Genie in a bottle – Resolving pool chloramine exposures with UV systems

BCMSA Conference November 2011

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Agenda

- Chloramine production
- Health Effects
- Chloramine exposure factors
- New building syndrome – case study
- UV – options and mechanisms
- Trichloramine Exposures in local pools
- UV Pros and Cons
- Other trichloramine mitigation options

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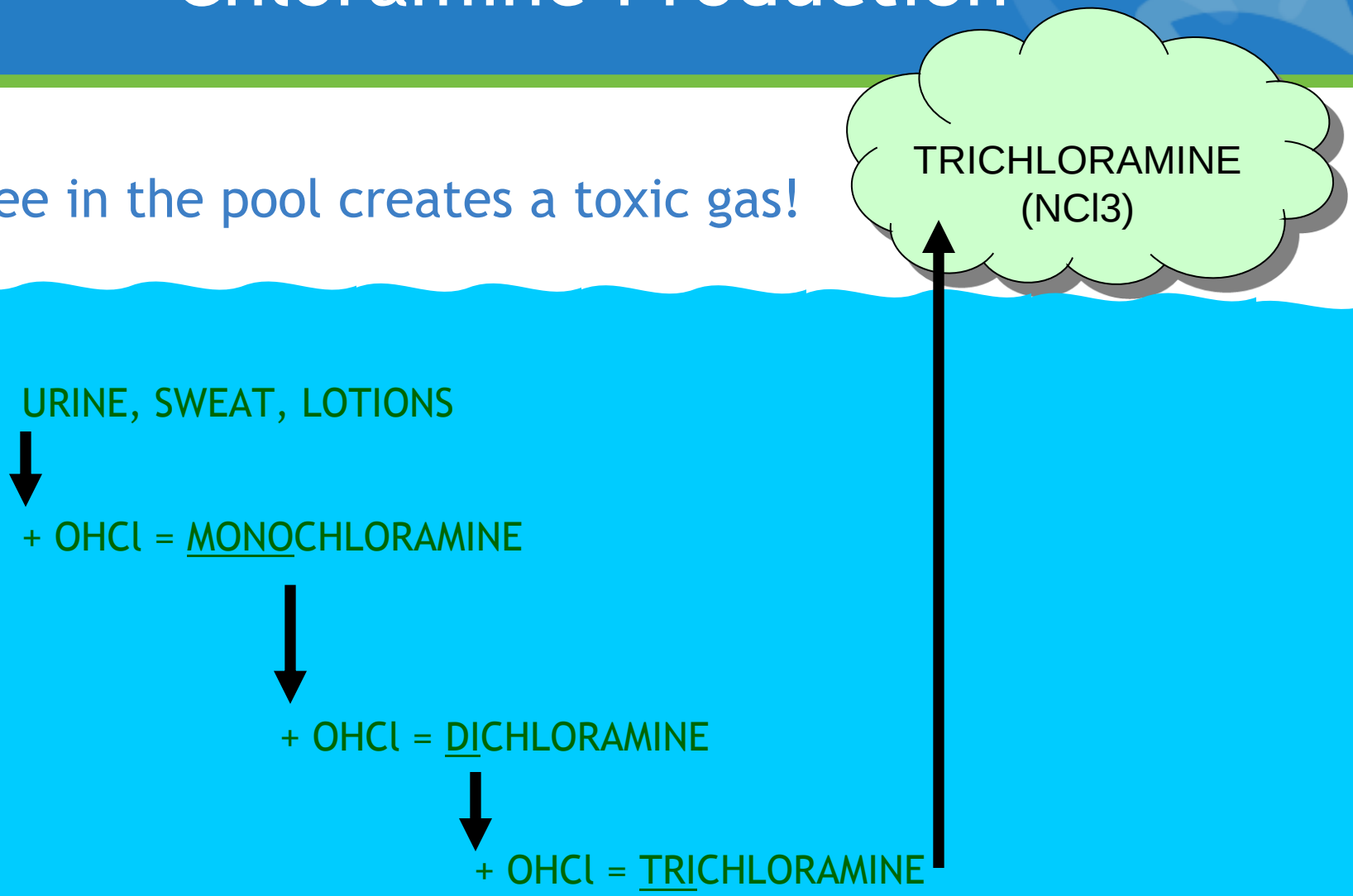
Chloramine Production

Pee in the pool creates a toxic gas!



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Chloramine Health Effects

- Mono and dichloramine in pool water and aerosol is linked to irritation of the eyes and respiratory tract.
- Trichloramine associated with:
  - Occupational asthma
  - Childhood asthma
  - Acute respiratory irritation
  - Irritation of eyes and respiratory tract

- Trichloramine has same irritancy as chlorine gas!

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Factors that Increase Chloramine Exposure

- Increasing water temperature
- Increased bather load
- Poor bather hygiene
- Increased water agitation
  - Water features especially spray features
  - Patron activities disturbing the water
- Reduced fresh air dilution
- Low (acidic) pH conditions

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Case study – Pool #5 - 2005

- The Usual New Building Syndrome?

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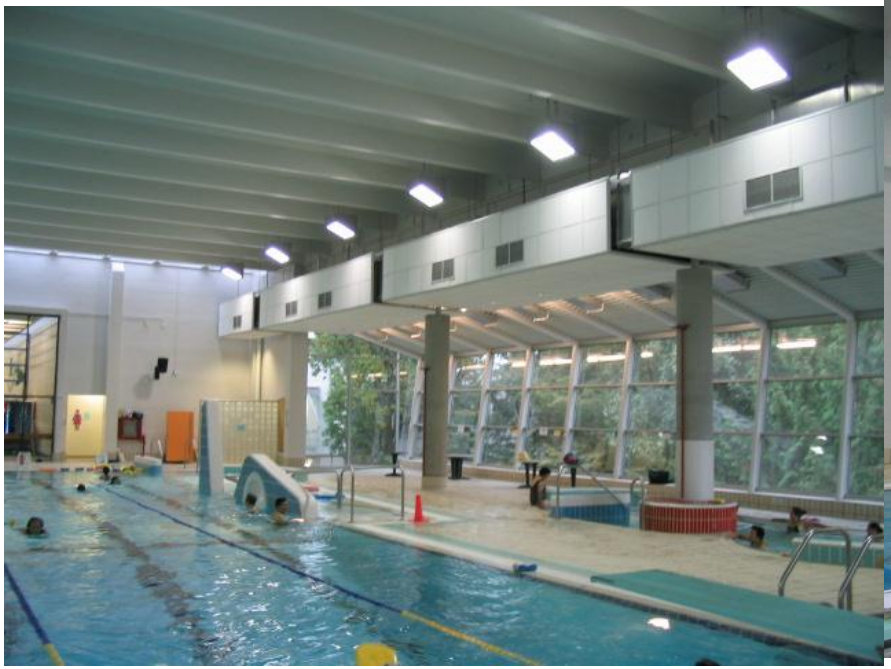

