U.S. Environmental Protection Agency
Science Advisory Board
Quality Review Teleconference

June 16, 2011
12:00 – 4:00 p.m. Eastern Time

**Minutes of the Meeting**

**Purpose**: to conduct a quality review of a draft (5-31-11) SAB report, entitled *Efficacy of Ballast Water Treatment Systems: a Report by the EPA Science Advisory Board*.

**Attendees:**
**Chartered SAB Members**: Drs. Deborah Swackhamer (Chair), Terry Daniel, George Daston, Otto Doering III, David Dzombak, Taylor Eighmy, Bernd Kahn, Nancy Kim, Kai Lee, Cecil Lue-Hing, L.D. McMullen, Judith Meyer, Keith Moo-Young, Eileen Murphy, Duncan Patten, James Sanders, Kathleen Segerson, and Thomas Zoeller (see Roster, Attachment A).

**SAB Staff Office:** Stephanie Sanzone (Designated Federal Officer), Iris Goodman, Anthony Maciorowski

**Other Attendees:** Names of those who requested the teleconference call-in number are provided in Attachment B.

**Meeting Materials:**
All materials discussed at the meeting are available on the SAB website, http://www.epa.gov/sab, at the June 16, 2011 SAB Meeting page.

**Summary of Discussions:**

The meeting was announced in the Federal Register[1] and proceeded according to the meeting agenda[2], as revised. **Stephanie Sanzone**, Designated Federal Officer for the meeting, convened the meeting and noted that the chartered Science Advisory Board (SAB) operates in accordance with the Federal Advisory Committee Act. This means that meetings are announced and open to the public, meeting minutes are prepared, and all materials prepared for or by the SAB are available to the public. She noted that the SAB members participating in the meeting were in compliance with conflict of interest and ethics rules that apply to them. She reminded members that all materials for the meeting (including the draft document prepared by the SAB Ballast Water Panel[3], a compendium of member comments[4], and 6 sets of public comments[5]) were available on the SAB website, www.epa.gov/sab. Ms. Sanzone then turned the meeting over to the Chair of the chartered SAB, Dr. Deborah Swackhamer.

**Dr. Swackhamer** noted that the purpose of the meeting was to conduct a quality review of the draft SAB report (dated May 31, 2011) entitled, *Efficacy of Ballast Water Treatment Systems: A Report by the EPA Science Advisory Board*. The chartered SAB must review and approve all SAB reports before they are transmitted to the Administrator. She noted that there had been no requests from the public to provide oral comment, but referred members to the written comments that had been provided.

The following is a summary of the issues discussed and conclusions reached during the meeting.

## A. Overview of the Draft Report

**Dr. Judy Meyer**, chair of the Ecological Processes and Effects Committee (EPEC) Augmented for the Ballast Water Advisory (the panel), gave an overview of the panel's review process and key conclusions. She noted that the EPEC had been augmented for the review to include expertise in invasive aquatic species, ballast water management, marine engineering, and water treatment engineering. She thanked SAB member Jim Sanders and other members of the panel for their hard work, and commended Iris Goodman of the SAB Staff for her extraordinary efforts in pulling together the draft report. She noted that the panel's draft report had been released on May 31, 2011, to meet an Agency commitment in a consent decree relating to a future General Vessel Permit for ballast water discharges. Dr. Meyer also noted for the record that one member of the panel had indicated that he did not concur with the draft report that had been submitted to the chartered SAB for quality review. Dr. Meyer suggested that the panel roster would be changed to indicate that the member had not concurred.

Dr. Meyer noted that, to set the stage for the responses to the specific charge questions on ballast water management systems (BWMS), the panel report first describes the regulatory context, a glossary of terms, the need to take a risk assessment approach, and statistical issues associated with trying to detect a small number of organisms in a large volume of water. She then briefly summarized the panel's response to each of the charge questions:

- The panel concluded that it had been provided reliable data for 5 types of systems and that these systems were able to meet the IMO D2/USCG Phase 1 standards but unlikely to meet standards 100 or 1000 times more stringent.
- The 5 types of systems met the IMO D2/Phase 1 standards and were based on reasonable engineering principles used in industrial water treatment, but the panel did not have adequate data to speculate on whether these types of systems could meet higher standards, and the panel noted some of the difficulties encountered in adapting standard water treatment technologies to shipboard operation.
- Incremental improvements are possible to existing systems, but these are not likely to lead to 100 or 1000-fold further reductions in organism concentration in the discharge; some ideas are offered for design of new systems that might yield further reductions, but the panel was not able to predict which combinations of new technologies would be most effective; the panel noted that effectiveness will vary across organism type, but that sterilization of discharge is not possible.
- In response to the broader charge to provide advice on technologies and systems to minimize the impacts of invasive species in vessel ballast water discharge, the panel report discusses needed changes in testing and reporting procedures, problems with assessing viability since the standards are with respect to living organisms, issues for compliance monitoring, and a stepwise approach to developing a compliance monitoring program.
- In addition to ship-board systems, the panel report also discusses the advantages and challenges to using onshore reception facilities to treat ballast water. Other approaches that could be considered include: managing ballast water uptake, mid-ocean exchange, reducing or eliminating ballast water volume, location and timing of ballast water uptake and discharge, and combinations of approaches.
- To illustrate the panel's call for a risk management approach to ballast water, the panel also included an example of one such approach: the Hazard Analysis and Critical Control Points (HACCP) approach.

In closing, Dr. Meyer noted that the appendices to the panel's report include a list of documents provided to the panel by EPA, a literature review of onshore reception facilities, and issues with respect to reception facilities for which the panel had not achieved consensus.

