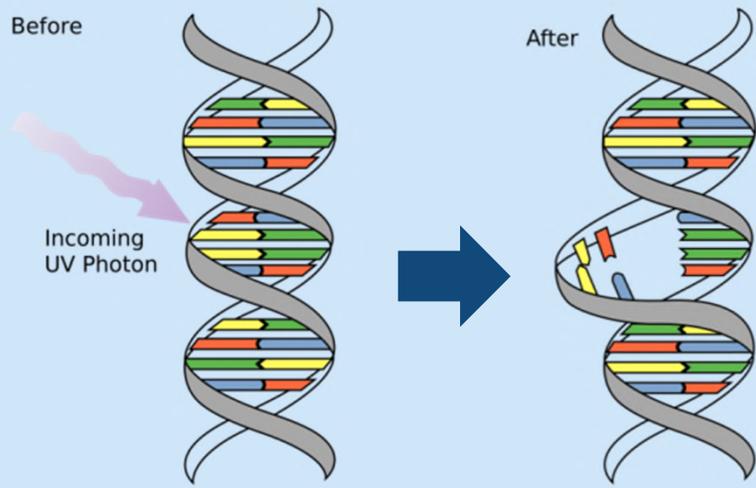


OTCO Marietta Workshop --- 2022-03-22  
Presented by: Doug Borkosky (Baker & Assoc.)

**ENAGUA**  
A GRUNDFOS INNOVATION COMPANY™

# UV – The Right Choice

- Ultraviolet light irradiation is a proven disinfection process using of short wave length 254nm Ultraviolet (UV) energy to neutralize harmful microorganisms.
- UV radiation disrupts the DNA of pathogenic organisms such as bacteria, viruses and molds, leaving them unable to replicate.
- UV has been used to disinfect various types of effluent from low-quality combined sewer overflow (CSO) to high-quality tertiary effluent.
- More than 20% of WWTP in the US are already using UV as their preferred technology and this percentage is rapidly increasing.



**ADVANTAGES & BENEFITS**  
Compared to conventional Chlorination

	Ultraviolet Light	Sodium Hypochlorite	Chlorine gas
Disinfection effectiveness	HIGH	HIGH*	HIGH*
Disinfection by products	NO	YES	YES
Safety risks	LOW	HIGH	HIGH
De-chlorination required	NO	YES	YES
Contact channel	SMALL	LARGE	LARGE
pH dependency, Corrosion	NO	YES	YES
O&M Cost	LOW	HIGH	MEDIUM
Capital Investment	MEDIUM	LOW	HIGH

\*Cryptosporidium and Giardia are resistant against chlorination

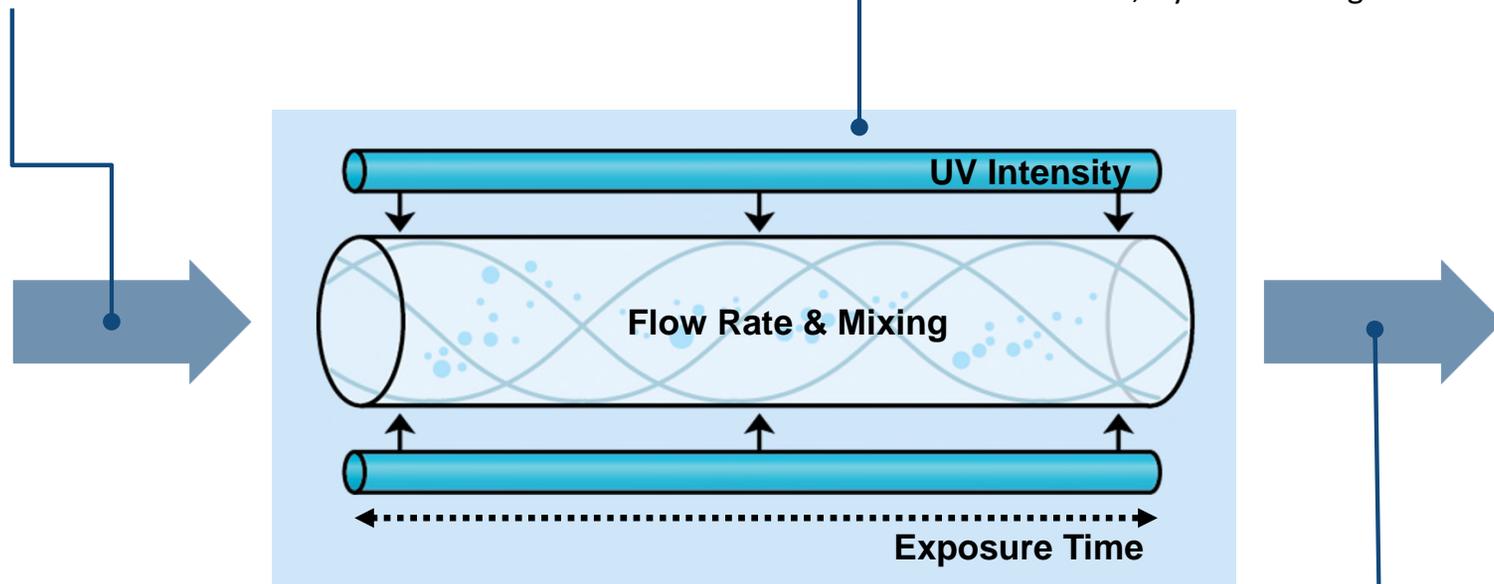
# 3 UV Key Design Criteria

## 1. Water quality

- UV light penetration (UVT, turbidity)
- “Shield” effect of pathogens (TSS)

## 2. UV Dose

UV Dose = UV Intensity x Exposure Time  
Limiting factors: Lamp aging, Sleeve Fouling, Sleeves Deterioration, Hydraulic design of reactor (mixing)



