Hetch Hetchy Regional Water System

Operated by the San Francisco Public Utilities Commission

ULTRAVIOLET DISINFECTION FOR THE HETCH HETCHY AQUEDUCT

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Wholesale Customer Workshop 11-9-11

Hetch Hetchy Regional Water System

Overview

- LT2ESWTR and HH disinfection strategy
- UV 101
  - UV light and microbial inactivation
  - UV lamps
  - UV Absorbance & Transmittance
- Tesla Treatment Facility
  - Design Criteria
  - Layout & Siting Issues
  - UV Reactors
  - Project Delivery

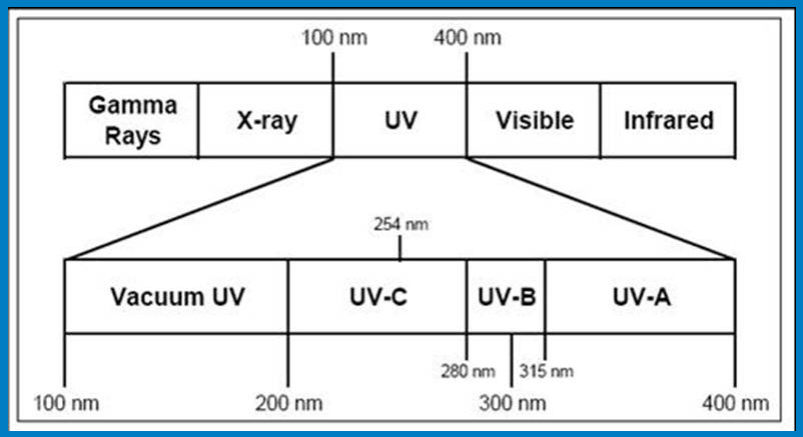
Hetch Hetchy Disinfection Strategy

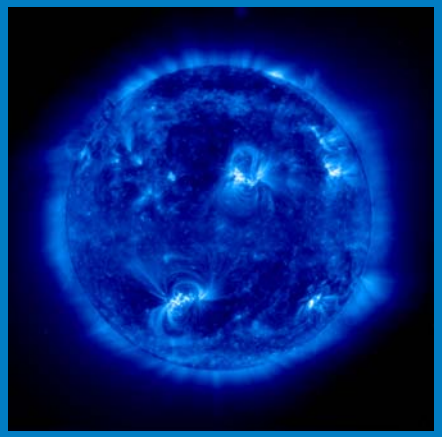
- LT2ESWTR requires a minimum of two disinfectants for unfiltered supplies by April 1, 2012.
- Each disinfectant must, by itself, meet one of the following:
  - 2-log or 3-log *Cryptosporidium* inactivation (level depends on source water)
  - 3-log *Giardia* inactivation
  - 4-log Virus inactivation
- www.epa.gov/safewater/disinfection/lt2/compliance.html

Hetch Hetchy Disinfection Strategy

Objective	Parameter	Target	Technique
SJPL Protection	pH	10-10.5	Lime Addition
Disinfection	Crypto	2-log Op (3-log design)	UV
Disinfection	Giardia	3-log	UV and Chlorine
Disinfection	Virus	4-log	Chlorine
LCR	pH	9.4	Lime Addition NaOH trim

