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Making Ends Meet: Using A Market-Based Approach to Incentivize Foreign Vessels to Comply with the Air Emission Standards of MARPOL Annex VI

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MAKING ENDS MEET: USING A MARKET-BASED APPROACH TO INCENTIVIZE FOREIGN VESSELS TO COMPLY WITH THE AIR EMISSION STANDARDS OF MARPOL ANNEX VI*

*Xiaoxin Shi***

INTRODUCTION

Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL) sets mandatory air emission standards for ocean-going vessels. Ratifying countries are required to enact legislation to implement MARPOL Annex VI (Annex VI) within their jurisdictions. The United States adopted Annex VI through the Act to Prevent Pollution from Ships (APPS),[1] administered by the Environmental Protection Agency (EPA). Two

* The conclusions of this paper reflect the author's findings between late 2013 to early 2014, when the paper was completed. Since then, there have been new developments in the Chinese policies and regulations on air emissions from ships and vessels. The most significant development is the new Emission Control Area (ECA) Implementation Plan, promulgated by the Chinese Ministry of Transport on December 2, 2015 (http://www.gov.cn/xinwen/2015-12/04/content_5019932.htm). The Plan establishes three ECAs along China's coast. Beginning on January 1, 2016, ports within the three ECAs will start to require ships to switch to 0.5% sulfur fuel while berthing. Starting on January 1, 2019, all ships will be required to switch to 0.5% sulfur fuel when operating in the three ECAs. Before December 31, 2019, the Ministry of Transport plans to evaluate the effectiveness of the fuel switching program and decide whether to mandate all ships operate within the ECAs to switch to 0.1% sulfur fuel and whether to extend the geographical scopes of the ECAs.

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1 The Act to Prevent Pollution from Ships, 33 U.S.C. §§ 1901-1915 (2008).

Emission Control Areas (ECAs) have been established under Annex VI in the U.S. territory.[2] All vessels of United States registry or nationality to which MARPOL applies, if found to have violated the emission standards of ECAs within the U.S. territory, are subject to criminal or *in rem* civil liabilities.[3]

The majority of the vessels calling at U.S. ports are registered in foreign countries, many of which have not yet fully enforced Annex VI through domestic legislation.[4] Employing judicial proceedings as the primary instrument to enforce the compliance of foreign flagged vessels, therefore, could be cumbersome and expensive administratively, especially considering the large number of calls at U.S. ports. This paper explores the perspectives of market-based mechanisms, as supplements to judicial enforcement, to incentivize the compliance of foreign flagged vessels when operating in ECAs in the United States, and ultimately, to foster the enforcement of Annex VI in all major destinies of international shipping.

This paper first introduces the regulative scheme to enforce MARPOL Annex VI standards on foreign ships operating in U.S. waters in Section II. Technological alternatives to achieve compliance and their constraints are also discussed, along with the review of

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[2] The North American Emission Control Area (ECA) was jointly proposed by the United States, Canada, and France, approved by the International Maritime Organization (IMO) in 2010 and came into effect on August 1, 2012. *See* Int'l Mar. Org. [IMO], *North American Emission Control Area,* Res. MEPC.190(60) (Mar. 26, 2010). The United States also proposed the United States Caribbean Sea ECA, which was adopted by the IMO in 2011 and will take effect on January 1, 2014. *See* Int'l Mar. Org. [IMO], *Designation of the United States Caribbean Sea Emission Control Area and Exemption of Certain Ships Operation in the North American Emission Control Area and the United States Caribbean Sea Emission Control Area under Regulations 13 and 14 and Appendix VII of MARPOL Annex VI*, Res. MEPC.202(62) (July 15, 2011).

[3] 33 U.S.C. § 1908.

[4] *See* U.S. DEP'T of TRANSP., VESSEL CALLS SNAPSHOT, 2011 (2013). In 2011, foreign-flagged vessels accounted for 89% of calls at U.S. ports. The number of U.S.-flagged vessels calling at U.S. ports had a range of 6,869 to 7,356 between 2006 and 2011. *Id.* at 8; *see also* Sandra Y. Snyder, *EPA's Category 3 Marine Emission Standards: Mimicking MARPOL Annex VI or Mocking the Clean Air Act?* 71 BROOK. L. REV. 1065, 1089 (2005) (most vessels entering U.S. ports are foreign vessels).

relevant Annex VI provisions. Section III leads a comparison of Annex VI regulative schemes in the United States and a major marine trade partner, China. The comparison concludes that the United States and U.S. shipping companies are likely to bear unfair burdens administratively and financially in enforcing this multi-national convention due to the uneven regulative landscape globally. Having examined, from an economic perspective, the factors that could affect the effectiveness of enforcement measures, Section III recommends using incentive programs as an interim solution to solicit wider voluntary compliance while foreign countries such as China are yet to give effect to Annex VI through domestic legislation. Finally, Section IV discusses the feasibility of two main types of potential market-based incentive programs, cap-and-trade and emission credit trading, to provide non-complying foreign ships a "last offer" to avoid criminal penalties for violation of Annex VI while operating in U.S. waters. This paper favors an emission credit trading program, considering the increasing demand of international shipping service, in general, and the need to synergize technological developments in the ship building industry with the regulatory requirements of Annex VI.

I. ANNEX VI ENFORCEMENT SCHEME FOR FOREIGN FLAGGED VESSELS CALLING AT U.S. PORTS

Foreign flagged vessels, just as U.S. flagged vessels, are regulated under the APPS when they operate in U.S. waters. Vessels have to use low-sulfur fuels, the quality and quantity of which are documented in Bunker Delivery Notes, and provide engine certificates to prove compliance with Annex VI standards. Civil or criminal liabilities may be imposed for violations. The U.S. Coast Guard, under an agreement with the EPA, has the authority to undertake onboard inspections.

A. MARPOL Annex VI and Its Adoption in the United States

MARPOL,[5] as modified by Protocol of 1978,[6] is the main international convention to prevent marine environment pollution from ocean-going vessels.[7] Annex VI of MARPOL sets limits for NO_x,[8] SO_x,[9] and particulate matter (PM)[10] emissions from ocean-

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[5] International Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 1973 U.S.T. Lexis 322, 1340 U.N.T.S. 184 [hereinafter MARPOL Annex VI].

[6] Protocol of 1978, Feb. 17, 1978, 1978 U.S.T. Lexis 322, 1340 U.N.T.S. 61.

[7] *International Convention for the Prevention of Pollution from Ships (MARPOL)*, INT'L MAR. ORG., http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-(MARPOL).aspx (last visited Feb. 15, 2015).

[8] NO_x (Nitrogen Oxides) forms through the diesel engine combustion process when the temperature reaches 2000 degrees Kelvin (equivalent to about 3140 Fahrenheit) and the nitrogen in the air reacts with oxygen. The amount of NO_x emission is not strongly affected by the specific fuel consumption, but is dependent on the temperature, pressure, and duration of combustion time of the engine fuel. Most nitrogen is oxidized into nitric oxide (NO) in the early stage of combustion. Some of the NO will convert to nitrogen dioxide (NO_2) and nitrous oxide (N_2O) during the later expansion process and in the exhaust. NO_x is the mixture of NO, NO_2, and N_2O. One way of measuring NO_x emission is based on the main engine's rated speed, presented as revolutions per minute (rpm). *See* LAURIE GOLDSWORTHY, DESIGN OF SHIP ENGINES FOR REDUCED EMISSIONS OF OXIDES OF NITROGEN §2 (2002), available at http://www.flamemarine.com/files/AMCPaper.pdf. NO_x emission is significantly higher when an engine operates at lower rpm (50 to 550); Lasse Johansson, Emission Estimation of Marine Traffic Using Vessel Characteristic and AIS-Data 19 (Sept. 19, 2011) (Master's thesis, Aalto University), available at www.lib.tkk.fi/Dipl/2011/ urn100529.pdf. NO_x are precursor components for a photochemical reaction through which ozone is formed, and catalysts for the formation of acid rain. *Id.* at 5. Exposure to NO_x, even if for a short term from 30 minutes to 24 hours, would adversely affect the human respiratory system, including airway inflammation in healthy people and increased respiratory symptoms in people with asthma. *Nitrogen Dioxide*, U.S. ENV'L PROT. AGENCY, http://www. epa.gov/air/nitrogenoxides/health.html (last updated Feb. 14, 2013).

[9] SO_x is the mixture of SO_2, SO_3, and SO_4. The amount of SO_x emission from vessels is directly related to the sulfur content of marine fuel burned. *See* Johansson, *supra* note 8; Zoi Nikopoulou et al., *The Role of A Cap-and-Trade Market in Reducing NO_x and SO_x Emissions: Prospects and Benefits for Ships Within the Northern European ECA*, 227(2) J. ENG'G FOR THE MARINE ENV'T 136, 136 (2013). Current world-wide average sulfur content in marine fuel is about 2.7% (27,000

going vessels that are of 400 gross tonnages or more, and general enforcement and monitoring procedures.[11] The International Maritime Organization (IMO), a United Nations specialized agency responsible for improving maritime safety and preventing pollution from ships, administers the enforcement of Annex VI worldwide.[12] Annex VI requires ratifying states to designate certain sea areas as ECAs where "mandatory measures" are required to control the emission of "NO_x or SO_x and [PM] or all three."[13] These "mandatory measures" include limiting the sulfur content of fuel oil to reduce SO_x and PM emissions through Regulation 14,[14] and prescribing three "tiers" of design standards for marine diesel engines

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ppm). DONALD DABDUB & SATISH VUTUKURU, AIR QUALITY IMPACTS OF SHIP EMISSIONS IN THE SOUTH COAST AIR BASIN OF CALIFORNIA 2 (2008). SO_x can react with other compounds in the atmosphere to form small particles, which can penetrate deeply into lungs and cause or worsen respiratory diseases. *Sulfur Dioxide*, U.S. ENV'L PROT. AGENCY, http://www.epa.gov/airquality/sulfurdioxide/health.html (last updated June 28, 2013). The SO_x particles usually spread up to a few hundred kilometers depending on weather and wind conditions. In the presence of catalysts such as NO_x, SO_x can form H_2SO_4 causing acid rain. Johansson, *supra* note 8.

[10] PM (Particulate Matter), measured by $PM_{2.5}$ (diameters of the particulates are less than 2.5 μm) and PM_{10} (diameters of the particulates are less than 10 μm), is produced during combustion in the form of soot, ash, organic and elemental carbon, SO_4 and its associated water molecules. The amount of PM emission from vessels is linearly dependent on the sulfur content of the fuel oil. *See* Nikopoulou et al., *supra* note 9, at 136-37; Johansson, *supra* note 8. PM contains microscopic solids and liquid droplets small enough to get into the lungs and cause a range of health problems to the lungs, respiratory systems, and heart. *Particulate Matter*, U.S. ENV'L PROT. AGENCY, http://www.epa.gov/airquality/particlepollution/health.html (last updated Mar. 18, 2013).

[11] *See* MARPOL Annex VI, *supra* note 5.

[12] *See Introduction to IMO*, ABOUT IMO, http://www.imo.org/About/Pages/Default.aspx(last visited Feb. 15, 2015).

[13] MARPOL Annex VI, *supra* note 5, Regulation 2, ¶ 8. Emissions of NO_x, SO_x, and particulate matter from ocean-going vessels could cause adverse impacts to the environment and public health, including premature mortality, cardiopulmonary disease, lung cancer, chronic respiratory ailments, acidification and eutrophication. *Id.*, Appendix III Criteria and Procedures for Designation of Emission Control Areas, ¶ 1.2.

[14] MARPOL Annex VI, *supra* note 5, Regulation 14. In ECAs, upper limits of the sulfur content of fuel oil used on board ships are 1.50% m/m before July 1, 2010; 1.00% m/m on and after July 1, 2010; 0.10% m/m on and after Jan. 1, 2015. *Id.* ¶ 8.

to control NO_x emission through Regulation 13.[15] Depending on the vessel's operational area and the time when the vessel engine is installed, different levels of NO_x emission standard apply: Tier I standard applies to engines that are installed on a ship constructed between 2000 and 2011;[16] Tier II standard applies to engines that are installed on ships constructed on or after January 2011, and if operating outside ECAs, ships constructed on or after January 1, 2016;[17] the most stringent Tier III standard applies to engines that are installed on ships constructed on or after January 1, 2016 if such ships operate in ECAs.[18] Notably, at the 65th session meeting held in May 2013, the IMO considered the proposal of delaying the implementation of Tier III standards in ECAs until January 1, 2021.[19] The IMO eventually made only a partial compromise. At the 66th session meeting in 2014, the IMO decided to uphold the original

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[15] Considering the long service life of ocean-going vessels that may last for decades, MARPOL Regulation 13 sets three "tiers" of NO_x emission standards for marine diesel engines that are installed on ships constructed between 2000 and 2011, after 2011, and after 2016. These emission limits are relative, presented in formulas with the rated engine speed (rpm, revolutions per minute) as the variable. MARPOL Annex VI, *supra* note 5, Regulation 13.

[16] For engines that are installed on ships constructed on or after January 1, 2000 and before January 1, 2011, Tier I standard applies: NO_x emission shall be under 17.0 g/kWh when the rated engine speed is less than 130 rpm; under $45\times n^{(-0.2)}$ with "n" being the rated engine speed is between 130 rpm and 2,000 rpm; under 9.8 g/kWh when the rated engine speed is above 2,000. MARPOL Annex VI, *supra* note 5, Regulation 13, ¶ 3.

[17] For engines that are installed on ships constructed on or after January 1, 2011, and ships constructed on or after January 2016 and operate outside ECAs, Tier II standard applies: NO_x emission shall be under 14.4 g/kWh when the rated engine speed is less than 130 rpm; under $44\times n^{(-0.23)}$ with "n" being the rated engine speed is between 130 rpm and 2,000 rpm; under 7.7 g/kWh when the rated engine speed is above 2,000. MARPOL Annex VI, *supra* note 5, Regulation 13, ¶¶ 4, 5.1.3.

