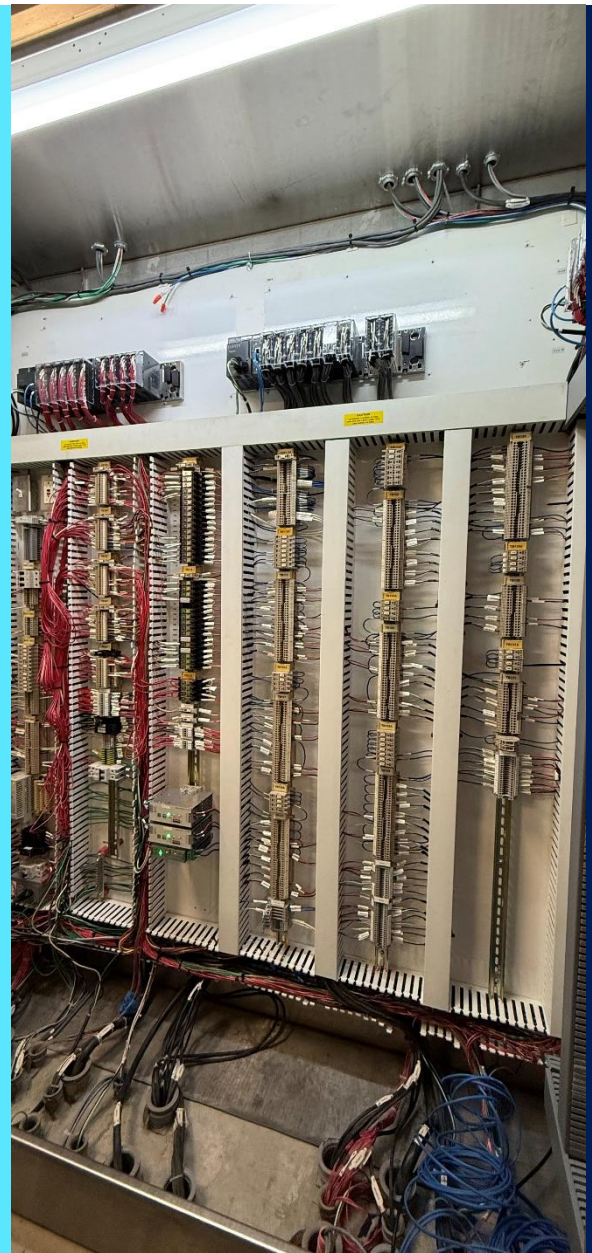
Seattle Public Utilities

Control Without Compromise: PLC Migration While Maintaining Operations of an Ozone System

Amy Gao, P.E.

