## ABSTRACT

## CHALLENGES OF PERMITTING BALLAST WATER DISCHARGES FROM COMMERCIAL VESSELS IN U.S. WATERS

**by**
**Paul Rodriguez**

On February 5, 2009, the US Environmental Protection Agency (US EPA) issued the Vessel General Permit (VGP), under the Clean Water Act (CWA), for discharges incidental to the normal operation of vessels, including ballast water discharges. This set forth permit requirements for most commercial vessel discharges within 3 nautical miles of U.S. shore. Since it will expire in December 2013, the US EPA recently issued a draft 2013 VGP. One of the significant changes is the proposal of numerical ballast water discharge standards requiring most commercial vessels to install ballast water treatment systems onboard.

The objective of this thesis is to review, analyze and present the impacts of the VGP ballast water regulations. An overview of the concerns of ballast water discharge, the VGP and other related ballast water regulations, and classes of vessels affected is exhibited. Using the US EPA VGP Notice of Intent (NOI) database, this study presents the challenges of the upcoming 2013 VGP ballast water regulations. The challenges discussed are organized into five aspects: ballast water treatment system (BWTS) manufacturers, vessels requiring BWTSs, impact on foreign and domestic vessels, additional state regulations, and government agencies' involvement. Finally, conclusions and recommendations are made with regard to such challenges.

# CHALLENGES OF PERMITTING BALLAST WATER DISCHARGES FROM COMMERCIAL VESSELS IN U.S. WATERS

by
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## APPROVAL PAGE

## CHALLENGES OF PERMITTING BALLAST WATER DISCHARGES FROM COMMERCIAL VESSELS IN U.S. WATERS

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To my parents and brother

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Under the Clean Water Act (CWA), all discrete discharges of pollutants into navigable waters of the U.S. are prohibited unless authorized by an issued National Pollutant Discharge Elimination System (NPDES) permit or exempted. However, shortly after the CWA went into effect in 1973, the U.S. Environmental Protection Agency (US EPA) issued a regulation excluding discharges incidental to the normal operation of vessels, including ballast water, from NPDES permitting. In December 2003, a coalition of environmental groups sued the US EPA to repeal the vessel exemption. The lawsuit arose from a petition asking the US EPA to repeal its exemption on discharges incidental to the normal operations of vessels, claiming that the vessels are "point sources" requiring NPDES permits for discharges to U.S. waters. The court ultimately held in March 2005 that the vessel exemption was beyond US EPA's authority to grant, and therefore, ultimately ordered that the vessel exemptions be annulled by December 19, 2008 (US EPA, 2008). The regulation of the vessel discharges through the VGP can improve the water quality through the control of a variety of materials, which include invasive species, nutrients, pathogens, oil and grease, metals, conventional pollutants, and other toxic and non-conventional pollutants with toxic effects. However, instead of imposing numerical effluent limits, the US EPA decided to request a vessel to carry out certain "Best Management Practices" (BMPs) with regard to each of the discharges.

Vessels owners are required to apply for coverage through the submission of a Notice of Intent (NOI) form to the US EPA.

After the issuance of the 2008 VGP, environmental groups and Michigan argued that the VGP does not use a technology- or water quality-based approach as required by the Clean Water Act. A settlement was reached on March 8, 2011, and US EPA agreed to include numeric concentration-based effluent limits for discharges of ballast water in the next draft VGP.

Several other government agencies and organization that are concerned about ballast water discharges have proposed ballast water discharge standards in the past. These include the US Coast Guard (USCG), the International Maritime Organization (IMO), and several state governments. Therefore, the establishment of additional ballast water discharge standards for commercial vessels through an NPDES permit has caused much controversy in the maritime industry.

## 1.2 Purpose and Objectives

This thesis serves to analyze the impact and challenges presented by the multitude of ballast water regulations in the U.S. through data provided from the US EPA VGP NOI data and discussions with the maritime industry. In 2011, the New Jersey Department of Transportation (NJDOT) granted NJIT a research project, “Impacts of EPA 2012 Commercial Pump-Out Regulations”, to study the potential impacts of the VGP on the maritime industry and the graywater and bilgewater prohibitions that were instated in New York’s 401 state certifications of the VGP. The NJIT faculty and author have worked over the past year and a half with NJDOT and the maritime industry in analyzing the VGP and related regulations, soliciting and analyzing US EPA and USCG databases, conducting vessel site visits, developing impact studies, and holding stakeholder meetings. The stakeholder's meeting included representatives from the NJDOT, NJDEP (Department of Environmental Protection), NYDEC (Department of Environmental Conservation), US EPA, USCG, and several maritime organizations. In these meetings the potential problem of ballast water regulations in the U.S. was presented and thoroughly discussed.

With the next issuance of the VGP permit approaching in December 2013, the vessel universe faces several challenges. Using the US EPA VGP NOI Database, it would be easier to understand the challenges of the upcoming 2013 VGP ballast water regulations. The VGP is unique compared with other ballast water regulations in that it is an NPDES permit thus allowing states to include additional limitations through 401 state certifications. The new 2013 VGP permit regulations will also require many vessels to install ballast water treatment systems (BWTSs) or discharge ballast water to onshore facilities. These new permit regulations have caused much debate, controversy and concern for the maritime industry. This thesis discusses ballast water and ballast water management methods in Chapter 2, the existing and proposed ballast water regulations in Chapter 3, the affected vessels in Chapter 4, presents analyzed US EPA data in Chapter 5, and the upcoming challenges due to this permit in Chapter 6. The challenges discussed are organized into five aspects: BWTSs manufacturers, vessels requiring BWTSs, impact on foreign and domestic vessels, additional state regulations, and government agencies' involvement.

## 1.3 Literature Search

The objective of this study is to analyze the impact of the VGP on U.S. maritime industries through the VGP NOI database. The NOI database is available online to the public but not in a manner that can be easily analyzed. The NOI database used in this study was solicited from the US EPA on February 2011 and includes information for all vessels registered for the 2008 VGP as of that date. Through an extensive literature search the author found no source has investigated the impact of the VGP and ballast regulations using the VGP NOI data. King et al. has used ship registry data from Lloyd's Register to analyze the impact of international ballast regulations, which has been published through the Maritime Environmental Resource Center [King et al., 2010]. However, the Lloyd's Register includes information for all vessels and does not apply directly to impacts from the VGP but more so from international regulations. The US EPA has used five data sets in analyzing the economic impacts of both the 2008 and 2013 VGP, including (1) the USCG Marine Information for Safety and Law Enforcement (MISLE) database, (2) the U.S. Army Corps of Engineers Navigation Data Center's Waterborne Transportation Lines of the United States (WTLUS) database, (3) information submitted by the International Association of Drilling Contractors, (4) the Foreign Traffic Vessel Entrances and Clearances (FTVEC) database, and (5) the USCG's National Ballast Information Clearinghouse (NBIC) database [US EPA, 2011a]. The US EPA has also analyzed some VGP NOI data on ballast sediment for the draft 2013 VGP so the author has not included this information in this thesis [US EPA, 2011c].

# CHAPTER 2

# BALLAST WATER

## 2.1 Description of Ballast Water

Ballast water as defined by the VGP is "any water and suspended matter taken on board a vessel to control or maintain, trim, draught, stability, or stresses of the vessel, regardless of how it is carried" [US EPA, 2009]. Ballast water is held in ballast tanks, which is any tank carrying "ballast water" regardless if the tank was designed for that purpose. Large commercial vessels usually have tanks within the ship dedicated to containing ballast but some other vessels may use empty cargo tanks for this purpose [US EPA, 2011c]. When unloading cargo, ballast water must be taken up to keep the vessel's stability. Similarly, when loading cargo, ballast water is discharged. This process is shown in Figure 2.1. Also vessels may discharge or load ballast water in transit through shallow waters, to clear low bridges, or for maneuverability.

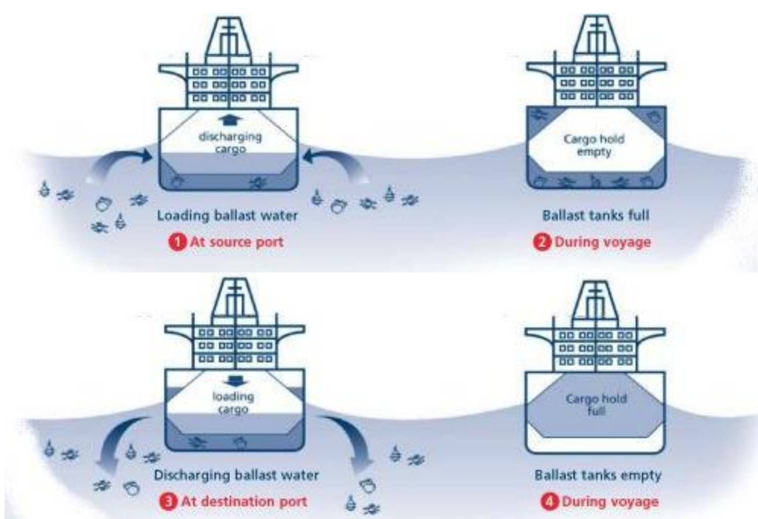



**Figure 2.1** Cross-section of ship showing ballast tanks and ballast water cycle.

[Source: Global Ballast Water Management Programme]

The ballast water capacity on vessels vary significantly, from some water ferries that contain as little as 5 $m^3$ of ballast water to large passenger vessels such as cruise vessels which can contain approximately 3,000 $m^3$ on average and ultra-large crude carriers that contain a representative ballast quantity of 95,000 $m^3$ [US EPA, 2011c; ABS, 2011].

Ballast water is drawn into ballast tanks from surrounding water and so aquatic species native to the surrounding water are also taken in. The ballast water is currently not treated and only passed through screens, which still allow the entrance of aquatic species such as virus, bacteria, protists, diapausing eggs, macro-invertebrates, and in some cases medium size fish (30cm) [NRC, 2011]. When transported to non-native waters, some of these species can outcompete native species and become invasive also known as aquatic nuisance species (ANS). Other pollutants in ballast water can be rust inhibitors, flocculent compounds, epoxy coating materials, zinc or aluminum (from anodes), iron, nickel, copper, bronze, silver, and other material or sediment from inside the tank, pipes, or other machinery [US EPA, 2008]. If a cargo tank is used as a ballast tank (chemicals or materials from cargo previously held in tanks can also be pollutants), this is considered as “dirty ballast water” by the U.S. Navy.

According to a National Ballast Information Clearinghouse report, approximately 111.4 million metric tons (MT) of ballast water was discharged from foreign vessels in the U.S., which is 51.1% more than reported in 2004 – 2005.  Of this volume, 20.3 MT was reported discharged without prior ballast water exchange.  During the same period, 280.2 MT of ballast water was discharged from domestic vessels in the U.S. [NBIC, 2011].

## 2.2 Problems of Aquatic Nuisance Species

ANS are nonindigenous invasive species that have caused an increased persistent problem in U.S. coastal and inland waters over the past couple decades. Vessels have introduced ANS into U.S. water starting in the 1860's through the disposal of solid ballast. A substantial increase in concern for ballast water as a means of ANS introduction would follow in 1959 with the opening of the St. Lawrence Seaway (the only entryway for commercial vessels into the Great Lakes) [Reid and Sturtevant, 2009]. There are several other vectors of ANS transport including vessel fouling, aquaculture, live bait industries, aquarium and pet industries, the live seafood industry, and the unregulated purchase and distribution to the public [NRC, 2011; Lodge et al., 2006]. The transfer of ANS from one water body to another is aided largely by the maritime industry traveling from varying water bodies throughout the nation and internationally. Vessels mainly introduce ANS from ballast water and sediment from ballast tanks, chain lockers, anchor chains and vessel hulls.

The US EPA states that ANS pose dangers to aquatic ecosystems and damage to recreational and commercial fisheries, infrastructure and water based recreation and tourism. ANS is unlike other forms of pollution that can degrade over time. These invasive species can outcompete native species, threaten endangered species, and in the absence of its natural predators ANS can increase, persist, and spread. ANS can then damage habitats, alter aquatic environments and damage marine ecosystems, costing millions to remediate and monitor the ecosystem damage spread. Studies have reported estimates of hundreds of billions of dollars per year lost due to damages caused by ANS and tens of hundreds of dollars lost per year due to invasive zebra mussels alone. [US EPA, 2011c; U.S. Commission on Ocean Policy, 2004].

The first reported and most well-known ANS is the zebra mussel (Dreissena *polymorpha)* native to Eurasia and first discovered in U.S. waters in 1988 in the Great Lakes. The zebra mussel has further spread to the Mississippi River and is now found in most of eastern U.S. and some western states [US EPA, 2011c]. The zebra mussels consume algae from water that native species depend on for food and also damage public infrastructure causing environmental and economical problems.

### 2.3 Ballast Water Exchange and Saltwater Flushing

Ballast water exchange is a common management measure taken to reduce the risk of ANS for the past two decades. Ballast water exchange requires the discharge of ballast water taken near shore and replacing it with deep ocean water, beyond 200 nm from shoreline. The exchange of freshwater for saltwater causes a salinity shock that can kill many freshwater organisms. The National Oceanic and Atmospheric Administration (NOAA) reports that introduction of ballast water exchange since the 1993 has resulted in an overall 97% reduction in total potential ballast loads, equivalent to eliminating approximately 3.3 million tons per year of unexchanged ballast water (and therefore, potential ANS) in the Great Lakes [Reid and Sturtevant, 2009].

For vessels with unpumpable ballast water or empty ballast tanks containing residual sediment, a similar technique used is saltwater flushing, mainly to kill species present in the sediment of ballast tanks. Saltwater flushing is the addition of mid-ocean water into empty tanks, mixing through motion of the vessel and discharging until loss of suction, before discharging into near shore water. A salinity level of 30 parts per thousand is commonly required in the tank during saltwater flushing.

