## Comments

# Escaping the Nuclear Ice Age: The Nuclear Regulatory Commission's Race to Regulate Small Modular Reactors

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### ABSTRACT

Humanity is facing an environmental emergency. Climate change is forcing the world to mitigate the harm caused by fossil fuels and acclimate through innovation, either by creating new technology or updating existing technology. The technology required to address climate change includes energy sources that do not emit greenhouse gas emissions into the atmosphere, such as wind, solar, hydropower, and nuclear energy.

For the nuclear industry, pictures of large power plants looming above towns come to mind. The current generation of nuclear reactors caused the industry to idle because of safety, cost, and flexibility concerns. Modernization aims to cure the industry's stagnation through small modular reactors ("SMRs"). SMRs are poised to usher in the future of the nuclear industry, and they are a leading participant in confronting climate change.

Before SMRs can benefit society, however, they face a significant barrier to entry into the energy sector: federal regulation. The Nuclear Regulatory Commission (NRC) heavily regulates the nuclear industry.

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Such regulation limits SMRs because current regulations were designed for older, larger reactors. These regulations follow a deterministic approach, using more rigid compliance criteria for reactor designs than the contemporary, risk-informed approach. Throughout the twenty-first century, the NRC has failed to adequately update the licensing of nuclear reactors, inhibiting the approval, and thus the implementation of, SMRs. After years of conforming to an old design standard, the nuclear industry has radically changed the look and use of nuclear reactors for the better. If the industry was able to invest in new technology and adapt, with hopes of aiding the future of humanity, then the NRC can, too. The NRC's best opportunity for reducing restrictive, deterministic criteria is to remove those criteria when creating 10 C.F.R. § 53, allowing SMRs to successfully enter the energy arena.

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## I. INTRODUCTION

The 2002 animated movie *Ice Age* follows the journey of unlikely friends.[1] A sabretooth tiger, a sloth, and a wooly mammoth work together to bring a lost child home.[2] However, when watching this family-friendly tale, it is easy to ignore the environmental crisis occurring in the background: the ice age.[3] Like the animals in *Ice Age*, humans, too, have gone about their lives pushing a threatening, ongoing environmental phenomenon into the background: climate change.[4]

Today, climate change is a central issue in society because of its negative impacts on the planet, including changing weather patterns and rising sea levels.[5] These effects are a result of increased greenhouse gas emissions, mainly due to burning fossil fuels, which warm the earth's atmosphere.[6] In an effort to reduce this warming, the 2015 Paris Agreement created a commitment amongst participating countries to prevent global temperatures from rising above two degrees Celsius.[7] Achieving this commitment requires the world to shift the energy mix away from fossil fuels.[8] Recently, reducing fossil fuels has proven especially difficult because of the economic rebound following the COVID-19 pandemic, which increased oil and gas prices.[9] Further, the global market for oil became more volatile after Russia invaded Ukraine in early 2022.[10] In the wake of this market volatility, the world is struggling to combat high energy prices.[11]

Through these events, the world is realizing that a greater investment in clean energy sources is the long-term answer.[12] For example, in late 2022, Poland contracted with Westinghouse Electric Company, a U.S.

1. *See 5 Animation Movies on How Climate Change and Human Activities Affects the Environment*, LIFENVI BLOG (Dec. 11, 2019), https://bit.ly/3fGY5kY.
2. *See id.*
3. *See id.*
4. *See* Nsikan Akpan, *How Your Brain Stops You from Taking Climate Change Seriously*, PBS (Jan. 7, 2019, 12:50 PM), https://to.pbs.org/3E5qPNG.
5. *See id.*
6. *See id.*
7. *See How can nuclear combat climate change?*, WORLD NUCLEAR ASS'N, https://bit.ly/3DJhmtQ (last visited Dec. 20, 2022).
8. *See id.*
9. *See Global Energy Crisis*, INT'L ENERGY AGENCY, https://bit.ly/3FSdyZZ (last visited Dec. 14, 2022).
10. *See id.* (detailing how Russia's invasion of Ukraine tightened Europe's energy needs because of its dependence on Russian gas).
11. *See id.*
12. *See id.*

nuclear power firm, to build the country's first nuclear power plant.[13] Simultaneously, this decision displayed to Russia that Poland refuses to depend on Russia's gas supply, and it expressed to the world that nuclear power is a pathway toward reducing climate change.[14] As a clean energy source, nuclear power is one solution to the current energy crisis and the prolonged battle against climate change.[15]

Nuclear energy is an established source of electricity.[16] As of September 2022, over 50 countries across the globe used nuclear energy, accounting for 10% of the world's electricity.[17] The United States is a leading producer of nuclear energy, accounting for 20% of the country's electricity through the operation of 92 reactors.[18] The United States' nuclear profile is strong compared to other countries, but, historically, it has remained stagnant.[19] The stagnation in nuclear energy comes from public fear and a lack of innovation.[20] However, small modular reactors ("SMRs") are a recent technological advancement that can place nuclear energy at the forefront of the energy and climate solution.[21]

This Comment begins by comparing the older generation of nuclear reactors, large-scale reactors ("LSRs"), with newer designs of nuclear reactors, SMRs, highlighting how SMRs can solve the long-running issues of safety, cost, and flexibility in the nuclear industry.[22] Next, this

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13. *See* Justyna Pawlak & Anna Koper, *Poland picks U.S. offer for its first nuclear power plant, prime minister says*, REUTERS (Oct. 28, 2022, 8:10 PM), https://reut.rs/3NC0U3g.

14. *See id.*

15. *See* Richard Rhodes, *Why Nuclear Power Must Be Part of the Energy Solution*, YALE ENV'T 360 (July 19, 2018), https://bit.ly/3fFU4x4.

16. *See Nuclear Power in the World Today*, WORLD NUCLEAR ASS'N, https://bit.ly/3CIC3XB (last visited Dec. 14, 2022).

17. *See id.* (explaining that although other renewable energy sources will have their place within the solution to climate change, nuclear energy remains a crucial part of the solution and therefore deserves less criticism).

18. *See Nuclear Power in the USA*, WORLD NUCLEAR ASS'N, https://bit.ly/3Vg5bNh (last visited Dec. 14, 2022). *Compare Frequently Asked Questions (FAQs): How many nuclear power plants are in the United States, and where are they located*?, U.S. ENERGY INFO. ADMIN., https://bit.ly/3Dxx3Wu (last visited Dec. 14, 2022) (listing more than 90 nuclear power reactors across the United States), *with Nuclear Power Plants*, CANADIAN NUCLEAR SAFETY COMM'N, https://bit.ly/3DxyzYM (last visited Dec. 14, 2022) (describing Canada's production of nuclear energy as providing 15% of the country's electricity with only 22 reactors).

19. *See* OFF. OF NUCLEAR ENERGY, SCI. AND TECH., U.S. DEP'T OF ENERGY, THE HISTORY OF NUCLEAR ENERGY 9 (2002), https://bit.ly/3RW37aU [hereinafter OFF. OF NUCLEAR ENERGY, SCI. AND TECH.]. In 1991, like today, nuclear energy comprised approximately 20% of the energy produced in the United States. *See id.*

20. *See Advantages and Challenges of Nuclear Energy*, OFF. NUCLEAR ENERGY (Mar. 29, 2021), https://bit.ly/3fsHSQb [hereinafter OFF. NUCLEAR ENERGY: *Advantages and Challenges*].

21. *See* Joanne Liou, *What are Small Modular Reactors (SMRs)?*, INT'L ATOMIC ENERGY AGENCY (Nov. 4, 2021), https://bit.ly/3NnQxQu.

22. *See infra* Section II.A.

Comment discusses how the Nuclear Regulatory Commission ("NRC") regulates the licensing of nuclear reactors in the United States while also providing a practical comparison of the Canadian Nuclear Safety Commission's ("CNSC") licensing approach,[23] including a review of the NRC's and CNSC's development of SMR technology and their joint efforts.[24] A case study of the SMR designed by NuScale further discusses how the NRC has tackled the licensing process of SMRs.[25] This Comment then highlights the concerns with the NRC's current approach to approving licenses for SMRs using specific examples from the NRC's collaboration with the CNSC and NuScale's design certification process.[26]

Using these examples, this Comment argues that the implementation of SMRs in the marketplace will only be successful if, throughout the licensing process, the NRC stops defaulting to unnecessarily deterministic regulations.[27] Finally, this Comment argues that the prime opportunity for the NRC to achieve this goal and finally transition to the technology-inclusive, risk-informed, and performance-based ("TI-RIPB") approach is through the creation of an additional licensing regime, specifically 10 C.F.R. § 53, a partially drafted, proposed rule.[28] These efforts create a more flexible licensing approval process for SMRs, thereby allowing SMRs to aid the nuclear industry in solving the climate and energy crises.

## II. BACKGROUND

Appreciating the current state of the NRC's licensing approach and how it affects the approval of SMRs requires an understanding of SMRs and the benefits SMR technology creates for the nuclear industry in resolving the larger energy crisis.[29] Considering the immense technological differences between LSRs and SMRs also provides context as to why an analysis of the current nuclear reactor licensing scheme is necessary. In addition, a historical foundation of the NRC's approaches to licensing and how to license a nuclear reactor is essential.[30] As a comparison, the CNSC's licensing approach will likewise be described.[31]

23. *See infra* Sections II.B. and II.C.2.
24. *See infra* Section II.D.
25. *See infra* Section II.E.
26. *See infra* Section III.A.
27. *See infra* Section III.A.
28. *See infra* Section III.B.
29. *See infra* Section II.A.
30. *See infra* Section II.B.1.
31. *See infra* Section II.B.2.