## 3. Inactivation of pathogens

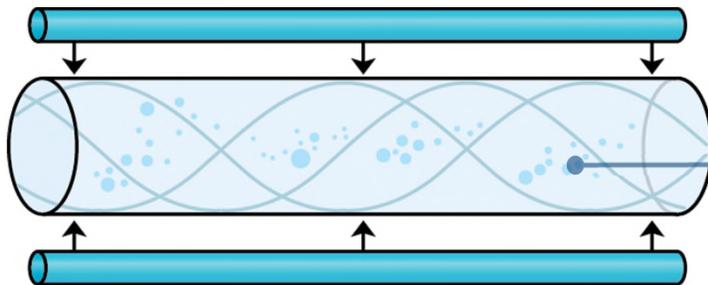
Reduction of pathogens by a predictable amount (log reduction)

# General Disinfection Principles

Each wastewater disinfection process includes the following process components

	Enaqua's Non-Contact UV	Conventional Contact UV	Chlorine gas or chemical
Disinfectant	Intensity of UV radiation	Intensity of UV radiation	Quantity of chemical
Mixing	High with turbulent tube flow	Low with required uniform flow	High with turbulent flow
Contact Time	Exposure time to UV light	Exposure time to UV light	Chlorine contact chamber
Dechlorination	Not required	Not required	Complex chemical dosing system

Disinfection Process



High turbulent flow in Enaqua's AFP™ tubes ensures an optimal mixing without any further devices. The benefits are uniform UV exposure and effective disinfection in only a fraction of the time!

# Napoleon Pictures





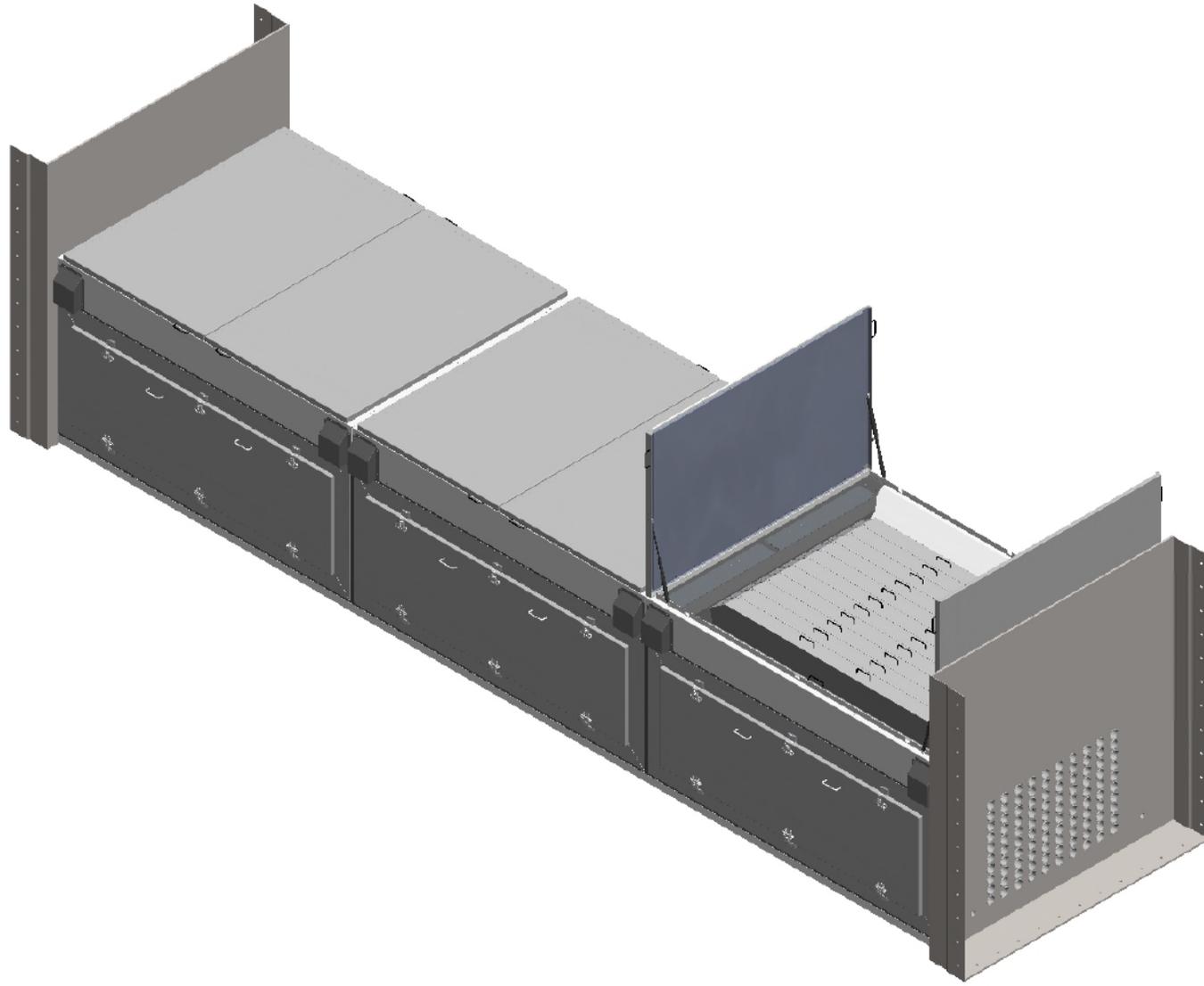
# Napoleon Pictures



# Napoleon Pictures



# Napoleon Reactor



# Defiance Pilot

- Single Phase Units Available down to “Package Plant” sizes.