NOAA frequently reports that these are good methods for some level of protection, “in the absence of proven alternatives” [US EPA, 2008]. However, these methods do not provide a measurable treatment and environmental and economic impacts still occur due to invasive species.

## 2.4 Ballast Water Treatment Systems

A variety of ballast water treatment systems (BWTSs) have been in development over the past decade in response to pending international and national regulations. BWTSs are more reliable then ballast water exchange methods and provide measurable treatment levels of discharge. These treatment systems are designed to meet IMO D-2 standard (see Chapter 3).

Treatment of ballast water can take place during the uptake of ballast water or during discharge. Some vessels with residual biocides require treatment during both uptake and discharge. Over the years, there has been much advancement in ballast water treatment using a combination of physical separation and physical or chemical disinfection, shown in Table 2.1.

**Table 2.1** Ballast Water Treatment System Types

| Physical Separation | Disinfection | |
|---|---|---|
| | **Physical** | **Chemical** |
| • Filtration<br>• Hydro-cyclonic<br>• Coagulation | • UV light<br>• De-oxygenation<br>• Heat<br>• Cavitation/Ultrasound | • Ozone<br>• Chlorination<br>– Chlorine<br>– Chlorine Dioxide<br>– Sodium Hypochlorite<br>• Chemical/Biological Biocides<br>– Peracetic acid<br>– Hydrogen Peroxide<br>• Electrolysis/Electro-chlorination |

Source: [ABS, 2011; Lloyds Register, 2011]

The physical separations methods are capable of removing larger suspended microorganisms in water to make the disinfection process more efficient. Physical systems commonly include filtration, hydro-cyclonic separation, and enhanced coagulation processes. Filtration uses disk and screen filters during ballast intake. Cyclonic separation uses centrifugal forces as a form of sedimentation to separate particles denser then water. Coagulation separation injects a flocculent to aggregate particles for removal through magnetic separation or filtration.

Disinfection inactivates microorganisms and is present through a physical or chemical process in all systems to be able to achieve the required discharge standards. Physical disinfection of ballast water includes ultraviolet (UV) light, de-oxygenation, heat, cavitation or ultrasound. UV light transmits UV radiation to kill organism or destroy the organism's ability to reproduce. Cavitation is the formation and implosion of vapor bubbles in a liquid.  It can be created by sound waves, laser, or by fluctuations in fluid pressure (hydrodynamic cavitation). Cavitation, ultrasound and gas injection disrupt cell walls of organism to destroy the organisms. De-oxygenation removes dissolved oxygen in the water to kill aerobic organisms.

Chemical disinfection is the use of a substance to kill organisms or pathogens. IMO refers to these substances as “active substances” and requires additional approval for BWTSs using active substances. Chemical disinfection of ballast water is mostly carried out through disinfecting biocides, such as chlorine, chlorine dioxide, sodium hypochlorite, peracetic acid, hydrogen peroxide and ozone. Another method is electro-chlorination, which uses the salts in the ballast water to generate free chlorine, sodium hypochlorite or hydroxyl radicals. Some chemical treatments also require residual control through chemicals such as sodium bisulphite [ABS, 2011; Lloyd’s Register, 2011].

BWTSs must undergo an approval process before being installed and used on a vessel. The IMO has developed an approval system, shown in Figure 2.2.

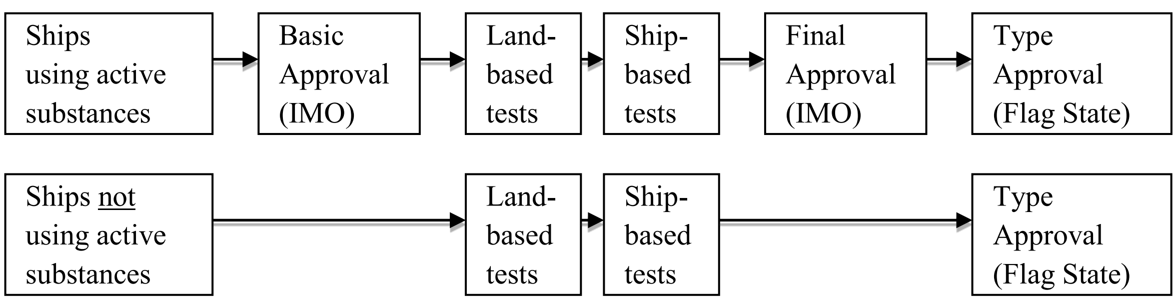



**Figure 2.2** Summary of IMO approval pathway for BWTSs.

[Source: Modified from Lloyd’s Register, 2011]

BWTSs with active substances (chemicals) must obtain basic and final approval showing that there is no environmental impact of discharged ballast water. All BWTSs must undergo rigorous land-based tests, ship-based tests, and receive “type approval” from a flag administration, indicating that the system can achieve the required discharge standards.

The US EPA, in partnership with the USCG, has developed its own BWTS verification process through the Environmental Technology Verification (ETV) Program to verify performance characteristics of innovative BWTSs and facilitate introduction of new technologies into the marketplace. Under the ETV protocol, a third party testing organization prepares a test/quality assurance plan (TQAP), conducts shipboard and land-based testing, A verification organization, consisting of managers and operator of various technology centers under cooperative agreements with the US EPA, oversees TQAP development, testing activities, and development and approval of the verification report and verification statement for the BWTS. The USCG has authority to board vessels for inspection, so they are the main contact for shipboard testing procedures. The US EPA oversees the ETV program, works with a project officers to manage cooperative agreements with verification organization organizations, and reviews treatment system-specific TQAP [NSF International, 2010]. The US EPA also accepts systems that have been verified by foreign states, if they have an approved BWTS certificate which meet certain conditions identified in the VGP.

## 2.5 Onshore Ballast Treatment

Onshore ballast water treatment is another method proposed to treat ballast water. One of the very few, the Valdez Marine Terminal in Alaska is for ballast water treatment. Prior to concerns of invasive species, the major concern with ballast water was the discharge of hydrocarbons and other chemicals in ballast water from the petroleum and chemical industry. Therefore, the Valdez facility was actually designed for hydrocarbon removal and not for the removal of living organisms. Some existing ports are actively considering building ballast water treatment facilities [Brown and Caldwell, 2007]. However, it will be costly to build these facilities and it will take some time before they will be available for use. Land-based facilities can also be coupled with treatment barges to facilitate the collection of ballast water at different ports.

# CHAPTER 3

# REGULATIONS

There are a multitude of international, national, and state regulations covering the discharge of ballast water. This chapter serves to explain the different regulations and clarify their importance and the relation between each standard. First the international regulations are covered since these are the basis for most other ballast water discharge standards.

## 3.1 International Maritime Operations (IMO) Regulations

The International Maritime Organization (IMO) is a specialized agency of the United Nations charged with regulating international maritime matters. The IMO began to consider ballast water management as early as 1988 when Canada reported on invasive marine species in the Great Lakes and in 1991 adopted voluntary guidelines similar to those proposed and carried out by Canada. Through an adopted resolution in 1997, the IMO's Marine Environmental Protection Committee (MEPC) was required to determine uniform implementation guidelines for ballast water management. The MEPC formed a Ballast Water Working Group, including the US EPA and USCG, to develop the IMO's *International Convention for the Control and Management of Ships' Ballast Water and Sediments* (herein referred to as The Convention), which was adopted in February 2004 [NRC, 2011].

The Convention established a phased set of standards, IMO D-1 and IMO D-2. The IMO D-1 standard sets requirements for ballast water exchange. The IMO D-2 standard sets numeric limits (Performance Standard) for ballast water discharge, shown in Table 3.1, and compliance schedule, shown in Table 3.2.

**Table 3.1** IMO D-2 Ballast Water Discharge Standards

| **Organism Size Class** | **Standard** |
|---|---|
| Organisms greater than 50 μm in minimum dimension | < 10 viable organisms / $m^3$ |
| Organisms 10 - 50 μm in minimum dimension | < 10 viable organisms / ml |
| Toxicogenic *Vibrio cholera (*O1 and O139) | < 1 CFU /100 ml |
| *Escherichia coli* | < 250 CFU /100 ml |
| Intestinal Enterococci | < 100 CFU /100 ml |

Source: [IMO, 2011]

**Table 3.2** IMO D-2 Standards Compliance Schedule

| | **Vessel's Ballast Water Capacity ($m^3$)** | **Vessel's Compliance Date** |
|---|---|---|
| Vessels constructed in or after 2009 | <5000 | On Delivery |
| Vessels constructed between 2009-2012 | >5000 | By 1/1/2016 |
| Vessels constructed in or after 2012 | >5000 | On Delivery |
| Vessels constructed before 2009 | <1500 | By 1/1/2016 |
| | 1500-5000 | By 1/1/2014 |
| | >5000 | By 1/1/2016 |

Source: [IMO, 2011]

The Convention's standards will enter into force twelve months after ratification by at least 30 states representing 35% of the world merchant shipping tonnage. As of July 2011 the Convention is only ratified by 28 states representing 25.43% of the world merchant shipping tonnage [IMO, 2011].

### 3.2 US EPA's Permit Regulations

In December 2003, a coalition of environmental groups sued the US EPA to repeal an exemption of discharges incidental to the normal operation of vessels from CWA NPDES permitting. Petitioners claimed that these vessel discharges are from "point sources" requiring NPDES permits for discharges to U.S. waters. The courts ultimately held in March 2005 that the vessel exemption was beyond US EPA's authority to grant and ordered the exemption to be vacated by December 19, 2008.

Therefore, the US EPA began to develop the Vessel General Permit (VGP) for discharges incidental to normal operations of commercial vessels in U.S. waters. However, due to the limited time provided in developing the VGP and the need to allow for public comments and input from the States, the US EPA requested an extension for the implementation of the VGP by noting that the maritime industry would need some time to prepare for the requirements of the Final VGP. The court agreed to extend the vessel exemption through February 6, 2009.

### 3.2.1 US EPA's 2008 Vessel General Permit

The US EPA issued the 2008 Vessel General Permit (VGP) on February 6$^{th}$, 2009 regulating all non-recreational, non-military, commercial vessels greater than 79ft in length while in U.S waters. The VGP requires vessels to submit a Notice of Intent (NOI) in order to receive coverage. The permit included discharge requirements, monitoring, inspection, recordkeeping and reporting requirements, and additional state requirements. For this permit EPA chose to mainly implement "Best Management Practices" (BMPs) with regards to each of the discharges. Under the CWA Section 401(d) states are allowed to include additional conditions to a federal permit in order for the discharge to be in compliance with state water quality standards. These additional state requirements have been subject to much debate and are discussed later in this chapter and in Chapter 6.

Ballast water in the 2008 VGP is regulated through several BMPs, none of them containing numerical standards. However, under the 2008 VGP, discharges of ballast water must comply with USCG regulations (33 CFR Part 151), which require vessels operating outside of the U.S. Exclusive Economic Zone (EEZ), 200nm (nautical miles) from U.S shore, to conduct mid-ocean ballast water exchange. The VGP also includes regulations to conduct training of crew members, maintain a ballast water management plan with specific and suggested practices, maintain recordkeeping and reporting requirements, prohibit ballast tank sediment discharge within U.S. waters, and stricter regulations for vessels in pacific nearshore voyages, the Great Lakes or Hudson River. US EPA did not include numeric discharge standards because studies at the time, determined numeric standards were not practicable, achievable, or available.

### 3.2.2 US EPA's 2013 Proposed Vessel General Permit

In 2009, a collaboration of environmental groups and the State of Michigan brought a challenge to court against the US EPA's 2008 VGP. The petitioners argued that the VGP's BMPs approach in regulating ballast water was too lenient and did not include either technology-based nor water quality-based numerical standards [NRC, 2011]. On March 8$^{th}$ 2011, a settlement was reached between the US EPA, the environmental groups and the State of Michigan. This settlement concluded that the next issuance of the VGP must include numeric concentration-based effluent limits for ballast water discharges and that the US EPA would arrange for the National Academy of Science's National Research Council (NRC) and US EPA's Science Advisory Board (SAB) to prepare reports that would assist in the determination of new standards [Settlement Agreement, 2011; NRC, 2011]

After reviewing the NRC and SAB report, and with the 2008 VGP expiration date of December 18th 2013 approaching, the US EPA has released a draft 2013 Vessel General Permit and Small Vessel General Permit (sVGP), to go into effect on December 19th, 2013. The proposed 2013 VGP regulates commercial vessels greater then 79ft and introduces numerical ballast water discharge standards. The proposed sVGP addresses commercial vessels and commercial fishing vessels less than 79ft and carrying less than $8m^3$ of ballast water, which were previously exempt by a moratorium [US EPA, 2011b].

The additional ballast requirements in the 2013 VGP propose to achieve significant reduction in spread of aquatic nuisance species by implementing numeric discharge limitations which are the same as IMO D-2 standards as shown in Table 3.1. The proposed 2013 VGP compliance schedule of these standards, shown in Table 3.3, is different than the IMO D-2 standards considering that the permit will take effect on December 2013.

**Table 3.3** VGP Discharge Standards Compliance Schedule

| | **Vessel's Ballast Water Capacity ($m^3$)** | **Vessel's Compliance Date** |
|---|---|---|
| New Vessels (Constructed after 1/1/2012) | Any | On Delivery |
| Existing vessels (Constructed before 1/1/2012) | <1500 | First scheduled drydock after 1/1/2016 |
| | 1500-5000 | First scheduled drydock after 1/1/2014 |
| | >5000 | First scheduled drydock after 1/1/2016 |

[Source: US EPA, 2011b]

The discharge standards apply to all vessels covered under the VGP with a ballast water capacity of $8m^3$ or more. These vessels have the option of four ballast water management measures to meet these numerical discharge standards:

1. Approved ballast water treatment system
2. Onshore treatment of ballast water or by another vessel such as a treatment barge
3. Use of treated public water as ballast water
4. No discharge of ballast water

The VGP excludes certain vessels from the numerical discharge standards including: 1) vessels engaged in short distance voyages, 2) unmanned, unpowered barges, 3) vessels in the USCG Shipboard Technology Evaluation Program, 4) Great Lakes freight ships built before 2009 confined to the Great Lakes upstream of the Welland Canal, and 5) vessels with a ballast capacity of less than $8m^3$. Vessels that are excluded or awaiting installation of treatment system must follow ballast exchange and flushing requirements similar to the 2008 VGP. Vessels that meet discharge standards will not need to conduct ballast exchange and flushing requirements.

