The Floating Chameleon:

Floating Nuclear Power Plants and the Nexus of Maritime and Nuclear Security Law

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I. Introduction

During the 63rd regular session of the International Atomic Energy Agency (IAEA) General Conference, as part of Norway's statement to the General Conference, Mr. Audun Halvorsen, State Secretary for Norway, made the following statement about transportable nuclear power plants (TNPPs):

> Deployment of transportable nuclear power plants—TNPPs—demands our attention. The Agency must intensify its conversations of all aspects of the safety and security of such facilities. . . . The scope and applicability of existing requirements and instruments need to be clarified and developed including dialogue with the International Maritime Organization [IMO].[1]

Ensuring the security of TNPPs is essential for their deployment and implementation. TNPPs may be floating nuclear power plants (FNPPs), which bring together elements of nuclear security related to the nuclear power plant with elements of maritime security. Insofar as an FNPP weds the principles of nuclear and maritime security, it also weds the two domains, the ancient traditions and contemporary practices of maritime law with the contemporary practices of nuclear law. Fundamentally, this raises the question, what are the legal requirements for the security of a FNPP? Although both maritime law and

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[1] Mr. Audun Halvorsen, State Secretary (Deputy Minister), Statement of Norway at the 63rd regular session of the IAEA General Conference (September 17, 2019), on 63rd IAEA General Conference statements: https://www.iaea.org/sites/default/files/19/09/gc63-norway.pdf (last visited Apr 30, 2020).

nuclear law have established regimes for security through various legal instruments, does an FNPP expose gaps between the current international legal instruments?[2]

The previous question of whether international legal regimes define requirements for the security of FNPPs, but a threshold question remains: what is an FNPP? For purposes of nuclear and maritime security, is an FNPP a facility, is an FNPP a vessel and therefore a transport, or does an FNPP change its status based upon temporal and spatial considerations such as when it is docked at a port generating power or in transit to its destination? This set of questions, and others addressed later in this article, highlights that the issue is not merely a question about security but intersects elements of safety whether an FNPP is in uncharted waters of the international regime for both nuclear and maritime law.

This paper addresses many of the questions posed above related to the security regulations for an FNPP. First, the existing international security and maritime security regime does start to address FNPPs, but existing international legal regimes for both nuclear and maritime security do not explicitly address or account for FNPPs. For example, under both nuclear law and maritime law, is a host State required to provide security for an FNPP while it is docked at a port or while it is floating in a host State's territorial waters? The existing International Ship and Port Facility Security (ISPS) Code does not discuss the maritime security of nuclear material in a port.[3] Further, the international legal framework does not address the interaction of a supplier State, which may also be the flag State for an FNPP, and the host State for ensuring nuclear security. Second, as to the proper security coverage for an FNPP, this analysis will describe the challenge with defining an FNPP as either a facility or a transport and will argue that an

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[2] See Convention on the Physical Protection of Nuclear Material (1980), IAEA Doc. INFCIRC/274 Rev. 1 1456 UNTS 125, entered into force 8 February 1987 (CPPNM); Amendment to the Convention on the Physical Protection of Nuclear Material (2005), IAEA Doc. INFCIRC/274/Rev. 1/Mod. 1, entered into force 8 May 2016 (ACCPNM); International Ship and Port Facility Security Code, Chapter XI-2 of the International Convention for Safety of Life at Sea (SOLAS Convention), entered into force 1 July 2004 (ISPS Code); International Maritime Dangerous Goods Code (2018), Amendment 39-18, updated regularly (IMDG Code). See also IAEA (2011), Nuclear Security Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities, Nuclear Security Series, No. 13, IAEA Doc. INFCIRC/225/ Rev. 5, IAEA, Vienna; IAEA (2015).

[3] See International Ship and Port Facility Security Code, Chapter XI-2 of the International Convention for Safety of Life at Sea, entered into force 1 July 2004 (ISPS Code); but see International Maritime Dangerous Goods Code (2018), Amendment 39-18, updated regularly (IMDG Code).

FNPP may be both because at various stages of its transport and subsequent use its security measures change. Such changes are not driven by security but rather by safety considerations, which highlights the interdependent nature of safety and security.

The paper will address the arguments above through the following structure. The first section of this paper discusses TNPPs and focuses on the FNPP. Essentially, this will provide scope and context for discussing FNPPs versus land-based TNPPs. This section will discuss the only operating FNPP, the *Akademik Lomonosov*, and briefly discuss the historical development of the FNPP, which has roots back in the Atomic Age.[4] The section will also briefly introduce gaps in existing international instruments. The second section will provide a deeper discussion about the definition of an FNPP in the context of existing international instruments. Specifically, when does a transport of an FNPP end and its use begin? The third section will focus on the jurisdictional considerations for security of an FNPP depending on its location within a host State's territorial waters.[5] Although nuclear security is ultimately the responsibility of the State, that responsibility and the ability to enforce its laws and regulations may depend on the FNPP's location within a State's maritime boundaries and the function or functions the FNPP is performing. The fourth section will discuss the different security guidance provided by the IAEA in ensuring security of nuclear material in use versus in transport, with the final section discussing gaps in the existing regime and recommendations for subsequent work and analysis.

Ultimately, the goal of this paper is to assess the existing international framework and how an FNPP is protected from acts of theft, sabotage, or terrorism. As Mr. Halvorsen discussed in his statement to the IAEA General Conference in late 2019, the need to evaluate existing international requirements is not only the responsibility of the IAEA but it will also require collaboration and inclusion of

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[4] Kramer, A. E., "The Nuclear Power Plant of the Future May Be Floating Near Russia," N.Y. Times (Aug. 26, 2018); Nikitin, A. & Andreyev, L. (2011), "Floating Nuclear Power Plants," https://network.bellona.org/content/uploads/sites/3/Floating-nuclear-power-plants.pdf.

[5] For this paper, territorial waters, also known as the "territorial sea," shall extend from the baseline of a coastal State 12 nautical miles (nm) outward. See Kelo, J. et al. (2007), Coastal and Ocean Law Cases and Materials 3d. ed, p. 391.

organizations, such as the IMO.[6] The arguments in this analysis highlight one view on the challenges of FNPPs and the interdependencies that are created between safety and security and more broadly, between nuclear law and maritime law as a result of the development of the FNPP.

II. A Brief History and Legal Challenges involving FNPPs within Nuclear and Maritime Security Law

According to the IAEA, a TNPP is defined as "factory manufactured, transportable and/or relocatable nuclear power plant which, when fueled, is capable of producing final energy products such as electricity, heat and desalinated water."[7] The plant includes the reactor (with or without fuel), turbine, generator, and fuel storage facilities, where appropriate.[8] It is important to make the distinction that a TNPP is physically transportable, but it is not designed to produce energy during transport or provide energy for the propulsion of the vessel or vehicle in which the reactor is being moved.[9]

The FNPP evolved over the last forty-five years and continues to develop beyond a nuclear reactor positioned on a barge. Below are a few examples of different designs of FNPPs.

A. The *Sturgis*

The United States of America was the first to experiment with floating nuclear power plants during the 1960s.[10] In 1963, the U.S. Army converted the World War II Liberty Ship *SS Charles H. Cugle* into the *Sturgis*.[11] During the conversion to non-propelled barge, the propulsion system and midsection of the *Sturgis* were removed and replaced with a mobile power source,, a "high power (less than 10,000 kW) pressurized water reactor designated 'MH-1A.'"[12] When the reactor was installed on the *Sturgis*, a 350-

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[6] Halvorsen, supra note 1.
[7] IAEA (2013), "Legal and Institutional Issues of Transportable Nuclear Power Plants: A Preliminary Study," IAEA Nuclear Energy Series, No. NG–T–3.5 at 7, IAEA, Vienna [hereinafter IAEA FNPP Report].
[8] Id.
[9] Id.
[10] Honerlah, H. B. & Hearty, B. P. (2002), "Characterization of the Nuclear Barge Sturgis," presentation at Waste Management Symposium, February 24–28, https://xcdsystem.com/wmsym/archives//2002/Proceedings/44/168.pdf .
[11] Id. at 2.
[12] Id.

ton steel containment sphere and a concrete collision barrier were also installed.[13] The *Sturgis* reactor contained not only the reactor but also primary and secondary cooling systems and the electrical system to operate the reactor.[14] After its construction, the *Sturgis* spent one year at Ft. Belvoir, Virginia, and in 1968, since it no longer had a propulsion system, was towed to Gatun Lake in what was the Panama Canal Zone, where it augmented land-based electrical capacity until 1976 for both civilian and military.[15]

In 1976, it was determined that the *Sturgis* was no longer needed in the Panama Canal Zone and was towed back to Fort Belvoir for decommissioning.[16] At the time of decommissioning, the decision to deactivate the reactor was made based on costs, lack of military funding, and damage the *Sturgis* incurred on the voyage back to the United States due to severe weather.[17] During decommissioning, it was determined that the reactor "operated at an overall capacity factor of 0.54 for a total of nine years, giving a total operating time (effective full-power years irradiated time) of 4.86 years."[18]

As part of the decommissioning process, the reactor was defueled, with the majority of spent fuel rods shipped to the Savannah River Site (formerly known as the Energy Research and Development Administration facility) in Aiken, South Carolina.[19] Irradiated control rods were shipped to Chemical Nuclear Systems Inc. in South Carolina with two new fuel elements shipped to the Y-12 National Security Complex in Oak Ridge, Tennessee.[20] Additional activities included the disposal of 3,143.8 cubic feet of radioactive waste, sealing of contaminated material on the vessel itself, and decontamination of all other plant areas to within prescribed limits for release as an unrestricted area.[21] Following completion of these activities, the *Sturgis* was towed to Savannah River for dry-dock work and then subsequently towed

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[13] Id.
[14] Id.
[15] Id.
[16] Id.
[17] Id. at 3.
[18] Id.
[19] Id.
[20] Id.
[21] Id. at 3-4.

to the James River Reserve Fleet for safe storage.[22] By 1978, the majority of tasks required to deactivate the *Sturgis* were completed.[23]

B. *Akademik Lomonosov*

Although the United States built and operated the *Sturgis*, the Soviet Union was also experimenting with the concept of floating nuclear power reactors. In the 1980s, the Soviet military explored the development of an FNPP with a 12-megawatt pressurized water reactor; however, this project was abandoned in the early stages.[24] Even after the collapse of the Soviet Union, the Russian government attempted to develop an FNPP during the 1990s.[25] However, because of internal factors including economic and political transitioning from communist to post-Soviet governance, the political, economic, and social conditions were not in place for sustained development of the FNPP concept at that time.[26]

Early in 2002, Ministry of Atomic Energy (Minatom), the predecessor to today's Rosatom and the now defunct Russian Shipbuilding Agency, agreed to an initial technical design for an FNPP.[27] At the time of this agreement, however, there was no buyer or contractor interested in designing the prototype. [28] In 2006, the shipyard Sevmashpredpriyatiye (Sevmash) won the tender to construct the first FNPP, and in August of that year Rosatom signed a contract with Sevmash to begin construction.[29] In April 2007, Sevmash laid the keel and began construction on the FNPP.[30] After a change in the construction company, the hull assembly began in 2009.[31] At the same time that construction was occurring on the FNPP, land-based infrastructure was built at the deployment location, Vilyuchinsk, a city within the Kamchatka Krai

