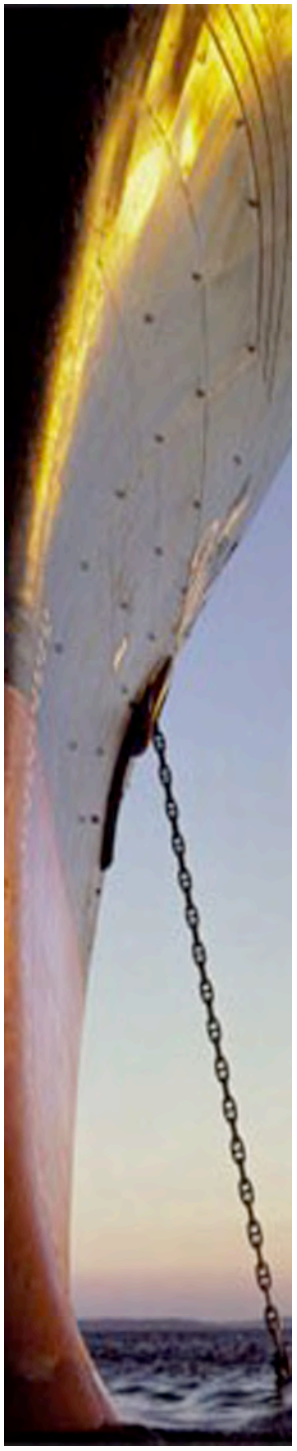

Implementing Ballast Water Regulations: Treatment Systems and Enforcement

Mario Tamburri

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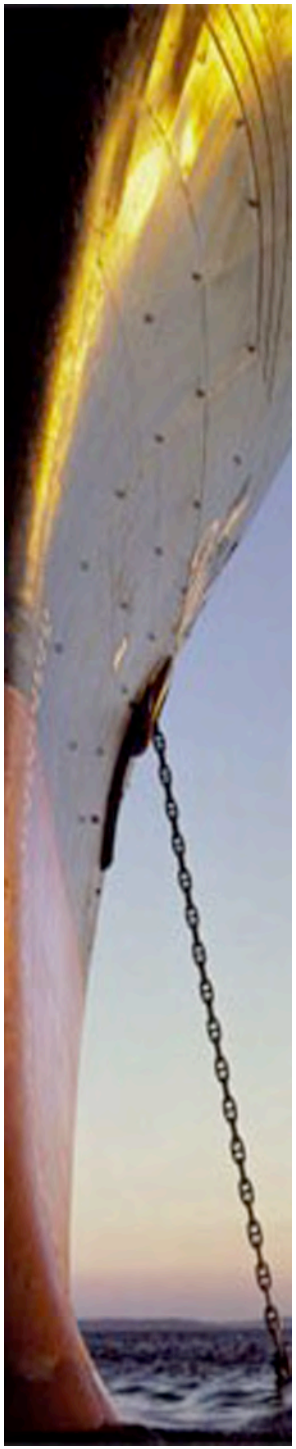


Keys to Successful Ballast Water Discharge Regulations

- Limits on concentrations of living organisms
- Ability to measure regulations with confidence
- Availability of technologies to meet regulations
- Willingness of ship owners to install, maintain, and effectively using treatment technologies
  - Certification of treatments
  - Compliance monitoring
  - Enforcement
  - Penalties

Ballast Water Treatment Testing Facilities

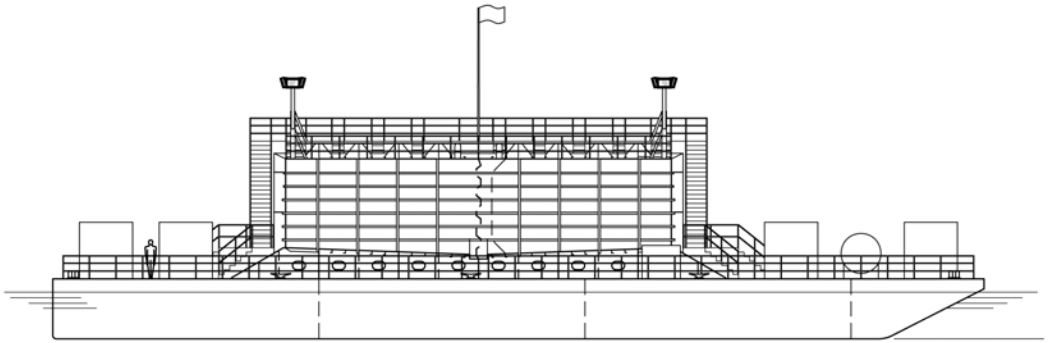
- **Norwegian Institute for Water Research (NIVA)**

