

Abstract

The spread of marine invasive species across the world's oceans in the ballast water (BW) of ships is recognized as a significant threat to ocean health and is known to severely disrupt coastal ecosystems and cause tens of billions of dollars per year in economic losses in fisheries, aquaculture, and other ocean-dependent industries.

On September 8, 2016, the International Maritime Organization (IMO) of the United Nations acted to reduce these threats by ratifying the Ballast Water Management (BWM) Convention. When it goes into force on September 8, 2017 it will require ships that discharge ballast water (BW) to install and use ballast water management systems (BWMS) that have been certified by an IMO member nation as being capable of killing or removing enough living organisms in BW to allow the BW discharged by ships to meet regulated discharge standards. Compliance with this convention also requires that, when tested during routine ship operations, a ship's BW discharges must actually meet these regulated BW discharge standards.

There are many reasons why this second compliance requirement will pose significant challenges to BW regulators. The three most important and least recognized reasons are: (1) The IMO guidelines (G8) for testing and certifying BWMS are so vague and open to so many different interpretations that many of the roughly 65 types of BWMS that have been certified by various IMO member nations will not be capable of routinely achieving allowable BW discharge standards. (2) Because of similar inconsistencies in the US Coast Guard (USCG) program for testing and certifying BWMS, the same situation is expected to exist with USCG-certified BWMS when they begin to reach market. (3) Shipping industry leaders have stated clearly that the owners of the approximately 50,000 merchant ships in the affected global fleet will not spend between \$1 million and \$3 million per ship to purchase and install certified BWMSs unless they have "absolute confidence" that they will be able to comply with BW discharge standards.

The problem this poses to BW regulators is not as simple as some ships with certified BWMS not being able to meet allowable BW discharge standards. Temporary regulatory solutions to deal with that problem could include simply not testing the BW discharge of those ships or not penalizing operators of those ships if their BW discharge fails testing. The bigger problem BW regulators are likely to face is that once shipping industry leaders and political leaders who support them determine that this situation exists, they will use "quality uncertainty" to prevent markets for certified BWMS from developing enough to allow other ships to purchase and install certified BWMS. Correcting serious problems in global BWMS markets due to inadequate or inconsistent BWMS certification testing will be far more difficult for BW regulators to correct than certification testing problems themselves.

Two responses by BW regulators are necessary to prevent market-based noncompliance problem from delaying when it will be possible to enforce global BW regulations. First, IMO needs to act quickly and aggressively not only to revise G8 guidelines for BWMS testing and certification, but to reduce the "quality uncertainty" problems that existing G8 guidelines have already created in global BWMS markets. This means retesting previously certified BWMS and purging global BWMS markets of those BWMS that fail. Second, the USCG needs to avoid contributing to problems in global BWMS markets and help resolve them by establishing a rigorous, consistent, and transparent BWMS testing and certification program that will result in potential buyers and sellers and prospective investors in global BWMS markets having confidence that USCG-certified BWMS will be capable of routinely meeting allowable BW discharge standards. Unfortunately, at present, the USCG program for testing and certifying BWMS is heading in the opposite direction.

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For more publications by Dennis King dealing with global ballast water regulations visit <http://www.maritime-enviro.org/Reports.php>

Introduction

To maintain stability and maneuverability, merchant ships need to offset the weight of cargo they offload in port by taking aboard some type of ballast. In the days of wooden ships, laborers loaded sand or stones into the cargo holds of ships when they needed ballast. However, at the start of the twentieth century when steel hull ships replaced wooden hull ships, new ships were designed to save time and money by using conveniently available seawater as ballast. Since that time, ships routinely pump seawater, along with whatever living organisms are in it, into on-board tanks when they offload cargo and need ballast, and then discharge it at other ports when they pick up cargo or, for other reasons, need less ballast.

