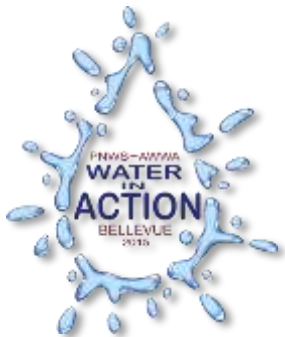


Presented at
PNWS-AWWA Conference
Bellevue, WA
May 1, 2015

UV Disinfection: Design Assumptions vs. Operation

Qianru Deng, P.E.



MWH[®]

BUILDING A BETTER WORLD

Outline



Overview of UV Disinfection

Edward Springs Treatment Facility

Design Assumptions vs. Operation Data

Medium Pressure UV System – Action Spectra Bias & Correction

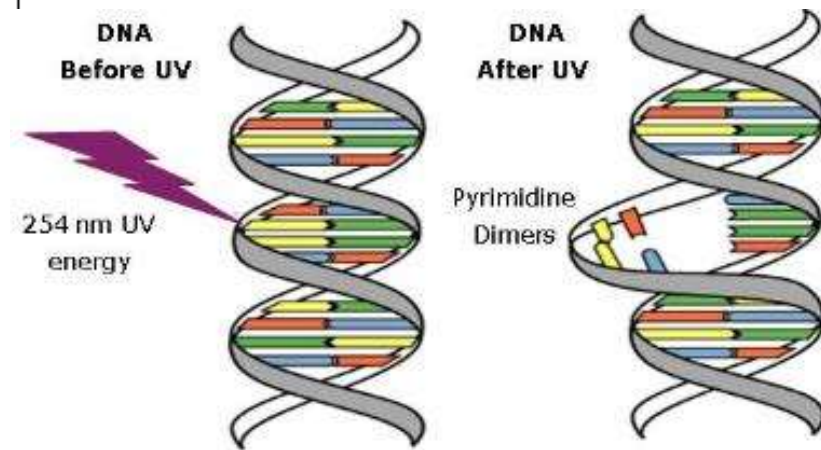
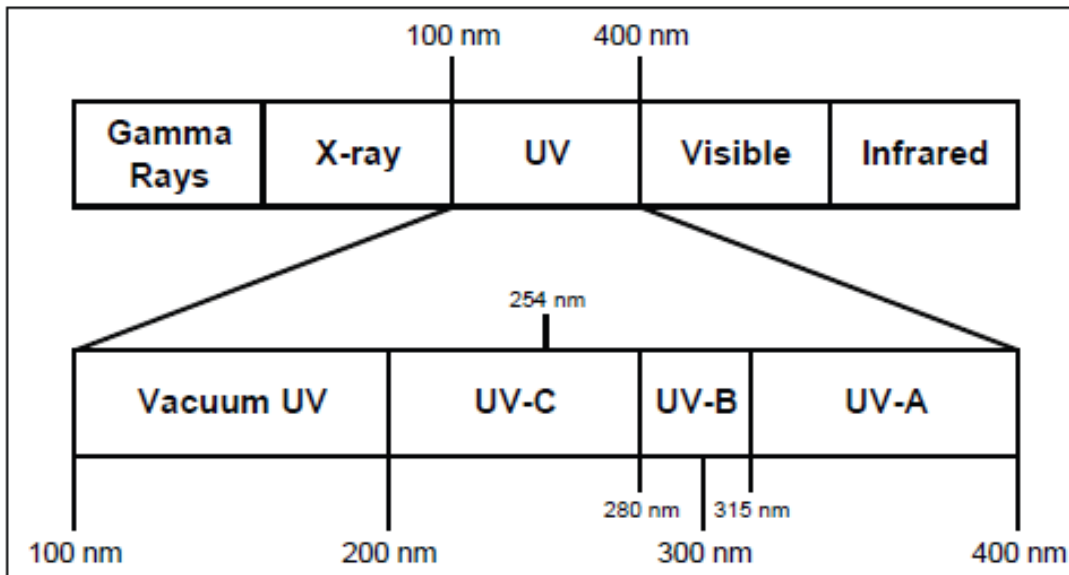


Ultraviolet (UV) Disinfection Overview



UV Disinfection

How does it work?



Does not kill, inactivates nucleic acid through dimerization of pyrimidines (loss of reproduction)

