NUREG/CR-XXXX

United States Nuclear Regulatory Commission
Protecting People and the Environment

THE PRICE-ANDERSON ACT: 2021 REPORT TO CONGRESS

Public Liability Insurance and Indemnity Requirements for an Evolving Commercial Nuclear Industry

UPDATED FINAL DRAFT REPORT – DO NOT DISTRIBUTE

SUBMITTED TO NRC ON June 4, 2021

Office of Nuclear Reactor Regulation
Office of Nuclear Material Safety and Safeguards

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NUREG/CR-XXXX

The Price-Anderson Act: 2021 Report to Congress

Public Liability Insurance and Indemnity Requirements for an Evolving Commercial Nuclear Industry

Manuscript Completed: Month Year
Date Published: Month 20xx

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ABSTRACT

This report fulfills the mandate of Subsection 170(p) of the Atomic Energy Act of 1954, as amended, which requires that the U.S. Nuclear Regulatory Commission (NRC *or* Commission) submit to Congress by December 31, 2021, a detailed report on the continuation or modification of Section 170 of the Atomic Energy Act of 1954, namely the Price-Anderson Nuclear Industries Indemnity Act (Price-Anderson Act, PAA, *or* Act). Part 1 presents an overview of the Price-Anderson system. Part 2 examines the issues that the Commission is required by statute to study (i.e., condition of the nuclear industry, state of knowledge of nuclear safety, and availability of private insurance). Part 3 covers other issues of interest and importance to Congress and to the public, such as international agreements relevant to the Price-Anderson Act and the potential financial burden of increasing retrospective premium assessments. Part 4 contains conclusions and recommendations. Part 5 is the list of references. This report includes four appendices: Appendix A, Listing of Litigation Surrounding the Price-Anderson Act and the Summary Results; Appendix B, Historical Claims Data from ANI; Appendix C, Listing of Each Price-Anderson Act Report Submitted to Congress Since 1957; and Appendix D, Currently Operating Nuclear Power Reactors.

FOREWORD

Since the establishment of the civilian nuclear power industry in the 1950s, the issue of how to handle public liability in response to a nuclear event has been regularly considered by stakeholders and the U.S. Congress.[1] From the beginning of the nuclear industry, stakeholders sought to assure that adequate funds are available to the public to satisfy claims if a nuclear event were to occur. Additionally, there was a desire to remove barriers to private sector participation in the nuclear power industry given the perceived potential for significant liability claims in the event of a catastrophic nuclear event. Congress responded in 1957 by passing the Price-Anderson Act, which added Section 170 of the Atomic Energy Act of 1954 (42 U.S.C. 2210). The 1957 law established accident liability limits for the nuclear industry (i.e., the maximum amount of damages for public liability that the nuclear industry could be required to cover) and a mechanism to assure that damage compensation would be readily available within those limits. The Price-Anderson Act has been extended by Congress several times since its enactment. At the time of each extension, Congress also reviewed the Price-Anderson Act and modified various aspects of the law as were deemed necessary at the time.

In the Energy Policy Act of 2005, Congress extended the Price-Anderson Act through 2025 and modified certain elements of the Price-Anderson Act framework. Through the Energy Policy Act of 2005, Section 606, Congress required that the Commission submit to the Congress by December 31, 2021, a detailed report “concerning the need for continuation or modification of [the Price-Anderson Act], taking into account the condition of the nuclear industry, availability of private insurance, and the state of knowledge concerning nuclear safety at that time, among other relevant factors, and shall include recommendations as to the repeal or modification of any of the provisions of [the Price-Anderson Act].” This report provides the required information and the Commission’s recommendations to support Congress’s upcoming review of the Price-Anderson Act.

This report represents the contributions of many individuals. This report was prepared by ICF, a government contractor. Significant contributions to the development of this report were made by technical experts across many offices at the NRC and the nuclear industry insurance experts at American Nuclear Insurers (ANI).

[1] The term “public liability” means any legal liability arising out of or resulting from a nuclear incident or precautionary evacuation (42 U.S.C. 2014(w)). Insurance under Price-Anderson covers bodily injury, sickness, disease or resulting death, property damage and loss, including reasonable living expenses for evacuated individuals.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Price-Anderson provisions of the Atomic Energy Act of 1954, as amended, have met their intended core objectives since their enactment in 1957. In particular, the Price-Anderson provisions have assured that a significant amount of funds would be available to the public to satisfy claims if a nuclear event were to occur and removed barriers to private sector participation in the nuclear power industry resulting from the threat of potentially very significant liability claims in case of a catastrophic nuclear event. The assurance of adequate funding is provided through a combination of a primary layer of financial assurance provided through commercial insurance, a secondary layer of financial assurance provided through industry retrospective premiums, and, in certain limited circumstances, government indemnification. The assurance of adequate funding has been strengthened as the system has grown in depth of coverage over the years, including after the Three Mile Island (TMI) incident, which occurred in 1979 and is the largest nuclear accident in the United States.

Even with a decrease in the number of operating reactor units in the last 24 years (i.e., a decrease from 110 reactor units operating at 69 sites in 1996 to 94 reactor units operating at 56 sites in 2020), private sector interest in the nuclear industry has remained and commercial nuclear energy continues to make up approximately a 20-percent share of total domestic electricity generation. Furthermore, the Price-Anderson Act has met its objectives at a negligible cost to the public. Specifically, while the Act provides for government indemnification to cover public liability associated with a nuclear event in certain limited circumstances, because of the level of private sector participation in the nuclear industry and the associated level of financial protection provided by the nuclear industry, the Federal indemnity obligations under the Act have effectively been eliminated for large, operating commercial nuclear power reactors since 1982.

As the nuclear power industry continues to evolve in the coming years, the core objectives of ensuring adequate coverage to the public and removing barriers to participation in the nuclear power industry will remain essential. The Commission is recommending only modest changes in connection with the Act’s continuation because the Act:

1. has benefited from extensive public discussion and legislative modification over the years, creating an effective and balanced framework for financial protection, and

2. provides the NRC a fair amount of discretion and flexibility in implementing that framework.

The NRC will act within the scope of its authority, including rulemaking when necessary, to address Price-Anderson implementation.

Purpose of this Report

Subsection 170(p) of the Atomic Energy Act of 1954, as amended in 2005, requires the Commission to submit to the Congress by December 31, 2021, a detailed report “concerning the need for continuation or modification of [the Price-Anderson Act], taking into account the condition of the nuclear industry, availability of private insurance, and the state of knowledge concerning nuclear safety at that time, among other relevant factors, and shall include recommendations as to the repeal or modification of any of the provisions of [the Price-Anderson Act].” This report is submitted in response to that congressional requirement. This report pertains only to issues for which the NRC is responsible.[1] The NRC submitted a comparable report to Congress on the Price-Anderson Act in 1983 and 1998.[2, 3]

Part 1. Overview of the Price-Anderson System

The Price-Anderson Act was enacted on September 2, 1957, as Section 170 of the Atomic Energy Act of 1954, to meet two basic objectives:

1. Assure that adequate funds are available to the public to satisfy liability claims if a catastrophic nuclear accident were to occur.

2. Remove the deterrent to private sector participation in atomic energy presented by the threat of potentially enormous liability claims in the event of a catastrophic nuclear accident.[4]

The Price-Anderson Act requires coverage under the Act of all production and utilization facilities, ranging from the largest power reactors to the smallest research reactors and testing facilities, and uranium enrichment facilities, except those uranium enrichment facilities constructed after 1990. Additionally, NRC has exercised its discretion under the Price-Anderson Act to also cover licensees possessing and using plutonium in a plutonium processing and fuel fabrication plant. Commercial nuclear power reactors are the main focus of the Price-Anderson Act and this report to Congress.

Financial protection under the Act means the ability to cover damages for public liability (including costs of incident response or precautionary evacuation) and to meet the costs of investigating and defending claims and settling lawsuits for such damages. Although subject to the interpretations of courts reviewing the specific facts of a case, under broad interpretations of the definition of nuclear incidents, Price-Anderson Act coverage may include accidents or malicious attacks occurring in the course of transportation of nuclear fuel or material to a site covered under the Act; the storage of nuclear fuel at a covered site; the operation of a covered facility, including discharges of radioactive emissions or effluents; the storage of nuclear wastes at reactor sites; and the transportation of radioactive material from a covered site to a storage or disposal site.

This report identifies two Price-Anderson Act issues requiring clarification related to the prohibition of punitive damages and the coverage of legal defense costs. It is currently unclear whether the Price-Anderson Act's prohibition on payment of punitive damages extends to every case where a defendant has entered into an indemnification agreement with the United States under Price-Anderson – not just where damages would exceed non-governmental financial protection. Regarding legal defense costs, NRC has interpreted the Price-Anderson Act to bar the indemnification of nonprofit NRC licensees for legal costs incurred in connection with the settlement of a claim. However, no court has addressed this issue. Further discussion of these

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[1] This report does not include any discussion of issues related to U.S. Department of Energy (DOE) contractor activities indemnified under Subsection 170(d) of the Atomic Energy Act of 1954.

[2] Appendix C includes a listing of each Price-Anderson Act Report submitted to Congress since 1957.

[3] References to materials discussed in this report are found within the main body of the report where more detailed information is provided on the topics mentioned in the Executive Summary. Section 5 of the report also provides the full citations for all references relied upon in the main body of the report.

[4] Throughout this report the adjectives "catastrophic," "severe," and "significant" are used generically ~~and interchangeably~~ to emphasize the serious nature of a nuclear incident, event, or accident; these adjectives are not intended to refer to any existing standards for categorizing such incidents.~~.~~

issues is provided in Sections 1.2.7 and 1.2.9 of this report, and it is recommended that congressional clarification be provided to resolve them.

The amount of coverage provided may be the most important issue covered in this report because the total coverage provided by the Act determines the limit of public liability. The total coverage includes both the required financial protection as arranged for by industry participants, and the Federal indemnity, if any. Federal indemnification funds are only available if the private financial protection required of a licensee is insufficient to meet the Price-Anderson Act's limit of public liability. The Federal Government no longer stands as the indemnifier for large commercial nuclear power reactors, except in certain scenarios. The original limit of public liability under the Price-Anderson Act for all nuclear licensees was based on available commercial insurance and was equal to the amount of Federal indemnification provided ($500 million) plus the amount of financial protection then available in commercial insurance ($60 million), resulting in a total limit of public liability of $560 million. The Price-Anderson Act was amended in 1975 to reduce the amount of government indemnity to correspond~~ingly~~ to increases in financial protection requirements above the original $60 million available in commercial insurance. This has resulted in a phase-out of government indemnity for large, operating commercial nuclear power reactors.

Since 1975, the financial protection requirements for large commercial reactors have been increased to reflect the sum of both the commercial insurance that makes up a primary layer of financial protection and a secondary layer of financial protection to be funded through retrospective premium assessments. Specifically, the second layer of financial protection is supported by industry-wide licensee obligations to pay a pro-rated share of damages in excess of the primary insurance amount up to a specified limit per reactor, per incident, in the event such an incident were to occur. As the population of large, operating commercial nuclear power reactors grew, the available amount for retrospective assessments increased. In November 1982, when the 80th large nuclear power reactor was licensed, the amount of funding available under the primary and secondary layers of financial protection exceeded the original $560 million limit of public liability. Thus, the Federal indemnity obligations under the Act were effectively eliminated for large, operating commercial nuclear power reactors. The original limit of public liability ($560 million, which includes a maximum Federal Government indemnification of $500 million) remains in place under the Price-Anderson Act for licensees of reactors with a rated capacity less than 100 MW(e) and non-reactor licensees for which the NRC requires financial protection under the Price-Anderson Act.[5]

Commented [A1]: Start new paragraph here as shown.

Based on the number of large commercial nuclear power reactors operating as of October 2020, the nuclear power industry is insured to a maximum per-incident dollar level of $13.4 billion under the Price-Anderson framework. Congress long has recognized that a nuclear incident might involve damages in excess of the limit of public liability. In 1975, Congress explicitly committed to take necessary actions to protect the public from the consequences of a disaster of such magnitude. And, in 1988, Congress enacted statutory provisions modifying the language added in 1975, describing Congress's goal as "full and prompt compensation" to the public for "all public liability claims" resulting from such a disaster, and establishing a process for the

[5] The Price-Anderson Act does, however, provide for the limit of public liability for this category of licensees to exceed $560 million, if the Commission were to require financial protection of a licensee in an amount greater than $560 million. In that event, government indemnification would be phased out, and the limit of public liability would be the amount of financial protection required of the licensee (42 U.S.C. 2210(e)(1)(C)(ii)). To date, the Commission has not imposed financial protection requirements for this category of licensees in an amount that would increase the limit of public liability above $560 million.

preparation of compensation plans after any nuclear incident involving damages that could exceed the applicable limit of public liability.

Part 2. Principal Issues Bearing on the Need to Continue Price-Anderson

Through the Energy Policy Act of 2005, Congress required the Commission to consider in this report the condition of the nuclear industry, the state of knowledge concerning nuclear safety, and the availability of private insurance for handling claims. This report addresses each of these three considerations.

Condition of the Nuclear Industry

Although the NRC regulates a broader nuclear industry than nuclear power reactors alone, this report focuses on the large commercial nuclear power reactors because the nuclear power reactor profile and anticipated changes to that profile will have the most significant impact on the Price-Anderson system. As of October 2020, there were 94 operating commercial nuclear power reactors in the United States with a combined capacity of 96, 557 MW(e), and no major safety issues reported. Specifically, this report considers the anticipated net decrease in the number of large, operating commercial nuclear power reactors in the coming years and the need to continue or modify the Price-Anderson Act. This r~~R~~eport also discusses the emergence of new nuclear technologies and how the Price-Anderson Act may be applied to each.

A reduction in the number of large, operating commercial nuclear power reactors is significant because the number of power reactors participating in the retrospective premium plan is a major factor in the amount of financial protection provided by the Price-Anderson system. Despite current projections for the expected decrease in the number of power reactors participating in the retrospective premium plan, the existing Price-Anderson system is expected to continue to make a significant amount of funding available. Moreover, should such funding fall short of society's needs in addressing a nuclear incident, Congress can be called upon under the existing provisions of the Price-Anderson Act to provide additional compensation for public liability claims resulting from a nuclear incident if damages occur in excess of the limit of public liability and the available funding from the primary and secondary layers of financial protection.

State of Knowledge of Nuclear Safety

This section of the report covers three topics: (1) safety management of production and utilization facilities, (2) potential for occurrences of accidents, and (3) scientific advances over the last 23 years related to radiation exposure health effects.

<u>Safety Management of Production and Utilization Facilities</u>

With regard to safety management of production and utilization facilities, this report discusses new nuclear technologies, the impact of changes in regulations on safety management of nuclear power reactors, and lessons learned from the nuclear power plant exercise known as Southern Exposure 15 (SE15), held in 2015.

Since the 1998 Price-Anderson Act Report to Congress, several new nuclear technologies have emerged, including new large light water reactor (LWR) designs, small modular reactors (SMRs), non-LWR and micro-reactor designs, and radioisotope production facilities. As described in this report, the NRC has considered how each type of new nuclear technology may fit into the Price-Anderson Act framework. The NRC has concluded that, based on current knowledge and anticipated development of these new nuclear technologies, the Price-Anderson Act adequately addresses the new nuclear technologies or provides the NRC discretion to address the insurance and indemnity requirements for these new nuclear technologies through rulemaking and guidance, as needed. Therefore, the NRC is not recommending congressional action related to new nuclear technologies at this time.

In recognition of the continued evolution of nuclear technologies, this report also discusses the implications of the use of the terms megawatts electric (MW(e)) and megawatts thermal (MW(t)) in the Price-Anderson Act, and whether the Act's reliance on MW(e) in any way limits the NRC's ability to impose Price-Anderson Act financial protection and indemnity requirements on nuclear technologies that do not produce electricity. The NRC has determined that, at this time, no changes are needed to the Price-Anderson Act related to the use of the capacity rating terminology.

The report also describes the regulations that the NRC has implemented since the 1998 Report to Congress to address issues that affect public health and safety. In particular, the report describes regulatory actions that were taken to enhance security and emergency preparedness after the terrorist events of September 11, 2001, and the Fukushima Dai-ichi accident on March 11, 2011.

Finally, this portion of the report describes lessons learned from the 2015 SE15 exercise. SE15 was a 5-day nuclear power plant exercise sponsored by the NRC, the State of South Carolina, Duke Energy, the Department of Energy (DOE), and the Federal Emergency Management Agency (FEMA). To address the challenges that were identified by participants during the exercise, an interagency improvement plan includes several follow-up action items related to the Price-Anderson Act. At this time, however, the NRC has not identified any needed modification to the Price-Anderson Act to address lessons from SE15.

Potential for Occurrences of Accidents

This section of the report discusses the state of knowledge of nuclear safety, including advancements in probabilistic risk assessment (PRA). Interest in the use of PRAs for regulatory activities, particularly those surrounding seismic and high winds, floods, and other (HFO) external initiating events, has continued to increase, particularly following the accidents at Japan's Fukushima Dai-ichi reactors in 2011. Overall, PRAs continue to be a useful decision-making tool in NRC's regulatory processes and the probability of core damage incidents remains low at a probability of 0.05 over 10 years.

The NRC has concluded that, while the two layers of financial protection made available by the Price-Anderson system provide liability protection for most postulated nuclear power plant accidents, there are low probability, high-consequence accidents that could result in public liability claims in excess of the present and projected amounts of required financial protection. In the event a nuclear incident results in public liability claims that exceed the maximum amount of financial protection available, Congress is committed to determine whether additional relief is required.

Availability of Private Nuclear Liability Insurance

The private insurance industry developed a means by which nuclear power plant operators could meet their financial protection responsibilities, in addition to government indemnity under the Price-Anderson Act. The insurance industry chose the “pooling” technique to secure large amounts of insurance capacity by spreading the risk of a small number of exposure units (i.e., reactors and other nuclear-related risks) among a group of insurance companies. As a result, ~~the NRC understands that~~ insurers and other observers ~~believe~~ have reported that the Price-Anderson Act has been effective in enabling insurers to provide stable, high-quality capacity for nuclear risks. The Price-Anderson Act has encouraged maximum levels of insurance for the nuclear risk in the face of traditionally significant obstacles for insurers (i.e., catastrophic loss potential, lack of credible predictability, very small spread of risk, and limited premium volume). This has been accomplished over more than 60 years without interruption and without the “ups and downs” (or market cycles) that have affected nearly all other lines of insurance business. ANI, an insurance industry association, currently writes all nuclear liability insurance policies.

In the 23 years since the last Price-Anderson Act Report to Congress, the amount of available primary financial protection coverage has risen three times, including most recently in 2017, when the maximum amount of available primary insurance was increased to $450 million. Such increases contribute only marginally to the total aggregate coverage given the greater size of the secondary layer of financial protection. However, the primary layer of financial protection coverage provides a substantial cushion for accidents comparable to the 1979 TMI accident. Because ANI members have been increasing the primary insurance coverage regularly, independent of market cycles, the Commission believes that at this time, no congressional action is needed related to the maximum amount of available primary insurance.

Claims History Under Price-Anderson

From 1957 to December 2018, claims for 243 alleged incidents involving nuclear material under various liability policies were filed with ANI. Most, but not all, of the reported claims experience is related to policies required under NRC’s Price-Anderson Act implementing regulations found in 10 CFR Part 140. The insured losses and expenses paid through this period total approximately $522 million. Of this amount, about $71 million ($42 million in indemnity and $29 million in expenses) arose out of the Three Mile Island Unit 2 (TMI-2) accident that began on March 28, 1979.

Part 3. Other Relevant Price-Anderson Issues

Through the Energy Policy Act of 2005, Congress required the Commission to consider in this report the need to continue or modify the provisions of the Price-Anderson Act based on other relevant topics. This report discusses other relevant topics, such as understanding estimated costs for liability from a radiological accident, adequacy and appropriateness of government indemnification, issues raised by international agreements, and the potential financial burden of increasing retrospective premium assessments.

Estimated Costs for Liability from a Radiological Accident

This report discusses historical liability claims in the United States; liability claims for the Fukushima Dai-ichi accident; differences between U.S. reactors and Fukushima Dai-ichi reactors and potential for occurrence of accidents; the U.S. regulatory response to Fukushima Dai-ichi; and the NRC’s post-Fukushima understanding of liability claims.

The largest nuclear accident that has occurred in the United States took place at a pressurized water reactor (PWR) in 1979 at TMI-2, near Middletown, Pennsylvania. The TMI-2 accident did not result in any detectable health effects on plant workers or the public. The cleanup at TMI-2 cost approximately $973 million and took about 12 years to complete. Altogether, insurance pools paid approximately $71 million in liability claims costs and litigation expenses associated with the TMI-2 accident. The TMI-2 accident damages paid by insurance were covered by the primary layer of financial protection, which was required in the amount of $160 million in 1979.

On March 11, 2011, a 9.0-magnitude earthquake, followed by a 45-foot tsunami, heavily damaged the nuclear power reactors at Japan's Fukushima Dai-ichi facility. The Fukushima Dai-ichi accident resulted in damages exceeding $200 billion (2011$).[6] The total cleanup costs of the accident at TMI-2 were less than 0.5 percent of Fukushima's estimated costs, which are ongoing. The accident costs at TMI-2 and Fukushima Dai-ichi varied due to the total contamination and scale of the respective accidents. Post-Fukushima, the NRC commissioned studies to identify the differences between U.S. and Japanese nuclear power reactors, to identify vulnerabilities, and to inform regulatory action. Overall, despite the low likelihood of an accident like the Fukushima Dai-ichi event occurring in the United States, the NRC has imposed safety-enhancement measures to mitigate the potential consequences of such an event.

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For the purposes of describing in this report potential liability claims data for severe nuclear accidents in the United States, and due in part to very limited historical liability claims data for severe nuclear accidents in the United States, the NRC compiled data from PRAs in environmental reports prepared by NRC licensees as part of license renewal applications. In this analysis performed during the preparation of this report to Congress, the NRC focused on data included in each PRA related to the most extreme projected nuclear accident in terms of offsite economic costs. Offsite economic costs estimated in the PRAs ranged from a low of $6.05 billion to a high of $56.8 billion.

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These results indicate that nuclear accidents in the United States could exceed the amount of funding currently available under the primary and secondary layers of financial protection. Therefore, in the unlikely situation that a severe accident were to occur, Congress may be called upon under the existing provisions of the Price-Anderson Act to provide additional compensation to the public for public liability claims resulting from a nuclear incident if damages occur in excess of the limit of public liability and the available funding from the primary and secondary layers of financial protection.

Adequacy and Appropriateness of Government Indemnification

Under the Price-Anderson Act, government indemnification provides an additional funding mechanism that may be made available to supplement the required coverage provided by nuclear industry licensees, including both nuclear power reactors and other nuclear licensees. However, due to Price-Anderson Act amendments that created the secondary layer of financial protection for large, operating commercial nuclear power reactors, government indemnification was effectively eliminated for these facilities.[7]

As the number of operating nuclear power reactors has decreased, concerns have been raised about the potential need to adjust Price-Anderson Act requirements to assure adequate

[6] Note that the Convention on Supplementary Compensation for Nuclear Damage, discussed below, was not in effect at the time of the accident at Fukushima Dai-ichi.

[7] Although not an indemnity nor a government guarantee, it is relevant to note that the Price-Anderson Act provides for Congress to be called upon to provide additional compensation to the public for public liability claims resulting from a nuclear incident if damages occur in excess of the limit of public liability and the other Price-Anderson Act funding mechanisms are exhausted.

coverage if a catastrophic nuclear event were to occur. To assess the adequacy and/or appropriateness of the current government indemnification framework, this report discusses the overall Price-Anderson Act government indemnification framework; background on the use of government indemnification or other government funding mechanisms in other related international programs; strengths and weaknesses of government indemnification; the appropriateness of reinstating government indemnification for large, operating commercial nuclear power reactors; and indemnity fees for new, operating, and decommissioning large, commercial nuclear power reactors.

Based on the current Price-Anderson Act framework, the adequacy of available funding is impacted by the amount of coverage provided by industry and the level of government indemnification associated with a site. During the January 23, 2002, congressional hearing related to the most recent reauthorization of the Price-Anderson Act, witnesses and senators raised concerns about the limit of public liability included in the Price-Anderson Act and the related adequacy of funding that would be available in response to a nuclear event. The reinstatement of some form of government indemnification is one potential option for responding to the concern of the adequacy of available funding without having to increase the level of responsibility for the nuclear industry.

Issues Raised by International Agreements: The Convention on Supplementary Compensation for Nuclear Damage

The Convention on Supplementary Compensation for Nuclear Damage (the Convention, adopted in 1997 and entered into force in 2015) is an international convention on civil nuclear liability that in large part is modeled after the Paris and Vienna Conventions on Nuclear Liability (concluded in 1960 and 1963, respectively), which were in turn rooted in the earlier Price-Anderson Act. The subject matter of the Convention overlaps with and contains provisions that replicate many of those in Price-Anderson. Though the Convention does not conflict with present Price-Anderson Act provisions, the United States' 2008 ratification of the Convention, followed by its entry into force in 2015, render the terms of the Convention relevant to continuation of or modifications to the Price-Anderson Act.

In addition to ratifying the Convention, Congress provided for its implementation in the 2007 Energy Independence and Security Act (EISA). EISA provided that funds made available under the Convention may be used to satisfy public liability resulting from a Price-Anderson incident and that, where available, these funds would increase the overall public liability allowable under Price-Anderson. EISA also provided that the DOE would be responsible for implementing a ~~risk-based~~ retroactive ~~premium~~ risk pooling program under~~scheme by~~ which suppliers and transporters of nuclear equipment contribute to a Convention-mandated fund for non-Price-Anderson Act incidents occurring outside the United States. The DOE has not issued a final rulemaking on the subject.

Any modifications to the Price-Anderson Act necessarily would have to consider U.S. obligations under the Convention. However, so long as Congress continues Price-Anderson's overarching principles, U.S. ratification of the Convention does not restrict congressional action. The Convention generally permits great flexibility in the specific terms of national law, and even greater flexibility under the Convention's "grandfather" clause, which permitted the United States to become a Party to the Convention without amending ~~the~~ Price-Anderson's unique provisions that are designed to accommodate our Federal system. Failure to continue the Price-Anderson Act to provide coverage for future as well as existing nuclear facilities under the Act, or failure to otherwise replace it with a similar law meeting the requirements of the Convention, would be inconsistent with ratification.

Potential Financial Burden of Increasing Retrospective Premium Assessments

When Congress enacted legislation in 1957 to limit liability and indemnify the nuclear power industry, it anticipated a time when Federal Government indemnification no longer would be necessary. By requiring that reactor units be insured to the maximum amount of available insurance, Congress set the stage for the gradual reduction of Federal indemnification. A more dramatic reduction in indemnification occurred in 1975, when Congress required licensees to implement a secondary layer of financial protection to be funded through retrospective premium assessments if necessary, in addition to the maximum amount of available commercial insurance. As a consequence, Congress reduced the need for government indemnification by providing for increased private insurance coverage. Retrospective insurance, however, poses a potential additional expense for licensees that might significantly affect a company's finances. In 1988, Congress recognized this issue and limited the maximum annual retrospective premium payment to a non-inflation adjusted $10 million ($22 million in 2019$) per reactor, per incident.[8] In 2005, Congress then increased the maximum annual retrospective premium to $15 million ($20 million in 2019$) per reactor, per incident, and mandated that this value be adjusted for inflation at 5-year intervals. The maximum annual retrospective premium ~~has been~~ was increased to $20.496 million per reactor, per incident, in ___. The next adjustment should take place in 2023.

Commented [A4]: Insert the year of the last increase.

In past Reports to Congress, the NRC studied different levels of retrospective assessments and licensees' ability to afford such assessments. A report prepared by Professor Melicher of the University of Colorado in 1976 established a template that has been updated ~~at regular~~ periodically~~intervals~~, including in 1979, 1983, and 1998. This report applies the same methodology using financial data from 2019. The updated 2020 analysis concludes that the maximum annual assessment that selected licensees could afford ranges between $20 and $50 million. Above $50 million, smaller licensees, and those licensees owning multiple reactor units, may show signs of an inability to pay into the retrospective premium plan.

Part 4. Conclusions and Recommendations

Created to meet the two objectives stated in the Price-Anderson Act, the structured payment system, currently providing billions of dollars in liability coverage and consisting of the two layers of financial protection as discussed throughout this report, has operated for over 60 years with effective cost, assured that significant funds are available to the public to satisfy claims if a nuclear event were to occur, and ~~has~~ enabled private sector participation in the nuclear power industry.

As discussed in detail in this report, the Price-Anderson system functioned in connection with the payment of claims arising out of the TMI-2 accident in 1979, the only major nuclear accident for which it was relied upon. Companies representing both reactors and support service and equipment suppliers have indicated that they would likely not participate in the nuclear industry without some method of public liability limitation, such as that provided under the Price-Anderson Act. Despite a nearly 15 percent decline in the number of operating nuclear power reactor units since the last report to Congress and the expected early retirement of additional

[8] Values within this report are adjusted to 2019$ using the Consumer Price Index (CPI) from the Bureau of Labor Statistics, available at: https://www.bls.gov/cpi/.

units in the future, Price-Anderson will continue to make a large sum of funds available to victims of nuclear incidents for at least the next decade based upon its existing framework.

Recommendations

(1) Based on its evaluation of the Price-Anderson Act provisions of the Atomic Energy Act, consistent with the direction in Energy Policy Act of 2005, Section 606; the Commission concludes that there is an ongoing need for the Price-Anderson Act, taking into account the condition of the nuclear industry, availability of private insurance, and the state of knowledge concerning nuclear safety. Therefore, the Commission recommends continuing the Act for 10 years to allow Congress to be better able to consider substantial changes related to trends in decommissioning and in advanced reactor technologies that are anticipated to continue within the nuclear power industry. The Commission has no recommendations as to the repeal or modification of any of the specific provisions of the Price-Anderson Act. The Commission recommends that the Congress clarify its intent on the following issues that have been sources of uncertainty in implementing Price-Anderson:

   a. Address whether the prohibition on payment of punitive damages extends to every case where a defendant has entered into an indemnification agreement under Price-Anderson, or only to those where damages would exceed the non-governmental first and second layers of financial protection and actually involve the government paying for punitive damages, to resolve conflicting holdings from district courts described in more detail in Section 1.2.7 of this report.

   b. Clarify that a nonprofit NRC licensee shall not be indemnified for legal costs incurred in connection with the settlement of a claim, to confirm the Commission's interpretation of the relationship between 42 U.S.C. 2210(h) and 42 U.S.C. 2210(k) described in more detail in Section 1.2.9 of this report.

(2) The Commission recommends that any modifications considered to the Price-Anderson Act should take into account U.S. obligations under the Convention on Supplementary Compensation for Nuclear Damage, which is described in more detail in Section 3.3 of this report.

ABBREVIATIONS AND ACRONYMS

ABWR	Advanced Boiling Water Reactor
ADAMS	Agencywide Documents Access and Management System
ALARA	As low as is reasonably achievable
ANI	American Nuclear Insurers
AP600	Advanced Passive Reactor 600
AP1000	Advanced Passive Reactor 1000
APR1400	Advanced Power Reactor 1400
ASP	Accident Sequence Precursor
BEIR VII	Biological Effects of Ionizing Radiation VII
BWR	Boiling water reactor
CDF	Core damage frequency
CISF	Consolidated Interim Storage Facility
COL	Combined license
CPI	Consumer Price Index
DBT	Design basis threat
DNA	Deoxyribonucleic acid
DOE	U.S. Department of Energy
EA	Environmental assessment
EBT	Earnings before taxes
EFA	Emergency financial assistance
EIA	U.S. Energy Information Administration
EIS	U.S. Environmental impact statement
EISA	Energy Independence and Security Act
ENO	Extraordinary nuclear occurrence
EP	Emergency preparedness
EPS	Earnings per share
ER	Environmental report
ERR	Excess relative risk
ESBWR	Economic Simplified Boiling Water Reactor
ET	Effective taxes
ETR	Effective tax rate
FEMA	Federal Emergency Management Agency
FFD	Fitness for Duty
GAO	U.S. Government Accountability Office
GDP	Gross domestic product
GW	Gigawatt
Gy	Gray
HFO	High winds, floods, and other
HHS	U.S. Department of Health and Human Services

HTGR	High temperature gas-cooled reactor
IAEA	International Atomic Energy Agency
ICM	Interim compensatory measures
ICRP	Industry Credit Rating Plan
INES	International Nuclear and Radiological Event Scale
INWORKS	International Nuclear Workers Study
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination of External Events
IPP	Independent power producer
ISFSI	Independent Spent Fuel Storage Installation
kW	Kilowatt
kWh	Kilowatt-hour
LERF	Large early release frequency
LNT	Linear, no-threshold
LSS	Life Span Study
LWR	Light water reactor
mGy	Milligray
Mo-99	Molybdenum-99
MSR	Molten salt reactor
MW	Megawatts
MW(e)	Megawatts electric
MWh	Megawatt-hour
MW(t)	Megawatts thermal
NEI	Nuclear Energy Institute
NEIL	Nuclear Electric Insurers Limited
NI	Net income
Non-LWR	Non-light water reactor
NRC	U.S. Nuclear Regulatory Commission
NWMI	Northwest Medical Isotopes, LLC
PCV	Primary containment vessel
PEG	Public Service Enterprise Group Inc.
PG&E	Pacific Gas and Electric
PRA	Probabilistic risk assessment
Price-Anderson Act, PAA, *or* Act	Price-Anderson Nuclear Industries Indemnity Act
PWR	Pressurized water reactor
QHO	Quantitative health objectives
RIDM	Risk information in decision-making activities
ROCE	Return on common equity
ROP	Reactor Oversight Process
S&T	Suppliers and Transporters

SAMA	Severe accident mitigation alternative
SAMDA	Severe accident mitigation design alternative
SDP	Significance Determination Process
SE15	Southern Exposure 15
SEC	U.S. Securities and Exchange Commission
SFR	Sodium-cooled fast reactor
SHINE	SHINE Medical Technologies, Inc.
SMR	Small modular reactor
TCGA	The Cancer Genome Atlas
TMI	Three Mile Island
TMI-2	Three Mile Island Unit 2
TPA	Third-party administrator
TTX	Table Top Exercise
TVA	Tennessee Valley Authority
UCLA	University of California, Los Angeles
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
UV	Ultraviolet

1 OVERVIEW OF PRICE-ANDERSON SYSTEM

Part 1 provides an overview of the Price-Anderson Act, including amendments through the latest (2005) extension and an update on legal issues pertaining to nuclear insurance and indemnity. Specifically, this section includes the following subsections:

1.1 – History, Major Provisions, and Scope
1.2 – Legal Issues Associated with Price-Anderson Litigation

1.1 History, Major Provisions, and Scope

The Atomic Energy Act of 1954, 42 U.S.C. ch. 23, removed the restrictions placed by the Atomic Energy Act of 1946 on the possession and use of substantial quantities of fissionable materials by private persons and organizations and authorized a comprehensive regulatory program. In the period immediately following the enactment of the 1954 legislation, attention focused on a significant impediment to the development of peaceful uses of atomic energy by the private sector of the economy: the lack of adequate available insurance. Although a major nuclear accident was considered unlikely to occur in the United States, the consequences of such an event could have resulted in liability claims that would have exhausted the levels of insurance that were then available and imposed on the nuclear industry large potential losses for which no insurance was available. In response to this situation, the Price-Anderson Act[1] was enacted on September 2, 1957, as Section 170 of the Atomic Energy Act of 1954.

The Price-Anderson Act was enacted to meet two basic objectives:

1. Assure that adequate funds are available to the public to satisfy liability claims if a catastrophic nuclear accident were to occur.

2. Remove the deterrent to private sector participation in atomic energy presented by the threat of potentially enormous liability claims in the event of a catastrophic nuclear accident.

Congress designed the Price-Anderson Act to balance the public's needs with the needs of industry. Specifically, Congress required that licensees provide financial protection[2] for risks of liability for nuclear damage, indemnified the nuclear power industry as necessary, and limited total public liability to the nuclear power industry in the event of an incident.

The Price-Anderson Act has been successful in removing liability-related impediments for firms to participate in the civilian nuclear sector. The Act accomplished this with its Federal Government indemnification program and public liability limits. Both power companies and support service and equipment suppliers indicated they would likely not participate in the nuclear industry without some method of public liability limitation, such as that provided under the Price-Anderson Act. Public testimony submitted during initial enactment of the

[1] Pub. L. 85-256, 71 Stat. 576, amending the Atomic Energy Act of 1954 to include Section 170 and related definitions in Section 11.
[2] Although Price-Anderson offers optional methods of providing financial protection, licensees have always purchased nuclear liability insurance to meet the requirement for financial protection.

Price-Anderson Act in 1957 and its subsequent extensions (most notably, in 1965, 1988, and 2005) supported this viewpoint.[3]

1.1.1 Provisions Enacted in 1957

The original Price-Anderson Act limited licensees' public liability for any single nuclear incident to $560 million ($5 billion in 2019$).[4] This was the sum of $500 million per reactor provided by Federal Government indemnification plus the maximum amount of private insurance (i.e., $60 million arranged for and purchased by industry participants, available to insure the industry as a whole) available at the time. This private commercial insurance is referred to in this report as the "primary layer of financial protection," "primary insurance," or "primary coverage." In the event of an incident, the licensees were responsible for the first $60 million in payments, with the Federal Government responsible for the next $500 million. The obligation by the government in the original Price-Anderson Act to provide funds for a nuclear event once the primary layer of financial protection for that event had been exhausted is referred to as "Federal indemnity" or "government indemnity."

1.1.2 Early Amendments to the Price-Anderson Act and their Impacts to Government Indemnification for Large, Operating Commercial Nuclear Power Reactors

The Price-Anderson Act has had several major modifications (a listing of all amendments is provided in Table 1-1). In 1965, the Act was extended through August 1, 1977. In recognition of the intent of the insurance industry to raise its liability capacity above $60 million ($487 million in 2019$), the 1965 Amendments stipulated that government indemnity would be reduced dollar-for-dollar to the degree that financial protection was increased above $60 million while still retaining the overall public liability limit of $560 million.

The 1966 Amendments introduced the related concepts of extraordinary nuclear occurrence (ENO) and waiver of defenses. The regulations associated with the determination of an ENO are contained in 10 CFR Part 140, "Financial Protection Requirements and Indemnity Agreements." When the Commission determines that a nuclear incident is an ENO, a recovery scheme referred to as "waiver of defenses" is activated. A "defense" allows the alleged responsible party to avoid paying all or part of a claim. Defenses differ across State laws. Under the Federal "waiver of defenses," Price-Anderson claimants would need to show only (1) personal injury or property damage, (2) monetary amount of loss, and (3) causal link between the loss and the radioactive material released. To pursue their claims, claimants would not need to show the fault of any party. These provisions were needed because, at the time, many States did not have strict liability (i.e., no fault) laws applicable to claims from nuclear events. The 1966 waiver of defenses provision also stated that defenses based on a statute of limitations[5] may be raised only for ENOs that occurred 10 years or more prior to a suit being instituted ~~(i.e., period~~

[3] See, e.g. Hearings Before the Joint Committee on Atomic Energy, 85 Cong. 146-147 (1957) (Statement of Francis K. McCune of General Electric Co.); Hearing Before the Subcommittee on Legislation of the Joint Committee on Atomic Energy, 89 Cong. 225 (1965) (Statement of James Campbell of Edison Electric Institute); Hearing Before the Subcommittee on Energy Research and Development of the Committee on Energy and Natural Resources of the United States Senate on S. 1225, 99 Cong. 305 (1985) (Statement of Steve C. Griffith on behalf of Atomic Industrial Forum, Inc., American Nuclear Energy Council, and Edison Electric Institute); The Energy Policy Act of 2005: Hearing Before the Subcommittee on Energy and Air Quality, 109 Cong. 451 (2005) (Statement of John E. Kane of the Nuclear Energy Institute (NEI)).

[4] Generally, dollar amounts used in this report are *nominal* value dollars, often followed by an approximate *real* or *constant* dollar value reflecting the inflation-adjusted value for the cited year. In this example, $560 million in 1957 nominal dollars is approximately equal to $5 billion in 2019 real dollars, as adjusted for inflation.

[5] A statute of limitations prescribes the period of time in which an action or proceeding in law must be brought.

~~from occurrence of the nuclear incident)~~ or 3 years after a claimant knew or should have known of the injury and its cause ~~(i.e., period after claimant knew or should have known of injury and its cause)~~.

The Act was again amended on December 31, 1975, to provide for an additional 10-year extension through August 1, 1987. The 1975 Amendments directed the Commission to require that licensees maintaining the maximum amount of available primary insurance (i.e., large, operating commercial nuclear power reactors having capacities of 100 MW(e) or more) also participate in a secondary layer of financial protection to be funded through a retrospective premium insurance plan. Under the secondary layer of financial protection, in the event of a nuclear incident resulting in damages exceeding the amount of primary insurance coverage, licensees that were required to maintain the maximum amount of available primary insurance would, in addition, be required to pay a pro-rated share[6] of the damages in excess of the primary insurance amount, up to a total of $5 million per reactor, per incident, in retrospective premiums (also called “deferred premiums”). The 1975 Amendments also revised the provisions related to the statute of limitations. Specifically, while retaining the availability of Federal statute of limitations related defenses 3 years after the claimant knew or should have known of injury and its cause, the 1975 Amendments expanded the period of time in which the defense would be waived where claimants lacked knowledge of their injury or its cause from 10 years to 20 years after the occurrence of an ENO. The effect of this change was to provide an expanded opportunity for claimants to discover injuries and the related cause without prematurely barring claimants from seeking compensation.

Because the limit of public liability remained at $560 million under the 1975 Amendments, the effect of the secondary layer of insurance was to reduce the indemnity obligation of the government. In November 1982, when the 80th large nuclear power reactor was licensed, the total retrospective coverage became $400 million (80 reactors times $5 million) ($1 billion in 2019$). The $400 million secondary layer of financial protection, in combination with the $160 million primary insurance layer then available, resulted in a total of $560 million ($1.48 billion in 2019$) – equal to the existing limit of public liability – so that the government indemnity under the Act was essentially eliminated. Congress also provided that the limit of public liability, which equaled the total financial protection of the primary and secondary layers, would grow in $5 million increments as each new reactor was licensed to operate. Finally, in recognition of concerns about the adequacy of the limit of public liability at the time, the 1975 Amendments explicitly provided that “in the event of a nuclear incident involving damages in excess of [the] amount of aggregate liability, the Congress will thoroughly review the particular incident and will take whatever action is deemed necessary and appropriate to protect the public from the consequences of a disaster of such magnitude.”

1.1.3 Amendments Since 1988 and the Further Increases to the Secondary Layer of Financial Protection

In the 1988 Amendments, Congress extended the Price-Anderson Act through 2002; established Federal original jurisdiction over public liability actions; made a larger pool of funds available to pay public liability claims by increasing the maximum secondary layer to $63 million ($136 million in 2019$) per reactor, per incident; raised the maximum annual retrospective

[6] A licensee’s share is based on the ratio of (1) the licensee’s maximum retrospective premium, which is a function of the number of its licensed reactors that are subject to the secondary layer of financial protection requirement; and (2) the total maximum retrospective premium of all licensees, which is a function of the total number of licensed reactors subject to the secondary layer of financial protection requirement.

premium from $5 million to $10 million ($21 million in 2019$) per reactor, in the event of an accident; added a provision requiring that licensees additionally pay up to 5 percent of the standard retrospective premium in the event that an incident exceeds the maximum financial protection available; and excluded the payment of defense costs from the insurance layers under certain conditions when the public liability from an incident may exceed the limit of public liability. Congress did not, however, eliminate the limit on the nuclear industry's public liability.

Additionally, the 1988 Amendments further modified the statute of limitations provision, providing an indefinite period of time in which claimants could gain knowledge of injury and cause of injury after the occurrence of an ENO and still have the opportunity to seek compensation. Specifically, while retaining the availability of statute of limitations related defenses 3 years after a claimant knew or should have known of injury and its cause, the 1988 Amendments indefinitely expanded the period of time in which the defense would be waived where the claimant lacked such knowledge by eliminating the period from occurrence portion of the provision from the statute.

The 1988 Amendments also mandated the establishment of the Presidential Commission on Catastrophic Nuclear Accidents, "to study means of fully compensating victims of a catastrophic nuclear accident that exceeds the amount of aggregate public liability." The "Report to the Congress of the Presidential Commission on Catastrophic Nuclear Accidents" (the "Presidential Commission Report"), published in August 1990, included an exploration of administrative systems for compensating latent injury[7] claims. Following submission of its report, the study commission terminated, as specified by Congress.

In the Energy Policy Act of 2005, Congress extended the Price-Anderson Act through 2025 and modified certain elements. The 2005 Act revised the $63 million maximum secondary layer to reflect inflation, setting the new limit to $95.8 million ($125 million in 2019$) per reactor, per incident. The 2005 Act also raised the maximum annual retrospective premium from $10 million to $15 million ($19.6 million in 2019$) per reactor per incident and mandated that this value be adjusted for inflation in the future. The NRC conducts rulemaking at least once every 5 years from the previous adjustment to implement this inflation adjustment.

The 2005 Act also provided for financial protection regulations applicable to "modular reactors" – designs where a number of reactors with less individual capacity than a typical commercial reactor are grouped together. The 2005 Act provided that a combination of two or more reactors located at a single site, with individual capacities between 100 and 300 MW(e) but a combined capacity of 1,300 MW(e) or less, should be considered as a single, 100 MW(e) reactor for the sole purpose of assessing financial obligations under the Price-Anderson Act.

Table 1-1 Listing of previous amendments to the Price-Anderson Act

Date of Amendment	Public Law Citation	Public Statutes Citation	Brief Description
Aug. 23, 1958	Pub. L. 85-744	72 Stat. 837	Exempted nonprofit educational institutions from

[7] Latent injuries are those health effects that might not become apparent for many years but that could be attributed to the nuclear accident ("Presidential Commission Report").

Date of Amendment	Public Law Citation	Public Statutes Citation	Brief Description
			financial protection requirements.
Aug. 1, 1964	Pub. L. 88-394, Sections 2, 3	78 Stat. 376	Extended the Act to 1967.
Sept. 29, 1965	Pub. L. 89-210, Sections 1-5	79 Stat. 855, 856	Extended the Act to 1977 and provided for the reduction of Federal indemnity by an amount equal to the increase in liability capacity available from the insurance industry beyond its prior $60 million limit.
Oct. 13, 1966	Pub. L. 89-645, Sections 2, 3	80 Stat. 891	Provided for the waiver of defenses in the event of an ENO.
Dec. 31, 1975	Pub. L. 94-197, Sections 2-14	89 Stat. 1111	Extended the Act to 1987 and added the secondary layer of financial protection requirements that licensees participate in a retrospective premium insurance plan, setting maximum retrospective premiums at $5 million per reactor.
Aug. 20, 1988	Pub. L. 100-408, Sections 2-4(a); 5(c); 6-10; 11(a), (c), (d)(1); 12-15; 16(a)(2), (b)(3)-(6), (c), (d)(4)-(7), (e)	102 Stat. 1066-1080	Extended the Act to 2002;[8] established Federal original jurisdiction over public liability actions; increased the funding available to pay public liability claims to $63 million per reactor, per incident; required that the maximum total retrospective premium that may be charged to a licensee following a nuclear incident be adjusted for inflation; set the maximum annual retrospective premium to $10 million per reactor; added a provision requiring that licensees additionally pay up to 5 percent of the standard

[8] The next extension of the Act, as it pertains to NRC licensees, was in 2003.

Date of Amendment	Public Law Citation	Public Statutes Citation	Brief Description
			retrospective premium in the event that an incident exceeds the maximum financial protection available; eliminated the 20-year period from occurrence of the nuclear incident statute of limitations provision for ENOs; commissioned a study of administrative systems for compensating latent injury claims; and mandated the Presidential Commission on Catastrophic Nuclear Accidents.
Nov. 10, 1998	Pub. L. 105-362, Title XII, Subsection 1201(b)	112 Stat. 3292	Removed annual reporting requirements for NRC under the Act.
Feb. 20, 2003	Pub. L. 108-7, Division O, Section 101	117 Stat. 551	Extended the Act to 2004.
Aug. 8, 2005	Pub. L. 109-58, Title VI, Subtitle A, Sections 602-608	119 Stat. 779	Extended the Act to 2025, increased the funding available to pay public liability claims, required that maximum annual retrospective premiums be adjusted for inflation, and provided for the regulation of modular reactors under the Price-Anderson Act financial protection framework.

