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2011 UPDATE: BALLAST WATER TREATMENT SYSTEMS FOR USE IN CALIFORNIA WATERS

PREPARED FOR THE CALIFORNIA STATE LANDS COMMISSION
BY THE MARINE INVASIVE SPECIES PROGRAM

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August 16, 2011

EXECUTIVE SUMMARY

The Coastal Ecosystems Protection Act of 2006 (Act) expanded the Marine Invasive Species Program to more effectively address the threat of nonindigenous species introduction through ballast water discharge. The Act charged the California State Lands Commission (Commission) to implement performance standards for the discharge of ballast water and to prepare reports assessing the efficacy, availability and environmental impacts, including water quality, of currently available ballast water treatment technologies eighteen months in advance of each of the individual implementation dates. The performance standards regulations were adopted in October 2007, and subsequent legislatively-mandated ballast water treatment technology assessment reports were approved by the Commission in December 2007 (see Dobroski et al. 2007), December 2008 (see Dobroski et al. 2009), and August 2010 (see California State Lands Commission 2010). This current update was requested by the Commission and serves as a follow-up to the August 2010 legislatively-mandated report to ensure that technologies are developing on schedule to allow for the implementation of California's performance standards for vessels with a ballast water capacity of greater than 5000 metric tons (MT) for which construction begins on or after January 1, 2012.

Commission staff reviewed 60 ballast water treatment systems for this update. Because of the limitations of testing data and the variable conditions present in the "real world," this update examines treatment system performance data to determine whether or not systems have demonstrated the **potential** to comply with California's standards. Based on currently available information and using best assessment techniques, 10 treatment systems have demonstrated the potential to comply with the Commission's performance standards (see Table 4) – an increase of two since the 2010 report and an increase of eight since 2009. Efficacy data for these systems indicate that at least one test (averaged across replicates) met California's standards for every testable organism size class during either land-based or shipboard testing. Five of the 10 systems show the potential to meet California standards more than 50% of the time over multiple tests (3 or more) during either land-based or shipboard testing. One system demonstrated potential compliance with California's standards 100% of the time in shipboard testing,

although no system has yet met California's standards 100% of the time in land-based testing. This review does not constitute an endorsement or approval of any treatment system, system manufacturer or vendor by the Commission or its staff.

Since the August 2010 technology assessment report, there has been significant activity concerning performance standards implementation and ballast water technology assessment at the state, federal and international levels. Recent reports from the Great Lakes Ballast Water Collaborative (GLBWC 2010), Wisconsin Department of Natural Resources (WDNR 2010), and the U.S. Environmental Protection Agency (EPA) Science Advisory Board (SAB 2011) have concluded that the current limits of testing methods prevent evaluating, with a high level of statistical sensitivity, whether or not treatment systems can meet standards more stringent than the International Maritime Organization (IMO) (see Table 1). California's standards were not specifically reviewed in these reports. California's discharge standard for organisms greater than 50 micrometers (one millionth of a meter, μm) is "no detectable living organisms," and is not defined by a specific volumetric concentration. Thus, California's standard for this organism size class is not directly comparable to the IMO or standards proposed by other entities evaluated by these reports.

It is important to note that, as a whole, treatment systems have undergone a relatively small number of tests, under a limited range of environmental conditions. This leads to inherent uncertainty regarding treatment system performance across the spectrum of potential variables, including ship type and source water properties (e.g. temperature, turbidity, salinity). This uncertainty is likely to persist over the next several years. In the absence of a significant worldwide effort to install and test treatment systems on multiple vessels and under all possible environmental scenarios, it is unreasonable to expect that sample sizes and available data will increase adequately in the near future to demonstrate, with a high level of confidence, that treatment systems will consistently meet California's performance standards under every potential situation and under all circumstances. However, continuing to wait for such information will only serve to delay progress. Due to the inherent uncertainty regarding treatment system performance and

evaluation, the utilization of an adaptive management approach will be essential at all stages of implementation in order to move forward and protect California's aquatic resources from the impacts of species introductions.

Because of the difficulties of testing treatment technologies to meet California's standards with a high level of statistical confidence, staff convened the ballast water treatment technology technical advisory panel (established by Public Resources Code (PRC) Section 71204.9) in December 2010 and March 2011 to discuss options for implementing California's performance standards for the discharge of ballast water. The panel discussed three options including: 1) recommending that the Legislature amend the standards, 2) recommending that the Legislature implement the use of Best Available Technologies until such time that staff can statistically verify that treatment system meet the standards, or 3) develop and adopt regulations defining specific protocols to verify vessel compliance with California's performance standards. The panel agreed that the best option for moving forward was to develop and adopt compliance verification protocols. These protocols will allow system manufacturers and vessel owners/operators to verify that their treatment technologies are meeting California standards using the same methods, and with the same statistical sensitivities, that will be used by Commission personnel to determine compliance. Commission staff has convened a panel of experts to develop the compliance protocols and intends to begin the rulemaking process in late-2011.

In conclusion, Staff continues to see great progress in the development and testing of ballast water treatment technologies. While there are some challenges verifying that treatment systems meet California's standards, Commission staff have worked with a technical advisory panel of regulators, industry members, scientists and environmental organizations to discuss options for proceeding with the implementation of California's standards. Based on those discussions, Commission staff is in the process of developing verification protocols to ensure that all vessels discharges are compliant with California law. Staff recommends that the Commission continue to support staff's effort to implement California's performance standards for the discharge of ballast water.

These efforts will continue to move the state towards the elimination of the discharge of nonindigenous species into California waters.

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ABBREVIATIONS AND TERMS

Act	Coastal Ecosystems Protection Act
CCR	California Code of Regulations
CFR	Code of Federal Regulations
CFU	Colony-Forming Unit
Commission	California State Lands Commission
Convention	International Convention for the Control and Management of Ships' Ballast Water and Sediments
EPA	United States Environmental Protection Agency
ETV	Environmental Technology Verification Program
GLBWC	Great Lakes Ballast Water Collaborative
IMO	International Maritime Organization
MEPC	Marine Environment Protection Committee
ml	Milliliter
MT	Metric Ton
NRC	National Academies of Sciences' National Research Council
PRC	Public Resources Code
R&D	Research and Development
SAB	EPA Science Advisory Board
SB	Senate Bill
Staff	Commission staff
STEP	Shipboard Technology Evaluation Program
µm	Micrometer
USCG	United States Coast Guard
UV	Ultraviolet Irradiation
Vessel General Permit	Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels
WDNR	Wisconsin Department of Natural Resources

I. PURPOSE AND DISCLAIMER

This update provides information regarding the ability and availability of ballast water treatment systems to meet California's performance standards for the discharge of ballast water. This update is produced by California State Lands Commission (Commission) staff as a follow-up to the recent legislatively mandated report, "2010 Assessment of the Efficacy, Availability and Environmental Impacts of Ballast Water Treatment Systems for Use in California Waters" (see California State Lands Commission 2010). Because this update is a companion document, not all components included in the legislatively mandated treatment technology assessment report are discussed. The purpose of this update is to review the latest system efficacy (i.e. performance) data and information to ensure that technologies are developing on schedule to allow for the implementation of California's performance standards for newly built vessels with a ballast water capacity of greater than 5000 metric tons (MT) on January 1, 2012.

This update does not constitute an endorsement or approval of any treatment system, system manufacturer or vendor by the Commission or its staff. It is the responsibility of the vessel owner/operator to select treatment systems that will ensure that all ballast water discharged in California waters is in compliance with applicable laws, regulations and permits.

II. INTRODUCTION

The Coastal Ecosystems Protection Act (Act) (Chapter 292, Statutes of 2006) expanded the Marine Invasive Species Act (Chapter 491, Statutes of 2003, Public Resources Code (PRC) Sections 71200 *et seq*.) to more effectively address the threat of nonindigenous species introductions through ballast water discharge. The Act mandated that the Commission implement performance standards for the discharge of ballast water and prepare reports assessing the efficacy, availability, and environmental impacts, including the effect on water quality, of currently available ballast water treatment technologies prior to each implementation date. The performance standards regulations were adopted in October 2007 (Title 2 California Code of Regulations (CCR)

Section 2291 *et seq*., see Table 1), and the first ballast water treatment technology assessment report was approved by the Commission in December 2007 (see Dobroski et al. 2007).

In response to the recommendations in the 2007 report, the California Legislature passed Senate Bill (SB) 1781 (Chapter 696, Statutes of 2008) which, among its provisions amended PRC Section 71205.3 and delayed the initial implementation of California's performance standards for newly built vessels with a ballast water capacity of less than or equal to 5000 MT from January 1, 2009 to January 1, 2010 (see Table 2 for implementation schedule). Additionally, SB 1781 required an update of the treatment technology assessment report by January 1, 2009. The 2009 report (see Dobroski et al. 2009) presented data indicating that at least two ballast water treatment technologies had demonstrated the potential to comply with California's performance standards for the discharge of ballast water. As such, the report recommended that the Commission proceed with the initial implementation of California's performance standards beginning January 1, 2010 for newly built vessels with a ballast water capacity of less than or equal to 5000 MT.

Table 1. Ballast Water Treatment Performance Standards

Organism Size Class	IMO Convention Regulation D-2[1]	California[1,2]
Organisms greater than 50 µm[3] in minimum dimension	< 10 viable organisms per cubic meter	No detectable living organisms
Organisms 10 – 50 µm in minimum dimension	< 10 viable organisms per ml[4]	< 0.01 living organisms per ml
Living organisms less than 10 µm in minimum dimension		< 10^3 bacteria/100 ml < 10^4 viruses/100 ml
Escherichia coli	< 250 cfu[5]/100 ml	< 126 cfu/100 ml
Intestinal enterococci	< 100 cfu/100 ml	< 33 cfu/100 ml
Toxicogenic *Vibrio cholerae* (O1 & O139)	< 1 cfu/100 ml or < 1 cfu/gram wet weight zooplankton samples	< 1 cfu/100 ml or < 1 cfu/gram wet weight zoological samples

[1] See Table III-2 below for dates by which vessels must meet California and IMO Ballast Water Performance Standards.
[2] Final discharge standard for California, beginning January 1, 2020, is zero detectable living organisms for all organism size classes.
[3] Micrometer – one-millionth of a meter
[4] Milliliter – one-thousandth of a liter
[5] Colony-forming unit – a measure of viable bacterial numbers

Table 2. Implementation Schedule for Performance Standards

Ballast Water Capacity of Vessel	Standards apply to new vessels in this size class constructed on or after	Standards apply to all other vessels in this size class beginning in[1]
< 1500 metric tons	2009 (IMO)[2] /2010 (CA)	2016
1500 – 5000 metric tons	2009 (IMO)[2] /2010 (CA)	2014
> 5000 metric tons	2012	2016

[1] In California, the standards apply to vessels in this size class as of January 1 of the year of compliance. The IMO Convention applies to vessels in this size class no later than the first intermediate or renewal survey, whichever occurs first, after the anniversary date of delivery of the ship in the year of compliance (IMO 2005).
[2] IMO has pushed back the initial implementation of the performance standards for vessels constructed in 2009 in this size class until the vessel's second annual survey, but no later than December 31, 2011 (IMO 2007).

Per PRC Section 71205.3, the Commission must update the ballast water treatment technology assessment report to the Legislature 18 months prior to each of the implementation dates for the performance standards (see Table 2). In August 2010, the Commission presented its third treatment technology assessment report (California State Lands Commission 2010) to the Legislature evaluating the availability of ballast water treatment systems for newly built vessels with a ballast water capacity of greater than 5000 MT. These vessels must meet the standards beginning January 1, 2012. The August 2010 report concluded that eight ballast water treatment systems have demonstrated the potential to comply with California's performance standards, and three of the eight systems surpassed the standards more than 50% of the time over multiple tests. Furthermore, vessels for which construction begins on or after January 1, 2012 will not be expected to meet California's standards until construction is complete and the vessel is operational in California waters, likely sometime in 2014. Thus the Commission concluded that the lead time available for further technology development and refinement is sufficient to indicate that technologies are developing on schedule and will be available by the time these vessels must meet California's discharge standards.

However, in recognition of the fact that the field of ballast water treatment technology is developing rapidly and that there remains some uncertainty about the availability of treatment systems to meet California's standards, the Commission requested that staff prepare an updated report by September 1, 2011 to ensure that treatment technologies will be available to meet California's performance standards for newly built vessels with a ballast water capacity of greater than 5000 MT on January 1, 2012. This update is intended to provide the Commission, as well as vessel owners/operators and other interested stakeholders, with the most current information available on system development and availability, with a focus on system efficacy. This update presents data and information gathered as of August 1, 2011.

III. RECENT STATE, FEDERAL AND INTERNATIONAL ACTIVITIES RELATED TO BALLAST WATER PERFORMANCE STANDARDS, AND THEIR IMPLICATIONS FOR CALIFORNIA

Though the focus of this update is the availability and efficacy of ballast water treatment systems to meet California's performance standards, there has recently been much activity surrounding the potential adoption of performance standards at other state, federal, and international levels. As a result, several meetings, public discussions, hearings and regulatory actions outside of California have been underway during the last 12 months. Reports produced from these activities have included reviews of treatment technology development and performance assessment that bear mention here, as they may impact efforts to implement California's performance standards. Selected issues are discussed below.