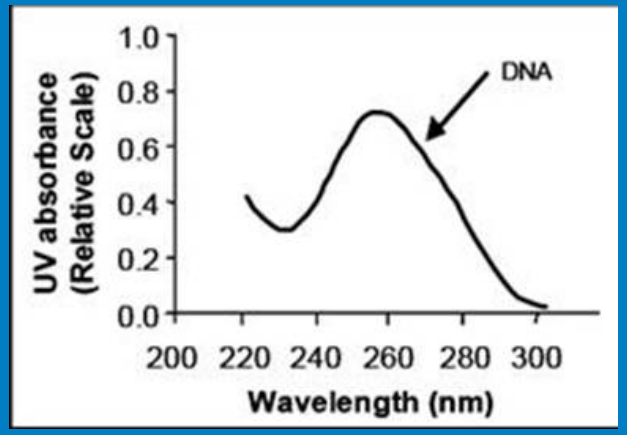
Light Spectrum & UV

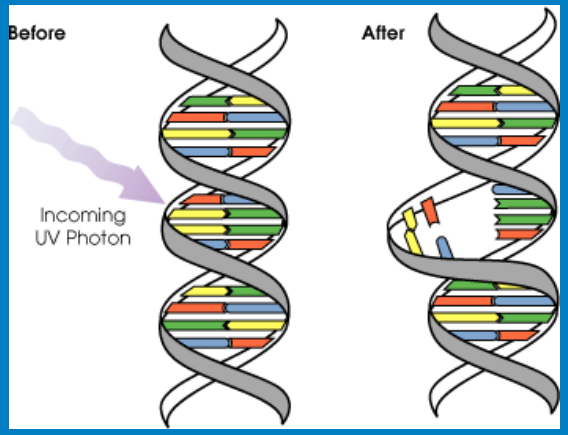




- Light is a particle (photon) traveling in a wave.
- Wavelength defines characteristics like color & energy.
- Sun emits all UV bands but 98.7% of UV radiation reaching Earth's surface is UVA.
- UVB induces Vitamin D in skin but also causes sunburn, a form of DNA damage.

Microbial Inactivation





- DNA is composed of single- or double-stranded polymers called nucleotides which are either purines or pyrimidines.
- Absorbed UV light induces damage in the pyrimidines (dimers most common damage).
- Pyrimidine dimers prevent parasite replication.

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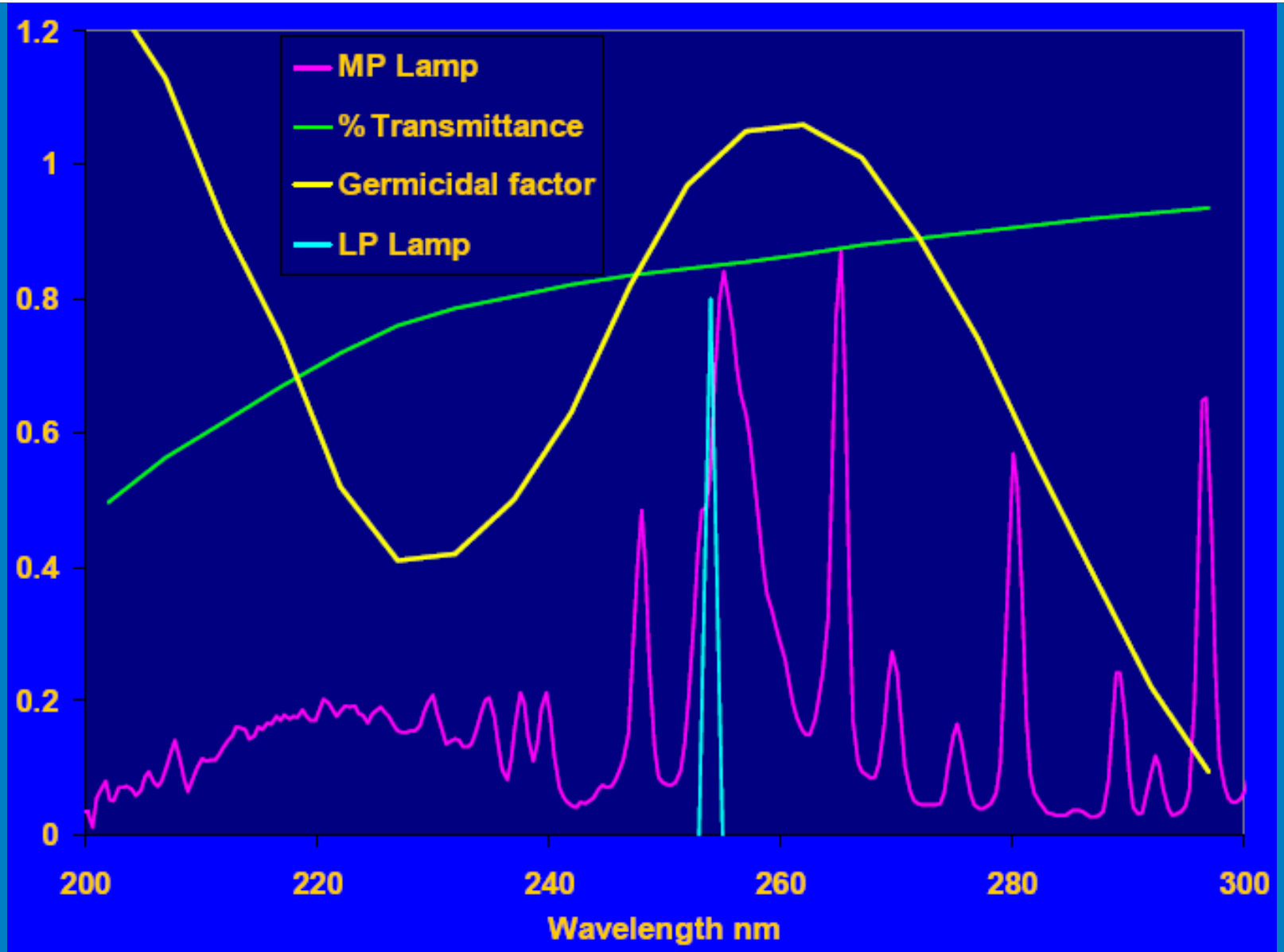
Microbial Inactivation



