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Russian Floating Nuclear Reactors: Lacunae in Current International Environmental and Maritime Law and the Need for Proactive International Cooperation in the Development of Sustainable Energy Sources

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RUSSIAN FLOATING NUCLEAR REACTORS: LACUNAE IN CURRENT INTERNATIONAL ENVIRONMENTAL AND MARITIME LAW AND THE NEED FOR PROACTIVE INTERNATIONAL COOPERATION IN THE DEVELOPMENT OF SUSTAINABLE ENERGY SOURCES

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Abstract: During the second half of 2003, Russia announced plans to build barges carrying two nuclear reactors capable of supplying electricity to a town of fifty thousand people. Rapidly developing countries seem particularly interested in this proposal, as these reactors can meet their growing power needs. In addition, these floating nuclear reactors provide an alternative to coal, oil and natural gas, all sources of energy that contribute to global warming. These reactors, however, pose a substantial risk to the environment, particularly in light of Russia's lax environmental policies, and the design of the barges themselves make them susceptible to a wide variety of threats.

Currently there are no international legal regimes that would either prescribe enforceable standards for Russia regarding the design and operation of these reactors, or impose liability on Russia in the event of an accident and resulting damage to the environment. All of the relevant treaties administered by the International Atomic Energy Agency have gaps that preclude them from imposing regulatory duties or liability on Russia as a state, and its agents, in the event of an accident. Similarly, although both international customary environmental law and the United Nations Convention on the Law of the Sea impose upon nations the duty to prevent pollution of the marine environment, the ability to enforce those duties and impose legal liability for their breach remains in doubt. Therefore, the international community should either: 1) close the gaps in current legal regimes (including treaty-based and customary law regimes) 2); develop a new regime (either based on treaties, or through further development of customary international law) that would effectively regulate and impose liability for damage to the environment resulting from an accident involving these reactors; or 3) cooperate in developing and deploying safer alternative technologies to fulfill the need for power generation that these floating reactors address. Of these alternatives, the simplest is the closing of current gaps in treaties, although the most effective may be a combination of approaches that effectively utilizes the strengths of each alternative.

I. INTRODUCTION

In the second half of 2003 Russia announced plans to build small nuclear reactors mounted on barges that would be moored off of multiple

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countries in the Pacific Rim, including India,[1] China,[2] South Korea,[3] and Indonesia, [4] to provide power to coastal areas. More recently, Russia also expressed interest in cooperating with Libya to place a floating nuclear power plant off of the Libyan coast.[5] Although these proposed floating nuclear reactors may help to provide energy needed in developing countries, and an alternative to fossil fuel sources for that energy, they are not without substantial environmental risk. That risk is exacerbated by the limited or non-existent international legal regimes that would impose duties on Russia to regulate the operation of those barges in a manner that minimizes risks, and impose liability on Russia in the event of an accident. Therefore, as Russia moves to exploit this technology, the international community should take a proactive approach to ensure that the risks associated with these reactors are minimized.

The positive reception received by Russia's proposals in many countries demonstrates the emerging need for smaller power sources in developing areas that could be filled by small, portable nuclear reactors. Unlike older, land-based, stationary reactors that typically generate hundreds to thousands of megawatts of electricity,[6] enough power for a large city, these floating reactors would generate sixty megawatts of electricity, enough power for a town of fifty thousand people.[7] Due to their mobility, they could desalinate water or provide power to coastal towns and could be relocated to new areas as demand patterns shift.[8] Recent reports suggest that the first plant will be completed within the next three years.[9]

This Comment argues that the impending completion of the first floating nuclear reactor in Russia, and the risks that these floating nuclear

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[1] Vladimir Radyuhin, *Russia Offers India Floating N-Plants*, THE HINDU, Nov. 20, 2003, *available at* 2003 WL 66828375.

[2] *Russian Firms Close in on China Nuclear Power Plant Deal*, CHINA ENERGY REP. WKLY., Dec. 12, 2003, *available at* LEXIS, News Library.

[3] *Russia, South Korea Develop Cooperation in Nuclear Energy*, BBC MONITORING INT'L REP., Oct. 23, 2003, *available at* LEXIS, News Library.

[4] *Atomic Energy Ministry to Sign Framework Agt with Indonesia*, ITAR-TASS NEWS AGENCY, Aug. 25, 2003, *available at* LEXIS, News Library.

[5] *Russia Willing to Build Nuclear Power Plants in Libya*, BBC MONITORING INT'L REP., Dec. 23, 2003, *available at* LEXIS, News Library.

[6] As of March 2004 there were 440 nuclear reactors in operation globally, generating 361,696 megawatts of energy, averaging 820 megawatts per reactor. *See* World Nuclear Association, *World Nuclear Power Reactors 2002-04, and Uranium Requirements*, *available at* http://www.world-nuclear.org/info/reactors.htm (last visited May 21, 2004).

[7] Eduard Fesko, *Russian Floating Nuclear Reactors—Proliferation Risks*, June 24, 2003, *available at* http://cns.miis.edu/pubs/week/020624.htm (last visited May 21, 2004).

[8] *Id.*

[9] *Russia May Complete Floating Nuclear Power Plant in Three Years*, BBC MONITORING INT'L REP., Dec. 17, 2003, *available at* LEXIS, News Library.

reactors pose to the environment, requires immediate action to proactively shape Russia's construction and operation of these floating reactors in a manner that minimizes the risks to the environment. Part II discusses the emerging demand for energy in the Pacific Rim that may be partially met by these floating reactors, the impacts of relying on fossil fuels to meet the majority of this energy need, and alternative technologies that may be substituted for Russia's proposed floating nuclear reactors. Part III outlines the substantial risks to the environment associated with the Russian proposal. Part IV then demonstrates that the three most likely avenues to proactively address these risks—treaties and standards administered by the International Atomic Energy Agency, customary international law, and the environmental protection provisions of the United Nations Convention on the Law of the Sea—all have gaps that render them inapplicable to the safe construction and operation of these floating nuclear reactors. Finally, Part V suggests three possible avenues to effectively address the risks posed by these floating reactors: 1) modification of existing legal regimes; 2) creation of a new regime to address these unique risks; or 3) use of international cooperation and market-based incentives to substitute alternative technologies for the Russian proposal.

II. ENERGY CONSUMPTION IN THE PACIFIC RIM COUNTRIES WILL INCREASE DRAMATICALLY AS NATIONS INDUSTRIALIZE

The interests of India, China, Indonesia, and South Korea in the Russian proposal to use small, portable, nuclear reactors as a source of energy demonstrates the increasing demand of Pacific Rim nations for energy and electricity.[10] For example, China's domestic energy consumption is expected to triple in the next twenty-five years, largely due to an increase in home appliances such as air conditioners and refrigerators, and energy use associated with cooking and heating.[11] Other developing nations, particularly those poised for strong economic growth in the Pacific Rim, will see a similar growth in domestic electricity and energy consumption.[12]

Increasing coal, oil, and natural gas combustion are currently forecasted to be the most common fuel sources used to meet the majority of this demand, with coal being the most commonly utilized fuel in developing

[10] Energy consumption is forecasted to increase 58% globally between 2001 and 2025, with 40% of this increase accounted for by Asia alone. *See* Energy Information Administration, *International Energy Outlook 2003*, at 1, *available at* http://www.eia.doe.gov/oiaf/ieo/ (last visited May 21, 2004).

[11] *Id.* at 4.

[12] *Id.*

countries such as India and China.[13] Industrialized nations, in contrast, are expected to continue shifting away from coal to natural gas combustion.[14] In combination with increased fossil fuel consumption, Asian countries, including China, South Korea, and India, are projected to dramatically increase their nuclear capacity between 2001 and 2025.[15] Even with such an increase, however, nuclear power will still provide only a fraction of Asia's energy compared to fossil fuel combustion.[16]

Asia's projected reliance on fossil fuels has the potential to exacerbate global climate change, with the impacts of that change being focused on developing countries.[17] There is broad scientific consensus that combustion of fossil fuels, and its resulting emissions of greenhouse gases, is responsible for most of the warming of the climate observed over the last fifty years[18] and that this warming will continue,[19] with diverse impacts on both humans and the environment.[20] Impacts of climate change include increased damage to property due to floods, mudslides, landslides and avalanches, increased soil erosion, decreased crop yields, decreased water quality and quantity, increased risk of forest fires, increased risk of infectious disease, increased coastal erosion, and ecosystem impacts such as damage to coral reefs and mangroves.[21] Even though industrialized countries are responsible for the majority of past greenhouse emissions, the adverse impacts associated with

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[13] Although the proportion of total energy produced globally by coal combustion is expected to decrease, large increases in coal consumption in developing nations in Asia, including China and India, are projected, with those two countries accounting for 75% of the total increase in coal use. *Id.* at 3.

[14] *Id.*

[15] *Id.* at 102.

[16] *Id.*

[17] *Id.* at 12.

[18] *See generally* Intergovernmental Panel on Climate Change, *Climate Change 2001: Synthesis Report, Summary for Policymakers*, *available at* http://www.ipcc.ch/ (last visited May 21, 2003) [hereinafter *IGPCC Synthesis Report*].

