Case Study: UV Upgrade Produces Real Energy Savings for Ayer, MA WWTP.

How Innovative Non-Contact Technology Cut Power Consumption and Costs

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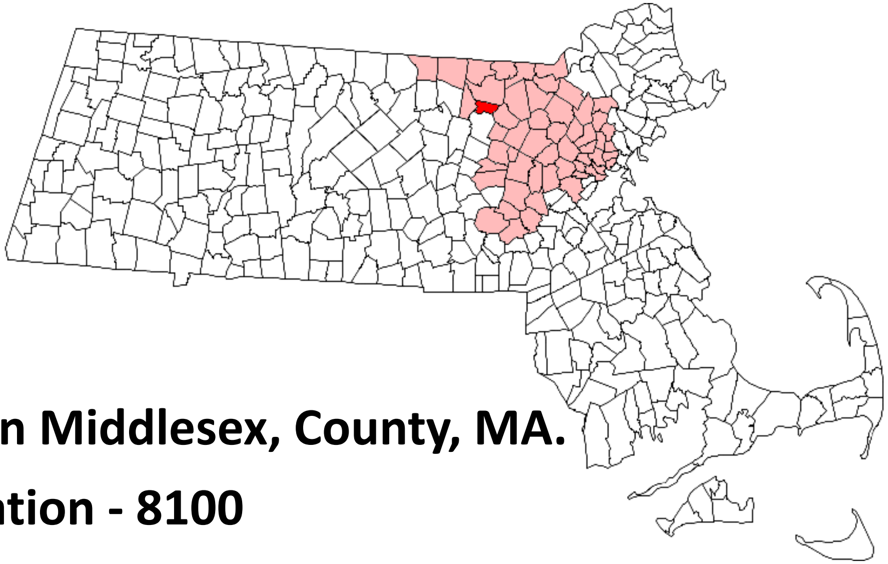
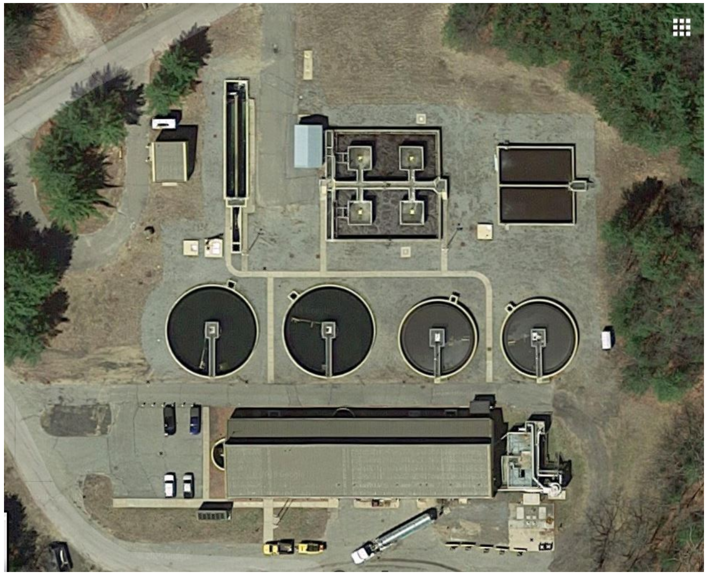
BACKGROUND



- Ayer WWTP – CAS w/Tertiary Filtration.
- Discharges into the Nashua River.
- ADF: 1.8 MGD
- PDF: 2.4 MGD
- Wet Weather flow: 4+ MGD

- Town in Middlesex, County, MA.
- Population - 8100
- Incorporated in 1871.



- Changed from Chlorine & Sodium Bisulfite to UV for final effluent disinfection in 2007.

- Had two (2) different UV suppliers from 2007 to 2013 and 2013 to present.

WHY CHANGE TO UV (2007)

- Safety – Chemical exposure and handling
- Cost – Chemicals had to purchased on a regular basis
- Storage Equipment – Tanks, containers, etc.
- Equipment – Eliminate Metering pumps and feeders and associated costs to purchase and maintain.
- Reduce equipment power consumption and costs.
- Unreliable chemical deliveries. Subject to weather, roads, natural disaster

PAST UV EXPERIENCE (2007)

- **FIRST UNITS INSTALLED IN 2007 REQUIRED THE ADDITION OF SODIUM HYPOCHLORITE AND BISULFITE TO GET COMPLETE KILL**
- **EXCESSIVE ENERGY CONSUMPTION**
- **DIFFICULT TO MAINTAIN AND KEEP CLEAN (HAD TO TAKE SYSTEM OFF-LINE…REDUCED DISINFECTION)**
- **MANY EXTENSIVE AND EXPENSIVE REPLACEMENT PARTS**

SIX (6) YEARS OF OPERATION REQUIRING SUPPLEMENTAL CHEMICALS AND HIGH O&M COSTS JUST TO MEET EPA REGION 1 COLIFORM PERMIT!