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22 Id. at 4.
23 Id.
24 Nikitin & Andreyev at 6.
25 Id.
26 Id.
27 Id. at 7.
28 Id.
29 Id.
30 Id. at 8.
31 Id.

where the FNPP would be deployed at the naval base.[32] In 2012, the *Akademik Lomonosov* was commissioned, and construction was completed in August 2019.[33] The *Akademik Lomonosov* was towed from Murmansk to the Port of Pevek, located in Chukotka.[34]

The *Akademik Lomonosov* is a floating power plant with two modified naval propulsion reactors modeled on the KLT-40C reactor.[35] The barge is not self-propelled but rather is towed by tugs and other support vessels. The FNPP also contains two steam-turbine electrical-generating plants.[36] The hull of the barge houses both the reactors and the turbines.[37] The hull also has storage facilities that can accommodate fresh and spent fuel assemblies and solid and liquid radioactive waste.[38] Additionally, the barge contains spaces for the service systems and equipment, the automatic control system, power system, living quarters, and work areas.[39] Included on the barge is a bar, a gym, and a swimming pool for the approximately 70 personnel onboard.[40]

The two KLT-40 reactors onboard the *Akademik Lomonosov* each generate 35 megawatts of power, 300 megawatts thermal.[41] It is estimated that the power generated by the reactors can supply power to a city of approximately 100,000 residents.[42] At its current location, however, Pevek is only a city of 4,700 residents. Reports state that the remaining power that is not used to power the city of Pevek is used to power local mining operations and offshore oil drilling rigs.[43] The reactors can operate for

[32] Id.
[33] Nuclear Threat Initiative, "Akademik Lomonosov", (last visited December 22, 2019).
[34] Russia connects floating plant to grid: New Nuclear - World Nuclear News, World-nuclear-news.org (2020), https://www.world-nuclear-news.org/Articles/Russia-connects-floating-plant-to-grid (last visited Apr 30, 2020).; Digge, C., "Russia Ponders a Floating Nuclear Power Plant for India," Bellona, (18 Nov. 2019), https://bellona.org/news/nuclear-issues/2019-11-russia-ponders-a-floating-nuclear-plant-for-india (last visited Apr 30, 2020).
[35] Wetherall, A. (2019), "Special Session: Legal Aspects of Small and Medium Size Reactors," slideshow presented at 2019 Nuclear Law Institute, IAEA; Nikitin & Andreyev at 9.
[36] Nikitin and Andreyev at 9.
[37] Id.
[38] Id.
[39] Id.
[40] Kramer, A. E., "The Nuclear Power Plant of the Future May Be Floating Near Russia," N.Y. Times (Aug. 26, 2018).
[41] Digge at 2.
[42] Id.
[43] Id.

approximately 12 years before they need to be refueled.[44] At the end of construction, it was estimated that the cost to build the *Akademik Lomonosov* was approximately USD 480 million.[45]

C. MIT's Offshore Floating Nuclear Plant Concept

In addition to the *Sturgis* and the *Akademik Lomonosov*, the Massachusetts Institute of Technology (MIT) is currently developing concepts for offshore floating nuclear plants (OFNPs).[46] Although conceptually similar to the *Sturgis* and the *Akademik Lomonosov*, the OFNP concept developed by MIT deploys higher power reactors in its two designs.[47] In both the OFNP-300 and OFNP-1100, the MIT concept relies on reactor designs such as the Westinghouse AP1000 and the Westinghouse small modular reactor.[48] In a departure from the "vessel type" construction of the previously two discussed FNPPs, OFNPs are cylindrical hull platforms that MIT argues offer substantially improved stability compared to other OFNP designs.[49] This design is similar to conventional platforms used for offshore oil and gas drilling.[50] MIT argues that in contrast to the barge design, the cylindrical design provides greater security provided that most of the platform is beneath the waterline, minimizing effects from airplanes or collisions from other maritime vessels.[51] In both designs developed by MIT, the reactor vessel is well beneath the waterline in comparison with the *Akademik Lomonosov*, where the reactor is near or slightly above the waterline.[52]

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[44] Id.
[45] Id.
[46] Buongiorno, J. et al. (2016), "The Offshore Floating Nuclear Plant Concept," Nuclear Technology. Vol. 194, pp. 1–14.
[47] Id.
[48] Id.
[49] Id.
[50] Id.
[51] Id. at 4.
[52] Id.

TNPPs are not addressed in the international legal regime.[53] In 2013, the IAEA published its findings on the legal and institutional issues of TNPPs, and the report made the following acknowledgements about TNPPs:

> [operating A TNPP, factory assembled, supplier factory fueled and tested, supplier factory maintained and refueled or decommissioned] presupposes legal clarity at all stages. Since a TNPP is fueled in the supplier State, that State's legislation and applicable international laws . . . would govern activities in relation to the TNPP in its territory . . . Should a TNPP transit through a territory [including territorial waters] of a third State on its way from the supplier State to the host State, a special arrangement should be reached with that third State. Sea transport, including passage through international straits, other maritime areas, or the high seas will be governed by applicable rules of international law, including the law of the sea.[54]

The report goes on to acknowledge potential conflicts between States related to the transit and innocent passage of vessels transporting radioactive waste.[55]

FNPPs raise at least two issues that affect their security. First, how is an FNPP classified? The literature ranges in describing an FNPP as a facility, a vessel, or a platform.[56] From the perspective of the nuclear law framework and nuclear security specifically, the Convention on the Physical Protection of

[53] Wetherall, A. (2019), "Special Session: Legal Aspects of Small and Medium Size Reactors," slideshow presented at 2019 Nuclear Law Institute, IAEA, at slide 12.
[54] IAEA FNPP Report at 32.
[55] Id. See e.g. Van Dyke, J. M. (2002), "The Legal Regime Government Sea Transport of Ultrahazardous Radioactive Materials," Ocean Development International Law, Vol. 33, pp. 77–108; Van Dyke, J. M. (1996), "Applying the Precautionary Principle to Ocean Shipments of Radioactive Materials," Ocean Development International Law, Vol. 27, pp. 379–397.
[56] See generally Redgwell, C. & E. Papastavridis (2018), "International Regulatory Challenges of New Developments in Offshore Nuclear Energy Technologies—Transportable Nuclear Power Plants," D. Zillman et al. (eds.), Innovations in Energy Law and Technology: Dynamic Solutions for Energy Transitions; FNPP as a platform, see, e.g., Buongiorno, J. et al. (2016), "The Offshore Floating Nuclear Plant Concept," Nuclear Technology. Vol. 194, pp. 1–14.; FNPP as a vessel see, e.g., Boyd, J., "Is the World Ready for Floating Nuclear Power Stations?", IEEE Spectrum (Sept. 30, 2019), https://spectrum.ieee.org/energywise/energy/nuclear/is-the-world-ready-for-floating-nuclear-power-stations; FNPP as a facility see, e.g., Dowdall, M. & W. J. F. Standring (2008), Nuclear Power Plants and Associated Technologies in the Northern Areas, Norwegian Radiation Protection Report, StralevernRapport No. 15.

Nuclear Material (CPPNM) and the Amendment to the Convention on the Physical Protection of Nuclear Material (ACPPNM) will still control the overall security of such material for each State party to the CPPNM.[57] However, the IAEA's Nuclear Security Series contains different guidance for developing security measures for a nuclear facility and for nuclear material that is in transport.[58] Because an FNPP is in transit, do the security measures of Nuclear Security Series No. 26-G, *Security of Nuclear Material in Transport*, apply? Do the security measures "switch" to security for facilities as prescribed under Nuclear Security Series No. 13, *Nuclear Security Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities*, and Nuclear Security Series No. 27-G, *Physical Protection of Nuclear Material and Nuclear Facilities (Implementation of INFCIRC/225/Revision 5)*?[59] Outside nuclear security considerations, how do the provisions of the International Ship and Port Facility Security (ISPS) Code apply to such a maritime structure? The provisions of ISPS Parts 7–9 and Parts 14–16 call for specific security measures for vessels and facilities.[60] The IAEA defers to relevant security provisions within the International Maritime Dangerous Goods (IMDG) Code, but the guidance is silent about harmonization with the ISPS Code.[61] The IMDG Code provision 1.4.3.2.3 specifies the security for nuclear material and is somewhat circular in that the IMO defers to the requirements of the ACPPNM, the CPPNM, and

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[57] See Amendment to the Convention on the Physical Protection of Nuclear Material (2005), IAEA Doc. INFCIRC/274/Rev. 1/Mod. 1, entered into force 8 May 2016 (ACCPNM); Convention on the Physical Protection of Nuclear Material (1980), IAEA Doc. INFCIRC/274 Rev. 1 1456 UNTS 125, entered into force 8 February 1987 (CPPNM).

[58] IAEA (2011), Nuclear Security Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities, Nuclear Security Series, No. 13, IAEA Doc. INFCIRC/225/ Rev. 5, IAEA, Vienna; IAEA (2015), Security of Nuclear Material in Transport, Nuclear Security Series, No. 26-G, IAEA, Vienna; IAEA (2018), Physical Protection of Nuclear Material and Nuclear Facilities (Implementation of INFCIRC/225/Revision 5), Nuclear Security Series, No. 27-G, IAEA, Vienna.

[59] Id.

[60] International Ship and Port Facility Security Code, Chapter XI-2 of the International Convention for Safety of Life at Sea, entered into force 1 July 2004 (ISPS Code).

[61] IMDG Code at 1.4.3.2.2. within the IMDG Code Section 1.4.3.2.3 explicitly recognizes that "For radioactive material, the provisions of this chapter are deemed to be complied with when the provisions of the Convention [for the] Physical Protection of Nuclear Material and the IAEA circular on the Physical Protection of Nuclear Material and Nuclear Facilities are applied. In the 39-18 Amendments of the IMDG Code, INFCIRC/225/Rev. 4 is recognized. However, during the last Editorial and Technical Review of the IMDG Code with Amendments for 40-20 Edition, the footnote was updated to reflect the IAEA adoption of INFCIRC/225/Rev. 5.

Nuclear Security Series No. 13, *Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities*.[62]

The second question arises from the provisions of the United Nations Convention on Law of the Sea (UNCLOS).[63] Under UNCLOS, specific maritime zones were established that delineate a State's jurisdictional reach and authorities in those zones.[64] As the IAEA recognized in its 2013 report, the need for special arrangements during maritime transport would need to be consistent with the jurisdictional limits established in UNCLOS. Article 4 of the CPPNM speaks to this in two parts; in Article 4.3 the Convention states:

> A State Party shall not allow the transit of its territory or internal waters or through its airports or seaports of nuclear material between States that are not parties to this Convention unless the State Party has received assurances as far as practicable that this nuclear material will be protected during international nuclear transport . . .[65]

Additionally, Article 4.4 of the CPPNM states that "[e]ach State Party shall apply within the framework of its national law the levels of physical protection . . . to nuclear material being transported from a part of that State to another part of the same State through international waters or airspace."[66] In both of these provisions, the Convention is clear that when moving through a State Party's port facilities or international waters, the transport must meet security levels of the transit State or that the transit State received assurances as far as practicable that the material will be protected during transit.

