UNIVERSITY OF PITTSBURGH LAW REVIEW

Vol. 80 ● Spring 2019

THE NUCLEAR REGULATORY COMMISSION'S NEXT STEPS IN ENCOURAGING INNOVATION IN NUCLEAR ENERGY

Erik Slobe

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635

http://lawreview.law.pitt.edu

THE NUCLEAR REGULATORY COMMISSION'S NEXT STEPS IN ENCOURAGING INNOVATION IN NUCLEAR ENERGY

Erik Slobe*

I. INTRODUCTION

The nuclear energy industry is regulated predominantly by the United States Nuclear Regulatory Commission[1] ("NRC"). The NRC was established by the Energy Reorganization Act of 1974, which abolished the Atomic Energy Commission ("AEC") and assigned the NRC with all licensing and related regulatory functions that were previously assigned to the AEC.[2] One of the important roles of the NRC is certifying the designs of nuclear power facilities.[3] Certified nuclear power plant designs can be used by applicants in combined license[4] applications.[5] The NRC certifies nuclear power plant designs in the form of a rule after it determines the design meets all applicable standards and requirements.[6]

In order for innovative nuclear power plant designs to be built in the United States, it is essential that they are able to undergo the design certification process of the NRC. One challenge with innovative designs is that they can create uncertainties in the licensing process. Because nuclear power plants can cost tens of billions of

---

* Candidate for J.D., 2019, University of Pittsburgh School of Law.

[1] 10 C.F.R. § 1.1(a) (2018).

[2] *Id.*

[3] *Id.* § 52.41.

[4] *Id.* § 52.1 ("*Combined license* means a combined construction and operating license for a nuclear power facility issued under subpart C of [10 C.F.R. § 52]." The granting of a combined license allows the construction and operation of a nuclear power plant.). *Id.*

[5] *Id.* § 52.43.

[6] *Id.* § 52.54.

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

dollars to construct,[7] significant uncertainties in licensing can cause many to hesitate at the prospect of investing in advanced nuclear technology. Therefore, it is necessary for the NRC to minimize uncertainties in the design certification process for advanced nuclear power plant designs to encourage investment in advanced designs.

One way the NRC can help reduce uncertainties in the design certification process is to publish approved methodologies plant designers can use to show regulatory compliance. While the NRC has published and approved of several such methodologies,[8] most of these methodologies only apply to older technologies and designs of nuclear power plants. Due to significant innovation that has occurred in advanced nuclear power plant designs, many of these approved methodologies are not applicable to the advanced designs.[9] Thus, many nuclear power plant designers must develop their own methodologies during the design phase of the plant, and then have the NRC approve the methodology after a large portion of the overall plant design has already been completed.[10] In order to reduce uncertainty in the design certification process, and thus encourage innovation in nuclear power plant designs, it is necessary for the NRC to begin to preemptively approve methodologies that advanced nuclear power plant designers can use to show that they meet the regulatory requirements.

II. BRIEF HISTORY OF NUCLEAR POWER PLANT DESIGN

Nuclear power plant designs have been divided into five different categories: Generation I, II, III, III+, and IV.[11] Generation I reactors are the early prototype reactors.[12] Generation II reactor designs include Pressurized Water Reactors ("PWRs") and Boiling Water Reactors ("BWRs"), collectively known as Light Water Reactors ("LWRs").[13] All currently operating nuclear power plants in the

---

[7] Gavin Bade, *Vogtle Nuke Cost Could Top $25B as Decision Time Looms*, UTIL. DIVE (Aug. 3, 2017), https://www.utilitydive.com/news/vogtle-nuke-cost-could-top-25b-as-decision-time-looms/448555/.

[8] *NRC Regulatory Guides*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reading-rm/doc-collections/reg-guides/ (last updated June 1, 2018).

[9] *See infra* Parts V–VI.

[10] *See infra* Part V.

[11] STEPHEN M. GOLDBERG & ROBERT POSNER, NUCLEAR REACTORS: GENERATION TO GENERATION 1 (2011).

[12] *Id.* at 3.

[13] *Id.* at 4.

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

United States are Generation II BWRs and PWRs.[14] Generation III reactors are similar to Generation II reactors, but include improvements in fuel technology, thermal efficiency, modularized design, safety systems, and standardized design.[15] There are no Generation III reactors operating in the United States.[16] Generation III+ reactors, including the Westinghouse AP1000 plant design, include significant safety improvements over Generation III designs.[17] There are no operating Generation III+ nuclear power plants in the United States, but two AP1000 nuclear power plants are currently under construction in Georgia.[18] Although Generation III and III+ reactors include advanced evolution of prior designs, they operate in similar ways to previous generations. The first commercial nuclear power plant operated in the United States was the Shippingport Atomic Power Plant, a PWR that first began operating in 1957.[19] This represents 60 years of LWR operation in the United States, and nuclear regulations in the United States were built upon these 60 years of LWR experience.

Generation IV reactors demonstrate significant advances in technology for the next generation of nuclear power plant design. The Generation IV International Forum, an international group for collaboration in the development of Generation IV nuclear energy systems,[20] identified six different technologies to advance, including the Gas-cooled Fast Reactor ("GFR"), Lead-cooled Fast Reactor ("LFR"), Molten Salt Reactor ("MSR"), Supercritical Water-Cooled Reactor ("SCWR"), Sodium-cooled Fast Reactor ("SFR"), and Very High Temperature Reactor ("VHTR").[21]

Many of these Generation IV reactor designs are significantly different from any nuclear power plants in operation, or under construction, in the United States. While all Generation II–III+ reactors utilized in the United States operate by passing

---

[14] *List of Power Reactors Units*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reactors/operating/list-power-reactor-units.html (last updated May 16, 2018).

[15] GOLDBERG & POSNER, *supra* note 11, at 6.

[16] *Id.* at 7.

[17] *Id.*

[18] *Nuclear Power in the USA*, WORLD NUCLEAR ASS'N, http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power.aspx (last updated Oct. 2018).

[19] Katherine Nicol, *America's First Civilian Nuclear Plant*, PA. CTR. FOR BOOK (Spring 2010), http://pabook2.libraries.psu.edu/palitmap/Shippingport.html.

[20] *Origins of the GIF*, GENERATION IV INT'L F., https://www.gen-4.org/gif/jcms/c_9334/origins (last visited Nov. 21, 2018).