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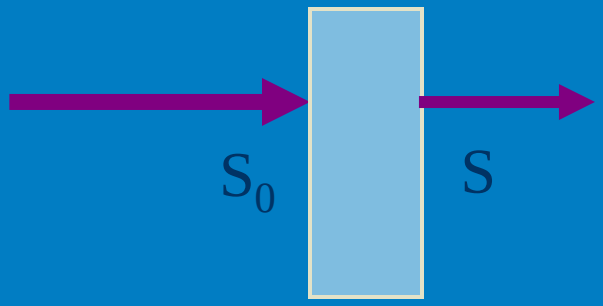
UV Lamps

- Low Pressure High Output (LPHO)
  - Higher germicidal efficiency; nearly all output at 254nm
  - Smaller power draw per lamp (less reduction in dose if lamp fails)
  - Longer lamp life
- Medium Pressure
  - Higher power output
  - Fewer lamps for a given application

UV Light in Water

- UV Absorbance (A)
  - Quantifies the decrease in the amount of incident light as it passes through a water sample over a specified distance (typically reported per cm).
- UV Transmittance (UVT)
  - UVT is the percentage of light passing through water over a specified distance.
  - % UVT = 100% x 10^{-A}
- % UVT = 100% x (S/S_0) Beer's Law



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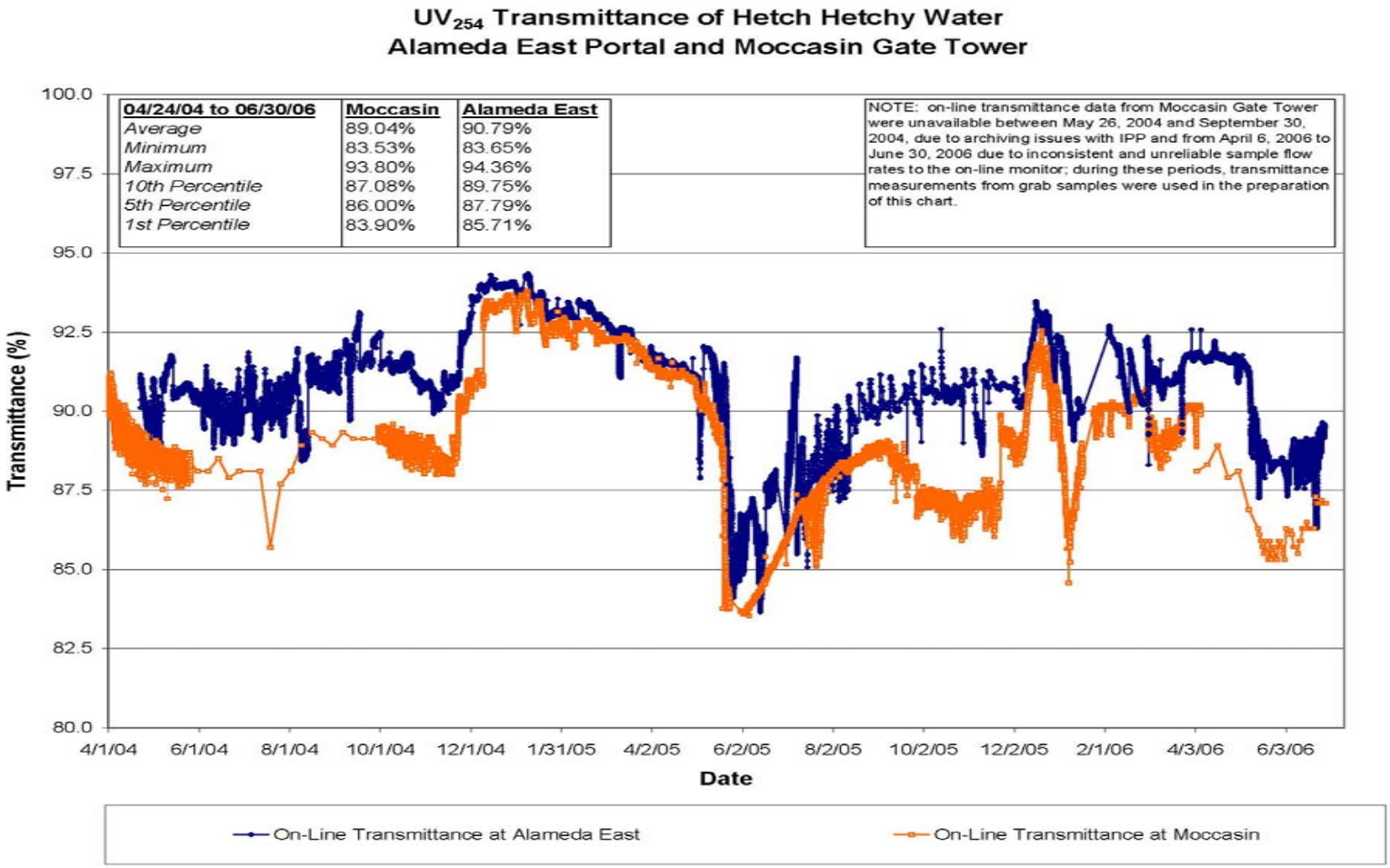
On-line UVT Monitoring