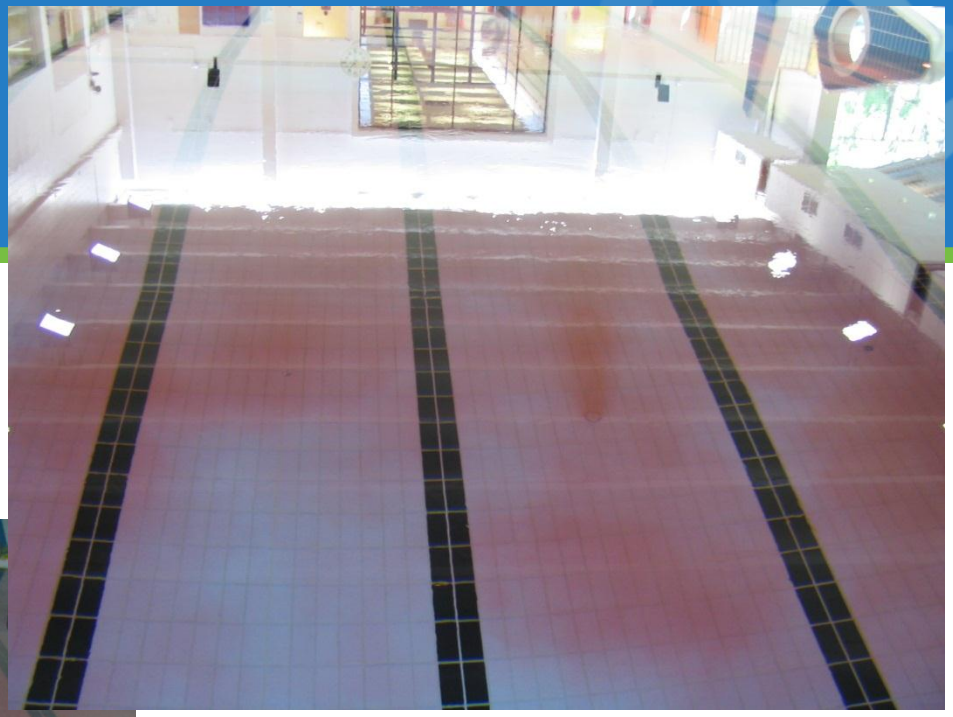

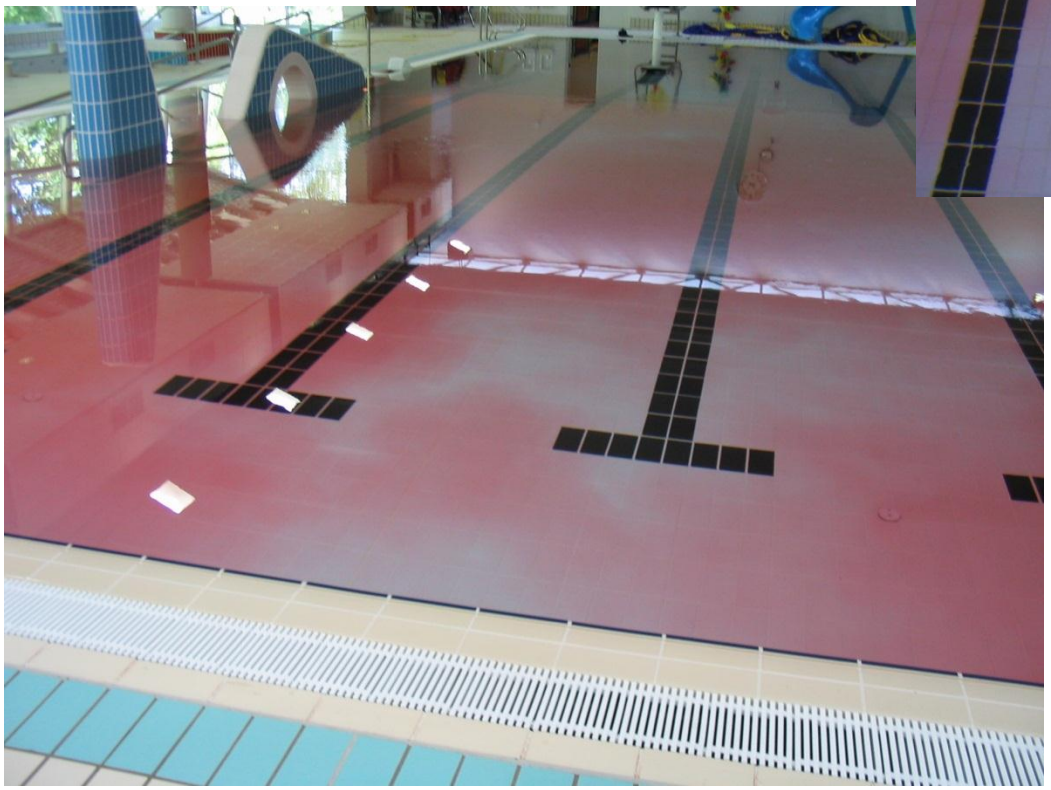

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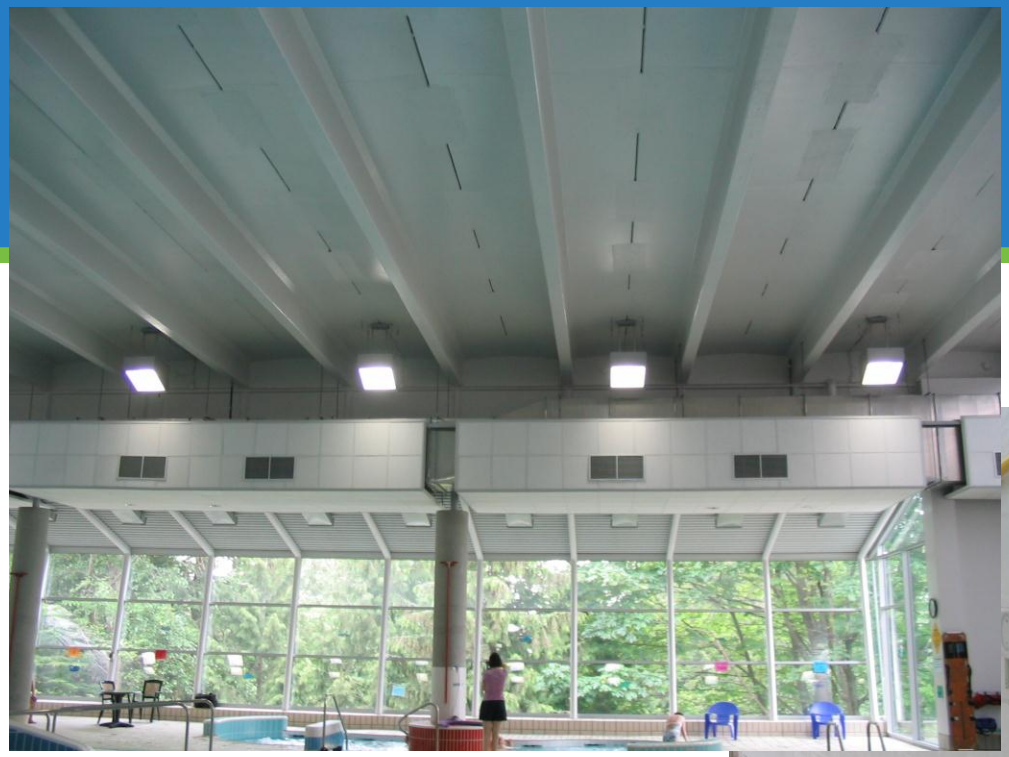