[19] *Id.* at 31.

[20] The Intergovernmental Panel on Climate Change quantifies the risk of adverse impacts on the environment and human health in statistical ranges. "Very Likely" is defined as having a 90-99% chance of occurring. "Likely" is defined as having a 66-90% chance of occurring. Consequences of global warming that are very likely to occur include higher maximum temperatures, leading to more hot days and heat waves over nearly all land areas. Corresponding to this increase in temperature is an increase in minimum temperatures, and "fewer cold days, frost days and cold waves over nearly all land areas." Projected impacts of increase in temperatures include increased incident of death and serious illness among older age groups and the urban poor, heat stress on livestock, wildlife and crops, and increased electricity demand, leading to a decrease in energy supply reliability. Consequences of global warming that are likely to occur include more intense precipitation events, increased summer drying in mid-latitudes, leading to increased risks of drought, increased intensity and frequencies of cyclones, droughts, floods and El Niño events, and increasing variability of Asian summer monsoon events, an important source of fresh water to the Asian continent. *Id.* at 15-16, 31.

[21] *Id.* at 15.

the industrialized world's emissions are expected to fall disproportionately on developing countries. [22]

The mitigation of global warming will require the participation of all countries in reducing greenhouse gas emissions.[23] Developing countries can facilitate this mitigation by decreasing their reliance on fossil fuels and increasing use of non-fossil fuel energy sources, such as solar, tidal, and even nuclear energy, if done in a manner that minimizes risks to the environment. Russia's floating nuclear reactors could be part of this effort to decrease the use of fossil fuels, but the mitigation of greenhouse gas emissions must be weighed against the threat this particular technology poses to the environment.

A. Environmental Justice Considerations Regarding Global Warming

The distribution of fossil fuel use impacts and the source of greenhouse gases raise important environmental justice considerations. The majority of greenhouse gas emissions have historically been the result of fossil fuel combustion in wealthy, industrialized nations. Although the effects of these emissions will impact all humans, they will "fall disproportionately upon developing countries and poor persons within all countries, and thereby exacerbate inequities in health status and access to adequate food, clean water, and other resources."[24] Therefore, the same developing countries increasingly relying on fossil fuel combustion to develop their economies will also bear the most negative impacts of global warming. In contrast, the benefits of past greenhouse gas emissions will be enjoyed by developed countries, which did not experience the adverse impacts of warming while developing, and consequently did not internalize the costs of such impacts.

B. Changing the Mixture of Power Sources in Countries of the Pacific Rim Region Will Help Mitigate the Impacts of Global Warming

Although humans may be able to adapt to changes wrought by global warming, technological diversification[25] may help delay or reduce the damage from climate change. Humans may adapt to global warming,[26] for

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[22] *Id.* at 12.

[23] Intergovernmental Panel on Climate Change, *Climate Change 2001: Mitigation, Summary for Policy Makers*, at 4, *available at* http://www.ipcc.ch/ (last visited May 21, 2004) [hereinafter *IGPCC Summary for Policy Makers*].

[24] *See IGPCC Synthesis Report, supra* note 18, at 12.

[25] *See id.*

[26] *IGPCC Summary for Policy Makers, supra* note 23.

instance, through changing the patterns of food growth, although that adaptation will not completely mitigate the damage due to climate change. Therefore, efforts to reduce greenhouse gas emissions are still necessary, because they will either delay or reduce the damage from climate change.[27] These efforts require new technologies and a switch to non-fossil fuel burning power sources.[28] Although this change in the mix of electricity sources depends on many factors and will involve a variety of non-fossil fuel technologies, nuclear power may be one of the more viable alternatives to fossil fuels in terms of reducing greenhouse gas emissions.[29]

C. *Alternative Nuclear Technologies May Meet the Need for Increased Power Generation Without Resulting Greenhouse Gas Emissions*

The projected mix of energy sources needed to meet the increased demand in the Pacific Rim does not consider new nuclear technologies, because these projections are based on currently utilized technologies. Russia's floating reactors are a new application of an outdated, thirty-year old Soviet-era naval reactor originally designed to power ships.[30] There is also concerted global effort to develop new nuclear reactor technologies, some of which may be safer than the Russian floating reactor proposal. This effort includes both national and multinational programs to design small, modular reactors[31] that could fill the emerging demand for energy that cannot be met by established power grids.[32]

Many countries have national programs to develop new reactor technologies.[33] In addition to the floating reactor concept, Russia has developed a lead-bismuth cooled fast reactor that may reduce the possibility of severe accidents.[34] The reactor can be manufactured, delivered to a site ready to operate, and then returned to the factory for disassembly after an

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[27] *See IGPCC Synthesis Report, supra* note 18, at 21.

[28] *See IGPCC Summary for Policy Makers, supra* note 23, at 4.

[29] For a discussion of the role nuclear energy can play in mitigating global warming, *see* World Energy Council, *Global Nuclear Energy in a Sustainable Development Perspective*, Oct. 2001, *available at* http://www.nea.fr/html/ndd/docs/2000/nddsustdev.pdf (last visited May 21, 2004) [hereinafter *WEC Sustainable Development Perspective*].

[30] *See* Fesko, *supra* note 7.

[31] The IAEA defines a small reactor as one generating under 300 MWe. *See Small Nuclear Power Reactors, UIC Nuclear Issues Briefing Paper #60*, Nov. 2003, *available at* http://www.uic.com.au/nip60.htm (last visited May 21, 2004).

[32] *Id.*

[33] Debu Majumdar, *Advanced Reactors Around the World*, NUCLEAR PLANT J. EDITORIAL ARCHIVE (2003), *available at* http://www.npjonline.com (last visited May 21, 2004).

[34] Lead-cooled reactors use molten metal instead of water to conduct heat off the reactor core, and in so doing avoid the corrosion problems of water-cooled reactors. *Id.*

eight to ten year operating cycle.[35] Similarly, India is developing smaller reactors using thorium as a fuel source,[36] and other countries such as South Korea, Canada, France, Argentina, Japan, China, South Africa, and the United States are developing similar small reactor designs.[37]

In addition to individual technological development, a group of countries and international agencies are currently cooperating to develop new reactor technologies, referred to as "Generation IV."[38] This group identified new reactor concepts, including a lead-cooled small fast reactor that may have significant advantages over existing reactor concepts.[39] Assembled in a factory with a closed fuel cycle,[40] this reactor has a long life, is fairly difficult to dismantle—a feature that helps to deter the harvest of nuclear materials that could be used in weapons—and is safer because the use of lead as a coolant shields the reactor and is not as corrosive as other coolants such as water.[41] This reactor can be produced, shipped to a site where it can provide power for thirty years, and then shipped back to the production facility for servicing.[42] Although this type of reactor seems ideal, certain technical advances, including innovations in materials technology, are necessary to produce it.[43] In contrast, Russia proposes to complete its first floating nuclear reactor in three years,[44] thus raising immediate environmental and safety concerns.

Japan's recent proposal to test the small reactor that it is developing in a remote village in Alaska demonstrates the potential utility of these new technologies.[45] Japan's reactor, designed to produce ten megawatts of

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[35] *Id.*

[36] *Id.*

[37] *Id.*

[38] Argentina, Brazil, Canada, France, Japan, the Republic of Korea, the Republic of South Africa, the United Kingdom, the United States, and Euratom, Europe's Nuclear Agency, began this international effort in January 2000. *See What is Generation IV?*, *available at* http://gen-iv.ne.doe.gov (last visited May 21, 2004).

[39] U.S. Department of Energy, *The U.S. Generation IV Implementation Strategy*, Sept. 2003, at 4, *available at* http://gen-iv.ne.doe.gov/ (last visited May 21, 2004) [hereinafter *Gen IV Strategy*].

[40] A closed fuel cycle extracts uranium and plutonium through reprocessing of the spent fuel in the reactor. This uranium and plutonium is then used in the fission process to generate more power. The net result is the production of waste that does not have long-lived actinides as a component, resulting in waste that will decay in a much shorter time, and is more manageable. *See* Argonne National Labs, *Six Labs Draft Plan to Develop Advanced Reactor Systems with Closed Fuel Cycle*, *available at* http://www.anl.gov:80/OPA/frontiers/d6ee.html (lasted visited May 21, 2004).

[41] *See Gen IV. Strategy*, *supra* note 39, at 4.

[42] *Id.*

[43] *Id.*

[44] *See Russia May Complete Floating Nuclear Power Plant in Three Years*, *supra* note 9.

[45] Joel Gay, *Village Invited to Test Cheap, Clean Nuclear Power*, ANCHORAGE DAILY NEWS, Oct. 21, 2003.

power,[46] is similar to the Generation IV project's lead-cooled reactor.[47] Like the sealed design of the Generation IV's lead-cooled reactor, the Japanese design reportedly has a very low chance of releasing nuclear material, and, because of its size and design, is unable to melt down, precluding Chernobyl-type accidents.[48] Therefore, because of their safer design, these small Japanese reactors may provide a safer alternative to the floating Russian reactors, although they are still in development and, unlike the Russian proposal, may not be available in the near future. Considering the risks associated with the Russian floating reactors, however, waiting to develop new, safer technologies may very well be warranted.