Although the ACPPNM, the CPPNM, and relevant IAEA nuclear security guidance documents call for notification and cooperation between shipping States, transit States, and receiving States, a tension remains between the ability to transport nuclear material and the "precautionary principle" as

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[62] See footnote 61 for more specific discussion about provision 1.4.3.2.3 of the IMDG Code.
[63] Convention on the Law of the Sea (1982), 1833 UNTS 397, entered into force 1 November 1994 (UNCLOS).
[64] Bardin, A. (2002), "Coastal State's Jurisdiction over Foreign Vessels," Pace International Law Review, Vol. 14, Pace University, p. 27.
[65] CPPNM, art. 4.3.
[66] CPPNM, art. 4.4.

established in the Rio Declaration of 1992.[67] In the *Handbook on Nuclear Law*, Stoiber et al. explain that the precautionary principle can be defined as the "concept of preventing foreseeable harm," meaning that actions involving nuclear material, including its transport, should be taken to ensure that actions involving nuclear material do not cause harm.[68]

An example of this tension between transporting nuclear material and the desire for a coastal State's attempts to apply the precautionary principle and request consent before transit through their waters can be illustrated through the work of Jon Van Dyke and his discussions of the precautionary principle for transporting radioactive waste.[69] Van Dyke refers to countries such as New Zealand and South Africa, both signatories to the CPPNM, which both expressed reservation to nuclear material shipments through their waters, specifically on mixed oxide fuel shipments.[70]

The next section will focus on the first question, determining what is an FNPP and defining the status of an FNPP. This next section will focus on the definition of a vessel and whether an FNPP qualifies as a vessel and, ostensibly, a transport, or if the FNPP is a platform or facility that should be protected using security measures akin to those used at a land-based nuclear facility.

III. A Red, White, and Blue Box Housing a Nuclear Reactor, Pool, and Bar: Classifying the FNPP for Means of Security of Nuclear Material

The *Akademik Lomonosov* has been called many things; environmentalists have called it the "Nuclear Titanic" and Greenpeace has dubbed it the "Floating Chernobyl," but what exactly is the

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[67] United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, June 3–14, 1992, Rio Declaration on Environment and Development, U.N. Doc A/CONF.151/26 (Vol. I) (Aug. 12, 1992) [hereinafter Rio Declaration]. "The 'precautionary principle' enshrined in the Rio Declaration," and that 'there should be recognition in international law of the right of potentially affected coastal States to prior notification, and; ideally, prior informed consent for shipments of nuclear material.'"; Van Dyke, J. M. (2002) "The Legal Regime Government Sea Transport of Ultrahazardous Radioactive Materials," Ocean Development International Law, Vol. 33, p. 80; See also C. Azurin-Araujo, "The Rationale of Communication Between States About Environmental Impact Assessments and Notification Prior to Shipments of Nuclear Fuel, Residues and Radioactive Wastes," presented at International Conference on the Safety of Transport of Radioactive Material, July 7–11, p. 48.
[68] Stoiber, C. et al. (2003), Handbook on Nuclear Law, IAEA, Vienna, pp. 5–6.
[69] Van Dyke, J. M. (2002) "The Legal Regime Government Sea Transport of Ultrahazardous Radioactive Materials," Ocean Development International Law, Vol. 33, p. 80.
[70] Id.

FNPP?[71] Does an FNPP like the *Akademik Lomonosov* qualify as a vessel under international maritime law, or does an FNPP fit more squarely into the classification of a facility for purposes of security and nuclear facility? Because an FNPP may not necessarily dock at a port facility and can operate within a host State's territorial waters independent of a port facility, are security measures similar to those applied to an oil platform, and as such, what are the specific security requirements that should apply under existing international and guidance to support an FNPP within a host State's territorial waters? This section will explore what constitutes a vessel under maritime law and the role that nuclear safety may play in determining the status of an FNPP if it is a vessel or a facility.

A. FNPPs as a Vessel

One of the core challenges in maritime law with defining an FNPP or any maritime structure is the definitional ambiguity that accompanies the term "vessel." Under UNCLOS, one of the primary conventions governing the law, the drafters of the convention did not define what constitutes a "ship" or for that matter, a "vessel."[72]

There are many definitions for what constitutes a "vessel," whether adopted through domestic law, or defined by others, but no such agreed definition exists within UNCLOS. For example, approximately seven years after UNCLOS entered into force, the American Branch of the International Law Association Law of the Sea Committee attempted to define terms not defined in the Convention, here being UNCLOS.[73] During their analysis of UNCLOS, the committee identified that the English text of the Convention uses "ship" and "vessel" interchangeably.[74] Looking at other conventions, the 1962 Amendments to the 1954 Oil Pollution Convention defines a ship as "any seagoing vessel of any type

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[71] Barnes, T., "Russia's Floating Power Branded 'Nuclear Titanic' Sets Sail on Controversial First Voyage," Independent (28 Apr. 2018), www.independent.co.uk/news/world/europe/floating-nuclear-power-plant-russia-floating-chernobyl-nuclear-titanic-akademik-lomonosov-launch-a8327316.html.
[72] Richards, R. K. (2011), "Deepwater Mobile Oil Rigs in the Exclusive Economic Zone and the Uncertainty of Coastal Jurisdiction," International Business and Law, Vol. 10, p. 389.
[73] Walter, G. K. & J. E. Noyes, (2002), "Definitions for the 1982 Law of the Sea Convention—Part II, California Western International Law Review, Vol. 33, p. 194.
[74] Id. at 217.

whatsoever including floating craft, whether self-propelled or towed by another vessel making a sea voyage."[75] Reviewing the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78 definition, the two are similar in that a vessel includes any type "whatsoever operating in the marine environment . . . includ[ing] hydrofoil boats, air cushion vehicles, submersibles, floating craft[,] and fixed or floating platforms."[76] In the last convention reviewed by the committee, the Ship Registration Convention (not in force), defines a ship as any "self-propelled sea-going vessel used in international seaborne trade for the transport of goods, passengers or both . . ."[77] Other sources define vessel in a variety of different ways that mirror one of the definitions from the previous three conventions discussed. Black's Law Dictionary defines a vessel as a "ship, bring, sloop, or other craft used—or capable of being used—to navigate on water."[78] At the conclusion of its analysis, the committee chair proposed the following definition for the terms "ship" and "vessel":

> "Ship" or "vessel" have the same, interchangeable meaning in the English language version of the 1982 LOS [Law of the Sea] Convention. "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 . . .[79]

The definition developed by the committee borrows heavily from the MARPOL Convention, particularly in the examples provided in the definition.[80] The committee did note that the definitions for both the Oil Pollution Convention and the MARPOL were more inclusive, although MARPOL's definition included platforms, which UNCLOS treats separately within the convention.[81]

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[75] Id. (citing 1962 Amendments to the 1954 Convention for Prevention of Pollution of the Sea by Oil, Apr. 11, 1962, Annex, art. 1(1), 600 UNTS, 332, 334).
[76] Id. (citing Protocol of 1978 Relating to International Convention for Prevention of Pollution from Ships, 1973, Feb. 17, 1978, art. 1 & Annex: Modifications and Additions to the International Convention for the Prevention of Pollution from Ships, 1973 Annex I, 1340 UNTS 61, 63, 66 (incorporating by reference International Convention for Prevention of Pollution from Ships, Nov. 2, 1973, art. (2)(4), 1340 UNTS 184, 185).
[77] Id. (citing United Nations Convention on Conditions for Registration of Ships, Feb. 7, 1986, UN Doc TD/RS/CONF/23, 26 ILM 1229, 1237 (1987) (not in force)).
[78] Black's Law Dictionary at 1594 (8th ed. 2004).
[79] Walker & Noyes at 218.
[80] Id.
[81] Id. at 217.

With respect to FNPP, limited analysis is available that determines the legal status of an FNPP under UNCLOS. Because of the lack of a consistent legal definition for the term "ship" or "vessel," the status of an FNPP remains relatively undefined. One analysis of the legal status for Russian FNPPs concluded that they are vessels covered by the provisions of UNCLOS.[82] Using the definition developed by Professor Walker for the International Law Committee, Steding's analysis starts with the premise that the barge that the reactors are mounted on is meant to be portable so that it can provide a mobile source of power.[83] The barges will transport the reactors, equipment, and personnel in the marine environment, echoing the definition developed by Professor Walker.[84] Steding concluded his analysis by arguing that once in position, whether docked in a port or out in a host State's territorial waters, the reactors will be on a floating platform.[85] Steding's analysis mentioned the potentiality of the FNPP being analogized to a jack-up rig or other temporary platform.[86] In either case, Steding argued, that given these factors and the definition provided by Professor Walker, the FNPP qualifies as a vessel and falls within the scope of UNCLOS. [87]

Although Professor Walker developed a definition for "ship" and "vessel," Professor Noyes expressed concern that any definition for either term would be too broad or too narrow as to over-include or over-exclude a particular structure.[88] He focuses on Professor Walker's analysis that the definition provided by the committee should in fact exclude fixed platforms, although the definition would allow for a fixed platform to be defined as a "vessel" because it "operates in the marine environment."[89] Noyes goes on to say that although fixed platforms would not make sense to be a vessel, how would the

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[82] Steding, D. J. (2004), "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," Pacific Rim Law and Policy Journal, Vol. 13, p. 732–34.
[83] Id. at 733.
[84] Id.
[85] Id.
[86] Id.
[87] Id. at 734.
[88] Walker & Noyes at 317.
[89] Id. at 318.

definition proposed handle "temporary platforms?"[90] Explaining that the definition for ship is broad in the MARPOL convention to include fixed platforms, he argues that an over-inclusive definition in MARPOL makes sense but should the definition, if any, in UNCLOS, be drafted as broad to include platforms as vessels?[91]

Professor Noyes' challenge to the need to define "ship" was not based on personal concern but on historical research. He cites the 1950 International Law Commission in trying to define "vessel."[92] He explained that a definition for vessel was proposed, but it was unanimously voted for deletion.[93] Other scholars have studied the lack of uniform definition for ship or vessel. Their analyses conclude that a definition is desirable, but a preferable solution is to delineate factors describing what constitutes a vessel, rather a definition itself.[94] Meyers states that

> There may be good grounds in favor of either very broad or very narrow definitions. It all depends upon what subject-matter is at issue. It would seem quite undesirable to adopt one and the same definition as obtaining for the whole of the law of the sea. . . . One detailed, all-embracing concept: ship, obtaining under all circumstances, does not and cannot exist for all the purposes of international.[95]

Noyes cites Meyers but reaches his own conclusion, noting that "water-tight definitions [for a ship or vessel] do not exist."[96] Noyes concludes that the absence of a definition for ship in general was a "wise one."[97] In his view, defining the term would produce such a broad definition that it would be meaningless.[98]

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[90] Id. at 319.
[91] Id.
[92] Id. at 320.
[93] Id.
[94] Id. at 321 (citing Lucchini, L. (1992), Le Navire et Les Navieres, in Le Navire en Droit International 11 ¶34 in Société Français pour le Droit International ed.).
[95] Id. (citing H. Meyers, the Nationality of Ships 17 (1967)).
[96] Id.
[97] Walker & Noyes at 322.
[98] Id.