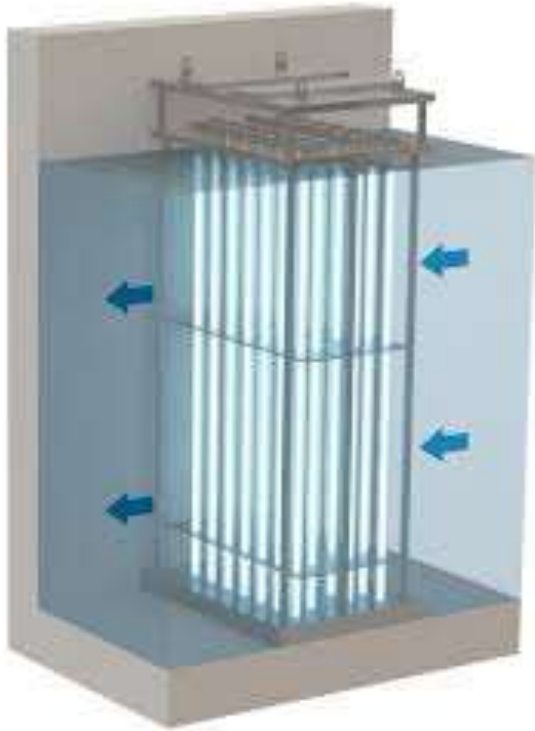


UV Disinfection

Closed Vessel UV Reactor

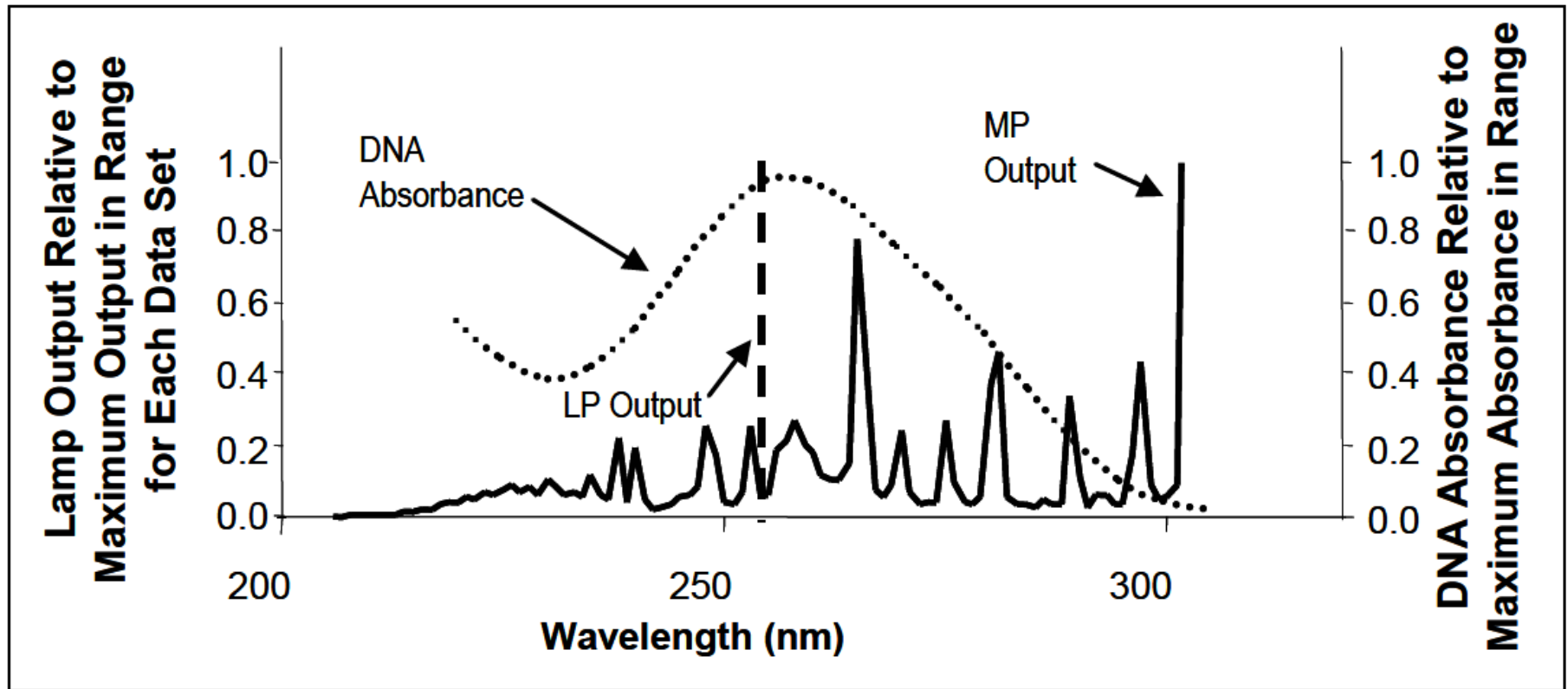


UV Disinfection Open Channel System



UV Disinfection Lamp Technology

Low Pressure High Output (LPHO) & Medium Pressure (MP)

