

STANDARD OPERATING PROCEDURE Procedure for Determining Percent Transmittance (%T) of Light in Water at 254 nm

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RECORD OF AMENDMENTS:

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STANDARD OPERATING PROCEDURE

Procedure for Determining Percent Transmittance (%T) of Light in Water at 254 nm

BACKGROUND

The [Great Ships Initiative](#) (GSI) is a collaborative effort to end the problem of ship-mediated invasive species in the Great Lakes-St. Lawrence Seaway System through independent research and demonstration of environmental technology, financial incentives and consistent basin-wide harbor monitoring. To that end, GSI has established research capabilities at three scales—bench, land-based, and shipboard. Each scale is dedicated to addressing specific evaluation objectives, with protocols as consistent with IMO and federal requirements as practicable. Developers of ballast treatment systems apply for GSI research services [online](#), and awards are offered based on an objective review process. GSI incubation/testing will allow meritorious ballast treatment systems to progress as rapidly as possible to an approval-ready and market-ready condition.

GSI bench-scale tests take place year-round at the University of Wisconsin-Superior's Lake Superior Research Institute (LSRI) in Superior, Wisconsin. The LSRI is amply equipped with staff expertise and resources to conduct the tests, and has a long history of successfully undertaking similar tests.

The overarching goals of GSI bench-scale testing are to explore dose-effectiveness, chemical degradation, residual toxicity, and sensitivity to challenge conditions of a proposed ballast treatment method about which little is known. To that end, the tests are “range-finding” missions, to determine the optimal treatment dose/intensity that would maximize effectiveness and minimize residual toxicity. Findings help treatment developers better design an effective system and/or to move to the next stage of treatment evaluation. The tests are also a form of trouble-shooting to encounter possible problems with the proposed treatment in advance of more extensive and larger scale tests.

INTRODUCTION

This GSI Standard Operating Procedure (SOP) describes the procedure used to determine the percent transmittance (%T) of light in water at a wavelength of 254 nm. Organic compounds, especially aromatic organics, absorb ultraviolet (UV) light with a wavelength of 254 nm. Because other analyses such as total organic carbon (TOC), dissolved organic carbon (DOC), biological oxygen demand (BOD), and chemical oxygen demand (COD) are time consuming and costly, UV transmittance at 254 nm is frequently used as an indicator of the concentration of organic matter in water. Using this method, good correlations between DOC values and %T at 254 nm can be obtained. Filtration of samples may need to be considered because suspended solids present in water samples will cause blockage and scattering of light resulting in elevated %T values. This would result in an over-estimation of the organic content of the water.

DEFINITIONS

Biological/Biochemical Oxygen Demand (BOD): A measure of the rate of molecular oxygen utilization by biological organisms for the degradation of organic material in water (Eaton *et al.*, 2005).

Brackish Water (BW): Synthetic water created from laboratory water (LW) with the addition of commercially prepared salts, such as Instant Ocean, to obtain a salinity of 16 parts per thousand (as measured by a refractometer).

Chemical Oxygen Demand (COD): A measure of the oxygen required to oxidize all organic and inorganic compounds in water (US EPA, 2009)

Dissolved Organic Carbon (DOC): The fraction of total organic carbon (TOC) present in water that passes through a 0.45 μm pore diameter filter (Eaton *et al.*, 2005).

High Organic Content Laboratory Water (HOC-LW): Synthetic water created from laboratory water (LW) and used as a surrogate in place of Duluth-Superior Harbor water.

Laboratory Water (LW): City of Superior, Wisconsin municipal water that has been dechlorinated by passage through an activated carbon filter. Note: Based on data from previous testing, background levels of chlorine from below the limit of detection -10 $\mu\text{g/L}$ are expected in dechlorinated laboratory water, depending on the source of the water.

Prospective Ballast Treatment System (BTS): A system containing an active substance and/or component that mechanically, physically, chemically, or biologically serves to remove, render harmless, or avoid the uptake or discharge of potentially invasive organisms within ballast water (IMO, 2005).

Total Organic Carbon (TOC): All carbon atoms present in water that are covalently bonded in organic molecules (Eaton *et al.*, 2005).

Salt Water (SW): Synthetic water created from laboratory water (LW) with the addition of commercially prepared salts, such as Instant Ocean, to obtain a salinity of 32 parts per thousand (as measured by a refractometer).

EQUIPMENT LIST

- Spectrophotometer capable of analysis at 254 nm.
- UV transparent cuvettes (quartz or silica), 1 cm.
- Kimwipes.
- Wash bottle with deionized water.
- Containers for sample collection.
- Personal protective equipment.
- Filtration apparatus.

- Glass fiber filters without organic binder (i.e. Whatman 934-AH).

PROCEDURE

Sample Collection

1. Collect sample water in beakers or sample bottles from the appropriate location(s) depending on the type of test being conducted.
2. Collect a minimum of 10 % of samples in duplicate.
3. Filter samples if they contain suspended solids prior to analysis.
4. Conduct analysis as soon as possible after sample collection. Store samples in a dark, cool area until analysis.

Sample Analysis

1. Turn spectrophotometer on and allow the instrument to warm up.
2. When the instrument is ready, set the wavelength of analysis to 254 nm and the readout mode to %T.
3. Place deionized water in the reference and sample cuvettes and adjust the readout to 100% T.
4. Empty the sample cuvette, rinse with several small portions of the sample water, and then fill cuvette at least two-thirds full with sample.
5. Read and record the %T value of the sample.
6. Repeat steps 4 and 5 for each sample.

QUALITY ASSURANCE/QUALITY CONTROL

1. Conduct all quality assurance/quality control procedures according to the GSI/QAPP/1 - Quality Assurance Project Plan (QAPP) for Great Ships Initiative Bench-Scale and Land-Based Biological Tests (2009). Analyze data to ensure that all applicable data quality criteria are met.
2. Collect and analyze in duplicate at least 10 % of the samples to document sampling and analytical variability.
3. Follow all procedures outlined in this SOP. Any deviations known ahead of time must be approved by the GSI Lead Investigator for Bench-Scale Studies. Any deviations made

during the experiment must be recorded and also approved by the GSI Lead Investigator for Bench-Scale Studies as soon as practicable.

4. Record data on data collection forms or in specific laboratory notebooks. All instrument data output and data forms must be stored in a project-specific three-ring binder. Ensure hard copies of instrument data output and data collection forms are scanned and stored electronically.

DATA STORAGE AND ARCHIVING

1. Store and archive data according to GSI/QAPP/1 - Quality Assurance Project Plan (QAPP) for Great Ships Initiative Bench-Scale and Land-Based Biological Tests (2009).
2. Archive all hard- and electronic-copies of data and records generated for a period of five years.

REFERENCES AND RELATED DOCUMENTS

Cangelosi AA (2006). RDTE Facility for the Great Ships Initiative (GSI) (OAR-SG-2006-20000364). Project Proposal to the National Oceanic and Atmospheric Administration/U.S. Fish and Wildlife Service.

Eaton, AD, Clesceri, LS, Rice, EW, and AE Greenberg, Eds. (2005). Standard Methods for the Examination of Water and Wastewater, 21st Edition. American Public Health Association, Washington, DC.

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International Maritime Organization (IMO) (2005). Guidelines for Approval of Ballast Water Management Systems (G8) Adopted by Resolution MEPC.125 (53). London, England.

United States Environmental Protection Agency (2009). Performance Track Results: Non-Target Discharges to Water. <http://www.epa.gov/performance-track/results/outputs/nontoxic-back.htm>, June 9, 2009.