Insofar as maritime law has struggled to define the term ship or vessel, other domains have defined the term for purposes of their use-specific to subjects. Outside of maritime law, the IAEA defined a vessel for purposes of transport safety and the need to move radioactive materials. In addition to publishing guidance through the Nuclear Security Series, the IAEA also published Safety Standards for the safe use and transport of radioactive material. In the publication, *Regulations for the Safe Transport of Radioactive Material* (No. SSR-6 Rev. 1), vessel is defined as “any sea-going vessel or inland waterway craft used for carrying cargo.”[99] In contrast to the definitions within the three maritime conventions, two in force and one that is not, the IAEA definition of “vessel” avoids defining types of vessels and their capability to navigate water, rather it focuses on the ability to carry cargo.[100]

In the course of its analysis, the International Law Committee recognized that in many instances, national legislation does attempt to define the term “vessel,” most of which tack to the definition supplied by the Ship Registration Convention.[101] For example, the U.S. Congress defined vessel as including “every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water.”[102] In 1978, a report by the Comptroller General described a nuclear reactor mounted on a barge for the purpose of power generation (not for transport) as a vessel that needed to comply with vessel construction requirements.[103]

Although Congress defined what a vessel is, the definition is not as clear-cut as Congress drafted. Critics argue that the definition does not have much influence over admiralty and maritime cases because of the breadth of the definition.[104] Various cases have required the U.S. Supreme Court to determine what

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[99] IAEA (2018), Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards No. SSR-6 Rev.1 at 13, IAEA, Vienna.
[100] Compare with notes 74–76.
[101] Walker & Noyes at 217.
[102] “Vessel” as including all means of water transportation, 1 USC § 3 (1947).
[103] Staats E. B. (1973), Before Licensing Floating Nuclear Powerplants, Many Answers Are Needed. EMD-78-36; B-127945.
[104] Robertson D. W., S. F. Friedell et al. (2001), Admiralty and Maritime Law in the United States, p. 59.

is a vessel.[105] The most recent case, *Lozman v. City of Riviera Beach*, the Supreme Court rejected its previous interpretation and applied a "reasonable person" test to determine whether or not a maritime structure is a vessel.

The facts in *Lozman*, while not related exactly to an FNPP, illustrate the level of detail U.S. courts took in determining vessel status. In *Lozman*, Fane Lozman purchased a 60-foot by 12-foot floating home.[106] The home consisted of a house-like plywood structure with French doors on three sides.[107] The home contained a sitting room, bedroom, closet, bathroom, and kitchen, along with a stairway leading to a second floor with office space.[108] There is an empty bilge space underneath the main floor that kept the home afloat.[109] Failing to pay marina fees and other taxes, the City of Riviera Beach commenced an *in rem* action against Lozman's home.[110] In the lower court proceedings, both the district court and the Eleventh Circuit Court of appeals determined that Lozman's floating home was, in fact, a vessel.[111]

In a 7-2 decision at the Supreme Court, Justice Breyer writing for the Court, determined that Lozman's structure was not a vessel.[112] The majority determined that Lozman's structure was not a vessel because a "reasonable observer" would not consider the house to be designed or suitable to "any practical degree for carrying people [and] things on the water."[113] The majority opinion rejected the lower court's test as overbroad as being able to encompass all structures, similar to the argument advanced by Professor Noyes.[114] This opinion is in contrast to the Supreme Court's holding in *Stewart v. Dutra Construction*

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[105] See Stewart v. Dutra Constr. Co., 543 US 481, 2005 AMC 609 (2005), but see Lozman v. City of Riviera Beach, 568 U.S. 115, 2013 AMC 1 (2013).
[106] Lozman, 568 U.S. at 118, 2013 AMC at 2.
[107] Id.
[108] Id.
[109] Id.
[110] Id.
[111] City of Riviera Beach v. That Certain Unnamed Gray, Two Story Vessel Approx. Fifty-Seven Feet in Length, No. 09-80594-CIV, 2009 WL 8575966 (S.D. Fla. Nov. 19, 2009), aff'd City of Riviera Beach v. That Certain Unnamed Gray, Two-Story Vessel Approximately Fifty-Seven Feet in Length, 649 F.3d 1259, 2011 AMC 2891 (11th Cir. 2011).
[112] Maass, D. R. (2013), "If It Looks Like a Vessel: The Supreme Court's 'Reasonable Observer' Test for Vessel Status," Florida Law Review, Vol. 65, p. 902.
[113] Id. at 902 (citing Lozman, 568 U.S. at 118, 2013 AMC at 2).
[114] Id. at 902.

Co., which concluded that a barge with a clamshell bucket used as part of the Big Dig project was a vessel.[115] Instead of applying the analysis applied in *Stewart*, the Court in *Lozman* developed a new test: would a reasonable observer consider the structure to be "designed to [any] practical degree for carrying people [and] things over water?"[116] Applying this test, the majority determined that Lozman's home could not be a vessel.[117] The Court looked at the fact that the home had doors and windows, not hatches or portholes and that other than the two times it was towed into position, the evidence shows that such a structure is not a vessel.[118] In the majority opinion, Justice Breyer focused heavily on the fact that the reasonable observer test fits the Statute's text and purpose. Citing examples such as washtubs, dishpans, or doors taken off their hinges are not vessels, a reasonable observer would call these things out for what they are, "artificial contrivances."[119]

In his analysis of the *Lozman* case, Maass discussed the impact of the *Lozman* decision and the "new" reasonable observer test on vessel determination cases. Maass argues that the reasonable observer test developed by the Court in *Lozman* for vessel determination is flawed.[120] He concludes that the reasonable observer test will create dis-uniformity within admiralty jurisdiction and add litigation about what constitutes a vessel given the test devised by Court.[121] In the alternative, Maass determines that the decision in *Lozman* is not as broad as originally thought. First, Maass points out that the Supreme Court did not overrule the decision of *Stewart*, rather created a test for those instances where the decision was on a borderline case.[122] In those instances, the analysis developed in *Stewart* is still applicable in that the decision in *Stewart* applies a strict statutory interpretation of what Congress drafted for the vessel

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[115] Stewart v. Dutra Constr. Co. 548 US 481, 2005 AMC 609 (2005).
[116] Maass at 902 (citing Lozman 568 U.S. at 128, 2013 AMC at 12).
[117] Id. at 902.
[118] Id.
[119] Lozman 568 U.S. at 121, 2013 AMC at 5.
[120] Maass at 906.
[121] Id. See also Robertson, D.W. & M. F. Sturley (2013), "Vessel Status in Maritime Law: Does Lozman Set a New Course?" Journal of Maritime Law and Commerce, Vol. 44, p. 393.
[122] Maass at 905–06.

definition.[123] This is supported by maritime scholars such as Professor Robertson and Professor Sturley who argue that the decision in *Lozman* does not chart a new course for vessel determination cases, rather deals with those narrow instances where structure determination is a borderline case.[124] Maass concludes his analysis by arguing that even if the *Lozman* reasonable observer test is applied and the structure is not determined to be a vessel, the fallback position would be to apply the statutory interpretation analysis from *Stewart* to determine the capability of the structure.[125]

For FNPPs, the vessel determination may in fact require a *Lozman*-type analysis deploying the reasonable observer test. The *Sturgis* may pass such a test, but structures like the *Akademik Lomonosov* or the OFNP concept developed by MIT may lead a reasonable observer to determine that an FNPP is not a vessel, rather deeming it a facility or platform. Maass notes that the phrase "capable of being used [as a means of transportation]" may in fact leverage the reasonable person to conclude that an FNPP is a vessel.[126] If an FNPP is determined to be a vessel, at what point does a vessel change from being a transport to being a facility, if it does at all? This decision may not be a legal question, rather it may be a question of engineering based at least in part on a reasonable observation.

One argument that may be made is that the FNPP should be granted status as a "flagged vessel" under international maritime law. In general, a vessel that is under a State's flag must abide by that State's regulations and commitments under international law.[127] In the same way that the vessel must abide by that State's laws and regulations, that vessel is also cloaked and protected by the same laws and regulations that it must abide by.[128] However, as the previous section outlined, it is unclear whether or not an FNPP is a vessel. Because the *Akademik Lomonosov* is not self-propelled and only moves once every

[123] Id. at 895–96.
[124] Robertson, D. W. & M. F. Sturley (2013), "Vessel Status in Maritime Law: Does Lozman Set a New Course?" Journal of Maritime Law and Commerce, Vol. 44, p. 393.
[125] Maass at 905–06.
[126] Id. at 906–07.
[127] Anderson III, H.E. (1996), "The Nationality of Ships and Flags of Convenience: Economics, Politics, and Alternatives," Tulane Maritime Law Journal, Vol. 21, p. 141.
[128] Id.

twelve years based on operational considerations, it may not qualify as a vessel, rather it would only be a vessel while in transport under power of a tug and the reactor and fuel fall under provisions of the IMDG Code and SSR-6, assuming it meets proper safety requirements.[129]

B. An FNPP as a Vessel Laden with Cargo-Irradiated Nuclear Fuel Code and International Maritime Dangerous Goods Code Considerations

The previous section focused on the ambiguity of the definition for the term “ship” and “vessel” and whether an FNPP qualifies as a vessel, both under international maritime law and under U.S. law. Steding’s analysis also claimed that the FNPP constitutes a vessel under UNCLOS because it met the elements outlined in the definition developed by Professor Walker.[130] However, this conclusion is reached too quickly, especially when considering other international instruments that define maritime carriage of fresh and irradiated nuclear fuel. Existing international law, specifically, the International Code for the Safe Carriage of Package Irradiated Nuclear Fuel, Plutonium, and High-Level Radioactive on Board Ships (INF Code), prescribes the types of vessels that are permitted to carry irradiated nuclear fuels.[131] Under Chapter 1.1.2 of the INF Code, the following INF Class Ships are identified and defined:

- Class INF 1 ship—Ships that are certified to carry INF cargo with an aggregate activity less than 4,000 TBq.
- Class INF 2 ship—Ships that are certified to carry irradiated nuclear fuel or high-level radioactive wastes with an aggregate activity less than 2×10^6 TBq and ships that are certified to carry plutonium with an aggregate activity less than 2×10^5 TBq.

[129] Compare International Convention for the Safety of Life at Sea (1974), 1184 UNTS 2, 284, entered into force 25 May 1980 (SOLAS); see also Kodeks Torgovogo Moreplavaniia Rossiiksoi Federatsii [KTM RF] [Code of Merchant Shipping], art. 7 (Eng.).
[130] Steding at 734.
[131] International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on board Ships (1999), entered into force on 1 Jan. 2001, amendments to the INF Code entered into force on 1 July 2009.

