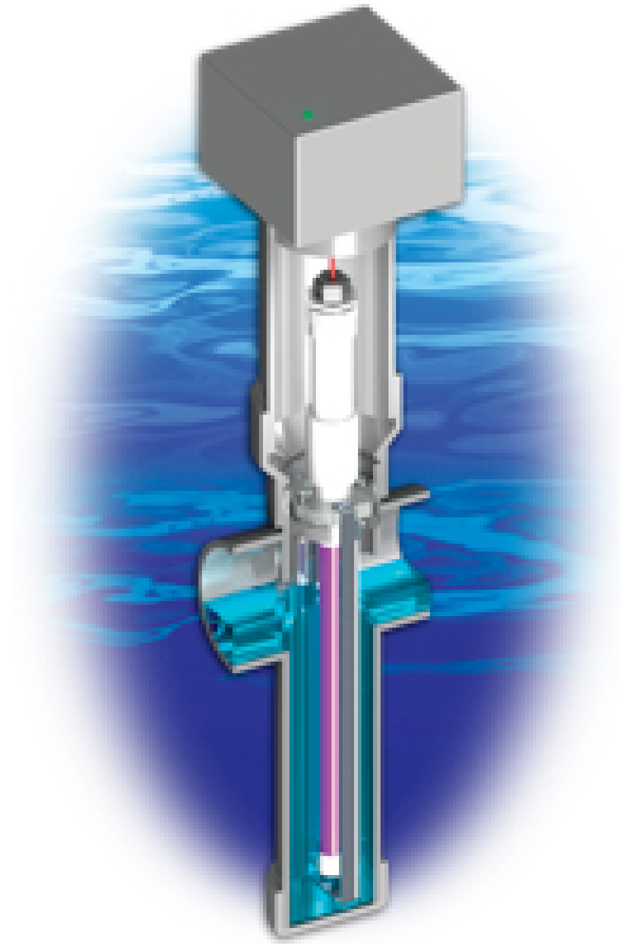
SALCOR INC

Ultraviolet Disinfection

"37 Years of Excellence"



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President

Typical Wastewater Influent Concentration Ranges for Pathogenic and Indicator Organisms

(Casson *et al.*, 1990; Rose, 1988; and U.S. EPA, 1979b)

Organism	Minimum, no./100 mL	Maximum, no./100 mL
Total coliforms	1 000 000	-----
Fecal coliforms	340 000	49 000 000
Fecal streptococci	64 000	4 500 000
Virus	0.5	10 000
Cryptosporidium oocysts	85	1 370
Giardia cysts	80	320

Secondary Effluent Ranges for Pathogenic and Indicator Organisms Before Disinfection

(U.S. EPA, 1986)

Organism	Minimum, No./100 mL	Maximum, No./100 mL
Total coliforms	45 000	2 020 000
Fecal coliforms	11 000	1 580 000
Fecal streptococci[a]	2 000	146 000
Viruses	0.05	1 000
Salmonella sp.	12	570

[a] Assuming removal efficiencies for fecal streptococci similar to the fecal coliform removal efficiencies.

Survival Times of Pathogens in Soil and on Plant Surfaces (U.S. EPA, 1992)

	Soil		Plants	
Pathogen	Absolute maximum [a]	Common maximum	Absolute maximum	Common maximum
Bacteria	1 year	2 months	6 months	1 month
Viruses	1 year	3 months	2 months	1 month
Protozoan cysts [b]	10 days	2 days	5 days	2 days
Helminth ova	7 years	2 years	5 months	1 month

a Greater survival time is possible under unusual conditions such as consistently low temperatures or highly sheltered conditions (for example, heminth ova below the soil in fallow fields).

b Few, if any, data are available on the survival times of Giardia cysts and Cryptosporidium oocysts.

Summary Comparison of UV, Chlorine & Ozone Disinfection for Small Wastewater Flows

EFFECT	UV	CHLORINE (tablets)	OZONE
pH	No	Yes	Yes
Temperature	No	Yes	Yes
Residual	No	Yes	Dependent on pH & temp.
Contract time required	Very short	Very long	Medium
Operator skill required	Little	Little	Moderate
Equipment maintenance	Little	Moderate	High
Ammonia interference	No	Yes	Yes
Water chemistry change	No	Yes	Yes
Dissolved iron interference	Yes	Yes	Yes
Dissolved organic interference (e.g. phenol, humic acid, lignin sulfonates)	Yes	Yes	Yes
Capital cost	Low	Medium	High
Operating cost	Low	High	Medium


caution
Super Bug!

Superbug

Blamed for 60 percent of hospital infections in the US, caused 19,000 deaths out of 94,000 infections there in 2005

MRSA

- Methicillin-resistant Staphylococcus aureus
- Caused by Staphylococcus aureus bacteria (staph)

Origins

- Recognised first in hospitals around 1960
- Entered wider community in 1990s, where it came to be known as community-associated MRSA or CA-MRSA
- Dramatic rise of the disease in community reported in recent years

The problem

Bacteria has evolved to survive common antibiotics

e.g. penicillin, oxacillin, methicillin, amoxicillin

Generally harmless to healthy adults unless enters body through cut or wound

Symptoms

- Minor skin problems
- Deep abscesses
- Can reach bone, joints, bloodstream, major organs
- Can lead to death

Risk environments

- Hospitals
- Long-term care facilities
- Sporting facilities and equipment
  e.g. towel sharing in changing rooms, on the field in contact sports
- Crowded, unsanitary living conditions

Source: Mayo Clinic/CDC

281008 AFP

SUPERBUGS!!

- Superbugs are on the rise in chlorinated wastewater effluent.
- The multidrug resistant gene NDM - 1 is able to give antibiotic resistance to E. Coli, Salmonella, and other bacteria.
- A Rice University study of Asian treatment plants indicated a minimal NDM - 1 reduction in spite of chlorine disinfection.
- ***They recommended using a UV disinfection system.***
- See the ACS Journal, *Environmental Science and Technology*, December, 2013.

Key Superbug Facts

- **60,000 tons/year of antibiotics consumed to raise livestock and for human health**
- **Bacteria are becoming resistant, e.g., MRSA**
- **Antibiotic Resistant Genes, ARG transfer to human pathogens, ARB**
- **Wastewater plants are incubators for ARG and ARB**

UV VS CHLORINE FOR SUPERBUGS

- UV dose for inactivation is roughly the same as for normal and ARB
- ARG transfer can be nearly eliminated by a UV dose of 10 mj/cm^2
- Chlorine doses of up to 40 mg-min per/liter prevented ARG transfer
- Chloramine stimulated the bacteria and further helped ARG transfer
- UV is clearly superior to chlorine for reducing the ARG problem