### A. *An Overview of Small Modular Reactors*

The latest and most drastic design technology for the nuclear industry is the development of SMRs, which are advanced "nuclear reactors generally 300 MWe[32] equivalent or less."[33] SMRs have special characteristics: they can be created in a modular fashion, can be constructed in factories using economies of series production, and require shorter construction timelines than LSRs.[34] Multiple designs for SMRs and micro modular reactors were produced throughout the past decade, such as light water reactors and molten salt reactors, but such designs have not yet become operational in the United States.[35]

Historically, LSRs are the main nuclear reactors created for commercial use,[36] a fact that poses significant challenges for the nuclear industry.[37] Even though LSRs are the largest source of clean power in the United States,[38] the nuclear industry failed to increase support for LSR use chiefly due to safety, cost, and flexibility concerns.[39] Challenges with LSRs led to the new and innovative design of SMRs.[40]

Accidents at LSRs, such as the partial meltdown of the reactor plant at Three Mile Island in 1979,[41] created public fear about the safety of nuclear reactors.[42] Despite several roadblocks in the latter half of the 1900s, opportunities for the construction of new reactors in the early 2000s led people to believe a nuclear renaissance was on the horizon.[43] However, these hopes were short-lived because, in 2011, the Fukushima nuclear reactor melted down after a 15-meter tsunami struck the power plant, forcing the evacuation of over 100,000 people from their homes.[44] The reactors' melting at Three Mile Island and Fukushima emphasized that

32. *See Megawatts electric*, ENERGY EDUC., http://bit.ly/3EiqzdG (last visited Feb. 18, 2023) (defining MWe as megawatts electric).

33. *Small Nuclear Power Reactors*, WORLD NUCLEAR ASS'N, https://bit.ly/3BP8Ycq (July 2023) (explaining how SMRs are drastically different from prior generations of nuclear reactors that range up to 1600 MWe and describing micro modular reactors as SMRs with less than ten MWe).

34. *See id.*

35. *See id.*

36. *See id.*

37. *See* OFF. NUCLEAR ENERGY: *Advantages and Challenges*, *supra* note 20.

38. *See 5 Fast Facts About Nuclear Energy*, OFF. NUCLEAR ENERGY (Mar. 23, 2021), https://bit.ly/3WnPuUM [hereinafter OFF. NUCLEAR ENERGY: *5 Facts*].

39. *See* OFF. NUCLEAR ENERGY: *Advantages and Challenges*, *supra* note 20.

40. *See id.*

41. *See History*, NRC (Sept. 10, 2021), https://bit.ly/3fTowmV.

42. *See* Padmaparna Ghosh, *Nuclear Power 101*, NAT'L RES. DEF. COUNCIL (Jan. 5, 2022), https://on.nrdc.org/3rG5B1L.

43. *See* Romney Duffey & Igor Pioro, *What Happened to the Nuclear Renaissance?*, AM. SOC'Y MECH. ENG'RS (Nov. 11, 2019), https://bit.ly/3DphKgV.

44. *See Fukushima Daiichi Accident*, WORLD NUCLEAR ASS'N, https://bit.ly/3qKtFAb (Jan. 2023).

radiation exposure was a real and present risk.[45] Even though Fukushima was a more severe nuclear incident than Three Mile Island, current evidence does not show detrimental health effects on workers or residents within the surrounding areas.[46] However, the public feared acute radiation syndrome.[47]

SMRs solve reactor safety concerns because SMRs have smaller reactor cores than LSRs, meaning a smaller amount of radioactive material is present at the site.[48] Less radioactive material within SMRs allows for reduced shielding and offsite emergency planning zones ("EPZs"), therefore involving a smaller safety risk than LSRs.[49]

Another safety benefit of SMRs includes the passive safety system,[50] which provides a longer lead time for an operator to solve a potential issue before any consequences occur.[51] Because of the passive safety system, SMRs are less reliant on pumps and alternating current ("AC") power for accident mitigation as compared to LSRs.[52]

In addition to the passive system, the modular characteristic of certain SMR designs is safer than LSRs' design because the design allows for a single module to shut down for refueling, maintenance, or an accident, without affecting the remaining modules.[53] Some SMR designs even have the reactor installed underground, which protects the reactor from both natural incidents, such as earthquakes, and intentional incidents, such as terrorist threats.[54] Overall, the safety features of SMRs surpass those of LSRs based on the amount of radioactive material present, the passive safety system, and the modular design.[55]

While safety concerns surrounding LSRs persist, the lengthy construction timelines and exorbitant costs, ranging from five billion to

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45. *See* NRC, *supra* note 41.

46. *See id.*

47. *See* Ghosh, *supra* note 42 (explaining that radiation poisoning poses severe health effects including burns, vomiting, and even death).

48. *See* NUCLEAR ENERGY AGENCY, OECD, SMALL MODULAR REACTORS: CHALLENGES AND OPPORTUNITIES No. 7560, 31 (2021), https://bit.ly/3UiLClR [hereinafter NUCLEAR ENERGY AGENCY].

49. *See id.*

50. *See Use of Passive Safety Features in Nuclear Power Plant Designs and their Safety Assessment*, INT'L ATOMIC ENERGY AGENCY, http://bit.ly/3UFHAVg (last visited Dec. 14, 2022) (defining passive safety features as using "natural forces or phenomena such as gravity" to maintain safety).

51. *See* NUCLEAR ENERGY AGENCY*, supra* note 48, at 31 n.1.

52. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

53. *See* José N. Reyes, Jr., *NuScale Plant Safety in Response to Extreme Events*, 178 NUCLEAR TECH. 153, 153 (2012).

54. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

55. *See id.*

ten billion dollars for a new power plant, also create financial fears.[56] For example, construction of the Vogtle nuclear power plant in the state of Georgia was delayed by several years, and the project ended up costing more than twice the budget.[57] The Vogtle plant demonstrates why investors may not leap for a chance to participate in the backing of an LSR.[58] Further, LSRs run at $129–198/megawatt hour ("MWh"),[59] whereas one projection for the cost of the NuScale SMR was estimated at $40-65/MWh.[60] Also, construction times for SMRs are shorter because SMRs take advantage of the economy of series production in factories.[61] While SMRs do not benefit from economies of scale, the series production overcomes this financial impediment through its modular, simplified, and standard design to provide for lower construction risks.[62] Due to their pre-fabrication, factory-built SMRs also present a greater opportunity for manufacturers to apply lessons learned to achieve shorter and more predictable construction timelines than LSRs.[63]

Lastly, unlike LSRs, the SMR modular design has the flexibility to be built independently or as part of a larger reactor.[64] The capability to alter electricity production by adding or reducing modules is a key feature of SMRs.[65] For example, SMRs service small electricity grids, even those under approximately four gigawatts of electrical output ("GWe").[66] In comparison, LSRs present flexibility issues because their peak operation is typically at 100%, which prevents the ability to adjust to energy demand.[67] The modular capacity of SMRs not only allows for the exact

56. *See* Chris Vlahoplus & Sean Lawrie, *Small Modular Reactors – A Viable Option for Clean Energy Future?* 4 (KENAN FLAGER ENERGY CTR. CONF., 2021), https://bit.ly/3K9zi51.

57. *See* Ghosh, *supra* note 42.

58. *See id.*

59. *See* Vlahoplus & Lawrie, *supra* note 56, at 5*; see also* Christopher Minott, *What is a Megawatt and a Megawatt-Hour?*, CLEAN ENERGY AUTH. (May 4, 2010, 3:33 PM), https://bit.ly/3YGBMNQ (explaining that a MWh "is equal to 1,000 kilowatts of electricity used continuously for one hour," which can provide electricity to "about 330 homes during one hour").

60. NUSCALE, ADVANCED NUCLEAR TECHNOLOGY TO POWER THE FUTURE 2 (2022), https://bit.ly/3Pt7lZp.

61. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

62. *See* NUCLEAR ENERGY AGENCY*, supra* note 48, at 11.

63. *See* Vlahoplus & Lawrie, *supra* note 56, at 5 (explaining that current timeline projections for SMR production run at approximately three years). *See also Economics of Nuclear Power*, WORLD NUCLEAR ASS'N, http://bit.ly/3hM3tUB (Aug. 2022) (explaining that LSRs usually take over five years to construct).

64. *See* Vlahoplus & Lawrie, *supra* note 56, at 5.

65. *Id.*

66. *See* WORLD NUCLEAR ASS'N, *supra* note 33; *see also* A.J. Dellinger, *Gigawatt: The solar energy term you should know about*, CNET (Nov. 16, 2021, 5:00 AM), https://bit.ly/3WFitCC ("[O]ne gigawatt is enough energy to power about 750,000 homes.").

67. *See* Vlahoplus & Lawrie, *supra* note 56, at 3.

amount of energy to be produced, but it also allows for SMRs to be placed in locations unattainable for LSRs.[68] An SMR can deploy to a remote region or can produce electricity for a specific purpose, thereby adapting to consumers' changing needs.[69] In sum, SMRs resolve persistent issues that LSRs have faced, creating a new path to preserving the nuclear industry.

