



Encontro Técnico  
**AESABESP**

31º Congresso Nacional  
de Saneamento e  
Meio Ambiente

# Princípios e aplicações da radiação UV para desinfecção de água potável e efluentes

*Carlos Rivas*

*Novas Aplicações UV Sul América*

*Novembro 2020*

**Aquaculture**



**Food & Beverage**



**Municipal**



**Pharmaceutical**



**Heavy Industry**



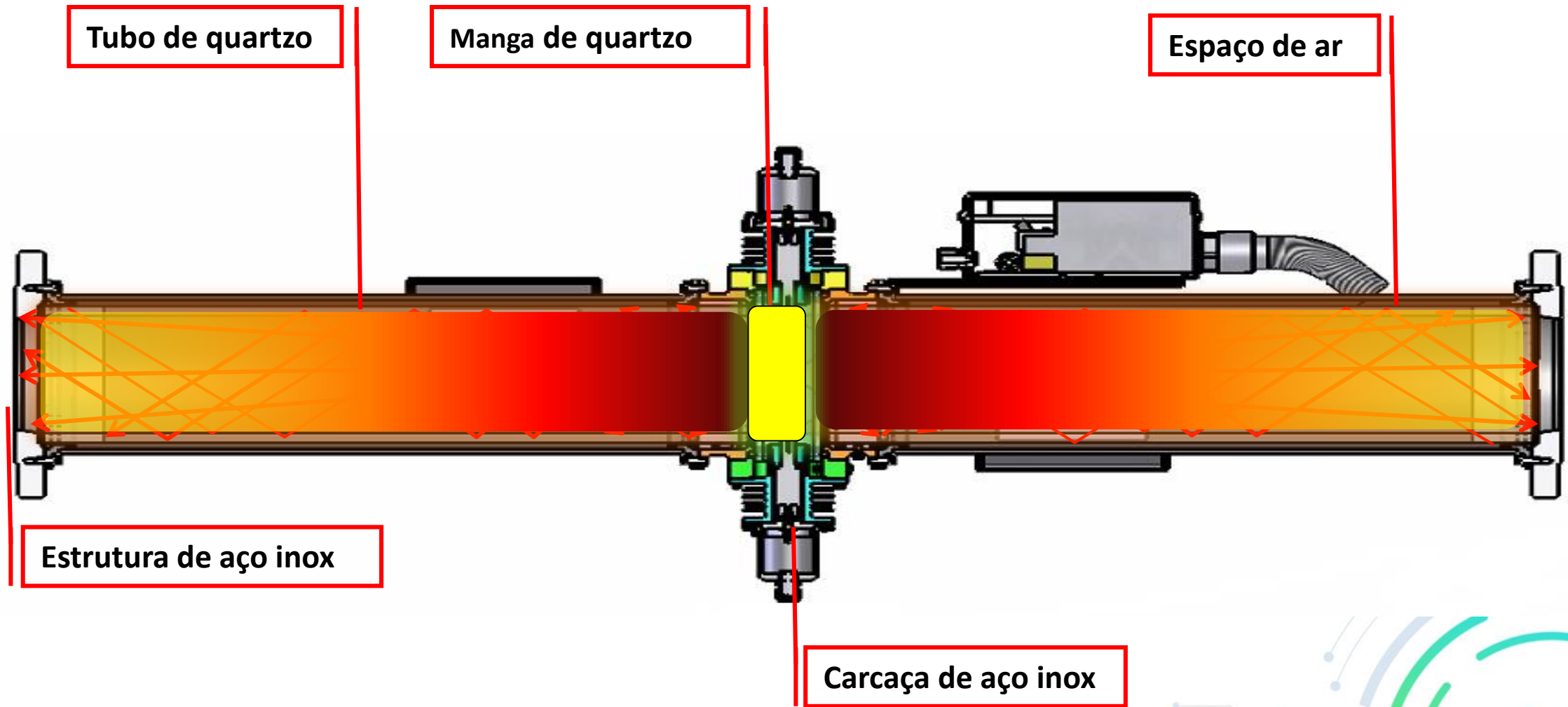