Reference

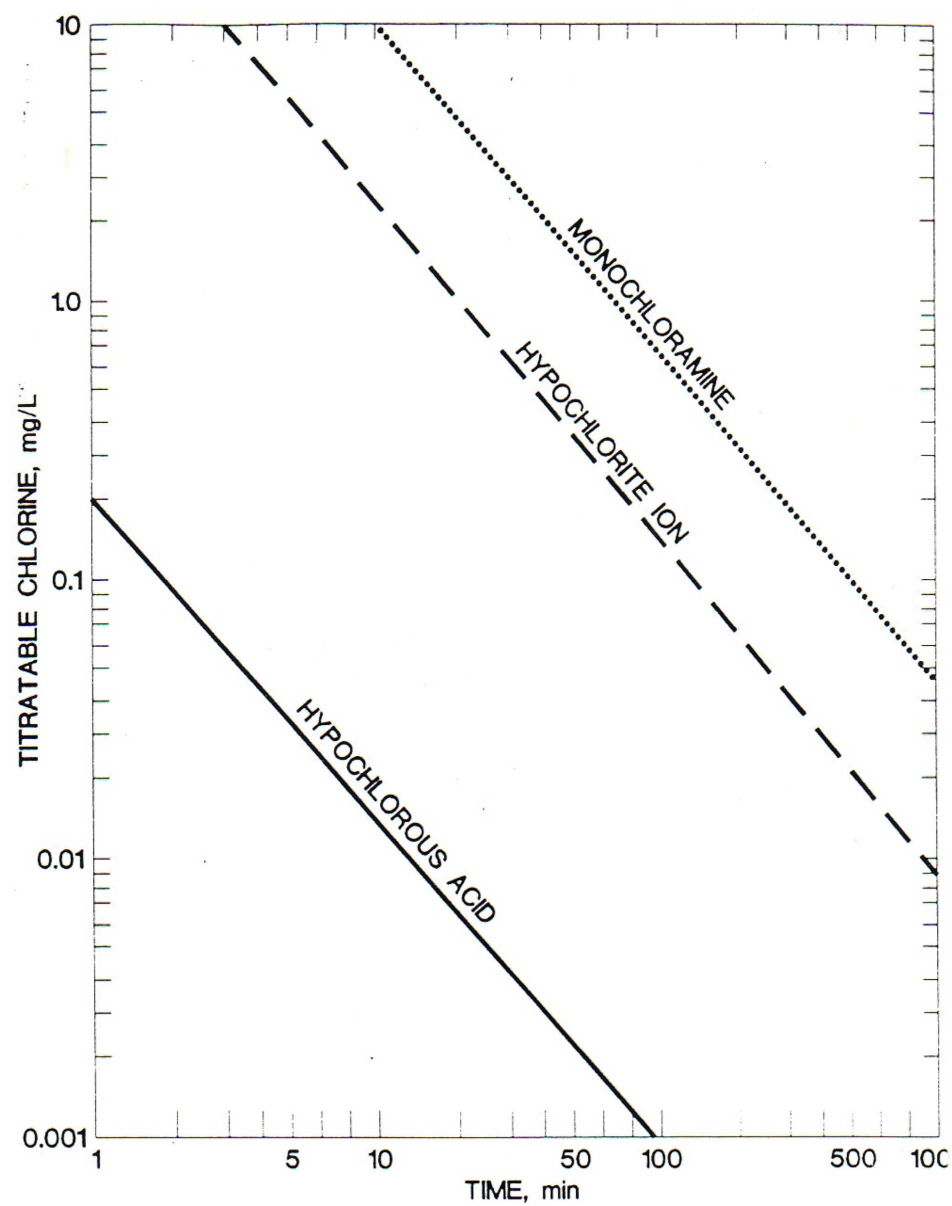
Are Antibiotic-resistant Bacteria a New Challenge to Disinfection?

Mei-Ting Guo. guomeiting@tongji.edu.cn

College of Environmental Science & Engineering, Tongji University, Shanghai, 200092 China

IUVA News,/Vol. 17 No. 3, Winter 2015, Pgs.1617

Figure 5.5
Escherichia coli kill times versus residual concentration (from Clarke, N.A., *et al.* [1964] *Human Viruses in Water: Source, Survival and Removability, Advances in Water Pollution Research.* Vol. 2, Pergamon Press, London, U.K., 523

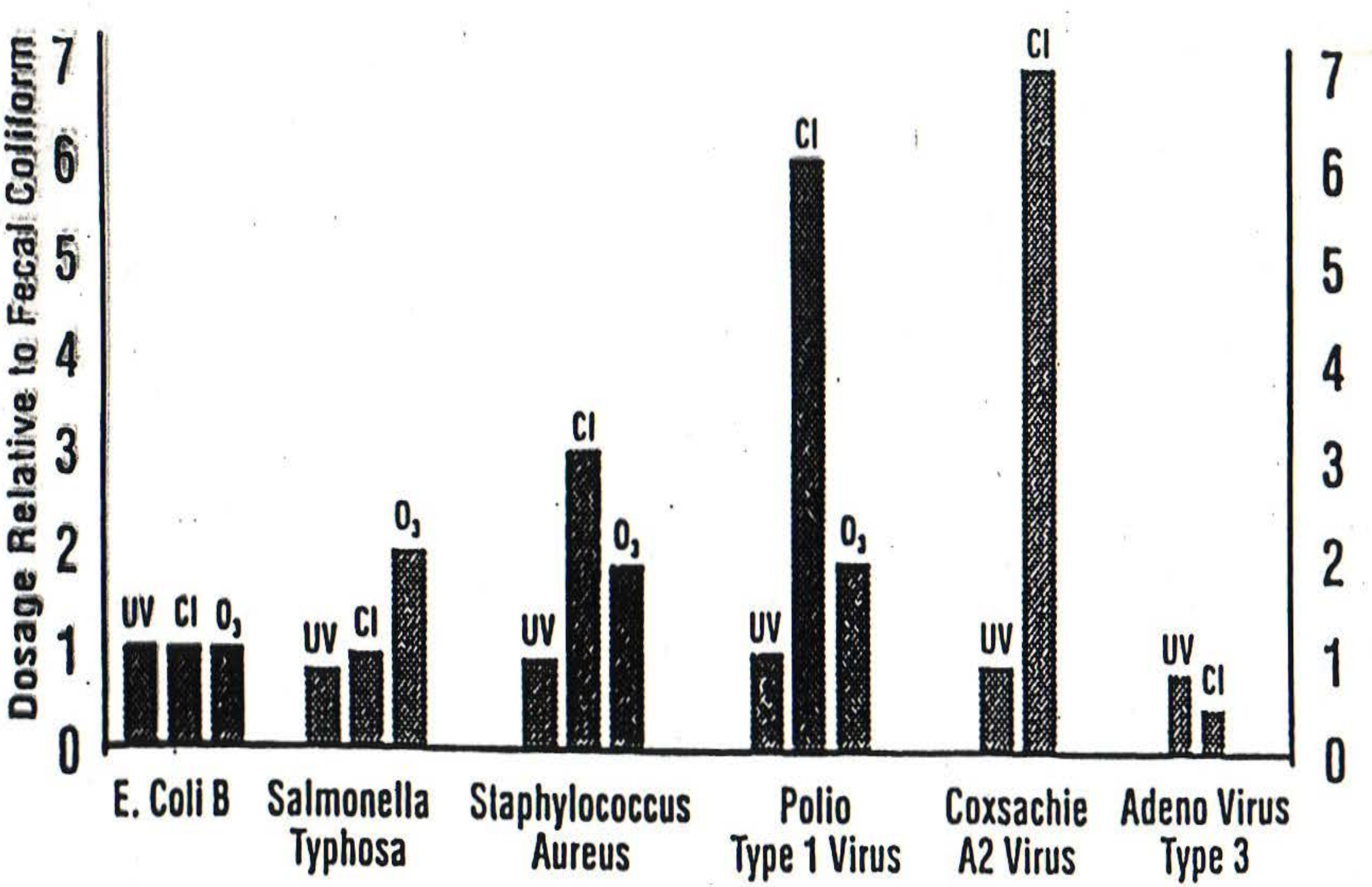


Effect of Lower Chlorine dosage at Buffalo WWTP (Continued)

Sample Date	Chlorine Residual (mg/L)	Fecal Coliform (MPN/100 ml)	Flow Rate (MGD)
7/8/1996	**0.78**	**110**	**130**
7/9/1996	**1.22**	**20**	**154 <- Reduction**
7/15/1996	***0.30***	***12023***	***197***
7/16/1996	**0.92**	**40**	**155**
7/22/1996	**0.58**	**55**	**159**
7/23/1996	***0.42***	***339***	***142***
7/30/1996	***0.39***	***575***	***210***
8/5/1996	***0.41***	***912***	***161***
8/6/1996	***0.35***	***224***	***150***
8/12/1996	***0.48***	***1660***	***152***
8/13/1996	***0.48***	***1662***	***158***
8/19/1996	**0.76**	**40**	**138**
8/20/1996	**0.88**	**44**	**160**