During the second half of the twentieth century, the number and size of merchant ships increased and global trade expanded to the point where tens of billions of tons of water, along with all the bacteria, microbes, small invertebrates, eggs, and larvae living in that water, were being transferred each year across the world's oceans. Early on, scientists determined that some of these organisms were extremely invasive in the sense that when they were released into coastal waters they out-competed native species and destroyed or severely disrupted native coastal and ocean ecosystems.

In some places the introduction of these invasive species led to devastating environmental impacts, including pest-scale invasions, and also billions in economic losses. Some studies report that pathogens in BW discharges could also be responsible for outbreaks of deadly diseases. A list of the world's most troublesome marine invasive species and their regional impacts is available on the International Maritime Organization (IMO) website.

The complexity of global shipping and the diversity of invasive species found in the BW of ships have made the search for solutions to invasive species problems associated with BW very difficult. But, on September 8, 2016, after more than 40 years of effort by researchers and regulators and 12 years of difficult international negotiations, a milestone was reached when the IMO announced that the international Ballast Water Management (BWM) Convention had received enough signatures by IMO member nations to be ratified. The BWM Convention will be in force on September 8, 2017.

With the BWM Convention scheduled to be implemented next year, a great deal of shipping industry attention is now focused on all the unanswered questions that remain regarding when and how regulations specified in the Convention will be enforced, and how that will be influenced by the ability of ships to comply. Ocean advocates are taking things one step further by asking questions about when shipping industry compliance with the terms of the BWM Convention can be expected to start reducing the significant environmental, economic, and public health problems associated with the discharge of untreated BW.

The answers to all of these questions depend on how quickly global markets develop where ship owners can purchase and install certified ballast water management systems (BWMSs), which are estimated to cost between \$1 and \$3 million each. Recently some simple BWMS market forecasts have been published that are based on the phased-in compliance schedule specified in the BWM Convention and the characteristics of the affected global fleet. These forecasts predict BWMS markets will grow quickly over the next few years, reaching over \$50 billion and allowing full compliance by the existing merchant fleet on schedule by

2022. They predict that global BWMS markets will then collapse and be supported only by one or two thousand newly built ships each year. Slightly less optimistic BWMS market forecasts are based on the assumption that BWMS manufacturing and installation bottlenecks will require IMO to issue compliance extensions which will delay BWMS market development and widespread shipping industry compliance by an additional five to ten years.

Description of the Problem

The BWM Convention requires all ships that discharge BW to install and use a BWMS that has been tested and certified, by an approved laboratory in an IMO member nation, as being capable of killing or removing enough living organisms for the ship to meet specified allowable BW discharge standards. However, compliance with the BWM Convention also requires that the BW discharged by ships with a certified BWMS, when tested during routine operations, must actually meet those allowable BW discharge standards.

For reasons that will be described throughout this paper, unless there is a significant shift in the way BWMSs are tested and certified, and more attention paid by BW regulators to conditions that are emerging in BWMS markets any optimistic prediction about when it will be possible to enforce global BW regulations will most certainly be wrong. Two areas of Nobel Prize winning economic research explain why, and provide a conceptual basis for determining where to look for information that can be used to predict the future of BWMS markets and, hopefully, can be used to help shape them in ways that will allow the timely implementation of global BW regulations.

The first area of research earned three economists (George Akerlof, A. Michael Spence, and Joseph Stiglitz) the 2001 Nobel Prize in economics by demonstrating conclusively that

“quality uncertainty” destroys markets, prevents them from developing, or results in bad quality forcing good quality out. In the case of regulation-driven markets, like global BWMS markets, this is particularly important because buyers and sellers in regulation-driven markets are only as quality conscious as regulators require them to be. If BW regulators do not impose strict quality criteria in BWMS markets from the beginning, bad quality can be expected to force out good quality. If that were to happen, BWMS markets would not develop in a way that would allow them to play the critical roles they need to play for BW regulations to succeed.