III. ENVIRONMENTAL AND SAFETY CONCERNS RELATED TO RUSSIA'S FLOATING NUCLEAR REACTORS

Russia's likely deployment of floating nuclear reactors is starting to draw attention from a variety of concerned parties.[49] This concern relates to a general public wariness about the expansion of nuclear power, given historical nuclear reactor use, the magnitude of environmental damage resulting from past accidents, and the potential for damage from future catastrophes.[50]

There are multiple safety concerns associated with the Russian proposal. For instance, the reactors run on highly enriched uranium,[51] which is more readily converted into weapons-grade uranium than other fuels used in nuclear reactors.[52] As a result, the reactors are likely to be targets for terrorists and countries interested in obtaining uranium for nuclear weapons.[53] In addition, Russia's nuclear agency, Minatom, has a poor track record of environmental protection, with many instances of radioactive

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[46] *Id.*

[47] *See Gen IV. Strategy, supra* note 39, at 4.

[48] *See* Gay, *supra* note 45.

[49] Andrey Mikhaylov, *Floating Nuclear Power Plant to Emerge in Russia*, BELLONA FOUNDATION NEWS, Nov. 7, 2002, *available at* http://www.bellona.no/en/international/russia/npps/27075.html (last visited May 21, 2004); *see also* Fesko, *supra* note 7.

[50] Reflecting the concerns of many international organizations, Greenpeace contends that "safe nuclear power is a myth," basing these contentions on the history of nuclear energy, and the resulting contamination to the environment. *See generally* Greenpeace International, *Nuclear Campaign*, *available at* http://www.greenpeace.org/international_en/campaigns/intro?campaign_id=3940 (last visited May 21, 2004).

[51] Highly enriched uranium is defined as containing greater than 20% of the 235 isotope of uranium. *See* Fesko, *supra* note 7.

[52] *Id.*

[53] *Id.*

contamination and questionable handling of nuclear waste.[54] The Soviet Navy's history of nuclear reactors and their treatment and disposal also raises concerns, as that history suggests a lack of proper stewardship of the environment.[55] As a result, the safe operation of these reactors is in question.

Russia is also currently facing a lack of funds for a new nuclear program.[56] Nevertheless, the floating reactor concept is part of Russia's current "crash program of rapid expansion" of its nuclear generating capacity over the next two decades.[57] Because funding for all Russian nuclear projects is scarce, however,[58] both scientists and scholars are concerned about Russia's practice of diverting funds obtained for the disposal of foreign nuclear waste away from clean-up efforts towards expanding its nuclear program.[59] This diversion of funds towards new nuclear activities and away from addressing historic contamination issues suggests that stewardship of the environment is not a priority in Russia, and, as a result, the safe operation of these floating nuclear reactors may also not be a priority.

In addition to present funding concerns, the environmental and safety history of Minatom[60] raises concerns that the agency is not prepared to embark on programs such as the floating reactor program.[61] One of the most prominent examples of flawed Russian environmental practices is the ongoing pumping of liquid radioactive wastes into underground tunnels from a nuclear chemical plant in Seversk.[62] In addition, despite Minatom's denials of responsibility for releases of radioactive waste from military facilities in the Tomsk region, the Tom and Romashka rivers have the highest degree of radioactive contamination in the world.[63] Moreover, problems such as leaks and other incidents at civilian nuclear plants are

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[54] Paul Josephson, *Minatom: Dreams of Glory*, 40 BULL. ATOM. SCIENTISTS (2002), *available at* 2002 WL 9055553.

[55] For instance, the Bellona Institute, an organization monitoring the effects of Russia's nuclear activities on the North Sea express concerns that these floating reactors may become "floating Chernobyls." *See* Mikhaylov, *supra* note 49.

[56] *See* Josephson, *supra* note 54.

[57] *Id.*

[58] *Id.*

[59] *Id.*

[60] Minatom is the parent agency of the publicly traded company Malaya Energetika, the company that is developing these floating reactors. *See* Fesko, *supra* note 7.

[61] *Id.*

[62] *Id.*

[63] *Id.*

common[64] and safety at Russian nuclear plants remains an issue,[65] as is waste disposal and handling.[66]

The Russian Navy's treatment and disposal of nuclear reactors suggests a similar lack of concern regarding environmental protection.[67] The Northern Fleet documented fifty-two accidents involving nuclear submarines during the Cold War, and made a practice of dumping low-level waste into the Barents Sea.[68] In addition to these historic practices, the lack of funding for the Russian nuclear program has hampered the decommissioning of Russian naval reactors.[69] This lack of funding results in improper storage of spent fuel assemblies, contributes to a deteriorating infrastructure, and leads to widespread contamination of the decommissioning facilities.[70] This deteriorating infrastructure also poses a major hazard to the surrounding population and environment.[71] The international community, including bordering states that are threatened by these practices, have recognized this hazard and, as a result, are participating in international efforts to clean up these facilities.[72]

The unique design of Russia's floating reactors magnifies the underlying risks associated with Russia's nuclear program. Unlike land-based reactors, the current floating design does not include a concrete containment wall.[73] As a result, these floating reactors are particularly vulnerable to terrorist attack and natural threats like tsunamis, earthquakes, and weather.[74] Another design flaw is the plan to store spent fuel on the barge.[75] This presents the legitimate concern that extra waste may be dumped overboard if there is no room for it on the barge, a reportedly common practice in the Soviet Navy.[76]

Despite Russia's poor history of responsible nuclear safety practices, these floating nuclear reactors are likely to be deployed to help meet the Pacific Rim's increased need for energy, to help allay concerns over fossil

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[64] *Id.*
[65] *Id.*
[66] *Id.*
[67] For a detailed discussion of the issues associated with the decommissioning of the Northern Fleet, *see* Justin Mellor, *Radioactive Waste and Russia's Northern Fleet: Sinking the Principles of International Environmental Law*, 28 DENV. J. INT'L. L. & POL'Y 51 (1999).
[68] *Id.* at 54.
[69] *Id.* at 54-55.
[70] *Id.*
[71] *Id.* at 55.
[72] *Id.* at 57.
[73] *See* Fesko, *supra* note 7.
[74] *Id.*
[75] *Id.*
[76] *Id.*

fuel consumption, to diversify energy sources, and encourage the still-nascent development of other potentially safer nuclear technologies. Because of Russia's likely construction and deployment of floating nuclear reactors, the international community faces a choice: either proactively address the risks associated with these reactors, or wait until an accident occurs and respond after the environmental damage has occurred. Current international law does not sufficiently address these risks, but existing laws could be amended, new laws passed, or a new emphasis on technological innovation fostered to address these concerns.

IV. RUSSIA'S LEGAL DUTIES REGARDING THE DEPLOYMENT OF FLOATING REACTORS UNDER CURRENT INTERNATIONAL LAW

Though comprehensive, existing international legal regimes are insufficient to proactively address the unique risks created by Russia's proposed floating nuclear reactors. Such regimes include the standards and treaties administered by the International Atomic Energy Agency[77] ("IAEA"), international environmental law, and the United Nations Convention on the Law of the Sea. Accordingly, these regimes should be modified, new legal regimes should be developed, or other avenues such as market-based incentives should be explored to minimize the possibility of damage to human health and the environment from these floating nuclear reactors.

An ideal legal regime to address the risks associated with Russia's floating reactors would include at least three specific features. First, it should prescribe strict regulatory standards that would bind Russia to minimize risks in designing and operating these floating reactors. Second, it should provide injured parties a method of recovery for damage caused by operation or accidents associated with these reactors. A liability mechanism would promote accountability and help minimize risks. Third, a regulatory regime should also have a mechanism that could prevent the deployment of these floating reactors completely if the risks were found to be unacceptable to the international community, perhaps through a licensing authority. Although numerous laws exist, this ideal regime does not yet exist because of the unique nature of the current problem.

Alternatively, a less desirable legal regime would at least prescribe standards to bind Russia in its development and operation of these floating nuclear reactors, but may not proscribe the liability framework or

[77] The International Atomic Energy Agency is the principle organ responsible for treaties and standards regulating the peaceful use of nuclear power for energy production.

preventative mechanisms of an ideal regime. Successfully cobbling together such a regime from existing legal frameworks, however, is highly unlikely; there is a large body of existing standards that may be applied, but ensuring compliance with these standards by Russia is difficult. As discussed below, the deployment of these floating reactors is likely to exploit current gaps in international law. Therefore, the international community needs to either develop a new legal regime to regulate Russia's plan, or explore other avenues such as offering countries interested in Russia's floating nuclear reactors alternative energy sources.

Although there may be many creative international approaches that could be used to regulate Russia in its endeavor, this Comment focuses on three potential legal regimes that may each provide some of the components necessary to address this unique situation. These potential regimes include 1) the regime administered by the IAEA; 2) international environmental law; and 3) the United Nations Convention on the Law of the Sea ("UNCLOS"), the major treaty governing the use of the world's seas. Despite the potential that all three regimes have for regulating Russia's floating nuclear reactors, each of them, on its own, fall short of providing an effective mechanism to regulate these floating nuclear reactors.