# Defiance Pictures



# Defiance Pictures



# UV MADE SIMPLE

FEATURES AT A GLANCE



Electrical Panel



Ensure Dosing System (EDS)

Individually fused and switched Lamp Racks



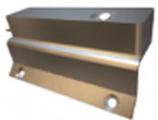
Single Lamp Ballast

Open discharge, no weirs required

Flow & Level Pacing

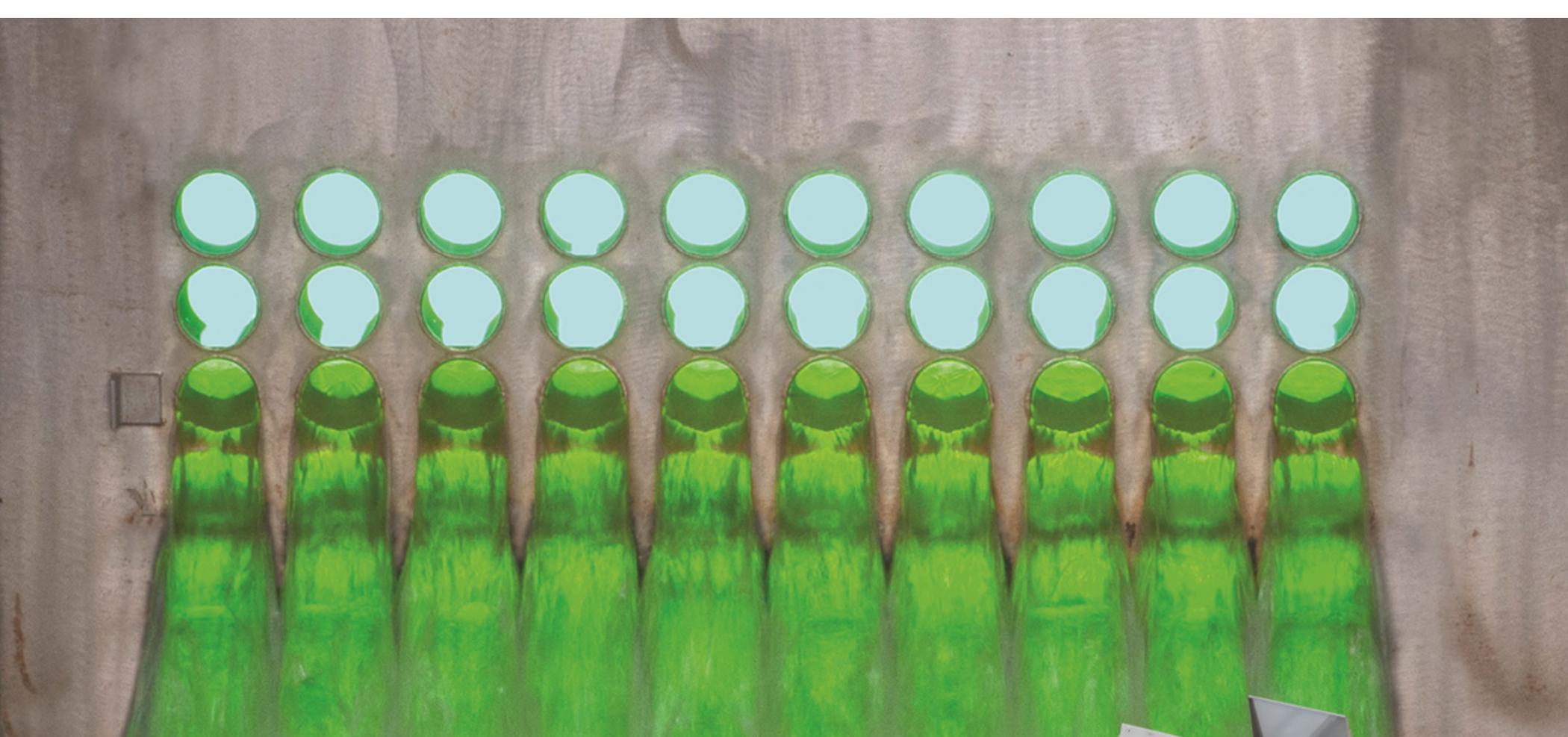


Heat Exchange System



UV Intensity Monitor

ENADUA



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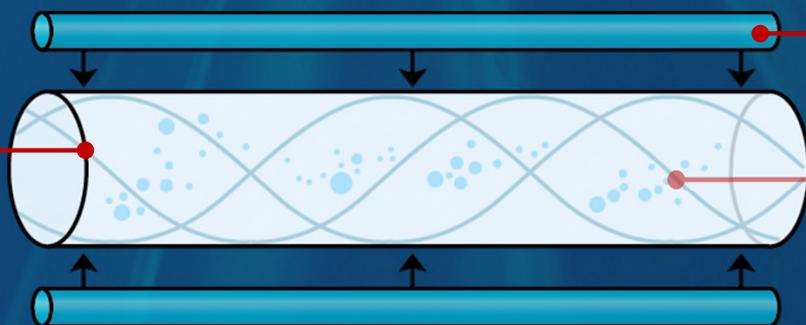
# ALWAYS DRY

