UV•Xchange Frequently Asked Questions

How does UV work as an antifoulant?

In general terms the progression of marine biofouling occurs in five stages, summarized as:

1. A primary film is developed through the adsorption of macromolecules (both organic and inorganic) immediately following surface immersion.
2. Microbial cells are transported and immobilized on the surface.
3. A microbial film is then produced through the consolidation of extracellular polymer production by the attached bacteria.
4. Development of higher order communities through the attachment of multicellular species to the surface: microalgae, debris, sediments.
5. Adhesion of larger marine invertebrates such as barnacles, mussels, etc.

The driving mechanism behind the progression of each of these stages is cellular replication of colonizing cells - a process susceptible to disruption by UV. Much of the radiation present in the UVC band (200 – 280 nm) is absorbed by DNA nucleotides, which damages them and arrests cellular division. This prevents the replication of early-stage adsorbing cells such as biofilms and other colonizers, precluding progression to late-stage higher order communities and ultimately resulting in the complete arrest of biofouling development.

What are the power requirements?

UV•Xchange is available in a number of different configurations depending on sensor payload and application. At the fundamental level, UV•Xchange is comprised of a base titanium stem with UV-source modules stacked on top. The base stem is common to all configurations while the quantity and power of the UV-source modules varies by application. For this reason, power requirements are application dependant.

The following table provides a breakdown of current draw by UV•Xchange component, as well as a summary of typical configurations.

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Breakdown by Individual Component

Component	Description	Typical Current draw (@9-36 VDC supplied to instrument)
Titanium base stem	Common to all configurations	22 mA
High power UV module	Identified by '3mW' label on side of module. This refers to the optical power of the module.	80 mA
Low power UV module	Identified by '.5mW' label on side of module. This refers to the optical power of the module.	30 mA

Standard Configurations

XCH-UV-V	UV•Xchange with one high power upward facing module.	102 mA (80 mA + 22 mA)
XCH-UV-LLLV	UV•Xchange with three lowe power sideways facing modules and one high power upward facing module.	192 mA (80 mA + 3x30mA + 22 mA = 192 mA)
XCH-UV-BBBV	UV•Xchange with three blank modules and a high power upward facing module.	102 mA (80 mA + 22 mA)

These power specifications refer specifically to UV•Xchange and represent current draw in addition to instrument specifications. Total peak current draw with UV•Xchange is therefore calculated as follows:

Total peak current draw = (instrument current draw) + (UV•Xchange current draw)

Refer to the relevant instrument specification sheet for instrument power draw.

Can I use UV•Xchange with non-AML sensors?

Yes: While UV•Xchange is compatible with all AML sensors, it is also suitable for use with a wide range of non-AML sensors. Contact AML Oceanographic for further information.

What are the safety implications of UVC?

In instances of overexposure, UVC has the potential to cause to burns to the skin akin to a sunburn. It may also cause painful inflammation of the eyes referred to as photokeratitis, an effect better known as welder's arc flash or snow blindness. In all but the most extreme cases however, the symptoms of both of these injuries are temporary and short lived: typically a few days.

UVC exposure limits are not governed by OSHA regulations, however standards set out by the American Conference of Government Industrial Hygienists (ACGIH) have been adopted in both the United States of America and the United Kingdom Health and Safety Executive. These standards provided Threshold Limit Values (TLV) for UVC irradiation. These TLVs are considered conservative in the case of skin exposure, and satisfactory for exposure of the eyes.

The optical power of UV•Xchange is low. When applying ACGIH standards to UV•Xchange, a target surface would have to be continuously irradiated for over 5 minutes at a range of 7 cm to exceed the TLV.

To further reduce the risk, AML Oceanographic recommends users protect any exposed skin and wear appropriate eye protection when working in close proximity to an operating UV•Xchange.

What should the duty cycle be?

Selecting the correct duty cycle is key to optimizing the effectiveness of the product while minimizing power consumption. High duty cycles (ie. 50% or greater) provide more bio-fouling protection for deployments in environments with aggressive fouling, but with a penalty in power consumption. Alternatively, less aggressive fouling environments may warrant a reduced duty cycle to reduce power consumption. It is not possible to recommend one duty cycle that is appropriate for all deployments due the wide array of factors such as available power, aggressiveness of fouling in the environment, water turbidity, seasonal variation, depth, etc.

With these factors in mind, **AML Oceanographic generally recommends a duty cycle of 50%, consisting of 20 minutes on and 20 minutes off**. This duty cycle has been shown to be effective in aggressive bio-fouling environments: tropical locations, shallow depth, high insolation deployments, etc. Increasing or decreasing the duty cycle may be appropriate however, based on the discretion of the user.

What is the effective distance and surface area?

Each UV module of UV•Xchange emits light in a broad cone of 70 degrees in sea water. UV intensity diminishes with an increase in distance from the source, however the area of coverage increases due to the beam angle. A minimum irradiance of 10 $\mu W/cm^2$ at a 20 minute on - 20 minute off duty cycle is recommended to keep a target surface clear of biofouling. For low power modules (0.5 mW optical power), this implies a maximum distance of approximately 7 cm from the centre axis of UV•Xchange to the target surface, resulting in a circular protected area approximately 10 cm in diameter. For high power modules (3 mW optical power), a maximum distance of approximately 10 cm is recommended. This results in a protected area approximately 14 cm in diameter.

What is the lifetime of the UV source?

The UV sources are rated to 5,000 hrs of continuous operation, at which time output of the sources will diminish to 50% of their original intensity. At a 50% duty cycle, this allows UV•Xchange to remain effective for more than 13 months of continuous operation. In some cases, deployment lengths may be increased beyond 13 months by increasing the duty cycle after the specified lifetime to compensate for the reduction in optical output.

What is depth rating?

The depth rating for UV•Xchange is 500m.

Will UV•Xchange work in '*x*' environment?

Generally speaking, yes. AML Oceanographic has successfully tested UV•Xchange in a wide range of environments and applications. The functional mechanism of UV•xchange is effective on all single and multi-cell organisms so applications are not limited by species.

Is UV•Xchange compatible with third party equipment?

UV•Xchange will prevent marine growth on virtually any submerged surface including cameras, structures, lights etc. If the equipment is UV compatible, it can be protected by UV•Xchange.

Will this work on legacy •Xchange AML instruments?

Legacy X-series instruments are not compatible with UV•Xchange as endcap, hardware and firmware upgrades are required.