1.1.4 Scope and Implementation of Price-Anderson

The key parameters of the Price-Anderson framework discussed in this report include: (1) which NRC licensees[9] are subject to Price-Anderson, (2) the total amount of funds available to cover Price-Anderson claims, (3) what costs are covered, and (4) the compensation process. Each of these parameters is discussed in the following sections.

[9] As mentioned in footnote 1 of the Executive Summary, this discussion is limited to NRC licensees and does not discuss the scope of the Price-Anderson Act as it relates to DOE contractors.

1.1.4.1 NRC Licensees Subject to Price-Anderson

The Price-Anderson system channels to the operator the obligation to pay compensation for damages and provides “omnibus” coverage (i.e., the same protection available for the operator of a covered facility extends to any person who may be legally liable, regardless of the identity of the person liable or their relationship to the licensed activity). Thus, those who are injured are assured of the availability of funds to pay their claims, and firms that contribute in some manner to the construction (including design), operation, and/or maintenance of covered licensees are all protected. For example, each defendant company that at the time of the accident was an owner and operator of the Three Mile Island facility, together with each company that supplied design, engineering, or maintenance services, or that was a vendor of systems or equipment incorporated in the facility, was covered through the Price-Anderson financial protection system. Because Price-Anderson channels to the party licensed to operate the nuclear reactor the obligation to pay compensation for damages, a claimant need not sue all these parties but can bring its claim to the reactor licensee.

The Price-Anderson Act specifies in 42 U.S.C. 2210(a) that

> [e]ach license issued under section 2133 [Commercial licenses] or 2134 [Medical, industrial, and commercial licenses] of this title and each construction permit issued under section 2235 of this title shall, and each license issued under section 2073 [Domestic distribution of special nuclear material], 2093 [Domestic distribution of source material], or 2111 [Domestic distribution] of this title may, for the public purposes cited in section 2012(i) of this title, have as a condition of the license a requirement that the licensee have and maintain financial protection of such type and in such amounts as the Nuclear Regulatory Commission (in this section referred to as the “Commission”) in the exercise of its licensing and regulatory authority and responsibility shall require in accordance with subsection (b) to cover public liability claims.[10]

Subsection (b)(1) ~~referred to in~~of section 2210(a) establishes the amount of required financial protection for “facilities designed for producing substantial amounts of electricity and having a rated capacity of 100,000 electrical kilowatts or more” and gives the Commission discretion to establish a lesser amount for other licensees. Hence, Price-Anderson’s primary focus is on “production and utilization facilities,” including all nuclear reactors ranging from the largest nuclear power reactors to the smallest research reactors and testing facilities. The NRC is required to apply the provisions of the Act to all production and utilization facilities and to uranium enrichment facilities, except those uranium enrichment facilities constructed after 1990.[11] The NRC is also given discretionary authority to apply the provisions to other types of licensees not involved in the operation of production or utilization facilities, such as those possessing radioactive materials. The NRC’s current 10 CFR Part 140, “Financial Protection Requirements and Indemnity Agreements,” regulations apply

(1) To each person who is an applicant for or holder of a license issued under 10 CFR parts 50, 52, or 54 to operate a nuclear reactor;

[10] 42 U.S.C. 2210(a).

[11] Pub. L. 101-575, 104 Stat. 2835 (1990), added to Section 193 of the Atomic Energy Act of 1954 a Subsection (e) stating that Section 170 of the Atomic Energy Act of 1954 shall not apply to any license under sections 53 or 63 for a uranium enrichment facility constructed after the date of enactment of this subsection.

(2) With respect to an extraordinary nuclear occurrence, to each person who is an applicant for or holder of a license to operate a production facility or a utilization facility (including an operating license issued under part 50 of this chapter and a combined license (COL) under part 52 of this chapter), and to other persons indemnified with respect to the involved facilities; and

(3) To each person licensed pursuant to part 70 of this chapter to possess and use plutonium in a plutonium processing and fuel fabrication plant.[12]

As described below, the Price-Anderson Act currently applies to (1) large commercial nuclear power reactors, (2) reactors under 100 MW(e), and (3) plutonium processing and fuel fabrication facilities:

- Large Commercial Nuclear Power Reactors. Licensees of nuclear power reactors having a rated capacity of 100 MW(e) or more must provide proof to the NRC that they have financial protection in an amount equal to the maximum amount of liability insurance available at reasonable cost and on reasonable terms from private sources. These licensees also must participate in the secondary layer of financial protection through the retrospective premium program (42 U.S.C. 2210(b)(1); 10 CFR 140.11(a)(4)).
    - Decommissioning Large Commercial Nuclear Power Reactors. Under the Price-Anderson Act and associated regulations, no distinction is made for the financial protection requirements of large, operating commercial nuclear power reactors compared to large commercial nuclear power reactors in decommissioning. However, the NRC has been providing licensees in decommissioning with exemptions from financial protection requirements and allowing them to reduce the amount of coverage as they progress through the decommissioning process. The NRC is undertaking a rulemaking that would codify reduced financial protection requirements throughout decommissioning without the need for obtaining exemptions from NRC's regulations. The proposed rule, as provided by the staff to the Commission for its deliberation, would provide licensees, once certain criteria are satisfied, the option to provide a reduced amount of $100 million to satisfy the primary layer of financial protection and withdraw from the retrospective premium program under the secondary layer of financial protection.[13]

Commented [A5]: Update this as well as any other references re: decommissioning as needed to reflect direction in the final SRM on SECY-18-0055.

- Reactors Under 100 MW(e). Licensees authorized to operate nuclear reactors of less than 10 MW(t) capacity are required by the NRC to have and maintain financial protection in amounts ranging between $1 and $2.5 million depending on the facility's power level.[14] Financial protection requirements for power reactors authorized to operate above 10 MW(t) and below 100 MW(e) are established in accordance with a formula designed to take into account the population in a reasonably sized area around the

[12] 10 CFR 140.2, Scope. Part 140 also describes liability insurance requirements "for each person licensed pursuant to parts 40 and 70 of this chapter to construct and operate a uranium enrichment facility." 10 CFR 140.2, Scope, and 10 CFR 140.13b, Amount of liability insurance required for uranium enrichment facilities. However, as discussed above, these liability insurance requirements are not Price-Anderson Act requirements.
[13] Proposed rule, Regulatory Improvement for Production and Utilization Facilities Transitioning to Decommissioning (May 22, 2018) (ML18012A022).
[14] Amount and type of financial protection for licensees, 42 U.S.C. 2210(b)(1); 10 CFR 140.11(a)(1) and (3).

reactor. Under the formula, population is weighted roughly in inverse proportion to the square of the distance of the population from the reactor site.[15]

- Federal Licensees. Federal agencies licensed to operate nuclear reactors are not required to provide financial protection and receive government indemnity coverage from the first dollar up to $500 million. (DOE facilities are covered by separate provisions under the Price-Anderson Act.)[16]

- Nonprofit Educational Institutions. A number of State-owned nonprofit educational institutions are unable to comply with Subsection 170(a) of the Act (the requirement to provide financial protection that includes coverage of the legal costs of defending against suits) because of sovereign immunity from public liability and a resulting lack of authority to waive immunity or pay insurance premiums. To address this issue, Congress enacted ~~remedial~~ legislation in 1958 (Pub. L. 85-744, 72 Stat. 837), which became Subsection 170(k) of the Act. As a result, licensees found by the NRC to be nonprofit educational institutions (whether State-owned or private) are granted a waivable exemption from the financial protection requirements of the Price-Anderson Act. The NRC is required to indemnify such licensees from public liability arising out of a nuclear incident in excess of $250,000, up to the statutory maximum of $500 million, and to make payments without regard to immunity that the institution may have. Some of the licensed nonprofit educational institutions have chosen to purchase nuclear liability insurance to cover the un-indemnified $250,000.[17]

- Plutonium Processing and Fuel Fabrication Facilities. Subsequent to the extension of the Price-Anderson Act of 1975, the NRC considered whether its discretionary authority to extend Price-Anderson coverage should be applied to persons using plutonium in plants defined in NRC regulations as "plutonium processing and fuel fabrication facilities." The NRC decided to exercise its discretionary authority and require, as of August 1, 1977, that plutonium processors having authorized plutonium possession limits of five kilograms or more must provide financial protection in the amount of $125 million.[18] The NRC has since increased that amount to $200 million.[19]

NRC licensees that are not currently required by NRC regulation to maintain financial protection under the Price-Anderson Act include (1) other materials licensees, (2) radiopharmaceutical licensees, (3) stand-alone Independent Spent Fuel Storage Installations (ISFSIs) specifically licensed under Part 72, and (4) nuclear waste repositories, as described below:

- Other Materials Licensees. Subsequent to 1977, the NRC also evaluated whether it should exercise its discretionary authority and require financial protection for materials licensees other than those possessing plutonium. Based on work performed for the NRC by the Oak Ridge National Laboratory (NUREG/CR-0222, "Economic Consequences of Accidental Release from Fuel Fabrication and Radioisotope Processing Plants"), NRC staff refinement of that report, and an in-house study of this question, the NRC decided

[15] Amount and type of financial protection for licensees, 42 U.S.C. 2210(b)(1); 10 CFR 140.12.
[16] Indemnification of licensees by Nuclear Regulatory Commission, 42 U.S.C. 2210(c); 10 CFR 140.10.
[17] Exemption from financial protection requirement for nonprofit educational institutions, 42 U.S.C. 2210(k); 10 CFR 140.10.
[18] Implementation of Legislation Amending the Price-Anderson Act, 42 FR 48 (Jan. 3, 1977).
[19] 10 CFR 140.13a.

that no apparent need existed to extend Price-Anderson to other classes of materials licensees.[20]

- Radiopharmaceutical Licensees. The 1988 Amendments directed the NRC to initiate a proceeding to determine whether radiopharmaceutical licensees should be indemnified under Price-Anderson. Following a negotiated rulemaking process, the arbitrator decided that the NRC should not revise its regulations to require financial protection for these licensees.[21] However, as discussed below in section 2.2. ("Non-power Production and Utilization Facilities"), license applicants for these facilities have committed to obtain off-site financial protection, where available.

- Stand-alone ISFSIs Specifically Licensed under Part 72. Unlike a generally-licensed ISFSI located at a power reactor and licensed under 10 CFR Part 50 requirements, stand-alone ISFSIs specifically licensed under 10 CFR Part 72 are not subject to financial protection regulations as such requirements are not provided for under 10 CFR Part 72 regulations.[22] ISFSIs specifically licensed under Part 72 are also not indemnified under Price-Anderson and have no limit of public liability. The NRC staff has identified this as a regulatory disparity between ISFSIs at power reactors licensed under Part 50 and ISFSIs specifically licensed under Part 72. In SECY-04-0176, "Exemption Requests to Reduce Liability Insurance Coverage for Decommissioning Reactors after Transfer of All Spent Fuel from a Spent Fuel Pool to Dry Cask Storage," the NRC staff recognized that the "ISFSI regulations in 10 CFR Part 72 do not require any insurance or financial liability protection for ISFSIs. The [NRC] staff acknowledges that there is little technical difference between a generally-licensed ISFSI at a decommissioning reactor under the requirements of Part 50 and a stand-alone, specifically-licensed ISFSI under the requirements of Part 72." Thus, the staff recognizes that after a Part 50 reactor site completes decommissioning and retains spent fuel at an onsite ISFSI, by regulation, it must continue to maintain insurance, while current NRC regulations do not require insurance for a stand-alone, Part 72 ISFSI. ~~However, in the absence of Part 72 financial protection requirements, license applicants for stand-alone, Part 72 ISFSIs have committed to obtain off-site financial protection, where available. The NRC staff anticipates this approach could be used in the future to provide financial protection for stand-alone ISFSIs specifically licensed under Part 72.~~ The NRC staff is currently exploring available options to address the regulatory disparity between ISFSIs at power reactors licensed under Part 50 and ISFSIs specifically licensed under Part 72, under the ongoing rulemaking titled "Regulatory Improvement for Production and Utilization Facilities Transitioning to Decommissioning."[23]

- Nuclear Waste Repositories. Long-term storage of nuclear waste at a nuclear waste repository would not be covered by Price-Anderson Act financial protection. Instead, it

[20] The only other instances in which the NRC has exercised its discretionary authority involved spent fuel produced at one reactor and stored at the site of another reactor owned by the same licensee. ~~The two licensees involved were Carolina Power & Light Company and Duke Power Compa~~ny.

[21] "10 CFR Part 140," Federal Register, Vol. 54, No. 99, May 24, 1989, pp. 22444-22445.

[22] Although none currently exist, ISFSIs located at nuclear power reactors could be generally licensed under Part 52. ISFSIs generally licensed under Part 52 would be subject to similar Price-Anderson Act financial protection requirements as ISFSIs generally licensed under Part 50.

[23] Regulatory Basis Document, Appendix G – Offsite and Onsite Financial Protection Requirements and Indemnity Agreements, Regulatory Improvements for Power Reactors Transitioning to Decommissioning (November 20, 2017) (ML17215A010). Proposed rule, Regulatory Improvement for Production and Utilization Facilities Transitioning to Decommissioning (May 22, 2018) (ML18012A022).

would be covered by The Nuclear Waste Fund, which was established under the Nuclear Waste Policy Act of 1982.

1.1.4.2 Total Amount of Funds to Cover Price-Anderson Claims

Under the Act, total available coverage, which determines the limit of public liability, includes both the required financial protection provided ~~for~~ by licensees, if any, and the Federal indemnity, if any. The sum of required financial protection and Federal indemnity equals the aggregate limit of public liability.

When the NRC requires that licensees provide financial protection, Subsection 170(b) of the Act provides that the amount required will be the maximum amount of private insurance available from private sources, with exceptions (which are not applicable to large commercial power reactors). For example, the NRC may establish a lesser amount on the basis of criteria that take into consideration factors such as (1) the cost and terms of private insurance; (2) the type, sizes, and location of the licensed activity and other factors pertaining to the hazard; and (3) the nature and purpose of the licensed activity. The NRC may revise these criteria from time to time and at its discretion.

Licensees operating large commercial nuclear power reactors (with a power level of 100 MW(e) or more) are required to purchase the maximum amount of available primary insurance. Initially, Federal indemnification under the Price-Anderson framework filled the gap (up to $500 million)[24] between required amounts of financial protection and the aggregate limit of public liability. As the required amounts of financial protection increased for commercial power reactors, the gap disappeared, along with Federal indemnity. Thus, current required amounts of financial protection (i.e., the sum of the primary insurance and the secondary layer of financial protection provided by licensees) equals the aggregate limit of public liability.

Since its enactment, the Price-Anderson Act has maintained its requirement that, under the primary layer of financial protection, large, operating commercial nuclear power reactors be insured to the maximum amount of available primary insurance. As the private insurance market increased its maximum amount of available primary insurance, each nuclear power reactor unit in turn needed to increase its coverage level. The maximum amounts of available primary insurance required to satisfy the primary layer of financial protection since 1957 are shown in Table 1-2.

[24] Federal indemnification cannot exceed $500 million. For licensees with financial protection requirements of less than $560 million, the Act mandates that the NRC provide indemnity protection in the amount of $500 million for each nuclear incident less the amount by which the required financial protection exceeds $60 million.

Table 1-2 Maximum amounts of available primary insurance required to satisfy the primary layer of financial protection

Year, Citation	$ (millions)	$ (millions in 2019$)
1960, 25 FR 2944	60	518
1966, 30 FR 14779	74	584
1969, 34 FR 705	82	571
1972, 37 FR 3423	95	581
1974, 39 FR 5310	110	570
1975, 40 FR 7081	125	594
1977, 40 FR 20139	140	591
1979, 44 FR 20632	160	563
1989, 54 FR 24157	200	412
2003, 68 FR 46929	300	417
2010, 75 FR 16645	375	440
2017, 81 FR 96347	450	469

The 1975 Amendments, as previously noted, created a secondary layer of financial protection, in addition to the primary insurance layer, for the commercial nuclear power industry (those that operate large commercial nuclear power reactors). Using what is known as “retrospective premiums,” these licensees provide for a retrospective insurance program in the form of a pooled fund to be made available in the event of an incident. The industry thereafter was required to provide retrospective insurance in addition to the primary insurance. (The retrospective insurance coverage initially was to make available a pool of funds in a sum based on a maximum total assessment of $5 million ($24 million in 2019$) per incident for each power reactor.) If an incident were to occur, licensees – industry-wide – would be responsible for paying for those damages that exceed the maximum amount of available primary insurance, up to the maximum secondary assessment level.

After November 1982, with 80 operational reactor units, the maximum amount of available financial protection totaled $560 million ($1.48 billion in 2019$), reflecting the sum of the maximum retrospective premium assessments ($5 million per unit per incident multiplied by 80 units, or $400 million), and the maximum amount of then-available primary insurance ($160 million). Thus, beginning in 1982, because the Price-Anderson Act required Federal indemnification only of licensees who were required to provide financial protection of less than $560 million, Federal indemnification for large, operating commercial nuclear power reactors was essentially eliminated.

To make even more funds available to pay public liability claims, the 1988 Amendments, as mentioned above, increased maximum retrospective premium assessments under the secondary layer of financial protection to $63 million per reactor, per incident, with the provision that retrospective premium assessments thereafter would be adjusted for inflation at least once every 5 years from the previous adjustment.[25] In the 1988 Amendments, Congress also added a provision requiring that licensees additionally pay up to 5 percent of the standard retrospective premium (i.e., a 5-percent surcharge) in the event that an incident exceeds the maximum amount of available financial protection. With the increase in 1988 of the maximum amount of available primary insurance to $200 million from $160 million, combined maximum primary and secondary financial protection coverage totaled $7.34 billion ($15.86 billion in 2019$) for all operating reactor units in 1988, of which $7.14 billion came from the secondary layer of financial protection. This larger amount of funds was expected to make the compensation system more equitable, reliable, and efficient.

Congress arrived at the $63 million standard deferred premium figure as a compromise that both substantially increased the compensation available to victims of nuclear accidents and imposed greater financial risk for such accidents on the nuclear industry without unduly burdening it. Congress also noted that the $63 million figure represented less than a third of the average total premiums a utility pays over the 40-year lifespan of a reactor, and about half of the nuclear waste disposal fees a utility would pay over the same period.[26] The first adjustment to the maximum retrospective premium in 1993 used the difference between the September 1988 and the March 1993 CPI for all urban consumers. This difference equaled 19.9 percent and increased the maximum retrospective premium payment, as of August 20, 1993, to $75.5 million per incident. Most recently, in 2018, the NRC updated the maximum retrospective premium to $131.056 million per reactor, per incident, with a maximum annual retrospective premium of $20.496 million per reactor, per incident. The next adjustment should take place in 2023.

The maximum retrospective premiums required to satisfy the secondary layer of financial protection since 1975 are shown in Table 1-3.

[25] These adjustments are to be made using the aggregate change in the CPI for all urban consumers from the base period.
[26] H.R. Rep. No. 100-104, Part 1, at pp. 9–10 (1987).

Table 1-3 Maximum retrospective premiums, per reactor, per incident

Year, Citation	$ (millions)	$ (millions in 2019$)
1975, Pub. L. 94-197	5	23.8
1988, Pub. L. 100-408	63	136.2
1993, 58 FR 42852	75.5	133.6
1998, 63 FR 39015	83.9	131.6
2005, Pub. L. 109-58	95.8	125.4
2008, 73 FR 56451	111.9	132.9
2013, 78 FR 41835	121.255	133.1
2019, 83 FR 48202	131.056	131.1

Based on the number of large, operating commercial nuclear power reactors as of October 2020, the nuclear power industry is insured to a maximum per-incident dollar level of $13.4 billion under the Price-Anderson framework. This dollar figure results from adding the maximum amount of available primary insurance of $450 million to the maximum available retrospective premiums of $12.935 billion ($137.609 million per unit [$131.056 million x 5-percent surcharge[27]] multiplied by 94 units [October 2020]).

If the number of participating nuclear power reactor units decreases, the total amount of available funding will decrease, absent further changes to the Price-Anderson Act. Nonetheless, even with the expected future reduction in reactor units, the aggregate amount of coverage will continue to provide a large amount of assurance to meet potential nuclear incidents in the foreseeable future.

1.1.4.3 Covered Costs

The covered costs under the Price-Anderson Act are derived from a series of statutory definitions and provisions. “Financial protection” under 42 U.S.C. 2014(k) means “the ability to respond in damages for public liability and to meet the costs of investigating and defending claims and settling suits for such damages.” Public liability is defined in 42 U.S.C. 2014(w) as follows:

> any legal liability arising out of or resulting from a nuclear incident or precautionary evacuation (including all reasonable additional costs incurred by a State, or a political subdivision of a State, in the course of responding to a nuclear incident or a precautionary evacuation), except: (i) claims under State or Federal workmen’s compensation...; (ii) claims arising out of an act of war; and

[27] “If the sum of public liability claims and legal costs authorized under paragraph (2) arising from any nuclear incident exceeds the maximum amount of financial protection required under subsection (b), any licensee required to pay a standard deferred premium under subsection (b)(1) shall, in addition to such deferred premium, be charged such an amount as is necessary to pay a pro rata share of such claims and costs, but in no case more than 5 percent of the maximum amount of such standard deferred premium described in such subsection.” 42 U.S.C. 2210(o)(1)(E).

> (iii)... claims for loss of, or damage to, or loss of use of property which is located at the site of and used in connection with the licensed activity where the nuclear incident occurs.

Subsection 11(q) defines the term "nuclear incident" to mean any occurrence within the United States causing bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of source, special nuclear, or byproduct material. This definition of "nuclear incident" is subject to interpretations of courts reviewing the specific facts of a case. Under broad interpretations of the definition of "nuclear incident," the scope of Price-Anderson coverage for nuclear facility sites subject to Price-Anderson requirements may include accidents or malicious attacks occurring in the course of transportation of nuclear fuel or material to a covered site; the storage of nuclear fuel at a covered site; the operation of a covered facility, including discharges of radioactive emissions or effluents; the storage of nuclear wastes at a reactor site; and the transportation of radioactive material from a covered site to a storage or disposal site. For additional information on the scope of coverage, see Section 1.2.3, *Definition of a "Nuclear Incident,"* and Section 2.3.4, *Nuclear Energy Liability Insurance and Special Features of the Policies*. Required "financial protection" covers defense costs and "public liability." Government indemnity also covers "public liability" and covers additional costs as specified in the Act.

Which costs are recoverable under the rubric of public liability may differ across State jurisdictions and has evolved over time.[28] All States allow recovery for bodily injury and property damage, but other types of costs have been disputed under Price-Anderson, as described below and in Section 1.2, *Legal Issues Associated with Price-Anderson Litigation*.

Coverage for Precautionary Evacuation

A report by the Government Accountability Office (GAO) (then the General Accounting Office) dated September 14, 1981 (EMD-81-111), examined whether the Price-Anderson Act covered public liability claims in potential nuclear event situations, even in the absence of a radioactive release. Although that report focused primarily on the Price-Anderson Act's applicability to DOE nuclear operations,[29] GAO examined the question of whether the definition of "nuclear incident" in the Act was broad enough to cover liability resulting from a nuclear incident in which a radiation release appeared imminent but did not occur and yet a precautionary evacuation was ordered.

Until 1988, neither the Price-Anderson Act nor its legislative history specifically addressed the question whether costs arising from a precautionary evacuation are covered. The 1988 Amendments enlarged the Subsection 11(w) definition of "public liability" to include liability resulting from a "precautionary evacuation" and added new Subsections 11(gg) and 170(q). Subsection 11(gg) defines "precautionary evacuation." Subsection 170(q) precludes any court from awarding costs of a precautionary evacuation unless such costs constitute a "public liability" under Subsection 11(w).

[28] For example, States may differ on whether claims for emotional distress, chromosomal injury, medical monitoring, increased risk, stillbirth, and public response costs following nuclear events are recoverable.

[29] DOE contractors are not required to maintain nuclear insurance for their activities but are indemnified by the DOE under the Price-Anderson Act for any claims up to the public liability limit of power reactor licensees.

1.1.4.4 Compensation Process

The Price-Anderson Act addresses several aspects of the process of compensation. Principal obstacles to a claimant's recovery for injuries or damages under the Price-Anderson Act are the traditional legal defenses against liability, such as conduct of the claimant, fault of persons indemnified, or charitable or governmental immunity. Congress intended to remove these obstacles in 1966 by amending the Price-Anderson Act to introduce the concepts of ENO and waiver of defenses. The Act defines the term "extraordinary nuclear occurrence" as any event causing an offsite discharge or dispersal of source, special nuclear, or byproduct material from its intended place of confinement in amounts offsite, or causing radiation levels offsite, that the NRC determines to be substantial, and that the NRC determines has resulted or will probably result in substantial damages to persons located offsite or property offsite.[30] The 1966 Amendments authorized the Commission both to incorporate certain "waivers of defenses" into indemnity agreements and to require that insurance policies used to satisfy financial protection provisions incorporate such waivers as well. The waivers include: (1) any issue or defense as to conduct of the claimant or fault of persons indemnified; (2) any issue or defense as to charitable or government immunity; and (3) any issue or defense based on any statute of limitations, if the suit is instituted within 3 years from the date in which the claimant first knew, or reasonably could have known, of the injury or damage and its cause. After an ENO, claimants need only demonstrate:

- bodily injury and/or property damage,
- monetary loss associated with the damage and/or injury, or
- causation of damages and losses by the release of radioactive material from the ENO.

In other words, legal defenses of negligence, contributory negligence, charitable or government immunity, and assumption of risk are waived in the event of an ENO; the result essentially is a system of strict or "no fault" liability. The importance of the ENO provision has diminished due to the adoption of strict liability in almost all States, which accomplishes a similar result. However, in cases arising from nuclear incidents that do not qualify as ENOs, issues concerning defenses and standard of care may be raised (as discussed further in Section 1.2.2 below).

In 1975, having recognized that a nuclear incident might involve damages in excess of the limit of public liability, Congress explicitly committed to take necessary action to protect the public from the consequences of such a disaster ~~involving damages in excess of the limit of public liability~~. Further, in the 1988 Amendments, Congress modified somewhat the language added in 1975 about incidents involving damages in excess of the aggregate limit of public liability; the 1988 language better defines the procedures Congress will follow and describes the goal as "full and prompt compensation" to the public for "all public liability claims" resulting from such a disaster. Furthermore, Congress added statutory language in Subsection 170(i) for the preparation of compensation plans after any nuclear incidents involving damages that are likely to exceed the applicable amount of aggregate public liability.

[30] In addition, the occurrence must arise out of, result from, or occur in the course of one or more broadly defined activities. See 42 U.S.C. 2210(n)(1).

The Price-Anderson Act confers original jurisdiction over a public liability action on the Federal district court for the district where the nuclear incident that gave rise to the action occurred; a defendant in such action or the NRC may have any action pending in a State or another Federal court removed on motion to the appropriate Federal court (Subsection 170(n)(2)).[31] ~~If the incident involves damages that are likely to exceed the limit of public liability, the Commission is charged with surveying the causes and extent of damage and submitting a report to Congress, the representatives and senators of the affected areas, the parties involved, and the courts (Subsection 170(i)(l)).~~ The court, upon the petition of an indemnitor or other interested party, must determine whether public liability in the case may exceed the limit of public liability or have an unusual impact on the work of the court (Subsections 170(n)(3), (o)).

If the court determines that public liability may exceed the aggregate public liability available in the first two layers of financial protection, the President is directed to submit to Congress an estimate of the financial extent of damages, recommendations for additional sources of funds, and compensation plans providing for "full and prompt compensation for all valid claims" (Subsection 170(i)(2)). Additionally, if the incident involves damages that are likely to exceed the limit of public liability, the Commission is charged with surveying the causes and extent of damage and submitting a report to Congress, the representatives and senators of the affected areas, the parties involved, and the courts (Subsection 170(i)(l)).

A determination that public liability may exceed the limit of public liability also triggers a number of restrictions on the public liability action: total payments made by or for all indemnitors are limited to 15 percent of the limit of public liability without prior court approval, and such approval is not authorized until the court approves a plan of distribution or finds that the payments are not likely to prejudice the subsequent adoption and implementation of the plan. The plan, which may be submitted to the court by the Commission or an interested indemnitor, must contain an allocation of "appropriate amounts" for personal injury, property, and latent injury claims and establish priorities between claimants and classes of claims to ensure the most equitable allocation of available funds. Restrictions are also imposed on the authorization of payment of legal costs to ensure that they were incurred in good faith and are reasonable and equitable (Subsection 170(o)(2)).

In terms of the handling, investigation, and settlement of claims, the Commission is directed to use the facilities and services of private insurance organizations, to the maximum extent practicable, and to enter into agreements with other indemnitors to establish coordinated procedures. Payments for the purpose of providing immediate assistance following the incident are explicitly authorized (Subsections 170(g), (m)).

The Presidential Commission on Catastrophic Nuclear Accidents considered in detail the process of compensation and set forth recommendations in its "Presidential Commission Report"; these recommendations are discussed in more detail below. The "Presidential Commission Report" reviewed the foregoing provisions for the payment of claims and concluded that, in large part, combined with existing procedural law, such provisions might be sufficiently adaptable to effectuate its recommendations, but that constitutional issues might arise unless

[31] Questions were raised as to the constitutionality of the jurisdictional provision, but the Third, Sixth, and Seventh Circuit Courts of Appeal have each upheld its constitutionality. *In re TMI Litigation Cases Consolidated II*, 940 F.2d 832 (3d Cir. 1991); *Niemen v. NLO, Inc.*, 108 F.3d 1549 (6th Cir. 1997); *O'Conner v. Commonwealth Edison Co.*, 13 F.3d 1099 (7th Cir. 1994).

the statute were amended. It also determined that certain of its recommendations, such as the application of Federal law, could not be achieved without amendment, while in other cases, presiding judges may be required to implement its recommendations within the framework of existing law. The “Presidential Commission Report” also identified areas in which the possibility of implementation is unclear under existing law (“Presidential Commission Report” at pp. 57–67).[32]

Among the options for handling the complicated claims resolution process that would follow a catastrophic nuclear incident, the Presidential Commission considered the possibility of establishing an administrative mechanism such as workers’ compensation or no-fault insurance as an alternative to the tort system. The Presidential Commission identified a number of benefits of this option, such as uniformity in treating like injuries, low costs, rapid decision-making, and evenhandedness, as well as the possibility of staffing an agency with scientific and medical professionals. In addition, Congress readily could expand an agency as necessary in terms of its workload, resources, and responsibilities.

Ultimately, however, the Presidential Commission concluded that ~~retention of~~ continued reliance on the judicial model was preferable. Witnesses before the Presidential Commission cited the independence and visibility of the judiciary; the perception of the average citizen of impartiality and fair treatment; the greater flexibility that could be obtained by using a court with special masters as opposed to establishing an administrative apparatus; and the fact that the remoteness of the possibility of an event makes it unreasonable to establish any agency before an event actually occurred, while the courts are in place and could begin handling claims immediately (“Presidential Commission Report” at pp. 34–36).

The Presidential Commission did, however, recommend changes to the judicial model. Specifically, the Presidential Commission recommended the adoption of a system using a tripartite judicial procedure[33] coupled with administrative features for the handling of public liability claims following a catastrophic nuclear accident. The “trigger” for the application of such a system would be the point at which there is a reasonable likelihood that claims will exceed the first layer of financial protection and that there will be a multiplicity of claimants. The Presidential Commission further recommended that exclusive jurisdiction and venue over a public liability claim should be vested in a single Federal court applying Federal statutory and common law, incorporating such features of present law as the waivers of defenses and provision for emergency payments. Congress held hearings on the “Presidential Commission Report,” but no further actions were taken.

1.2 Legal Issues Associated with Price-Anderson Litigation

This section discusses legal issues that have been addressed in Price-Anderson litigation, including the following:

- Constitutionality

[32] Since the “Presidential Commission Report” was prepared, there have been a number of major amendments to Title 28 of the U.S. Code, “Judiciary and Judiciary Procedure,” designed to improve the functioning of the Federal courts.

[33] According to the “Presidential Commission Report,” this procedure would include “a preliminary phase when claims are consolidated before a single decisionmaker, a second phase in which generic issues are identified and decided by the court with the assistance of relevant experts; and a third phase consisting of individualized informal procedures culminating in a right to binding arbitration or, if claimants so choose, to adjudication on a modified tort model.”

- Standard of Care
- Definition of a "Nuclear Incident"
- Removal or Transfer of Any Public Liability Lawsuit Resulting from a Nuclear Incident to a U.S. District Court
- Preemption of State Law Claims in the Absence of a Proven Nuclear Incident
- Proof of Causation of Harm Resulting from Exposure to Radiation
- Punitive Damages
- Costs of Investigating, Settling, and Defending Claims
- Costs of Investigating, Settling, and Defending Claims Brought Against Nonprofit Educational Institutions

1.2.1 Constitutionality

The constitutionality of the Price-Anderson Act has been confirmed in several notable cases. In *Duke Power Company v. Carolina Environmental Study Group, Inc.*, the Supreme Court held without dissent that the liability limitation of Price-Anderson does not violate equal protection. Chief Justice Burger stated for the Court that the liability limit was neither arbitrary nor irrational because the statutory limit was rationally related to Congress's desire to encourage the private sector to build and operate nuclear power plants.[34] The Court went on to state that the $560 million figure chosen as the liability limit was also constitutional.[35]

In connection with litigation related to the TMI accident, the Court of Appeals for the Third Circuit ruled in the *TMI* cases that Congress did not exceed its authority under Article III of the Constitution in establishing Federal jurisdiction over Price-Anderson Act public liability actions relating to nuclear incidents; nor did its retroactive application violate constitutional principles of federalism, State sovereignty, due process, or equal protection.[36]

1.2.2 Standard of Care

A standard of care defines the degree of caution legally required of a defendant's conduct for the protection of others against unreasonable risk of harm. If the defendant failed to meet the standard of care, they may be liable for a plaintiff's injuries or other civil liability. Federal courts have provided different interpretations of the standard of care to be applied in litigation under the Price-Anderson Act. Relying on the 1988 Amendments, which stated that the rules that

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[34] *Duke Power Co. v. Carolina Envtl. Study Grp.*, 438 U.S. 59, 84 (1978).
[35] ~~*Duke Power Co. v. Carolina Envtl. Study Grp.*, 438 U.S. 59,~~ *Id.* at 93 (1978).
[36] *In re TMI Litigation Cases Consol. II*, 940 F.2d 832 (3d Cir. 1991); Similarly, the Sixth and Seventh Circuit Courts of Appeal have also upheld the Price-Anderson Act's constitutionality in the context of claims for occupational injuries. See *Niemen v. NLO, Inc.*, 108 F.3d 1549 (6th Cir. 1997); *O'Conner v. Commonwealth Edison Co.*, 13 F.3d 1099 (7th Cir. 1994).

govern Price-Anderson Act public liability actions come from “the law of the State in which the nuclear incident involved occurs, unless such law is inconsistent” with the Act (42 U.S.C. 2014(hh)), Federal courts have differed as to the standard of care in Price-Anderson Act public liability actions alleging personal injury and other tort law claims arising from a nuclear incident.[37] In public liability actions arising from a nuclear incident, most courts have followed the Third Circuit’s approach[38] in setting the standard of care by adopting dosage limits found in the Federal nuclear regulations at then 10 CFR 20.105 through 20.106 (now found at 10 CFR 20.1201 through 20.1301), where applicable, rather than using the “as low as is reasonably achievable” (ALARA) standard~~guidance~~ found elsewhere in NRC regulations.[39] However, a minority of courts have held that the ALARA standard[40] or State tort law standards[41] may apply in certain circumstances.

The consequences of the courts’ interpretation of 42 U.S.C. 2014(hh) to establish a standard of care consistent with Federal dosage regulations have been: (1) standardization of the applicable standard of care across many jurisdictions, (2) clarification of what facts are determinative in whether a defendant’s conduct failed to meet the standard of care as set by Federal dosage regulations, and (3) an increased~~ing the~~ evidentiary burden on plaintiffs bringing claims for nuclear incidents in jurisdictions applying dosage limits from Federal regulations as the standard of care. In jurisdictions following the Third Circuit’s approach, there is one standard of care, and it is clearly set forth by the dosage limitations in 10 CFR 20.1201 through 20.1301. This creates a scheme that is more certain than one applying often vague State law standards that vary across jurisdictions. However, plaintiffs have preferred State law and ALARA standards of care, as those provide plaintiffs with greater flexibility in establishing tortious conduct on the defendant’s part.

1.2.3 Definition of a “Nuclear Incident”

The Price-Anderson Act defines “nuclear incident” to mean “any occurrence, including an extraordinary nuclear occurrence, within the United States causing, within or outside the United States, bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of source, special nuclear, or byproduct material.” 42 U.S.C. 2014(q). The characterization of an occurrence as a nuclear incident controls whether the occurrence is covered by the Price-Anderson Act framework and whether defendants may remove the case to Federal court. The 1988 Amendments established Federal original jurisdiction over public liability actions in response to the TMI incident, which generated more than 150 separate cases in various courts. Providing for ~~Conferring~~ Federal jurisdiction in~~to~~ cases involving nuclear incidents was designed to allow for the consolidation and efficient, equitable resolution of separate claims arising from a single incident.

[37] As discussed in Section 1.1.4.4, in cases arising from an ENO, the defendant licensee will be required to waive defenses and, thus, subject to strict liability for harm arising from the occurrence. Strict liability imposes liability on an actor who causes harm to another person, regardless of the level of care exercised by the actor to prevent such harm. Nuclear incidents are not subject to the same waiver of defenses requirement.

[38] *In re TMI*, 67 F.3d 1103 (3d Cir. 1995).

[39] *O’Conner v. Commonwealth Edison Co.*, 13 F.3d 1090 (7th Cir. 1994); *Roberts v. Florida Power & Light Co.*, 146 F.3d 1305 (11th Cir. 1998); *In re Hanford Nuclear Reservation Litig.*, 534 F.3d 986 (9th Cir. 2008); *Bohrmann v. Me. Yankee Atomic Power Co.*, 926 F. Supp. 211 (D. Me. 1996); *Adkins v. Chevron Corp.*, 960 F. Supp. 2d 761 (E.D. Tenn. 2012).

[40] *McCafferty v. Centerior Serv. Co.*, 983 F. Supp. 715 (N.D. Ohio, 1997).

[41] *In re Hanford Nuclear Reservation Litig.*, 350 F. Supp. 2d 871 (E.D. Wash. 2004).

Courts have split over the interpretation of the definition of the term “nuclear incident.” Some have ruled that a nuclear incident requires that the occurrence take place at the site of an activity licensed by NRC.[42] Other courts, however, have applied a plain-language reading to the word “occurrence” within the definition of a nuclear incident.[43] Under such an interpretation, a nuclear incident is any happening or event that causes injury and arises out of the properties of nuclear material, regardless of whether the event occurred at the site of a Price-Anderson Act-indemnified activity.

1.2.4 Removal or Transfer of Any Public Liability Lawsuit Resulting from a Nuclear Incident to a U.S. District Court

Pursuant to 42 U.S.C. 2210(n)(2), any Price-Anderson Act public liability action arising out of or resulting from a nuclear incident can be removed or transferred from a State court to a U.S. district court upon motion of the defendant, the NRC, or the DOE.

In several lawsuits to which the United States was not party, defendant mining and milling companies sought to enjoin Tribal courts from asserting jurisdiction in lawsuits claiming harm to Tribal members or their property from radioactivity as a result of mining or milling operations that took place on Indian lands. Plaintiffs alleged that defendants had conducted uranium mining from 1950 to 1965 under a license and contract with the Atomic Energy Commission and argued that the complaint was covered by the Price-Anderson Act because the complaint alleged a “nuclear incident” and that any liability arising from a nuclear incident is covered by the Price-Anderson Act.

In *El Paso Natural Gas*, the Supreme Court addressed whether defendants had a right to remove such a case to Federal court. In a unanimous opinion, the Court held that the Tribal court exhaustion doctrine relied upon by the lower court did not invalidate defendants’ right to remove a Price-Anderson Act public liability action to Federal court. The Court reasoned that, through the preemption, removal, and jurisdictional provisions of Price-Anderson,

> Congress thus expressed an unmistakable preference for a federal forum, at the behest of defending party, both for litigating a Price-Anderson claim on the merits and for determining whether a claim falls under Price-Anderson when removal is contested.

Commented [A6]: Start new paragraph here as shown.

The Court further reasoned that requiring defendants to exhaust their Tribal remedies in a Price-Anderson suit would be contrary to the congressional goal of promoting efficient litigation, given that Price-Anderson would allow plaintiffs’ claims to be resolved only in a Federal forum. The Court remanded the case for resolution in Federal court.[44]

1.2.5 Preemption of State Law Claims in the Absence of a Proven Nuclear Incident

The Price-Anderson Act stipulates that State law provides the “substantive rules for decision” in a public liability action involving a nuclear incident, except to the extent State law proves “inconsistent” with the terms of the Price-Anderson Act, in which case the provisions of the

[42] *Gilberg v. Stepan Co.*, 24 F. Supp. 2d 325 (D.N.J, 1998); *Strong v. Republic Servs.*, 283 F. Supp. 3d 759 (E.D. Mo. 2017).
[43] *Carey v. Kerr-McGee Chem. Corp.*, 60 F. Supp. 2d 800 (N.D. Ill. 1999).
[44] *El Paso Nat. Gas Co. v. Neztsosie*, 526 U.S. 473 (1999).

Price-Anderson Act preempt State law (42 U.S.C. 2014(hh)). Courts have differed in their decisions in the way preemption is applied in cases where a nuclear incident is not proven by the plaintiff. In *Cotroneo v. Shaw Environment & Infrastructure, Inc.*, 639 F.3 d 186 (5th Cir. 2011), the court of appeals held that claims ~~alleging~~ of injuries resulting from the hazardous properties of nuclear materials, including "offensive contact" claims, could not be brought as State law claims and must be included in a public liability action under the Price-Anderson Act, regardless of whether the plaintiff actually can prove a nuclear incident occurred. In part, the court reasoned that "recovery on a State law cause of action without a showing that a nuclear incident has occurred would circumvent the entire scheme governing public liability actions, which is clearly inconsistent with section 2210." Thus, when the court found that plaintiffs had failed to show that their alleged exposure in cleaning up radioactive materials caused their claimed injuries and that no "nuclear incident" occurred, the court dismissed the case with prejudice, barring plaintiffs from bringing State law claims in State court.[45]

In contrast, in *Cook v. Rockwell Int'l Corp*., 790 F.3 d 1088 (10th Cir. 2015), the court of appeals held that when plaintiffs did not prove a nuclear incident under the Price-Anderson Act, the Act did not preempt their nuisance claim under State law because defendants forfeited such a preemption argument by failing to raise it in their first appeal in Federal court, and, more importantly, because the Price-Anderson Act did not expressly preclude State tort law claims for plaintiffs who plead but do not prove nuclear incidents.[46] As discussed further in Section 2.3.13, *An Emerging Concern of the Nuclear Industry and Its Insurers: Conflicting Interpretation of Price-Anderson Act Preemption*, the *Cook* decision has caused concern within the nuclear industry and among its insurers related to the potential for an expansion of the scope of liability for the nuclear industry and its insurers.

1.2.6 Proof of Causation of Harm Resulting from Exposure to Radiation

This section discusses the legal issues associated with proving causation in Price-Anderson Act claims, including a review of the findings from the 1990 "Presidential Commission Report." There have been no major legal developments related to causation since the 1998 Price-Anderson Act Report to Congress.

The 1988 Amendments committed Congress to providing "full compensation" to those injured as a result of a nuclear incident or precautionary evacuation. However, the 1988 Amendments left the resolution of the extent of proof required to establish compensable injury to State law. As it may often not be possible to establish by a preponderance of the evidence that later appearing health effects were caused by exposure during the event (as opposed to other environmental or genetic factors), State tort law governing the degree of proof of causation required to establish entitlement to compensation may result in the denial of compensation to individuals with latent health effects. Whether stress may be treated as a compensable injury varies under State law.

Any resolution of the issues of timing of compensation and burden of proof requires judgments on three related questions of policy: (1) whether to provide compensation immediately following the event to all those exposed or to defer compensation until it can be determined which of the individuals exposed actually develop health problems related to the incident, (2) what degree of proof claimants should be required to meet to establish the requisite causation between their injuries and the incident, and (3) what constitutes compensable injury within the meaning of full compensation.

[45] *Cotroneo v. Shaw Env't & Infrastructure, Inc.*, 639 F.3d 186 (5th Cir. 2011).
[46] *Cook v. Rockwell Int'l Corp*., 790 F.3d 1088 (10th Cir. 2015).

The current Price-Anderson scheme has addressed some, but by no means all, of these fundamental issues. While it leaves to State tort law the basic question of whether a legally cognizable injury has occurred, this policy is tempered by the waivers of defenses in ENOs, which effectively impose strict liability and nullify statutes of limitations that would bar latent health effects claims. Price-Anderson leaves to State law, however, the issues of the nature of the injuries to be compensated, the degree of proof required to establish the requisite causation, and the nature and extent of damages recoverable (except to the extent that the 1988 Amendments imposed a prohibition on the payment of punitive damages).[47] For example, not all States recognize emotional distress as a compensable injury, and most State tort laws require the plaintiff to establish causation by a preponderance of the evidence. Recovery under State tort law is generally limited to recovery of money damages; provision of non-pecuniary damages such as medical monitoring for those exposed as a result of the incident is not ordinarily available.

While the present Act provides no specific authorization for the compensation of claims arising out of latent health effects, it does assume that latent injury will be included in public liability. Under Subsection 170(o)(1)(e), the Commission must submit to the court having jurisdiction over an action where public liability may exceed the limit of public liability a plan for disposition of funds that

> include[s] an allocation of appropriate amounts for personal injury claims, property damage claims, **and possible latent injury claims which may not be discovered until a later time** [emphasis added] and shall include establishment of priorities between claimants and classes of claims, as necessary to insure the most equitable allocation of available funds.

In recognition of the need to address these issues, Congress included in the 1988 Amendments a requirement that the President establish a commission "to study means of fully compensating victims of a catastrophic nuclear accident that exceeds the amount of aggregate public liability." The Presidential Commission was charged with addressing the following three issues:

1. recommendations for any changes in the laws and rules governing the liability or civil procedures that are necessary for the equitable, prompt, and efficient resolution and payment of all valid damage claims, including the advisability of adjudicating public liability claims through an administrative agency instead of the judicial system

2. recommendations for any standards or procedures that are necessary to establish priorities for the hearing, resolution, and payment of claims when awards are likely to exceed the amount of funds available within a specific time period

3. recommendations for any special standards or procedures necessary to decide and pay claims for latent injuries caused by the nuclear incident

The report of the Presidential Commission was published in August 1990. Its conclusions and recommendations are summarized below.

The Presidential Commission considered a full range of options to address the issue of causation of latent illness. These included: (1) making immediate but small payments following

[47] See Section 1.2.7 for further discussion on punitive damages.

the incident to everyone exposed based on a theory of increased risk; (2) relaxing traditional requirements as to proof of causation and permitting payment to anyone exposed who later developed cancer; (3) retaining current law requiring the claimant to prove causation by a preponderance of the evidence, and (4) adopting a probability of causation approach, which would allow full recovery if probability were established by a preponderance of the evidence, and partial recovery based on a lesser evidentiary standard as to causation.

1.2.6.1 Increased Risk

The Presidential Commission rejected this option as a comprehensive solution because it would result in small payments both to individuals who never developed cancers and to those who did, resulting in a windfall to the former and a shortfall to the latter, who would not be compensated fully. It did conclude that certain immediate non-monetary relief, such as counseling and medical monitoring of those exposed at a certain level, would be appropriate ("Presidential Commission Report" at pp. 9, 74, 82, 88–91, 102, and 107).

