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SENATE

REPORT
111–314

NUCLEAR POWER 2021 ACT

SEPTEMBER 27, 2010.—Ordered to be printed

Mr. BINGAMAN, from the Committee on Energy and Natural Resources, submitted the following

R E P O R T

[To accompany S. 2812]

The Committee on Energy and Natural Resources, to which was referred the bill (S. 2812) to amend the Energy Policy Act of 2005 to require the Secretary of Energy to carry out programs to develop and demonstrate 2 small modular nuclear reactor designs, and for other purposes, having considered the same, reports favorably thereon with amendments and recommends that the bill, as amended, do pass.

The amendments are as follows:

1. On page 2, between lines 14 and 15, insert the following:

> "(C) EARLY SITE PERMIT.—The term "early site permit" has the meaning given the term in section 52.1 of title 10, Code of Federal Regulations (or a successor regulation).

2. On page 2, line 15, strike "(C)" and insert "(D)".
3. On page 3, line 8, strike "and".
4. On page 3, line 17, strike "2021." and insert "2021; and".
5. On page 3, between lines 17 and 18, insert the following:

> "(C) a program to obtain an early site permit for 2 sites for 1 or more small modular reactors.

6. On page 4, line 10, strike "(2) (A)" and insert "(2)(A), and each early site permit under paragraph (2)(C),".

PURPOSE

The purpose of S. 2812 is to require the Secretary of Energy to carry out programs to develop and demonstrate 2 small modular nuclear reactor designs.

BACKGROUND AND NEED

The first nuclear power plants built in this country were small. The first, Shippingport, which was built by the Atomic Energy Commission and began generating power in 1957, could generate 60 megawatts of electric power. The second, though first privately financed nuclear power plant, Dresden, which began operating in 1960, could generate 180 megawatts of electricity. The third, Yankee Rowe, which began commercial operation in 1961, could generate 140 megawatts of electricity.

From these modest beginnings, the nuclear industry scaled up the size of nuclear power plants rapidly. The four reactors that began operating in 1969 ranged in size from 581 to 867 megawatts of electric capacity. Five years later, four reactors with a rated capacity of more than 1,000 megawatts electricity were in commercial service.

Larger reactors offered utilities economies of scale, reducing the cost-per-kilowatt-hour of the electricity they generated. But increasing plant size also increased problems. Greater size increased capital costs, lengthened construction times, compounded financing expenses, added to design complexity and safety concern, and contributed to regulatory delay and uncertainty. These problems pose a substantial barrier to the deployment of new nuclear power plants, and they have led to a reexamination of the use of small modular reactors.

The term "small modular reactor" is generally understood to refer to a reactor with a rated capacity of less than 300 megawatts electric, which can be linked together with other small modular reactors, which can then be operated in combination. Small modular reactors offer several advantages over large nuclear power plants. They would have a lower capital cost, and thus would pose less financial risk, carry lower financing charges, and be more affordable to smaller utilities. They could also be used in smaller markets, which might not otherwise be able to support a large base-load nuclear power plant, or for industrial applications other than electric power production. Small modular reactor designs may also offer significant environmental and safety advantages and nonproliferation benefits. Importantly, they may also be fabricated in a factory, then transported and assembled onsite, improving quality control and significantly reducing the cost and schedule uncertainty of onsite construction.

Legislation is needed to increase research, development, and demonstration of small modular reactors in order to make nuclear power safer, more affordable, and more secure, and to remove barriers to its deployment.

LEGISLATIVE HISTORY

S. 2812 was introduced by Senator Bingaman on November 20, 2009. Senators Murkowski, Udall, Pryor, Landrieu, Risch, and Crapo are cosponsors. Similar legislation, H.R. 5164, was introduced in the House of Representatives on April 28, 2010.

The Committee on Energy and Natural Resources held a legislative hearing on S. 2812 on December 15, 2009. S. Hrg. 111–375. The Committee ordered S. 2812 favorably reported, with amendments, at its business meeting on July 21, 2010.

COMMITTEE RECOMMENDATION

The Senate Committee on Energy and Natural Resources, in open business session on July 21, 2010, by voice vote of a quorum present recommends that the Senate pass S. 2812, if amended as described herein.

Senator Sanders asked to be recorded as voting no.