### 3.2.3 Additional State Regulations

Since the VGP is an NPDES general permit, state's must certify that the requirements in the permit will meet state water quality standards, through a CWA 401 certification. In the case that the state water quality standards are not sufficiently met, a state may include additional requirements for discharges within state water bodies. Table 3.4 displays the twenty-six (26) states that have conditioned their 2008 VGP certifications on additional discharge requirements, with those that added ballast regulations in bold.

**Table 3.4** States With Additional 2008 VGP Discharging Restrictions

| | | | |
|---|---|---|---|
| **California** | **Illinois** | **Minnesota** | Pennsylvania |
| **Connecticut** | **Indiana** | Missouri | Rhode Island |
| Florida | **Iowa** | Nebraska | Utah |
| Georgia | Kansas | Nevada | Vermont |
| Guam | Maine | New Hampshire | Wyoming |
| **Hawaii** | **Massachusetts** | **New York** | |
| Idaho | **Michigan** | **Ohio** | |

[Source: GMS, 2009]

Additionally Michigan, Minnesota, Oregon, Washington, Wisconsin, and Virginia have passed laws covering ballast water discharge separately from the VGP 401 certification [GMS, 2010]. For example, Washington and Oregon do not have additional ballast water conditions in their 401 certification but these states do regulate ballast waters through separate state regulations, i.e. Washington State Ballast Water Management Rules and Oregon Ballast Water Program. Therefore 15 states in total have additional requirements for ballast water discharges.

The additional regulations vary, with some states like Hawaii, Michigan, Minnesota, Oregon requiring additional reporting requirements such as the submittal of Ballast Water Report Forms to a state entity. Michigan also requires the vessel owner to obtain a certificate of coverage from the state before discharge. Minnesota has a separate discharge permit as well. California, Illinois, Indiana, Minnesota, New York, and Ohio, included numerical discharge standards similar or more stringent than IMO.

Of particular concern is the proposed more stringent numerical standards in California and New York. California proposed standards considered 1000 times IMO-D2 and New York proposed standards 100 times IMO-D2. New York later changed its proposal to less stringent standards considered 10 times IMO-D2 in more recent comments to the US EPA, shown in Table 3.5. The standards 1,000 times, 100 times, and 10 times IMO-D2 refer to the organism size classes in the first two columns of Table 3.5.

**Table 3.5** 10x, 100x, and 1000x IMO D-2 Ballast Water Discharge Standards

| **Organism Size Class** | **NY Standard (10x IMO-D2)** | **NY Standard (100x IMO-D2)** | **California Standard (1000x IMO-D2)** |
|---|---|---|---|
| Organisms greater than 50 µm in minimum dimension | < 1 / $m^3$ | < 1 / 10 $m^3$ | None Detectable |
| Organisms 10 - 50 µm in minimum dimension | < 10 / ml | < 1 / 10 ml | < .01 / ml |
| Toxicogenic *Vibrio cholera (*O1 and O139) | < 1 CFU /100 ml | < 1 CFU /100 ml | not regulated |
| *Escherichia coli* | < 126 CFU /100 ml | < 126 CFU /100 ml | < 126 CFU /100 ml |
| Intestinal Enterococci | < 33 CFU /100 ml | < 33 CFU /100 ml | < 33 CFU /100 ml |

[Source: US EPA, 2009; GMS, 2010]

With the resistance from the maritime industry and subsequent research of these more stringent standards, some states have removed their conditions since the more stringent requirements are impractical at the current moment. It is still not fully known what conditions states will propose in the upcoming 2013 VGP.

### 3.3 US Coast Guard Regulations

Before the court's removal of the vessel exemption, Congress intended for the USCG to establish a regulatory program for discharges incidental to the normal operations of vessels. Therefore Congress enacted statutes to authorize the USCG to regulate these discharges, including the Act to Prevent Pollution from Ships, Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA), and the National Invasive Species Act of 1996 (NISA) to reauthorize and amend the NANPCA.

### 3.3.1 Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990

The NANPCA of 1990 was at the time the primary federal law in the U.S. regulating ballast water discharge along with prevention and control of ANS. The NANPCA was aimed at reducing ANS from entering the Great Lakes. The statute required the USCG to issue voluntary guidelines within 6 months for vessels entering the Great Lakes. The NANPCA allowed the program to be voluntary for 2 years before mandating the regulations. The USCG regulatory program required all vessels that traveled from the Exclusive Economic Zone (200 nautical miles from shore) to implement ballast management operations prior to entering the Great Lakes and northern sections of the Hudson River. It also required vessels to conduct open-ocean ballast water exchange or alternative treatment methods approved by the USCG.

Beyond the Great Lakes, the NANPCA included outreach, research, monitoring and prevention/control programs at national and regional levels. At a national level it established the Aquatic Nuisance Species Task Force, an intergovernmental organization in charge of implementing NANPCA. Six regional panels including the Great Lakes, Northeast, Mid-Atlantic, Gulf of Mexico, Mississippi River Basin, and Western regions were also established to investigate issues applicable to each area and recommend regional actions [U.S. Commission on Ocean Policy, 2004]. The statute also provided funding to help states establish management plans to detect and monitor ANS, educate the public, and encourage collaborations but with only fourteen states establishing plans, this was not effective on a national level [U.S. Commission on Ocean Policy, 2004].

### 3.3.2 National Invasive Species Act of 1996

To address the lack of national action, Congress enacted the National Invasive Species Act of 1996, which reauthorized and amended the NANPCA program. NISA required the USCG to establish a voluntary national ballast management program that would become mandatory in 3 years if voluntary involvement was not adequate. Through NISA the USCG implemented a national program similar to the Great Lakes program established through the NANPCA with the addition of ballast water management reporting requirements to be able to assess voluntary compliance. The National Ballast Information Clearinghouse (NBIC) program was established in 1997 to gather ballast water reporting forms from vessels discharging ballast in U.S waters. The 2001 NBIC biennial report to Congress concluded that reporting on a voluntary basis had been too low so USCG made these requirements mandatory 3 years later in July 2004 [Ruiz et al., 2001; NRC, 2011].

### 3.3.3 USCG Ballast Water Discharge Standards Final Rule

Under the authorization of NANPCA as amended by NISA, the USCG is allowed to amend its regulations on ballast water management if there is an alternative method at least as effective as ballast water exchange. On 2009 the USCG released a notice of proposed rulemaking containing Phase 1 and Phase 2 numeric standards for ballast water treatment [USCG, 2009]. Phase 1 contained ballast water discharge standards equivalent to IMO D-2 standards, while Phase 2 was much more stringent at 1000 times IMO D-2 standard. On March 23, 2012, the Final Rule was released to be effective on June 21, 2012. The Final Rule removed the more stringent Phase 2 standard since not enough data is currently available to assess its practicability [USCG, 2012].

The USCG Final Rule varies from the VGP mainly in that it only applies to two groups of vessels: 1) Vessel currently required to conduct ballast water exchange (which is all vessels that traveled from the U.S. Exclusive Economic Zone, 200 nautical miles from shore) and 2) seagoing vessels that do not operate beyond the U.S. Exclusive Economic Zone, that take on and discharge ballast water in more than one Captain of the Port Zone, and are greater than 1,600 gross register tons. Similar to the VGP, the Final Rule requires vessels to meet the standard through the installation of a ballast water treatment system (BWTS) unless it does not discharge ballast water at all, discharges only to shoreside facilities, or uses public drinking water as ballast water. However, the Final Rule has additional requirements such as: requiring sampling ports on vessels for easy sampling of ballast water by USCG inspectors, requiring vessel crew to operate the BWTS during shipboard testing, and providing the possibility to request extensions on compliance dates.

USCG adds that additional research is to be conducted such that future rulemaking may still include the more stringent Phase 2 standards and expansion of vessels covered.

## 3.4 Proposed US Coast Guard Bill to Congress

### 3.4.1 Commercial Vessel Discharge Reform Act of 2011

The Commercial Vessel Discharge Reform Act of 2011 (H.R. 2840) is a proposed legislation from the U.S. Coast Guard that serves to amend the Clean Water Act to regulate discharges from commercial vessels, and for other purposes. It is included in the

Coast Guard and Maritime Operations Act of 2011 (H.R. 2838), which has passed the House and is to be reviewed by the Senate.

This legislation requires US EPA and USCG to complete thorough studies on aspects of ballast water management provisions and discharges incidental to the normal operation of a commercial vessel. It requires USCG to set ballast water discharge standards for all commercial vessels carrying ballast water (regardless of size), including numerical discharge limits unless the vessel meets safety exemptions, alternative methods of compliance or travels in geographically limited areas. It eventually removes VGP terms and conditions on ballast water when certain criteria is met for each vessel and does not affect the VGP terms and conditions on discharges incidental to normal operations of commercial vessels (expect for 401 certifications). One of the most controversial aspects of this regulation is that it withdraws a state's authority to include state-specific requirements through 401 state certifications. The maritime industry has been very supportive of this regulation since it has the ability to remove the varying state standards and create one uniform national standard.

# CHAPTER 4

# VESSEL TYPES

## 4.1 US EPA Vessel Classifications

The US EPA classifies commercial vessels into 9 categories in the VGP permit:

1. Barge
2. Oil and Gas Tanker
3. Other
4. Commercial Fishing Vessel with Ballast Water
5. Large Ferry (250+ passengers or more than 100 tons of cargo)
6. Large Cruise Ship (500+ passengers)
7. Medium Cruise Ship (100 to 499 passengers)
8. Research Vessel
9. Emergency Vessel

The reason for this particular classification is not specified by the US EPA, however, it can be inferred that it was based on facilitating the addition of vessel type specific requirements in Section 5 of the permit.

A barge is a flat-bottomed vessel that is mainly used to carry cargo in inland waters. Most barges are non-powered and non-self-propelled vessels so have to be pushed or pulled by a tugboat. Barges are mostly used in smaller water bodies like rivers, lakes or canals. The VGP particularly exempts barges that are unmanned and unpowered from numeric ballast water discharge standards. The author visited two small non-powered barges owned by the Vane Bunkering Fleet in Brooklyn, New York, named Double Skin 506 and Double Skin 33, shown in Figure 4.1.


**Figure 4.1** Barges.

Oil and Gas Tankers are self-propelled liquid carrying vessels. Since they carry oil and petroleum products in bulk tanks, they can potentially cause environmental harm through discharges of oil, during loading and unloading of liquid cargo. Also tankers may sometimes use the petroleum or chemical tanks to hold ballast water, potentially discharging hydrocarbons and other chemicals in ballast water if not treated onboard or onshore. These oil and gas tankers vary in size from Very Large Crude Carriers (VLCC) to small wine or juice tankers, both shown in Figure 4.2.

**Figure 4.2** Tankers. Very Large Crude Carrier (left), Small Wine Tanker (right).

[Source: Sharda, 2011]

“Other” vessels, is a classification for those vessels which do not identify with the given categories. According to the VGP NOI data, vessels under the “Other” class have identified themselves as but are not limited to: Cargo Ships, Bulk Carrier, Container Carrier, Oil/Chemical Tanker, Offshore Supply Vessel, Non-tank Vessel, Tug, Reefer Vessel, Roll-on Roll-of, Pure Car Truck Carrier, Dredge, Passenger Ferry, Dry Cargo Vessel, Dockside Casino, Multipurpose Cargo, Utility Boat, Industrial Vessel, Dive Support Vessel, Training Vessel, Mobile Offshore Drilling Unit, Lift Boat, Fuel Container Ship, Yacht, Crane Barge, Cable Layer/Repair Vessel, Small Passenger Boat with Ballast Water. As will be shown in the Chapter 5, from the available data the majority of other vessels are some type of carrier/freight ships (81.47%). Carrier/Freight ships are self-powered vessels that transport a variety of cargo, goods and materials. Carrier/Freight ships are used for significant loads and for long-distance ocean travel. The author visited a self-powered freight ship, the Horizon Discovery built in the 1960’s. Similar freight ships are shown in Figure 4.3. The “Other” category also contains tug/tow vessels (5.54%), which are used to pull or push barges or help maneuver and steer a large boat into dock. Tugs are mainly used coastwise or in inland waters. The author also visited a tug named Nanticoke owned by the Vane Bunkering Fleet in Brooklyn, New York, shown in Figure 4.4.


**Figure 4.3** Freight Ships.

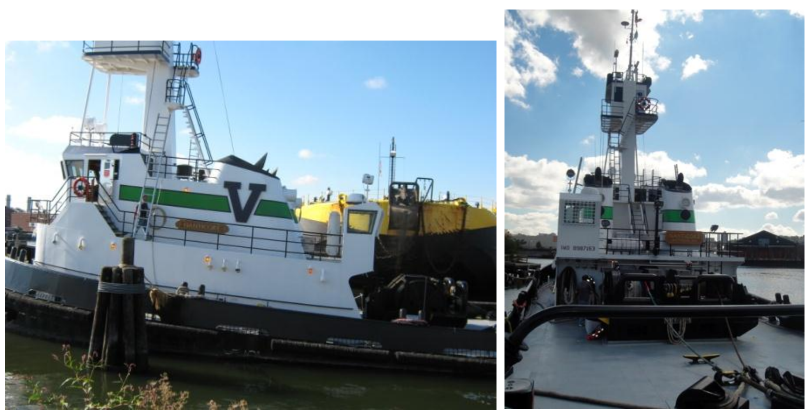


**Figure 4.4** Tug Boat.

Ferries are vessels that carry passengers and/or vehicles between two ports. A large ferries as defined by the VGP is a ferry that is authorized to carry 250 or more people or has a capacity of 100 tons or more cargo, e.g., for cars, trucks, trains or other land-based transportation [US EPA 2009]. Most ferries travel within a single USCG Captain of the Port (COTP) zone, and may not need to comply with the 2013 VGP ballast water discharge standards. The author visited the Staten Island Ferry that transports passengers between Staten Island and Manhattan in the New York-New Jersey Harbor, shown in Figure 4.5.