1.2.6.2 Relaxation of Requirements of Proof of Causation

Citing the proportion of the U.S. population that eventually develops some form of cancer, the Presidential Commission concluded that this option would be excessively expensive unless benefits were capped at a level that would fail to cover the costs of medical treatment. It also concluded that relaxation of requirements of proof would be contrary to the policy underlying amendments to the Price-Anderson Act beginning in 1975. That policy is that the costs of nuclear power should be internalized by putting responsibility for absorbing the actual costs of producing nuclear power on the industry and its rate payers ("Presidential Commission Report" at pp. 107–108). Relaxation of the degree of proof required to establish causation would result in the industry's absorption of costs for cancers it had not caused, thereby artificially inflating, rather than internalizing, the cost of producing nuclear power.

1.2.6.3 Retention of Current Law

Retention of current law, on the other hand, would not, in the opinion of the Presidential Commission, have been consistent with the charge contained in the 1988 Amendments that the Presidential Commission recommend special standards or procedures necessary to decide and pay claims for latent injuries.

The Presidential Commission concluded that application of existing law would lead to the rejection of many deserving claims ("Presidential Commission Report" at p. 108). Under the law of most States, the plaintiff must sustain two burdens of proof: that of going forward with the evidence and that of persuasion. The first burden is not difficult to meet; the plaintiff must merely allege sufficient facts to make out a prima facie case. The second burden, however, generally requires the plaintiff to establish the case by a preponderance of the evidence, that is to show it is more likely than not that the facts were as alleged. The elements of a tort claim for personal injury include establishing the injury itself and that the defendant's conduct was the cause of the injury. Individuals suffering latent health effects would have great difficulty in establishing the latter requirement of causation by a preponderance of the evidence. These issues are discussed more fully in the NRC's Price-Anderson Act Report to Congress published in December 1983 prior to the enactment of the 1988 Amendments (1983 Report to Congress at D-12 through D-15).

1.2.6.4 Probability of Causation Approach

To avoid the problem of establishing causation under current law, some commentators have suggested that the plaintiff's burden of proof be modified by shifting the burden to the defendant after the plaintiff has introduced all the facts that they can reasonably be expected to have access to, or through the use of presumptions (1983 Report to Congress at D-12 through D-15). After reviewing various of these alternatives, the Presidential Commission concluded that the method best suited to carry out the purposes of the Act was application of a technique that has come to be known as probability of causation. Under this technique, causation is attributed by weighing such factors as level of exposure, age, sex, personal habits, type of cancer, and latency period. Tables have been prepared by the National Institutes of Health of the U.S. Department of Health and Human Services (HHS) pursuant to unrelated legislation but with the anticipation that they would be used to implement later enacted legislation relating to injury caused by radiation exposure ("Presidential Commission Report" at p.109 and fns. 27 and 28). These tables could be used to establish the probability that a certain cancer was caused by the nuclear incident. Recovery then would be made on the basis of the degree of probability established; below a certain level of probability no recovery would be allowed, above that level awards would be made at a level proportionate to the degree of probability assigned. The Presidential Commission acknowledged that adoption of a plan of compensation incorporating a probability of causation approach would require a departure from common law tort principles and adoption of a Federal standard to be applied consistently to all claims ("Presidential Commission Report" at pp. 3, 10).

1.2.6.5 Proof of Causation under the Price-Anderson Act Today

There have been no amendments to the Price-Anderson Act to address the Presidential Commission's recommendation that standards or procedures be developed to ensure the payment of claims for latent injuries. Additionally, since the last NRC Price-Anderson Act Report to Congress in 1998, there have been no major changes in the Price-Anderson Act or in Price-Anderson Act related case law with respect to proof of causation. State law still controls proof of causation issues in public liability actions for nuclear incidents. Additionally, whether emotional distress and medical monitoring qualifies as a compensable harm continues to vary across jurisdictions. As the probability of causation approach described in Section 1.2.6.4 above is not the general rule, in most jurisdictions, plaintiffs seeking redress for latent injuries will face difficulties when seeking compensation. For example, in *Cotroneo v. Shaw Env't & Infrastructure, Inc.*, plaintiffs demonstrated exposure to radiation but were unable to disprove other plausible causes of their injuries. Applying Texas law, the court dismissed the case for plaintiffs' failure to prove causation.[48]

1.2.7 Punitive Damages

In the 1984 case of *Silkwood v. Kerr-McGee Corp.,* the Supreme Court addressed the question of whether the Federal preemption of State law in the area of regulating the safety aspects of nuclear energy under the Atomic Energy Act of 1954 precluded the award of punitive damages in cases involving the release of nuclear material. Respondent Kerr-McGee, supported by the United States as amicus curiae, argued that punitive damages were intended to punish and deter conduct that could create radiation hazards, and that awards of such damages were

[48] *Cotroneo v. Shaw Env't & Infrastructure, Inc.*, 639 F.3d 186, 193 (5th Cir. 2011).

therefore regulatory in effect and inconsistent with Federal preemption. The Court, relying in part on the legislative history of the Price-Anderson Act, rejected this argument.[49]

Congress subsequently amended the Price-Anderson Act in 1988 to add a new subsection that provides as follows:

> No court may award punitive damages in any action with respect to a nuclear incident or precautionary evacuation against a person on behalf of whom the United States is obligated to make payments under an agreement of indemnification covering such incident or evacuation (42 U.S.C. 2210(s)).

There have been differing interpretations as to the scope of this subsection.

The Court of Appeals for the Third Circuit addressed the prohibition against punitive damages in a 1995 decision. After an extensive review of the legislative history of the subsection, the court concluded that Congress intended to prohibit payments of punitive damages by the Federal Government only and that the prohibition did not apply to damages payable out of the primary and secondary layers of financial protection. In doing so, the court rejected the defendants' contention that the prohibition against punitive damages applied in cases against any party with whom the United States has entered into an indemnification agreement, regardless of whether damages in a particular case ever reach the limit of financial protection.[50]

The Third Circuit noted the possible inequities built into a statutory scheme where plaintiffs must resort to a finite fund to get compensatory as well as punitive damages, but it declined to "usurp Congress' policymaking function."[51] Finally, the court commented that the authority vested in the district court to prioritize claims, and the adaptability of the Price-Anderson's tri-level insurance scheme to such prioritization, could avoid such inequities. The court suggested that priority should be given to compensation of the injured, rather than to payment of punitive damage awards.[52]

The Third Circuit's interpretation appears consistent with the NRC's ~~post-1998 retention of~~ model forms for insurance and indemnity agreements, which even after 1998 ~~contain~~ contained clauses excepting claims for punitive damages from the scope of circumstances requiring waivers of defenses based on negligence.[53] Such clauses would be unnecessary if punitive damages were prohibited in any action governed by the Price-Anderson Act.

[49] *Silkwood v. Kerr-McGee Corp.*, 464 U.S. 238, 104 S. Ct. 615, 78 L. Ed. 2d 443 (this litigation did not involve a Price-Anderson claim).
[50] *In re TMI*, 67 F.3d 1119.
[51] 67 F.3d at 1128.
[52] "It cannot be gainsaid that '[i]f there is a limited fund, priority should be given to compensating those who have been injured rather than conferring windfalls on those who have already been compensated.' Citation omitted. We see nothing in the Act that precludes a district court from using its discretion to limit or even preclude punitive damages in accordance with the financial constraints of the fund and the Act's prohibition against punitive damage awards being paid out of the federal layer of insurance." 67 F.3d at 1128.
[53] 10 CFR 140.91, App. A, "Waiver of Defenses Endorsement," ¶2(c); 140.92, App. B, Art. II, ¶5(d); 140.93, App. C., Art. II, ¶5(d); and 140.95, App. E, ¶3(d) and revisions following the enactment of the 1988 Amendments published in 54 FR 24157, which incorporated various provisions of the 1988 Amendments, but left unchanged the provisions relating to punitive damages.

The "Presidential Commission Report" noted that the Act was unclear on the issue of whether punitive damages may be awarded from non-government funds. The Presidential Commission recommended that punitive damages not be recoverable under the Price-Anderson compensation system. If punitive damages are not excluded, the Report recommended that they be ascribed the lowest degree of priority in any plan of distribution adopted under 42 U.S.C. 2210(o) of the Price-Anderson Act ("Presidential Commission Report" at pp. 4, 72, 75, 95, 100).

To date, neither any other Federal court of appeals nor the Supreme Court has addressed this issue. A district court issued a holding consistent with the Third Circuit's ruling that non-governmental entities could be required to pay punitive damages.[54] Conversely, another district court held that the same provision prohibited the award of punitive damages in any action against any person who is a party to an indemnification agreement as a DOE contractor, subcontractor, or supplier.[55]

Given the lack of clarity and varying judicial opinions regarding the scope of the Price-Anderson Act's limitation on punitive damages, and the potential significance of this issue for both claimants and defendants,~~Thus~~, the NRC recommends that Congress consider amending the statute to address whether the prohibition on payment of punitive damages extends to every case arising under the Price-Anderson Act, or only to those where damages exceed the first two layers of financial protection.

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1.2.8 Costs of Investigating, Settling, and Defending Claims

The costs of investigating, settling, and defending claims (often termed "defense costs") can be substantial~~ in amount~~. Treatment of these costs under the Act is complex and has varied over time. Prior to 1975, the reasonable costs of investigation, settlement, and defense of claims had been included in the scope of the indemnification. To ensure that the Price-Anderson Act was used to compensate the victims of a nuclear incident and not to pay attorneys' fees and other costs of processing claims, the so-called Hathaway Amendment of 1975[56] excluded the costs of investigating, settling, and defending claims from government indemnification under Subsection 170(e). ~~Prior to the 1975 Amendments, the reasonable costs of investigation, settlement, and defense of claims had been included in the scope of the indemnification.~~

Because the Hathaway Amendment excluded defense costs only from those sections of the Price-Anderson Act relating to government indemnity, and because no other sections of the Price-Anderson Act were similarly amended, the insurance pools and others believed that defense costs could continue to be paid out of the required financial protection. ~~Insurers believed that if defense expenses were not included, and they were asked to be responsible for additional undetermined sums for claims expense, insurers would reduce the amounts they commit to compensate to allow for the unknown expense factor, and some insurers likely would withdraw from the market because of the uncertainty that would be created. The NRC originally believed that Senator Hathaway intended that defense costs be excluded from both the financial protection and government indemnity layers, so as to make available the full $560 million to compensate injured parties. To do otherwise, the Commission believed at the time, would be to negate the effect of the Hathaway Amendment, especially as the secondary retrospective~~

[54] *Smith v. GE*, 938 F. Supp. 70 (D. Mass. 1996).
[55] *Cook v. Rockwell Int'l Corp.*, 755 F. Supp 1468 (D. Colo. 1991).
[56] Amendment of the "costs" provisions of the Price-Anderson Act was proposed by Senator Hathaway during Senate consideration of the bill. There was virtually no legislative history beyond Senator Hathaway's remarks introducing the amendment and a short colloquy that followed.

~~insurance layer would continue to increase and eventually eclipse the government indemnity layer. Because of these differing interpretations~~To clarify the scope of the Hathaway Amendment, the NRC requested an interpretation ~~of the Hathaway Amendment~~ by the U.S. Department of Justice. The Department's response, which discussed only the scheme for power reactors, concluded that the Amendme~~e~~t should be interpreted to exclude the costs of investigation, settlement, and defense of claims from the government indemnity but include these costs in the primary layer of insurance required as financial protection.

Commented [A8]: If the Department's interpretation is publicly available, add a citation to the interpretation either in a footnote or as a reference.

The 1988 Amendments altered the Subsection 170(b) provisions on amount and type of financial protection for licensees by adding that any payments made under the retrospective insurance plan shall not exceed a licensee's pro rata share of "public liability claims and costs (excluding legal defense costs subject to Subsection (o)(l)(D)..., payment of which has not been authorized under such subsection)." Subsection (o)(l)(D) was added by the 1988 Amendments to address the distribution of funds in situations where a district court determines that the public liability from a nuclear incident "may exceed" the applicable limit of public liability; among the provisions are conditions on the payment of legal costs (the costs would be payable only if they met the standards of new Subsections 170(o)(2)(A) and (B)) and specification that the court may authorize payment of legal costs only from the insurance layers.

~~The exclusion of defense costs from the insurance layers is not otherwise required by the Price-Anderson Act. Accordingly, NRC regulations define "financial protection" to include defense costs (10 CFR 140.3).~~ The 1988 Amendments left unchanged the exclusion of defense costs from any Federal indemnity of NRC licensees. Also left unchanged was the limitation on aggregate public liability, which is defined as inclusive of legal costs authorized to be paid under Subsection (o)(l)(D). Furthermore, t~~T~~he 1988 Amendments did not alter Subsection 170(h), which, in any settlement of a claim that arose under the Act, excludes from indemnification by the government "expenses in connection with the claim incurred by the person indemnified."[57] ~~However, the 1988 Amendments did alter provisions applicable to educational institutions.~~

1.2.9 Costs of Investigating, Settling, and Defending Claims Brought Against Nonprofit Educational Institutions

The 1988 Amendments did, however, alter provisions applicable to educational institutions. In particular, the 1988 Amendments modified 42 U.S.C. 2210(k), which ~~Subsection (k)~~ grants a waivable exemption for nonprofit educational institutions from the financial protection requirement and provides for indemnification by the NRC of such institutions from public liability in excess of $250,000. ~~It also~~As modified, Subsection (k) provides that "[t]he **aggregate indemnity** for all persons indemnified in connection with each nuclear incident shall not exceed $500,000,000, **including such legal costs of the licensee as are approved by the Commission** [emphasis added]."

In 1996, the Regents of the University of California, Los Angeles (UCLA), sought indemnification from the NRC under ~~42 U.S.C. 2210(k),~~Subsection (k) for attorneys' fees and expenses incurred in connection with the voluntary dismissal, under terms of settlement agreements, of cases

[57] The section provides in pertinent part:

> The Commission... shall have final authority on behalf of the United States to settle or approve the settlement of any such claim on a fair and reasonable basis with due regard for the purposes of this chapter. Such settlement shall not include expenses in connection with the claim incurred by the persons indemnified.

The last sentence of this section has been interpreted by the Commission to exclude attorneys' fees from government indemnity.

arising out of alleged releases of radioactivity from an NRC-licensed reactor. ~~Subsection (k) grants a waivable exemption for nonprofit educational institutions from the financial protection requirement and provides for indemnification by the NRC of such institutions from public liability in excess of $250,000. It also provides that "[t]he **aggregate indemnity** for all persons indemnified in connection with each nuclear incident shall not exceed $500,000,000, **including such legal costs of the licensee as are approved by the Commission** [emphasis added]."~~

The UCLA Regents ~~took the position that this provision of Subsection (k), regarding legal costs, added by the 1988 Amendments, should be deemed controlling. They~~ argued that Subsection (k) dealt specifically with licenses of the type issued to UCLA and, therefore, prevailed over the more general restriction of Subsection (h).

This argument was rejected by the Commission in a formal opinion published on May 29, 1997, on the grounds that: (1) the provisions of Subsection (h), left intact by the 1988 Amendments, specifically prohibited indemnifying a licensee for legal expenses incurred in connection with settling a Price-Anderson case and could not be repealed by implication; (2) "public liability" by its terms did not include legal costs, in contrast to the licensee's own financial protection; and (3) the aggregate of $250,000 public liability was never reached in the UCLA cases and, in fact, no public liability was ever paid.[58]

The UCLA Regents did not ~~No legal~~ challenge ~~was brought on~~ the Commission's decision. Thus, there has been no ~~further consideration of the question~~ judicial determination of whether a nonprofit educational institution that is exempt from financial protection requirements may be indemnified for legal costs incurred in connection with the settlement of a claim. To eliminate potential ambiguities and to confirm the Commission's interpretation of the relationship between 42 U.S.C. 2210(h) and 42 U.S.C. 2210(k), the NRC recommends that Congress clarify that a nonprofit NRC licensee shall not be indemnified for legal costs incurred in connection with the settlement of a claim.

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[58] *In re Regents of the University of California*, 45 NRC 358 (1997).

2 PRINCIPAL ISSUES BEARING ON THE NEED TO CONTINUE OR MODIFY PRICE-ANDERSON

This section discusses the three principal issues the Price-Anderson Act requires the Commission to consider in reporting on the need to continue or modify its provisions. Specifically, this section includes the following subsections:

2.1 – Condition of the Nuclear Industry
2.2 – State of Knowledge of Nuclear Safety
2.3 – Availability of Private Nuclear Liability Insurance

2.1 Condition of the Nuclear Industry

The NRC regulates the following activities within the commercial nuclear industry:

- construction, operation, and decommissioning of commercial reactors and fuel cycle facilities, and import and export of major and minor components used by the nuclear industry

- possession, use, processing, export, and import of nuclear materials and waste, and the handling of certain aspects of their transportation

- siting, designing, constructing, operating, and closing nuclear waste disposal sites

Through the licensing process, the NRC authorizes these activities. Table 2-1 briefly summarizes the current status of NRC's licensing activities:

Table 2-1 Status of licensing activities by types of NRC licensees[1]

***Commercial Nuclear Power Reactors.** Commercial nuclear power reactors produce electricity. As of October 2020, there were 94 nuclear power reactors licensed by the NRC to operate (NUREG-1350, Vol. 32).
***Nuclear Research Reactors and Testing Facilities.** Nuclear research reactors and testing facilities, also called "non-power reactors," are primarily used for research, training, and development to support science and education in nuclear engineering, physics, chemistry, biology, anthropology, medicine, materials sciences, and related fields. These reactors do not produce electricity. Most U.S. non-power reactors are at universities or colleges. The largest U.S. non-power reactor (which operates at 20 MW(t)) is approximately 80 times smaller than the smallest U.S. commercial nuclear power reactor (which operates at 1,677 MW(t)). As of October 2020, there were 31 non-power reactors licensed to operate (NUREG-1350, Vol. 32).
Radioisotope Production Facilities. In support of the national initiative to establish a domestic supply of molybdenum-99 (Mo-99), the NRC has received license applications for radioisotope production facilities. Two radioisotope facilities are authorized for construction (SHINE Medical Technologies, LLC (SHINE), in Janesville, WI, and Northwest Medical Isotopes, LLC (NWMI), in Columbia, MO), and one operating license application is under review (SHINE) (NUREG-1350, Vol. 32).

[1] (*) denotes that the provisions of Price-Anderson apply to this category of NRC licensees

Uranium Recovery. The NRC does not regulate conventional mining but does regulate the processing of uranium ore, known as milling. Milling can be done at three types of uranium recovery facilities: (1) conventional mills, (2) in situ recovery facilities, and (3) heap leach facilities. The NRC regulates an in situ uranium recovery facility in Nebraska. Two in situ recovery facilities, one in South Dakota and another in New Mexico, have been licensed but not constructed. Nine in situ recovery facilities are operating in Wyoming under State regulations, as Wyoming became an NRC Agreement State in 2018 (NUREG-1350 Vol. 32). The NRC is overseeing the decommissioning of five uranium recovery facilities – three in New Mexico, one in Oklahoma, and another one in Wyoming that was not transferred to the State under its agreement with the NRC. Fifteen sites in agreement states are undergoing decommissioning – six in Wyoming, four in Texas, three in Colorado, one in Washington, and one in Utah (NRC, 2020e).

Fuel Cycle Facilities. The NRC licenses all commercial fuel cycle facilities involved in conversion, enrichment, and fuel fabrication. As of October 2020, the NRC licensed 10 fuel cycle facilities, including one uranium hexafluoride conversion facility, five uranium fuel fabrication facilities, two gas centrifuge uranium enrichment facilities, one uranium enrichment laser separation facility, and one depleted uranium deconversion facility (NUREG-1350, Vol. 32).

High-Level Radioactive Waste. Commercial spent nuclear fuel, although highly radioactive, is stored safely and securely throughout the United States. The NRC licenses and regulates the storage of spent fuel, both at commercial nuclear power plants and at separate storage facilities.

Most reactor facilities were not designed to store the full amount of spent fuel that the reactors would generate during their operational lives. Facilities originally planned to store spent fuel temporarily in deep pools of continuously circulating water, which cools the spent fuel assemblies. After a few years, the facilities were expected to send the spent fuel to a reprocessing plant. However, in 1977, the U.S. Government declared a moratorium on reprocessing spent fuel in the United States. Although the government later lifted the restriction, commercial reprocessing has not resumed in the United States. As a result, facilities expanded their storage capacity by using high-density storage racks in their spent fuel pools. To provide supplemental storage, some fuel assemblies are stored in onsite dry casks. These facilities are called ISFSIs and are licensed by the NRC.

The NRC regulates facilities that store spent fuel in two different ways, including through site-specific licenses and general licenses. The NRC may grant site-specific licenses after a safety review of the technical requirements and operating conditions for an ISFSI. The NRC has also issued~~s~~ a general license, as specified in Subpart K of 10 CFR Part 72, ~~s~~ authorizing nuclear power reactor licensees to store spent fuel onsite in dry storage casks that the NRC has certified. As of October 2020, there were ~~NRC licensed~~ 80 operating ISFSIs, including 15 ISFSIs authorized to operate under a site-specific license~~s~~ and 65 ISFSIs authorized to operate under the general license~~s~~ (NUREG-1350, Vol. 32).

The remainder of this section focuses on nuclear power reactors because the nuclear power reactor industry profile and anticipated changes to that profile will have the most significant impact on the Price-Anderson system. Applicability of Price-Anderson to other types of NRC licensees is discussed in Section 1.1.4.1, *NRC Licensees Subject to Price-Anderson,* and Section 2.2.1.1, *New Nuclear Technologies*.

This section has three major subsections:

- Current Nuclear Power Reactor Industry Profile
- Trends Impacting the Nuclear Power Reactor Industry Profile
- Impact of Changes in Nuclear Power Reactor Industry Profile on Price-Anderson System

2.1.1 Current Nuclear Power Reactor Industry Profile

2.1.1.1 Types of Commercial Operating Nuclear Power Reactors

At the time of the 1998 Price-Anderson Act Report to Congress, the nuclear power industry in the United States was dominated by two models of LWR units, boiling water reactors (BWRs) and PWRs (NUREG/CR-6617). An LWR is a reactor unit where the cooling medium is ordinary water. As of 2020, all commercial nuclear power reactors licensed to operate are LWRs.

The commercial byproduct of the nuclear fission process is heat. Power is generated by the absorption of heat from the fission process by water and the transfer of the energy potential from heated water to steam to move turbines. If the heat is not absorbed and transferred away from the fuel rods in the reactor core, then the temperature can increase beyond safety limits. To prevent such an occurrence, the heat generated by the fuel rods is carefully managed, by continually circulating water among the fuel rods to cool the reactor core.

Heat absorption can be either direct or indirect in LWR units. This distinguishes the BWR from the PWR, in that water can either circulate directly among the fuel rods to absorb heat potential (i.e., direct system) or through piping to a steam generator where another loop of water is heated (i.e., indirect system). The former of these processes generally is known as an “open loop system” and is found in the BWR unit design. The latter process generally is known as a “closed loop system” and is found in the PWR unit design.

Boiling Water Reactor

The BWR is the older technology of the two reactor types. During the 1950s, the BWR was adapted from military to commercial application. The BWR consists of one self-contained loop for both cooling and power generation processes, hence the term “open loop.” Water is circulated among the core’s fuel rods and heated until steam is generated. The steam exiting the reactor vessel is directed through main st~~r~~eam lines to the main turbine, causing it to turn the turbine generator, which produces electricity. After exiting the turbine, the steam cools and is condensed into water. The resulting water is pumped out of the condenser by a series of pumps, is reheated, and pumped back to the reactor vessel, where the process is repeated. As of October 2020, there were 31 BWRs operating across 20 sites (NUREG-1350, Vol. 32). In 2020, operating BWRs had a net summer capacity ranging from 617 to 1,401 MW(e), with the average being 1,060 MW(e) (EIA, 2021b). In 2020, operating BWRs generated 267,702,809 megawatt hours (MWh), with each BWR generating on average 8,365,712.78 MWh (EIA, 2021b).

Pressurized Water Reactor

In contrast to the BWR, within a PWR, water does not circulate through a single loop. In a PWR, pressurized water circulates through the reactor core (i.e., absorbing heat), exits into a reactor coolant loop, and carries heat to a steam generator. Inside the steam generator, the heat from the reactor coolant loop vaporizes the water in a second, self-contained (closed) circulation loop. The steam from the secondary loop then drives the main turbine and generates electricity. Each technology has its merits, but an advantage of the PWR is its reduced volume of contaminated material relative to the BWR unit. Specifically, exposure to radioactive material is limited to one closed loop, hence the volume of water and the amount of piping contaminated is smaller. Roughly two-thirds of operating units in the United States are PWRs. As of October 2020, there were 63 PWRs distributed across 36 sites (NUREG-1350, Vol. 32). In 2020, operating PWRs had a net summer capacity ranging from 874 to 1,313 Mw(e), with the average being 1,011 Mw(e) (EIA, 2021b). In 2020, operating PWRs generated 519,456,739 MWh, with each PWR generating on average 8,245,345 MWh (EIA, 2021b).

2.1.1.2 Number of Nuclear Power Reactor Units and Sites

As shown in Table 2-2, as of October 2020, there were 94 operational commercial nuclear power reactor units in the United States. About two-thirds of the units and sites were PWRs.

Table 2-2 Number of operating units and sites by reactor type

Reactor Type	Total Number of Operating Units by Reactor Type	Total Number of Operating Sites by Reactor Type
BWR	31	20
PWR	63	36
Totals	*94*	*56*

These 94 reactor units were operated at 56 sites. The MW(e) capacity size of the sites in the United States varied, with the net summer capacity ranging from 593 MW(e) to 1,499 MW(e), averaging 1,027 MW(e) (EIA, 2021b). The 56 operational sites had a combined capacity of 96,557 MW(e) (EIA, 2021b).

2.1.1.3 Location of Operating Nuclear Power Reactors

Reactor units operate in 29 States across the country, with the majority distributed east of the Mississippi River. Figure 2-1 shows a map of the locations of the reactor units that were in operation in 2019 in the United States. The majority of units were located in the Midwest and along the Atlantic seaboard. Of the 94 units shown, only 20 units were located west of the Mississippi River, and there were no commercial units in either Alaska or Hawaii (NUREG-1350, Vol. 32).

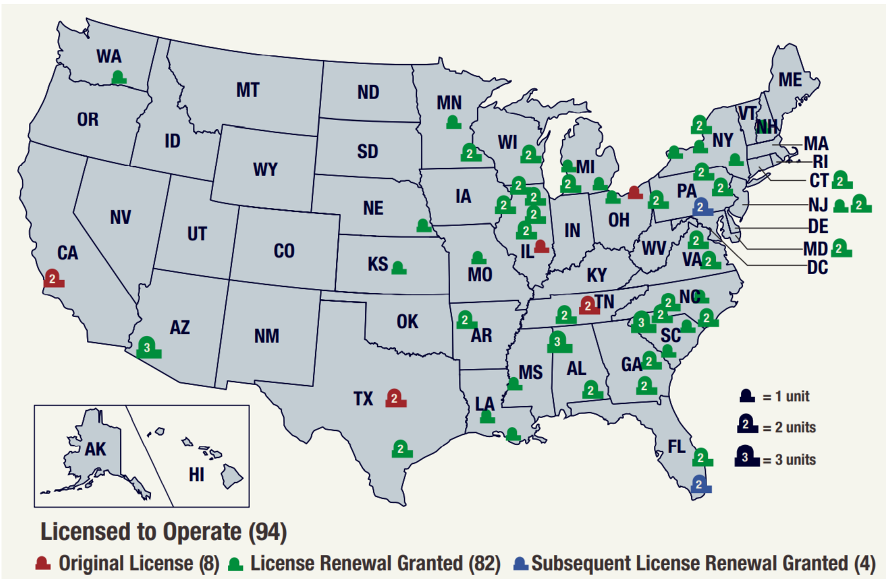

Figure 2-1 Operating commercial nuclear power reactors in the United States (2019)

2.1.1.4 Gross Electricity Generated by Nuclear Power Reactors by State

Across the United States, nuclear power's ~~reactor generated electrical energy and~~ contribution to the U.S. electrical grid varies~~y~~ significantly. As seen in Table 2-3, two States (Illinois and Pennsylvania) generated more than 60,000,000 MWh each from nuclear power in 2018, while Massachusetts and Iowa generated about 5,000,000 MWh in that year. Not shown in Table 2-3 are the 20 States that generated no commercial electric energy from nuclear power.

Table 2-3 Gross electric energy generated in each State by nuclear power (2018)

State	Total Nuclear Energy Generated by State (in thousand MWh)
Illinois	97,191
Pennsylvania	83,199
South Carolina	54,344
Alabama	42,651
North Carolina	42,374
New York	42,167
Texas	38,581
New Jersey	34,032

State	Total Nuclear Energy Generated by State (in thousand MWh)
Georgia	33,708
Michigan	32,381
Arizona	32,340
Tennessee	31,817
Virginia	30,533
Florida	29,146
California	17,901
Ohio	17,687
Connecticut	16,499
Louisiana	15,409
Maryland	15,106
Minnesota	13,904
Arkansas	12,691
Kansas	10,647
New Hampshire	9,990
Wisconsin	9,648
Missouri	8,304
Washington	8,128
Mississippi	7,364
Nebraska	6,912
Iowa	5,213
Massachusetts	5,047

Source: NUREG-1350, Vol. 32.

2.1.1.5 Single- vs. Multi-unit Sites

The majority of nuclear sites across the country house more than one reactor unit. Table 2-4 shows that, as of 2020, 62 percent of nuclear sites had more than one reactor, whereas in 1998, 54 percent of nuclear sites had more than one reactor.

Table 2-4 Single- versus multi-unit reactor sites (1998 versus 2020)

Units Per Site	Sites in 1998[2]	Sites in 2020[3]
1	32	21
>1	37	35

At the time of the 1998 Price-Anderson Act Report to Congress, 32 sites were single-unit facilities, but since that time, 11 single-unit sites have shut down. By comparison, over the same time period, only two multi-unit sites have shut down, and the only reactors currently under construction are located at an existing multi-unit site (Vogtle Units 3 and 4). No single-unit reactors are under construction or planned.

In 2018, 80 percent of total electricity generated by nuclear facilities was generated at sites with more than one reactor (NEI, 2018). In the coming years, this percentage is expected to increase. Economies of scale indicate that sites with multiple reactor units and greater generating capacity will have lower per-electrical-unit generation costs. Multi-unit sites permit operators to spread operational and capital costs across multiple reactors, resulting in a lower per-unit generating cost. For example, in 2018, the average total generating cost at multi-unit sites was $29.01 per MWh, compared to $42.01 per MWh for single-unit sites (NEI, 2019 a). Additional discussions on the emergence of small modular reactors, a new nuclear technology that is anticipated to comprise multiple reactor units located at individual sites, and other related new nuclear technologies, can be found in Section 2.1.2.1, *Emergence of New Nuclear Technologies* (found within the broader discussion of trends impacting the nuclear power reactor industry profile), and Section 2.2.1.1, *New Nuclear Technologies* (found within the broader discussion of safety management at production and utilization facilities).

2.1.2 Trends Impacting the Nuclear Power Reactor Industry Profile

Several factors may affect the Price-Anderson system by reducing the number of nuclear power reactors participating in the system or otherwise changing the characteristics of the industry in a way that could impact the availability of funding in the event of a nuclear incident at a nuclear power reactor. These include the following:

- Emergence of New Nuclear Technologies
- Competitive Electricity Markets and Consolidation of Nuclear Power Ownership
- Increasing Costs of Nuclear Power Reactor Construction and Operation
- Trends in Electric Power Generation Impacting the Nuclear Industry
- Aging of the Nuclear Fleet

[2] NRC, NUREG/CR-6617, “The Price-Anderson Act – Crossing the Bridge to the Next Century: A Report to Congress,” October 1998, Agencywide Documents Access and Management System (ADAMS) Accession No. ML12170A857.

[3] NRC, List of Power Reactor Units, Aug. 27, 2020, available at https://www.nrc.gov/reactors/operating/list-power-reactor-units.html.

- Nuclear Power Plant Licensing and Renewals
- Decommissioning Nuclear Power Reactors

Each of these topics is discussed below.

2.1.2.1 Emergence of New Nuclear Technologies

Since the 1998 Price-Anderson Act Report to Congress, several new nuclear technologies have emerged, including new large LWR designs, light water-based SMRs with passive safety features, reactors that do not use light water as a coolant or a moderator (non-LWR and micro-reactors), and radioisotope production facilities. Each new nuclear technology is briefly summarized below:

- New large LWRs build upon traditional, large LWR designs, employing advanced and simpler safety features that use natural driving forces, such as gravity flow and natural circulation flow, or other innovative approaches.
- SMRs typically use water to cool the reactor core in the same way as large LWRs do. However, SMR designs are smaller and often bundle several reactors together in a single facility. An SMR typically generates 300 MW(e) (1,000 MW(t)) or less compared to large LWR designs that generate 1,000 MW(e) (3,300 MW(t)) or more per reactor.
- Non-LWRs employ advanced technologies that are different than traditional reactors. Non-LWRs are cooled using liquid metals, molten salt mixtures, or inert gases, whereas traditional LWRs use water for both cooling and supporting the nuclear reactions in the core by moderating or slowing neutrons generated by the fission process. Non-LWRs also include micro-reactors, which are generally small (less than roughly tens of MW(t)), with low potential accident consequences, and are generally of simpler design.
- Radioisotope production facilities are designed to produce Mo-99 for use in medical diagnostic procedures. Potential and current applicants have proposed a variety of technologies to produce Mo-99, including accelerator-driven subcritical operating assemblies and hot cell structures.

In 2008, the NRC issued the Commission’s Policy Statement on the Regulation of Advanced Reactors (NRC, 2008) to improve the NRC’s licensing environment for advanced reactors and to minimize complexity and uncertainty in the regulatory process. Section 2.2.1.1, *New Nuclear Technologies,* provides additional information on these technologies and how the Price-Anderson Act may be applied to each.

2.1.2.2 Competitive Electricity Markets and Consolidation of Nuclear Power Ownership

Competitive Electricity Markets. Since the 1998 Price-Anderson Act Report to Congress, there have been significant changes to the electricity markets. Prior to the mid-1990s, electrical power markets were regarded as regulated monopolies where power utilities received exclusive rights from States to provide electricity to rate payers and to charge those payers prices set by cost-of-service regulations established by the States. Cost-of-service regulations allow power utilities to recuperate prudently incurred costs of generating, transmitting, and distributing electrical services, and they often include guaranteed rates of profit for the power utility. Cost-of-service regulations can have the unintended effect of limiting the incentive of power utilities to increase efficiency or decrease costs. By the early to mid-1990s, several States had begun to provide incentives for utilities to increase efficiency and decrease costs, and by the late 1990s multiple States had begun to deregulate their electricity markets. At the same time, utilities began to sell portions of their electricity generating portfolios to independent power companies. Wholesale electricity markets were established in several geographic regions and promoted the growth of independent power producers (i.e., merchant plants), which were non-utility generators owned by power companies.

The deregulatory period of the mid- to late 1990s drove competition in the energy sector and expanded wholesale electricity markets in the United States. According to the Energy Information Administration (EIA), economic deregulation led to about half of all nuclear sites (31 out of the 60 nuclear sites operating at the time the EIA analysis was performed) generating and selling electricity into deregulated (i.e., merchant) wholesale electricity markets (EIA, 2018). In wholesale electricity markets, prices of electricity are determined using local marginal pricing. Although merchant nuclear plants can have similar generating costs as regulated facilities, merchant plants tend to have lower revenues due to competition from other power-generating resources (EIA, 2018).

As discussed elsewhere, changes in the electricity markets resulted in premature shutdown of uneconomic units, but these changes also led to a competitive nuclear power industry by 2019. In 2016, the Tennessee Valley Authority's (TVA) Watts Bar Unit 2 became the first new U.S. reactor to come online since 1996. Vogtle Units 3 and 4 are the first new reactors to receive construction approval in more than 30 years. Despite this additional nuclear capacity, the EIA projects in its *Annual Energy Outlook 2019* reference case that less total nuclear-generated electricity will be produced in every year through 2050.

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Some States have responded to the potential retirement of nuclear power units by enacting policies that provide financial support to recognize the value of carbon-free electricity generation and other beneficial attributes (e.g., reliability, jobs) of nuclear power (NEI, 2020 a). NEI has reported on such legislation enacted in New York (2016), Illinois (2017), Connecticut (2017), and New Jersey (2018), and ~~with~~ discussions on enacting similar legislation are underway in States such as Ohio, Pennsylvania, and others (NEI, 2020 a).

Consolidation in Nuclear Power Ownership. The increase in competition and advantages of scale in competitive markets have contributed to greater consolidation in the nuclear power industry. The consolidation of the nuclear industry has come through mergers of utility companies, as well as the acquisition of units by independent power companies looking to expand their energy portfolio. In 1991, a total of 101 individual entities had some (including minority) ownership interest in operating nuclear power plants. At the end of 1999, that number had dropped to 87, with the largest 12 entities owning 54 percent of the generating capacity (World Nuclear Association, 2020b).

By 2019, the number of owners of operating nuclear power plants had fallen to 77, with the 12 largest owning 56 percent of the generating capacity. However, of those 77 owners, many were themselves owned by the same holding (parent) company. Specifically, in 2019, the 97 operational nuclear power units were owned by 77 companies and held by 59 holding companies. Taking parent company ownership into account, the 12 largest holding companies owned 77 percent of the total nuclear generating capacity. Also, in 2019, 31 operational nuclear power units had two or more owners, including ownership interests of two or more parent companies, while 66 operational nuclear power units were 100 percent owned by a single parent company (NEI, 2019b). ~~The diversity and variation in ownership of nuclear power units contribute to a financially strong industry despite the consolidation of ownership (e.g., in Exelon, Duke Energy, Entergy) in the industry as a whole since the 1998 Price-Anderson Act Report to Congress.~~

In the 2000s there were 20 reactor purchase deals involving 23 reactors, mostly in States where electricity pricing had been deregulated (World Nuclear Association, 2016). The units acquired were often those with high production costs, offering the potential for increased margins if costs could be reduced through economies of scale. In many cases, large power companies acquired reactors from local utility companies and at the same time entered contracts to sell electricity back to the former owners (World Nuclear Association, 2016).

The diversity and variation in ownership of nuclear power units contribute to a financially strong industry despite the consolidation of ownership (e.g., in Exelon, Duke Energy, Entergy) in the industry as a whole since the 1998 Price-Anderson Act Report to Congress. Further ~~In the context of the Price-Anderson Act, increased~~ consolidation in the nuclear industry could, however, pose concerns for the long-term viability of ~~the~~ Price-Anderson's approach to compensation ~~program~~. Should consolidation continue, the proportion of primary and secondary financial protection contributed by the largest entities would increase, somewhat elevating the structural risk of this approach~~e program~~ should one of the larger entities experience substantial financial difficulties.

2.1.2.3 Increasing Costs of Nuclear Power Reactor Construction and Operation

While generation costs remain competitive with other electrical generating sources, nuclear power plant construction costs have soared over the decades. Historically, nuclear plants have had relatively low operational costs and long operating lives (40-80 years), but long construction periods and high upfront capital costs. During the 1970s and 1980s, the number of reactor units finishing construction was increasing; however, the construction costs of those units soared. Between 1970 and 1985, reactor unit construction costs increased more than 300 percent (DOE, 1986).

As shown in Table 2-5, starting in the 1960s, overnight construction costs[4] for new nuclear power reactors topped $1,600/kilowatt-hour (kWh) (2018 dollars). By the 1970s, construction costs had increased 3-4 times those experienced only a decade before (DOE/EIA-0485). In recent decades, technological improvements and greater access to resources led to lower projected construction costs, but significant construction cost overruns led to higher actual costs. A 2016 EIA report estimated overnight construction costs for new nuclear power reactors to be around $5,945/kilowatt (kW) (EIA, 2016b).

[4] Overnight cost is the cost of a project if no interest was incurred during the construction of the project.

Table 2-5 Overnight construction cost of nuclear power reactor unit

1966-1967	$1,642/kWh
1974 -1975	$6,176/kWh
2018	$6,034/kWh

Source: DOE/EIA, An Analysis of Nuclear Power Plant Construction Costs, DOE/EIA-0485. DOE/EIA, Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2019.

Dramatic increases in construction costs are due, in large part, to global competition for the resources, commodities, and manufacturing capacity needed in the design and construction of new power reactors (Synapse Energy Economics, 2008). Global competition has dramatically increased the costs of key nuclear power reactor components and equipment. Capacity limitations in the manufacturing and construction industries also have extended construction timelines for reactors and facilities.

Cost overruns can have significant consequences for utilities, rate payers, and regulators. Increasing construction costs can lead to the failed completion of nuclear power reactors whose construction is underway. Additionally, elevated construction costs can increase prices for consumers, particularly those in regulated electricity markets. Finally, construction costs beyond what was predicted can lead to severe financial problems for the utility or merchant licensee. For example, in 1988, the Public Service Company of New Hampshire filed for bankruptcy due to financing difficulties associated with the Seabrook nuclear plant (Synapse Energy Economics, 2008). Additionally, Westinghouse Electric Company was forced to declare bankruptcy in 2017 following severe cost overruns associated with the construction of the V.C. Summer and Vogtle power plants in South Carolina and Georgia, respectively (Chappell, 2017). While the Vogtle plant is still proceeding with construction with funding from other project operators, construction of the V.C. Summer units was suspended, and, in 2019, the NRC approved the termination of the V.C Summer units' COLs (NRC, 2019e). High construction costs are a significant threat to future nuclear power production and capacity building.

2.1.2.4 Trends in Electric Power Generation Impacting the Nuclear Industry

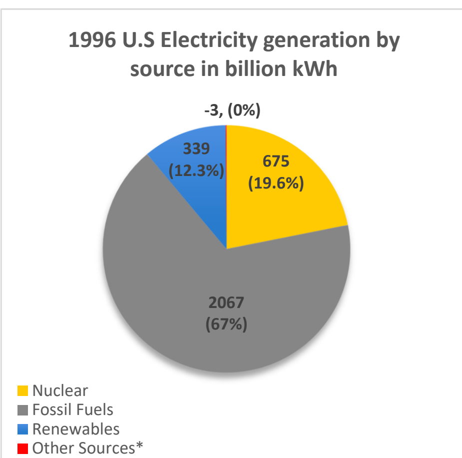
Trends external to the nuclear power industry have affected both supply and demand for electricity and will continue to do so into the future. These macroeconomic trends affect the competitive economics of nuclear power reactors and thereby can impact the Price-Anderson Act framework. These trends include the following:

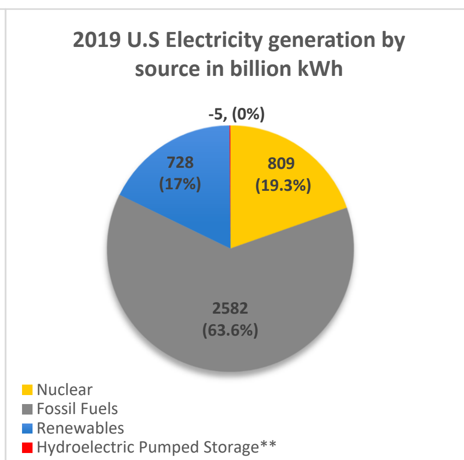
- trends in natural gas, solar, and wind
- trends in electricity storage
- trends in energy markets
- trends in electricity demand

- shift to electric-powered vehicles
- carbon pricing

Each trend is discussed in this section. The discussion primarily draws on data collected by the EIA for the years 2002 through 2017.

~~Trends in Natural Gas, Solar, and Wind. Nuclear power is but one option for generating electricity. Since 1998, there has been a decrease in the number of nuclear units and sites in operation. In 1996, 110 reactor units were operating at 69 sites compared with 94 reactor units operating at 59 sites in 2020. Despite a decrease in the number of operating reactors, the share of total electricity generated by nuclear power reactors in the United States remained consistent with 1998's share of total electricity generated by nuclear power reactors. For example, in 2019 the total electricity generation (all sources) in the United States was estimated at roughly 4 trillion kWh (EIA, 2020c). Of the four trillion kWh of generation, nuclear power facilities contributed 809 billion kWh (i.e., 19 percent of the total electricity generated) (EIA, 2020c). As stated in the 1998 Price-Anderson Act Report to Congress, in 1996 total generation by electric utilities was estimated to be 3,078 billion kWh with nuclear power reactor units generating 675 billion kWh (i.e., 20 percent of the total utility electricity generated) (EIA, 1997 a). Despite a lower number of operating reactors in 2019 relative to 1996, the share of total electricity generated by nuclear power reactors in the United States remained consistent with the share generated in 1996. The operating nuclear power reactor fleet has maintained a consistent nearly 20-percent share of the total annual U.S electricity generation due to a combination of power plant uprates (modifications that increase capacity) and high-capacity utilization rates. Some reactors also have shortened the length they are offline for refueling to increase annual electricity generation (EIA, 2020 d).~~





* The category "Other Sources" refers to hydroelectric pumped storage. Hydroelectric pumped storage represents total pumped storage facility production minus energy used for pumping (EIA, 1997a).

** Hydroelectric pumped storage represents pumped storage facility production minus energy used for pumping (EIA, 2020c).

Figure 2-2 Comparison of 1996 and 2019 electricity generation by source

Trends in Natural Gas, Solar, and Wind. Nuclear power is but one option for generating electricity. According to the EIA, the top sources of electricity generation in the United States have included coal, natural gas, nuclear, hydroelectric, petroleum, solar, and wind, with much variation across the country. The use of natural gas has increased significantly due to inexpensive new supplies starting in 2006-2007 resulting from new extraction technologies such as fracking and horizontal drilling. Natural gas prices began to drop in 2009 due to the combined impact of supply increases and low demand during the economic recession. As a result, natural gas surpassed coal as the top source of electricity in the United States in 2016. The *Quadrennial Energy Review* stated that between 2016 and 2040, changes in electricity generation are expected to be uneven both by technology and region; over this time period, nuclear generation is projected to remain relatively flat nationwide (DOE, 2017 a). Baseload electricity generation fueled by coal, nuclear, and natural gas is expected to decrease somewhat from 86 percent of grid-connected power in 2016 to 74 percent by 2040, based upon business-as-usual projections (EIA, 2016 a). According to the DOE, with the sustained drop in natural gas prices, natural gas-fired combined-cycle plants are a less costly source of baseload generation than coal or nuclear power in many regions of the country (DOE, 2017b). A key finding of the *Quadrennial Energy Review* is that existing nuclear merchant plants are having difficulty competing in restructured electricity markets due to low natural gas prices and flat or declining electricity demand (DOE, 2017 a).

At the time of the last Price-Anderson Act Report to Congress, the contribution of wind and solar energy—both utility-scale and distributed – was small nationwide. Because of improvements in technology and implementation of various public policies, tax incentives, and mandates favoring use of such renewables (e.g., State renewable portfolio standards), significant quantities of wind and solar electricity began to impact grid operations around 2010. The trend has resulted in wind providing more than 6 percent of electricity generation and solar nearly 2 percent nationwide in 2017. These figures are expected to continue to rise due to lower variable operating costs than coal, nuclear, and hydro. The Midwest and the Great Plains have become major sources of wind power.

Trends in Electricity Storage. A drawback of solar and wind energy results from intermittent access to the sun and winds. Thus, these renewables cannot reliably meet our diurnal energy needs, absent technologies that can store solar and wind power for later use. For both wind and solar, a continuing challenge remains cost-effective storage of previously generated electricity during periods of low winds and at night. In the long run, as stated in the 2017 *Quadrennial Energy Review*, grid-scale storage could yield significant advantages for technologies such as wind and solar, ~~adversely affecting~~reducing the need for traditional baseload in the very long term (DOE, 2017 a).

Although ~~it~~ small scale distributed energy storage has historically represented a negligible percent of total electricity generating capacity, as recognized in the ~~2017~~ *Quadrennial Energy Review*, such storage ~~also recognized that small scale distributed energy storage~~ could be a transformative technology (DOE, 2017a). In more recent years, the EIA has acknowledged a general trend of increased pairing of renewables with energy storage and an expectation that this trend will continue, as the cost of energy storage continues to decrease. A 2020 EIA report shows that the number of solar and wind generation sites co-located with batteries has grown (from 19 in 2016 to 53 in 2019), and the trend is expected to continue (EIA, 2020b).