PNWS AWWA Conference
May 7, 2026



Agenda

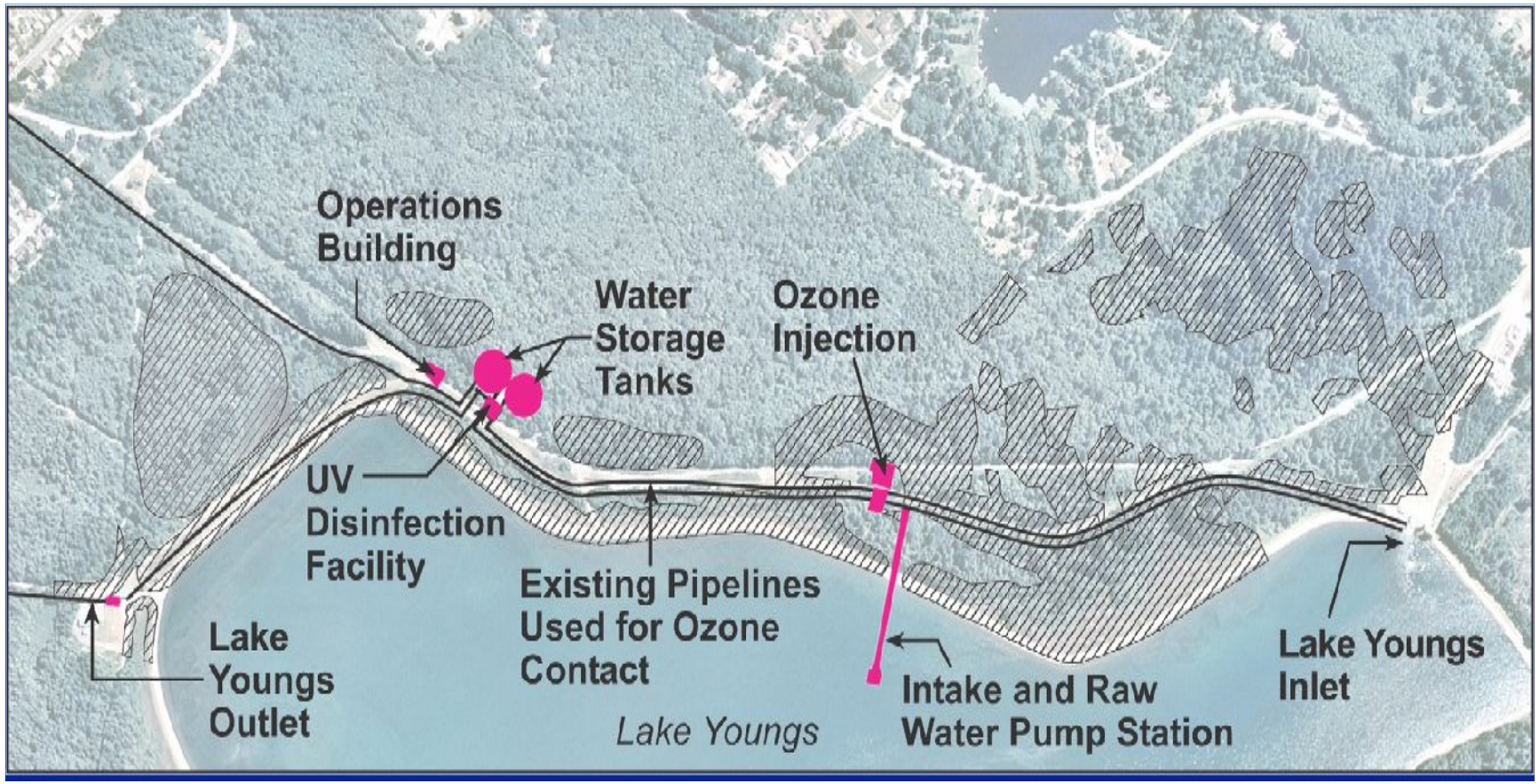
1. **Background: Cedar Water Treatment Facility**
2. **Project Overview:**
    - Ozone System
    - Design Scope
    - Challenges
3. **Construction and Startup**
4. **Lessons Learned**