- Class INF 3 ship—Ships that are certified to carry irradiated nuclear fuel or high-level radioactive wastes and ships that are certified to carry plutonium with no restriction of the maximum aggregate activity of the material.[132]

The Code describes conditions for the various classes of INF vessels, including factors such as damage stability, fire safety, temperature control of cargo spaces, structural considerations, cargo securing, radiological protection, and shipboard emergency planning.[133] Of particular interest is Chapter Six, *Cargo Securing Arrangements* and the relevant provisions for storing irradiated nuclear fuel onboard a vessel.[134] Under Chapter 6.1, the INF code calls for "adequate permanent securing devices shall be provided to prevent movement of the packages within the cargo spaces."[135] The definition of *package* within IAEA No. SSR-6 Rev.1 "means the complete product of the packing operation, consisting of the packaging and its contents prepared for transport. The types of package covered by these Regulations that are subject to the activity limits and material restrictions of Section IV [of SSR-6 Rev.1] . . ."[136] To carry spent nuclear fuel, such as what is generated by the KLT-40 reactors used on the *Akademik Lomonosov*, a Type B package would be needed to store the fuel.[137] It is unclear whether the *Akademik Lomonosov* has space for Type B packages. Since the FNPP does not need to be refueled for up to twelve years, the argument could be made that the KLT-40 reactor vessel is itself a Type B package.[138] However, nowhere in the IAEA safety series does it comment on whether a reactor vessel can also be a package for purposes of transport. Packages undergo rigorous testing to ensure protection of the spent fuel; tests include a 9 m (30 ft) drop test onto an unyielding surface, a puncture test consisting of a 1 m (40 in.) drop onto steel

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[132] Id. at Chapter 1.1.2.
[133] Id. at Chapters 2-6, 8, and 10.
[134] Id. at Chapter 6.
[135] Id. at Chapter 6.1.
[136] IAEA (2018), Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards No. SSR-6 Rev.1 at 10, IAEA, Vienna.
[137] Id. at 21-23.
[138] Digge at 2.

rod, a 30-minute high-temperature thermal exposure test, and a water submersion test.[139] To date, this analysis is unaware of any similar testing of the nuclear reactors used or to be used on an FNPP, including other types of small modular reactors such as those developed by Russia, China, and Argentina.[140]

Given the existing provisions of the INF Code, the following conclusions could be drawn. A reactor containing nuclear fuel on an FNPP may not clearly fit within the existing Class INF 1–3 categories as outlined in the INF Code. For example, to the extent that when the fuel in the FNPP's reactor is in transport so long that the reactor is not undergoing fission and so long as the reactor can be demonstrated to meet the SSR-6/IMO IMDG Code package testing requirements, it may be possible to classify the reactor as a Type B package and therefore be considered cargo on an INF Code vessel. Alternatively, the FNPP may be so unique because of its packaging and stowage requirements for the nuclear reactors that such a configuration requires a new category within the INF Code. Further consideration about treating the fuel and the reactor as purely cargo while in transit would be necessary, defaulting back to the provisions of the IMDG Code but not discounting the gap in INF classification.[141] In the latter case, this would be a decision of the IMO rather than the IAEA as the IMO is the body charged with developing maritime-specific regulations and standards for the transport of dangerous cargoes, recognizing that the INF code was developed by the IMO, not the IAEA.

C. FNPP as a Facility

In contrast to the previous discussion as to whether an FNPP can be classified as a vessel, the argument for classifying an FNPP as a facility is more straightforward. Under Nuclear Security Series No. 20, *Objective and Essential Elements of a State's Nuclear Security Regime*, a "nuclear facility" is defined as "[a] facility (including associated buildings and equipment) in which nuclear material is

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[139] IAEA (2018), Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards No. SSR-6 Rev.1 at 13, IAEA, Vienna; International Maritime Dangerous Goods Code (2018), Amendment 39-18, updated regularly.
[140] Wetherall, A. (2019), "Special Session: Legal Aspects of Small and Medium Size Reactors," slideshow presented at 2019 Nuclear Law Institute, IAEA at slide 4.
[141] IMDG Code at 1.5, 2.7, and 6.4 et seq.

produced, processed, used, handled, stored or disposed of and for which an authorization or license is required."[142] Additionally, the term *associated facility* is also defined as "[a] facility (including associated buildings and equipment) in which nuclear material or other radioactive material is produced, processed, used, handled, stored or disposed of and for which an authorization is required."[143]

In both cases, an FNPP could be considered either a *nuclear facility* or an *associated facility*, especially when the FNPP is docked at a port facility. Although the facility is floating, it contains the trappings of a nuclear power plant, including the reactor(s), steam turbines, and nuclear material storage areas. In the case of the OFNP concept and previous experiments by the U.S. government, the FNPP was more a floating island with buildings housing nuclear reactors for the purposes of power generation.[144] In terms of security, if docked at a port facility, the FNPP would resemble a facility for purpose of physical security, with the appropriate defense-in-depth and corresponding safety, security, and safeguards measures. The security measures for securing a nuclear facility will be discussed in subsequent sections.

In the previous section, the current challenge with defining an FNPP as a "vessel" outright is the safety considerations and the potential gap in the INF Code that does not categorize an FNPP like the *Akademik Lomonosov* as a Class INF vessel. In the alternative, the next logical argument would be that because the reactor is not supporting transport of the vessel when it is moving between the supplier State and the host State, the fuel and the reactor can be treated as cargo as appropriate under the IMDG Code provisions.[145] Once the host State receives or provides receipt of the reactor in the host State's jurisdiction, its subsequent connection to land-side infrastructure and power generation by the reactor would signify that the FNPP is no longer deemed "transport" and would change its classification from

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[142] IAEA (2013), Objective and Essential Elements of a State's Nuclear Security Regime, Nuclear Security Series No. 20 at 12, IAEA, Vienna.
[143] Id. 11.
[144] Buongiorno, J. et al. (2016), "The Offshore Floating Nuclear Plant Concept," Nuclear Technology. Vol. 194, pp. 1-14; Staats E. B. (1973), Before Licensing Floating Nuclear Powerplants, Many Answers Are Needed. EMD-78-36; B-127945 at 3.
[145] IMDG Code at 1.5, 2.7, and 6.4 et seq.

transport to facility. Subsequent sections of this paper will discuss the difference security guidance provided for nuclear material at a facility versus nuclear material in transport.

D. FNPP as a Temporary Floating Platform

Earlier in the discussion about whether an FNPP is a vessel, Steding's analysis briefly touched on whether an FNPP can be classified as a temporary platform.[146] In a similar vein, the MIT OFNP compares its concept to a floating oil rig.[147] In both cases, the FNPP would be constructed in the supplier State and towed into position between 5 and 12 nautical miles (nm) offshore from the host State, usually within the host State's territorial waters.[148]

The problem with defining the FNPP as a facility is that it runs into the same problem of defining the FNPP as a vessel, particularly as it relates to UNCLOS. Under UNCLOS, there is no definition for the term platform; however, Professor Noyes pointed to other places with UNCLOS that address "temporary platforms."[149] Article 56 and Article 60 of UNCLOS discuss artificial islands, installations, and structures and the rights of Coastal States to exercise jurisdiction over these elements as part of their sovereignty.[150] Professor Noyes' argument rests on an FNPP being equated to such an installation or structure.[151] However, the provisions of Article 56 and Article 60 deal with jurisdictional constraints for artificial islands, structures, and installations in the Exclusive Economic Zone (EEZ)[152], approximately 24–200 nm away from a Coastal State.[153] In the scenario described here, an FNPP would be towed into position

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[146] Steding at 733.
[147] Buongiorno, J. et al. (2016), "The Offshore Floating Nuclear Plant Concept," Nuclear Technology. Vol. 194, p. 2.
[148] Id. at 10 (illustrating security zones for the OFNP with a monitored area of approximately 8 nm).
[149] Walker & Noyes at 319.
[150] 1833 UNTS at 418–19.
[151] Walker & Noyes at 319.
[152] The Exclusive Economic Zone (EEZ) extends from the end of the 12 nm territorial seas outward to approximately 200 nm. Within the EEZ is an area known as the Contiguous Zone. This zone starts at 12 nm and extends to 24 nm from a coastal State's baseline. Kelo, J. et al. (2007), Coastal and Ocean Law Cases and Materials 3rd ed., p. 391.
[153] 1833 UNTS at 418–19.

approximately 5–12 nm from a Coastal State, the jurisdictional limitations are not as imposing as the jurisdictional constraints of the EEZ, which is sometimes referred to as the "high seas."[154]

In contrast to the scenario where an FNPP is docked within a host State's port facility and is operating, consider a situation where an FNPP from a supplier State is towed into position within a host State's territorial waters. For example, if the FNPP is determined to be a vessel and claims to be under the flag of the supplier State, what laws apply? Specifically, which nuclear and maritime security regulations does the FNPP abide by? Is the FNPP beholden to the security regulations of the Coastal State hosting the FNPP, or is the FNPP still required to follow the nuclear and maritime security regulations of the supplier State? In the case of the *Akademik Lomonosov*, what laws and regulations would the FNPP and its crew be responsible for abiding to if the FNPP, under tow, were to leave Russian territorial waters and were to be moored offshore of another coastal State?[155] Does an FNPP have the right to claim a flag and therefore cloak itself in the rights of the supplier State, or does the fact that the FNPP is not self-propelled disqualify it from being flagged? The next section of this analysis will focus on the jurisdictional rights and controls, both for the supplier State and the owner of the FNPP and the Coastal State (host State) that will be receiving the FNPP. Not to be forgotten in the analysis, the next section will also discuss the rights under the CPPNM, ACPPNM, and other international instruments for notification of transit through a State's territorial waters as an FNPP makes it voyage to its destination.

IV. Jurisdictional Considerations for the Transport of an FNPP

Unlike a land-based nuclear reactor, an FNPP may need to be transported from the supplier State to a host State. In some instances, such transport may transit through the waters of one or more transit States. In the 2013 report studying the legal and institutional challenges for TNPPs, the IAEA acknowledged the legal difficulties with transporting an FNPP between a supplier State and a host State

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[154] See Richards, R. K. (2011), "Deepwater Mobile Oil Rigs in the Exclusive Economic Zone and the Uncertainty of Coastal Jurisdiction," International Business and Law, Vol. 10, p. 399.
[155] See Digge, C., "Russia Ponders a Floating Nuclear Power Plant for India," Bellona (18 Nov. 2019).

because of the various legal arrangements that need to be in place before the transport.[156] In the report, the agency recognized that should the transport of an FNPP need to transit through the waters of one or more transit States, special arrangements would need to be agreed upon with that transit State.[157]

The question shifts from what an FNPP is as discussed in the previous section to what the jurisdictional responsibilities and limits are, especially for transport of an FNPP. This section will focus on the jurisdictional considerations for the transport of an FNPP, focusing on the supplier State's responsibilities potentially as a flag State for the FNPP, a transit State's prerogatives under both nuclear and maritime law, and finally the rights of a Coastal State, specifically within the territorial waters of that State. Much of the maritime rights and responsibilities flow from the provisions of UNCLOS and the ocean jurisdictional zones that the Convention created.[158]

In each case, the rights and responsibilities may be different and emphasizes the conclusion by the IAEA that special arrangements will be needed for the transport and security of an FNPP as it is transported from the supplier State to the host State.[159]

A. Supplier State

If the supplier State is a party to the CPPNM and ACPPNM, it is required to comply with the provisions of those conventions. In addition to the requirements for domestic and international transport, Fundamental Principle C of the ACCPNM requires the development of legislative and regulatory framework to govern the security of nuclear material.[160] The regulatory framework should provide for the establishment of procedures for licensing, authorizing, and inspecting both nuclear facilities and transport of nuclear material.[161]

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[156] IAEA FNPP Report at 32.
[157] Id.
[158] Kelo, J. et al. (2007), Coastal and Ocean Law Cases and Materials 3rd ed, p. 391.
[159] IAEA FNPP Report at 32.
[160] Nuclear Energy Agency, Compendium of International Legal Instruments in the Field of Nuclear Law, Part II 103 (2019).
[161] Id. Id.