### *B. An Explanation of the Nuclear Reactor Licensing Process*

The NRC's licensing process for nuclear reactors includes a plethora of regulations and a general attitude towards creating and interpreting the regulations.[70] Both the United States and Canada engage in this practice but vary on how their chosen approaches are used in practice.[71] An understanding of general approaches to licensing and the United States' existing options for licensing a nuclear reactor helps to explain how the extreme design changes of SMRs make it difficult to obtain NRC approval through existing regulations.

#### 1. The United States: How the NRC Approves Licenses

The United States has been a strong force in the nuclear sector for decades with the help of the NRC, the leading administrative agency for governing nuclear power.[72] The NRC was established through the Energy Reorganization Act ("ERA") of 1974.[73] Before this legislation was enacted, the Atomic Energy Commission ("AEC") carried out the NRC's functions.[74] In 1974, the ERA divided the AEC's power between two entities: the Energy Research and Development Administration ("ERDA") and the NRC.[75] The ERDA's primary role was "to bring together and direct Federal activities relating to research and development . . . , to increase the efficiency and reliability in the use of energy, and to carry out the performance of other functions[,]" such as "military and production activities."[76] The ERDA's historical role is juxtaposed with the NRC's authority for licensing and regulation.[77]

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68. *See* Liou, *supra* note 21.
69. *See* WORLD NUCLEAR ASS'N, *supra* note 33.
70. *See* NRC, *Risk-informed and Performance-based Regulation*, Commission Paper SECY-98-144, at *1, Mar. 1, 1999, ADAMS Accession No. ML003753601.
71. *See infra* Sections II.B.1, II.B.2.
72. *See* OFF. OF NUCLEAR ENERGY: SCI. AND TECH., *supra* note 19.
73. *See id.*
74. *See id.*
75. *See id.*
76. 42 U.S.C. § 5801(b). The ERDA no longer exists; in 1977, the Department of Energy took over the ERDA's role. *See* OFF. OF NUCLEAR ENERGY: SCI. AND TECH., *supra* note 19.
77. *See* 42 U.S.C. § 5841(f).

The NRC holds the authority to create and regulate the licensing process for nuclear power plants.[78] Presently, two regulations govern the options for obtaining a license to build and operate a nuclear power plant: 10 C.F.R. § 50 and 10 C.F.R. § 52.[79] In both of these options, the NRC uses a broad licensing approach to determine whether a license application complies with current regulations.[80] Historically, the NRC took a deterministic approach using requirements that were more rigid, especially when defined prescriptively.[81] When creating these regulations, the NRC focused the requirement thresholds mainly on test results and expert judgment that analyzed scenarios based on possible nuclear reactor system failures.[82] An applicant's design was required to account for these worst-case scenarios and to attempt to minimize concerns to meet the NRC's goal of "protect[ing] public health and safety."[83]

However, because of the deterministic approach's stringent characteristics, the NRC spent decades attempting to add risk-informed and performance-based approaches to licensing.[84] In 1995, the NRC produced a policy statement to establish a risk-informed approach to regulation using the Probabilistic Risk Assessment ("PRA")[85] to complement the deterministic approach.[86] However, because the deterministic regulations are not easily replaced, the shift in approaches was to be incremental.[87]

The PRA extends the deterministic approach by examining criteria with more discretion, thereby reducing the rigidity of the licensing process.[88] The performance-based approach is unlike the deterministic approach because it prioritizes activities based on their potential harm and importance, honing in on the regulation's requirement rather than the

78. *See* OFF. OF NUCLEAR ENERGY: SCI. AND TECH., *supra* note 19.

79. *See* NRC, NUCLEAR POWER PLANT LICENSING PROCESS 2, 4 (2004), https://bit.ly/3UkaV83; *see also* 10 C.F.R. §§ 50, 52 (2023).

80. *See* NRC, *supra* note 70, at *1.

81. *See History of the NRC's Risk-Informed Regulatory Programs*, NRC, https://bit.ly/3dv3R88 (Sept. 30, 2021) [hereinafter *History of the NRC's RIR Programs*] (stating that prescriptive criteria describe how and what the applicant needs to do to comply with a regulation).

82. *See id.*

83. NRC, *supra* note 70, at *2.

84. *See id*.

85. *See Probabilistic Risk Assessment (PRA)*, NRC, http://bit.ly/3hHz0qA (July 7, 2020) (defining the PRA as a risk assessment "computing real numbers to determine what can go wrong, how likely is it, and what are its consequences"); *see also History of the NRC's RIR Programs*, *supra* note 81 (explaining that a probabilistic risk assessment "considers nuclear safety in a more comprehensive way" to evaluate the risk in many scenarios).

86. *See* NRC, *supra* note 70, at *1.

87. *See id.*

88. *See id.* at *2.

process or method used to meet the requirement.[89] The performance-based approach allows for more solutions to be approved in licensing because the applicant is allowed to use any means to achieve the requirement specified by the regulation.[90]

Similarly, the risk-informed approach broadens the licensing process analysis, providing benefits such as

> (a) allowing explicit consideration of a broader set of potential challenges to safety[;] (b) providing a logical means for prioritizing these challenges based on risk significance, operating experience, and/or engineering judgment[;] (c) facilitating consideration of a broader set of resources to defend against these challenges[;] (d) explicitly identifying and quantifying sources of uncertainty in the analysis (although such analyses do not necessarily reflect all important sources of uncertainty)[;] and (e) leading to better decision-making by providing a means to test the sensitivity of the results to key assumptions.[91]

The risk-informed approach is less conservative than the deterministic approach because it looks not only at the consequences of an event but also at the probability and risk of the event occurring.[92] In 2017, the Licensing Modernization Project ("LMP") went one step further by developing the TI-RIPB.[93] The project attempted to address problems in the regulatory framework for licensing advanced reactors.[94]

Through the implementation of risk-informed, performance-based, and probabilistic approaches, the NRC sought to increase the flexibility of its regulations while maintaining calculability.[95] In 1995, the NRC took its

89. *See id.* at *4.

90. *See Risk and Performance Concepts in the NRC's Approach to Regulation*, NRC, https://bit.ly/3CKBaho (July 7, 2020) [hereinafter *Risk and Performance Concepts*] (providing examples of performance-based requirements, such as the requirement that skydiving companies must have a parachute open above 5,000 feet without a requirement regarding what mechanism skydiving companies must use to open the parachute).

91. NRC, *supra* note 70, at *3.

92. *See Risk and Performance Concepts*, *supra* note 90.

93. *See NRC Approves New Approach to Streamline Advanced Reactor Licensing Process*, OFF. NUCLEAR ENERGY (July 9, 2020), https://bit.ly/3driKIG.

94. *See* WAYNE L. MOE, IDAHO NAT'L LAB'Y, LICENSING MODERNIZATION PROJECT FOR ADVANCED REACTOR TECHNOLOGIES: FY 2018 PROJECT STATUS REPORT v (2018), https://bit.ly/3RMFIrP; *see also* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED REVIEWS FOR ADVANCED REACTORS: COMPARING THE US LICENSING MODERNIZATION PROJECT WITH THE CANADIAN REGULATORY APPROACH 66 (2021), https://bit.ly/3RTC6VP [hereinafter NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED] ("The fundamental thesis of the LMP is that a [PRA] should be used early in the design process to help define the licensing basis of a non-LWR rather than to confirm the acceptability of a non-LWR that has been designed using the traditional, deterministic approach.").

95. *See* NRC, *supra* note 70, at *5.

first step in using these new approaches.[96] However, in practice, it seems that the NRC still follows its deterministic approach to licensing reactors by analyzing every step an applicant must take to comply with the regulations, even when unnecessary.[97]

The first option for obtaining an NRC license appears in 10 C.F.R. § 50 and has two requirements: a construction permit and an operating license.[98] The construction permit includes preliminary safety analyses, an environmental review, and a statement describing the need for the nuclear power plant.[99] In addition, the NRC conducts an environmental review according to the National Environmental Policy Act ("NEPA"), which must include an environmental impact statement ("EIS").[100] Once these steps are complete, the NRC issues a construction permit to the applicant.[101]

The second step in the licensing process in 10 C.F.R. § 50 is to obtain an operating license.[102] Typically, the applicant sends the application for the operating license to the NRC while constructing the nuclear power plant.[103] The application must include an environmental report and a more thorough safety analysis than that required to obtain the construction permit.[104] The NRC and Federal Emergency Management Agency (FEMA) review the emergency plans to determine their feasibility.[105] Finally, the Advisory Committee on Reactor Safeguard ("ACRS") reviews the application and the safety report during a public meeting.[106]

The second option for receiving a license is found in 10 C.F.R. § 52.[107] The NRC created this second option to solve issues with 10 C.F.R. § 50.[108] The original two-step process led to uncertainty regarding the creation of a nuclear power plant because, even as the plant is being constructed, the ability to operate the plant is not yet confirmed, creating increased risk for the owner.[109] The option for licensing under 10 C.F.R. §

96. *See* Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities; Final Policy Statement, 60 Fed. Reg. 42,622 (Aug. 16, 1995).
97. *See* Letter from Thomas Bergman, Vice President of Regulatory Affairs, NuScale, to Margaret M. Doane, Executive Director for Operations, NRC, on Lessons-Learned from the Design Certification Review of NuScale Power, LLC Small Modular Reactor 1.
98. *See* NRC, *supra* note 79, at 1.
99. *See id.* at 2–3.
100. *Id.* at 3.
101. *Id.* at 3–4.
102. *See id.* at 4; *see also* 10 C.F.R. § 50 (2023).
103. *See* NRC, *supra* note 79, at 4.
104. *See id.*
105. *See id.*
106. *Id.*
107. *See id.*
108. *See id.* at 4; *see also* 10 C.F.R. § 52 (2023).
109. *See* NRC, *supra* note 79, at 1.

