CAL MARITIME
EXTENDED LEARNING
CSU The California State University

Ballast Treatment Test Facility Activities

Pacific Ballast Water Group, April 2015

Bill Davidson
Cal Maritime
Golden Bear Facility (GBF)

Department of Sponsored Projects
and Extended Learning

Golden Bear Facility (GBF)

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A Shipboard & Land-based Ballast Treatment Test Facility

Our Partners:

- Cal Maritime
- MARAD
- Moss Landing Marine Laboratories
- Pacific Ecorisk (PER)
- California State Lands Commission
- NOAA Sea Grant
- University of Washington

Presentation Outline

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1. Brief facility description
2. Overview of key past and current year activity – USCG T-A testing
3. Ballast Responder development and validation project
4. Nick Welschmeyer MPN background and activities
5. Other university/facility projects – Advisory Board
6. Conclusion

Facility Arrangement & Services

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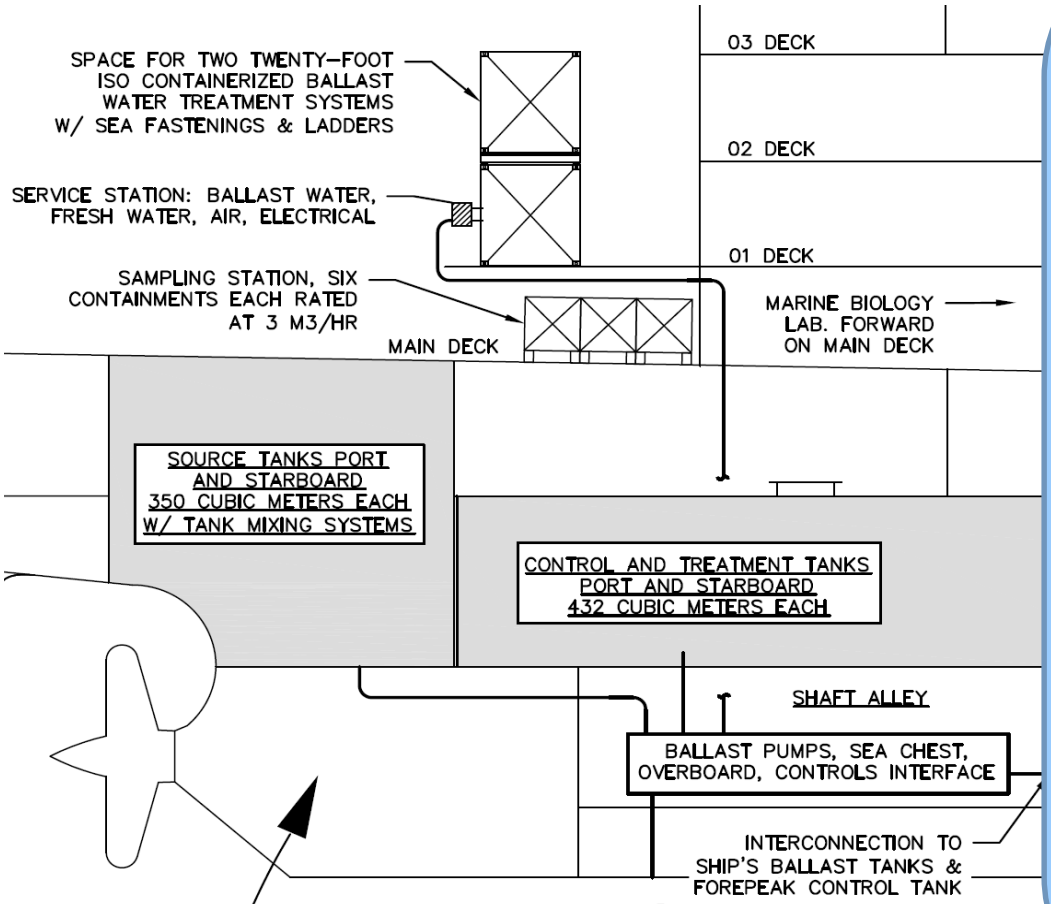