Enaqua Non-Contact Technology



## AFP™ TUBES

Fouling resistant virtually self-maintaining



## SMART LAMPS

Cost efficient non-amalgam

Turbulent flow ensuring optimal UV exposure

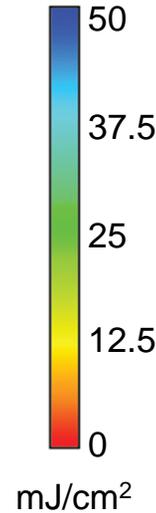
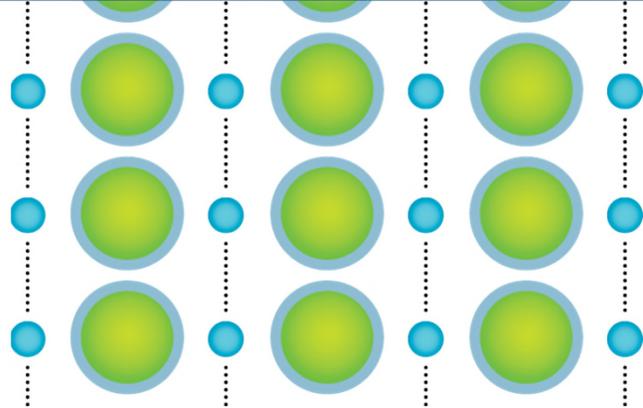
ENAQUA

# ALWAYS DRY

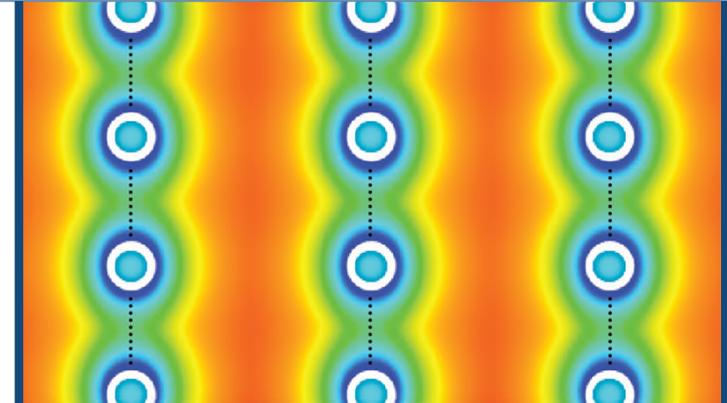
## Technologies in Comparison



### ENAQUA AFP™ NON-CONTACT TECHNOLOGY



### QUARTZ SLEEVE UV TRADITIONAL CONTACT TECHNOLOGY



Uniform UV Dose

Non-Uniform UV Dose

Low cost high output lamps

High cost amalgam lamps

No quartz sleeves

Fragile quartz sleeves with risk of mercury and glass contamination

Fouling-resistant AFP™ tube

Fouling-prone quartz sleeves

Turbulent flow provides self-cleaning of AFP™ tube

Cleaning system required

No AFP™ tube replacement under normal conditions

Quartz sleeves need to be replaced over time

Simple pipe hydraulics makes UV disinfection easy to predict

Channel hydraulics makes UV disinfection less predictable

No level control devices required

Level control devices increase footprint

# SIMPLE

Maintenance made clean, fast and easy

## NO MORE:

- High cost amalgam lamps
- Dirty and fouled quartz sleeves
- Problems with quartz cleaning devices
- Interrupt of flow
- Removal of any hydraulic seals
- Heavy duty cranes required for maintenance
- Time consuming lamp replacements
- Algae growth on the lamp racks
- Quartz sleeves to break and replace\*

*“Our maintenance on the Enaqua UV units over the last few years is essentially zero...We no longer have cleaning as a standard SOP as the system seems to keep itself self cleaning...”*

**Plant Superintendent**  
20 MGD CSO WWTP



\*No AFP™ tube replacement under normal conditions (20+ year history)

# Factors that affect Fouling & Scaling



	Non-Contact	Traditional Quartz
Water chemistry and temperature	High content of iron	Iron, Manganese, Hardness, organic content
Interfacial temperature	LOW	HIGH
UV intensity	–	–
Hydrodynamics	TURBULENT PLUG FLOW	TRADITIONALLY SAME VELOCITY AS CHANNEL
The quartz microstructure and topography	N/A- AFP TUBE HAS SMOOTH CHEMICALLY INERT SURFACE	HIGH

# Example of AFP™ Tubes vs. Quartz



Third Party Validation of UV reactors per NWRI 2012 protocol. Fouling Factor Study.

- AFP tube non contact reactor and traditional quartz tube UV reactor operated side by side at plant with waste water fouling potential of >1%/day.
- After continuous operation for 73 days:
  - **QUARTZ reactor fouled 79%**
  - AFP tubes show no fouling

*Proven over 22 years of continuous operation*



Figure 4 Comparison of New Tube (top) to Tubes and Quartz Sleeve after 73 Days

# AFP™ versus Quartz Sleeves

AFP™ Tube utilize the same monomer as PTFE but is polymerised in a different configuration.

	Enaqua AFP™	PTFE	Quartz
UV Utilization	HIGH	LOW	HIGH
Fouling and Calcification (Surface charge)	LOW	MEDIUM	HIGH
Deterioration	NO	YES	YES
Replacement required	NO	YES	YES
Breakable	NO	NO	YES

**AFP™ - Proven over 20+ years of continuous operation!**

# Bio Fouling in Quartz UV Reactors



- Bio fouling typically occurs in between the UV Modules/Banks in a Channel
- Is a serious issue from both a maintenance and disinfection performance standpoint
- The biological growth if not cleaned regularly can affect the disinfection performance through particulate shielding