**B. EPA Remarks**

**Ms. Deborah Nagle,** from the EPA Office of Water, thanked Dr. Meyer and the panel members for all the effort that went into the report, and noted her appreciation also for the staff efforts to try to meet the consent decree schedule. She stated that the SAB report had the potential to play a significant role in policy decisions for the November draft general permit, and noted that she and the EPA staff were looking forward to receiving the final report. She apologized for not being able to stay on the call, but noted that Dr. Albert from the Office of Water would be available throughout the meeting to respond to any questions.

**C. Chartered SAB Discussion**

**Dr. Swackhamer** opened the chartered SAB discussion of the draft ballast water report, reminding members of the quality review questions:

1. Were the original charge questions to the SAB Panel adequately addressed?
2. Are there are any technical errors or omissions in the report or issues that are not adequately dealt with in the Panel's report?
3. Is the Panel's report clear and logical?
4. Are the conclusions drawn or recommendations provided supported by the body of the Panel's report?

She requested the SAB lead reviewers—Drs. David Dzombak, Taylor Eighmy, Keith Moo-Young, and Kathy Segerson—to lead off the discussion by providing their answers to the quality review questions.

**Dr. Dzombak** acknowledged the complexity of the topic and the charge, which required consideration of many technologies and combinations of technologies. He commended the panel for a good job working through the information provided by EPA. He agreed that the report represents a snapshot, and provides the panel's assessment based on data and technologies they examined. He characterized the essence of the charge as a treatment technology performance evaluation, and noted that the panel's report goes beyond the charge questions (e.g., to discuss statistical and other issues surrounding biologically based water quality standards, alternatives to on-board treatment, and the importance of a broader risk assessment context for invasive species). While acknowledging the value of these additional discussions, Dr. Dzombak urged that the report clearly separate these issues from the responses to the charge questions, and that this distinction be kept in the executive summary and letter. He also recommended that the points of non-consensus not be included in the executive summary or among the primary conclusions of the report, and that the panel check to be sure that the primary conclusions and recommendations in the report had been brought forward and accurately summarized in the executive summary.

**Dr. Eighmy** noted that the report had been a pleasure to read and represented a "Herculean" effort. He agreed with Dr. Dzombak that the panel had gone beyond the charge questions and that the new issues they raised should be separated from the review of treatment technologies. He noted that the panel appeared to be offering a new way of thinking about ballast water management, and that the report

should emphasize that point. He also commented that the report could have included a bit more information on the costs to international fleets of ship-board vs. on-shore vs ballast water exchange options, and some discussion of how effective U.S. policies would be, given the international nature of shipping. He suggested that section 3 (on statistical issues) and perhaps other issues could be moved to an appendix to keep the report focused.

**Dr. Moo-Young** noted that Drs. Dzombak and Eighmy had summarized many of the issues. He felt that the report was very well organized, but did want some discussion and clarification of several issues. First, he recommended that the letter more clearly present the key report findings, especially on the technology assessment. Second, given the need for research and development to achieve the standard, and the time needed to design, build, assess and implement new systems, he felt that the report should recommend that EPA and the Coast Guard consider an interim approach based on available best practices for ballast water management.

**Dr. Segerson** noted that she had focused her review on section 6 and appendix C. She felt that the over-arching conclusion, stated in section 6, was that "insufficient attention has been given to integrated sets of practices and technologies including (1) managing ballast uptake to reduce presence of invasives, (2) reducing invasion risk from ballast discharge through operational adjustments and changes in ship design to reduce or eliminate need for ballast water, (3) development of voyage-based risk assessments and/or HACCP principles, and (4) options for treatment in reception facilities." She recommended that this statement, if it was the consensus of the panel, should be included in the letter and earlier in the report. In that case, appendix C is not needed and in fact deals with a subset of the issues that would need to be considered. Dr. Segerson also suggested that the detailed discussion of HACCP could be moved to an appendix, but Dr. Meyer noted that the panel had felt strongly about including that material in the body of the report.

In response to the lead reviewer comments, **Dr. Meyer** asked clarifying questions, and suggested revisions that could be made in response:

- Clarify in the report that the Agency is considering revisions to the proposed ballast water standards, and the panel is recommending a risk management approachthat would go beyond simply setting discharge standards. She noted that this point would be separate from the panel's assessment of the ability of BWMS to meet the currently proposed standards.
- Add additional detail on key recommendations to the letter.
- Note that economic analysis of onboard treatment vs. on-shore treatment vs. ballast water exchange is needed going forward, but this was beyond the panel's scope of expertise
- The proposed regulation includes time to implement these systems, but be clear in panel recommendations that further research on alternative approaches is needed to support potentially more stringent standards in the future.
- Make the point early in the report that a broader context is needed to frame the ballast water discussion, perhaps as part of the risk management section, then reference the later discussion.

**Dr. Meyer** asked for guidance from the SAB on what to do with appendix C, noting that some Board members had recommended that the material be deleted because it was not part of the charge, and other members had noted that the material was important. Following subsequent discussion, the members agreed that appendix C should be deleted from the report, but that the issues in the appendix should be listed (in a sentence or two) as examples of issues that needed more attention by EPA and others.