Effect of Lower Chlorine dosage at Buffalo WWTP

Sample Date	Chlorine Residual (mg/L)	Fecal Coliform (MPN/100 ml)	Flow Rate (MGD)
6/3/1996	**0.80**	**692**	**264**
6/4/1996	**0.92**	**63**	**190**
6/10/1996	**1.00**	**24**	**202**
6/11/1996	**0.95**	**50**	**210**
6/17/1996	**1.15**	**47**	**158**
6/18/1996	**1.00**	**76**	**225**
6/25/1996	**1.10**	**28**	**158**
6/26/1996	**0.95**	**33**	**147**
7/1/1996	**1.08**	**32**	**160**
7/2/1996	**0.82**	**33**	**146**
7/8/1996	**0.78**	**110**	**130**

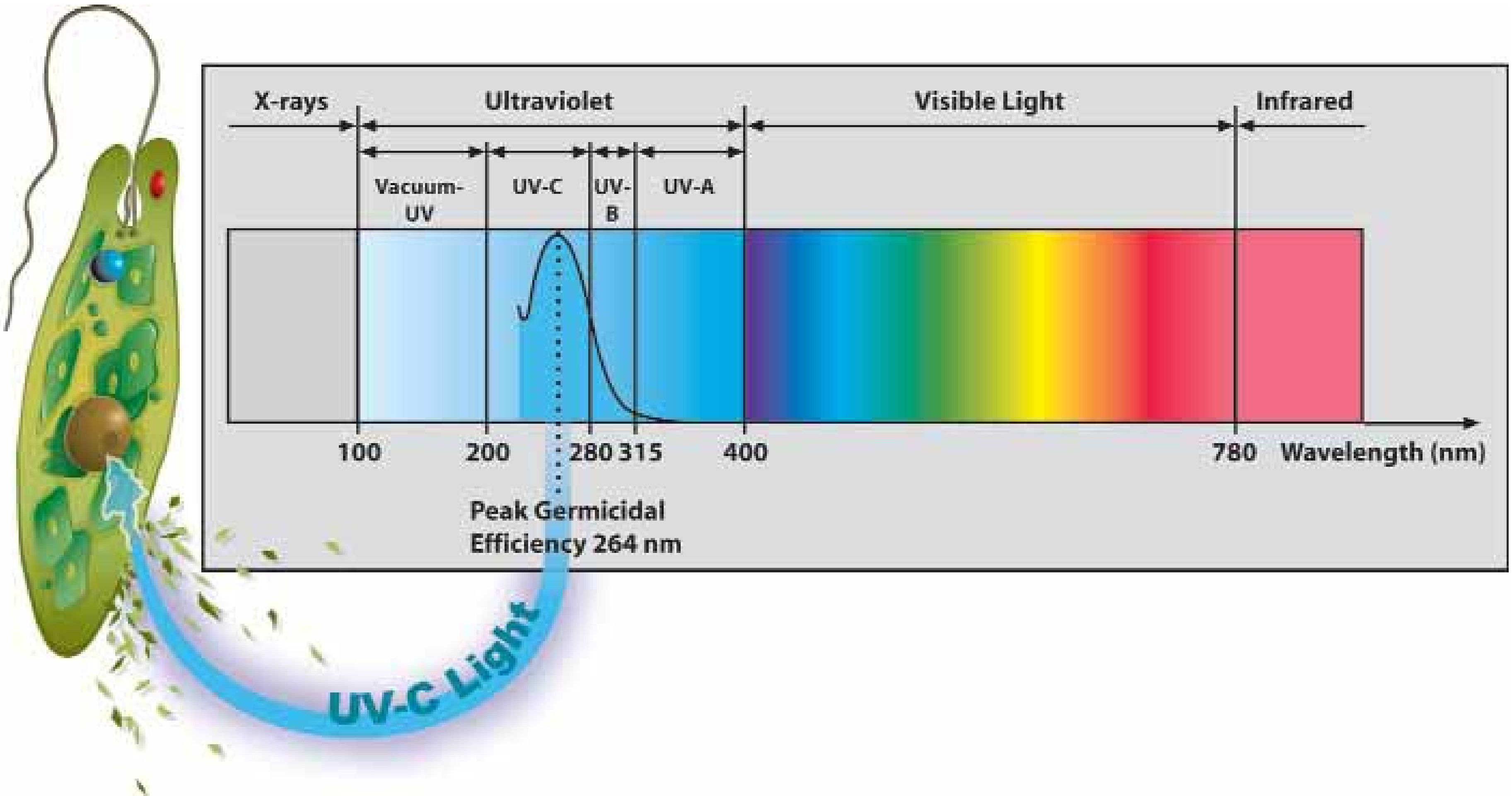


Dosage Relative to Fecal Coliform
0
1
2
3
4
5
6
7
UV
Cl
O3
E. Coli B
Salmonella Typhosa
Staphylococcus Aureus
Polio Type 1 Virus
Coxsachie A2 Virus
Adeno Virus Type 3

UV Disinfection – Basic Facts

- 240–260 nm UV light destroys microorganisms
- Dose is product of UV intensity and exposure time
- UV light transmission and suspended matter important variables
- Low–pressure mercury UV lamps are readily available at low cost
- Reliable delivery of UV dose to the fluid is the engineering design challenge

Electromagnetic Spectrum



UV Destruction Dosages (>99.9% Inhibition) For Important Microorganisms (mj/cm²)

BACTERIA

Clostridium tetani (Tetanus)………………………..	22.0
Dysentery bacilli………………………………....	4.2
Escherichia coli (indicator organism)……………….	6.6
Legionella pneumophila (Legionnaires' disease)….	2.76
Mycobacterium tuberculosis……………………….	10.0
Pseudomones aeruginosa (slime former)……….	10.5
Salmonella typhosa (Typhoid fever)………………..	4.1
Salmonella enteritides (Enteric fever)………….....	7.6
Staphylococcus aureus…………………………….	6.6
Streptococcus lactis………………………………....	8.8

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UV Destruction Dosages (>99.9% Inhibition) For Important Microorganisms (mj/cm²)

YEAST AND MOLD

Bakers Yeast	8.8
Saccharomyces sp.	17.6
Penicillium roqueforti	26.4
Aspergillus niger	330
Mucor racemosus A & B	35.2
Oospora lactis	11

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UV Destruction Dosages (>99.9% Inhibition) For Important Microorganisms (mj/cm²)

OTHER

Chlorella vulgaris (algae)	22
Fungi (typical)	45
Cryptosporidium (Oocysts)	20 – 30
Giardia lamblia (cysts)	20 – 30

UV Destruction Dosages (>90% Inhibition) For Important Microorganisms (mj/cm²)

VIRUS

Influenza	6.6	Influenza A	2.3
Polio Type I	6.0	Bacteriophage MS 2	23.7
Coxsachie A2	4.8	Papilloma Virus	9.8
Ebola (Zaire)	2.3	Hepatitis C	23.3
Mumps	4.7	Adeno Virus Type III	4.5
Norwalk	5.6	Herpes Virus Type 4	5.3

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Dose requirements needed for inactivation of viruses by UV light exposure (mj/cm^2)

Virus	90.0%	99.0%	99.9%	99.99%
Echovirus 1	8	16.5	25	33
Echovirus 2	7	14	20.5	28
Coxsackievirus B5	9.5	18	27	36
Coxsackievirus B3	8	16	24.5	32.5
Poliovirus 1	8	15.5	23	31
Adenovirus type 32	40	78	119	160

From: Appl Environ Microbiol. 2002 October; 68(10): 5167-5169.
Doi: 10. 1128/AEM.68. 10.5167-5169.2002