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Pool interventions

- Fixed obvious HVAC defects after rebuild, re-commissioning issues
- Changed air flow directions
- Studied water flow mixing
- Regular super chlorination
- High velocity fans to promote off gassing
- Emptying hot tub
- Increased dilution of hot tub and main pool
- Increased fresh air

Staff concerns persisted

Desperate measures…

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UV – Product options

- UV Low Pressure vs. Medium pressure lamps, facts or fiction?
- Informed decision (2006)
  - Mining the Internet
  - Manufacturers
  - Link with UBC
- Chloramine destruction requires 60 mJ/cm2 dose (intensity)
- Chloramines destroyed at different wavelengths
- Focused on hot tubs
- Medium pressure UV system is the right choice for pools

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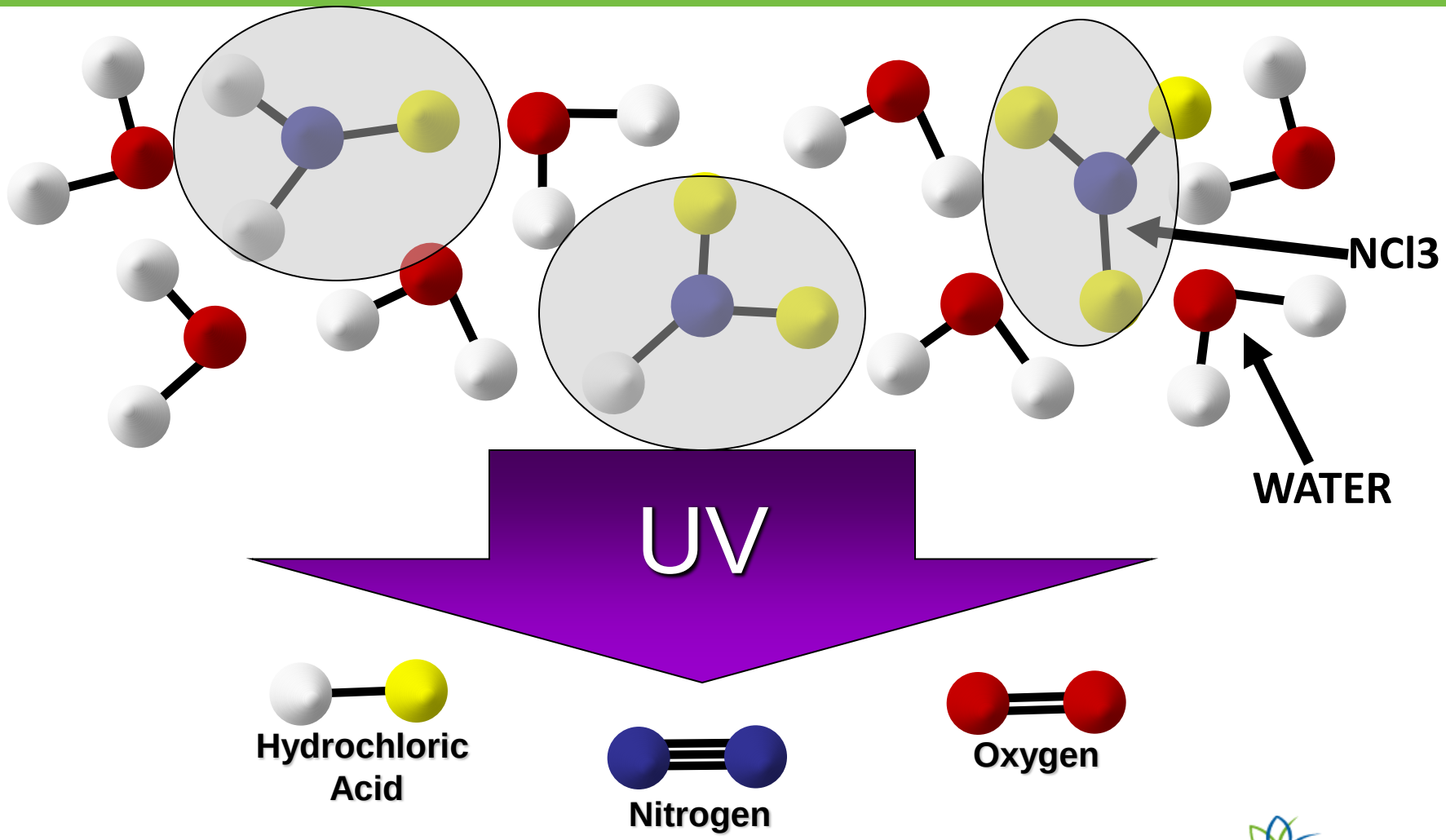
UV – Photochemical destruction of chloramines to less hazardous chemicals



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Ultra Violet (UV) wavelength spectrum and relative output comparisons for low pressure and medium pressure UV lamps