Services/Functions:

- **BWTS "Plug and Play"**
  - One Week to Install & Commission
  - Testing at 100 to 440 m3/hr
  - Two Test Tanks at 432 m3 each
  - Two Source Tanks at 350 m3 each
  - Total 7,141 m3 capacity in 28 tanks
- **BWTS Verification Testing**
  - IMO Land-based Guidelines
  - IMO Shipboard Guidelines
  - ETV Land-based Protocol
- **R&D Platform**
  - Treatment System Stress Testing
  - Filter Efficiency
  - Emergency/Interim Ballast Water Treatment
  - Compliance Monitoring Tools

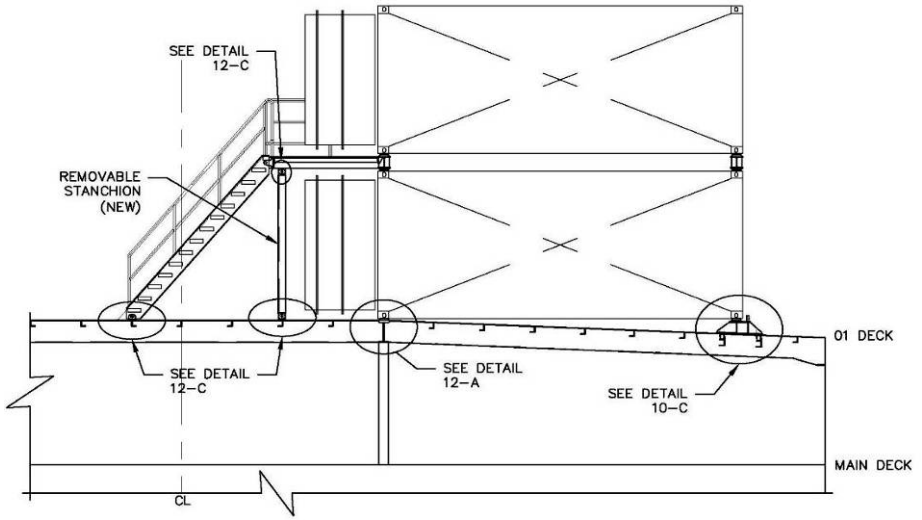
BWTS Service Station

Structural modifications allow placement of one or two 20’ ISO containers in stacked arrangement.

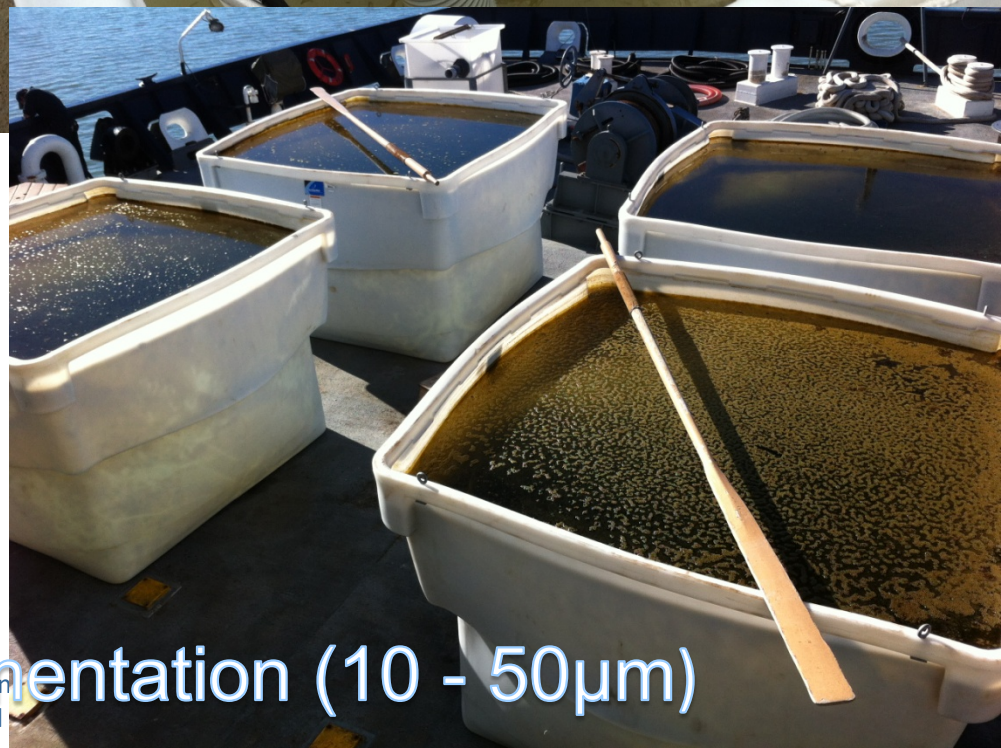
Containers may weight up to 25 tons total.