The following additional points were raised by members:

- **Dr. Doering** said that from his perspective as a member of a DOE advisory committee on invasive species, he thought the report was excellent and that the introductory sections were critical to set the policy frame. He urged that the letter say that the issue is broader than ballast water rules, and should be considered within the context of invasive species. Regarding costs, he agreed that it is extremely difficult to do that analysis, many of the technologies have not been tested, and a set of technologies will be needed that are both U.S. and internationally approved.
- **Dr. Daniel** noted that an advantage of eliminating appendix C from the report and bringing forward the consensus points is to not highlight the area where there was not consensus. He also agreed that it was extremely important that the panel was pointing out that the narrow focus on the technological ballast water question misses important aspects of the issue that require a broader context. He urged Dr. Meyer to include the broad charge language she referenced from the Federal Register notice (calling for nomination of candidates during panel formation), to emphasize that the panel felt compelled to go beyond the specific charge questions to meet that broader charge. With that rationale established clearly, the reader will understand why the additional discussions are included in the report.
- Several members suggested moving the statistical section (section 3) to an appendix, but other members felt this material was important to have in the body of the report. Dr. Meyer agreed to move some of the detail (e.g., the discussion of the Poisson distribution) to an appendix, and to further clarify in the section why the discussion was being presented before the responses to the charge questions. Dr. Daniel noted that public comments in favor of a "no living organisms" standard were statistically naïve, and emphasizes why the statistical discussion needs to be in the report.
- **Dr. Kim** and others urged that a short paragraph be added to the letter to emphasize the point that there are multiple levers to address the problem, including a HACCP approach, considering on-shore facilities, etc.

**D. Disposition of the Draft Report**

**Dr. Swackhamer** suggested that, based on the discussion, the changes to the draft report being requested by the Board were fairly minor, namely to clarify the messages in the letter and executive summary, bring forward a list of key topics from appendix C into the report and remove the appendix, tighten the discussion of section 3 and move the details to an appendix, and other editorial changes mentioned by members.

She reviewed the possible options for disposition of the draft report:

Option 1: Approve the report, with the discussed changes, subject to final review by the SAB Chair;
Option 2: Approve the report with edits, subject to final review by designated Board members and the SAB Chair; or
Option 3: Return the draft report to the Ballast Water Panel for further work, followed by a second Quality Review by the Board.

After noting her sense that nothing in the discussions had suggested a need for Option 3, **Dr. Swackhamer** indicated her readiness to entertain a motion. **Dr. Kim** made a motion that the Board adopt Option 1. The motion was second by **Dr. Doering**. **Dr. Swackhamer** then opened the floor for discussion.

Several members asked for clarification about how the non-concurring panel member's dissenting view would be dealt with, and **Dr. Segerson** asked if the changes suggested by the Board were likely to change the panel member's decision not to concur. Dr. Meyer noted that she made a number of efforts to accommodate the member's concerns, but without success. Several members suggested that the panelist should have an opportunity to explain the technical basis for the dissent. Dr. Meyer noted that she had received an email (Attachment C) from the panelist explaining the reason for the non-concurrence on procedural grounds. Dr. Swackhamer noted that the Board had flexibility to decide how best to reflect the fact that a panel member had not concurred with the draft report, but she made a distinction between a dissenting view based on scientific arguments that could be reflected in an attached minority report vs. a non-concurrence that is a rejection of the report as a whole based on procedural issues. She suggested that for the present case, the panel roster would include a note about the non-concurrence.

**Dr. Daniel** asked that the motion to adopt Option 1 for disposition of the report be amended to authorize Drs. Meyer and Swackhamer to work out the most appropriate means of conveying the non-concurrence in the final report.

**Dr. Dzombak** stated that he did not think that the changes to the report were minor, and he would prefer Option 2 for another look by the lead reviewers. Dr. Swackhamer noted that there needed to be a vote on the pending motion before alternative motions could be considered.

Upon calling for a voice vote, several members indicated opposition to the motion. Dr. Swackhamer then requested the Designated Federal Officer to conduct a roll call vote. The results of the vote on adoption of Option 1, as amended, were:

> In favor: Drs. Swackhamer, Daniel, Doering, Eighmy, Kahn, Kim, Lee, Lue-Hing, McMullen, Moo-Young, Murphy, Patten, Segerson, Zoeller
> Opposed: Drs. Daston, Dzombak
> Abstentions (members of the Ballast Water Panel): Drs. Meyer, Sanders

The motion was agreed to. As a point of clarification, **Dr. Lee** stated that he assumed that Drs. Swackhamer and Meyer retain the discretion to consult with other members, as needed. Dr. Swackhamer agreed that this was the case.

**E. Adjournment**

There being no further business, the DFO adjourned the teleconference meeting at 2:00 p.m.

Respectfully Submitted,

/s/

Stephanie Sanzone,
Designated Federal Officer
SAB Staff Office

Certified as Accurate,

/s/

Dr. Deborah L. Swackhamer,
Chair
Science Advisory Board

NOTE AND DISCLAIMER: The minutes of this public meeting reflect diverse ideas and suggestions offered by SAB members during the course of deliberations at the meeting. Such ideas, suggestions and deliberations do not necessarily reflect consensus advice from the SAB. The reader is cautioned not to rely on the minutes to represent final, approved, consensus advice and recommendations offered to the Agency. Such advice and recommendations may be found in the final advisories, commentaries, letters or reports prepared and transmitted to the EPA Administrator following the public meetings.

## Materials Cited

The following meeting materials are available on the SAB website, http://www.epa.gov/sab, at the June 16, 2011 SAB Meeting page.