52 solves this problem by creating one license that includes both the construction permit and the operating license.[110]

Section 52 describes the process for obtaining an early site permit, a standard design certification, and a combined license ("COL").[111] An early site permit is unique because an applicant receives approval to build a reactor at a specific site without having to immediately start building the reactor.[112] A standard design certification allows a reactor design to be used in the construction of a reactor for 15 years, with the potential for renewal.[113] The design certification is beneficial because it allows multiple reactor sites to use the same design, creating greater standardization in the industry.[114]

The COL can include an early site permit, a design certification, or neither, and the application requirements vary depending on what is included in the COL.[115] The ACRS reviews the application during a public meeting.[116] If the applicant includes a standard design certification, the NRC issues the license, verifying that the application satisfies the inspections, tests, analyses, and acceptance criteria ("ITAAC") before operations begin.[117] If an application does not include an approved standard design certification, then the applicant must subsequently provide this information.[118] If an application includes an early site permit, then the applicant must ensure that the design matches the permit and addresses any issues not previously recognized.[119] At least 180 days before the operation of a plant, the NRC must publish a notice stating that the public may participate in a hearing.[120]

While the NRC licensing process is complex because it provides two potential options for obtaining a license, the broad approaches are used throughout.[121] Further, the NRC will not only use these approaches in creating regulations but will also use these approaches when determining whether a reactor applicant is compliant with the regulations.[122]

110. *See id.*
111. *See id.* at 4.
112. *Id.* at 6.
113. *Id.* at 8.
114. *See id.* at 4.
115. *See id.* at 9.
116. *See id*.
117. *See id.* The ITAAC criteria are the only additional information needed for the COL compared to the operating license described in 10 C.F.R. § 50. *See id.*
118. *See id.* at 10.
119. *See* NRC, *supra* note 79, at 10.
120. *Id.*
121. *Id.* at 1.
122. *See* Letter from Thomas Bergman, *supra* note 97, at 1.

### 2. Canada: How the CNSC Approves Licenses

Similar to the NRC, the CNSC, which is the regulatory body for nuclear energy in Canada, also takes a broad approach to licensing nuclear reactors. Because the CNSC has discretion over the licensing process, the approach is implemented in regulations for five license types: preparation, construction, operation, decommission, and abandonment.[123] Throughout history, the CNSC has consistently applied the risk-informed approach by setting broad objectives that allow applicants the flexibility to meet regulatory requirements.[124] Thus, the CNSC's approach can be compared to the NRC's approach.

Similar to the NRC's approach, the CNSC's approach uses deterministic and PRA factors as one piece of the decision-making process.[125] However, throughout its risk-informed approach, the CNSC considers the graded approach, which allows applicants to propose alternative methods for meeting regulatory requirements when an "equivalent or superior level of safety" exists to satisfy the purpose of the requirement.[126] During the last decade, the CNSC has worked to become technology-neutral, meaning that regulatory requirements are made without having one type of reactor in mind, allowing new, advanced reactors to be licensed.[127]

## *C. The Effort to Implement SMRs into the Nuclear Industry*

After analyzing the benefits of SMRs, understandably, many countries have worked to implement the new technology into their nuclear profile.[128] Because the United States and Canada are leading producers of nuclear energy,[129] it is not surprising that they are also ready to dive into the "blue ocean" of SMRs.[130] The two countries have also worked together to increase knowledge of SMR technology to improve licensing practices.[131]

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123. *See* Licensing Process for Class I Nuclear Facilities and Uranium Mines and Mills, Version 2.1, REGDOC-3.5.1 (2022).

124. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at 25.

125. *See* ANDREW DUSEVIC, RISK-INFORMED DECISION MAKING AND THE REGULATION OF SMALL MODULAR REACTORS 26 (2019).

126. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at 38–39.

127. *See id.*

128. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

129. *See Nuclear Power Plants*, *supra* note 18 and accompanying text.

130. *See Red Ocean vs Blue Ocean Strategy*, BLUE OCEAN, http://bit.ly/3ttvFy9 (last visited Dec. 14, 2022) (defining a "blue ocean" as "the unknown market space, unexplored and untainted by competition").

131. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at 1.

### 1. The United States: Implementation Effort

In recent years, the United States has pursued a variety of actions aimed at shifting the nuclear industry's focus toward advanced reactors like SMRs. In 2018, Congress passed the Nuclear Energy Innovation Capabilities Act ("NEICA") to further advance reactor research and development.[132] As a complement to NEICA, Congress also passed the Nuclear Energy Innovation Modernization Act ("NEIMA") in 2019 to update nuclear energy regulation because existing regulations "may not be suitable for advanced technologies with unique characteristics."[133] The agency is also creating a third avenue for licensing nuclear reactors, 10 C.F.R. § 53, which will implement the TI-RIPB approach for licensing advanced reactors.[134] The final rule is projected to be issued by July 2025,[135] well within the December 2027 deadline imposed by NEIMA.[136]

In the private sector, the federal government is encouraging companies to partake in the development of advanced reactor technology, especially SMRs. The Department of Energy (DOE) has played a significant role in facilitating this process. In January 2012, the DOE stated that it would grant to applicants $452 million over a period of five years for the development of designs for light-water SMRs.[137] In March 2012, the DOE partnered with three companies, including NuScale, to construct SMRs.[138] In December 2013, the DOE entered another agreement with NuScale to support its design, certification, and licensing for up to $217 million.[139] Outside of the government's endorsement of SMRs, private companies, including Westinghouse, Holtec, General Atomics, and Hybrid Power Technologies, are also working to produce SMR technology.[140] There is no shortage of interest in implementing SMRs into the marketplace in the United States.

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132. *See* Nuclear Energy Innovation Capabilities Act of 2017, Pub. L. No. 115-248, 132 Stat. 3154 (codified as amended in scattered sections of 42 U.S.C.).

133. *See* Nuclear Energy Innovation Modernization Act, Pub. L. No. 115-439, 132 Stat. 5565 (codified as amended in scattered sections of 42 U.S.C.); *see also* S. Rep. No. 115-86, at 5 (2017).

134. *See* Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors, 85 Fed. Reg. 71002 (proposed Nov. 6, 2020) (to be codified at 10 C.F.R. pt. 53) (explaining how the new requirements are intended "to provide the necessary flexibility for licensing and regulating a variety of advanced nuclear reactor technologies and designs," as opposed to 10 C.F.R § 50 (2023) and 10 C.F.R. § 52 (2023), which are intended to regulate large light-water and non-power reactors).

135. *See Part 53—Risk Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors*, NRC (Oct. 4, 2022), https://bit.ly/3fK9ikP.

136. *See* 42 U.S.C. § 2133.

137. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

138. *See id.*

139. *See id.*

140. *See id.*

### 2. Canada: Implementation Effort

Canada's investment in SMR technology followed a different path than the United States' implementation. Beginning in 2018, Canada's SMR roadmap, published by the Canadian Small Modular Reactor Roadmap Steering Committee, presented a more centralized effort to handle the development of SMRs by bringing several focus groups together.[141] The roadmap concluded that the CNSC's current regulatory regime is sound for implementing SMRs in the nuclear industry.[142] However, the roadmap recommended that the CNSC work with industries and the public to "ensure a graded approach based on risk-informed criteria."[143] In furtherance of this initiative, the CNSC published regulatory document ("REGDOC") 1.1.5 to guide companies applying for a license with an SMR.[144] The CNSC, and Canada as a whole, are working diligently to adapt the existing regulations to SMRs without creating an entirely new licensing regime.[145]

For example, Global First Power ("GFP"), a private company, completed phase one of the pre-licensing vendor design review in February 2019.[146] A month later, GFP submitted its site preparation license application for the Chalk River Laboratories site.[147] The CNSC began the environmental assessment ("EA") in July 2019; and almost two years later, in May 2021, the CNSC began the formal license review for site preparation.[148] As of the time of publication, GFP is awaiting a draft of the EIS, which was projected to be released in late 2022 but, as of the date of this publication, is not currently published.[149] After CNSC releases the draft, a confirmation will follow stating that the EIS includes all necessary information, and the CNSC will conduct a technical review within 90 days.[150]

Because current SMRs approved by the CNSC are not far enough along in their licensing processes, it is not clear how the CNSC will fare

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141. *See* CANADIAN SMALL MODULAR REACTOR ROADMAP STEERING COMM., A CALL TO ACTION: A CANADIAN ROADMAP FOR SMALL MODULAR REACTORS ii–iii (Nov. 2018), https://bit.ly/3fQ5Rsm.

142. *See id.*

143. *Id.*

144. *See* Supplemental Information for Small Modular Reactor, REGDOC-1.1.5 (2019).