[18] Tier III standard applies to marine diesel engines that are installed on ships constructed on or after Jan. 1, 2016 and operate within ECAs. NO_x emission from such ships shall be under 3.4 g/kWh when the rated engine speed is less than 130 rpm; under $9\times n^{(-0.2)}$ with "n" being the rated engine speed is between 130 rpm and 2,000 rpm; under 2.0 g/kWh when the rated engine speed is above 2,000. MARPOL Annex VI, *supra* note 5, Regulation 13, ¶¶ 5.1.1, 5.1.2.

[19] *IMO Marine Environment Protection Committee 65th Session Pushes Forward with Energy-Efficiency Implementation*, INT'L MAR. ORG. NEWS BRIEFS (May 21, 2013), http://www.imo.org/MediaCentre/PressBriefings/Pages/18-MEPC65ENDS.aspx.

2016 deadline for Tier III NO_x requirement for marine diesel engines installed on new ships constructed on or after January 1, 2016, and accept the proposed delay until 2021 for engines installed on large yachts, viz. ships that are of less than 500 gross tonnage and 24 meters or more in length.[20]

Annex VI affords ratifying states with broad authority in enforcement. But such authority is qualified when the violation is caused by non-availability of low-sulfur fuels that are in compliance with MARPOL standards. To ensure compliance by ships, regardless of their country of registry, port states shall use "all appropriate and practicable measures of detection and environmental monitoring," including inspection and bringing proceedings.[21] Port states "shall [also] take all reasonable steps" to provide low-sulfur fuel at ports and terminals in their jurisdictions.[22] If a ship furnishes evidence, primarily through documentation, of good faith attempts to secure compliant fuel yet no such fuel is available,[23] the port state shall consider "not taking control measures."[24] Importantly, Annex VI explicitly provides that no deviation or delay of voyage should be required in order to achieve compliance.[25]

The United States ratified Annex VI in 2008 [26] and implemented the mandatory air emission standards domestically

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[20] IMO, REPORT OF THE MARINE ENVIRONMENT PROTECTION COMMITTEE ON ITS SIXTY-SIX SESSION MEPC 66/21, 36 (2014), *available at* http://www.uscg.mil/imo/mepc/docs/MEPC66-report.pdf.

[21] MARPOL Annex VI, *supra* note 5, Regulation 11, ¶¶ 1, 2, 4.

[22] *Id.* Regulation 18, ¶ 1.

[23] *Id.* ¶¶ 2.11, 2.12.

[24] *Id.* ¶¶ 2.3, 2.5.

[25] *Id.* ¶ 2.2.

[26] Int'l Mar. Org. [IMO], *Status of Multilateral Conventions and Instruments in Respect of Which the International Maritime Organization or Its Secretary-General Performs Depositary or Other Functions* (2015), *available at* http://www.imo.org/About/Conventions/StatusOfConventions/Documents/Status%20-%202015.pdf. Seventy five countries have ratified MARPOL Annex VI. *Status of Conventions*, INT'L MAR. ORG., http://www.imo.org/About/Conventions/StatusOfConventions/Pages/Default.aspx (accessed by clicking on the "excel chart listing ratifications by State"). Ratifying parties "shall co-operate" in enforcement of the provisions of this Annex. MARPOL Annex VI, *supra* note 5, Regulation 11, §1.

through amendments made in 2008 to the APPS[27] and the Clean Air Act.[28] Currently, two ECAs have been established covering virtually all U.S. coastlines. The North American ECA came into force on August 1, 2012, extending up to 200 nautical miles from the Pacific coast, the Atlantic coast, the Gulf coast, and the eight Hawaiian Islands.[29] The United States Caribbean Sea ECA, covering coastal waters around Puerto Rico and the U.S. Virgin Islands, was approved by the IMO in 2011 and became enforceable starting January 1, 2014.[30] Emissions of SO_x, NO_x, and PM are all regulated in both ECAs.

B. Enforcement Measures of MARPOL Annex VI on Foreign Flagged Vessels Operating in U.S. Waters

MARPOL Annex VI affords no differentiated treatment of foreign flagged vessels and U.S. flagged vessels.[31] The APPS provides that Annex VI applies to all foreign flagged vessels "in" or bound for "a port, shipyard, offshore terminal, or the internal waters of the United States."[32]

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27 33 U.S.C. §§ 1901-1915.

28 Clean Air Act, 42 U.S.C. §§ 7401-7431 (2006).

29 IMO, *North American Emission Control Area,* Resolution MEPC. 190(60) (Mar. 26, 2010); OFFICE OF TRANSPORTATION AND AIR QUALITY, U.S. ENVIRONMENTAL PROTECTION AGENCY, EPA-420-F-10-015, DESIGNATION OF NORTH AMERICAN EMISSION CONTROL AREA TO REDUCE EMISSIONS FROM SHIPS (2010), available at http://www.epa.gov/otaq/regs/nonroad/marine/ci/420f10015.pdf.

30 IMO, *Designation of the United States Caribbean Sea Emission Control Area and Exemption of Certain Ships Operation in the North American Emission Control Area and the United States Caribbean Sea Emission Control Area under Regulations 13 and 14 and Appendix VII of MARPOL Annex VI*, Resolution MEPC.202(62) (July 15, 2011); OFFICE OF TRANSPORTATION AND AIR QUALITY, U.S. ENVIRONMENTAL PROTECTION AGENCY, EPA-420-F-11-024, DESIGNATION OF EMISSION CONTROL AREA TO REDUCE EMISSIONS FROM SHIPS IN THE U.S. CARIBBEAN (2011)

31 International Convention for the Prevention of Pollution from Ships (MARPOL), Art. 5(4) (with respect to the ship of non-parties to the convention, parties shall apply the requirements of the present convention as may be necessary to ensure that no more favorable treatment is given to such ships).

32 33 U.S.C. § 1902 (5)(A), (B).

Civil penalties would be imposed for failure to provide documentation to prove compliance with Annex VI and each day of non-compliance would be considered a separate violation.[33] For non-compliant vessels, the U.S. EPA requires a corrective action plan signed by the ship owner or operator, and would report the non-compliance to the ship's country of registry.[34] A class D felony is committed if a ship owner or operator "knowingly violates" Annex VI.[35] Up to one half of the criminal fines may be paid to the "person giving information leading to conviction."[36] The U.S. Coast Guard is responsible for conducting ship inspections to verify compliance and investigations to establish criminal liability.[37]

1. Enforcement of Regulation 14 for SO_x and PM emissions. - To comply with Regulation 14, ships must use low-sulfur fuel,[38] be eligible for exemptions,[39] or use "equivalents."[40] Because the price

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[33] 33 U.S.C. § 1908 (2008); OFFICE OF COMMERCIAL VESSEL COMPLIANCE (CG-CVC), U.S. COAST GUARD, ECA JOB AID: DOMESTIC & FOREIGN VESSELS (2012).

[34] OFFICE OF COMMERCIAL VESSEL COMPLIANCE (CG-CVC), U.S. COAST GUARD, ECA JOB AID: DOMESTIC & FOREIGN VESSELS (2012).

[35] 33 U.S.C. § 1908, (a) (2008).

[36] *Id.*

[37] Memorandum of Understanding Between United States Coast Guard and United States Environmental Protection Agency Regarding Enforcement of Annex VI as Implemented by the Act to Prevent Pollution from Ships, June 27, 2011, available at http://www2.epa.gov/sites/production/files/documents/annexvi-mou062711.pdf (last visited Feb. 15, 2015).

[38] Regulation 14 of Annex VI specifies that ships operating within an Emission Control Area shall use fuel oil with sulfur content lower than 1.00% m/m on and after July 1, 2010, and lower than 0.10% m/m/ on and after January 1, 2015. MARPOL Annex VI, *supra* note 5, Regulation 14, ¶ 4. The term "low-sulfur fuel" in this paper is used broadly to include low-sulfur residual fuel, marine diesel oil, and marine gas oil. *See* Nikopoulou et al., *supra* note 9, at 141.

[39] Regulation 3 of Annex VI provides that ships on trial for emission control technology research could be exempted from certain Annex VI provisions if compliance would impede the technology development. MARPOL Annex VI, *supra* note 5, Regulation 3, ¶ 2. *See, e.g.*, Anna Lee Deal, *Liquefied Natural Gas as a Marine Fuel: A closer look at TOTE's Containership Projects* 12 (Nat'l Energy Policy Inst. Working Paper, May 7, 2013), *available at* http://www.glmri.org/downloads/lngMisc/NEPI%20LNG%20as%20a%20Marine%20Fuel%205-7-13.pdf (TOTE obtained a waiver from the EPA and Coast Guard allowing the company to operate its ships using distillate fuels above

of low-sulfur fuels is much higher than that of standard fuels,[41] a common practice to achieve compliance without splurging on cleaner fuel is to flush the fuel piping systems and fill the settling tanks with low-sulfur fuel only when approaching an ECA.[42] But fuel switching is less straightforward than it seems. Changing fuels when the fuel temperature is still very high causes loss of engine power.[43] Hence, vessels need to slow down when switching fuels to avoid malfunction.[44] Additionally, because the low viscosity of low-sulfur fuel[45] and the incompatibility of fuels[46] when mixed harms diesel

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regulative limit within the ECA during the conversion of these ships to liquefied natural gas so as to provide savings for the expensive environmental project).

[40] MARPOL Annex VI, *supra* note 5, Regulation 4, ¶ 1.

[41] *See* THEO NOTTEBOOM ET AL., ANALYSIS OF THE CONSEQUENCES OF LOW SULFUR FUEL REQUIREMENTS 16 (2010), *available at* www.schone scheepvaart.nl/downloads/rapporten/doc_1361790123.pdf.

[42] *See* DET NORSKE VERITAS (DNV), MARPOL 73/78 ANNEX VI REGULATIONS FOR THE PREVENTION OF AIR POLLUTION FROM SHIPS: TECHNICAL AND OPERATIONAL IMPLICATIONS 17 (2009), *available at* www.dnv.com/binaries/marpol%20brochure_tcm4-383718.pdf; Chengfeng Wang et al., *Cost-Effectiveness of Reducing Sulfur Emissions from Ships*, 41 (24) ENV'T SCI. TECH. 8233, 8234 (2007), *available at* http://pubs.acs.org/doi/abs/ 10.1021/es070812w (switching from high-sulfur marine fuels with a sulfur content of 2.7%, the worldwide average, to low-sulfur marine fuels with sulfur content not exceeding 1.5% can reduce about 44% of SO_2 emissions).

[43] DET NORSKE VERITAS (DNV), *supra* note 42.

[44] AMERICAN BUREAU OF SHIPPING, FUEL SWITCHING ADVISORY NOTICE 17 (2010), *available at* http://www.eagle.org/eagleExternal PortalWEB/ShowProperty/BEA%20Repository/References/ABS%20Advisories/ FuelSwitchingAdvisory (operational manual for fuel switching and training for staff is necessary).

[45] Main operational problems caused by the low viscosity of low-sulfur fuel are the reduced effectiveness of the fuel as a lubricant, loss of capacity in fuel supply and circulation pumps, and increased chances of leakage of fuel through the fuel pump barrel and plunger, and suction and spill valve push rods, and less energy generated per volume of fuel. AMERICAN BUREAU OF SHIPPING, FUEL SWITCHING ADVISORY NOTICE 9, 10(2010).

[46] Incompatibility between different fuels would result in excessive sedimentation, sludging, and separator and filter problems. Hence, an additional set of fuel supply systems may be necessary. DET NORSKE VERITAS (DNV), *supra* note 42.

engines and boilers, modifications to the fuel system are often necessary.[47]

Annex VI encourages technological innovation by affording flexibilities in achieving compliance. Under Regulation 4, port states can allow "any fitting, material, appliance or apparatus . . . or other procedures, alternative fuel oils, or compliance methods" so long as such alternatives are as effective in terms of emission reductions as the measures provided by Annex VI.[48] If obtaining low-sulfur fuel is difficult, installing desulfurization units to achieve compliance is also technically feasible and permissible under MARPOL Annex VI.[49] But the high cost of such exhaust gas cleaning systems make this alternative unattractive.[50] Even if the cost of a desulfurization unit itself is justified, its installment would probably require re-designing the fuel system due to the limited space in the engine room, and therefore lead to additional investments in vessel retrofitting.[51] Another rapidly developing technology,[52] because of the heightened environmental standards driven by MARPOL Annex VI, is using

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47 *See* AMERICAN BUREAU OF SHIPPING, FUEL SWITCHING ADVISORY NOTICE 11-14 (2010) (modifications that may be needed include installing separate purifier and piping system for the low-sulfur fuels, additional fuel coolers if the vessel operates in summer and tropical conditions, special fuel injection pumps); DET NORSKE VERITAS (DNV), *supra* note 42 (ship owners may consider upgrading the capacity of diesel tanks, or installing an additional set of service and settling tanks for low sulfur fuels).

48 MARPOL Annex VI, *supra* note 5, Regulation 4, ¶ 1.

49 AMERICAN BUREAU OF SHIPPING, FUEL SWITCHING ADVISORY NOTICE 7 (2010); DET NORSKE VERITAS (DNV), MARPOL 73/78 ANNEX VI REGULATIONS FOR THE PREVENTION OF AIR POLLUTION FROM SHIPS: TECHNICAL AND OPERATIONAL IMPLICATIONS 16 (2009) (exhaust gas cleaning alternatives will also reduce PM emissions); *see* Chengfeng Wang et al., *supra* note 42, at 8234.

50 DET NORSKE VERITAS (DNV), *supra* note 49 (further technological developments or legislation are needed to lower the installation costs of a desulfurization unit, which is about $1 million (USD) to $2 million (USD), to make this alternative cost-beneficial).

51 *See* AMERICAN BUREAU OF SHIPPING, FUEL SWITCHING ADVISORY NOTICE 12 (2010); DET NORSKE VERITAS (DNV), *supra* note 49, at 17-18.

52 *See*, *e.g.*, Bridget C. Brett, Potential Market for LNG-Fueled Marine Vessels in the United States 34 (June 2008) (Master's thesis, Massachusetts Institute of Technology), *available at* http://dspace.mit.edu/handle/1721.1/44920#files-area (the four main manufactures who have the technology for LNG-fueled vessels are Rolls-Royce, GE, Wärtsilä, and MAN Diesel).