Outside of nuclear security and the nuclear law framework, domestic maritime security provisions will need to be implemented. In the cases of the *Sturgis*, the *Akademik Lomonosov*, and the OFNP concept developed by MIT, the construction of such structures occurred or would occur at a shipyard. For example, the *Akademik Lomonosov* was constructed at a shipyard in Murmansk, and the *Sturgis* was set into a facility in Savannah for repairs on its voyage to decommissioning.[162] Under the ISPS Code, a State needs to ensure maritime security measures are in place at the facility where the FNPP is being constructed or repaired, and subsequent maritime security measures must be in place for the vessel and its crew when the FNPP makes its journey from the supplier State to the host State.[163] Such security measures include the designation of a Facility Security Officer for the facility where the FNPP is constructed or repaired, a Vessel Security Officer who will oversee security while the FNPP is in transit and that there is a Facility Security Plan (FSP) and Vessel Security Plan in place at all times. These will be discussed in further detail in later sections of this paper.[164]

Once an FNPP starts to be moved, under power of tug or another mechanical vessel, the supplier State shall exercise full jurisdiction, both of its nuclear and maritime law. According to UNCLOS, the supplier State shall exercise full legal jurisdiction in its territorial waters.[165] As the FNPP moves out of the territorial waters into the EEZ, the jurisdictional reach of the supplier State begins to decrease. This is where, for example, the FNPP may now be on the high seas or travel through a transit State's EEZ or, for that matter, its territorial waters.

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[162] Kramer, A. E., "The Nuclear Power Plant of the Future May Be Floating Near Russia," N.Y. Times (Aug. 26, 2018); Honerlah, H. B. & Hearty, B. P. (2002), "Characterization of the Nuclear Barge Sturgis," presentation at Waste Management Symposium, February 24–28, www.wmsym.org/archives/2002/proceedings/44/168.pdf.
[163] See generally International Ship and Port Facility Security Code, Chapter XI-2 of the International Convention for Safety of Life at Sea, entered into force 1 July 2004 (ISPS Code).
[164] Id.
[165] Bardin, A. (2002), "Coastal State's Jurisdiction over Foreign Vessels," Pace International Law Review, Vol. 14, Pace University, p. 33.

B. Transit State

Before the CPPNM and the ACPPNM, the only other international nuclear law instrument referencing "transboundary movements," is the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.[166] Article 27 of the Joint Convention discusses transboundary movements.[167] Although the Article discusses responsibilities for the contracting party, the originating State, and the State of destination, the article is silent about the rights of a transit State in protecting its people and environment.[168] The article does mention the need for contracting parties to abide by international obligations that are relevant to the particular modes of transport used, but there is no mention of how that translates into rights for transit States whose maritime borders or airspace maybe crossed by a shipment.[169]

One of the observations from the Joint Convention is the lack of legal rights or protections for "transit States," those States where spent fuel may travel through but may neither be the originating State or the State of destination.[170] Tonhauser and Jankowitsch Prevor observed that the Joint Convention "seems to accord less protection to States of transit . . ." because in the judgment of the group of experts involved in drafting the convention, no new legal rights needed to be developed for these States.[171] In their view, UNCLOS provided sufficient protections for those States that were signatories to UNCLOS, but States outside the UNCLOS framework voiced their opposition.[172]

In contrast to the Joint Convention, the CPPNM and its Amendment recognized the importance of continuity of security of nuclear material even in the transit State.[173] Specifically, Article 4.3 of the

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[166] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (1997), IAEA Doc. INFCIRC/546, 2153 UNTS 357, entered into force 18 June 2001 (Joint Convention).
[167] Id. at art. 27
[168] Id. at art. 27(1) (i–v).
[169] Id. at art. 27(1)(ii).
[170] Tonhauser, W. & O. Jankowitsch Prevor (2006), The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste at 210, International Nuclear Law in the Post Chernobyl Period, www.peacepalacelibrary.nl/ebooks/files/OECD_NEA_TONHAUSER_JANKOWITSCH.pdf.
[171] Id.
[172] Id.
[173] CPPNM art. 4.3.

CPPNM requires that a State Party shall not allow transit through its territory, including airspace and waters, unless that party has received assurances as far as practicable that the nuclear material will be protected during the transport.[174] Where the Joint Convention failed to provide protection for transit States, the CPPNM and its Amendment, through the requirement of continued security of nuclear material, brought the transit States into the discussion and required that shippers of nuclear material ensure that security measures for the transit country were abided by and at the State level, if a State is not party to the CPPNM or the Amendment, adequate assurance be provided to ensure security of nuclear material will be maintained during the transport.

Nuclear law requires communication between originating States and transit States, but maritime law is less clear, depending on where the vessel is within a transit State's maritime boundaries. As previously mentioned, if the FNPP is traveling through a transit State's territorial waters, the transit State retains full jurisdictional control over those waters, with the exception of allowing for innocent passage through such waters.[175] Article 18 of UNCLOS defines "passage" as "navigation through territorial waters without entering the internal waters of the coastal State or for the purpose of entering or leaving the internal waters with the condition that the passage be continuous and expeditious . . ."[176] This right has been recognized by the International Court of Justice.[177]

If an FNPP transits through a coastal State's EEZ, the jurisdictional reach is more limited. Under UNCLOS Article 56(1), the coastal State's jurisdictional reach is only for the purposes of "exploring, exploiting, conserving, and managing the natural resources . . ." for this area.[178] The coastal State also has control over artificial islands, installations, and structures in this area.[179] This phrase "artificial, islands, installations and structures," is what Professor Noyes discusses in his analysis of why UNCLOS does

[174] Id.
[175] Bardin at 33.
[176] Bardin at 34 (citing UNCLOS art. 18).
[177] See Corfu Channel case (U.K. v. Albania), 1949 ICJ 1 (April 9).
[178] Bardin at 41 (citing UNCLOS art. 56(1)).
[179] Id.

recognize temporary floating platforms such as oil rigs, although the language is ambiguous and UNCLOS does not define artificial island, installation, or structure.[180] Bardin explains that foreign States, such as a supplier State transiting through with an FNPP, enjoy certain rights within a transit State's EEZ.[181] Such rights include the following freedoms: navigation, overflight, the laying of submarine cables and pipelines, and other internationally lawful uses of the sea related to those freedoms.[182]

A supplier State would have the freedom of navigation in either the territorial waters or the EEZ of a transit State. While those freedoms exist, the CPPNM and the ACPPNM also require States to communicate to ensure security of nuclear material is in place. As previously mentioned, the transport of nuclear material has led to the discussion about whether the freedom of innocent passage is appropriate because of the ultra-high risks involved with nuclear material. [183] Balancing principles such as the freedom of navigation with the precautionary principle of avoiding harm have led some to question whether, for nuclear material, other arrangements should be considered, such as regional agreements or creating dedicated sea-lanes for such transports.[184]

C. Host State

Once the FNPP reaches the host State's territorial waters, the host State's laws and regulations should have full legal force. Similar to the jurisdictional rights of the supplier State, once the FNPP is towed into position, either at a port facility or moored within the territorial waters of the host State, the nuclear security regime for the host State should apply and the host State's implementation of the ISPS code will also take effect. While a supplier State may try to argue that certain laws, such as nuclear security and safeguards provisions of the host State may not apply to the FNPP, as the FNPP is not a

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180 Id. See also Walker & Noyes at 319.
181 Bardin at 43.
182 Id. (citing UNCLOS arts. 87–88).
183 See Welming, L. (2007), The Transportation of Nuclear Cargo at Sea Shrinkage of the Right of Innocent Passage?, p. 34 (University of Lund); Van Dyke, J. M. (2002), "The Legal Regime Government Sea Transport of Ultrahazardous Radioactive Materials," Ocean Development International Law, Vol. 33, pp. 77–108.
184 Welming at 39–40.

flagged vessel under international maritime law, it is more analogous to critical infrastructure, or at the very least, a floating barge that has been decommissioned and turned into a hotel or a casino.

When transporting an FNPP, nuclear law and maritime law jurisdictional awareness is critical. Nuclear Security Series No. 20 stresses that nuclear security is the responsibility of the State, and when an FNPP is moving between multiple jurisdictions, recognizing the jurisdictional reaches, especially in the maritime domain, is important.[185] Having discussed the jurisdictional boundaries of the CPPNM, the ACPPNM, and the subsequent reaches of jurisdiction within a State's maritime boundaries, there is a need for a constant awareness of where the FNPP may be located at a given time. Further, what communications are necessary between States about security measures that remain in place through the whole voyage?

Having discussed the jurisdictional considerations for transporting an FNPP, the next section will discuss the security measures that would be needed. In the context of security, the next section will discuss security measures and their application at nuclear facilities and in transport of nuclear material.

V. Security Considerations for an FNPP

Previous work analyzing the security of FNPPs focused exclusively on the nuclear security considerations with limited discussion or acknowledgment of the maritime equities involved.[186] Because of the maritime environment, nuclear security considerations are not the only requirements for ensuring security of the FNPP. In addition to the recommendations and guidance from the IAEA, a country should apply its maritime security regulations as appropriate and in alignment with its obligations under the IMDG and ISPS codes. This section will discuss the security guidance developed for facilities and

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[185] IAEA (2013), Objective and Essential Elements of a State's Nuclear Security Regime, Nuclear Security Series No. 20 at 1, IAEA, Vienna.
[186] See Conway, J. et al. (2019), "Physical Security Analysis and Simulation of the Multi-layer Security System for the Offshore Nuclear Plant (ONP)," Nuclear Engineering and Design, Vol. 352, p. 110160; Skiba, J. M. & Scherer, C. P. (2015), Los Alamos National Laboratory, Nuclear Security for Floating Nuclear Power Plants, LA-UR-15-27946, https://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-15-27946; Nikitin, A. & Andreyev, L. (2011), "Floating Nuclear Power Plants," https://network.bellona.org/content/uploads/sites/3/Floating-nuclear-power-plants.pdf; Dowdall, M. & W. J. F. Standring (2008), Nuclear Power Plants and Associated Technologies in the Northern Areas, Norwegian Radiation Protection Report, StralevernRapport No. 15.

security during transport in both the nuclear and maritime security domains. Much of the guidance overlaps, but it is important for a country to apply both nuclear security and maritime security requirements in preparing for delivering, receiving, or being a transit State for an FNPP.