145. *See* CANADIAN SMALL MODULAR REACTOR ROADMAP STEERING COMM., *supra* note 141, at 38.

146. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

147. *See* INT'L ATOMIC AGENCY, ADVANCES IN SMALL MODULAR REACTOR TECHNOLOGY DEVELOPMENTS 296 (2020), https://bit.ly/3RVnPaX.

148. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

149. *See Update on Global First Power's Micro Modular Reactor Project*, CANADIAN NUCLEAR SAFETY COMM'N, https://bit.ly/3qKLIWP (last visited Dec. 14, 2022).

150. *See id.*

in applying existing regulations.[151] However, as shown, the CNSC has indicated a strong commitment to using existing regulations creating a comparison to the NRC's progress in SMR development.

3. Collaborative Implementation Efforts Between the United States and Canada

While Canada's efforts in SMR development and production serve as a progress indicator for the United States, the two countries also work together. Since 2017, the countries have committed to sharing best practices and feedback from design reviews.[152] In 2019, the CNSC and NRC signed a Memorandum of Cooperation ("MOC") to increase collaboration for advanced reactor technologies, including SMRs.[153] The collaboration helps improve the regulation of SMRS and reduces burdens for licensing reviews approved in either country.[154]

As a result of the MOC, in 2021, the CNSC and NRC published a work plan comparing the CNSC's risk-informed approach and the NRC's TI-RIPB approach.[155] The work plan provided several examples in which the CNSC and NRC differ, especially in risk metric requirements.[156] The individual early fatality risk and population cancer risk are two examples of the NRC's deterministic ties.[157] The early fatality risk is assessed using a 1.6-kilometer boundary within the exclusion area boundary ("EAB"),[158]

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151. *See Pre-licensing Vendor Design Review*, CANADIAN NUCLEAR SAFETY COMM'N, http://bit.ly/3g8Hsic (last visited Dec. 14, 2022). No pre-licensing vendor design reviews have completed phase two. *Id.*

152. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at i.

153. *See* Memorandum of Coop. on Advanced Reactor and Small Modular Reactor Tech. Between the U.S. NRC and the Canadian Nuclear Safety Comm'n. (Aug. 15, 2019) (on file with NRC) (describing such undertakings as including shared technical review approaches, "collaboration on pre-application" activities, and research and training on the new SMR approaches).

154. *See id.*

155. *See id.*

156. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at 66–67.

157. *See id.* at 66. The NRC describes individual early fatality risk as:

> "the risk to an average individual in the vicinity of a nuclear power plant of prompt fatalities that might result from reactor accidents should not exceed one-tenth of one percent . . . of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed[,]" whereas the CNSC has no comparative requirement.

*Id.* at 67. Similar to the fatality risk metric, the NRC requires the risk of cancer fatalities to "not exceed [0.1%] . . . of the sum of cancer fatality risks resulting from all other causes," while the CNSC has no comparative requirement. *Id.*

158. *See Exclusion Area*, NRC, https://bit.ly/3VSSJSG (Mar. 9, 2021) (defining exclusion area as "the area surrounding the reactor where the reactor licensee has the authority to determine all activities, including exclusion or removal of personnel and property").

while the cancer fatality risk is 16 kilometers within the EAB.[159] The requirements use these boundaries to define the areas that are considered within the "vicinity" or "near" a nuclear power plant.[160] Unlike the NRC, the CNSC does not provide the requirements for early or latent health effects in its work plan.[161] Instead, the CNSC only provides prescriptive requirements when referencing broader safety criteria.[162] To guide these requirements, the CNSC and the NRC created broad safety goals, including reducing any potentially major reactor events and ensuring that severe events rarely happen; but, the NRC has included additional criteria.[163]

A third example of the differences in risk metric requirements for the CNSC and NRC within the work plan includes relative risk metrics, specifically relative risk significance sequence.[164] The permissible amount of risk for an initiating event sequence is based on specific percentages deriving the relative risk from the baseline risk.[165] For an initiating event to be determined, it must "contribute[] a specified percentage of the baseline risk" for the nuclear reactor.[166] Comparatively, the CNSC's requirement uses a performance-based approach by having an overall objective to ensure that no event significantly increases the risk of an initiating event.[167] Through these three examples of risk metric requirements, the work plan provides a comparison between the two countries' regulatory regimes and is a clear way to improve SMR development.[168]

### *D. An SMR Licensing Success Story in the United States: The NuScale SMR Design*

While SMRs remain novel technologies, one company played a large part in the effort to launch SMR technology into the marketplace. NuScale, a nuclear power company, is executing its mission of "provid[ing] scalable

159. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at 56.
160. *See id*.
161. *See id.* at 57.
162. *See id*. (explaining that the three safety goals for "protect[ing] the environment and the health and safety of the public" focus on release frequency and core damage frequency ("CDF")).
163. *See id.* at 56.
164. *See id.* at 68 (describing a relative risk significant sequence as "the aggregate percentage . . . [at] 95%, and the individual event sequence or event sequence family percentage [at] 1% of the total integrated risk or risk of a specific combination of source of radioactive material, hazard, and plant operating state"). In contrast, the CNSC does not have a calculated metric. *See id.* The CNSC simply provides an overall goal of preventing a large impact on risk for a feature or event. *See id.*
165. *See id.*, at 68.
166. *See id*.
167. *See supra* note 164 and accompanying text.
168. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at i.

advanced nuclear technology . . . to improve the quality of life for people around the world" through its advanced reactor SMR design.[169] NuScale's SMR design is a water-cooled, pressurized water reactor producing 77 MWe.[170] The SMR is installed below ground, set in a pool of water, and operated with a passive cooling system.[171] The design could house up to 12 reactor modules, allowing the reactor to adjust according to electricity needs.[172] Each module runs separately, but every module is managed from the same control room for accurate safety and energy requirements.[173] NuScale targets this SMR design to begin operating in 2027, with a planned operational lifetime of 60 years.[174] The SMR design will first be built at the Idaho National Laboratory as a six-module unit.[175]

NuScale's licensing process began in 2008 through initial communications with the NRC, and, within five years, NuScale spent $130 million on licensing.[176] By January 2017, NuScale completed its application for design certification under 10 C.F.R. § 52 and submitted it to the NRC for approval.[177]

In 2018, NuScale responded to the NRC's recommendation for a regulation exemption under 10 C.F.R. § 52.7, allowing specific exemptions in accordance with 10 C.F.R. § 50.12.[178] NuScale's exemption request was based on General Design Criteria ("GDC") 27,[179] concerning combined reactivity control systems.[180] Originally, NuScale did not believe an exemption request from GDC 27 was necessary.[181] Based on NuScale's interpretation, its design met the NRC's goal for reactivity

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169. *About Us*, NUSCALE, https://bit.ly/3Dvtdvl (last visited Dec. 14, 2022).

170. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

171. *See id.*

172. *See id.*

173. *See* INT'L ATOMIC ENERGY AGENCY, *supra* note 147, at 89.

174. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

175. *See US regulator to issue final certification for NuScale SMR*, WORLD NUCLEAR NEWS (Aug. 2, 2022), https://bit.ly/3RKIdec.

176. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

177. *See id*.

178. *See* 10 C.F.R. § 52.7 (2023).

179. *See* 10 C.F.R. § 50 (2023) app. A. (defining GDC as the "minimum requirements for the principal design criteria for water-cooled nuclear power plants" and requiring the design of reactivity control systems "to have a combined capability, in conjunction with poison addition by the emergency core cooling system, of reliably controlling reactivity changes to assure that under postulated accident conditions and with an appropriate margin for stuck rods the capability to cool the core is maintained").

180. *See* NRC, SECY-18-0099, NUSCALE POWER EXEMPTION REQUEST FROM 10 CFR PART 50, APP. A, GENERAL DESIGN CRITERION 27, "COMBINED REACTIVITY CONTROL SYSTEMS CAPABILITY" (Oct. 9, 2018) [hereinafter NRC, EXEMPTION REQUEST] (noting that the criteria "requires a reactor to achieve and maintain long term subcriticality using only safety-related equipment following a [postulated accident] with margin for stuck control rods").

181. *See* Letter from Thomas Bergman, *supra* note 97, at 7.

control described in the text of GDC 27.[182] NuScale's assertion focused on this high-level goal, implementing a more risk-informed interpretation of the regulation.[183] NuScale's design managed reactivity through control rods that would sustain a shutdown and, in addition, passive cooling systems to keep the core cooled without any release of radiation.[184]

Even though NuScale believed it met the GDC requirement, it filed the exemption request because NuScale could not appeal the NRC's interpretation of the criterion.[185] During the exemption request, the NRC parted from its traditional use of deterministic criteria and instead used risk-informed principles.[186] By accounting for the "likelihood and consequences of a return to power," the NRC granted NuScale's GDC 27 exemption request, determining that the design met the required safety functions.[187] However, the process was lengthy for NuScale.[188] The NRC admitted that the GDC were created with early-generation reactors in mind and that "fulfillment of some of the GDC may not be necessary or appropriate for some designs."[189]

In September 2020, the NRC issued its design approval for the 50 MWe-version of NuScale's SMR, which approval would be valid for 15 years.[190] In July 2021, the NRC published its proposed rule to certify the NuScale standard design.[191] In the proposed rule, the NRC identified three

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182. *See* 10 C.F.R. § 50 app. A. (stating that the control systems must be reliably coordinated to ensure that the "capability to cool the core is maintained"); *see also* NUSCALE POWER, LLC SUBMITTAL OF WHITE PAPER ENTITLED "NUSCALE REACTIVITY CONTROL REGULATORY COMPLIANCE AND SAFETY," REVISION 0 (Nov. 2, 2016) (explaining how, under the NuScale design, "the probability of a stuck rod occurring coincident with other reactor conditions necessary to cause a return to power is less than 1E-6 per reactor year").