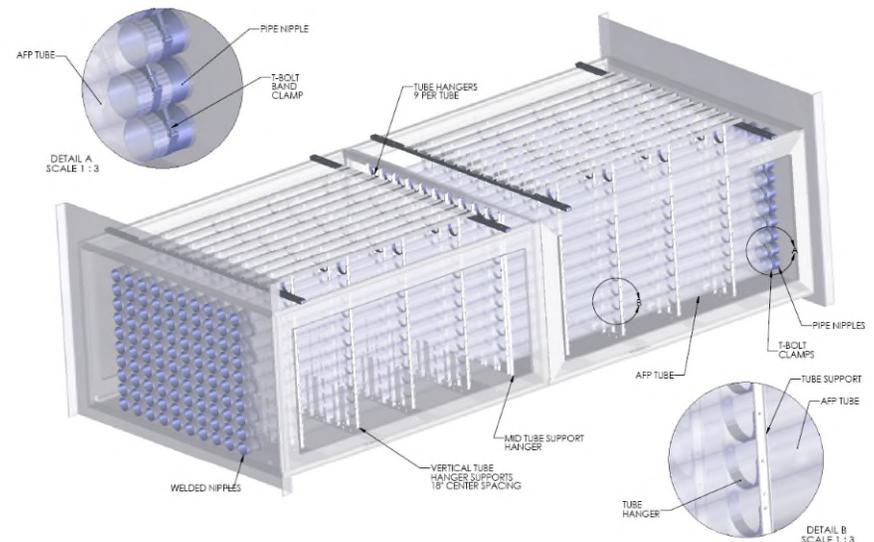
# Bio Fouling –Manual Cleaning in Quartz



- In plants with high bio fouling potential, each channel has to be periodically cleaned:
  - Cleaning is a manual and labor intensive process
  - Each channel needs to be isolated, taken offline, hosed off, scrubbed, then chemically treated
  - In some plants this process needs to be repeated as often as every 14 days

# Bio Fouling Resistance of Enaqua's UV

- In Enaqua's non contact reactors, there is no space between banks of UV, as in traditional Quartz tube based UV reactors. Typically there is a 3-4 ft. gap between UV modules
  - Hence the quiescent zone between banks (condition) without UVC does not exist in AFP tube based UV reactors
- The highly turbulent Plug flow regime inside the AFP tube reactors, with higher velocity of effluent prevent any potential for biological growth inside the AFP tubes
- The inert and smooth surface of AFP tubes (no microporous structure) don't allow the attachment and development of organic films, and biofilms.



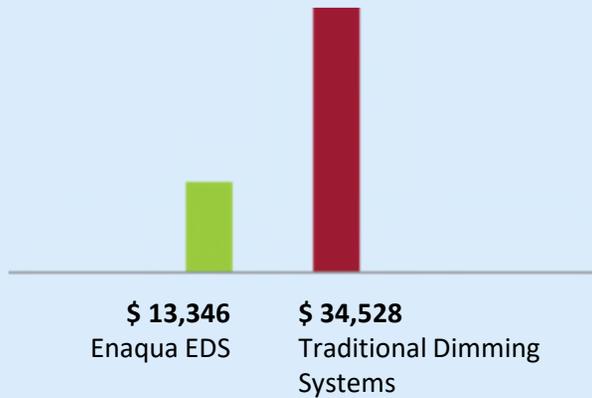


# Flow & Level Pacing

Enaqua's Flow & Level Pacing system automatically turns on only lamps which are required

- Improved lamp life
- Improved ballast life
- Reduces power consumption compared to "dimming" systems

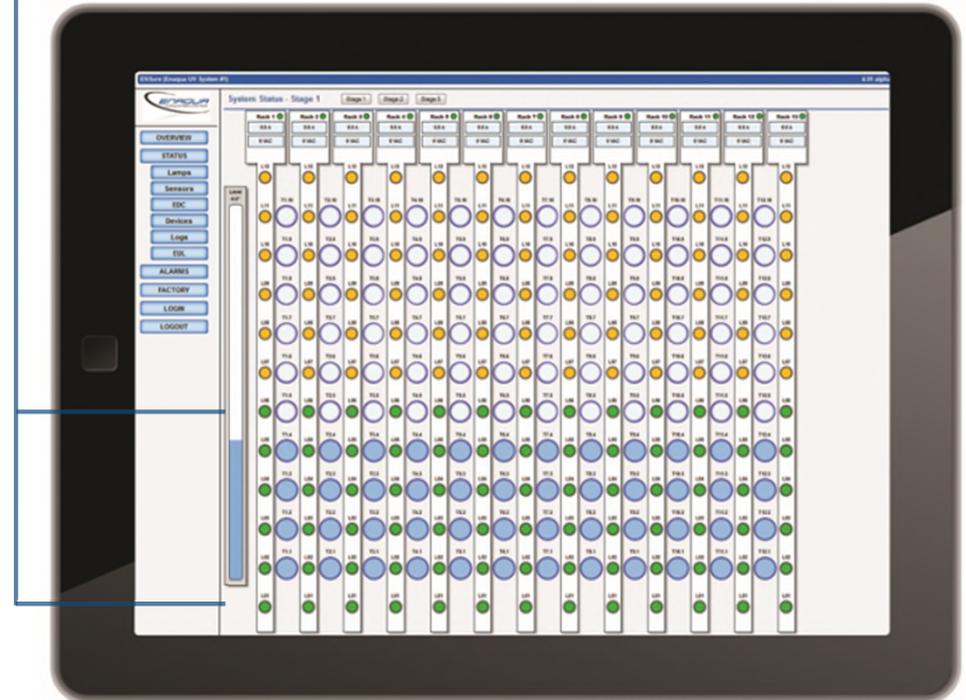
## Annual Energy Cost Comparison



**Energy Cost Savings of 61%**

Actual comparison of bid guaranteed UV energy costs for Wastewater Plant, Peak 28MGD, Average 6MGD, \$0.10/kWh.