International Maritime Organization (IMO)

As of July 31, 2011, 28 countries representing 25.43% of the world's shipping tonnage have signed the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Convention) (see IMO 2005, IMO 2011). The Convention will be ratified when signed by 30 countries representing 35% of the world's shipping tonnage. The Convention enters into force 12 months after ratification. Some experts predict that the Convention will be ratified by January 1, 2012 with entry into force by January 1, 2013. As of August 2011, the U.S. has not signed on to the Convention.

Among its provisions, the Convention imposes performance standards for the discharge of ballast water (Regulation D-2, see Table 1) with an associated implementation schedule (see Table 2). Additionally, the Convention requires the development of guidelines for the approval of ballast water management systems using active substances (i.e. biocides; see Guideline G9, MEPC 2008a) and guidelines for flag state administrations to Type Approve systems as compliant with the Convention's performance standards (see Guideline G8, MEPC 2008b).

While the Convention does not directly impact California's ability to implement performance standards, implementation of the Convention will spark an international surge in the sale and installation of ballast water treatment systems. Already, anticipation that the Convention will be ratified has led to an increase in the number of systems under development and the number of systems conducting Type Approval testing according to the IMO Guidelines (G8) (see Section IV, Treatment Systems). Thus far, a critical barrier to the advancement of treatment systems has been a lack of installation and testing on active vessels. Implementation of the Convention should lead to more systems being installed on actively trading vessels and the opportunity for scientists, regulators and stakeholders to gather valuable information about treatment system usage and efficacy under real-world conditions to ensure better worldwide protection against species introductions.

U.S. Federal Programs

Ballast water discharges in the United States are regulated by both the United States Coast Guard (USCG) and the United States Environmental Protection Agency (EPA). Prior to February 6, 2009, ballast water was regulated solely by the USCG through regulations developed under authority of the National Invasive Species Act of 1996. EPA also began regulating ballast water in 2009 after a court decision required ballast water and other discharges incidental to the normal operation of vessels to be regulated under the Clean Water Act. The USCG and EPA regulations and permits do not relieve vessel owners/operators of the responsibility of complying with applicable state laws and/or regulations. Thus vessels face a challenging environment for the management of ballast water discharges marked by the need to navigate regulation by two federal agencies as well as the states. Recent efforts by both USCG and EPA, described below, have included working collaboratively to reduce confusion amongst the regulated industry while developing a strong federal program for ballast water management.

USCG

In August 2009, the United States Coast Guard proposed regulations to establish federal performance standards for living organisms in ships' ballast water discharged in

U.S. waters. The proposed regulations would amend Title 33 Code of Federal Regulations (CFR) Part 151 to include a two-phase ballast water discharge standard and implementation schedule. Phase one would require vessels to meet the IMO Regulation D-2 standards (see Table 1) by 2012. Phase two would require that discharged ballast comply with a standard roughly 1000 times more stringent than IMO (similar to California's standards) by 2016, contingent upon a review of the availability of treatment technologies to meet that standard. The public comment period on the proposed rule closed in December, 2009. The USCG received thousands of comments, and as of August 2011 the final rule had not yet been released. The USCG has indicated that it hopes to publish the final rule sometime in late-2011. In the meantime, the USCG has begun developing protocols to verify vessel compliance with the proposed federal standards. Commission staff has been asked by USCG to participate and provide input.

The USCG continues to support the development of novel ballast water treatment technologies through the Shipboard Technology Evaluation Program (STEP). STEP provides an avenue for vessels to install and operate experimental ballast water treatment systems in U.S. waters. Vessels accepted into the program receive an equivalency for future federal performance standards. As of August 2011, six vessels have been accepted into STEP. Currently, the USCG has not finalized the shipboard testing protocols to verify system performance, and STEP vessels are therefore unable to proceed with shipboard testing for treatment system biological efficacy.

Commission staff continues to work with the USCG and encourage the operation of STEP vessels in California waters. In 2011, the California Senate Environmental Quality Committee introduced Senate Bill 935. Among its provisions, SB 935 would extend the date by which vessels engaged in the experimental evaluation of ballast water treatment systems (mainly STEP vessels) may apply to the Commission for approval to operate those experimental systems in California waters. PRC Section 71204.7 currently sets January 1, 2008 as the deadline by which vessels must apply to the Commission to receive approval to operate experimental systems in California. Following Commission

approval, experimental STEP vessels are grandfathered for five years as compliant with California's standards. The January 2008 deadline has passed, and only five STEP vessels currently have permission to use their experimental systems in California waters. SB 935 would extend the application date to January 1, 2016. Extending the application deadline would provide incentives for vessels to continue to install and evaluate experimental treatment systems and would provide an avenue for future STEP vessels to operate their treatment systems in California waters.

EPA

In December 2008 the EPA issued the "Vessel General Permit for Discharges Incidental to the Normal Operation of Vessels" (Vessel General Permit). The Vessel General Permit regulates 26 discharges, including ballast water, incidental to normal vessel operation. In 2009, the State of Michigan and environmental groups filed suit against EPA charging that the Vessel General Permit violates the Clean Water Act because it does not adequately protect U.S. waters from invasive species and could lead to violation of water quality standards. In March 2011, plaintiffs and the EPA reached a settlement in the case. The settlement requires EPA to release a draft revised Vessel General Permit by November 30, 2011. Among the provisions in the settlement, the revised Vessel General Permit must include numeric effluent limits for the concentration of living organisms in discharged ballast water (i.e. performance standards). Additionally, EPA must provide additional time to states to review the draft permit and add state-specific provisions under the Section 401 certification process. Lastly, the permit must be finalized by November 30, 2012, a full year before it goes into effect on December 19, 2013, in order to provide time for the regulated industry to comply.

Commission staff is closely following both the USCG rulemaking and the EPA revisions to the Vessel General Permit. It is not known at this time how the two may intersect and impact the regulated community. The National Invasive Species Act and the Clean Water Act allow states to implement more stringent standards, therefore federal actions should not directly impact the Commission's efforts to implement California's performance standards. However, the regulatory landscape is becoming increasingly

complicated and confusing for vessels transiting between various jurisdictions. Commission staff is working closely with stakeholders to ensure that vessels clearly understand California's ballast water management requirements.

EPA/USCG Collaborative Activities

To better inform EPA's understanding of ballast water discharges and treatment technologies, EPA in conjunction with the USCG, commissioned two scientific studies in 2010 to examine: 1) the risk of species introduction given certain living organism concentrations in ballast water discharges, and 2) the efficacy and availability of ballast water treatment technologies. The National Academy of Sciences' National Research Council (NRC) was charged with evaluating the organism concentration question, and the EPA Office of Water requested the Science Advisory Board's (SAB) Ecological Processes and Effects Committee, augmented with experts in ballast water issues, to address the efficacy/availability question.

On June 2, 2011, the NRC released the report "Assessing the Relationship Between Propagule Pressure and Invasion Risk in Ballast Water" (see NRC 2011). The goal of the report is to "inform the regulation of ballast water by helping EPA and the USCG better understand the relationship between the concentration of living organisms in ballast water discharges and the probability of nonindigenous organisms successfully establishing populations in U.S. waters." The report concluded that there is currently insufficient information to determine the probability of invasion associated with any particular discharge standard. The report recommends establishing a benchmark discharge standard (such as the IMO D-2 standard) followed by the selection of a risk-based model to guide the collection of experimental and field-based data for further analysis to inform the selection of science-based standards in the future.

The SAB report, "Efficacy of Ballast Water Treatment Systems: a Report by the EPA Science Advisory Board," was finalized in July 2011 (see SAB 2011). The panel examined 51 ballast water treatment technologies, however, only nine systems were deemed to have reliable data (defined by the SAB as including, at a minimum, methods

and results from land-based or shipboard testing) that allowed for scientifically credible assessment of performance. The SAB evaluated the ability of those 9 systems, condensed into five operational types (e.g. filtration + electrochlorination), to meet various existing and proposed performance standards, ranging from the IMO D-2 standard to a standard 1000 times more stringent than IMO. California's standards were not explicitly included in the analysis. Some argue that California's standard should be considered roughly 1000 times more stringent than IMO. However, out of California's seven different organism size class standards (see Table 1), only one (the 10-50 micrometer size class) is specifically 1000 times more stringent than IMO; the California standard for organisms greater than 50 micrometers in minimum dimension is "no detectable living organisms" which cannot be directly compared to the IMO standard of 10 organisms per cubic meter. California's remaining standards for organisms less than 10 micrometers in size either have no comparison to the IMO standards (e.g. total bacteria and viruses) or are only 2-3 times more stringent than IMO (e.g. human health indicator species).

The SAB report concluded that the nine systems could meet the IMO D-2 standard, but that the current limits of testing methods precluded a statistically valid analysis of whether or not the systems could meet more stringent standards (including standards 100 and 1000 times more stringent than the IMO D-2 standard). However, based on the available data, the panel does not believe that systems can currently meet standards more stringent than IMO D-2. The panel concluded that reasonable changes to existing systems could result in the achievement of standards roughly 10 times more stringent than IMO, but that novel treatment techniques would likely be required to meet more stringent standards. In addition to the review of available treatment technologies, the panel advocated for the use of risk management systems approaches to reduce species introductions from vessels, including, for example, modifications to vessel operations and ship design and options for shore or barge-based ballast water reception facilities.

In addition to efforts to manage and revise the Vessel General Permit, the EPA has been engaged with the USCG in the development of standardized protocols to verify

ballast water treatment technology performance. The EPA Environmental Technology Verification (ETV) Program "verifies the performance of innovative technologies that have the potential to improve protection of human health and the environment" (EPA 2011). In 2001, the USCG and EPA established a formal agreement to implement an ETV program for ballast water treatment technologies. After many years of development and testing, the ETV Program released the "Generic Protocol for the Verification of Ballast Water Treatment Technology" in September 2010 (see EPA 2010). The protocol established specific methods and procedures for verifying ballast water treatment system performance at land-based testing facilities. The USCG has indicated that the ETV protocols may be incorporated into future procedures for the Type Approval of ballast water treatment systems for use in the United States.

Commission staff has yet to receive any reports on treatment technology performance evaluation based on the testing model presented in the ETV protocols. However, Commission staff is using the protocols as a valuable resource to gauge the reliability of existing data for evaluating system performance. Additionally, Commission staff is using the ETV protocols to inform the development of methods to verify vessel compliance with California's performance standards (see Section VI. Implementing California's Performance Standards for more information).

The ETV program is also currently pursuing the development of shipboard protocols to verify treatment system performance. Commission staff has been invited to participate and provide expertise during the development of both the land-based and shipboard protocols.

U.S. States

The Great Lakes Ballast Water Collaborative (GLBWC) is a workgroup of Great Lakes states, U.S. federal and Canadian regulators, and associated stakeholders. The GLBWC met in Duluth, Minnesota in July 2010 to discuss various aspects of ballast water treatment technologies, verification strategies and policies. Commission staff was

invited to participate in this meeting to offer expertise and experience in ballast water management and technology assessment.

A focus of the GLBWC meeting in Duluth was to provide information to the Wisconsin Department of Natural Resources (WDNR) on the availability of treatment technologies to meet Wisconsin's performance standards for the discharge of ballast water. Wisconsin established ballast water performance standards in 2010 through a General Permit to Discharge under the Wisconsin Pollutant Discharge Elimination System. The standards were originally 100 times more stringent than IMO, to be implemented on January 1, 2012 and January 1, 2014 for new and existing vessels, respectively. Prior to the implementation of the standards, WDNR was required to conduct an assessment of the availability of treatment systems to meet the Wisconsin standards. If technologies were determined to be unavailable, the Wisconsin standards would be revised to the IMO standards (see Table 1).

Based on the information discussed at the Duluth meeting and in the report produced by the GLBWC (see GLBWC 2010), WDNR released the "Wisconsin Ballast Water Treatment Feasibility Determination" in December 2010 (see WDNR 2010). The WDNR's report concluded that there were several barriers to the implementation of Wisconsin standards, including: 1) It is not possible to verify at this time that any treatment system can meet the Wisconsin standards (100 times more stringent than IMO) due to a lack of formal verification protocols ; 2) Because there are no protocols to determine if technologies meet the Wisconsin standards, technologies cannot be considered commercially available to meet them; and 3) It is not feasible to install the technologies onboard new and existing vessels operating in Wisconsin waters. Therefore, WDNR determined that ballast water treatment technologies are not available to meet the proposed Wisconsin standard, and instead the IMO standards will be implemented.

Commission staff believes that while the WDNR and GLBWC reports offer a great deal of information about the development and assessment of treatment technologies, the

situation in California is not analogous. Wisconsin's ports are located in the freshwater environment of the Great Lakes. Very few ballast water treatment manufacturers have tested the performance of their systems in freshwater. Furthermore, the age and configuration of many of the bulk carriers on the Great Lakes are unlike the types and configuration of vessels that arrive in California. Therefore the challenges of installing treatment systems on Great Lakes vessel are not equivalent to challenges experienced by vessels trading in California.

