

# UV Technology: Design & Controls

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# Agenda

## **Section 1:** Equipment Design

- Lamp Life, Ballast Types, Warm-up Times, Submergence Ratings

## **Section 2:** Electrical Design

- Voltage Requirements, Harmonics, Power Factors, Back-up Power

## **Section 3:** Operation & Maintenance

- Maintenance Requirements, Control Philosophy

## **Section 4:** I&C Connections

- Lamp to Ballast, P&ID's, SCADA connections

# 1

# Equipment Design

# UV Lamps

| Lamp Type                 | Lo-Lo   | Typical Lo-Hi   | Advanced Lo-Hi  | Medium Pressure  |
|---------------------------|---------|-----------------|-----------------|------------------|
| Power Consumption (Watts) | 40 - 80 | 250 – 315       | 600 – 1,000     | 3,000 – 20,000   |
| Output Adjustment         | 100%    | 50-100%         | 30-100%         | 30-100%          |
| Operating Temp.           | 90°C    | 100°C           | 100°C           | 600-1,000°C      |
| Lamp Life (hours)         | 9000    | 12,000 – 14,000 | 14,000 – 15,000 | 3,000 – 8,000    |
| Restart Delay             | None    | None            | None            | Up to 15 minutes |

## Notes:

- Warranties are typically pro-rated
- Length of lamps should be considered
- On/off cycles are important

# UV Lamps - Continued

## Lamp On/Off Cycles:

- Typically stated as a maximum of 4 per day
- Tied into lamp warranty
- Critical to lamp life



## Reasoning:

- UV Lamps are similar to incandescent bulbs
- The filament has to heat up in order to operate the lamp
- High voltage is used to initially ignite the lamp
- Every on/off cycle impacts the filament

# UV Ballasts



## Magnetic:

- Simple by design
- Older ballast technology
- Large and heavy

## Electronic:

- Operates 1-2 UV lamps
- Provide higher reliability
- Microprocessor Controlled



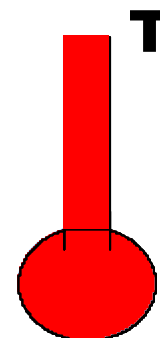
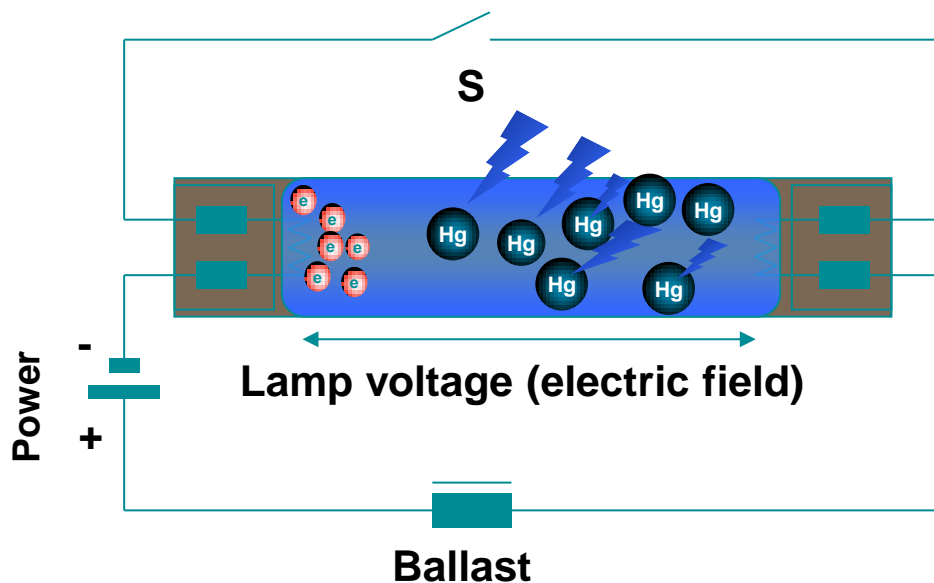
# Lamp Warm-up Times