## Flow & Level Pacing



# Level Pacing

Reduce Energy  
Consumption

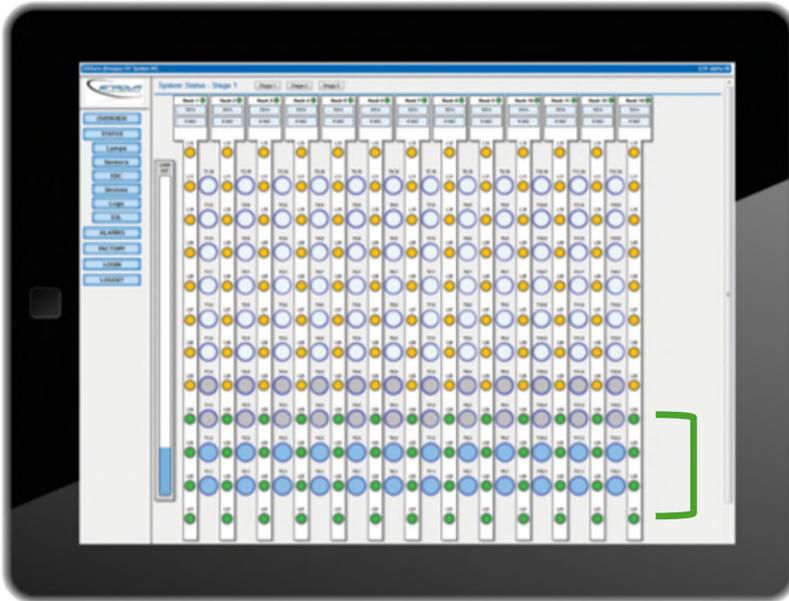


# Intelligent Flow & Level Pacing 2/2



## ENAQUA

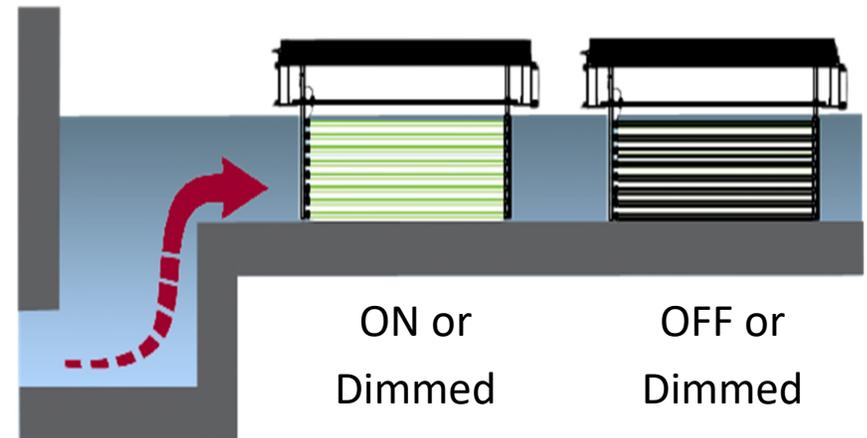
Required lamps are turned on/off



## CONVENTIONAL

Lamp banks are turned on/off  
or lamps are dimmed

LOW  
FLOW



**Enaqua's Flow & Level Pacing is always the most energy efficient system!**

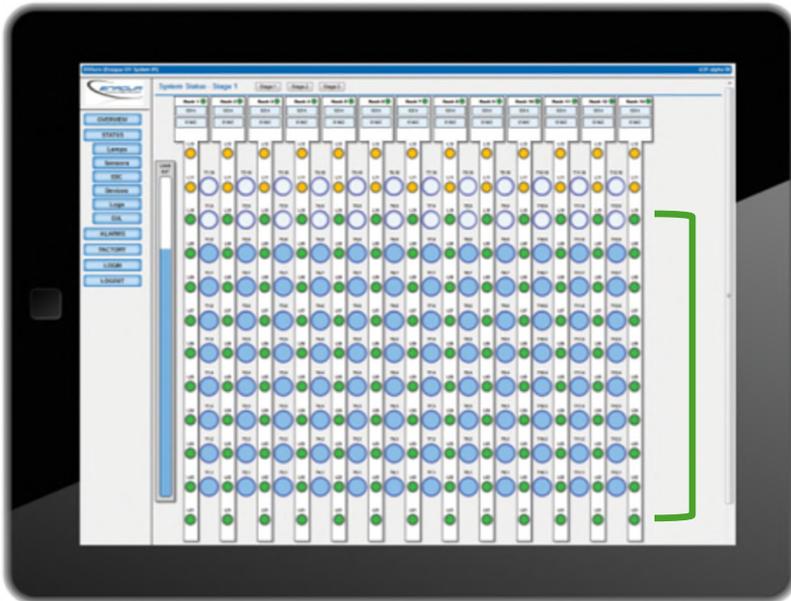
**- No matter what the flow -**

# Intelligent Flow & Level Pacing 1/2



## ENAQUA

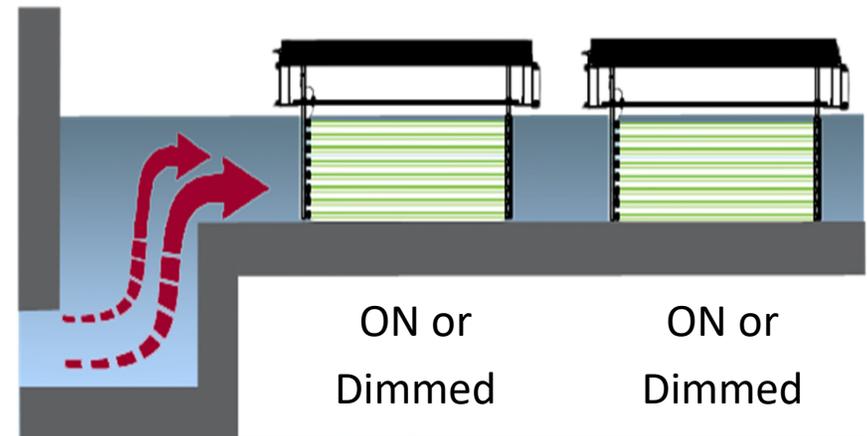
Required lamps and ballasts are turned on/off