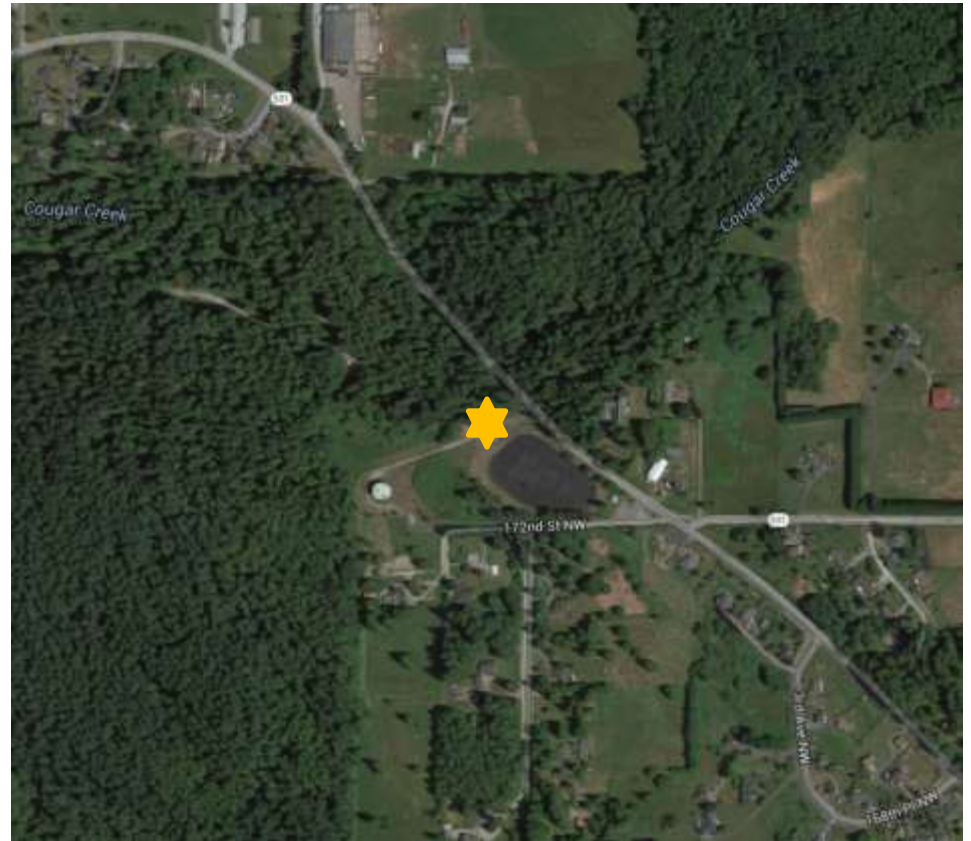
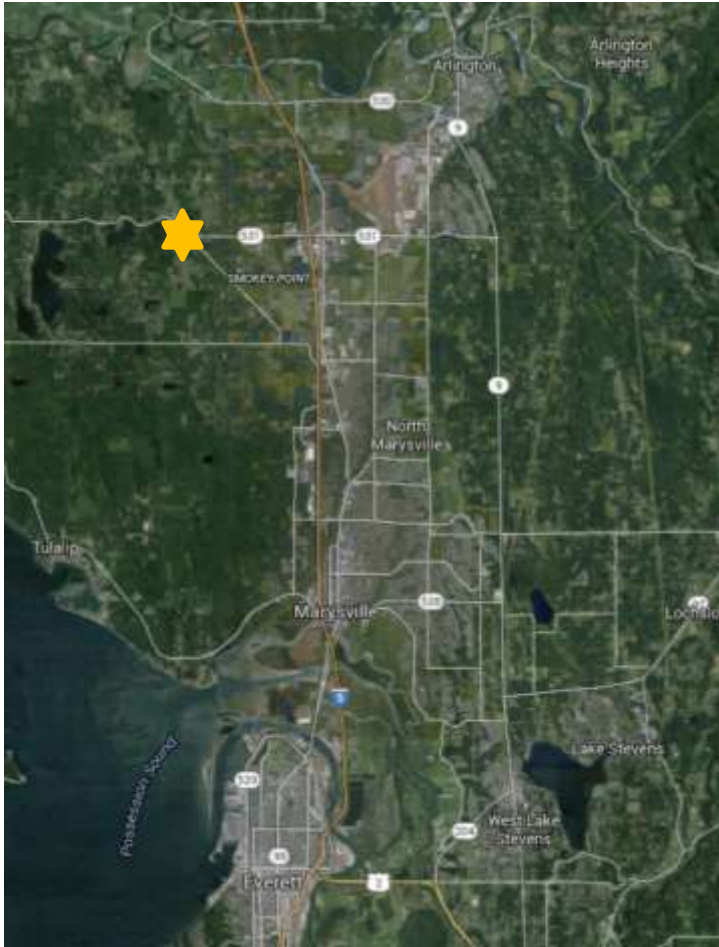


Edward Springs Treatment Facility



Edward Springs Treatment Facility

City of Marysville



Edward Springs Treatment Facility

City of Marysville

UV System Capacity

- Flow Rate: 2 MGD (two reactors)
- Min UVT: 80%/cm
- UV Dose (RED): 48 mJ/cm²

UV System Configuration

- Two UV reactors installed in Q1 2014
- Six Lamps per Reactor
- 8-inch Diameter
- LPHO
- With Mechanical Wipers



Edward Springs Treatment Facility

City of Marysville

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Edward Springs Treatment Facility

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Design Assumptions vs. Operation Data