[1] Federal Register Notice Announcing the Meeting (76 FR 30149-30150)

[2] Meeting Agenda, chartered Science Advisory Board, June 16, 2011

[3] Efficacy of Ballast Water Treatment Systems: a Report by the EPA Science Advisory Board (5-31-11 draft)

[4] Pre-Meeting Comments (6/15/11) from SAB Members on the draft report, *Efficacy of Ballast Water Treatment Systems: A Report by the EPA Science Advisory Board*

[5] Public Comments Submitted for the June 16, 2011, Meeting of the Science Advisory Board:

- Comments from Caitlyn Stewart on behalf of The American Waterways Operators
- Comments from Joel Mandelman, Nutech O3, Inc.
- Comments from Jonathan Grant, Battenkill Technologies, Inc
- Comments from Kathy Metcalf on behalf of Chamber of Shipping of America
- Comments from Maurya Falkner, California State Lands Commission, Marine Invasive Species Program
- Comments from Scott Crisafulli, NYS Dept. of Environmental Conservation

**Attachment A: Science Advisory Board Roster**

# U.S. Environmental Protection Agency
# Science Advisory Board

**CHAIR**

**Dr. Deborah L. Swackhamer**, Professor and Charles M. Denny, Jr. Chair in Science, Technology and Public Policy, Hubert H. Humphrey School of Public Affairs and Co-Director of the Water Resources Center, University of Minnesota, St. Paul, MN

**SAB MEMBERS**

**Dr. David T. Allen**, Professor, Department of Chemical Engineering, University of Texas, Austin, TX

**Dr. Claudia Benitez-Nelson**, Full Professor and Director of the Marine Science Program, Department of Earth and Ocean Sciences , University of South Carolina, Columbia, SC

**Dr. Timothy J. Buckley**, Associate Professor and Chair, Division of Environmental Health Sciences, College of Public Health, The Ohio State University, Columbus, OH

**Dr. Patricia Buffler**, Professor of Epidemiology and Dean Emerita, Department of Epidemiology, School of Public Health, University of California, Berkeley, CA

**Dr. Ingrid Burke**, Director, Haub School and Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming, Laramie, WY

**Dr. Thomas Burke**, Professor, Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD

**Dr. Terry Daniel**, Professor of Psychology and Natural Resources, Department of Psychology, School of Natural Resources, University of Arizona, Tucson, AZ

**Dr. George Daston**, Victor Mills Society Research Fellow, Product Safety and Regulatory Affairs, Procter & Gamble, Cincinnati, OH

**Dr. Costel Denson**, Managing Member, Costech Technologies, LLC, Newark, DE

**Dr. Otto C. Doering III**, Professor, Department of Agricultural Economics, Purdue University, W. Lafayette, IN

**Dr. David A. Dzombak**, Walter J. Blenko, Sr. Professor of Environmental Engineering , Department of Civil and Environmental Engineering, College of Engineering, Carnegie Mellon University, Pittsburgh, PA

**Dr. T. Taylor Eighmy**, Vice President for Research, Office of the Vice President for Research, Texas Tech University, Lubbock, TX

**Dr. Elaine Faustman**, Professor and Director, Institute for Risk Analysis and Risk Communication,

School of Public Health, University of Washington, Seattle, WA

**Dr. John P. Giesy**, Professor and Canada Research Chair, Veterinary Biomedical Sciences and Toxicology Centre, University of Saskatchewan, Saskatoon, Saskatchewan, Canada

**Dr. Jeffrey K. Griffiths**, Associate Professor, Department of Public Health and Community Medicine, School of Medicine, Tufts University, Boston, MA

**Dr. James K. Hammitt**, Professor, Center for Risk Analysis, Harvard University, Boston, MA

**Dr. Bernd Kahn**, Professor Emeritus and Associate Director, Environmental Radiation Center, Georgia Institute of Technology, Atlanta, GA

**Dr. Agnes Kane**, Professor and Chair, Department of Pathology and Laboratory Medicine, Brown University, Providence, RI

**Dr. Madhu Khanna**, Professor, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, Urbana, IL

**Dr. Nancy K. Kim**, Senior Executive, Health Research, Inc., Troy, NY

**Dr. Kai Lee**, Program Officer, Conservation and Science Program, David & Lucile Packard Foundation, Los Altos, CA

**Dr. Cecil Lue-Hing**, President, Cecil Lue-Hing & Assoc. Inc., Burr Ridge, IL

**Dr. Floyd Malveaux**, Executive Director, Merck Childhood Asthma Network, Inc., Washington, DC

**Dr. Lee D. McMullen**, Water Resources Practice Leader, Snyder & Associates, Inc., Ankeny, IA

**Dr. Judith L. Meyer**, Professor Emeritus, Odum School of Ecology, University of Georgia, Lopez Island, WA

**Dr. James R. Mihelcic**, Professor, Civil and Environmental Engineering, University of South Florida, Tampa, FL

**Dr. Jana Milford**, Professor, Department of Mechanical Engineering, University of Colorado, Boulder, CO

**Dr. Christine Moe**, Eugene J. Gangarosa Professor, Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, GA

**Dr. Horace Moo-Young**, Dean and Professor, College of Engineering, Computer Science, and Technology, California State University, Los Angeles, CA

**Dr. Eileen Murphy**, Grants Facilitator, Ernest Mario School of Pharmacy, Rutgers University, Piscataway, NJ

**Dr. Duncan Patten**, Research Professor, Hydroecology Research Program , Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT

**Dr. Stephen Polasky**, Fesler-Lampert Professor of Ecological/Environmental Economics, Department of Applied Economics, University of Minnesota, St. Paul, MN

**Dr. Arden Pope**, Professor, Department of Economics, Brigham Young University, Provo, UT

**Dr. Stephen M. Roberts**, Professor, Department of Physiological Sciences, Director, Center for Environmental and Human Toxicology, University of Florida, Gainesville, FL