A. The International Atomic Energy Agency Lacks the Authority to Make Russia Operate Floating Reactors in a Manner Acceptable to the International Community

The current legal regime administered by the IAEA does not proactively address the environmental risks created by Russia's nuclear reactors. Rather, the IAEA's potentially applicable conventions can only prescribe standards and guidelines, without the necessary enforcement mechanisms, or at best, provide for international assistance after an accident has occurred. The 1994 Convention on Nuclear Safety[78] promotes the safe operation of nuclear facilities, while two other conventions, the Convention on Early Notification of a Nuclear Accident[79] and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency,[80]

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[78] 1994 Convention On Nuclear Safety, IAEA, Sept. 20, 1994, IAEA Doc. INFCIRC/449, 33 I.L.M. 1514, *available at* http://www.iaea.org/Publications/Documents/Conventions/nukesafety.html [hereinafter CNS] (last visited May 21, 2004).

[79] Convention on Early Notification of a Nuclear Accident, Nov. 18, 1986, 1439 U.N.T.S. 275, 25 I.L.M. 1395, *available at* http://www.iaea.org/Publications/Documents/infcircs/Others/inf335.shtml (last visited Apr. 29, 2004).

[80] Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, Sept. 26, 1986, 1457 U.N.T.S. 133, 25 I.L.M. 1377, *available at* http://www.iaea.org/Publications/Documents/Infcircs/Others/inf336.shtml (last visited May 21, 2004).

are designed to lessen the impact of an accident after it has occurred. If Russia chooses not to comply with these non-obligatory standards and guidelines, there is little that can be done to force its compliance.

1. The 1994 Convention on Nuclear Safety Does Not Apply to Floating Reactors

Despite Russia's acquiescence to its terms in 1996,[81] the Convention on Nuclear Safety ("CNS") does not apply to the particular floating nuclear reactors currently at issue. The CNS's purpose includes "promot[ing] an effective nuclear safety culture"[82] through implementation of prescribed standards,[83] followed by self reporting and subsequent peer review of a nation's nuclear safety program.[84] These obligations would provide valuable transparency for implementing a safety program for the floating reactors. However, the drafters of the CNS consciously decided to create voluntary obligations that only apply to "land-based civil nuclear power plant[s]" under the jurisdiction of a party to the CNS.[85] This restriction would exempt Russia's floating reactors unless the CNS was modified to include this new class of floating reactors. Even if such a modification occurred, the self-reporting obligations remain voluntary and would do little to force Russia to comply with higher safety standards that may be desired by other countries.

2. Accident Response Conventions Will Not Contribute to the Safe Operation of Floating Reactors

Russia is a party to two conventions that, together, provide for international assistance in the event of a nuclear accident, but these conventions only apply to accident response, and not accident prevention. For instance, the Convention on Early Notification of a Nuclear Accident[86] obligates parties to notify states that may be affected by a nuclear accident,[87] while the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency prescribes international cooperation in response to a nuclear accident.[88] Drafted in response to the Chernobyl accident,[89] these

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[81] *See* IAEA, *Status of the Convention On Nuclear Safety, available at* http://www.iaea.org/Publications/Documents/Conventions/nukesafety.html (last updated Sept. 2003) (last visited May 21, 2004).

[82] CNS, *supra* note 78, pmbl. § iv.

[83] *Id*, art. 4.

[84] *Id.* art. 5.

[85] *Id.* art. 2.

[86] Convention on Early Notification of a Nuclear Accident, *supra* note 79.

[87] *Id.* art. 2.

[88] *Id.*

conventions provide an important framework for international response to nuclear accidents but will not facilitate the safe operation of nuclear reactors.

3. *The Vienna Convention on Civil Liability for Nuclear Damage is Unable to Impose Liability on Russia in the Event of an Accident*

Liability conventions provide a mechanism by which an injured party may seek compensation from a state for its injury and, therefore, can provide an important deterrence mechanism that may lead to greater safety in the operation of these floating reactors. However, the liability convention that would be most relevant to the nuclear barges, the Vienna Convention on Civil Liability for Nuclear Damage ("Vienna Convention"), does not apply to Russia, which has signed but not ratified it.[90] Even if Russia ratifies the Vienna Convention, it may not apply to floating nuclear reactors due to a definition similar to the one in the CNS.[91]

The Vienna Convention imposes liability upon operators of nuclear installations.[92] As drafted in 1963 (for land-based civilian reactors), the original convention defined a "nuclear installation" as "any nuclear reactor other than one with which a means of sea or air transport is equipped for use as a source of power, whether for propulsion thereof or for any other purpose."[93] If the barge upon which these reactors are installed qualifies as a means of sea transport,[94] then the floating nuclear reactors arguably are exempt under this provision. The Vienna Convention further defines a "nuclear installation" as "any facility where nuclear material is stored."[95] Thus, if spent fuel is stored on the barge as proposed,[96] the Vienna Convention may apply to these floating reactors. Despite a possible

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[89] *See* IAEA, *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency-Background*, *available at* http://www.iaea.org/Publications/Documents/Conventions/cenna.html (last visited May 21, 2004). *See also* IAEA, *Convention on Early Notification of a Nuclear Accident*, *available at* http://www.iaea.org/Publications/Documents/Conventions/cacnare.html (last visited May 21, 2004).

[90] Russia signed the convention on May 8, 1996, but has not ratified it. *See Latest Status to the Vienna Convention on Civil Liability for Nuclear Damage*, Mar. 20, 1996, *available at*, http://www.iaea.org/Publications/Documents/Conventions/liability.html (last visited May 21, 2004).

[91] *Compare* CNS, *supra* note 78, art. 2 *with* Vienna Convention on Civil Liability for Nuclear Damage, art. I(j)(i), May 21, 1963, 1063 U.N.T.S. 265, 2 I.L.M. 727 [hereinafter Vienna Convention].

[92] *See id.* art. II(1).

[93] *Id.* art. I(j)(i).

[94] If the barges are defined as a method of sea transport, they appear likely to be exempt from the Vienna Convention. However, defining these barges as a method of sea transport is critical in applying the United Nations Convention on the Law of the Sea to these barges, which contains numerous obligations to prevent the pollution of the marine environment through accidents associated with vessels. *See infra* Part IV.C.1.

[95] Vienna Convention, *supra* note 91, at art. I(j)(iii).

[96] *See* Fesko, *supra* note 7.

application under nuanced definitional interpretations, it remains questionable whether the Vienna Convention would apply under its original definitions.

It seems more likely that the reactor barges would be covered under the 1997 amendments to the Vienna Convention. The purpose of the 1997 amendments was to "provide for broader scope, increased amount of liability of the operator of a nuclear installation, and enhanced means for securing adequate and equitable compensation"[97] in the event of a nuclear accident. As a means of broadening the scope, the IAEA Board of Governors received discretion to include within the convention facilities that originally were not covered, including "such other installations in which there are nuclear fuel or radioactive products or waste."[98] Under this provision, the IAEA could specifically regulate the floating reactors, while preserving the original convention's overall exemption of reactors used in sea transportation. Even if the Board of Governors implemented such a regulation, Russia would still have to ratify the Vienna Convention to be bound by it and liable for any damage resulting from an accident involving a floating reactor. Given this kind of potential liability, it seems unlikely that Russia will ratify the Vienna Convention in the foreseeable future.

B. Under International Environmental Law, Russia has a Duty to Ensure that Activities Within Its Jurisdiction or Control Do Not Pollute the Environment Beyond Its Borders

Although international customary law articulates duties that Russia likely is obligated to follow in operating the floating reactors, it may be difficult to enforce liability if a breach of such duties occurs. Article 38 of the treaty establishing the International Court of Justice uses international custom as a valid source of law in international tribunals; such custom is evidenced by "a general practice accepted as law."[99] Breach of such general practices accepted as law may lead to the imposition of liability on a state,[100] and the threat of that liability may cause a state to take action to prevent the imposition of liability.

These principles have been used in the development of international environmental law. One of the seminal international environmental law

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[97] Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage, Sept. 12, 1997, pmbl., 36 I.L.M. 1454, 1455.

[98] Vienna Convention, *supra* note 91, at art. I(1)(iv).

[99] Statute of the International Court of Justice, art. 38(1)(b), 59 Stat. 1055, 1060 (1945).

[100] For instance, in the *Trail Smelter* case, Canada was found liable for transboundary pollution that harmed the United States. *See Trail Smelter Arbitral Decision*, 35 AM. J. INT'L L. 684 (1941).

cases addressing this concept is *Trail Smelter Arbitral Decision*.[101] In *Trail Smelter*, the United States brought a claim against Canada that resulted in the signing of a convention that created a special arbitral panel.[102] The United States alleged that pollution from Canada had crossed the border into the United States and caused damage to resources and human health.[103] After a long trial held before the tribunal created to address this issue, that tribunal awarded monetary damages to the United States and stated two fundamental principles of international environmental law. First, states have a duty to ensure that activities under their control do not cause damage to the environment of other states, where that damage is of a serious consequence and is demonstrated by clear and convincing evidence.[104] Second, if damage to another state does occur, the polluter should pay.[105] These principles have subsequently been reiterated. For example, Principle 21 of the United Nations Conference on the Human Environment at Stockholm ("Stockholm Convention") declares that states have the "responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or to areas beyond the limits of national jurisdiction."[106] More recently, the 1992 Rio Declaration on Environment and Development again emphasized this principle in the same language as the Stockholm Convention.[107]

1. International Legal Liability is Not an Effective Deterrent Because International Liability May Not Lead to Recovery of Damages

Despite this ideal of global environmental responsibility, actual enforcement and recovery for liability stemming from trans-boundary environmental harm remains difficult. The difficulty in seeking compensation for trans-border environmental damage is poignantly highlighted in two accidents involving Russian nuclear technology: a 1978 crash of a nuclear-powered satellite in Northern Canada, and the 1986 Chernobyl explosion.