Trends in Energy Markets. At the time of the 1998 Price-Anderson Act Report to Congress, the NRC had begun to develop its responses to national and State efforts to de-regulate energy markets in pursuit of such goals as increasing efficiency and encouraging innovation. Resulting trends saw separation of generation from transmission and distribution businesses as opposed to the prevailing model of vertically integrated power utilities.[5] While a number of States attended to changing their retail power markets, the Federal Government became very active in the restructuring of wholesale markets. Centrally organized wholesale electricity markets were in the early stages of implementation in 2002; competition within those markets among a large segment of merchant generation did not take effect until the mid-2000s. At roughly the same time, many States chose to establish State energy standards that required greater purchases of electricity from favored sources, such as renewables.[6] By 2010, demand response[7] emerged as a way for customers also to compete in most centrally organized wholesale markets. Changes in energy markets have~~s~~ led to lower market prices for electricity, which has put pressure on many nuclear power plants.

Trend in Electricity Demand. For many decades, electricity production was highly correlated with gross domestic product (GDP).[8] Thus, projections for GDP (e.g., based on population increases) could reliably be associated with future electricity demand. However, over the last several decades, increases in GDP have been associated with smaller increments of electricity use. As ~~long with moderating~~ population growth has moderated, the economy has become increasingly energy efficient and industries have become less energy intensive. Electricity use has been roughly flat since 2008. According to the *Quadrennial Energy Review,* looking forward to 2040, electricity use is projected to grow slowly (DOE, 2017 a). This means that the economy as a whole is spending less for electricity and competition for marginal revenue dollars is more intense. This trend of flat demand growth is not considered favorable for nuclear power (Idaho National Laboratory, 2016).

Shift to Electric-Powered Vehicles. As of 2019, some companies and governments have begun to explore powering vehicles through electricity, as opposed to current vehicle dependence on refined petroleum and, to a much lesser extent, compressed natural gas. A shift to electric cars could ~~be a plus for~~increase demand for nuclear power, all other factors being the same, in the long run. Nonetheless, while the~~The January~~ 2017 *Quadrennial Energy Review* ~~, despite~~ projected~~ing~~ an increase of electricity use in the transportation sector of 134 percent between 2014 and 2040, ~~nevertheless~~ it also estimated the transportation sector as comprising less than 1 percent of total U.S. electricity consumption by 2040.

Carbon Pricing. Although not a robust trend, carbon pricing remains in the national conversation about energy sources. Carbon pricing can take a variety of forms, including rewarding relatively low-carbon energy sources, such as nuclear power and renewables, and/or penalizing relatively high-carbon energy sources such as coal. As a result, nuclear power could benefit from carbon pricing programs. As discussed above, some States have provided financial rewards for zero-carbon nuclear power units, but as of 2020, these programs have been ad hoc.

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[5] As described earlier, these trends resulted in the rise of merchant plants for nuclear power.

[6] As described earlier, some States and the Federal Government have considered and enacted policies that would address potential retirements of nuclear power units through financial incentives.

[7] Demand response refers to programs whereby utilities, typically during peak demand periods, can call on customers to offer to reduce their loads at certain prices.

[8] According to the EIA, between 1950 and 2013, there was a 66-percent correlation between GDP and electricity use. Vipin Arora and Jozef Lieskovsky, "Electricity Use as an Indicator of U.S. Economic Activity," EIA, working paper series, 2, 2014, available at https://www.eia.gov/workingpapers/pdf/electricity_indicator.pdf (cited in DOE, 2017a).

2.1.2.5 Aging of the Nuclear Fleet

In the 1998 Price-Anderson Act Report to Congress, the NRC highlighted the age range of the nuclear units in operation. The majority of units (100) were between 10 and 29 years old, with only five units under 10 years of age. In that report, the NRC noted that an aging nuclear fleet could be of concern in the coming decades if aging units were not replaced by younger units. Figure 2-3 shows reactor units' age distribution as of October 2020 and compares the ages of the current fleet of nuclear units with those in 1998.

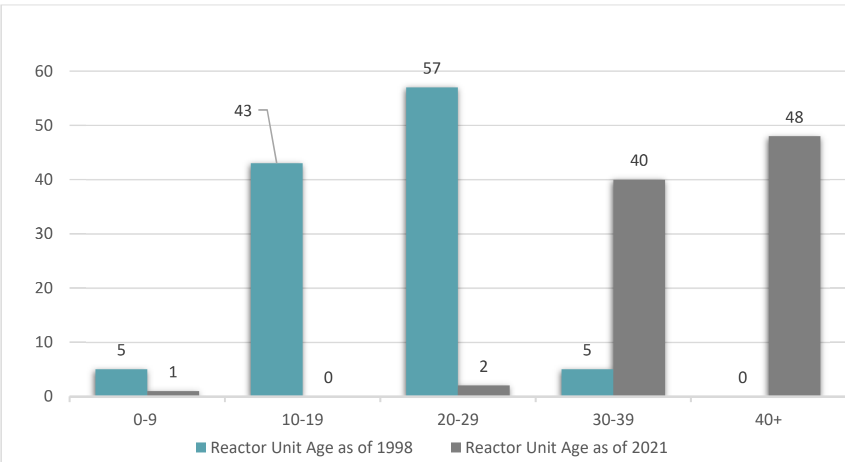

Figure 2-3 Age of nuclear power reactor fleet (1998 versus 2021)

In 2019, most reactor units (96.7 percent) were 30 years old or older (NUREG-1350, Vol. 32). Only one reactor unit was constructed less than 20 years ago. One point of consideration is that because economic and antitrust considerations informed the initial time period of power reactor licensing of 40 years, most operating BWRs and PWRs may have some components, some systems, or structures that may have been engineered on the basis of an expected 40-year service life (NUREG-1350, Vol. 31). However, relicensing procedures and subsequent licensing procedures have been established that allow for reactors to operate up to 60 and 80 years, respectively, if the reactor meets a specific set of requirements based primarily on the reactor's design (NUREG-1350, Vol. 31). As of January 2021, the average age of the current fleet of operating reactors is 40 years (NRC, 2021 a). If the current fleet of operating reactors were to shut down when their current licenses expire (e.g., no ~~additional~~ license renewals or subsequent license renewals), 45 units will have shut down by 2040 (in the next 20 years). If no new facilities are licensed, under this scenario, the yearly electricity generating capacity of the nuclear fleet would decrease from 789,919,000 MWh to 452,461,000 MWh (EIA, 2021b).

As of October 2020, two nuclear power reactor units are actively under construction: Vogtle Units 3 and 4 in Georgia. These units are expected to have a combined capacity of 2,226 MW(e) (NUREG-1350, Vol. 32). The Vogtle project is the first new nuclear power plant to be licensed and begin construction in the United States in more than three decades. The construction project has experienced significant cost overruns and delays, including the bankruptcy of one of the project's operators (Hals, 2017). Similarly, following the initiation of construction at the Vogtle plant, two units, V.C. Summer Units 2 and 3 in South Carolina, were licensed and began construction. Construction of the V.C. Summer units was suspended due to higher than expected construction costs (NRC, 2017 d). In 2019, the NRC approved the termination of the V.C Summer units' COLs (NRC, 2019e).

2.1.2.6 Nuclear Power Plant Licensing and Renewals

Prior to May 1989, in order to construct and operate a nuclear power plant, applicants for a nuclear power reactor had to obtain both a construction permit and an operating license from the NRC under 10 CFR Part 50. Since 1998, only one Part 50 commercial operating power license has been issued, for the Watts Bar Unit 2 facility, which completed testing and received final licensing in 2015. The Watts Bar Unit 2 license is expected to expire in 2055, unless renewed.

In 1989, in an effort to streamline the licensing process, the NRC created a COL under 10 CFR Part 52.[9] The COL combines a construction permit and an operating license with conditions for plant operation (NUREG-1350, Vol. 31). The vast majority of currently operating reactors used the approach of obtaining both a construction permit and an operating license from the NRC under 10 CFR Part 50. As of 2020, there were five licensees with COLs for eight new reactor units. Two COLs were issued to Southern Nuclear Operating Company for Vogtle Electric Generating Plant Units 3 and 4 (NRC, 2020f); one COL was issued to DTE Electric Company for the Enrico Fermi Nuclear Plant Unit 3; two COLs were issued to Duke Energy Carolinas for William States Lee III Nuclear Station Units 1 and 2;[10] one COL was issued to Virginia Electric and Power Company for the North Anna Unit 3;[11] and two COLs were issued to Florida Power & Light Company for Turkey Point Units 6 and 7.[12] Additionally, after issuance of COLs, three licensees requested to have their licenses terminated by the NRC. Two COLs issued to South Carolina Electric & Gas Company for V.C. Summer Nuclear Station Units 2 and 3 were terminated on March 6, 2019; two COLs issued to South Texas Project Nuclear Operating Company for South Texas Project Units 3 and 4 were terminated on July 12, 2018; and two COLs issued to Duke Energy Florida for Levy Nuclear Plant Units 1 and 2 were terminated on April 26, 2018 (NRC, 2020f).

The Atomic Energy Act of 1954 allows the NRC to issue licenses for commercial nuclear power reactors to operate for up to 40 years. The NRC regulations in 10 CFR Part 54 permit these licenses to be renewed beyond the initial 40-year term for an additional period of time, limited to 20-year increments per renewal, based on the results of an assessment to determine if the nuclear facility can continue to operate safely during the proposed period of extended operation. There are no limitations in the Atomic Energy Act of 1954 or the NRC regulations restricting the number of times a license may be renewed.

The period after the initial licensing term is known as the period of extended operation (i.e., the period from 40 to 60 years). As of October 2020, the NRC had granted 86 of 94 operating

[9] 54 FR 15372 (April 18, 1989).
[10] Since that time, Duke Energy has canceled the proposed construction of the two units.
[11] Since that time, Dominion Energy has suspended the planned construction of North Anna Unit 3.
[12] Since that time, construction on the proposed reactors has been postponed.

nuclear power reactors license renewals, while 8 of the 94 reactors continue to operate under their original license (NUREG-1350, Vol. 32). Additionally, the NRC has developed guidance and a standard review plan for subsequent license renewals that would allow plants to operate for more than 60 years (i.e., the 40 years of the original license plus 20 years in the initial license renewal). The Commission determined that the agency's existing regulations are adequate for subsequent license renewals, which extend a nuclear plant's period of operation from a 60-year to an 80-year period (NUREG-1350, Vol. 31).[13] As of February 2021, the agency is currently reviewing 3 applications for 6 units. Review for 2 applications have been completed for 4 units (Turkey Point Units 3 and 4; Peach Bottom Units 2 and 3) (NRC, 2021b). The NRC has received letters of intent to apply for a subsequent license renewal in 2021 from Oconee Nuclear Station Units 1, 2, and 3, and St. Lucie Plant Units 1 and 2 (NRC, 2021b).

Licensing terms in themselves do not appear to have contributed to unit retirements. Between 2012 and 2018, six units shut down operations earlier than their licensed lifetimes.[14] One recent analysis estimates some 17 potential retirements being likely in the near term, and that roughly one-half of the nation's nuclear power plants located in competitive markets are at risk of early retirement (Herndon, 2016).

2.1.2.7 Decommissioning Nuclear Power Reactors

Decommissioning involves safely removing a facility or site from service and reducing residual radioactivity to a level that permits the license to be terminated, with property released either for unrestricted use or under specified restricted conditions. Decommissioning a nuclear power reactor is a complex process for which NRC regulations allow up to 60 years, from the time fuel is removed from the reactor core, to complete. Within the NRC's regulatory framework, decommissioning can be achieved in a period shorter than 60 years. Although the Price-Anderson Act and associated regulations make no distinction for the financial protection requirements of large, operating commercial nuclear power reactors compared to large commercial nuclear power reactors in decommissioning, the NRC has been providing exemptions to licensees in decommissioning from financial protection requirements and allowing them to reduce the amount of coverage as they progressed through the decommissioning process. Additionally, the NRC is undertaking a rulemaking that would codify reduced financial protection requirements throughout decommissioning without the need for obtaining exemptions from NRC's regulations. The proposed rule, as provided by the staff to the Commission for its deliberation, would provide licensees, once certain criteria are satisfied, the option to provide a reduced amount of $100 million to satisfy the primary layer of financial protection and withdraw from the retrospective premium program under the secondary layer of financial protection. Consequently, the status of decommissioning nuclear power reactors is relevant to a complete understanding of the Price-Anderson Act framework.

Commented [A13]: Staff should update the discussion of the decommissioning rulemaking, if appropriate.

Assuming no new nuclear plant additions occur beyond 2022 and existing plants have 2 gigawatts (GW) of uprates starting in 2022, the EIA projects nuclear electricity generating capacity to decrease from 98 GW to 79 GW between 2019 and 2050 due to nuclear power plant shutdowns and decommissioning (EIA, 2020 a). To date, 12 reactor sites have shut down and fully decommissioned. As of October 2020, 25 reactor units were undergoing decommissioning (NUREG-1350, Vol. 32). Owners have stated that their decisions to permanently shut down reactors are based, in part, on risk-adjusted net present-value assessments of reactors

[13] The NRC published the final guidance documents for subsequent license renewals in 2017.
[14] Two retirements (San Onofre and Crystal River) resulted from mechanical failures that were considered too costly to repair; the other retirements were market decisions.

operating in newly created, deregulated markets where the estimated annual future revenue would not exceed anticipated costs of maintaining operational commercial units (EIA, 2018). Although no units shut down between 1999 to 2013, since 2013, 11 units have shut down and 8 additional units are scheduled to shut down by 2025, due in part to economic forces (EIA, 2021 a). If all 8 units close, the nuclear fleet will have decreased by 9 percent, to 86 units.

In 2017, four reactor units that initially had announced plans to close reversed their closure decisions due to State price supports for nuclear power producers in the form of zero-emission credits (Charles, 2018). Five additional nuclear power facilities have also requested State-level price support. These five nuclear power facilities have suggested that their longevity relies on public intervention, such as the economic recognition of nuclear power's environmental benefits relative to fossil fuels. To prevent or delay retirements of nuclear power facilities with marginal finances, some States have begun discussions on compensating such facilities for their contribution to zero-carbon electricity generation (World Nuclear Association, 2020b).

2.1.3 Impact of Changes in Nuclear Power Reactor Industry Profile on Price-Anderson System

The number of power reactors participating in the retrospective premium plan is a significant factor in the amount of financial protection provided by the Price-Anderson system. Thus, this section focuses on projections of power reactor shutdowns. According to the EIA, 8 nuclear power reactors are scheduled for shut down by 2025, due in part to economic forces (EIA, 2021 a). If all 8 units close, the nuclear fleet will have decreased by 9 percent, to 86 units. Over the longer term, the EIA projects nuclear electricity generating capacity to decrease from 98 GW to 79 GW between 2019-2050 due to shutdowns and decommissioning (EIA, 2020 a). This is equivalent to a 20-percent decrease in nuclear capacity by 2050. Accordingly, assuming a 20-percent decline in the number of operating reactors, approximately 79 reactors would remain in operation and approximately $11.3 billion in Price-Anderson Act funding would be available based on current levels of required primary and secondary coverage.

Figure 2-4 shows how the pool of available funding under the current Price-Anderson Act framework would decrease if the number of reactors participating in the retrospective premium plan decreased. Specifically, Figure 2-4 shows that, based on current levels of required primary and secondary coverage, each reactor retirement reduces the available pool of funding by approximately $138 million (roughly a 1% change for each reactor retirement currently).

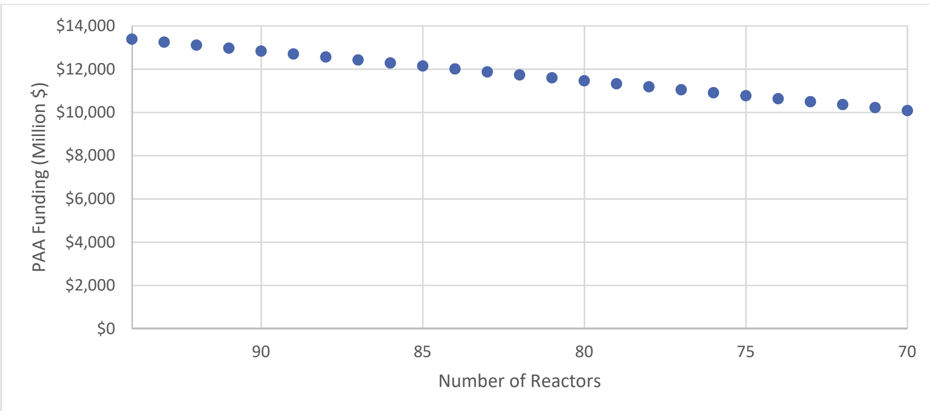

Figure 2-4 Amount of available Price-Anderson Act funding if number of reactors decreases

While changes in the nuclear power reactor profile are inevitable, including a likely decrease in the number of power reactors participating in the retrospective premium plan, the existing Price-Anderson system would continue to make available a significant amount of funding considering current trends and projections, such as projected by the EIA.

2.2 State of Knowledge of Nuclear Safety

This section of the report covers three topics:

- safety management of production and utilization facilities
- potential for occurrences of accidents
- scientific advances over the last 23 years related to radiation exposure health effects

2.2.1 Safety Management of Production and Utilization Facilities

To address safety management of production and utilization facilities, this section discusses new nuclear technologies, the impact of changes in regulations on safety management of nuclear power reactors, and lessons learned from the nuclear power plant exercise known as SE15.

2.2.1.1 New Nuclear Technologies

New nuclear facilities based on advances in new technologies are often considered to be any facilities proposed in addition to the current fleet of operating reactors.[15] These new technologies can be grouped into four categories: new large LWRs, SMRs, non-LWRs, and new non-power production or utilization facilities. New large LWRs incorporate new elements such as passive safety systems and simplified system designs. SMRs are about one-third the size of typical reactors, and they can be installed underground~~,~~ and built with passive safety systems. A new generation of non-LWRs use materials such as liquid metals (e.g., sodium), gases (e.g., helium), or molten salts as coolants instead of water, as traditionally used in LWR designs. In addition to these reactor technologies, there are new non-power production or utilization facilities, including commercial accelerator-driven subcritical operating assemblies or other radioisotope production facilities. The following sections describe each of these new technologies, as well as other considerations related to regulating new nuclear technologies under the existing Price-Anderson Act framework.

New Large Light Water Reactors

The NRC has certified multiple new large LWR technologies that build on the designs of traditional large LWRs. Since the 1998 Price-Anderson Act Report to Congress, the NRC has issued design certifications for the AP1000, Advanced Power Reactor 1400 (APR1400), Advanced Boiling Water Reactor (ABWR), and Economic Simplified Boiling Water Reactor (ESBWR).

The AP1000 is a larger version of the AP600. This 1,100 MW(e) advanced PWR is similar to the AP600 design but generates more power by accommodating more fuel in a longer reactor vessel and using larger steam generators and a larger pressurizer. The APR1400 is also an advanced PWR design that builds upon the Combustion Engineering System 80+ design (now owned by Westinghouse), which was certified in May 1997. It is similar to several reactors currently operating in the United States and incorporates advanced design features to enhance safety.

The ABWR, with a rated power of 1,300 MW(e) improves on the electronics, computer, turbine, and fuel technology of existing BWRs. The design's safety enhancements include protection against over pressurizing the containment, passive methods to cool accident debris, an independent water resupply system, three emergency diesels and a combustion turbine as an alternate emergency power source. The ESBWR is a 1,500 MW(e) BWR with passive safety features. This design builds on the Simplified BWR and includes some ABWR features. The ESBWR enhances natural heat transport by using a taller vessel, a shorter core, and by enhancing water flow. The design's isolation condenser system controls high-pressure water levels and removes decay heat when active systems are unavailable. After the automatic depressurization system operates, a gravity-driven cooling system controls low-pressure water levels. Another passive system cools the reactor containment.

The provisions of the Price-Anderson Act and the Commission's regulations in 10 CFR Part 140, "Financial Protection Requirements and Indemnity Agreements," require, in part, that each holder of a license issued pursuant to 10 CFR Part 52, "Licenses, Certifications, and Approvals

[15] The Nuclear Energy Innovation and Modernization Act (NEIMA; Public Law 115-439) included fusion reactors within the definition of "advanced nuclear reactor," for which the NRC is to develop a technology inclusive regulatory framework. The NRC staff is evaluating possible approaches to the regulation of fusion energy systems, including financial protection requirements. Fusion energy systems are not specifically addressed within this report due to the current status of scientific research related to the technologies and the ongoing assessments within the NRC on appropriate regulatory approaches for the possible development and deployment of fusion energy systems

for Nuclear Power Plants," have and maintain financial protection. Therefore, the new large LWRs described above that are licensed under Part 52 must comply with the Price-Anderson Act and Part 140 once the NRC staff verify that the licensee has met all Inspections, Tests, Analyses, and Acceptance Criteria or ITAAC under 10 CFR 52.103(g).

Small Modular Reactors

SMRs are smaller in size and capacity than traditional large LWRs, with a generating capacity of less than 300 MW(e). In addition, SMRs could be manufactured in a factory environment allowing for standardization of design and parts for construction and maintenance. These factors are expected to result in a number of benefits including:

- *Reduced costs:* The smaller size and standardization of SMRs allow for reduced construction costs compar~~t~~ed to LWRs. This is a result of their smaller size and simplified safety features. As compared with LWRs, SMRs can operate with fewer coolant pumps and motors, or with passive processes.

- *Shorter construction times:* SMRs are expected to take about 3 to 4 years to build, as opposed to 6 years for traditional nuclear power plants. In addition, as most SMR facilities are expected to consist of multiple reactor modules, units can potentially come online as they are individually installed, rather than waiting for each unit in an entire facility.

- *Increased flexibility:* SMR facilities are intended to have a smaller footprint making more locations suitable for construction. The smaller size of SMR units will also make nuclear power more accessible to areas that don't need large facilities with high capacity, and potentially make nuclear power accessible to more remote and rural communities.

The NRC has issued a standard design approval to NuScale Power, LLC.[16] The NRC also reviewed, approved, and issued in December 2019 an early site permit for TVA's Clinch River Nuclear Site, which supports potential future licensing of an SMR design on the site. The NRC also has engaged with General Electric-Hitachi BWRX-300 and Holtec SMR-160 in pre-application activity for the development of small modular reactor designs. It is anticipated that SMRs will provide enhanced safety margins and use simplified, inherent, passive, or other innovative means to accomplish safety and security functions.

The regulation at 10 CFR 140.11, "Amounts of Financial Protection for Certain Reactors," states that nuclear reactors designed for the production of 100 MW(e) or more are required to carry $450 million of liability insurance. Section 140.11 also requires that each licensee of a facility above 100 MW(e) will, in the event of a nuclear incident that results in public liability in excess of the amount of primary liability insurance carried by the licensee where the incident occurred, contribute up to $131.1 million toward public liability and no more than $20.5 million per reactor within one calendar year.

The regulation at 10 CFR 140.12, "Amount of Financial Protection Required for Other Reactors," identifies financial protection requirements for nuclear reactors not addressed in 10 CFR 140.11. Reactors that generate in excess of 10 MW(t), but do not generate electrical power, and reactors that generate less than 100 MW(e) are required to carry an amount of liability

[16] "NuScale Power, LLC; NuScale Small Modular Reactor," Federal Register, Vol. 85, No. 189, September 29, 2020, p. 61038.

insurance between $4.5 and $74 million. The exact amount is determined by a formula described in the regulations, which is based on thermal power and on a site's population factor. Because the power level for each reactor module is less than 100 MW(e), these reactors are not required to participate in the secondary retrospective premium plan.

Section 140.11 also allows a combination of facilities above 100 MW(e) but below 300 MW(e) each, with a combined rated capacity of no more than 1,300 MW(e), that are located at a single location to be treated as a single facility for assessing the financial protection requirements. Given that nuclear reactors below 100 MW(e) are not required to participate in the secondary layer of financial protection, the Act and the NRC's regulations are silent as to a combination of facilities below 100 MW(e) participating in the secondary retrospective premium plan.

The NRC has noted that, based on this approach, an SMR facility with multiple reactors below 100 MW(e) would only be required to purchase primary insurance despite a significantly higher overall capacity of the facility (SECY-11-0178).[17] Such an approach could be an issue if events affecting multiple units resulted in the risks of offsite consequences being significantly higher than the risk posed by a single unit. The NRC assesses multi-unit risks as part of the licensing process for nuclear reactors, including SMRs and future advanced reactor designs. The assessments are used to ensure appropriate treatment of important insights related to multi-unit design and operation. The information gathered through the licensing process for specific designs and facilities, together with the analysis performed for the development of a regulatory framework for advanced reactors (SECY-21-0010),[18] will inform future decision-making relating to Price-Anderson Act coverage of SMR facilities. At this time, the staff does not recommend changes to the Price-Anderson Act framework to address different designs of SMR facilities and will monitor the progress of SMR technology and operational experience with SMR facilities to further assess this topic for future consideration as it relates to Price-Anderson Act coverage.

Non-Light Water Reactors

Advanced non-LWRs use coolants including molten salts, liquid metals, and even gases such as helium, and are typically smaller and simpler designs. The two most mature non-LWR technologies include high temperature gas-cooled reactors (HTGRs) and sodium-cooled fast reactors (SFRs). The interest in advanced non-LWRs has significantly increased over the last few years. Numerous reactor designers are in various stages of pre-application activities. In addition, the Department of Energy has established the Advanced Reactor Demonstration Program (ARDP) focused on the advancement of advanced reactor designs and the commercial demonstration of two different technologies by 2027.

HTGRs are helium cooled graphite moderated thermal reactors. HTGRs operate at higher coolant outlet temperatures than traditional LWRs and can operate at a temperature of 700-1,000ºC compared to 330ºC for LWRs. The higher temperature enables better thermodynamic conditions, leading to higher efficiency.

Since the 1960s, several nuclear companies have experimented with the development of HTGRs. Over this time period, a number of experimental and commercial HTGRs have been developed in countries around the world, including the United States, United Kingdom, Japan,

[17] SECY-11-0178 - Insurance and Liability Regulatory Requirements for Small Modular Reactor Facilities (ML113340133)
[18] SECY-21-0010: Enclosure - Non-Light Water Reactor Implementation Action Plan Progress Summary and Future Plans (ML20345A241)

Germany, and China. In the United States, the development of HTGRs has been promoted by the DOE's Next Generation Nuclear Plant Program, established through the Energy Policy Act of 2005. In comparison to LWRs, HTGRs are expected to have design features that would result in a smaller and slower release of radioactive material in the unlikely event of an accident. Events involving the potential release of radioactive materials, including the loss of helium pressure boundary, would continue to be evaluated and addressed with the design and licensing processes. The NRC is engaged with X-energy in pre-application activities on their XE-100 pebble bed reactor. This design was chosen by DOE for demonstration as part of the ARDP.

SFRs use liquid metal (sodium) as a coolant instead of the water that is typically used in U.S. commercial power reactors. This allows for the coolant to operate at higher temperatures and lower pressures than in current reactors, which provides possible improvements in the efficiency and safety of the system. SFRs also have been operating over the last several decades in the United States and several other countries. The DOE is currently exploring building and operating an SFR as the Versatile Test Reactor as part of a project led by the Idaho National Laboratory. The NRC is engaged with TerraPower in pre-application activities on their Natrium SFR design. This design was chosen by DOE for demonstration as part of the ARDP.

Molten salt reactors (MSRs) are another non-LWR technology currently under development. MSRs are reactors that use molten salts as a coolant or fuel. MSRs vary in design but are known for their sustainability, as liquid fuel in an MSR can be processed or refueled during the operation of the reactor. It is also believed that MSRs will be less costly to operate than traditional LWRs due to potentially smaller containments, higher reaction temperatures leading to greater efficiency, and lower costs associated with fuel fabrication. MSR technology has been under development for over 60 years. The first MSRs developed in the United States were built at Oak Ridge National Laboratory in the 1950s and 1960s. Currently, MSRs are being developed in Europe, China, the United States, and Canada. The NRC is also engaged with Kairos in pre-application activities on their fluoride salt-cooled high temperature reactor (FHR). This design uses similar fuel as an HTGR but uses molten salt as the coolant.

MSRs may have safety advantages relative to LWRs. Unique to some MSR salt-fueled designs is a safety feature known as a "freeze plug" below the reactor core. The salt plug is cooled to a solid state, and in the event of an overheating in the reactor core, the plug melts allowing the molten salt fuel to drain into a basin that is designed to contain the fuel and prevent it from undergoing further fission reaction. In addition, MSRs can be refueled continually and, therefore, can have very low excess reactivity, meaning there is no need to load extra fissile material into the reactor to support an operating cycle. An attribute of MSRs providing possible safety benefits is that they operate at lower pressures than LWRs.

A primary concern with MSRs is that the molten salt fuel is in a liquid state rather than a solid fuel state like in traditional LWRs. The movement of radioactive materials within the reactor system and resultant high radiation areas within the facility likely will introduce operational challenges in comparison to LWRs. The NRC is also engaged with Terrestrial in pre-application activities on their Integral Molten Salt Reactor (IMSR) design.

Micro-reactors are generally small (less than roughly tens of MW(t)), with low potential accident consequences and generally of simpler design. Proposed designs have unique heat removal systems, for example, using heat pipes; or new fuel forms that have not previously been licensed. Some proposed designs are considering factory manufacturing and transporting the reactor to a site fully fueled where they may be operated remotely or semi-autonomously. The exposure to the public from any postulated accident in some designs may be essentially zero or much lower than current acceptance criteria (BNL, 2020). On March 11, 2020, Oklo, Inc. filed a COL application with the NRC for the company's Aurora compact fast reactor. The micro-reactor would generate approximately 1.5 MW(e) of power. The NRC is also engaged in pre-application activities with Westinghouse Electric Corporation for a proposed micro-reactor design that also uses heat pipes.

Each of the advanced non-LWR technologies discussed in this section are at different stages of development with ultimate licensing decisions uncertain at this time. However, the Commission's Policy Statement on the Regulation of Advanced Reactors (NRC, 2008) states that "the Commission expects that advanced reactors will provide enhanced margins of safety and/or use simplified, inherent, passive, or other innovative means to accomplish their safety and security functions." Given the expectation that advanced non-LWR technologies will provide at least the same degree of protection as existing reactors, questions about modifying the current Price-Anderson system should consider : (1) whether the risk profiles for advanced reactor facilities are comparable to existing facilities, for which the current insurance and liability requirements were established; and (2) whether the attributes of advanced reactor designs reduce the risk profiles in comparison to existing facilities such that changes to insurance and liability requirements might be warranted. Regarding the first question, the staff will document its assessments of the potential risks associated with advanced reactor facilities, including multi-module issues, as part of the regulatory framework to be developed to address advanced reactor design certification and the licensing process for specific designs and facilities. Regarding the second question, the feedback from stakeholders during public meetings on this topic (e.g., the December 21, 2020, Advanced Reactor Stakeholder Public Meeting (NRC, 2020c)), including designers and industry organizations, is that no immediate actions are called for to address the possibility that reduced risks posed by advanced reactors might warrant changes to the current insurance and liability requirements. Therefore, at this time, the NRC has determined that no changes are needed to the Price-Anderson Act to address advanced non-LWR technologies.

Non-power Production and Utilization Facilities

Doctors worldwide rely on a steady supply of Mo-99 to produce technetium-99 m in hospitals, which is used in radiopharmaceuticals in approximately 50,000 medical diagnostic procedures daily in the United States. The NRC supports the national policy objective of establishing a reliable, domestically available supply of this medical radioisotope by reviewing license applications for Mo-99 production facilities. Since 2013, the NRC has received two construction permit applications for radioisotope production facilities from SHINE and NWMI. The proposed facilities would irradiate low-enriched uranium targets in utilization facilities, such as SHINE's proposed accelerator-driven subcritical operating assemblies, then separate Mo-99 from other fission products in hot cells contained within a production facility. The NRC approved the construction permits for SHINE in February 2016, and for NWMI in May 2018.

There is interest in establishing additional non-power production and utilization facilities. Two companies, Eden Radiopharmaceutical and Atomic Alchemy, have engaged with NRC in pre-application activities for medical isotope production facilities. Abilene Christian University is also engaged in pre-application activities with the NRC for a molten salt research reactor. As of July 2021, Kairos plans to submit a construction permit application in Fall 2021 for a test reactor, a scaled version of its FHR design.

Both the SHINE and NWMI facilities described plans for integration into the Price-Anderson system in their NRC-approved construction permit applications. The SHINE application described plans to maintain financial protection of $1.5 million to cover all irradiation units in the facility and execute and maintain an indemnification agreement with the NRC. Similarly, the NWMI application described plans to maintain financial protection in the form of nuclear liability insurance prior to the facility becoming operational.

The NRC has determined that no changes are needed to the Price-Anderson Act to address non-power production and utilization facilities, like the SHINE and NWMI facilities. The staff notes, however, that the current requirements in 10 CFR Part 140 do not prescribe an amount of financial protection that would be adequate for non-reactor technologies such as the production and utilization facilities proposed by either the SHINE or NWMI. Consistent with the requirements of the Price-Anderson Act, NRC staff is considering the type of technology, size of facility, hazards associated with proposed operation, as well as the nature and purpose of the licensed activity to determine the appropriate type and amounts of financial protection for non-reactor technologies to be licensed under 10 CFR Part 50 for the purposes of producing medical radioisotopes such as Mo-99, including SHINE and NWMI. The NRC staff is considering ~~contemplating exploring~~ whether a rulemaking to revise Part 140 is necessary to address this gap for radioisotope production facilities, but it has not begun any formal work on a potential rulemaking.

Implications of the Use of Megawatts Electric and Megawatts Thermal Terminology in the Price-Anderson Act

As nuclear technologies have continued to evolve, the NRC has considered whether the Price-Anderson Act is written in a technology inclusive way to allow the NRC to regulate evolving nuclear technologies under the existing framework. In particular, the NRC has considered whether the Price-Anderson Act's reliance on the term megawatts electric (MW(e)), as opposed to megawatts thermal (MW(t)), in any way limits the NRC's ability to apply Price-Anderson Act financial protection and indemnity provisions on nuclear technologies that produce little or no electricity.[19]

To date, the Price-Anderson Act's use of MW(e) and MW(t) has not limited the NRC's ability to regulate a broad range of nuclear technologies. Within the Act, MW(e) or MW(t) are referenced in three provisions that address: (1) the amount of financial protection, (2) the limit of public liability, and (3) indemnification fees. The Act uses MW(e) in establishing the maximum amount of required financial protection for large commercial electric power reactors and a limit of public liability for large commercial electric power reactors. The Act uses MW(t) in establishing indemnification fees.

Amount of financial protection. The Price-Anderson Act establishes a specific standard for the required amount of financial protection for "facilities designed for producing substantial amounts of electricity and having a rated capacity of 100,000 electrical kilowatts or more" (42 U.S.C. 2210(b)(1)). A rated capacity of 100,000 electrical kW is equal to 100 MW(e). The Commission is given the discretion to determine the required amount for all other licensees: "the Commission may establish a lesser amount on the basis of criteria set forth in writing, which it may revise from time to time, taking into consideration such factors as the following: (A) the

[19] MW(e) is a term used to describe the electric energy produced by a facility, whereas MW(t) is a term used to describe the thermal energy produced by a facility. In short, due to conversion inefficiencies, electric energy produced by today's large nuclear reactors equates to approximately one third of the thermal energy produced.

costs and terms of private insurance, (B) the type, size, and location of the licensed activity and other factors pertaining to the hazard, and (C) the nature and purpose of the licensed activity" (42 U.S.C. 2210(b)(1)). This provision of the Act provides the NRC with the flexibility to establish alternative amounts of financial protection for facilities not designed for producing electricity of 100 MW(e) or more based on factors other than electrical generating capacity. Therefore, the NRC has determined that no changes are needed to the Act in order to apply financial protection requirements on nuclear technologies that do not produce electricity.

Limit of public liability. The Price-Anderson Act establishes a specific limit of public liability for "facilities designed for producing substantial amounts of electricity and having a rated capacity of 100,000 electrical kilowatts or more" (42 U.S.C. 2210(e)(1)(A)) and separate standards for the limit of public liability for all other licensees: "in the case of all other licensees of the Commission required to maintain financial protection under this section— (i) $500,000,000, together with the amount of financial protection required of the licensee; or (ii) if the amount of financial protection required of the licensee exceeds $60,000,000, $560,000,000 or the amount of financial protection required of the licensee, whichever amount is more" (42 U.S.C. 2210(e)(1)(C)). This provision of the Act provides the NRC with the flexibility to establish alternative limits of public liability for facilities not designed for producing electricity of 100 MW(e) or more based on factors other than electrical generating capacity. Therefore, the NRC has determined that no changes are needed to the Act in order to apply limits of public liability on nuclear technologies that are not designed for producing 100 MW(e) or more of electricity.

Indemnification fees. The Price-Anderson Act establishes an indemnification fee based on "thousand kilowatts of thermal energy capacity" for facilities licensed under 42 U.S.C. 2133 (i.e., production and utilization facilities for industrial or commercial purposes). A rating of 1,000 kW of thermal energy capacity is equivalent to 1 MW(t). The Commission may reduce the required indemnification fee for these facilities as the amount of required financial protection increases above $60 million and the level of government indemnification decreases below $500 million (42 U.S.C. 2210(f)). The Commission is given discretion to establish indemnification fees for other licensees, "taking into consideration such factors as (1) the type, size, and location of facility involved, and other factors pertaining to the hazard, and (2) the nature and purpose of the facility" (42 U.S.C. 2210(f)). This provision of the Act, and the use of thermal energy capacity rather than electrical generating capacity, provides the NRC with the flexibility to establish alternative indemnification fees for all types of facilities. Therefore, the NRC has determined that no changes are needed to the Act in order to apply appropriate indemnification fee requirements on a broad range of nuclear technologies.

Because the NRC has not identified aspects of the Price-Anderson Act related to the MW(e) and MW(t) terminology that would limit the NRC's ability to regulate a broad range of nuclear technologies, the NRC has determined that, at this time, no changes are needed to the Price-Anderson Act related to the use of the capacity rating terminology. Furthermore, the NRC will continue to evaluate progress in new nuclear technologies for consideration in future recommended modifications to the Price-Anderson Act.

2.2.1.2 Impact of Changes in Regulations on Safety Management of Nuclear Power Reactors

Since the 1998 Price-Anderson Act Report to Congress, the NRC has implemented regulations to address issues that affect public health and safety. In particular, several regulatory initiatives were undertaken to enhance security and emergency preparedness (EP), and thus help reduce the likelihood of a nuclear incident, following the terrorist events of September 11, 2001, and the

Fukushima Dai-ichi accident in March 2011. The following sections describe the regulatory actions by topic area and include a discussion of their impact on safety.

Post-September 11, 2001, Response

Following the terrorist events of September 11, 2001, the NRC issued a series of orders to ensure that nuclear power reactors and other licensed nuclear facilities continued to have effective security measures in place given the changing threat environment. Through these orders, the NRC supplemented the design basis threat (DBT) and mandated specific training enhancements, access authorization enhancements, and enhancements to defensive strategies, mitigative measures, and integrated response. Additionally, through generic communications, the NRC specified expectations for enhanced notifications to the NRC for certain security events or suspicious activities. The NRC issued the following security orders to licensees:

- EA-02-026, “Interim Compensatory Measures (ICM) Order,” issued February 25, 2002
- EA-02-261, “Access Authorization Order,” issued January 7, 2003
- EA-03-039, “Security Personnel Training and Qualification Requirements (Training) Order,” issued April 29, 2003
- EA-03-086, “Revised Design Basis Threat Order,” issued April 29, 2003

While the specifics of these enhancements are protected as Safeguards Information consistent with 10 CFR 73.21, the enhancements resulted in measures such as increased patrols; augmented security forces and capabilities; additional security posts; additional physical barriers; vehicle checks at greater standoff distances; enhanced coordination with law enforcement authorities; augmented security and emergency response training, equipment, and communication; and more restrictive site access controls for personnel including expanded, expedited, and more thorough employee background investigations.

The NRC proceeded to codify these orders~~,~~ and introduced further security requirements~~,~~ with a series of rulemaking activities. The specific details of the first, NRC’s DBT rule, published on March 19, 2007, are not publicly available.[20] But~~,~~ in general, the DBT outlines threats and adversary characteristics against which facilities must demonstrate they can defend. The DBT is based on realistic assessments of the tactics, techniques and procedures used by terrorist groups and organizations. The rule made generically applicable security requirements similar to those previously imposed by the NRC’s DBT Order (EA-03-086), based upon experience and insights gained by the NRC during implementation~~,~~ and redefined the level of security requirements necessary to ensure that the public health and safety and common defense and security are adequately protected.

The NRC built on the post-September 11, 2001, security orders, as well as the DBT rule, with the Power Reactor Security Requirements final rule published on March 27, 2009.[21] This rulemaking established and updated generically applicable security requirements similar to the requirements under the ICM Order (EA-02-026). Additionally, this rulemaking added several new requirements developed as a result of insights gained from implementation of the security

[20] “Design Basis Threat,” Federal Register, Vol. 72, No. 52, March 19, 2007, pp. 12705-12727.
[21] “Power Reactor Security Requirements,” Federal Register, Vol. 74, No. 58, March 27, 2009, pp. 13925-13993.

orders, review of site security plans, implementation of the enhanced baseline inspection program, and NRC evaluation of force-on-force exercises. This included enhanced measures for cyber security requirements, safety/security interface reviews, functional equivalency of the central and secondary alarm stations, uninterruptable backup power for detection and assessment equipment, and video image recording equipment. The rulemaking also updated the NRC's security regulatory framework for the licensing of new nuclear power plants and provided additional assurance of licensee capabilities to protect against the DBT.

On June 12, 2009, the NRC published an additional rule stemming from the ICM Order (EA-02-026) amending regulations to require applicants for new construction permits, new operating licenses that reference a new construction permit, new standard design certifications, renewal of any of the four existing design certifications if the design has not previously been amended to comply with the final rule, new standard design approvals, and some other applicants to perform a design-specific assessment of the effects of the impact of a large commercial aircraft.[22] The rule required applicants use realistic analyses to identify and incorporate design features and functional capabilities to show, with reduced use of operator actions, that either the reactor core remains cooled or the containment remains intact, and either spent fuel cooling or spent fuel pool integrity is maintained. In addition, these revisions required control changes to any design features or functional capabilities credited to show that a facility can withstand the effects of an aircraft impact. The rule helped ensure that new nuclear power reactor facilities are more inherently robust with regard to an aircraft impact. The rule provided an enhanced level of protection beyond that which is provided by the existing adequate protection requirements, which all operating power reactors are required to meet.

In addition to security requirements, the terrorist events of September 11, 2001, also spurred rulemaking activity related to EP. In 2011, the NRC published a final rule that codified certain voluntary protective measures and generically applicable requirements similar to those previously imposed by the ICM Order (EA-02-026).[23] In addition, the final rule amended other licensee emergency plan requirements based on a comprehensive review of the NRC's EP regulations and guidance. These new regulations enhanced a licensee's ability to prepare and take certain EP actions and protective measures in the event of a radiological emergency; addressed, in part, security-related EP issues identified after the terrorist events of September 11, 2001; clarified regulations to effect consistent emergency plan implementation among licensees; and modified certain EP requirements to be more effective and efficient.

Post-Fukushima Response

Following the Fukushima Dai-ichi accident on March 11, 2011, the NRC named a formal task force of senior NRC experts to examine information from the accident. The task force reviewed NRC regulations to determine whether any actions were needed to ensure the safety of U.S. nuclear power plants. The task force recommended a dozen broad enhancement areas for the NRC to consider. The NRC also created the Japan Lessons Learned Project Directorate to lead implementation of the task force recommendations. As a result of these activities, the NRC issued three orders:

[22] "Consideration of Aircraft Impacts for New Nuclear Power Reactors," Vol. 74, No. 112, June 12, 2009, pp. 28111-28417.
[23] "Enhancements to Emergency Preparedness Regulations," Vol. 76 No. 226, November 23, 2011, pp. 72559-72600.

- EA-12-049, “Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” issued March 12, 2012

- EA-12-051, “Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation,” issued March 12, 2012

- EA-13-109, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Conditions,” issued June 6, 2013

These orders implemented requirements that facilities obtain and protect additional emergency equipment, such as pumps and generators, to support all reactors at a given site simultaneously following a natural disaster; install enhanced equipment for monitoring water levels in each plant’s spent fuel pool; and improve or install emergency venting systems that can relieve pressure in the event of a serious accident (only for reactors with designs similar to the Fukushima Dai-ichi facility).

The NRC published the Mitigation of Beyond-Design-Basis Events final rule on August 9, 2019, which codified orders EA-12-049 and EA-12-051.[24] The rule included added requirements in 10 CFR 50.160 that nuclear facilities have sufficient procedures, strategies, and equipment to indefinitely cool their reactor core and spent fuel upon loss of power and ensured facilities can monitor spent fuel pool water levels. The rule also established regulatory requirements for an integrated response capability, including supporting requirements for command and control, drills, training, and documentation of changes, as well as enhanced onsite emergency response capabilities. Section 3.1.4, *U.S. Regulatory Response to Fukushima Dai-ichi*, discusses the NRC’s regulatory response to the Fukushima Dai-ichi disaster in more detail.

Other Relevant Rulemaking Activity

The NRC has also engaged in general rulemaking related to security issues outside of the direct response to the terrorist events of September 11, 2001, and the Fukushima Dai-ichi accident. Rulemakings that address security issues at commercial nuclear reactors or fuel cycle facilities are relevant to a discussion of the Price-Anderson Act, because they may impact the likelihood or severity of a nuclear accident that would be subject to Price-Anderson Act funding.

Relevant rulemakings include two rules related to staffing and access to nuclear power facilities. In March 2008, the NRC published regulations for Fitness for Duty (FFD) programs to update FFD requirements and enhance consistency with advances in other relevant Federal rules and guidelines, including the HHS Mandatory Guidelines for Federal Workplace Drug Testing Programs, and other Federal drug and alcohol testing programs that impose similar requirements on the private sector.[25] The rule required nuclear power plant licensees and other entities to strengthen the effectiveness of their FFD programs and required licensees and other entities to enhance consistency of FFD programs with NRC’s access authorization requirements for nuclear power plants. The revisions also required nuclear power plant licensees to ensure against worker fatigue adversely affecting public health and safety and the common defense and security by establishing clear and enforceable requirements for the management of worker fatigue. The final rule is intended to ensure~~d~~ that individuals who are subject to these regulations are trustworthy and reliable, as demonstrated by avoiding substance abuse; are not under the influence of drugs or alcohol while performing their duties; and are not mentally or

[24] “Mitigation of Beyond-Design-Basis Events,” Federal Register, Vol. 84, No. 154, August 9, 2019, pp. 39684-39722.
[25] “Fitness for Duty Programs,” Federal Register, Vol. 73, No. 62, March 31, 2008, pp. 16966-17235.

physically impaired from any other cause that would in any way adversely affect their ability to perform their duties safely and competently.

Additionally, in May 2012, the NRC published a final rule on the Requirements for Fingerprint-Based Criminal History Records Checks for Individuals Seeking Unescorted Access to Nonpower Reactors.[26] This rule required non-power reactor licensees to obtain fingerprint-based criminal history records checks before granting any individual unescorted access to their facilities. This action brought NRC's security requirements in line with Section 652 of the Energy Policy Act of 2005, which amended Section 149 of the Atomic Energy Act of 1954, to require fingerprinting and a Federal Bureau of Investigation identification and criminal history records check~~s~~ of any individual~~ls~~ permitted unescorted access to a utilization facility.

In March 2013, the NRC published the Physical Protection of Byproduct Material final rule, which established security requirements for the use and transport of category 1 and category 2 quantities of radioactive material.[27] The final rule applied to a wide range of NRC licensees, including some fuel cycle and reactor licensees. The rule provided reasonable assurance of preventing the theft or diversion of category 1 and category 2 quantities of radioactive material. The regulations also included security requirements for the transportation of irradiated reactor fuel that weighs 100 grams or less in net weight of irradiated fuel. The NRC considered these quantities of material to be risk significant and, therefore, to warrant additional protection.