Design Assumptions vs. Operation Data

UV Intensity Measurements

$$RED = 10^A \times UVA^B \times (S/S_0)^C \times Q^D \times Banks^E$$

UV Dose

UV Absorbance
 $10^{UVA} = 1/UVT$

UV Intensity

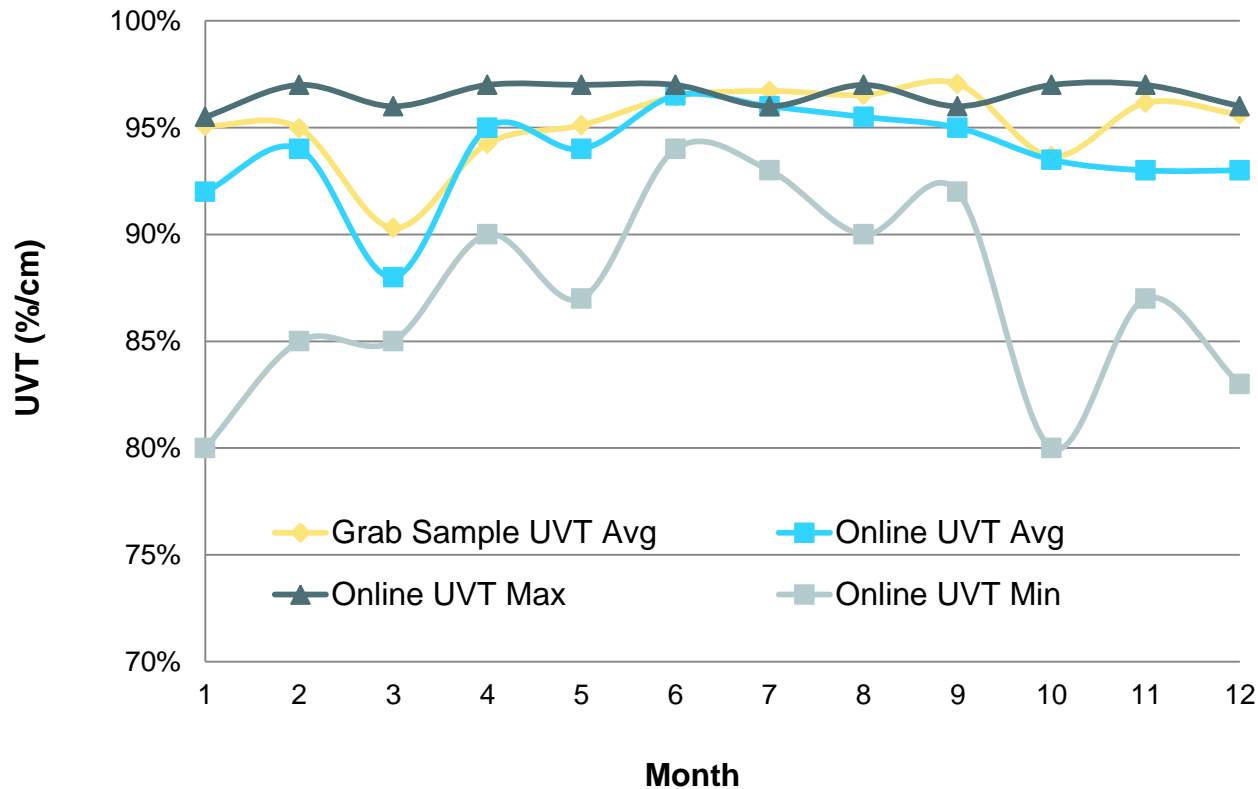
Flow Rate

Number of operating banks of lamps



Design Assumptions vs. Operation Data

Water Quality – UV Transmittance (UVT)



Online UVT monitoring is necessary to capture minimum UVT.



Design Assumptions vs. Operation Data

UV Intensity Measurements



Design Assumptions vs. Operation Data

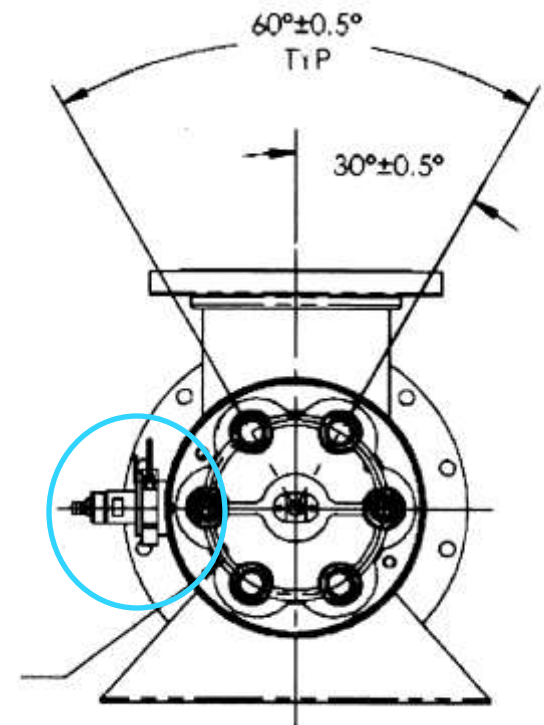
UV Intensity Measurements

UV Intensity Sensor Configuration

- One UV intensity sensor per reactor
- Only measures UV intensity of the nearest lamp (#1)

Lamp Placement

- Rotate lamps to place oldest lamp in position #1



Design Assumptions vs. Operation Data

Fouling

Fouling Factors

- Oxidation status: No pre-oxidation
- Inorganics (Fe, Mn) Level: Low
- Mitigated by wipers or off-line chemical cleaning:
Equipped with mechanical wipers