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Typical Ultraviolet Transmission Data On Water and Wastewater

Water Type	Percent Transmission of 253.7 nm UV per cm	Absorption Coefficient (253.7 nm UV) (cm^{-1})
Distilled or High Purity Water	99	0.01
High Purity Drinking Water (no ferric iron or absorbing organics)	95	0.05
Poor Quality Drinking Water (<0.3 ppm iron, slight amount of absorbing organics)	82	0.2
Filtered Secondary Effluent (<10 SS, <10 BOD)	71	0.35
Unfiltered Secondary Effluent (<30 SS, <30 BOD)	65	0.43
Lagoon Effluent (<100 SS, < 30 BOD)	61	0.5
Water containing 10 ppm Humic Acid	56	0.58
Water containing 10 ppm Ferric Iron	25	1.4

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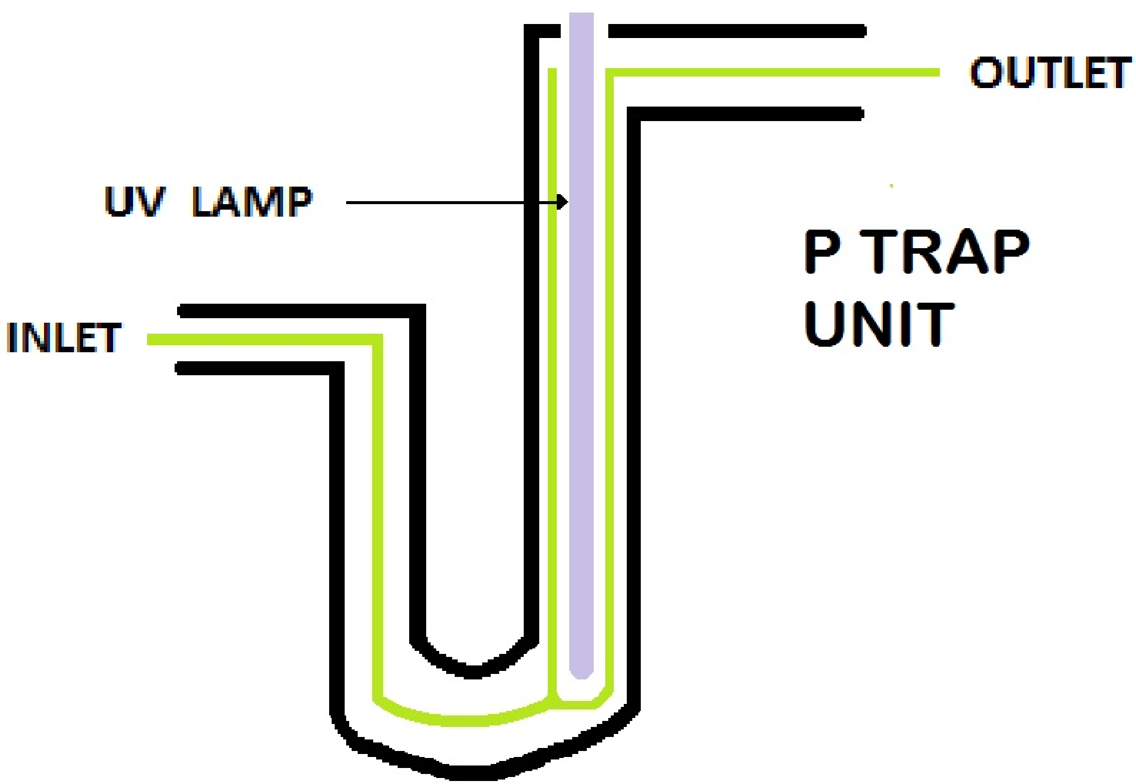
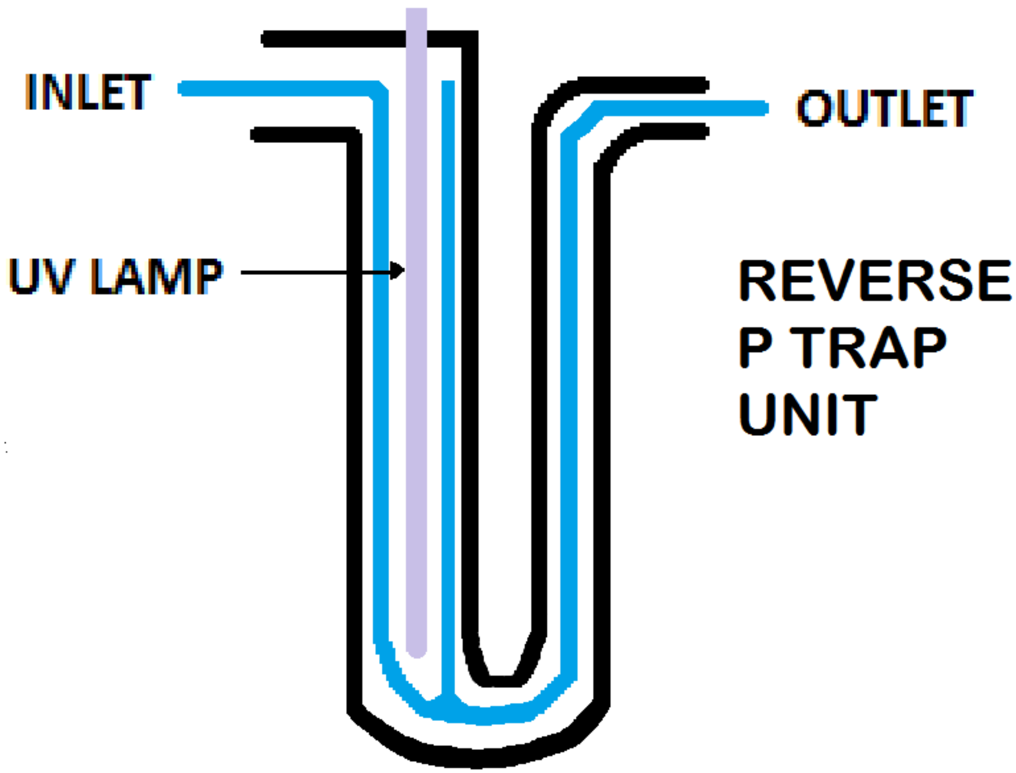
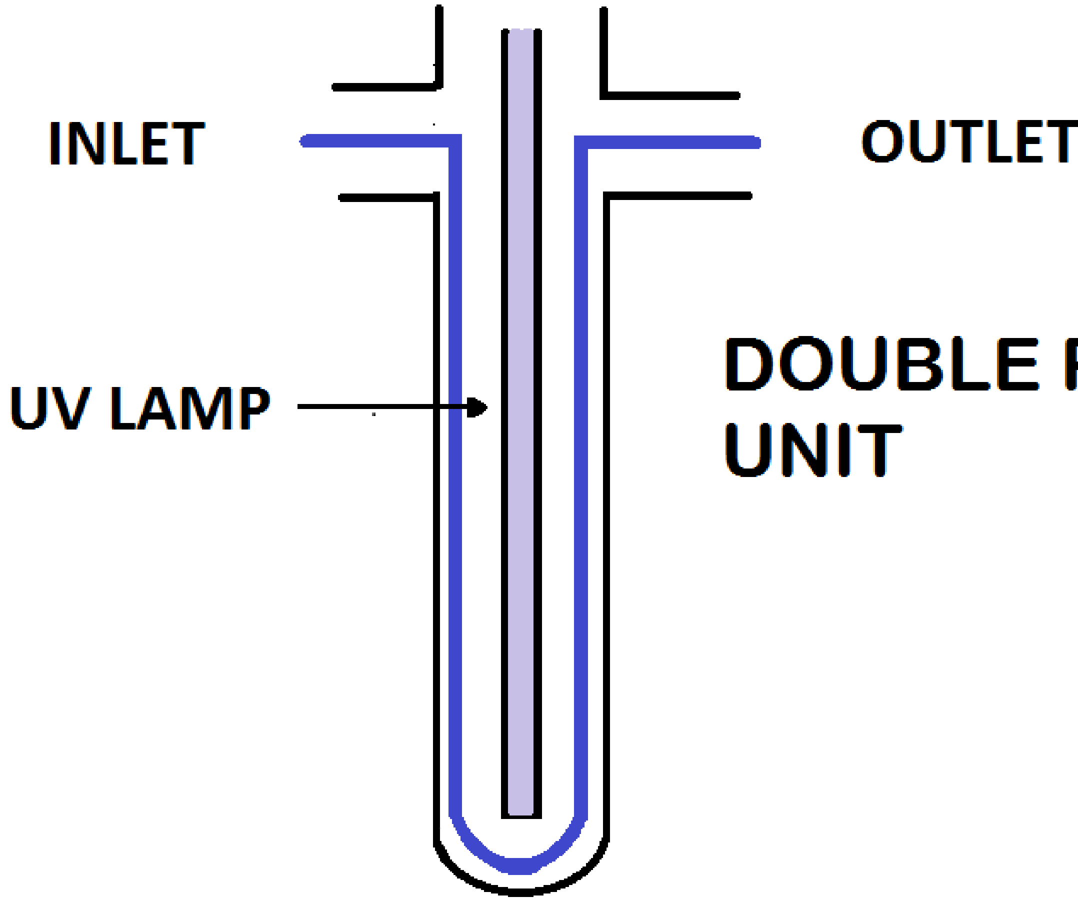