ACTION PLAN IMPLEMENTED

- **SUMMER, 2011**
  - **Engineer retained to investigate and recommend new UV system**

PROBLEMS TO ADDRESS:

- **CLOTH TERIARY FILTERS FLOODED DURING HIGH FLOW / WET WEATHER EVENTS**
- **VERY HIGH MAINTANENCE AND PARTS COST**
- **POWER CONSUMPTION (ENERGY COSTS)**
- **CHEMICAL COSTS (SUPPLEMENTAL)**

UV PRIORITY NEEDS – ACTION PLAN

1. Meet NPDES permit effluent requirements w/o chemicals
2. Energy efficient and reduce power consumption.
3. Fit within the existing system footprint and hydraulic profile of the facility
4. Minimize/eliminate impact to existing pipe system or need for open channel
5. Operator friendly, accessible for maintenance, and have readily available (local sourcing) spare parts
6. Interface with existing plant SCADA system (compatible protocol)

<u>THREE (3) DIFFERENT MANUFACTURERS INTERVIEWED!</u>

EVALUATION CRITERIA

- **Capital Cost - Look at overall capital cost as well as ancillary equipment necessary to operate and maintain a new UV system (hoists, compressors, weirs, cleaning tanks etc.).**
- **Power consumption - New UV system must be an energy saving system (Low pressure system).**
- **O&M – ease of use and ease of periodic/preventive maintenance**
- **Replacement parts cost and source - lamps, ballasts, wipers, sleeves, etc. and local availability**
- **Other – Company, installs, feedback**
- **Most important…**

Able to get complete 100% kill w/o chemical addition!

DESIGN CRITERIA

Peak Flow Rate – 2.4 MGD (per reactor)

Average Daily Flow Rate – 1.4 MGD

TSS - >30 mg/l (30 day average grab samples)

UV Transmittance – 65% Minimum

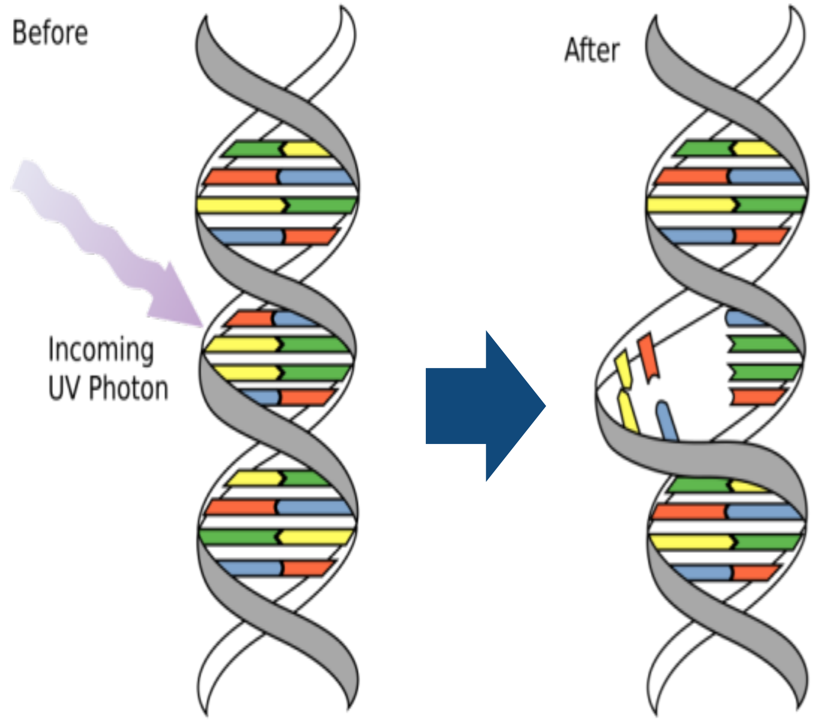
Annual Effluent Temperature Range – 46 to 75 degrees F

Max. Mean Particle size – 30 microns

Effluent standards - 200 fecal coliform/100 ml based on single day grab samples as a 30 day Geometric Mean of daily samples

HOW DOES UV DISINFECTION WORK?

- Disinfection process using of short wave length 254nm Ultraviolet (UV) energy to kill.
- Disrupts DNA of pathogenic organisms (bacteria, viruses, molds). Unable to replicate.
- Applied to effluents from low-quality combined sewer overflow (CSO) to high-quality tertiary effluent.
- > 20% of WWTP in the US are already using UV.