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Background: Cedar TF

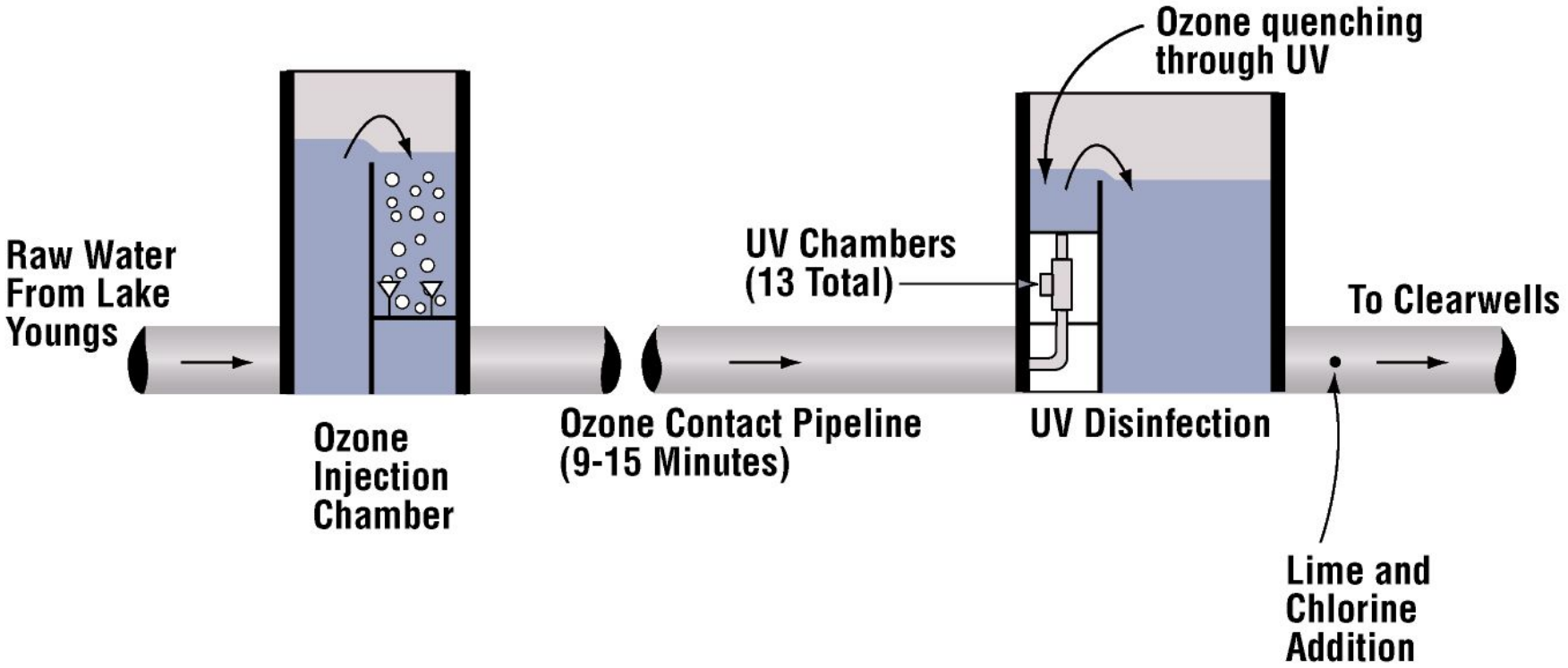
Cedar Water Treatment Facilities

- 180 mgd
- Owned by SPU
- Operated by Jacobs
- Commissioned in 2004



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Cedar Treatment Process



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Disinfection Compliance Approach

Limited Alternative to Filtration:

3/4/5 Cryptosporidium/Giardia/Virus (95% of the time daily)
2/3/4 log removal (99% of the time monthly)
Must Operate All Three Disinfectants for Compliance: Ozone, UV, Chlorine

OZONE:

Utilizing SWTR Guidance Manual
Giardia: Maximum 3-log inactivation credit
Virus: Maximum 4-log inactivation credit

Minimum Dose: 1-log *Giardia* and >0.1 mg/L residual at first monitoring point

UV:

Crypto: Maximum credit 40 mJ/cm^2 equals 3-log inactivation **(40CFR.141.729(d))**
Giardia inact. = to *Crypto* inact.

Individual UV Reactor off-spec is considered a bypass to the UV system and no treatment is credited

CHLORINE:

Utilizing SWTR Guidance Manual
Virus: Maximum 4-log Virus inactivation credit

Minimum Dose: 1-log virus and ≥ 0.5 mg/L residual at entry to clearwell, ≥ 0.2 mg/L at entry to distribution

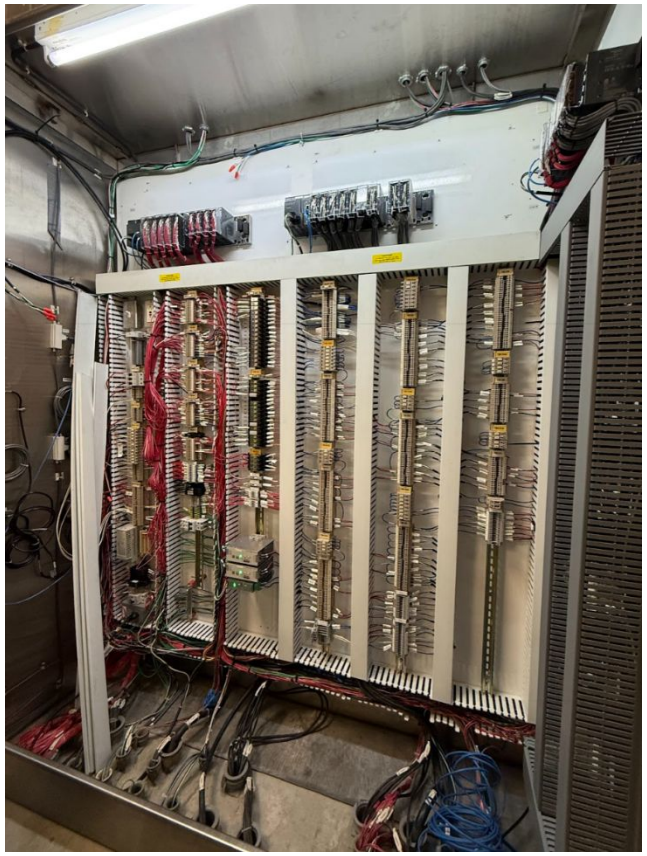
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Project Overview: Ozone PSU Replacement