A. Facility Security

For an FNPP that is docked at a port facility or is moored offshore within a State's territorial waters, the elements of physical security resemble those used for security of either maritime infrastructure, such as a port facility, or in the case of nuclear security, a traditional land-based power plant. In either case, there are recommendations or requirements for physical security at both ports and nuclear facilities.

i. Nuclear Security

Under the Amendment to the Convention on the Physical Protection of Nuclear Material, Article 2A (1) calls for the security of nuclear material and nuclear facilities.[187] In contrast to the CPPNM, which solely focused on international transport, the ACPPNM adds State requirements for security for domestic use and storage of nuclear material.[188] Within Fundamental Principle G of the ACPPNM, the Amendment calls for security requirements to be "based on a graded approach, taking into account the current evaluation of the threat, relative attractiveness, the nature of the material and potential consequences associated with the unauthorized removal of nuclear material and with sabotage against nuclear material or nuclear facilities."[189] Referring back to the original CPPNM, the Amendment applies the Annex II of the CPPNM for determining material categorization based on the quantity of material and whether it is irradiated or fresh.[190] This categorization is applied throughout the Nuclear Security Series documents for determining and developing security measures for various categories of nuclear material.[191]

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[187] ACPPNM at art. 2A(1).
[188] Id.
[189] Id. at art 2A (3).
[190] See CPPNM at Annex II, Categorization of Nuclear Material.
[191] See IAEA (2011), Nuclear Security Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities, Nuclear Security Series, No. 13, IAEA Doc. INFCIRC/225/Rev. 5, IAEA, Vienna; IAEA (2015), Security of Nuclear Material in Transport, Nuclear Security Series, No. 26-G, IAEA, Vienna; IAEA (2018) Physical

Although the ACPPNM requires security of nuclear materials at nuclear facilities, the Convention is silent as to the development of such security requirements. Within the IAEA Nuclear Security Series documents, there are a series of documents known as Nuclear Security Recommendations, which "set out measures that States should take in order to achieve and maintain an effective regime."[192] Nuclear Security Series No. 13, also referred to as INFCIRC/225/Rev. 5, provides recommendations for the security of nuclear materials and nuclear facilities.[193] Nuclear Security Series No. 13 applies principles of nuclear security such as detection, delay, and response to ensure protection of nuclear material against malicious acts, including theft and sabotage.[194] These principles focus on early detection of intruders or insiders trying to remove nuclear material without authorization, delay of the theft or sabotage with barriers or obstacles to such removal, and effectively responding to such an event[195].

As part of security, Nuclear Security Series No. 13 also calls for a layered defense of nuclear material. Depending on the categorization of the material, the following layers of security may be applied:

- **Limited Access Area**: A designated area containing a nuclear facility and nuclear material to which access is limited and controlled for physical protection purposes.
- **Protected Area**: An area inside a limited access area containing Category I or II nuclear material, sabotage targets or both, surrounded by a physical barrier with additional physical protection measures.
- **Inner Area**: An area with additional protection measures inside a protected area, where Category I nuclear material is used, stored, or both.

Protection of Nuclear Material and Nuclear Facilities (Implementation of INFCIRC/225/Revision 5), Nuclear Security Series, No. 27-G, IAEA, Vienna.

[192] IAEA (n.d.), Nuclear Security Series, https://www.iaea.org/resources/nuclear-security-series (last visited December 27, 2019).

[193] See IAEA (2011), Nuclear Security Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities, Nuclear Security Series, No. 13, IAEA Doc. INFCIRC/225/Rev. 5, IAEA.

[194] Id. at 21.

[195] Id. at 24.

- **Vital Area**: Area inside a protected area containing equipment, systems, or devices or nuclear material, the sabotage of which could directly or indirectly lead to high radiological consequences.[196]

Nuclear Security Series No. 13 not only focuses on the security elements that more traditionally could be described as "guards, gates, and guns," but it also provides recommendations for security issues at facilities such as computer security, trustworthiness of personnel, and recommendations for contingency planning for a nuclear security event.[197]

Beyond the recommendations of Nuclear Security Series No. 13, the IAEA also develops implementation guides that provide guidance about how States can implement the recommendations.[198] Nuclear Security Series No. 27-G provides an extensive discussion about to how to implement the recommendations of Nuclear Security Series No. 13, providing further detail on specific security measures that need to be deployed to protect nuclear material and nuclear facilities.[199] One element discussed at length in Nuclear Security Series No. 27-G is the development of a security plan.[200] The plan is based on the State's threat assessment or the design basis threat and includes sections about dealing with design, evaluation, implementation, and maintenance of the security system and contingency plans.[201] This will look similar to the facility security plan under the relevant provisions of the ISPS Code.[202]

The security of the *Akademik Lomonosov* is not known to the public, but work by the Norwegian Radiation Protection Authority tried to find equivalent application, providing an analogue to the Russian

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[196] IAEA (n.d.), "Key Considerations—Drafting Regulations for Physical Protection of Nuclear Material and Nuclear Facilities," at slide 12. Presentation material used in the International Training Course on Developing Regulations and Associated Administrative Measures for Nuclear Security, 24-28 June 2019, Beijing, China.
[197] See IAEA (2011), Nuclear Security Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities, Nuclear Security Series, No. 13, IAEA Doc. INFCIRC/225/Rev. 5, IAEA.
[198] IAEA (n.d.), Nuclear Security Series, https://www.iaea.org/resources/nuclear-security-series (last visited December 27, 2019).
[199] See IAEA (2018) Physical Protection of Nuclear Material and Nuclear Facilities (Implementation of INFCIRC/225/Revision 5), Nuclear Security Series, No. 27-G, IAEA, Vienna.
[200] Id. at 93.
[201] Id.
[202] See ISPS Code at Part A section 16.

Federation's Atomflot and the civilian nuclear icebreaker fleet.[203] According to the report by the Norwegian Radiation Protection Authority, when a nuclear icebreaker is being fueled, the fuel is brought into the facility by rail and moved to a service vessel.[204] Atomflot imposes a 2 km security zone around the entire facility, and the Russian Navy patrols the northern and western seaward approaches.[205] The facility is surrounded by a double security fence with intrusion monitoring/detection systems and guard towers.[206] Guards and patrols are supplied by the Interior Ministry, and there is only one pedestrian entry point to the facility.[207]

ii. Maritime Security

According to Joseph Ahlstrom in his book, *Vessel Security Officer*, "the ISPS Code encompasses a global maritime strategy for anti-terrorism that shares cost and responsibility along a broad spectrum of government and private institutions."[208] Similar to the nuclear security framework, the ISPS Code and its domestic implementation by States relies on layered security to provide continuous security from the originating port facility, to the transit port facility, and to its eventual destination.[209]

The ISPS Code, Part A has specific sections that delineate facility security requirements.[210] Under the ISPS Code, Contracting Parties are required to "act upon the security level set by the Contracting Party within whose territory it is located."[211] The Code further defines different Maritime Security (MARSEC) levels. Level 1 MARSEC is the lowest security level, and MARSEC level 3 is the highest with the strictest protective measures.[212] Additionally, each port facility within a Contracting

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[203] Dowdall, M. & W. J. F. Standring (2008), Nuclear Power Plants and Associated Technologies in the Northern Areas, Norwegian Radiation Protection Report, StralevernRapport No. 15.
[204] Id.
[205] Id.
[206] Id.
[207] Id.
[208] Ahlstrom, J. (2006), Vessel Security Officer, p. 3.
[209] Id. at 3.
[210] ISPS Code at Part A sections 14–17.
[211] ISPS Code at Part A section 14.1.
[212] Id. at sections 14.2–14.4.

Party to ISPS shall undergo a port facility security assessment and have a port facility security plan (or FSP).[213] Section 16.3 of ISPS addresses what the plan should contain, including

- measures designed to prevent weapons, or any other dangerous substances and devices intended for use against person ships or ports . . . from being introduced in the port facility or on board a vessel;
- measures to prevent unauthorized access to the port facility [and ships moored at the facility];
- procedures for responding to security threats or breaches of security. . .;
- procedures for responding to any security instructions. . . the port facility may give at MARSEC level 3; and
- procedures for evacuation in case of security threats or breaches of security.[214]

The plan components listed above are not exhaustive but provide an example of what should be included in an FSP. To implement the FSP, the ISPS calls for the designation of a facility security officer, whose responsibility includes maintaining the FSP, inspecting the facility, and enhancing security awareness at the facility.[215] The ISPS Code does not address security precautions for moving, handling, or storing dangerous cargoes such as radioactive or nuclear material within a port facility.[216] The ISPS Code addresses maritime security at floating and fixed platforms and mobile offshore drilling units on location by suggesting that Contracting Parties to ISPS establish "appropriate security measures" for these installations to allow for interaction with ships that are required to comply with the ISPS Code.[217]

In the scenario an FNPP is docked at a port facility, both elements of nuclear security and maritime security should be applied. In both instances, a graded approach is used to evaluate the threat

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[213] Id. at sections 15–16.
[214] ISPS Code at Part A section 16.3.1–16.3.5.
[215] Id. at 17.2.1–17.2.6.
[216] But see 33 CFR § 105.295 (2003) (describing security measures for securing certain dangerous cargoes in a port facility).
[217] ISPS Code at Part B section 4.19. See also Buongiorno, J. et al. (2016), "The Offshore Floating Nuclear Plant Concept," Nuclear Technology. Vol. 194, pp. 9–10.

condition at the facility, but layers of security should be implemented to detect, delay, and respond to any attempts at malicious actions against the FNPP. Such layers may include the designation of security areas that blend the areas discussed for nuclear security with the port facility security requirements.[218] Additionally security requirements for personnel trustworthiness should be adopted to mitigate insider threats.[219]

B. Security during Transport

In its 2013 report on TNPPs, the IAEA explained the difference between security at fixed sites and security during transport.[220] In short, the agency explained that

> [p]hysical protection measures applied to the transport of nuclear material are generally considered to be distinct from those applied to fixed site facilities because of the additional complexities encountered during transport. These complexities arise from the need to transport the protection system along with the material and from the changing physical and threat environment through which the transport moves.[221]

The complexities described by the IAEA do not end with the security measures. Transport security is complex because it is multimodal, multijurisdictional, and involves multiple stakeholders.[222] Whether in nuclear security or maritime security, the number of stakeholders involved with transport increases the complexity of nuclear security and general security exponentially.

i. Nuclear Security

Like facilities, the CPPNM and ACPPNM are the primary nuclear law instrument for ensuring security of nuclear material during transport. Whereas the CPPNM solely focused on international