[21] *Generation IV Systems*, GENERATION IV INT'L F., https://www.gen-4.org/gif/jcms/c_59461/generation-iv-systems (last visited Nov. 10, 2018).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

water through the reactor core made of uranium located in metal rods, this is not the case for many of these new nuclear power plant designs. The MSR dissolves the fuel in molten fluoride salt,[22] the VHTR utilizes helium instead of water, and the fuel is encased in graphite instead of being held in metal rods,[23] the SFR uses liquid sodium instead of water,[24] and the LFR utilizes molten lead instead of water.[25] These design changes result in significant differences in how these plants can meet regulatory requirements compared to the older Generation II, III, and III+ reactor designs.[26]

III. CURRENT ADVANCED DESIGN LICENSING EFFORTS

As of December 2016, there were 37 advanced nuclear power plant designs, not counting fusion reactors, being researched and developed by companies, universities, and national laboratories within the United States and Canada.[27] Another 67 advanced nuclear reactor projects, not counting fusion reactors, are being developed in countries outside of the United States and Canada.[28] This represents significant innovation in the nuclear technology industry. However, despite all of these nuclear projects, few have engaged the NRC to begin licensing the designs. The NRC provides a list of companies that have "formally engaged" the NRC regarding new power plant designs, which includes Oklo, Transatomic Power, Terrestrial Energy, X-Energy, TerraPower, Kairos Power,[29] NuScale, BWXT mPower, and Holtec.[30] However, NuScale is the only company to submit a licensing

---

[22] *Molten Salt Reactor (MSR)*, GENERATION IV INT'L F., https://www.gen-4.org/gif/jcms/c_42150/molten-salt-reactor-msr (last visited Nov. 10, 2018).

[23] *Very-High-Temperature Reactor (VHTR)*, GENERATION IV INT'L F., https://www.gen-4.org/gif/jcms/c_42153/very-high-temperature-reactor-vhtr (last visited Nov. 10, 2018).

[24] *Sodium-Cooled Fast Reactor (SFR)*, GENERATION IV INT'L F., https://www.gen-4.org/gif/jcms/c_42152/sodium-cooled-fast-reactor-sfr/ (last visited Nov. 10, 2018).

[25] *Lead-Cooled Fast Reactor (LFR)*, GENERATION IV INT'L F., https://www.gen-4.org/gif/jcms/c_42149/lead-cooled-fast-reactor-lfr (last visited Nov. 10, 2018).

[26] *See infra* Parts V–VI.

[27] Todd Allen, Ryan Fitzpatrick & John Milko, *The Advanced Nuclear Industry: 2016 Update*, THIRD WAY (Dec. 12, 2016), http://www.thirdway.org/infographic/the-advanced-nuclear-industry-2016-update.

[28] John Milko & Todd Allen, *The Global Race for Advanced Nuclear*, THIRD WAY (May 18, 2017), http://www.thirdway.org/infographic/the-global-race-for-advanced-nuclear.

[29] *Advanced Reactors (Non-LWR Designs)*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reactors/new-reactors/advanced.html (last updated Nov. 13, 2018).

[30] *Small Modular Reactors (LWR Designs)*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reactors/new-reactors/smr.html (last updated Nov. 8, 2018).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

application for design certification in the United States.[31] Some of the other companies' formal engagement has been very limited. Kairos Power submitted a request to "begin discussions with the NRC staff" in March 2018, with the first pre-application review meeting to be held in September 2018.[32]

Many companies are looking outside the United States in order to begin licensing. TerraPower, a company researching MSRs based in Bellevue, Washington,[33] has announced they are entering a joint venture with the China National Nuclear Corporation to advance the development of their reactor design.[34] TerraPower has been pursuing opportunities in China since at least 2011 because the NRC was not "ready to conduct a safety analysis for such a radical design."[35] Ten companies have started pre-licensing reviews in Canada with the Canadian Nuclear Safety Commission, and Terrestrial Energy has already finished phase one of the vendor design review.[36]

The uncertainty associated with licensing nuclear power plants in the United States results in companies going abroad to develop their technologies. The United States has been the world leader in nuclear energy technology since the 1940s.[37] However, with these newer technologies, the United States is slowly losing its place.[38] Without changes, other countries will surpass the United States in nuclear technology development. Changes in the NRC review process are necessary to

---

[31] *Design Certification Applications for New Reactors*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reactors/new-reactors/design-cert.html (last updated Sept. 13, 2017).

[32] MICHAEL LAUFER, KAIROS POWER LLC, KAIROS POWER LLC REQUEST TO INITIATE PRE-APPLICATION ENGAGEMENT 1 (2018), https://www.nrc.gov/docs/ML1807/ML18075A352.pdf.

[33] Allen et al., *supra* note 27.

[34] *TerraPower Establishes Joint Venture with CNNC for TWR Co-Development*, TERRAPOWER (Oct. 2, 2017), http://terrapower.com/updates/terrapower-establishes-joint-venture-with-cnnc-for-twr-co-development/.

[35] *TerraPower Seeks Wisdom in China*, AM. NUCLEAR SOC'Y (Dec. 15, 2011), http://ansnuclearcafe.org/2011/12/15/terrapower-seeks-wisdom-in-china/#sthash.8jZGfce1.dpbs.

[36] *Pre-Licensing Vendor Design Review*, CANADIAN NUCLEAR SAFETY COMMISSION, http://nuclearsafety.gc.ca/eng/reactors/power-plants/pre-licensing-vendor-design-review/index.cfm (last updated July 18, 2018).

[37] TIMOTHY A. FRAZIER, COLUMBIA SIPA CTR. ON GLOB. ENERGY POLICY, THE ROLE OF POLICY IN REVIVING AND EXPANDING THE UNITED STATES' GLOBAL NUCLEAR LEADERSHIP 5 (2017).

[38] Robert Hargraves, *'Energy Is Worth a War': US Nuclear Supremacy Is Collapsing but There's a Way to Win It Back*, BUS. INSIDER (June 26, 2017), http://www.businessinsider.com/nuclear-power-fall-rise-united-states-2017-6.

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

reduce uncertainty in the licensing process and to encourage the development and licensing of advanced nuclear power plant designs in the United States.