OUTLET
UV LAMP
INLET
P TRAP
UNIT


INLET
OUTLET
UV LAMP
REVERSE
P TRAP
UNIT



DOUBLE PASS UNIT

Design Features

- Easy Installation – Ground or Pump Tank
- Cost Efficient – 2 year "Long Life" UV Lamp, Uses Less Than 30 Watts of Power
- Gravity Flow to 6 GPM
- UV Resistant Materials
- UV Sub Assembly Easily Removed
- Teflon® Film Resists Fouling
- Underground "Floodproof" UL and cUL Listed Wastewater Disinfection UV Unit
- Power Surge and Electrical Noise Suppression

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DESIGN PARAMETERS

- Maximum flow rate: 3 GPM for 30:30 effluent, 6 GPM for 10:10 effluent.
- Fecal coliform reduction at lamp end-of-life (2 years) greater than 99.9%.
- Inlet and outlet pipe is 4-inch schedule 40 ABS.
- Pressure drop is less than 0.5 inches of water at maximum flow rate.
- Power use is 30 Watts. Energy use is 0.7.2 kW/hr/day, assuming continuous operation.
- UV lamp is low-pressure mercury, 90% of output is at 253.7 nanometers.

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DESIGN PARAMETERS, *continued*

- **Minimum arc length is 30 inches, and the UV intensity is greater than 190 μW/cm^2 at 1 meter**
- **The unit and the "long life lamp" are warranted for two years.**
- **UV dose is greater than 55 mj/cm^2 (55,000 μW-seconds/cm^2).**
- **UV lamp ballast is 90% efficient, high frequency operation (50 kHz) with thermal link protection.**
- **Input voltage is 120 VAC at 50 or 60 Hz. Input current is up to 0.5 Amps.**

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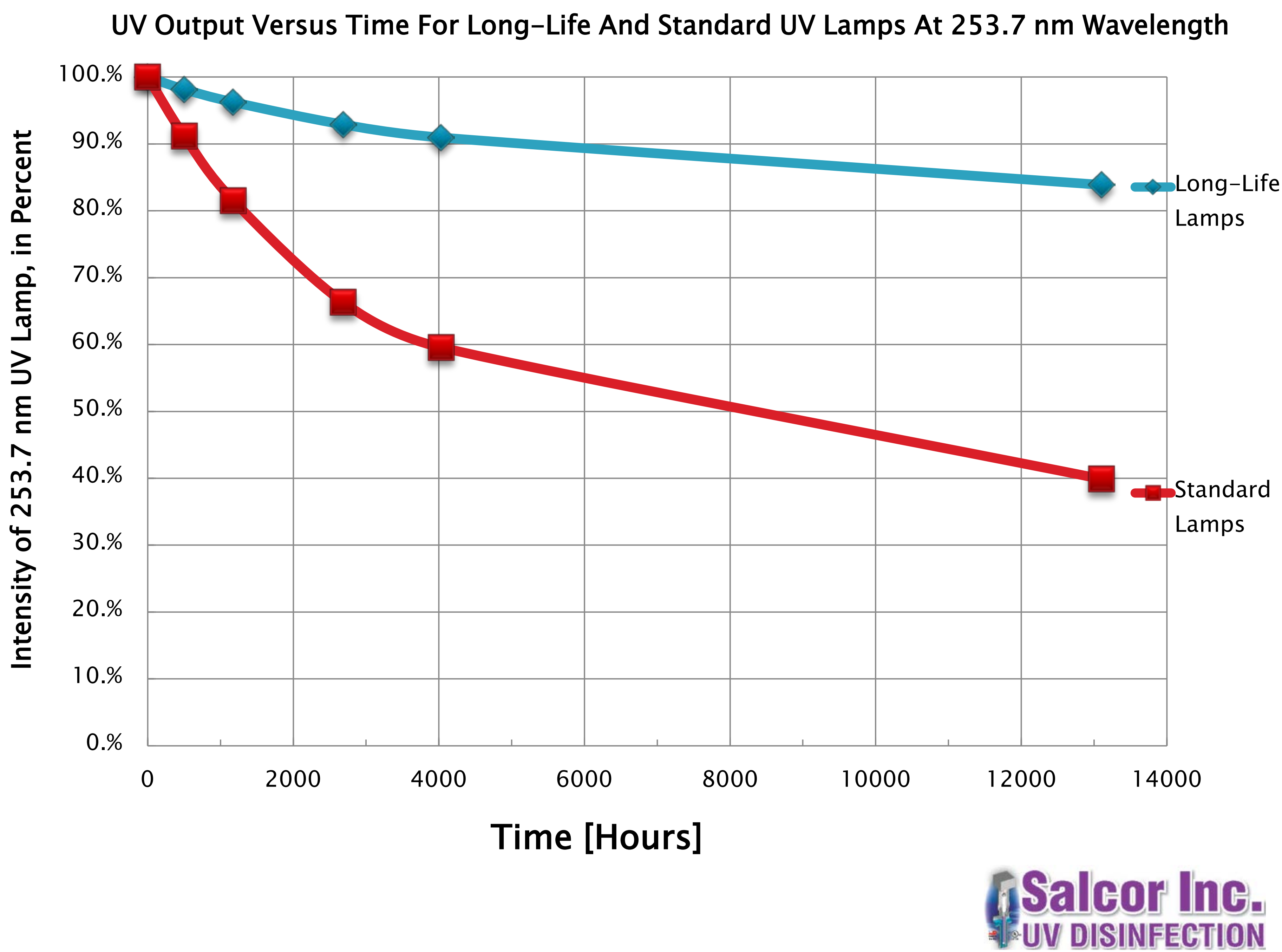