## Typical Warm-up Periods:

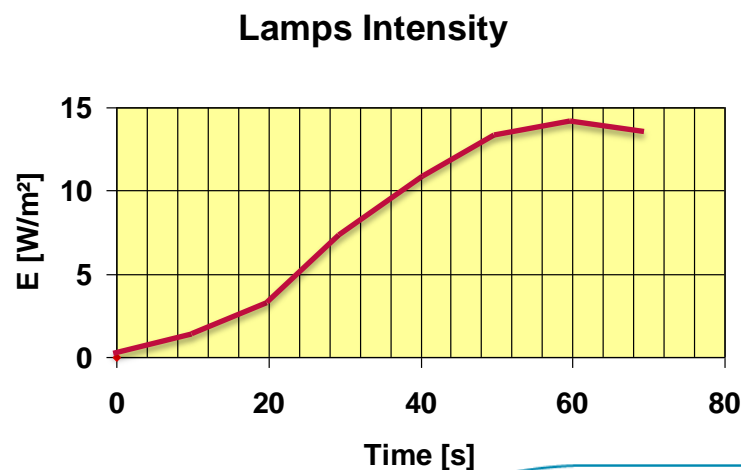
- Warm Start: 3 minutes
- Cold Start: 10 minutes

## Reasoning:

- Similar to incandescent bulbs
- Mercury is excited as heat is generated
- Guarantees lie with UV lamp output



**t = 0** → **ignition**



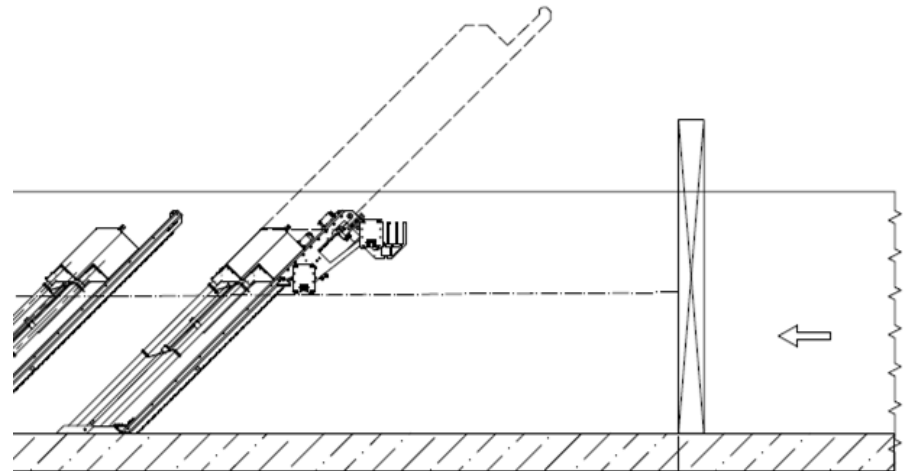
# Submergence Ratings

## Typical Offerings:

- IP and NEMA
- IP67 – temporary 1m submergence
- NEMA 6P – prolonged 6ft submergence