IV. COST OF NRC REVIEW

The NRC review process can be a very expensive endeavor, and the fee structure of the NRC is one reason why uncertainty in the licensing process acts as a deterrent for developing innovative designs. Unlike many other federal agencies, 90% of the NRC's annual budget is recovered through collecting fees it charges to applicants and holders of NRC licenses.[39] The NRC charges an average of $275 per hour for staff review of applications.[40] Thus, the more hours NRC staff spends reviewing an application, the more expensive the application becomes.

Historically, design certification of a new nuclear power plant design by the NRC has cost between $14.1 million and $68.2 million.[41] These costs are based on the ABWR design, System 80+ design, AP600 design, AP1000 design, and ESBWR design.[42] All of these designs are either BWRs or PWRs.[43] These numbers do not consider the challenges many Generation IV reactor designs will face due to the significant differences in the designs compared to the currently operating fleet of reactors. As seen with the license amendment costs, one outlier costs 10 times the average of most other license amendments.[44] Problems arising during these application processes have the potential to increase costs substantially. These numbers also do not reflect the cost to the licensees, in terms of the number of person-hours they must expend to respond to NRC inquiries or make changes to designs or analyses based on NRC comments. In total, developing and certifying a new nuclear

---

[39] *License Fees*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/about-nrc/regulatory/licensing/fees.html (last updated June 25, 2018).

[40] 10 C.F.R. § 170.20 (2018).

[41] *New Reactors Business Line Fee Estimates*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reactors/new-reactors/new-licensing-files/nro-fee-transformation-data.pdf (last visited Nov. 12, 2018).

[42] *Backgrounder on New Nuclear Plant Designs*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/new-nuc-plant-des-bg.html (last updated Dec. 19, 2016).

[43] *Id.*

[44] *New Reactors Business Line Fee Estimates*, *supra* note 41.

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

power plant design can cost $1 billion to $2 billion, with between $50 million and $75 million being spent on licensing fees.[45]

Innovative plant designs will require new methodologies to meet regulations, which can also be a very costly and time-consuming process. The South Texas Project Nuclear Operating Company ("STPNOC") previously sought approval for a new methodology to address concerns stemming from a loss of coolant accident at a nuclear power plant where debris affected emergency system performance.[46] The approval of the methodology took over seven years and involved "continuous interactions between five divisions and [fourteen] branches of the NRC staff," fifty public meetings, four hundred requests for additional information, and thirteen project audits.[47] The NRC's hourly rate for such extensive interaction in the approval of new methodologies can be costly. Therefore, it is unsurprising that nuclear power plant designers typically utilize NRC-approved methodologies when they are capable of doing so. Using approved methodologies results in significant savings as it reduces the number of comments made by the NRC, the amount of effort expended to ensure accuracy of results, and the calendar time necessary for approving a result.

With such high costs of design certification and methodology reviews, uncertainties in time schedule and cost can result in difficulty obtaining financing.[48] Reducing the uncertainties is necessary for the success of, and investment into, these advanced designs. The NRC has a significant amount of power to aid in reducing uncertainty in the time schedule and cost of certifying the designs of advanced reactors. Although the NRC has taken some steps towards reducing this uncertainty, there are still further steps that the agency should take. One of the most direct ways in which the NRC can aid in reducing uncertainty is through its regulatory guides.

---

[45] U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-15-652, TECHNOLOGY ASSESSMENT: NUCLEAR REACTORS: STATUS AND CHALLENGES IN DEVELOPMENT AND DEPLOYMENT OF NEW COMMERCIAL CONCEPTS 3 (2015).

[46] *Texas A&M Nuclear Research Team Solves Generic Safety Issue—191 in Collaboration with South Texas Project Plant*, TEX. A&M (Aug. 22, 2017), https://engineering.tamu.edu/news/2017/08/texas-am-nuclear-research-team-solves-generic-safety-issue-191-in-collaboration-with-south-texas-project-plant.html.

[47] *Id.*

[48] U.S. GOV'T ACCOUNTABILITY OFFICE, *supra* note 45, at 24.

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

V. CURRENT USE AND DEVELOPMENT OF REGULATORY GUIDES FOR ADVANCED REACTORS

An important aspect of designing a nuclear power plant is the use of the NRC's regulatory guides, which provide "an acceptable means of meeting regulations."[49] "The Regulatory Guide series provides guidance to licensees and applicants on implementing specific parts of the NRC's regulations, techniques used by the NRC staff in evaluating specific problems or postulated accidents, and data needed by the staff in its review of applications for permits or licenses."[50] The use of Regulatory Guides can reduce the uncertainty in the licensing process when attempting to get a plant design certified by the NRC.

Due to the risks associated with new methodologies, if a company is able to, it will often avoid deviating from a Regulatory Guide approved methodology for showing regulatory compliance. One of the regulations that nuclear power plants must meet is 10 C.F.R. 20.1302(2)(i), which states that it must be demonstrated that "[t]he annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table 2 of Appendix B to Part 20."[51] For LWRs, Regulatory Guide 1.112 states that NUREG-0016[52] and NUREG-0017[53] "provide acceptable methods for calculating annual average expected releases of radioactive material in gaseous and liquid effluents from light-water-cooled nuclear power reactors."[54] Effluents refer to radioactive material that is released from a plant.[55] NUREGs are "[r]eports or brochures on regulatory decisions, results of research, results of incident

---

[49] *A Risk-Informed, Performance-Based Regulatory Framework for Power Reactors*, 2002 NUCLEAR ENERGY INST. 19.

[50] *NRC Regulatory Guides*, *supra* note 8.

[51] 10 C.F.R. § 20.1302(2)(i) (2018).

[52] *See generally* U.S. NUCLEAR REGULATORY COMM'N, NUREG-0016, CALCULATION OF RELEASES OF RADIOACTIVE MATERIAL IN GASEOUS LIQUID EFFLUENTS FROM BOILING WATER REACTORS (BWR-GALE CODE) (1979) [hereinafter NUREG-0016].

[53] *See generally* U.S. NUCLEAR REGULATORY COMM'N, NUREG-0017, CALCULATION OF RELEASES OF RADIOACTIVE MATERIAL IN GASEOUS AND LIQUID EFFLUENTS FROM PRESSURIZED WATER REACTORS (1985) [hereinafter NUREG-0017].