Proximity to 20 ton deck crane for handling.

Services provide compressed air, fresh water, electrical, ballast main, and drain connections.



Zooplankton Augmentation (≥ 50µm)



Phytoplankton Augmentation (10 - 50µm)

Recap of Key Past Activities

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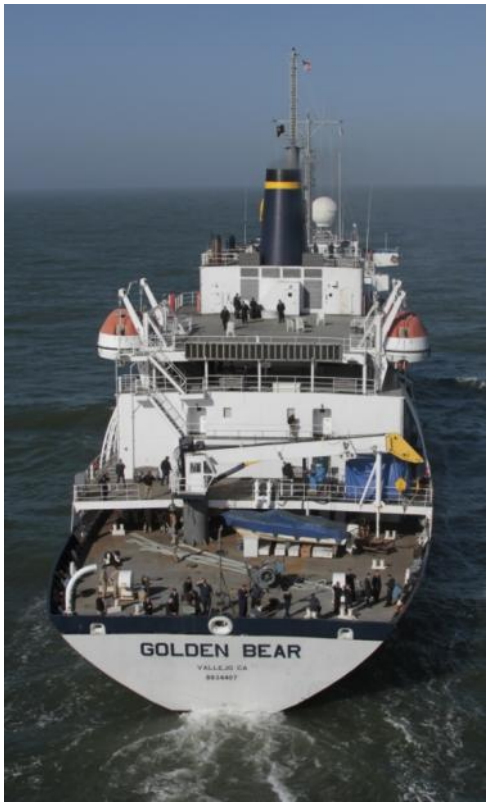

2012 – Provided facility and capabilities for testing emergency ballast water treatment protocols (multi-agency project through GSI).

2012/13 – GBF continued work funded by California SLC through Glosten Associates and MLML to develop compliance monitoring sample apparatus and techniques. Tested prototype in Summer/Fall 2013.

April - November 2013 – *Efforts toward USCG and IL approval continue.* ***Accepted as USCG approved sub-lab to DNV GL in November 2013****. Quality System Implementation to better meet USCG and ISO 17025 compliance in progress*.

August 2013-January 2014 – Facility physical plant improvements to achieve greater statistical confidence in testing goals. Includes ability to eliminate tank residuals from testing via stripping lines, automated back-pressure control, and upgraded water quality injection. **Now testing at flow rates up to 400 m^3/hr.**