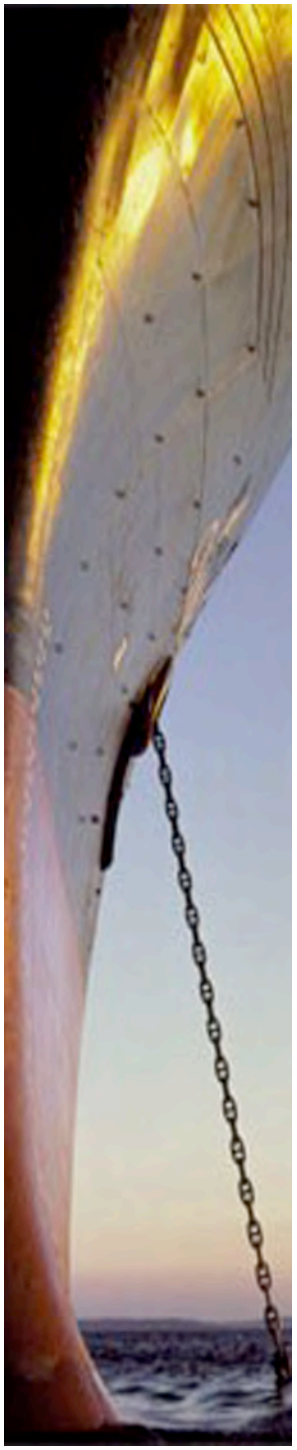
- **Royal Netherlands Institute for Sea Research (NIOZ)**

