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Department of Homeland Security
United States Coast Guard

Your letter d.d.	Your reference	Number	Our refference	datum
n.a.	n.a.	+31 (0)23 517 5962		11-01-16

subject
Performance Monitoring of BWMS

To Whom it May Concern,

Motivated by the "Coast Guard decision on use of the Most Probable Number method." from 14 December 2015 in the Coast Guard Maritime Commons I would like to draw the attention to some issues that are in my opinion of importance for the ballast water management.
During the last 20 years I have been working in the field of drinking water quality control and my experience and involvement in various projects is dominated by research in microbial ecology of drinking water. Therefore, I feel that my opinion about recent decisions on analytical approaches in ballast water management might be helpful.
The main goal of ballast water management is to protect indigenous biological diversity in the marine environment by preventing the spreading of the harmful aquatic organisms from one region to another. Disinfection of ballast water is an important treatment step that is designed to reach this goal. In the recent decision Coast Guard announced that MPN-based methods are not suitable for evaluation of the efficiency of ballast water treatment systems because the MPN-based methods are not equivalent to "live/dead" staining methods.
In drinking water practice, disinfection is usually achieved by post chlorination, but the disadvantages of chlorination are well documented and recognized. In various countries, alternatives to chlorination are preferably applied in drinking water treatment in order to avoid consumer exposure to harmful disinfection byproducts and create false safety.

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In the Netherlands, most commonly applied alternatives to chlorination are oxidation by ozone, slow sand filtration and UV irradiation. The performance of disinfection processes and safety of drinking water is evaluated through a quantitative microbial risk assessment (QMRA) that includes three major elements:

i) The concentration level of the index (pathogenic) organisms in the source,

ii) The reduction of the index organisms during the treatment and

iii) Consumption of drinking water.

The first two elements, the concentration level of organisms in the source water and their reduction during the treatment are both determined by standard methods of microbiology that are based on cultivation in most of the cases. Although alternative, culture independent methods for quantification of various microorganisms in water are available, uncertainties related to interpretation of results that are based solely on the detection of the presence or activity of specific molecules and markers still hamper the application of these methods in drinking water practice.

The inactivation of microorganisms by UV irradiation is based on damage to nucleic acids. The damage of nucleic acid by UV irradiation does not immediately cause cell death and metabolic activity generally continues for some time after the exposure. However, cells with damaged nucleic acid can not reproduce and, although still active, these cells generally do not have the ability to invade a host. The UV dose that would be required to immediately kill a cell is much higher and would thus require much higher energy usage. It is questionable whether a higher energy usage, and consequently higher environmental and economical burden, could be justified when lower doses are sufficient to prevent replication and propagation of treated cells in a new environment.

The "live/dead" staining methods, prescribed by the USCG are suitable to test the systems that are designed to destroy cellular structures or render metabolic activity. Although highly conservative, this approach does not exclude risks due to various drawbacks of "live/dead" staining methods that don't actually give definitive "live/dead" status. They are commonly referred to as "live/dead" stains, but they actually test membrane integrity and/or enzyme activity.

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It is likely that cells will die if membrane integrity and enzyme activity are compromised, but cell death is not exclusively related to these functional elements. When the UV light damages the nucleic acids, cell membrane remains intact and enzymatic activity continues for some time, but the ability of cell to replicate is lost resulting in eventual cell death.

However, methods based on membrane integrity and enzymatic activity are not able to properly evaluate the effectiveness of UV irradiation in rendering the organisms to replicate and invade. As a consequence, ballast water treated by UV and evaluated by "live/dead" staining method will falsely not meet the prescribed requirements which can lead to unjust exclusion of UV technology for ballast water treatment. The evaluation of the efficacy of UV treatment of ballast water requires different analytical approach that will be able to demonstrate the efficacy of a treatment to render the ability of an organism to reproduce in a new environment. MPN-based assays are available and represent a better analytical approach to test the UV-based ballast water management systems.

The inclusion of MPN-based assays in regulation for the assessment of ballast water management systems would ensure that benefits of environmentally responsible and sustainable UV-based methods remain available for the management of ballast water. By means of this letter, I would like to invite you to consider redefining the criteria for analytical approaches in testing the efficiency of ballast water management systems so that new criteria would also be suitable for UV based treatment.

If you have specific questions, please do not hesitate to contact me.

Sincerely,

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