## Additional Details:

- Inclined systems should be stored in a lifted position





# 2

## Electrical Design

# Voltage Requirements

## Common Input Voltages:

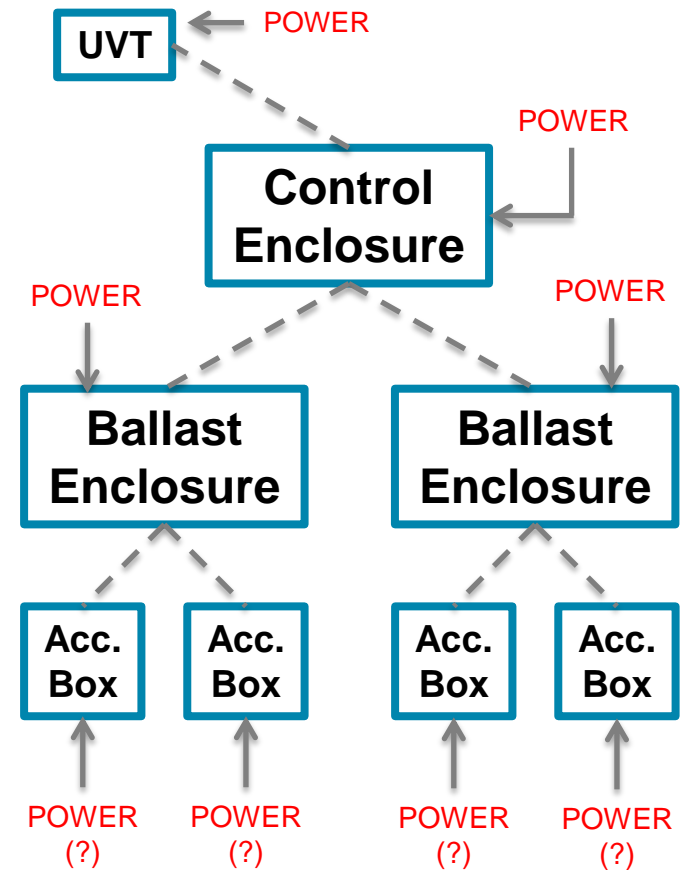
- 480V, 3 phase, 4 wire + ground (WYE)
- 480V, 3 phase, 3 wire + ground (Delta)
- 120V, single phase

## Secondary Voltages:

- 24VDC PLC/HMI platform
- 120VAC PLC/HMI platform
- 120VAC Accessory Items

## Considerations:

- Isolation Transformers
- Channel Instrumentation
- Level Control



# Harmonics

## Standard Practice:

- IEEE 519 Compliance
  - $V_{THD} = 8\%$  max
  - $I_{THD} = 15\%$  max
- Updated Ballast Technology
  - Microprocessor Controlled
  - Power Factor correction circuit

## Considerations:

- Incoming Power Tolerances
- Power Surge / Lags
- In-Line equipment

# Power Factor

Typically 95-99%



# Back-up Power

## Common Power Sources:

- Diesel Generators
- Full-system UPS (RARE)

## Considerations:

- What is the switchover time?
- UPS on control systems (time, memory retention, etc.)
- Auto restart of UV system?

# 3

## Operation & Maintenance

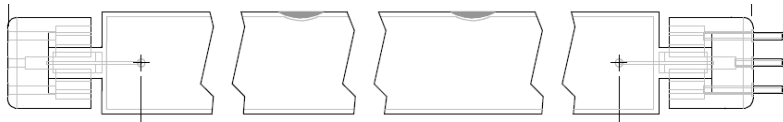
# Maintenance Requirements

## UV Lamps:

- 14,000 – 15,000 hr warranty
- Simple replacement

## Considerations:

- Length of lamp
- Disruption of operation
- Tools required
- Recycle policy
- Safety features (lamp shut off, etc.)



[Click picture for video example](#)

## UV Ballasts:

- 5 – 10 year warranty
- Simple replacement

## Considerations:

- Location of ballasts
- Disruption of operation
- Tools required
- Safety features (power shut off, etc.)



[Click picture for video example](#)

# Maintenance Requirements

## Quartz Sleeves:

- 20 year warranty

## Considerations:

- Length of sleeve
- Disruption of operation
- Tools required
- Safety features (lamp shut off, etc.)



[Click picture for video example](#)

## Wiper Rings & Cleaning Solutions:

- Based on strokes or time basis
- Mechanical and/or chemical

## Considerations:

- Disruption of operation
- Tools required
- System complexity



[Click picture for video example](#)