UV LAMP DESIGNS (2007)

1. <u>MEDIUM PRESSURE</u>

- Refers to the vapor pressure in the lamp body (a sealed tube)
- Medium Pressure Lamps are very inefficient (>10%)
  at converting Electric power into useful UV 254nm
- They tend to be higher power (Watts) 1000W-3000W
- Can only be operated horizontally
- Take a long time to warm up –
  must be “dimmed” rather then cycled

UV LAMP DESIGNS (cont'd) 2013

2. LOW PRESSURE

•**Low Pressure Lamps are more energy efficient (33%+) at converting Electric power into useful UV 254nm**

•**Lower power (Watts) 75-1000W**

•**Similar to Fluorescent lamps (filaments)**

•**Operated horizontally or vertically**

•**Can be "dimmed" or cycled depending on the lamp design**

•**Most Common Lamps in Wastewater**

PREVIOUS AYER UV SYSTEM (2007)

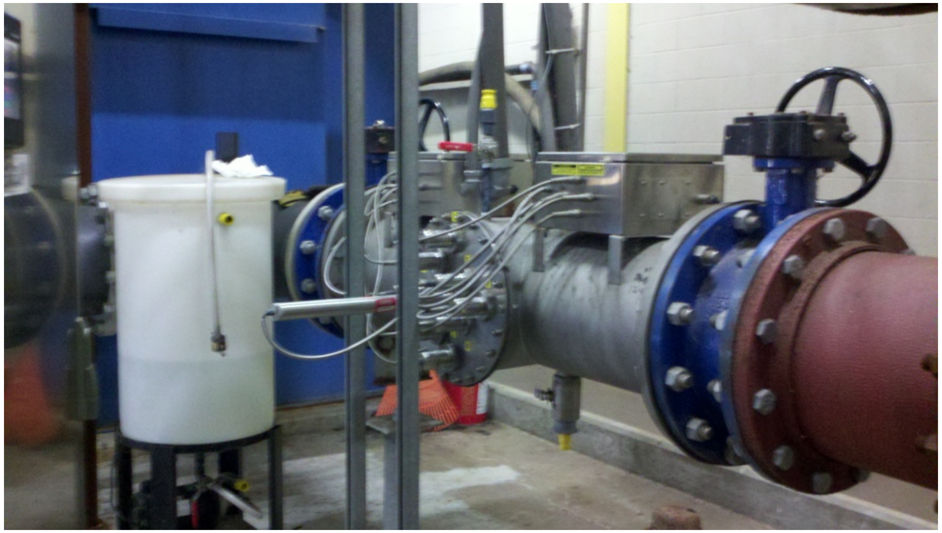
1. CONTACT TYPE (Lamps in Contact with water) – Medium Pressure

- In-line system, lamps continuously submerged in contact with water

- System had to be completely drained to perform routine maintenance

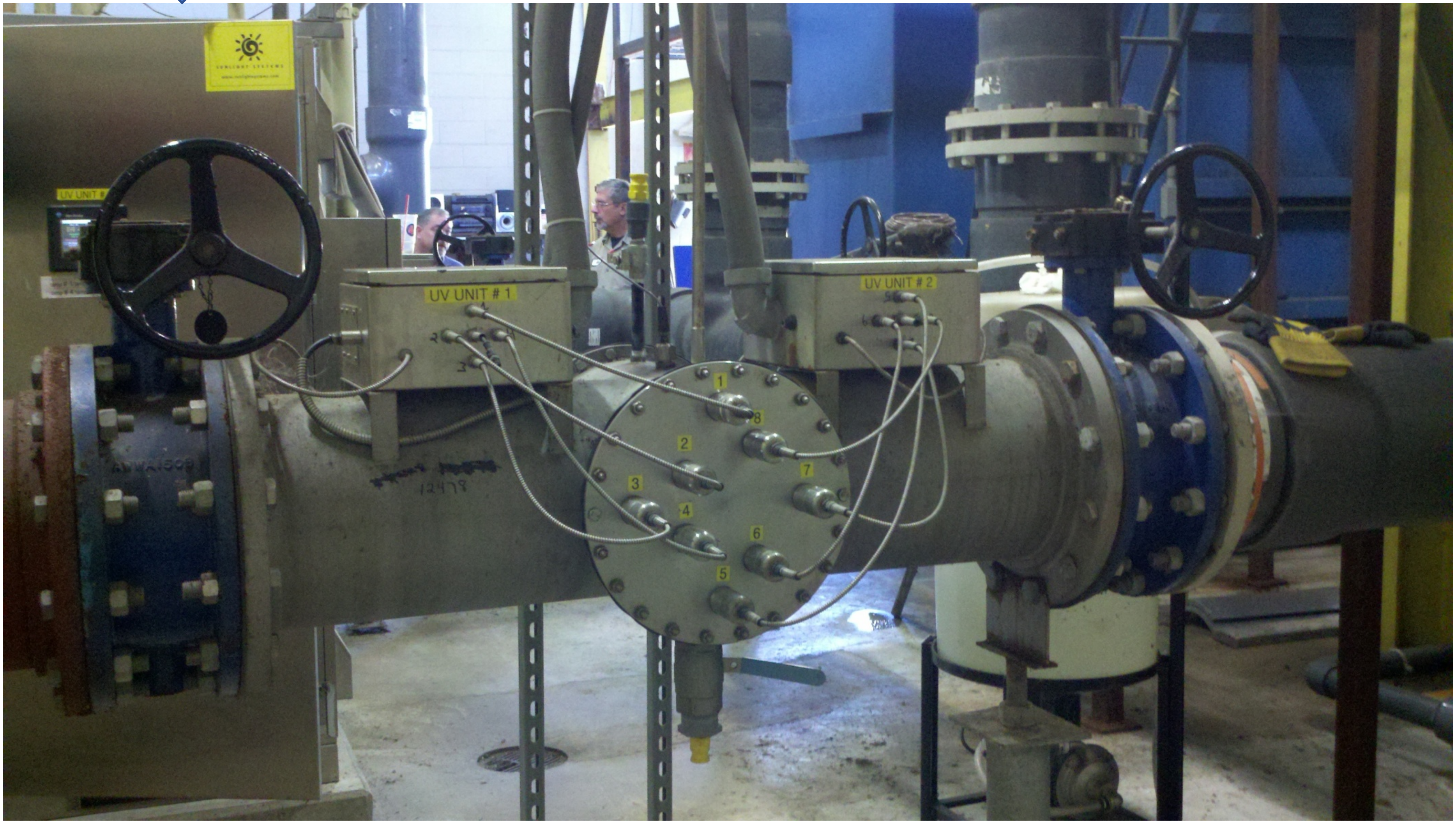
- Piping and hydraulics caused water to back up into the filters occasionally flooding the room