183. *See* NUSCALE POWER, *supra* note 182 (explaining that NuScale's approach focused on proving compliance with the broad objective rather than a specific methodology for meeting the requirement).

184. *See id.*

185. *See* Letter from Thomas Bergman, *supra* note 97, at 6.

186. *See id.* at 9.

187. *See* NuScale Small Modular Reactor Design Certification, 86 Fed. Reg. 34,999 (proposed July 1, 2021) (to be codified at 10 C.F.R. 52).

188. *See* NUSCALE POWER, LLC, GAP ANALYSIS SUMMARY REPORT 28 (2012), https://bit.ly/3jBMdCi (stating that NuScale, in 2012, believed that the GDC 27 was satisfied within the NuScale design and therefore concluded that an exemption is not required); *see also* NRC, EXEMPTION REQUEST, *supra* note 180, at 5 (informing the NRC of NuScale's exemption request over six years after NuScale made their initial position that the design satisfied GDC 27); NuScale Small Modular Reactor Design Certification, 86 Fed. Reg. at 34,999 (confirming the approval of NuScale's exemption request almost three years after the request was made).

189. *See* Letter from Advisory Committee on Reactor Safeguards to Honorable Kristine L. Svinicki, Chairman of NRC, NRC (Feb. 21, 2018) (on file with the NRC).

190. *See* WORLD NUCLEAR ASS'N, *supra* note 33.

191. *See* NuScale Small Modular Reactor Design Certification, 86 Fed. Reg. at 34,999.

issues that were not resolved, including "the potential for containment leakage from the combustible gas monitoring system,"[192] which is regulated under 10 C.F.R. § 50.34(f)(2)(xxvi).[193] The NRC stated its concern with the combustible gas monitoring system ("CGMS") and that NuScale or a later COL applicant may resolve the concern by providing radiation dose calculations to prove the design would stay within dose limits.[194] However, 10 C.F.R. § 50.34(f)(2)(xxvi) provides the requirement for leakage control and does not require any quantitative dose limit to show compliance with the regulation.[195] The regulation only demands that a leakage program be established "to reduce leakage as-low-as-practical levels."[196] The NRC's concern regarding the CGMS did not impede the next step in the approval process because the NRC stated it could be addressed later in the COL application process.[197]

Not all issues with the NuScale design have been resolved; conversations continue between NuScale and the NRC regarding several areas, including the emergency planning zone ("EPZ") methodology.[198] One of the NRC's EPZ issues focuses on addressing a loss-of-coolant

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192. *See id.*

193. *See* 10 C.F.R. § 50.34(f)(2)(xxviii) (2023) ("Evaluate potential pathways for radioactivity and radiation that may lead to control room habitability problems under accident conditions resulting in an accident source term release and make necessary design provisions to preclude such problems.").

194. *See* NuScale Small Modular Reactor Design Certification, 86 Fed. Reg. at 34,999. The NRC explained that

> [t]here was insufficient information available regarding NuScale combustible gas monitoring system and the potential for leakage from this system outside containment. Without additional information regarding the potential for leakage from this system, the NRC was unable to determine whether this leakage could impact analyses performed to assess main control room dose consequences, offsite dose consequences to members of the public, and whether this system can be safely re-isolated after monitoring is initiated due to potentially high dose levels at or near the isolation valve location.

*Id*.

195. *See* 10 C.F.R. §§ 50.34(f)(2), (f)(2)(xxvi) (explaining that to comply with the regulation, an applicant must "provide sufficient information" for "leakage control and detection in the design of systems outside containment that contain (or might contain) accident source term radioactive materials following an accident," which includes "submit[ting] a leakage control program, including an initial test program, a schedule for re-testing these systems, and the actions to be taken for minimizing leakage from such systems").

196. *See* NRC, NUREG-0737 CLARIFICATION OF TMI ACTION PLAN REQUIREMENTS, at Item III.D.1.1 (Nov. 1980), https://bit.ly/3WknuAV; *see also* 10 C.F.R. § 50.34(f)(2)(xxvi) ("[T]he goal is to minimize potential exposures to workers and public, and to provide reasonable assurance that excessive leakage will not prevent the use of systems needed in an emergency.").

197. *See* NuScale Small Modular Reactor Design Certification, 86 Fed. Reg. at 34,999.

198. *See* Letter from Thomas Bergman, *supra* note 97, at 1.

accident ("LOCA").[199] Any reactor design must follow 10 C.F.R. § 50.46, requiring a showing of an adequate evaluation model for pipe ruptures in the reactor coolant pressure boundary.[200] However, as part of the new passive safety system design found in SMRs, NuScale's design does not use large-bore piping, which eliminates large break LOCAs historically found in LSRs.[201] Additionally, small breaks are not a concern for LOCAs because the core is always submerged under water, thereby keeping the reactor cooled to prevent small breaks.[202] Still, the NRC created a "deterministic extension" by requiring NuScale to "evaluate ruptures of valve nozzles as a design-basis LOCA."[203]

Aside from lingering differences between the NRC and NuScale, the NRC was prepared to issue a final rule certifying NuScale's design for use.[204] Overall, the NRC's review of the NuScale design lasted 41 months, one month less than the timeframe set by the NRC.[205] The final rule was published in the Federal Register on January 19, 2023 and became effective on February 21, 2023.[206] The final rule permits licensees to use NuScale's design certification for the construction and operation of a nuclear reactor.[207] The NuScale SMR proved successful throughout the NRC's certification of its design and continues to lead in the development of SMRs.[208] However, NuScale's success was not easy.[209] Because of the NRC's long history with LSRs, the expansive deterministic approach to licensing reactors may not suit advanced reactors, such as SMRs, into the nuclear industry.[210]

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199. *See* 10 C.F.R. § 50.46(c)(1) (defining LOCAs as "hypothetical accidents that would result from the loss of reactor coolant . . . from breaks in pipes in the reactor coolant pressure boundary").

200. *See* Letter from Thomas Bergman, *supra* note 97, at 10*; see also* 10 C.F.R. § 50.46 (stating that an evaluation model for LOCAs must be created to assess the emergency core cooling system, but not mentioning the evaluation of valve nozzles).

201. *See* Letter from Thomas Bergman, *supra* note 97, at 10. *See also* INT'L ATOMIC ENERGY AGENCY, NUSCALE POWER MODULAR AND SCALABLE REACTOR 7, https://bit.ly/3GlmWoM (last visited Dec. 27, 2022).

202. *See id.*

203. *See* Letter from Thomas Bergman, *supra* note 97, at 10.

204. *See* Press Release, Scott Burnell, Public Affairs Officer, NRC to Issue Rule Certifying NuScale Small Modular Reactor (July 29, 2022), https://bit.ly/3dqWPBd.

205. *See* Letter from Thomas Bergman, *supra* note 97, at 2.

206. *See* NuScale Small Modular Reactor Design Certification, 88 Fed. Reg. 3,287 (Jan. 19, 2023) (to be codified at 10 C.F.R. pt. 52).

207. *See id.*

208. *See* WORLD NUCLEAR NEWS, *supra* note 175.

209. *See supra* Section II.D.

210. *See infra* Section III.

## III. ANALYSIS

The stark contrast between current, operational reactors and SMRs create new challenges for the NRC approving SMR licenses.[211] The NRC's traditional deterministic approach precludes flexibility in achieving regulatory compliance.[212] Although the NRC has attempted to transition to risk-informed and performance-based approaches, these efforts must increase.[213]

For SMRs to succeed, the NRC must stop relying on deterministic criteria unless those criteria are the only means for achieving health and safety requirements.[214] The joint efforts with the CNSC show that deterministic criteria are unnecessary, while the NuScale design certification process provides an example of how these criteria specifically impede the licensing approval of SMRs.[215] The NRC must reduce these deterministic criteria in regulations, allowing the TI-RIPB approach to be further implemented, thereby meeting the NRC's long-term goal.[216] Lastly, the NRC has a prime opportunity to implement this change during the creation of 10 C.F.R. § 53, a new licensing regime, allowing the NRC to successfully license SMRs in the future.[217]

### *A. The NRC's Continued Use of a Deterministic Approach Creates Barriers to Bringing SMRs into the Nuclear Marketplace*

Recently, the NRC tried to implement the modern TI-RIPB approach to licensing nuclear reactors because such an approach is more flexible.[218] However, the NRC's efforts fell short because the NRC continues to rely on the deterministic approach, including the use of prescriptive criteria.[219] This reliance detrimentally affects the development of SMRs because the deterministic approach eliminates the possibility of new reactor designs meeting regulatory requirements through alternative or non-traditional methods.[220] The NRC must understand how engrained the deterministic approach is in existing regulations in order to successfully implement SMRs into the future marketplace.[221] By analyzing the NRC and CNSC joint efforts along with the NuScale design certification application

211. *See supra* Section II.A.
212. *See History of the NRC's RIR Programs*, *supra* note 81.
213. *See* NRC, *supra* note 70, at 5.
214. *See* Letter from Thomas Bergman, *supra* note 97, at 1.
215. *See infra* Section III.A.1.
216. *See* Letter from Thomas Bergman, *supra* note 97, at 1.
217. *See infra* Section III.B.
218. *See supra* notes 93–94 and accompanying text.
219. *See History of the NRC's RIR Programs*, *supra* note 81.
220. *See supra* note 81 and accompanying text.
221. *See* Letter from Thomas Bergman, *supra* note 97, at 1.

process,[222] a pattern of overreliance on deterministic criteria appears. In recognizing similar trends, the NRC can reduce its reliance on these criteria and smoothly shift into following the TI-RIPB approach for SMR licensing.