Low fouling potential was expected



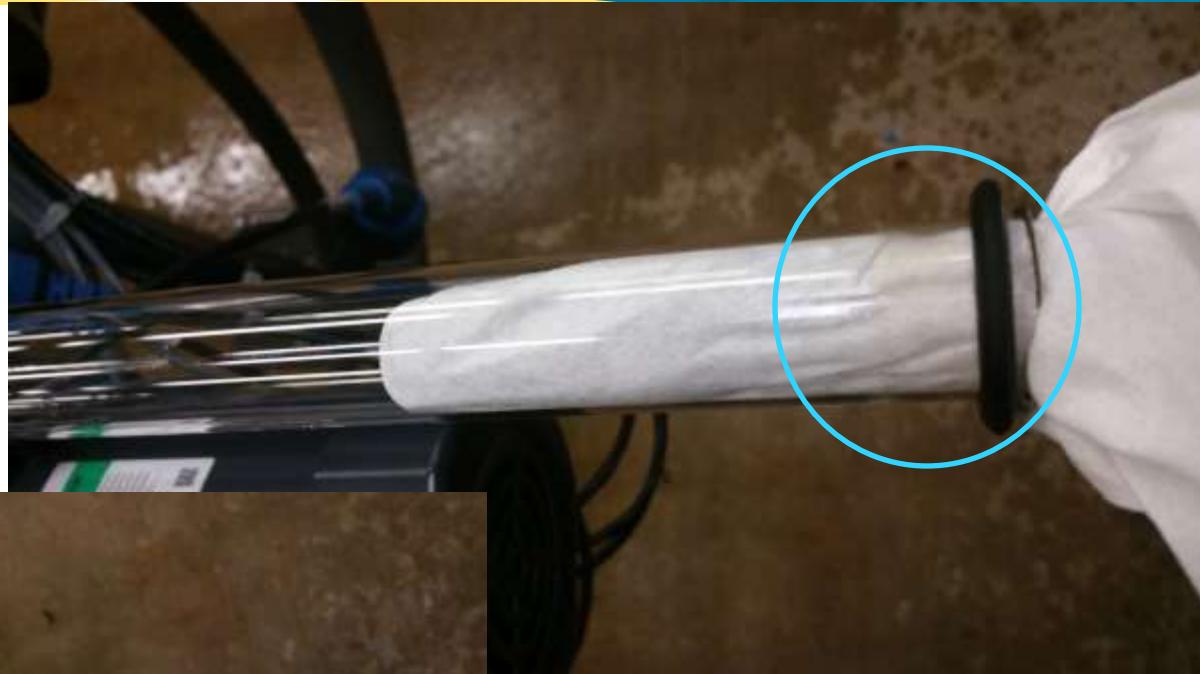
Design Assumptions vs. Operation Data

Fouling



Design Assumptions vs. Operation Data

Fouling



Design Assumptions vs. Operation Data

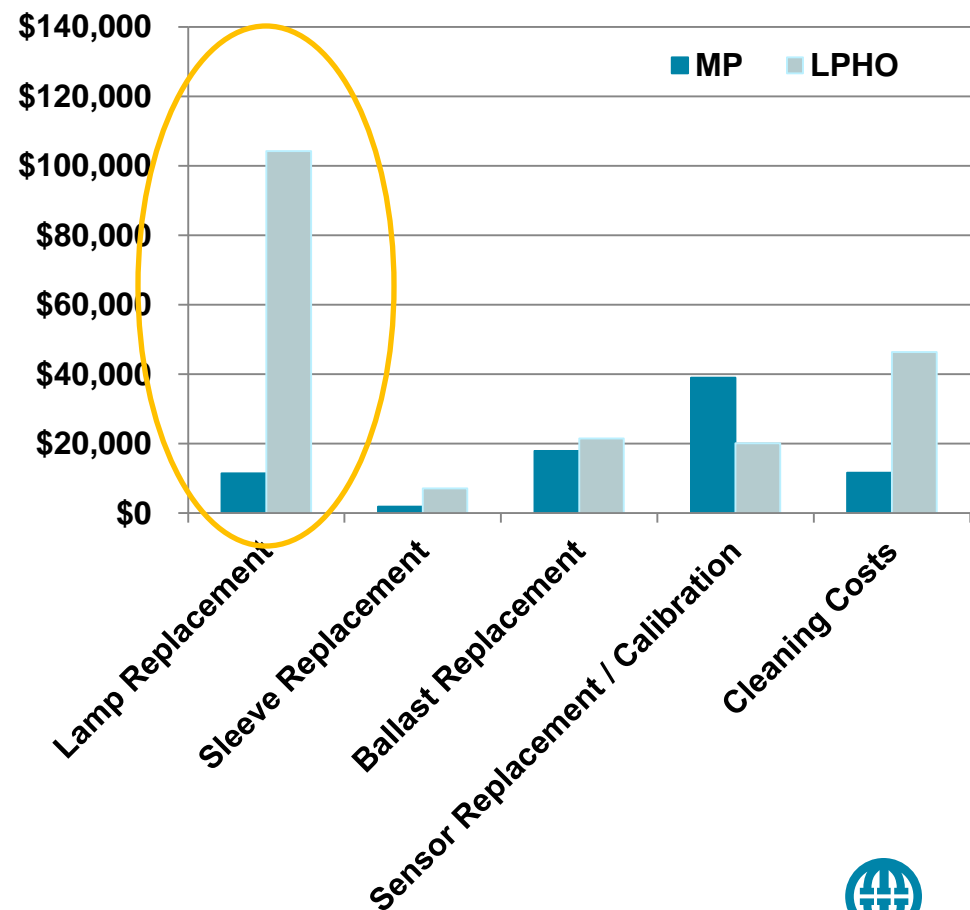
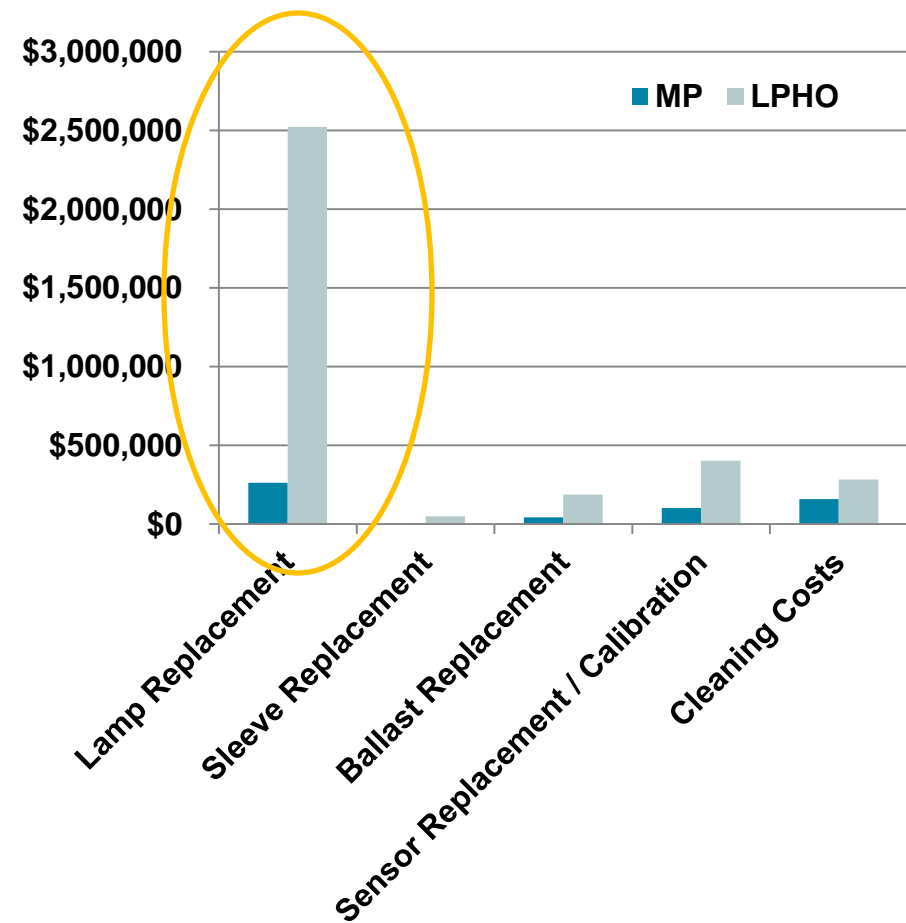
Life Cycle Cost – Operation & Maintenance

Components	Design Assumptions	Operation Data
Lamp Replacement – Operator Time, hr/lamp	.2	1
Quartz Sleeve Replacement – Operator Time, hr/sleeve	0.5	3
Ballast Replacement – Operator Time, hr/ballast	0.5	1
UV Intensity Sensor Calibration, No./year	1	2
Wiper Replacement – Operator Time, hr/wiper	0.25	6



Design Assumptions vs. Operation Data

Life Cycle Cost – Operation & Maintenance



Conclusions

Online UVT sampling is necessary for capturing low UVT events and identifying worst case scenario.

Fouling can be mitigated by mechanical cleaning system.

UV intensity sensor & lamp placement is critical.