- Parts were expensive. Not sourced in USA

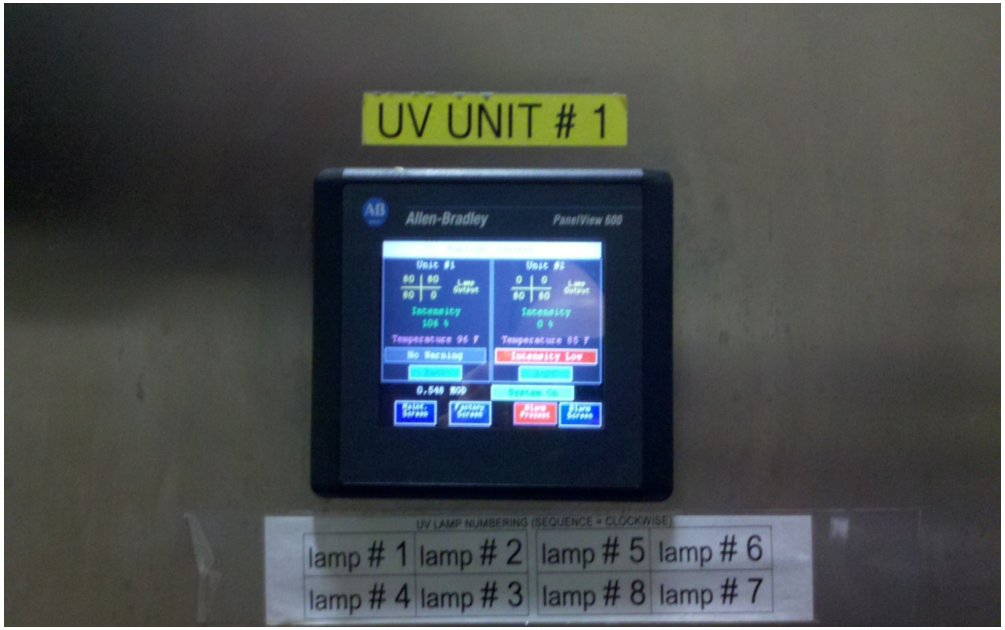


UV UNIT(S) CONTROL PANEL (2007)

- Large, free-standing panel/unit



UV UNIT(S) CONTROL PANEL OIT (2007)



PRESENT AYER UV SYSTEM (2013)