### 1. Establishing Risk Metric Requirements: the NRC's Use of Deterministic Criteria Compared to the CNSC's Risk-Informed Approach

The 2021 work plan between the NRC and CNSC analyzing both countries' TI-RIPB approaches provides a comparison of the two regulatory regimes.[223] Even though the NRC and CNSC licensing regimes are generally similar,[224] there are distinct differences in how each regulator sets requirements, including the complexity and depth of risk metrics.[225] This Comment analyzes only a comparison of the individual early fatality risk, population cancer risk, and relative risk metrics within the work plan. Throughout the work plan, the NRC's regulations are stricter than the CNSC's plan,[226] thereby reducing the NRC's ability to approve new reactor technology with existing regulations.[227]

As shown through the individual early fatality risk and population cancer risk, the NRC chose to adopt specific thresholds for radiological risks.[228] However, the CNSC has no equivalent risk metric.[229] While the necessity of monitoring for early fatality and cancer risk cannot be understated, the CNSC succeeded in creating safe risk metrics without the prescriptive thresholds required by the NRC.[230] The NRC also elevated their qualitative goals to specific quantitative requirements,[231] making it more difficult for SMRs to comply with regulatory requirements because regulations were constructed around a dissimilar design.[232]

The NRC's early fatality and cancer risk metrics pose an example of how deterministic requirements create issues for SMRs because of how these requirements are measured.[233] Both metrics provide a measurement

222. *See infra* Section III.A.1; *see also infra* Section III.A.2.
223. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at i.
224. *See id.* at ii.
225. *See supra* notes 157 and 164 and accompanying text.
226. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at 66–67.
227. *See History of the NRC's RIR Programs, supra* note 81.
228. *See supra* note 157 and accompanying text.
229. *See id.*
230. *See supra* notes 161–62 and accompanying text.
231. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED *supra* note 94, at 66–67.
232. *See id.* at 56–57.
233. *See supra* note 157 and accompanying text.

within the EAB,[234] which could change for SMRs because, due to their size, they can be located near a larger number of people.[235] A safe boundary for an LSR may be very different from those for SMRs that are designed to have lower levels of radioactive material present at the site and are safe enough to be near more people than previous LSR designs.[236] Because of the enhanced safety measures present in SMRs, the NRC may not need such stringent requirements.[237] The CNSC demonstrated that a safe regulatory regime does not require prescriptive, deterministic criteria for early fatality and cancer risk.[238] The NRC's requirements do not allow SMRs the opportunity to prove whether the design would present these risks;[239] a design either meets the prescriptive requirement or fails to be approved.[240] Therefore, the NRC could adapt its regulations to eliminate these requirements and implement broader objectives so SMRs have a greater chance of licensing approval.[241]

Relative risk metrics, including the relative risk significant sequence, are yet another example of the NRC relying on unnecessary deterministic requirements. While the risk requirement is described as falling under the modern LMP approach,[242] the relative risk metric is more realistically characterized as deterministic because the metric does not account for an SMR's baseline risk being lower than an LSR's baseline risk.[243] Because an SMR's baseline risk is lower than an LSR's baseline risk, an initiating event sequence may trigger for an SMR even though the overall risk to the surrounding area is lower.[244] The lower threshold predetermines SMRs as "dangerous" under NRC standards, when in actuality, SMRs are safer than LSRs.[245] The relative risk metrics prevent the safety advancements of SMRs from being recognized and place a more stringent standard on a

234. *See supra* notes 158–59 and accompanying text.

235. *See* NUCLEAR ENERGY AGENCY, *supra* note 48, at 31.

236. *See* Liou, *supra* note 21.

237. *See* Advisory Committee on Reactor Safeguards, *supra* note 189.

238. *See supra* text accompanying note 157.

239. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at 66–67.

240. *See* NRC, *supra* note 70, at *4.

241. *See infra* Section III.B.

242. *See supra* note 164 and accompanying text.

243. *See* NUSCALE POWER, INC., RISK SIGNIFICANCE DETERMINATION 2 (2015), https://bit.ly/3JeWhvF. For example, less radioactive material at the site of an SMR and passive safety systems in SMR designs may contribute to a smaller baseline risk than LSRs. *See supra* note 164 and accompanying text; *see also* NUSCALE POWER, INC., *supra*, at 2, (explaining that current LSRs have a baseline core damage frequency of $1 \times 10^{-5}$ per year as opposed to NuScale's at $1 \times 10^{-7}$).

244. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94; *see also* NUSCALE POWER, INC., *supra* note 243, at 2.

245. *See* NUSCALE POWER, INC., *supra* note 243, at 2.

safer reactor.[246] The metric does not follow a logical risk-informed path because it does not consider a lower SMR baseline risk.[247]

In contrast, the CNSC's requirement allows SMRs a greater chance to comply by having an overall objective, providing the option for an applicant to show that the design would not create considerable risk.[248] A prescriptive, deterministic requirement, like the NRC's, does not provide the same opportunity.[249] The CNSC's requirement allows flexibility for approving the new designs of SMRs because the relative risk can differ between traditional LSRs and new SMRs.[250]

The 2021 NRC work plan provides specific examples of how deterministic criteria linger in the NRC's framework and how they fail to support the transition to the widespread use of SMRs in the nuclear industry.[251] For SMRs to receive license approval through the current regulatory regime, their designs must adapt to requirements intended for older LSRs.[252] As a result, companies invest more time and money into licensing approval for advanced technology, delaying the introduction of SMRs into the marketplace.[253] The CNSC's risk-informed approach shows areas where the NRC can reduce deterministic criteria without reducing the safety of the reactors.[254] Additionally, NuScale's licensing process provides a realistic example of the time and money spent by a design applicant to adapt to the rigid, deterministic approach of the NRC.[255]

#### 2. Complications with NuScale's Design Certification Process Because of the NRC's Use of Deterministic Criteria

The NuScale SMR design certification process shows that the NRC is still deeply committed to the deterministic approach, impeding the implementation of the SMR design because of its novelty in the industry.[256] The NuScale reactor design approval process offers multiple

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246. *see id.* (stating that a "plant with a baseline CDF of 1 x $10^{-5}$ per year would allow an increase in CDF of 1 x $10^{-5}$ per year, whereas a much safer plant with a baseline CDF of 1 x $10^{-7}$ would only allow an increase of 1 x $10^{-7}$ per year before an item becomes risk-significant"); *see also supra* Section II.A.

247. *See Risk and Performance Concepts*, *supra* note 90.

248. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94 (eliminating any stringent criteria for an SMR, or any reactor design, to comply with).

249. *See id.*

250. *See* NUCLEAR ENERGY AGENCY, *supra* note 48, at 31.

251. *See* NRC, TECHNOLOGY INCLUSIVE AND RISK-INFORMED, *supra* note 94, at i.

252. *See* Advisory Committee on Reactor Safeguards, *supra* note 189.

253. *See infra* Section III.A.2.

254. *See infra* Section III.A.2.

255. *See infra* Section III.A.2.

256. *See* DUSEVIC, *supra* note 125, at 27.

examples of the NRC using a deterministic approach, including the CGMS, the EPZ sizing methodology, and the GDC 27.[257]

First, the NRC's issue with the potential leakage of the CGMS in the NuScale design certification illustrates how a deterministic approach to licensing creates problems for SMR approval.[258] The NRC's recommendation for NuScale in complying with 10 C.F.R. § 50.34(f)(2)(xxvi) was inconsistent with the requirements stated in the regulations.[259] Further, NuScale investigated other leakage programs in the industry and concluded that there was no quantifiable limit for the requirement.[260] If NuScale needed to provide calculations, which the NRC has chosen to require in countless other regulations, then the regulations could have plainly said so.[261] By stating in the proposed rule that NuScale should provide more quantifiable information to comply, the NRC deviates from the text of the regulation.[262] The deviation confuses design applicants with inconsistent guidance and implements unnecessary deterministic criteria.[263] Because the NRC chose to continue with its approval of the NuScale design certification, a COL applicant using NuScale's design would now be required to spend significant time producing radiation dose calculations for the NRC.[264] Implementing a dose limit requirement and deviating from the broader objective shows how the NRC chose to needlessly implement a prescriptive, deterministic criterion.[265]