Liquefied Natural Gas (LNG) as a marine fuel.[53] The cost-effectiveness of conversion to LNG varies from vessel to vessel, and is affected, primarily, by three factors: (1) the amount of time the vessel operates in an ECA; (2) LNG tanker size relative to the vessel size; and (3) LNG fuel availability.[54]

However, Regulation 4 leaves the gap of identifying "equivalents," i.e., alternative compliant measures, to the port states to fill in through bilateral negotiations. Currently, the United States requires foreign port states to submit to the U.S. Coast Guard proposals of equivalents for compliance.[55] The United States is seeking IMO's coordination in identifying equivalents[56] to minimize the need for enforcement actions if the U.S. Government disagrees with the equivalents approved by other port states.[57] Absent IMO's

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[53] Natural gas is a type of fossil fuel consisting mainly of methane (CH_4). *Id.* Gaseous Natural gas transforms into liquid, called Liquefied Natural Gas (LNG), when the natural gas is cooled to -162 Celsius degrees. LNG creates the economics of scale by saving 99% of the space that natural gas with the same energy content in gaseous form would take. *Id.* at 15-16. NLG is considered the cleanest form of fuel because it contains no sulfur and thus all SO_x emissions and most PM emissions are eliminated. Because LNG burns at lower temperatures than standard fuels, NO_x emissions are also reduced significantly. Johansson, *supra* note 8. The use of LNG as marine fuel became economically attractive when natural gas became cheaper than residual oil in early 2006. Nikopoulou et al., *supra* note 9, at 143. But the cost of LNG-fueled systems is generally 12% higher than the capital investment for a standard diesel engine. Bridget C. Brett, *supra* note 52, at 57.

[54] Anna Lee Deal, *supra* note 39, at 12 (LNG facilities are being planned for Cameron Parish and Port Fourchon in Los Angeles, along the Mississippi River, and in the Great Lakes region).

[55] U.S. DEP'T OF HOMELAND SEC., 16711/CG-CVC Policy Letter, GUIDELINES FOR COMPLIANCE AND ENFORCEMENT OF THE EMISSION CONTROL AREAS ESTABLISHED WITHIN THE UNITED STATES JURISDICTION AS DESIGNATED IN MARPOL ANNEX VI REGULATION 14 (2012), § 5b(ii).

[56] *See* Letter from Jeffrey G. Lantz, Dir., Commercial Regulations and Standards, U.S. Coast Guard, and Margo Tsirigotis Oge, Dir., Office of Transp. and Air Quality, U.S. Envtl. Prot. Agency, to Koji Sekimizu, Secretary-General of Int'l Mar. Org. (Mar. 12, 2012), *available at* http://www.epa.gov/otaq/regs/nonroad/marine/ci/letter-epa-and-uscg-to-imo.pdf.

[57] U.S. DEP'T OF HOMELAND SEC., 16711/CG-CVC Policy Letter, GUIDELINES FOR COMPLIANCE AND ENFORCEMENT OF THE EMISSION CONTROL AREAS ESTABLISHED WITHIN THE UNITED STATES JURISDICTION AS DESIGNATED IN MARPOL ANNEX VI REGULATION 14 (2012), § 5b(ii).

intervention, countries such as the United States, which are enforcing Annex VI in advance of the other countries, might have to act as the *de facto* global administrator of Annex VI.

The Bunker Delivery Note, where the quality and quantity of fuel oil supplied to vessels for combustion purposes is documented,[58] serves as the main evidentiary source for verifying compliance with Regulation 14. If the sulfur content of fuel oil exceeds Annex VI limits,[59] and no exemption or equivalents apply, the ship owner should provide documentation to prove that best efforts were made to procure compliant fuel oil and notify the EPA of the non-availability of such fuel oil before entering the ECA.[60] Taking together the regulative requirements and available technologies, owners of ships registered in countries where Annex VI is not fully enforced or no equivalents under Regulation 4 are formally established would probably have no choice but to change voyage plans, with the *hope*[61] of avoiding criminal charges in the United States.

2. Enforcement of Regulation 13 for NOx emissions. - The reduction of NOx emissions is a function of multiple factors, including: engine design, engine age, fuel type, operational mode, energy efficiency,[62] and any add-on emission reduction equipment.[63]

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58 MARPOL Annex VI, *supra* note 5, Regulation 18, ¶ 6.

59 *Id.* Regulation 14, ¶ 4.

60 U.S. ENVTL. PROT. AGENCY, INTERIM GUIDANCE ON THE NON-AVAILABILITY OF COMPLIANT FUEL OIL FOR THE NORTH AMERICAN EMISSION CONTROL AREA (2012), 3-4; OFFICE OF COMMERCIAL VESSEL COMPLIANCE (CG-CVC), U.S. COAST GUARD, ECA JOB AID: DOMESTIC & FOREIGN VESSELS (2012), § 3.

61 Evidence of good-faith attempt to secure low-sulfur fuel as required by Annex VI is only relevant in EPA's determination of the appropriate administrative actions, but does not necessarily remove the possibility of finding criminal liability. *See* U.S. ENVTL. PROT. AGENCY, *supra* note 60, at 4-5.

62 NO_x emission is actually a side effect of engine designs that aim to enhance energy efficiency by maximizing the completeness of fuel combustion, *i.e.*, increasing the pressure and temperature of combustion process. PER KÅGESON, MARKET-BASED INSTRUMENTS FOR NO_X ABATEMENT IN THE BALTIC SEA 10 (2009), *available at* http://www.cleanshipping.org/download/2009_11_nox_report_baltic_sea.pdf (Air Pollution and Climate Series 24, the European Environmental Bureau and the European Federation for Transport and Environment).

To a certain extent, the level of compliance with the NOx emission standards of Annex VI reflects the sophistication of technological research and development in the shipbuilding industry.[64] The

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[63] *See* DAVID COOPER & TOMAS GUSTAFSSON, METHODOLOGY FOR CALCULATING EMISSIONS FROM SHIPS: 1. UPDATE OF EMISSION FACTORS 13-15 (2004). The technical issues involved in restricting engine design to minimize air emissions are complex not only because the engine design has to fit various ship configurations but also because of safety concerns as ships must be able to depend on their sources of power in tough weather conditions and navigational hazards. *See generally* Int'l Mar. Org. [IMO], *Supplementary Information to the Final Report of the Correspondence Group on Assessment of Technological Developments to Implement the Tier III NO_x Emission Standards under MARPOL Annex VI*, MEPC 65/INF. 10 (Feb. 8, 2013) (countries including the United States, Finland, Japan, Germany, Sweden, and the United Kingdom reviewing technology developments to achieve Tier III standards for NO_x emission that is to be in force in 2016).

[64] Several technically feasible means exist to achieve the relative standards for NO_x emission under Annex VI. For low-speed two-stroke engines, compliance can be achieved through replacing conventional fuel valves by low-NO_x slide valves. For other engines, compliance is achieved through more complex engine modifications, including miller cycling, which achieves a lower temperature in the combustion chamber without a loss in power output; direct water injection, which rebuilds the engine to enable fresh water being sprayed into the combustion air to remove NO_x from the exhaust gas; exhaust gas recirculation, where exhaust gases are filtered, cooled, and redirected into the engine to reduce the combustion temperature; selective catalytic reduction, a commercialized catalytic exhaust treatment system that is applicable to both new vessels and retrofit installations; humid air motor, which prevents NO_x formation during combustion by adding water vapor to the engine's combustion air; and low-NO_x engines, which employs techniques to control fuel injection, spray formation, and fuel-air mixture to reduce temperature throughout the combustion process. *See* KÅGESON, *supra* note 62, at 10-13 (Air Pollution and Climate Series 24, the European Environmental Bureau and the European Federation for Transport and Environment); Seita Akimoto et al., *Techniques for Low NO_x Combustion on Medium Speed Diesel Engine*, 2(1) BULLETIN OF THE MECH. ENG'G SCIENTIFIC J., 8 (2000), *available at* http://www.jime.jp/e/publication/ bulletin/english/pdf/mv28n012000p08.pdf; KÅGESON, *supra* note 62, at 10 (Air Pollution and Climate Series 24, the European Environmental Bureau and the European Federation for Transport and Environment). Tier I and II standards of Annex VI, Regulation 13 are achievable with relatively simple engine modifications. *See* Johansson, *supra* note 8, at 20 (some engine manufactures have already been producing Tier II compliant engines for the last decade). The international shipbuilding industry is more concerned with the compliance with the Tier III standards. *See* Int'l Mar. Org. [IMO], *Supplementary Information to the Final Report of the Correspondence Group on Assessment of Technological Developments to Implement the Tier III NO_x Emission Standards under MARPOL Annex VI*, MEPC 65/INF. 10 (Feb. 8, 2013). Currently, only three technologies could

primary evidentiary source for verifying compliance is the International Air Pollution Prevention Certificate,[65] which should be issued to individual engines based on emission tests on the engine manufacturer's test bed.[66] Therefore, although ship owners or operators seem to be the directly affected parties, the underlying rationale of Regulation 13 is to urge manufacturers to design vessels that meet higher emission standards by creating market demand from the ship owners and operators.

In 2010, the EPA published a rule to regulate NO_x emissions from new Category 3 engines with the same level of stringency as Annex VI, Regulation 13.[67] The EPA rule applies to Category 3 engines installed on U.S. vessels only.[68] The regulated parties are mainly the manufacturers of Category 3 marine diesel engines,[69] most of which are incorporated in Finland, Germany, and Japan.[70] The U.S. vessel manufacturing industry is affected only to the extent that domestic vessel manufacturers have to adapt vessel designs and manufacturing processes to the new engine designs.[71]

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meet Tier III standards: selective catalytic reduction, humid air motor, and liquefied natural gas engine. Jerzy Herdzik, *Emissions from Marine Engines Versus IMO Certification and Requirements of Tier 3*, 18 J. KONES POWERTRAIN & TRANS. 161, 165-66 (2011) (IMO's Tier III standards would require sharp increase in the development of new control systems adapted to the operation of compliant marine engines).

65 MARPOL Annex VI, *supra* note 5, Regulation 1, ¶ 1; MARPOL Regulation 13, ¶ 7.3; MARPOL Appendix I, Form of International Air Pollution Prevention (IAPP) Certificate (Regulation 8).

66 DET NORSKE VERITAS (DNV), *supra* note 49, at 9 (later onboard verification procedures are initially decided by the engine manufacturer).

67 Category 3 engines refer to compression-ignition engines at or above 30 liters per cylinder. *See* 40 C.F.R. § 94, 1042 (2010).

68 40 C.F.R. § 94.1 (b)(2). *See also* Bluewater Network v. EPA, 372 F.3d 404, 412-13 (D.C. Cir. 2004) (upholding the EPA's decision not to regulate Category 3 on foreign-flagged vessels because of particular deference to agency decision under the Clean Air Act).

69 U.S. ENVTL. PROT. AGENCY, REGULATORY IMPACT ANALYSIS: CONTROL OF EMISSION OF AIR POLLUTION FROM CATEGORY 3 MARINE DIESEL ENGINES (2009), pt. 1 at 5-6, pt. 8 at 3.

70 *Id.*

71 *Id.*

For foreign vessels, the NO_x emissions are instead controlled directly through implementing ECAs.[72] Hence, the compliance of foreign vessels with NO_x emission standards relies largely on whether their countries of registry have given effect to Annex VI through legislation. The U.S. EPA plays only a secondary role in the sense that it has no direct control over the upstream regulatory necessities, *viz.*, engine designs of the vessels that are registered and manufactured in foreign countries. As such, an "administrative vacuum" exists in enforcing Regulation 13 on foreign vessels.[73]

II. CHALLENGES OF ENFORCING ANNEX VI: AN UNEVEN GLOBAL REGULATIVE LANDSCAPE

In the United States, APPS sets a rather low threshold for finding criminal liability, risking the efficiency and economy of the administrative enforcement process. In most foreign countries that are major maritime trading partners with the United States, however, Annex VI has not been fully enforced. The disparity between the compliance environments at calling ports in different countries needs to be addressed to minimize the enforcement cost borne by the United States in implementing Annex VI.

A. "Knowing Violation" as the Legal Threshold for Finding Criminal Liability

The owner or other parties involved in a non-compliant foreign flagged vessel who "knowingly violates" MARPOL would be criminally charged.[74] But APPS provides no other language to substantiate the threshold of "knowing violation." The EPA guidelines indicate indirectly that criminal liability could be found if the ship has previously reported non-availability of compliant fuel oil, or if insufficient quantity of compliant fuel oil is obtained at U.S. ports even though the ship operator knows that the vessel will return

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72 40 C.F.R., Summary III, A.

73 *See generally* Snyder, *supra* note 4, at 1072-80 (criticizing EPA's Category 3 rule as inadequate for not extending to foreign vessels).

74 33 U.S.C. § 1908 (a) (2008).

to the ECA and complaint fuel oil is unavailable outside the ECA.[75] The EPA also refuses to consider the cost of compliant fuel oil as a relevant factor to establish "unavailability."[76]

Recent cases regarding enforcement of MARPOL on foreign vessels indicate that federal courts are unlikely to limit finding criminal liability, especially when the violation is caused by an affirmative action, as opposed to omissions. In *United States v. Pena*, the court confirmed the conviction of a surveyor of an institute organized in Florida for failing to conduct the required survey under MARPOL Annex I of a Panamanian-flagged vessel.[77] The court found "knowing violation" was established when the non-compliant performance of the ship had been in place for months and the defendant surveyor did not test the parts of the ship that he knew were not functional.[78]

MARPOL Annex I was enforced in a more aggressive manner in *United States v. Sanford Ltd.*[79] Defendant Sanford is a fishing company incorporated in New Zealand and transports cargo to U.S ports on a regular basis. Sanford was charged, *inter alia*, for not recording discharges of oily bilge water in the vessel's Oil Record Book (ORB), even though such omission occurred in the high seas before entering U.S. water and would not necessarily result in criminal liability under the MARPOL enforcement regulations in New Zealand.[80] The court upheld the conviction on two grounds. First, although finding APPS does not intend to apply extraterritorially, the court reasoned that the triggering point of the violation is "at the moment a vessel enters a U.S. port with an

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75 *See* U.S. ENVTL. PROT. AGENCY, INTERIM GUIDANCE ON THE NON-AVAILABILITY OF COMPLIANT FUEL OIL FOR THE NORTH AMERICAN EMISSION CONTROL AREA (2012), at 8.