**Dr. Amanda Rodewald**, Professor of Wildlife Ecology, School of Environment and Natural Resources, The Ohio State University, Columbus, OH

**Dr. Jonathan M. Samet**, Professor and Flora L. Thornton Chair, Department of Preventive Medicine, University of Southern California, Los Angeles, CA

**Dr. James Sanders**, Director and Professor, Skidaway Institute of Oceanography, Savannah, GA

**Dr. Jerald Schnoor**, Allen S. Henry Chair Professor, Department of Civil and Environmental Engineering, Co-Director, Center for Global and Regional Environmental Research, University of Iowa, Iowa City, IA

**Dr. Kathleen Segerson**, Philip E. Austin Professor of Economics , Department of Economics, University of Connecticut, Storrs, CT

**Dr. Herman Taylor**, Director, Principal Investigator, Jackson Heart Study, University of Mississippi Medical Center, Jackson, MS

**Dr. Barton H. (Buzz) Thompson, Jr.**, Robert E. Paradise Professor of Natural Resources Law at the Stanford Law School and Perry L. McCarty Director, Woods Institute for the Environment, Stanford University, Stanford, CA

**Dr. Paige Tolbert**, Professor and Chair, Department of Environmental Health, Rollins School of Public Health, Emory University, Atlanta, GA

**Dr. John Vena**, Professor and Department Head, Department of Epidemiology and Biostatistics, College of Public Health, University of Georgia, Athens, GA

**Dr. Thomas S. Wallsten**, Professor and Chair, Department of Psychology, University of Maryland, College Park, MD

**Dr. Robert Watts**, Professor of Mechanical Engineering Emeritus, Tulane University, Annapolis, MD

**Dr. R. Thomas Zoeller**, Professor, Department of Biology, University of Massachusetts, Amherst, MA

**SCIENCE ADVISORY BOARD STAFF**

**Dr. Angela Nugent**, Designated Federal Officer, U.S. Environmental Protection Agency, Science Advisory Board (1400R), 1200 Pennsylvania Avenue, NW, Washington, DC, (nugent.angela@epa.gov)

**Stephanie Sanzone**, Designated Federal Officer, U.S. Environmental Protection Agency, Science Advisory Board (1400R), 1200 Pennsylvania Avenue, NW, Washington, DC, (nugent.angela@epa.gov)

**Attachment B: Science Advisory Board Teleconference, June 16, 2011-- Other Attendees**

(Persons who requested the teleconference call-in number.)

Ryan Albert
EPA Office of Water

John W. Butler
World Shipping Council

Nicole Dobroski
California State Lands Commission

Marvourneen K. Dolor, Ph.D.
U.S. Department of Transportation

Bronwyn G. Douglass
Office of Maritime & International Law
Commandant (CG-0941)
U.S. Coast Guard

Colin Henein, Ph.D.
Transport Canada

Gregory Kirkbride
U.S. Coast Guard

Marcie Merksamer
EnviroManagement, Inc.

Azin Moradhassel
Canadian Shipowners Association

Deborah Nagle
EPA Office of Water

David F. Reid, Ph.D
Ann Arbor, MI

Mario N. Tamburri, Ph.D.
University of Maryland
Center for Environmental Science

**Attachment C: Letter from Andrew Cohen to Judith Meyer, May 27, 2011**

27 May 2011

Dr. Judith L. Meyer
Chair, Ecological Processes and Effects Committee Augmented for the Ballast Water Advisory

Dear Dr. Meyer,

I concur with the report in general, but must take exception to two items, and I request that this reply be included in the report as a statement of non-concurrence.

The discussion of treating ballast water in reception facilities has been a deeply contentious issue almost from the inception of the Panel. Eleven days ago, ten Panel members, including those members who had argued for opposing views, met in teleconference and reached a consensus on how to present the reception facility discussion in the final draft report. This consensus included agreement on the exact wording of the relevant conclusions and recommendations; and agreement that those issues on which there was not consensus would be presented in an appendix as opposing or differing views (Appendix C), with each side free to write its own views as it saw fit.

When the Panel received the final draft report after close-of-business three days ago, these two areas of the agreement had not violated. First, an argument, which I believe is misleading, had been added to the conclusions. Because this change was made at the last minute there has been no opportunity for the Panel to discuss it, or even for the people who had been involved in developing and critiquing and editing the reception facility section to discuss it. This timing, combined with the rules that the Panel operates under, prohibited us from even communicating to the Panel our concerns about it. Making last minute changes to the report's conclusions which the Panel members then had no opportunity to discuss is obviously a poor process, and at some level undermines the integrity of the report.

The other violation of the agreement is that the final draft of the views submitted for the non-consensus appendix were not included in the report, although other last minute changes and additions to the opposing views were made. I can see no possible justification for this.

Accordingly, and regretably, I cannot concur with the report as it is written; and I ask that the final version of the views submitted to you be considered instead of the current version in Appendix C, which does not accurately represent my views.

The final submitted version is as follows:

**Number of treatment plants and treatment capacity needed**

***View A***

To compare the number of treatment plants needed to treat all ballast water discharges into U.S. waters by either shipboard BWMS or by reception facilities, we started with EPA projections of 40,000 cargo vessels and 29,000 other vessels (primarily barges) being subject to EPA ballast water requirements over 5 years (Albert & Everett 2010). No estimate of what portion of these will need to treat their ballast discharges is available (Ryan Albert, US EPA Office of Water, pers. comm.); however, for these screening-level estimates we used lower and upper bounds of 25% and 100%. This yields a lower bound estimate of 10,000 treatment plants needed on cargo vessels and 7,250 plants needed on other vessels, and an upper bound estimate of 40,000 plants on cargo vessels and 29,000 plants on other vessels.[1] For the reception facility scenario, an estimated 360 treatment plants will be needed based on the total number of commercial sea and river ports in the U.S. (American Association of Port Authorities 2011). Even considering only the treatment plants needed on cargo vessels, this suggests that approximately 30-110 times as many treatment plants would be needed to treat the ballast water in BWMS compared to treating it in reception facilities.