Second, the review of NuScale's EPZ sizing methodology was challenged by the NRC, again leading to an additional deterministic requirement outside of the regulatory text.[266] In challenging the EPZ sizing methodology, the NRC used a deterministic approach by requiring an evaluation without considering the probability of a rupture, which is low.[267] It appears that the NRC refused to see how the NuScale SMR has improved from previous reactor designs in reducing the risk of a LOCA.[268] If the NRC included the likelihood of a rupture, NuScale likely would not

257. *See id.*
258. *See id.* at 3.
259. *See supra* notes 193–96 and accompanying text.
260. *See* Letter from Thomas Bergman, *supra* note 97, at A3.
261. *See id.*
262. *See supra* notes 195–960 and accompanying text.
263. *See* Letter from Thomas Bergman, *supra* note 97, at A3.
264. *See* NuScale Small Modular Reactor Design Certification, 86 Fed. Reg. at 34,999 (to be codified at 10 C.F.R. pt. 52).
265. *See* Letter from Thomas Bergman, *supra* note 97, at A3.
266. *See supra* notes 199–200 and accompanying text.
267. *See* Letter from Thomas Bergman, *supra* note 97, at 10.
268. *See supra* notes 200–01 and accompanying text.

have been required to evaluate ruptures of valve nozzles using a probabilistic approach.[269]

The additional requirement for NuScale's evaluation model is not explained within the regulation,[270] so the NRC's use of the deterministic approach extends further than the text of the regulation.[271] Complying with the additional requirements necessitates more money and time to perform and prove the accuracy of these evaluations.[272] For NuScale, it has been a long road since its initial communications with the NRC more than 15 years ago.[273]

Lastly, NuScale encountered a laborious process in receiving a GDC 27 exemption request, stemming from a deterministic criterion.[274] The criterion is deterministic because it does not consider the slim likelihood of an accident happening that prevents the core from being cooled.[275] If the NRC had considered the low risk of this event, the NuScale design would have complied with GDC 27.[276] But, again, the NRC required more from NuScale.[277]

The GDC approval process also exemplifies how the NRC could use risk-informed principles to allow for approval of the design of SMRs.[278] The NRC was slow and stubborn in implementing the risk-informed approach to the exemption request, which, like the CGMS and EPZ issues, costs time and money.[279] For the nuclear industry, there is no time to waste in pushing SMRs into the marketplace because they are a source of growth for the industry and a potential solution to the climate and energy crisis.[280]

### B. *For SMRs to be Successful, the NRC Should Ensure a Reduction in the Use of Deterministic Criteria for the New Licensing Regime: 10 C.F.R. § 53*

For the implementation of SMRs to be successful in the United States, the NRC's licensing approval requires increased flexibility. However, as shown through collaboration with the CNSC and the NuScale design certification process, the NRC values specificity, even when it is

269. *See id.*
270. *See supra* note 200 and accompanying text.
271. *See supra* note 200 and accompanying text.
272. *See supra* note 200 and accompanying text.
273. *See* WORLD NUCLEAR ASS'N, *supra* note 33.
274. *See supra* notes 97, 178–80.
275. *See supra* notes 179, 182–87 and accompanying text.
276. *See id.*
277. *See* Letter from Thomas Bergman, *supra* note 97, at 7.
278. *See supra* notes 97 and 187.
279. *See supra* note 188 and accompanying text.
280. *See Small Nuclear Power Reactors*, WORLD NUCLEAR ASS'N, https://bit.ly/3BP8Ycq (July 2023).

unnecessary.[281] In these instances, reducing the number of deterministic criteria would allow the NRC to license new reactor technology, including SMRs.[282] To remove these unnecessary criteria from the current regulations, the NRC has three options: grant specific regulatory exemptions on a case-by-case basis, amend existing regulations, or create a new licensing regime.[283] Because the NRC is already in the process of completing a final rule for 10 C.F.R. § 53,[284] creating a new licensing regime is the best option for successfully licensing SMRs.[285]

The design certification process for the NuScale SMR shows that an alternative to a new licensing regime—granting specific exemptions[286]—is not a viable option for reducing deterministic criteria to approve more SMRs. Granting exemptions extends the already protracted timeframe for receiving NRC approval.[287] Within its GDC 27 exemption request,[288] NuScale showed that applying for individual NRC exemptions can be a lengthy, ongoing process.[289] The NRC also admits that the current licensing regimes, 10 C.F.R. § 50 and 10 C.F.R. § 52, would require "extensive use of the exemption process for regulations that include prescriptive requirements."[290] Even after completing the extensive work required to send an exemption request to the NRC, applicants may not be as lucky as NuScale.[291] An exemption request does not guarantee approval.[292]

Individual exemption requests also lack certainty for future design applicants. During the design certification process, NuScale needed consistency from the NRC to comply with regulations.[293] While granting specific exemptions may be more cost-effective than creating a new licensing regime, approval for SMRs cannot be extended through case-by-

281. *See supra* Section III.A.

282. *See supra* Section III.A.

283. *See* Eric Leis, *Facilitating Fission: How the NRC Can Improve the Licensing of Small Modular Reactors*, 72ND PROC. INST. ON OIL & GAS L. 1, 23 (2021) (discussing the three options for regulatory revision in the context of siting requirements).

284. *See supra* note 136 and accompanying text.

285. *See supra* note 136 and accompanying text.

286. *See* Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors, 85 Fed. Reg. 71,002 (proposed Nov. 6, 2020) (to be codified at 10 C.F.R. pt. 53).

287. *See* Letter from Thomas Bergman, *supra* note 97, at 9.

288. *See supra* notes 178–89.

289. *See supra* note 188 and accompanying text.

290. *See* Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors, 85 Fed. Reg. at 71,002.

291. *See supra* text accompanying note 187.

292. *See* 10 C.F.R. § 50.12 (2023).

293. *See* Letter from Thomas Bergman, *supra* note 97, at 4.

case exemptions because of the increased time and uncertainty that arises for future design applicants.[294]

Amending current regulations is also not the best option for the approval of SMRs. Amending a regulation does not provide a time advantage to creating a new licensing regime because, under the Administrative Procedure Act (APA), an amendment must go through the notice-and-comment rulemaking process, like a new regime.[295]

Amending regulations would provide the clarity that specific exemptions lack because amended regulations are published in the Code of Federal Regulations to apply to all design applicants.[296] However, amendments could create issues with the substance of current regulations. Amending a regulation means keeping criteria intended for LSR designs and adding pieces for new, advanced designs including SMRs, potentially failing to consider the design differences.[297] Similar to current regulatory issues, amending a regulation could result in trying to approve a reactor design using inappropriate or inapplicable criteria.[298] The NRC attempted to mix the old with the new for decades but has failed.[299] New efforts by the NRC, such as the LMP approach, have not fully implemented the TI-RIPB approach in current regulations because of lingering deterministic criteria.[300] Amending regulations could result in this same failure.[301]

A new licensing regime provides a fresh start for the NRC to finally reach a comprehensive approach to licensing SMRs. Creating a new licensing regime allows applicants of SMRs to better understand how to meet the requirements for an application.[302] Creating an entirely new regime also allows for greater dialogue between the NRC and concerned parties to provide opinions on issues including regulatory text and requirements.[303] While 10 C.F.R. § 53 will be a costly endeavor, it is the

294. *See id*. Additionally, these factors could lead to a greater cost than creating a new licensing regime would require.

295. *See* OFF. OF THE FED. REG., A GUIDE TO THE RULEMAKING PROCESS 10, https://bit.ly/3YncQKv.

296. *See Understanding the eCFR*, CODE FED. REG., https://bit.ly/3pqKm6I (last visited Jan. 28, 2023).

297. *See supra* note 189 and accompanying text.

298. *See supra* Section III.A.

299. *See supra* Section III.A.

300. *See supra* Section III.A.1.

301. *See supra* Section III.A.

302. *See* Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors, 85 Fed. Reg. at 71,002 (intending to "recognize technological advancements in reactor design").

303. *See* Letter from Nicholas McMurray, Senior Program Director, ClearPath, to NRC Staff, on ClearPath Comments on Proposed Rule, "Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors" (July 2, 2021).

long-term solution the NRC has been trying to achieve.[304] The creation of this new regime is already underway, providing enhanced clarity, specifically for SMRs, and potentially creating a shorter timeline than any meaningful amendments would take.[305] Creating a new regime, 10 C.F.R. § 53, can finally reduce unnecessary deterministic criteria that are deeply intertwined in the current licensing regimes, thereby allowing the licensing approval of SMRs.

## IV. CONCLUSION

SMRs could be the future of the nuclear industry, launching the industry to the front of the energy and climate solution. To bring us into that future, the NRC needs to achieve two tasks. First, the NRC must understand that the deterministic approach needs to be curtailed in existing regulations because it is restricting the life of SMRs. Second, the NRC can best limit deterministic criteria by creating a new licensing regime that relies on TI-RIPB criteria instead. Reducing the NRC's reliance on deterministic criteria in the new licensing regime, 10 C.F.R. § 53, is the solution for SMRs. The NRC should implement these steps because SMRs are the sun in the barren ice age that is the nuclear industry.

304. *See* Memorandum from Annette L. Vietti-Cook, Sec'y, for Margaret Doane, Exec. Dir. for Operations, NRC, to the Comm'rs 2 (Oct. 2, 2020) (approving the NRC's approach to rulemaking in creating the final rule for 10 C.F.R. pt. 53 by Oct. 2024).

305. *See supra* notes 135–36 and accompanying text.