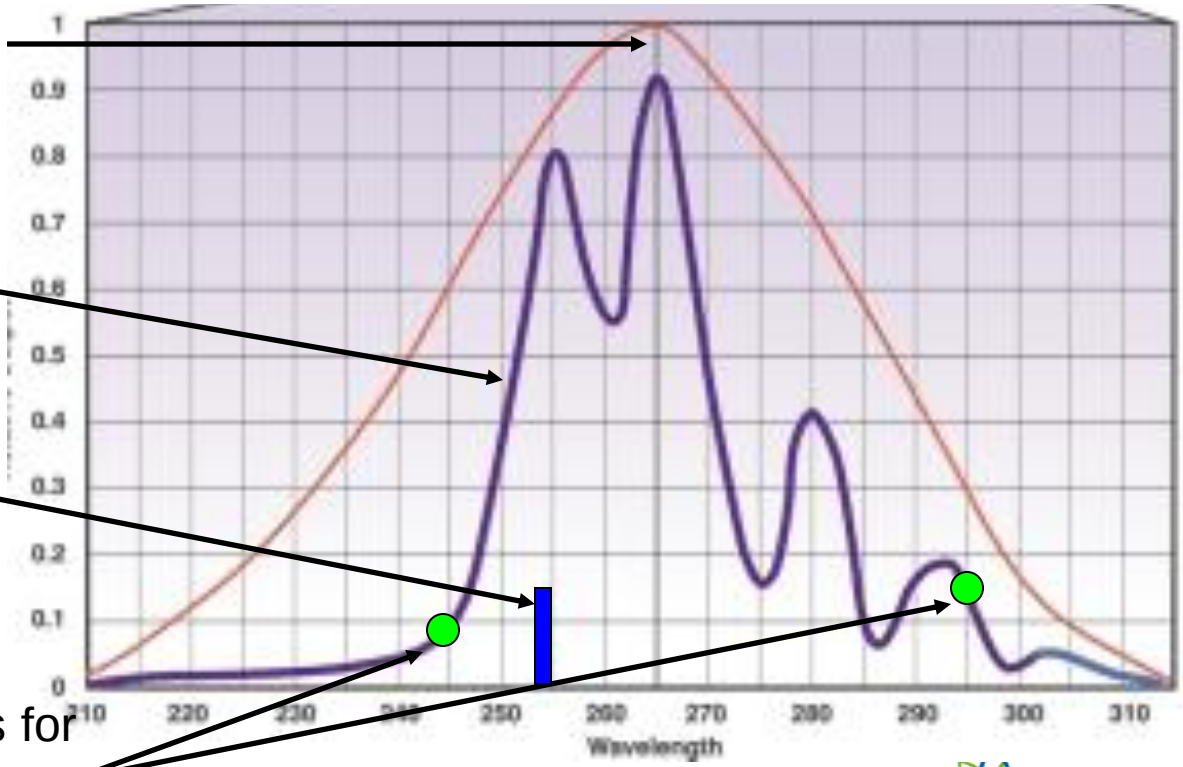
Peak DNA destruction by UV

Medium pressure lamp

Low pressure lamp

(potable water treatment)

Peak destruction wavelengths for mono and dichloramine



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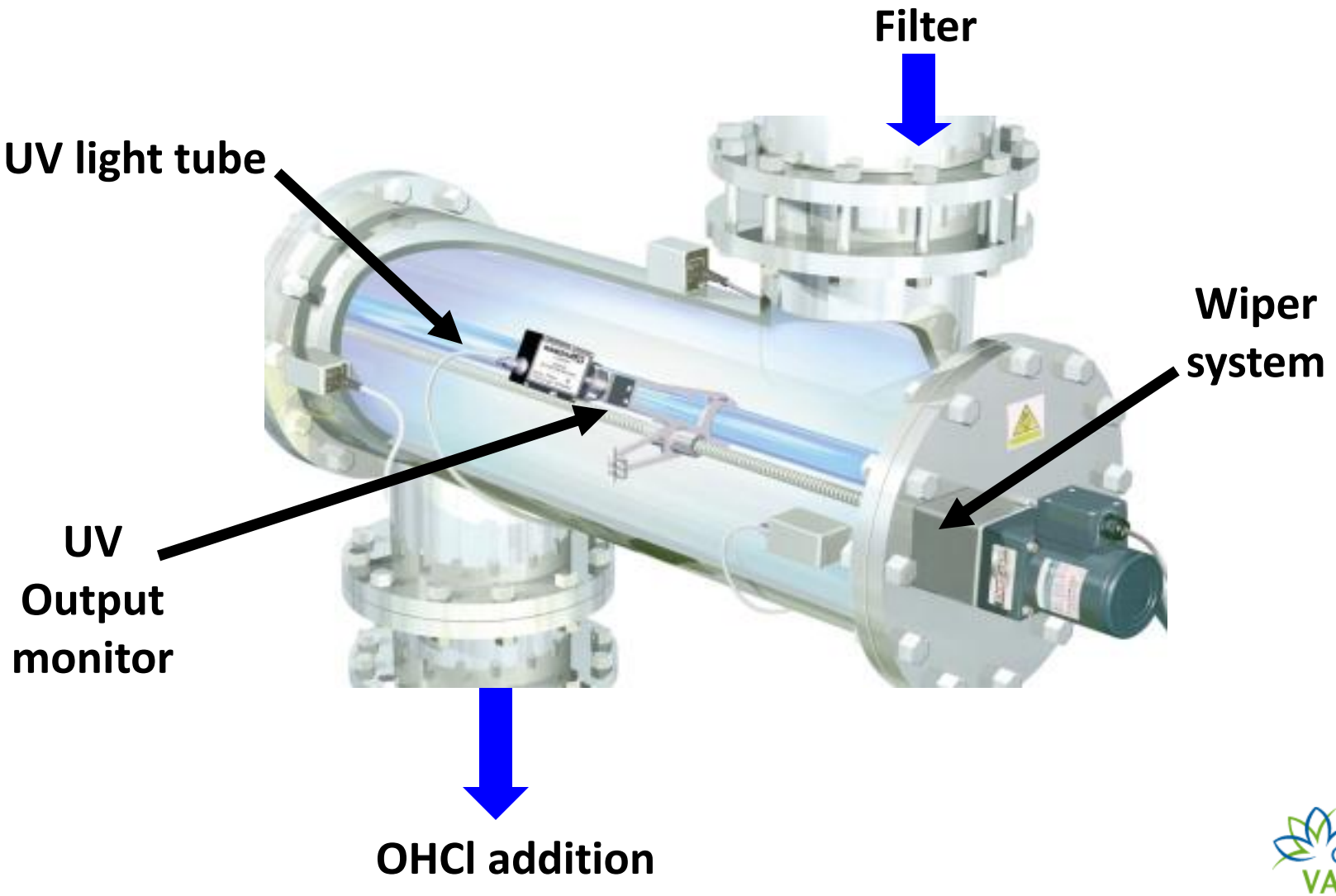
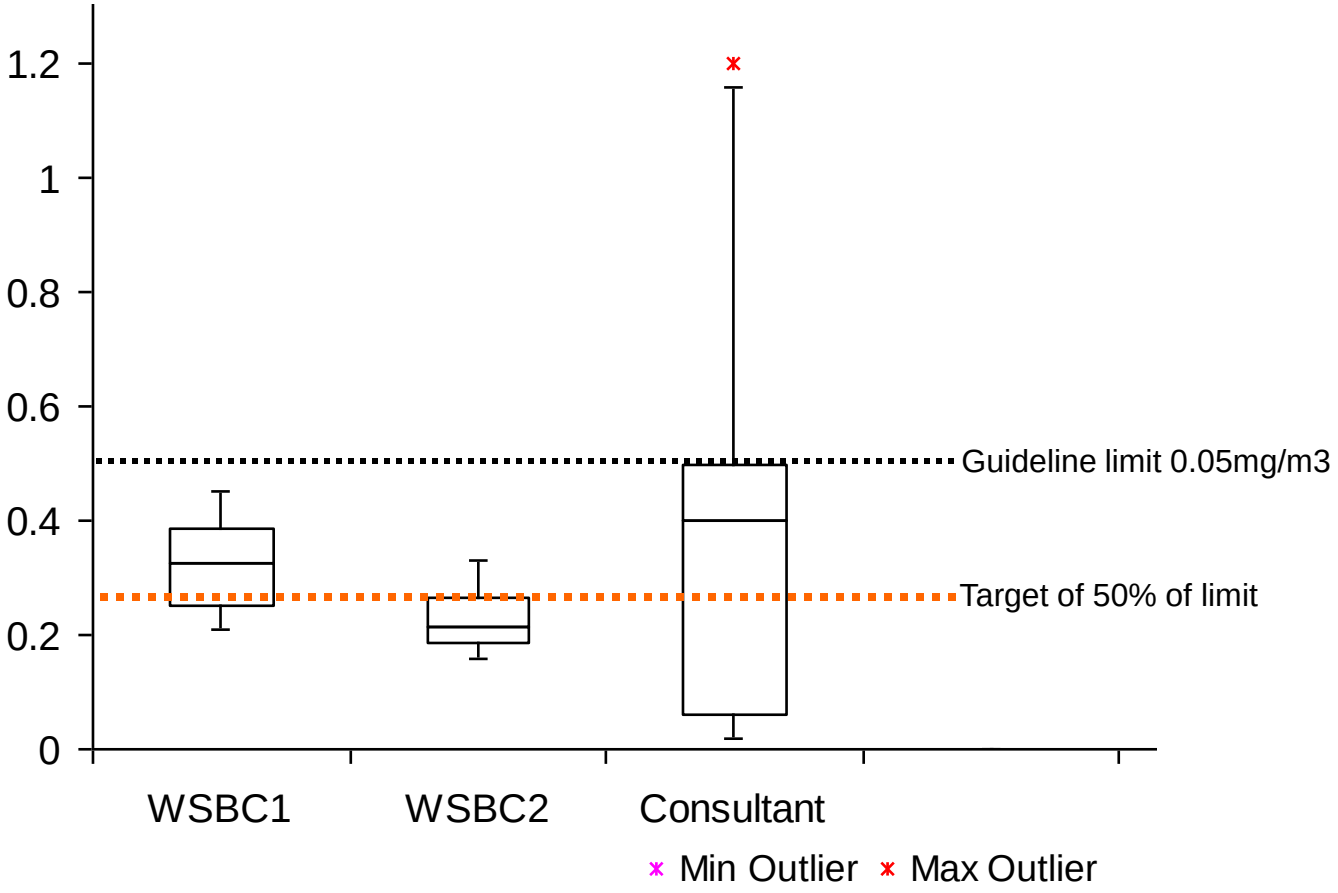
Construction of UV lamp and water flow