[54] U.S. NUCLEAR REGULATORY COMM'N, REGULATORY GUIDE 1.112, CALCULATION OF RELEASES OF RADIOACTIVE MATERIALS IN GASEOUS AND LIQUID EFFLUENTS FROM LIGHT-WATER-COOLED NUCLEAR POWER PLANTS (2007) [hereinafter REGULATORY GUIDE 1.112].

[55] *Backgrounder on Environmental Monitoring*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/env-monitoring.html (last updated Apr. 26, 2016).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

investigations, and other technical and administrative information" that are published by the NRC.[56]

The methodologies of NUREG-0016 and NUREG-0017 are incorporated into computer simulation codes BWR-GALE[57] and PWR-GALE,[58] respectively. Every Generation III and Generation III+ nuclear power plant design that has received certification, or is under review by the NRC, with the exception of NuScale Power, has used the methodologies of NUREG-0016 or NUREG-0017 in their calculations of estimating effluent releases.[59] These reactors represent designs that were developed by companies based in the United States, France, Japan, and South Korea.[60] The fact that multiple companies from foreign countries utilized the methodologies approved in the regulatory guides, instead of methodologies utilized in their home countries, shows the weight of importance that these approved methodologies have on the decisions the designers make in terms of how to show they meet the NRC regulations.

NuScale's SMR design is currently under review by the NRC.[61] NuScale did not utilize NUREG-0016 or NUREG-0017 because it is a Small Modular Reactor (SMR) design.[62] NuScale states in their Final Safety Analysis Report that "[t]he development of an alternate methodology is necessary since the existing PWR-GALE code (NUREG-0017) was originally developed in the 1980s for the existing

---

[56] *NUREG-Series Publications*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reading-rm/doc-collections/nuregs/ (last updated Mar. 16, 2017).

[57] NUREG-0016, *supra* note 52, at 1-1.

[58] NUREG-0017, *supra* note 53, at 1-1.

[59] WESTINGHOUSE, AP1000 DESIGN CONTROL DOCUMENT: RADIOACTIVE WASTE MANAGEMENT § 11.3.3.2 (2011); GE HITACHI NUCLEAR ENERGY, 26A6642BJ, ESBWR DESIGN CONTROL DOCUMENT: RADIATION PROTECTION § 12.2.2.1 (2014); GE HITACHI, ABWR DESIGN CONTROL DOCUMENT: RADIATION PROTECTION § 12.2.2.1 (1997); AREVA, U.S. EPR FINAL SAFETY ANALYSIS REPORT, GASEOUS WASTE MANAGEMENT SYSTEMS § 11.3.3.2 (2013); MITSUBISHI HEAVY INDUS., LTD, MUAP-DC011, DESIGN CONTROL DOCUMENT FOR THE US-APWR: RADIOACTIVE WASTE MANAGEMENT § 11.2.3.1 (2013); KOREA ELEC. POWER CORP. & KOREA HYDRO & NUCLEAR POWER CO., APR1400-K-X-FS-14002-NP, APR1400 DESIGN CONTROL DOCUMENT: RADIOACTIVE WASTE MANAGEMENT § 11.3.1.2 (2014).

[60] *Advanced Nuclear Power Reactors*, WORLD NUCLEAR ASS'N, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/advanced-nuclear-power-reactors.aspx (last updated Oct. 2018).

[61] *Design Certification Applications for New Reactors*, *supra* note 31.

[62] NUSCALE POWER, NUSCALE STANDARD PLANT DESIGN CERTIFICATION APPLICATION: RADIOACTIVE WASTE MANAGEMENT § 11.1 (2016).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

fleet of reactors and is not representative of the NuScale Power small modular reactor design."[63] However, NuScale still used some values from NUREG-0017 where they could.[64] NuScale's design is an integrated PWR design that combines the reactor core, steam generators, and pressurizer into a single reactor vessel.[65] Therefore, it still shares some significant similarities with existing PWRs which allows them to use some of the information in NUREG-0017. NuScale's approach is still under review by the NRC, and the NRC has not yet provided any comments on the approach. If the NRC determines that the approach is not acceptable, NuScale could have to expend resources and money on redoing calculations and may have to complete redesign efforts if new analyses show they are necessary. This causes uncertainty to remain in the validity of the design.

The NRC has taken some steps towards enacting regulatory guides to aid in advanced nuclear power plant designs to reduce uncertainty in the licensing process. Regulatory Guide 1.232 was issued in April 2018 and covers developing design criteria for non-light-water reactors.[66] However, the purpose[67] of the regulatory guide is to determine which General Design Criteria (GDC) from 10 C.F.R. 50 Appendix A[68] apply to advanced nuclear power plant designs and which new design criteria should apply to non-LWR designs. This draft regulatory guide also only applies to sodium-cooled fast reactors (SFR) and modular high-temperature gas-cooled reactors (MHTGR).[69] Therefore, there are many other designs which still do not have this guidance.[70] The guide also addresses only one set of regulations, specifically General Design Criteria.[71] There remain many other regulations in which SFRs and

---

[63] *Id.*

[64] *Id.* §§ 11.16, 11.214.

[65] *Id.* § 11.12.

[66] *See generally* U.S. NUCLEAR REGULATORY COMM'N, REGULATORY GUIDE 1.232, GUIDANCE FOR DEVELOPING PRINCIPLE DESIGN CRITERIA FOR NON-LIGHT-WATER REACTORS (2018) [hereinafter REGULATORY GUIDE 1.232].

[67] *Id.*

[68] *See generally* 10 C.F.R. § 50 app. A (2018).

[69] REGULATORY GUIDE 1.232, *supra* note 66, at 8.

[70] *See infra* text accompanying notes 20–25.

[71] *See generally* 10 C.F.R. § 50 app. A (2018).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

MHTGRs still do not have clear guidance from the NRC.[72] Although the Regulatory Guide 1.232 is a good step towards aiding next generation reactors, there are additional efforts that must be made.

VI. NEXT STEPS FOR NRC TO AID ADVANCED REACTORS IN LICENSING PROCESS

As shown in Regulatory Guide 1.232, there are regulations that do not apply to advanced nuclear power plant designs.[73] There are still ongoing efforts by the NRC to determine the requirements that advanced nuclear power plant designs must meet.[74] Therefore, it would be difficult for the NRC to provide guidance in meeting regulations that have not yet been determined. In order to provide the greatest benefit to new nuclear power plant designers now, it is important for the NRC to focus on approving methodologies for regulations that apply to all nuclear power plants regardless of the specifics of the nuclear plant design.