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[101] *Id.*
[102] *Id*
[103] *Id.*
[104] *Id.* at 684.
[105] *Id.*
[106] *Stockholm Declaration of the United Nations Conference on the Human Environment*, princ. 21, U.N. Doc. A/CONF.48/14/Rev.1, 11 I.L.M. 1416 (1972).
[107] *1992 Rio Declaration on Environment and Development*, princ. 2, U.N. Doc. A/CONF. 151/26 (Vol. I), *reprinted in* 31 I.L.M. 874, 876 (1992).

a. The crash of Cosmos 954

The first of these accidents involved the crash of a Russian nuclear-powered satellite, Cosmos 954, in northern Canada in 1978.[108] Launched by the Russians in late 1977 and powered by a nuclear reactor containing highly enriched uranium,[109] this satellite experienced technical failures that resulted in its reentry into the earth's atmosphere on January 24, 1978.[110] Contrary to the Soviet Union's back channel assurances, the reactor did not burn up and disperse its radioactive core throughout the upper atmosphere, as it was designed to do upon reentry.[111] Rather, it spread radioactive debris, some of which was of lethal radioactivity,[112] across a large swath of Northern Canada, including the Northwest Territories and the provinces of Alberta and Saskatchewan.[113] The United States and Canada cooperated in cleaning up the debris, but only a small amount of the satellite was recovered.[114] Total clean up costs paid by the Canadian government exceeded US$ 14 million.[115]

Canada relied on both an international treaty and international environmental law in its efforts to recover this cost.[116] The treaty claim was based on Article II of the Convention on International Liability for Damage Caused by Space Objects[117] ("Space Liability Convention"), a relatively unique treaty that abrogated state sovereign immunity and conferred strict

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[108] *Canada: Claim Against the Union of Soviet Socialist Republics for the Damage Caused by Soviet Cosmos 954*, Pub. No. FLA-268, *available at* http://www.dal.ca/~wwwlaw/kindred.intllaw/SOVIET.htm (last visited January 24, 2004) [hereinafter *Cosmos 954 Settlement*].

[109] *See* Gus W. Weiss, *Life and Death of Cosmos 954*, STUD. IN INTELLIGENCE (1978). This document was originally a classified document that was declassified in the 1990s, detailing the joint response of Canada and the United States to the threat of Cosmos 954 reentering the atmosphere over North America, referred to as Operation Morning Light.

[110] *Cosmos 954 Settlement, supra* note 108.

[111] The Soviet Union responded to inquiries by officials involved in Operation Morning Light with reassurances that the reactor onboard Cosmos 954 was designed to "burn up on reentry." *See* Weiss, *supra* note 109, at 4. *See also Cosmos 954 Settlement, supra* note 108, at para. 5 (detailing Soviet assurances that even if the reactor did not burn up, there "should not be any sizeable hazard and that in places of impact there could only be insignificant local pollution requiring very limited measures of disactivation.").

[112] *See Cosmos 954 Settlement, supra* note 108, para. 10.

[113] *Id.* at para. 9.

[114] *See generally id.*

[115] *Id.* at. para. 8.

[116] *See generally id.*

[117] Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 (entered into force Sept. 1, 1972) [hereinafter Space Liability Convention]. This treaty was negotiated in the United Nations and adopted by General Assembly Resolution 2777 (XVI) in 1972. Since its adoption, 81 states have ratified the convention, and 26 others have signed it.

liability upon the Soviet Union for the accident.[118] In addition, Canada relied on the general international law principles articulated in *Trail Smelter*.[119] Although Russia settled the case in 1981 for a lump sum, the principles upon which the settlement was made are unclear because the settlement does not contain a clear indication of what law had been applied.[120] As a result, this case is not useful in further defining an international standard for trans-boundary environmental liability.[121]

Nevertheless, the Cosmos 954 settlement process provides an interesting illustration of how the treaty's presence shaped the negotiations between Canada and the Soviet Union,[122] an assertion supported by the Soviet's rejections of liability except for that imposed by the 1972 Space Liability Convention.[123] The Canadian/Soviet negotiations also illustrate the difficulty of recovering compensation for harm caused by another state. Even with an applicable convention, Canada was still able to only recover costs of clean up, not compensation for damage to the environment.[124] Finally, the careful rejection of customary law principles by the Soviet Union reinforces the inability to recover for such damage relying solely on those principles.

b. The 1986 accident at Chernobyl: the "polluter gets paid" principle

In 1986, the notorious Russian nuclear accident at Chernobyl sparked changes in international law, but did not result in a clear mechanism for recovery of environmental damage from a nuclear accident. The Chernobyl reactor operators were performing a test on the reactor cores when one reactor experienced a loss of coolant pressure, partly because the safety interlocks designed to shut the reactor down if coolant pressure became insufficient had been circumvented.[125] Unfortunately, this loss of coolant

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[118] Space Liability Convention, *supra* note 117, at art. II. (declaring that "[a] launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft flight.").

[119] *See Cosmos 954 Settlement, supra* note 108.

[120] RENÉ LEFEBER, TRANSBOUNDARY ENVIRONMENTAL INTERFERENCE AND THE ORIGIN OF STATE LIABILITY 164 (1996); *see also Cosmos 954 Settlement, supra* note 108.

[121] *See* LEFEBER, *supra* note 120, at 164.

[122] *See id.*

[123] *See id.*

[124] Russia eventually paid a lump sum that was less than the amount spent by Canada on clean up. *See generally Cosmos 954 Settlement, supra* note 108.

[125] *See generally* Nuclear Energy Agency, Organisation for Economic Co-Operation and Development, *Chernobyl: Assessment of Radiological and Health Impacts, 2002 Update of Chernobyl, Ten Years On* (2000), *available at* http://www.nea.fr/html/rp/chernobyl/chernobyl.html (last visited May 21, 2004).

led to a surge in heat production and to two explosions of the reactor core.[126] These explosions resulted in widespread environmental contamination and years of negotiation to close the reactor after the accident.[127] Along with awareness of the devastation that a nuclear accident can cause, Chernobyl created a new and unexpected outcome that violates international environmental law: the notion that the polluter gets paid.

Rather than bearing the financial responsibility for this accident, the Soviet Union and, after the dissolution of the Soviet Union, Ukraine, received tremendous financial assistance, both to assist the clean up efforts, and in exchange for finally closing the reactor down in 1995.[128] The result of these payments, however, is the undermining of the international principle of state responsibility, with the threat of future accidents used as a "negative lever or a form of environmental blackmail in order to obtain financial assistance,"[129] which results in the creation of a "polluter gets paid" principle.[130] The creation of the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency[131] is a codification of this principle, as it encourages and promotes international assistance in the clean up of a nuclear accident.[132] Not only is the current international nuclear regulatory regime ineffective in addressing the risks posed by floating reactors, it also creates incentives for the deployment of such reactors by transferring liability from the potential individual polluter to the greater global community.

Given the lack of fora for enforcing liability under international law, the experiences of Cosmos 954 and Chernobyl demonstrate that relying solely on customary international law is unlikely to provide an effective mechanism to require compensation from Russia in the event of an accident involving one of its floating nuclear reactors. Despite repeated calls for international liability regimes for environmental damage, there has been an inability to widely develop those regimes.[133] The current international

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[126] *Id.*

[127] *Id.*

[128] This money was in addition to the international efforts to clean up the accident itself. Estimated at US$ 2.3 billion, this money was intended to both assist in the final closure of the plant, and to provide monetary assistance in mitigating the loss of power generation capacity due to that closure. *Id.* at 115-20.

[129] Justin Mellor, *The Negative Effects of Chernobyl on International Environmental Law: The Creation of the Polluter Gets Paid Principle*, 17 WIS. INT'L L. J. 65, 66 (1999).

[130] *Id.*

[131] Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, *supra* note 80.

[132] *See supra* Part IV.A.3.

[133] *See* LEFEBER, *supra* note 120, at 5. (noting that statements contained in the Stockholm Declaration (1972) and the Rio Declaration (1992) both include "urgent appeals to develop international liability law," but that international liability law is yet to emerge.).

regime offers little legal substance that will significantly shape Russia's decisions on deploying floating reactors. These experiences, along with the international assistance required to clean up Russia's Northern Fleet, suggests precisely the opposite: Russia now can proceed without considering, or internalizing the trans-border risks posed by its nuclear policies.