**Ballast Management**



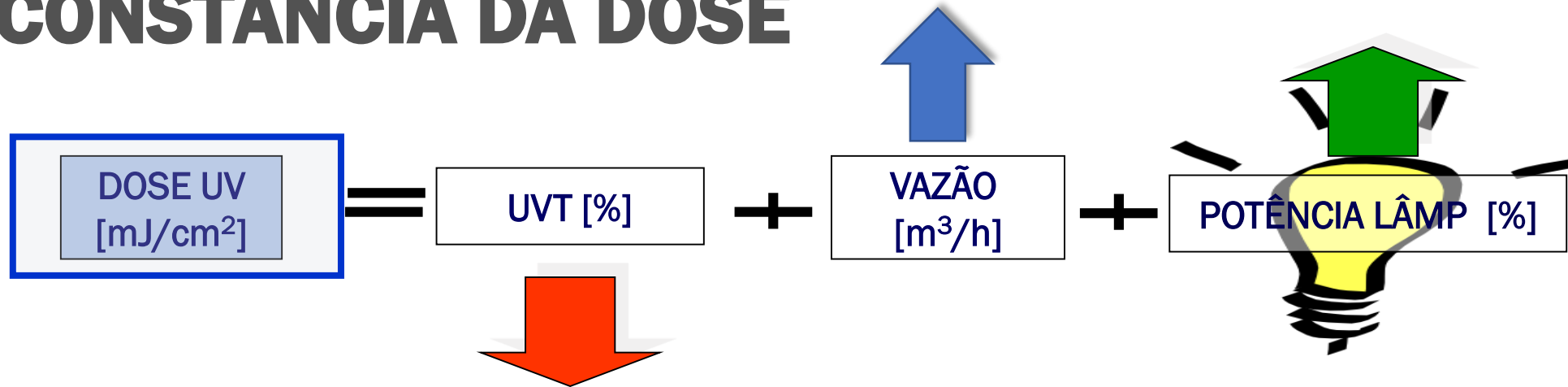


# Sistema Hydro-Optic Disinfection (HOD) da Atlantium



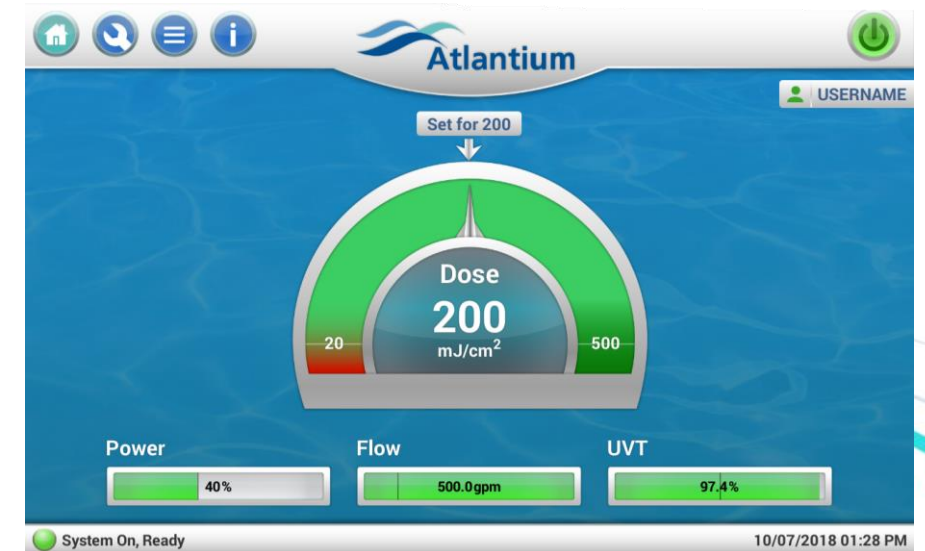


# AJUSTE DE VARIÁVEIS PARA GARANTIR A CONSTÂNCIA DA DOSE



## Garantia de desempenho: Constância da dose UV

- Sensores dedicados : transmitância, vazão, potência
- Monitoramento e controle on-line: ajuste automático
- Integração com SCADA
- Geração de relatórios