Airborne trichloramine levels in BC pools



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Air sampling results – WSBC Study 2

	Trichloramine	Mono + Dichloramine
	mg/m^3	
High up	0.17	0.046
Breathing zone	0.27	0.051
Floor / water level	0.24	0.042
Average (n=9)	0.23	0.045 (16%)

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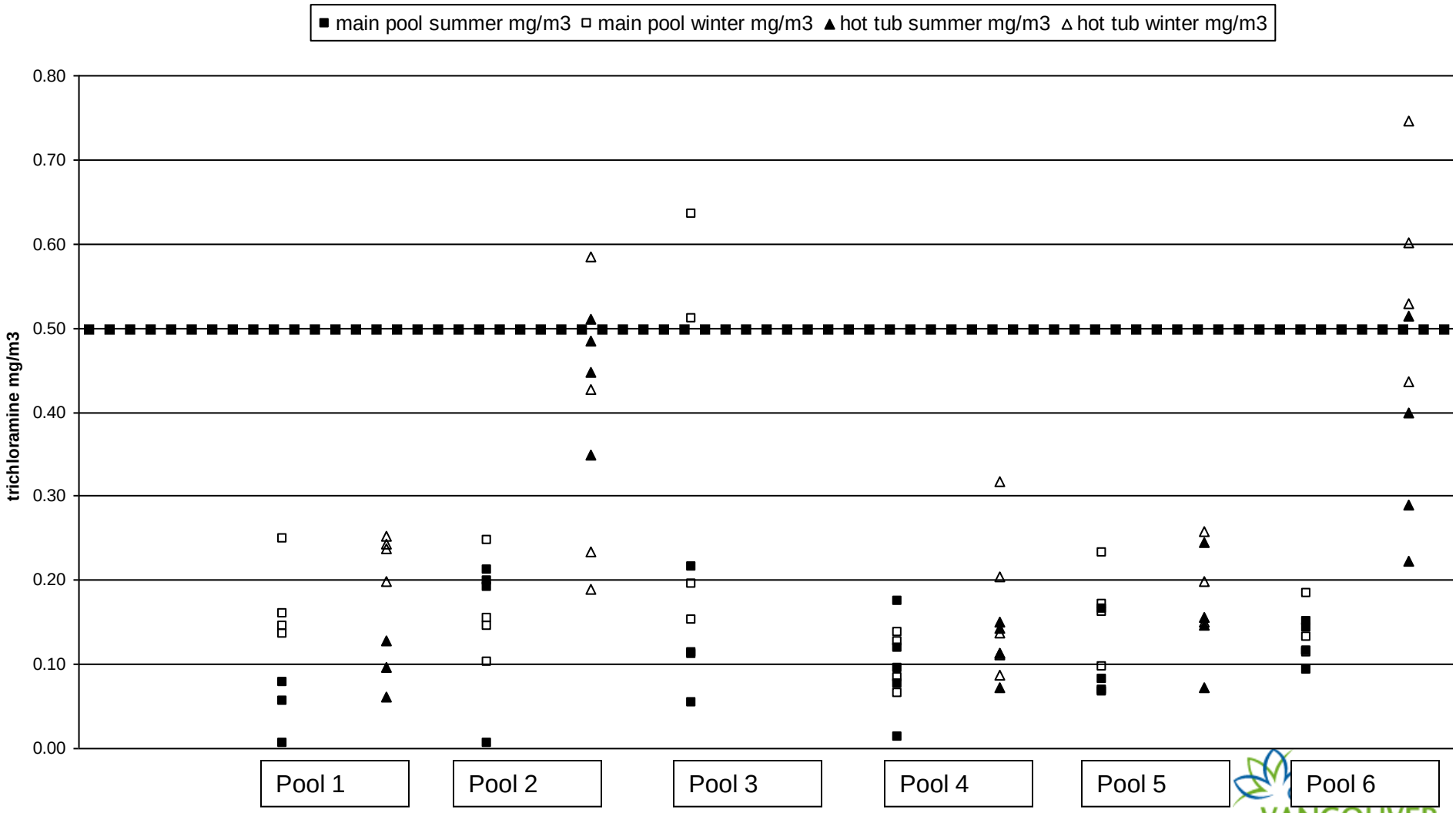
Airborne trichloramine levels by season and pool type at different pools