C. *The United Nations Convention on the Law of the Sea Prescribes Duties to Prevent Pollution to the Marine Environment, but it is Unclear if There is an Effective Enforcement Mechanism for Breach of Those Duties*

Due to the lack of applicable treaties and standards and the inversion of the customary "polluter pays principle" after Chernobyl, both treaties and customary international law are ineffective regimes in terms of imposing enforceable liability on Russia in the event of an accident involving one of its floating nuclear reactors. The United Nations Convention on the Law of the Sea ("UNCLOS"),[134] however, provides a framework for protecting the marine environment If there are effective enforcement mechanisms within the UNCLOS, that treaty may be able to provide the necessary threat of liability to shape Russia's behavior.

Reflecting the customary international law principles articulated in *Trail Smelter* and the Stockholm Convention, the UNCLOS requires states to protect and preserve the environment[135] and prescribes measures that are designed to deal with all sources of pollution[136] to the marine environment.[137] Having ratified this treaty on March 12, 1997,[138] under Article 217,[139] Russia has the primary responsibilities as the flag state, or state under whose jurisdiction the floating nuclear reactors operate.[140] The

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[134] United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 3, 21 I.L.M. 1261 (1982) [hereinafter UNCLOS].

[135] *Id.* at art. 192.

[136] *Id.*at arts. 207-12.

[137] The "marine environment" is not defined in the UNCLOS. However, Article 1(4) states that the marine environment includes estuaries, and the usage of the term in the UNCLOS suggests that the marine environment includes estuaries, territorial waters, and the high seas. See *infra,* Part IV.C.2.b.

[138] *See Chronological List of Ratifications to the United Nations Convention on the Law of the Sea, available at* http://www.un.org/Depts/los/reference_files/chronological_lists_of_ratifications.htm (last visited May 21, 2004).

[139] This article prescribes the duty of the flag state to ensure that vessels under their jurisdiction comply with relevant international standards and rules, for the prevention, reduction, and control of pollution to the environment. UNCLOS, *supra* note 134, at art. 217 (1). This article also prescribes the duty of the flag state to prevent the operation of a vessel that cannot meet these requirements. *Id.* at art. 217(2).

[140] *Id.* at arts. 91, 94.

host state in whose waters the barge is moored,[141] however, may also have duties to prevent pollution from these floating nuclear reactors. As discussed below, Article 211 in particular contains numerous obligations that apply to vessel-source pollution.[142]

As in the conventions administered by the IAEA, definitional issues again affect whether the UNCLOS will apply to these floating reactors. First, Article 211 applies only to vessels; these barges must meet the definition of a "vessel" in order for the Article 211 obligations to bind Russia.[143] Second, these duties apply to parties to the UNCLOS that have jurisdiction or control over the barges. Russia, as the flag state, would be the most obvious state to have jurisdiction or control over these barges, but the host state,[144] through contractual relationships, could also have jurisdiction or control over these barges.

The terms "flag state,"[145] "territorial waters"[146] and "internal waters"[147] all have specific meanings under the UNCLOS. While "flag state" is not explicitly defined in the UNCLOS, its meaning can be deduced from Articles 91 and 94,[148] with the flag state being the state that has granted its nationality to a ship.[149] "Territorial waters" are defined in the UNCLOS, and extend up to twelve miles out to sea[150] from the "baseline," defined as "the low-water line along the coast as marked on large-scale charts officially recognized by the coastal State."[151] "Internal waters" are defined as waters on the landward side of the baseline.[152]

As discussed below, the extent of the marine environment is poorly defined in the UNCLOS. This is important because the obligations of the UNCLOS are centered on pollution of the marine environment. If the marine environment extends to internal waters as well as territorial waters,

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[141] If these barges are under the shared control of the host state and the flag state, then the host state, under Article 211, has a duty to prevent, reduce and control pollution of the marine environment as well. UNCLOS *supra* note 134, at art. 211.

[142] *See infra* Part IV.C.2.

[143] UNCLOS *supra* note 134, at art. 211. Whether a floating nuclear barge is a "vessel" is explored in Section IV.C.1 *infra*.

[144] Here, the host state is the state that is contracting with Russia and is mooring these floating nuclear reactors in its waters.

[145] Articles 91 and 94 of the UNCLOS provide the closest definition of a "flag state." See the discussion of Walker and Noyes' proposed definition, *infra* note 148.

[146] UNCLOS *supra* note 134, at arts. 3, 4.

[147] *Id.* art. 8.

[148] George K. Walker & John E. Noyes, *Definitions for the 1982 Law of the Sea Convention-Part II*, 33 CAL. W. INT'L L.J. 191, 204-05 (2003).

[149] UNCLOS *supra* note 134, at art. 91.

[150] *Id.* at arts. 3-5.

[151] *Id.* at art. 5.

[152] *Id.* at art. 8(1).

then that duty would be imposed on those states that have jurisdiction over these barges in their internal waters. However, the UNCLOS only superficially addresses internal waters, leaving a state with full jurisdiction and sovereignty over these waters.[153] If internal waters are not a part of the marine environment, then a host state would not be bound by the obligations of Articles 192 and 194 to prevent pollution to those waters. Therefore, the UNCLOS duties not to pollute the marine environment apply to both a host state and the flag state, but depend on the barge first being defined as a vessel, the location of the barge in the host state's waters, and the extent of the marine environment.

1. Russia's Floating Reactors Are Vessels as Defined by International Law and Proposed Definitions for the UNCLOS and, Therefore, Are Subject to the Requirements of the UNCLOS

Although the term "vessel" is not explicitly defined in the UNCLOS, usage in this and other conventions suggests a clear working definition. In the English version of the UNCLOS, "vessel" is used interchangeably with the term "ship," while Russian and Spanish translations use one word, suggesting that "vessel" and "ship" have the same meaning.[154] Other conventions contain definitions that can guide the development of a definition for the UNCLOS,[155] including the 1962 amendments to the 1954 Oil Pollution Convention,[156] the MARPOL 73/78 Convention,[157] and the United Nations Convention on Conditions for Registration of Ships.[158] Further, the International Convention on Salvage of 1969 defines a vessel as

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[153] ERIK JAAP MOLENAAR, COASTAL STATE JURISDICTION OVER VESSEL-SOURCE POLLUTION 185 (1998).

[154] Walker & Noyes, *supra* note 148, at 217.

[155] *Id.* at 217-18.

[156] 1962 Amendments to the 1954 Convention for Prevention of Pollution of the Sea by Oil, Apr. 11, 1962, Annex, art. 1(1). 17 U.S.T. 1523, 1524, 600 U.N.T.S. 332, 334 (defining a ship as "any sea-going vessel of any type whatsoever, including floating craft, whether self-propelled or towed by another vessel, making a sea voyage.").

[157] Protocol of 1978 Relating to International Convention for the Prevention of Pollution from Ships, 1973, Feb. 17, 1978, art. 1, 17 I.L.M. 546; Annex: Modifications and Additions to the International Convention for the Prevention of Pollution from Ships, 1973, Annex I. 1340 U.N.T.S. 61, 63, 66, *reprinted in* 12 I.L.M. 1319 (defining a ship as a "vessel of any type whatsoever operating in the marine environment.").

[158] United Nations Convention on the Conditions for Registration of Ships, Feb. 7, 1986, 26 I.L.M. 1229 (1987).

"any ship or craft, or any structure capable of navigation."[159] Finally, various other conventions liberally define a ship as any seagoing vessel.[160]

Relying on these conventions and definitions, Professors Walker recently authored a definition of vessel consistent with both general usage of the term in international agreements, and the specific purposes of the UNCLOS.[161] That definition states that a:

> "[s]hip or vessel ha[s] the same interchangeable meaning in the English language version of the 1982 [UNCLOS]. Ship is defined as a vessel of any type whatsoever operating in the marine environment, including hydrofoil boats, air-cushion vehicles, submersibles, floating craft and floating platforms."[162]

The floating Russian nuclear barges fit the definition of a vessel under both existing international law, and the proposed definition above. First, these barges are designed to be portable; indeed, the purpose of mounting the nuclear reactors on a barge is to provide a mobile source of power both to the Russian Far North East and to countries abroad.[163] Second, these barges will be used for transporting the reactors, as well as equipment and personnel, in the marine environment when they move either from Russia to the host country's waters, or back to Russia for servicing. Third, when moored and providing power to a country, the barge will serve as a floating platform for the reactors. Although there is some controversy regarding whether the above definition should include jack-up rigs,[164] or platforms that can be transported on the seas and then converted to a stationary platform on supports that extend to the sea bottom, there is no indication that these barges will be built in such a manner. However, Professor Noyes, in his comments on Professor Walker's definition, notes that, due to the intent of

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[159] International Convention on Salvage, Apr. 28, 1989. art. 1(b), S. Treaty Doc. 102-12.

[160] *Id.* art. II.2, (defining a ship as "(a) any sea-going vessel or any type whatsoever, and (b) any floating craft"); Hazardous and Noxious Substances Convention Nov. 1996, Art. 1.1, 35 I.L.M. 1406, 1415 (1996) (defining a ship as "any seagoing vessel and seaborne craft, of any type whatsoever"); International Convention on Oil Pollution Preparedness, Response and Co-operation Nov. 30, 1990, art. 2(3), 30 I.L.M. 733, 737 (1991) (defining a ship as "a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, and floating craft of any type."). Although these conventions often limit the definition of a ship to include those classes of ships the convention is drafted to regulate, the common thread in all these definitions is that a vessel is of a broader class than a ship, must be seagoing, and generally must operate in the marine environment.