Existing Ozone System







- Two Ozone Generators and PSUs: 825 lb/day @ 12% and 1250 lb/day @ 6%
- Manufacturer: Veolia
- Veolia master control panel housed within the Cedar PLC CP-10

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Ozone System PSU Replacement Timeline

- 2022
  - Jacobs began design to replace **end-of-service-life Plant PLCs**
- 2023
  - Veolia notified Jacobs that core PSU components were obsolete
  - Evaluated alternatives
- 2024
  - Jacobs and SPU decided to replace the PSUs
  - MOCP
  - Start procurement of PSUs
- 2025
  - Design of PSU and CP-10 Conversion
- 2026
  - Construction

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Alternatives Evaluation for PLC Replacement of the Ozone System

Item	Alternate 1 – Partial PSU Retrofit	Alternate 2 – Full PSU Replacement
PSU Equipment	Existing PSU cabinets remain	Two new PSUs furnished by Veolia
Control System Scope	Replace proprietary PLCs only inside existing PSU cabinets	New PSUs include updated proprietary control systems
Electrical Transformer	Existing transformer retained	New PSU integrated transformer
Cooling Water System	Existing PSU cooling system retained	New PSU cooling water system
Installation Work	New control components installed and wired inside existing cabinets	Existing PSUs removed; new PSUs set in place
Construction Complexity	Higher field wiring complexity inside energized cabinets	Reduced internal wiring; factory-assembled equipment
Downtime Risk	Increased risk due to extended field wiring	Reduced risk; faster change-out
Jacobs Role	Field installation labor	Field installation labor (remove/install PSUs, reconnect utilities)
Veolia Role	Supply parts; provide field oversight	Supply complete PSUs; provide field oversight
Key Consideration	**Lower capital cost but higher integration and outage risk**	**Higher capital cost but improved reliability and schedule control**

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Design Scope

- **PSU Replacement**
- **Master Control Panel Upgrade**:
  - Segregated from the main plant PLC
  - Redundant PLCs and new operator interfaces
  - SCADA interfaces updates
- **System Reconnection and Maintenance**:
  - Reconnect power and control
  - Evaluate existing cooling systems
  - Change fuses in generators
  - Inspect and clean ozone generator vessels
- **Performance guarantee**



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PSU Replacement Challenges

- **Continuous Water Production During Construction**
  - PSU Replacement
  - CP-10 conversion to MOCP

•New MOCP Panel
  •Not feasible due to lack of physical space within the ozone facility
  •Highest installation cost

•Convert CP-10 to MOCP: Suitcase PLC
  •Decreased safety and reliability

•Convert CP-10 to MOCP: Maintain PLC-1 Ozone Controls
  •Allows operator to see all existing signals and alarms
  •Can switch back to full ozone controls if major issues arise

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Phased Construction Approach: PSU Replacement

- **Phase 1: PSU 2 Replacement**
  - Easiest to disconnected from control daisy chain
  - Integrate and Operate New PSU with SCADA
    - existing logic and PLC 1
- **Phase 2: PSU 1 Replacement**
  - Integrate and Operate New PSU with SCADA
- Planned Shutdowns (4 hour max):
  - Connecting new PSU with Electrical Utility Supply
  - Breaking existing control system daisy chain
  - Flushing shared cooling water system
  - Testing Ozone System Interlocks



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Phased Construction Approach: CP-10 to MOCP Conversion (Phase 3)

- Work in Advance of Conversion
  - RIO panel to move signals not related to ozone out of CP-10
  - All ozone signals located on RIO for control via PLC-1 during construction
  - Wiring done in advance of PSU installation and MOCP conversion to test signals to PLC-1
- Operate Generator 1 Locally while MOCP is tested (1 week)
- Planned Shutdowns (4 hour max):
  - Download interim and new SCADA programs
  - Testing Ozone System Interlocks