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[218] IAEA (n.d.), "Key Considerations—Drafting Regulations for Physical Protection of Nuclear Material and Nuclear Facilities" at slide 12. Presentation material used in the International Training Course on Developing Regulations and Associated Administrative Measures for Nuclear Security, 24-28 June 2019, Beijing, China.
[219] See 33 CFR § 101.514 (2016) (describing the Transportation Worker Identification Credential and its use at Maritime Transportation Security Administration facilities).
[220] IAEA FNPP Report at 41.
[221] Id.
[222] Fialkoff, M. R. (2019), "Regulatory Design for Transport Security Regulations of Nuclear and Other Radioactive Material," presented at Purdue Conference on Active Non-proliferation, Lafayette, Indiana, Mar. 22–23.

transport of nuclear material, the ACPPNM added security requirements for domestic transport.[223] Again, similar to facilities, neither the CPPNM nor the ACPPNM provide guidance about how to ensure security during transport. Nuclear Security Series No. 13 provides recommendations for securing nuclear material against unauthorized removal during transport.[224] Although Nuclear Security Series No. 13 provides recommendations, the U.N. Model Regulations, and by extension, the IMDG Code addresses Nuclear Security Series No. 13 as a way of satisfying requirements for nuclear material and imposes such recommendations directly on maritime shippers of nuclear materials.[225] The recommendations call for a graded approach to protect nuclear material,[226] including the following recommendations associated with transport:

- Minimizing the total time during which the *nuclear materials* remains in *transport*
- Minimizing the number and duration of *nuclear material* transfers
- Protecting *nuclear material* during *transport* and in temporary storage in a manger consistent with the category of that *nuclear material*
- Avoiding the use of predictable movement schedules by varying times and routes
- Requiring predetermination of the trustworthiness of individuals involved during *transport* of *nuclear material*
- Using a material transport system with passive and/or active *physical protection measures* appropriate for the *threat assessment* or *design basis threat*[227]

Nuclear Security Series No. 13 set forth provisions and recommendations for specific security measures for the various categories of nuclear material categorized under the CPPNM, Annex II.

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[223] ACPPNM at 2A (1)(a).
[224] See IAEA (2011), Nuclear Security Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities, Nuclear Security Series at 38, No. 13, IAEA Doc. INFCIRC/225/Rev. 5, IAEA.
[225] IMDG Code at 1.4.3.2.3 Footnote 2. The current edition of the IMDG Code cites INFCIRC/225/Rev. 4, but recent changes recognize the most recent version of INFCIRC/225/Rev. 5.
[226] See IAEA (2011), Nuclear Security Recommendation on Physical Protection of Nuclear Material and Nuclear Facilities, Nuclear Security Series at 39, No. 13, IAEA Doc. INFCIRC/225/Rev. 5, IAEA.
[227] Id.

Speaking to maritime transport for Categories I and II of nuclear material, section 6.31 of Nuclear Security Series No. 13 recommends that for maritime transport, nuclear material should be shipped in a secure compartment or container that is locked and sealed.[228] For Category I nuclear material, the shipment should be carried on a dedicated transport vessel.[229]

Whereas facilities have Nuclear Security Series No. 27-G which provides implementing guidance for nuclear facilities and nuclear material, Nuclear Security Series No. 26-G provides implementation guidance for security of nuclear material during transport. Like the jurisdictional considerations discussed in section 3.11 of Nuclear Security Series No. 26-G, the importance of identifying transfers and responsibilities as a vessel transits through another State's territorial waters.[230] On advanced notification and coordination, for all categories of nuclear material, the IAEA suggests that the shipper or carrier should provide advanced notice of arrival and the mode on which the nuclear material will arrive.[231] This helps the receiver ensure security measures are in place consistent with the category of material and alerts the competent authority to the arrival of nuclear material within its jurisdiction.[232]

Nuclear Security Series No. 26-G also calls for the development of a transport security plan (TSP) when moving nuclear materials.[233] According to Nuclear Security Series No. 26-G, "[t]he TSP should document all security measures and arrangements necessary to adequately address the security requirements when transporting nuclear material."[234] It should also identify stakeholders and their responsibilities for all aspects for the security of nuclear material during transport.[235] Unlike Nuclear Security Series No. 13 which did not include much about maritime transport of nuclear material, Nuclear Security Series No. 26-G goes into great detail about ensuring maritime transport security measures, but it

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[228] Id. at 43.
[229] Id. at 45.
[230] IAEA (2015), Security of Nuclear Material in Transport, Nuclear Security Series at 9, No. 26-G, IAEA, Vienna.
[231] Id. at 52.
[232] Id.
[233] Id. at 43.
[234] Id.
[235] Id.

only does so for Category I nuclear material.[236] Such suggestions include the vessel, inspection, securing sensitive areas on the vessel, and the use of guards on vessels carrying such material.[237]

ii. Maritime Security

Vessel security under the ISPS Code follows the requirements for facilities under the ISPS Code very closely. Part A, section 7 of ISPS describes how a vessel and its crew should react to different MARSEC levels and refers to the guidance in ISPS to identify and take preventive measures against security incidents.[238] A vessel under ISPS should undergo a ship security assessment to identify existing security measures, identify shipboard operations that need protection, identify possible threats to shipboard operations, and identify weaknesses, both technological and human factors in the existing policies and procedures for vessel security.[239]

Subsequent to the ship security assessment, a vessel security plan should also be developed that includes

- measures designed to prevent weapons or any other dangerous substances and devices intended for use against person ships or ports and the carriage of which is not authorized from being taken on board the ship;
- identification of the restricted areas and measures for the prevention of unauthorized access to them;
- measures for the prevention of authorized access to the ship;
- procedures for responding to security threats or breaches of security, including maintaining critical operations of the ship . . .;
- procedures for auditing security activities;

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[236] Id. at 67–69.
[237] Id. For further discussion on physical protection of FNPPs, see Dowdall, M. & W. J. F. Standring (2008), Nuclear Power Plants and Associated Technologies in the Northern Areas, Norwegian Radiation Protection Report, StralevernRapport No. 15, pp. 53–54.
[238] ISPS Code at section 7.2–7.4.
[239] Id. at section 8.4.1–-8.4.4.

- procedures for interfacing with port facility security activities;
- procedures the periodic review of the plan and for updating;
- identification of the ship security officer.[240]

ISPS requires a ship security officer (also known as a vessel security officer) on each vessel.[241] The vessel security officer is responsible for ensuring vessel security, conducting regular inspections to ensure appropriate security is maintained, implement the vessel security plan, propose modifications to the vessel security plan where appropriate, enhance security awareness on the vessel, and report all security incidents.[242]

For FNPPs, maritime and nuclear security are interdependent, emphasizing the need for communication between nuclear security professionals and maritime security professionals. As previously discussed in this paper, the nuclear reactor and fuel will most likely exist as cargo on a vessel during transport because of the current international framework. Further, the vessel security officer will need to coordinate their activities and security procedures with the shipper to ensure that the nuclear security requirements for transporting nuclear material by maritime transport are met. This includes developing a transport security plan consistent with guidance from Nuclear Security Series No. 26-G and ensuring that the vessel security plan is in alignment with the transport security plan and vice versa.[243] All of this reinforces the conclusion reached by the IAEA that the transport of a TNPP, including an FNPP, is complex and will require the coordination of multiple stakeholders at multiple levels of government within the State, between States, and between the private parties involved.

In addition to the ISPS Code, two additional maritime conventions focus more generally on vessel security during maritime transport. The Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation of 1988 (SUA Convention), its additional protocol, the Protocol to the

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[240] Id. at section 9.4.1–9.4.18.
[241] Id. at section 12.1.
[242] Id. at section 12.2.1–12.2.10
[243] IAEA (2015), Security of Nuclear Material in Transport, Nuclear Security Series at 43, No. 26-G, IAEA, Vienna.

Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (2005 Protocol to the SUA Convention), and the Protocol for the Suppression of Unlawful Act against the Safety of Fixed Platforms Located on the Continental Shelf of 1988 apply here as well.[244] Even though it is less specific than the ISPS Code for specific security measures on vessels, the purpose of these conventions and additional protocols was to ensure proper action by State parties in the event a person or persons commit specified unlawful acts against ships and platforms.[245] Such unlawful acts included seizure of vessels by force, violence against persons on board vessels, and the placement of devices on board a vessel that are likely to damage or destroy it.[246] As noted in the IAEA Report on TNPPS from 2013, the 2005 Protocol to the SUA Convention expanded its coverage to include nuclear material in use for peaceful purposes.[247] The agency recognized that in this instance, security and implementation of the SUA Convention and its 2005 Protocol are within the purview of the maritime law enforcement organ of the State and not the nuclear security organization of the State.[248]

VI. Conclusion—Floating on and through: Addressing Possible Gaps in the International Legal Framework for Physical Security of FNPPs

It is understatement to say that this comment only scratches the surface of the complexity of the deployment of FNPPs. This comment sought to analyze the overlapping and interdependent nature between maritime security law and nuclear security law. Throughout the paper, maritime security considerations and nuclear security considerations are one. This work sought to answer the following question: whether the existing international legal framework in the maritime and nuclear law systems provide sufficient security for an FNPP? The short answer is yes, but although the international legal framework for nuclear and maritime security is sufficient, is it adequate? This paper highlighted the interplay between nuclear safety and nuclear security and how the package in which nuclear fuel is

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[244] IAEA FNPP Report at 75–76.
[245] Id. at 76
[246] Id.
[247] Id.
[248] Id.

transported cannot currently double as both a transport container and nuclear reactor. It also requires proper application by the stakeholders involved. This instance highlights the need for additional understanding between transport safety and transport security and identification of the interfaces, including packaging design and testing.

Furthermore, this paper discussed the need for further clarification in certain international instruments, such as the INF Code and the ISPS Code. The INF Code addresses specific vessels that can transport nuclear material, but the FNPP presents a question about the status of the FNPP during towing. While being towed into place, should an FNPP be accounted for in the INF Code, or should such a contrivance be relegated to a reactor full of fuel that is non-critical during transport and therefore is merely cargo? The ISPS Code does not address security of certain dangerous cargo in vessels and at facilities. The IMDG Code acknowledges security within Section 1.4.3.2.2 and 1.4.3.2.4, but because it defaults back to whether a State is a State Party to the CPPNM, its amendment and Nuclear Security Series No. 13, this is insufficient guidance, especially for long-term operation of an FNPP at an ISPS compliant facility.[249]

The FNPP highlights how nuclear technology can bring together disparate legal domains. In this case, FNPPs combine the ancient traditions of maritime law with the contemporary facets and eccentricities of nuclear law. While reinforcing the need for coordination and communication, the influence of one law on another set of legal principles should not go unnoticed and should be considered. Whether a FNPP or a vessel transporting spent nuclear fuel from France to Japan is being considered, the contemporary challenges of nuclear and maritime security should force practitioners in both maritime and nuclear law to look into other legal domains to further understand and open a dialogue about such issues. Although there is currently only one operating FNPP, others may be on the horizon, and the nuclear renaissance will force a re-evaluation of law and legal traditions beyond that of maritime law.

[249] IMDG Code at 1.4.3.2.3.