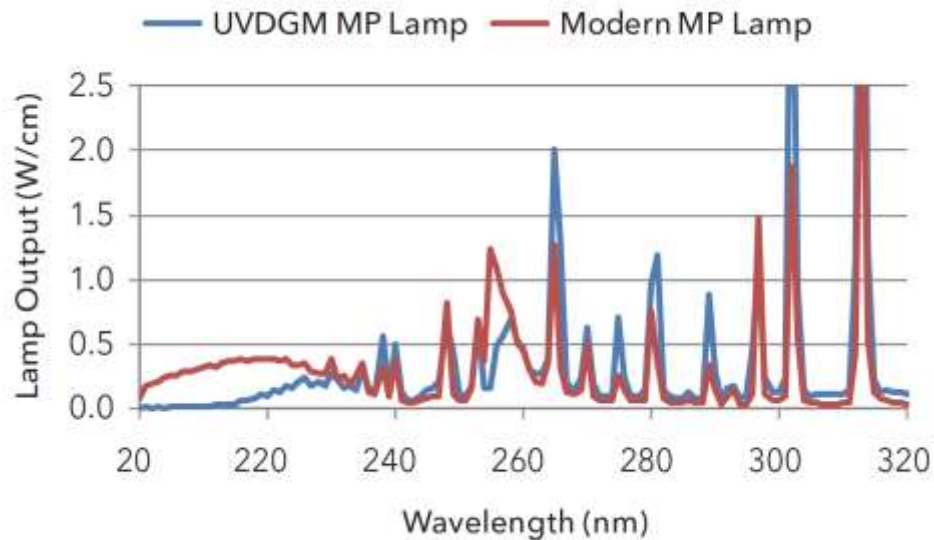
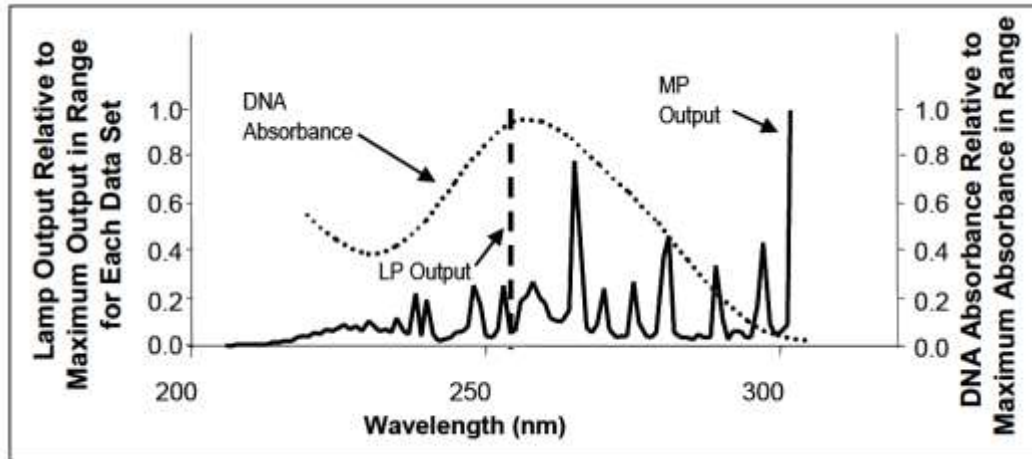
Use reference site data for life cycle cost analysis.



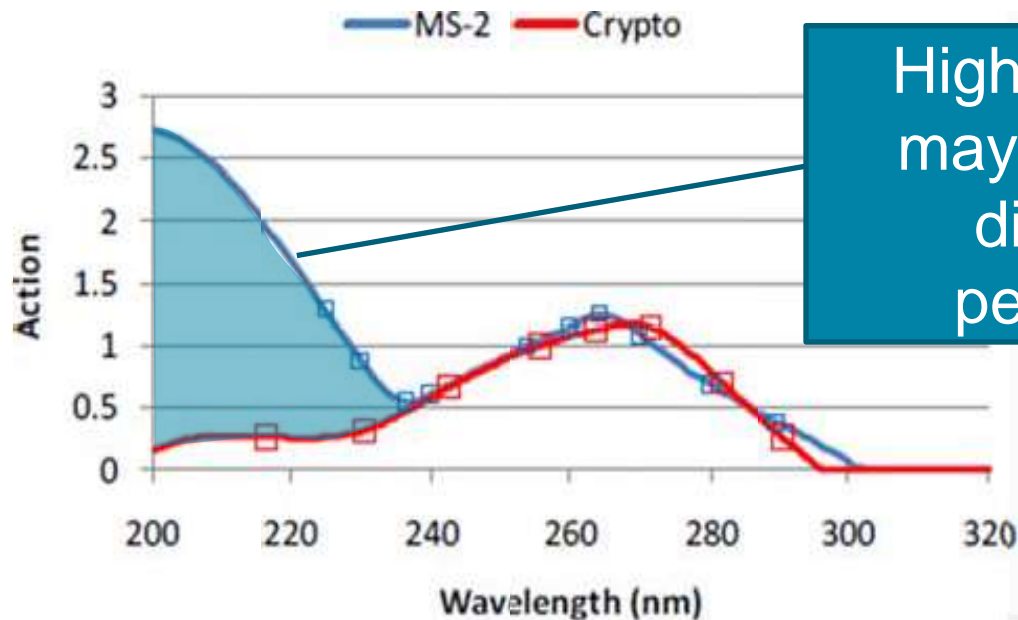
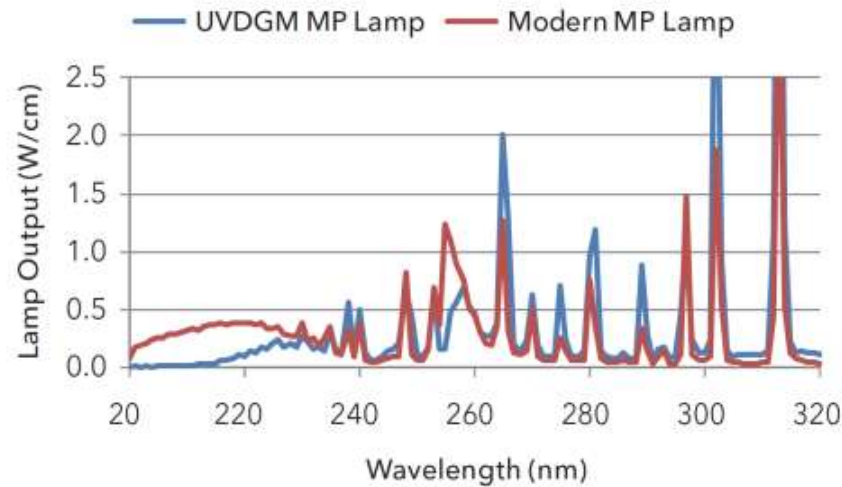
Medium Pressure UV System Action Spectra Bias & Correction