- **Great Ships Initiative (GSI)**

- **Maritime Environmental Resource Center (MERC)**

MERC Testing - Port of Baltimore

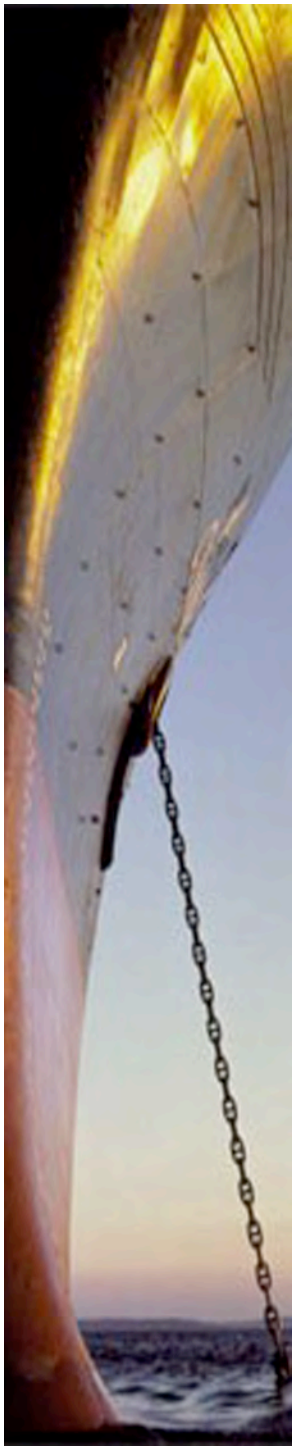




Challenges for Land-Based Evaluations and Shipboard Validations

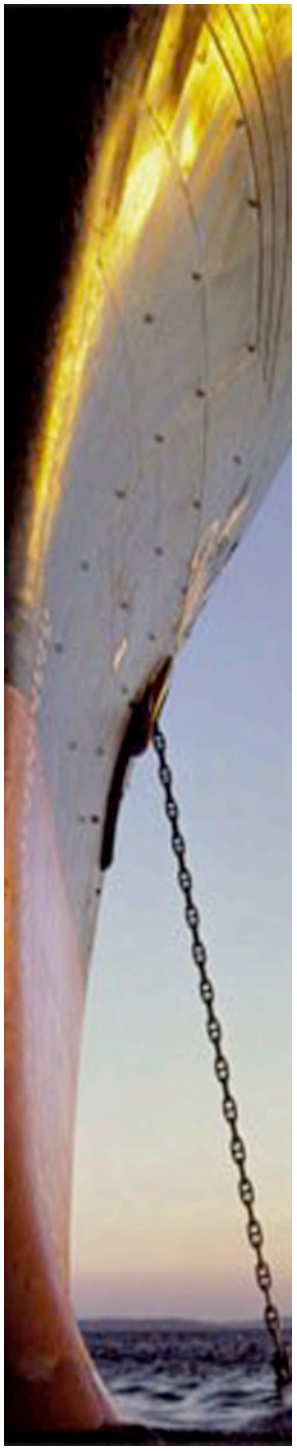
- Open, standardized and rigorous testing
- Successful = meet standards, no discharge toxicity, no mechanical failures
- Sample volumes and detection limits
- Size class / minimum dimension
- Live organisms 10 – 50 µm in size
- Test challenge conditions

- Phase 1 is possible, Phase 2 is not



Ballast Water Treatments

- Mechanical
  - Filtration
  - Hydrocyclone
- Chemical (Biocides)
  - Oxidizing - chlorine, chlorine dioxide, ozone, bromine, hydrogen peroxide, peracetic acid
  - Non-oxidizing - gluteraldehyde, menadione, acrolein
- Physical
  - Cavitation
  - Deoxygenation
  - Flocculation
  - Heat
  - Ultrasound
  - Ultraviolet Radiation
- Several Combinations



Recent Reviews

- US Coast Guard NPRM
- Lloyd's Register (Sept 2008)
- California State Land Commission (Oct 2009)
  - 30 Treatment Systems (9 countries)
  - 18 combination of 2 or more
  - 22 chemical (19 oxidizing, 3 non-oxidizing)
  - 10 have been tested onboard active vessels

IMO Certified Ballast Water Treatments

Manufacturer	Treatment Name	Treatment Type	Type Approval Certification
Alfa Laval (Sweden)	PureBallast	Filtration + Oxidation	Norway
Hamann Degussa (Germany)	SEDNA System	Hydrocyclone + Filtration + Peracetic Acid (Peraclean)	Germany
Hyde Marine (USA)	Hyde Guardian	Filtration + UV	UK
NEI Treatment Systems (USA)	Venturi Oxygen Stripping	Deoxygenation + Cavitation	Liberia and Marshall Islands
Oceansaver AS (Norway)	OceanSaver BWMS	Filtration + Cavitation + Nitrogen Supersaturation + Chlorination	Norway
OptiMarin (Norway)	OptiMarin Ballast System	Filtration + UV	Norway
Techcross (Korea)	Electro-Cleen	Electrochlorination	Korea

* IMO Basic and Final Approval ≠ Type Approval Certification

Can any current approach meet Phase 2 / 1000x IMO / California Standards?

- **USCG concluded that no current technologies/treatments can meet Phase 2 (1000x IMO)**

- **CSLC states "**…seven systems that have demonstrated the capability of complying with California's performance standards have at least one testing replicate, at either full-scale land-based or shipboard scale that demonstrates compliance with the standards. Vessel owners/operators should closely scrutinize the available data, however, to ensure that systems will meet California's standards on a regular basis…**"**

- **Personal experience…**

- **New innovation needed for Phase 2**

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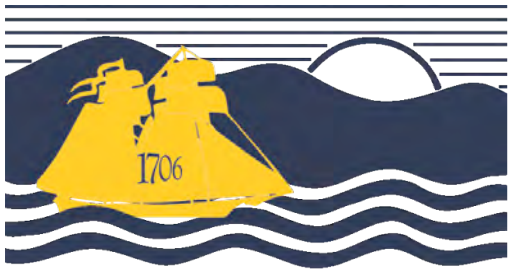

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