We compared the total treatment capacity needed by two approaches. First, by developing and comparing estimates of the capacities needed for either BWMS or reception facility treatment; and second by considering the ratio of time an average vessel would use its BWMS to the time its BWMS would sit idle, and comparing this to a reception facility whose treatment plant operates nearly continuously.

In the first approach, to estimate the needed BWMS treatment capacity we multiplied the lower and upper bounds on cargo ship number derived above by the average ballast pumping capacity of cargo vessels operating in U.S. waters of approximately 1,100 MT/h (derived from USCG 2008b, Tables 2.2, 3.4 & C-1). This yielded an estimate of 11-44 million MT/h. No data are available on the average ballast pumping capacity of the non-cargo vessels that EPA expects to be subject to discharge requirements, so no estimate could be made of the BWMS treatment capacity they would need.

To estimate the treatment capacity that would be needed to treat U.S. ballast discharges, we started with a published estimate of the reception facility treatment capacity needed for ballast discharges into California waters that was based on handling two consecutive days of maximum reported daily discharge (from CAPA 2000), adjusted that figure upward using the most recent ballast discharge data corrected for reporting rates (Miller et al. 2007), and then multiplied by the ratio between the ballast discharges into U.S. and California waters (Miller et al. 2007). This yielded an estimate of 36,000 MT/h. As a check on that estimate, we calculated the average ballast water discharge rate into U.S. waters, which is the theoretical minimum treatment capacity needed. From the discharge quantities given in Miller et al. (2007), corrected for reporting rates, the average discharge rate is 27,000 MT/h,[2] which is consistent with an estimate of 36,000 MT/h. Considering only the BWMS needed on cargo vessels, this suggests that approximately 300-1,200 times greater capacity would be needed to treat the ballast discharge in BWMS compared to treating it in reception facilities.

For the second approach, we assume that all vessels that discharge any ballast water into U.S. waters discharge all their ballast water into U.S. waters, and that they always deballast at a rate equal to their

[1] These numbers may be compared to the Coast Guard's estimates of 7.575 vessels operating in U.S. waters in one year (2007) that would be potentially subject to the Coast Guard's proposed ballast water discharge standards, and 10,895 vessels that would need to install BWMS over the first 5 years that the standards were in effect (these numbers include passenger ships, fishing vessels and offshore drilling vessels as well as cargo ships, but do not include crude oil tankers engaged in coastwise trade or barges) (US Coast Guard 2008c).

[2] Miller et al. (2007) reported 258 million MT of ballast water discharged into U.S. waters over a 2-year period, which gives an average of 14,700 MT/h, before correcting for reporting rates.

needed BWMS treatment capacity (which is typically equal to their maximum ballast pumping rate). With these assumptions, the reception facility treatment capacity that would be needed to treat the vessels' total discharge is the average fraction of time that each vessel spends deballasting times times the total needed BWMS treatment capacity for all these vessels. The fraction of time that a vessel spends deballasting can vary significantly. A bulk carrier travelling between ports in the Great Lakes, for example, may spend only four days on a round trip voyage and deballast for eight hours, so the fraction of time spent deballasting is 1/11. A trans-Pacific container ship might deballast for only six hours on a 14 day run, thus deballasting for 1/55 of the time. If these represent upper and lower bounds on the average fraction of time spent deballasting, then between 11 and 55 times greater capacity would be needed to treat the total U.S. discharge from such vessels in BWMS compared to treating it in reception facilities.

Both approaches indicate that at least an order of magnitude greater treatment capacity would be needed to treat U.S. ballast water discharges on ships than on shore. However, the two approaches give very different results, and it's not clear why. In the first approach, the needed reception facility treatment capacity was based on extrapolating a published estimate for California to the entire U.S., and it's possible that either the California estimate was widely off or the method of extrapolation was inappropriate. However, the check on that estimate was based only on the total reported amount of U.S. ballast water discharge, and it's unlikely that this could be off by enough to bring the two approaches into agreement. The second approach assumed that ships always discharge at their maximum rate and discharge all their ballast into U.S. waters. Violation of either of these assumptions would tend to decrease the needed reception facility treatment capacity relative to the needed BWMS treatment capacity and thus bring the approaches closer to agreement.[3]

The above calculations address the plants and capacity needed to treat all ballast water discharged into U.S. waters. If other countries implement ballast water discharge standards, depending on the standards implemented these might require either the installation of BWMS on some vessels or the construction of reception facilities in some countries. These scenarios are discussed briefly below in *International issues*.