**Figure 4.5** Staten Island Ferry.

Cruise Ships are vessels that provide overnight accommodations and are licensed to carry passengers for hire. Large Cruise Ships are described as those that are authorized to carry 500 or more passengers. Medium Cruise Ships are described as those that authorized to carry between 100 to 499 passengers. The main discharges of concern on cruise ships are sewage and graywater due to the large number of passengers. The VGP adds graywater management and treatment requirements for cruise ships. Cruise must also comply with several other stringent regulations for sewage treatment, through advanced wastewater treatment systems. The operators are therefore already accustomed to monitoring of treatment systems, testing, and reporting. The author visited the Celebrity Silhouette Cruise Ship in the Cape Liberty Cruise Port shown in Figure 4.6.


**Figure 4.6** Celebrity Silhouette Cruise Ship.

[Source: (left) Celebrity Cruises website]

Research vessels are those that conduct investigations or experimentations and include state, federal, non-profit, educational, and occasionally corporate vessels. Emergency vessels include firefighting boats, police boats, and other boats with a public safety mission [US EPA, 2011c].

## 4.2 USCG Vessel Classification

The U.S. Coast Guard Data also collects data from commercial vessels. A vessel must submit a notice of arrival/departure (NOAD) when entering or departing a U.S. port. NJIT solicited this data from 2011 to 2012 (Haug, 2012). The USCG NOAD data considers 10 types of vessel that enter New Jersey Ports. These 10 types of vessels can be further categorized into the following 7 types:

1. General
2. Articulated Tug and Barge (Tug)
3. Towing Behind (Tug)
4. Fish Catching Vessel
5. Ocean Cruise Vessel
6. Chemical/Petroleum Tanker

    a. Petroleum Oil Tank Ship
    b. Chemical Tank Ship
7. Cargo/Freight Ship
8. Container Ship
    a. Ro-Ro/Container
    b. Vehicle Carrier

### 4.3 National Ballast Information Clearinghouse (NBIC) Vessel Classification

The National Ballast Information Clearinghouse (NBIC) is a joint program of the Smithsonian Environmental Research Center and USCG, that collects data on ballast water management practices of commercial vessels in U.S. waters. Commercial vessels with ballast water capacity are required by the National Invasive Species Act of 1996 to submit a ballast water report when entering U.S. ports. The data is available to the public. Also USCG produces biennial reports to quantify the amounts and origins of ballast water discharged and the degree to which ballast water exchange or alternative treatments are conducted. NBIC classifies vessels that submit ballast water reports into 9 categories (NBIC, 2011):

1. Bulker
2. Combo
3. Container
4. General Cargo
5. Other
6. Passenger
7. Reefer
8. Ro-Ro
9. Tanker

# CHAPTER 5

# DATA COLLECTION AND ANALYSIS

## 5.1 US EPA VGP NOI Data

To understand the challenge of permitting ballast water through the VGP, information about vessels covered by the permit is needed. According to the VGP, vessels entering U.S. waters must submit a Notice of Intent (NOI) to US EPA 30 days prior to discharging in order to receive permit coverage. Vessels greater than or equal to 300 gross tons or with more than eight cubic meters of ballast water had to submit an NOI by September 19, 2009 [Albert 2009; US EPA, 2008]. The NOI database is available to the public online but not in a database format. Through this NJDOT research project, NJIT was able to solicit and analyze the NOI database from US EPA on February 2011. The NOI collects owner/operator information, vessel information, general voyage information, and discharge information. In interpreting this data one must be aware that the information is provided by vessel owners/operators and subject to error by the submitter. Although there are other databases that have been used to determine the effect of these new regulations on the maritime industry, the NOI database gives a better picture of the amount of vessels directly affected by the VGP.  Input from stakeholders of the maritime industry and various government agencies in the New York metropolitan area also helped in understanding the concerns of permitting ballast water through the VGP.

### 5.1.1 General Information

Approximately 57,000 vessels have submitted NOIs to maintain coverage at the time the database was received. Table 5.1 shows the number and percentage of each type of vessel registered under the VGP.

**Table 5.1** Types of Vessels Registered for the VGP

| Vessel Primary Type | Number of Vessels | Percentage |
|---|---|---|
| Barge | 30,658 | 53.66% |
| Other | 20,638 | 36.12% |
| Oil or Gas Tanker | 5,010 | 8.77% |
| Commercial Fishing Vessel with Ballast Water | 233 | 0.41% |
| Large Ferry | 164 | 0.29% |
| Large Cruise Ship | 189 | 0.33% |
| Medium Cruise Ship | 35 | 0.06% |
| Research Vessel | 143 | 0.25% |
| Emergency Vessel | 62 | 0.11% |
| **Total** | **57,132** | **100%** |

It is seen from Table 5.1 that the largest group is barge vessels (53.66%) and the second largest is “Other” (36.12%). However, after checking the database, only ¼ of “Other” vessels (5,521 vessels) provided information for their specific vessel type. Out of these “Other” vessels reporting additional vessel type information it was found that the majority of “Other” vessels are carrier/freight ships (81.47%), and the remaining are tug/tow vessels (5.54%), oil or gas tankers (3.43%), support/supply/utility vessels (3.23%), passenger vessels (0.95%), drilling/dredging (0.64%), and other (4.73%). Since such a large majority of the “Other” vessels are carrier/freight ships, we will interpret the “Other” category as mainly carrier/freight ships.

The NOI also provides data on the types of discharges incidental to the normal operation of commercial vessels. The VGP includes 3 types of effluent limits. The second type (technology-based discharge specific effluent limits and related requirements) regulates the discharge of 26 potential pollutants. Out of the 57,132 vessels that have filed an NOI, 46,570 vessels provide information regarding to applicable discharges in the VGP as shown in Figure 5.1. Figure 5.1 also exhibits the percentage of vessels that may generate each of the 26 specific discharges.

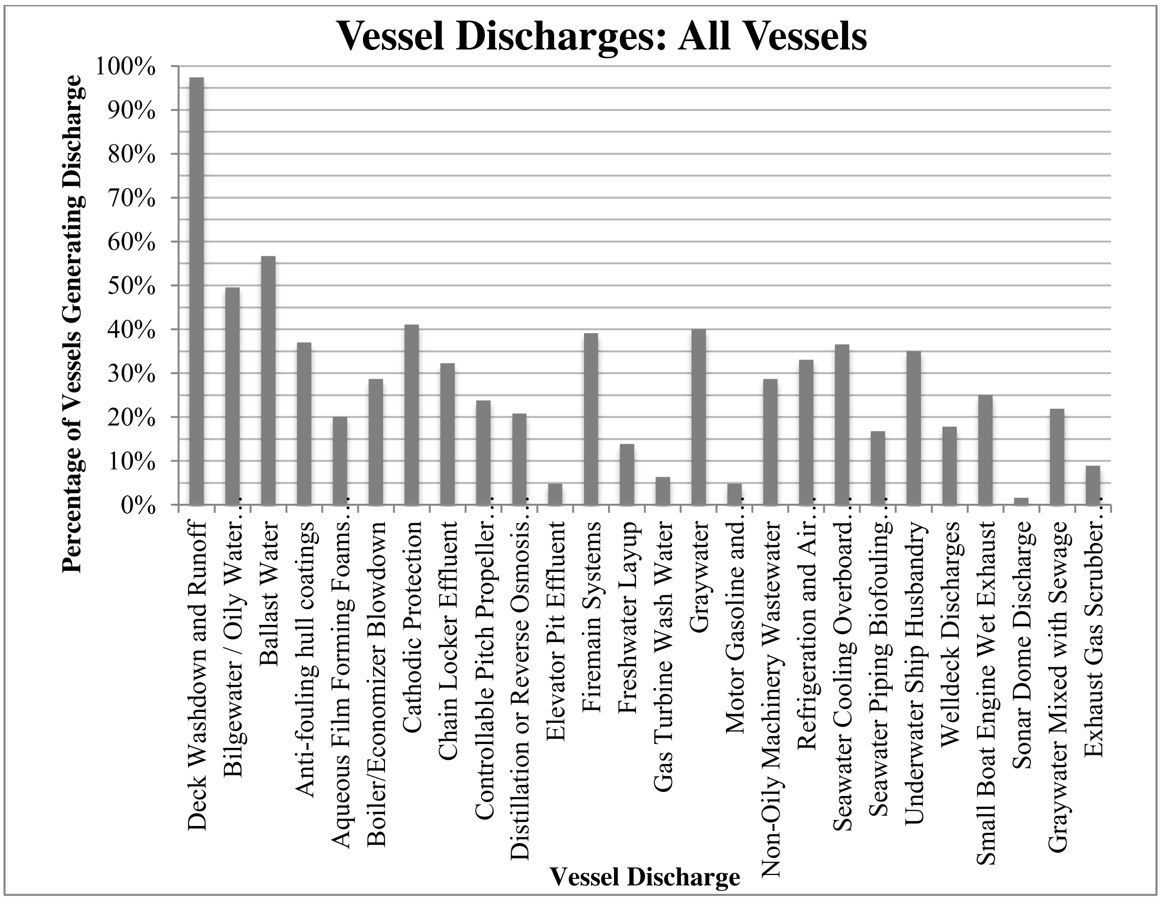



**Figure 5.1** Vessel discharges and the percentage of vessels generating each discharge.

Figure 5.1 indicates that the most common discharge of all vessels is deck washdown and runoff. According to US EPA, it is infeasible to set numeric effluent limits for deck washdown and runoff so BMPs that promote good housekeeping are best suited to control deck washdown and runoff [US EPA, 2008]. The second most common discharge is ballast water with 56.70% of vessels (26,404 vessels) requesting permit coverage for ballast water. Ballast water being one of the most common discharges, in highest volume, and of environmental and economic concern to the maritime industry has made it subject to numerous and strict regulations.

### 5.1.2 Ballast Water Specific Information

Since the NOI database classifies vessels into different categories, it can be determined which vessels more commonly carry ballast water. Table 5.2 shows the amount of vessels types stating ballast water as an applicable discharge.

**Table 5.2** Vessel Types with Ballast Water

| Vessel Primary Type | Vessels Providing Applicable Discharge Information | Vessels with Ballast Water | Percentage of Vessels with Ballast Water |
|---|---|---|---|
| Barge | 25,752 | 7,305 | 28.37% |
| Other | 16,302 | 14,743 | 90.44% |
| Oil or Gas Tanker | 3,926 | 3,870 | 98.57% |
| Commercial Fishing Vessel w/ Ballast Water | 211 | 184 | 87.20% |
| Large Ferry | 157 | 38 | 18.01% |
| Large Cruise Ship | 174 | 139 | 79.89% |
| Medium Cruise Ship | 31 | 16 | 51.61% |
| Research Vessel | 113 | 88 | 77.88% |
| Emergency Vessel | 61 | 59 | 96.72% |
| **Total** | **46,570** | **26,404** | **56.7%** |

As expected it can the most prevalent types of vessels carrying ballast water are Oil and Gas Tankers (3,870 vessels or 98.57%) and "Other" vessel (14,743 vessels or

90.44% mainly cargo/freight ships as mentioned previously). These vessels carry a large quantity of solid or liquid materials from one port to another. When unloading cargo, ballast water must be taken up to keep the vessel's stability. Similarly, when loading cargo, ballast water is discharged. Also these vessels may discharge or take on ballast water when traveling through certain deep or shallow waters or to clear bridges. Even though only 28.37% of barges report discharging ballast water, this still amounts to 7,305 barge vessels discharging. Certain other vessels such as Ferries may not require the discharge of ballast (only 18% discharge ballast water) since they only undergo short voyages from one port to another nearby port.

The US EPA NOI data was further analyzed to find the amount of vessels reporting the capacity of their ballast tanks. Only 24,625 vessels submitted a ballast water capacity numerical quantity and have a capacity $\geq 8m^3$. This information is important since commercial vessels that will require ballast water treatment systems fall into 3 categories based on the amount of ballast capacity: 1) less than 1,500 $m^3$ 2) between 1,500 $m^3$ and 5,000 $m^3$ and 3) greater than 5,000 $m^3$. The deadlines for these vessels categories to install ballast water treatment systems are shown in Table 3.3. The amount of vessels that fall into each category is shown in Table 5.3.