# Hydro-Optic Disinfection (HOD)– Product Lines

## Modular Systems



RZ104-11

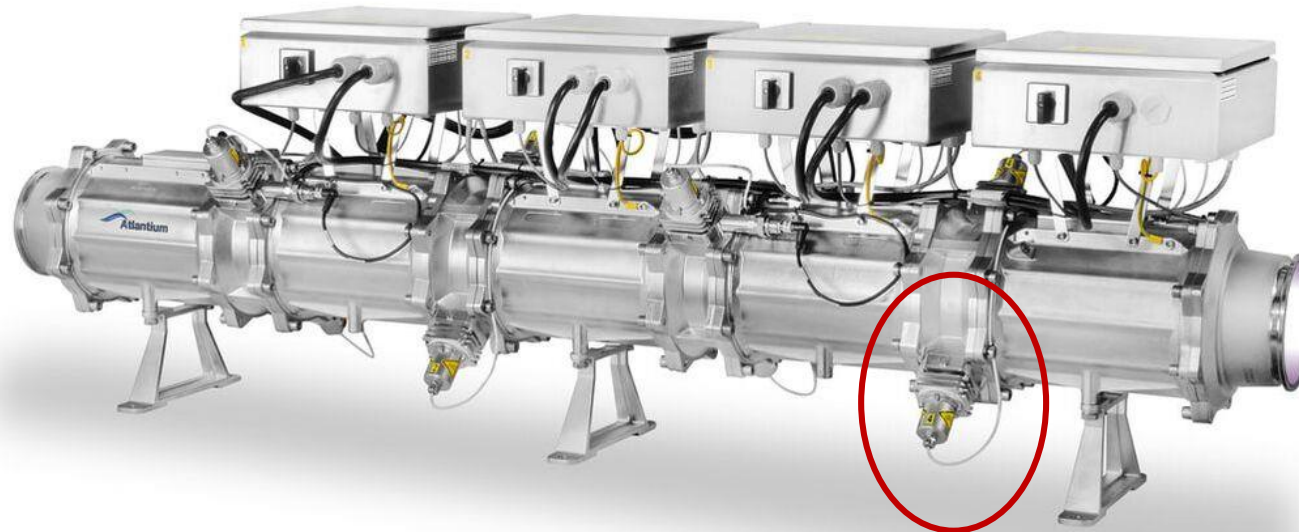
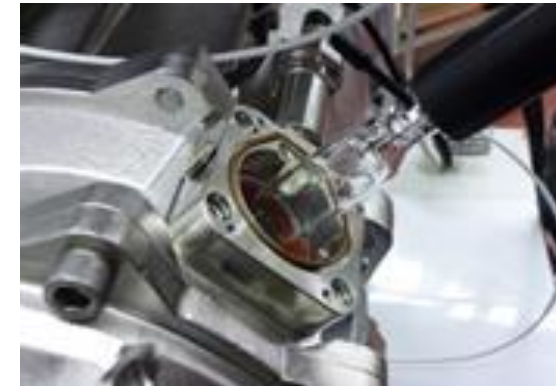


RZ163-12



RZ300-14

# Substituição de lâmpadas em equipamentos HOD UV



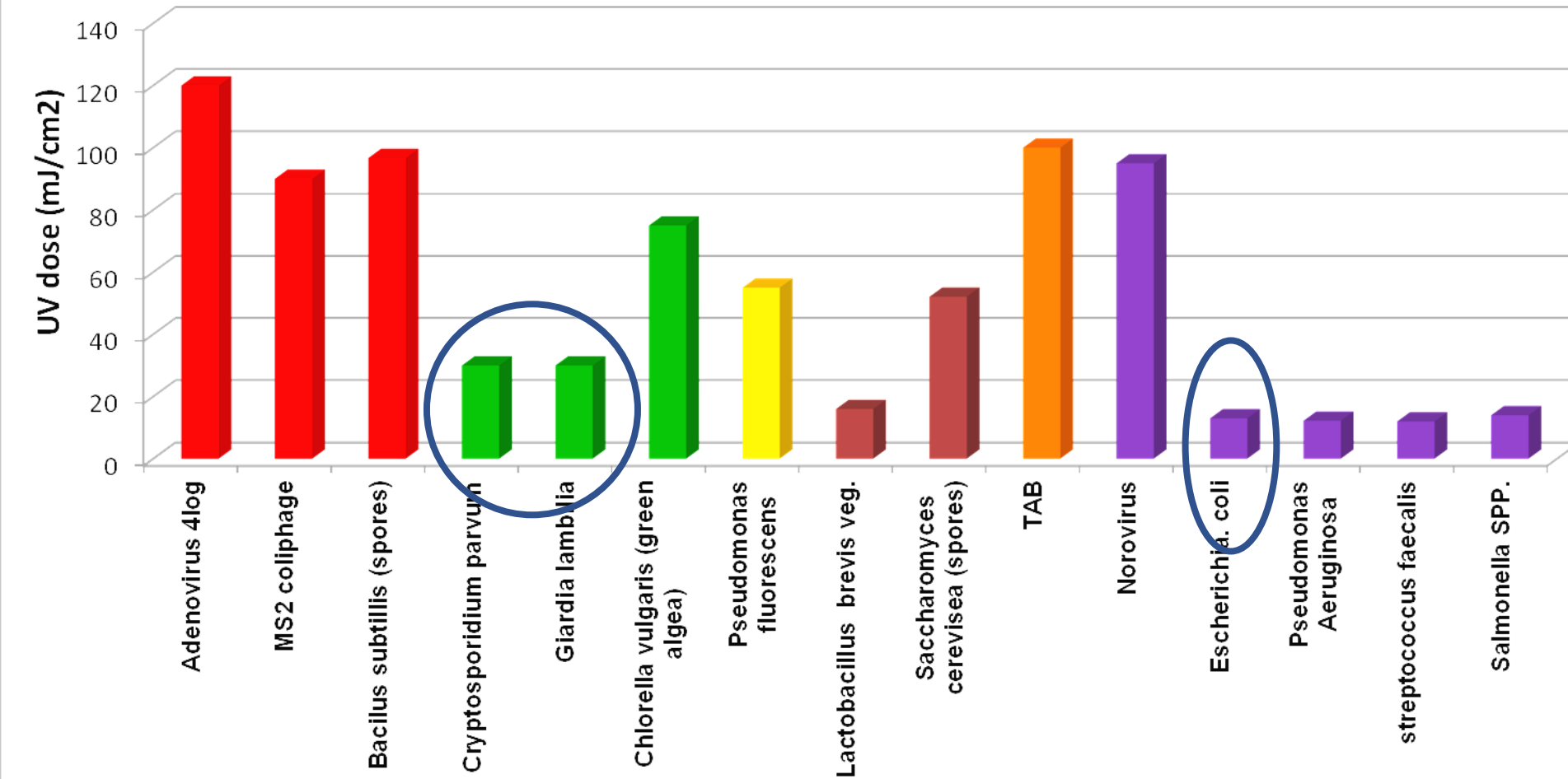
## *Hydro-Optic (HOD) UV: Principais vantagens*