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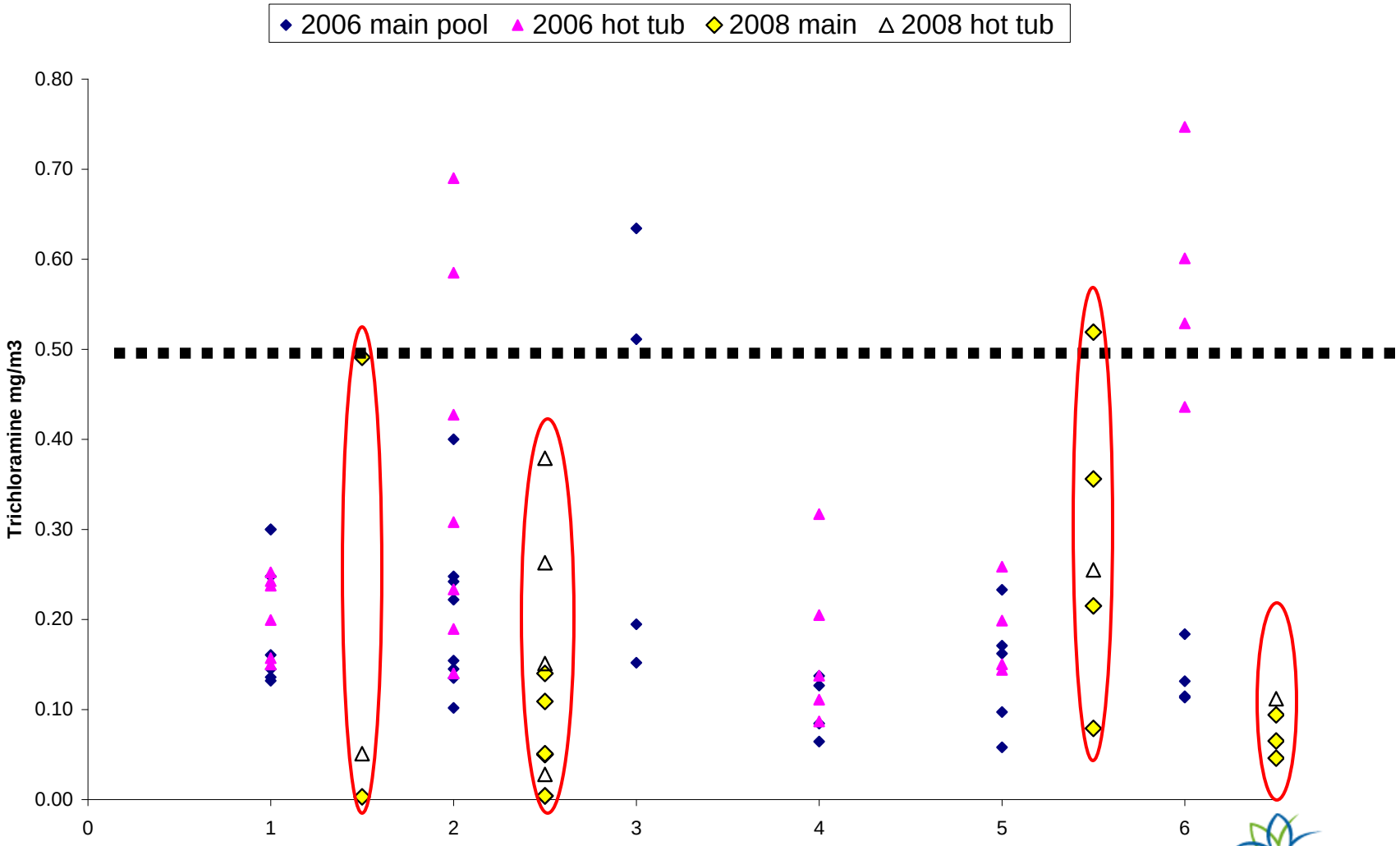
Trichloramine levels before and after UV installations