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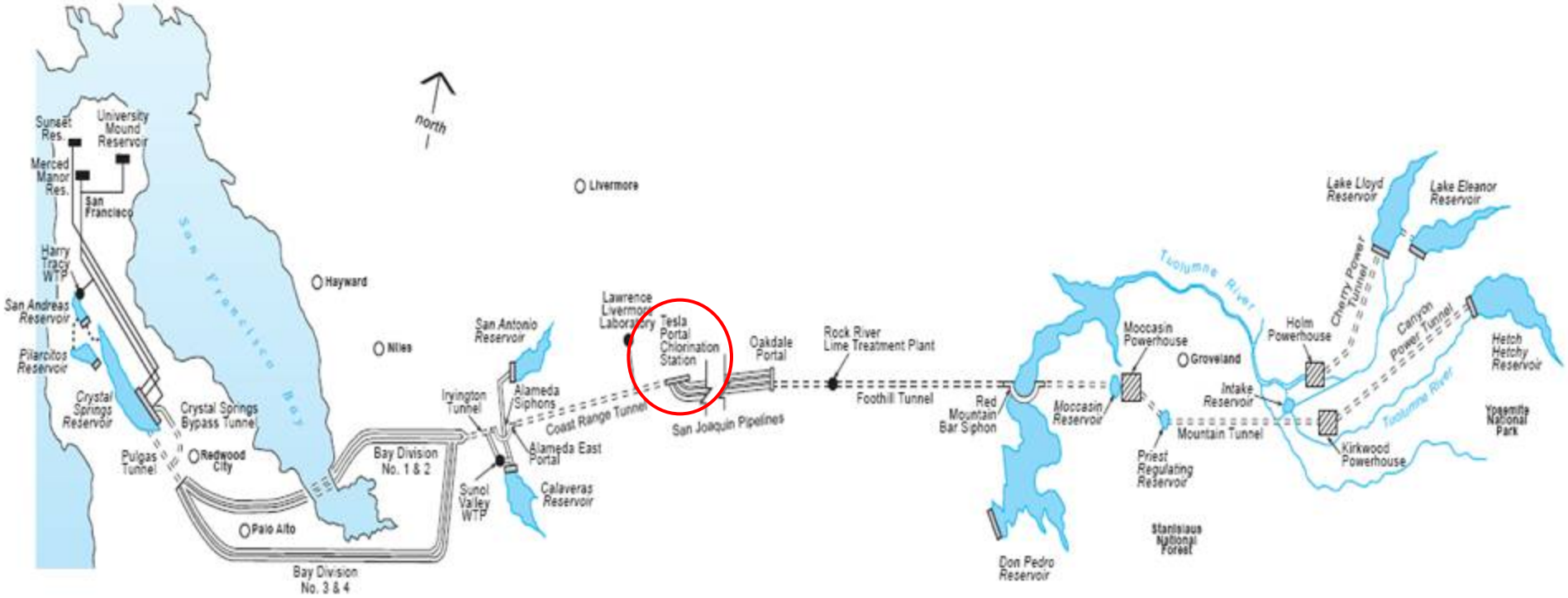
SFPUC Regional System