- *Reflexão interna total: menor consumo de energia*
- *Dose UV mínima garantida*
- *Controle de dose UV on line*
- *Design modular*
- *Substituição simples das lâmpadas : não precisa interromper a operação , simplicidade de manutenção*
- *Lâmpadas de media pressão : emissão policromática*
- *Lâmpadas de alta potencia: a menor quantidade de lâmpadas por m<sup>3</sup> = menor custo de substituição*
- *Em resumo : performance mais confiável com menor o OPEX*



# DESINFECÇÃO POR RADIAÇÃO UV

Required UV Dose for 5Log Reduction



# VÍRUS TRANSMISSÍVEIS ATRAVÉS DA ÁGUA

Nome corrente	Doenças causadas
Adenovirus	Adenovirus infection, pharyngitis, conjunctivitis, fever
Astrovirus	Gastroenteritis, diarrhea
Norovirus, winter vomiting bug	Gastroenteritis, fever
SARS-CoV	SARS, gastroenteritis, respiratory disease
Torovirus	Gastroenteritis
Hepatitis E virus, HEV	Hepatitis E
Coxsackie A virus	Hand, foot, and mouth disease, paralysis, meningitis, fever, respiratory disease, myocarditis, heart anomalies
Echovirus	Meningitis, fever, respiratory disease, rash, gastroenteritis
Poliovirus	Polio
Hepatitis A virus, HAV	Hepatitis A
Rotavirus	Gastroenteritis

## Sobrevivência dos vírus na água:

Não há comportamento único.

Depende de vários fatores que incluem temperatura, exposição à luz, pH, salinidade, matéria orgânica, sólidos em suspensão e interfaces ar-água.

# CAPACIDADE DE RADIAÇÃO UV PARA INATIVAR VÍRUS INCLUINDO SARS COV-2

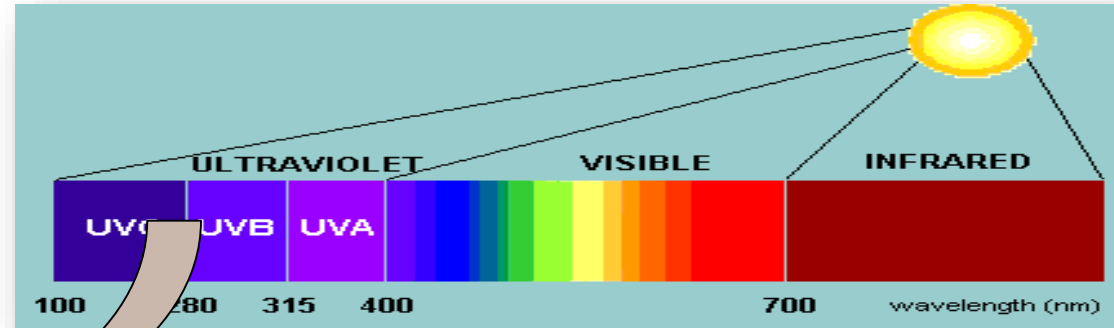
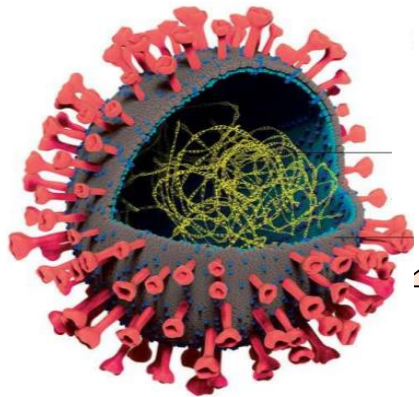
March 12, 2020 “Coronavirus Research Update” webcast, Water Research Foundation (WRF)

Dr. Mark Sobsey of the Gillings Schools of Global Public Health, University of North Carolina Chapel Hill commented on what is known about SARS-CoV-2 UV inactivation. Sobsey was a leading researcher on an EPA study of UV inactivation of adenovirus and other microbial species.