# Maintenance Requirements

## Miscellaneous Maintenance:

| Component          | Item                                    | Task Description  | Frequency +) |             | TDC            |
|--------------------|---|---|--------------|-------------|----------------|
|                    |   |   | Run Hours    | Cycle       |                |
| Electrical Cabinet | HMI                                     | Check HMI that lamp running hours and on/off cycles are not exceeded. | -            | Monthly     | -              |
| Electrical Cabinet | Filter fans                             | Check operation of inlet fans.  | -            | Daily       | -              |
| Electrical Cabinet | Filter fans                             | Function check  | -            | Daily       | -              |
| Electrical Cabinet | Filter fans                             | Replace filter fans of electrical cabinet.                            | 30 000       | -           | REPL...        |
| Electrical Cabinet | Filter fans                             | Clean all filter mats of the electrical cabinets.                     | -            | Monthly ++) | CLEAN...       |
| Electrical Cabinet | AC Filter                               | Clean all filter mats of the AC unit                                  | -            | Monthly ++) | CLEAN...       |
| Electrical Cabinet | Fans of Electronic Ballasts (rack fans) | Replacement   | 40 000       | -           |                |
| UV Channel         | Weir                                    | Check for objects blocking flow and leakage around sealed joints .    | -            | Daily       | -              |
| UV Channel         | Level Probe                             | Check for objects around probes .                                     | -            | Daily       | Remove objects |
| UV Modules         | Wiping system                           | Check cleaning function of wiper rings.                               | -            | Weekly      | -              |
| UV Modules         | Sensor wipers                           | Check cleaning function of sensor rubber lips.                        | -            | Weekly      | -              |
| UV Modules         | Quartz sleeves                          | Check quartz sleeves for ingress of water.                            | -            | Monthly     | -              |
| Compressor         | Air Receiver Tank                       | Drain air receiver tank. <sup>1)</sup>                                | -            | Weekly      | -              |
| Compressor         | Filter                                  | Check operation of automatic drain valve at filter <sup>1)</sup> .    | -            | Weekly      | -              |



# Control Philosophy

## Typical Bank On/Off Variables:

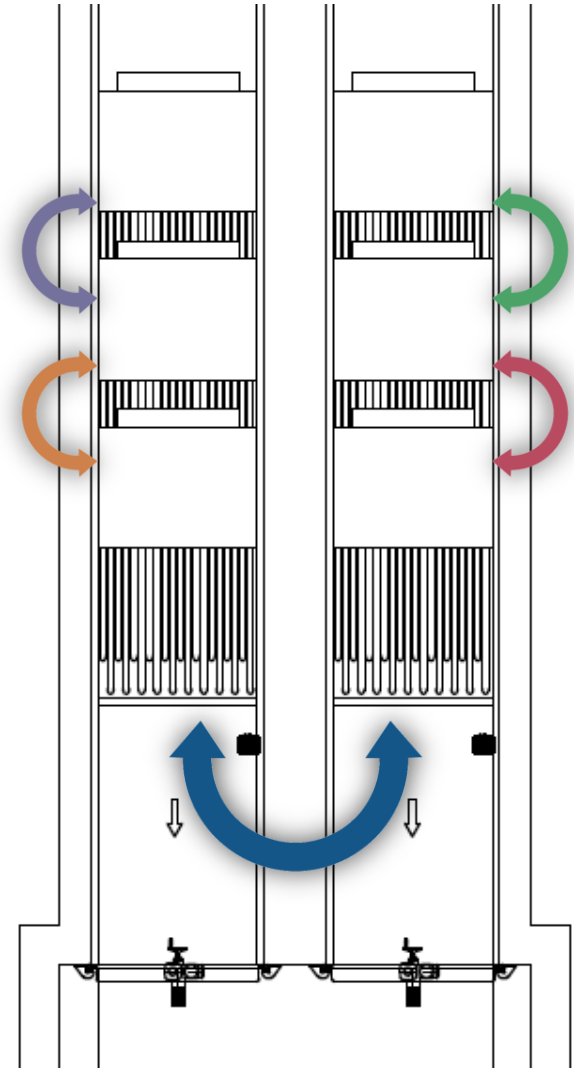
- Dose status
- Minimum on time periods
- Dimmed mode duration

## Typical Bank Rotation:

- Considers above variables
- Finds bank with longest running hours
- Ramps power and shuts bank off
- Manual bank rotation is possible