COMMITTEE AMENDMENTS

During its consideration of S. 2812, the Committee adopted an amendment to require the Secretary to conduct a program to obtain an early site permit for two sites for one or more small modular reactors, an amendment to add a definition of the term "early site permit," and to make four technical or conforming changes.

SECTION-BY-SECTION ANALYSIS

Section 1 provides a short title.

Section 2 amends section 952 of the Energy Policy Act of 2005 (42 U.S.C. 16272) by adding at the end a new subsection (f), which establishes a new Nuclear Power 2021 Initiative.

Paragraph (1) of the new subsection (f) defines terms used in the subsection.

Paragraph (2) directs the Secretary of Energy to carry out three programs, through cooperative agreements with private sector partners to develop and demonstrate small modular reactors.

Paragraph 2(A) requires the Secretary to carry out a program to develop a standard design for each of two small modular reactors, at least one of which has a rated capacity of not less than 50 electrical megawatts, and to obtain a design certification from the Nuclear Regulatory Commission for each of the two standard designs by January 2018.

Paragraph 2(B) requires the Secretary to carry out a program to demonstrate the licensing of small modular reactors by developing applications for a combined license for each of the designs and obtaining a combined license from the Nuclear Regulatory Commission for each design by January 1, 2021.

Paragraph 2(C) requires the Secretary to carry out a program to obtain an early site permit for two sites, each for one or more small modular reactors.

Paragraph (3) requires the Secretary to select proposals for cooperative agreement on the basis of an impartial review of their scientific and technical merit, and through the use of competitive procedures.

Paragraph (4) requires the Secretary to take into account the efficiency, cost, safety, and proliferation resistance of competing reactor designs in evaluating proposals.

Paragraph (5) requires that at least 50 percent of the cost of developing small modular reactor designs and early site permits under subparagraphs (A) and (C) of paragraph (2), and at least 75 percent of the cost of the licensing demonstration of each small modular reactor design under paragraph (2)(B) be provided by a non-Federal source.

COST AND BUDGETARY CONSIDERATIONS

The following estimate of costs of this measure has been provided by the Congressional Budget Office.

S. 2812—Nuclear Power 2021 Act

Summary: S. 2812 would authorize appropriations for the Department of Energy (DOE) to enter into cooperative agreements with private-sector entities to develop and license standard designs for small modular nuclear reactors with capacities of up to 50 megawatts. CBO estimates that implementing S. 2812 would cost $407 million over the 2011–2015 period, assuming appropriation of the necessary funds. Enacting S. 2812 would not affect direct spending or revenues; therefore, pay-as-you-go procedures do not apply.

S. 2812 contains no intergovernmental or private-sector mandates as defined in the Unfunded Mandates Reform Act (UMRA) and would impose no costs on state, local, or tribal governments.

Estimated cost to the Federal Government: The estimated budgetary impact of S. 2812 is shown in the following table. The costs of this legislation fall within budget function 270 (energy).

	By fiscal year, in millions of dollars—					
	2011	2012	2013	2014	2015	2011–2015
CHANGES IN SPENDING SUBJECT TO APPROPRIATION						
Estimated Authorization Level	35	125	100	100	100	460
Estimated Outlays	21	85	99	102	100	407

Basis of estimate: S. 2812 would direct the Secretary of Energy to enter into cooperative agreements with private-sector entities to develop standard designs for small modular nuclear reactors as well as processes for licensing such reactors with the Nuclear Regulatory Commission (NRC). The bill would authorize appropriation of the necessary sums for DOE to cover up to 50 percent of the cost of developing designs for such reactors and up to 25 percent of the cost to demonstrate licensing processes and would specify a final deadline for all work to be completed by January 1, 2021.

CBO estimates that fully funding S. 2812 would require appropriations totalling $460 million over the 2011–2015 period and an additional $100 million in 2016. That estimate is based on information from DOE about the agency's costs to develop facilities and demonstrate licensing processes for new, large-scale nuclear reactors and takes into account the cost-share requirements specified in the bill. Assuming appropriation of those amounts, CBO estimates that resulting outlays would total $407 million over the 2011–2015 period.