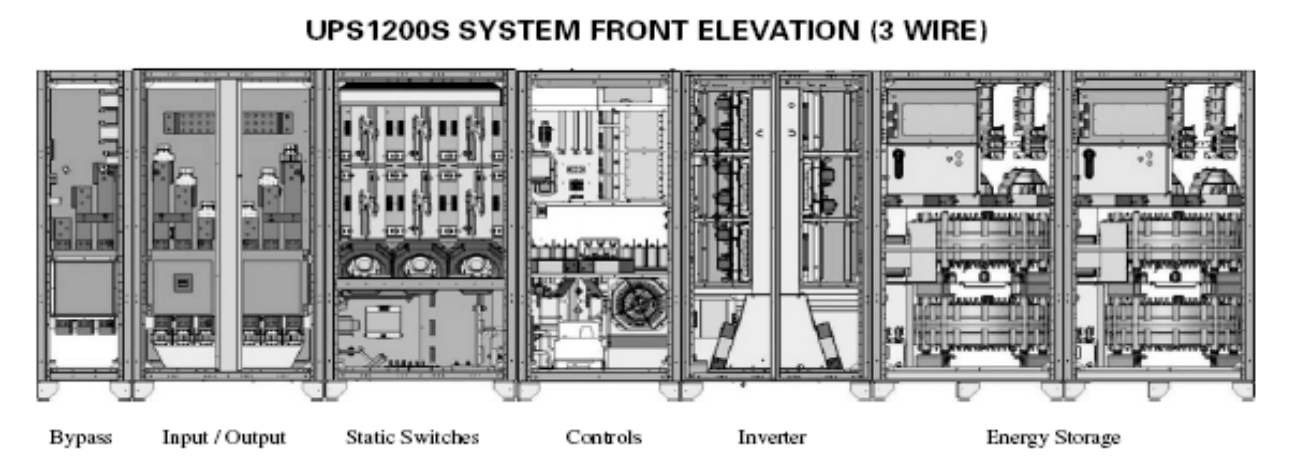
Key UV Design & Operating Criteria

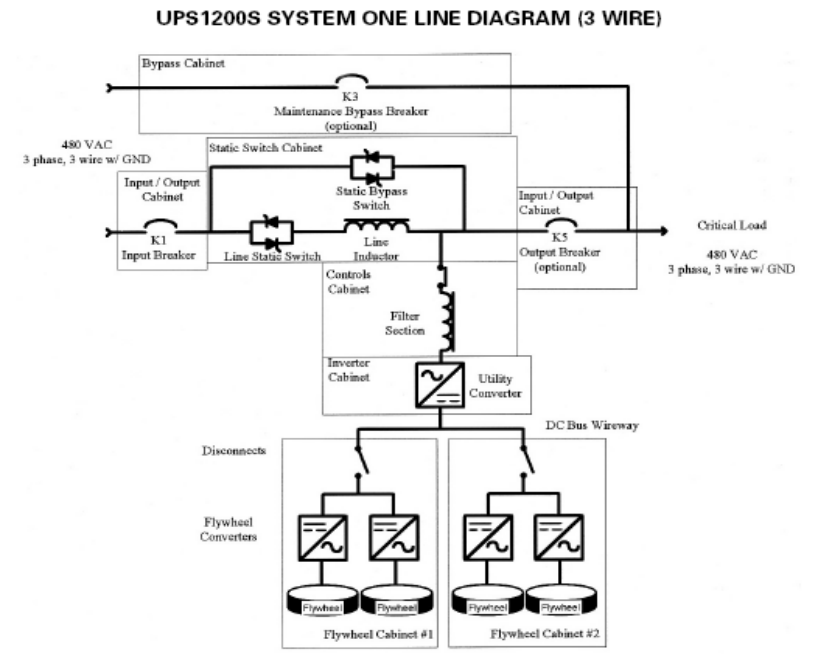
- Design
  - 3.4 log Cryptosporidium using MS2
  - 82.5% UVT (Validated off-site down to 75% UVT)
  - 315 mgd (max)
  - 10 Duty and 2 Standby reactors at max flow
- Operation
  - 2.3 log Cryptosporidium using MS2 (includes 20% dose safety factor)
  - 89% UVT annual average
  - 45 mgd max flow per reactor