Several Great Lakes states, other than Wisconsin, have also had recent activity regarding the implementation of performance standards. Among them, New York and Pennsylvania included provisions for the establishment of ballast water performance standards in their Section 401 certification of the EPA Vessel General Permit. The State of New York included provisions requiring vessels to meet a standard equivalent to 100 times more stringent than the IMO D-2 standard by 2012, and vessels constructed on or after 2013 must install systems that meet California's performance standards. In their Section 401 certification, New York provided vessel owners with an opportunity to request a delay in the implementation of the performance standards if the vessel could provide sufficient justification. Based on the requests for delay from many vessels owners, New York released a letter in 2011 that extended the date by which existing vessel must comply with the New York standards from January 1, 2012 to August 1, 2013. Like New York, Pennsylvania also adopted standards through the Section 401 certification process. However, in December 2010, EPA provided notice in the Federal Register that Pennsylvania deleted the Section 401 certification conditions from the Vessel General Permit that require vessels to meet ballast water performance standards.

New Information from Non-Regulatory Sources

Statistical Research

One of the central questions associated with treatment technology assessment is whether or not enough ballast water has been sampled for statistical rigor. Most of the gray literature (non-peer reviewed) reports reviewing treatment technologies and

available data on system efficacy do not specifically quantify the statistical reliability of results as they relate to sample collection methods and volumes of water sampled. This issue of the statistics of ballast water sampling came to the forefront of federal (USCG/EPA) and state (GLBWC, WDNR) discussions and reports during 2010-11. One paper in particular, Miller et al. (2010) has been widely cited for its in-depth analysis and statistical modeling of sample volumes, organism concentrations and regulatory scenarios. The paper discusses the statistics of Type I and Type II error (i.e. the chance of false positives vs. false negatives) and how these errors relate to the ability to detect non-compliant discharge concentrations. The paper has served as a valuable reference for Commission staff during the preparation of compliance verification protocols (see Section VI, Implementing California's Performance Standards).

Classification Society Reports and Advisories

Recently, several maritime classification societies (organizations that establish and apply technical standards for ship design, construction and survey) have provided guidance documents for ship owners and operators regarding the selection and installation of ballast water treatment systems to meet various ballast water performance standards. In September 2010, Lloyd's Register (U.K.) released the report, "Ballast Water Treatment Systems: Guidance for Ship Operators on Procurement, Installation and Operation" (see Lloyd's Register 2010), and in June, 2011 published the fourth edition of their "Ballast Water Treatment Technology" guide (see Lloyd's Register 2011). The American Bureau of Shipping (U.S.) published their "Ballast Water Treatment Advisory" in mid-2010, which was later updated in April 2011 (see ABS 2011). Germanischer Lloyd (Germany) distributed the "Model Booklet for Ballast Water Management," in May 2011 (see Germanischer Lloyd 2011). These documents review current regulations and standards, provide information on available treatment systems and guidance on system selection and installation, discuss safety considerations, and serve as a resource as vessels owners/operators develop and revise ballast water management plans for new treatment technologies. Classification societies have also begun offering approval and certification of ballast water treatment systems. These approvals specifically relate to the engineering, safety and operational concerns

associated with the integration of treatment systems into vessels. System performance (i.e. biological efficacy) is addressed by the Type Approval granted by the flag state administration, and not by classification societies.

IV. TREATMENT SYSTEMS

Coinciding with the recent flurry of state, federal and international activities related to ballast water discharge performance standards, staff has seen an almost linear increase in the number of treatment systems under development and the number of treatment systems that have received IMO G8 Type Approval since the Commission's first technology assessment report in 2007 (see Figure 1). The ballast water treatment market is rapidly evolving and expanding as existing systems are modified and as new systems enter the market. Many of these systems have conducted or are in the process of conducting evaluations to assess compliance with California's performance standards and to receive approvals according to the IMO Convention and Guidelines. While system approvals granted under the IMO testing regime do not provide legal authority or guarantee of compliance when operating in California or U.S. waters, the IMO process does provide vessel owners/operators, interested stakeholders and regulators with important data on system operation and performance. IMO Marine Environment Protection Committee (MEPC) approvals of systems using active substances (Basic and Final Approval) and Type Approvals from flag state administrations as of July 18, 2011, are included in Table 3. For this update, Commission staff reviewed sixty ballast water treatment systems (Table 3).

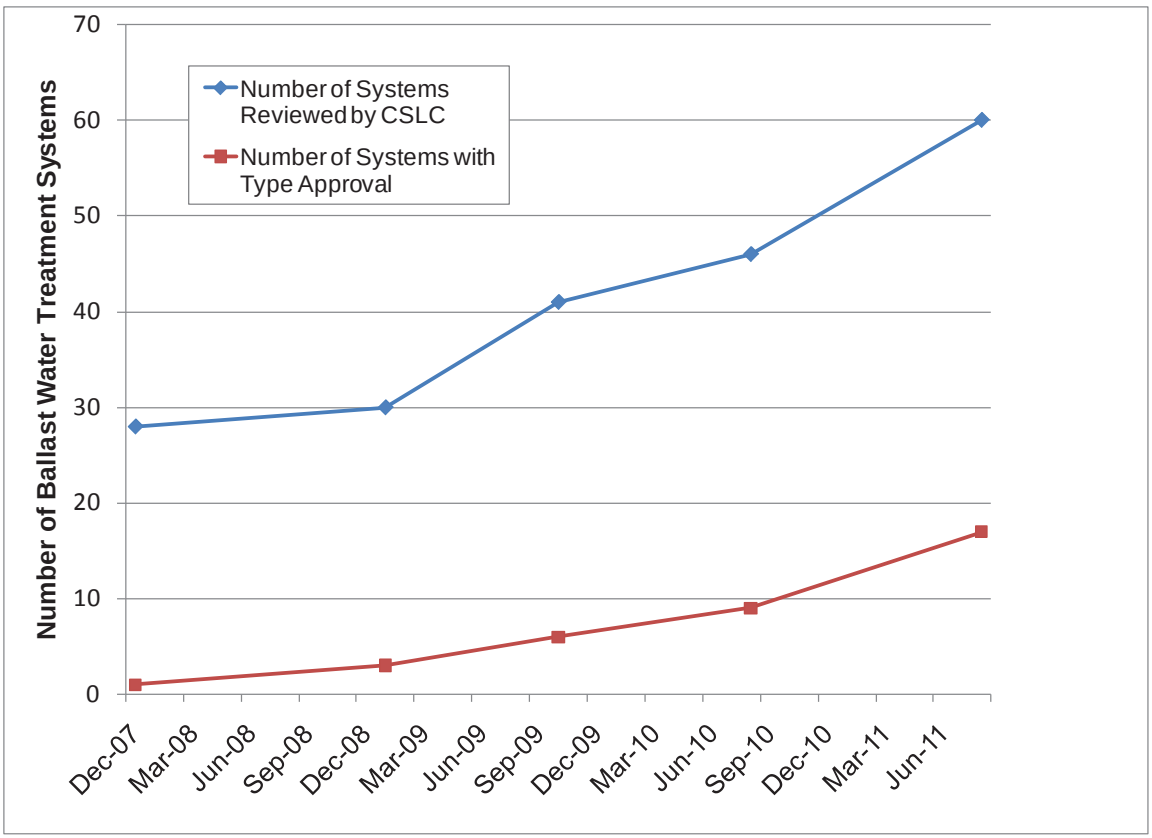

Figure 1. The number of treatment system reviewed by Commission staff during each of the Commission's treatment technology assessment reports. The number of systems with Type Approval is shown.

Table 3. Ballast Water Treatment Systems Reviewed by Commission Staff

Manufacturer	*Country*	*System Name*	*Technology Type*	*Technology Description*	*Approvals*
21st Century Shipbuilding Co. Ltd.	Korea	ARA Ballast (formerly Blue Ocean Guardian)	combination	filtration + plasma + UV	IMO Basic and Final
Alfa Laval	Sweden	PureBallast 2.0/2.0 Ex	combination	filtration + advanced oxidation technology (UV + TiO_2)	IMO Basic and Final, Type Approval (Norway)
AQUA Eng. Co. Ltd.	Korea	AquaStar™ BWMS	combination	filtration + electrolysis + neutralization (sodium thiosulfate)	IMO Basic
Aquaworx ATC GmbH	Germany	AquaTriComb™	combination	filtration + ultrasound + UV	IMO Basic
ATLAS-DANMARK	Denmark	ABWS	combination	filtration + electrolysis (ANOLYTE + CATHOLYTE)	
Auramarine Ltd.	Finland	CrystalBallast	combination	filtration + UV	
Brillyant	USA	BrillyantSea	physical	electric pulse	
Coldharbour Marine Ltd.	United Kingdom	Coldharbour BWTS	physical	deoxygenation	
China Ocean Shipping Company (COSCO)	China	Blue Ocean Shield	combination	hydrocyclone + filtration + UV	IMO Basic[2], Type Approval (China)
DESMI Ocean Guard A/S	Denmark	DESMI Ocean Guard BWTS	combination	filtration + ozone + UV	IMO Basic
Ecochlor	USA	Ecochlor® BWTS	combination	filtration + biocide (chlorine dioxide)	IMO Basic and Final, STEP[1]
EcologiQ	USA/Canada	BallaClean	biological	deoxygenation	
Electrichlor	USA	Model EL 1-3 B	chemical	electrolytic generation of sodium hypochlorite	
Environmental Technologies Inc. (ETI)	USA	BWDTS	combination	ozone + sonic energy	

[1] STEP is a USCG experimental use approval that applies to the combination of one vessel and one treatment system. While STEP enrollment includes a rigorous technical and environmental screening it is not a type approval process.
[2] Based on MEPC 59/24 – administrations may determine if BWMS that make use of UV light produce Active Substances. China does not believe this system uses Active Substances, so Final Approval is not necessary.

Table 3 (continued). Ballast Water Treatment Systems Reviewed by Commission Staff

Manufacturer	*Country*	*System Name*	*Technology Type*	*Technology Description*	*Approvals*
Envirotech and Consultancy Pte. Ltd.	Singapore	BlueSeas BWMS	combination	filtration + electrolysis + neutralization (sodium thiosulfate)	IMO Basic
Envirotech and Consultancy Pte. Ltd.	Singapore	BlueWorld BWMS	combination	filtration + electrolysis + neutralization (sodium thiosulfate)	IMO Basic
ERMA FIRST ESK Engineering Solutions S.A.	Greece	ERMA FIRST BWTS	combination	filtration + hydrocyclone + electrolysis + neutralization (sodium bisulfite)	IMO Basic
Ferrate Treatment Technologies LLC	USA	Ferrator	chemical	biocide (ferrate)	
GEA Westfalia Separator Group GmbH	Germany	BallastMaster BWMS	combination	filtration + electrolysis + neutralization (sodium thiosulphate)	IMO Basic
Hamworthy Greenship Ltd.	U.K./Netherlands	AQUARIUS[2]	combination	hydrocyclone + electrolysis	IMO Basic and Final
Hanovia	U.K.		combination	filtration + UV	
Hi Tech Marine	Australia	SeaSafe-3	physical	heat treatment	New South Wales EPA
Hitachi	Japan	ClearBallast	combination	coagulation + magnetic separation + filtration	IMO Basic and Final, Type Approval (Japan)
Hyde Marine	USA	Hyde Guardian	combination	filtration + UV	Type Approval (U.K.), STEP[1]
Hyundai Heavy Industries Co. Ltd.	Korea	EcoBallast	combination	filtration + UV	IMO Basic and Final
Hyundai Heavy Industries Co. Ltd.	Korea	HiBallast	combination	filtration + electrolysis + neutralizing agent (sodium thiosulfate)	IMO Basic and Final

[1] STEP is a USCG experimental use approval that applies to the combination of one vessel and one treatment system. While STEP enrollment includes a rigorous technical and environmental screening it is not a type approval process.
[2] Hamworthy has replaced the SEDINOX system with AQUARIUS. The system is undergoing testing and is not yet ready for full review.