## Cost comparison

### *View A*

We provide a screening-level comparison of capital costs for treating discharges from cargo vessels into U.S. waters. Operations and maintenance costs are not included because previous studies and preliminary estimates found them to be a small fraction of total costs (<5% of total costs for treatment of California ballast discharges in reception facilities (CAPA 2000, with estimated land and vessel modification costs included); <0.5% of total costs for shipboard BWMS treatment of U.S. ballast discharges (USCG 2008a)). Similarly, costs are not adjusted for inflation or adjusted to present values in these calculations. Neither such cost adjustments nor including O&M costs would substantially alter the comparison. Costs for vessels other than cargo vessels that EPA projects will be subject to ballast water regulations

[3] For example, Glosten (2002) reported on representative vessels of five types operating in Puget Sound, with relevant data on three of these: a bulk carrier operating on round trips from the Far East and Australia to the western U.S. and Canada typically deballasted at an average rate of about 75-80% of its maximum ballast pumping rate; a containership operating on 42-day round trips between a California port, Seattle and ports in the Far East typically spent less than 4 hours deballasting at Seattle (and an apparently similar time in California) at an average rate of about 30% of its maximum ballast pumping rate; and a car carrier operating on a monthly round trip between Japan and Puget Sound mainly shifted ballast between tanks, with deballasting being an unusual event. The ratios between needed BWMS treatment capacity and U.S. reception facility treatment capacity would be≈120:1 for the bulk carrier (assuming 1-month round trips and ballast discharge split between the U.S. and Canada), ≈420:1 for the containership, and probably a larger ratio for the car carrier.

(primarily barges) are not included, as no data are available regarding shipboard treatment plants or modification costs for these vessels.

To estimate the capital cost of reception facilities (not including vessel modification costs) we started with a published estimate for California of approximately $200 million (CAPA 2000), proportionately increased this to $700 million based on more recent and complete discharge data (Miller et al. 2007), added land costs of $100 million (based on internet-advertised prices for vacant land near California's ports), and extrapolated to U.S. waters by multiplying by the ratio between the ballast discharges into U.S. and California waters (Miller et al. 2007), yielding a U.S. estimate of $16 billion. Most of this cost is for vessel modification, pipelines, storage tanks, etc., with less than 10% for the treatment plants themselves.

Based on the average cost per unit of treatment capacity in recent cost estimates (Glosten 2000; Brown and Caldwell 2008) and an average ballast pumping capacity of 1,100 MT/h (from USCG 2008b), we estimated the average cost for modifying an existing vessel to allow it to discharge ballast water to a reception facility at $180,000. We used lower and upper bound estimates of 10,000 and 40,000 cargo vessels needing to treat ballast discharges over five years (see above), and doubled these for the 30-year lifetime of a reception facility based on fleet replacement with an average 25-year vessel lifetime. This yields a total capital cost for reception facilities (including both on-land facilities and vessel modification costs) of $20-30
billion.

The average interpolated cost for a 1,100 MT/h shipboard treatment plant is $700,000, based on cost data for 200 MT/h and 2,000 MT/h plants for the eight BWMS that Lloyd's Register (2010) lists as having type approval received or pending. For the estimated number of cargo vessels over 30 years, the total cost is $14-56 billion.

Both these shipboard BWMS and the onshore treatment plants on which the CAPA (2000) estimate was based are assumed to be capable of meeting the IMO D-2 standards. USCG (2008a,b) roughly estimated that achieving 10x and 100x IMO D-2 levels of treatment would require doubling and quadrupling the investment in the treatment plant, respectively. These figures are used to estimate the costs of meeting more stringent discharge standards (Table C.1). Because the treatment plant costs are a much smaller component of total costs for reception facilities than for shipboard BWMS, a comparison of costs increasingly favors reception facilities at higher levels of treatment.

**Table C.1. Estimated capital costs to meet different discharge standards with shipboard BWMS or with reception facilities.**

| Standard | Shipboard BWMSs | Reception Facilities |
|---|---|---|
| IMO D-2 | $14 - $56 billion | $20 - $30 billion |
| 10x IMO D-2 | $28 - $110 billion | $22 - $32 billion |
| 100x IMO D-2 | $56 - $220 billion | $25 - $35 billion |

This analysis is based on the treatment plants and costs needed to treat all ballast water discharges into U.S. waters, and the reception facility costs are based on on-land treatment plants. Estimates and cost comparisons for treating ballast water discharges in other countries or in barge-mounted treatment plants, would, of course, differ. Although O&M costs, inflation adjustments, and present valuation of costs were not included in the cost comparison presented here, a more detailed comparison including such elements was prepared and produced similar results. This cost comparison was undertaken because some studies

(e.g. Victoria ENRC 1997; Rigby & Taylor 2001a,b; California SLC 2009, 2010) and the EPA (SAB teleconference 11/26/10) claimed that reception facility treatment is infeasible or should not be considered because of its costs. Developing screening-level cost estimates are routine tasks for most engineers (two served on the Panel) and within the expertise of individuals with Masters-level economics training (one served on the Panel).

**Cost recovery**

***View A***

Two published studies stated that cost recovery could be an issue for reception facilities (Dames & Moore 1998; Oemke 1999). However, vessels could either be charged a fee for ballast water treatment sufficient to cover construction and operating costs; or alternatively, ports or government authorities could decide to subsidize part or all of the costs. Either way, there is no apparent obstacle to cost recovery.[4]

**Invested effort**

***View A***

EPA argued (SAB teleconference 11/26/10) that since considerable time has been spent working on shipboard BWMS, the U.S. should not waste this effort by adopting discharge standards so stringent that shipboard BWMS cannot meet them, even if reception facilities could do so. In economic and business analysis and in game theory decisions such as this are based on retrospective or sunk costs, and using the parlance of decision theory, are considered "irrational;" decisions considered to be "rational" invest resources where future benefits are expected to be greatest, not where investments have been made in the past (Arkes & Blumer 1985; Keasey & Moon 2000).