The NRC also would incur costs to certify designs and develop licensing procedures for small reactors under S. 2812. However, according to the NRC, the agency already plans to develop its capacity to support regulatory processes for small modular nuclear reactors. As a result, CBO estimates that implementing S. 2812 would not significantly affect net spending by that agency; any such spending would be subject to appropriation and would be largely offset by fees that the NRC is authorized to collect from regulated entities.

Pay-As-You-Go considerations: None.

Intergovernmental and private-sector impact: S. 2812 contains no intergovernmental or private-sector mandates as defined in UMRA and would impose no costs on state, local, or tribal governments.

Estimate prepared by: Federal costs: Megan Carroll; Impact on state, local, and tribal governments: Ryan Miller; Impact on the private sector: Amy Petz.

Estimate approved by: Theresa A. Gullo, Deputy Assistant Director for Budget Analysis.

REGULATORY IMPACT EVALUATION

In compliance with paragraph 11(b) of rule XXVI of the Standing Rules of the Senate, the Committee makes the following evaluation of the regulatory impact which would be incurred in carrying out S. 2812.

The bill is not a regulatory measure in the sense of imposing Government established standards or significant economic responsibilities on private individuals and businesses.

No personal information would be collected in administering the program. Therefore, there would be no impact on personal privacy.

Little, if any, additional paperwork would result from the enactment of S. 2052.

CONGRESSIONALLY DIRECTED SPENDING

S. 2812, as ordered reported, does not contain any congressionally directed spending items, limited tax benefits, or limited tariff benefits as defined in rule XLIV of the Standing Rules of the Senate.

EXECUTIVE COMMUNICATIONS

The testimony on S. 2812 given by the Assistant Secretary for Nuclear Energy at the Committee's December 15, 2009 hearing, and the written comments of the Nuclear Regulatory Commission submitted following the hearing follow:

STATEMENT OF WARREN F. MILLER, JR., ASSISTANT SECRETARY FOR NUCLEAR ENERGY, DEPARTMENT OF ENERGY

INTRODUCTION

Thank you, Chairman Bingaman, Ranking Member Murkowski, and Members of the Committee. I appreciate the opportunity to appear before you and comment on legislation under consideration by the committee, as well as to provide information on where small modular reactors fit in the Department of Energy's portfolio.

Let me start by saying clearly that the administration views nuclear power as an important element in its strategy to increase energy security and combat climate change. As the President said in Prague, "[w]e must harness the power of nuclear energy on behalf of our efforts to combat climate change, and to advance peace and opportunity for all people."

Secretary Chu and I are working hard to advance nuclear power in the United States, and we expect the De-

partment of Energy to award the first conditional loan guarantee for new nuclear plant construction soon.

In the Office of Nuclear Energy, we have developed five imperatives to guide our activities.

First, we are working with industry and the Nuclear Regulatory Commission to extend the lifetime of the existing reactor fleet. The 104 NRC-licensed commercial nuclear reactors produce roughly 20 percent of our nation's electricity but 70 percent of our carbon-free electricity. Whether those plants retire at 60 or, for example, 80 years of age could greatly affect our carbon emissions profile in the future. Research is needed to answer outstanding questions about how long these reactors can safely be operated.

Second, we are engaged with industry to enable new plant builds and improve the affordability of nuclear energy. I mentioned our efforts with respect to loan guarantees, but also some of our research, such as the soon-to-be-implemented Modeling and Simulation Hub, we expect will also help reduce costs.

Third, we are working to reduce the carbon footprint of the transportation and industrial sectors. Nuclear power can supply more low-carbon electricity for increased electrification of the transportation sector, and provide low-carbon process heat for a range of industrial applications.

Fourth, we are researching ways to create a sustainable nuclear fuel cycle. In particular, we are looking at ways of extending nuclear fuel supplies and reducing the amount and toxicity of waste requiring a permanent repository.

And fifth, we are working to understand and minimize proliferation risks. All nuclear fuel cycles entail some amount of risk, but that risk can be reduced with appropriate technology applications and international guidelines and agreements.

SMALL MODULAR REACTORS

With that, let me turn to the focus of today's hearing: small modular reactors (SMRs) and their potential benefits.

Let me first define what we mean by "small" and "modular".