If ship owners could be confident that purchasing and installing a certified BWMS would allow their ships to comply with BW discharge regulations, quality uncertainty would not be a problem in BWMS markets. However, it is highly likely that some of the 65 or so types of certified BWMS that are on the market, including some of the approximately 2,500 BWMS units that have been purchased and installed on ships, are not capable of consistently or reliably achieving allowable BW discharge standards under normal ship operating conditions. Until changes are made in certification testing and some already certified types of BWMS are purged from the marketplace, there will be quality uncertainty in global BWMS markets.

The second area of relevant economic research earned three other economists (John Harsanyi, John Nash, and Reinhard Selten) the 1994 Nobel Prize for work that involved the development “game theory” which they used to characterize and analyze, among other things, how regulated industries can be expected to employ legal and political strategies to avoid, delay, and reduce regulatory compliance costs, and the countervailing strategies regulators can use to

thwart those efforts. These “gaming models” were also used to show the likely outcome of competition between regulators and regulated industries.

In the case of BW regulations, for example, a gaming model would predict that if and when evidence becomes available that quality uncertainty in BWMS markets can result in some ships with certified BWMS being out of compliance with BW regulations, the shipping industry will vigorously challenge the enforcement of BW regulations. The outcome would then depend on the ability of BW regulators to muster enough technical and political support to deal with quality uncertainty in BWMS markets and with shipping industry challenges. This would require BW regulators and political leaders who support them to distinguish between reasonable shipping industry positions that are based on valid concerns and are aimed at improving BW regulations and extreme shipping industry positions that reflect gaming behavior aimed at delaying the enforcement of BW regulations.

The International Chamber of Shipping (ICS) represents about 80% of the global merchant fleet. The following sections provide a critical assessment of recent ICS position statements about BW regulations, unresolved problems with IMO’s process for testing and certifying BWMS (under the G8 Guidelines), and similar problems emerging in the United States Coast Guard (USCG) type approval certification program. Addressing these three issues should provide insights into what to expect when global BWMS markets begin to develop.

From an economic perspective, it makes sense to assume that the primary goal of the shipping industry with respect to the BWM Convention is to prevent, delay, and reduce the estimated \$50 billion in compliance costs it imposes on ship owners. The easiest way to achieve this goal is

to prevent, or at least inhibit, the development of BWMS markets where ship owners will be able to purchase and install BWMS in order to comply. And, the easiest way for shipping industry representatives to do this would be to demonstrate that the certified BWMSs available on the market are “not fit for purpose,” cannot routinely achieve regulated BW discharge standards, will not allow the BWM Convention to achieve its goals, and will put ship owners who purchase and install them at risk of facing criminal penalties and other sanctions.

There are two reasons why this is a credible threat that could significantly affect when the BWM Convention will start reducing the environmental, economic, and public health threats of invasive species introduced by BW. First, there is a high likelihood that some of the 65 or so types of BWMS that have been certified by various countries under the IMO convention, including some of the nearly 2,500 units that have already been installed on ships, will not be capable of routinely or reliably achieving allowable BW discharge standards. Second, because the USCG has not certified any BWMS as being capable of meeting the same BW discharge standards, there is growing political pressure (from inside and outside the USA) for the USCG-approved laboratories where BWMS are being tested to relax their testing standards to the bare minimum required by law in order to allow more BWMS to achieve USCG type approval certification. That would increase the appearance of progress, but will lead to more quality uncertainty in BWMS markets, more certified BWMS reaching market that cannot reliably meet allowable BW discharge standards under routine operations, and more opportunities and justification for the shipping industry to “game” BW regulations.