One example of a regulation that applies to all nuclear power plant designs is the dose limits for individual members of the public.[75] In order to show that the design will meet these dose limits, an applicant can demonstrate that the estimated gaseous and liquid effluents do not exceed[76] those listed in 20 C.F.R. Appendix B.[77] All nuclear power plants must show that radiation doses to members of the public are below the required levels. No differences in plant design would allow a nuclear power plant to exceed these limits. As stated earlier, Regulatory Guide 1.112 provides guidance for light-water-cooled nuclear power plants for compliance with effluent regulations.[78] However, equivalent guidance is not available for advanced reactor designs.

---

[72] *See generally NRC Regulations Title 10, Code of Federal Regulations*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reading-rm/doc-collections/cfr/ (last updated Nov. 1, 2018).

[73] REGULATORY GUIDE 1.232, *supra* note 66, at 8.

[74] U.S. NUCLEAR REGULATORY COMM'N, ML17165A069, NRC NON-LIGHT WATER REACTOR NEAR-TERM IMPLEMENTATION ACTION PLANS 5 (2017).

[75] *See generally* 10 C.F.R. § 20.1301 (2018).

[76] *Id.* § 20.1302.

[77] *See generally id.* § 20 app. B (including concentration limits of air and water effluents given in Table 2).

[78] Regulatory Guide 1.112, *supra* note 54, at 3.

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

The design of a nuclear power plant's gaseous radioactive waste systems,[79] liquid radioactive waste systems,[80] and radiation monitoring systems[81] can be dependent on the effluents of the plant and how much the effluents need to be reduced in order to meet the regulations. Early guidance on the correct methodology for calculating effluents allows for increased certainty not only in effluent estimates, but also helps plant designers confirm that the designs of their gaseous radioactive waste, liquid radioactive waste, and radiation monitoring systems are completed properly and will not need redesign during the certification process.

Another opportunity to provide guidance and decrease uncertainty associated with the licensing process exists in addressing accident source terms. The methodology for calculating accident source terms for light-water nuclear power plants is given in NUREG-1465.[82] This NUREG is used to show an approved methodology for meeting the individual dose limits for exclusion and low population zones following a postulated fission product release.[83] The methodology of NUREG-1465 is endorsed by the NRC in Regulatory Guide 1.183.[84] These source terms are also used for evaluating equipment qualification,[85] vital area access, and shielding calculations, and for determining if the design is suitable for the location.[86] Therefore, the use of accident source terms has a significant impact on several areas of the design of nuclear power plants. Increasing certainty in the validity of these

---

[79] U.S. NUCLEAR REGULATORY COMM'N TECH. TRAINING CTR., ML12151A430, RADIOACTIVE WASTE MANAGEMENT SELF STUDY 7-2 (2012).

[80] *Id.* at 4-6.

[81] *Id.* at 9-2.

[82] *See generally* U.S. NUCLEAR REGULATORY COMM'N, NUREG-1465, ACCIDENT SOURCE TERMS FOR LIGHT-WATER NUCLEAR POWER PLANTS (1995) (describing the calculations and assumptions that can be used to determine the portion of the reactor core that is released during an accident).

[83] *See generally* 10 C.F.R. § 100.11 (2018) (describing considerations that must be used to determine the exclusion area, low population zone, and pullulation center distance).

[84] U.S. NUCLEAR REGULATORY COMM'N, REGULATORY GUIDE 1.183, ALTERNATIVE RADIOLOGICAL SOURCE TERMS FOR EVALUATING DESIGN BASIS ACCIDENTS AT NUCLEAR POWER REACTORS 2 (2000) [hereinafter REGULATORY GUIDE 1.183].

[85] Equipment qualification refers to ensuring equipment important to safety can survive the environment of the nuclear power plant, including radiation exposure. *See generally* 10 C.F.R. § 50.49 (2018).

[86] U.S. NUCLEAR REGULATORY COMM'N, SECY-16-0012, ACCIDENT SOURCE TERMS AND SITING FOR SMALL MODULAR REACTORS AND NON-LIGHT WATER REACTORS 2 (2016).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

calculations can help reassure plant designers that significant portions of their plant will not need to undergo redesign efforts during design certification.

The mPower reactor designer previously submitted a whitepaper to the NRC on their methodology for calculating accident source terms.[87] The NRC "discussed with mPower several areas of the paper that would require clarification if mPower submitted it as part of a license application for NRC review" during a closed meeting.[88] Significant portions of the non-proprietary whitepaper have been redacted,[89] and comments made during a closed meeting are not disclosed to the public. The aspects of the methodology in the redacted whitepaper that are revealed are the steps aligning with Regulatory Guide 1.183.[90] The mPower design has since been halted.[91] While the mPower design has been able to benefit from this interaction, the redacted whitepaper and the closed meeting restrict the benefits these interactions can have on future plant designers. Therefore, the industry as a whole has not been able to benefit from this interaction. Regulatory Guide 1.183 also only discusses the accident source terms for PWRs and BWRs.[92] Therefore, although it may have application for small modular reactors of PWR or BWR design, it cannot be easily used for other advanced nuclear power plant designs. The redacted parts of mPower's whitepaper also make it difficult for future plant designers to know if they would need to make any modifications to the Regulatory Guide methodology in order to apply it to an SMR design.

Idaho National Laboratories ("INL") has also submitted a whitepaper to the NRC regarding the accident source terms for the Next Generation Nuclear Plant Project ("NGNP").[93] The NGNP was a HTGR design.[94] The design was a project between the INL and the Department of Energy ("DOE").[95] None of the whitepaper

---

[87] *See generally* BABCOCK & WILCOX MPOWER, INC., MPWR-EPP-005010-NP, POSITION PAPER ON RADIOLOGICAL SOURCE TERM METHODOLOGY FOR B&W MPOWER™ REACTOR (2013).

[88] U.S. NUCLEAR REGULATORY COMM'N, STATUS OF MECHANISTIC SOURCE TERM POLICY ISSUE FOR SMALL MODULAR REACTORS 2 (2014).

[89] *See generally* BABCOCK & WILCOX MPOWER, INC., *supra* note 87.

[90] *Id.* at 27–30.

[91] *See infra* text accompanying notes 113–18.