2014/15 Activities

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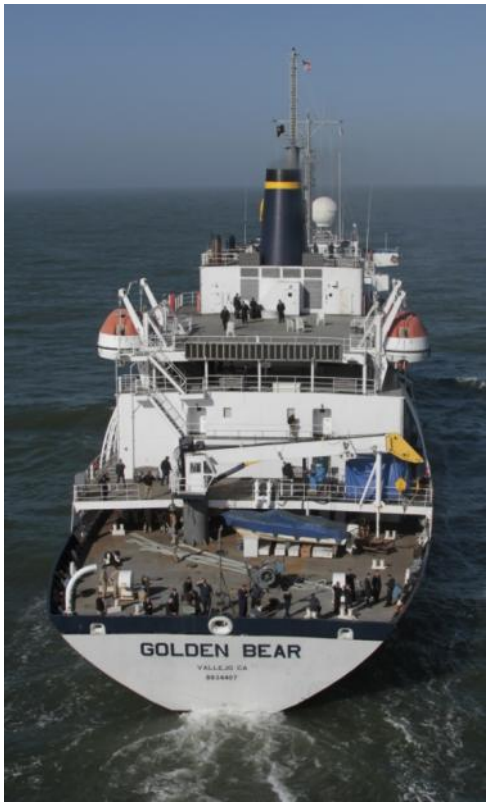

January/February 2014 – Several small R&D projects at pilot scale 1-2 weeks each.

March 2014-January 2015 – **First USCG-IL shipboard test series for North American manufacturer**. DNV-GL is Independent lab Report delivered January 2015.

March 2014-June2015 – First full USCG-IL test series for US manufacturer scheduled. Testing cancelled after early operational issues.

November - December 2014 – California State Lands sponsored project to test *Ballast Responder* BE using chlorine treatment and neutralization.

January 2015-present – **First full USCG-IL land-based and shipboard testing project for US manufacturer Ecochlor. Expect to complete project in late 2015 after 20+ total tests.**

Upcoming – 2nd BWMS installed for summer 2015; Proposed development and validation of upgrades to compliance monitoring tools with Cal SLC, MLML, Glosten; Booking for upcoming T-A tests.

Ballast Responder (BaR) Testing

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California State Lands Commission sponsored project

- Efficacy testing performed on the *USTS Golden Bear*, by Golden Bear Facility (GBF) and Moss Landing Marine Laboratories (MLML)
    - Bench scale dose response
    - R&D optimization testing
    - Validation testing of target dose and hold time
- GBF performed all ship operations, including equipment loading/offloading
- MLML coordinating with GBF to performed all sample collections and analysis
- Glosten Associates Inc., developer of the Ballast Responder, performed all mixing, dosing and neutralization with GBF support
- The testing will also served as an opportunity to train a team from the Grand Portage Tribe (GPT) and other potential operators/users on operating the BaR system

BaR Uptake/Challenge Summary

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UPTAKE						
Residence Time (hrs)	Sample ID	Sustained Dose (mg/L total chlorine)	>50 µm (org/m³)	10 – 50 µm (org/mL)	<10 µm E.coli (cfu/100mL)	<10 µm Enterococci (cfu/100mL)
48	48A1	4	110,909.1	346.1	22.4	62.3
	48A2	2				
24	24A1	12	102,222.2	262.1	48.1	130.4
	24A2	6				
24	24B1	12	100,000.0	163.7	13.1	13.1
	24B2	12				
8	08A1	12	104,040.4	95.0	16.1	327.6
	08A2	12				
18	18A1	12	87,878.8	157.8	28.6	250.4
	18A2	12				
18	18B1	12	117,272.7	106.9	19.9	860.7
	18B2	12				

Challenge meets shipboard phytoplankton and land-based zooplankton concentrations In most cases. No augmentation due to short schedule.