76 *Id.* at 5.

77 United States v. Pena, 684 F.3d 1137, 1143-44 (11th Cir. 2012), *cert. denied*, 2013 U.S. LEXIS 573 (2013) (upholding U.S. jurisdiction over foreign flagged vessels).

78 *Pena*, 684 F.3d, 1152-53.

79 United States v. Sanford Ltd., 880 F. Supp. 2d 9, 11 (D.C. 2012) (finding that the law-of-the-flag doctrine does not bar the U.S. Government from prosecuting defendants for their violations of MARPOL implemented by the Act to Prevent Pollution from Ships).

80 *Id.* at 12.

inaccurate ORB" rather than when the omission occurred.[81] Second, the court held that the defense of being subjected unfairly to the peculiar rules of a foreign sovereign does not prevail when the U.S. and foreign regulations for implementing MARPOL are "on their face . . . functionally identical."[82] However, the court narrowed this holding to cases where the regulations of the United States and the foreign country are unlikely to be in conflict.[83] The court noted implicitly that a "balancing of the delicate and important interests of comity and sovereignty" might be needed in some cases.[84]

In a similar case, *United States v. Ionia Mgmt. S.A.*,[85] defendant Ionia, incorporated in Liberia and headquartered in Greece, was convicted for making false entries in the ORB to conceal illegal discharges of oily wastewater and obstructing a federal investigation. The court upheld the order of forty-eight months of probation, a corrective ship management plan, and a fine of $4.9 million (USD).[86] The court held that the amount of the criminal fine, although not calculated based on the sentencing guidelines, was nevertheless reasonable given the culpability of the violation.[87] The sentencing was enforced through several hearings during the subsequent three years.[88]

B. Enforcement of Annex VI Outside the United States: China as an Example

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81 *Id.* at 14-15.

82 *Id.* at 21-23 (finding the discrepancies as to the interpretation of "machinery space" insufficient to support a finding of material difference between the U.S. and New Zealand regulations).

83 *Sanford Ltd.*, 880 F. Supp. 2d, 22.

84 *Id.*

85 United States v. Ionia Mgmt. S.A., 555 F.3d 303, 305 (2d Cir. 2009).

86 *Id.* at 310.

87 *Id.*

88 *See* United States v. Ionia Mgmt. S.A., No. 3:07-CR-134 (JBA), 2011 WL 5304117 (D. Conn. Nov. 1, 2011); United States v. Ionia Mgmt. S.A., No. 3:07-CR-134 (JBA), 2011 U.S. Dist. LEXIS 126089 (D. Conn. Oct. 28, 2011); United States v. Ionia Mgmt. S.A., No. 3:07-CR-134 (JBA), 2011 U.S. Dist. LEXIS 87122 (D. Conn. Aug. 3, 2011); United States v. Ionia Mgmt. S.A., No. 3:07-CR-134 (JBA), 2011 U.S. Dist. LEXIS 12996 (C. Conn. Feb. 9, 2011); United States v. Ionia Mgmt. S.A., No. 3:07-CR-134 (JBA), 2010 U.S. Dist. LEXIS 109063 (D. Conn. Oct. 11, 2010); United States v. Ionia Mgmt. S.A., No. 3:07-CR-134(JBA), 2009 WL 3074727 (D. Conn. Sept. 22, 2009).

The benefits of implementing Annex VI will be fully realized only when both U.S. and foreign vessels *actually* operate under the same environmental standards.[89] Not all countries, however, perceive air emissions from marine vessels as a significant pollution source as the United States does.[90] A review of regulations and policies on air pollution control in China, an example of one of the largest waterborne trading partners with the United States,[91] shows that such foreign countries are unlikely to enact legislation in the near term to implement Annex VI as stringently as the United States.

China has not enacted particular laws or regulations to implement Annex VI,[92] and will not do so, at least, until after 2015.

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89 *See* U.S. ENVTL. PROT. AGENCY, *supra* note 69, pt. 6 at 1.

90 Although the prioritization of sectors targeted in a country's air pollution control strategy is not always "objective," numbers do found a persuasive basis. In the United States, the transport sector contributes to about 54% of total NO_x emissions. ANDREW AULISI ET AL., GREENHOUSE GAS EMISSIONS TRADING IN U.S. STATES: OBSERVATIONS AND LESSONS FROM THE OZONE TRANSPORT COMMISSION (OTC) NO_X BUDGET PROGRAM 3 (Margaret B. Yamashita ed., World Resources Institute, 2005), *available at* http://www.wri.org/sites/default/files/pdf/nox_ghg.pdf (estimation based on inventory data released in EPA reports reviewing the performance of OTC NO_x Budget Program); *see also The 2011 National Emissions Inventory*, U.S. ENVTL. PROT. AGENCY (last updated on Dec. 24, 2013), http://www.epa.gov/ttn/chief/net/2011 inventory.html (emission sources from transport sector contributes about 62% to the total NO_x emissions from fuel combustion, gas stations, industrial processes, and road and non-road mobile sources). In other countries, the transport sector may contribute less to the total air pollutant emission by percentage than that in the United States due to the differences in industrial structure. In China, for example, the transport sector contributes only about 9% to the total NO_x emissions in 2005. J. Xing et al., *Projections of Air Pollutant Emissions and Its Impacts on Regional Air Quality in China in 2020*, 11 ATMOSPHERIC CHEMISTRY AND PHYSICS 3119, 3129 (2011), *available at* http://www.atmos-chem-phys.net/11/3119/2011/acp-11-3119-2011.html. The major source of NO_x emissions is instead power plants. *Id.* at 3128.

91 The waterborne container trade between China and the United States was at 29,477,025 TEUs in 2012. U.S. Dep't of Transp., U.S. Waterborne Foreign Container Trade by Trading Partners (Sept 26, 2013), http://www.marad.dot.gov/library_landing_page/data_and_statistics/Data_and_Statistics.htm (last visited Oct. 21, 2013).

92 China ratified MARPOL Annex VI in 2010. *Status of Conventions*, INT'L MAR. ORG., http://www.imo.org/About/Conventions/StatusOfConventions/Pages/Default.aspx (last updated Sept. 30, 2012). Ratifying parties "shall co-operate" in enforcement the provisions of this Annex. MARPOL Annex VI, *supra* note 5, Regulation 11, ¶1.

Only a set of quasi-regulative rules promulgated by the Ministry of Transport in 2010 requires that ships should hold certificates issued by the Marine Administration in accordance with international treaties that the Chinese government entered into or ratified.[93] However, this 2010 rule does not make reference to MARPOL Annex VI or specify what certificates the ships should hold.[94] Provisions of the 2010 rule are so generally stated that its on-the-ground enforcement cannot be realized until the adoption of more specific regulations or plans.[95]

Moreover, the approach employed by Chinese policies is rather different from the MARPOL approach to control air emission from waterborne transport. Once the numbers of national emission caps and energy saving objectives are established[96] for every five-year planning period,[97] the air pollution control policies for different sectors and sub-sectors are essentially allocations of the national goal.[98] Hence, air emissions from the marine transport sector are

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[93] Zhonghua renming gongheguo chuanbo jiqi youguan zuoye huodong wuran haiyang huanjing fangzhi guanli guiding (中华人民共和国船舶及其有关作业活动污染海洋环境防治管理规定) [Management Provisions on Preventing Pollution of Marine Environment from Ships and Related Activities of the People's Republic of China] (promulgated by the Ministry of Transport, Oct. 8, 2010, effective Feb. 1, 2011), art. 1, 5, http://www.gov.cn/flfg/2010-12/02/content _1758149.htm (last visited Feb. 15, 2015).

[94] *Id.*

[95] *See* Nengye Liu & Frank Maes, *Prevention of Vessel-Source Marine Pollution: A Note on the Challenges and Prospects for Chinese Practice under International Law*, 42 OCEAN DEV. & INT'L LAW 356, 358-59 (2011), *available at* http://www.tandfonline.com/doi/abs/10.1080/00908320.2011.619373 -.Usf9sRr8U5s.

[96] *See* Guowuyuan guanyu yingfa shi'erwu jieneng jianpai zonghexing gongzuo fang'an de tongzhi (国务院关于印发"十二五"节能减排综合性工作方案的通知) [State Council's Notification on Promulgating the Integrated Work Plan for Energy Saving and Emission Reduction for the Twelfth Five Year] (promulgated by the State Council Aug. 31, 2011, No. 26), *available at* http://www.gov.cn/zwgk/2011-09/07/content_1941731.htm.

[97] *See The First Ten Five-Year Plans of the People's Republic of China*, THE CENTRAL PEOPLE'S GOV'T OF THE PEOPLE'S REPUBLIC OF CHINA (Mar. 20, 2006), http://www.gov.cn/test/ 2006-03/20/content_231421.htm.

[98] *See* Andrew C. Mertha, *China's "Soft" Centralization: Shipfting Tiao/Kuai Authority Relations*, 184 CHINA QUARTERLY 791, 796-800 (2005), *available at* http://falcon.arts. cornell.edu/am847/pdf/Soft%20Centralization%20Final.pdf; *see also* Chenggang Xu, *The Fundamental Institutions of China's Reforms and Development*,

regulated based on the total amount of emissions for specified pollutants and reduction in energy consumption, rather than prescribing standards for marine fuels and diesel engines as MARPOL Annex VI does.[99] Currently, China is in the twelfth five-year planning period, which runs from 2011 until 2015.[100] The Twelfth Five-Year Plan for Energy Saving and Emission Reduction, one of the master national policies for this planning period, sets a target of reducing energy consumption of vessels for marine and inland waterway transportation by 10% to 6.29 kilograms of coal equivalent per ton of goods per 1,000 kilometers by 2015.[101]

49(4) J. ECON. LITERATURE 1076, 1082-84, 1086-92 (2011), *available at* www.sef.hku.hk/~cgxu/04_Xu.pdf (the functioning of Chinese government is not a mixture of de facto federal state and a centralized regime: regional decentralization exists as to economic governance, while other political and policy decision-making processes follows closer to an authoritarian regime).

[99] *See* Jiakuai tuijin luse xunhuan ditan jiaotong yunshu fazhan zhidao yijian (加快推进绿色循环低碳交通运输发展指导意见) [Guiding Principles on Promoting Green Low-Carbon Transport Development] (promulgated by the Ministry of Transport, No. 323, May 22, 2013) (*"Guiding principles (zhidao yijian)" are less rigid policies than "Opinions (yijian)."*), *available at* Ministry of Transport website: http://www.moc.gov.cn/2006/jiaotongjj/07jiaotjnw/wenjiangg/201305/t20130527_1417741.html;(2013年运输行业节能减排工作要点) [Key Tasks for Energy Saving and Emission Reduction in 2013 in Transport Sector] (promulgated by the Ministry of Transport, No. 37, Jan. 10, 2013), *available at* http://www.moc.gov.cn/2006/jiaotongjj/07jiaotjnw/wenjiangg/201301/t20130118_1356606.html; Gonglu shuilu jiaotong yunshu jieneng jianpai shi'erwu guihua (公路水路交通运输节能减排"十二五"规划) [The Twelfth Five-Year Plan for Energy Saving and Emission Reduction in Road and Water Transportation] (promulgated by the Ministry of Transport, July 8, 2011), *available at* http://www.moc.gov.cn/zhuzhan/zhengcejiedu/guihuajiedu/shierwuguihuaJD/xiangguanzhengcefagui/201110/t20111010_1064457.html.

[100] *See* Guomin jingji he shehui fazhan di shierge wunian guihua gangyao (国民经济和社会发展第十二个五年规划纲要) [The Outline of the Twelfth Five-Year Plan for Social and Economic Development] (promulgated by the State Council, Mar. 16, 2011), *available at* http://www.gov.cn/2011lh/content_1825838_2.htm.

[101] Jieneng jianpai shi'erwu guihua (节能减排"十二五"规划) [The Twelfth Five-Year Plan for Energy Saving and Emission Reduction] (promulgated by the State Council, No. 40, Aug. 6, 2012), Table 1, *available at* http://www.gov.cn/gongbao/content/2012/content_2217291.htm (last visited Oct. 22, 2013).

Subsequently, the Ministry of Transport (MoT) announced in the sector's leading policy[102] that building green ports would be a major task during the twelfth five-year planning period. This "green port" policy trickles down to retrofitting port infrastructures to use alternative powers in place of diesel fuel, including upgrading rubber-tired gantry to use electricity instead of fuel,[103] scaling up the use of shorepower and solar power at ports, and establishing automatic management systems to monitor energy consumption on vessels.[104] Government funding for such projects generally shall be no more than ¥10 million (RMB), according to the Temporary Management Measures for Special Funding for Energy Saving and Emission Reduction Projects in the Transport Sector issued jointly by the MOT and the Ministry of Finance.[105]

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[102] Gonglu shuilu jiaotong yunshu jieneng jianpai shi'erwu guihua (公路水路交通运输节能减排"十二五"规划) [The Twelfth Five-Year Plan for Energy Saving and Emission Reduction in Road and Water Transportation] (promulgated by the Ministry of Transport, July 8, 2011), section 4, sub-section 7, *available at* http://www.moc.gov.cn/zhuzhan/zhengcejiedu/guihuajiedu/shierwuguihuaJD/xiangguanzhengcefagui/201110/t20111010_1064457.html (last visited Oct 22, 2013)

[103] Rubber-tiered gantry (RTG), also called transtainer, is a mobile gantry crane used for stacking containers at container terminals. Diesel rubber-tired gantry (RTG) can represent a large percentage of a port's total fuel consumption. Electricity-powered RTGs offer a promising alternative in face of the increasing price of diesel fuel and more stringent ambient air standards. The cost of converting a diesel RTG to an electric cable reel connected one is approximately $250,000. The effectiveness of such fuel-to-electricity conversion depends primarily on the availability of electrical infrastructures connecting to the port, the remaining service life of the RTG, and how much the RTG is used. ELEC. POWER RESEARCH INST., ELECTRIC CABLE REEL RUBBER-TIRED GANTRY CRANES: COSTS AND BENEFITS 1, 4 (2010), *available at* http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001020646.