UV Output Versus Time For Long-Life And Standard UV Lamps At 253.7 nm Wavelength
Intensity of 253.7 nm UV Lamp, in Percent
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
0.%
0
2000
4000
6000
8000
10000
12000
14000
Time [Hours]
Long-Life Lamps
Standard Lamps
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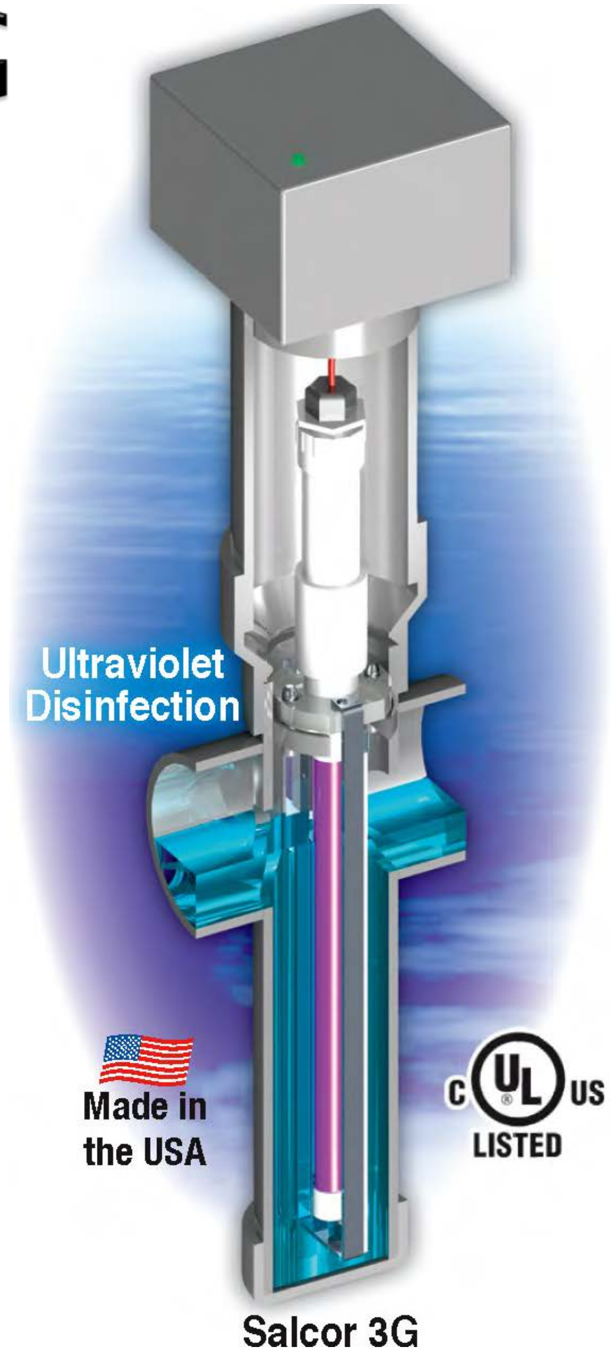
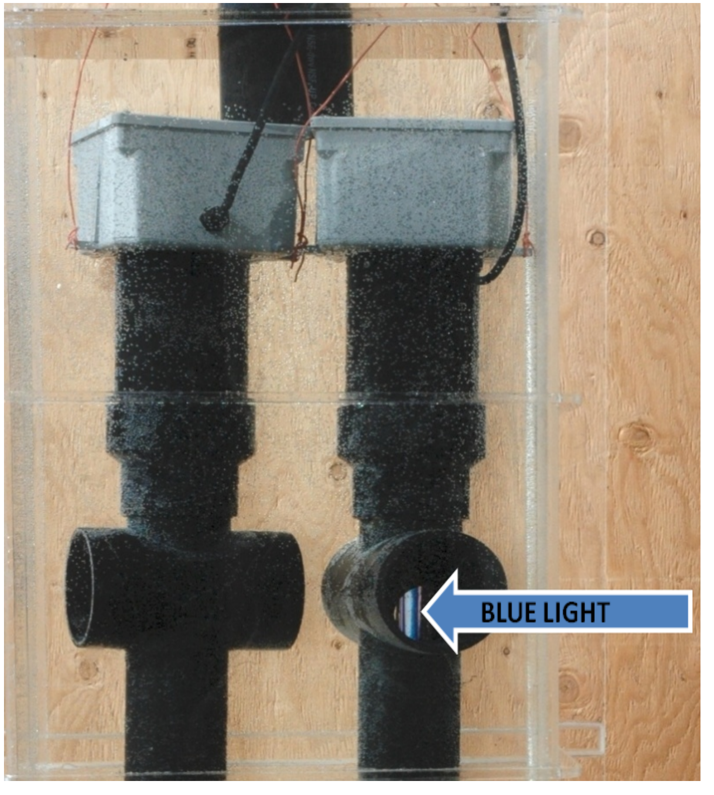
Model 3G

- NEMA 6P
- Flood Proof
- UL Certified
- Gravity Flow
- 6 GPM (9k GPD)
- <**30 Watts**



NEMA 6P Junction Box Passed a 30-Day UL Submergence Test. Two SALCOR Model 3G Units Operating in a Water Tank.



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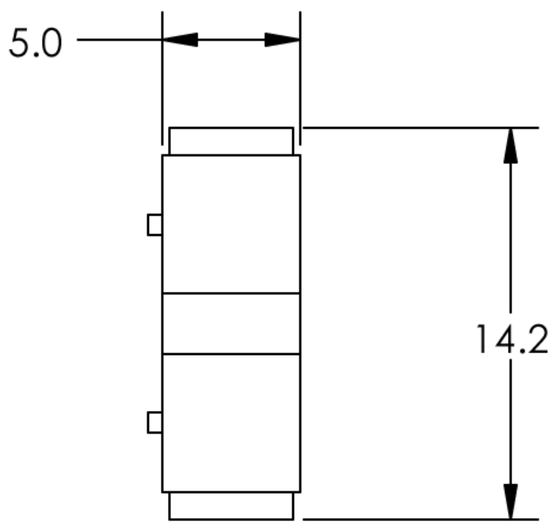
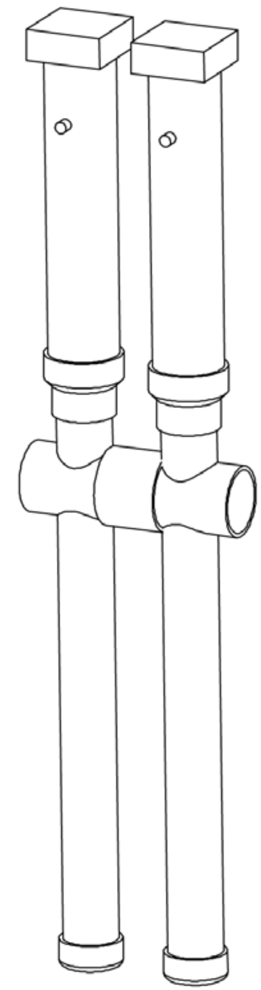
2 Units in Series





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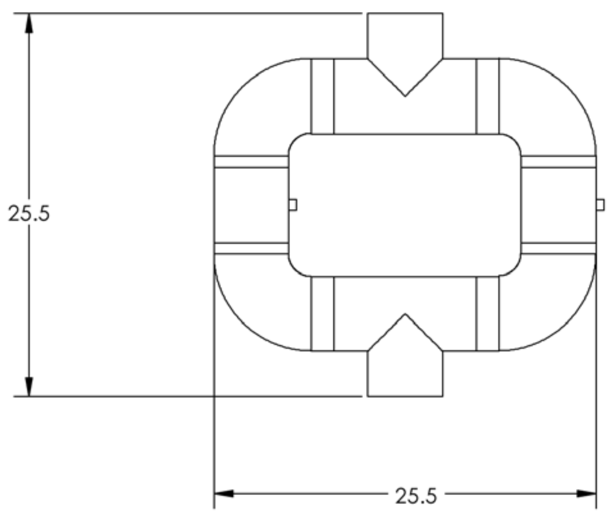
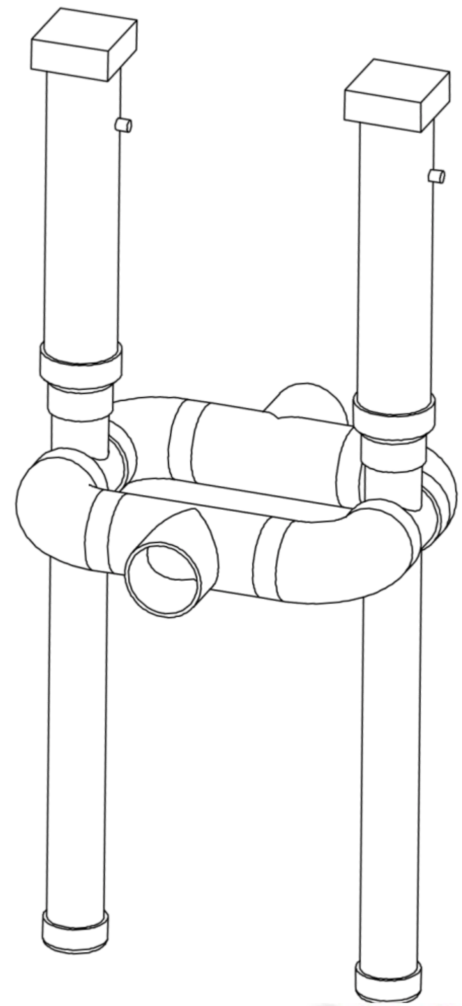
2 Units in Parallel