## Bank Rotation upon Lamp Failure:

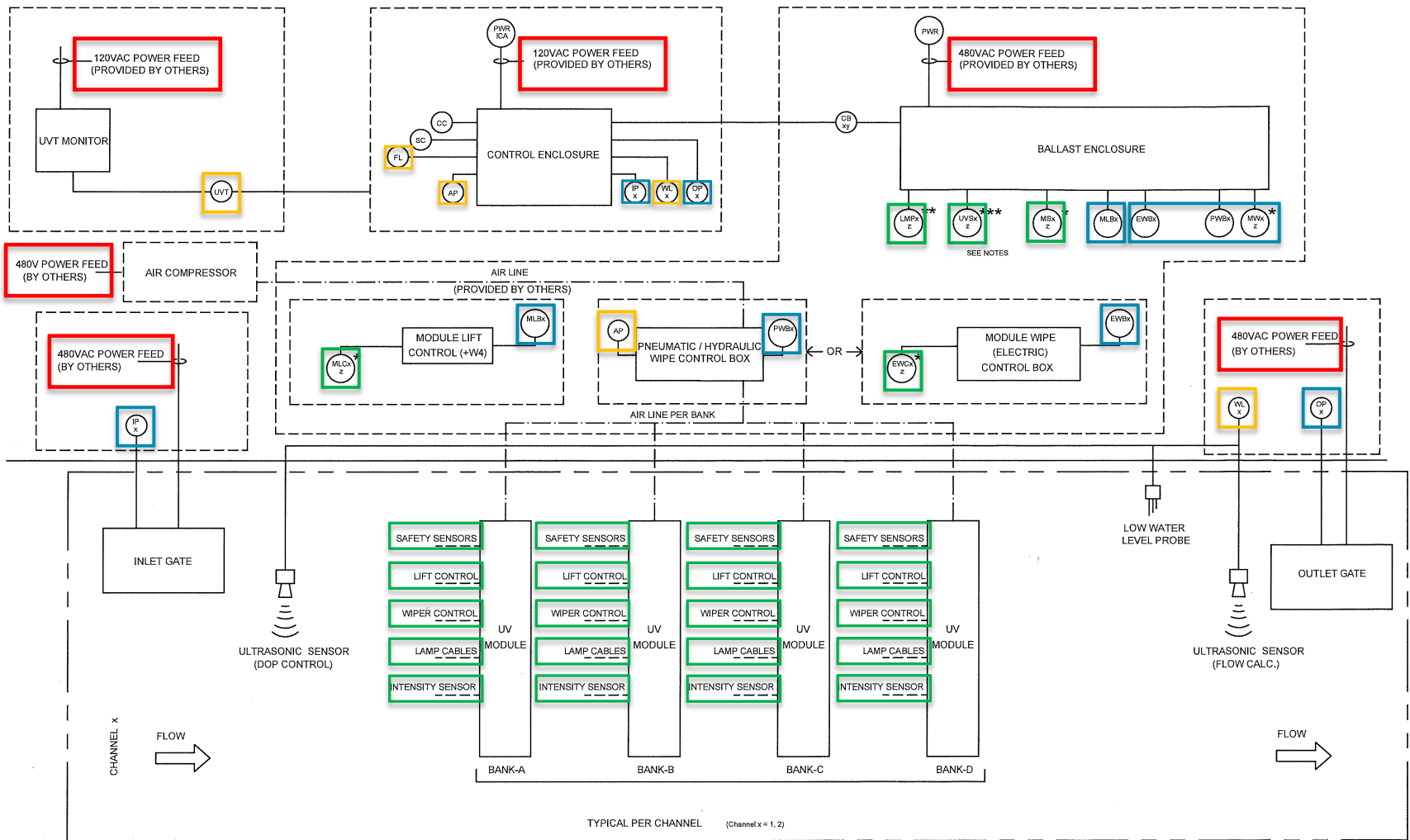
- Single lamp failure - **NO**
- Multiple lamp failure - **YES**
- Major bank failure (ballast, PLC, etc)