[104] *Id.*

[105] Jiaotong yunshu jieneng jianpai zhuanxiang zijin guanli zhanxing banfa (交通运输节能减排专项资金管理暂行办法) [Temporary Management Measures for Special Funding for Energy Saving and Emission Reduction Projects in the Transport Sector] (issued by the Ministry of Finance and Ministry of Transport, No. 374, June 20, 2011), chapter 2, art. 7, *available at* http://jjs.mof.gov.cn/zhengwuxinxi/tongzhigonggao/201107/t20110704_570700.html.

Recently, the Chinese government heightened the sulfur content standard for marine fuel oils. Under the new standard, the maximum sulfur content of fuel oils shall be 3.5% m/m,[106] which comports with Regulation 14 of Annex VI for ships operating outside ECAs.[107] Thus, even if all ships registered in China use fuel oils with less than 3.5% m/m sulfur content, many of them would still fail the U.S. standard since virtually all U.S. waters are in ECAs, where the sulfur content of fuel oils should be less than 1.00% m/m starting from July 1, 2010[108] and 0.10% m/m starting from 2015.[109]

The above review of policies and regulations shows that marine vessels have not moved to the top of the air-cleaning agenda of the Chinese government.[110] Any further legislation or policymaking to give effect to the terms of MARPOL Annex VI in China would probably only take place during the next planning period at the earliest, *viz.*, after 2015. Given this timing, China would have to implement the most stringent emission standards provided in Regulation 13 and 14 by the implementation schedule specified in Annex VI to be comparable with U.S. standards.[111]

C. Deficiencies of the Current Enforcement Mechanism

1. Deficiencies on a global scale. - A compliance environment that exposes foreign ships with rotating crews, trading at different ports where the stringency of a treaty is approached differently, poses

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106 Chuanyong ranliaoyou (船用燃料油) [Marine Fuel Oil Standard] (issued by the General Administration of Quality Supervision, Inspection and Quarantine, Standardization Administration, GB/T 17411-2012, July 1, 2013).

107 MARPOL Annex VI, *supra* note 5, Regulation 14, ¶1.2.

108 *Id.* ¶ 4.2.

109 *Id.* ¶ 4.3.

110 *See also* Qiang Zhang et al., *Cleaning China's Air*, 484 NATURE 161, 161-62 (2012) (curbing emissions from power plants and coal consumption in general remains the priority for tackling air emission for China given the country's continued rapid economic growth, even though tremendous governmental efforts have been made to raise the operational standards for coal-fired power plants).

111 Recall that starting from January 1, 2015, the sulfur content of fuel oil used on board ships shall be less than 0.10% m/m and Tier III standard for NO_x emission would start to apply in ECAs for engines installed on ships that are constructed on or after January 1, 2016. MARPOL Regulation 13, ¶ 5.1.2; MARPOL Regulation 14, ¶ 4.3. Again, MARPOL needs to be cited to earlier (see earlier notes) or if this is MARPOL VI it needs to be cited as such.

a daunting management challenge.[112] The uneven enforcement landscape for MARPOL Annex VI is the quintessence of a "prisoner's dilemma" situation [113] for which international environmental conventions that are not self-executing are often criticized.[114] If ratifying countries do not take enforcement measures of similar stringency,[115] some countries could obtain economic

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[112] *See, e.g.*, Claudia Copeland, *Cruise Ship Pollution: Background, Laws and Regulations, and Key Issues*, CONGRESSIONAL RESEARCH SERVICE, 26 (2010), http://www. eoearth.org/view/article/51dac6ac5948612528000716/ (the General Accounting Office found that the process for referring cruise ship violations to other countries does not appear to be working and recommended that the IMO encourage member countries to respond when pollution cases are referred to them).

[113] The Prisoner's Dilemma was initially developed by Merrill Flood and Melvin Dresher in 2950, later named by A.W. Tucker. Paul W. Grimm & Heather Leigh Williams, *The Judicial Beatings Will Continue Until Moral Improves: The Prisoner's Dilemma of Cooperative Discovery and Proposals for Improved Morale*, 43 U. BALT. L.F. 107, 108-09 (2013) [hereinafter Grimm & Williams, Judicial Beatings] (citing to Robert Axelrod's book "The Evolution of Cooperation"). The Prisoner's Dilemma is one of the models in the game theory trying to explain how self-interested, rational individuals interact in a collective decision-making process. MARTIN J. OSBORNE & ARIEL RUBINSTEIN, A COURSE IN GAME THEORY 15-18 (1994). It involves a scenario where two prisoners, retained separately under interrogation, must decide whether to keep silent or to confess. Grimm & Williams, Judicial Beatings, 43 U. BALT. L.F. 107, 108 (2013). Under the theoretical model of Prisoner's Dilemma, the rationality exercised by individuals for their best interests, instead of leading to a scenario where all individuals' interests are maximized, instead tends to lead to inefficient resource allocation, suboptimal environmental standards, and hence harms the overall welfare of the group of individuals. *See* Kirsten H. Engle, *State Environmental Standard-Setting: Is There a "Race" and Is It "To the Bottom"?* 48 HASTINGS L.J. 271, 275-76 (1997).

[114] *See* ROSS A. KLEIN, *GETTING A GRIP ON CRUISE SHIP POLLUTION*, FRIENDS OF THE EARTH, 17-28 (2009), http://www.foe.org/sites/default/files/CruiseShipReport_Klein.pdf (criticizing MARPOL for not being self-executing resulting in its low on-the-ground effectiveness); John Charles Kunich, *Fiddling Around While the Hotspots Burn Out*, 14 GEO. INT'L ENVTL. L. REV. 179, 191 (2001) (the Convention on Biological Diversity is another example where the Convention carries no real consequences for those ratifying countries which take no action, such as domestic legislation, to enforce the terms of this international agreement).

[115] *See* Robert W. Hahn & Kenneth R. Richards, *The Internationalization of Environmental Regulation*, 30 HARV. INT'L L.J. 421, 429 (1989) (country has incentive to develop a competitive advantage in industrial production by enjoying the benefits of the other countries' environmental protection activities, while taking limited action at home country).

advantages by holding to more relaxed environmental standards intentionally.[116] This "race to the bottom" phenomenon, or "reluctance to move to the top" phenomenon, in response to regulations on maritime safety and pollution has already been observed in the international shipping industry.[117] Therefore, if land-based transport routes are available to replace certain sections of marine transport routes, the business interests of U.S. ports would likely be adversely affected by the heightened environmental standards, which often implicate increased operational cost for shipping.[118]

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[116] *See* Peter P. Swire, *The Race to Laxity and the Race to Undesirability: Explaining Failures in Competition Among Jurisdictions in Environmental Law*, 14 YALE L. & POL'Y REV. 67, 80-82 (1996) (states respond to the interstate competition for industry by lowering regulatory standards forming a "race to the bottom" phenomenon, which might be remedied by promulgating federal laws); *but see* Karen Palmer et al., *Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm*, 9(4) J. ECON. PERSP. 119, 129-30 (1995) (arguing generally that no clear evidence to establish the conclusion that higher environmental regulation in the United States has a large adverse effect on economic competitiveness on U.S. firms, especially considering that the stringency of U.S. environmental regulations is actually similar to that of European regulations).

[117] Alan Khee-Jin Tan, VESSEL-SOURCE MARINE POLLUTION: THE LAW AND POLITICS OF INTERNATIONAL REGULATION 7 (James Crawford & John S. Bell eds., 1st ed. 2006) (whenever any actor in the shipping industry tries to maintain safety and pollution prevention standards, he is faced with the prospect of losing business to cheaper standards; as a result, the proliferation of new rules and regulations confers a competitive advantage on sub-standard operators). But the other countries disadvantaged by the "race to the bottom" might push legislation to raise the environmental standard globally, when their firms already developed or have the capacity to develop the advanced manufacturing technologies to achieve such higher standards, to turn themselves back to the leadership in the industry. *See* RIMA MICKEVICIENE, THE ECONOMIC GEOGRAPHY OF GLOBALIZATION 202, 216 (Piotr Pachura eds. 1st ed. 2011) (a large part of technical innovations in the shipbuilding industry has to be presented in relation to the goal of reducing exhaust gas emissions).

[118] *See* Erin Tanimura, *Pacific Merchant II's Dormant Commerce Clause Ruling: Expanding State Control over Commerce Through Environmental Regulation*, 47 U.C. DAVIS L. REV. 419, 421-26 (2013) (arguing that the court's ruling in favor of California's more stringent air emission standards on ships would disadvantage business and commercial interests as these standards would increase the operational cost by $30,000 (USD) per call); Harilaos N. Psaraftis & Christos A. Kontovas, *Balancing the Economic and Environmental Performance of Marine Transportation*, TRANSPORTATION RESEARCH PART D 15, 458, 459 (2010) (a side-effect of

Theoretically, the threat of civil penalties and criminal punishment would induce the shipping industry, and eventually the shipbuilding manufacturing industry, to modify their practice as a whole to internalize the business externalities, *viz*., the environmental and health impacts caused by air emissions from marine vessels.[119] But before reaching that point, the industries have to first internalize the increased shipping costs due to delays in voyages to obtain compliant fuels,[120] or otherwise face possible civil penalties. The industry tends to respond by using cost-saving measures that usually require less capital investment than new engine designs or ship retrofitting.[121] Generally speaking, under the pressure of both the higher environmental standards and continued preference of cheaper carriers from powerful clients such as oil companies,[122] ship owners would choose to register their international vessels in countries where MARPOL is implemented much less seriously,[123] even though no differentiated treatment based on flag state is afforded officially,[124] hire cheaper and usually ill-trained seafarers who are more likely to cause environmental violations, and demand standard quality ships to

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requiring speed reduction, a way to reduce ship emissions, in short but sometimes deep sea shipping may induce a shift to more environmentally intrusive land-based transport modes).

119 See Stephen J. Darmody, *The Oil Pollution Act's Criminal Penalties: On a Collision Course with the Law of the Sea*, 21 B.C. ENVTL. AFF. L. REV. 89, 118-21 (1993).

120 *See infra* text accompanying notes 127-34.

121 *See generally* Nikopoulou et al., *supra* note 9, at 145 (for a Selective Catalytic Reduction system for NOx control, a 2.7 years of payback period is required for 100% return on investment; for a Humid Air Motor system for NOx control, a 3.8 years of payback period is needed for a 51% return on investment for a new ship, and a 4.2 years of payback period is needed for a 37% return on investment for retrofitting).

122 KHEE-JIN TAN, *supra* note 117, at 40 (the volatile freight rates during the past few decades have caused oil companies to count for the cheapest available rate at any time, and therefore tend to favor sub-standard operators).

123 *See generally* DEP'T OF TRANSP., COMPARISON OF U.S. AND FOREIGN-FLAG OPERATING COSTS 68-69 (2011), *available at* http://www.marad.dot.gov/documents/Comparison_of_US_and_Foreign_Flag_Operating_Costs.pdf (the higher environmental costs when operating in the United States is one main reason accounting for the higher operational costs incurred by U.S. flagged vessels than foreign-flagged vessels).

124 *See* 33 U.S.C. § 1902 (5)(A), (B) (2008).

be delivered at the lowest price possible.[125] In response, shipbuilders often use cheaper materials, rendering ships more vulnerable.[126]

For different reasons, including the limited time and resources of administrative agencies to undertake thorough inspections or bring prosecutions, or simply "good luck,"[127] the number of vessels that operate in full contravention with MARPOL remains "unacceptably high," both in the United States[128] and internationally.[129] Apparently, some vessels are still able to continue business as usual by taking the risk of being caught then implementing those cost-saving measures discussed above.[130] Arguably, one reason for the large number of violations could be that the punishment is not severe enough to carry a sufficient deference effect. However, given the precedents of imposing a criminal fine in the millions of dollars,[131] a more plausible inference should be that the MARPOL standards have not operated in synergy with the economics of the maritime transport sector.[132] In fact, this lack-of-

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125 KHEE-JIN TAN, *supra* note 117, at 6.

126 *Id.*

127 *See* ROSS A. KLEIN, *supra* note 114 (many reports of MARPOL violation have come from citizen observations and therefore detection of violations could be missed, unless the cruise ship staff and the company for which they work report voluntarily); Jeanne M. Grasso & Gregory F. Linsin, *United States: Current Trends in MARPOL Enforcement – Higher Fines, More Jail Time, The Banning of Ships, and Whistleblowers Galore*, MONDAQ (Oct. 7, 2011), http://www.mondaq.com/unitedstates/x/148086/Marine+Shipping/Current+Trends+In+MARPOL+Enforcement+Higher+Fines+More+Jail+Time+The+Banning+Of+Ships+And+Whistleblowers+Galore (more than 50% of the MARPOL cases in recent years stem from whistleblowers making reports to the Coast Guard). But the number of whistleblowers for Annex VI violations might decrease as it would be rather difficult to detect excessive air emission with naked eyes.

128 David P. Keho, *United States v. Abrogar: Did the Third Circuit Miss the Boat?* 39 ENVTL. L. 1, 41 (2009).

129 ORG. FOR ECON. CO-OPERATION AND DEV. (OECD), COST SAVINGS STEMMING FROM NON-COMPLIANCE WITH INTERNATIONAL ENVIRONMENTAL REGULATIONS IN THE MARITIME SECTOR 47 (2003).

130 *See generally id.* at 4 (about 5,000 to 7,500 substandard commercial vessels are engaged in international trade).

131 *Ionia*, 555 F.3d at 310 (imposing a fine of $4.9 million (USD)).