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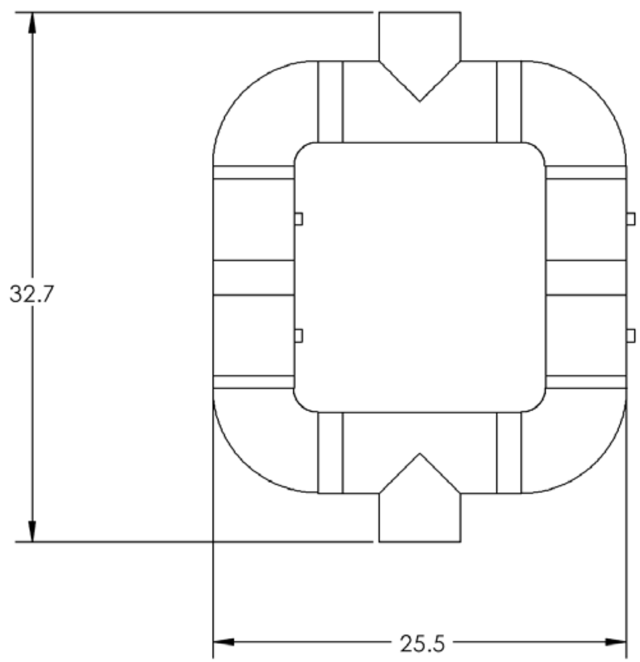
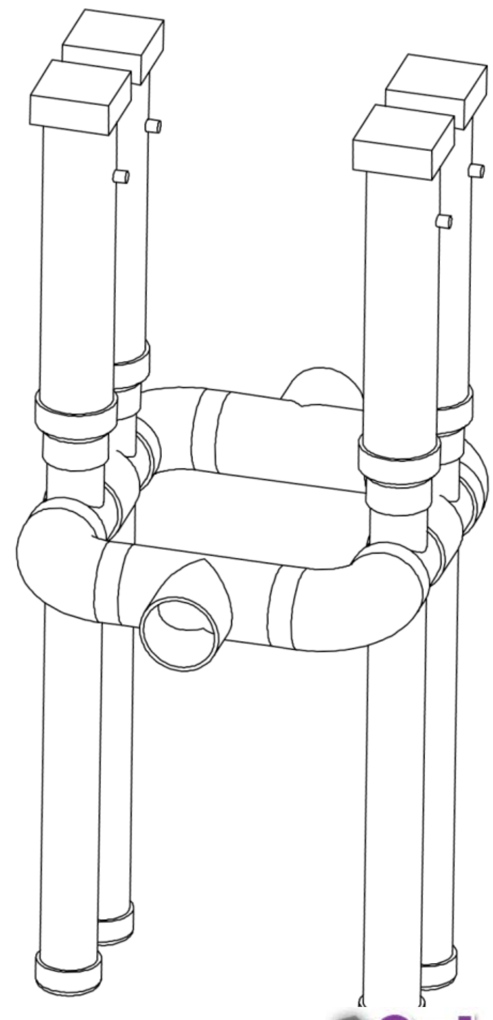
4 Unit Series & Parallel





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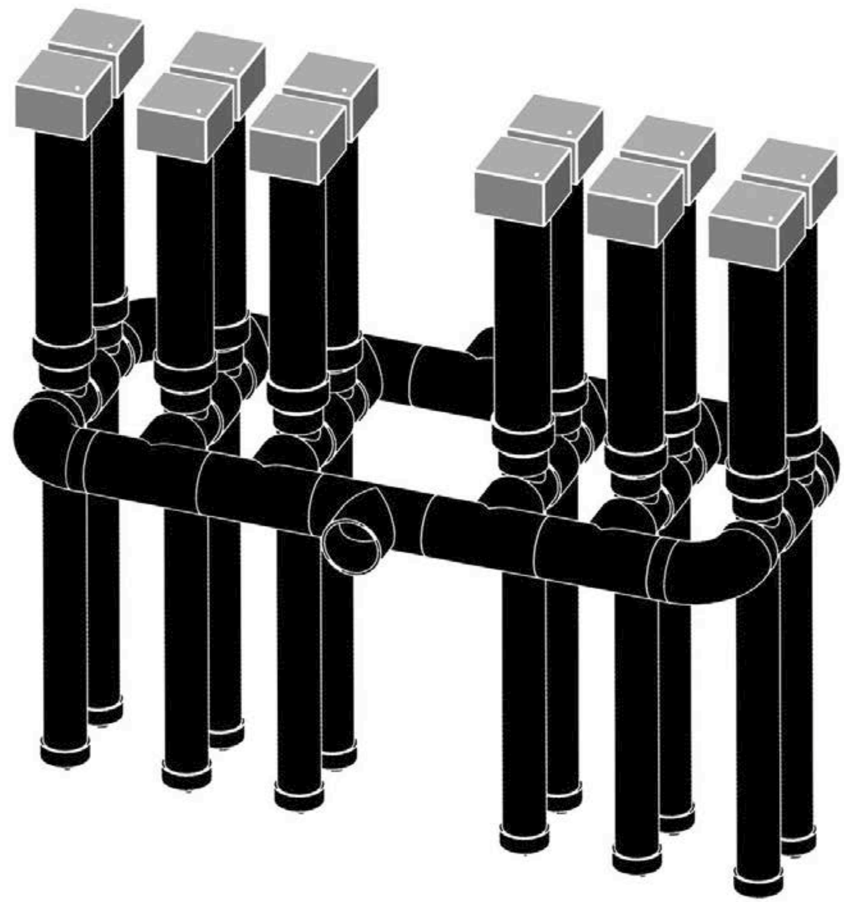
SALCOR

Model 3G Unit

9,000 GPD

Salcor 3G

12 Units in Parallel/Series



Disinfect >100,000 GPD

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WASHINGTON STATE TESTING

- **Advanced Treatment Unit & SALCOR UV**
- **NSF Standard 40 & WA State Fecal Coliform Reduction Protocol**
- **Duration 26 weeks**
- **All Twenty-one Completed Successfully, And One is in Progress.**
- **3G UV Effluent Fecal Coliform Counts Ranged From 2 to 35 Per 100 ML (Geometric Mean)**
- **Demonstrates That the 3G UV Unit Operates Reliably Without Maintenance for 6+ Months**

NSF / Washington Protocol Tests with 21 Treatment Systems:

- Aero Tech
- AK Industries - Hydro Action
- ANUA (Bord na Mona)
- Aqua Klear
- Bio Microbics - Microfast 0.5
- Clearstream
- Consolidated Treatment
  - Enviro-Guard .75
  - Multiflo
  - Nyadic