Table 3 (continued). Ballast Water Treatment Systems Reviewed by Commission Staff

Manufacturer	*Country*	*System Name*	*Technology Type*	*Technology Description*	*Approvals*
JFE Engineering Corp.	Japan	JFE BallastAce	combination	filtration + biocide (sodium hypochlorite)[2] + cavitation + neutralizing agent (sodium sulfite)	IMO Basic and Final, Type Approval (Japan)
Katayama Chemical Inc.	Japan	SKY-SYSTEM	chemical	biocide (Peraclean® Ocean) + neutralization (sodium sulfite)	IMO Basic
Kuraray Co. Ltd.	Japan	Kuraray BWMS	combination	filtration + biocide (calcium hypochlorite) + neutralizing agent (sodium sulfite)	IMO Basic
Kwang San Co. Ltd.	Korea	En-Ballast	combination	filtration + electrolysis + neutralizing agent (sodium thiosulfate)	IMO Basic
MAHLE Industriefiltration GmbH	Germany	Ocean Protection System (OPS)	combination	filtration + UV	Type Approval (Germany)
MARENCO Technology Group	USA	MARENCO BWTS	combination	filtration + UV	
Maritime Solutions Inc. (MSI)	USA	MSI BWTS	combination	filtration + UV	
Mexel Industries	France	Mexel®	chemical	non-oxidizing biocide	
MH Systems	USA	MH BWT System	combination	deoxygenation (inert gas + CO_2)	
Mitsui Engineering and Shipbuilding	Japan	SP-Hybrid BWMS Ozone	combination	filtration + mechanical treatment + ozone + neutralization	IMO Basic and Final
Mitsui Engineering and Shipbuilding	Japan	SPO-SYSTEM	combination	filtration + mechanical treatment + biocide (Peraclean Ocean)	IMO Basic (from Peraclean MEPC 54)
Mitsui Engineering and Shipbuilding	Japan	FineBallast MF	physical	pre-filtration + microfiltration (membrane)	
NEI	USA	Venturi Oxygen Stripping (VOS)	combination	deoxygenation + cavitation	Type Approval (Liberia, Malta, Marshall Islands, Panama), STEP[1]

[1] STEP is a USCG experimental use approval that applies to the combination of one vessel and one treatment system. While STEP enrollment includes a rigorous technical and environmental screening it is not a type approval process.
[2] JFE is currently applying for Basic Approval for use of NEO CHLOR MARINE, a dry version of the same chemical used in BallastAce.

Table 3 (continued). Ballast Water Treatment Systems Reviewed by Commission Staff

Manufacturer	*Country*	*System Name*	*Technology Type*	*Technology Description*	*Approvals*
NK-03	Korea	BlueBallast	chemical	ozone	IMO Basic and Final, Type Approval (Korea)
ntorreiro	Spain	Ballastmar	combination	filtration + electrochlorination + neutralization (sodium metabisulphite)	
Nutech 03 Inc.	USA	Mark III	chemical	ozone	
OceanSaver	Norway	Mark II	combination	filtration + electrolysis	IMO Basic and Final, Type Approval (Nor.)[2]
OptiMarin	Norway	OptiMarin Ballast System	combination	filtration + UV	Type Approval (Norway)
Panasia Co. Ltd	Korea	GloEn-Patrol™	combination	filtration + UV	IMO Basic and Final, Type Approval (Korea)
Pinnacle Ozone Solutions	USA	Aquatic enhancement system	combination	filtration + ozone + UV	
Qingdao Headway Technology Co. Ltd.	China	OceanGuard™ BWMS	combination	filtration + electrolysis + ultrasound	IMO Basic and Final, Type Approval (China)
RWO Marine Water Technology	Germany	CleanBallast	combination	filtration + electrolysis + neutralization (sodium thiosulfate)	IMO Basic and Final, Type Approval (Ger.)
Samsung Heavy Industries Co. Ltd.	Korea	Neo-Purimar™ BWMS	combination	filtration + electrolysis + neutralization (sodium thiosulfate)	IMO Basic
Sea Knight	USA	INSITU BWMS	combination	deoxygenation + biological augmentation	

[1] STEP is a USCG experimental use approval that applies to the combination of one vessel and one treatment system. While STEP enrollment includes a rigorous technical and environmental screening it is not a type approval process.
[2] The Norwegian Administration is reviewing biological efficacy of the updated treatment system and may considering issuing a new Type Approval Certificate. The system is not reviewed here until that determination can be made and data from the updated system is made available to Commission Staff.

Table 3 (continued). Ballast Water Treatment Systems Reviewed by Commission Staff

Manufacturer	*Country*	*System Name*	*Technology Type*	*Technology Description*	*Approvals*
Severn Trent De Nora	USA	BALPURE®	chemical	filtration + electrochlorination + neutralizing agent (sodium bisulfite)	IMO Basic and Final, STEP[1], Type Approval (Ger.)
Siemens	Germany	SiCure™	combination	filtration + electrochlorination	IMO Basic
STX Metal Co. Ltd.	Korea	Smart Ballast	chemical	electrolysis + neutralization (sodium thiosulfate)	
Sumitomo Electric Industries, Ltd.	Japan	SEI-Ballast System	combination	filtration + UV	
Sunrui Marine Environment Eng. Co.	China	BalClor™ BWMS	combination	filtration + electrochlorination + neutralizing agent (sodium thiosulfate)	IMO Basic and Final, Type Approval (China)
Techcross Co. Ltd.	Korea	Electro-Cleen™ System	chemical	electrolysis + neutralizing agent (sodium thiosulfate)	IMO Basic and Final, Type Approval (Korea)
Techwin Eco Co. Ltd.	Korea	Purimar™ BWMS	combination	filtration + electrolysis + neutralization (sodium thiosulfate)	IMO Basic and Final
Wärtsilä Corporation	Finland	Wartsila BWTS	combination	filtration + UV	
Wilhelmsen/Resource Ballast Technologies	Norway/ South Africa	Unitor BWTS	combination	cavitation + ozone + sodium hypochlorite + filtration	IMO Basic and Final, Type Approval (South Africa)
Wuxi Brightsky Electronic Co. Ltd.	China	BSKY™ BWMS	combination	filtration + UV	Type Approval (China)

[1] STEP is a USCG experimental use approval that applies to the combination of one vessel and one treatment system. While STEP enrollment includes a rigorous technical and environmental screening it is not a type approval process.

V. SYSTEM EFFICACY

Treatment system performance (i.e. efficacy) can be defined as the extent to which a system removes or kills organisms in ballast water. For this update, Commission staff's specific focus is on the ability of available treatment systems to meet California's performance standards for the discharge of ballast water for newly built vessels with a ballast water capacity greater than 5000 MT (see Tables 1 and 2 for performance standards and implementation schedule).

Recent reports at the state and federal level (see GLBWC 2010, WDNR 2010, SAB 2011) have concluded that testing protocols are not available to determine if treatment systems can meet any standard more stringent that IMO D-2 with a high degree of statistical certainty. Specific concerns have focused on the extremely large volumes of water (thousands of cubic meters) necessary to assess compliance with a standard 100 or 1000 times more stringent than IMO for organisms greater than 50 µm in size. California's standards for organisms greater 50 µm is defined as "no detectable living organisms," and does not define a specific volumetric concentration. Many outside parties have reasoned that compliance with this standard is not verifiable because the volumes of ballast water required to determine compliance are too large to be practical for shipboard compliance verification. However, it is important to note that, unlike the IMO standard for the same size class (see Table 1), the standard for California is unitless. Whereas IMO defines its standard for organisms greater than 50 µm as less than 10 ***per cubic meter***, California's standard does not set forth a volume requirement. Therefore compliance and performance testing for this size class could occur with any volume of water, especially volumes that are more realistic to sample under shipboard operation. For the other organism classes, volumes specified in California's standards do not appear to pose statistical, logistical or analysis problems.

Because of the aforementioned limitations of available testing protocols, as well as limited data demonstrating system performance under the variable conditions present in the "real world," this update examines treatment system performance data to determine whether or not systems have demonstrated the **potential** to comply with California's

performance standards. Commission staff does not have the practical ability to test and approve treatment systems for operation in California waters. Positive assessment for the purpose of this update does not guarantee system compliance when operated in California waters, nor does the update suggest or imply system approval. Vessel owners and operators should consult extensively with treatment system vendors to ensure that thorough system verification work has been conducted, and that the system is appropriate for the type and behavior of the vessel in question under normal ballasting conditions. Vessel owners/operators, not the treatment system vendor, are responsible for complying with California's performance standards for the discharge of ballast water.

Commission staff compiled and reviewed all available scientific literature and performance data in order to assess system potential to meet California's performance standards. Staff was able to collect efficacy data on 38 of the 60 treatment systems reviewed in this update. With the exception of the evaluation of system performance for inactivating the bacterium *Vibrio cholerae*, laboratory (benchtop scale) data was not used for evaluation purposes because of the large discrepancy in scale between the laboratory and land-based and shipboard investigations. Of the 38 systems with available data, three had only laboratory data available, and therefore were not included in this assessment (see Appendix A for a list of systems with only laboratory data available).

For those systems with available land-based and shipboard testing data, the EPA SAB report (see SAB 2011) highlighted the need to differentiate between data collected for research and development (R&D) purposes versus data obtained as part of the formal Type Approval testing process. Systems tested for R&D purposes may still be undergoing modification and may not represent the final version of the system available for sale; therefore, it is not appropriate to consider R&D data to determine if a system can meet California's standards. Furthermore, the SAB noted that not all data can be considered "reliable." The SAB (2011) defined reliable data as including, "…at a minimum, methods and results from land-based or shipboard testing." Commission staff

agrees with this designation and its criteria, and used it to further refine the list of systems with available data. For this analysis, only systems with reliable data (reports including both methods and results) gathered as part of the Type Approval testing process were considered (see Appendix A for list of systems with R&D and/or incomplete data files). Ultimately, staff examined the efficacy data for 18 ballast water treatment systems for this update (see Table 4).

Commission staff proceeded with system data analysis using the best available methods and techniques for assessing organism concentration and viability for each of the size classes in California's performance standards. As with previous reports, Commission staff assessed compliance with the bacterial standard by using a proxy group of organisms (culturable, aerobic, heterotrophic bacteria – hereafter culturable heterotrophic bacteria) to represent the larger group of all bacteria (see discussion in Dobroski et al. 2009). Analysis of viral species remains challenging. Commission staff believes that at this time no widely accepted technique or proxy is available, and thus systems were not evaluated for compliance with the viral standard.

Staff assessed the performance rates of those systems with available, reliable land-based and shipboard data from Type Approval testing (Table 4). The assessed data is presented in fraction form, with the number of tests (averaged across replicates) that demonstrated **potential** compliance with California's standards in the numerator, and the total number of tests in the denominator. Systems that presented data for a given size class with insufficient detail to compare to California's standards (e.g. data was presented as non-detectable, but the lower limit of detection was not stated) are classified as "Unknown." This detailed review provides the opportunity to identify systems that have undergone more tests, and have demonstrated higher rates of potential compliance. The source(s) of the data for each system can be found in the Literature Cited section.

Table 4. Summary of systems with data available for assessment of efficacy

Systems with reliable land-based or shipboard test results from Type Approval testing are assessed in Table 4. The number of tests (averaged across replicates) that demonstrated **potential** compliance with California's standards is presented in the numerator, and the total number of tests in the denominator. Systems in bold conducted at least 3 tests and demonstrated the potential to meet California's standards at least 50% of the time at either land-based or shipboard scale.

Manufacturer	>50		10 - 50		<10 (bacteria)		*E. coli*		Enterococci		*Vibrio*		Literature Cited[2]
	Land	Ship	Land	Ship	Land	Ship	Land	Ship	Land	Ship	Land	Ship	
Alfa Laval[1]	4/10	1/4	3/10	1/4	0/10	2/2	10*/10	4*/4	10*/10	4*/4	10*/10	4*/4	59,61,65
Auramarine	3/11		5/11		0/11		11*/11		11*/11		11*/11		66
Ecochlor	**8/15**	**3/3**	**9/11**	**3/3**	**8/11**		**10/10**	**3/3**	**11/11**	**3/3**	**1/1 (lab)**	**3*/3**	**15,54,69**
ERMA First	5/12	0/2	9/12	2/2	0/Unk[3]		10*/10	2*/2	10/10	2/2		2*/2	16,57
Hyde	1/10	3/3	0/10	1/3	5/10	3/3	10*/10	3*/3	10*/10	3*/3		3*/3	55,76
JFE	6/11	3/6	11/11	5/6	3/11		11*/11	6/6	11/11	6/6	11*/11	6*/6	23,62
MSI	0/5		0/5		3/5		5/5		5/5		5*/5		51
NEI	1/5	1/2	0/1	Unk	0/2	0/2	0/1	2*/2	0/1	Unk		2*/2	71,72,73
NK-03	5/14	1/5	9/14	4/5	0/14	1/1	10*/10	5*/5	10*/10	5*/5	10*/10	5*/5	26,28
Nutech	0/3	2/3	0/2	0/3	3/3	2/2		3*/3		3*/3		3*/3	18,77
OptiMarin	8/12	0/8	6/12	2/8	2/12		12*/12	8*/8	12*/12	8*/8	12*/12	8*/8	58,60
Panasia	1/1		1/1										27
Qingdao	**4/13**	**3/3**	**8/13**	**3/3**	**9/13**	**3/3**	**13*/13**	**3*/3**	**13*/13**	**3*/3**	**13*/13**	**3*/3**	**63,68**
RWO	**0/13**	**4/5**	**6/13**	**3/3**	**7/13**		**13*/13**	**5*/5**	**13*/13**	**5/5**	**13*/13**	**5*/5**	**13,64**
Severn Trent	**7/11**	**2/4**	**8/11**	**1/3**	**10/11**	**2/4**	**10*/10**	**4/4**	**10/10**	**4/4**		**4*/4**	**12,56**
Siemens	0/10		5/10		0/10		10/10		7/10		10*/10		17,52
Techcross	**8/11**	**3/3**	**9/11**	**3/3**	**5/5**	**1/1**	**10/10**	**3/3**	**11/11**	**3/3**	**11*/11**	**3*/3**	**29,30**
Wilhelmsen	2/2	2/3	1/2	0/3			2/2	3*/3	2/2	3/3	2/2	3*/3	2,14

* Concentration at intake was zero, non-detectable or unknown.