132 This inference should not be simply rephrased as "the compliance cost is too high." Virtually no regulated party would ever gratefully applaud the reasonableness or inexpensiveness of compliance measures. The meaning of "synergy" can be understood from two perspectives: monetary cost and the

synergy could well be the reason for IMO to finally consider and agree with delaying the implementation of Tier III standards for NO_x emission for five years. The industry is frustrated with this expensive "green storm."[133] More incentives in the enforcement regime for compliance with MARPOL seem to be needed.[134]

prevalence of technologies to achieve compliance in the regulated industry. Of course, the rare availability of necessary technologies that can be commercialized in the market is accountable for the high monetary cost. *See* THEO NOTTEBOOM ET AL., *supra* note 41, at 70-71 (concluding based on analysis of European shipping industry that Annex VI requirements may be quite costly for the shipping industry, driving up the cost by 25.5% to 40% depending on the specific type of low-sulfur fuel used).

133 Remarks of Christopher Koch, President & CEO of the World Shipping Council, World Trade Association of Philadelphia 2 (Nov. 8, 2013), *available at* http://www.worldshipping.org/public-statements/CLK_Philadelphia_Speech__November_8_2013.pdf (criticizing MARPOL Annex VI as "the single most expensive environmental regulation the shipping industry has ever faced").

134 *See* KHEE-JIN TAN, *supra* note 117, at 17 (MARPOL is far from really working).

2. Deficiencies viewed from the perspective of foreign flagged vessels. - One chief concern has been the non-availability of low-sulfur fuels since IMO's adoption of Annex VI. In the final working group report to IMO Marine Environment Protection Committee (MEPC) at the 57th session meeting in 2008, the International Petroleum Industry Environmental Conservation Association[135] cautioned that the oil industry did not expect marine fuels at 0.10% and 0.50% sulfur content would be available to all regions by desired dates of 2015 and 2020, respectively.[136]

The availability of low-sulfur fuel under the scenario of full compliance with MARPOL Annex VI is too complex an issue to be generalized by a "yes" or "no" conclusion.[137] The prediction of availability depends on the combination of multiple factors including the enforcement area, fuel price, cargo load, volume of pre-purchased fuels under the contracts between vessel operators and fuel suppliers, projected capacity of refineries, shipping route, number of suppliers at specific ports, and the type of fuel used.[138] Although some

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135 The Int'l Petroleum Industry Envtl. Conservation Ass'n (IPIECA) is the global oil and gas industry association for environmental and social issues veering over half of the world's oil production, formed in 1974 following the launch of the United Nations Environment Program. IPIECA is the industry's principal channel of communication with the United Nations. *About Us*, IPIECA: THE GLOBAL OIL AND GAS INDUSTRY ASSOCIATION FOR ENVIRONMENTAL AND SOCIAL ISSUES (2013), http://www.ipieca.org/about-us.

136 *See* IMO, *Prevention of Air Pollution from Ships: Report of the Working Group on Annex VI and the NO_x Technical Code*, MEPC 57th Session Agenda Item 4, MEPC 57/WP.7 (Apr. 4, 2008); *see also* MARPOL Annex VI Revision Signals New Low-Emissions Era, Annex VI Special Report (May 19, 2008), *available at* http://www.bunkerworld.com/news/magazine.download?magazine_item_id=120 (Linda K. Wright, Global Director at ExxonMobil Marine Fuels, warned at the 29th International Bunker Conference held in April 2008 that there is no guarantee that sufficient low-sulfur fuel will be available and the oil industry's misgivings about the significant refinery investment cost associated with producing more low-sulfur fuels).

137 *See* TETRA TECH, LOW-SULFUR FUEL AVAILABILITY STUDY 2-3, 11 (2008), http://www.portoflosangeles.org/DOC/REPORT_Fuel_Availability_Study_Final_041408.pdf.

138 *See id.* at 53-60, 62-67, 76; MICHELLE KOMLENIC ET AL., EVALUATION OF THE AVAILABILITY OF LOW SULFUR MARINE DISTILLATE FUEL FOR OCEAN-GOING VESSELS THAT VISIT CALIFORNIA 9-12 (2008), *available at* http://www.arb.ca.gov/regact/2008/fuelogv08/ appffuel.pdf.

estimation findings are more optimistic than others, the common conclusion is that low-sulfur fuel (less than 0.5% m/m sulfur content) shortages exist mainly in Central and South America and Asia, especially in China,[139] Japan, and Korea.[140]

Ideally, port states should exercise their responsibilities under Annex VI to formally establish equivalents, such as add-on exhaust cleaning systems to reduce air emissions, which vessels shall use in case of non-availability of low-sulfur fuels.[141] Absent such formal recognition of alternative compliance measures, the solution to avoid regulative penalties would be to store up compliant fuels at ports along the voyage when compliant fuel is available. However, for foreign flagged ships which are registered in countries where low-sulfur fuel is likely to be unavailable and do not have predictable schedules to visit U.S. ports, they seem to have little incentive to purchase more low-sulfur fuel than what is necessary to sail out of the ECA.[142] When such vessels decide to visit U.S. ports again, they may have to change planned voyages to buy low-sulfur fuel since the compliant fuel is unlikely to be readily available at their departing terminals.[143] Otherwise, they would likely face criminal charges for a "knowing violation" in the United States.[144]

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[139] *Low-Sulfur Marine Fuel in the Pipeline*, CHINA DAILY (Sept. 4, 2010, 10:56 AM), http://www.chinadaily.com.cn/business/2012-09/04/content_15731857.htm (PetroChina planned to expand its provision of low-sulfur bunker to Yangshan port near Shanghai to satisfy increased demand).

[140] *See* TETRA TECH, *supra* note 137, at 68-72; DET NORSKE VERITAS (DNV), *supra* note 49, at 15 (highly uncertain as to whether the availability of low sulfur fuel will be adequate in worldwide ports); KOMLENIC ET AL., *supra* note 138, at 57; Starcrest Consulting Grp., Evaluation of Low Sulfur Marine Fuel Availability – Pacific Rim 3 (2005), *available at* http://webcache.googleuser content.com/search?q=cache:E8b1JJZr3g4J:www.portoflosangeles.org/DOC/REPORT_Fuel_Study_Pacific_Rim_Exec_Sum.pdf+&cd=1&hl=en&ct=clnk&gl=us.

[141] MARPOL Annex VI, *supra* note 5, Regulation 4, ¶ 1.

[142] *See generally* Deal, *supra* note 41, at 4 (ECA compliant fuel, blend of marine distillates and ultra low sulfur diesel, is about 25% to 30% more expensive than the marine distillate fuel that is currently used in TOTE ships).

[143] *See id.* (there is currently not enough distillate fuel to meet global demand for the world's entire commercial fleet to switch from residual fuel oil to distillate fuel to meet fuel standards when operating in ECAs).

[144] *See supra* text companying notes 73-87.

Additionally, shipping companies have been using "slow-steaming," a technique that emerged along with the soaring fuel prices in 2002 and global environmental movement for greenhouse gas reduction, to reduce fuel cost.[145] Some voyages now take longer than they used to.[146] The increased expenditure on fuels to comply with Annex VI would only make this practice more prevalent, at least in the short term. As such, an enforcement regime that structures itself around the "panacea" of criminal liability,[147] coupled with issues associated with the availability of low-sulfur fuel and the cost-saving culture of the shipping industry, is likely to operate contrary to the intent of Annex VI of preserving the freedom of navigation on the high seas.[148]

3. Deficiencies viewed from the U.S. perspective. - Litigation arising from the enforcement of Annex VI on specific vessels has been silent except for suits against the creation of ECA.[149] Given that the memorandum between the EPA and the Coast Guard to enforce Annex VI was only signed in 2012,[150] current enforcement venue can

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145 *See* Remarks of Christopher Koch, *supra* note 133; RASMUS JORGENSON, SLOW STEAMING: THE FULL STORY, MAERSK 2, *available at* http://www.maersk.com/Innovation/WorkingWithInnovation/Documents/Slow%20Steaming%20-%20the%20full%20story.pdf.

146 *See* Ronald D. White, *Ocean Shipping Lines Cut Speed to Save Fuel Costs*, L.A. TIMES (July 31, 2010), http://articles.latimes.com/2010/jul/31/business/la-fi-slow-sailing-20100731 (some freighters were taking fifteen days to make a Pacific crossing that used to take eleven days).

147 *See* Keho, *supra* note 128, at 41 (the U.S. Department of Justice has used a two-pronged approach that involves the prosecution of both the corporate ship operators and chief engineers or other supervisory crew members as the best way of changing the non-compliance culture and increasing deterrence in the shipping industry); Darmody, *supra* note 119, at 143.

148 *See* MARPOL Annex VI, *supra* note 5, Regulation 18, ¶ 2.2 (no delay or change of planned voyages shall be required to achieve compliance).

149 *See* Alaska v. Kerry, No. 3:12-cv-00142-SLG, 2013 U.S. Dis. LEXIS 133687, at 21-100 (D. Alaska 2013) (State of Alaska sued the Secretary of States and the EPA for the designation of ECA under the APPs and the Administrative Procedure Act but the suit was dismissed by the court).

150 Memorandum of Understanding Between United States Coast Guard and United States Environmental Protection Agency Regarding Enforcement of Annex VI as Implemented by the Act to Prevent Pollution from Ships, June 27, 2011, *available at* http://www2.epa.gov/sites/production/files/documents/annexvi-mou062711.pdf (last visited Oct. 17, 2013).

be presumed to be primarily administrative.[151] But the effective administration of compliance by foreign flagged vessels, especially those registered in countries where Annex VI is not fully enforced and do not participate regularly in the U.S. commerce, is likely to become more difficult.

As the Annex VI enforcement scheme rolls out, incidents where "knowing violation" could be established are likely to increase, despite the deterrence effect of criminal charges. On the one hand, the number of foreign flagged vessels calling at U.S. ports is likely to increase continuously.[152] The total number of vessels of the top twenty-five flags of registry was 28,178 as of January 31, 2013, increased by 14% of the total in 2010.[153] This 14% increase comes almost entirely from countries and regions where no ECAs are designated.[154] On the other hand, the situation of low-sulfur fuel shortages and lack of regulation on engine designs is likely to continue due to some foreign countries' reluctance to adopt regulations to enforce Annex VI during the next few years.[155] Many vessels might still choose to keep their businesses as usual, especially if they do not spend much time in ECAs. Furthermore, "knowing violation" is a low threshold for finding criminal liability,[156]

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151 *See generally* KLEIN, *supra* note 114, at 17-28 (violations of MARPOL standards are largely revealed by reviewing of ship logs and reports from citizen observations; as such, a large number of violations may not be detected).

152 *See America's Ports: Gateways to Global Trade*, AMERICAN ASSOCIATION OF PORT AUTHORITIES (2013), http://www.aapa-ports.org/Industry/content.cfm?ItemNumber=1022 (by 2020, the total volume of cargo shipped by water is expected to be double that of 2001 volumes).

153 U.S. Dep't of Transp., *Top 25 Flag of Registry* (Sept 27, 2013), http://www.marad.dot.gov/library_landing_page/data_and_statistics/Data_and_Statistics.htm (last visited Oct. 21, 2013).

154 *Id.* These countries and regions include Liberia, Marshall Islands, Hong Kong, Singapore, Malta, China, Japan, Antigua and Barbuda, and Malaysia. *Id.*

155 *See supra* section III, C, 2.

156 *See* David M. Uhlmann, *Environmental Crime Comes of Age: The Evolution of Criminal Enforcement in the Environmental Regulatory Scheme*, 2009 UTAH L. REV. 1223, 1235 (2009) (numerous commentators criticized that the Congress had reduced the mental state requirement for environmental crime when it changed the "willfulness" standard to the "knowingly" standard, and the number of environmental criminal cases surged because of the adoption of this standard); see also Wesley D. Sherman, *The Economics of Enforcing Environmental Laws: A Case for*

considering the practical difficulties for some vessels to obtain means to achieve compliance. Courts have also been relaxing the standard of proof to establish the required mens rea in environmental crime cases.[157] Such a relaxed threshold for finding criminal liability expands prosecutorial discretion,[158] which could counterbalance the deterrence effect of these environmental laws.

To deter crimes, one fundamental economic theory is that the expected cost of punishments on the violators should exceed the gains from violation.[159] If p is the possibility of being criminally charged and M is the monetary loss incurred because of the criminal charge and eventual penalties, the expected cost of punishments is $p \times M$.[160] For vessel owners, the gain from a violation is primarily the avoided capital investment in the air emission control measures to maintain the operational cost at the pre-regulation level. If such capital investment is C, non-compliance seems to be more attractive economically if $C > p \times M$.

To enhance the deterrence effect, enforcement agencies could try to increase p, the possibility of a criminal charge. A major

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Limiting the Use of Criminal Sanctions, 23 J. LAND USE & ENVTL. LAW 87, 95, 104 (2007) (culpability should be established based on a higher level of *mens rea* than "knowing" violation considering that courts do not require the knowledge of the environmental law at issue, the seriousness of the penalties, and the complexity of the environmental laws).

157 *See* Darmody, *supra* note 119, at 122-26.

158 Uhlmann, *supra* note 156, at 1242.

159 Gary S. Becker, *Crime and Punishment: An Economic Approach*, 76(2) THE J. OF POLITICAL ECON. 169, 180 (1968).

160 This formula is adapted from Becker's proposal. In Becker's formula, the cost of punishments is the probability of conviction multiplied by costs to the offender. But deterrence should arguably take effect when an offender thinks of the possibility of being served by a court order. So the actual cost of punishments could be distorted since the actual conviction is also affected by many technicalities of the trial process, and tends to be smaller than the probability of being charged. These technicalities of the trial process might not play in the minds of offenders when they learn the charges through word of mouth and media exposure, and feel being deterred. Alternatively, the cost of punishment may be magnified if it is calculated based on the probability of detection, because the discretion of government agencies and whistleblowers tend to make the actual number of criminal proceedings brought against the offenders less than the number of detected violations.

implication is on agency budget because criminal convictions are generally more costly than agency adjudication.[161] Also, enforcing the implementation of corrective action plans, as in the *Ionia* case, could be lengthy.[162] If no additional budget is allocated, agencies might be left with wide prosecutorial discretion to decide whether to bring an enforcement proceeding.[163] Courts are generally deferential to prosecutor discretion[164] as it is a function of resource allocation, policy considerations, and the delegation of power from Congress to allow agencies to resolve the ambiguity of the statute.[165] However, even though foreign defendants are unlikely to prevail on claims challenging such agency discretion in prosecuting Annex VI violations, reputational criticisms from the public against such practices may emerge, ultimately compromising the integrity of the enforcement regime.