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Construction and Startup

“Even the best-planned projects encounter unforeseen challenges that require adaptation and a change in course”

Manufacturer Coordination

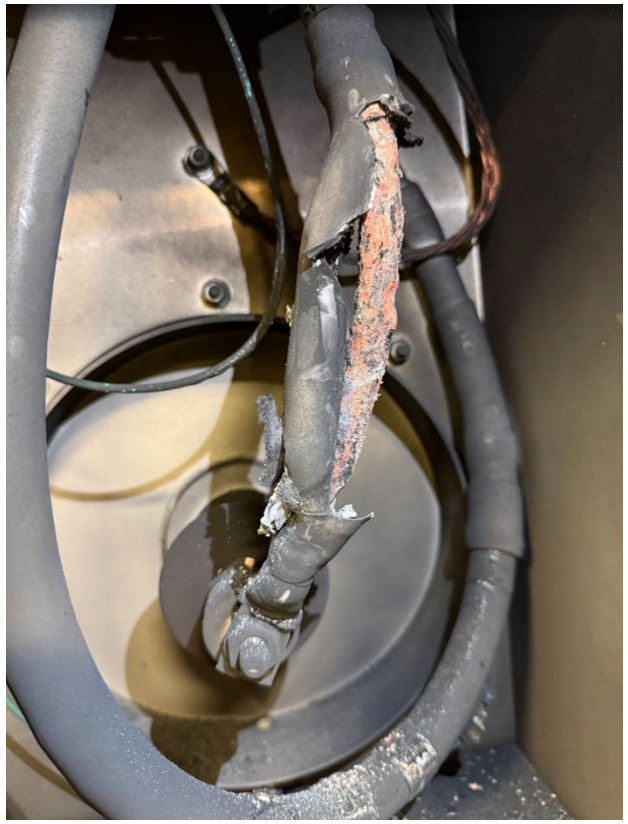
- PSU Delays
  - 2 month delayed ate into schedule float
  - Condensed schedule
- Fuse Replacements
  - Planned prior performance testing
  - Needed also for testing of new PSUs
- MOCP Parts Delays
  - Long lead times require change in manufacturer
  - Testing in the field instead of at Veolia facility



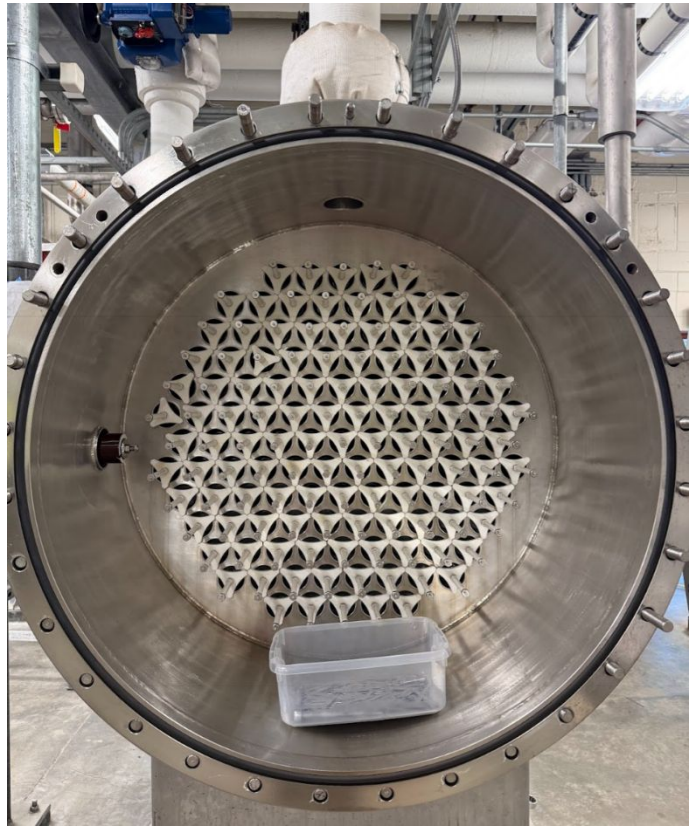
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Unanticipated Issues

- Faulty Medium Voltage Conductor
  - Damage assessed
  - Replaced conductors, ground wiring, generator isolator