To begin with, there is no exact definition for what constitutes a "small" reactor. The International Atomic Energy Agency defines them to be less than 300 MWe as does S.2812. This boundary is based mainly on two factors: (1) Liability insurance, and (2) factory fabrication and portability to a site by rail or truck. For liability reasons, reactors above 300 MWe must carry separate indemnification insurance for each unit. Reactors modules that are sized 300 MWe and below can be linked together to form one reactor unit for liability insurance. Reactor modules of this size are conducive to off-site fabrication prior to transportation by rail or truck, rather than by barge, to an approved site for assembly.

The term "modular" implies several things that could create a potential advantage over larger plants. First, modular reactors can be linked together to create a larger power plant. This is potentially advantageous because it allows an owner the flexibility to incrementally increase the size of a plant. As demand increases, the owner can add more modules. Secondly, a smaller plant requires less initial capital outlay or investment. The existing operating modules can then be used to finance future additions. Multiple units are also important during refueling or maintenance because taking a single module offline does not require the shutdown of the entire plant.

The term "modular" can also refer to potentially faster and more efficient construction techniques using factory fabrication. The U.S. defense nuclear shipbuilding industry is an excellent example where modular construction techniques have been proven to be highly successful. These same techniques can be applied to the commercial nuclear industry. This fabrication technique has the potential to make nuclear energy more economical and appealing to investors because it reduces the perceived "risks" associated with new nuclear builds such as construction delays and schedule uncertainty.

There are several reasons why small modular reactors may prove advantageous compared to the Generation III+ nuclear plants in terms of economics, performance, and security.

First, the high capital cost for new nuclear reactors has been a challenge for private entities to finance. Smaller projects would carry lower investment risk and could be more affordable to smaller utilities. This reduction in investment risk also provides an advantage in rate recovery, regardless of whether the licensee is regulated through state public utility commissions or whether it must sell the electricity in unregulated commercial markets.

Second, there are areas in this country—and elsewhere in the world—where large plants are not needed or the existing infrastructure cannot support the larger capacity. Small modular reactors could be used to provide power to these smaller electrical markets, isolated areas or smaller grids. There is both a domestic and international market for small modular reactors and U.S. industry is well-positioned to lead and compete for these markets.

Third, some of the SMR designs may offer significant environmental or safety advantages for siting in industrial settings or where, for example, water for cooling is a problem. Some reactor designs would produce a higher temperature outlet heat that can be used for either electricity or process heat for nearby industries while others use little or no water for cooling.

Fourth, there are also some potential nonproliferation benefits to use of small reactors that could be designed to operate for decades without refueling. These reactors could be fabricated and fueled in a factory, sealed and shipped to the site for power generation, and then shipped back to

the factory to be defueled. This approach could minimize the spread of nuclear material.

Fifth, small reactors could also enter into traditionally non-nuclear energy markets for applications beyond electricity production. The possibilities include low carbon process heat for: fossil fuel recovery and refinement, synthetic or biofuel production, water desalination, hydrogen production, and a range of other petrochemical applications.

Finally, while traditional economy-of-scale concepts favor larger nuclear plants, there are a number of reasons why SMRs may have some economic advantages.

As mentioned previously, a sizeable portion of the cost and schedule uncertainty for building large nuclear plants is the amount of work that must be performed on site. Factory production and fabrication, and transport to and assembly onsite can significantly reduce that uncertainty.

Research into small modular reactors could address several of the Office of Nuclear Energy's imperatives: improving the affordability of nuclear power; supplying low-carbon electricity and process heat to the transportation and industrial sectors; and minimizing proliferation risks. More importantly, the advancement of SMRs will respond to U.S. economic and environmental market conditions for low-carbon energy sources.

COMMENTS ON S. 2052 AND S. 2812

It should be clear from the preceding comments that the Department believes that small modular reactors are an important area of research and development.

The Nuclear Energy Research Initiative Improvement Act of 2009, S. 2052, gives broad authority to conduct research into small modular reactors, as well as other related issues. The Department is still evaluating the details of the bill.

S. 2812, the Nuclear Power 2021 Act, would require the Department of Energy to carry out a program to develop and demonstrate two small modular reactor designs. The Department is still evaluating the details of the bill.

CONCLUSION

In considering a small modular reactor program, a variety of factors need to be assessed, including issues such as reactor size, industry readiness and responsibilities, and research and development needs.