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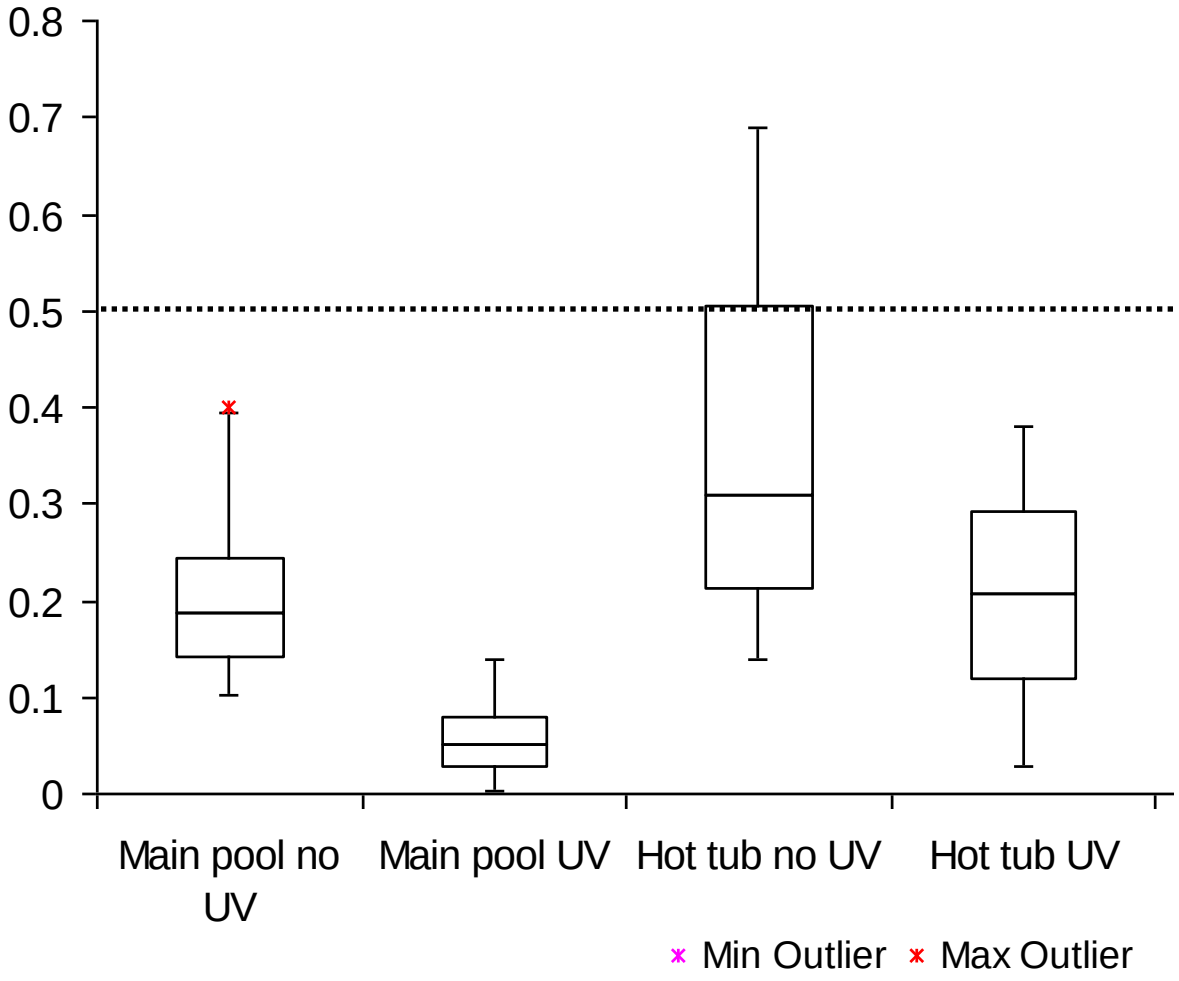
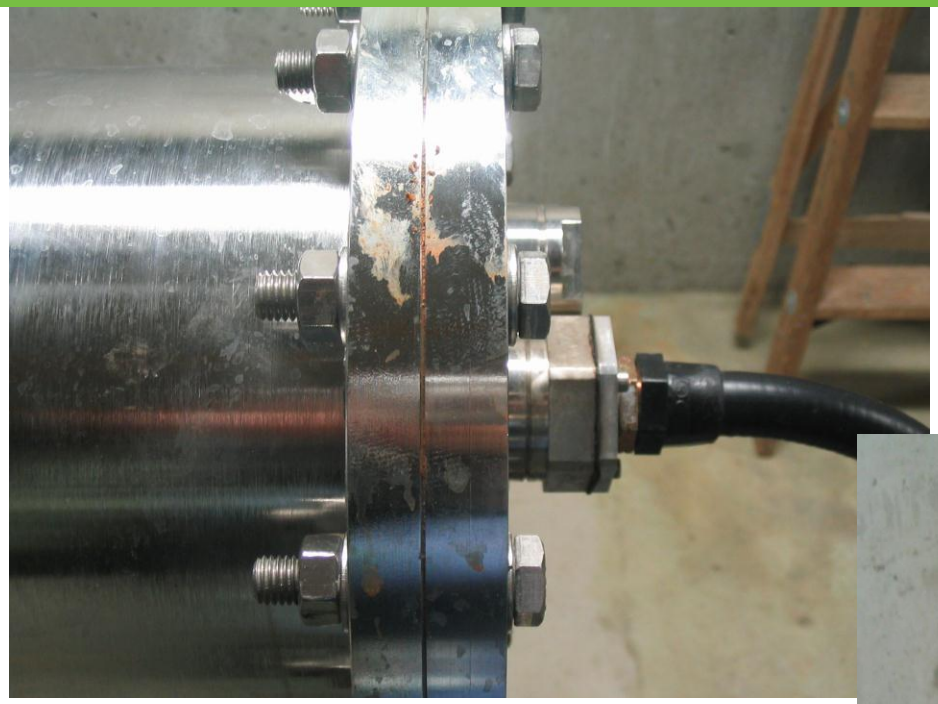
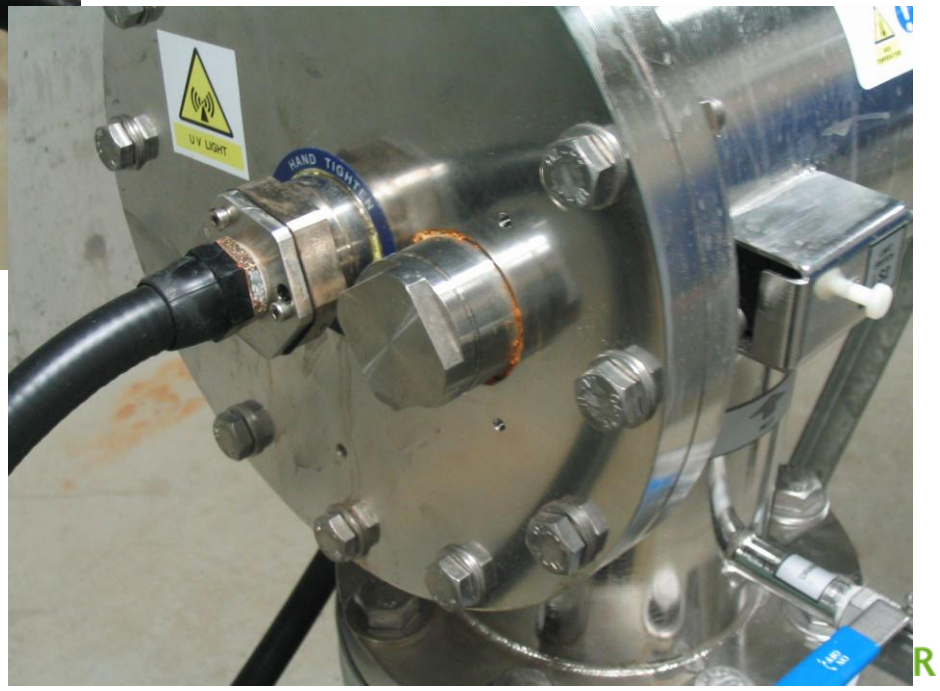
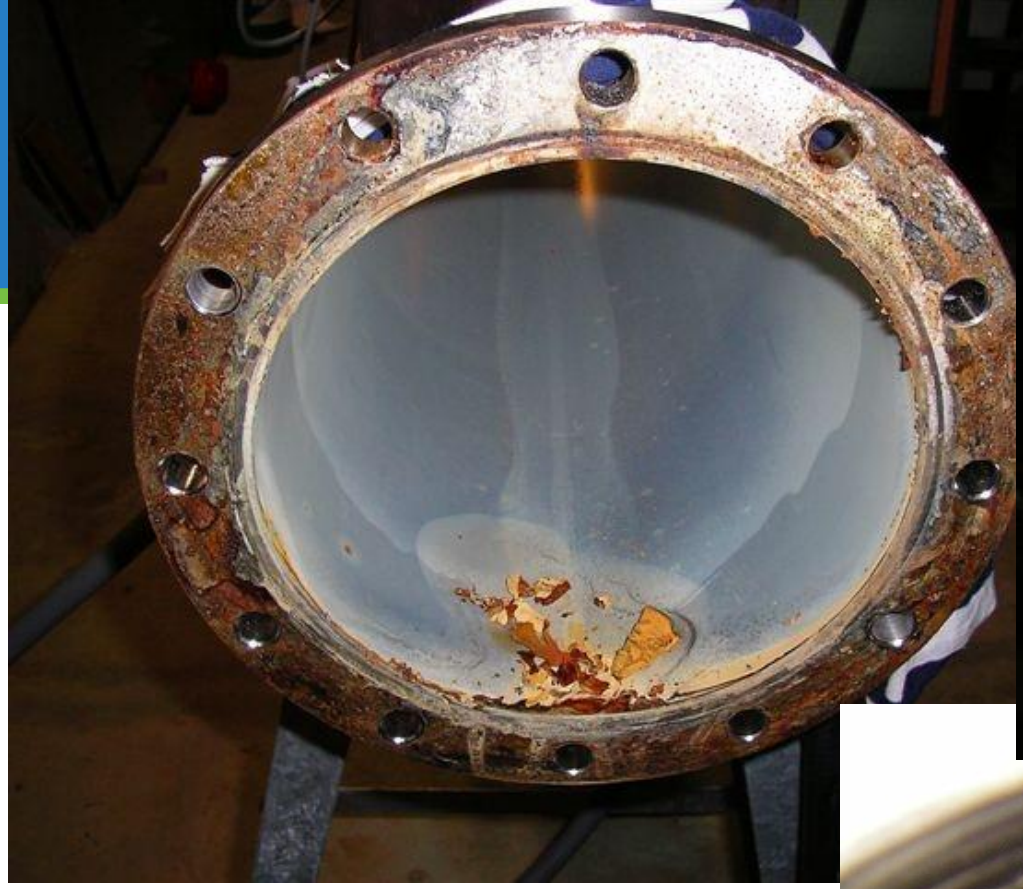
Trichloramine levels before and after UV installations, trichloramine declined after system installation