# 4

## I&C Connections

# Channel & Enclosure Connections



Power Feed

UV Module

Instruments

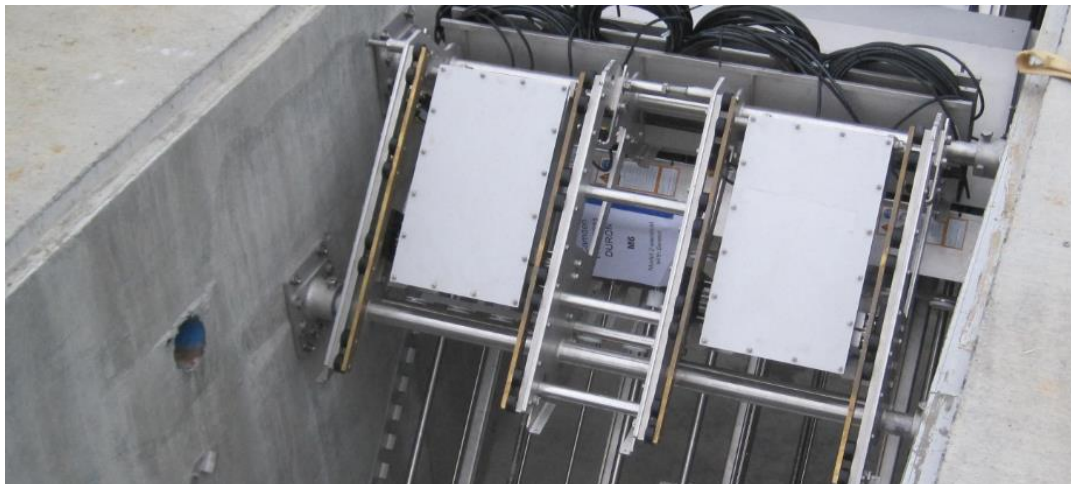
Equipment

# Common Cable Routing

## Embedded Cable Troughs



## Typical Conduits



## Other Methods

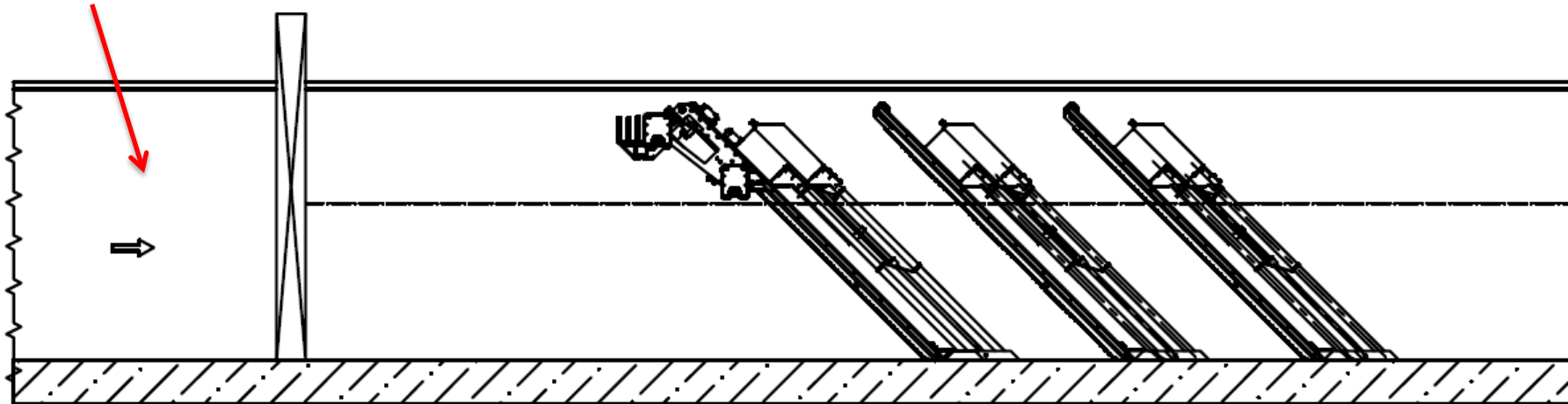
- Overhead cable tray
- SS cable troughs