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NSF / Washington Protocol Tests

- Delta Whitewater - DF-60
- Delta Whitewater - Ecopod
- Ecological Tanks - Aqua Safe
- Enviro Flo
- Fuji Clean
- Hoot Aerobics
- Jet Inc
- Lowridge Onsite Technologies
- Norweco - Singulair
- Orenco - AX 20N
- Quanics - ATS-CSAT-8-AC-C500
- Solar Air

WASHINGTON STATE
TEST RESULTS SUMMARY

Treatment Type	Geometric Mean Fecal Coliform/100 ml
Suspended Growth	18 – 33
Fixed/Suspended Growth	26 – 56
Fixed Growth – Textile	1.7
Fixed Growth – Peat	2.1
Fixed Growth – Foam	16

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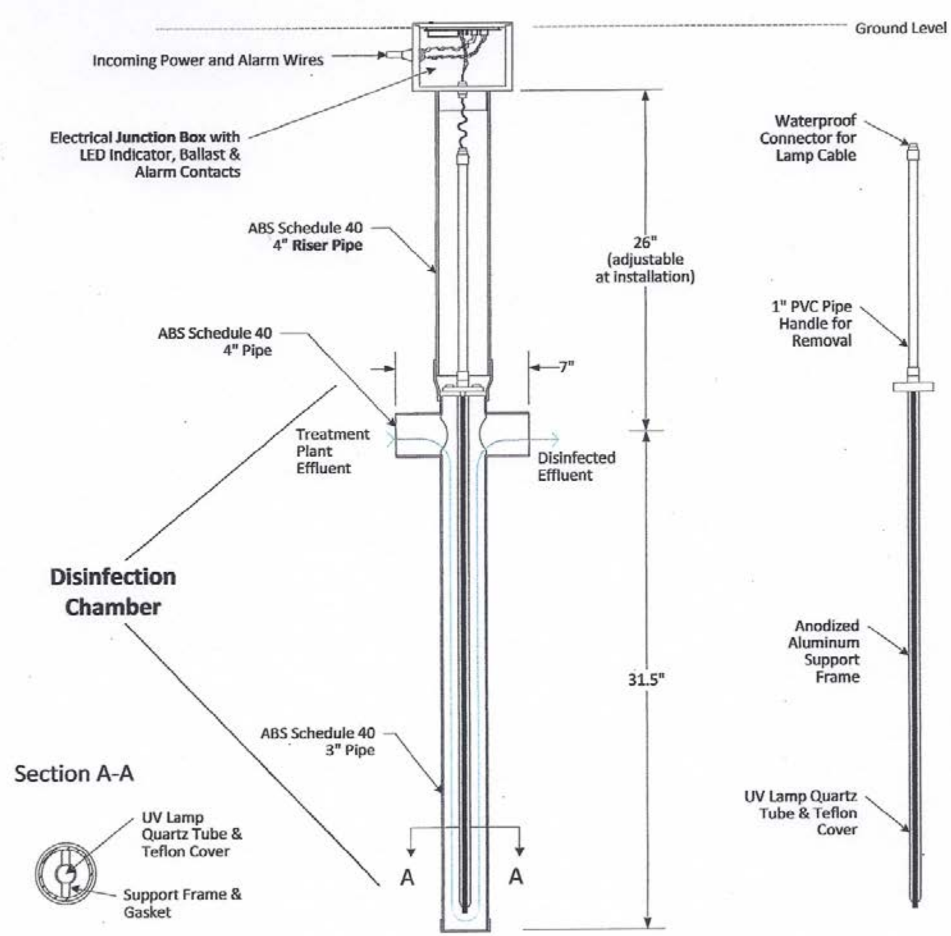
Salcor 3G Disinfection Unit

NOTE: Not all dimensions to scale



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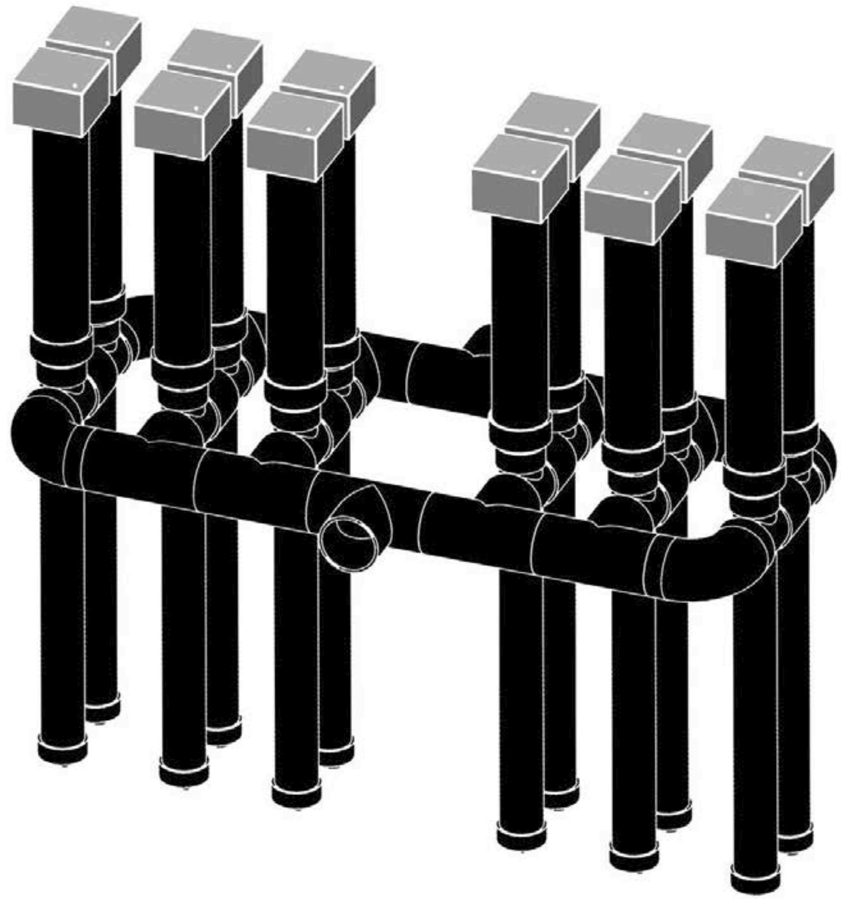

Disinfect >100,000 GPD

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Easy *Installation* and Reliable *Operation*

- **Teflon® Film Resists Fouling**
- **Alarm Light and Contacts for a Remote Alarm Provide Monitoring of Proper Performance of Unit**

Convenient *Maintenance*

- **Accessible Divider Sub-Assembly and Lamp Easily Removed for Yearly Maintenance**

Homeowner *Satisfaction*

- **No Handling of Caustic Chemicals**
- **Assures Highest "Kill" Rate Of Dangerous Pathogens (Bacteria, Viruses, and Parasites)**
- **Two-Year Warranty for Unit and UV Lamp**

Salcor Inc. UV DISINFECTION


25th
ANNIVERSARY
FALLBROOK
AVOCADO
FESTIVAL
April 17th
2011
FallbrookChamberofCommerce.org

Salcor Company History

- *Founded in 1978*
- Specializes in ultraviolet technologies for disinfection of wastewater and toxic chemical destruction
- FDA-approved system for processing food products (juices)

Salcor Company History

Dr. James E. Cruver

- **Founder - President – Inventor**
- **PhD in Chemical Engineering from the University of Washington.**
- **Over 40 years of experience in water treatment including reverse osmosis, filtration, and disinfection.**
- **Author of 70 technical papers and co-author of a graduate level textbook on water treatment.**

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THANK YOU FOR ATTENDING MY PRESENTATION

Salcor 3G

Ultraviolet Disinfection

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