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Opportunities

- Flushing the cooling water system and replenishing with new water and corrosion inhibitor
- Improvements to nitrogen control
- Improvements to cooling water controls
- SCADA screens
- Refresh of Ozone System SOPs
- Improvements for on automatic ozone dosing



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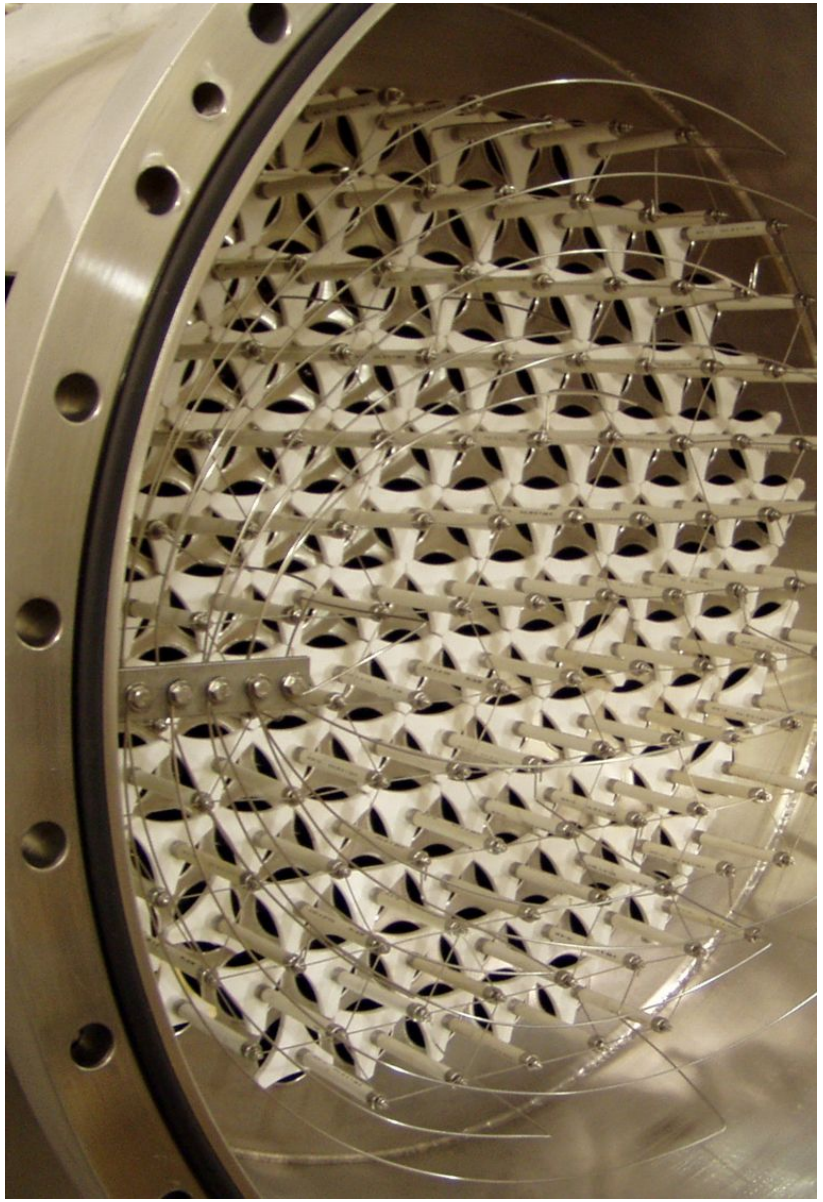
Startup and Testing

- Startup checklist – generate a list separate of what Veolia provided
  - All signals and communications tested
    - PSU to MOCP
    - MOCP to SCADA
  - All lead/lag functionality tested
  - All alarms tested
  - Safety interlocks
  - Startup sequence tested
    - Ozone
    - UV

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Next Steps

- Testing of automatic controls on ozone dosing to optimize LOX and energy costs
- Performance Testing



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Conclusions

- **Enhanced System Reliability**: Replacing obsolete components improves vendor supportability and reduces unplanned outages in critical disinfection processes.
- **Operational Improvements**: Updated SCADA graphics and modern PLC platforms boost situational awareness and ease operator workload.
- **Regulatory Compliance**: Maintaining original design criteria ensures compliance with drinking water regulations without re-approval needs.
- **Phased Construction Strategy**: Phased construction protects service reliability throughout implementation, ensuring continuous customer support.

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Thank You

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