Ballast Water Treatment Retrofit
A Case Study and Reality Check

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Outline of Topics

- Review of Design Study
- Planned Installation
- Installation Time Line and Difficulties/Realities of shipboard work on the fly
- Cost and Schedule drivers
- Equipment issues
- Cost to date/status
Full Scale Design Studies of Ballast Water Treatment Systems

Study by: Glosten - Herbert LLC and Hyde Marine for the

Great Lakes Ballast Technology Demonstration Project

Sponsors: Northeast-Midwest Institute and the Lakes Carriers Association
Study Focus

BALLAST WATER MANAGEMENT
Solutions to the NIS Problem

PORT-BASED
- TREAT AFTER DEBALLASTING
  - Land-based Plant Receiving Vessel
- BALLAST WITH TREATED WATER

SHIPBOARD
- ONBOARD TREATMENT
- BALLAST WATER EXCHANGE
  - Emptying & Refilling Flow-through Exchange

PRIMARY
- Filtration
- Cyclonic

SECONDARY

<table>
<thead>
<tr>
<th>MECHANICAL</th>
<th>CHEMICAL</th>
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</thead>
<tbody>
<tr>
<td>Ultra Violet (UV)</td>
<td>Biocides</td>
</tr>
<tr>
<td>Heat (in transit)</td>
<td>Chlorine</td>
</tr>
<tr>
<td>Ultra Sound</td>
<td>Ozone</td>
</tr>
<tr>
<td>Magnetic Field</td>
<td>Hydrogen Peroxide</td>
</tr>
<tr>
<td>Electrical Field</td>
<td>Organic Chemicals</td>
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<tr>
<td></td>
<td>Other</td>
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</table>

Paper Focus
- Installation
- Engineering Costs
- Operational Impact
Scope of Study

- Develop flow-through on-board treatment systems for Two “Target Vessels:”
- Develop Life Cycle Costs
- Use currently available technologies
Target Vessels

**Design Study #1**
“Vessel of at least 10,000 MT Displacement”
POLAR ENDEAVOUR

**Design Study #2**
2000 TEU or Greater Containership
Regularly Calling on U.S Port
R.J. PFEIFFER
Treatment System Requirements

- Maximizes kill and/or inactivation rate
- Minimizes adverse effects on environment
- Minimizes changes to the vessel’s existing ballast system and process
- Minimizes initial and life-cycle costs
- Designed for shipboard marine environment
- Meets existing safety standards
Selected Treatment Systems

- Cyclonic Separation
- Ultra-violet (UV) Light Irradiation
- Filtration with Backflush
- Chemical Biocide Injection
**Polar Endeavour**

**Type:** 125,000 Dwt Crude Oil Carrier in TAPS Trade  
**Owner:** Polar Tankers, Inc.  
**L x B x D:** 273m x 46m x 25.3m  
**DWT:** 127,005 MT  
**Ballast Cap:** 60,700 m³  
**Ball. Pumps:** 2 @ 2,860 m³/hr mains, 2@1,000 m³/hr aft  
**No. Ball Tks:** 6 pairs + 1 fo’c’sle + 4 aft tanks
Polar Endeavour
Ballast Treatment Systems

- Primary System - Cyclonic Separator
- Secondary System - UV Radiation on intake and discharge
- Alternate System - Chemical Treatment
  - Use in addition to or instead of Primary and Secondary
  - SEAKLEEN Biocide
**R.J. Pfeiffer**

- **Type:** 2,420 TEU Container Ship
- **Owner:** Matson Navigation
- **L x B x D:** 217m x 32m x 20m
- **DWT:** 28,758 MT
- **Ballast Cap:** 14,600 m³
- **Ball. Pumps:** 2 @ 350 m³/hr
- **No. Ball Tks:** 26
R.J. Pfeiffer
Ballast Treatment System Options

- **Option 1:**
  - Primary System - **Cyclonic Separator**
  - Secondary System - Ultraviolet Radiation
    - UV irradiation on intake and discharge

- **Option 2:**
  - Primary System - **Filtration with Backflush**
  - Secondary System - Ultraviolet Radiation
    - UV irradiation on intake and discharge
Selection of Treatment Type
Cyclonic Separator over Filtration with Backflush