Alternatively, the severity of penalties could be raised through judicial discretion to increase the cost of punishment, $p \times M$. But, the shipping industry has been using a controversial arrangement called

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161 *See* Roger Bowles et al., *The Scope of Criminal Law and Criminal Sanctions: An Economic View and Policy Implications*, 35(3) J. OF LAW AND SOCIETY 389, 405, 415 (2008) (raising the probability of detection is costly); *see also* Wesley D. Sherman, *The Economics of Enforcing Environmental Laws: A Case for Limiting the Use of Criminal Sanctions*, 23 J. LAND USE & ENVTL. LAW 87, 95 (2007) (a criminal justice system is more costly than using administrative law to protect the environment).

162 *See* Sherman, *supra* note 161, at 85-88.

163 *See* David A. Barker, *Environmental Crimes, Prosecutorial Discretion, and the Civil/Criminal Line*, 88 VA. L. REV. 1387, 1405 (2002) (prosecutorial discretion became a concern when the Environmental Crimes Section of the Department of Justice refused to prosecute a substantial number of referrals from EPA and refused to consent to some prosecutions sought by local U.S. Attorneys); *see generally* Charles J. Babbitt et al., *Discretion and the Criminalization of Environmental Law*, 15 DUKE ENVTL. L. & POL'Y F. 1, 3-4 (2004) (environmental administrators and the prosecutors to whom they refer criminal cases together enjoy very broad prosecutorial discretion, limited primarily by the Constitution and the rules of prosecutorial ethics).

164 *See* United States v. Mendoza, 464 U.S. 154, 161-62 (1984) (holding non-mutual collateral estoppel does not apply to governmental litigant); *see also* United States v. Dotterweich, 320 U.S. 277, 285 (1943) ("the good sense of prosecutors, the wise guidance of trial judges, and the ultimate judgment of juries must be trusted").

165 *See* Richard J. Lazarus, *Meeting the Demands of Integration in the Evolution of Environmental Law: Reforming Environmental Criminal Law*, 83 GEO. L.J. 2407, 2453, 2456, 2460 (1995).

"one-ship" companies to limit their exposure to liability.[166] Under such arrangements, shipping carriers are shielded behind the corporate veil by organizing companies for the sole and explicit purpose of owning that ship.[167] The limited capital of such shell companies is likely to hinder the fulfillment of judgment, particularly concerning the payment of huge criminal fines. Moreover, unlike the compensation and penalty calculation in oil spill cases, the estimation of the economic harm to third parties caused by inhaling additional air pollutants such as SO_x and NO_x from a vessel tend to be more speculative, primarily because of the considerable lapse between exposure to air pollutants and actual formulation of diseases, numerous intervening causes, and the difficulties in measuring the scale of harmful level of exposure. Hence, non-monetary sanctions seem to be a more pragmatic redress to Annex VI violations.[168]

As to the capital investments by foreign vessels to achieve compliance, *C*, the EPA could play only a limited role except for trying to engage industries to provide sufficient low-sulfur fuels. Foreign manufacturers and buyers of ocean-going vessels[169] would have to decide together who should bear the up-front cost of advanced design[170] if the buyers intend that their ships meet Annex VI standards.[171] The buyers also need to take into account

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166 KHEE-JIN TAN, *supra* note 117, at 34-35.

167 *Id.*

168 *See* Roger Bowles et al., *The Scope of Criminal Law and Criminal Sanctions: An Economic View and Policy Implications*, 35(3) J.L. & SOC'Y 389, 405 (2008).

169 *See generally* MICKEVICIENE, *supra* note 117, at 207 (China has surpassed Japan in 2006 in ship building. South Korea, in 2009, became a main player in the global ship building industry, exporting ships to about 169 countries and regions, mainly to Asia and Europe).

170 *See generally* ALAN E. BRANCH, ELEMENTS OF SHIPPING 28 (8th ed. 2007) (in choosing the type of ship to be built, the ship-owner must consider the primary trade in which she is to operate, which governs the size and propelling machinery, and the cost and availability of fuel, the length and duration of voyages, minimum carrying capacity required, and other technical and statutory considerations); see also Nikopoulou et al., *supra* note 9, at 136, 147 (switching to LNG would increase shipbuilding costs by 20 to 25%).

171 *See* MICKEVICIENE, *supra* note 117, at 202, 214 (government subsidies and favorable loads, mandatory requirements on domestic ocean going ship buyers to order ships at domestic yards, and cheap labor are the main reasons for China's high-order book volumes).

technological developments and associated uncertainties[172] during the time lapse between the order and delivery.[173] In many countries, governments are extending generous credit facilities, subsidies, favorable tax treatment, and direct investment grants to maintain their national yards as competitive in the global market.[174] These financial instruments, at the discretion of foreign governments, could be powerful instruments to impose Annex VI compliance conditions. In contrast, the regulative authority of a U.S. government agency appears pale in these contract negotiations.

III. MAKING "ENDS" MEET

A. The Need for Market-Based Requirements

Previous discussions on the deficiencies of the Annex VI enforcement regime indicate that certain additional elements may be necessary to change the weights of the two sides of the formula. An option that is within the control of the EPA is to provide incentives, so that $C - I < p \times M$, where I is the monetary incentives obtained from participating in governmental programs.

Programs that are initiated by the government and industry leaders to provide incentives to induce wider voluntary compliance based on market-based principles, often referred to as Market-Based Mechanisms (MBMs), are not new in the United States.[175] MBMs

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172 *See* Frederick Adamchak & Amokeye Adede, LNG AS MARINE FUEL, 7 (Gas Technology Institute training materials, 2013) (one main problem with using LNG as marine fuel is the "chicken-and-egg" situation between ship owners. This is when developers for LNG fueling infrastructures and ports remain uncertain as to who would and should act first), *available at* http://www.gastechnology.org/ Training/Documents/LNG17-proceedings/7-1-Frederick _Adamchak.pdf.

173 World Shipping Council, *The Liner Shipping Industry and Carbon Emissions Policy*, 17 (2009) (ships are often ordered in a set of four to ten. Moreover, they are ordered three or more years in advance of delivery), *available at* http://www.worldshipping.org/pdf/liner_shipping_co2emissions_policy_september.pdf.

174 BRANCH, *supra* note 170, at 481.

175 *See generally* EPA CLEAN AIR MARKETS DIVISION, AN OVERVIEW OF THE REGIONAL CLEAN AIR INCENTIVES MARKET (RECLAIM) 1-2 (2006) (RECLAIM is the first trading program in the national created to reduce SO2 and

provide business operators means to reduce compliance costs as much as possible[176] while the industrial standard is under transition in response to regulative changes.[177] MBMs would also likely reduce the practical disparities for shipping companies when they operate worldwide, and eventually help overcome the political difficulties in bringing comparable environmental standards to all voyages' end destinations.

MBMs are most suitable when the emission standards can be achieved through alternative technologies and the cost of emission abatement differs widely among regulated sources.[178] Both of these conditions are present in the case of enforcing Annex VI. In addition to fuel-switching,[179] the industry has also identified several alternative technologies including selective catalytic reduction systems, humid air motor systems, seawater scrubbers, and using LNG-fueled vessels.[180]

NOx emissions in urban areas), *available at* www.epa.gov/airmarket/resource/docs/ reclaimoverview.pdf.

[176] *See* ROBERT N. STAVINS, EXPERIENCE WITH MARKET-BASED ENVIRONMENTAL POLICY INSTRUMENTS 2-3 (Karl-Göran Mäler et al. eds., 2001) (holding all firms to the same environmental target/standard can be expensive and sometimes counterproductive).

[177] *See* Mel Davies, *Emissions Trading for Ships – A European Perspective*, 118(3) NAVAL ENG'G J. 131, 132 (2006) (ship emission trading could offer a way of complying on short notice, as a transition mechanism in the face of increasingly stringent regulations on a range of emissions from ship. The cost and long service life of cargo vessels may render regulations that require drastic changes of industrial standards within few years impracticable); *See* World Shipping Council, *The Liner Shipping Industry and Carbon Emissions Policy*, 17 (2009) (a container ship capable of carrying 8,500 TEU's costs approximately $100 million (USD) and will be used for 20 to 25 years), *available at* http://www.worldshipping.org/pdf/ liner_shipping_carbon_emissions_policy_presentation.pdf.

[178] *See* James J. Corbett et al., AN EVALUATION OF PUBLIC-PRIVATE INCENTIVES TO REDUCE EMISSIONS FROM REGIONAL FERRIES: TECHNICAL MEMORANDUM TWO 14-15 (2004), *available at* http://policy.rutgers.edu/vtc/documents/ProgEval.FerryEmissions.pdf.

[179] *See generally* Theo Notteboom et al., ANALYSIS OF THE CONSEQUENCES OF LOW SULFUR FUEL REQUIREMENTS 2 (2010) (alternative fuels include low-sulfur fuel oil, marine gas oil, marine diesel oil), *available at* www.schone scheepvaart.nl/downloads/rapporten/doc_1361790123.pdf.

[180] Nikopoulou et al., *supra* note 9, at 141; see also ENNIO CODAN ET AL., IMO III EMISSION REGULATION: IMPACT ON THE TURBOCHARGING SYSTEM 2-3 (2010), *available at*

Studies show that depending on the vessel's conditions, the cost-effectiveness of the same technology varies. Generally, compliance by bigger vessels is less expensive than smaller vessels.[181] Compared with fuel switching, NO_x abatement technologies take longer to introduce because they usually take about ten years to be amortized, and hence, more risk-taking is involved in investment.[182] Vessels that approach the end of their service life[183] or those that spend a small portion of service time inside ECAs are likely to struggle the most under the current Annex VI enforcement scheme.[184] It has been reported that some shipping carriers have started passing the increased compliance cost on to customers.[185] The increased shipping price, an unintended effect of Annex VI, calls for the well-recognized flexibilities that MBMs could offer.[186]

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http://www05.abb.com/global/scot/scot267.nsf/veritydisplay/1abd7848c7849981852578110051bee0/$file/IMO%20III%20Emission%20Regulation.pdf.

181 KÅGESON, *supra* note 62, at 13.

182 *Id.*

183 *See* KÅGESON, *supra* note 62, at 26 (it is better for infrequent visitors or ships with few remaining years in operation to just pay for the costs of pollution); PER KÅGESON, ECONOMIC INSTRUMENTS FOR REDUCING SHIPPING EMISSIONS: A PILOT PROJECT FOR THE BALTIC SEA 10 (2006) (abatement of SO_x differs from that of NO_x because a shift to low sulfur fuel might still be cost effective even for ships that are approaching the end of their operation life), *available at* www.airclim.org/sites/default/files/ documents/apc24_0.pdf.

184 *See* Mel Davies, *Emissions Trading for Ships – A European Perspective*, 118(3) NAVAL ENG'G J. 131, 136 (2006).

185 *See* Jim Romeo, *New IMO Low-Sulfur Fuel Regulations Creating Challenges for Vessel Operator*, PROF'L MARINER (Nov. 8, 2012, 11:29 AM), http://www.professional mariner.com/December-January-2013/New-IMO-low-sulfur-fuel-regs-creating-challenges-for-vessel-operators/ (ZIM Integrated Shipping Services Ltd. said that it will implement a low-sulfur fuel charge of $20 (USD) per 20-foot equivalent unit for trade between North Europe/Mediterranean and all North American coasts in both directions); *see also* Michiel Vervloet, Emission Trading in the Shipping Industry: Where Goes/Is the Money? (Dec. 5, 2010) (unpublished Masters' thesis, Ghent University) (on file with University Library, Ghent University), at 11.

186 *See generally* T.H. Tietenberg, *Economic Instruments for Environmental Regulation*, 6(1) OXFORD REV. ECON. POL'Y 17, 18, 30 (1990) (because emissions trading allows the issue of who will pay for the pollution from who will install pollution control measures, it introduces additional flexibility).

B. Possible Market-Based Mechanisms (MBMs)

MBMs could be categorized broadly as emission charges or emission trading regimes.[187] Based on the "polluters pay" principal, emission charges could take the form of a tax, an abatement subsidy, or differentiated service fees.[188] Sweden pioneered differentiated fairway dues at ports to encourage reductions in NO_x and SO_2 emissions at ports since 1998.[189] Because all major ports participated in this program, adverse economic impacts, if any, on port businesses have not been evident.[190] Norway launched a NO_x tax, forming a funding pool, which provides grants to fund vessels to apply emission reduction technologies.[191] Without getting into details, two main concerns arise if a MBM is designed that voluntarily imposes additional dues based on the environmental performance of vessels. First, the program would risk diluting the force of Annex VI enforcement regime by shifting the focus on vessels to ports, weakening the regime's deterrence effects. Adequate levels of regulative pressure on foreign vessel owners should be maintained since they have to invest in emission control measures eventually. Second, viewed from ship owners' standpoint, the purpose of the environmental charges duplicates that of the civil penalties under APPS.

Therefore, this comment focuses on the other two main types of emission trading schemes: cap-and-trade and emission credit trading. This comment argues in favor of an emission credit trading mechanism based on a consumption-emission formula. This MBM

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187 *See* DAVID HARRISON ET AL., ECONOMIC INSTRUMENTS FOR REDUCING SHIPS EMISSIONS IN THE EUROPEAN UNION 1, 9, 29, 45, 66 (2005), *available at* http://ec.europa.eu/environment/air/pdf/task3_final.pdf; Tietenberg, *supra* note 186, at 18-21.