2. NON-CONTACT TYPE (No contact with water) – Low Pressure

•Water flows through transparent polymer tubes

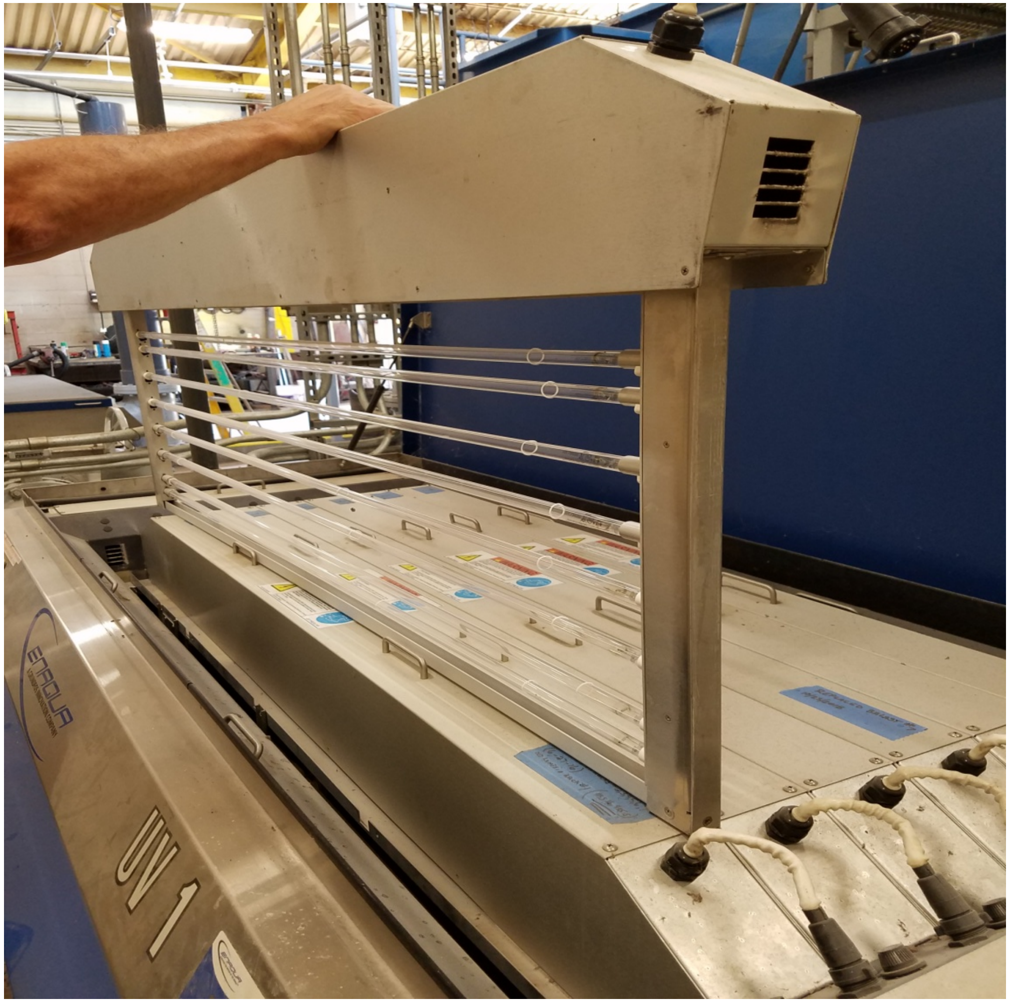
•UV lamps surround these tubes outside the flow of water (DRY)