BaR Treated Discharge Summary

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DISCHARGE						
Residence Time (hrs)	Sample ID	Sustained Dose (mg/L total chlorine)	>50 µm (org/m³)	10 – 50 µm (org/mL)	<10 µm E.coli (cfu/100mL)	<10 µm Enterococci (cfu/100mL)
48	48A1	4	2.1	1.7	3.0	0.7
	48A2	2	5.5	1.7	3.7	11.0
24	24A1	12	6.9	3.4	0.0	1.3
	24A2	6	14.6	4.2	0.7	5.5
24	24B1	12	8.8	3.4	2.1	2.0
	24B2	12	113.3	9.3	0.0	1.4
8	08A1	12	9.18	1.9	0.3	<1.0
	08A2	12	21.5	1.7	2.4	0.7
18	18A1	12	13.2	0.95	<1.0	0.3
	18A2	12	11.3	1.7	0.7	15.0
18	18B1	12	1.2	1.9	<1.0	2.7
	18B2	12	0.34	1.7	<1.0	24.6

Sampling: Continuous integrated sampling 6 m³ beginning/middle/end for treated discharges vs. simultaneous triplicate. Found most live orgs in last 1 m³

Assessing Ballast Water Treatment Efficacy from UV-Based Systems

The following slide provides typical results obtained for UV treatment systems:

1. Uptake (non-treated) samples yield 10-50 um organism concentrations that are
   comparable for a) MPN assays and b) numeric FDA counting assays (cytometry)

2. Discharge (treated) samples yield quite different results
   - MPN shows almost no growth with numeric concentrations that easily **PASS** BWDS
   - FDA numeric counts show large reductions in 10-50 um concentrations,
   but results often lie **FAIL** BWDSs

Filtration + UV-based BWTS Test

San Francisco Bay, CA , March 17, 2012

Dilution factor	Uptake A (untreated)	Uptake B (untreated)	Uptake C (untreated)
1	17 24 13 46 14	3 14 11 67 45	4 41 5 41 42
5	97 50 87 52 66	150 53 78 14 40	130 53 19 190 34
25	90 104 102 73 126	14 9 41 88 64	131 10 24 321 140
125	149 150 88 103 130	28 25 57 124 82	32 19 14 239 42
625	143 94 56 14 23	2 3 1 164 113	1 6 258 5 35
3125	1 105 1 1 1	1 1 1 2 47	118 1 1 6 2
15625	2 1 1 2 2	1 2 1 2 1	1 1 1 2 1
blank	1 1 1 1 1	1 1 1 1 1	1 1 1 2 1

Sample	MPN Mean live cells/mL	FDA FC Mean live cells/mL
Uptake A	450	682
Uptake B	150	557
Uptake C	360	633

Treatment Discharge A	Treatment Discharge B	Treatment Discharge C
1 1 1 1 1	2 1 2 1 1	1 1 1 5 1
1 1 1 1 1	1 2 1 1 1	1 1 1 1 1
1 1 2 1 1	1 2 2 1 1	1 1 1 2 1
1 1 1 1 2	1 1 1 2 1	2 2 1 1 1
1 2 1 1 1	1 1 2 1 2	2 1 1 2 1
1 1 1 2 1	1 1 1 2 2	1 1 1 1 1
1 1 2 1 2	1 2 1 1 1	1 1 1 1 1
1 1 1 2 1	2 2 2 1 1	3 1 1 1 1

Sample	MPN Mean live cells/mL	FDA FC Mean live cells/mL
Treatment A	<0.053	5
Treatment B	<0.053	26
Treatment C	0.058	15