Finally, the NRC published the Cyber Security Event Notification final rule in November 2015, which introduced cyber security regulations that govern nuclear power reactor licensees. The rule codified certain reporting activities associated with cyber security events contained in security advisories issued by the NRC.[28] This rule also established new cyber security event notification requirements that contribute to the NRC's analysis of the reliability and effectiveness of licensees' cyber security programs. The rule played an important role in efforts to provide high assurance that digital computer and communication systems and networks are adequately protected against cyber-attacks up to and including the DBT.

The result of these rulemakings was a net improvement to safety and decreased both the likelihood and severity of a nuclear accident that would be subject to Price-Anderson Act funding.

2.2.1.3 Lessons Learned from SE15

SE15 was a nuclear power plant exercise sponsored by the NRC, State of South Carolina, Duke Energy, the DOE, and FEMA. SE15 consisted of 5 days of exercises in July 2015 and September 2015. Prior to the exercise, the NRC, State of South Carolina, Duke Energy, and FEMA also held a preparatory "PAA and Other Funding Mechanisms Workshop" to discuss financial responsibilities of specific agencies or organizations associated with recovery from a nuclear power plant incident, including the Price-Anderson Act and Stafford Act.[29] Section I of the exercise, the operational phase, consisted of the H.B. Robinson Plant graded NRC exercise

[26] "Requirements for Fingerprint-Based Criminal History Records Checks for Individuals Seeking Unescorted Access to Non-Power Reactors (Research or Test Reactors)," Federal Register, Vol. 77, No. 92, May 11, 2012, pp. 27561-27574.
[27] "Physical Protection of Byproduct Material," Federal Register, Vol. 78, No. 53, March 19, 2013, pp. 16922–17022.
[28] "Cyber Security Event Notifications," Federal Register, Vol. 80, No. 211, November 2, 2015, pp. 67264-67277.
[29] Robert T. Stafford Disaster Relief and Emergency Assistance Act, Pub. L. 100-707, signed into law November 23, 1988; amended the Disaster Relief Act of 1974, Pub. L. 93-288. This act constitutes the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and FEMA programs.

on July 21, 2015, and an exercise with the South Carolina Emergency Management Division and county emergency management activities on July 22, 2015. Section II of the exercise, on July 23, 2015, consisted of a “Day Fourteen” Table Top Exercise (TTX) in Florence, SC focusing on transition from response to recovery at 14 days post incident. The TTX included four breakout sessions with one focusing on impacts to the Food and Agriculture sector. The SE15 exercise activity concluded with Section III, a Long-Term Recovery TTX from September 9, 2015, to September 10, 2015.

Activities and discussions related to the Price-Anderson Act spanned all three sections of the SE15 exercise. During Section I, the NRC incident response program provided training on recovery activities related to the Price-Anderson Act. Exercises during Section I also focused on oversight of licensee actions including reentry and recovery planning specific to the Price-Anderson Act. This continued into Sections II and III of the exercise, where the Price-Anderson Act was a major focus in discussions related to post-event response and recovery procedures (Southern Exposure 2015 After Action Report, 2016).

SE15 Successes

With regard to implementation of the Price-Anderson Act, the SE15 exercise resulted in several identifiable successes related to pre-event planning as well as coordination during and after the exercise. Notably, Price-Anderson Act liability claims and Price-Anderson Act gaps/overlaps with Stafford Act funding had been a major concern for participants. As a result, in preparing for the SE15 exercise, the NRC’s Office of Nuclear Security and Incident Response worked closely with ANI, Duke Energy, and FEMA to facilitate multiple pre-exercise workshops for interested stakeholders. While feedback suggested these workshops were successful in helping participants in understanding how the Price-Anderson Act’s provisions would be implemented after an event, questions regarding these gaps and overlaps between the Price-Anderson Act and Stafford Act persisted post-exercise (see SE15 Challenges). Throughout each section of the SE15 exercise, staff expertise in post-event Price-Anderson Act requirements provided to the Senior NRC official at the Unified Coordinating Group, and NRC recovery organization operations, helped the official to operate effectively as a member of the Unified Coordinating Group. This was critical given the importance of Price-Anderson Act insurance payments, both emergency financial assistance (EFA) and the longer traditional claims process, to State and local responders in addressing the needs of affected citizens.

During Day 14 TTX, the NRC successfully developed consensus around use of the National Disaster Recovery Framework to provide structure and basic organization to the recovery effort. Initial discussions took place about how post-event Price-Anderson Act activities could be incorporated into the economic aspects of the National Disaster Recovery Framework structure (DHS, 2016). Additionally, the NRC played a substantial role in facilitating accomplishments of post-event Price-Anderson Act responsibilities and ensuring Price-Anderson Act related information was provided to stakeholders.

SE15 Challenges

The most significant challenge resulting from the exercise was continued confusion regarding the roles of the Price-Anderson Act and the Stafford Act. Throughout the exercise there was a lack of awareness and understanding of response/recovery funding and damage compensation that could be available following a radiological event at a nuclear power plant. State and Federal partners who were not involved in the “PAA and Other Funding Mechanisms Workshop” prior to the exercise did not fully understand the purpose or requirements associated with the implementation of the Price-Anderson Act or the role of ANI. ANI representatives suggested that they would primarily coordinate with the licensee and the State on the establishment of claims centers in the vicinity of reception centers outside the contaminated zone.

The exercise also identified ~~that~~ a gap ~~exists~~ in information sharing among key organizations responsible for providing remedies to claimants. Due to existing legal restrictions, ANI is prohibited from sharing personally identifiable information on evacuated persons and their status as it applies to receiving EFA, which could possibly result in a duplication of data collection efforts on the parts of ANI, States, FEMA, and any other agencies providing financial assistance. During the exercise, responders who did not participate in the workshop believed ANI viewed itself as self-sufficient, not needing to communicate or coordinate with the State or other Federal agencies. This belief resulted in ~~unwarranted and uninformed~~ concern regarding the potential for FEMA Individual Assistance providing duplicative remedies to the same claimants receiving benefits from ANI.

During the exercise, development and implementation of the NRC's draft Plan for Distribution of Funds generated significant discussion. In the event of an incident which the Federal district court determines may result in public liability that exceeds the limit of public liability, the NRC is required by the Price-Anderson Act to submit a Plan for Distribution of Funds to the Federal district court, recommending how to categorize and prioritize claims for funds made available by Price-Anderson Act requirements. The court has the ultimate authority to decide how funding is to be distributed, after taking into consideration the NRC's and other proposed Plans for Distributions. Should funding for all needed response and recovery activities not be available under the Price-Anderson Act or Federal district court authorization, an additional request for funding would need to be submitted to Congress. During the exercise, observations were made by exercise participants that, based on the severity of the incident, not all classes of claimants described in the NRC's draft Plan for Distribution of Funds would be compensated before funding required by the Price-Anderson Act would be exhausted.

One topic of particular interest was the low priority placement of reimbursement of "reasonable additional State/local response costs associated with the evacuation" in the NRC's draft Plan for Distribution of Funds. The NRC staff participating in the exercise was able to explain to most participants that the language of the Price-Anderson Act -- in particular, language specifically directing that the NRC's Plan for Distribution of Funds include an allocation of amounts for "personal injury claims, property damage claims, and possible latent injury claims" -- places a greater priority on compensating individual damages (personal and property) than on reimbursing State/local response costs. The NRC staff participating in the exercise explained that the Price-Anderson Act provisions require a "compensation plan" to be submitted by the President to Congress for Price-Anderson Act claims that may exceed the limits of aggregate public liability provided for in the Price-Anderson Act. Therefore, all potentially valid classes of claimants should be reflected in the NRC's Plan for Distribution of Funds so that those not compensated by existing insurance layers may be clearly shown as an unmet need in excess of aggregate liability and elevated to Congress in a request for supplemental funding, per the Price-Anderson Act.

In addition, there was no specific class of claims in the draft Plan for Distribution of Funds for compensation of homeowners whose homes lose value as a result of the incident. This raised the question of whether the NRC Plan for Distribution of Funds should include compensation of homeowners for loss of property value as a cost covered under the Price-Anderson Act.

Finally, ANI, through the EFA program, will provide living expenses and lost wages to those directly affected by the evacuation. However, those who evacuate outside of the official order or who lose income indirectly may not be included in the EFA program. The existence of the Price-Anderson Act (and the EFA program) may preclude FEMA's ability to justify a major Stafford Act declaration that would potentially address the needs of these populations that are indirectly affected by the incident. As a result, exercise participants felt the difference between the State ordering an evacuation and the State ordering a relocation with regards to the Price-Anderson Act and the EFA warranted further discussions between the NRC and FEMA.

To address these challenges, and others identified during the SE15 exercise, an interagency improvement plan was developed that includes the following action items related to the Price-Anderson Act:

1. ANI, the NRC, FEMA and other interagency, State, local, and industry representatives should engage to define coordination and public information requirements relating to assistance under all mechanisms including the Price-Anderson Act and Stafford Act.

2. The NRC and FEMA should identify potential compensation for county operations that are unlikely to be compensated under the Price-Anderson Act.

3. The NRC should evaluate the possibility of including compensation of homeowners for loss of property value due to the incident in the NRC plan of distribution.

4. The NRC and FEMA should discuss the difference between the State ordering an evacuation and the State ordering relocation and how that may impact the EFA provided by ANI (Southern Exposure 2015 After Action Report, 2016).

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Updates on SE15 Action Items

Since the completion of the SE15 exercise, the NRC, FEMA, ANI, and State and local governments have worked toward clarifying these action items, and they have taken steps to address issues identified or help stakeholders better understand the purpose and role of the Price-Anderson Act.

A number of issues identified by SE15 participants, especially at the State and local level, were a result of a lack of familiarity with the Price-Anderson Act. A key component of the interagency response to the SE15 Price-Anderson Act action items is a FEMA sponsored and coordinated State Recovery Workshop held at State and local venues that includes a session by NRC and ANI on the Price-Anderson Act. FEMA organizes four to five of these workshops each year and to date 19 workshops have been held across the country. In these workshops the NRC and ANI discuss the limitations and processes for compensation from ANI as outlined by the Price-Anderson Act. FEMA has received positive feedback from the States that have participated in these workshops. In addition to the 19 workshops, there have also been 15 other events with Federal interagency partners (such as National Radiological Emergency Preparedness Conferences and Regional Assistance Committee meetings) where the NRC and ANI gave presentations on the Price-Anderson Act.

1. Coordination and public information requirements.

FEMA engaged partners, including NRC, ANI, and State and local governments, regarding coordination and public information requirements related to the Stafford Act and the Price-

Anderson Act. From this engagement FEMA developed the State Recovery Workshops to inform State, local and industry representatives on the key elements of the Price-Anderson Act and compensation through ANI. FEMA worked with these partners to schedule and conduct State Recovery Workshops that include Price-Anderson Act presentations by the NRC and ANI to clarify the provisions and requirements of the Price-Anderson Act and how it relates to the Stafford Act. A number of issues identified by SE15 participants, especially at the State and local level, were a result of a lack of familiarity with the Price-Anderson Act. The NRC continues to use the State Recovery Workshops to improve coordination and public information.

2. Compensation for county operations.

The NRC and FEMA were not able to identify potential compensation for county operations that are unlikely to be compensated under the Price-Anderson Act. As discussed above in Section 1.1.4.3, *Covered Costs,* those costs that are covered by the Price-Anderson Act derive from a series of statutory definitions and provisions. “Financial protection” under 42 U.S.C. 2014(k) of the Price-Anderson Act means “the ability to respond in damages for public liability and to meet the costs of investigating and defending claims and settling suits for such damages.” Further, “public liability” is defined in 42 U.S.C. 2014(w) of that Act, in part, as follows: “any legal liability arising out of or resulting from a nuclear incident or precautionary evacuation (including all reasonable additional costs incurred by a State, or a political subdivision of a State, in the course of responding to a nuclear incident or precautionary evacuation).” The Price-Anderson Act does not specifically address what is considered to be “reasonable additional costs” incurred by State or local governments. In the event of a nuclear incident, county governments would take safety- and security-related actions that are considered to be part of their baseline responsibilities and, therefore, not reimbursed under the Price-Anderson Act. To the extent that county governments incur costs to perform supplemental or additional actions beyond their baseline responsibilities, those activities may be reimbursable under the Price-Anderson Act. The NRC and FEMA continue to emphasize this approach in the State Recovery Workshops so that county government stakeholders have more clarity on what to expect in response to an incident.

3. Compensation for loss of property value.

The NRC evaluated the possibility of including compensation of homeowners for loss of property value due to the incident in the NRC Plan for Distribution of Funds during SE15. NRC’s input is developed and provided in its Plan for Distribution of Funds. 42 U.S.C. 2210(o)(1)(c) of the Price-Anderson Act calls on the Commission to submit to such district court a plan for the disposition of pending claims and for the distribution of remaining funds available. Such a plan shall include an allocation of appropriate amounts for personal injury claims, property damage claims, and possible latent injury claims which may not be discovered until a later time and shall include establishment of priorities between claimants and classes of claims, as necessary to insure the most equitable allocation of available funds.

Various provisions within the Price-Anderson Act help to define the scope of property damage claims covered by the Act. Specifically, the Price-Anderson Act applies to “any suit asserting public liability.” 42 U.S.C. 2014(hh). It defines “public liability” to mean, in part, “any legal liability arising out of or resulting from a nuclear incident.” 42 U.S.C. 2014(w). A “nuclear incident” refers to “any occurrence” that causes “bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties” of nuclear materials. 42 U.S.C. 2014(q). However, whether compensation for loss of property value is allowed under the Price-Anderson scheme is an issue ultimately resolved by “the law of the State in which the nuclear incident involved occurs, unless such law is inconsistent” with the Price-Anderson Act. 42 U.S.C. 2014(hh).

The current Price-Anderson scheme leaves to State tort law the basic question of whether a legally cognizable injury has occurred, the nature of the injuries to be compensated, the degree of proof required to establish the requisite causation, and the nature and extent of damages recoverable (except to the extent that the 1988 Amendments imposed a prohibition on the payment of punitive damages). Different States will have different legal standards associated with compensation for the loss of property value (e.g., some States will require physical harm to the claimant’s property to allow for compensation for loss of property value and some States will not).

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As referenced above, the Price-Anderson Act provides that the NRC’s Plan for Distribution of Funds shall include an allocation of amounts for “personal injury claims, property damage claims, and possible latent injury claims.” 42 U.S.C. 2210(o). Consistent with this direction, the staff prioritized personal injury and loss of property in its Plan for Distribution of Funds during SE15 and did not include potential monetary claims such as loss of property value. This interpretation has not changed.

4. Evacuations and relocations.

After SE15 and in developing the State Recovery Workshops the NRC and FEMA discussed the difference between the State ordering an evacuation and the State ordering relocation and how that may impact the Emergency Financial Assistance (EFA) provided by ANI. In short, ANI distributes EFA funds in the case of an evacuation. Those who evacuate outside of an official evacuation order or those who are ordered to relocate would be able to submit claims for compensation in accordance with the plan of distribution and thus may be reimbursed, but would not receive funds from ANI’s EFA. The limits of the EFA are discussed in the State Recovery Workshops so that the State decision makers understand the differences in their protective action decisions.

At this time, the NRC believes that issues raised by these action items do not require action from Congress.

2.2.2 Potential for Occurrences of Accidents

This section of this report discusses the state of knowledge of nuclear safety, including advancements in PRA. Specifically, this section covers the following topics:

- safety goals and objectives
- development and use of PRAs
- independent risk models for each nuclear plant
- assessment of the current programs and processes in regulating nuclear reactor risks

2.2.2.1 Safety Goals and Objectives

In 1986, the Commission issued its policy statement on safety goals for the operation of nuclear power plants titled “Safety Goals for the Operation of Nuclear Power Plants; Policy Statement”

(NRC, 1986). Since that time, including the years following the 1998 Price-Anderson Act Report to Congress, the two qualitative safety goals have remained unchanged and are as follows:

1. Individual members of the public should be provided a level of protection from the consequences of nuclear power plant operation such that individuals bear no significant additional risk to life and health.

2. Societal risks to life and health from nuclear power plant operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.

In its 1986 policy statement, the Commission also identified two quantitative objectives to be used in determining achievement of the qualitative safety goals. Similarly, since that time, the Commission's two quantitative objectives, or quantitative health objectives (QHOs), have remained unchanged and are as follows:

1. 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 (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.

2. The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.

Surrogate Risk Measures and Safety Goals

The safety goal policy statement incorporated discussion of surrogate subsidiary objectives that provide guidance for implementing the safety goals. Surrogate risk measures provide an approximate method for determining when the safety goals are met. Because surrogate risk measures are easier to compute than quantitative risk estimates they are useful when making certain types of risk-informed decisions.

The NRC uses two surrogate risk measures that are directly related to the safety goals: large early release frequency (LERF) and core damage frequency (CDF). LERF is the frequency of a rapid, unmitigated release of airborne fission products from the containment to the environment that occurs before effective implementation of offsite emergency response and protective actions, such that there is a potential for early health effects. LERF is the surrogate risk measure for individual prompt fatality risk (the first quantitative objective used to determine achievement of the safety goals). CDF is the surrogate risk measure for individual latent cancer fatality risk (the second quantitative objective used to determine achievement of the safety goals) (NUREG-2201).

With Commission support the staff developed and adopted the following subsidiary numerical objectives (SECY-89-102)[30]:

[30] Through a series of SECYs and associated Staff Requirements Memorandums issued during 1990, the Commission elected to include three risk metrics and associated quantitative goals in the design certification process: 1) a CDF of less than < 10^{-4} per reactor-year, 2) a large release frequency of < 10^{-6} per reactor-year, and 3) a conditional containment failure probability of less and 0.1 (SRM-SECY 89-102 and SRM-SECY-90-16).

- LERF < 10^{-5} per reactor-year (prompt fatality QHO)
- CDF < 10^{-4} per reactor-year (latent cancer fatality QHO)

Table 2-6 The Commission's safety goals for the operation of nuclear power plants

Qualitative Safety Goal	Associated QHO	Surrogate for QHO
Individual members of the public should be provided a level of protection from the consequences of nuclear power plant (NPP) operation such that individuals bear no significant additional risk to life and health.	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 (0.1 percent) of the sum of prompt fatality risks resulting from other accidents to which members of the U.S. population are generally exposed.	LERF <10^{-5} per reactor-year (individual prompt fatality QHO)
Societal risks to life and health from NPP operation should be comparable to or less than the risks of generating electricity by viable competing technologies and should not be a significant addition to other societal risks.	The risk to the population in the area near a nuclear power plant of cancer fatalities that might result from nuclear power plant operation should not exceed one-tenth of one percent (0.1 percent) of the sum of cancer fatality risks resulting from all other causes.	CDF < 10^{-4} per reactor-year (individual latent cancer fatality QHO)

Source: NRC, 2011, "The Structure and Evolution of Probabilistic Risk-Assessment and Risk-Informed Regulation."

2.2.2.2 Development and Use of PRAs

Introduction

This section discusses PRA methodologies and updates to PRA methodologies, use, and guidance. The following discussion on the development and use of PRAs is not intended to be an exhaustive analysis of all PRA studies published since 1998.

Overall, PRAs continue to be a useful decision-making tool in NRC's regulatory processes and the probability of core damage incidents remains low, at a probability of 0.05 over 10 years (NUREG-2201, Section C6).[31] Additionally, several technical studies of spent fuel pool accidents at decommissioning plants (most recently NUREG-1738) used PRAs to support development of a risk-informed technical basis for reviewing exemption requests and a regulatory framework for

[31] The probability of a core damage incident anywhere in the Unites States is about $5x10^{-3}$ per year. NUREG-2201 pg. 39.

integrated rulemaking. This is one of the many ways that PRAs have been used to inform decision-making and oversight to improve safety. Despite improvements in PRA technologies and methodologies, the levels of uncertainty in CDF and LERF PRA results can be high, and this is a continued focus area for the agency.

Definitions of Risk and PRAs

Risk is defined by three questions that consider (1) what can go wrong, (2) how likely is it, and (3) what are the consequences. These three questions allow the NRC to understand likely outcomes, sensitivities, areas of importance, system interactions, and areas of uncertainty, which can be used to identify risk-significant scenarios. The NRC uses PRAs to estimate risk by computing real numbers to determine what can go wrong, how likely it is, and the consequences.

PRAs provide a structured analytical process yielding both qualitative insights and quantitative estimates of risk by identifying potential sequences that can challenge system operations and lead to adverse events, estimating the likelihood of those sequences, and estimating the consequences associated with these sequences if they were to occur.

History of Development and Use of PRAs

The NRC has gradually introduced the use of PRA into its regulatory processes. Since the accident at TMI-2 in 1979, there was a shift in the Commission's focus to provide greater consideration of the risks from severe accidents in its decision-making. While the first study using PRA methodologies was conducted in 1975, it was not until the NRC required each plant to conduct an Individual Plant Examination (IPE) in 1988 (Generic Letter No. 88-20) that the PRA methodology was used more broadly as an evaluation tool. Between 1989 and 1995, the NRC issued five supplements to the IPE methodology contained in Generic Letter No. 88-20 to provide additional clarity and scope for IPEs.

Important milestones in PRA history include:

- NUREG-1150, which was published in 1990 and summarized the assessment of risk at five nuclear power plants;

- NRC's PRA Implementation Plan, which was published in 1994 and updated through 1999;

- NRC's PRA Policy Statement, which was published in 1995;

- the Risk-Informed Regulation Implementation Plan (RIRIP), which was published in 2000 and replaced the PRA implementation Plan; and

- the Risk-Informed and Performance-Based Plan (RPP), which was published in 2007 and replaced the RIRIP.

The PRA Policy Statement was important because it promoted regulatory stability and efficiency through consistent and predictable implementation of potential PRA applications. This formalized the Commission's commitment to risk-informed regulation through the expanded use of PRA.

These actions by NRC have led the nuclear industry and the NRC to develop PRAs and apply them to a variety of regulatory needs, such as maintenance rule risk assessments and risk-informed license amendments. In addition, the use of PRAs has provided a foundation for the nuclear industry to develop consensus codes and standards that have improved safety and streamlined the review of plant modifications.

Finally, these actions have led to the issuance of guidance documents for the development of PRAs that have improved consistency and applicability of PRAs and, ultimately, lead to better risk-informed decisions. These guidance documents include:

- Regulatory Guide (RG) 1.174, Revision 3,"An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" (2018)

- RG 1.200, Revision 3, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities"

- NUREG-1855, Revision 1, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making" (2017)

The NRC continues to routinely use risk information to complement traditional deterministic engineering approaches in several components of NRC's regulatory process, including licensing and certification, regulations and guidance, oversight, and operational experience. In 2017, the NRC published "Plans for Increasing Awareness of Risk Information in Decision-Making Activities" (RIDM) (SECY-17-0112). This policy issue described both NRC's challenges and plans to increase the use of RIDM. The NRC outlined a set of strategies aimed to increase awareness, knowledge, and support for risk-informed decision-making by evaluating and updating RIDM guidance documents; developing a graded approach for licensing reviews; and enhancing mandatory training requirements related to RIDM for managers and staff. Additionally, the policy issue encouraged communication enhancements on RIDM. Successful implementation of the strategies will benefit current and future licenses as PRAs become increasingly used (SECY-17-0112).

PRAs also support the environmental review required by 10 CFR Part 51, specifically the evaluation of severe accident mitigation alternatives (SAMAs) and severe accident mitigation design alternatives (SAMDAs). A SAMA or SAMDA analysis is a systematic search for potentially cost-beneficial enhancements to reduce nuclear power plant risk from severe accidents. While the scope of each analysis is similar, it is the timing of the analysis that differs between the two. The enhancements identified through this type of analysis have become known as SAMDAs when applied at the design stage or SAMAs when applied in the context of extending an existing license. The regulations in 10 CFR 51.30(d) require the staff to consider the costs and benefits of SAMDAs in a design certification environmental assessment (EA) and the bases for not incorporating SAMDAs in the design certification. For license renewal, 10 CFR 51.53(c)(3)(ii)(L) requires a consideration of the costs and benefits of SAMAs in an applicant's environmental report (ER) if the staff have not previously considered SAMAs in an environmental impact statement (EIS), in a related supplement, or in an EA. Conversely, a license renewal applicant for a plant that already has had a SAMA analysis considered by the NRC as part of an EIS, a supplement to an EIS, or an EA does not need to provide another

SAMA analysis in the subsequent or second license renewal ER. However, under 10 CFR 51.53(c)(3)(iv), the applicant's ER also must provide any new and significant information regarding the environmental impacts of license renewal, including any cost-benefit information with respect to a prior SAMA analysis. Under 10 CFR 51.54, a manufacturing applicant must address the costs and benefits of SAMDAs and the bases for not incorporating SAMDAs in the design. Finally, under 10 CFR 51.55, design certification applicants must address the costs and benefits of SAMDAs, and the bases for not incorporating SAMDAs in the design.

2.2.2.3 Independent Risk Models for Each Nuclear Plant

The NRC's and industry's experience with plant-specific PRAs led to the conclusion that systematic examinations of nuclear plants can identify plant-specific vulnerabilities to severe accidents that could be fixed with low-cost improvements. Thus, in 1988, the NRC created the IPE program that requested that licensees perform a plant examination to “identify plant-specific vulnerabilities” (Generic Letter 88-20). A second phase of the IPE program called the Individual Plant Examination of External Events (IPEEE) was commenced in 1991 (Generic Letter 88-20 Supplement 4). The NRC staff concluded that the perspectives and insights gained from the IPEEE program would be particularly useful in

- NRC and industry risk-informed regulatory initiatives and activities,
- guidance for future external events standards and PRAs, and
- prioritization of research to improve risk analysis methods.

The second phase of the IPE program that was focused on external events was completed in 1999 and led to important findings and regulatory action for seismic, fire, and other external and internal events.

Following the conclusion of the IPEEE study in 1999, the NRC published “Perspectives Gained from the Individual Plan Examination of External Events Program” in 2002 (NUREG-1742). This report summarized the overall strengths and weaknesses in the licensees' implementation of external event evaluation methodologies, which included PRAs and other techniques. For example, while some of the seismic analyses and most of the fire analyses were based on PRAs, most of the seismic, internal fires, and HFO external initiating events assessments were not based on PRAs. Only 15 percent of HFO-related IPEEE studies used a PRA (NUREG-1742). The NRC's report, NUREG-1742, found that

- seismic and fire events were important contributors to CDF for a majority of plants;
- the CDF contribution from seismic or fire events can, in some cases, approach, or even exceed, that from internal events;
- the CDF estimates varied over several orders of magnitude across the fleet of nuclear power plants; and
- the seismic PRA or SPRA results indicated that broad plant-to-plant variability arises from a combination of many factors, including differences in methods and analytical assumptions as well as variations in plant designs and locations.

The need to consider the risk posed by seismic and HFO events, has continued to gain in importance, especially following the accidents at the Fukushima Dai-ichi reactors in 2011.

The IPE and IPEEE programs and associated reports have led NRC to develop independent probabilistic risk models (Standardized Plant Analysis Risk or SPAR models) for each nuclear plant. The SPAR models consist of a standardized, plant-specific set of risk models that employ a standard approach for event-tree development as well as a standard approach for input data for initiating event frequencies, equipment performance, and human performance. These input data can be modified to be more plant- and event-specific when needed. To date, the NRC staff has completed 68 SPAR models for the operating reactors to represent all 94 commercial operating units and benchmarked them against licensee PRAs during the onsite quality assurance reviews of these models.

Accident Sequence Precursor (ASP) Program
The ASP Program is designed to systematically evaluate nuclear power plant operating experience to identify, document, and rank operational events to determine if they might increase the probability of core damage. The NRC publishes a report of ASP analyses each year, which provides an annual snapshot of trends in the number and type of precursors.

The NRC uses these models for

- developing risk-informed new or revised regulations;
- supporting the Accident Sequence Precursor (ASP) Program;
- informing inspection activities to focus on plant systems, operations, and human performance that are most important to safety; and
- assessing safety impacts under the Reactor Oversight Process (ROP) when mistakes occur or plant performance declines.

The use of PRAs in conjunction with the ASP Program and the ROP has provided NRC with much greater insight into the state of the nuclear power industry over the last 20 years, compared to prior decades.

Reactor Oversight Process (ROP)
The ROP was initiated in 2000 to formalize a revised program to inspect, measure, and assess the safety and security performance of operating commercial nuclear power plants, and to respond to any decline in performance. There are three key strategic performance areas that are addressed under the ROP: (1) reactor safety, (2) radiation safety, and (3) safeguards. The ROP provides a mechanism for the NRC to collect information about licensee performance, assess the information for its safety significance, and provide for appropriate licensee and NRC response.

2.2.2.4 Assessment of the Current Programs and Processes in Regulating Nuclear Reactor Risks

Since the last NRC Price-Anderson Act Report to Congress in 1998, the NRC has continued to develop processes and programs and revise existing operating procedures to ensure the security and safe operation of nuclear plants. These processes and programs include

- the IPE and IPEEE programs,
- the ROP,
- the Significance Determination Process (SDP), and
- the ASP Program.

Significance Determination Process (SDP)
The SDP is used by the NRC staff to evaluate inspection findings to determine their safety significance. The SDP involves assessing how the inspection findings affect the risk of a nuclear plant accident, either as a cause of the accident or the ability of plant safety systems or personnel to respond to the accident.

The NRC collects, assesses, and reports on information generated through these processes and programs. Information from these and other programs allows the NRC to assess the state of the U.S. nuclear power plant fleet on an ongoing basis.

While the IPE and IPEEE programs were completed in 1999, with the assessment report published in 2002 (NUREG-1742), these programs laid a strong foundation for the use of PRAs for a broader set of regulatory and oversight activities. The use of PRAs has helped the NRC focus on issues with higher risk-significance, thus more efficiently leveraging the NRC's resources to ensure the safe operation of the nuclear power plant fleet.

Information collected through the ROP annual self-assessment for 2019 shows that:

- The ROP was effective because it was implemented in accordance with applicable governance documents, met its intended outcomes, and met its goals of providing objective, risk-informed, understandable, and predictable oversight.
- NRC inspectors independently verified that commercial nuclear plants were operated safely and securely.
- The SDP continued to be an effective and efficient risk-informed process for focusing staff resources on issues that are potentially more risk-significant (SECY-20-0040).

During 2019, through the ROP, the NRC documented 422 inspection findings, with more than 99 percent of them determined to be of very low safety or security significance (SECY-20-0040).

The ASP Program systematically evaluates nuclear power plant operating activities and experiences to identify, document, and rank operational events by calculating the change in core damage probability due to those events. The ASP Program conducts a 10-year rolling trend analysis of all power plant events, and as of 2020 showed downward trends in six of the eight precursor categories, with the remaining two categories having a flat trend (ASP Program 2020 Annual Report). The 2020 program evaluation concludes that the current agency oversight programs and licensing activities remain effective, as shown by the decreasing 10-year trends.

These reports provide high confidence that the industry continues to meet the NRC's safety goal policy statement, and that the state of safety at U.S. nuclear plants continues to be high and improving.

2.2.3 Scientific Advances Over the Last 23 Years Related to Radiation Exposure Health Effects

Summarizing developments in radiation exposure health effects science is important for understanding potential Price-Anderson Act liabilities, because eligible claims for personal injury under the Price-Anderson Act likely will call upon scientific literature and expertise, as required by State laws. Both plaintiffs and defendants will draw upon the most recent scientific knowledge concerning the association of exposure to radiation and various health effects. Much new work on low-dose exposure has yielded findings that appear inconsistent with a threshold below which exposure is harmless or possibly beneficial. This section summarizes all relevant developments in radiation exposure health effects science in the last 23 years. These advances include a more refined and robust scientific understanding of the relationships between radiation exposure health effects and specific cancer types; new information on the exposures and health risk for protracted and fractionated sources of low-dose exposure (e.g., environmental, occupational, medical); an improved understanding of the steps in carcinogenesis; and advances in approaches to quantify radiation dose-response in relation to specific types of cancer and other serious radiation-related health outcomes (e.g., specific benign tumors, cataracts, and cardiovascular diseases). While studies about the health effects of radiation during the last 23 years have advanced our understanding and are important in the context of the Price-Anderson Act framework and potential liabilities for which the Price-Anderson Act was created, the report includes no recommendations to Congress as a result of these recent advances in knowledge about the health effects of radiation.

2.2.3.1 Overview

The past 23 years has been a period of rapid progress in the scientific understanding of radiation exposure health effects and associated outcomes.

As discussed further in Section 2.2.3.2, continuing follow-up of the Japanese atomic bomb survivors and other long-term epidemiological studies have contributed to a more refined understanding of how radiation-related dose-response relationships for individual cancer types and other serious diseases vary by age of exposure, attained age, time since exposure, sex, and for individual cancer types and sources of exposure (Berrington de Gonzalez et al., 2017). The availability of large dosimetry and medical records data sets, as well as pooling of data into very large cohorts, has enabled several large, new, statistically well-powered cohorts and nested case-control studies. These studies have been particularly informative for occupational and environmental sources of radiation exposure.

Although radiation exposure health effects from most sources have been on the decline for several decades, an increasing public health concern in recent decades has been the increased exposure from medical imaging and cancer radiotherapy treatment (Berrington de Gonzalez et al., 2017). Understanding the dose-response relationships of these exposures is a current topic of research interest.

Section 2.2.3.3 discusses advances from laboratory research. New methods in genomic and epigenomic research have begun to shed light on the biochemical mechanisms of radiation carcinogenesis and enabled a better classification of tumor types. Genomic research also has begun to identify biomarkers to distinguish tumors that are radiation-induced from those that are not. With more progress in these areas, it may become possible to provide science-based evidence linking specific radiation sources and individual cancers.

An important focus of epidemiologic research within the last decade has been to clarify dose-response relationships for low-dose exposures. This issue has practical implications for risk estimation and radiation protection standards. The preponderance of new epidemiological research on this topic supports the LNT hypothesis. However, the evidence is not definitive, and debate continues within the scientific community. The state of the science on radiation dose-response relationships for low-dose exposure is discussed further in Sections 2.2.3.4 and 2.2.3.5.

2.2.3.2 Epidemiological Research

During the last 23 years, epidemiological research has provided new findings about risks from environmental, occupational, and medical radiation exposure. Among these findings are risk estimates of various cancer types associated with different types and sources of radiation, dose-response relationships, temporal relationships between exposure and health effects, differences in susceptibility among population groups (e.g., children, women), and risks of secondary primary cancers among radiotherapy patients.

Epidemiological Studies of Environmental Sources of Exposure

The premier radiation epidemiology study remains the Life Span Study (LSS) of Japanese atomic bomb survivors (Berrington de Gonzalez et al., 2017). The LSS involves a cohort of more than 94,000 atomic bomb survivors and 27,000 unexposed individuals monitored since 1950. More than 22,500 cancers have been reported over nearly 75 years since detonation. The LSS continues to yield new findings and refinements to previous estimates. For example, risk estimates have been adjusted to control for smoking for the first time. Results of the LSS indicate that most types of cancer result from ionizing radiation exposure. The most recently updated estimates of the excess relative risk (ERR)[32] for males and females are 0.2 and 0.64 for total solid cancers at 1 Gy (100 rad), respectively. Expressed as excess absolute risk, the estimates are 42.9 and 54.7 cases per 10,000 person years at 1 Gy (100 rad). While risks for females are linear, the most recent follow-up of the LSS suggests that risk for males appears to increase with an upward curvature (i.e., greater ERR with greater exposure) for reasons that are not yet known. For the total cohort, risks decline with increasing age at exposure and attained age, but risks remain elevated 60 years after exposure. A statistically significant linear dose-response relationship is still evident for both males and females when the data are restricted to low-dose (i.e., <0.1 Gy or <10 rad) exposures only (Grant et al., 2017).

Epidemiological research has benefited in the past 23 years from computational and electronic information resources that enable the gathering, linkage, and analysis of very large data sets. For example, researchers in the UK used national cancer registry data to support a nested case-control study of natural background radiation in relation to childhood cancer risks based on 27,447 cases of childhood cancer. Radiation doses were estimated by linking mother's addresses at the time of birth and a national survey of natural background radiation (Kendall et al., 2013). This study found a significant dose-response relationship for gamma radiation and childhood leukemia consistent with the LSS.

Several other epidemiological studies have provided new findings about environmental radiation exposure health effects. Large case-control studies (Darby et al., 2005; Krewski et al., 2006) of residential radon exposure have provided lung cancer risk estimates for higher radon doses consistent with previous estimates (Lubin et al., 1997) based on radon-exposed underground

[32] ERR expresses the proportion of risk attributable solely to exposure. ERR is calculated by dividing the rate of disease in an exposed population by the rate of disease in an unexposed population, minus 1. ERR is reported for the unit rate of exposure for the exposed population (e.g., ERR at 1 gray (Gy) exposure).

miners. In addition, radon exposure and smoking evidently have a multiplicative effect on an exposed individual’s risk of lung cancer (Darby et al., 2005).

Continuing follow-up studies from the Chernobyl nuclear power accident provide new risk information for exposed populations. A study involving 12,514 Ukrainian children exposed to I-131 from environmental fallout due to the Chernobyl accident reported elevated thyroid cancer risks (Brenner et al., 2011) consistent with thyroid cancer estimates from children exposed in Belarus (Zablotska et al., 2011), as well as with thyroid cancer risks following childhood exposure in the Japanese atomic bomb survivors. Risks of leukemia for Chernobyl cleanup workers were much greater than estimates based on the LSS. However, these risk estimates should be considered uncertain due to limitations in radiation exposure health effects estimation (e.g., Jargin, 2014).

Childhood leukemia risks have been studied for populations living near nuclear power stations in Switzerland (Spycher et al., 2011), France (Sermage-Faure et al., 2012), and Germany (Kaatsch et al., 2008). Although these studies provided little or no evidence of a relationship between risk and distance from facilities, distance is a poor proxy for radiation exposure and study limitations included weak statistical power due to very low radiation exposure, the rarity of childhood leukemia, and potential confounding. A statistically significant dose-response relationship was reported for all solid cancers and leukemia in residents living on the Techa River downstream from the Mayak nuclear weapons facilities in the southern Urals of Russia (Krestinina et al, 2007, 2013). This population received decades of intermittent radioactive exposure due to accidental and intentional releases of radionuclides to air and water. Focusing on low exposure doses (i.e., <100 milligray (mGy) or <10,000 millirad (mrad)) only, Preston et al. (2016) reported that the risks of solid cancers and leukemia in the Techa River cohort were comparable to or slightly greater than risk estimates for a similar cohort of Japanese atomic bomb survivors.

Epidemiological Studies of Occupational Sources of Exposure

Large numbers of workers in nuclear, medical, mining, and various other industries receive protracted or intermittent radiation exposure. Overall, in recent years occupational exposures for most radiation workers are comparable to natural background exposure, after trending downward over several decades (Berrington de Gonzalez et al., 2017). Research interest in medical workers has grown in the last 23 years due to the increasing use of fluoroscopically guided procedures, positron emission tomography and cardiac nuclear medicine scans, and radiotherapy. In addition, occupational risk studies have received attention in recent years for their relevance to understanding dose-response relationships for protracted, low doses.

Several robust epidemiologic studies for nuclear workers have been made possible by the availability of individual dose reconstruction data and long-term follow-up for very large worker cohorts. For example, between 1948 and 1982 about 26,000 workers received protracted low-dose external gamma ray exposure at the Mayak nuclear weapons facilities in the former Soviet Union. Some workers in the Mayak plutonium-refining facility also received high doses on plutonium exposure due to a series of spills and accidents between 1948 and 1958. Epidemiological studies published in the last decade show elevated risks of lung, bone, leukemia, and liver cancer associated with plutonium exposure in both men and women. Risks tend to be higher for women. For reasons not yet known, the reported risk estimates are significantly lower than comparable estimates from the LSS of Japanese atomic bomb survivors.

A very large cohort of nuclear industry workers has been assembled by pooling high-quality dosimetry and mortality follow-up data from the UK, France, and the United States. The International Nuclear Workers Study (INWORKS) cohort includes more than 300,000 workers with more than 500 leukemia deaths and almost 18,000 solid cancer deaths (Hamra et al., 2016). The risks of leukemia and of total solid cancers is significantly elevated, and similar point estimates of risk are obtained using data for the full cohort and only those with low-dose (<100 mGy or 10,000 mrad) exposures.

The increasing use of fluoroscopically guided interventional procedures and nuclear medicine procedures has raised concerns about radiation exposure health effects to medical workers. Individual dose reconstruction for 110,000 members of the U.S. Radiological Technologists or USRT cohort was completed in 2014, leading to numerous epidemiological publications in recent years. Significant dose-response relationships were not seen for skin cancer or brain cancer. The only significant dose-response relationship found is for breast cancer in workers who started work before 1950 and received the highest doses (Preston et. al., 2016). Statistically significant associations were not found for women born in later years. The mean annual doses for women who began work before and after 1950 were 37 mGy (3,700 mrad) and 1.3 mGy (1,300 mrad), respectively.

Epidemiological Studies of Medical Sources of Exposure

Between 1980 and 2006, the number of CT scans performed on patients in the United States increased from 3 million to 80 million per year. The dose from individual procedures is low, but relatively high compared to other medical imaging technologies. In 2007, the average effective radiation dose per person from CT scans was 1.47 mSv (147 mrem), which was about 24 percent of the total effective dose per person (NCRP, 2009). This trend, as well as similar but smaller increases in other countries, has prompted several large cohort studies for patients, particularly children due to their greater sensitivity to radiation exposure, using high-quality dose information from medical records. A study involving 180,000 children and young adults in the UK showed significant dose-response relationships for leukemia and brain tumors that were comparable to risk estimates from the LSS (Pearce et al., 2012; Berrington de Gonzalez et al., 2016).

In recent decades, cancer treatment has become more successful resulting in more survivors and longer survival times. Therefore, patients treated with radiation are more likely to develop secondary primary cancers as a result of their treatment. This has been an increasing public health concern and topic of research during the last 23 years. A review (Berrington de Gonzalez et al., 2013) of 28 epidemiological studies with dose-response estimation for high-dose radiotherapy found little evidence of non-linearity, except for thyroid cancer, which showed a downward response curve above doses of 20 Gy (2,000 rd). This finding contradicts a hypothesized down-turn due to cell death at very high doses and potential deoxyribonucleic acid (DNA) repair between intermittent doses. However, the ERR from the radiotherapy exposure was estimated to be 5 to 10 times lower than the risk from acute exposure above 2 Gy (200 rd) experienced by Japanese atomic bomb survivors. Long term follow-up studies of cancer survivors treated with radiation therapy, and particularly newer radiation therapy modalities (such as proton therapy), are needed for further understanding of these risks.

2.2.3.3 Laboratory Research

Mechanisms of Carcinogenesis

The potential outcomes of ionizing radiation exposure to living cells include short-term cell death, biochemical changes that cause cancer, other effects, or no effects at all. In addition, affected cells may repair themselves though natural processes. A longstanding focus of laboratory research has been to gain a more refined understanding of these processes, particularly carcinogenesis and cell repair. In recent decades, research has identified direct and indirect mechanisms of carcinogenesis and associated mechanisms of tumor development, as well as the mechanisms of DNA repair (Berrington de Gonzalez et al., 2017). This knowledge sheds light on the relationships between cancer risk and various types of radiation (e.g., X-rays, neutrons, protons), different tissues, and different levels and patterns of exposure.

Radiation may directly damage DNA when ionizing energy damages nucleotide bases, causes single or double breaks within the double helix strands of DNA, or causes crosslinks between strands (National Research Council, 2006). Repair of damaged nucleotides and single strand breaks involve excision and replacement of damaged components. Double strand breaks are more difficult to repair and usually involve several processes or separate mechanisms (Berrington de Gonzalez et al., 2017).

Indirect DNA damage has become a more recent focus of research, in part because it is relevant to understanding secondary primary cancers that may occur in nontargeted tissues (West and Barnett, 2011). It is now understood that ionizing radiation can create reactive oxygen species and reactive nitrogen species, which may foster tumor development outside of the radiotherapy fields by inducing inflammation and stress responses and by stimulating the release of growth factors and other conducive biochemicals (Barnett et al., 2009).

Living cells can detect and repair most DNA damage caused by free radicals (e.g., reactive oxygen species, reactive nitric oxide species). However, damage that cannot be repaired typically leads to cell death. Damage that is unrepaired or repaired incorrectly may result in mutation, genetic instability, and possible carcinogenesis.

Researchers have identified and studied distinct biological functions that are hallmarks of cancer development and tumor growth. These include sustained proliferative signaling, evasion of growth suppressors, resistance of cell death, induction of angiogenesis, activation of invasion and metastasis, reprogramming of energy metabolism, and evasion of immune destruction (Hanahan and Weinberg, 2011). Enabling conditions of these hallmarks of cancer include genetic instability and inflammation.

Genetic Basis of Radiosensitivity

The development of new genetic sequencing and analysis methods has enabled new lines of study in radiation exposure health effects science. Goals of this research include a greater understanding of how radiation exposure leads to cancer, how cancer risk differs among individuals in a similarly exposed population, whether cancers can be attributed to specific radiation sources, and whether new markers of exposure can be used for early detection and treatment.

Epidemiological and other research showed that some people are more prone than the general population to radiation health effects (Berrington de Gonzalez et al., 2017). Genetic and laboratory research has contributed to a better understanding of this phenomenon. For example, certain specific heritable genetic mutations (e.g., ataxia telangiectasia) have been linked to radiation sensitivity, and other research has investigated the roles of such mutations in carcinogenesis (Deschavanne et al., 1986). The idea that traits of susceptibility to certain diseases and radiation sensitivity are attributable to rare, high-risk genetic variants is referred to as the common-disease, rare variant hypothesis (Schork et al., 2009).

An alternative to the common-disease, rare variant hypothesis is the common-disease, common variant hypothesis, which holds that such traits as radiosensitivity may arise from the combined effect of multiple common genetic variants that individually have lower likelihoods of expression (Schork et al., 2009; Berrington de Gonzalez et al., 2017). Multiple genetic pathways, such as DNA repair, radiation fibrogenesis, and oxidative stress, have been linked to radiosensitivity, which supports the common-disease, common variant hypothesis as a cause of varying degrees of radiosensitivity in the population (Barnett et al., 2009).

Within the past 10 years, it has become possible to rapidly analyze DNA samples for thousands of genetic markers. As a result, gene-linked diseases and other phenotypic traits are more easily associated with individual genetic sequences, and it is easier to conduct polygenic (i.e., multiple gene) analyses. For example, the genome-wide association study or GWAS approach has been used to identify hundreds of risk loci for various types of cancer (Chung and Chanock, 2011). Further research is needed to understand how radiation and other carcinogens interact with cancer-associated genes.

As the connection between the human genome and radiosensitivity becomes better understood, radiation exposure risk assessments may be able to account for variations in individual sensitivity in exposed populations.

Biomarkers as Radiation Signatures

For decades, researchers have sought molecular or biological indicators, or signatures, of radiation that could be used to distinguish radiation-induced tumors from those that are not radiation induced. Such signatures are expected because the unique physicochemical properties cause various carcinogens to interact with DNA in different ways (Behjati et al., 2016). Early efforts to identify radiation signatures involved the detection of large-scale chromosome abnormalities and, later, mutations in specific genes. Subsequent advances enabled researchers to more easily examine multiple genes at once, and consequently, investigate polygenic involvement. For example, Hadj-Hamou et al. (2011), identified a collection of 135 genes that in combination provide a high predictive signature of radiation-induced sarcomas. The relationship between this potential radiation signature and radiation dose is an area of continuing research (Berrington de Gonzalez et al., 2017).