[161] Walker & Noyes, *supra* note 148, at 218. This definition was proposed by Professor Walker, Professor Noyes disagreed with the definition. *See Id.* at 318-19.

[162] *Id.* at 218.

[163] Fesko, *supra* note 7.

[164] Walker & Noyes, *supra* note 148, at 318-19.

the UNCLOS to broadly protect the marine environment, the definition of ship should encompass temporarily fixed platforms.[165] Regardless of being either in transport or on site, these floating barges are a vessel under the UNCLOS. As a result, Russia is obligated to operate these barges in a manner consistent with the UNCLOS.

2. *Russia's Regulatory Obligations Under the UNCLOS Result in a Duty to Prevent Pollution from the Operation or Accidents Associated With Floating Reactors*

The UNCLOS contains many well-defined duties that Russia, as a party to the convention, is obligated to follow. The UNCLOS requirements include general obligations to "protect and preserve the marine environment"[166] and to "take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment."[167] The UNCLOS incorporates a broad definition of pollution including the "introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries"[168] that either is likely to result in or in fact results in "harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities."[169] In an extension of customary international environmental law, Article 194 mandates measures "necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life."[170] Further, Article 196 prescribes a duty to prevent, reduce, and control pollution from technologies under a state's control,[171] and Article 199 mandates the development of contingency plans to respond to incidents of pollution to the marine environment.[172] In addition, Article 204 prescribes a duty to monitor the environment for potential adverse impacts,[173] while Article 206 prescribes a duty to assess the potential impacts and risks of activities to the

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[165] *Id.*
[166] UNCLOS, *supra* note 134, at art. 192.
[167] *Id.* art. 194.
[168] *Id.*
[169] *Id.*
[170] *Id.*
[171] *Id.* at art. 196.
[172] *Id.* at art. 199.
[173] *Id.* at art. 204.

environment.[174] Finally, Article 211 prescribes a standard for the rules and regulations that must be promulgated by a state to prevent pollution from a vessel to the environment.[175]

a. As a party to the UNCLOS, Russia is also obligated to follow generally accepted international rules and standards in the operation of floating reactors

Although Russia is not directly bound by the IAEA treaties, UNCLOS Article 211 may indirectly bind Russia to the standards set forth in such treaties.[176] Pursuant to Article 211, guidelines adopted by Russia to protect the environment must "at least have the same effect as that of generally accepted international rules and standards established through the competent international organization or general diplomatic conference."[177] Given the unique nature of Russia's proposal to build floating reactors for power generation, the IAEA conventions, including the Convention on Nuclear Safety, would be the most widely accepted and followed standards.[178] Scholars agree that the scope of Article 211 includes internationally agreed standards including IAEA guidelines.[179] Similarly, established international rules and procedures would govern the construction and operation of the floating reactors.[180] As the flag state, Russia has a duty to ensure that its barges do not sail unless they are built to international rules and standards "established through competent international organization or general diplomatic conference."[181] Further, the barges' safety and security, and their susceptibility to terrorist attack, could be addressed by international standards such as the IAEA's Code of Conduct on the Safety and Security of Radioactive Sources,[182] and other rules promulgated by the IAEA.[183]

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[174] *Id* at art. 206.

[175] *Id*. at art. 211.

[176] *Id*. at art. 211.

[177] *Id.* at art. 211(2).

[178] For a summary of the relevant technical guidelines, *see* http://www.iaea.org (last visited Apr. 28, 2004).

[179] PATRICIA BIRNIE & ALAN BOYLE, INTERNATIONAL LAW AND THE ENVIRONMENT 353-54 (2nd ed. 2002).

[180] UNCLOS *supra* note 134, at art. 217.

[181] *Id.*

[182] IAEA, *Code of Conduct on the Safety and Security of Radioactive Sources* (2004), *available at* http://www.iaea.org/Publications/Standards/index.html (last visited May 21, 2004).

[183] *See generally* http://www.iaea.org//Publications/Documents/index.html (last visited May 21, 2004).

b. The coastal host state's obligations under the UNLCOS are the same as Russia's only if the barges are located in their territorial waters or an accident results in pollution of the marine environment

Because a state has sovereignty over its internal waters, the UNCLOS does not prescribe any mandatory duties regarding the environmental stewardship of those waters. Under Articles 21 to 25, a state may choose to regulate the discharge of pollution to its internal waters.[184] For example, Article 21 gives coastal states the authority to adopt laws to protect the living resources of their waters[185] and to preserve the marine environment by reducing and controlling sources of pollution to those waters.[186] Article 23 specifically addresses the transportation of nuclear materials through territorial waters, imposing a duty on that vessel to adhere to "special precautionary measures established for such ships by international agreements."[187]

A port state's right to prescribe laws to protect its internal waters, however, are not obligations owed to the greater international community. Rather, they are rights to be enjoyed and exercised by the port state,[188] including the right to undertake investigations and inspections of the vessel's stewardship of the marine environment[189] and the right of the port state to prevent a vessel from sailing if its seaworthiness would threaten the marine environment.[190] If a coastal state chooses to host one of Russia's floating reactors in its internal waters, however, that state is unlikely to adopt rules and laws that would impede the operation of such reactors, as this is likely to unnecessarily increase the transaction costs of using these reactors. Because of this sovereignty over internal waters, any obligation to protect the marine environment springs from the obligation not to pollute the marine environment in Articles 192 and 194, but the coverage of those articles is ambiguous.

The ambiguity of the extent of coverage of Articles 192 and 194 results from the lack of a clear definition of "marine environment" in the UNCLOS, inasmuch as the UNCLOS seems to treat estuaries[191] differently in different articles. In Article 194, the definition of the marine environment

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[184] UNCLOS, *supra* note 134, at arts. 21-25.
[185] *Id.* at art. 21(1)(d).
[186] *Id.* at art. 21(1)(f).
[187] *Id.* at art. 23.
[188] *See* BIRNIE & BOYLE, *supra* note 179, at 370-71.
[189] UNCLOS, *supra* note 134, at art. 218.
[190] *Id.* at art. 219.
[191] An estuary is the interface between a river and the ocean.

includes estuaries, but Article 207, which covers pollution from land-based sources, appears to group estuaries as part of land-based sources, presumably part of internal waters.[192] This dual treatment of estuaries suggests that there is a dual obligation to prevent pollution to estuaries (included in the marine environment in Article 194)[193] and to prevent pollution migrating from estuaries to the marine environment (as estuaries are included in Article 207's land-based sources).[194] This dual treatment is not surprising considering that estuaries are the interface between fresh water (considered internal waters) and the ocean.[195] As such, they may straddle the baseline, as defined by maritime charts, and be both internal waters and territorial waters.

c. *Enforcement of obligations and liability under the UNCLOS and international law would be difficult*

While the duty not to pollute the oceans and liability for breach of that duty are developed in both customary international law and under the UNCLOS, as in customary international law, an injured state is unlikely to be able to enforce such liability.[196] Article 235 binds parties to their UNCLOS "obligations concerning the protection and preservation of the marine environment."[197] If those obligations are not met, states "shall be liable in accordance with international law."[198] By referencing international law, Article 235 codifies international customary law, and as such, binds signatories to the UNCLOS to that law.

There is however, an overall reluctance by states to be bound by international liability agreements — a reflection of the "lack of political will,

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[192] Article 207 groups estuaries, along with rivers, which are internal waters, as "land-based sources" of pollution, which are, according to Article 194, a part of the marine environment. UNCLOS, *supra* note 134, at arts. 194, 207. It appears that the distinction between the marine environment and internal waters is the baseline. As estuaries are the natural interface between terrestrial, fresh waters, and the marine environment, it is not surprising that these water bodies could be viewed as both internal waters and a part of the marine environment, as they will sometimes straddle the baseline.

[193] *See supra* Part IV.C.2.

[194] If a country that is a party to the UNCLOS has these reactors under its jurisdiction or control, it has an obligation to prevent pollution of the marine environment. *See* UNCLOS, *supra* note 134, at arts. 192, 194.

[195] For instance, the American Heritage Dictionary defines *estuary* as "1. The part of the wide lower course of a river where its current is met by the tides; 2. An arm of the sea that extends inland to meet the mouth of a river." NEW AMERICAN HERITAGE DICTIONARY 466 (2d ed.).

[196] For a general discussion on the inability of the international community to develop state liability, *see* LEFEBER, *supra* note 120. An example of the reluctance of a state to be bound by a liability convention is Russia's reluctance to ratify the Vienna Convention on Civil Liability for Nuclear Damage. *See supra* Part IV.A.3.

[197] UNCLOS, *supra* note 134, at art. 235(1).

[198] *Id.* at art. 194(5).