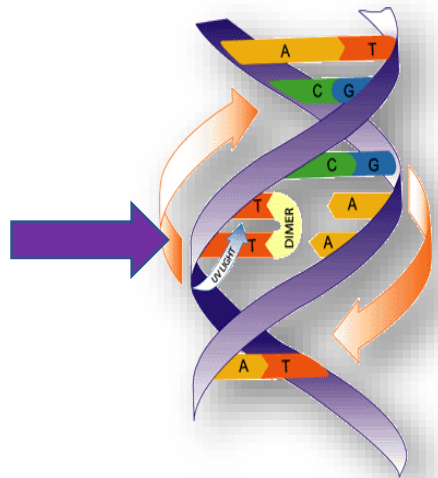
- “We actually have a little bit of data on UV inactivation of some other corona viruses, and again, they can be inactivated with UV. Data that is available suggests that they are relatively persistent to UV, probably somewhere in between adenoviruses and others that are less resistant than adenoviruses, but certainly not more than adenoviruses. Depending on the design criteria and dosing criteria for UV systems, current UV systems that can inactivate adenoviruses should be fine for a virus like this, based on the other corona viruses. UV should be effective.”



# INATIVAÇÃO DE MICRORGANISMOS POR RADIAÇÃO UV



- A luz UV inativa células danificando seu DNA.
- A inativação significa afetar todas as funções vitais, não apenas a reprodução senão a respiração e a assimilação de nutrientes.
- As lâmpadas de média pressão atuam no espectro germicida completo obtendo uma eficiência superior (200 – 320 nm).
- Inativam totalmente os mecanismos de reparação celular.



# *Desinfecção de água potável sem DBPs*

- Substitui a cloração (total ou parcialmente )
- Atlantium tem provado sua capacidade para inativar 4 log de Adenovirus com doses relativamente menores devido á utilização de lâmpadas de média pressão e seu eficiente sistema HOD (Hydro-Optic Disinfection)
- Seus sistemas encontram-se totalmente validados por EPA conseguindo atingir os 4 log de redução com uma dose validada bem menor do que a baixa pressão.
- EPA (USA States Environmental Protection Agency) desenvolveu a **Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)**.

Target Pathogens	Log Inactivation						
	0.5	1.0	1.5	2.0	2.5	3.0	3.5
<i>Cryptosporidium</i>	1.6	2.5	3.9	5.8	8.5	12	15
<i>Giardia</i>	1.5	2.1	3.0	5.2	7.7	11	15

# Validación EPA



February 13, 2007

Project File: ATLTM.001

To whom it may concern:

HydroQual Environmental Engineers and Scientists, P.C. provides this letter to confirm that validation testing has been satisfactorily completed for the Hydro Optic R-200 UV disinfection system (Serial Number 1019, Quality Control Document EC200-1019), developed and manufactured by Atlantium Technologies, Har Tuv Industrial Park, POB 11071, Israel 99100. The Validation Test Plan was developed to comply with the protocols specified by the United States Environmental Protection Agency UV Disinfection Guidance Manual (UVDGM, EPA 815-R-06-007 November 2006). Validation testing was conducted for the Hydro Optic R-200 in conformance with United States Regulations 40 CFR 141.720, and the Long Term 2 Enhanced Surface Water Treatment Rule, effective January 5, 2006, which require dose-delivery performance validation of UV reactors that are used for the disinfection of drinking waters.

HydroQual Engineers and Scientists, P.C. conducted all testing, sampling and analysis, data analysis and documentation, and will prepare the final validation report. The full-scale reactor testing was conducted at the UV Validation and Research Center of New York, Johnstown, NY. We certify that the Hydro Optic R200 was validated over a range of flow rates, feed water UV transmittances, and power levels to encompass a wide range of MS2 reduction equivalent doses (RED), in accordance with UV dose requirements that meet US Drinking Water Standards. The unit demonstrated MS2 log-inactivation greater than 5.0 and RED performance at levels greater than 120 mJ/cm<sup>2</sup>. Additionally, tests were conducted with a more sensitive T1 coliphage surrogate. The T1 tests demonstrated greater than 4-log reduction at low dose levels, indicating significant capability for low-dose protozoan inactivation. Direct actinometry testing with dyed-microspheres revealed excellent dose-distribution within the reactor, with evidence that there are no low-dose tracks over a wide range of operating conditions. Analysis of RED performance shown by dyed-microspheres demonstrated excellent correlation with bioassay results.