•Each tube gets exposed to ultraviolet light from all sides

•No flow leveling weirs after the UV – Open Discharge – Improved hydraulics

1. Fit in the allotted space
2. Cleaned up the piping arrangement
3. Improved the hydraulics through the plant

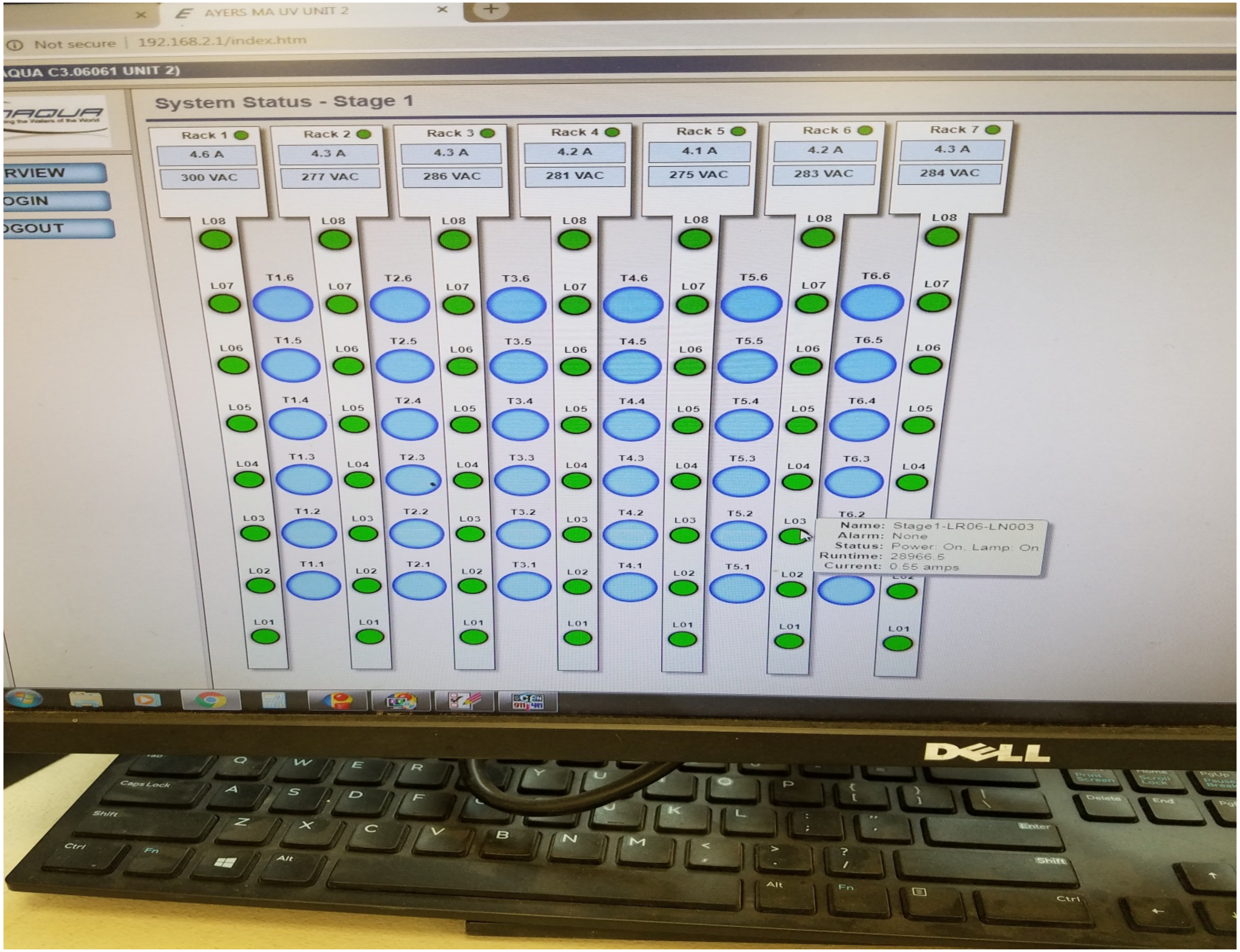
NON-CONTACT LAMP RACKS



UV UNIT(S) CONTROL PANEL AND OIT (2013)

- Compact Wall-mounted (1)
- Windows-based
- Large Screen
- Access to graphics, alarms
- Ethernet DH to SCADA

SCADA DISPLAY – LAMP AND TUBE ARRAY



LOOK AT THE NUMBERS – POWER & COSTS

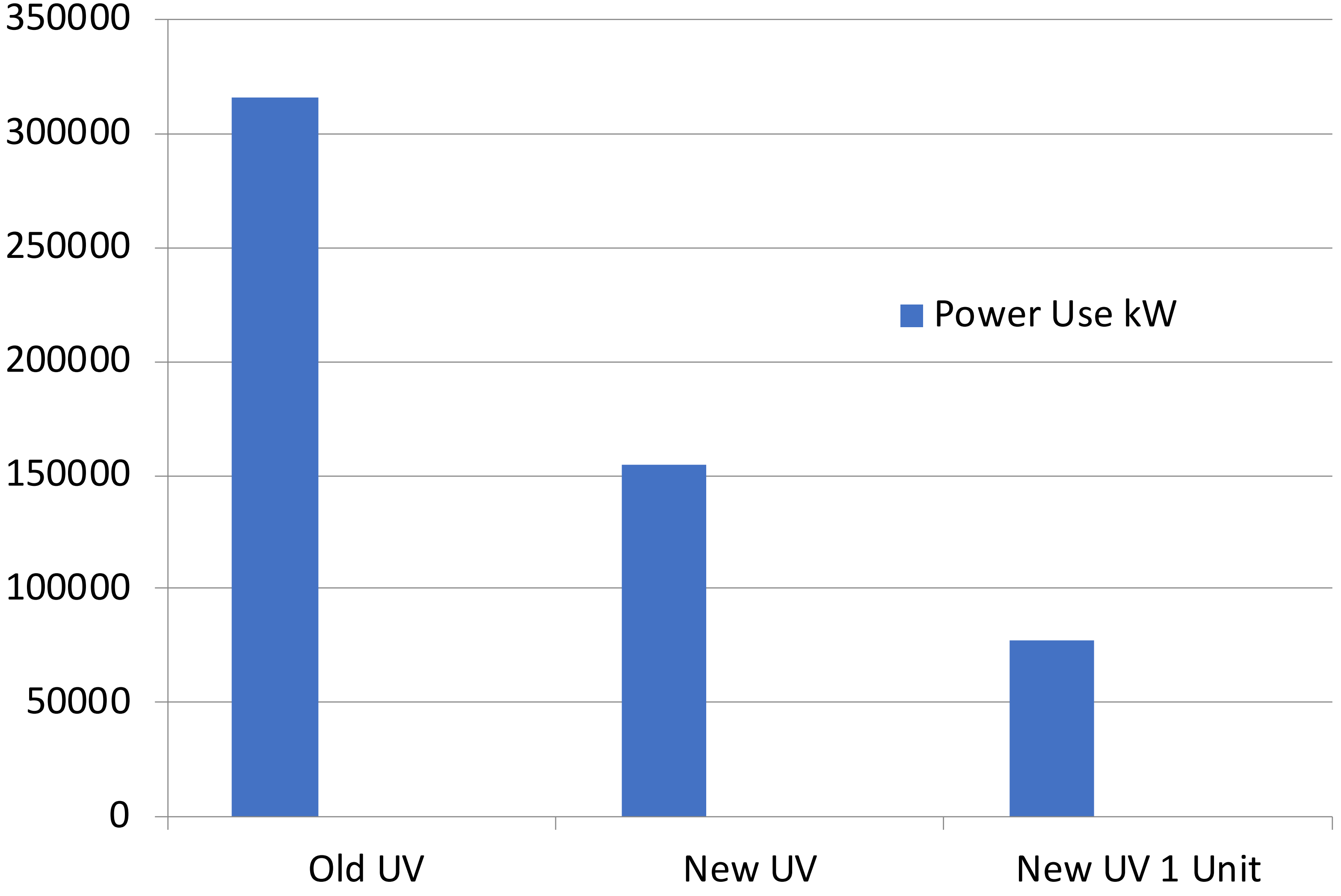
- **<u>OLD SYSTEM (2 Units Req'd) – Medium Pressure, Contact Type (2007)</u>**
- UV Unit = Each unit draws 18.0kW/hr x 2 = 36.0 kW
- 24hrs/day x 36kW/hr = 864kW/day
- 864kW/day x 365 days = 315,360 kW/year (POWER CONSUMPTION)
- 315,360 kW/yr x $0.16/kW = $50,458/year (COST)