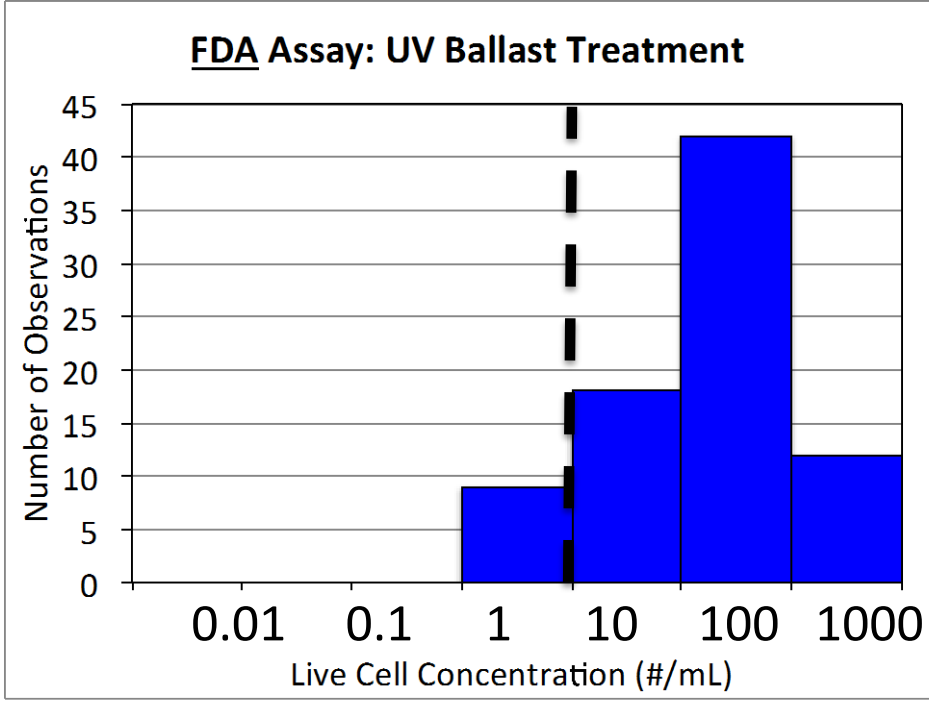
Numerical Counts: FDA vs. MPN UV Treatment Results

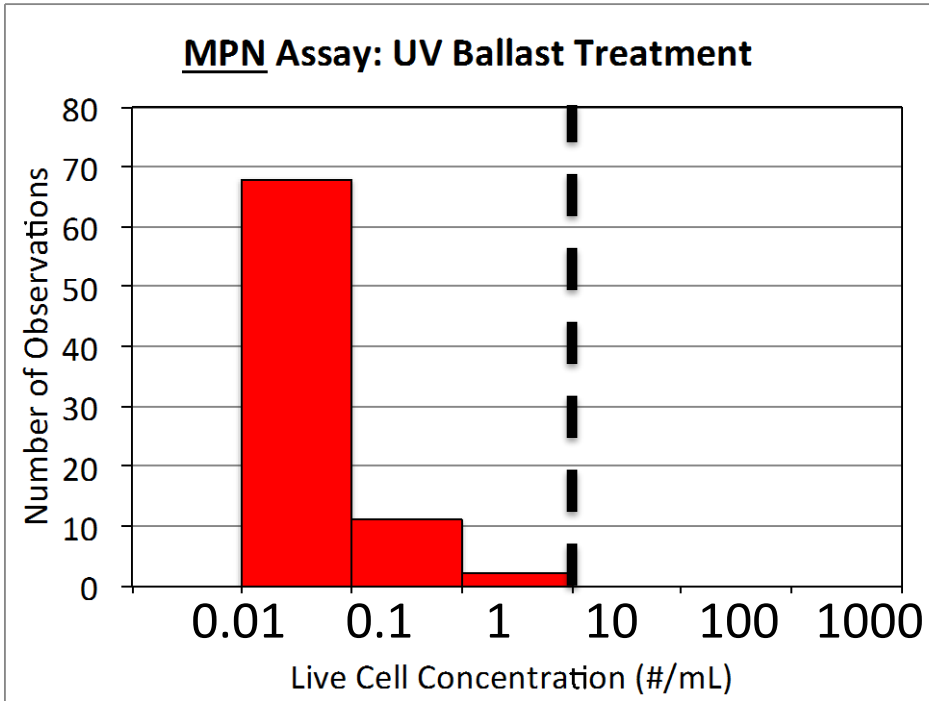
- FDA: 9 of 81 samples <10 live cells/mL

  11.1% passed Ballast Water Discharge Std.

- MPN: **81 of 81 samples** <10 live cells/mL

  100% passed Ballast Water Discharge Std.





When in doubt… form a committee!!