Medium Pressure Action Spectra Bias



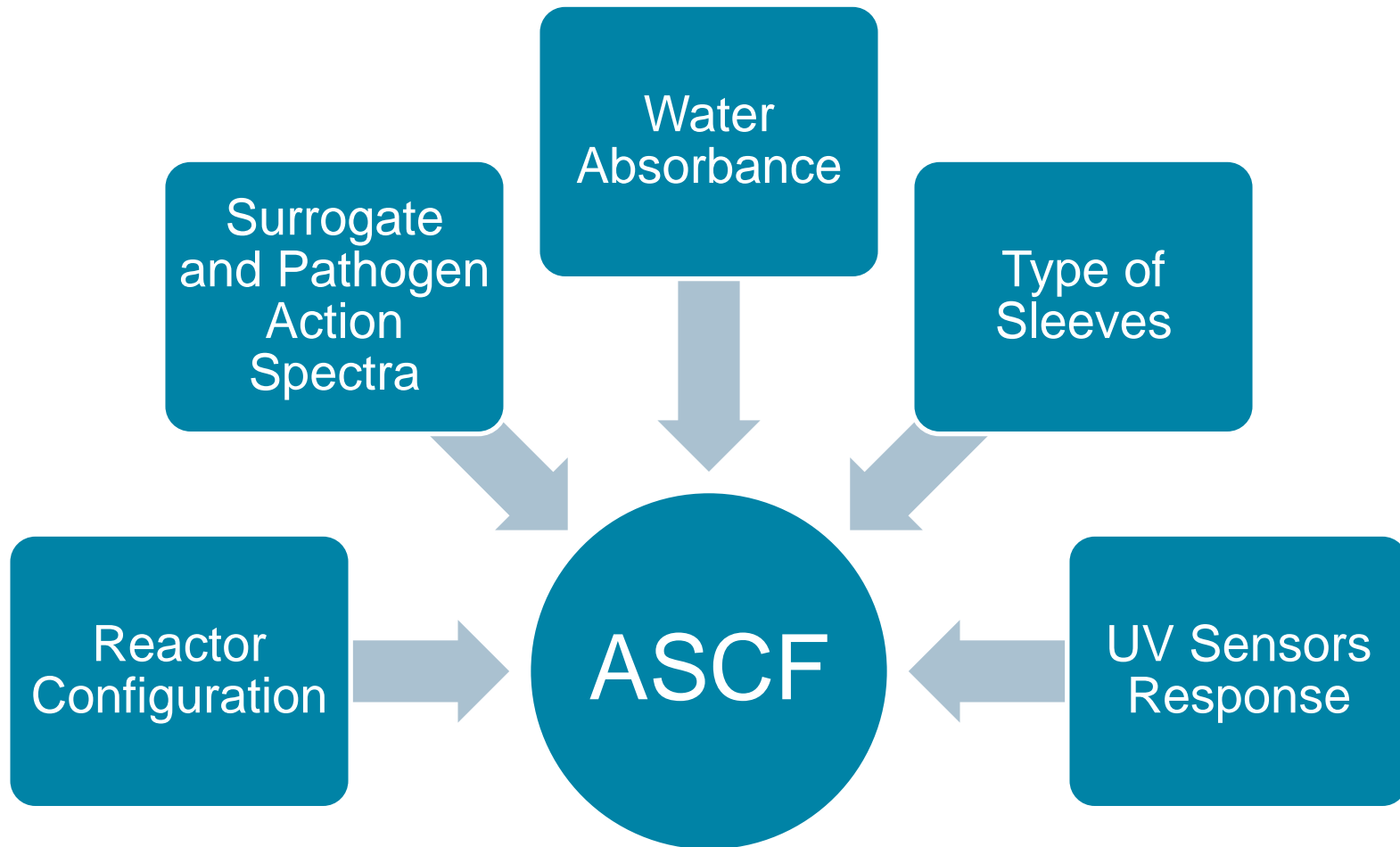
Medium Pressure Action Spectra Bias



Higher sensitivity
may over predict
disinfection
performance



Medium Pressure Action Spectra Bias



Medium Pressure Action Spectra Correction

Applies to MP system only

Action Spectra Correction Factor (ASCF)

- Blanket ASCF
- Site Specific ASCF

To be continued...



Questions?

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