Further progress to identify biological signatures of radiation-induced cancers has been made possible by significant methodological advances in the last 10 years. Methods and technologies collectively referred to as “next generation sequencing,” have vastly increased the speed of genomic sequencing. For example, an entire human genome can be sequenced within a single day (Behjati and Tarpey, 2013). Next generation sequencing has been instrumental to large new initiatives to sequence cancer genomes. Established in 2006 by the National Cancer Institute and the National Human Genome Research Institute of the National Institutes of Health, The Cancer Genome Atlas (TCGA) is a collaborative effort by 20 research institutions in the United States and Canada that has targeted 33 types of cancer for intensive genomic research. TCGA participates in the International Cancer Genome Consortium, which was established in 2007 to facilitate international cooperation and data sharing among cancer genome research programs in 16 countries.

TCGA research has revolutionized the classification of tumors and tumor subtypes based on distinct genetic alterations and has shed new light on the molecular pathways of carcinogenesis. In addition to genome sequencing and mutation analysis, next generation research is examining gene transcription and the epigenetic gene expression and regulation mechanism that affect tumor growth and development.

Although not a major research focus of TCGA and related efforts, scientists have begun using tumor genome data to identify biomarkers of radiation and other environmental carcinogens. A large-scale computational analysis of tumor genome data by Alexandrov et al. (2013) identified strong associations between tobacco and ultraviolet (UV) radiation exposure and distinct mutational patterns in cancers commonly associated with those carcinogens (e.g., between UV light and malignant melanomas). More recently, Behjati et al. (2016) showed that ionizing radiation generates distinctive mutational signatures that explain its carcinogenicity. In particular, the authors used the genomes of four tumor types (including osteosarcoma and breast cancer) to compare tumors attributed to radiotherapy to tumors of the same type in patients without therapeutic radiation exposure. Two radiation signatures were found to distinguish radiation-induced tumors irrespective of tumor type. The authors also validated their findings using data from previously published studies of prostate tumors in radiation exposed and unexposed patients (Behjati et al., 2016). However, this work has not been broadly replicated and research to identify distinctive mutational signatures of ionizing radiation is in its infancy.

2.2.3.4 Dose-response Relationships

Epidemiological studies beginning with the LSS have provided dose-response relationships for various types of cancer, radiation types and sources, and for demographic subgroups. A major research focus in the past 23 years has been the relationship between low-dose radiation exposure and human cancer. Most importantly, research has sought to clarify whether a low-dose threshold exists below which ionizing radiation can be considered to pose no risk of cancer, or whether there is no lower limit to the linear dose-response relationships seen at higher doses. This threshold issue has implications for estimating risks and setting radiation safety standards for low-dose sources that are either acute (e.g., low-dose medical imaging) or protracted (e.g., natural background radiation).

In the absence of data to conclusively identify a no-effects threshold, most national and international regulatory agencies have assumed an LNT hypothesis as a prudent basis for setting safety standards. This approach dates to 1956, when it was recommended by the National Academy of Sciences Committee on Biological Effects of Atomic Radiation (BEAR 1). In the decades since, the LNT hypothesis has been reexamined, most recently in 2006 by the National Research Council-published *Biological Effects of Ionizing Radiation VII* (BEIR VII) and in 2018 by the National Council on Radiation Protection in Commentary 27 (NCRP, 2018).

The BEIR VII report included a review of low-dose human and animal epidemiological studies to address the low-dose threshold issue. BEIR VII concluded that “the available scientific evidence is consistent with a linear dose-response relationship between ionizing radiation and the development of cancer in humans” (NRC, 2006). However, the epidemiological review was used to develop a dose and dose rate adjustment factor of 1.5 for protracted exposures below 100 mGy (10,000 mrad). This factor implies a one-third risk reduction for low-dose and protracted exposures (Berrington de Gonzalez et al., 2017). Since publication of BEIR VII, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) concluded that because dose-response relationships depend on many factors, “a reduction in the radiation-induced effects per unit dose at low doses and low dose rates relative to acute exposures with moderate or high doses cannot be expressed by a single value" (UNSCEAR, 2018).

Since the publication of BEIR VII in 2006, several large-scale epidemiological studies have reported LNT dose-response relationships for low-dose and protracted exposures. Preston et al. (2007) reported a significant linear dose-response relationship using LSS data restricted to doses below 100 mGy (10,000 mrad). Using similarly restricted data for the Techa River cohort, risk for all solid cancers and leukemia were comparable to or greater than low-dose risks estimated from the LSS data (Preston et al., 2016). Gilbert et al. (2013) reported comparable and statistically significant dose-response relationships for Mayak nuclear weapons facility workers when considering the full cohort and for those with doses below 200 mGy (20,000 mrad). In a similar comparison using the INWORKS cohort, researchers found a comparable dose-response relationship for doses restricted to 100 mGy (10,000 mrad) (Leuraud et al., 2015).

Despite the growing evidence, the LNT hypothesis remains a subject of dispute. For example, UNSCEAR concluded that available dose-response estimates for low-dose radiation are too uncertain "owing to both limited statistical power and limitations in other aspects such as residual confounding and inaccuracies in exposure assessment" (UNSCEAR, 2018).

In addition, Marcus (2015) petitioned the NRC to amend 10 CFR Part 20 ~~so as~~ to remove the presumption of the LNT hypothesis. The petition discusses several epidemiological studies as either not supporting or contradicting the LNT hypothesis. In addition, the petition argues that ionizing radiation provides beneficial effects at low doses that counter any harmful effects. The petitioner contends that U.S. and international nuclear regulatory agencies and various stakeholder groups are biased and support LNT for self-serving, non-scientific motives (e.g., continued funding). Although these views are not supported by most epidemiologists and other radiation scientists, the NRC continues to work diligently to make a determination regarding this petition.[33]

Commented [A16]: The staff should update the discussion of the petition for rulemaking regarding the Linear No Threshold model.

Commented [A17]: Please update this discussion and any related references to reflect denial of this petition. See *Federal Register* notice from 8/17/21.

To evaluate whether available epidemiological studies have been affected by biases, including dose uncertainty, confounding, and outcome misclassification, a systematic review and meta-analysis was performed for 26 relevant studies published from 2006 to 2017 (Berrington de Gonzalez et al., 2020; Hauptmann et al., 2020). This work found that although the epidemiological studies had several limitations, only a few positive studies were potentially biased, and the majority of studies supported reported positive risk estimates. The authors concluded that epidemiological research findings since 2006 "directly support excess cancer risks from low-dose ionizing radiation." In addition, the authors concluded that "the magnitude of the cancer risks from these low-dose radiation exposures was statistically compatible with the radiation dose-related cancer risks of the atomic bomb survivors" (Hauptmann et al. 2020).

2.2.3.5 Fractionated Exposure

Fractionated exposure occurs when a cumulative dose is received intermittently, such as from repeated radiotherapy treatments. Fractionated exposures are of interest to researchers to determine whether DNA repair, cell death, or other phenomena between exposures cause dose-response relationships to differ from other exposure patterns. A review of 28 relevant epidemiological studies concluded that risk per unit dose from high-dose fractionated exposures

[33] The NRC received two additional petitions on the same topic (PRM-20-29 and PRM-20-30); all three petitions were docketed using the same Docket ID (NRC-2015-0057).

were generally 5 to 10 times lower than reported for the Japanese atomic bomb survivors (Berrington de Gonzalez et al., 2013). Although cell death and DNA repair mechanisms were expected to cause a downward turn in the dose-response curves at very high doses, the review found no evidence of this even at doses greater than 60 Gy (6,000 rad). The only exception to this finding was a downward turn for thyroid cancer when doses were greater than 20 Gy (2,000 rad) (Berrington de Gonzalez et al., 2013).

2.3 Availability of Private Nuclear Liability Insurance

This section discusses various topics related to the availability of private nuclear liability insurance, including discussions on the following topics:

- Formation and Operation of the Nuclear Liability Insurance Pooling System
- Maximum Amount of Available Primary Insurance
- Operations of American Nuclear Insurers
- Nuclear Energy Liability Insurance and Special Features of the Policies
- Premium Development Under Nuclear Energy Liability Policies
- Terrorism Coverage
- Industry Credit Rating Plan
- Provisions of the Price-Anderson Act Important to Insurers
- Insurers' View on the Price-Anderson Act Continuation and the Future
- Nature of the Risks and Claims
- Summary of Claims Data
- American Nuclear Insurers' General Observations and Commentary on the Claims Data
- An Emerging Concern of the Nuclear Industry and Its Insurers: Conflicting Interpretations of Price-Anderson Act Preemption
- American Nuclear Insurers' Views on the Claims Landscape in the Absence of the Price-Anderson Act
- American Nuclear Insurers' Emergency Response Program
- Conclusion

As with previous versions of NRC's Price-Anderson Act Report to Congress, much of the discussion included in this Section (Section 2.3) was contributed by ANI (ANI, 2019).

2.3.1 Formation and Operation of the Nuclear Liability Insurance Pooling System

The Price-Anderson Act was enacted by Congress in 1957 for the dual purposes of providing financial protection to the public in the unlikely event of a catastrophic nuclear occurrence and removing barriers to private sector participation in the nuclear power industry resulting from the threat of potentially very significant liability claims in case of a nuclear event. The Act also established a legal framework for adjudicating potential liability claims.

Commercial power utilities were initially wary of the potential liabilities associated with nuclear technology that previously had been the sole province of the Federal Government. Congress eased these concerns by establishing a limit of public liability for a nuclear incident while also establishing requirements to assure adequate financial protection for the public. In addition to fostering the development of the commercial use of nuclear technology, Congress encouraged the private insurance industry to develop a means by which nuclear power plant operators could meet their financial protection responsibilities. The insurance industry chose the "pooling" technique. Pooling provides a way to secure large amounts of insurance capacity by spreading the risk of a small number of exposure units (i.e., reactors and other nuclear-related risks) over multiple insurance companies. ANI and its predecessor entities have served as the U.S. nuclear liability insurance pool since 1956. ANI currently comprises 23 member companies representing more than $300 billion in surplus from many of the world's largest and most recognizable insurance entities (ANI, 2019).

The pooling system initially provided an unprecedented level of insurance capacity,[34] while insurers were also wary of the risks associated with nuclear power. The Price-Anderson Act, by providing a limit of public liability and removing barriers to industry that facilitated the development of commercial nuclear power, became a catalyst for significant investment on the part of the insurance community and the nuclear industry to ensure the safe operation of the U.S. nuclear fleet and the protection of the public.

The nuclear risk is viewed by insurers as unique: an example of a risk that presents low frequency/high severity loss potential, with no significant loss history upon which to model the exposure. For most lines of insurance, insurers can spread their risk over a large, fairly stable premium base. This approach is particularly well suited where accidents are fairly common, and the severity of loss is moderate, such as with automobile insurance. Knowledge of loss frequency and severity allows insurers to develop risk premiums based on statistical probabilities. Such knowledge is not the case with the nuclear risk.

The probability of a catastrophic nuclear event is much lower than it is for other property and casualty risks, such as natural disasters. However, the consequences for a "worst case scenario" event would be unprecedented. This, coupled with a very small spread of risk and no significant loss experience, presents unique challenges for insurers. As actuarial assessments are not possible, insurers must rely on underwriting judgment to make decisions involving coverage and rates.

Due to these unique circumstances, the only practical way of insuring the nuclear liability risk is to insure the industry as a whole and to spread the risk over an extended period of time. This technique assumes that past losses will be paid, in part, out of future premiums; and that future losses will be paid, in part, out of premiums collected in the past. The Industry Credit

[34] The pooling system formed in 1956 offered $60 million in public liability limits. At that time, the largest amount of insurance capacity made available to other American industries had never exceeded $15 million.

Rating Plan (ICRP), developed by ANI and described in greater detail later in this report, is an equally unique mechanism that helps make the process effective. This concept requires a consistent supply of insurance capacity along with a stable premium base.

Insurance and the Act provide a financial protection framework consisting of two distinct layers. Operators of nuclear power plants are first required to maintain primary financial protection equal to the maximum amount of liability insurance available from private sources at reasonable cost and on reasonable terms. Currently, all commercial nuclear power plant operators satisfy their primary financial protection requirement with insurance policies issued by ANI. As of 2020, those policies provide a public liability limit of $450 million per site. In addition to the primary layer of financial protection, operators of nuclear power plants are required to participate in the secondary layer of financial protection. This secondary layer is a retrospectively rated program with premium charges deferred in whole or major part until public liability from a nuclear incident exceeds or appears likely to exceed the primary layer of financial protection required of the affected facility. If the secondary layer is triggered, the Act then requires all operators of nuclear power plants to pool funds that will be used to provide financial protection to the public. Retrospective premium amounts are set by the NRC on a per-reactor basis and adjusted every 5 years for inflation, most recently in 2018. As of 2020, the maximum amount of standard retrospective premium for each reactor is $137.609 million per incident. With 94 reactor units currently participating in the secondary layer, the total amount of funds available under the secondary layer of financial protection stands at $12.935 billion.

With the Act as its cornerstone, the commercial nuclear industry and the pool that insures it are poised to respond to the financial needs of the public in the event of a nuclear incident. When combining the primary financial protection requirement with the aggregate retrospective premiums under the secondary layer of financial protection program administered by ANI, the Act provides for funds totaling approximately $13.4 billion as of 2020 that can be made available in response to a nuclear incident.

2.3.2 Maximum Amount of Available Primary Insurance

The Act requires power reactor licensees to maintain primary financial protection equal to the maximum amount of liability insurance available from private sources. As noted throughout this report, ANI currently provides primary nuclear liability limits up to $450 million, as well as administers the secondary layer of financial protection program.

The requirement in the Act for power reactor licensees to demonstrate evidence of financial protection in an amount equal to the maximum amount of liability insurance available from private sources has been essential in terms of enabling insurers to develop and sustain quality insurance capacity. Evidence of this lies in the stability of limits, price, and coverage that insurers historically have provided for what is viewed as a special line of business. After the TMI accident in 1979, nuclear liability limits actually increased from $140 million to $160 million ($563 million in 2019$) and prices rose only modestly. Despite disruptions in the marketplace affecting conventional commercial coverages, the availability of third-party nuclear liability insurance has remained consistent, with limits increasing regularly over the years independent of market cycles. In the mid-1980s, for example, when liability insurance became unavailable at almost any price for many commercial insurance buyers, nuclear liability insurers continued to provide a stable market for their limited customer base. Following the events of September 11, 2001, when uncertainty again plagued the commercial insurance markets, nuclear liability insurance limits increased by 50 percent from $200 million to $300 million ($417 million in 2019$). ~~In spite of~~ Despite the challenges facing the financial markets in 2008-2010, ANI's members maintained their commitment to the nuclear risk, with limits of $300 million and another increase in 2010 to $375 million ($440 million in 2019$). ANI last increased its maximum nuclear liability insurance policy limits from $375 million to $450 million in 2017.

The Price-Anderson Act establishes a unique financial protection model. As mentioned earlier, the limitation on aggregate public liability is equal to the combined total of primary and secondary financial protection – currently $13.4 billion ($450 million primary + $12.935 billion secondary). However, as reactors are permanently shut down and exempted from the Act's requirements, the total amount of available financial protection will be reduced. Although the reductions will be partially offset by periodic increases in the primary insurance limit and inflationary adjustments in the maximum retrospective premium payable in the secondary layer, the net impact of continued reactor shutdowns will be a reduction in the total limits available to respond to public liability claims. This assumes no additional reactors joining the existing fleet other than Georgia Power's Vogtle Units 3 and 4, which are currently under construction as of 2020.

Listed below in Table 2-7 are the countries with the highest amounts of non-governmental funds available for a nuclear incident.[35] To provide context to the amount of funds available, the table also shows the GDP of each country (World Bank Group, 2021) and the number of operating reactors in each country (World Nuclear Association, 2020 a). With the exception of Germany, these countries do not have programs similar to the secondary layer of financial protection program in the United States that applies in excess of the primary insurance limit. As is evident, the $13.4 billion in available funds under the Act far exceeds all other global nuclear regimes. In fact, the sum of funds from non-governmental sources in the United States surpasses the sum of the next ten highest liability regimes in the world combined.

Table 2-7 Non-governmental sources of funds available for a nuclear incident

Country	Funds in U.S. Dollars (2019$)*	Source (ANI, 2020)	GDP in U.S. Dollars (2019$)	Number of Operating Reactors
United States	13.385 Billion	The Price-Anderson Act	21,433 Billion	94
Germany	2.806 Billion	The Atomic Energy Act, Section 13(3) (most recently updated in 2002)	3,861 Billion	17
Sweden	1.385 Billion	Nuclear Liability Act (1968:45), Section 17, as amended by SFS 1988:875	531 Billion	6
Belgium	1.347 Billion	State Aid SA.46602 (2017/N)	533 Billion	7

[35] See Section 3.2.2, *Background on Use of Government Indemnification or Other Government Funding Mechanisms in Other Related International Programs*, for a discussion of governmental funding mechanisms.

Country	Funds in U.S. Dollars (2019$)*	Source (ANI, 2020)	GDP in U.S. Dollars (2019$)	Number of Operating Reactors
Netherlands	1.347 Billion	Subsection 5(2) of the Nuclear Incidents Third Party Liability Act of 1979, as amended in 1991; A Royal Decree (No. 577) of November 14, 1997, increased the maximum amount of operator's liability to its current amount	907 Billion	1
Japan	1.098 Billion	Act on Compensation for Nuclear Damage, Section 7 (Act No. 147 of 1961, as amended by Act 19 of April 17, 2009)	5,082 Billion	33
Switzerland	0.994 Billion	Swiss Federal Council adopted a revision of the Nuclear Energy Third Party Liability Ordinance on March 25, 2015	703 Billion	4
Finland	0.831 Billion	The Nuclear Liability Act (No. 484/1972, as amended by Acts Nos. 128/1977, 388/1986, 820/1989, 588/1994, 89/1999, 416/2002, 493/2005 and 581/2011).	269 Billion	4
France	0.786 Billion	Decree No. 2016-333 of March 21, 2016, implementing Article 597-28 of the French Environmental Code	2,716 Billion	56

Country	Funds in U.S. Dollars (2019$)*	Source (ANI, 2020)	GDP in U.S. Dollars (2019$)	Number of Operating Reactors
Spain	0.786 Billion	BOE-A-2011-9279, Article 4(b)	1,393 Billion	7
Canada	0.631 Billion	Nuclear Liability and Compensation Act, Section 24(1)(c) (S.C. 2015, c.4, s.120)	1,736 Billion	19

** Based on May 13, 2019, exchange rates*

It is also worth noting that while China has the world's most rapidly expanding fleet of nuclear reactors and is on course to become the world's second largest fleet, its liability regime affords only $48 million in non-governmental funds available to respond to a nuclear incident (State Council of the People's Republic of China, 2007).

2.3.3 Operations of American Nuclear Insurers

ANI is a voluntary, unincorporated joint underwriting association that acts as managing agent for its member companies. Its Board of Directors comprises representatives from its member companies. Several Committees provide input in areas including underwriting, claims, and finance.

The association writes nuclear liability insurance for nuclear facilities in the United States. ANI issues policies, collects premiums, handles claims, and otherwise administers the program. Technically, however, ANI is not an insurance company. The insurance is provided by participating member insurance companies, which each receive a pro rata share of the premiums collected. ANI also provides reinsurance for foreign-based nuclear facilities through reinsurance arrangements with similar pools outside the United States.

ANI operates four different underwriting programs: Domestic Liability, Foreign Liability and Property, Property, and Builders Risk. In 2019, ANI's members totaled 23, all of which participate in the domestic liability program. Participation in all other pools is optional. At the time of the 1998 Price-Anderson Act Report to Congress, ANI's members totaled 58, of which 47 participated in the nuclear liability program. Because ANI is a voluntary joint underwriting program, participation in which is predicated on satisfying and maintaining membership criteria that ensure financial strength, ANI's membership fluctuates over time for various reasons. These reasons can include strategic business issues at member company corporate levels, mergers and acquisitions within the insurance industry that consolidate member companies, failure to maintain ANI membership criteria, and reactions to developments in the nuclear liability insurance market, among others. For example, in the wake of the September 11, 2001, terrorist incidents, several member companies withdrew from ANI due to concerns about the terrorism risk at nuclear facilities, which is covered under ANI's policies. Similarly, a member withdrew in the aftermath of the Fukushima Dai-ichi nuclear accident.[36] Membership also has fluctuated in response to changes in ANI's business model. In the late 1990s, ANI exited the direct property business for nuclear facilities, a role now filled by the industry mutual Nuclear Electric Insurers Limited (NEIL). At the time, the liability and property risks were combined in a single ANI pool. Participation in that combined pool was mandatory for membership, while other pools, such as reinsurance of foreign pools, was optional. ANI later bifurcated this combined pool into two (liability and property) and required members to participate in the liability pool only as a condition of membership. Some members that previously had participated only in the property business elected to exit the association. ANI also has added members over time, including most recently in 2017, when three new member companies joined the association. In the past, ANI comprised a larger number of members with smaller, fractional shares of the risk. Today, ANI's membership comprises many of the largest, most sophisticated, and most financially sound insurers and reinsurers doing business in the United States. Moreover, the members have increased their retention of the risk and hold much more significant stakes in the business (discussed more below).

The first nuclear energy liability policy was issued on June 1, 1957, to a transporter of nuclear material. On September 1, 1958, ANI issued its first policy to a nuclear reactor operator. At that time, the maximum nuclear liability limit written by insurers was $60 million ($530 million in 2019$). This primary limit has been increased over the years and currently stands at $450 million. Table 2-8 shows the limits of liability written by ANI over time.

Table 2-8 History of maximum primary nuclear liability insurance available from 1957-2019 (ANI, 2019)

Year	Liability limits ($ in millions)	Increase over prior limit	$ in millions of 2019$	Increase over prior limit (2019$)
1957	60		546	
1966	74	23.3%	584	6.96%
1969	82	10.8%	571	-2.23%
1972	95	15.8%	581	1.75%
1974	110	15.8%	570	-1.89%
1975	125	13.6%	594	4.21%
1977	140	12.0%	591	-0.51%

[36] Although the Fukushima Dai-ichi nuclear accident was not an insured loss and, as a result, did not directly impact ANI's business, ANI's membership was deeply concerned by the repercussions and potential for similar losses at a U.S. nuclear facility where ANI's policies would respond. ANI staff monitored the Fukushima Dai-ichi event closely, including daily briefings with NEI and other industry sources, and provided their members with regular updates regarding the event and ongoing education regarding the ensuing post-Fukushima safety enhancements instituted by the U.S. nuclear fleet under guidance from the NRC. Although one member of ANI withdrew in the aftermath of Fukushima, premiums and reserves did not change because of the Fukushima Dai-ichi event. In fact, ANI significantly increased its liability limits in 2017 supported entirely by the membership.

Year	Liability limits ($ in millions)	Increase over prior limit	$ in millions of 2019$	Increase over prior limit (2019$)
1979	160	14.3%	563	-4.74%
1988	200	25.0%	432	-23.27%
2003	300	50.0%	417	-3.47%
2010	375	25.0%	440	5.52%
2017-present	450	20.0%	450	2.27%

Each member company participating in a particular ANI program signs a declaration of participation in which it agrees to pay a specified portion of insured losses, up to a specified maximum per policy. Each insurer then receives the commensurate portion of the premiums, after allowance for expenses. The obligation of each member company is several and not joint, meaning no member insurer is liable for the default of any other member company with respect to payment of insured losses.

Although there are 23 participating member insurer companies in the domestic liability program, only a subset is listed on the policy as subscribers (i.e., as insurers). ANI has chosen to allow only those participants that are admitted as insurers in all 51 U.S. jurisdictions as subscribers.[37] These insurers subscribe to respective portions of the insurance under each policy issued by ANI. In case of insured loss, each subscriber is liable for its proportion of the loss as specified in the policy. Insured losses, however, are spread among all 23 participating members in the domestic liability program. The declaration of participation, as referred to previously, and ANI's Constitution provide that premiums and the responsibility for payment of insured losses are allocated among all the participating members of the program – not just the subscribing members named in the policy. This arrangement allows a member company that has not been admitted into all the jurisdictions to participate in all the business of the program. Essentially, the subscribing companies are reinsured by the non-subscribing members.

In 2019, ANI's members retained 66 percent of the liability exposure under each policy, ceded 27.1 percent to NEIL, and ceded 6.9 percent to reinsurers around the world. ANI's reinsurers include similar pooling operations in several foreign countries – each comprising their own native group of member insurance companies. This approach allows ANI to use the resources of the worldwide insurance community and spread the uncertainties of the risk over a very large financial base.

At the time of the 1998 Price-Anderson Act Report to Congress, ANI's members retained 31.1 percent of the liability exposure under each policy and ceded 68.9 percent to reinsurers around the world. The change in the relative amount of the risk held by ANI's members and ceded to

[37] Under the laws of the several States, unless an insurer has been licensed by a given State as an admitted insurer, the insurer may not conduct business (except by mail) in that State. A licensed insurer whose charter was issued by that State (that is, a domiciled company) is an admitted insurer in that State. For an insurer to be licensed (and thereby to be admitted to conduct business) in a State other than where its charter was issued, the insurer must satisfy that State as to adequacy of capitalization, degree of financial solidity, integrity of business practices, and related matters. Once an insurer has been admitted into a State, the insurer can issue policies in that State subject to the insurance regulatory laws of that State.

reinsurers since the NRC's last Price-Anderson Act Report to Congress is the result of ANI's evolving membership, which has condensed, while member engagement has intensified, as large, sophisticated insurers became more comfortable with the nuclear liability risk. This trend mirrors the experience of nuclear insurance pools around the world. As a result, members are retaining a greater amount of the risk and ceding less to reinsurers. Since 1998, ANI has increased the limits of insurance three times. At the time of each limit increase, ANI's members and reinsurers individually assess their appetite for the risk. Many factors are considered in determining an insurer's or reinsurer's nuclear risk appetite and ANI is not necessarily privy to them. NEIL assumed a 45-percent share of the liability exposure from ANI from 1999 through 2002. When ANI increased limits by 50 percent in 2003 (from $200 million to $300 million), NEIL chose to provide approximately the same capacity as in 2002, resulting in a decrease in their percentage share. In 2017, ANI raised its nuclear liability limits 20 percent (from $375 million to $450 million) and its members retained 100 percent of the increase. This increase in ANI member retention results in a reduction in the share of participation by ANI's reinsurers. How future limit increases will be funded will depend on market forces and strategic decision-making by ANI and its members at the time.

Table 2-9 summarizes the types of nuclear liability policies issued by ANI as of January 1, 2019, including both nuclear liability policies issued to NRC licensees for purposes of satisfying Price-Anderson Act financial protection requirements and other nuclear policies voluntarily purchased by the nuclear industry.

Table 2-9 Types of facilities and related operations insured by American Nuclear Insurers in the United States (ANI, 2019)

Type of Risk	Number of Policies
Operating Power Reactors Sites*	58
Non-power Reactors, including University Reactors	10
Fuel Fabrication/Enrichment Facilities	5
Waste Disposal/Storage Facilities	2
Miscellaneous Nuclear Facilities, including Nuclear Laundries and Research Laboratories	24
Discontinued/Decommissioned Facilities Operations	18
Suppliers and Transporters	166

** There were 98 reactor units operating at these 58 sites*

2.3.4 Nuclear Energy Liability Insurance and Special Features of the Policies

There are four basic policies written by ANI covering nuclear liability exposures in the United States. Three of these (the Facility Form Policy, the Secondary Financial Protection Master Policy, and the Master Worker Policy) are used by nuclear facility licensees to satisfy their financial protection requirements under the Price-Anderson Act. The remaining policy form (the Suppliers and Transporters (S&T) Policy) is not used to satisfy financial protection requirements under the Price-Anderson Act and instead is issued to entities that provide products or services to nuclear facilities. Because there is no nexus between the Price-Anderson Act framework and the Supplier's and Transporter's Policy, policy provisions are not summarized below for this type of ANI policy.

The brief descriptions that follow do not summarize all the policy provisions or state precisely the terms used in those provisions~~In the brief descriptions that follow, no effort is made to summarize all the policy provisions or to state precisely any of the terms~~. Certain provisions are highlighted and paraphrased for general information purposes only.

2.3.4.1 The Facility Form Policy

The Facility Form policy is issued to licensees of nuclear production or utilization facilities, including the operators of nuclear power reactors. This policy has been used by reactor licensees as evidence of the primary financial protection required under Subsections 170(a) and (b) of the Act. ANI currently provides coverage limits up to $450 million under this policy.

- **Definition of Insured** – A key feature of the Facility Form policy is its broad omnibus definition of insured, which, in addition to the named insured, includes any other person or organization that may have contributed to the cause of a nuclear incident. The only exception to the definition of insured is the U.S. Government or any of its agencies. The definition of insured is broader than in typical property and casualty policies to give effect to the channeling aspects of the Act. The definition is consistent with the omnibus application of indemnity in Subsection 170(c) of the Act, in which the NRC agrees to indemnify the licensee and other "persons indemnified" for public liability claims arising out of a nuclear incident.

- **Policy Period and Limit** – Once issued, the policy remains in effect continuously, subject to annual payments of premium, until canceled or terminated by exhaustion of its limit of public liability. Facility Form policies remain in effect throughout the decommissioning phase of a nuclear plant, and beyond decommissioning in the instances where the used fuel remains onsite at an ISFSI. The policy contains a single aggregate limit of public liability for the entire policy period. The limit is automatically reduced by payments for claims or claims expense. If reduced by payments for claims or claims expense, the limit can be reinstated by ANI at its discretion. Reinstatements have generally been approved by ANI.

- **Waiver of Defenses** – The policy provides that, in the event of an ENO,[38] insurers and insureds waive most standard legal defenses normally available to them under State law.[39] The effect of this provision is to create strict liability for a severe nuclear event. To be compensated under such circumstances, claimants would have to show only that the injury or damage suffered was caused by the release of nuclear material from the insured facility. Fault on the part of a particular defendant need not be established in these circumstances. The provision helps to ensure prompt compensation of accident victims.

[38] This term is defined in 42 U.S.C. 2014(j). Without citing all the specifics, the term refers to a significant nuclear incident that results in severe offsite consequences.

[39] The legal defenses waived in the policy include (i) any issue or defense as to the conduct of the claimant or the fault of the insured, (ii) any issue or defense as to charitable or governmental immunity and (iii) any issue or defense based on any statute of limitations if suit is instituted within 3 years from the date on which the claimant first knew, or reasonably could have known, of their bodily injury or property damage and the cause thereof.

- **Scope of Coverage** – The policy terms obligate insurers to pay on behalf of the insured all sums (up to the policy limit) that the insured becomes legally obligated to pay as "covered damages" because of "bodily injury" or "property damage," or as "covered environmental cleanup costs" because of "environmental damage." The coverage afforded by the policy applies only to loss caused during the policy period by the "nuclear energy hazard," if such claims are brought within 10 years of policy cancelation or termination. The terms in quotes are specifically defined in the policy. The definition of "nuclear energy hazard" included in the policy is not the same as the definition of "nuclear incident" in the Price-Anderson Act. Since coverage is limited to liability for bodily injury or property damage caused solely by the "nuclear energy hazard," the definition of this term is highlighted here:

  > "nuclear energy hazard" means the radioactive, toxic, explosive, or other hazardous properties of nuclear material...

  The definition further specifies in paraphrased form that the insurance applies only to nuclear material that: (i) is at the facility described in the policy declarations, (ii) has been discharged or dispersed therefrom without intent to relinquish possession thereof to any person or organization, or (iii) is in transit to or from the insured facility.

  The coverage under the ANI policy is limited to the "nuclear energy hazard" and does not eliminate the need for conventional liability insurance.

- **Insured Shipments** – The policy also affords coverage for liability that arises out of an "insured shipment." This coverage provides the insured with protection against public liability claims that are brought as a result of an incident involving specified categories of nuclear material while in transit.

- **Covered Environmental Cleanup Costs** – Coverage for "covered environmental cleanup costs" was added to the policy in 1990.

- "Covered environmental cleanup costs" means only those environmental cleanup costs that are incurred directly for monitoring, testing for, cleaning up, neutralizing, or containing environmental damage as a result of an ENO or a transportation incident; but covered environmental cleanup costs do not include onsite cleanup costs.

  "Transportation incident" is defined in the policy and is highlighted here:

  > "transportation incident" means a discharge or dispersal of nuclear material from an insured shipment caused by collision or upset of the transporting conveyance, or an accident that breaks open, punctures or ruptures the shipping containers or containment thereon; but only if both the discharge or dispersal and the collision, upset or accident take place away from any nuclear facility and away from any disposal site, and both occur in the course of the transportation, including handling and temporary storage incidental thereto.

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Cleanup costs that stem from an “extraordinary nuclear occurrence” or a “transportation incident” can be tied to clearly identifiable events. Insurers are able to extend coverage for cleanup costs under these circumstances.

Coverage under the nuclear liability policy is intended to apply only to damages that are awarded in an action at law because of bodily injury or property damage sustained by members of the offsite public, which is consistent with the financial protection requirements imposed by the Act.

- **Additional Costs Incurred by a State or Municipality** – In 1994, coverage was added (specifically under Facility Form policies issued to power reactor licensees) for the additional costs incurred by a State or municipality in response to evacuating the public during a severe nuclear incident. The coverage provides for a direct reimbursement for the added costs incurred in providing emergency food, shelter, transportation, or police services stemming from an evacuation of the public. The coverage applies only to those additional costs incurred by a State or municipality during the time the official evacuation order is in effect, plus an additional 30-day period immediately thereafter.

  For coverage to apply, the evacuation would have to be: (i) the result of an event that causes imminent danger of bodily injury or property damage from the nuclear energy hazard, and (ii) initiated by a State official who is authorized to do so.

- **Exclusion of Coverage for Worker’s Compensation and Employer’s Liability** – The Facility Form policy excludes coverage for worker’s compensation and employer’s liability. These exclusions are consistent with the exclusion of such claims under the Act. The exclusions also are intended to dovetail with the coverage available in the conventional insurance market for radiation-related worker’s compensation or employer’s liability claims.

2.3.4.2 The Master Worker Policy

Although claims under State or Federal worker’s compensation statutes are excepted by the Price-Anderson Act, radiation tort claims by a worker against someone other than their employer are not. Examples of such claims include a claim by a power plant employee against a contractor or a claim by an employee of a contractor against the power plant operator. These claims are covered by ANI under the Master Worker Policy.

The Master Worker Policy provides liability coverage for the tort claims of those persons engaged in work-related activities at nuclear facilities insured by ANI, except claims arising from an ENO (i.e., a catastrophic nuclear event), which are covered by the Facility Form Policy. The policy is subject to a single industry-wide aggregate limit of public liability of $450 million that can be reinstated by ANI. In this sense, the policy is akin to a group insurance contract. Coverage under the Master Worker Policy applies to individual insureds through Certificates of Insurance. The Master Worker Policy was issued effective January 1, 1998 and replaced an earlier version that expired by its terms on December 31, 1997.

Coverage under the policy applies only to bodily injury to a worker that: (i) is caused by the nuclear energy hazard on or after the inception date of the Facility Form policy identified in the Certificate; (ii) is first reported to ANI on or after January 1, 1998; and (iii) is discovered and for which written claims are made against the insured no later than 1 year after the end of the continuous policy period. The net effect of all this is to provide coverage retroactively to the date coverage incepted under a particular Facility Form policy if claims are brought within 1 year of cancelation or termination of the Master Worker Policy and/or Certificate(s) of Insurance.

The separate Master Policy approach to providing coverage for worker tort claims was first introduced in 1988. It was the result of a joint effort by insureds and insurers to provide coverage for occupational exposures, without diluting the protection available to the public under the Facility Form, for onsite events that result in severe offsite consequences.

2.3.4.3 The Secondary Layer of Financial Protection Master Policy

ANI administers the secondary layer of required financial protection. Subsection 170(b) of the Act requires commercial power reactor licensees to participate in a retrospective premium program for loss in excess of primary financial protection. The program is written and administered by ANI. Should circumstances warrant, ANI would collect the retrospective premiums due and administer the disposition of the funds pursuant to the terms of the Secondary Layer of Financial Protection Master Policy.

The Secondary Layer of Financial Protection Master Policy provides “following form” coverage, meaning it tracks the coverage provided under underlying policies for “excess losses.” Excess losses are defined, in part, to mean all damages and claim expenses that are in excess of all sums paid or payable under all applicable primary financial protection. The Master Secondary Layer of Financial Protection Master Policy is in the possession of the NRC.

Coverage applies to individual insureds through Certificates of Insurance. Among other things, each Certificate identifies the named insured; the particular reactor to which the Certificate applies; and the underlying primary financial protection (i.e., the individual Facility Form policy and the Master Worker Policy) applicable to the reactor.

In the event a loss exceeds primary limits, each participant in the secondary layer of financial protection program is obligated under Subsection 170(b) of the Act, and under the terms of the Secondary Layer of Financial Protection Master Policy, to pay retrospective premiums of up to $131.056 million (plus 5 percent should those premiums be insufficient)[40] per reactor, per incident, subject to a 2020 maximum annual retrospective premium of $20.496 million per reactor, per incident. The 2020 maximum retrospective premium of $137.609 million ($131.056 million x 5 percent) is subject to inflationary adjustments at 5-year intervals.[41] The next adjustment should take place in 2023.

The limit of the insurers’ liability under this program is equal to the amount of retrospective premium collected from participating insureds, plus a contingent liability of up to $30 million for one incident, or up to $60 million for more than one incident, payable by ANI. The purpose of the contingent liability is to cover retrospective premiums that are in default. However, under the terms of a bonding agreement, ANI is entitled to reimbursement, with interest, for any monies it advances under the program.

In October 2020, there were 94 reactor units participating in the secondary layer of financial protection program, bringing the combined level of primary and secondary financial protection to approximately $13.4 billion ($450 million under the primary Facility Form + $137.609 million x 94 reactor units in the secondary layer of financial protection program).

[40] Atomic Energy Act of 1954, as amended, Subsection 170(o)(1)(E).
[41] Atomic Energy Act of 1954, as amended, Subsection 170(t).

2.3.5 Premium Development Under Nuclear Energy Liability Policies

This section provides a brief overview of the method by which premiums are determined under nuclear liability policies and also outlines the ICRP – a program that requires ANI to make premium refunds based on industry-wide loss experience.

2.3.5.1 Calculations of Premiums[42]

After more than 63 years of operation, the basic risk circumstances that confronted the original underwriters continue to exist. The loss experience of the nuclear industry remains limited, and the spread of risk across the country is small.

In the absence of credible loss experience, underwriting judgment represents the predominant factor in the rating process. While exercising that judgment, underwriters strive to develop premiums that equitably reflect exposure on a comparative risk basis.

2.3.5.2 Calculations of Premiums for the Facility Form Policy

To provide consistency in the treatment of similar risks, the premiums that apply under Facility Form policies issued to reactor operators are developed based on a careful review of the following risk characteristics:

- reactor type (boiling water, pressurized water, gas-cooled)
- reactor use (power, test, training, research, etc.)
- reactor size (MW(t) power level)
- reactor location (population densities, property values, etc.)
- reactor containment (fully or less than fully contained)
- reactor operating history (environmental releases, regulatory performance, abnormal occurrences, etc.)

Reactor size and location are typically the most variable factors and have the greatest impact on premium. The relative risk presented by the size of a reactor represents an evaluation of the relative exposure presented at various power levels. Assuming all other risk characteristics are equal, a larger reactor will be charged a higher premium than a smaller unit.

The evaluation of the location and its environs centers around population densities and property values within a given radius of the insured facility. Factors such as seismology and meteorology also are considered. Again, if one assumes all other risk characteristics are equal, a reactor located in a high population density area with higher property values will be charged a higher premium than one not so situated.

[42] The description is confined to the calculation of premiums for power reactors only. Other rating approaches are used to develop premiums for other facilities or for policies issued to suppliers or transporters.

In reviewing a reactor's operating history, the performance of each reactor is measured against the performance of all insured reactors. Premium credits or charges are applied to reflect individual reactor performance.

In those instances where a Facility Form policy covers more than one reactor at the same location or site, a substantial discount is applied to the premium for each additional unit. The discount is intended to reflect the fact that the policy limit is shared.

Liability premiums vary from one location to another, based on individual risk characteristics. In 2019, the average premium for policies providing the maximum limit of $450 million at a one-unit reactor site was $987,000; $1.5 million at a two-unit reactor site; and $1.9 million at a three-unit reactor site. The ICRP described below provides for a refund of up to 75 percent of premiums paid after consideration of historical claims experience.

2.3.5.3 Calculation of Premiums for the Master Work Policy

In the absence of any clearly identifiable distinguishing factors associated with tort claims of workers at different locations, the premiums applicable to individual power reactor licensees under the Master Worker Policy are "flat" premiums. In 2019, flat premiums of $67,000 per insured reactor were applied. Lesser premiums were applied for non-reactor facilities that also are insured under this policy. The total industry-wide premium produced under the Master Worker Policy in 2019 was approximately $7.6 million.

2.3.5.4 Calculation of Premiums for the Secondary Financial Protection Policy

ANI's liability under this program is limited to the retrospective premiums collected from participating insureds, plus a contingent liability to cover possible defaults in retrospective premium obligations. A flat charge of $30,000 per insured reactor was applied in 2019 to reflect this contingent liability and to cover administrative costs, such as emergency response and preparedness training, associated with the program. With 99 reactors participating in the program in 2019, a total industry-wide premium of approximately $3.0 million was charged.

2.3.6 Terrorism Coverage

ANI's policies provide coverage for liability arising from a terrorist act. There are no terrorism exclusions. ANI is able to provide terrorism coverage because it is reinsured by the U.S. Government under the Terrorism Risk Insurance Program Reauthorization Act of 2015. If a terrorist act meets the prerequisites under the program, ANI would be reimbursed for any amounts paid subject to a pre-determined deductible and retention. If the Terrorism Risk Insurance Program Reauthorization Act is discontinued, ANI likely would limit coverage for all its insureds to one shared industry aggregate limit instead of separate policy limits. This was the case following the terrorist acts of September 11, 2001, before the U.S. Government enacted the Terrorism Risk Insurance Act of 2002 and the subsequent extensions.

2.3.7 Industry Credit Rating Plan

In recognition of the lack of any actuarially significant loss data, the ICRP provides a mechanism to adjust premiums over time based on the experience of all domestic liability policyholders. All Facility Form policies, S&T policies, and the Master Worker Policy are subject to the ICRP. The Secondary Layer of Financial Protection Master Policy is not subject to the ICRP.

Under the ICRP, approximately 75 percent of each insured's standard liability premium is set aside in a reserve fund,[43] the sole purpose of which is to pay claims or claims expense. Reserve premiums are held for 10 years, after which a portion of the premiums is returned to policyholders based on historical claims experience for the industry. Thus, any refund due on reserve premium paid in 2009 will be made in 2019. As of 2019, the last refund was made in July 2018 and amounted to just over $53 million, or approximately 92 percent of the reserve premiums paid in 2008. On a total cumulative basis, insurers have returned to policyholders more than $782 million, or about 62 percent of total reserve premiums paid from 1957 to 2008.

Investment income on the fund balance is retained by member companies and reinsurers and represents around half of their income for the risks they insure.

Table 2-10 illustrates the annual industry-wide premiums collected and refunds made by insurers since inception in 1957.

Table 2-10 Premiums and refunds under the Industry Credit Rating Plan through 2018

Year	Industry Standard Premium	Industry Reserve Premium	Industry Reserve Premium Refund*	Industry Standard Premium Refunded	Industry Reserve Premium Refunded
1957-1975	74,009	53,722	33,890	45.8%	63.1%
1976	15,352	11,373	4,239	27.6%	37.3%
1977	17,533	13,008	6,752	38.5%	51.9%
1978	19,184	14,232	7,669	40.0%	53.9%
1979	20,316	15,070	9,077	44.7%	60.2%
1980	23,002	17,080	10,702	46.5%	62.7%
1981	27,521	20,454	13,637	49.6%	66.7%
1982	30,256	22,501	15,313	50.6%	68.1%
1983	32,389	24,101	16,969	52.4%	70.4%
1984	35,543	26,463	16,638	46.8%	62.9%
1985	42,054	31,376	19,293	45.9%	61.5%
1986	55,402	41,465	26,074	47.1%	62.9%

[43] The remaining 25 percent of the premium is available to insurers for administrative expenses, engineering expenses, State premiums taxes, brokers' commissions, and profit.

Year	Industry Standard Premium	Industry Reserve Premium	Industry Reserve Premium Refund*	Industry Standard Premium Refunded	Industry Reserve Premium Refunded
1987	60,029	44,969	29,045	48.4%	64.6%
1988	73,513	55,183	32,058	43.6%	58.1%
1989	71,147	53,405	11,475	16.1%	21.5%
1990	75,489	56,677	17,811	23.6%	31.4%
1991	61,152	45,649	16,023	26.2%	35.1%
1992	52,827	39,356	13,068	24.7%	33.2%
1993	52,845	39,407	19,917	37.7%	50.5%
1994	52,767	39,465	21,949	41.6%	55.6%
1995	53,663	40,043	21,037	39.2%	52.5%
1996	53,407	39,931	18,474	34.6%	46.3%
1997	44,752	33,458	15,592	34.8%	46.6%
1998	41,435	30,726	19,153	46.2%	62.3%
1999	36,247	26,739	22,015	60.7%	82.3%
2000	31,732	23,371	19,775	62.3%	84.6%
2001	35,130	26,108	18,895	53.8%	72.4%
2002	43,971	32,876	24,784	56.4%	75.4%
2003	71,787	54,196	42,076	58.6%	77.6%
2004	71,070	53,678	41,658	58.6%	77.6%
2005	76,800	58,081	46,606	60.7%	80.2%
2006	76,735	58,104	47,931	62.5%	82.5%
2007	75,941	57,525	49,515	65.2%	86.1%
2008	76,003	57,585	53,181	70.0%	92.4%
2009	75,564	57,225			

Year	Industry Standard Premium	Industry Reserve Premium	Industry Reserve Premium Refund*	Industry Standard Premium Refunded	Industry Reserve Premium Refunded
2010	90,116	68,471			
2011	90,227	68,546			
2012	89,054	67,654			
2013	89,312	67,905			
2014	98,546	74,985			
2015	98,135	74,664			
2016	98,493	74,956			
2017	112,568	85,894			
2018					
Totals	*2,523,018*	*1,897,677*	*782,291*	*31.0%*	*41.2%*

** Dollars in thousands. Refund made 10 years after the premium for a given calendar year is paid; thus, the refund on reserve premiums paid in 2008 was made in 2018.*

2.3.8 Provisions of the Price-Anderson Act Important to Insurers

There are certain key provisions of the Act that nuclear insurers have identified as allowing and encouraging insurers to maintain, and occasionally increase, their capacity commitments to ANI's nuclear liability insurance program. Those factors are noted individually below (ANI, 2019).

- **Economic Channeling of Liability** – The omnibus nature of the coverage provided under the Facility Form policy and of the indemnity provided under the Act channels financial responsibility and the insurance obligation for injury to the public directly to the operator of the nuclear power plant. Channeling has significant benefits for the public and for insurers. It simplifies claimants' ability to establish liability for a nuclear incident and assures it will be backed by solid financial resources to pay for damages sustained. It also provides a concentration of risk and a stable premium base necessary to spread the risk of a potentially catastrophic loss over an extended period of time.

- **Limitation on Aggregate Public Liability** – The limit of public liability makes the channeling of liability to the plant operator possible without the need for special State or Federal statutes. In the absence of these provisions, each supplier of products or services to the nuclear industry would seek liability protection for their own accounts. As insurance capacity is a finite commodity, the exponential demand for insurance from suppliers could not be filled without reducing the amount of insurance available to the plant operator. Insurers then would face the prospect of cumulation of liability under multiple policies, in turn resulting in a further reduction of available capacity as they mitigate the risk of cumulation. The limitation on aggregate public liability encourages insurers to maximize the capacity they commit to the nuclear business.

- **Federal Court Jurisdiction in the Public Liability Action** – The Act confers jurisdiction over public liability actions on the Federal district court in which an incident occurs. For insurers providing capacity commitment, this provision removes the confusion and uncertainties of applicable law that would otherwise result when multiple claims and lawsuits are filed in multiple jurisdictions. Consolidation of public liability claims in the Federal courts also reduces legal transaction costs and streamlines the process of compensating those injured as a result of a nuclear incident.