## CONVENTIONAL

Lamp banks are turned on/off or lamps are dimmed

HIGH FLOW

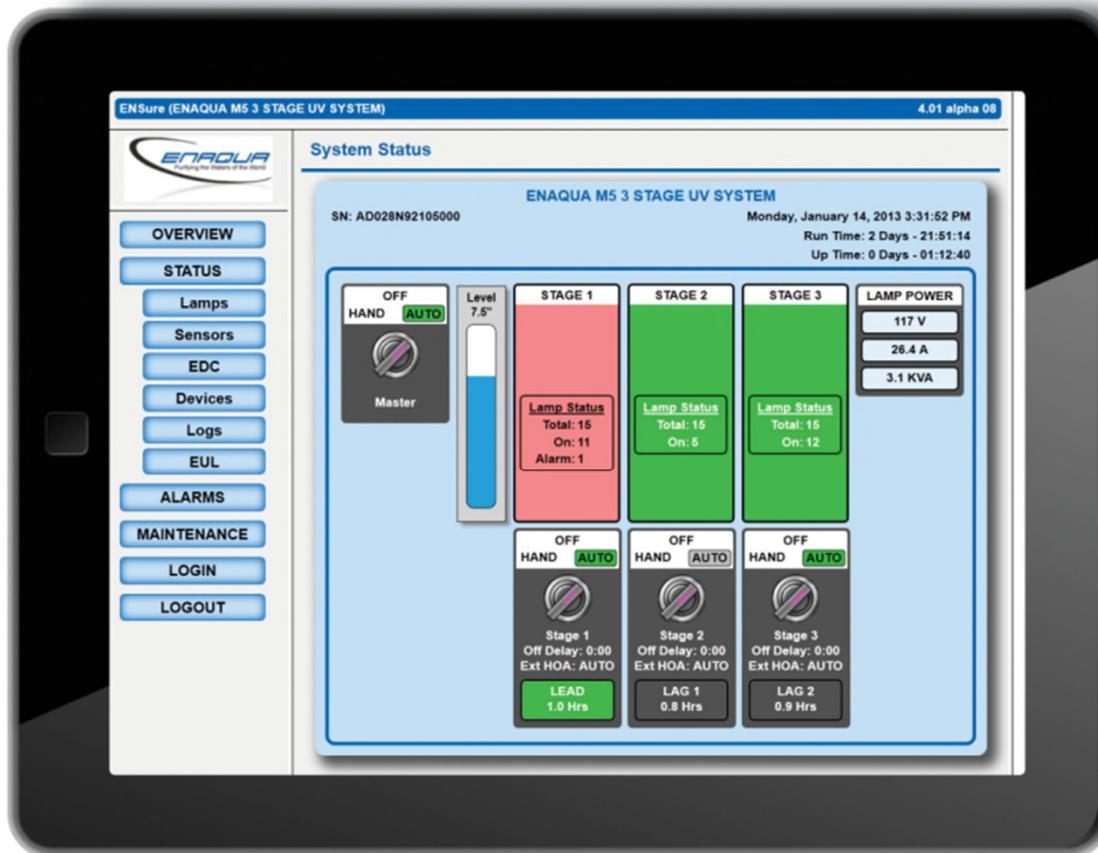


Enaqua's Flow & Level Pacing is always the most energy efficient system!

- No matter what the flow -

# INTELLIGENCE – UV SCADA built in

Full system control and performance monitoring wherever and whenever you want



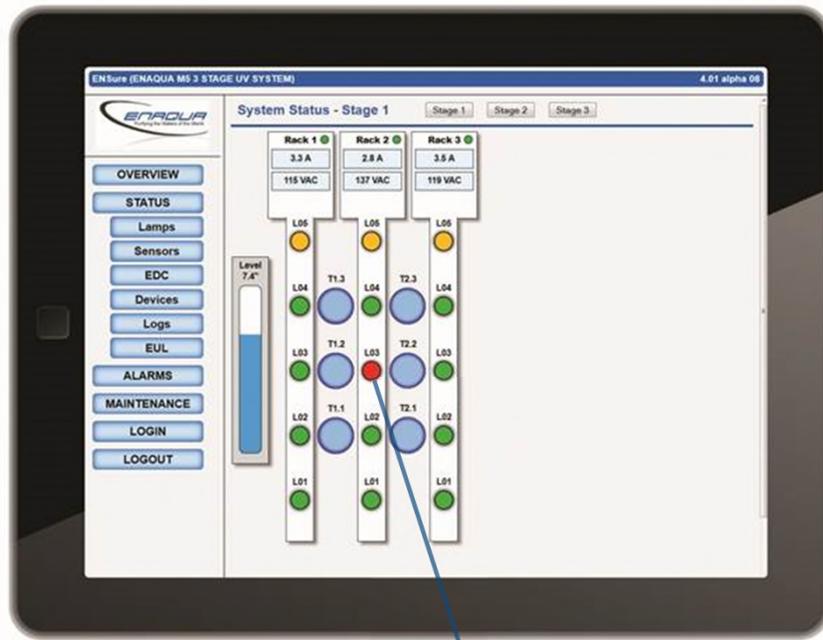
- No special hardware and software requirements
- Simple connection via web browser
- Multiple Levels of Access
- Remote monitoring and control via Internet
- Stand-alone WiFi control with any PC, tablet or Smart Phone
- SCADA integration with ModBUS TCP/IP
- Remote troubleshooting
- Email and text notification