[92] REGULATORY GUIDE 1.183, *supra* note 84, at 12–15.

[93] IDAHO NAT'L LAB., INL/EXT-10-17997, MECHANISTIC SOURCE TERMS WHITE PAPER (2010).

[94] *Id.* at 1.

[95] *Id.* at 5.

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

was redacted.[96] The paper gave more detailed information regarding the considerations in the calculations of the accident source terms compared to the mPower whitepaper, and also gave the computer codes used to calculate the source terms.[97] The NRC gave a detailed response to NGNP's proposed methodology and gave statements regarding recommendations as to the steps necessary to prove the adequacy of the methodology.[98] The NRC concluded, "[s]ubject to further consideration and resolution of the details and issues noted herein, the staff has identified no fundamental shortcomings that would necessarily preclude successful implementation of the presented high-level approaches towards developing much of the technical bases for related NGNP prototype licensing submittals."[99] However, the NRC also clarified, "this NRC assessment feedback does not provide final staff positions or regulatory conclusions on any aspect of the NGNP design or technical safety basis."[100] Although not completely conclusive, these documents gave not only the NGNP but all HTGR plant designers' guidance on how to approach accident source terms for their specific design. However, similar whitepapers are not available for other advanced nuclear power plant designs.

A third regulation that applies to all designs and has important implications in the early stages of design, is provided by the Probabilistic Risk Assessment ("PRA") programs. Design certification applications must include the results of their PRA programs.[101] A PRA program analyzes "the causes of initiating events (hazard groups) that can potentially challenge and disrupt the normal operation of the plant, and if not prevented or mitigated, would eventually result in core damage and/or a large release."[102] Therefore, the PRA program is an important aspect of ensuring a nuclear power plant design is sufficient to minimize the risk of core damage or large releases. An insufficient PRA program may not identify all of the possible pathways that could lead to core damage and, thus, not identify all of the safety systems and

---

[96] *See generally* IDAHO NAT'L LAB., *supra* note 93.

[97] *Id.* at 84–95.

[98] *See generally* U.S. NUCLEAR REGULATORY COMM'N, ASSESSMENT OF WHITE PAPER SUBMITTALS ON FUEL QUALIFICATION AND MECHANISTIC SOURCE TERMS (2017).

[99] *Id.* at 51.

[100] *Id.*

[101] 10 C.F.R § 52.47(a)(27) (2018).

[102] U.S. NUCLEAR REGULATORY COMM'N, REGULATORY GUIDE 1.200, AN APPROACH FOR DETERMINING THE TECHNICAL ADEQUACY OF PROBABILISTIC RISK ASSESSMENT RESULTS FOR RISK-INFORMED ACTIVITIES 6 (2009).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

features that would be necessary. It is important for plant designers of advanced nuclear power plants to ensure that their PRA program meets the requirements of the NRC early in the design process. Although the NRC has provided Interim Staff Guidance ("ISG") for assessing the adequacy of advanced light-water reactor PRA,[103] there is still a lack of guidance related to the Generation IV reactor designs.

Guidance on PRA for non-LWR designs has been developed by the American Nuclear Society ("ANS") and the American Society of Mechanical Engineers ("ASME").[104] Representatives of the NRC were involved in the development of the PRA standard, but so far have not officially endorsed it.[105] The NRC has not been able to endorse the standard because "there were no active licensing interactions with a prospective non-LWR licensee when the standard was issued for trial use."[106]

The NRC should not wait until there is an active licensing interaction before approving a methodology. Because the NRC was involved with the creation of the PRA standard, the approval of the standard should not take as significant an effort compared to other standards in which they have had no input. Endorsing the standard now will give confidence to plant designers that the standard is acceptable and that efforts to comply with the standard will not be wasted.

It is acknowledged that there can be significant challenges with developing these methodologies in the early stages of design for advanced nuclear power plants. There are likely many options designers can take that might impact how they determine appropriate methodologies. However, this uncertainty cannot excuse failure to pursue any other options. If the NRC is unable to develop a methodology to encompass all possible variations in particular advanced nuclear power plant designs, the NRC should at least provide specific guidance on a small sample of the design variations. Developing a plant's PRA, and understanding the plant's accident source terms and effluents, are some of the most basic aspects of a plant design that have substantial impact on large portions of the overall power plant systems. By focusing on a couple of variations, regulators can provide power plant designers with

---

[103] *See generally* U.S. NUCLEAR REGULATORY COMM'N, DC/COL-ISG-028, ASSESSING THE TECHNICAL ADEQUACY OF THE ADVANCED LIGHT-WATER REACTOR PROBABILISTIC RISK ASSESSMENT FOR THE DESIGN CERTIFICATION APPLICATION AND COMBINED LICENSE APPLICATION (2016).

[104] *See generally* AM. NUCLEAR SOC'Y, ASME/ANS RA-S-1.4-2013, PROBABILISTIC RISK ASSESSMENT STANDARD FOR ADVANCED NON-LWR NUCLEAR POWER PLANTS (2013).

[105] SOUTHERN CO., SC-29980-101, MODERNIZATION OF TECHNICAL REQUIREMENTS FOR LICENSING OF ADVANCED NON-LIGHT WATER REACTORS PROBABILISTIC RISK ASSESSMENT APPROACH 71 (2017).

[106] *Id.*

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

a solid starting point. This may be essential for many smaller nuclear power plant design companies to enter the field. Without this solid starting point, there will be few advanced nuclear power plant designs even reaching the point where they can apply for design certification.

If a nuclear power plant design does not end up matching the design assumptions utilized in an approved methodology, it is still possible for the designer to use portions of the methodology. As seen in NuScale's design certification process, even though the plant design did not match the assumptions utilized by NUREG-0017 in regard to effluent calculations, it was still able to use portions of the NUREG's guidance.[107] The mPower design was also able to utilize portions of Regulatory Guide 1.183 in its accident source term calculations, despite not matching the exact assumptions of the plant designs utilized in the Regulatory Guide.[108] Therefore, even if an advanced nuclear power plant design varies from the assumptions utilized in the NRC's advanced methodologies, it does not mean that the approved methodologies will be useless. As long as there are still significant similarities between the methodology assumptions and the plant design, some aspects of the methodology can still be utilized by the advanced nuclear power plant designers. Even if no aspect of the methodology is applicable, it can still be used by designers to understand the types of tests that should be completed in the development of the methodology and the amount of uncertainty that is acceptable.