[1] This data includes land-based testing of system v. 2.0 and shipboard testing of system v. 1.0. DNV did not require shipboard testing of v. 2.0.

[2] Numbered references can be found in the Literature Cited section.

[3] Unknown, minimum and maximum values provided but not the total number of tests.

The data presented in Table 4 are highly variable. Several systems performed very well during shipboard testing, but did not reach the same level of potential compliance during more rigorous and tightly controlled land-based testing. Conversely, a few systems performed better at land-based testing but were not able to demonstrate potential to meet California standards during shipboard testing, although this situation occurred infrequently. Some systems have only been tested over a few test cycles while others have undergone 10 or more test cycles. Furthermore, much of the performance data for human health indicator species was collected when the initial pre-treatment concentration of microbes, particularly *Vibrio cholerae,* was zero, non-detectable or unknown. The IMO G8 Guidelines do not require testing organizations to "spike" testing water with microbes due to safety concerns. Testing can proceed in the absence of natural populations of these species. However, the conclusions drawn from these tests may be of questionable value because they do not demonstrate how effectively a system may eliminate such microbes under high concentration conditions.

Of the 18 systems with reliable land-based or shipboard data from Type Approval testing in Table 4, 10 systems demonstrated the potential to meet California's performance standards for all organism size classes in at least one land-based or shipboard test (averaged across replicates). In order to determine if systems are available to meet California standards on a more consistent basis, Commission staff reviewed the data (summarized in Table 4) for systems that have conducted three or more tests per organism size class (either land-based or shipboard) and have demonstrated the potential to meet each of the California standards (for all organism size classes) at least 50% of the time. Five treatment systems meet these more rigorous criteria (see systems in bold in Table 4). One of these five systems, developed by Qingdao Headway Tech, demonstrated the potential to meet California's standards 100% of the time in shipboard tests (see Table 4). Four of the five systems that have met California's standards more than 50% of the time are Type Approved according to the IMO G8 Guidelines. The other one has completed Type Approval testing and is awaiting response from its flag state administration. All five systems are commercially available.

Vessel owners/operators should closely scrutinize the available data, however, to ensure that systems will meet California's standards on a regular basis given the configuration of the vessel and piping/water flow requirements. This review does not constitute an endorsement or approval of any ballast water treatment system, manufacturer or vendor.

VI. IMPLEMENTING CALIFORNIA'S PERFORMANCE STANDARDS FOR THE DISCHARGE OF BALLAST WATER

Commission staff is in the process of implementing California's performance standards for the discharge of ballast water. As of January 1, 2010, newly built vessels (vessels for which construction began on or after January 1, 2010) with a ballast water capacity of less than or equal to 5000 MT must comply with California's performance standards. Vessel construction often takes a year or more, and it is anticipated that the first vessels that must meet the performance standards will begin arriving in California in late-2011 or early 2012. Vessel owners and operators have been contacting Commission staff to receive guidance on complying with California's performance standards, and staff is aware of several vessels that have purchased systems to comply with the standards. Many other vessels are in the midst of construction and are leaving dedicated space for a ballast water treatment system so that it may be installed at the last possible moment to ensure that the system purchased is the most up-to-date available.

These positive steps towards the implementation of California's standards have recently been countered by reports (see GLBWC 2010, WDNR 2010, and SAB 2011) indicating there are no protocols available to verify, with adequate statistical certainty, that treatment systems can meet California's standards. While the Commission has a legal mandate to implement California's standards, Commission staff is also required to assess the availability of treatment technologies to meet those standards. If treatment systems are not available, the Commission must inform the Legislature and make appropriate recommendations for action.

Commission staff places great importance on working collaboratively with stakeholders to ensure that management strategies are developed based on the best available science and with consideration to the concerns of the regulated industry. Because of the recent uncertainty about the availability of treatment technologies, staff convened the ballast water treatment technology technical advisory panel (established by PRC Section 71204.9) in December 2010 and March 2011 to discuss options for effectively implementing California's performance standards for the discharge of ballast water.

In December 2010, the Commission convened a subset of panel members with expertise in science and engineering (hereafter, scientific panel) to focus on the science of standards implementation and technology assessment (see meeting notes, Appendix B). Commission staff discussed three potential options with the scientific panel for moving forward with California's performance standards, including: 1) recommending that the Legislature change the performance standards; 2) recommending that the Legislature adopt the use of Best Available Technologies (BAT) until such time that the standards could be met; or 3) establish methods (via regulation) to verify vessel compliance with the standards.

The scientific panel agreed that changing the standards was not a feasible solution because there would be little political will to weaken California's standards and because it would be extremely difficult to make the standards stricter in the future when technologies improve. Likewise the panel felt that option two, the use of BAT, would also not be ideal because of the requirement for legislative action in addition to the need for staff to approve BATs. The scientific panel felt that the most productive approach to implementing California's standards would be to establish a specific set of compliance verification protocols. Scientific panel members argued that setting the performance standards is only half of the equation. It is equally important that California define and implement protocols to verify vessel compliance with those standards. Furthermore, by establishing the protocols in regulation, those protocols will be available as a resource for system manufacturers and vessel owners/operators so they can verify that their

treatment technologies are meeting California standards using the same methods that will be used by Commission personnel to determine compliance.

Commission staff provided the notes from the December scientific panel meeting to the entire advisory panel and convened a meeting in March 2011 to discuss staff's plans for moving forward and to receive comments from panel members (see meeting notes, Appendix C). Generally, the advisory panel was supportive of staff's efforts to move forward. Some panel members were concerned about how a gradual improvement of compliance methods would impact vessels that demonstrated compliance under previous verification protocols (i.e. would vessels be penalized if they were compliant under one set of protocols but not compliant under a new, more sensitive, set of protocols?) Additionally, there was some concern from industry about whether the Commission could be sued if the compliance protocols are not able to detect compliance with California's standards with a high level of statistical certainty. While these specific issues remain to be addressed, there was no objection from the panel to moving forward with the development of compliance verification protocols as the best possible mechanism to implement California's performance standards.

Therefore, Commission staff has begun the process of developing protocols to verify vessel compliance with California's performance standards. Staff convened a new technical advisory panel of experts for a meeting to discuss compliance assessment in June 2011 and held a second meeting in August 2011. Staff intends to submit the proposed protocols for compliance verification to the California Office of Administrative Law to begin the public rulemaking process in late 2011, with hopes to finalize the compliance protocols by mid-2012. Additionally, staff is in the process of contracting with a marine engineering firm, The Glosten Associates, to conduct a thorough feasibility study, prototype design and testing of a monitoring tool to assist with ballast water sample collection and analysis. The compliance protocols will be used in conjunction with new information reporting forms that were adopted in the fall of 2010 (the Ballast Water Treatment Technology Annual Reporting Form and the Ballast Water Treatment Supplemental Reporting Form, see Title 2, CCR Section 2297.1) to guide

information collection and enable the fair and effective implementation of California's ballast water discharge standards.

VII. SUMMARY AND CONCLUSIONS

Ballast water treatment continues to be a rapidly expanding industry as new technologies are developed and existing ones refined in search of the most effective methods to reduce the spread of nonindigenous species. This update provides a brief summary of state, federal and international discussions and reports on performance standards and ballast water treatment systems since the last Commission report was approved in August 2010. Additionally, this report reviews the latest data on system performance to ensure that systems will be available for vessels with a ballast water capacity of greater than 5000 MT, for which construction begins on or after January 1, 2012.

Recent state and federal reports (GLBWC 2010, WDNR 2010, SAB 2011) have concluded that methods do not yet exist to determine if systems can meet California standards with high statistical certainty, and therefore treatment systems cannot be deemed available for use to meet California standards. The conclusions are largely based on the fact that extremely large volumes of water would need to be sampled in order to determine compliance with a standard 100 or 1000 times as stringent as the IMO D-2 standard, particularly for the largest organism size class (i.e. greater than 50 µm). However, unlike the IMO standard for organisms greater than 50 µm, California's standard is "no detectable living organisms" for this size class, and is also unitless. There is no volume requirement set forth in that particular standard. Therefore, compliance and performance testing can occur with any volume of water, as will be set forth in the proposed compliance verification protocols. The volumes of water sampled for the remaining size classes are small enough so that they do not pose an issue.

Overall, this review of system performance indicates that progress continues to be made in the development of treatment systems to meet California's performance standards for the discharge of ballast water. Ten treatment systems have demonstrated

the potential (in at least one land-based or shipboard test) to meet all of California's performance standards (Table 4). A more stringent review indicates that five systems have demonstrated the potential to meet California's standards greater than 50% of the time over multiple tests. One system met California's standards 100% of the time in shipboard testing, although no system has yet met California's standards 100% of the time in land-based testing. All five systems are commercially available and three are Type Approved according to the IMO G8 Guidelines.

Commission staff has met with technical advisory panel members including regulators, industry representatives, and scientific and engineering experts familiar with ballast water treatment technology assessment to discuss a plan to implement California's performance standards. Commission staff believes that while we cannot verify that treatment systems meet all of California's standards with high statistical certainty at this time, the development of specific compliance verification protocols provides a path forward. These compliance protocols, to be developed in consultation with scientific and industry experts, will provide a mechanism for both technology vendors and vessel operators to verify that systems are meeting California's standards based on the specific protocols that the Commission's marine safety personnel will use to conduct vessel compliance inspections. The compliance protocols are expected to be adopted via the rulemaking process by early 2012. Therefore Staff recommends that the Commission continue to support staff's effort to implement California's performance standards for the discharge of ballast water. These efforts will continue to move the state towards the elimination of the discharge of nonindigenous species into California waters.

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APPENDIX A: RESEARCH AND DEVELOPMENT DATA

Sixty ballast water treatment systems were reviewed by Commission staff for compliance with the California performance standards. Thirty-eight systems had data on system efficacy available for review. Systems with reliable data (including methods and results) collected during land-based or shipboard testing as part of the Type Approval process are reviewed in the main body of the report (see Table 4). The systems reviewed here (Table A) include systems for which: 1) staff did not have access to full test reports (including methods of analysis); 2) the data was collected as part of research and development and not the Type Approval process; or 3) testing was only conducted at the laboratory scale.

Systems with at least one test (averaged across replicates) demonstrating potential compliance with the performance standard are scored with a “Y.” Efficacy data with no tests demonstrating potential compliance with the standards are scored with a “N.” Systems that presented data for a given organism size class but presented the results in metrics not comparable to the standards are classified as “Unknown.” For example, a system that presented results of system efficacy as percent reduction of zooplankton abundance could not be compared against the California standards, and thus ability of the system to comply with the standards is unknown. Cells with hashing indicate lack of data for a given organism size class. Compliance with the bacteria standard was assessed using the concentration of culturable heterotrophic bacteria in discharged ballast water. Due to the lack of available methods to both quantify and assess the viability of all viruses, systems cannot be assessed for compliance with the viral standard at this time. The source(s) of the data for each system can be found in the Literature Cited section of the main report.

Table A. Summary of systems with available results for assessment of efficacy

Systems with at least one test (averaged across replicates) in compliance with the California performance standards are denoted by a "Y." Non-compliance is denoted by an "N," and those systems with data in metrics not directly comparable to the performance standards were designated as "Unknown." A cell with hashing indicates that no data was available.

Manufacturer	> 50 µm	10 - 50 µm	< 10 µm (bacteria)[1,2]	*E. coli*	Enterococci	*V. cholerae*	References[3]
21st Century Shipbuilding	Y	N		Y[4]	Y[4]	Y[4]	43
AQUA Eng. Co. Ltd.	N	Y		Y[4]	Y[4]	Y[4]	45
COSCO	Unknown	Unknown	Unknown	Y	Y	Y[4]	48
ETI		N	N				35,36,37
Ferrate Treatment Tech.							Lab data only
Hi Tech Marine	N	Unknown	Y	Y			7,19
Hyundai Hvy Ind. EcoBall.	Y	Y		Y[4]	Y[4]	Y[4]	40
Hyundai Hvy Ind. Hi Ball.							Lab data only
Katayama Chemical	Y	Unknown		Y	Y	Unknown	44
Kwang San Co. Ltd.	N	N	Y	Y	Y	Y[4]	41
MAHLE	Y	Y	N	Y	Y		3
MARENCO	Y	N	Y				31,32,75
MH Systems							Lab data only
Mitsui Eng. SP Hybrid	N	Unknown	Unknown	Unknown	Unknown	Unknown	22,24,25
Mitsui Eng. FineBallast	Y	Unknown		Unknown	Y	Unknown	42
STX Metal	Y	Y		Y[4]	Y[4]	Y[4]	47
Sunrui	Y	Y		Y	Y	Y	50
TWECO	Y	Y	Y	Y	Y	Y[4]	46
Wuxi Brightsky Elect.	Y	Y	Y	Y	Y	Y	49

[1] Bacteria were assessed through examination of aerobic culturable heterotrophic bacteria (expressed as colony-forming units).

[2] No methods exist to quantify and assess the viability of viruses at this time.