**Table 5.3** Vessel Types with Ballast Capacity Quantity Information in 3 Ranges

| | Ballast Capacity | | | |
|---|---|---|---|---|
| **Vessel Type** | **< 1500m$^3$** | **1500-5000m$^3$** | **> 5000m$^3$** | **Total Reporting Information** |
| Barge | 4,991 | 481 | 248 | 5,720 |
| Other | 3,061 | 1,538 | 9,917 | 14,516 |
| Oil or Gas Tanker | 55 | 379 | 3,414 | 3,848 |
| Commercial Fishing Vessel w/ Ballast Water | 81 | 15 | 86 | 182 |
| Large Ferry | 37 | 7 | 8 | 52 |
| Large Cruise Ship | 23 | 98 | 25 | 146 |
| Medium Cruise Ship | 15 | 5 | 1 | 21 |
| Research Vessel | 82 | 15 | 2 | 99 |
| Emergency Vessel | 37 | 0 | 4 | 41 |
| **Total** | **8,382** (34.0%) | **2,538** (10.3%) | **13,705** (55.7%) | **24,625** |

Overall it can be seen that a greater number of vessels will have to comply with ballast water discharge standards after January 1st, 2016 drydock which includes vessels with < 1500m$^3$ ballast (34.0% of vessels) or > 5000m$^3$ ballast (55.5% of vessels). Only 10.3% of vessels (ballast capacity between 1,500 and 5000 m$^3$) will have to comply after the first deadline of after January 1st 2014 drydock. Note that the main method of compliance is expected to be through the installation of ballast water treatment systems. Of the particular vessel types with greater amount of vessels it is observed that Barges mostly have ballast capacity less than 1500m$^3$, "Other" (mainly cargo/freight) vessels have a great amount of vessels with ballast capacity in all ranges but the majority being greater than 5000m$^3$, and Oil or Gas Tankers mostly have ballast capacity greater than 5000m$^3$.

### 5.1.3 Domestic and Foreign Information

The VGP database also provides several pieces of information regarding vessel registration, which include country (of the company), registry port, homeport, and US visiting ports. As shown in Figure 5.2 of all vessels registered in NOI, 33,565 (62.08%) are domestic owned vessels and 20,505 (37.92%) are owned by foreign companies. Foreign vessels come from up to 69 countries. If vessels are classified based on Registry port, then 20,660 vessels (50.80%) are domestic and 20,011 ships (49.20%) are from foreign countries.

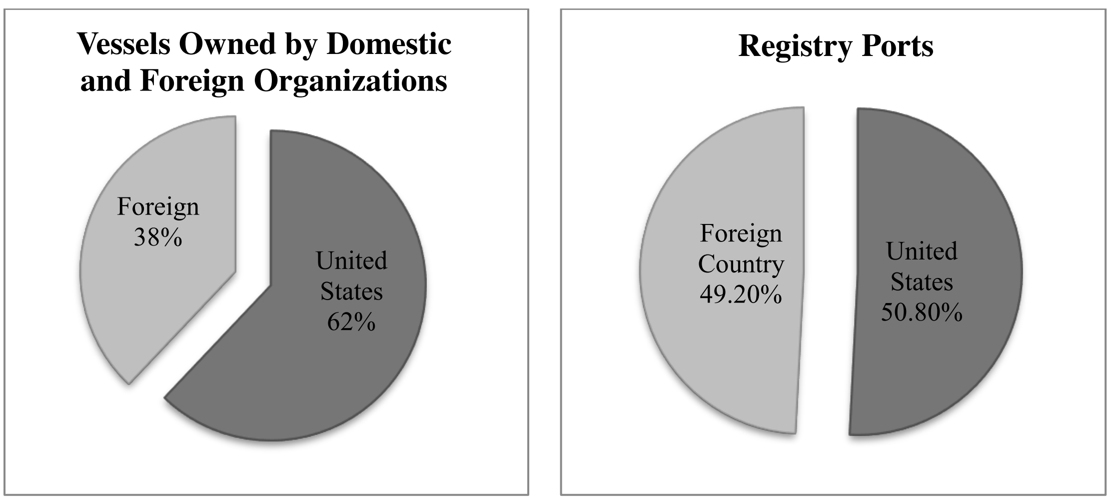



**Figure 5.2** Foreign and domestic vessel ownership and vessel registrations.

The visiting ports can be classified into five regions. The number of vessels that may visit the East Coast, West Coast, Alaska, Hawaii, and the fifth region is 9,937 (21.71%), 6,615 (14.45%), 485 (1.05%), 430 (0.94%), and 28,295 (61.83%), respectively. The fifth region includes the Gulf Coast, Mississippi River System, Gulf Intracoastal Waterway, and Great Lakes. Vessels included in this fifth region visit more than one water body and hence the exact location is difficult to define. This information is not an actual record of visiting; it is simply an "anticipated visit" reported by vessel owner/operators. The database was not designed to give detailed information as to which ports a vessel may visit, and hence can only be used as an estimate. Some vessels may visit more than one region and some may or may not visit a region at all.

It is interesting to compare these figures with the values in a NBIC report, which may provide more insight with regard to ports visit [NBIC 2011]. For the 100,861 vessels arrived from overseas registered by the National Vessel Movement Center (NVMC) for the period from January 1, 2006 to December 31, 2007. The East Coast received the greatest proportion of arrivals (39.2%), followed by the Gulf of Mexico (26.2%), West Coast (15.8%), the Caribbean (14.3%), Hawaii (2.5%), Guam (0.9%), Alaska (0.5%) and the Great Lakes (0.5%).

The data could also be analyzed more specifically to determine if ballast water regulations in the VGP will have a greater impact for foreign or domestic vessels. The data was analyzed based on the company that owns the vessel for the U.S. and foreign nations in Tables 5.4 and 5.5, respectively. This data can be used to determine what vessels will be most impacted in the U.S. and in foreign companies, thus determining where the greater economic impact may be. See Chapter 6 for a more detailed analysis and discussion of this data. The data on registry ports shows similar conclusions as Tables 5.4 and 5.5 so is not included.

**Table 5.4** U.S. Owned Vessels by Vessel Type and Ballast Capacity

| | Ballast Capacity | | | |
|---|---|---|---|---|
| **Vessel Type** | **< 1500m$^3$** | **1500-5000m$^3$** | **> 5000m$^3$** | **Total Reporting Information** |
| Barge | 4,964 | 471 | 236 | 5,671 |
| Other | 2,560 | 204 | 288 | 3,052 |
| Oil or Gas Tanker | 6 | 4 | 140 | 150 |
| Commercial Fishing Vessel w/ Ballast Water | 66 | 1 | 1 | 68 |
| Large Ferry | 37 | 5 | 1 | 43 |
| Large Cruise Ship | 18 | 64 | 22 | 104 |
| Medium Cruise Ship | 7 | 3 | 0 | 10 |
| Research Vessel | 57 | 3 | 0 | 60 |
| Emergency Vessel | 33 | 0 | 0 | 33 |
| **Total** | **7,748** | **755** | **688** | **9,191** |

**Table 5.5** Foreign Owned Vessels by Vessel Type and Ballast Capacity

| | Ballast Capacity | | | |
|---|---|---|---|---|
| **Vessel Type** | **< 1500m$^3$** | **1500-5000m$^3$** | **> 5000m$^3$** | **Total Reporting Information** |
| Barge | 3 | 10 | 12 | 25 |
| Other | 483 | 1,330 | 9,513 | 11,326 |
| Oil or Gas Tanker | 49 | 375 | 3,266 | 3,690 |
| Commercial Fishing Vessel w/ Ballast Water | 8 | 14 | 84 | 106 |
| Large Ferry | 5 | 1 | 7 | 13 |
| Large Cruise Ship | 0 | 34 | 3 | 37 |
| Medium Cruise Ship | 8 | 2 | 1 | 11 |
| Research Vessel | 25 | 12 | 2 | 39 |
| Emergency Vessel | 4 | 0 | 4 | 8 |
| **Total** | **585** | **1,778** | **12,892** | **15,255** |

### 5.1.4 Year Vessel is Built Information

The data was also able to provide information on the year vessels covered by the VGP were built. Only vessels that indicated a ballast water capacity were analyzed to allows us to predict how many vessels will be able to install ballast water treatment systems. The data was solicited on February 2011, so it includes existing vessels that have submitted an NOI as of that date. Figure 5.3 shows the total number of vessels with ballast capacity information built in each year since 1960 as well as the total number of vessels except barges. There are some registered vessels built before that year but they are minimal. The reason the data is displayed this way is because the VGP exempts barges that are unmanned and unpowered from meeting numeric ballast water discharge standards. Table 5.6 is more detailed showing vessel types with ballast capacity information by the year the vessel is built in periods of 5 years ending on 2010.

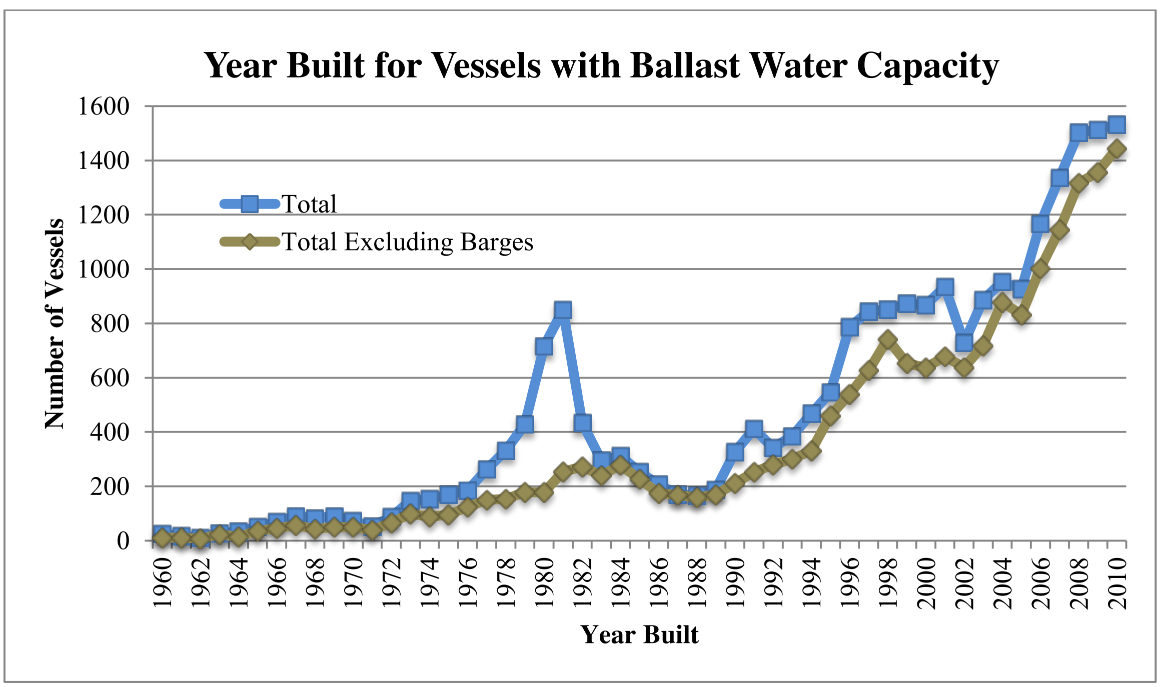



**Figure 5.3** Vessels with ballast water capacity information built per year since 1960

**Table 5.6** Number of Vessel Distinguished by Types, Year Built, and Vessel Age

| \| **Year Built** | | 2010-2006 | 2005-2001 | 2000-1996 | 1995-1991 | 1990-1986 | 1985 or less |
|---|---|---|---|---|---|---|---|
| **Vessel Type** | **Vessel Age (from 2012)** | 2-6yrs | 7-11yrs | 12-16yrs | 17-21yrs | 21-26yrs | 27+yrs |
| Barge | | 787 | 685 | 1024 | 528 | 174 | 2502 |
| Other | | 4447 | 2683 | 2512 | 1257 | 736 | 2694 |
| Oil or Gas Tanker | | 1741 | 995 | 585 | 301 | 95 | 97 |
| Commercial Fishing Vessel w/ Ballast Water | | 18 | 15 | 33 | 15 | 21 | 77 |
| Large Ferry | | 5 | 7 | 10 | 5 | 2 | 23 |
| Large Cruise Ship | | 34 | 33 | 39 | 19 | 7 | 14 |
| Medium Cruise Ship | | 3 | 2 | 2 | 3 | 6 | 5 |
| Research Vessel | | 14 | 7 | 16 | 10 | 13 | 38 |
| Emergency Vessel | | 2 | 2 | 1 | 21 | 3 | 12 |
| **Total** | | 7051 (29%) | 4429 (18%) | 4222 (17%) | 2159 (9%) | 1057 (4%) | 5462 (22%) |
| Total without Barges | | 6264 (34%) | 3744 (15%) | 3198 (13%) | 1631 (7%) | 883 (4%) | 2960 (12%) |

The year built / vessel age information is useful since it can help predict if a vessel would be able or willing to comply with new regulations requiring the installation of costly and large ballast water treatment systems. As mentioned in Chapter 3, the first ballast water discharge standards were released by IMO in 2004 but the IMO MEPC was considering the issuing of these standards since 1997. Therefore many vessels built in the past 8-15 years may have been aware of the possibility of numeric discharge standards and the need for ballast water treatment systems in the near future. These vessels (especially more recently) may have considered the addition of extra space for the future addition of treatment systems.

From Figure 5.3 it can be seen that a large number of vessels with ballast capacity information that are registered for the VGP were built after the mid 1990's. A lot of barges with ballast capacity information built in the early 1980's are also still in use today and are covered by the VGP.

Table 5.6 points out that the majority of vessels, not including barges and with ballast capacity information were built between 2010 and 2006 (34%). This is followed in the next three periods, between 2005 and 2001 (15%), between 2000 and 1995 (13%), and before 1985 (12%). The 34% of vessels built in between 2010 and 2006 have a high chance of having space available for BWTSs since regulations were first introduced in 2004. The 12% of vessels built before 1985 will experience more difficulty in installing BWTSs due to the age of the vessel and potential lack of space. Vessels built over 25 years ago are mainly "Other" vessels, barges and commercial fishing vessels with ballast water.