Under the circumstances, it is nearly certain that before or soon after the BWM Convention

is entered into force, shipping industry groups will mount legal and political challenges to the enforcement of BW regulations until global markets for BWMS are purged of “certified” systems that cannot routinely or reliably achieve the BW discharge standards, and until markets adjust and grow enough to allow widespread compliance. At the current time, it seems likely that these challenges will succeed. More importantly, it seems likely that these challenges will result in many potential buyers and sellers in BWMS markets and many prospective investors in BWMS manufacturing and installation capacity refraining from entering the BWMS market, thereby preventing BWMS markets from developing. That, in turn, would make it impossible to enforce BW regulations, saving the shipping industry about \$50 billion in compliance costs.

To put this challenge in perspective, consider three position statements offered by Esben Poulsson, chairman of ICS, a few days after the IMO announcement that the BWM Convention has been ratified.

He first alerts the world that “there is an urgent need for governments to act to clarify the legislative chaos that surrounds the BWM Convention”. He then acknowledges that this “chaos” will exist “until IMO member states finalize the revision of the G8 type approval guidelines” and states that “ICS will be working with IMO member states to impress upon the United States the importance of coming to a pragmatic solution.” The important “pragmatic solution” he wants the United States to reach, of course, is to have the USCG accept BWMS certification by other IMO countries and accept the testing and certification methods and standards those countries have been using. Given the acknowledged problems with IMO’s BWMS testing and certification program and the lack of confidence that exists regarding

some certified BWMS being capable of meeting allowable BW discharge standards, this “pragmatic solution” seems like a step in the wrong direction. It would result in the USCG adding to uncertainty in global BWMS markets.

The chairman of the ICS then states that “We must ensure that ship owners can have absolute confidence that the expensive equipment they will soon have to install will be effective in treating ballast water...and be regarded as fully compliant during Port State Control inspections.”

This statement can be interpreted as a clear shot across the bow of IMO and USCG BW regulators. To comply with IMO or USCG regulations, ship owners must meet two separate requirements. First, their ships must be equipped with BWMS that have been certified as being capable of meeting legally allowable BW discharge standards; and, second, the BW discharged by those vessels must actually be below those allowable BW discharge standards. This statement by the ICS lets BW regulators know that the shipping industry will use its considerable political and legal strength to prevent the enforcement of regulations that force ship owners to invest \$50 billion on equipment to achieve the first compliance requirement if that equipment may not allow them to comply with the second requirement.

What is important here is that the problem facing BW regulators will not be as simple as some ships being unable to meet the second compliance requirement because their BWMS cannot achieve allowable BW discharge standards; that could be addressed by simply not testing BW discharge water or not penalizing ships if their BW discharge fails testing. The problem will be that if some certified BWMS are determined to be “not fit for purpose” and ship owners cannot have “absolute confidence” in them, the shipping

industry will work to prevent BWMS markets from developing. That would prevent ships from meeting the first compliance requirement by purchasing and installing BWMS.

There are many reasons why the BW discharged by ships outfitted with a certified BWMS may not be able to comply with regulated BW discharge standards. A ship's BWMS unit may have manufacturing defects, it may not have been installed properly or scaled correctly to meet the BW discharge requirements of the ship, it may not have been adequately serviced or maintained, and so on. However, the early noncompliance problems that threaten to derail BWMS markets involve the BW discharged from a ship with a certified BWMS that was properly scaled, installed, and operated, but did not meet regulated BW discharge standards because the ship has a type of BWMS that passed IMO G8 or USCG certification testing when it should have failed. These are the cases where ship operators, through no fault of their own, could be found out-of-compliance during port state inspections and face penalties and sanctions as a result of problems with IMO G8 or USCG testing and certification methods.

So, how likely is it that the inability of certified BWMS to consistently and reliably meet BW discharge standards will prevent or delay BWMS market development? The conditions described below suggest that unless immediate and significant changes are made in the IMO and USCG programs for testing and certifying BWMSs, this outcome is highly likely.