[3] Numbered references can be found in Literature Cited section

[4] Concentration at intake was zero, non-detectable or unknown.

APPENDIX B: NOTES FROM SCIENTIFIC PANEL MEETING (DECEMBER 2010)

Implementing California's Performance Standards for the Discharge of Ballast Water
California State Lands Commission
Marine Invasive Species Program
December 20, 2010, 10 am – 12:30 pm

Advisory Panel Teleconference Meeting Notes

Attendees:
Greg Ruiz, Smithsonian Environmental Research Center
Nick Welschmeyer, Moss Landing Marine Laboratories
Kevin Reynolds, Glosten Associates
Andrew Cohen, Center for Research on Aquatic Bioinvasions
Nicole Dobroski, California State Lands Commission
Maurya Falkner, California State Lands Commission
Chris Scianni, California State Lands Commission
Lynn Takata, California State Lands Commission

Introduction
(Dobroski) Goal of meeting: Begin discussion about implementing California's performance standards for ballast water discharge. This will be the first of multiple discussions. A larger panel will be brought together in January or February.

Background
(Dobroski) In 2005, as per the Marine Invasive Species Act, performance standards were recommended to the state legislature, and later passed in 2006 in the Coastal Ecosystems Protection Act. In 2007 regulations were developed to implement the standards. Since then, the California State Lands Commission (CSLC) has developed several reports evaluating the ability for treatment systems to meet standards. Though systems have demonstrated the potential to meet California's standards, it is not clear they can meet them 100% of the time.

(Dobroski) The CSLC has gone forward with implementing the standards for new vessels with a ballast water capacity of less than or equal to 5000 MT as of January 1, 2010. Since these are for vessels with keels laid on or after January 1, 2010, none have arrived to the state yet.

(Reynolds) Side note, we have been involved with installing the Hyde system on board an Alaskan research vessel in order to meet CA regulations.

(Dobroski) The next implementation date is for vessels constructed on or after January 1, 2012 with over 5000 MT ballast water capacity. This category will cover the majority of vessels that visit California, and industry has become very concerned about system

availability. It is becoming clear, through scientific panels convened by other groups, that protocols are not available to test to standards as stringent as California's, and there are also questions whether systems are even available. California would like to push the development and utilization of technologies forward, but cannot force industry to meet a standard for which it is not clear if technologies are available. The goal today is to explore options on how to move forward. On the handout sent before this meeting are three proposed options to begin our discussion. However, we are certainly open to other ideas, as we are seeking your professional opinion.

Review of Options Handout

(Dobroski) Option 1 is to change the standard. This would require legislative action, for which the outcome wouldn't be guaranteed. If this option is desirable, what would the standard be changed to? Is IMO protective enough, or would it need to be 10X or 100X IMO (for the 2 largest size classes, not bacteria).

(Falkner) Any decision we make about changing standards will need substantial scientific justification for any possibility of it happening. This is a reason why we've asked for this smaller group meeting to get your professional opinion.

(Dobroski) Option 2 is to keep the current standards, and move forward with a best available technology (BAT) approach until technologies and or testing methods show standards can be confidently met. This option would require deciding what would be BATs, with an advisory panel, possibly using STEP and/or IMO approvals and such to come up with a list that would be updated as necessary. This option would require legislative action and likely regulatory (rulemaking) action as well, but could be a good interim step to move forward.

(Dobroski) Option 3: Instead of legislation, codify in regulations specific compliance verification procedures so technologies can be tested for California's standards specifically. When testing techniques get better, new vessels would need to meet CA standards using these new techniques, and vessels already tested could be grandfathered under the older techniques.

(Dobroski) The overall goal is to keep moving forward with implementation. Options we consider/discuss here need to account for the abilities of today's technologies.

(Welschmeyer) Does BAT apply to treatment technologies or for measurement methods?

(Dobroski) Treatment.

General Discussion

(Reynolds) A huge issue is how to do compliance monitoring and enforcement. The standards are only ½ of the equation (having worked with equipment on ships that often don't work all the time). The standard could be anything. The rub is how you measure it. Once this is clearly defined for folks, systems can be tested to them.

(Falkner) It is unlikely that port state officials will be taking many water samples.

(Reynolds) For vessel sewage systems, most (USCG) inspectors simply ask to see the device, see that it's operating, write down the name plate, and away they go.

(Falkner) We would like a California inspection to be more thorough, perhaps checking a system data logger to see that the system is operating per spec. Assuming it hasn't been off or tampered with, you then make an assumption that the system is working. If there's a red flag, a sample may be taken for a rough idea if the vessel is way out of compliance (lots of big things swimming around), then go from there with a more in-depth review. I can't see pursuing civil or criminal penalties based only on a sample. A sample would be a 3rd step, probably after paperwork and data metrics.

(Reynolds) I like IMO D2 because it's generally verifiable, which is nice. But CA has a higher standard on books, so a more relevant consideration here for compliance and enforcement is to have: 1) A certificate with the equipment showing its testing and approval records, 2) Operational logs (each supplier should be measuring key operational parameters), and 3) If things don't look right, a test CA can do that is widely publicized so everyone knows how you will test. Something practical, simple that ships/owners can do themselves to self-check for compliance. As testing methods get better, requirements can evolve so there is a phase-in period, and maybe grandfathering for those tested using older methods.

(Ruiz) For option 3, a standard is *de facto* defined by the testing method utilized, as it would limit what level of standard you can detect with confidence. Whether or not options 2 or 1 are in play, you would need to have 3 in play as well. A key question is whether you ratchet up your standard as the sensitivity of testing methods improve. The current challenge is that we cannot tell if there are systems that exceed IMO at the present time. Option 1 is not advisable, since you would lose flexibility to ratchet up as technologies and testing improves. Not sure how BAT identification for option 2 would work. Option 3 effectively defines a standard. For enforcement, the goal of a sample would be to detect gross exceedence of a standard you can test for. If a vessel shows multiple gross exceedences, the chances of erroneous detection of a violation decrease dramatically over multiple incidents.

(Reynolds) Testing for gross exceedence is the practical reality, when it comes to field compliance.

(Ruiz) Another crucial issue is how extensively onboard systems have been tested, the quality of the data, and the level of confidence in that data. Right now there isn't an independent body to assess quality of testing data. There are many places data can come from, and they there not equal. If quality of data is deemed very good, system

data indicators of use (e.g. log use) are more believable, in comparison with those with data/experiments that are not well outlined or understood.

(Reynolds) There is also a need to understand how systems are operated, and there can be a lot of sloppiness with this. For example, if a very large crude carrier has lots of ballast water - say 90,000 cubic meters, and 1 second of water is discharged before system is turned on, that volume discharged could exceed CA standard for entire 90,000 m^3. As we get to stricter standards, it's more difficult to get them [vessels] to comply. So, in this way too, detection of gross exceedence is appropriate.

(Welschmeyer) The essential part of the compliance/enforcement issue is not unique to CA. We have the burden of setting precedence here. We will likely be copied or scrutinized by others (IMO, other states). I like the idea of being able to encourage ports, techs, ship crew etc. to perform gross exceedence sampling – to give ship operators the advantage of checking their own water to remain in compliance. The more we can do to facilitate this, the more attention/ability will be given by operators to ensure compliance, rather than only relying only on logs. I agree with Kevin. We can't turn our back on compliance procedures. You [systems] can pass IMO through initial Type Approvals, but testing later/again would require a treatment testing facility to carry out the assay required. Jo-Schmo can't test their own ship this way. We've [IMO, U.S.] created an impossible test situation, as there are only a couple of centers that can test or re-test compliance with IMO in the U.S., and these centers can't accommodate the thousands of vessels in the fleet.

(Reynolds) This is an important point – IMO has made the manpower needs so high and Type Approval testing is so important that compliance testing is forgotten. As a model example, oily water separators have a meter that tells operators when it's not meeting a specific standard. If vessel operators have a metric to work against and enforce themselves, they can be very creative to keep machines running or operating to standards, say, by avoiding a bloom, or operating the vessel a certain way.

(Cohen) There is an assumption here that there is no system that can meet CA standards. That may be true if we restrict to shipboard systems, but not so for onshore treatment.

> (Falkner) Onshore isn't usable, especially for vessels that need to deballast on the way in before coming to port.
>
> (Cohen) There is no data indicating vessels must deballast on the way to port for operational purposes.
>
> (Reynolds) There is a need for ships to deballast/ballast to get under bridges and such, though it's true that much deballasting on the way in is a money matter, especially for large volume vessels that deballast on the way in to save time. However, containers often have to ballast/deballast to get under cranes.

(Dobroski) We're certainly interested in shore-based facilities, but the challenge is to move forward by 2012. Right now there just aren't land based facilities available. The question here is how to move forward.

(Cohen) There's no evidence it would take more time to implement shore based treatment systems than it will to implement shipboard systems.

(Dobroski) What would you recommend for moving forward by 2012?

(Reynolds) In working with the Golden Bear, I have recently tuned in to how good a land based facility can be. The EPA-ETV challenge is reliability engineering, and the IMO D2 standard requires a 4 log reduction on challenge water. We go to 7 log reduction for ETV, and from information I've seen, it's doubtable whether shore facilities can do better than a 5 log.

(Cohen) The EPA drinking water guidelines require land-based facilities to go to a 6-log reduction for viruses and 5-log for Giardia, depending on the source water.

(Ruiz) For Nicole's question, though, how does that work in time for 2012?

(Cohen) That's not an appropriate technical question. It's clear land based systems can do better than a ship based system by several orders of magnitude. The Pacific Merchant Shipping Association has even said it's not our responsibility to help vessels comply.

(Reynolds) I'm interested in seeing evidence that land-based facilities can get a 7 log reduction in the over 50 micron size class. Pretty sure they would be unable to make it.

(Welschmeyer): I do love the philosophical/scientific nature of this conversation, however, the reality is that California needs something more concrete. Some things are clear from our conversation – there is the need for a change in philosophy on what test criteria are. The one that is currently internationally used – testing counts for live organisms – isn't really practical. If we continue to focus on counting living organisms, we're never going to meet any standards, because they are so rare after treatment, and the world's oceans are too diverse. The IMO standards numbers are phenomenal. You can't even achieve that dilution in the laboratory. We need a philosophical change to a more analytical, more usable, less logistically difficult (vs. counting large live organisms, large volumes) and go to something that is more sensible and more numerous (e.g. bacteria/phytoplankton). Zooplankton are uncountable at the fantastic level required by IMO. Instead, maybe a single taxa of bacteria or singe cell eukaryotes as an indicator? We should use a testing method that has some scientific background to it, to indicate that we can meet practical zero (an acceptably low number) for the larger size class. Biomass level measures may allow for these, and may allow a ship or laboratory to do the test to indicate how a system is functioning on the ship.

(Cohen) Agree with moving towards looking at smaller organisms for compliance, and using other measurements rather than counting live organisms is more useful, more manageable.

(Reynolds) CA has recognized correctly that they're in an impossible spot with standards and no way of testing for them. I think it's less important to change the standard. Though a D2 equivalent standard is pretty fantastic, folks aren't just meeting them, they're trying to kill everything in there to exceed it. It would be nice to do what Nick is saying - find a simple test to measure for gross exceedence, even if it's just for smaller organisms. It would be a powerful statement, and practical for ships/ owners/agents to use as well.

(Ruiz) Share Nick's opinion that the D2 standards are pretty good, though they could go further. I like the idea of defining a finer grain assay that could be done by a broad range of people.

(Dobroski) This discussion has a lot of very good points. The quality of data is important, as not all testing has been equal. Are there any recommendations for comparing data quality? Are there certain tests/reports for which the data source is not clear, but they've gotten Type Approval through IMO?

(Reynolds) (IMO) Type Approval type testing does serve a purpose. It's onerous, but it puts a system through its paces at least once. States have gotten themselves into a pickle by requiring equipment on ships. My understanding is that you (CA) can have standards but you can't prescribe equipment.

> (Dobroski) But we can prescribe testing methods.
>
> (Reynolds) In an ideal world, a ship gets Type Approval, then as systems come online you prescribe testing protocols for CA so manufacturers can guarantee to ship owners that their system will meet them. Phase in new tests as better testing come online. Have grandfathering for ships that met standards via older methods.

(Cohen) EPA drinking water systems require an initial demonstration that has to be done when a system is installed to show that it has the ability to meet the standards. Demonstrations of meeting the standards are based on bench top testing and performance of existing systems. Then there is also continuous testing that has to be done at least annually, with certain limits that have to be met (daily and other). So there's a combination of evaluation based on available data, followed by compliance monitoring during operation. There are two separate sets of requirements. Could do a similar thing for ballast water – demonstrate marks can be met using data out there at least initially. Then test as best you can at the compliance level. Will probably need to use indicators, rather than counting live organisms, to show you're meeting targets as much as possible.

(Welschmeyer) In some ways, the ability to test is related to ability to comply. One uses the best methods of the day as earmarks of success, then tweak methods so it becomes more sensitive into the future. But the answer you get is the bottom line, which may not exactly meet the regulations.