That concludes my formal remarks. Thank you for the opportunity to testify and I look forward to answering your questions and working with the Committee to achieve the administration's goals of energy security and reducing the nation's carbon emissions.

UNITED STATES,
NUCLEAR REGULATORY COMMISSION,
Washington, DC, December 10, 2009.

Hon. JEFF BINGAMAN
Chairman, Committee on Energy and Natural Resources,
U.S. Senate, Washington, DC.

DEAR MR. CHAIRMAN: As requested in your letter dated December 1, 2009, I am submitting, on behalf of the U.S. Nuclear Regulatory Commission (NRC), the following comments regarding S. 2052, the "Nuclear Energy Research Initiative Improvement Act of 2009," and S. 2812, the "Nuclear Power 2021 Act."

Because of our role as a regulator, the NRC offers no comments on whether, as a policy matter, small modular reactors or other new nuclear reactor technologies should or should not be pursued. The NRC's role would be limited to ensuring that any reactors utilizing new technologies will be constructed and operated in a manner that will provide adequate protection of public health and safety and the common defense and security. Accordingly, the NRC's comments relate to the NRC's regulatory role.

S. 2052

S. 2052 would require the U.S. Department of Energy (DOE) to "conduct research to lower the cost of nuclear reactor systems." This language would not, though, expressly direct the DOE to conduct research on safety in conjunction with its research related to cost reduction for nuclear reactor systems. Such safety research could be valuable in supporting the NRC's role in determining whether particular cost-saving measures are consistent with public health and safety—a determination the NRC would need to make before making any licensing decisions. Accordingly, the NRC suggests adding the words "consistent with protection of public health and safety" after the words "lower the cost of nuclear reactor systems" in the provision of Section 2 of S. 2052 that would add a new paragraph (2) to section 952(a) of the Energy Policy Act of 2005.

To the extent that the research into nuclear reactor systems leads to submission to the NRC of applications based upon new technologies or designs, the NRC may need to conduct infrastructure development and confirmatory research before receiving applications in order to ensure an efficient and effective review process once applications do arrive. To facilitate efficient licensing reviews, Congress would therefore need to provide the NRC with adequate appropriations to cover this pre-application work.

S. 2812

S. 2812 requires the DOE to obtain two small modular reactor design certifications from the NRC by January 1, 2018, and to obtain two NRC combined licenses—one for each certified design—by January 1, 2021. As the NRC staff has indicated in prepared written testimony for the Committee's December 15, 2009 hearing, the NRC has already begun conducting preparatory work on various matters related to small modular reactors. However, the amount of additional work that the NRC must do to prepare itself for efficient reviews of the small modular reactor design certification and combined license applications described in S. 2812 will vary based upon

the technologies ultimately chosen. For example, the NRC expects that it is much closer to being able to efficiently evaluate applications for small modular reactors that would utilize light water reactor technology—the same technology employed in the existing fleet of large commercial nuclear plants—than applications reliant on technologies with which the NRC has much less experience.

Thus, while the NRC is not contending that the deadlines in S. 2812 are unattainable, and while the NRC would make a concerted effort to make licensing decisions within any statutory timeframe, the NRC emphasizes that the time and resources it will need to develop the appropriate infrastructure and conduct any necessary confirmatory research could vary substantially depending upon which small modular reactor technologies are ultimately pursued. S. 2812 does set target dates for ultimate receipt of NRC licenses, but it sets no deadline for determining which technologies will be chosen as the basis for the designs that the DOE and its private-sector partners would seek to have licensed. Therefore, it is not clear how much advance warning the NRC would have about which technologies the license applications will reference.

In addition, pursuant to its Atomic Energy Act responsibilities, the NRC will not grant a license if the applicant does not demonstrate to the NRC that public health and safety and common defense and security will be adequately protected. Therefore, for the deadlines in S. 2812 to be met, the NRC would need to receive appropriations adequate to support any necessary infrastructure development and confirmatory research as well as the application reviews themselves, and applicants would need to submit high quality applications in a timely manner.