- **Compensable Damages** – Damages compensable in a "public liability action" are set forth within the Act's definition of "nuclear incident" and include "bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of source, special nuclear, or byproduct material." Those courts having addressed this definition dismiss pure emotional distress claims as unrecoverable under the Act, instead requiring a threshold showing of some physical injury to maintain a valid public liability action. This requirement comports with the U.S. Congress's intent to make clear the extent of compensable injury was the same as the term "bodily injury" specified in the policy of insurance.[44] The concern was then, and remains to this day, the potential deluge of emotional distress litigation based solely on anxiety associated with radiation exposure risks, which would significantly drain the available financial protection funds established by the Act.

- **Limitation on Punitive Damages** – Insurers believe that punitive damages distort a system intended to provide prompt and sure compensation for damages sustained by the public from a nuclear incident. ~~Punitive damages generally, but e~~Especially in a catastrophe situation, punitive damages may constitute a windfall to a few at the expense of many other injured people. In the Price-Anderson context, punitive damages also undercut the government's authority and responsibility to penalize non-compliance with safety regulations. All of this is recognized by the provision in the Act that no court may award punitive damages as respects a nuclear incident if the Federal Government is obligated to make payments under an agreement of indemnification.

- **Costs for Investigating, Settling, and Defending Claims –** The Price-Anderson Act defines "financial protection" to include "the ability to respond to damages for public liability and to meet the costs of investigating and defending claims and settling suits for such damages." The origins of this provision date back to the creation of the Price-Anderson Act, wherein the U.S. Congress recognized that potential liability from a

[44] The 9th Circuit in *Berg v. E.I. DuPont de Nemours & Co. (In re Berg Litig.)*, 293 F.3d 1127, 1131 (9th Cir. 2002) found U.S. Congress's intent as follows: The legislative history indicates that Congress added the words "sickness" and "disease" after "bodily injury" in order to clarify what it meant by "bodily injury." Congress intended to make clear "that the extent of bodily injury was the same as the definition of bodily injury as specified by the standard NELIA insurance policy." S. Rep. No. 296, 85th Cong., 1st sess., 1817-18. NELIA is the Nuclear Energy Liability Insurance Association, an association that provided a specialized form of nuclear energy liability insurance. 10 CFR 140.91, App. A. NELIA policies insured against bodily injury or property damage caused by nuclear incidents. Id. Since NELIA policies did not provide coverage for purely emotional injuries, we conclude that Congress intended the same scope for the Act. (Note: NELIA is the predecessor entity to what is today ANI.)

nuclear event dwarfed the ability of the industry and private insurance companies to absorb the risk. The Act offered a major incentive to utilities and private insurers to invest in nuclear power by limiting aggregate liability and accepting insuring terms reasonable to both utilities and insurers, which includes “financial protection” limits inclusive of defense costs. The inclusion of costs of investigating and defending claims within the definition of “financial protection” continues to encourage insurers to provide the capacity that exists today, which is “the maximum amount available at reasonable cost and on reasonable terms.”

- **Compensation Framework –** The Price-Anderson Act provides a framework for the disposition of public liability claims following a nuclear incident or precautionary evacuation. This framework exists mainly for the protection of members of the public impacted by a severe nuclear event, assuring expedient, efficient, fair, and equitable compensation. This is also important to insurers, however, by providing structure and guidance for the disposition of claims as discussed further below.

  1. Immediate Emergency Assistance: The Act provides that payments may be made to claimants for the purpose of providing immediate assistance. ANI’s Emergency Response program, which is described in greater detail below, exists primarily to provide immediate financial assistance to qualified evacuees.

  2. Court Plan for Distribution of Funds: The Act provides for court management of funds in the event of a significant nuclear incident. Following a court determination of damages possibly above financial protection limits, the NRC will, and other interested parties may, submit to the court a plan for the disposition of pending claims and for the distribution of remaining funds available. The court is expressly authorized to approve, disapprove, or modify proposed plans and to determine the proportionate share of sums available to each claimant. This provision for independent judiciary approval and management of fund distributions ensures the expedient, fair, and equitable disposition of public liability claims.

  3. Use of Private Insurers: The Act expressly authorizes the NRC to use, to the maximum extent practicable, the facilities and services of private insurance organizations such as ANI. Presumably, the NRC would contract with ANI to use already deployed claim resources and structure to adjust claims in accordance with the court-adopted distribution plan.

  4. U.S. Government Compensation Plan: The Act further includes provisions for the Federal Government to follow to provide full and prompt compensation for all valid claims above the Act’s aggregate limit of liability.

  5. Judicial Procedures: The Act provides recommended judicial procedures in the event of a significant nuclear incident. The chief judge of the U.S. district court with jurisdiction may appoint a special case load management panel to oversee and/or undertake listed measures to encourage the equitable, prompt, and efficient resolution of claims, which would likely include oversight of the court-approved distribution plan.

2.3.9 Insurers’ View on the Price-Anderson Act Continuation and the Future

For more than six decades, Congress has encouraged the private insurance market to gather the maximum amount of nuclear liability insurance at reasonable cost and terms to protect the public, and the industry, against the financial consequences of a major incident.

The Price-Anderson Act strikes a balance between society's need for nuclear power as a carbon-free energy source and its need for financial protection in the unlikely event of a large-scale accident. It also strikes a balance between the use of private and public funds. The law states its purpose and scope in simple, clear terms:

> In order to protect the public and to encourage the development of the atomic energy industry, in the interest of the general welfare and of the common defense and security, the United States may make funds available for a portion of the damages suffered by the public from nuclear incidents, and may limit the liability of those persons liable for such losses.

For the nuclear industry, particularly in deregulated energy markets, economic pressures created by cheap natural gas, market incentives favoring renewable energy sources, and transmission grid constraints have forced operators to announce the premature shutdown of otherwise solidly performing nuclear plants. Yet the insurance capacity supporting the financial protection program remains intact throughout the decommissioning phase and beyond. Although the insurance industry has experienced its own challenges and a great deal of consolidation since the last extension of the Act, the participation of the industry in insuring the nuclear risk remains stable and strong (ANI, 2019).

2.3.10 Nature of the Risks and Claims

The nuclear liability risk extends beyond the catastrophic event contemplated by the Price-Anderson Act. All nuclear power plants and various facilities within the nuclear fuel cycle release radiation during normal operations. Facility licensees are required to ensure that nuclear workers and members of the public receive only radiological doses within NRC regulatory permissible limits. These NRC regulatory limits are predicated on consensus opinions regarding exposure risk held in the scientific community and developed over many decades of study around the world.

The TMI accident is the only U.S. nuclear liability claim arising out of a significant nuclear event. Most nuclear liability claims governed by the Price-Anderson Act have been made by facility workers arising from single exposure events or members of the public claiming bodily injury or property damage arising from normal operational releases within regulatory limits. Due to the latency period or "long tail" (the delay that can occur between the time of exposure and the time of manifestation of injury or disease), claims made by workers and the public have been, and will likely continue to be, slow to emerge.

As indicated previously, coverage under ANI's Facility Form policy can apply to claims for radiation-related bodily injury or property damage caused during the policy period if such claims are brought within 10 years of policy cancelation or termination. For an ENO, the 10-year "discovery period" is extended to 20 years from the date of the occurrence. All ANI policies include periods that are continuous unless the policy is canceled or terminated. The effect of having a continuous policy period that, in many instances, incepts from the date of initial facility operations is to make the discovery period for latent injury claims academic unless the 10-year reporting period is triggered by cancelation or termination.

Given the coverage afforded by ANI's policies and the long latency period associated with radiation exposure, it is possible for claims to be filed against ANI insureds many decades after the alleged exposures. Some claims within the last 10 years allege present-day bodily injury caused by exposures dating as far back as the 1960s. For this reason, ANI's claims experience to date may not necessarily be indicative of the claim landscape that lies ahead. The importance of the ICRP reserve fund is reinforced by the long-tail nature of nuclear liability claims.

2.3.11 Summary of Claims Data

The claims experience in nuclear liability insurance is summarized here for nuclear incidents reported from the inception of the Price-Anderson Act in 1957 through December 2018. Claims data related to these incidents are provided in Appendix B. ANI's claims experience and the claims data presented in Appendix B include both claims made against 10 CFR Part 140 required policies and other claims paid by ANI related to other nuclear liability insurance policies. The totality of this experience with nuclear liability insurance is summarized below to inform an understanding of future Price-Anderson Act related claims.

The observations and commentary included below are separated into two categories for ease of reference and to trace the evolution of claims ANI has managed over the past six decades.

Bodily Injury Claims:

- Radiologically induced bodily injury claims during the early decades involved discrete events clearly identifiable in terms of time and location.

- Because of the very limited incidence of alleged radiation-induced injury preceding the TMI accident, ANI not only monitored incidents of interest (primarily, worker's compensation proceedings arising out of occupational exposure), but also recorded them as potentially giving rise to public liability claims. The reasoning was that worker's compensation activity might lead to personal injury lawsuits for compensatory damages. However, from a period of 1957 to 1979, these lawsuits did not materialize.
- Personal injury lawsuits multiplied after 1979. The catalysts for the increase were the highly publicized TMI accident and the jury verdict and punitive damages awarded in *Silkwood v. Kerr-McGee*. With the legal community's heightened awareness of the radiation risk and potential for large verdicts, legal expenses increased significantly.

- Personal injury lawsuits regularly flowed from claimed releases with little to no identity except for latent or long-tail injury phenomenon common in the toxic tort field. In many instances, information was limited in that it was impossible to identify any physical impact apart from the allegation of a latent disease or illness due to undefined exposures over an unspecified time period. The genesis of these lawsuits typically is described as the alleged effect (e.g., somatic, psychosomatic, genetic) from exposure to radiation at low levels over years of employment at nuclear facilities or residing within surrounding communities.

- With the enactment of the 1988 Amendments and the issuance of Third Circuit *TMI* decisions construing these amendments, a legal framework emerged governing public liability claims. Personal injury lawsuits now are litigated with all parties experiencing improved guidance on the course of litigating radiation-induced bodily injury claims.

Property Damage Claims:

- The nature and scope of property damage claims have shifted dramatically with varying legal interpretations of the Act. Early events in nuclear fuel cycle operations were largely triggered by damage to shipping containers used to transport nuclear material.

- Later property damage claims focused less on distinct events than on "stigmatization" or de-valuing of real property because of its proximity to nuclear facilities. In those cases, the measure of damage was alleged to be the decrease in value of property unrelated to any presence of radiological contaminants.

- The nature and scope of property damage claims again shifted with courts finding the Act requires, at a minimum, actual damage as a threshold element for a compensable public liability claim. What constitutes actual damage under the Act remains unsettled, with legal debate focused on either an actual physical injury to personal or real property or, to a lesser degree, contamination with radioactive material to such an extent that there is no longer a safe or appropriate use for the property.

- ANI has expressed concern that, due to recent court decisions, additional State law claims for property damage associated with nuclear facilities – claims that ANI believes previously would have been preempted by the Price-Anderson Act – may become available to potential claimants and expand the potential liability for nuclear insurers and the nuclear industry. ANI has expressed the view that such additional State law claims may change the nature and scope of actionable property damage claims, and that such court decisions and their ramifications could materially impact insurers and the industry in future cases. This concern stems from the 2015 Tenth Circuit *Cook v. Rockwell* decision that found no Price-Anderson Act preemption impeding State law claims for insults to property that do not rise to the threshold of a Price-Anderson Act nuclear incident compensable under the Price-Anderson Act public liability framework. ANI is concerned that, in reliance on *Cook*, litigants without claims of actual property damage will renounce the Price-Anderson Act expressly to pursue State law nuisance or trespass remedies for nothing more than a trivial radiological discovery within the boundaries of their properties. (See Section 2.3.13, *An Emerging Concern of the Nuclear Industry and Its Insurers: Conflicting Interpretation of Price-Anderson Act Preemption*, below for a more detailed discussion).

2.3.12 American Nuclear Insurers' General Observations and Commentary on the Claims Data

- The TMI accident promoted the use of class action lawsuits as a device to satisfy the public demand for accountability beyond compensatory damages.

- The class action incidents designated in Appendix B by the asterisk (*) are for pure economic loss unassociated with bodily injury. Those designated by the double asterisk (**) are mass tort actions for bodily injury and property damage. Lastly, the incident designated by the triple asterisk (***) is a mass tort case arising out of alleged non-consensual human radiation experiments, now declassified by the Federal Government. (Asterisk designations cited here are presented in columns reflecting property damage, bodily injury, and loss of life within Appendix B.)

- Incidents identified in Appendix B for which no coverage under nuclear liability policies existed are those in which the entire claim (or a portion of the claim) clearly fell outside the scope of coverage. The reasons vary but generally fit into one or more categories:

  - "Public liability," as defined, is not the subject of the claim (e.g., the claim may be for workers compensation or for damage to the insured's own facility).

  - The nuclear energy hazard is not the subject of the claim (e.g., the claim may involve exposure to non-"nuclear material" as defined).

  - The claim does not seek "damages" within the meaning of the insuring agreement (e.g., the action may be for injunctive or equitable relief).

  - The claim is subject to Federal indemnity.

  - The policy was canceled and the "discovery period" expired.

- There has been no relationship between the amount of radiation exposure on which a claim is based and the legal expense necessary to investigate and defend it.

- Legal expense is especially impacted by lawsuits that seek class certification for both compensatory and punitive damages. In these cases, there is a dramatic drain on financial resources under the Price-Anderson Act compensation system. The cost of handling ten class actions approached $291 million. In contrast, the total expense incurred to respond to all 243 incidents is about $371 million. Therefore, the current cost for these class actions alone represents just over 78 percent of total expense dollars.

- Paid expense exceeds paid loss (indemnity) by a margin of nearly two-and-one-half to one. However, this allocation of financial protection may be misleading due to the *TMI* personal injury settlements and the payout made in a more recent case, *Babcock & Wilcox Co. v. ANI* (*B&W*), where insureds settled with hundreds of claimants over ANI's objection. More representative of the long-term trend is the ratio of paid expense to paid loss (nearly 15 to 1) after subtracting the *TMI* and *B&W* indemnity payments, which dominate the loss experience to date.

- The importance of incorporating legal expense as a component of "public liability actions" is compelling. The judicial process, while expensive, exposes claims with no basis in law or fact. Except for the settled economic loss claims in *TMI*, the remainder of the class actions revealed no legal basis for recovery. Even the more recent iteration of the *B&W* case – where nearly one hundred additional claimants filed copy-cat lawsuits encouraged by insureds' settlement over ANI's objection – resulted in dismissal after being scrutinized by the court and judged based on sound principles of radiation science.

2.3.13 An Emerging Concern of the Nuclear Industry and Its Insurers: Potentially Conflicting Interpretations of Price-Anderson Act Preemption

ANI believes that the 2015 Tenth Circuit decision in *Cook v. Rockwell* departs from existing legal interpretations of Price-Anderson Act preemption, causing concern within the nuclear industry and its insurers. ANI states that Federal circuit cases generally interpret the Act's language as preempting all State law claims based on allegations of harm caused by radiological exposure or contamination events. ANI concludes that the U.S. Congress would not have incorporated State law into the Act's Federal "public liability action" if plaintiffs were permitted to initiate freestanding State law claims.[45]

The *Cook* court dismissed those cases, however, reasoning that the Supreme Court disfavors preemption and that the text of Price-Anderson Act "merely affords a federal forum when a nuclear incident is 'assert[ed].'" Affirming a near billion-dollar jury award premised on State nuisance law, the *Cook* court found no express language within the Act prohibiting claimants from seeking traditional State law remedies when alleged radiological damages fall below the threshold of those within the Act's definition of a "nuclear incident."

If the *Cook* interpretation ~~proliferates to~~ is adopted by other circuits, the scope of potential liability for the nuclear industry and its insurers may greatly expand. ANI is concerned that the *Cook* decision threatens the Act's primary purpose – assuring a significant pool of funds is available for nuclear accident victims – by creating uncertain, unlimited, and potentially uninsured liabilities conceivably premised on radiological releases from normal everyday plant operations, permissible under NRC regulations, without injury. According to ANI, liabilities may not only include State law awards premised on nuisance, but also pure emotional distress claims (with no attendant bodily injury) that Congress in the 1988 Amendments sought to exclude by amending the Act to add the words "sickness" and "disease" after "bodily injury." ANI envisions that facilities operating in full compliance with Federal regulatory limits nonetheless may be burdened with defending against and funding significant State court nuisance or emotional distress claims and awards based solely on a jury's subjective opinions as to reasonableness. ANI does not want to see a re-emergence of forum shopping and protracted costly litigation, which the 1988 Amendments were designed to prevent. ANI acknowledges that the post-*Cook* legal landscape has yet to reveal itself, but concern exists despite what ANI believes to be the Act's current plain language, history, and purpose requiring complete preemption over all nuclear hazard claims.

The holding of *Cook* is narrow and, as acknowledged by ANI, the actual legal implications of *Cook* are still unknown. Interested parties will need to monitor future court decisions to better understand the potential impacts of *Cook* and related future court decisions on the scope of potential liability for the nuclear industry and its insurers.

2.3.14 American Nuclear Insurers' Views on the Claims Landscape in the Absence of the Price-Anderson Act

Failure to continue the Act would have a devastating impact on risk and claims. In the absence of the Act's compensation structure, economic channeling to the entity required to provide financial protection would cease to exist, possibly necessitating protracted and costly litigation among potentially liable, insolvent persons. The exclusivity of Federal court jurisdiction and

[45] As described by ANI, preemption is a matter of congressional intent. See *Gobeille v. Liberty Mut. Ins. Co.*, 136 S. Ct. 936, 946 (2016). Congressional intent to provide complete preemption is evident by way of the Act's purpose to strike a balance between protecting the public financially and encouraging industry development by defining compensable damage and providing aggregate liability protection. It is further evident by way of the Act's definition of "public liability," which excepts claims arising out of an act of war. Following the logic of *Cook*, claimants sustaining any nuclear injury or damage arising from acts of war are perversely invited to bring suits under State law for enormous, uncapped, and likely uninsured judgements – in direct conflict with Congress's bargain with the industry (ANI, 2019).

remediation under a single Federal cause of action would vanish, resurrecting the litigation turmoil following TMI and predating the 1988 Amendments. It follows that nearly 60 years of established case law interpreting the Act – which provides the present-day legal landscape for compensating nuclear liability claims – would become obsolete. Compensable damages would be based on~~at the whim of~~ State law, resulting in unpredictable, uncapped, and potentially uninsured judgments. The legal community's awareness of nonrenewal – and lack of legal precedent and protections afforded by the Act – likely would recharge the pursuit of large nuclear liability verdicts, increasing legal expense significantly and casting uncertainty on the continued insurability of the entire industry. Perhaps most concerning, beyond the eradication of mandated public financial protection, would be the dismantling of the compensation framework to be followed in the unlikely event of a significant nuclear incident, the very creation of which was, and remains to this day, designed to benefit the public (ANI, 2019).

2.3.15 American Nuclear Insurers' Emergency Response Program

ANI's Emergency Response program exists primarily to address the provision within the Price-Anderson Act encouraging licensees and their insurers to provide immediate assistance to members of the public impacted by a nuclear incident or precautionary evacuation. In such an event, ANI is prepared to respond on behalf of insureds to provide onsite EFA payments to evacuees who live and work within recommended evacuation zones for essential living expenses, such as food, lodging, and transportation. ANI is further prepared to provide lost wage compensation and emergency interim funds to impacted businesses located within evacuation, embargo, or quarantine zones.

Historically, ANI's member companies were required to dedicate emergency claim personnel for the onsite adjustment of EFA claims. The process was implemented successfully in response to the TMI accident in 1979, where a claim office was staffed and opened within 24 hours of the governor's evacuation advisory to certain individuals living within the site's 5-mile radius. Families impacted by the advisory were given advance payments for immediate out-of-pocket living expenses for food, lodging, and transportation. Compensation for business interruption loss and lost wages were provided later.

ANI since has contracted with a third-party administrator (TPA) to assist with its Emergency Response program. The TPA has extensive experience in handling emergency evacuation and business loss claims from large-scale industrial accidents. ANI's business relationship with this TPA gives ANI access to an established claims support structure, including the immediate provision of a large number of experienced emergency response adjusters, as well as the claims-handling expertise the TPA has accumulated over the years. ANI regularly meets with the TPA to improve continually both internal and onsite response readiness capabilities.

ANI's Emergency Response program is designed not only to ensure internal readiness, but also to educate local, State, and Federal emergency planning stakeholders on ANI's response role and the Price-Anderson Act's compensation structure. ANI accomplishes this by participating each year in nuclear industry drills, workshops, and meetings with insureds/licensees, emergency management professionals, and industry support organizations. Interacting with these groups continues to strengthen response coordination efforts and builds upon already established important relationships (ANI, 2019).

2.3.16 Conclusion

The Act has served as the foundation for both the development of commercial nuclear power and a financial protection regime for the benefit of the public for more than 60 years. The insurance industry, through ANI, built a model of insurance around the contours of the Act.

Over time, ANI has amassed insurance capacity from member insurance companies that understand and appreciate the nuclear risk. The stability and security of that capacity, coupled with the loss control insights and emergency response capabilities developed by ANI and inherent in the insurance products, supports the nuclear fleet's ability to operate safely, reliably, and resiliently. In turn, the insurance industry's appetite for the nuclear risk is symbiotic with the fleet's record of safe operations and dependent on the provisions of the Act that provide clarity, certainty, and consistency in the way financial protection, and any attendant claims, is administered.

As with any foundational concept, the key to the Act's success has been consistency in its terms, interpretation, and application. Changes have been adopted sparingly and thoughtfully in order to avoid unintended consequences that could undermine the structure of the financial protection program or the industry it supports. Although the dynamics of the nuclear industry have changed somewhat since the Act was last extended and are likely to evolve further in the years to come, the core contours of the Act remain relevant. Supported by a regulatory scheme that affords the necessary flexibility to adapt to changing markets and technologies, financial protection for the U.S. nuclear industry and the public provided by the insurance market continues to be secure and robust.

3 OTHER RELEVANT PRICE-ANDERSON ISSUES

This section discusses other topics potentially relevant to recommendations for continuing, modifying, or repealing the provisions of the Price-Anderson Act. Specifically, this section includes the following subsections:

- 3.1 – Estimated Costs for Liability from a Radiological Accident
- 3.2 – Adequacy and/or Appropriateness of Government Indemnification
- 3.3 – Issues Raised by International Agreements: The Convention on Supplementary Compensation for Nuclear Damage
- 3.4 – Potential Financial Burden of Increasing Retrospective Premium Assessments

3.1 Estimated Costs for Liability from a Radiological Accident

Historical liability claims, including those in the United States and elsewhere, can help inform an understanding of the estimated costs for liability from a radiological accident. Accordingly, this section discusses:

- historical liability claims in the United States;
- liability claims for the Fukushima Dai-ichi accident;
- differences between U.S. reactors and Fukushima Dai-ichi reactors and potential for occurrence of accidents;
- U.S. regulatory response to Fukushima Dai-ichi; and
- post-Fukushima understanding of liability claims.

3.1.1 Historical Liability Claims in the United States

The largest nuclear accident that has occurred in the United States took place at a PWR in 1979 at the TMI-2 reactor, near Middletown, Pennsylvania. The TMI-2 accident did not result in any detectable health effects on plant workers or the public (NRC, 2018b). A combination of equipment malfunctions, design-related problems and worker errors led to the partial meltdown of TMI-2 and very small offsite releases of radioactivity (NRC, 2018b).

On the International Nuclear and Radiological Event Scale (INES), events are rated at seven levels (International Atomic Energy Agency, 2019). Figure 3-1 shows the seven levels of the INES scale, with Levels 1-3 broadly categorized as incidents and Levels 4-7 categorized as accidents. Each level is subcategorized, with Level 1 being the least severe classification (anomaly) and Level 7 being the most severe classification (major accident). The scale is logarithmic; that is, the severity of an event is about 10 times greater for each increase in level of the scale.

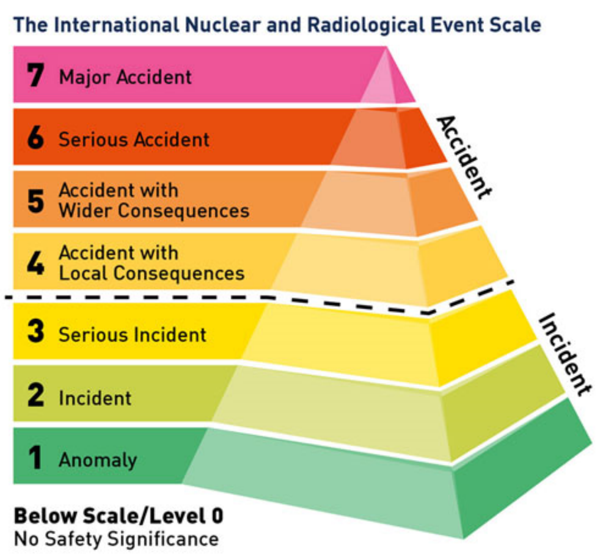

Figure 3-1 International Nuclear and Radiological Event Scale

Source: NRC. 2017. International Nuclear and Radiological Event Scale. https://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/emerg-classification/event-scale.html.

The TMI-2 accident was rated at Level 5 (accident with wider consequences). The cleanup at TMI-2 cost approximately $973 million and took about 12 years to complete (World Nuclear Association, 2012). Altogether, insurance pools paid approximately $71 million in liability claims costs and litigation expenses associated with the TMI-2 accident (NRC, 2019b). The TMI-2 accident damages paid by insurance were covered by the primary layer of financial protection, which was required in the amount of $160 million in 1979.

3.1.2 Liability Claims for the Fukushima Dai-ichi Accident

On March 11, 2011, a 9.0-magnitude earthquake struck Japan about 231 miles northeast of Tokyo. Japan's Fukushima Dai-ichi facility lost all power from the electric grid, with diesel generators providing power for about 40 minutes. At that point, an estimated 45-foot-high tsunami hit the site, damaging many of the generators. Four of six Fukushima Dai-ichi reactors lost all power from the generators. The tsunami also damaged some of the site's battery backup systems. Units 1, 2, and 3 at Fukushima Dai-ichi were operating when the earthquake hit. Units 4, 5, and 6 were shut down for routine refueling and maintenance. One of Unit 6's diesel generators continued working, providing power to keep both Units 5 and 6 safely shut down.[1] Steam-driven and battery-powered safety systems at Units 1, 2 and 3 worked for several hours, but those systems eventually failed and all three reactors overheated, melting their cores to some degree (NRC, 2018).

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The Fukushima Dai-ichi accident resulted in damages exceeding $200 billion. This estimate was calculated considering a broad range of costs, such as support for accident evacuees; offsite decontamination; replacing power from idled nuclear plants; and image or reputation losses (National Academies of Sciences, 2014). On May 11, 2011, Fukushima Dai-ichi's owner, TEPCO, accepted terms established by the Japanese government for state support to compensate those affected by the accident at the Fukushima Dai-ichi plant. A state-backed institution was created to expedite payments to those affected by the Fukushima Dai-ichi accident. The state-backed institution receives financial contributions from electric power companies with nuclear power plants in Japan, and from the government through special bonds that can be cashed in when necessary. The government bonds total JPY 5 trillion ($60 billion). TEPCO accepted the conditions imposed on the company as part of the package. That included not setting an upper limit on compensation payments to those affected, making maximum efforts to reduce costs, and agreeing to cooperate with an independent panel set up to investigate its management (World Nuclear Association, 2021). The accident was rated as a Level 7 event (major accident) on the INES scale. The Fukushima Dai-ichi accident was rated two levels higher on the INES scale, or 100 times more severe, than the TMI-2 accident. The total cleanup costs of the accident at TMI-2 were less than 0.5 percent of estimated cleanup costs at Fukushima Dai-ichi, which are ongoing, varying significantly due to differences in total contamination and scale of the respective accidents.

[1] NRC Backgrounder on NRC Response to Lessons Learned from Fukushima, September 2018

3.1.3 Differences Between U.S. Reactors and Fukushima Dai-ichi Reactors and Potential for Occurrence of Accidents

Post-Fukushima, the NRC commissioned studies to identify the differences between the United States and Japanese nuclear power reactors, to identify vulnerabilities, and to inform regulatory action.

Currently, 19 of the 31 operating BWR nuclear units in the United States have the same BWR and containment designs as the Fukushima Dai-ichi units (Mark I). The NRC conducted a study in 2013 that identified the differences between the United States and Japanese regulatory requirements at the time of Fukushima Dai-ichi (NRC, 2013b). While Japanese and U.S. design basis requirements were comparable, Japanese regulatory requirements did not consider beyond-design-basis events such as station blackout events, anticipated transients without scram,[2] and terrorist attacks. Additionally, Japanese regulatory requirements did not have any apparent regulatory guidance on tsunamis and design basis floods (NRC, 2013b). While there were differences in regulatory requirements at the time of the Fukushima Dai-ichi accident, the lack of certain regulatory requirements does not imply that the Fukushima Dai-ichi accident and associated consequences could have been completely mitigated if Japan had the same regulatory framework as the United States prior to the accident. However, understanding these differences has allowed the United States and the Japanese nuclear regulatory bodies to gain insight as how to better prepare for and prevent Fukushima-like accident consequences.

The majority of United States BWRs and Japanese BWRs had similar containment venting systems at the time of Fukushima Dai-ichi, which were hardened containment vents that were installed as additional safety measures. However, Japanese utilities adopted a different containment venting strategy than adopted by U.S. reactors. Japan's primary containment vessel (PCV) strategy delayed venting as long as possible to avoid radioactive materials released, while the U.S. PCV venting strategy was designed to vent earlier to reduce potential for explosions in the PCV (NRC, 2013b). Conditions associated with the accident at Fukushima Dai-ichi hindered emergency operators' ability to operate the containment venting system that contributed to the progression of inadequate cooling of the core leading to core damage (EA-13-109). The accident at Fukushima Dai-ichi demonstrated the need for reliable hardened containment venting strategies at U.S. Mark I and Mark II BWRs if a similar station blackout situation were to occur.

Overall, despite the low likelihood of an accident like the Fukushima Dai-ichi event occurring in the United States, the NRC has made safety-enhancement measures to mitigate negative potential consequences of such an event. Both the United States and Japanese nuclear regulatory bodies have updated requirements to reduce the probability of core damage and melting.

3.1.4 U.S. Regulatory Response to Fukushima Dai-ichi

U.S. Regulatory Response to Nuclear Accidents, Including the Fukushima Dai-ichi Accident

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[2] Anticipated transients without scram is one of the "worst case" accidents, consideration of which frequently motivates the NRC to take regulatory action. Such an accident could happen if the scram system (which provides a highly reliable means of shutting down the reactor) fails to work during a reactor event (anticipated transient). The types of events considered are those used for designing the plant.

Since the publication of the 1998 Price-Anderson Act Report to Congress, there have not been any significant accidents in the United States. Safety enhancements made post TMI-2 and post-Fukushima improved nuclear power reactor plants' abilities to cope with unforeseen events or natural disasters. NRC regulatory actions focused on four key areas of interest post-Fukushima to reduce the probability of major accidents (NRC, 2018c):

1. need to maintain key plant safety functions following large-scale natural disasters

2. requiring new equipment to better handle potential reactor core damage events

3. improving EP capabilities

4. preparing for the potential impact of seismic and flooding events

Need to Maintain Key Plant Safety Functions Following Large-scale Natural Disasters

To mitigate the potential impacts of unforeseen events, the NRC accepted the nuclear industry's recommended approach called diverse and flexible coping strategies or FLEX (NRC/NEI, 2012). This approach focused on the major problem encountered at Fukushima Dai-ichi—the loss of power to maintain effective reactor cooling—by stationing another layer of backup equipment at facility sites and opening two National Response Centers (NEI, 2016). The National Response Centers, located in Memphis, Tennessee and Phoenix, Arizona, store additional equipment and resources that can be deployed to a plant during an emergency.

Requiring New Equipment to Better Handle Potential Reactor Core Damage Events

Prior to the Fukushima Dai-ichi accident, many Mark I and Mark II BWR licensees had installed hardened containment vents as additional safety measures but there existed a wide variation of operation reliability in the event of severe accident conditions resulting from an extended loss of power (EA-13-109). Following the Fukushima Dai-ichi accident, the NRC ordered that Mark I and Mark II BWR licensees improve or install "reliable hardened containment vents capable of operation under severe accident conditions" that can help delay reactor core damage or melting. The NRC also ordered that these vents remain functional in the conditions following reactor core damage (NRC, 2019 a).

The Fukushima Dai-ichi accident led to questions about the safe storage of spent fuel and whether the NRC should require the expedited transfer of spent fuel from pools to dry cask storage containers at U.S. nuclear power plants. Although the spent fuel pools and the used fuel assemblies stored in the pools remained intact after the Fukushima Dai-ichi accident, spent fuel pools could overheat and potentially release significant amounts of radiation if enough water were boiled away or were lost during a severe accident. To protect against the possibility of spent fuel pools overheating after a nuclear event, the NRC required all U.S. nuclear plants to install water level instrumentation in their spent fuel pools (NRC, 2018c).

Improving EP Capabilities

In 2012, the NRC requested that nuclear plants assess their emergency plans including their communications systems. NEI created a document titled "Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities" which the NRC approved as an acceptable guidance for licensees to use to respond to the recommendations (NRC, 2012e). Nuclear plants were tasked to update their emergency plans and were asked to ensure that communication equipment properly operated. NRC inspectors reviewed all enhancements (NRC, 2018c).

Preparing for the Potential Impact of Seismic and Flooding Events

A 2014 NRC study titled "Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S Mark I Boiling Water Reactor" (NUREG-2161) provided consequence estimates of a hypothetical spent fuel pool accident initiated by a low likelihood seismic event at a specific reference plant. The study concluded that spent fuel pools are likely to withstand severe earthquakes without leaking and the likelihood of a radiological release from the spent fuel after a hypothetical severe earthquake is about one time in 10 million years or lower. The study also concluded that the individual cancer fatality risk for a member of the public from spent fuel pool accidents would unlikely challenge the Commission's QHO of two in one million per year (2×10^{-6}/year). Qualitative arguments provided in the study show that the likelihood of fuel damage from spent fuel pool accidents is low for most U.S. commercial nuclear power plants (NUREG-2161). The study's results informed a broader regulatory analysis of the spent fuel pools at U.S. nuclear power reactors as part of the Japan Lessons-learned plan.

Despite the low likelihood of fuel damage from spent fuel pool accidents, in August 2019, the NRC published a final rule that established regulatory requirements for nuclear power reactor applicants and licensees to mitigate beyond-design-basis events. This rulemaking codified several NRC orders that were made post-Fukushima as regulatory requirements for licensing.[3]

3.1.5 Post-Fukushima Understanding of Liability Claims

As discussed above in Section 3.1.1, *Historical Liability Claims in the United States*, there is very limited historical liability claims data associated with severe nuclear accidents in the United States. Therefore, for the purposes of describing in this report potential liability claims in the United States after a severe nuclear accident, the NRC compiled data from PRAs in environmental reports prepared by NRC licensees as part of their license renewal applications. In this analysis performed during the preparation of this report to Congress, the NRC focused on the data included in each PRA related to the most extreme projected nuclear accident in terms of offsite economic costs. Table 3-1, below, contains information on five different nuclear facilities, including the data collected about the most extreme projected nuclear accident at these plants in terms of offsite economic costs.

Table 3-1 Sample PRA results demonstrating offsite economic costs anticipated for most severe nuclear accidents

Facility/ Environmental Report Accession #	Unit	Region	Reactor Type	Rated Power Level (MW(t))	Geography	Offsite Economic Cost (Billions of 2019$)	Frequency (%/year)
Indian Point/ ML071210562	2	I	PWR	3,216	Urban/ Landlocked	42.2	0.000065

[3] "Mitigation of Beyond-Design-Basis Events," Federal Register, Vol. 84, No. 154, August 9, 2019, pp. 39684-39722.

	3	I	PWR	3,216	Urban/ Landlocked	36.8	0.0000943
Nine Mile Point/ ML041490222	1	I	BWR	1,850	Rural/ Shoreline	6.05	0.000309
	2	I	BWR	3,467	Rural/ Shoreline	10.89	0.000682
Sequoyah/ ML13024A010	1	II	PWR	1,148	Rural/ Landlocked	11.96	0.0006431
	2	II	PWR	1,126	Rural/ Landlocked	11.96	0.0007409
Fermi/ ML14121A540	2	III	BWR	1,535	Urban/ Shoreline	56.8	0.00072
Waterford/ ML16088A324	3	IV	PWR	3,716	Urban/ Shoreline	29.7	0.000188

The five facilities included have a range of diverse characteristics, including reactor type (boiling water or pressurized water), geography (urban or rural and coastal or landlocked), and power level in MW(t). As shown in Table 3-1, the costliest accidents at each plant are very unlikely. The estimated offsite economic cost for nuclear power reactor accidents depends on several factors, such as level and effectiveness of implementation of offsite emergency response and protective actions; containment pressure level at the time of the vessel breach; and the reactor's location, geography, reactor type, and rated power level. The offsite economic costs in 2019$ estimated in the PRAs range from a low of $6.05 billion at the Nine Mile Point Unit 1, a reactor unit in a rural and shoreline geography, to a high of $56.8 billion at Fermi Unit 2, which is located in an urban and shoreline setting.

Based on the estimates of nuclear power reactor accidents from PRAs in license renewal applications, nuclear accidents in the United States are not expected to create offsite economic damage on the scale of the Fukushima Dai-ichi incident in 2011, which led to $200 billion in damages. However, given the uncertainties associated with the results of the PRAs, economic damages of the most severe nuclear accidents in the United States could exceed the amount of funding currently available under the primary and secondary layers of financial protection. Therefore, in the unlikely situation that a very severe accident were to occur, Congress may be called upon, under the existing provisions of the Price-Anderson Act, to provide additional compensation for public liability claims resulting from a nuclear incident if damages occur in excess of the limit of public liability and the available funding from the primary and secondary layers of financial protection coverage.

3.2 Adequacy and/or Appropriateness of Government Indemnification

Under the Price-Anderson Act, government indemnification provides government funding to cover specified liabilities that are not covered by industry financial protection requirements. Government indemnification was originally introduced into the Price-Anderson Act framework because of the lack of available insurance in an amount sufficient to assure that adequate funds were available to satisfy liability claims if a nuclear event were to occur. To assess the adequacy and/or appropriateness of the current government indemnification framework, this section includes:

- overview of the Price-Anderson Act government indemnification framework;

- background on the use of government indemnification or other government funding mechanisms in other related international programs;

- discussion of the strengths and weaknesses of government indemnification;

- consideration of the appropriateness of reinstating government indemnification for large, operating commercial nuclear power reactors; and

- review of the indemnity fees for new, operating, and decommissioning large commercial nuclear power reactors.

3.2.1 Overview of the Price-Anderson Act Government Indemnification Framework

Under the Price-Anderson Act, government indemnification is a funding mechanism that may be made available to supplement the required coverage provided by nuclear industry licensees, including both nuclear power reactors and other nuclear licensees. When Congress enacted the Price-Anderson Act in 1957, it provided coverage for public liability by requiring that licensees obtain private insurance and, beyond that, by directly indemnifying licensees with Federal funds. As originally enacted, if a nuclear incident caused public liability exceeding the private insurance of a licensee, the Federal Government would be responsible for providing up to $500 million (the indemnification) to cover the excess costs. Since then, private financial assurance mechanisms (i.e., increased amount of available private insurance under the primary layer of financial protection and the industry retrospective premium plan under the secondary layer of financial protection) have largely displaced the Federal Government's role in providing coverage for nuclear incidents at large nuclear power reactors. As a result of the current available amount of private insurance and the size of the secondary retrospective premiums, the Federal Government no longer indemnifies reactors with a rated capacity at or exceeding 100 MW(e).[4] The Price-Anderson Act still makes government indemnification available for all other licensees required by the NRC to have financial protection but now reduces dollar-for-dollar the $500 million maximum indemnity by the amount that a licensee's required financial protection exceeds $60 million (42 U.S.C. 2210(c)). Although not an indemnity or a government guarantee of funding, in recognition of concerns about the adequacy of the total amount of coverage, including private financial assurance mechanisms and government indemnification, the 1975 Amendments explicitly provided that "in the event of a nuclear incident involving damages in excess of [the] amount of aggregate public liability, the Congress will thoroughly review the particular incident and will take whatever action is deemed necessary and appropriate to protect the public from the consequences of a disaster of such magnitude" (42 U.S.C. 2210(e)(2)). This addition was intended to clarify that, in the event of a major catastrophe, Congress would take whatever action is needed to protect the public, and it reflected an understanding that the risk for such major catastrophes should be borne by the whole of society rather than nuclear utilities or victims alone.[5]

Subsection 2210(f) of the Price-Anderson Act allows the NRC to collect an indemnification fee from all licensees with whom the NRC has executed a Price-Anderson Act indemnification

[4] 42 U.S.C. 2210(c) provides indemnification only for licenses for which the NRC requires financial protection of less than $560 million; 10 CFR 140.11(a)(4) requires that nuclear reactors with a rated capacity of 100 MW(e) or more maintain both $450 million in a primary layer of private insurance and a secondary, industry-funded layer of financial protection, resulting in public liability protection valued at nearly $12.9 billion.

[5] S. Rep. No. 94-454 at 12 (1975) and H.R. Rep. 94-121 at 39055 (1975).

agreement. The Price-Anderson Act requires that indemnity fees be $30 per 1,000 kW of thermal energy capacity for production and utilization facility licensees and authorizes the NRC to reduce the fee in "reasonable relation" to the financial protection requirements in excess of $60 million applied to such facilities. The NRC is also authorized to establish lesser fees for other licensees. However, the Price-Anderson Act specifies that no indemnity fee collected by the NRC under Subsection 2210(f) of the Price-Anderson Act may be less than $100 per year.

Pursuant to Subsection 2210(f) of the Price-Anderson Act, in 1977, the NRC established the following five-tiered schedule of indemnity fees for reactor licensees, which is the same schedule in place today:

- for indemnification from $500 million to $400 million inclusive, a fee of $30 per year per thousand kilowatts of thermal capacity authorized in the license

- for indemnification from $399 million to $300 million inclusive, a fee of $24 per year per thousand kilowatts of thermal capacity authorized in the license

- for indemnification from $299 million to $200 million inclusive, a fee of $18 per year per thousand kilowatts of thermal capacity authorized in the license

- for indemnification from $199 million to $100 million inclusive, a fee of $12 per year per thousand kilowatts of thermal capacity authorized in the license

- for indemnification from $99 million to $1 million inclusive, a fee of $6 per year per thousand kilowatts of thermal capacity authorized in the license (10 CFR 140.7 (a))

The 1977 rulemaking also reflected NRC's view that reactor licensees should pay a minimum fee, but no less than $100 annually, even if the government has no indemnity obligation, based on the reasoning that the NRC is ultimately responsible as the "guarantor of the retrospective premium and evaluator of the financial ability of reactors…."[6] NRC regulations in 10 CFR 140.7(a)(2) specify that large, operating commercial nuclear power reactor licensees participating in the industry retrospective premium plan that provide a certified financial statement as a guarantee of payment of deferred premiums in accordance with 10 CFR 140.21(e) are subject to an annual indemnity fee of $1,000. NRC's regulations also specify that licenses for the possession and use of plutonium in plutonium processing and fuel fabrication plants are subject to an annual $5,000 fee (10 CFR 140.7(c)).

Table 3-2 summarizes the Price-Anderson Act insurance and indemnity framework by type of NRC licensee.

Table 3-2 Price-Anderson Act insurance and indemnity framework by type of NRC licensee (based on January 2021 Price-Anderson Act requirements)

[6] 42 FR 46 (1977).

Type of License	Amount of Required Primary Financial Protection	Amount of Required Secondary Financial Protection	Level of Available Government Indemnification[7]	Annual Indemnification Fee Required
Large, Operating Commercial Nuclear Power Reactors (rated capacity of 100 MW(e) or more)	$450M (maximum amount available)[8]	$137.6M[9] per incident for each reactor	$0	No less than $100[10]
Decommissioning Large Commercial Nuclear Power Reactors	$100M (under consideration by the NRC)[11]	$0 (under consideration by the NRC)	$460M (under consideration by the NRC)	$0
Reactors Under 100 MW(e) and Greater than 10 MW(t)	$4.5M-$74M[12]	$0	$486M to $500M	$30 per 1,000 kW of thermal capacity[13]
Reactors Under 10 MW(t), Generally	$1M-$2.5M[14]	$0	$500M	$30 per 1,000 kW of thermal capacity[15]
Reactors Under 100 MW(e), Federal Licensees	$0	$0	$500M	$30 per 1,000 kW of thermal capacity[16]
Reactors Under 100 MW(e), Nonprofit Educational Institutions	$0	$0	$500M, for liability exceeding $250,000[17]	$30 per 1,000 kW of thermal capacity[18]
Plutonium Processing and	$200M[19]	$0	$360M	$5,000[20]

[7] 42 U.S.C. 2210(c) provides the basis for all figures listed in this column, unless noted otherwise.
[8] 10 CFR 140.11(a)(4).
[9] 10 CFR 140.11(a)(4). Includes the 5-percent surcharge that could be applied in the event that an incident exceeds the maximum financial protection available.
[10] 10 CFR 140.7(a)(2).
[11] Proposed rule, Regulatory Improvement for Production and Utilization Facilities Transitioning to Decommissioning (May 22, 2018) (ML18012A022).
[12] 10 CFR 140.12(a).
[13] 10 CFR 140.7(a)(1)(i).
[14] 10 CFR 140.11(a)(1)-(3).
[15] 10 CFR 140.7(a)(1)(i).
[16] 10 CFR 140.7(a)(1)(i).
[17] 42 U.S.C. 2210(k)(1).
[18] 10 CFR 140.7(a)(1)(i).
[19] 10 CFR 140.13(a).
[20] 10 CFR 140.7(c).

Type of License	Amount of Required Primary Financial Protection	Amount of Required Secondary Financial Protection	Level of Available Government Indemnification[7]	Annual Indemnification Fee Required
Fuel Fabrication Facilities				

3.2.2 Background on Use of Government Indemnification or Other Government Funding Mechanisms in Other Related International Programs

Across international jurisdictions, common nuclear liability principles found in laws regarding third-party liability for nuclear events at large commercial nuclear power reactors include mandatory financial coverage of the operator's liability (at differing levels of required coverage) and limits of liability in amount and in time. By limiting the amount that operators would have to pay, the risks of an accident are effectively externalized beyond a certain amount of damage. As discussed in Section 2.3.2, *Maximum Amount of Available Primary Insurance*, the financial protection framework in the United States includes the highest amount of non-governmental funds available for a nuclear incident across the world. And only a minority of countries engaged in nuclear power operations include within their financial protection frameworks government funding mechanisms (e.g., including Federal Government indemnification) to supplement owner/operator funding if the operator's liability limit is exceeded (OECD NEA, 2020). For those countries that do include some kind of government guarantee, the specifics and form of the government funding mechanisms differ. Even when taking government funding mechanisms into account, no other framework has been identified in other countries that provides the amount of funding available through non-governmental funding mechanisms under the Price-Anderson Act framework.

Outside of the civilian nuclear power reactor liability context, other examples of the use of government funding mechanisms can be found in programs designed to cover potentially very significant liabilities, including both in the United States and internationally. For example, government funding mechanisms exist in the regulatory frameworks related to geologic disposal of nuclear wastes or other radioactive wastes (e.g., Germany and South Africa), long-term geologic storage of carbon dioxide (e.g., Australia, Belgium, Canada, France, Scotland, Spain, and the United Kingdom), underground injection of liquid waste (e.g., Australia), and solid waste landfills (e.g., Netherlands).

3.2.3 Strengths and Weaknesses of Government Indemnification

Government indemnification as a funding mechanism for programs associated with potentially very significant liabilities has strengths and weaknesses. Strengths of government indemnification as a funding mechanism to address potentially very significant liabilities include the following:

- <u>Certainty of coverage</u>. Governments tend to maintain very high credit ratings, making the certainty of coverage high.

- <u>Sufficient amount of coverage</u>. If claims turn out to be higher or more frequent than expected, governments have the means to provide the necessary funds.