  
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December 31, 2008

Project File: ATLTM.002

To whom it may concern:

HydroQual Inc. provides this letter to confirm that validation testing has been satisfactorily completed for the RZ-163 in-line UV disinfection system, developed and manufactured by Atlantium Technologies, Har Tuv Industrial Park, POB 11071, Israel 99100. The Validation Test matrix was developed to comply with the protocols specified by the United States Environmental Protection Agency UV Disinfection Guidance Manual (UVDGM, EPA 815-R-06-007 November 2006). Validation testing was conducted for the RZ-163 in conformance with United States Regulations 40 CFR 141.720, and the Long Term 2 Enhanced Surface Water Treatment Rule, effective January 5, 2006, which require dose-delivery performance validation of UV reactors that are used for the disinfection of drinking waters.

HydroQual, Inc. conducted all testing, sampling and analysis, data analysis and documentation, and will prepare the final validation report. The full-scale reactor testing was conducted at the UV Validation and Research Center of New York, Johnstown, NY. We certify that the RZ-163 was validated with one and two lamp configurations over a range of flow rates, feed water UV transmittances, and power levels to encompass a wide range of MS2 and T1 coliphage reduction equivalent doses (RED), in accordance with UV dose requirements that meet US Drinking Water Standards. The unit demonstrated MS2 log-inactivation greater than 4.0 and RED performance at levels up to 95.6 mJ/cm<sup>2</sup>. The T1 tests demonstrated greater than 5-log reductions at low dose levels, indicating significant capability for protozoan inactivation at low doses. Direct measurement of dose-distribution is anticipated for early 2009, using dyed microspheres.

  
the UV Center  
om

HYDROQUAL, INC.  
MANTON, NEW JERSEY 07430 T: 201-529-5151 F: 201-529-5728 WWW.HYDROQUAL.COM



## ULTRAVIOLET DISINFECTION GUIDANCE MANUAL FOR THE FINAL LONG TERM 2 ENHANCED SURFACE WATER TREATMENT RULE

Office of Water (4607)  
EPA 815-R-06-007  
November 2006





# STATE OF NEW YORK DEPARTMENT OF HEALTH

Flanigan Square 547 River Street Troy, New York 12180-2216  
[www.health.ny.gov](http://www.health.ny.gov)



Nirav R. Shah, M.D., M.P.H.  
Commissioner

SENT VIA E-MAIL

February 25, 2011

Phyllis B. Posy  
Vice President, Strategic and Regulatory Affairs  
Atlantium Technologies Ltd.  
POB 11071, Industrial Park, Har Tuv 99100, Israel

Re: Acceptance of the Atlantium Hydro  
Optic Medium Pressure Ultra Violet  
Disinfection System-Model R200 DL/SL for  
4-log Virus Inactivation at the Village of  
Mohawk, Herkimer County.

Dear Ms. Posy,

In response to your letter of January 13, 2011 we are pleased to hereby accept the above referenced Ultraviolet Disinfection Unit for meeting the requirements of 4-log virus inactivation for the Village of Mohawk public water system in Herkimer County. The system will continue to require chlorination at a minimum to maintain a distribution system residual and also maintain the ability to chlorinate at current levels in the event that the UV system must be taken off line.

This acceptance is based on the significant full scale validation testing that your company has completed through HydroQual including validation using live adenovirus, MS-2, T-1, Q-Beta and Dyed Microspheres and HydroQual's third party certification of the unit's capability.


The unit must continue to be operated within the parameters for which it was validated and we support the upgrade of the system's software to meet the operational requirements for the 4 log virus inactivation. Our department will also consider the installation of this unit for other public water systems in New York State for the same treatment provided that the water entering the unit is similar in quality as the water used during the validation testing.

We know this has been a difficult and long process over many years and we appreciate your company's patience during our reviews of the validation report and scientific literature that was published as a result of the ground breaking work your company was pursuing. We appreciate your company's effort to ensure that the protection of public health remained the top priority throughout the process.

We look forward to meeting with your company staff at the facility, after the software upgrade, to go over the operational capabilities that will be added.

Please contact me if you have any questions at 518-402-7676 or by email at [mjtm07@health.state.ny.us](mailto:mjtm07@health.state.ny.us).