**International issues**

***View A***

EPA argued (SAB teleconference 11/26/10) that an environmental injustice would result if the U.S. based its discharge standards on reception facilities' greater efficacy. The argument is that less stringent U.S. standards would promote the installation of shipboard BWMS on part of the world's fleet, which would make it more likely that certain countries would adopt and enforce similar standards because some vessels serving those countries would have already installed the necessary equipment. On the other hand, if the U.S. adopted more stringent standards that could not be met by shipboard BWMS, then vessels would not install BWMS, and those countries would be less likely to adopt or enforce any discharge standards at all because the economic hurdles to implementation would be higher.

Another argument is that additional costs could result if the U.S. based its standards on reception facilities' greater efficacy, because some countries would subsequently adopt and enforce standards that could be met by shipboard BWMS, and reception facilities would not be built at those countries' ports. Vessels discharging ballast water in both those countries and the U.S. could then incur both the costs of

[4] Cohen & Foster (2000) noted that low-interest or no interest government loans, a form of subsidy, were then available to construct facilities to treat wastewater in California, including ballast water; and further noted that reception facilities operated by ports or private companies could potentially turn a profit.

installing and operating BWMS, and vessel modification costs to enable ballast discharge to reception facilities as well as reception facility fees.

We note that for any country, the two scenarios above are mutually exclusive; and other scenarios are possible, such as countries not adopting and enforcing ballast discharge standards regardless of what standards the U.S. adopts, or countries being influenced by U.S. adoption of stringent reception-facility-based standards to do so as well. We are unaware of any analysis of the relative likelihood of the various possible international scenarios.

In addition, to demonstrate environmental injustice, one would have to show that adverse impacts would fall disproportionately on protected populations. However, the federal government's definition of environmental justice is explicitly restricted to issues of disproportionate impacts between populations *within* the United States.[5] Also, the usual remedy is to reduce impacts for the more adversely affected population. EPA argued for the opposite: rather than helping other countries to implement stronger environmental protections, it argued that the U.S. should adopt weaker ones. There appears to be no precedent for this.

**Implementation schedule**

***View A***

Additional factors that may affect the implementation schedule are a potential lag of several years needed to development facilities for large-scale production of shipboard BWMS (USCG 2008c), and the time needed to develop an effective monitoring and enforcement program. As discussed earlier, a larger and more costly program would be needed to monitor and enforce shipboard treatment, and this could affect the overall time to implementation.

**Need for further study**

***View B*** *(Note: This responds to the argument in the last two paragraphs of* **Number of treatment plants and treatment capacity needed**, View B.)

Substantial questions remain about both reception facility and BWMS treatment. The biggest question for the use of reception facilities to treat U.S. ballast water discharges is probably the extent of certain operational challenges—including ballast discharges currently conducted away from ports on some voyages—and the cost of dealing with them. With better information on these factors, this question could be addressed analytically. Another question that has been raised is the effectiveness of available treatment processes to remove or kill the range of organisms and salinities represented in ballast discharges. For treatment processes used in BWMS that have been tested for type approval, the limited data published from those tests are available, in addition to data on some BWMS treatment processes in the ballast water treatment literature. For some of those BWMS processes (e.g. chlorine treatment, UV treatment), as well as other processes used in conventional and advanced drinking water treatment that are not suitable for shipboard use, there is a large amount of efficacy data from many decades of drinking water treatment and testing at a wide range of scales (from bench-top tests to full-scale operating facilities), using a variety of source waters. Additional data is available for some processes related to their use in fouling control in industrial and cooling water systems. The drinking water data, however, is

[5] Executive Order 12898, which charged agencies with "identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands."

nearly all limited to freshwater salinities and organisms, and there may be a need to verify the performance of some of these processes against a broader range of salinities and organisms, which could probably be addressed by small scale testing.

Questions remain regarding the broad-scale efficacy of BWMS. There are data on some of the processes used in BWMS in the ballast water treatment literature and in the drinking water treatment and fouling control literature. In addition, there are limited data on processes employed in specific BWMS available from type approval testing. Where these latter are available for a BWMS, they are derived from a minimum of five test runs conducted over a few days in an on-land test facility under more-or-less specified test conditions and three test runs on board a ship. For some BWMS, data from a small number of additional test runs may be available; for others, including some type-approved BWMS, some or all of the test data have never been released. Aside from the limited range of salinities and organism diversity that can be tested with a severely limited testing regime, an additional concern with the type approval tests is that BWMS manufacturers are allowed to use them as an extension of product development. That is, a manufacturer can test a BWMS that is configured and tuned to barely meet the expected test conditions at a particular on-land facility; if it passes the test, then (with an acceptable shipboard test) it is type approved for universal use; if not, the manufacturer can tweak the system and immediately retest, and continue tweaking and retesting until the system passes. These and other defects are discussed ithe report. Where the available data are inadequate to assess the broad-scale efficacy of BWMS, this could be addressed by more extensive testing of BWMS or of the treatment processes used in them, including BWMS testing conducted with improved type approval test criteria.

Another major question regarding BWMS concerns their long-term reliability and performance under shipboard operating conditions. These systems are newly-developed, only a small number have been installed on ships,[6] and other than the type approval test data that have been released there are little or no data available on these systems' performance. When installed on new ships, BWMS may be kept in service for 20, 25, even 30 years in some cases. How effective they will remain over that period can only be assessed by performance evaluation after years of actual use.

While emphasizing the importance of these questions, we recognize that the regulatory schedule may not admit all of them to be fully answered before regulatory decisions must be made. However, due consideration should be given to them.

Sincerely,

Andrew N. Cohen
Director, Center for Research on Aquatic Bioinvasions

[6] Of the types of BWMS for which the Panel concluded there is evidence that they meet or come close to meeting IMO D2 standards, only 33 had been installed on vessels by 2010 (Lloyd's Register 2010).