[and] the alleged legal complexity of liability regulations."[199] Recognizing this, Article 235 also prescribes the duty to "ensure that recourse is available in accordance with their legal systems for prompt and adequate compensation or other relief" for activities caused by parties within their jurisdiction.[200] Finally, Article 235 requires state cooperation in the implementation of existing international law,[201] further development of international law relating to liability and responsibility,[202] and development of standards and procedures for ensuring adequate compensation, including compulsory insurance or compensation funds.[203] This article attempts to resolve the lack of international liability regimes by prescribing both the duty to provide a domestic forum for recovery of damages and the duty to cooperate in the development of international liability regimes. Because these forums do not exist, however, the UNCLOS also provides for specific avenues for settlement of disputes arising between parties to the convention.[204]

Article 287 provides four different avenues for settlement of these disputes arising under the UNCLOS: 1) the International Tribunal for the Law of the Sea ("ITLOS"); 2) the International Court of Justice ("ICJ") 3) an arbitral panel that can be constituted for general disputes; or 4) a special arbitral panel for certain categories of disputes.[205] Article 298 allows a state to choose the applicability of such forums when ratifying the treaty.[206] For protection of the marine environment, Russia has only consented to the jurisdiction of a special arbitral panel, not the ICJ or the ITLOS.[207] However, if a party brings a claim against Russia under the UNCLOS, and the forum cannot be agreed upon, then, under Articles 287(3) and 287(5) recourse would be through a general arbitral panel.[208] Therefore, the effectiveness of these panels would undoubtedly influence the manner in which Russia would behave in building and operating these floating reactors. In addition, a concerned party may, through Article 290, also bring a request for provisional measures through the ITLOS, a procedure that could lead to

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[199] *See* LEFEBER, *supra* note 120, at 53.
[200] UNCLOS, *supra* note 134, at art. 235(1).
[201] *Id.* at art 235(3).
[202] *Id.*
[203] *Id.*
[204] *Id.* at art. 287.
[205] *Id.* at art. 287(1).
[206] *Id.* at art. 298.
[207] *See Declaration of the Russian Federation Upon Signature and Upon Ratification, available at* http://untreaty.un.org/ENGLISH/bible/englishinternetbible/partI/chapterXXI/treaty6.asp#Declarations (last visited May 21, 2004).
[208] UNCLOS, *supra* note 134, at art., 287(3), (5).

the ITLOS stopping Russia's deployment of these reactors while dispute resolution proceeded through the use of an arbitral panel.[209] This has occurred three times in the young history of the ITLOS, with varying effectiveness.[210] However, these procedures are reactive rather than proactive in nature, consume large amounts of time, and are still developing as a legal tool. Further, once provisional measures are prescribed,[211] the dispute would be resolved through an arbitral panel, as Russia has not consented to ICJ or ITLOS jurisdiction. While the UNCLOS, makes a major advance in both articulating standards and duties regarding the protection of the environment, and providing obligatory dispute resolution mechanisms, its value is still questionable in providing a binding international liability regime for recovery of damages resulting from activities that pollute the marine environment.

V. AS INTERNATIONAL LAW FAILS TO EFFECTIVELY ADDRESS THE RISKS OF RUSSIA'S FLOATING REACTORS, CONCERNED STATES SHOULD ACTIVELY PROMOTE EFFECTIVE LEGAL REGIMES OR DEVELOP AND DEPLOY ALTERNATIVE TECHNOLOGIES

Given the risks associated with Russia's proposal to deploy floating nuclear reactors and the real possibility that Russia may ignore those risks, the international community should proactively address this pressing issue. The international community has at least three main options: 1) close the current gaps in existing law to cover the risks posed by the floating reactors; 2) develop new legal regimes to specifically address these risks; or 3) actively promote development of alternative technologies that would meet the same demand that the floating reactors are currently designed to address. Regarding this last option, there is also the opportunity for the international community to proactively develop alternative sustainable technologies to meet increasing power demands.

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[209] *Id.* art. 290.

[210] *See Case Concerning Land Reclamation by Singapore in and Around the Straits of Johor (Malaysia v. Singapore)*, INT'L TRIBUNAL FOR THE LAW OF THE SEA, Case No. 12, *available at* http://www.itlos.org/cgi-bin/cases/case_detail.pl?id=12&lang=en (last visited May 21, 2004); *The MOX Plant Case (Ireland v. United Kingdom)*, 42 I.L.M. 405 (2002); *Southern Bluefin Tuna Cases (New Zealand v. Japan; Australia v. Japan)*, 38 I.L.M. 1624 (1999).

[211] *See Declaration of the Russian Federation Upon Signature and Upon Ratification*, *supra* note 207.

A. Current Legal Regimes May Be Modified to Proactively Address the Risks of Russia's Floating Nuclear Reactors

The gaps in the current customary international law and treaty-based legal regimes outlined above could be closed, resulting in coverage of floating reactors by these regimes. Given the slow development of liability under customary international law (reflected in the lack of a general forum for recovery for damages resulting from a breach of customary international law), modification of existing treaties may be a more efficient method of addressing this issue. For instance, the CNS could be modified to specifically cover floating nuclear reactors, but still exempt other reactors used in maritime applications, such as those used to power military vessels. Another alternative would be to amend the Vienna Convention to specifically cover the floating reactors and somehow induce Russia to ratify the convention. Another, and perhaps easier, alternative would be for the IAEA to use its authority under the 1997 Vienna Convention amendments to promulgate regulations covering these specific types of floating reactors. As demonstrated by the Cosmos 954 incident, having a treaty to provide some sort of liability in the event of an accident may make the difference between some recovery and no recovery at all.

B. New Legal Regimes May Be Developed to Address the Risks Posed by Floating Reactors

If the gaps in the current legal regimes outlined above cannot be closed, a new regime would need to be developed to govern the unique risks posed by these floating reactors. That framework would ideally mirror the obligations to the environment contained in both customary law and the UNCLOS, but would also balance the need for new power sources with the risk inherent in some of those sources. Further, as demonstrated above, there is a particular need to develop liability and a means for recovery for damage. Finally, while ideally any new legal regime would afford the international community the opportunity to preempt particularly risky behaviors, there should at least be firm mechanisms for recovery of damages resulting from the operation of these reactors.

A possible model for new law already exists in the Draft Articles on the Prevention of Transboundary Harm from Hazardous Activities ("Draft Articles").[212] These articles reflect the principles articulated in customary

[212] International Law Commission, *Draft Articles on Prevention of Transboundary Harm From Hazardous Activities*, U.N. GAOR, 56th Sess., Supp. No. 10, U.N. Doc. A/56/10 (2001).

international law, requiring states to take all appropriate measures to minimize the risk of trans-boundary harm.[213] The Draft Articles state that those risks include both the high probability of causing significant harm, and the low probability of causing disastrous harm.[214] As the inability to develop similar liability regimes called for in other international instruments demonstrates, it is likely that the Draft Articles would suffer the same deficiencies as other conventions in liability enforcement, if adopted. This repeated theme of the inability to develop international liability regimes suggests that non-legal solutions to this problem should be considered, including international cooperation to develop and deploy the alternative nuclear technologies discussed in Part II(B).

C. *Market-Based Incentives to Adopt Alternative Technologies May Be Necessary to Address Floating Reactor Risks*

The international community should consider market-based incentives to develop alternative technologies for power generation in the same niche likely to be served by Russia's floating reactors. Ideally, that alternative would not contribute to global warming through the emission of greenhouse gases, nor would it pose an unacceptable risk to the environment. In addition, as energy policy transitions from a national to an international policy decision, the technology used should also be sustainable.[215] Those technologies could include solar, wind, tide or other non-greenhouse emitting sources, or alternative nuclear power sources.

VI. CONCLUSION

The Russian proposal to deploy floating nuclear reactors demonstrates the need for increased international cooperation and vigilance regarding both international human health and environmental policy. It also highlights the need for a proactive approach to international regulation of emerging technologies that have the potential for adverse impacts on not only a regional, but a global level. As the scientific understanding of the impacts of energy source choices increases, it is necessary for the global community to move from a domestically oriented energy policy to one that accounts for the global impacts of state actors' decisions. Such impacts will be borne not only by the acting state, but by the international community as a whole. Regardless of the approach taken by the international community, such an

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[213] *Id.*

[214] *Id.* at art. 2(a).

[215] *See WEC Sustainable Development Perspective, supra* note 29.

approach ideally will be proactive and consistent with the need to address and balance all risks associated with power generation. Failure to take any action until an accident involving one of these floating nuclear reactors may impact the marine environment irreparably, a risk that should not be imposed unilaterally by a single country.

The best approach to preventing the risks associated with these floating reactors is likely to be a mix of various cooperative tactics. First, a cooperative international agreement could include incentives designed to deploy safer technology in a cost-effective manner. This cooperative approach could be coupled with the development of Generation IV technology, or coupled with the adoption of other advanced reactor designs, and could be administered through the IAEA or other international organizations. Second, there should be strong controls over the operation of these reactors to minimize safety risks. Finally, an agreement with countries not to use the Russian floating reactors could be coupled with incentives and assistance in developing alternative technologies. As a whole, this approach could accomplish the goals of addressing the risks of these particular reactors. This approach could also move energy policy into the international arena, where the cooperation of states in identifying and developing consistent policy will result in the inability of one state to act unilaterally in a manner that is not acceptable to the overall international community.