Very few currently installed certified BWMS are routinely used, and even fewer have had their performance evaluated to establish that they can meet allowable BW discharge standards under normal operating conditions. Nonetheless, information has been widely circulated within the shipping industry and among BW scientists and regulators that, when

tested, many installed certified BWMS are not performing as expected. This has resulted in widespread skepticism about whether BW discharges from these ships can meet regulated BW discharge standards. Unfortunately, a recent independent review of the IMO program for testing and certifying BWMS (known as the D-2 Study) suggests that this skepticism is well founded.

The D-2 Study identified significant problems and inconsistencies in the methods and standards that BWMS test facilities have been using to certify systems, and a lack of evidence that certified BWMSs that have been purchased and installed on ships can actually meet IMO's pending BW discharge standards.

There are also reports that widely known differences in the rigor and transparency of testing and certification methods used at test facilities in various IMO countries are resulting in BWMS manufacturers applying to be tested in countries and at facilities where they believe they are most likely to pass. Since test facilities compete with one another for the business of testing BWMSs, some knowledgeable observers believe that these known differences in testing and certification standards have put facilities with appropriately rigorous testing methods at a competitive disadvantage and caused them to lose business. Unless IMO acts quickly to correct this situation, those rigorous BWMS test facilities (which are guided by the intent of the regulations rather than the goal of passing as many BWMS as possible) will need to either relax their testing standards or go out of business. And, without appropriate, consistent testing methods, it is also likely that some of the roughly 30 BWMS that reportedly await testing for certification will be approved for use and will add to noncompliance risks and uncertainty in global BWMS.

There remains a possibility that the future of the BWM Convention and global BWMS markets will be determined by decisions made in the USA regarding the USCG process for testing and certifying BWMS. The USA, which is not part of the BWM Convention, has its own BW regulations with the same BW discharge standards as those specified in the BWM Convention. And, the USCG operates its own BWMS testing and certification program using methods and standards that are believed to be more rigorous, uniform, consistent, and transparent than those used under the IMO G8 process. The USCG has not yet certified any BWMS as being capable of meeting its discharge standards, but is expected to start certifying BWMS sometime in 2016 or early 2017. Many shipping industry leaders and BW scientists and regulators remain hopeful that when this happens, widespread confidence in USCG certification will provide a “gold standard” that will resolve quality uncertainty problems in global BWMS markets.

However, some experts involved in testing BWMS for USCG certification are expressing concern that USCG testing is not rigorous or uniform enough to provide the confidence needed to reduce quality uncertainty in BWMS markets. They claim that USCG guidance provided to the five USCG-approved BWMS Independent Laboratories, and their multiple sub-laboratories, is too vague and that testing methods and standards at those facilities has been inconsistent and not transparent. And, they express concern that vaguely defined testing requirements (under ETV Protocols referenced in the USCG BW regulations) combined with political pressure from within and outside the USA for the USCG to be “more pragmatic” is making it difficult for the USCG to avoid the same types of problems as those that exist with IMO’s G8 testing and certification program.

For example, Dr. Mario Tamburri, a highly respected BW scientist who has been managing testing of BWMS at the USCG-approved University of Maryland Center for Environmental Science-based Maritime Environmental Resource Center (MERC), has now publicly expressed his concern that there “is very little consistency or comparability in testing (and thus probability of success) at different USCG-approved testing laboratories.” The enormously costly zebra mussel invasion of the Great Lakes is frequently used to illustrate the importance of dealing with ballast water problems. Dr. Tamburri recently reported to US congressional leaders that the USCG program for testing BWMSs is “so flawed that it would not have prevented the zebra mussel invasion of the Great Lakes and will not stop their spread.” Based on his more than 15 years of research and experience on this issue, he believes that “critical test methods are being used in ways that result in clearly live organisms being considered “dead” during certification testing simply because the analytical method used is not prohibited by regulations” Tamburri believes that flaws in the USCG BWMS certification “leaves the public with a false sense of security”.