Sincerely,

  
Michael J. Monfysko, P.E.  
Design Section Chief  
Bureau of Water Supply Protection

Cc: NYSDOH- Mr. Van Patten/Mr. Swider/Mr. Croswell  
Mr. Paccione/Mr. Dziejwski/Ms. Young/Ms Thapa  
Mohawk (V)- Mayor Dibble  
HydroQual-Mr Scheible



# CASO DE ESTUDO: BIG SKY, MONTANA, EUA





# AMERICAN WATER WORKS ASSOCIATION (AWWA): PRÊMIO MELHOR QUALIDADE DA ÁGUA 2015



*Validado pela  
EPA para 4 log  
de redução em  
adenovírus*

Vazão = 2000 m<sup>3</sup>/h

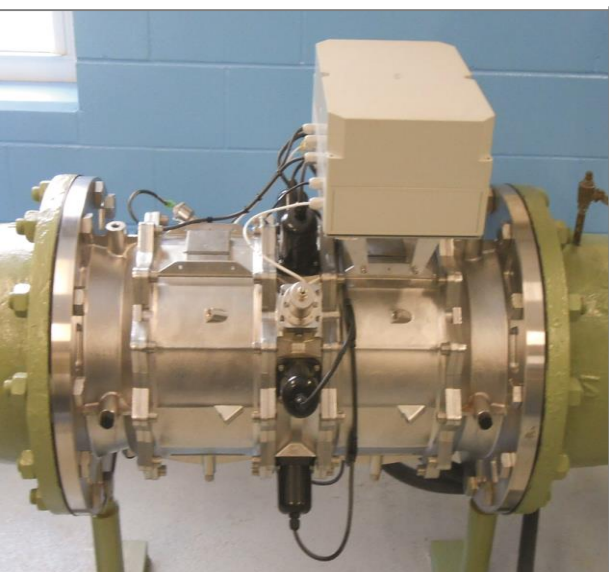
UVT > 95% (água subterrânea)

Sistema Atlantium: 3 x RZ 300 14, total 12 lâmpadas Média Pressão x 4,2 kw



## Case Study: Proteção Crypto/Giardia – Lunenburg MA

- Lunenburg Water District, Massachusetts decidiu segurar a proteção pelo cryptosporidium e giardia em todas suas fontes de abastecimento
- Decidiu a instalação dum sistema Atlantium UV RZ300-11 que permitiu atingir uma proteção total , com um design compacto de fácil integração com a planta existente (sem construções adicionais)





# Case Study: Hillsborough, NH – Excesso de DBPs

- A Cidade de Hillsborough, NH é abastecida de água a partir do reservatório Loon Pond de água superficial
- Alto conteúdo de matéria orgânica e requer uma alta dose de cloro para cumprir a exigência da EPA (4 log redução em vírus) o que conduz aos DBPs por acima dos limites admissíveis



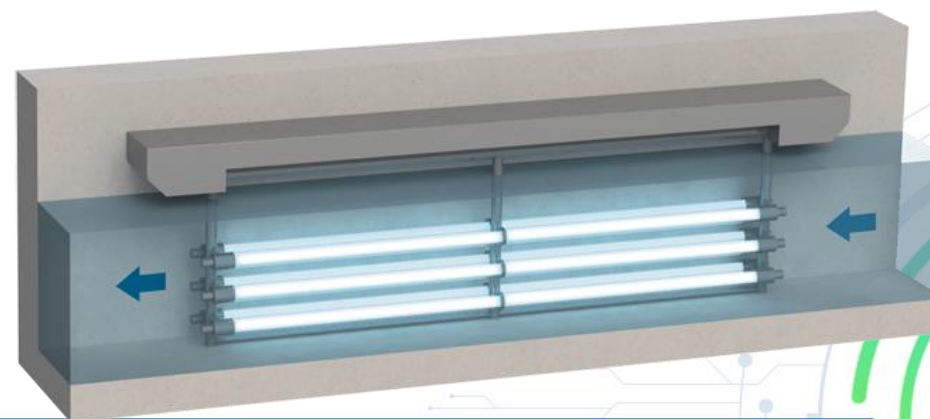


# DESINFECÇÃO DAS ÁGUAS RESIDUAIS

## Equipamentos UV de canal aberto



**Equipamento UV fechado**





# DESINFECÇÃO DE EFLUENTES MUNICIPAIS

## Vantagens:

- Significativa redução da Escherichia Coli e coliformes com baixa dose UV
- Operação contínua / fácil manutenção
- Substituição de cloro:
  - Evita o armazenamento e manuseio de um produto químico perigoso
  - Sem resíduos indesejáveis para as estações de tratamento localizadas águas abaixo da descarga
  - Água com alto teor de cloro não é apropriada em caso de reúso para irrigação
  - As obras civis são minimizadas pois não é necessária uma câmara de contato