188 *See* JINHUA ZHAO, IRREVERSIBLE ABATEMENT INVESTMENT UNDER COST UNCERTAINTIES: TRADABLE EMISSION PERMITS AND EMISSIONS CHARGES 18 (2000), *available at* http://www.card.iastate.edu/publications/dbs/pdffiles/00wp252.pdf; *see also* Tietenberg, *supra* note 186, at 20-21.

189 HARRISON ET AL., *supra* note 187, at 45-46 (Germany, Finland, and the State of Alaska also have such environmental programs at their ports).

190 KÅGESON, *supra* note 62, at 16.

191 *Id.* at 34-35.

could be offered to the violator as a final leniency before the prosecutor brings a criminal proceeding.

1. Cap-and-Trade (Allowance Trading). - Under a cap-and-trade scheme, the regulatory body sets a figurative cap for total emission on the industry, and allocates emission allowances to participating companies, which are the existing pollution sources.[192] Companies may continue to emit pollution as permitted by the pollution amount prescribed by the allowances until the allowances expire. When the initial allowances run out, the companies are supposed to purchase un-used allowance from other companies, which manage to reduce emissions through improved technologies.[193] The government might auction off the allowances to the highest bidders or, in a corresponding amount to the polluter's historical emission data, free of charge.[194]

Studies on cap-and-trade programs indicate that vessels could potentially decrease a considerable amount of the cost on emission control technologies through participation in such programs.[195] For SO_2 emission reduction, a market-based approach that allows vessels in ECAs to either undertake fuel switching, install exhaust cleaning systems, or purchase SO_2 emission allowances from other vessels could save each vessel up to $63 million (USD), annually.[196]

One option is to create an emission cap based on geographical area. Under this scenario, a macro-level design issue is

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192 *See generally* EPA CLEAN AIR MARKETS DIVISION, AN OVERVIEW OF THE REGIONAL CLEAN AIR INCENTIVES MARKET (RECLAIM) 1-6 (2006); Tietenberg, *supra* note 186, at 18-20.

193 *Id.*

194 *See generally* Sergey Paltsev et al., ASSESSMENT OF U.S. CAP-AND-TRADE PROPOSALS 4-5 (2007) (the free distribution of allowances to upstream entities may create an inequitable outcome whereby the emission costs are passed on to downstream fuel users. Meanwhile, the revenue from auctioning permits could be directed to those who ultimately bear the cost of abatement), *available at* http://dspace.mit.edu/bitstream/handle/1721.1/38460/MITJPSPGC_Rpt146.pdf?sequence=1.

195 *See* Nikopoulou et al., *supra* note 9, at 151.

196 Wang et al., *supra* note 42, at 8233, 8235 (the estimation is based on analysis of U.S. foreign commerce ships traveling in European or U.S. West Coast ECAs).

whether emission trading between different sectors should be permitted. Some researchers' answer is an ambitious "yes."[197] As an initial matter, a sufficient number of participating entities are required to keep the allowance trading market active.[198] Permitting vessels to trade with land-based emission sources not only ensures the scale of the market, but also benefits the shipping industry substantially since abatement costs for shipping are lower than that for land-based installations in general.[199] However, an over-inclusive trading scheme might give more room for companies to buy allowances or use basic cost-saving measures rather than being induced to invest in green technologies.[200] To determine whether the participating vessels would become "lazy" under such a program, an in-depth analysis of the emission reduction capacities of different sectors, which operate under quite different environmental and technical standards, would be required.

Another option is to impose a cap on the shipping industry itself. A major concern about the cap-and-trade mechanism is its economic impact on the shipping industry as a whole.[201] Reliance on ocean shipping to transport goods internationally is expected to rise, because ocean shipping is already one of the most economically and environmentally efficient modes of long-distance transportation.[202]

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197 *See* KRISTINA HOLMGREN ET AL., GREENHOUSE GAS EMISSIONS TRADING FOR THE TRANSPORT SECTOR 69 (2006), *available at* http://www3.ivl.se/rapporter/pdf/B1703.pdf.

198 *See* EPA Clean Air Markets Division, AN OVERVIEW OF THE REGIONAL CLEAN AIR INCENTIVES MARKET (RECLAIM) 17-18 (2006) (RECLAIM is criticized for not being an actually active market with few entities participating in its trading actions).

199 HOLMGREN ET AL., *supra* note 197, at 69.

200 Richard Toshiyuki Drury et al., *Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy*, 9 DUKE ENVTL. L. & POL'Y F. 231, 275-85 (1999).

201 WORLD SHIPPING COUNCIL, THE LINER SHIPPING INDUSTRY AND CARBON EMISSIONS POLICY, 9-10 (2009), *available at* http://www.worldshipping.org/pdf/liner_shipping_carbon_emissions_policy_presentation.pdf.

202 WORLD SHIPPING COUNCIL, THE LINER SHIPPING INDUSTRY AND CARBON EMISSIONS POLICY, 9, (2009), *available at* http://www.worldshipping.org/pdf/liner_shipping_carbon_emissions_policy_presentation.pdf; *see also* KHEE-JIN TAN, *supra* note 117, at 7 (the biggest contributor to marine pollution is land-based sources and pollutions from ships contributes a relative small fraction of the overall marine pollution (12%)).

Posing emission caps on the shipping industry is likely to force the industry to eventually purchase allowance from other sectors where similar cap-and-trade mechanisms apply.[203] As such, a large amount of money would flow into other sectors that are not subject to the same air emission standards as the shipping industry.[204] The emission reduction in other sectors would be a proxy to verify the effectiveness of emission control measures in the shipping industry. The result would probably be an "open-ended" regime where the actual emission reduction becomes difficult to track.

Further, a cap-and-trade mechanism might not be effective in terms of engaging new polluters. Experience of the Acid Raid Program of SO_s trading shows that most of the trading under the Program has been internal, namely, acquiring excess allowances from within the company, rather than inter-regional or inter-company.[205] If a cap-and-trade mechanism were applied to the shipping industry, large international shipping companies, which are already leading the industry's emission reduction endeavors, would possibly prefer obtaining extra allowances internally to avoid delays and transaction costs. As a result, there might not be enough active allowances for trade with new ships.

2. Emission credit trading. - A more straightforward model is to focus on the difference in emissions between vessels, targeting the non-compliant vessels.[206] The emission credit trading mechanism would require the establishment of a baseline of different ship models in terms of the correlation between the power output and the amount of pollutant emission.[207] Alternatively, correlation could be

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[203] WORLD SHIPPING COUNCIL, THE LINER SHIPPING INDUSTRY AND CARBON EMISSIONS POLICY 9 (2009).

[204] *See also* IMO, *Review of MBMs: Consolidated Proposal of Efficiency Incentive Scheme (EIS) Based on the Leveraged Incentive Scheme (LIS) and the Vessel Efficiency Systems (VES), Submitted by Japan and the World Shipping Council*, GHG-WG 3/3/2 (Feb. 24, 2011), *available at* http://www. worldshipping.org/industry-issues/environment/air-emissions/Japan_-_WSC_Consolidated_Proposal__GHG-WG_3-3-2.pdf.

[205] Jonathan Remy Nash, *Too Much Market? Conflict between Tradable Pollution Allowances and the "Polluter Pays" Principals*, 24 HARV. ENVTL. L. REV. 465, 488-92 (2000).

[206] *See* Vervloet, *supra* note 185, at 33.

[207] *See* KÅGESON, *supra* note 62, at 24.

established between the energy efficiency index of a ship[208] or a modification of the index,[209] and the amount of pollutant emission for the determination of the baseline. Trading entities should be primarily vessels. The participation by ship manufacturers should be limited or even prohibited, because the estimation of emission amount would be too speculative before the vessel is put into operation.[210]

The amount of credits that a vessel obtains would be determined on the amount of deviation of the vessel's performance from this baseline. The most powerful credit generators are large vessels that operate in ECAs for their entire service time. The purchasers who would benefit most from this scheme would be vessels that spend a small portion of their time inside ECAs.[211] Non-compliant vessels could be offered to opt-in to this trading mechanism; or else criminal proceedings would likely be brought. This offer could also be made during the plea bargaining stage.[212] Such offer should be conditioned on the facts that render the immediate implementation of compliant measures not cost-effective, such as the fact that the vessel is approaching its service life. Although, such program design requires a large volume of record keeping, it is nevertheless necessary for conveying a clear message to the polluters: this offer in lieu of criminal proceeding is not a way

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208 *See* IMO, *Amendments to the Protocol of 1997 to Amend the International Convention for the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978 Relating Thereto (Inclusion of Regulations on Energy Efficiency for Ships in MARPOL Annex VI)*, Resolution MEPC.203(62) (July 15, 2011). The regulation requires ships to be certified based on an assessment of Energy Efficiency Design Index (EEDI) and all ships shall have Ship Energy Efficiency Management Plans. The EEDI is a non-prescriptive, performance-based mechanism that leaves the choice of technologies to the industry, as long as the required energy efficiency level provide in Regulations 20 and 21 is attained. The amendment came into force on January 1, 2013. *Id.*

209 *See* Vervloet, *supra* note 185 at 33-34.

210 *Id.*

211 *See* Mel Davies, *Emissions Trading for Ships – A European Perspective*, 118(3) NAVAL ENG'G J. 131, 136 (2006).

212 *See also* James B. Nelson, *Alternative Sentencing under the MARPOL Protocol: Using Polluters' Fines to Fund Environmental Restoration*, 10 HASTINGS W.-N. W.J. ENV. L. & POL'Y 1, 23-26 (2003) (advocating the use of alternative sentencing provisions to MARPOL prosecutions to provide funding for clean-up projects to correct the harm caused by the defendant's actions).

through which vessels could pay to pollute, but only a regulative mercy considering the violator's economic hardship.

Additionally, participating foreign-flagged vessels should be required to designate local agents for service of process.[213] An independent trans-governmental authority could be established to monitor and verify the quality of credits.[214] This entity could be financed through the civil penalties collected from the non-compliant ships.

C. General Considerations on MBMs

Ideally, the MBM should be built under a bilateral agreement between the United States and its major waterborne trade partners that have not enforced Annex VI in full, such as China. Although treaties and executive agreements are treated alike under international law, an executive agreement would be preferable from a U.S. point of view, because no advice and consent of the Senate would be required as long as the executive agreement does not contradict statutory provisions.[215] The EPA would have the authority to run this trading program under the 1990 Amendments of the Clean Air Act, which added Title IV, relating to controlling acid deposition including SO_x and NO_x.[216]

Manifestly, the influence of a governmental agency, acting on its own, is rather limited when its ultimate purpose is to induce domestic legislation in a foreign country. Therefore, the overall structure of a bilateral agreement would lay a stronger foundation for the subsequent agreements on the technical parameters of the MBM;

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213 *See* SOUTH COAST AIR QUALITY MGMT. DIST., OVER A DOZEN YEARS OF RECLAIM IMPLEMENTATION: KEY LESSONS LEARNED IN CALIFORNIA'S FIRST AIR POLLUTION CAP-AND-TRADE PROGRAM, Chapter 1, 8 (2007).

214 *See also* Richard E. Ayres, *Expanding the Use of Environmental Trading Programs into New Areas of Environmental Regulation*, 18 PACE ENVTL. L. REV. 87, 117 (2000).

215 *See* Kathryn C. Wilson, *The International Air Quality Management District: Is Emissions Trading the Innovative Solution to the Transboundary Pollution Problem?*, 30 TEX. INT'L L.J. 369, 384-85 (1995).

216 1990 Amendments to the Clean Air Act of 1970, Pub. L. No. 101-549, 104 Stat. 2399.

the discussion of which could be led by agencies in the respective countries. Further, high-level official negotiation is more likely to identify and define the necessary flexibilities to connect the priorities of the United States and targeted foreign countries in controlling air pollutions. Given the facilitation by national governments, as opposed to administrative agencies delegated with the authority to enforce Annex VI under national laws, companies are more likely to agree upon the qualifying emission reduction measures to meet the same emission standards under Annex VI.

Finally, two important technical components need to be agreed upon under the bilateral agreement. The first component to be established is the eligible equivalents.[217] A clear mutual understanding of equivalents would not only help keep the trading market active,[218] but also benefit the later monitoring and verification of emission credits during implementation. The second component to be clarified is the monitoring and reporting procedures. Safeguards need to be established to prevent fraud and missed reporting, and furthermore, to ensure information transparency.[219] When necessary, penalties should be imposed on repetitive violation of reporting rules.[220]

CONCLUSIONS

The current U.S. regulatory scheme to enforce Annex VI leaves an administrative vacuum in terms of ensuring foreign-flagged vessels' compliance when operating in U.S. waters. The conventional combination of civil penalties and criminal charges is challenged when the enforcement of international environmental law is achieved through an uneven worldwide regulatory landscape and depends

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217 *See* KÅGESON, *supra* note 62, at 18.

218 *See* Nikopoulou et al., *supra* note 9, at 149 (switching to 1% sulfur residuals, without other alternative compliance measures, has the major disadvantage in that it does not create cost efficient credits for trading in the emissions' markets).

219 *See* SOUTH COAST AIR QUALITY MGMT. DIST., OVER A DOZEN YEARS OF RECLAIM IMPLEMENTATION: KEY LESSONS LEARNED IN CALIFORNIA'S FIRST AIR POLLUTION CAP-AND-TRADE PROGRAM, Chapter 5, 1-3 (2007).

220 *Id.* at 9-10.

heavily on the technological developments in the private sector. This comment recommends an emission credit trading mechanism as a supplement to the current Annex VI enforcement regime. The credit trading mechanism would encourage firms, based on their superior knowledge about the market and effectiveness of various technological options, to find the best solution in response to the regulative requirements without compromising their valued commercial interests. If the establishment of a credit trading mechanism is initiated through high-level official dialogues, as recommended by this comment, the U.S. enforcement agencies would be afforded a proper platform to work with foreign agencies to establish compliance equivalents under Annex VI. MBMs, therefore, would serve an important role in making the current rigid enforcement regime more adaptive during the transition period where firms are yet to phase out substandard vessels and plan for investments in vessel designs that are far more environmentally friendly.