## 5.2 Lloyd’s Register Database

To further support some of the discussions in this thesis, a supplemental set of data was analyzed. Lloyd’s Register is a maritime classification society that services the international maritime industry in risk assessment and risk management solutions. Over the past couple years, the organization has provided ballast water treatment technology guides to help vessel owners comply with the emerging ballast water regulations. The guide contains data provided by individual suppliers of BWTSs. This data is useful in determining the status of existing BWTSs and if the treatment industry is prepared to meet the demand for these systems in the coming years. This data was published in July 2011 with an update on September 2011 and March 2012. Lloyd’s register has analyzed some of this data but this thesis adds an additional update from other sources since June 2012 and provides further analysis not conducted by Lloyd’s register [Lloyds, 2011, 2012; Class NK, 2012].

The combined database contains 69 BWTSs that have available information. As of June 2012, there are 24 systems that have been granted “type approval” indicating that the system can meet the IMO D-2 discharge standards. Also there are 41 systems with active substances that have received “basic approval” and 26 systems with active substances that have received “final approval”. The basic and final approval does not indicate that they can meet the discharge standards but does show that the active substances used in these systems cause no environmental impact when used in the BWTS. Furthermore two type-approved systems have withdrawn their BWTS from the market so only 22 systems are available. In June 2011, one year earlier, only 14 systems received type approval, 28 systems received basic approval and 16 systems received final approval.

Other useful information is the types of treatment systems that are proving to be successful in attaining type approval. As mentioned in Chapter 2, most systems use a combination of physical separation and either chemical or physical disinfection. Figures 5.4, 5.5 and 5.6 show the types and number of physical separation systems, chemical disinfection systems and physical disinfection systems, respectively, that have been proposed and that have received type approval. It can be seen from this information that certain methods are not as successful as others. There have been no systems with hydro-cyclonic separation, chemical/biological biocides, or heat disinfection approved. The most successful methods have been filtration, electro-chlorination and UV radiation.

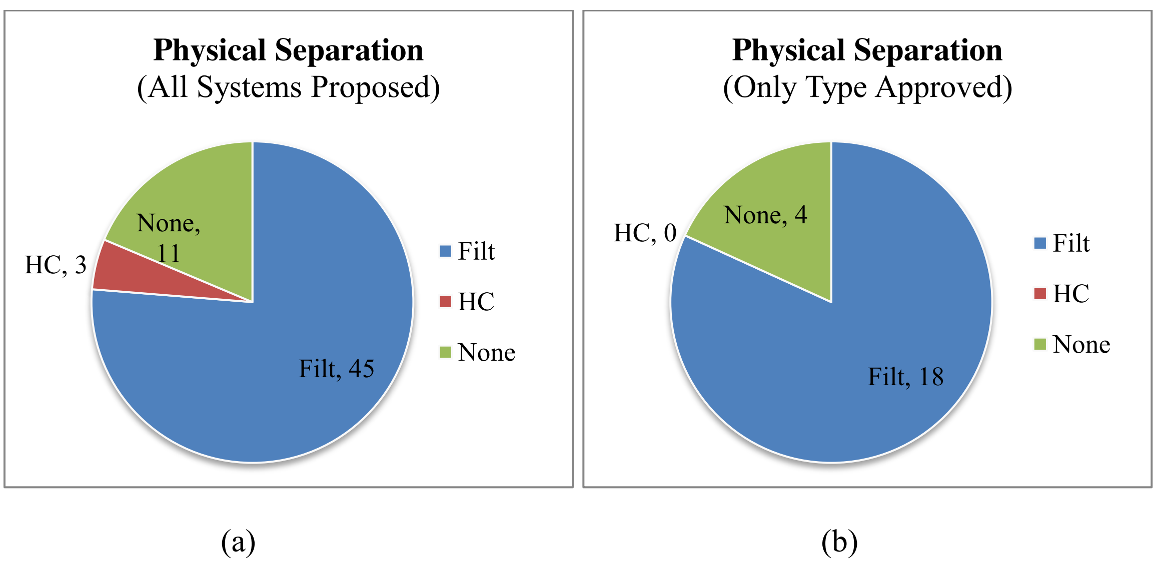
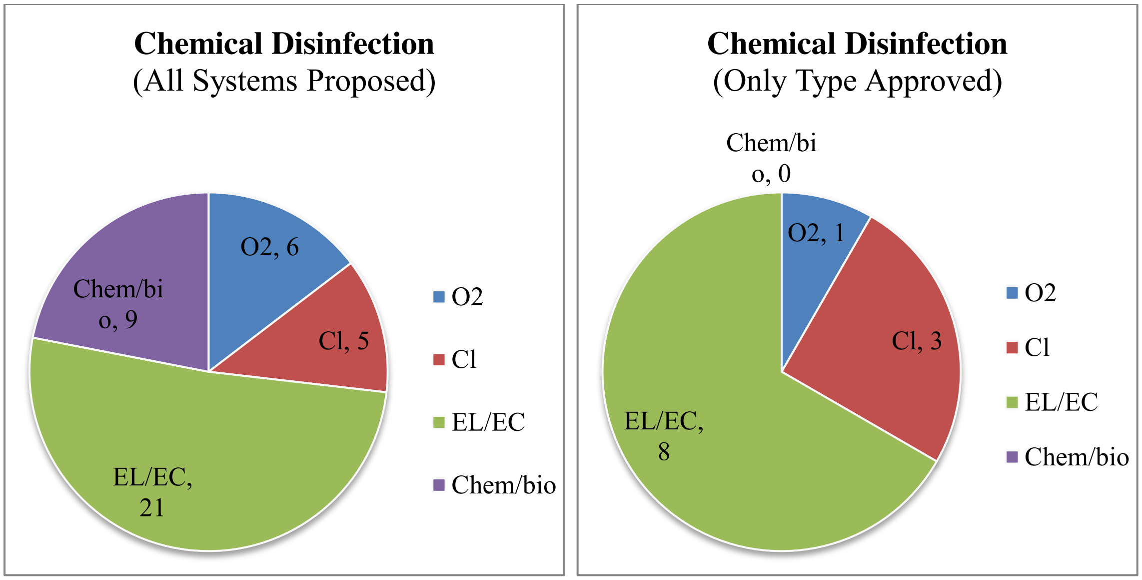
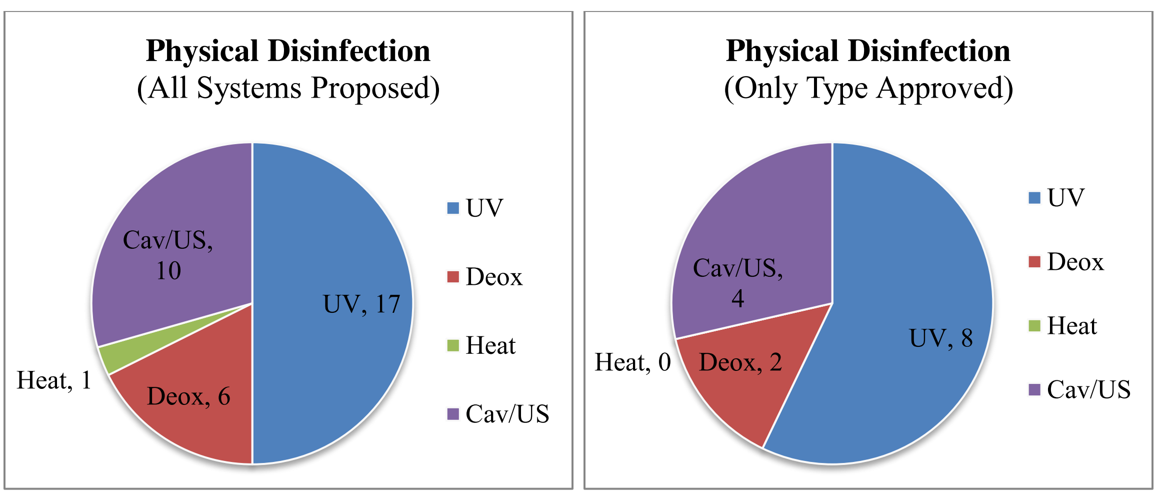



**Figure 5.4** (a) Proposed physical separation treatment systems (b) Type approved physical separation treatment systems. Note: Filt means filtration, HC means hyrdo-cyclonic, None means no physical separation is used.




(a) (b)

**Figure 5.5** (a) Proposed chemical disinfection treatment systems (b) Type approved chemical disinfection treatment systems. Note: O2 means ozone, CL means some form of chlorination is used, EL/EC means electrolysis/electro-chlorination, Chem/bio means chemical/biological biocide.




(a) (b)

**Figure 5.6** **(a)** Proposed physical disinfection treatment systems (b) Type approved physical disinfection treatment systems. Note: UV means ultraviolet radiation, Deox means de-oxygenation, Cav/US means mean cavitation/ultrasound

Among the type-approved systems 17 systems provided information on the surface area required on a vessel to install their systems, shown in Figure 5.7 is a box plot. The data shows that most systems fall in a close range for required surface area, between 3 to 6 $m^2$ for 200 $m^3/h$ ballast water discharge rates and between 8 to 13 $m^2$ for 2,000 $m^3/h$ ballast water discharge rates. The extension lines represent systems that require significantly larger or smaller surface areas than the average systems. There was one system that required 20$m^2$ for 200 $m^3/h$ discharge rates and 100$m^2$ for 2,000 $m^3/h$ discharge rates. This system used only chlorination for treatment and no filtration.

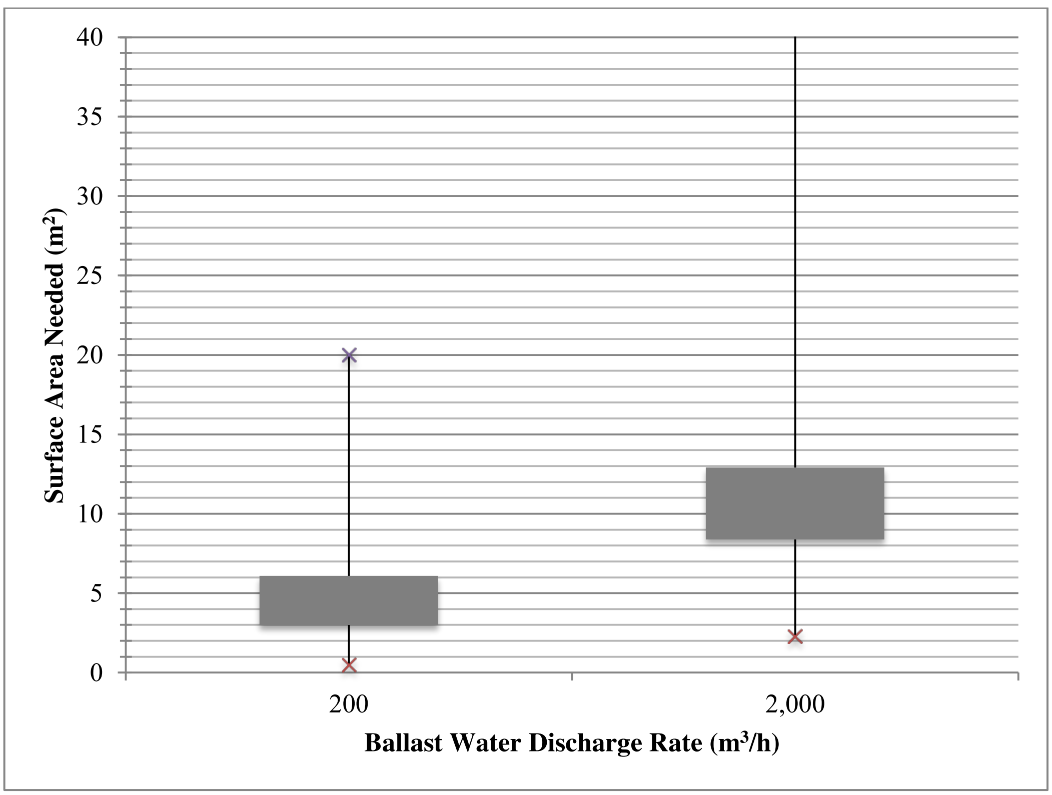



**Figure 5.7** Box plot of surface area needed to install BWTSs for 17 type approved systems for 200 and 2,000 $m^3/h$ discharge rates.

Lastly, the data also provides information as to the nation where the BWTS manufacturer operates, shown in Figure 5.8. This is usually the same nation that grants type approval if IMO D-2 discharge standards are met. The data shows that although there are many systems proposed in the USA, there are only 3 approved. China, Germany, Japan and Korea have more approved systems than the US.