(Cohen) Yes, we can't test them perfectly or perhaps even closely. But what do you start with is the question. You can draw on bench top data and prototype data. California should set up standards for what kind of data it needs or will accept. There are some systems for which initial test data show that they meet IMO D2 in the largest organism size class class, and perhaps in 2nd size class [10-50], but not for bacteria, and there is little data for viruses. With drinking water, data must be brought to EPA or state agency to prove compliance.

(Reynolds) I really think the west coast states missed the boat to use the IMO D2 standard, but with a more aggressive timeline, as it really is a rigorous standard. If we use a BAT approach for testing, we could recognize a method that tests to the D2 standard level, noting that the CA standard is the objective, and come up with usable test for compliance so vessels can self-monitor. This would set the bar low first, then ratchet it up as testing gets better. Shoreside treatment would be fantastic, but having worked with permits for other land facilities, it would be a 10-20 year program to get it going. That said, we should not lose sight of it. Right now, we should race ahead with what we've got. Even with a new pipeline at an existing berth, permitting/funding etc. would be a 5-10 year timeline at a minimum. I mean, it took me 5 years just to get piping installed on the Golden Bear.

(Cohen) Disagrees – a land based treatment option would have a shorter timeline.

(Welschmeyer) On verification tests, I think there is going to be a burden to prove that there are some simple tests for folks. Maybe have a trial period, and trial tests side-by-side with certification testing. This will be well worth the effort, but will require a break-in period to gain acceptance. Another component could be to form a subgroup with a focused task to identify one or more areas to discuss/develop compliance tests that are doable in a one year timeframe.

(Falkner) A subgroup is a great idea. Maybe we can have an extended discussion on who would be appropriate to have.

(Welschmeyer) Also, in April, Moss Landing Marine Laboratories (MLML) will host a workshop related to how to count the 10-50 micron size class. There will probably be a discussion about alternatives to direct counting. It will be paid for by Marcel's group (NIOZ) with E.U. funding. That might be a good opportunity to have a breakout discussion on the issue of how to deal with compliance testing. Some ad hoc discussion has been had in the past, but we need a focused, serious discussion. Kevin's point is important, you can validate an alternative testing procedure, but it won't be acceptable until the world can do/agree to the same test and get the same answers.

The MLML meeting maybe a good place to start this process. The best test is the one that takes the smallest volume, and measures the smallest amount of living tissue since it can be replicated. Then you ask if that organism group can represent compliance of the other size classes.

(Cohen) Believes it is unlikely that a single test would tell you about all size classes. When you look across the range of organisms, they have different resistances to various treatments. But we do want to look for as few tests as possible, and those that are easiest to do.

(Reynolds) That's why you look first at Type Approval type testing. Then later check to see if a system is working right by checking the mechanics and logs, and then check one indicator size class to have some confidence that the killing mechanism is still working.

(Welschmeyer) Agrees, but we need to start building up, and getting the word out about selecting tests that can be used.

(Reynolds) We would also need to use a statistical collection of data. As you collect data on ships coming in with installed systems, that information will help inform which systems might have more exceedences, and may require more in depth scrutiny.

(Welschmeyer) When we go down that path, the group has to understand a new idea of compromise. Start with detecting gross exceedences, and see if we can go lower. It would be pretty easy to show that certain tests don't have the sensitivity to test to low, low levels. There will be problems. Sometimes zero, by nondetectable standards, are still much, much higher than you want them to be, but you have to acknowledge that in advance.

(Dobroski/Falkner) (After asking if anyone had any more input) Thank you all for participating today. It was a really good discussion with great ideas. We'd like to look more into joining the MLML meeting, and getting input from the group that will be there. We'll contact Marcel for more information. Thank you.

APPENDIX C: NOTES FROM TECHNICAL ADVISORY PANEL MEETING (MARCH 2011)

California State Lands Commission
Marine Invasive Species Program
Treatment Technology Technical Advisory Panel Meeting
March 1, 2011

Attendees (in-person)
Sharon Shiba – CDFG/OSPR
Steve Morin – Chevron Shipping
Marc Holmes – The Bay Institute
John McLaurin – Pacific Merchant Shipping Association
Dominic Gregorio – CA State Water Resources Control Board
Tom Burke – California State Lands Commission
Jackie Mackay - California State Lands Commission
Maurya Falkner - California State Lands Commission
Nicole Dobroski - California State Lands Commission
Chris Scianni - California State Lands Commission
Lynn Takata – California State Lands Commission

Teleconference
Rian Hooff – Oregon Department of Environmental Quality
Spencer Schilling – Herbert Engineering
Shirley Fan – US Environmental Protection Agency
Karen McDowell – San Francisco Estuary Partnership
Bill Davidson – Cal Maritime Academy/Golden Bear Facility
Nick Welschmeyer – Moss Landing Marine Laboratories/Golden Bear Facility
Andrea Fox – California Farm Bureau Federation
Greg Ruiz – Smithsonian Environmental Research Center
Jon Stewart – International Maritime Technology Consultants
Lisa Swanson – Matson Navigation

(Dobroski) ***Introduction and Update (powerpoint)***

International updates
As of 31 Jan 2011, there have been 27 countries representing 25.32% of world shipping tonnage that have signed on to IMO Ballast Water Convention. Full ratification requires 30 countries representing 35% of world shipping tonnage, so IMO is getting close, and it appears that the threshold will be met sometime this year. Thus far, there have been 11 treatment systems that have received Type Approval.

We (SLC) have been working in collaboration with a number of international entities, including the Australian Quarantine and Inspection Service (AQIS), Biosecurity New Zealand, Transport Canada and Fisheries and Oceans Canada, and the North Sea Ballast Water Opportunity Group. We've also been continuing to work worldwide with scientists and vendors in addition to these international regulators.

Federal updates

The US Coast Guard (USCG) is expected to release their final performance standards rule soon. We've been told to expect it in April of this year, but we've heard at a meeting last week that it was expected to be released this spring, so we're not sure if the April release date still holds. In either case, we expect it within the next few months.

The USCG Shipboard Technology Evaluation Program (STEP) currently has 6 vessels enrolled. There has been a recent change in personnel; our new contact for this program is John Meehan. The USCG is still developing biological testing protocols and this has essentially stalled the program. They are continuing to accept new applications for entry into the program, and they are now targeting Great Lakes vessels. Five vessels that are enrolled in this program also have permission from CSLC to use their treatment systems in California with a five year grandfathering period before they'd need to meet CA performance standards. New proposed legislation introduced in CA would allow grandfathering for future STEP vessels (or vessel engaged in experimental treatment technology testing), we will keep you posted on how that progresses.

The US Environmental Protection Agency (EPA) held a listening session last fall to discuss the development of the second iteration of the Vessel General Permit (VGP). This listening session provided an opportunity for the public to recommend changes or additions to the permit. The EPA is tentatively scheduled to deliver a draft of the new permit to the state water quality agencies by late 2011, in time for them to develop their state-specific 401 certifications, so that the final draft can be released to the public in advance of December 19, 2013.

(Stewart) I've had a discussion with USCG regarding STEP. They have indicated that they are considering certain allowances because of the sunset of the grandfathering period. They're trying to address this by using placeholder applications, these would be incomplete applications but they would be in place and this may have implications for the CSLC program.

(Dobroski continued) A Memorandum of Understanding (MOU) was signed last month between USCG and EPA. There were multiple components, but basically it allows for the cooperative implementation and enforcement of the VGP. The MOU and associated details are available online.

There have been a number of recent discussions at the federal level involving groups of scientists and marine engineers. One of these has been the Science Advisory Board (SAB). The focus of the SAB is to discuss the status of existing and future treatment technologies, looking at available data, determining the reliability of those data, and

determining why certain data may not be reliable. They've held several public meetings over the past 8 months and they released a draft report in January 2011. They have an upcoming conference call scheduled for March 15 and 17 to discuss the draft final report. The final report is due by June 2011. The other group is the National Academy of Sciences (NAS) group, which is focused on evaluating numeric limits for living organisms in ballast water. The SAB has been much more open in terms of public information than the NAS group. None of the NAS meetings have been open to the public, so we will need to wait for the final report to come out to see what they have been discussing. This final report is also due by June 2011.

The ETV protocols, which resulted through a collaboration between the USCG and EPA, are land-based generic protocols for verification of ballast water treatment technologies. The protocols were finalized and released in September 2010 and are available online. They include information on biological performance, water quality, operation and maintenance. The goal is to provide a mechanism to verify performance of innovative technologies, but it is not the same as Type Approval. Labs would need to be certified through this process, but there are none so far that have gone through this completely. Another component of this would be shipboard protocols, and they [EPA/USCG] are starting to move forward with the development of those.

State updates

We have been involved with the Great Lakes Collaborative, even though we're obviously not a Great Lakes state. This group includes the Great Lakes states, US St. Lawrence Seaway Development Corp., Canada, industry representatives, researchers and vendors. During recent meetings, the Collaborative has assisted Wisconsin with their ballast water treatment assessment report. The reports and meeting presentations are all available online. This group is focused on the freshwater environment, but info coming out from this group is applicable to many systems.

As for individual states, Wisconsin recently completed a report assessing the availability of treatment systems. They decided to change their standards from what's referred to as 100XIMO to the IMO standards. This report is available online. New York recently extended the date to comply with implementation of their standards to August 1, 2013, for vessels that requested the extension. The NY standards are similar to ours in California. Iowa and Pennsylvania deleted their standards from the Section 401 Certification of the VGP in December 2010. Keep in mind that all of these states have established their standards through the Clean Water Act (VGP), unlike California (ours was put in place through legislative action).

As for the Pacific Coast, we have a meeting of the Pacific Ballast Water Group (PBWG) next week on March 8-9 in Portland, OR. The draft agenda is available online and usually most/all of the presentations are available online afterwards. This meeting provides a forum to present overviews of the different programs at state levels as well as federal updates.

(Hooff) The Oregon Legislature (2009) provided the Department of Environmental Quality with the authority to establish standards through rulemaking. Our agency, in consultation with our stakeholder group, opted to withhold the adoption of state-specific standards and implementation dates during our most recent rulemaking activities. Instead, waiting on release of USCG final rulemaking and/or EPA VGP re-issuance to assess adequacy for protecting state of Oregon waters. The new rulemaking did, however, establish a new rule describing when ballast water treatment systems may be used for discharge to state waters. At this time, the new rule allows for use of systems approved by USCG or EPA, and also allows the department to authorize the use of promising technologies in cases involving high-risk emergency discharge.

(Dobroski) The State of Washington no longer approves treatment systems, but they have the authority to develop standards. They may start the rulemaking process in May or June, depending on issues with their budget and the discussions held at the PBWG meeting next week.

For us in California, our most recent ballast water treatment technology assessment report was approved by the Commission in August 2010. Eight of the systems we evaluated showed the potential to comply with our performance standards, and all eight of these systems are commercially available. Three of these systems showed the potential to meet our standards more than 50% of the time. Seven of the eight systems have the ability to handle pump rates of 2000 cubic meters per hour, and therefore would accommodate 80% of the vessels in California. All eight of these systems comply with VGP limits on total residual chlorine (TRC) or don't produce TRC. The plan is for CSLC to proceed with the implementation of our standards on January 1, 2012 for new build vessels with a ballast water capacity of greater than 5000 metric tons. The January 1, 2012 date is the cutoff for the keel laid date. Even though it's not something that was legislatively mandated, we will produce an update of this report by September 1, 2011 at the request of our Commission.

We also recently prepared the legislatively mandated 2011 biennial report that was approved by the Commission in December 2010. This report includes vessel arrival statistics and compliance, data on hull husbandry practices, program activities, and an update of funded and cooperative research. In light of some of the discussions occurring at the federal level and within the Great Lakes Collaborative, we (CSLC) are discussing possible changes to our plans for implementing our performance standards. This does not mean that we are changing the actual standards themselves or the implementation schedule, despite recent reports suggesting that this is the case. Both the standards and implementation schedule are set in statute and cannot be changed by the Commission.

In December, we had a discussion with a mini-technical advisory group (TAG) consisting of scientists and a marine engineer about options for moving forward with the implementation of our performance standards. We discussed three possible options for moving forward:

1) Change the standards. This option would require legislative action, and there is no political will in the state to do this. Therefore, this isn't a very viable option.
2) Use of best available technologies (BAT). This would also require legislative action as well as regulatory implementation.
3) Codify compliance verification protocols via regulations. We would specifically lay out protocols to make it clear which processes CSLC inspectors would use to verify vessel compliance with CA's performance standards. By providing these protocols, there would be a benchmark for determining compliance with our standards.

The consensus from that group was to not change the standards, especially because of the lack of political will. The standards themselves are only half of the equation, how they will be measured is the other important part. The best option is to develop a set of protocols that will be used to verify compliance. As methods improve, regulations could evolve, and we could develop a process to grandfather the systems/vessels that were installed under certain verification regimes using the original methods/protocols.

(Holmes) Can you clarify that the mini-TAG meeting was on December 20?

(Dobroski) Yes

(Stewart) Have you considered what the grandfathering might look like? Also when developing verification protocols, you'd need to provide a concise statement for validation onboard stating that you would be deemed in compliance if you use certain protocols. What is exactly allowable under your mandate and what about your ability to defend this in court?