In light of the considerations described above, the NRC suggests adding language to the deadline provisions of S. 2812 to ensure there is no undue pressure on the DOE or the NRC to compromise on safety or security because of impending statutory deadlines. Section 645 of the Energy Policy Act of 2005 provides an example of possible alternative language. That act established the Next Generation Nuclear Plant Project, and Section 645(c) sets forth a specific date by which the DOE is to complete construction and begin operations of a prototype nuclear plant and associated facilities. But Section 645(c) also gives the DOE the option—in the event it cannot comply with the statutory deadline—of "submit[ting] to Congress a report establishing an alternative date for completion." The NRC believes that similar safety-valve language would be appropriate for S. 2812 to account for any complications related to safety or security that might arise as new small modular reactor technologies are developed and assessed.

If you have questions about these views, please do not hesitate to contact me.

Sincerely,

GREGORY B. JACZKO,
Chairman.

CHANGES IN EXISTING LAW

In compliance with paragraph 12 of rule XXVI of the Standing Rules of the Senate, changes in existing law made by the bill S. 2812, as ordered reported, are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new matter is

printed in italic, existing law in which no change is proposed is shown in roman):

ENERGY POLICY ACT OF 2005

Public Law 109–58

AN ACT To ensure jobs for our future with secure, affordable, and reliable energy.

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TITLE IX—RESEARCH AND DEVELOPMENT

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Subtitle E—Nuclear Energy

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SEC. 952. NUCLEAR ENERGY RESEARCH PROGRAMS.

(a) NUCLEAR ENERGY RESEARCH INITIATIVE.—The Secretary shall carry out a Nuclear Energy Research Initiative for research and development related to nuclear energy.

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(e) REACTOR PRODUCTION OF HYDROGEN.—The Secretary shall carry out research to examine designs for high-temperature reactors capable of producing large-scale quantities of hydrogen.

(f) NUCLEAR POWER 2021 INITIATIVE.—

(1) DEFINITIONS.—As used in this subsection—

(A) COMBINED LICENSE.—The term 'combined license' has the meaning given the term in section 52.1 of title 10, Code of Federal Regulations (or a successor regulation).

(B) DESIGN CERTIFICATION.—The term 'design certification' has the meaning given the term in section 52.1 of title 10, Code of Federal Regulations (or a successor regulation).

(C) EARLY SITE PERMIT.—The term 'early site permit' has the meaning given the term in section 52.1 of title 10, Code of Federal Regulations (or a successor regulation).

(D) SMALL MODULAR REACTOR.—The term 'small modular reactor' means a nuclear reactor—

(i) with a rated capacity of less than 300 electrical megawatts; and

(ii) that can be constructed and operated in combination with similar reactors at a single site.

(2) DUTY OF SECRETARY.—The Secretary shall carry out, through cooperative agreements with private sector partners—

(A) a program—

(i) to develop a standard design for each of 2 small modular reactors, at least 1 of which has a rated capacity of not more than 50 electrical megawatts; and

(ii) to obtain a design certification from the Nuclear Regulatory Commission for each of the 2 standard designs by January 1, 2018;

(B) a program to demonstrate the licensing of small modular reactors by—

(i) developing applications for a combined license for each of the designs certified pursuant to subparagraph (A); and

(ii) obtaining a combined license from the Nuclear Regulatory Commission for each of the designs by January 1, 2021; and

(C) a program to obtain an early site permit for 2 sites for 1 or more small modular reactors.

(3) MERIT REVIEW OF PROPOSALS.—The Secretary shall select proposals for cooperative agreements under this subsection—

(A) on the basis of an impartial review of the scientific and technical merit of the proposals; and

(B) through the use of competitive procedures.

(4) TECHNICAL CONSIDERATIONS.—In evaluating proposals, the Secretary shall take into account the efficiency, cost, safety, and proliferation resistance of competing reactor designs.

(5) COST-SHARE REQUIREMENTS.—

(A) DESIGN DEVELOPMENT.—Notwithstanding section 988, the Secretary shall require that not less than 50 percent of the cost of the development of each small modular reactor design under paragraph (2)(A), and each early site permit under paragraph (3)(C), be provided by a non-Federal source.

(B) LICENSING DEMONSTRATION.—Notwithstanding section 988, the Secretary shall require that not less than 75 percent of the cost of the licensing demonstration of each small modular reactor design under paragraph (2)(B) be provided by a non-Federal source.

(C) CALCULATION OF AMOUNT.—Non-Federal contributions shall be calculated in accordance with section 988(d).

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