- Shipboard service experience with automatic backflushing filters limited
- Crew maintenance/monitoring req’ts
- Capital and lifetime costs
- Filters require more space in ER
- No current efficacy standards
System Equipment and Installation

- Cyclonic Separator - Microkill HRN 350
  - 265-490 m³/hr
- UV Unit - Microkill LP400-16-200
  - 350 m³/hr, 16 lamps, 24 VAC 3A
- Installed on starboard ballast pump only
- Installation at ER floor plate level, outboard of Main Engine
- 10” ballast lines & valves, 2” sludge overb’d
- Controls/monitoring integrated with ballast control system
Main Ballast System Diagram

Starboard Side Only

To ballast main

From ballast main or sea suction
R.J. Pfeiffer
System Operation & Monitoring

- Designed for unattended ER operation
- All control / monitoring in ballast control office
- Open/close (3-6) additional motor operated valves
- Turn UV system on and monitor performance
- Use UV at intake and discharge
- Avoid deep ocean exchange
**R.J. Pfeiffer**  
Life Cycle Cost Summary

<table>
<thead>
<tr>
<th>Item</th>
<th>Installation Cost</th>
<th>Life Cycle (LC) Cost</th>
<th>Present Value of LC Cost</th>
<th>Uniform Equivalent Annual Cost (AAC)</th>
<th>Tons of Ballast Pumped/year</th>
<th>Cost / Ton</th>
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</thead>
<tbody>
<tr>
<td>Cyclonic Separator and UV Treatment</td>
<td>$358,000</td>
<td>$596,000</td>
<td>$429,000</td>
<td>$44,000</td>
<td>13,000</td>
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<tr>
<td>Filter and UV Treatment</td>
<td>$375,000</td>
<td>$832,000</td>
<td>$511,000</td>
<td>$52,000</td>
<td>13,000</td>
<td>$4.00</td>
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R.J. Pfeiffer
Planned Installation

- Matson Agreed to go forward with the installation as a test platform
- The R. J. Pfeiffer was successfully and easily carrying out ballast exchange
- Partial funding from the State Land Commission was provided $100,000
- Matson budgeted an additional $250,000 and committed crew time and other resources
Original Time Line
Equipment Installation
2001

- May 1 - Decision to proceed
- June 26 - ship at shipyard for piping work
- August / October - complete installation while ship in service
- November - System Efficacy Testing
Schedule drivers

- June 6, 2001 – last port call before shipyard, valves/piping ordered and on board

- Installation work to be accomplished while ship in service during 1-2 day port calls every 2-5 weeks or during 1 day coastal run

- October 2001 U/V and Separator arrive in LA, some equipment still tied up in customs
Achieved Milestones

- July 16, 2001 – only about 20% of pipe installed at shipyard
- Aug. 2, 2001 – 1st port call, ship in 5 week service
- Oct. 8, 2001 – U/V and Separator arrive, must be loaded from barge because stores crane outboard only
- Oct. 11, 2001 – decide to move U/V unit
- Oct. 17, 2001 – meet with ABS regarding equipment approvals
Achieved Milestones (cont’d)

- Oct. 2001 – ship enters 2 week HI service
- Dec. 12, 2001 – about 85% of piping fitted and removed for galvanizing
- Feb. 13, 2002 – start cabling for valve controls and automation
- Mar. 25, 2002 – finished piping
- Apr. 10, 2002 – first system tests
- Apr. 22, 2002 – scientists on board for efficacy testing, seal leaks and tube breakage stop tests
Achieved Milestones (cont’d)

- June 19, 2002 – manufacturer completes modifications
- July 2, 2002 – scientists load test gear, system still not functioning and tests canceled
- July 31, 2002 – manufacturer decides to remove U/V unit and replace with different design.
- Dec. 2002 – expected availability of new U/V unit
Costs To Date

- Total Budget about $350k
- Spent to date about $385k
Summary

- Even “currently available” technology isn’t
  - Still in prototyping stage
- Retrofits can be complex, costly and time consuming
  - Even when space is available – piping and controls are not trivial
  - Difficult to do when ship in service
- Class Societies do not provide oversight of these non-essential systems
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