# UVT Monitor Location

## Typical Installation:

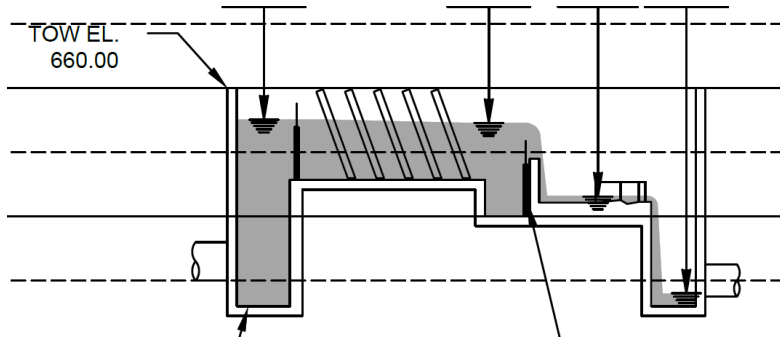
- UVT Monitor is located upstream of UV process
- Monitors water influent to UV system
- Located in common header if multi-channel system

UVT Located Here

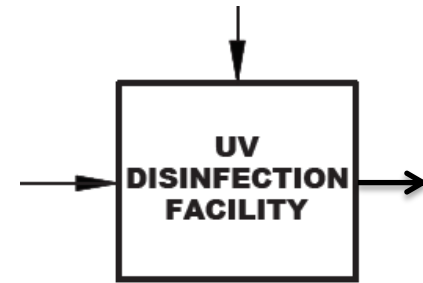


# P&ID's and UV

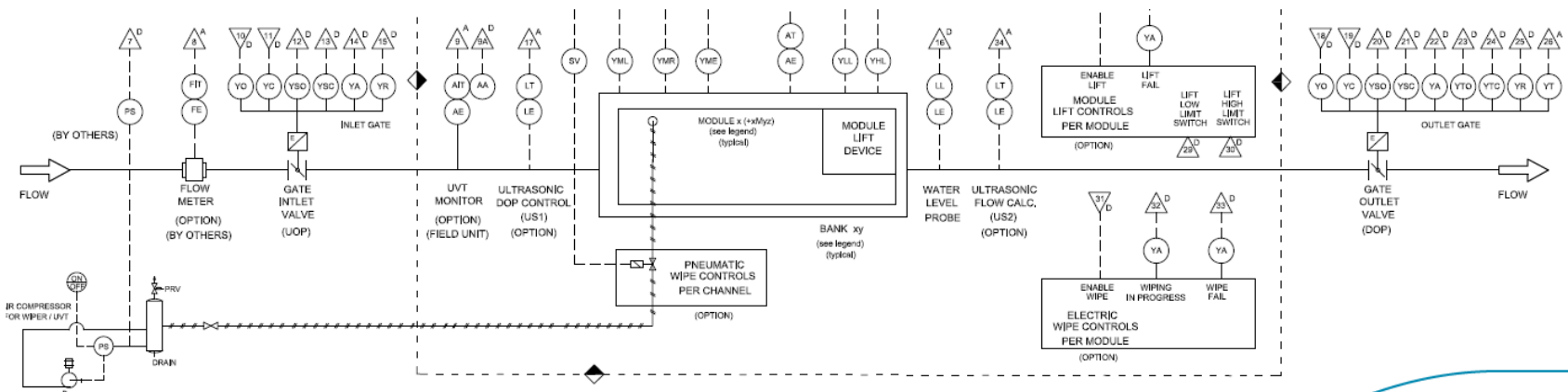
## Hydraulic Profiles:



## Process Flow Diagrams:



## Manufacturer P&ID:



# SCADA Information

## Lamp Data:

- Available on HMI for all UV banks (run hours, lamp failure, etc.)
- Can be transmitted via SCADA network
- Benefit in knowing details of alarm
- Benefit in planning maintenance

## SCADA Option Examples:

- System Flow Rate
- UVT Input
- UV Dose
- High/Low Priority Alarms
- Component Failure (UVT, Module Lift, Module Wipe, etc.)



# Questions?