Tamburri and others have been pointing out that even though no BWMS has been certified by the USCG program, the problems with the USCG testing and certification program are already having an effect on BWMS testing markets. BWMS manufacturers are gaming the USCG type approval system by applying to be tested for certification where they are most likely to pass rather than where tests are most likely to determine if their BWMS will be capable of meeting USCG-mandated BW discharge standards. As a result, USCG-approved laboratories, which compete with each other for the business of BWMS manufacturers, are using loopholes in USCG

testing guidance and attracting manufacturers by using testing methods that are relatively easy to pass. This, in turn, puts economic pressures on USCG testing facilities that are similar to those faced by some IMO G8-based test facilities; they either attract business by reducing their testing standards to increase probability of client's passing, they attempt to survive by attracting those few customers who are interested in rigorous and comprehensive BWMS testing, or they go out of business. Tamburri also points out that because the USCG is not overseeing what is actually being done at Independent Laboratories or their sub-laboratories, "the magnitude of these problems ...are likely far worse than we now know."

Conclusions and Recommendations

The future of global BW regulations depends on how soon and how effectively IMO and the USCG address the immediate and significant challenges they face not only with respect to BWMS testing and certification problems, but with the impacts their decisions are having on global BWMS markets. For years the IMO strategy for implementing BW regulations involved certifying many different types of BWMSs, letting them be sold and installed on ships, and then planning to resolve "technical problems" associated with some of them actually failing to perform as certified as they arise (e.g., by revising the G8 Guidelines). There are now reports that the USCG is embarking on a similar strategy; that is, "set the bar low" for certification testing in order to get some USCG-certified BWMS out on the market, and then deal with any resulting underperformance and noncompliance problems as they arise.

The problem with these strategies is that they do not address the fact that noncompliance problems that result, or are predicted to be likely, will add to existing quality uncertainty problems in global BWMS markets. That can be

expected to delay the development of these markets and when it will be possible to achieve widespread compliance. That will, in turn, delay when BW regulations can be enforced and start having an impact on ocean health. Problems implementing BW regulations that result from the failure of BWMS markets to develop will be far more difficult for BW regulators to resolve than technical problems associated with inadequate or inconsistent BWMS testing and certification methods and standards.

A certain amount of "constructive ambiguity" was necessary during negotiations to get BW regulations put into law in the USA and ratified by IMO member nations. And, a certain amount of flexibility was necessary in the initial testing and certification guidance that IMO and USCG provided to various BWMS testing facilities. However, the point has been reached where the future of IMO and USCG BW regulations will depend nearly completely on the timely development of global markets for certified BWMS. This requires buyers, sellers, and investors to have confidence in what can be expected from certified BWMS.

The IMO can support the development of global BWMS markets by establishing more rigorous and uniform BWMS testing and certification methods, and by purging global BWMS markets of systems that are already certified but are determined not to be able to pass revised certification testing. The USCG can support the development of global BWMS markets by not following IMO's example and allowing BWMS test facilities to use different testing methods; and by not yielding to political pressure to lower BWMS testing standards in order to allow USCG-certified BWMS to begin reaching market.

The ratification of the BWM Convention is a noteworthy regulatory milestone in the global effort to reduce marine invasive species problems. However, a far more significant

milestone will be reached when quality uncertainty problems in global markets for certified BWMS are reduced enough for supply and demand to grow and enable widespread compliance with the Convention. There are a few steps that IMO and USCG regulators can take now to reach that milestone. They need to pay close attention to how their decisions about BWMS testing and certification methods and standards, and about certifying, decertifying, and recertifying certain types of BWMS will affect decisions by buyers, sellers, and investors in global BWMS markets. Regulators need to do this without perpetuating what the ICS chairman has already defined as “regulatory chaos.” And, they need to do this without providing shipping industry leaders with too many opportunities to game BW regulations by exaggerating or exploiting regulatory or market setbacks, and using claims of “regulatory chaos” to delay the enforcement of BW regulations, reduce compliance costs, and lower penalties for noncompliance.