# Fail Safe – Intuitive Protection

In case a lamp in one stage fails, the system will command selected lamps in a redundant stage to power-on to compensate for any UV dosage reduction

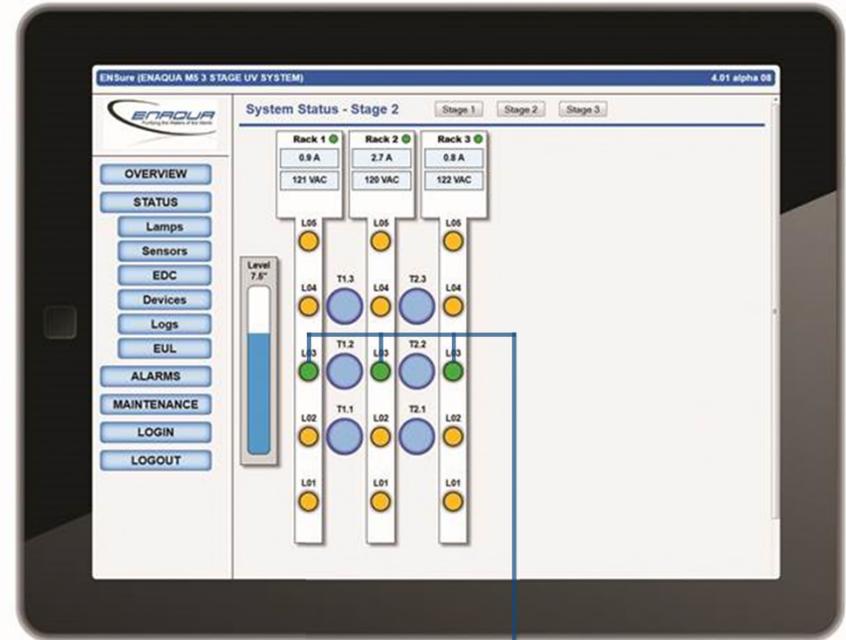


### Stage 1



Lamp fault in stage 1: Alarm Alerts

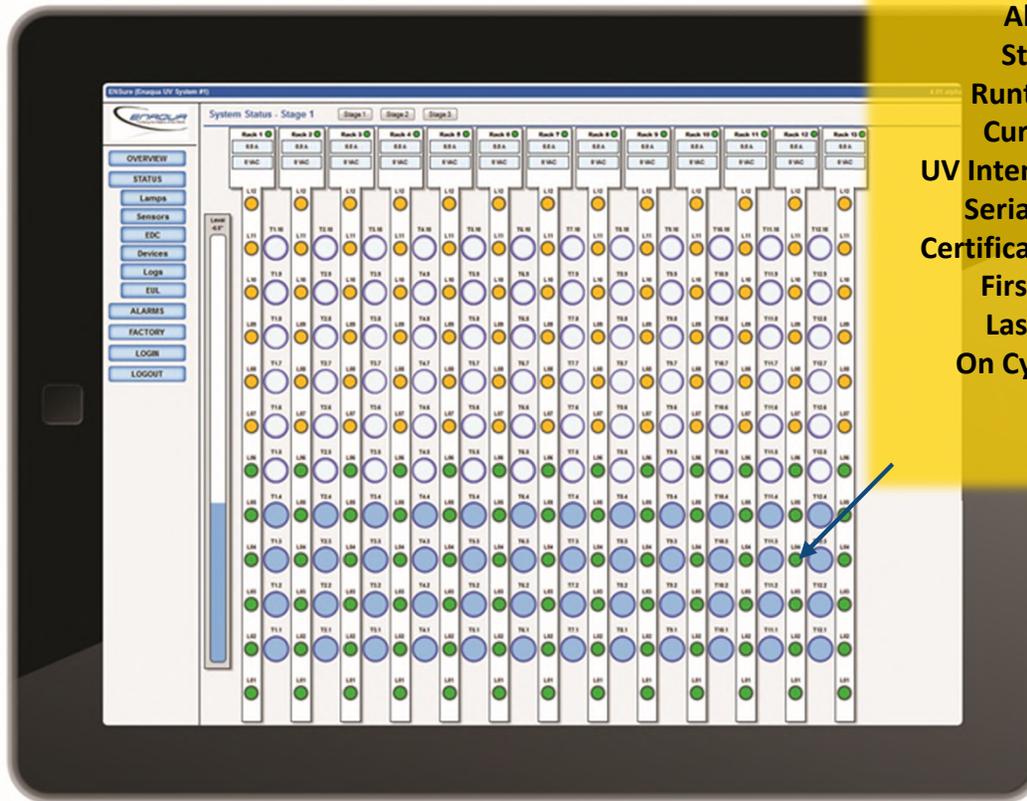
### Stage 2



Automatically turns on selective lamps to compensate faulty lamp position in stage 1

# SMART Lamps – Advanced Lamp Control

Enaqua's Low Pressure High Output (LPHO) lamps are equipped with a unique ID for monitoring status, runtime, date installed and other key parameters.



**Name:** Stage1-LR06-LN010  
**Alarm:** None  
**Status:** Power: On, Lamp: On  
**Runtime:** 552:30:00 hrs  
**Current:** 1.09 amps  
**UV Intensity:** 96%  
**Serial No:** 5B69802  
**Certification:** 1  
**First On:** 12/13/12  
**Last On:** 01/30/13  
**On Cycles:** 272  
**Life:** 16000 Hours

# Status of Technology

- Over 250 Installations
- Systems for:
  - Wastewater
  - Water Reuse
  - CSO
- System Sizes ranging from 10,000 gpd – 160MGD



# QUESTIONS OR COMMENTS

*ENAGUA*<sup>TM</sup>