Even if the NRC releases approved methodologies, "compliance with them is not required."[109] If the standard is accepted through the use of a Regulatory Guide, applicants are free to use alternative methods so long as the applicant "provide[s] a basis for the findings required for the issuance or continuance of a permit or license by the Commission."[110] Therefore, the industry is still free to develop its own methodologies. The use of the regulatory guides will not restrict industry innovation in new methods of compliance with safety standards. If an applicant is willing to accept additional uncertainty by utilizing a previously unapproved methodology, the applicant is still free to do so. However, in many cases, it may simply be cheaper for the plant designers to alter their design so that they can utilize an NRC pre-approved

---

[107] *See supra* text accompanying notes 62–65.

[108] *See supra* text accompanying notes 87–92.

[109] U.S. NUCLEAR REGULATORY COMM'N, REGULATORY GUIDE 1.231, ACCEPTANCE OF COMMERCIAL-GRADE DESIGN AND ANALYSIS COMPUTER PROGRAMS USED IN SAFETY-RELATED APPLICATIONS FOR NUCLEAR POWER PLANTS 3 (2017).

[110] *Id.*

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

methodology. Releasing NRC pre-approved methodologies will reduce uncertainty in design certification process, which can result in reduced costs and increased investor confidence, but will not result in stifling innovation in the industry.

VII. FUNDING

In order for the NRC to develop and approve of methodologies for advanced reactor designs prior to receiving them as part of a design certification application, it will be necessary to provide funding to the NRC so that the agency can pay for the efforts associated with approving or endorsing a methodology. However, as stated earlier, 90% of the NRC's budget must be obtained from fee recovery.[111] If the NRC staff are expending efforts on a project that does not have a direct paying applicant, then the costs of those efforts will be built into the fee charged to all of its applicants and license holders. Entities operating nuclear power plants, radioactive waste facilities, medical isotope production facilities, and fuel cycle facilities will certainly be against having their fees increased in order to approve methodologies which do not benefit their particular businesses. Therefore, it is necessary for the NRC to have an outside source of funding that the NRC can use to pay for these efforts.

One potential source of funding is from the Department of Energy ("DOE"). The DOE has awarded contracts worth hundreds of millions of dollars to various advanced reactor designers to help them in their licensing processes.[112] One of these contracts was awarded to Babcock and Wilcox ("B&W") for their mPower nuclear power plant design.[113] B&W was given access to $79 million of its awarded funds to be used in 2013.[114] However, just one year after getting access to the DOE funds,

[111] Revision of Fee Schedules; Fee Recovery for Fiscal Year 2018, 83 Fed. Reg. 29,622, 29,623 (June 25, 2018) (to be codified at 10 C.F.R. pts. 170, 171).

[112] *See, e.g.*, *NuScale Wins U.S. DOE Funding for Its SMR Technology*, NUSCALE POWER, http://www.nuscalepower.com/about-us/doe-partnership (last visited Nov. 11, 2018) ("NuScale Power was selected as the sole winner of the second round of the Department of Energy's [] competitively-bid, $226 million, five-year financial assistance award to develop nuclear SMR technology, and subsequently in 2015, the DOE awarded a $16.6 million award to NuScale Power . . . ."); *DOE Partnership*, X-ENERGY, https://www.x-energy.com/doe-partnership (last visited Nov. 11, 2018) (explaining that the DOE awarded X-ENERGY $40 million in cost share over a five year period); *SMR Funding Signed, Sealed and Delivered*, WORLD NUCLEAR NEWS (Apr. 16, 2013), http://www.world-nuclear-news.org/NN-SMR_funding_signed_sealed_and_delivered-1604137.html ("DoE is expected to make a total of about $150 million available during the five-year period of the award. The cooperative agreement also allows for further federal funding of $226 million.").

[113] *SMR Funding Signed, Sealed and Delivered*, *supra* note 112.

[114] *Id.*

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

B&W announced that they were reducing the annual budget of the project to just $15 million.[115] The pre-application review of the mPower design by the NRC was suspended in 2014.[116] The mPower project was then completely halted in March 2017.[117] In total, the DOE paid B&W $111 million.[118]

The DOE funds were meant to "provide U.S. utilities with low carbon energy options as well as create important export opportunities for the United States and advance our nation's competitive edge in this emerging global industry."[119] However, with the cancellation of the mPower project, the DOE funding that was spent on the project provided neither benefit to United States utilities or export opportunities. No other company is able to utilize the research or progress B&W was able to achieve on its design through the use of the DOE funds. For the funds to result in a benefit to utilities and the United States economy, the design must be commercialized. If any of the other companies that were awarded DOE funds do not end up commercializing their designs, this will also generally result in a waste of federal funds. Although Transatomic Power announced it will open-source its research regarding molten salt reactor technology after the decision to suspend operations,[120] this is not a guarantee that future companies will follow in Transatomic Power's footsteps.

A recently enacted law, the Nuclear Energy Innovation Capabilities Act, will continue this trend of the DOE awarding funds directly to advanced reactor designers.[121] This law allows the DOE to provide cost-sharing grants to applicants to

---

[115] *Funding for mPower Reduced*, WORLD NUCLEAR NEWS (Apr. 14, 2014), http://www.world-nuclear-news.org/C-Funding-for-mPower-reduced-1404141.html.

[116] *BWXT mPower*, U.S. NUCLEAR REG. COMMISSION, https://www.nrc.gov/reactors/new-reactors/smr/mpower.html (last updated Feb. 16, 2017).

[117] Will Davis, *mPower Consortium Halts Project*, AM. NUCLEAR SOC'Y (Mar. 16, 2017), http://ansnuclearcafe.org/2017/03/16/mpower-consortium-halts-project/.

[118] *Small Nuclear Power Reactors*, WORLD NUCLEAR ASS'N, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/small-nuclear-power-reactors.aspx (last updated Nov. 2017).

[119] *Energy Department Announces New Investment in U.S. Small Modular Reactor Design and Commercialization*, DEP'T OF ENERGY (Nov. 20, 2012), https://energy.gov/articles/energy-department-announces-new-investment-us-small-modular-reactor-design-and.

[120] *Open-Sourcing Our Reactor Design, and the Future of Transatomic*, TRANSATOMIC POWER, http://www.transatomicpower.com/open-source/ (last visited Oct. 16, 2018).