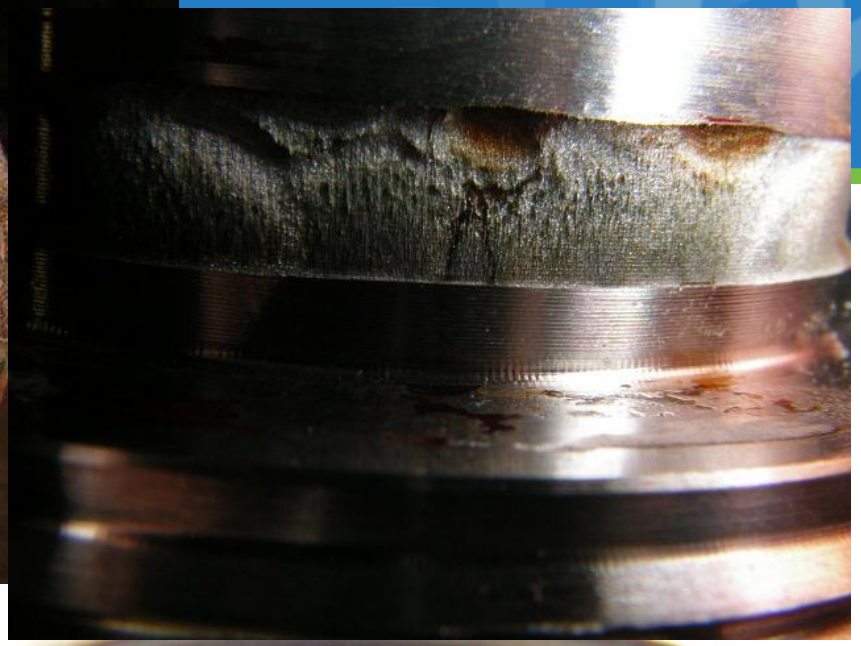


UV pros and cons









CoV UV Experience so far

Pros

- Immediate subjective improvements in IAQ
- Quantitative trichloramine results in air generally improve
- Installation easy
- Relatively cheap solution
- Easy maintenance –replacing a light every 9 to 12 months
- Reduced super chlorination and dilution

Cons

- Crevice corrosion, higher than expected maintenance costs
- Don’t turn the lights off
- Increased chemical usage, chlorine and sodium bicarbonate

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Literature comments for UV

- Chloramine reduction in water up to 80% and typically <0.2 mg/l
- Airborne trichloramine reduced by 30%
- Water consumption reduced by 30 to 60% (Europe)
- Disinfection by products generally reduced, except for chloroform.

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Mitigation – Increase HVAC fresh air

Pros

- NCl_3 not recirculated in the air to build up in pool

Cons

- Expensive and does not support sustainability goals
- Does not treat NCl_3 source in the hot tub, recreation pool

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Mitigation – Minimize water features aerating pool water

Pros

- Minimizes NCl_3 off gas from pool water (generally slow, 20 to 144 hrs)

Cons

- Patron experience diminished
- Not utilizing capital improvements
- Does not address removing source Mono or Dichloramines

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Mitigation – Increase dilution of hot tubs and recreation pools

Pros

- Mono and dichloramine levels diluted
- May be effective for hot tubs with small water volume

Cons

- Does not support sustainability goals
- Increased water and heating costs

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Mitigation – UV system, must be a medium pressure system

Pros

- Evidence of water and air quality improvements
- Retrofit old pools easily and at less cost than ozone
- Removes mono and di chloramine.

Cons

- Not as simple as turning on a light
- Increase in chemical usage

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Mitigation – Surge tank aeration system

Pros

- Relatively inexpensive to install and maintain
- Potential reductions of 60% NCl_3 in air

Cons

- Unproven approach
- Trial and error by staff, no off the shelf product
- Does not remove mono and dichloramine precursors or other DBPs

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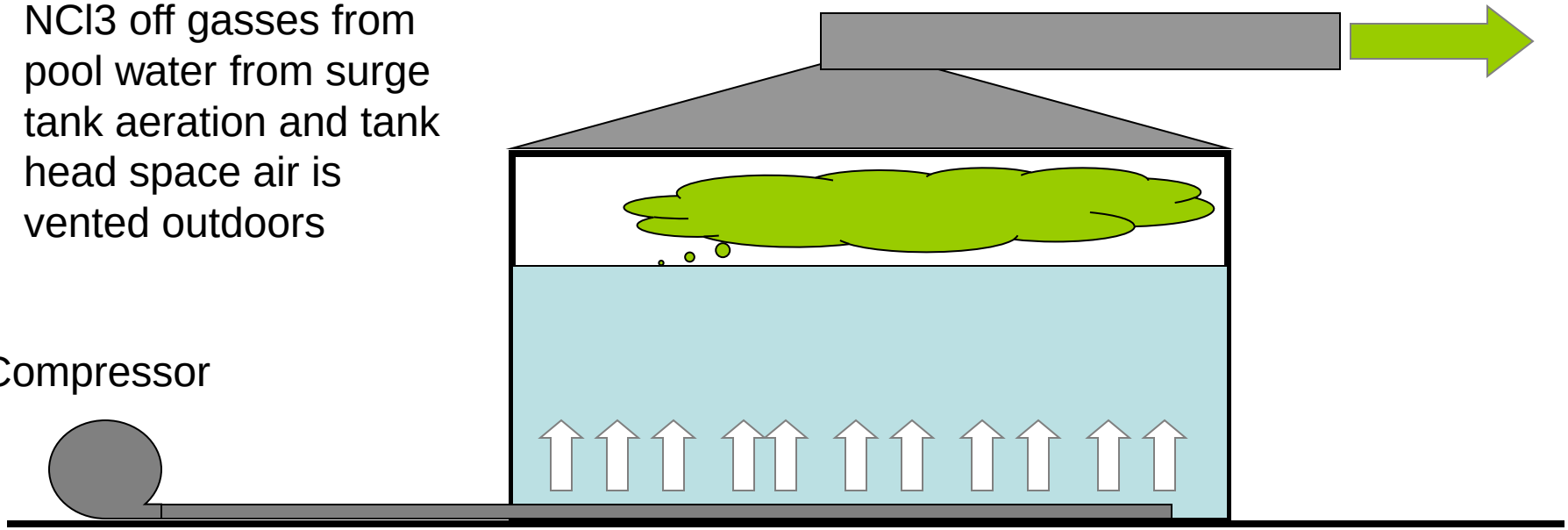
Surge tank aeration system diagram

NCl3 off gasses from pool water from surge tank aeration and tank head space air is vented outdoors



Cheaper alternative to a UV system

- Google highlight for paper on how to build a trichloramine stripping system for a surge tank

Presentation at the Budapest Conference 10 - 11 March 2005

Effects of nitrogen trichloride stripping on air quality in indoor swimming pools

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Questions

- (We still have lots!)

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