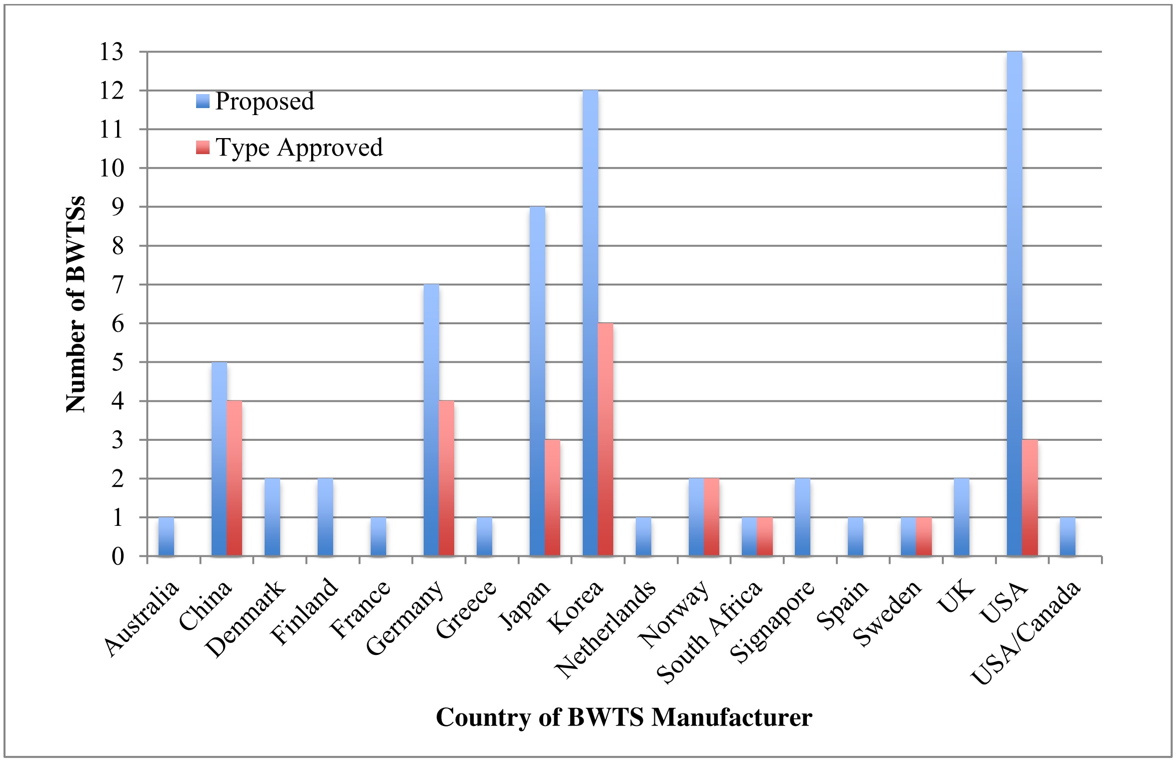



**Figure 5.8** Number of BWTSs proposed and approved based on the country of the BWTS Manufacturer.

# CHAPTER 6

# DISCUSSION OF CHALLENGES

## 6.1 BWTS Manufacturers

An important view to consider that has not been approached in other studies is the impact of ballast water treatment standards on BWTS manufacturers. Since IMO first proposed discharge standards, there have been many advances in ballast water treatment technologies with over 60 manufacturers proposing different technologies to combat invasive species.

Many vessels will have to comply to ballast water discharge standards by the appropriate deadline through the purchase and installation of a BWTS from a manufacturer with a type approved system. As shown in Table 3.3,the first deadline is after 1/1/2014 for existing vessels with ballast capacity between 1500-5000 $m^3$. The following deadline is after 1/1/2016 for existing vessels with ballast capacity less than $1500m^3$ or greater than $5000m^3$. These schedules seem to be determined by rule makers to allow technologies for smaller ($<1500m^3$ ballast) and larger ($>5000m^3$ ballast) treatment systems to improve and to lessen the impact on BWTS manufacturers. Smaller vessels will mostly need to treat lesser capacities of ballast water, therefore systems treating less than 1500 $m^3$ of ballast water need to be designed to consume less space and be made more affordable. Vessels with large ballast capacities $>5000m^3$ will need to treat at higher discharge rates so as to not disrupt normal operations. Ultra-large crude carriers have one of the highest representative ballast capacities of 95,000 $m^3$ resulting in the need for improved and more innovative systems to address the challenge of treating large ballast quantities in short durations [ABS, 2011]. Additionally, unlike certain other ballast standards the VGP has allowed for more flexible deadlines by allowing vessels to install the treatment system during the first drydock after the specified deadlines. This reduces the stress on manufacturers, vessel owners, and the maritime industry as a whole.

The US EPA NOI data in Table 5.3 shows that only 10.3% of vessels (1500-5000$m^3$ ballast) will have to meet the first deadline (drydock after 1/1/2014) and the remaining 89.7% will have to meet the later deadline (drydock after 1/1/2016). This will give manufacturers a chance to install their technologies on a smaller number of vessels before having to increase to a larger-scale production.

As seen from the Lloyd's register data Figure 5.7, most systems were approved in foreign nations; these foreign companies will have to also prove compliance with US EPA VGP technology certification requirements. Studies may be needed on the expected visits of vessels throughout the country and globally to predict where to establish manufacturing or delivery locations. The companies will have to develop innovative strategies to expand their business to thousands of ports throughout the world. The BWTS industry will be faced with the challenge of deadlines approaching quickly in the coming years and the need to receive "type approvals" in a timely fashion.

The BWTS industry will also have to consider the possibility of more stringent standards in the future and there is little question that environmental activists will increasingly demand the testing of systems to these more stringent standard as the precision and resolution of testing methods improve. New York for example has proposed the inclusion of standards 10 times and 100 times IMO while California is proposing standards 1000 times IMO. Although these are not currently practical, with time and technology improvements these states may begin to petition for these standards once again and implement them through VGP 401 certifications. Lloyd's register data also illustrates in Figures 5.4 to 5.6 that most approved treatment methods have consisted of either filtration, electro-chlorination or UV radiation. Systems with hydro-cyclonic separation, chemical/biological biocides, or heat disinfection have not been approved yet and BWTS proposing these technologies may not be successful in achieving "type approval" for more stringent standards. Technologies that can be easily upgraded or modified to meet more stringent standards may be the preferred choice. Manufacturers that are prepared for these possibilities will be best suited in the long run.

## 6.2 Vessels Requiring BWTSs

The 2013 VGP requires vessels with a ballast capacity greater than $8m^3$ to meet numerical limits for legal discharge of ballast water. Most vessels will have to comply with these standards by installing BWTSs, discharging to onshore facilities, or not discharging ballast water at all. Since many vessels with ballast water cannot avoid the discharge of ballast water, and onshore facilities are not available, onboard BWTSs will be required. The installation of BWTSs onboard vessels presents several challenges relating to available technology, costs, installation, vessel age and monitoring requirements.

Chapter 2 presented the different technologies available for treatment of ballast water. One of the vessel owner's greatest challenge will be choosing the correct BWTS for their specific vessel. Lloyd's Register suggests that consideration should be giving to flow capacity, effect on ballast coating, costs, and footprint and installation. The flow capacity will determine how fast ballast can be taken on or discharged, and thus the impact on the vessels normal operations. The effects on ballast coating relate to the potential detrimental effect of active substances on the coatings of tanks, 17 out of the 22 type approved systems use active substances. Strong oxidizing agents, like chlorine and ozone, may react with ballast tank coatings or walls. Engineers may have to evaluate the condition of ballast tanks depending on the active substance used in the desired system. Vessel owners will have to consider additional costs of these investigations and adequate protection if needed.

Costs will be the most difficult to compare for vessel owners since this is a new field and the estimation of costs will require vessel specific information. Interpretation of cost information between different suppliers can also be confusing due to the variation of calculating costs. The US EPA's economic analysis of the VGP requirements estimates that capital costs range from less than $300,000 to more than $2.5 million depending on the vessel characteristics (type and size) and the type of treatment system installed [US EPA, 2011a]. The US EPA further considers operation and maintenance costs to be comparatively low, at $1,708 per vessel per year on average. Vessel owners will have to be cautious in interpreting costs since the operational costs can be much higher for systems with chemical dosing or power consuming equipment, such as electro-chlorination or ozonation. Operational costs can be a major factor that should not be overlooked.

If vessels wish to use onshore treatment facilities, there will still be an additional cost to modify the ballast tanks for pump out. Other than sewage pump out facilities, very few land based treatment facility exist. The Valdez Marine Terminal in Alaska is one of the very few such facilities specifically designed for ballast water treatment. However, because it was constructed prior to the emergence of concerns for invasive species it had been designed primarily to address the discharge of hydrocarbons and other chemicals in ballast water which had been the historical focus of attention in the petroleum and chemical industry. Some existing ports are actively considering building these necessary and upgraded facilities, which address such current biological concerns [Brown and Caldwell, 2007]. However, it will be costly to build these facilities and it will take some time before they will be available for use.

In regards to footprint and installation, vessel owners will have to consider the available space near the ballast water tanks and pumps. Figure 5.7 shows that most systems fall under a close area range of 3 to 13 $m^2$ but some system can even require 100 $m^2$. Engineers and naval architects will need to inspect the available area and consider the best location to maintain stability of the vessel as such systems are designed and installed. Some vessels may even require costly redesign to accommodate treatment systems.

The age of a vessel presents a challenge as to how many vessels would be able to install a BWTS onboard the vessel (see Table 5.5). The data shows that although many vessels that registered for the VGP, excluding barges, were built more recently, there are still vessels that are older than 25 years or more. For example, as the NJIT team boarded a cargo vessel built in the 1960s and under repair the vessel staff mentioned that there is no available free space on the vessel. In this and many similar circumstances it would be very difficult to install additional ballast treatment systems and highlights the question of how compliance with new treatment and storage regulations will be achieved.

If a vessel is too old and does not have sufficient space for a treatment system or it is too costly to install a new treatment system on a vessel that is close to the end of its life, the vessel may be put out of commission. Under the CWA, it is acceptable for the issuance of a permit to result in the closure of facilities that cannot meet the new standards. However, the significance of the impact of such decommissioning to the maritime industries is still unclear.

With time, more cost effective and advanced treatment technologies will emerge that will enable the industry to accommodate more stringent standards. Vessels owners, however, will be well advised to track carefully the developments in discharge standards and to be particularly aware of emerging restrictions and technological requirements in new promulgations of the VGP. Keeping this in mind, progressive technologies that demonstrate flexibility and the advanced features necessary to meet stricter standards may be a better choice for vessels that wish to stay operational and in compliance in the long run.

Lastly, the additional monitoring requirements could also present challenges for vessel crews. The maritime industry is generally unfamiliar with biological testing. Vessels are generally required to have marine safety devices to treat sewage and oily water separators to treat bilge water before discharge. Once, these systems are inspected and installed, there is no requirement for sampling and testing. However, the VGP monitoring requirements for ballast treatment demands equipment calibration, collection of samples, and biological and chemical tests. The collection of ballast water would not be a safe or easy task. During installation of BWTSs, engineers must consider safe methods to collect treated ballast water for testing. To this end, vessels will have to consider an additional testing lab and train their crew to test the samples or hire third-party consultants to conduct the tests.

### 6.3 Impact on Foreign and Domestic Vessels

The data analyzed can help determine where the greater impact from these requirements will be. Many other studies have analyzed data to determine the impact on foreign and domestic vessels with respect to the VGP ballast water discharge standards [King et al., 2010; US EPA, 2011a]. However, their analyses are based on an international scale or do not distinguish vessels with ballast capacity. Instead they primarily utilize an over simplified and gross distinction by focusing only on commercial vessels greater than 300 gross tons. To understand such an impact of this U.S. specific permit, the NOI database was analyzed in Chapter 5 Section 5.1.3. Figure 5.2 shows that the majority of vessels impacted by the VGP are domestically owned vessels, which includes all vessels registered for the VGP. However, Table 5.4 and Table 5.5 go into more detail of only vessels with ballast capacity information.

From the specific data of vessels with ballast capacity, it can be seen that a greater number of foreign owned vessels would be affected by the VGP. Of the total number of vessels with ballast capacity information there are only 37.6% (9,191 vessels) domestic vessels but a large portion, 62.4% (15,255), are foreign vessels. It is determined that U.S. vessels are not nearly affected by the proposed limits as foreign vessels.

Furthermore, most barges are unmanned and unpowered, and these types of barges are excluded from the numeric discharge limits in the proposed 2013 VGP. Table 5.4 shows that U.S. vessels are mainly barges, which are widely used for inland or near shore voyages within U.S. waters. However, foreign entities have little use for barges in the U.S., demonstrated in Table 5.5 by the very small number of foreign barges with ballast capacity in U.S. waters. After taking out the exempted barge vessels, the impact becomes even less significant for the U.S. vessels. Recalculation shows only 18.8% (3,520 vessels) domestic vessels will be affected and percentage of foreign vessels affected rises to 81.2% (15,230 vessels). Therefore, foreign entities are far more affected by the impending VGP restrictions.

Similarly other features, too, make the impacts of the new rules greater for foreign vessels. From the data in Table 5.5 it can be seen that mostly foreign vessels have a ballast capacity greater than $5000m^3$ and are mainly oil or gas tankers, “Other” (which are mostly freight ships), or commercial fishing vessels. This can be due to the import and export activities with foreign countries. It will be much more costly for foreign owned vessels to install ballast treatment systems with a ballast capacity $>5000m^3$ since these technologies will require large systems that are more space demanding and energy consuming. This can also affect the schedules of foreign vessels during operations, since it will take longer to discharge the great amount of ballast water. However, in the U.S. most vessels have ballast capacity less than $1500m^3$ and are mostly barges, “Other”, commercial fishing vessels, research vessels or large ferries. This indicates U.S. owned vessels are less frequently used for foreign trade and are mostly utilized within U.S. waters for shorter duration interstate commerce. The smaller ballast capacity vessels of

U.S. will require less energy and lower discharge rates making them less expensive. U.S. vessels, as a whole, will therefore encounter less significant economic and technological impact by the requirement of BWTSs to meet proposed discharge limitations in U.S. waters.

One must also consider that since the VGP is only applicable in U.S. waters, the federal and state government may have to provide alternative methods of compliance for domestic and foreign vessels. Vessels that cannot install a BWTS onboard and cannot avoid discharge will need to discharge to onshore facilities. There are currently no such systems that treat ballast water. This is a concern that will impact U.S. entities in order to not disrupt maritime operations. Nonetheless, when IMO D-2 regulations are imposed, U.S. vessels operating in foreign countries must also consider the impending IMO D-2 regulations, which would affect most vessels and government entities internationally.

The careful application and analysis of the NOI data to determine impact on foreign and domestic vessels show that although U.S. government entities will encounter some challenges from the proposed regulations, U.S. vessels face a less significant impact than foreign vessels. As demonstrated this is largely due to the difference in vessel types, ballast capacities, vessel voyages, and how the vessels are used. The availability of BWTS manufacturers, types of BWTSs in the market, and compliance deadlines will affect a great number of foreign vessels with high ballast capacities. Therefore U.S. and foreign BWTS manufacturers and vessel owners will have to be prepared for the upcoming several thousands of foreign vessels (with $>5000m^3$ ballast capacity) requiring BWTSs by the 2016 deadline.