- **<u>NEW SYSTEM (1 Unit Req'd) – Low Pressure, Non-Contact Type (2013)</u>**
- UV Unit = Each unit draws 8.8kW/hr x 1 = 8.8 kW
- 24hrs/day x 8.8kW/hr = 211.2 kW/day
- 211.2 kW/day x 365 days = 77,088 kW/year (POWER CONSUMPTION)
- 77,088kw/yr x $0.16/kW = $12,334/year (COST – 1 UNIT)

So, $50,458 - $12,334 = $38,124 Savings/yr in Electric costs!!!
75% Savings/year in power consumption

BUT…ONLY ONE (1) NEW UNIT IS NECESSARY TO OBTAIN COLIFORM KILL!!!

POWER USAGE OLD/NEW

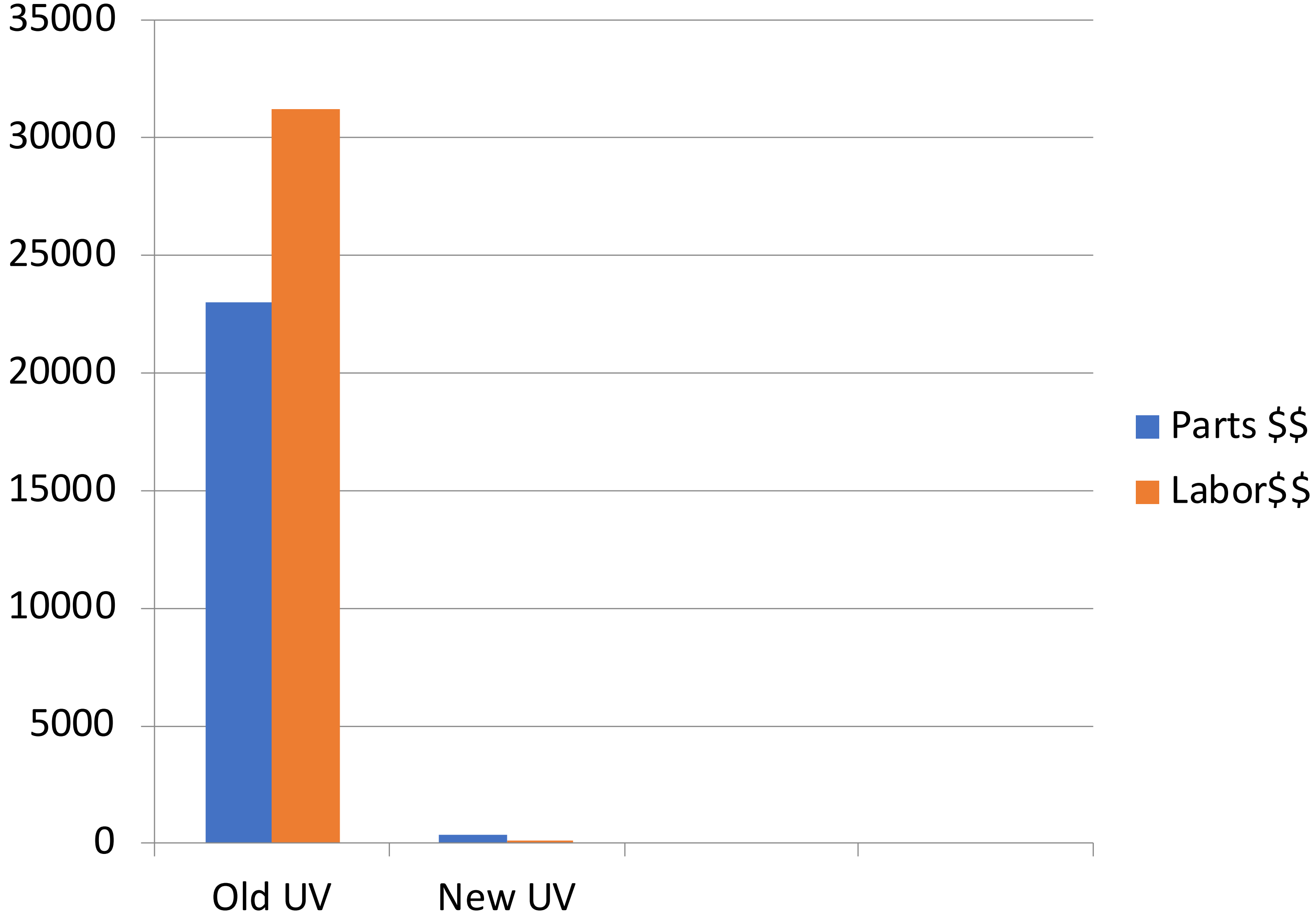


Reduced power consumption by 75% (from $50,000/yr. to $12,500/yr.) while maintaining disinfection limits.