**Retorno do Investimento por substituição da cloração por HOD UV :**

**2-3 anos !!**



<b>Análise de Viabilidade Substituição de cloro</b>				
<b>Bases:</b>				
Vazão media	m3/hr	2 x 266	532	
UVT estimada	%	> 70		
Nível desinfecção	> 5 log em E Coli / > 4 log em coliformes			
<b>Custos Operativos Cloração</b>				
<b>Hipoclorito de Sódio</b>				
	Dose cloro		5	gr/m3
	Solução hipoclorito 10%		0,05	lt/m3
	Volume diário efluente		12.768	<b>m3</b>
	Consumo diário hipoclorito		638	litros
	Consumo anual hipoclorito		233.016	litros
	Custo por litro		0,38	<b>US\$/ lt</b>
<b>Total</b>	<b>Custo Anual Hipoclorito</b>		<b>87381</b>	<b>US\$/ano</b>
<b>OPEX UV Atlantium 2 x RZB 300 12</b>				
<b>Lâmpadas</b>				
	Custo unitário (US\$ )	1000		
	Total 2 x 4 lâmpadas ( US\$)	8000		
	Vida útil (horas)	5000		
	Frequência de substituição (meses)	6,8		
	Custo Anual substituição lâmpadas		<b>14016</b>	<i>US\$/ano</i>
<b>Energia</b>				
	Potencia Instalada (kW)	33,6		
	Consumo para vazão media	25,2		
	Custo Energia MT (US\$/kwh)	0,08		
	Custo Anual Energia		<b>17418,2</b>	US\$/ano
<b>Total Opex UV</b>			<b>31434</b>	<b>US\$/ano</b>

# DIRETRIZES EPA PARA DESINFECÇÃO POR RADIAÇÃO UV

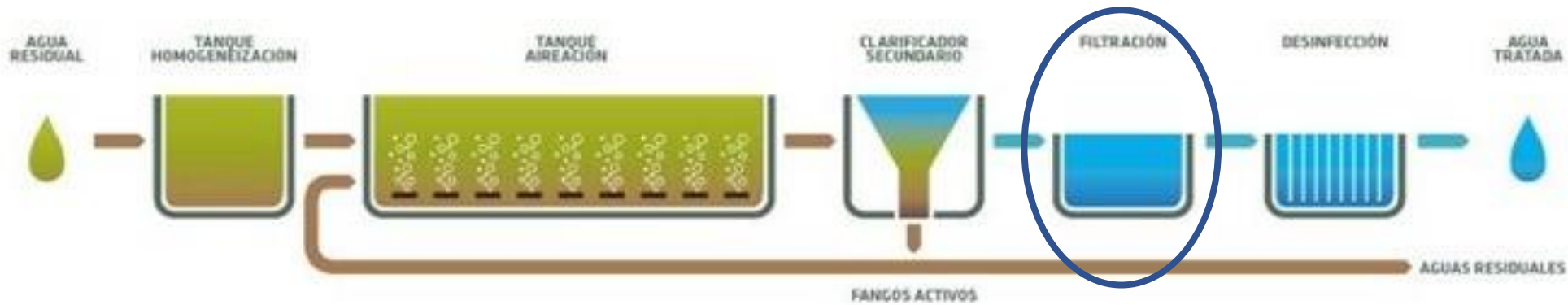
- A distribuição do tamanho das partículas pode afetar a eficácia da desinfecção UV
- **As partículas maiores que 20 micras de tamanho podem proteger os microrganismos da desinfecção pela luz UV.**
- A desinfecção ultravioleta é melhorada filtrando a água antes da desinfecção:
  - Redução de partículas grandes com microrganismos fixados e protegidos
  - Aumento da transmitância UV (UVT)
- Requerem-se por tanto um tratamento terciário efetivo

al., 1999). Particle size distribution may indicate the potential for UV disinfection efficiency, with smaller particles having less effect on UV efficiency than larger particles, as the shielding effect is reduced (Jolis et al., 2001); particles larger than 10 microns in size can shield microorganisms from disinfection by UV light. UV disinfection is enhanced by filtering water prior to disinfection, both by the reduction in particulates (a reduction in the number of large particles with embedded and shielded microorganisms) and by the





# DIAGRAMA DE PLANTA DE TRATAMENTO ABRANGENDO DESINFECÇÃO UV



# Exemplo para $> 1-2 \text{ m}^3/\text{seg}$





# Principais Aplicações da radiação UV pelo sistema HOD

## Soluciones para :

- Desinfecção de agua e efluentes
- Controle de bio-fouling : proteção de membranas RO (dessalinização , reuso)
- Oxidação Avançada para decomposição química: eliminação de contaminantes emergentes
- Decloração ( substituição FCA/MBSS)
- Controle de espécies invasoras ( ej. Mexilhão dourado )
- Ballast water





# Muito obrigado!

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