Additional Design Criteria

- Provide storage and chemical feed facilities for upgraded NaOCl, new fluoride (H_2SiF_6), and new CO_2 system to lower pH.
  - Allow 90 sec for adequate chemical mixing and dispersion.
- Maximum headloss of 6.5 feet over entire facility.
- Reduce inlet flow velocities to 2.2 fps for sand/grit settling.
- Fouling Factor of 0.8
  - End of lamp life (EOLL) factor of 0.9 for a Combined Aging and Fouling (CAF) of 0.72
- UPS and Diesel Generators
  - 3 – 1200 kVA/960 kW Flywheel UPS for UV system
  - Battery UPS for chemical pumps (4 hours)
  - 2 – 1875 kVA/1500 kW Diesel generators for entire plant (72 hour fuel storage)

Caterpillar Rotary UPS System





1200 kVA/960 kW Flywheel Units

- 45 to 60 second supply
- Condition power supply
- TTF has 3 units

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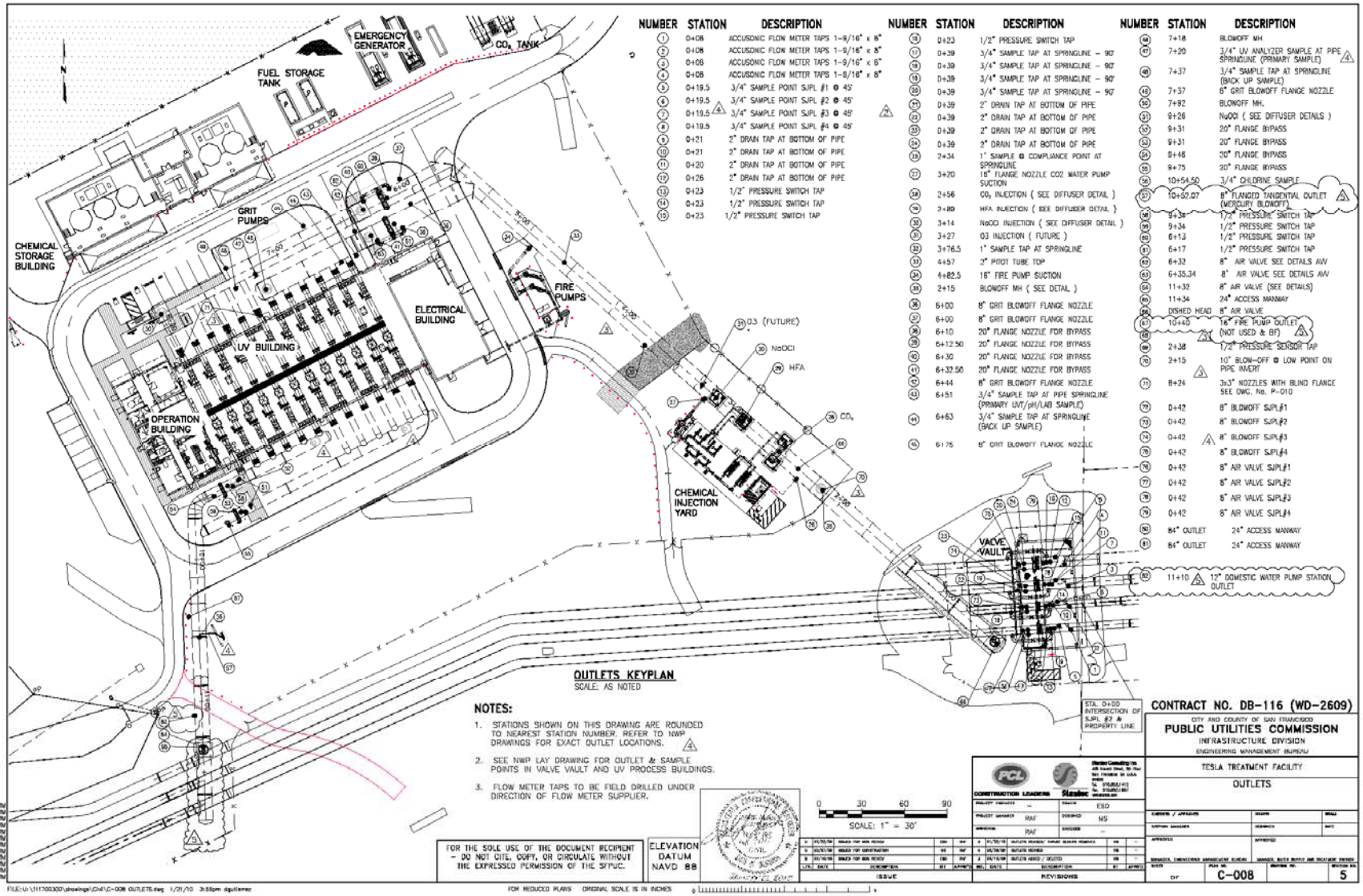
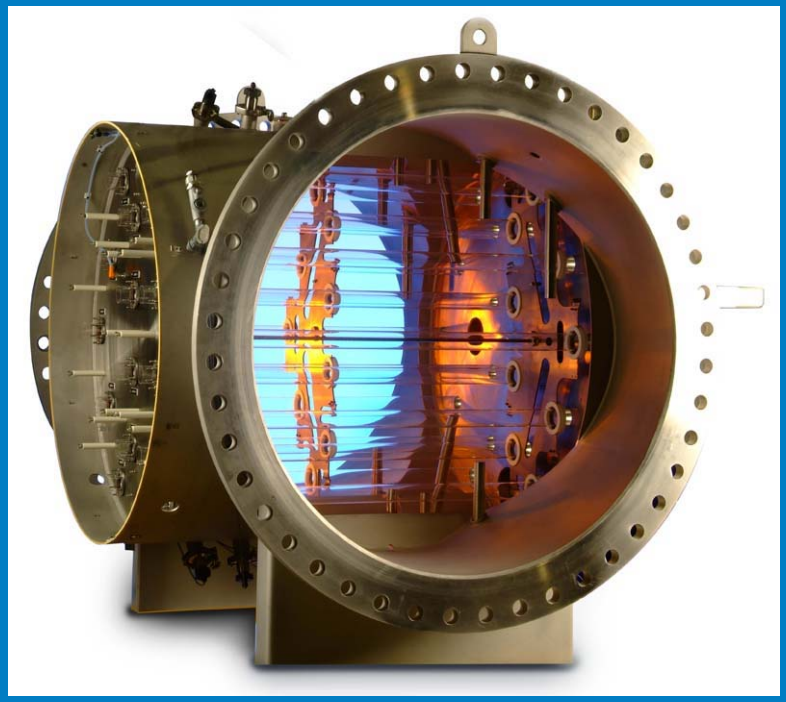
Tesla Layout



Tesla Physical Layout & Siting Issues

- Compliance Point Monitoring
  - Minimum 100’ downstream of manifold (based on CFD modeling)
- Chemical Addition Considerations
  - NaOCl upstream (for maintenance) and downstream (typical injection location) of UV
  - CO2 and fluoride upstream of UV (90 second reaction time for CO2)
- Flow Measurement for Process Control
- Grit Settling & Removal System

Sentinel Chevron 9 lamps (20 kW each)



(Courtesy of Calgon Carbon Corporation)

- UV Intensity Sensors
  - One sensor per lamp
  - Placed in dry well
  - Mechanical cleaning of sensor window
- Sleeve Cleaning
  - Mechanical system
  - Stainless steel brush
  - Wiper system alarm
- Ballasts
  - Electromagnetic
  - One lamp per ballast

Project Delivery

- Design-Build Contract
  - Completed over 33 months (October 2008 start design; March 2009 start construction; June 24, 2011 Substantial Completion)
  - 9 month commissioning period
  - LTESWTR compliance on April 1, 2012
  - Project bid $81,420,562
  - Project cost $86,537,720

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Questions?

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