(Dobroski) For the question relating to the timing of grandfathering, maybe 5 to 10 years. We haven't made that decision yet, we're just entering those discussions.

(Falkner) Regarding your other question, it would be similar to the Water Board. Just because compliance testing is conducted by the user doesn't mean that the regulator wouldn't still come on board and verify compliance.

(Stewart) If it was equivalent to the Water Board and other discharge regulations, that would be much more workable. Even with testing and monitoring requirements, there's certainly an option for the state to come out and verify.

(Gregorio) What we (State Water Resources Control Board) do is to require certified labs to carry out those analyses, the regulated party has to use certified labs. There are always problems with certain measurements (e.g. pH). Is CSLC going to use certified labs/testers?

(Falkner) This is still in the discussion phase. I envision three layers of testing. This is up on the screen.

(Dobroski) Our plan is for us to do the testing. We are required to inspect at least 25% of the arriving vessels. Most of the focus worldwide has been on land-based testing, this would be the first layer of testing. We're not talking about that when we talk about compliance verification. The methods and volumes of water used for land-based Type Approval testing aren't practical on board a ship. We're thinking about something more practical, for ship-based testing. This would be level 2. Tests that vessels can do or that we can do, like standard tests for *E. coli* etc.

(Morin) How quickly do those tests work?

(Gregorio) It takes 18-24 hours for most microbiological tests.

(Dobroski) When tests fail, our goal is to find out why they failed. Determine what we can do to get the vessel back on track. Our efforts will be to develop protocols for all size classes that our inspectors can do. Level three would be a dipstick type of test that would quickly tell you whether vessels have grossly exceeded the standard. A red/green light sort of test, this would be highly valuable to ship owners so they can conduct self-checks. A good example of this is the test that Nick Welschmeyer is developing.

(Welschmeyer) We're working on a quick and dirty test for bulk viability analyses that CSLC can conduct onboard themselves. The method has been tested during several IMO sea trials at the Golden Bear Facility and while the facility was being scrutinized for calibration and testing of the ETV protocols. We've been comparing the dipstick protocol to regular measurements and it has been quite successful, especially for determining gross exceedance. The system takes advantage of old technology, fluorescein diacetate (FDA), converted to seawater tests to get rid of false positives. It operates with a one-hour incubation, and the samples can be filtered down to specific size classes using traditional size fractionation. The readings are taken using a handheld battery-operated fluorometer. It has been encouraging, and we want to make it as portable as possible.

(Gregorio) Does this only tell you if there are critters there, with no indication of whether they are indigenous to California?

(Welschmeyer) Exactly, it's a bulk viability indicator. There is no indication of whether the organisms are indigenous or not.

(Gregorio) For testing level two, where would you do the testing at? Would you set up a lab at each harbor?

(Dobroski) Not sure. We're still trying to work out some of those details. We're participating at a meeting at Moss Landing Marine Labs late this month focusing on the 10-50 micron size class. We need to talk to some of the technical folks about this. We'll work through it, and our goal is to have a draft framework in place by the end of the year.

(Falkner) We've been getting emails with questions about protocols from vendors who want to test their systems for CA standards. The tests we're talking about (level 2) are things we'd do for an enforcement action, if the dipstick test fails or shows gross exceedance.

(Dobroski) It's important to remember that no one else has done this yet, worldwide. The compliance side of the equation has been largely ignored. There is a lot of info to draw from, but no one has brought it all together yet.

(Gregorio) Minor suggestion, it might be a good idea to contact the Southern California Water Coastal Water Research Project (SCCWRP). They've made great advancements in barcoding organisms, working with benthic sampling near outfalls.

(Dobroski) Thanks, you're right. The best way to do this is not by looking under a microscope, that would be too laborious, too much manpower. We do need bulk assay-type tests.

(Welschmeyer) I've been a member of SAB. The discussion was supposed to be on technologies but a tremendous amount of time spent on statistics and testing. The statistics involved are logistically troublesome. Why haven't we been working on compliance? The perfect test is so onerous and lab-specific that it can only be done once on a vessel. The appropriate buzzword is "compliance," and the issue is that we haven't been acting on compliance.

(Gregorio) Would the dipstick tests be conducted by the vessels?

(Falker) Anyone can conduct tests, including our inspectors. Data suggest that when systems fail, it's a gross failure.

(Welschmeyer) We can test for all of the size classes. The take home message is that the large size class is the rarest in seawater, and the problem with large water volumes is focused on that group. The statistics are in a sorry state of affairs. It's highly probable that we need a mindset change and acceptance of tests for small microbes, because of the small volumes involved and because they are more abundant than larger size classes.

(Falkner) We have a suite of organism size classes with volumes attached, but that's not the case for the larger size class. There is no volume attached to that standard. We'll have to use practical, pragmatic tests in the field.

(Ruiz) Is the rationale to look at smaller microbes as indicators for all size classes?

(Welschmeyer) Yes, but we'd have to repeat the experiment a lot to gain confidence in it. It would have to be pretty specific towards the implementation of the test. The odd irony in this is that the smaller size classes are the hardest test to conduct. Generally

everyone agrees that tests for the largest organisms are easiest since it's easy to determine live and dead organisms under a microscope. Ironically, the 10-50 category might be the hardest measuring category to use for compliance tests but the easiest in terms of the volume of water to sample.

(Dobroski) We might focus on some size classes more than others, but we're lucky that our large standard has no volume associated with it. If one organism is found, then it fails. If no organisms are found, then we can move on to the 10-50 micron size class.

(Shiba) There is no volume required for the greater than 50 microns size class?

(Dobroski) Correct. The CA standard is "non-detectable." There is not concentration or volume associated with that standard.

(Takata) The idea is to make it clear that these are the protocols that we would use for compliance monitoring. Look at it like going to a doctor and knowing which tests are going to be conducted.

(Dobroski) For our standards, there is no volume specified for greater than 50 microns. We would probably need to move to smaller organisms for statistical confidence.

(Shiba) One issue of concern is if users can inadvertently contaminate the sample for FDA tests.

(Dobroski) Nick has gotten pretty good results on the test, but definitely handling error would need to be minimized.

(Falkner) On inspections, we're going to ask questions like did you turn the system on, did you clean the sampling port? Red flags will lead to questions about why it failed. If the engineers are smart, certain engineering metrics would be included. Vessel owners can look at metrics to verify that system is working and then validate with dipstick. But contamination is an issue that will have to be addressed.

(Morin) For item 2, who do you envision collecting the samples and bringing it to lab?

(Falkner) We'd pull samples per protocol, but it could be that we could set up lab facilities in our field offices; we'd have to assess that. There is definitely a concern about having samples sit around for too long.

(Dobroski) We would encourage vessels to do some testing themselves to ensure they are in compliance.

(Takata) When we develop these protocols, we'll keep the end-user in mind. That will be part of how we define protocols, who would be doing it, statistical certainty, etc.

(Dobroski) [Back to the powerpoint presentation - treatment tech form slide] There were two reporting forms approved in November 2010. One of these is an annual form and the other is a ballast water treatment supplemental reporting form, similar to ballast water reporting form. Both of these are out there right now, and submission is required for vessels that have treatment systems installed and that discharged treated ballast in CA waters. This will help us gather information as well as help with our implementation of the standards over time. This will be very valuable once these systems are put on vessels.

In terms of other research and projects we're involved in, we're working with Matson Navigation on a system (Ecochlor – chlorine dioxide) installed on the *Moku Pahu*. We're also working with the APL England to install the NEI system (deoxygenation) onboard. Both of these vessels are enrolled in STEP. There's also the Golden Bear Facility, a plug and play setup that is the only testing facility on the west coast. It can conduct land-based and shipboard testing. They've tested the Severn Trent De Nora system and are working on testing ETV protocols.

(Gregorio) What do you mean by plug and play?

(Dobroski) A container with the system inside is loaded onto the back of the vessel, and plugged into the ballast system, rather than installing it into the bowels of the vessel. It can even handle two systems at the same time.

(Falkner) Initially, there was some concern about pressures and the representativeness of having the system on the back rather than in bowels of the vessel, but these were tested and concerns have been overcome. This setup is great for the cadets, great for the west coast, and hopefully they will help us in testing our protocols.

(Dobroski) Nick Welschmeyer is lead scientist and Bill Davidson is the Chief Engineer. This is great for the cadets, to introduce them to the idea of treating ballast water.

For our next steps, quite a few treatment systems have come onto the market since our 2010 report. We will continue to gather information about them and update our report in September 2011. We will start field testing our protocols once they are developed and we will continue to conduct outreach with treatment system vendors.

(Stewart) I have a question about the September 1 report to the Commission. If vendors are interested in being included in this, is there a cutoff date for them to get data to you?

(Dobroski) We will probably send a request out in next week or so. We may set our deadline for May 1st, but we'll let you know soon.

(Stewart) It's really encouraging to see someone taking the enforcement issue at hand in a pragmatic, doable manner. It hasn't been addressed yet, mainly because everyone is focused on type approval. The type approval can be done however an administration

wants, and this leads to disparity in testing and creating an imbalance in the playing field when it comes to promotion and marketing. It's really an unfair advantage. In CA, we're looking at limited data. Now there are more constructive ways of looking at systems, and I'm glad to see us digging our heels in and doing this.

(Morin) Looking at option one, I'm concerned that if standards are kept as is, then environmental groups would sue you to enforce the standards. And then we'd still be forced to meet the standards.

(Falkner) That's something that we'll deal with if and when the time comes. But other regulatory agencies have dealt with standards for which the limit of sampling detection can't meet the standard.

(Gregorio) Chlorine is a good example

(Falkner) Do you (Water Board) get sued by environmental organizations?

(Gregorio) Yes, but usually only for bigger issues. They usually sue us for our implementation of standards.

(Falker) If you utilize protocols and they pass, then they pass.

(Morin) But if someone sues you and they win, we'd have to comply with standards to the letter of the original law, regardless of whatever protocols you had in place.

(Gregorio) We've recently seen lawsuits where an NPDES discharger turns in reports and certifies it. The successful lawsuits were from groups suing because they weren't actually in compliance because of a nebulous portion of report. A recent suit by NRDC related to LA county signing forms saying they were in compliance but they really weren't.

(Falkner) Is that because they misrepresented data or what?

(Gregorio) This is just an example, but it was a blatant violation. It wasn't devious, but it happens (e.g. runoff).

(Falkner) If we had defined methods and protocols, and the system meets that, I don't know why anyone would sue anybody.

(Morin) What about environmental groups suing you like they did the EPA in order to regulate wastewater discharges under NPDES?

(Falkner) That was a different issue, nobody was doing it. We're doing the best we can.

(Takata) A lot of the best scientists around (SAB group, NAS, ETV) have discussed the fact that testing procedures don't test with the 95% statistic rugosity that's ideal. Testing

methods are onerous; I can't imagine an environmental group going against a group of scientists.

(Morin) Under option 3, if we install a system in 2012 and protocols improve, then we still only have to meet 2012 rules. If system is installed in February 2016, and new protocols are put in place in November 2016, would I have to meet the 2016 protocols?

(Dobroski) This example is just for overview purposes.

(Falkner) We will have a phase-in period, but we haven't yet worked out the details.

(Takata) Keep in mind that none of this has been codified, these are just notes.

(Falkner) There will be a grace period.

(Holmes) I want to ask about Andy Cohen's email. He's basically suggesting we take a look at land-based technology. It seems to be an idea to get around this lack of uncertainty. Are you still taking a look at it?

(Dobroski) We're still in support of land-based technologies and barge-based technologies as well. The challenge is that no one has developed a land-based system, and the Water Board would be regulator. It might be a very feasible option for certain ships or areas, but no one has been building them and there is no available land-based facility. We'd encourage use of it, but there's not much to work with right now.

(Falkner) We have supported it for certain vessels cruise lines in Long Beach. If vessels want absolute certainty that they would meet our standards, then they should start pushing for it. We can't tell the Port of LA to do this. If a barge-based system were to be implemented, that would be phenomenal. We've talked to Pacific Merchant Shipping Association about a co-op system for those vessels that don't discharge 90% of the time. There's the possibility that they may need to discharge every once in a while, and they can buy into the treatment co-op. It doesn't solve the worldwide problem though; we're trying to do this as an international community. We have heavily-invaded SF Bay water. I think shore-based systems would be great, it would be less expensive for industry, but not everyone can do this. If dedicated shipping lines (Maersk for example) wanted to do this that would be ideal.

(Gregorio) The infrastructure needed to service this require the entire port authority to get onboard, it would be a major infrastructure project.

(Falkner) But it would be technically feasible. We are totally supportive of barge-based or terminal-based systems.

(Dobroski) So yes, we're looking at it, and maybe it's a long-term option, but for now we're looking at ship-based technologies because that's where the industry's at now.

(Falker) They’d need to figure out how to do this in a practical sense.

(Dobroski) Andy’s report is on the SAB website if anyone wants to take a look at it.

(Falkner) It’s good that Andy has kept that option on the table, and it is an option to be considered by a variety of folks.

(Dobroski) So that’s it, we’ll send the slides and meeting minutes out to you soon

(Swanson) I just wanted to check in, I called in after the meeting started.

ADJOURN