LOOK AT THE NUMBERS – PARTS & LABOR

- **<u>OLD SYSTEM (2 Units) – Medium Pressure, Contact Type (2007)</u>**
  - Combined parts for quartz sleeves, lamps, ballasts
    - $23,000 yearly average (PO's)
  - Labor (maintenance)
    - 20hrs/wk (typical) x $30/hr x 52 weeks = $31,200 yearly average
- **<u>NEW SYSTEM (2 Units) – Low Pressure, Non- Contact Type (2013)</u>**
  - Eight (8) ballasts, Two (2) sets lamps (56 lamps/set x 2 = 112 total)
    - 8 x $137 + 112 x $115 = $13,976 / 6 years = $2,330/yr
  - Labor (maintenance)
    - 16 hrs (2 days) x $30 = $480
    - 2 ballasts x 1/hr x $30/hr = $60
    - $480 + $60 = $540/6 yrs = $90/yr

PARTS AND LABOR COST PER YEAR



New System / Old System Comparison Summary

	New	Old
Capital Cost	$86,000/UNIT $166,000(2 units)	$60K (approx.) $120K (approx.)
Yearly Power Consumption	154,176 kW (2 units)	315,360 kW(2 units)
Yearly Power Cost (@ $0.16 /kW)	$25,668 (2 units)	$50,458 (2units)
Yearly Power Cost – 1 unit*	$12,834	$25,229**
Yearly Replacement Parts Cost Average	$388 (2 units)	$23,000 (2 units)
Yearly Maintenance/labor Cost Average	$90 (2 units)	$31,200 (2 units)
Yearly Electric Cost Savings	$38,124	
	***Only 1 reactor needs to be in service**	****Both reactors need to be in service**

PAYBACK – ROI (Return on Investment)

<u>**NEW SYSTEM (1 Unit Req'd) – Low Pressure, Non-Contact Type (2013)**</u>

- **Power Savings/yr = $38,124 ($166,000 / $38,124 = 4.35 years)**
- **Parts/yr = ($23,000 - $2,330) = $20,670**
- **Labor/yr = ($31,200 - $90) = $31,100**

  Total Parts + Labor = ($20,670 +$31,100 = $51,770)

- **Savings/yr = $38,124 + 51,770 = $89,904**
- **New System Cost (2 units) = $166,000/$89,904 = 1.8 years!**

AYER MA- WWTP

HOW DID NON-CONTACT UV DISINFECTION SYSTEM MEET THE TOWNS NEEDS?

1. Installed system continually meets permit requirements
2. Two reactors fit the existing building and allotted space
3. No significant piping modifications (actually simplified the piping scheme)
4. User friendly operation with locally available, affordable parts
5. Reduced power consumption by 75% (from $50,000/yr. to $12,500/yr.) while maintaining disinfection limits.
6. Improved the hydraulic flow through filters and downstream process (eliminated flooding problem)
7. What is the cost of safety???

OTHER UV SAVINGS AREAS

- Elimination /Reduction:
  - Chemicals and associated feed/storage equipment
  - Bulk chemical hauling and associated costs with potential of accidental spill

- Safety :
  - Exposure to chemicals by operators
  - Elimination/reduction of strains, sprains, slips, falls performing maintenance/repair

Operations & Budget:

- Reduced overall WW operating budget and costs

Environment: Less chemicals used for disinfection means less going Into the environment!

UV Disinfection over Chemicals can produce tangible savings in plant operations and reduce financial burden to taxpayers!

EASY ACCESS

- Easy access to all parts of both reactors

OPERATIONS & MAINTENANCE

- Either (or both) filters can discharge through either UV reactor- providing great flexibility for operation and maintenance.

AYER UV SUMMARY

1. COMMITMENT TO ELIMINATE CHEMICALS FOR DISINFECTION

2. FIRST UV UPGRADE (2007) RESULTED IN HIGH COSTS FOR POWER CONSUMPTION, PARTS, AND MAINTENANCE

3. SECOND UV UPGRADE (2013) UTILIZED MORE EFFICIENT UV LAMPS AND A DIFFERENT TECHNOLOGY (NON-CONTACT)

4. ABLE TO MEET PERMIT WITH 1 UV REACTOR

5. THE RESULTS SHOWN ARE WHAT THE AYER, MA WWTP HAS EXPERIENCED FOR THE LAST 6 YEARS

6. YOUR RESULTS MAY VARY!

THANK YOU!

QUESTIONS???