[121] Nuclear Energy Innovation Capabilities Act of 2017, Pub. L. No. 115-248, § 3, 132 Stat. 3154, 3160 (2018).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

help fund licensing activities before the NRC.[122] The law takes some funds a step further and directs the DOE to construct a versatile neutron source that can be used by companies to conduct research on advanced materials and nuclear physics.[123] It also allows the construction of experimental reactors at National Laboratories or DOE sites.[124] Although this increases the capabilities of private companies to conduct research in order to advance their designs, this still keeps the knowledge gained in the hands of the private entities who conduct the research. The funds and resources utilized for these projects may still be wasted if the private companies do not commercialize their technologies.

The law also requires the DOE to develop additional advanced software and computing capabilities and ensure the tools are available to research communities and the private sector.[125] The development of these tools has the potential to provide the public with some guidance on how to analyze and develop their reactor designs. However, unlike the construction and operation of the experimental reactor, the development of the software does not include a knowledge transfer between the DOE and the NRC.[126] The DOE and NRC are separate agencies. Software methodologies developed by the DOE do not necessarily ensure that the NRC will determine the assumptions utilized in the software are appropriate or acceptable. It also provides no guidance in the results of the software computations that the NRC would find acceptable. Although this provides a significant step towards public availability of information for advanced reactor designers, which can help companies progress in their designs, it still does not decrease the uncertainty regarding whether the NRC will ultimately determine that the methodology or design is acceptable.

However, if the DOE instead provides the funds directly to the NRC in order to develop more generic approved methodologies, this would help the industry as a whole because any company will be able to utilize the approved methodologies. This will decrease uncertainty in licensing because the companies will have certain methodologies that they know will pass NRC review. The purpose of the DOE funds awarded to NuScale, X-Energy, and B&W, and will be awarded in upcoming cost-sharing initiatives, was to reduce the cost of licensing advanced nuclear power plant

---

[122] *Id.*

[123] *Id.* sec. 2, § 951(c), 132 Stat. 3154, 3155 (2018).

[124] *Id.* sec. 2(h), § 958, 132 Stat. 3154, 3157–59 (2018) (the experimental reactors are still designated as being funded by private companies).

[125] *Id.* sec. 2(g), § 957, 132 Stat. 3154, 3157 (2018).

[126] *Id.* sec. 2(g)–(h), §§ 957–58, 132 Stat. 3154, 3157–59 (2018).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

designs.[127] One of the major costs of licensing a design is the approval of the methodologies used to show regulatory compliance of the design.[128] By giving these funds directly to the NRC, it will still result in decreased costs of licensing because it will reduce the need for the NRC to review the various methodologies being used. However, instead of decreasing the licensing costs for one particular company, it will decrease the costs for any company that is pursing the advanced reactor designs.

The DOE could also give the funds to a national laboratory instead of the NRC directly. The national laboratory could then use the funds to develop the methodologies and have the methodologies licensed by the NRC. This would be similar to the NGNP whitepaper on accident source terms for an HTGR that was developed by Idaho National Labs.[129] This provides the public with an approved methodology that includes details easily incorporated into the designs of advanced nuclear power plants for any company that attempts the endeavor at a later time. By utilizing the expertise of the national labs, it may allow the methodologies to be developed more quickly than utilizing NRC expertise alone.

If Congress wanted to give the funds directly to the NRC, Congress could still do so, but the NRC would have to change its fee structure. As explained earlier, due to the NRC's requirement that 90% of its budget must be recovered by fees, any increases in the overall budget of the NRC would result in an increase in the fees charged by the NRC.[130] Therefore, in order for Congress to designate funds to the NRC directly for these efforts, without raising the cost of fees for applicants and licensees, it will be necessary to designate the funds exempt from the 90% recovery requirement.

One bill that has been introduced in Congress that will help with this effort is H.R. 1320.[131] The bill would remove costs associated with "the development of regulatory infrastructure for advanced nuclear reactor technologies" from the budget used to assess the NRC hourly fee.[132] It also limits the exemption to a maximum of

---

[127] *See infra* text accompanying notes 112–19.

[128] *See infra* text accompanying notes 46–48.

[129] *See supra* text accompanying notes 93–100.

[130] *See supra* text accompanying note 39–40.

[131] Nuclear Utilization of Keynote Energy Act, H.R. 1320, 115th Cong. (2017).

[132] *Id.* § 3(b)(1)(B)(iii).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu

$10.3 million.[133] This bill has been passed by the House of Representatives.[134] Although this bill would include efforts necessary to develop regulations for advanced nuclear reactor technologies, the current language of the bill makes it unclear if this exception would extend to guidance documents. Therefore, the bill should be amended to clarify what is included under "regulatory infrastructure" to ensure that regulatory guides and NUREGs which include approved methodologies for meeting the new regulations are also included under the exemption of the bill.

VIII. CONCLUSION

To reduce the uncertainty and costs of advanced nuclear power plant designs, the NRC should be taking a more proactive role in approving methodologies used to show regulatory compliance. To provide the greatest benefits to nuclear power plant designers at this stage, the NRC can concentrate on methodologies related to effluents, accident source terms, and PRA. These methodologies should be approved without having to wait for an applicant to approach the NRC with the methodology during a design certification application. Providing approved methodologies at the early stages of design for nuclear power plants allows plant designers to develop their nuclear power plants with greater confidence, while also saving on costs associated with developing their own methodologies and reducing licensing costs. For methodologies that may require more detailed information regarding nuclear plant designs, the NRC should at least assume a couple variations in the plant design in their methodology. Even if the methodology does not meet the exact design of a new applicant, the applicant will likely be able to still utilize a significant portion of the approved methodology. Designating the funds to be given to the NRC through payments by the DOE will allow the development of the methodologies to be completed without negatively impacting the fees that must be paid by the rest of the nuclear industry.

---

[133] *Id.*

[134] *All Actions H.R. 1320—115th Congress (2017–2018)*, CONGRESS, https://www.congress.gov/bill/115th-congress/house-bill/1320/all-actions?q=%7B%22search%22%3A%5B%22hr1320%22%5D%7D&r=1 (last visited Oct. 16, 2018).

ISSN 0041-9915 (print) 1942-8405 (online) ● DOI 10.5195/lawreview.2019.635
http://lawreview.law.pitt.edu