ETV – UV Tech Group:

Tom Stevens, NSF International (ETV)
Allegra Cangelosi, GSI
Brian Howes, U. Mass (ETV)
Lisa Drake, NRL (ETV)
Richard.A.Everett, USCG
Ray Frederick, EPA
Craig Taylor, WHOI (ETV)
Ernest R. Blatchley, Purdue Univ.
Dana Woodruff, PNNL
Gitte Petersen, DHI Denmark
Debra DiCianna, ABS
Gail.E.Roderick, USCG R&D

Rasmus Folsø - DESMI Ocean Guard (UV)
Brian Petri, Trojan UV Canada (UV)
Peer Krueger, Xylem Inc. (UV)
Keith G. Bircher, Calgon Inc. (UV)
Erik Koester, Hytecon Inc., Germany (UV)
Marcel Veldhuis, MEA-nl Netherlands
Louis Peperzak, NIOZ Netherlands
August Tobiesen, NIVA
Mario Tamburri, MERC
Nick Welschmeyer, MLML/GBF
Robert Donofrio, NSF International
Carlton Hunt, US EPA

Outcome Status

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Resulting Reports (now in review):

1. Evaluating the MPN Dilution-Culture Method for the Enumeration of Viable Phytoplankton Cells (A White Paper submitted to the ETV Tech Panel)

2. An Alternative Method for Determining the Number of Living Organisms in the 10-50 μ m Size Class for Ballast Water Management System Test Samples

3. MPN Method Development Experiments 1 to 6
   Inter-Lab Comparison of the MPN Dilution-Culture Method and Fluorescein-Based
   Staining Methods for the Enumeration of Viable or Living Phytoplankton Cells

SkySails GmbH

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SkySails GmbH, based in Hamburg, Germany, is the world leader in automated kite systems.

SkySails is the first company to successfully commercialize towing-kite technology into industrial products.

SkySails products efficiently capture high-altitude wind energy for both mobile and stationary applications.

SkySails on the GOLDEN BEAR

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The purpose of the proposal is to provide a demonstration and evaluation installation of a promising technology

The ultimate intent of the project would be to install and operate a SkySail propulsion installation on the Training Ship including a 400 m^2 sail installation on the bow and a performance management system on the bridge and perform a practical research and demonstration project for this unique technology

The purpose of the effort is to evaluate whether the potential positives in fuel savings, and emissions reductions outweigh the potential costs

2.1.1 GBF Purpose

The GBF was developed to conduct research, development, testing, and evaluation of technologies and operational practices that show promise for limiting the impact of marine vessel operations on the environment. Specifically, GBF provides:

- Onboard laboratory to enable rapid biological and chemical analysis to support research and testing activities;
- Access to all ship equipment; including the ballast water system, hull and apertures, bilge water and de-oiling equipment, sanitation system, and diesel engine exhaust systems;
- Specialized equipment to support BWMS evaluation, including a dedicated pump and piping system, a means of installing and integrating a treatment system, an automation system, and a water sampling system; and
- Equipment for use in land-based testing water augmentation, including biological concentrators, methods of various chemical delivery, and tank mixing systems.

GBF test protocols for BWMS apply to land-based and shipboard testing and are based on the International Maritime Organization (IMO) Guidelines for Approval of Ballast Water Management Systems (G8) and Procedure for Approval of Ballast Water Management Systems That Make Use of Active Substances (G9); and the EPA/600/R–10/146, September 2010 *Generic Protocol for the Verification of Ballast Water Treatment Technologies (ETV* Protocol).

2.1.2 Quality Management System Purpose

The purpose of the QMS described in this QMP is to establish policies, processes, and procedures that will ensure that the quality of data and products provided by GBF consistently meet client quality requirements and comply with all applicable regulations and standards. The QMS also ensures that all GBF data collection and processing activities are carried out in a consistent manner to produce data of known and documented quality.


THANK YOU