## 6.4 Additional State Requirements

As explained in Chapter 3, there are several varying regulations from international, federal and state agencies on ballast water, which can cause much confusion for vessel owners/operators. Initially Congress intended USCG to be the primary regulating agency of ballast water in the U.S. However after several court cases, the courts rejected US EPA's exemption of discharges incidental to normal operations of vessels from CWA NPDES permitting, including ballast water.

Previously under USCG regulations, the requirements would be mostly uniform. The VGP removes uniformity, because the CWA requires compliance with state water quality standards and other possible more stringent state requirements. Furthermore, due to the short time given to issue the permit, the public was not allowed to comment on state's additional regulations causing much controversy on stricter requirements imposed by the states. In the 2008 VGP eleven states added regulations on ballast water discharge and another six states control ballast water discharges through other state regulations. The two main issues with state ballast water regulations are stricter requirements and non-uniform regulations among the states.

In 2011, three maritime associations, the American Waterway Operators (AWO), Lake Carrier's Association and the Canadian Shipowners Association, petitioned in court that the US EPA violated federal law when they issued the final VGP without providing the regulated community an opportunity to comment on additional state regulations. The maritime associations requested that the courts vacate the section of the VGP containing these additional state regulations. US EPA countered that they do not have the authority to alter or reject state conditions. The courts ultimately agreed with the US EPA, since the US EPA could not amend or reject state requirements even if an opportunity for comment was given [DC Cir, 2011]. Congress also suggested that the CWA be legislatively amended to provide a solution for the maritime industry. Maritime industry considers this ruling as a call for "uniform and practical" regulations for vessel discharges. Furthermore, the industry believes the NPDES permit system is poorly suited for regulation of mobile sources such as vessels [Workboat, 2012].

As an example, a highly debated issue is New York's actions towards the possible use of stricter regulations 10 times IMO D-2 and 100 times IMO D-2 in the issuance of their 2013 VGP 401 certifications. This caused much worry to states and the maritime industry since the St Lawrence Seaway, located in New York, is the only waterway allowing entry into the Great Lakes. New York claimed that the US EPA was not considering the Best Available Technology (BAT) in their determination because treatment systems existed to meet standards greater than IMO D-2. New York determined that 3 systems are currently available to meet at least a standard 10 times IMO D-2 with a 99% confidence level and two of those systems are able to meet a standard 100 times IMO D-2 with a 58% confidence level [Gov. Martens, 2012]. However, the US EPA stated that since the data from these tests were meant to determine if systems could meet IMO D-2 limits, it does not have "significant precision or resolution to detect efficacy significantly beyond those limits" [US EPA, 2011]. Furthermore, New York's consideration of BAT did not even include an economic analysis of the stricter standards. Without the authority to reject a state's standards assigned to EPA, impractical regulations can be placed by states through CWA 401 certifications of the VGP.

The Wisconsin Department of Natural Resources (WNDR) also ran an analysis of the data and in consultation with the Ballast Water Collaborative, found that treatment technologies do not exist today to meet the 100 times IMO D-2 standard. Governors of Wisconsin, Indiana and Ohio in a letter to New York's governor urged the adoption of a consistent standard and claimed that unless the New York regulations were amended, it would possibly force the closure of the St. Lawrence Seaway and the loss of thousands of maritime-related jobs [Gov. Walker et al., 2011]. Eventually in May 2012, New York submitted their draft 2013 VGP certification stating that they will not be including these more stringent regulations but remained adamant about vessels installing systems that exceed IMO D-2 standards [NYDEC, 2012]. This example illustrates interstate disputes caused by the state 401 certifications and that these regulations go well beyond concerns for navigation but may also seriously impact state's economies, imports and exports, and jobs. There is little doubt that problems will arise with the inclusion of more stringent state based limitations in the issuance of future NPDES general permits for the commercial vessels discussed above.

During the first issuance of the VGP, states were given very little time to submit certifications of the permit so public comment periods and cost analyses of additional requirements were not conducted. The US EPA agreed in a settlement to improve its approach in implementing state certifications during it's second issuance of the VGP, but this did not change a state's rights to include additional requirements under CWA 401. In the 2013 VGP, the US EPA encouraged states to solicit public comments and gave sufficient time (7 months) to do so. However, this is still optional and the CWA does not require consideration of costs by the states. The CWA 401 certification is meant to enforce water quality-based effluent limits so states have no limit as to setting more stringent standards if needed to protect the water body, regardless of cost. However the VGP deals with mobile vessels, which extended beyond the well-defined boundary within a state. This non-uniformity of the state 401 regulations will add costs to other states, the private sector and the public. An economic impact analysis of New York's ballast regulations, by a third party, estimated that its issuance would "negatively affect over 72,000 jobs, more than $10 million in business revenue and over $1.4 million in federal, state/local and provincial taxes in the bi-national Great Lakes-St. Lawrence region" [Marinelink, 2012]. Since it is not practical to require all commercial vessels to meet a more stringent standard, a tax-based system may be implemented in which vessels meeting a lower discharge standard are charged a tax to enter the state's waters. More favorably, states like New York may consider an incentive program to continue to allow access into the Great Lakes through the St. Lawrence Seaway while promoting the use of improved system.

Since these state regulations can have a great impact on interstate commerce, it may be beneficial to look into the application of the Interstate Commerce Clause, from which environmental laws were derived. Environmental laws have historically been grounded in the federal authority found in the Commerce Clause by showing that "the regulated activity has a substantial effect on interstate commerce" [Percival et al. 2006]. As discussed state's additional regulations on these mobile sources can substantially affect interstate commerce. Therefore, it would follow that if state's regulations were to become problematic, Congress has the power to preempt state's 401 certifications of the VGP.

The CWA NPDES permit has proven to be poorly suited for commercial vessels. There are examples of other regulations taking a different approach for vessel regulations and also proposed regulations attempting to modify the CWA NPDES regulations for commercial vessels. In 1996, The US EPA and US Department of Defense promulgated the CWA Section 312(n) statute to establish the Uniform National Discharge Standards (UNDS) for armed forces vessels in U.S. waters out to 12 nm from shore. Through this statute states are preempted from including additional requirements. This is key in establishing rules for mobile discharges of vessels such that they must follow one uniform discharge standard in all U.S. waters. Furthermore the UNDS considers states, territories, tribes and other federal agencies an integral component to the rule making process, by holding meetings to obtain input and allowing states to petition for more stringent standards or establishing no-discharge zones (US EPA, 2012). The UNDS is a good example of how vessel discharges can be properly regulated by coordination between the states and maritime industry to establish manageable uniform rules that protect the environment. The USCG is attempting to take a similar approach in creating uniform standards for commercial vessel through the USCG Commercial Vessel Discharge Reform Act of 2011, but in stakeholder's meeting with NJIT the maritime industry has expressed that that it is unlikely for such a controversial bill to pass into law.

## 6.5 Government Agencies' Involvement

On a global level there will need to be strong communication and coordination between US EPA, USCG, IMO MEPC, and foreign agencies in developing a uniform ballast water standard. On a national level US EPA needs to coordinate with states, environmental agencies, and the maritime industries to avoid court challenges and compliance issues. Since states can affect the regulations as well, they must communicate with neighboring states, maritime industry, and the public to understand the regional impacts that are affected by their additional state 401 certifications.

Other tasks for the US EPA to accomplish will be to achieve both permit enforcement and environmental protection goals. According to the Memorandum Of Understanding (MOU) between US EPA and USCG, the USCG will conduct inspection onboard vessels and the US EPA will carry out enforcement based on these investigations [MOU, 2011]. Even with this understanding, the VGP has heavily relied on self-inspections and reporting by vessel owners. The varying ballast water regulations and timelines can cause confusion and lead to violations. To adequately protect the environment, the US EPA will have to develop an innovative plan to monitor thousands of vessels and BWTSs, which will not be easy since they are mobile sources. Checking over 20,000 BWTSs onboard vessels and over 50,000 vessels affected by the permit, even with USCG assistance, will be a draconic job.

The US EPA will also have the daunting task of addressing the funding of not only subsequent research efforts but also the possible on-shore facilities that may be required to comply with the VGP and state regulations. When the Clean Water Act was promulgated in 1972, it provided a construction grants program. This program funded the construction of sewage treatment plants, with many publicly operated treatment works (POTWS) in use today built during that period. Later in 1992, Congress passed the Clean Vessel Act (CVA) to help reduce pollution from vessel sewage discharges. The Act established a five-year federal grant program ($40 million) and it was reauthorized in

1998 with an additional $50 million for disposal of recreational boater sewage. However, even with the shortage of on-shore ballast water treatment facilities, there is no such construction grant available for these VGP requirements. With the present national and state financial conditions, it is unlikely that the government will provide financial support to build these facilities. In a planning study, the capital costs of feasible on-shore collection and treatment alternatives for ballast water ranged from $1.3 million to $6.6 million [Brown and Caldwell, 2007]. Since there currently is no funding for these costly facilities, many vessels will have to rely on the installation of BWTSs to meet the discharge standards.

# CHAPTER 7

# CONCLUSIONS AND RECOMMENDATIONS

The Vessel General Permit provides coverage for discharges incidental to the normal operation of commercial vessels operating as a means of transportation. The VGP requires vessel owners and operators to comply with various discharge requirements, monitoring, inspection and recordkeeping requirements, and additional state requirements. With the approaching expiration of the 2008 VGP approaching on December 19, 2013, the US EPA has released a draft 2013 VGP for public review. This draft 2013 VGP includes proposed numeric-based effluent limits for ballast water discharges equivalent to internationally proposed IMO D-2 standards. Since this permit will be the first to introduce numeric-based ballast water standards affecting vessels in U.S. waters, the challenges it presents to the maritime industry and government agencies have been thoroughly examined in this thesis.

In order to fully understand the impact that the proposed numeric-based VGP ballast water discharge limitations may have onto the maritime industry and various government agencies, the proposed rules and available VGP NOI data have been careful analyzed. The challenges have been discussed in five aspects: BWTS manufacturers, vessels requiring BWTSs, impact on foreign and domestic vessels, additional state regulations, and government agencies' involvement.

BWTS manufacturers will experience increased pressure over the next couple years to receive "type approval", plan for global distribution, market BWTS to appropriate commercial vessels, and meet installation deadlines. The NOI data shows that only approximately 1/10 of the affected vessel universe will have to meet the initial 1/1/2014 drydock installation deadline. This will gives BWTS manufacturers more time to prepare for the majority of installations that will have to occur after 1/1/2016 drydock deadline. It is recommended that BWTS manufacturers also keep in mind the possibility of more stringent ballast water effluent limits and continue research and improvements of their treatment technologies to evolve as testing methods increase in precision and resolution.

Due the lack of onshore facilities in the U.S., many vessel owners and operators will find that the most suitable method of compliance to the proposed standards will be through the installation of BWTSs. Vessels owners will face many challenges in selecting the most economical and technologically appropriate system for their specific type of vessel. Flow capacities, space limitations, effects on ballast coatings and costs are only a few of the factors that will affect the decision of purchasing and installing such systems. Older vessels with insufficient space or funds to install a BWTS onboard to comply may have to be decommissioned. Also many vessel owners and operators unfamiliar with treatment technologies onboard and monitoring practices will need to send their crew for environmental testing training or incur additional testing lab fees to address monitoring requirements of the VGP.

In terms of foreign and domestic impact, U.S. vessels will be facing a much less significant impact than foreign vessels. The majority of U.S. owned vessels requiring permit coverage are inland barges which are exempt from ballast water discharge standards while foreign owned vessels have a greater number of high ballast capacity vessels operating in the U.S. requiring BWTSs. These foreign companies and vessels will be affected more in meeting the proposed limits economically and technologically. Nonetheless, U.S. vessels operating in foreign countries must consider the impending IMO D-2 regulations if the IMO Convention is ratified, which would affect all vessels internationally. Since U.S. vessels will experience significantly less impact domestically, it would be wise for U.S. companies to begin considerations for installation of BWTS on vessels operating in foreign nations.

Additional state regulations also pose a substantial challenge to vessels discharging ballast water in U.S. waters. These regulations are imposed through state agencies or the VGP 401 state certifications in addition to federal requirements. One side of the problem lies in the non-uniformity amongst states established through varying state standards and requirements. Vessels are mobile sources and sometimes travel through several state waters during normal operation. The varying requirements can cause confusion for vessel owners and operators, which can lead to violations and penalties for non-compliance. Another aspect of the problem is the consideration of stricter ballast water discharge standards proposed by a few states, mainly New York and California. These proposed stringent standards have not been properly studied and require improved testing methods to adequately be considered. Economic analyses from states proposing stricter requirements should also be required. Unless uniform ballast water standards are adopted through legislation, it is recommended that states follow as close to a uniform international standard as possible to lessen the burden on vessels and maritime operations. If additional state regulations are instated, agencies should provide adequate resources for vessel owners and operators to be aware of and fully understand what is required of them in the pertinent state waters.

Finally, vessels and BWTS manufactures are not the only affected parties, U.S. government agencies face several difficulties in enforcing the ballast water discharge regulations imposed by the VGP. It is already a difficult task to deal with the variety of types of vessels, which travel to different regions of the U.S., and control 27 different types of discharges from over 50,000 vessels. With the inclusion of numeric-based ballast water discharge standards, the US EPA and USCG must provide additional workforce towards the inspection and enforcement of BWTS development, installation and operations. The VGP has focused largely on self-inspections which will not be adequate to protect the intended waters; therefore, the US EPA and USCG will have to develop an innovative plan to enforce all the VGP discharge regulations. Furthermore the US EPA must address the lack of available funding for on-shore treatment facilities, which may be the only method of compliance for some vessels. Lastly international, federal and state governments as well as environmental agencies must continue strong collaboration in standardizing BWTS certifications and the determination of future ballast water standards.

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