- Cost to industry. Lower cost to industry than increasing required amounts of financial protection.

- Market effects. Reduces internal and external pressures to discontinue nuclear power production by avoiding increase to required amount of financial protection for industry and providing additional protection to the public for liabilities exceeding industry provided financial protection.

Weaknesses of government indemnification as a funding mechanism to address potentially very significant liabilities include the following:

- Cost to public. If claims exceed the amount of financial protection, the public would either be uncompensated for damages or governments would have to act to provide this compensation.

- Moral hazard. There is the possibility of some moral hazard[21] because the owner/operator would be compensated by the government for liabilities exceeding the owner/operator's financial protection. Moral hazard is minimal for events with small consequences, as the owner/operator is required to provide insurance up to the liability limit. However, there is a reduced~~little~~ financial incentive for the owner/operator to focus more effort on preventing large releases that lead to widespread contamination compared to small events, as the financial liability may be the same in either case.

- Compensation uncertainty and timeliness. While the Price-Anderson Act includes provisions to the Federal Government to provide compensation above the aggregate limit, doing so requires congressional action, making the certainty and the timeliness of this compensation less clear.

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- Inconsistency with Polluter Pays Principle. By relieving owners/operators from responsibility for portions of liabilities, the transfer of responsibility to the government would be inconsistent with the Polluter Pays Principle.

Legislative history related to past reauthorizations of the Price-Anderson Act provides insight into historic perspectives on government indemnification. When introducing the 1985 Amendments, Senator McClure discussed the successes of the Price-Anderson Act. The senator specifically supported the use of the industry retrospective premium plan as an improvement compared to relying on government indemnification. He stated that the Price-Anderson Act "has been characterized by some as a subsidy to the commercial nuclear power industry…claims to date in fact have not exceeded the primary insurance layer of coverage, and thus the Government has never paid out 1 dime for public liability claims…." Senator McClure added that replacing government indemnification with a retrospective premium assessment both removed the possibility of Federal liability in most instances and increased the total amount of available financial protection provided by industry.[22]

Senator McClure's argument echoed rationales provided during the 1975 Amendments, which first established the retrospective premium framework.[23] In the debates surrounding the 1975

[21] "Moral hazard" is the concept that the owner/operator may take less care at the facility because the cost of liabilities will be covered by another.
[22] 131 Cong. Rec. S13712, at S13816 (May 24, 1985).
[23] 121 Cong. Rec. S41103, at S41270 (Dec. 17, 1975).

Amendments, senators argued that the government indemnification had finished serving its purpose, and that it was appropriate to begin phasing out indemnification in favor of increased private responsibility. Senator Tunney argued that “Federal indemnity provisions [were] designed to give the fledgling nuclear industry time to establish a track record of safety and time to grow into an economically potent entity which could assume its own risks.”[24]

3.2.4 Reinstatement of Government Indemnification for Large, Operating Commercial Nuclear Power Reactors

Due to the Price-Anderson Act amendments that created the secondary layer of financial protection for large, operating commercial nuclear power reactors, government indemnification was effectively eliminated for these facilities. As the number of operating nuclear power reactors has decreased, concerns have been raised about the potential need to adjust the Price-Anderson Act insurance and indemnity requirements to assure adequate coverage if a catastrophic nuclear event were to occur. Based on the current Price-Anderson Act framework, the adequacy of available funding is impacted by the amount of coverage provided by industry and the level of government indemnification associated with a site. During the January 23, 2002, congressional hearing related to the most recent reauthorization of the Price-Anderson Act, concerns were raised by witnesses and senators about the limit of public liability included in the Price-Anderson Act and the related adequacy of funding that would be available in response to a nuclear event. In response to those concerns a witness at the hearing representing ANI, Mr. Quattrochi, stated the following:

> In my view as an insurer, the Act represents a balancing of interest between the public interest and the need for insurers and nuclear operators to have a certain semblance of certainty and predictability. If you take away one leg of a three-legged stool, in this case the limit on liability, the stool will fall over. For example, without a limit on liability, how many utilities would accept joint liability, responsibility for an accident in California for which a utility in New York is now responsible to pay retro premium? How many utilities would continue to accept that responsibility? I think, Senator, very, very few, if any.[25]

The reinstatement of some form of government indemnification is one potential option for responding to the concern of the adequacy of available funding without having to increase the level of responsibility for the nuclear industry. Because of the significant level of financial protection provided by industry currently and for the foreseeable future, as well as the rationales discussed above in Section 3.2.3 related to the strengths and weaknesses of government indemnification, the NRC does not believe the reinstatement of government indemnification for large, operating commercial nuclear power reactors is necessary at this time. However, this is an issue that should be revisited as the nuclear industry evolves, especially under circumstances in which the number of large, operating commercial nuclear power reactors is significantly decreased and the available amount of coverage is similarly significantly decreased.

3.2.5 Reviewing the Indemnity Fees for New, Operating, and Decommissioning Large Commercial Nuclear Power Reactors

[24] 121 Cong. Rec. S40871, at S41003 (Dec. 16, 1975).
[25] Price-Anderson Act Reauthorization: Hearing Before the Senate Committee on Environment and Public Works, Subcommittee on Transportation, Infrastructure and Nuclear Safety, S. Hrg. 107-666 (2002) at p.43.

Since inception, the Price-Anderson Act has been extended and modified several times and was most recently modified and extended through December 31, 2025, by Section 602 of the Energy Policy Act of 2005 (Pub. L. 109-58). As large, operating commercial nuclear power reactors are now subject to a multi-layer financial protection system that exceeds the original maximum limit of public liability (approximately $13.4 billion today, versus $560 million [$5 billion in 2019$] originally), amendments to the Price-Anderson Act have phased out the availability of government indemnity for these large commercial nuclear power reactors while in operation. However, licensees continue to pay at least a minimum indemnity fee of $100, although they are no longer eligible for indemnification. This fee has remained constant since initially proposed without any adjustments for inflation. The NRC cost to recover the indemnity fee of $100 is approximately $45. In consideration of the above, the NRC is considering whether the agency should continue to collect indemnity fees for large commercial nuclear power reactors while in operation. However, no final policy decisions have been identified as of the date of this report. If the NRC determines that a change is needed related to indemnity fees for large, operating commercial nuclear power reactors, the NRC believes that this issue can be addressed through regulatory action and that no revisions to the Price-Anderson Act related to this topic are needed.

Similarly, when the NRC enters into an indemnity agreement with a new reactor licensee upon issuance of a license, the licensee is not subject to indemnification until it is authorized to load fuel and operate. At the time of operation (the most likely time when a licensee may be subject to any offsite public liability from a nuclear incident), licensees of large commercial nuclear power reactors are required to maintain the maximum amount of available primary insurance and to participate in the secondary layer of financial protection. This large amount of financial protection will eliminate the need for government indemnity, as discussed in the previous paragraph related to operating reactors. Currently, new reactor licensees are required to pay the same indemnity fees as operating reactors. As with operating reactors, the NRC is considering whether the agency should continue to collect indemnity fees for new reactors. However, no final policy decisions have been identified as of the date of this report. Similar to the conclusion above, if the NRC determines that a change is needed related to indemnity fees for new reactors, the NRC believes that this issue can be addressed through regulatory action and that no revisions to the Price-Anderson Act related to this topic are needed.

The NRC's regulations at 10 CFR 140.7 do not provide for indemnity fees for decommissioning reactors. As discussed above, the Commission established the amount of fees to be paid under 10 CFR Part 140 by certain licensees on the basis of two main factors: (1) the amount of government indemnification provided and (2) kW of thermal capacity authorized in the license. When the NRC issues a license amendment to a decommissioning licensee that reflects the defueled status of the facility, the amendment includes removal of the rated capacity of the reactor from the license. Therefore, a reactor that is undergoing decommissioning has no "rated capacity" and would not be subject to the indemnity fees in 10 CFR 140.7 as currently stipulated in NRC's regulations.

Further, reactors in decommissioning for which the NRC has docketed certifications under 10 CFR 50.82(a) and 10 CFR 52.110(a) to cease operations and defuel, and whose license no longer authorizes operations, may be eligible for exemptions from the financial requirements of 10 CFR 140.11(a)(4). When approved, these exemptions permit the licensee to reduce the required level of primary offsite liability insurance from $450 million to $100 million and allow it to withdraw from participation in the secondary layer of financial protection. Once a licensee is excused from participation in the secondary layer of financial protection, it is no longer required to provide a guarantee for payment of deferred premiums, nor is it subject to the indemnification fees described in 10 CFR 140.7. The NRC is considering a proposed rule that would codify reduced financial protection requirements throughout decommissioning without the need for obtaining exemptions from NRC's regulations. The current version of the proposed rule, which has not yet been approved by the Commission, would provide licensees, once certain criteria are satisfied, the option to provide a reduced amount of $100 million in primary insurance and withdraw from the secondary layer of financial protection's retrospective premium program. The current version of the proposed rule does not include direct revisions to indemnity fees.[26]

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For reactors in decommissioning, reducing the total required financial protection to $100 million will result in reinstatement of government indemnity (in the amount of $460 million). This has factored into considerations regarding indemnity fees for decommissioning reactors. However, the possibility of having a nuclear incident that would require insurance or government indemnification is greatly reduced when compared to operating reactors, and the associated potential for offsite financial liabilities from an accident is commensurately less. As with new and operating reactors, the NRC is considering whether the agency should collect any indemnity fees from decommissioning reactors. However, no final policy decisions have been identified as of the date of this report. Similar to the conclusions above, if the NRC determines that a change is needed related to indemnity fees for decommissioning reactors, the NRC believes that this issue can be addressed through regulatory action and that no revisions to the Price-Anderson Act related to this topic are needed.

3.3 Issues Raised by International Agreements: The Convention on Supplementary Compensation for Nuclear Damage

The Convention on Supplementary Compensation for Nuclear Damage (the Convention) is an international convention on civil nuclear liability that in large part is modeled after the Paris and Vienna Conventions on Nuclear Liability, which were in turn rooted in the earlier Price-Anderson Act. The subject matter of the Convention overlaps and has provisions that achieve many of the same outcomes as Price-Anderson (especially in the case of an extraordinary nuclear occurrence) but do not rely on the same legal framework. The Convention contains a provision that permits the United States to join the Convention without changing the Price-Anderson legal framework, as long as that framework continues to achieve certain specified objectives. Thus, the United States' 2008 ratification of the Convention and the Convention's entry into force in 2015 render the terms of that Convention relevant to the subject of continuing or modifying the Price-Anderson Act.

The Convention was adopted, after extensive negotiations in which the United States actively participated, by a Diplomatic Conference convened by the International Atomic Energy Agency (IAEA) in September 1997 and was opened for signature on September 29, 1997, during the IAEA General Conference. The United States led the way in signing the Convention at that time. The Convention provides for entry into force after ratification by five States with at least 400,000 MW(t) of installed nuclear capacity among them. The entry-into-force requirements were deliberately drafted to allow the Convention to enter into force only if the United States~~,~~ and France or Japan or two other States with medium size nuclear power programs ratified the Convention.

The Senate ratified the Convention on August 3, 2006, and the Department of State announced that the ratification instrument had been deposited with IAEA on May 21, 2008. The Convention

[26] Proposed rule, Regulatory Improvement for Production and Utilization Facilities Transitioning to Decommissioning (May 22, 2018) (ML18012A022).

entered into force on April 15, 2015, following Japan's acceptance of the Convention. In addition to ratifying the Convention, Congress provided for its implementation in EISA. EISA provided that funds made available under the Convention may be used to satisfy public liability resulting from a Price-Anderson incident and that, where available, these funds would increase the overall public liability allowable under Price-Anderson Act. EISA also provided that the DOE would be responsible for implementing a risk-based retroactive premium scheme by which suppliers and transporters of nuclear equipment contribute to a Convention-mandated fund for non-Price-Anderson incidents occurring outside the United States. The DOE has not issued a final rulemaking on the subject.

3.3.1 Summary of Provisions

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The Convention, which covers only civilian nuclear installations, establishes a framework for member parties to address legal issues that would arise if a significant nuclear accident occurs. In sum, the Convention establishes where jurisdiction over nuclear incidents lies (except in certain specified and unusual circumstances, with the courts of the Party within which the incident occurs), channels financial and legal responsibility to a single source (the "operator"), establishes a minimum level of funds (which the United States far exceeds under the Price-Anderson Act) that each Party that is the "installation" State of one or more nuclear facilities must assure is available in the event of a nuclear incident in that State, and provides the mechanism for the Parties to contribute to a contingent international fund to be constituted if needed to supplement compensation available to victims pursuant to the incident nation's domestic law in the event of a nuclear accident. The Convention covers accidents for which an operator of a nuclear installation within the territory of a Party is liable.

The Convention establishes two legal criteria that must be met in order for a nation to be eligible to join. One criterion is that the country, if it has any nuclear facilities, must be a Party to the Convention on Nuclear Safety. The United States satisfied that criterion by ratifying that convention on April 11, 1999. The other criterion pertains to the country's domestic nuclear liability system and is designed to ensure that all Parties to the Convention incorporate into their domestic nuclear liability systems the three fundamental principles of international nuclear liability law, which were originated by the Price-Anderson Act. These principles include (1) channeling to the facility operator the obligation to compensate claims for nuclear damages; (2) assuring the availability of funds (by public funds if necessary) to fulfill the operator's obligations up to the allowed limit of liability, and (3) dispensing with the need to prove fault (i.e., imposing strict liability) on the part of the operator. A State may satisfy this criterion by being a Party to and in compliance with either the IAEA's Vienna Convention on Civil Liability for Nuclear Damage or the Organisation for Economic Co-operation and Development's Paris Convention on Third Party Liability in the Field of Nuclear Energy, or by having in place domestic nuclear liability statutes that conform to the provisions set forth in the Annex to the Convention. The Annex contains a "grandfather clause" that was specifically designed to allow the United States to join the Convention without altering the Price-Anderson Act as it existed at that time. While both the Vienna Convention and the Paris Convention require channeling of legal liability, the grandfather clause allowed the United States to join the Convention while preserving the structure of the Price-Anderson Act based on economic channeling only. Economic channeling allows for only one licensee to become economically liable for a nuclear incident while other entities may be held legally liable. Nonnuclear nations must accept the jurisdictional provisions, limits of liability, and the like, but need not legislate provisions that would be meaningless in the absence of nuclear facilities.

Other significant aspects of the Convention include the following:

- The Parties' obligations to contribute to the international supplementary fund are triggered only if the incident State's funds are insufficient for compensation of the nuclear damage. The contribution amounts are determined pursuant to a formula relating to each Party's installed nuclear capacity and the United Nations rate of assessment. The potential contribution of the United States is "capped" (except for accidents within the United States) to prevent a disproportionate burden being placed on the United States, especially in the early phases before there is a broad membership by the large nuclear nations.

- The international supplementary fund is tilted toward transboundary damage: half of the international supplementary fund would be made available to compensate claims for nuclear damage suffered both in and outside the Installation State without discrimination, and the other half would be available for compensation of claims only for nuclear damage suffered outside the territory of the Installation State (i.e., transboundary damage). This latter half of funds is available to compensate damage suffered inside an Installation State if the Party has assured the non-discriminatory availability of funds above a certain limit.

- The Convention leaves the Parties, including the United States, free to determine through domestic legislation how each would provide for the international supplementary fund if the obligation were triggered. EISA provides for funding the United States contribution to the international fund without increasing the burden on operators under Price-Anderson.

3.3.2 Significance to the Price-Anderson Act

As noted above, the Convention contains a "grandfather" provision that permitted the United States to become a Party without amending the Price-Anderson Act's unique provisions, designed to accommodate our Federal system. Thus, no changes were needed in the Price-Anderson Act as a result of the United States ratifying the Convention. Any modifications to the Price-Anderson Act would necessarily have to take into account U.S. obligations under the Convention. The Convention generally permits great flexibility in the specific terms of national law and even greater flexibility to the United States under the "grandfather" clause. So long as Congress continues Price-Anderson's overarching principles that conform to the provisions set forth in the "grandfather" clause the U.S. would be able to meet its obligations under the Convention. Failure to continue the Price-Anderson Act to provide coverage for future as well as existing nuclear installations, or to otherwise replace it with a similar law not meeting the requirements of the Convention, would be inconsistent with ratification.

3.4 Potential Financial Burden of Increasing Retrospective Premium Assessments

When Congress enacted legislation in 1957 to limit public liability and indemnify the nuclear power industry, it anticipated a time when Federal Government indemnification would no longer be necessary. By requiring reactor units to be insured to the maximum amount of available primary insurance, Congress gradually reduced its indemnification. A more dramatic reduction occurred in 1975, when Congress required licensees to implement a secondary layer of financial protection to be funded through retrospective assessments in addition to the maximum amount of available primary insurance. Under the new secondary layer of financial protection requirements, licensees required to maintain the maximum amount of primary insurance would be required to pay a pro-rated share of the damages in excess of the primary insurance amount, up to $5 million per reactor, per incident, in retrospective premiums, in the event of a nuclear incident resulting in damages exceeding the amount of primary insurance coverage. As a consequence, Congress reduced government indemnification and industry provided for increased private insurance coverage. Retrospective insurance, however, poses a potential additional expense for licensees that might significantly affect a company's finances. In 1988, Congress recognized this issue and, along with an increase in the maximum total amount of retrospective premiums to $63 million ($136 million in 2019$) per reactor, per incident, limited the maximum annual retrospective premium payment to a non-inflation adjusted $10 million per reactor, per incident.[27] Since 1988, Congress has adjusted the total maximum retrospective premium payment and the maximum annual retrospective premium payment. In 2005, Congress revised the $63 million retrospective premium to reflect inflation, setting the new limit to $95.8 million ($125 million in 2019$) per reactor, per incident. The 2005 Act also increased the maximum annual retrospective premium to $15 million per reactor, per incident, and mandated that this value be adjusted for inflation at 5-year intervals. Currently, the maximum annual retrospective premium has been increased to $20.496 million per reactor, per incident. The next adjustment for inflation should take place in 2023.

In past Reports to Congress, the NRC studied different levels of annual retrospective assessments and licensees' ability to afford such assessments. A report prepared by Professor Melicher of the University of Colorado in 1976 established a template that has been updated at regular intervals, including 1979, 1983, 1998, and most recently, 2020. Section 3.4.2 of this report presents the results of the 2020 analysis.

3.4.1 Background Explanation of Melicher Study

In 1976, the NRC published a research paper prepared by Professor Ronald W. Melicher of the University of Colorado titled "Financial Implications of Retrospective Premium Adjustments on Electric Utilities."[28] The paper evaluated the possible financial consequence if licensees were required to pay retrospective premiums for nuclear liability insurance. Using four licensees producing electricity from nuclear power, Professor Melicher estimated the financial impacts of assessing retrospective premiums of $3 and $5 million during 1975. He concluded that each utility would have been able to pay either of the retrospective premiums without suffering undue financial stress. This finding substantiated the viability of the retrospective insurance program, because the paper determined that the licensees would be able to meet their financial obligations. Furthermore, during hearings before the Joint Committee on Atomic Energy in 1976, a Vice President and Division Executive of the Public Utilities Department, Chase Manhattan Bank, testified that he would feel at ease even with a $10 million per-reactor retrospective premium.[29]

In 1979, the NRC applied Melicher's methodology to 1978 operating data from the same four licensees used in the 1976 report. The NRC had three reasons for the update:

1. to test Professor Melicher's conclusions using 1978 utility operating results

[27] Restricting annual payments spreads retrospective assessments over longer time periods thereby lengthening the payment period and mitigating the annual financial effects of the total assessment.
[28] NR-AIG-003, September 1976.
[29] "To Consider Whether Financial Risk to Utilities Under the Price-Anderson Act Should Be Increased," Hearings Before the Joint Committee on Atomic Energy, March 3, 1976, 94th Cong., 2nd sess., 14.

2. to reflect the number of operational units owned by each of the four licensees[30]

3. to determine the financial effects of larger retrospective insurance premiums

The 1979 NRC update of the Melicher study corroborated many of the original report's conclusions. Specifically, the update concluded that the assessments of $3, $5, and even $10 million ($11, $18, and $35 million in 2019$) per reactor, per incident, could be absorbed without significant hardship. The update questioned, however, the ability of some nuclear licensees to pay substantial assessment levels without resorting to capital markets. Specifically, the NRC study observed that "On balance, it appears that although a $10 million assessment could be managed by the four respective licensees, a $20 million assessment might be marginal" (1983 Price-Anderson Act Report to Congress, Appendix H, p. 2.).

The 1983 Price-Anderson Act Report to Congress further evaluated when retrospective assessment levels become financially burdensome. It applied the Melicher method using 1981 operating data from the same four licensees previously studied. The 1983 analysis evaluated retrospective assessment levels of $5, $10, $20, and $50 million ($13, $26, $51, $128 million in 2019$). The 1983 analysis found that a $5 or $10 million assessment had little measurable impact; the $20 million level had some significant impacts; and $50 million would pose difficulties, especially for Commonwealth Edison.

The 1998 Price-Anderson Act Report to Congress performed another evaluation of the retrospective assessment levels. It applied the Melicher method using 1996 financial data from U.S. Securities and Exchange Commission (SEC) 10-K filings. Due to changes in the ownership status of various reactors, the 1998 analysis altered the list of assessed licensees based on the following changes: (1) Duke Power was substituted for the Public Service of Colorado, which no longer owned an operating nuclear power reactor (and so was no longer a licensee), and to provide a more representative sample of the nuclear power industry; (2) Duquesne Light became a wholly-owned subsidiary of DQE; and Commonwealth Edison became a wholly-owned subsidiary of Unicom. Due to these changes, the 1998 analysis assessed Duke Power, Unicom, DQE, and Northern States Power of Minnesota. The 1998 analysis evaluated retrospective assessment levels of $5, $10, $20, $50, $80, $100, $120, and $150 million ($8, $16, $31, $78, $125, $157, $188, and $235 million in 2019$). The 1998 analysis found that annual assessments up to $50 million had minimal financial impact; the $80 million level had some significant impacts; and the $150 million level showed unacceptable financial effects for all four licensees.

For the 2020 analysis, the NRC similarly evaluated the affordability of retrospective assessment levels (i.e., when a utility experiences either financial hardship or is unable to meet its financial obligations). This analysis also examined whether current retrospective assessment levels (i.e., total and maximum annual) could be increased to provide enhanced liability protection, without causing any undue financial burdens. To answer these questions, the analysis uses:

- financial data from 2018 SEC 10-K financial statements; and
- the Melicher method, as updated in 1983 and applied in 1998.

[30] Melicher's original study assumed each utility was responsible for a single power reactor unit.

This 2020 analysis is intended solely to update the previous analysis as a way to estimate the affordability of alternative retrospective premiums.

3.4.2 2020 Analysis of 2018 Financial Data Using 1998 Approach and Professor Melicher's Methodology

The 2020 analysis considers retrospective assessment levels of $5, $10, $20, $50, $80, $100, $120, and $150 million. This range brackets the levels used in previous analyses, tests licensees' ability to meet the existing maximum annual assessment of $20.496 million~~,~~ and determines whether licensees might be able to afford larger maximum annual premiums.

Since the 1998 Price-Anderson Act Report to Congress, the nuclear industry has undergone some significant changes, as discussed in detail in Section 2.1.2. For example, many reactor units are now controlled by large parent companies with energy subsidiaries. Several changes have occurred to the four previously assessed licensees: (1) Duke Power merged with PanEnergy in 1997 to form Duke Energy; (2) Unicom merged with PECO Energy in 2000 to form Exelon; (3) Northern States Power (both the Minnesota and Wisconsin companies) merged with New Century Energies in 2000 to form Xcel Energy; (4) Duquesne Light is a wholly-owned subsidiary of parent company DQE Holdings LLC and no longer owns an operating nuclear power reactor. Based on these changes to the previously assessed licensees, this 2020 analysis includes:

- Duke Energy (9.4 reactor units)
- Exelon Corp (17.4 reactor units)
- Evergy Inc (0.9 reactor units)
- FirstEnergy Corp (4 reactor units)[31]
- Pacific Gas and Electric (PG&E) (2 reactor units)[32]
- Public Service Enterprise Group Inc. (PEG) (3.10 reactor units)
- TVA (7 reactor units)[33]
- Xcel (3 reactor units)

This analysis includes Evergy as a replacement for DQE. In the 1998 analysis, Duquesne Light owned 0.75 reactor units but now no longer owns an operating nuclear power reactor. Evergy is a suitable replacement for DQE because it, too, is a small power company that is publicly traded. There are 31 reactor units where ownership is split across multiple companies. Evergy

[31] FirstEnergy's generation subsidiary, FirstEnergy Solutions, filed for Chapter 11 bankruptcy in March 2018, which is reflected in some of the negative values presented in this analysis.
[32] PG&E filed for Chapter 11 bankruptcy in January 2019, which is reflected in some of the negative values presented in this analysis.
[33] TVA is a federally owned corporation that is not publicly traded and is not subject to income taxes. This results in select figures from TVA, such as earnings per share or income taxes, being represented as NA or zero below.

owns a partial share of Wolf Creek 1, so in this analysis Evergy represents licensees that have only partial ownership of one reactor unit.

Furthermore, this analysis was supplemented with the addition of FirstEnergy, PEG, PG&E, and TVA. The inclusion of these companies creates a representative sample with a mix of company sizes based on annual performance data from 2019, type of power producer (i.e., independent power producer (IPP) or utility), and reactor units. Within this sample there are two small companies (Evergy and PEG), three medium sized companies (FirstEnergy, TVA, and Xcel Energy), and three large sized companies (Duke Energy, Exelon, and PG&E).[34] Moreover, Exelon, FirstEnergy, and PEG represent IPPs while the remaining companies in the sample are utility power producers.[35] The selected sample of companies further contains a mix of reactors in regulated and deregulated markets. Exelon, FirstEnergy, and PEG own reactors in deregulated markets, while the remaining companies in the sample own reactors in regulated markets. There is also discernable variation in the number of reactor units owned by each company, as noted in the bullets above. Table 3-3 below presents the characteristics of each company in the sample along with their size classifications.

Table 3-3 Selected companies' characteristics

Company	Reactor Units	Number of Units*	Annual Revenue (Million 2019$)	Size**	Regulated or Deregulated	Utility or IPP
Duke Energy	9.4	Many	$24,521	Large	Regulated	Utility
Evergy, Inc.	0.9	Few	$4,276	Small	Regulated	Utility
Exelon	17.4	Many	$35,985	Large	Deregulated	IPP
FirstEnergy	4	Several	$11,261	Medium	Deregulated	IPP
PEG	2	Few	$9,696	Small	Deregulated	IPP
PG&E	3.1	Several	$16,759	Large	Regulated	Utility
TVA	7	Many	$11,233	Medium	Regulated	Utility
Xcel	3	Several	$11,537	Medium	Regulated	Utility

* Number of units were classified as: fewer than 3 reactors = few; greater than or equal to 3 and fewer than 5 = several; greater than 5 = many
** Company sizes were classified as: less than $10B = small; between $10 and $15B = medium; greater than $15B = large

[34] Size classifications were determined with the following criteria: small means less than $10 billion in 2019 annual revenue; medium means between $10 and $15 billion in 2019 annual revenue; and large means greater than $15 billion in 2019 annual revenue.
[35] An IPP is an entity that is not a public utility but instead owns facilities to generate power for sale to utilities. A utility power producer is an entity that owns facilities to generate power and sells said power to the general public.

Table 3-4 presents selected data from SEC 10-K financial statements for the eight licensees included in this analysis. The Melicher method focuses on three financial indicators: earnings per share (EPS), interest coverage, and return on common equity (ROCE).

- *EPS* is calculated by dividing earnings available to common stock shareholders (i.e., after preferred stock dividend payments) by the number of common stock shares outstanding. The output of this calculation represents a company's profitability; a higher EPS indicates a greater value, because potential investors are willing to pay more for a share of the company.

- *Interest coverage* is the sum of net income and interest expense divided by interest expense.[36] The interest coverage ratio measures the number of times a given company can cover its interest payments with its available earnings. Essentially, it measures the margin of safety a company has when making payments in a given period.

- *ROCE* is earnings available to common stock shareholders divided by common equity. It represents the amount of profit or net income a given company earns per investment dollar; a company with a high ROCE is better at generating cash internally.

Table 3-4 Selected data from 2018 10-K financial statements (millions of $)

Metric	Duke Energy	Evergy Inc	Exelon	First Energy	PEG	PG&E*	TVA**	Xcel
Total operating revenue	$24,521	$4,276	$35,985	$11,261	$9,696	$16,759	$11,233	$11,537
Total operating expenses	$19,747	$3,342	$32,143	$8,759	$7,398	$26,459	$8,665	$9,572
Operating income earnings before interest and taxes	$4,685	$934	$3,898	$2,502	$2,298	($9,700)	$2,568	$1,965
Interest expense	$2,094	$280	$1,529	$1,116	$476	$929	$1,243	$700
Earnings before taxes	$3,073	$600	$2,232	$1,512	$1,855	($10,129)	$1,119	$1,442
Income taxes	$448	$59	$120	$490	$417	($3,292)	$0	$181
Net income	$2,666	$546	$2,084	$1,348	$1,438	($6,837)	$1,119	$1,261

[36] Typically, interest coverage ratios are calculated by dividing *earnings before interest and taxes* by *interest expense*. This analysis, to be consistent with previous NRC studies, has instead used *net income plus interest expense* divided by *interest expense*. Therefore, the interest coverage ratios presented in this report may not align with financial filings or annual reporting, but this methodology allows for the comparison of these results to previous Melicher updates.

Metric	Duke Energy	Evergy Inc	Exelon	First Energy	PEG	PG&E*	TVA**	Xcel
Preferred stock dividends	0	0	0	367	0	14	0	0
Earnings available to common shareholders	$2,666	$536	$2,010	$981	$4,980	($6,851)	NA	$1,261
Common equity	$43,817	$10,028	$30,764	$6,743	$14,377	$12,651	$10,283	$12,222
2018 effective income tax	14.60%	9.70%	20.20%	32.40%	22.50%	32.60%	0.00%	12.60%
Number of common stock shares outstanding (million)	713	255	968	850	504	517	0	509
Earnings per share	$3.76	$2.50	$2.07	$1.99	$2.85	($13.25)	NA	$2.47
Interest coverage	2.26	2.95	2.36	2.21	4.02	-6.36	1.9	2.8
Return on common equity	6.08%	5.44%	6.77%	19.99%	9.60%	-54.04%	10.88%	10.32%
Number of reactors currently owned	9.38	0.90	17.35	4.00	3.10	2.00	7.00	3.00

* Negative figures reflect PG&E filing for Chapter 11 bankruptcy in January 2019.
** TVA is a federally owned company that is not subject to income taxes and is not publicly traded.

Table 3-5 shows the effects of different assessment levels on Melicher financial indicators for the eight licensees. The results in Table 3-5 are calculated as follows:

- Earnings before taxes (EBT) are reduced by the assessment level (A) (e.g., $5, $10, $20, $50, $80, $100, $120, and $150 million) multiplied by the number (N) of reactor units owned by the utility (EBT – (A x N)).
- Effective taxes (ET) are the product of the 2018 effective tax rate (ETR) and EBT: ET = ETR x EBT.

- Net income (NI) is calculated by reducing EBT in proportion to the utility's ETR: NI = EBT – (EBT x ETR). NI is calculated for each assessment level and determines the financial impacts shown in Table 3-5.

The metrics in Table 3-5 vary according to the earnings of each company, the number of reactors currently owned, and the assessment level.

Table 3-5 Financial impacts of different amounts of assessments (i.e., pre-tax expense)

Metric*	Assessment (in millions of $ per reactor)	Duke Energy	Evergy Inc	Exelon	First Energy Corp	PEG	PG&E	TVA	Xcel
Earnings per share	5	$3.68	$2.11	$2.07	$1.19	$2.83	-$13.22	NA	$2.45
	10	$3.63	$2.09	$1.98	$1.17	$2.81	-$13.23	NA	$2.43
	20	$3.51	$2.06	$1.81	$1.14	$2.76	-$13.26	NA	$2.37
	50	$3.18	$1.97	$1.30	$1.04	$2.61	-$13.34	NA	$2.22
	80	$2.84	$1.87	$0.80	$0.95	$2.47	-$13.41	NA	$2.06
	100	$2.61	$1.81	$0.46	$0.88	$2.38	-$13.47	NA	$1.96
	120	$2.39	$1.74	$0.12	$0.82	$2.28	-$13.52	NA	$1.86
	150	$2.05	$1.65	($0.39)	$0.73	$2.14	-$13.60	NA	$1.70
Interest coverage	5	2.25	2.92	2.31	1.9	4	-6.36	1.87	2.78
	10	2.23	2.91	2.26	1.89	3.97	-6.36	1.84	2.76
	20	2.20	2.88	2.15	1.87	3.92	-6.38	1.79	2.73
	50	2.08	2.79	1.83	1.79	3.77	-6.42	1.62	2.61
	80	1.97	2.7	1.5	1.72	3.62	-6.46	1.45	2.5
	100	1.89	2.65	1.29	1.67	3.52	-6.49	1.34	2.43
	120	1.81	2.59	1.07	1.63	3.42	-6.52	1.22	2.35
	150	1.70	2.5	0.75	1.55	3.26	-6.57	1.06	2.24

Metric*	Assessment (in millions of $ per reactor)	Duke Energy	Evergy Inc	Exelon	First Energy Corp	PEG	PG&E	TVA	Xcel
Return on common equity	5	5.8%	5.40%	6.70%	15.00%	9.90%	-54.0%	10.5%	10.20%
	10	5.7%	5.30%	6.40%	14.80%	9.80%	-54.1%	10.2%	10.10%
	20	5.5%	5.20%	5.90%	14.40%	9.70%	-54.2%	9.5%	9.90%
	50	5.0%	5.00%	4.30%	13.20%	9.20%	-54.5%	7.5%	9.20%
	80	4.4%	4.80%	2.70%	11.90%	8.70%	-54.8%	5.4%	8.60%
	100	4.1%	4.60%	1.60%	11.10%	8.30%	-55.0%	4.1%	8.20%
	120	3.7%	4.40%	0.50%	10.30%	8.00%	-55.2%	2.7%	7.70%
	150	3.2%	4.20%	-1.10%	9.10%	7.50%	-55.6%	0.7%	7.10%

* The metrics in the above table are calculated assuming assessments increase operating expenses and, therefore, decrease net income pre-tax.

Table 3-6 presents the information in Table 3-5 in terms of the percent reduction in EPS and interest coverage, but not ROCE. The amount of debt and equity varies according to economic stressors and management discretion, making it a less useful metric for determining financial hardship. As shown, interest coverage is a less sensitive indicator than EPS. In terms of impacts on EPS, PEG would experience double-digit impacts starting at the $80 million assessment level. Duke Energy and Xcel would experience double-digit impacts starting at the $50 million assessment level. Exelon would experience double-digit impacts starting at the $20 million assessment level, Evergy and FirstEnergy would experience double-digit impacts starting at the $5 million assessment level. PG&E would not experience any double-digit impacts.

Table 3-6 Percent reduction in financial indicators at retrospective premium levels

Metric	Assessment (in millions of $ per reactor)	Duke Energy	Evergy Inc	Exelon	First Energy	PEG	PG&E	TVA	Xcel
Earnings per share	5	2.07%	15.57%	0.12%	40.38%	0.73%	< 0%	NA	0.78%
	10	3.57%	16.21%	4.21%	41.18%	1.56%	< 0%	NA	1.82%
	20	6.56%	17.49%	12.40%	42.78%	3.23%	0.05%	NA	3.91%
	50	15.52%	21.32%	36.98%	47.57%	8.25%	0.64%	NA	10.16%
	80	24.48%	25.15%	61.55%	52.37%	13.27%	1.23%	NA	16.42%

Metric	Assessment (in millions of $ per reactor)	Duke Energy	Evergy Inc	Exelon	First Energy	PEG	PG&E	TVA	Xcel
	100	30.46%	27.70%	77.93%	55.57%	16.62%	1.63%	NA	20.59%
	120	36.44%	30.26%	94.32%	58.76%	19.97%	2.02%	NA	24.77%
	150	45.40%	34.09%	>100%	63.56%	24.98%	2.61%	NA	31.02%
Interest Coverage	5	0.28%	1.04%	2.27%	13.78%	0.63%	< 0%	1.48%	0.70%
	10	1.12%	1.54%	4.55%	14.33%	1.26%	0.06%	2.96%	1.37%
	20	2.82%	2.52%	9.09%	15.43%	2.51%	0.29%	5.93%	2.71%
	50	7.89%	5.47%	22.72%	18.72%	6.28%	0.97%	14.82%	6.72%
	80	12.97%	8.43%	36.35%	22.01%	10.04%	1.66%	23.71%	10.73%
	100	16.36%	10.40%	45.44%	24.20%	12.56%	2.11%	29.64%	13.41%
	120	19.74%	12.36%	54.53%	26.40%	15.07%	2.57%	35.56%	16.08%
	150	24.82%	15.32%	68.16%	29.69%	18.83%	3.25%	44.45%	20.09%

The 1983 Price-Anderson Act Report to Congress presented a minimally acceptable threshold for the interest coverage ratio (i.e., 2.0). An interest coverage ratio of 2.0 is widely considered to be the minimum acceptable amount for a company that has consistent revenues, such as utilities.

The 1983 Price-Anderson Act Report to Congress illustrated financial hardship at assessment levels between $10 and $20 million (between $25 and $51 million in 2019$). The 1998 Price-Anderson Act Report to Congress illustrated financial hardship for three of the four licensees at assessment levels up to $50 million ($78 million in 2019$), and at levels up to $80 million ($125 million in 2019$) two of the four licensees still showed financial metrics within an acceptable range.

In comparison, this analysis shows that six of the eight licensees face financial stress up to a $50 (and even an $80) million assessment level, but an assessment level of $150 million is considered unacceptable for all the licensees. TVA and PG&E maintain an interest coverage ratio below the minimally acceptable 2.0 level without any assessment, and they drop below this threshold beginning at a $5 million assessment. Similarly, Exelon falls below this threshold beginning at a $50 million assessment level due to the large number of reactors it owns. EPS and ROCE are often examined against industry averages. The average EPS for the utility sector is $2.68;[37] however, five of the eight licensees start below this average at a $0 assessment level. Four of the five companies filed for bankruptcy, or had a subsidiary file for bankruptcy,

[37] Average EPS for the utility sector, including electric, gas, or water utilities, based on available data from September 2019 (Fidelity, 2019).

recently, implying that these companies are less financially stable than the industry average. Similarly, the ROCE industry average for the power sector is 9.27 percent,[38] and four of the eight licensees start below this average at a $0 assessment level. Therefore, it is difficult to assess the impacts based on the magnitudes of these metrics, and instead the analysis relies on the percent reduction (Table 3-6). If negative impacts are held within 10 to 15 percent, then Exelon sees the largest impacts due to its ownership of a large number of reactor units. Table 3-7 presents the financial hardship criteria along with the basis for each criterion.

Table 3-7 Melicher financial hardship criteria

Metric	Value	Description
Interest Coverage	>2.0	Minimally acceptable interest coverage ratio. Values less than this represent financial hardship for a company.
Return on Common Equity*	9.27%	Average ROCE for the utility sector. Values less than this represent a company that is underperforming relative to average.
Earnings Per Share**	$2.68	Average EPS for the utility sector. Values less than this represent a company that is underperforming relative to average.

* Average ROCE for the power industry based on available data from January 2019 (New York University, 2019).
** Average EPS for the utility sector, including electric, gas, or water utilities, based on available data from September 2019 (Fidelity, 2019).

In Table 3-8, cash flow data[39] from 2018 SEC 10-K financial statements are presented for each of the eight licensees. Net cash flow is the difference between the sources of funds from operations and the application of funds. Net cash flow is calculated for each assessment level using the net income associated with that assessment level (consistent with Table 3-5). Cash flow per share is net cash flow divided by magnitude of common stock outstanding.

[38] Average ROCE for the power industry based on available data from January 2019 (New York University, 2019).
[39] A utility's cash flow is one indicator of its ability to pay retrospective premiums. If a utility has sufficient cash flow, it can theoretically pay an assessment in cash rather than resorting to capital markets to finance the assessment. The NRC is mandated by 10 CFR 140.21 to review annually each licensee's ability to guarantee payment of retrospective premiums. In this process, the most common supporting evidence supplied by licensees is the ability to generate sufficient cash flow.

Table 3-8 Selected 2018 cash flow data (millions of $)

Metrics	Duke Energy	Evergy Inc	Exelon	First Energy	PEG	PG&E*	TVA	Xcel
Sources of funds from operations								
Net Income	$2,666	$546	$2,084	$1,348	$1,438	-$6,837	$1,119	$1,261
Net cash provided by operating activities	$7,186	$1,498	$8,644	$1,410	$2,913	$4,752	$3,938	$3,122
Application of funds								
Preferred stock dividends	$0	$0	$0	$367	$0	$14	$0	$0
Common stock dividends	$2,471	$371	$1,332	$718	$910	$0	$0	$730
Total dividends on capital stocks	$2,471	$371	$1,332	$1,085	$910	$14	$0	$730
Estimated net cash flow (i.e., sources less applications)	$4,715	$1,127	$7,312	$325	$2,003	$4,738	$3,938	$2,392
Per share funding								
Cash flow per share ($ per share)	$6.61	$4.43	$7.55	$0.38	$3.97	$9.16	NA	$4.70
Number of common stock shares outstanding (million)	713	255	968	850	504	517	0	509

* Negative figure reflects PG&E filing for Chapter 11 bankruptcy in January 2019.

These data are used in Table 3-9 to evaluate how the net cash flow and cash flow per share indicators are affected by different retrospective assessment levels. Because Exelon owns and/or operates more than 17 reactor units, its cash flow is the most affected of the eight licensees. In total dollars, Exelon's cash flow declines the furthest (i.e., $82 million) when assessed the $5 million premium.[40] But Exelon also has the greatest cash flow and is therefore best able to meet its financial obligations within a fiscal year. Table 3-9 illustrates that, from a cash flow perspective, all the licensees except FirstEnergy could handle a $50 million assessment level.

[40] The premium is a "before-tax expense"; thus, even though 17.35 reactors multiplied by $5 million is $86.75 million, the net effect on the utility is $82 million.

Table 3-9 Cash flow impacts of retrospective premium assessments (millions of $)

Metric	Assessment (per reactor)	Duke Energy	Evergy Inc	Exelon	First Energy*	PEG	PG&E	TVA**	Xcel
Net cash flow	5	$4,674	$1,118	$7,230	-$15	$1,991	$4,755	$3,903	$2,378
	10	$4,634	$1,114	$7,148	-$28	$1,979	$4,762	$3,868	$2,365
	20	$4,554	$1,106	$6,984	-$55	$1,955	$4,775	$3,798	$2,339
	50	$4,314	$1,082	$6,491	-$137	$1,883	$4,815	$3,588	$2,260
	80	$4,074	$1,057	$5,999	-$218	$1,811	$4,856	$3,378	$2,182
	100	$3,913	$1,041	$5,670	-$272	$1,763	$4,883	$3,238	$2,129
	120	$3,753	$1,025	$5,342	-$326	$1,715	$4,910	$3,098	$2,077
	150	$3,513	$1,000	$4,849	-$407	$1,643	$4,950	$2,888	$1,998
Cash flow per share	5	$6.56	$4.39	$7.47	-$0.02	$3.95	$9.20	NA	$4.67
	10	$6.50	$4.38	$7.38	-$0.03	$3.93	$9.21	NA	$4.65
	20	$6.39	$4.34	$7.21	-$0.07	$3.88	$9.24	NA	$4.60
	50	$6.05	$4.25	$6.70	-$0.16	$3.74	$9.31	NA	$4.44
	80	$5.71	$4.15	$6.20	-$0.26	$3.59	$9.39	NA	$4.29
	100	$5.49	$4.09	$5.86	-$0.32	$3.50	$9.44	NA	$4.18
	120	$5.26	$4.02	$5.52	-$0.38	$3.40	$9.50	NA	$4.08
	150	$4.93	$3.93	$5.01	-$0.48	$3.26	$9.57	NA	$3.93

* Negative values reflect FirstEnergy's subsidiary, FirstEnergy Solutions, filing for Chapter 11 bankruptcy in March 2018.
** TVA is a federally owned company that is not subject to income taxes and does not issue shares.

Table 3-10 extends the results from Table 3-9 by presenting the percentage changes in net cash flow associated with the different levels of assessments. Table 3-10 shows that FirstEnergy would incur significant cash flow reductions (>100 percent) for each assessment level and all assessment levels are infeasible for the company. For the other licensees, net cash flow is not a limiting factor in assessment levels.

Table 3-10 Percent reduction in net cash flow after assessing retrospective premiums

Metric	Assessment (millions of $ per reactor)	Duke Energy	Evergy Inc	Exelon	First Energy*	PEG	PG&E	TVA	Xcel
Net Cash Flow	5	0.86%	0.77%	1.12%	>100%	0.60%	0.35%	0.89%	0.58%
	10	1.71%	1.13%	2.25%	>100%	1.20%	0.50%	1.78%	1.13%
	20	3.41%	1.85%	4.49%	>100%	2.40%	0.78%	3.56%	2.22%
	50	8.51%	4.01%	11.23%	>100%	6.00%	1.63%	8.89%	5.51%
	80	13.61%	6.18%	17.96%	>100%	9.60%	2.49%	14.22%	8.80%
	100	17.00%	7.62%	22.45%	>100%	12.00%	3.06%	17.78%	10.99%
	120	20.40%	9.06%	26.94%	>100%	14.40%	3.63%	21.33%	13.18%
	150	25.50%	11.22%	33.68%	>100%	18.00%	4.48%	26.66%	16.47%

* Negative values reflect FirstEnergy's subsidiary, FirstEnergy Solutions, filing for Chapter 11 bankruptcy in March 2018.

Table 3-11 shows for each assessment level the number of reactor units that could be covered by cash flow. Generally, the number of reactor units that can be covered by each utility is approximately halved with each doubling of the assessment. The licensees would be able to cover a substantial number of reactors at the $5 million assessment level. At levels up to $150 million, the eight licensees have sufficient net cash flow to more than cover their pro rata shares, based on reactor ownership.

Table 3-11 Possible number of reactors covered by cash flow at various assessments

Assessment (millions of $ per reactor)	Duke Energy	Evergy Inc	Exelon	FirstEnergy	PEG	PG&E	TVA	Xcel
5	1,673	331	1,833	321	752	1,413	788	714
10	837	165	916	160	376	707	394	357
20	418	83	458	80	188	353	197	179
50	167	33	183	32	75	141	79	71
80	105	21	115	20	47	88	49	45
100	84	17	92	16	38	71	39	36
120	70	14	76	13	31	59	33	30

Assessment (millions of $ per reactor)	Duke Energy	Evergy Inc	Exelon	FirstEnergy	PEG	PG&E	TVA	Xcel
150	56	11	61	11	25	47	26	24

3.4.3 Methodology and Data Limitations

When considering the financial assessment level that reactor units must meet, Congress is concerned both with balancing the need to compensate the American public and not overburdening the licensees owning the nuclear power reactor units. Professor Melicher's method is one way of determining the level of assessment that can be borne by licensees without undue financial stress; however, it is subject to some significant limitations. The method's primary limitations include:

- representativeness of the sample;
- use of a single- vs. multi-year assessment test; and
- appropriate affordability/financial indicators.

3.4.3.1 Representativeness of the Sample

The Melicher method originally used only four licensees to characterize the nuclear industry, and the original Melicher method included only three of the 47 companies currently licensed to operate nuclear power reactors. The original method accounted for only 15.25 of the 110 reactors licensed. Data readily at hand indicated that the Melicher sample was not representative of licensees that owned nuclear power units.

The 1998 Price-Anderson Act Report to Congress came to similar conclusions. The 1998 analysis determined that the Melicher licensees did not represent all quartiles of the industry, and noted that Professor Melicher acknowledged in 1976 that the four investor-owned licensees he selected represented at the time two relatively small, one medium, and one large company in terms of revenue. DQE no longer owns an operating plant, and in order to make the sample more representative, the NRC substituted Evergy in the 2020 analysis. Furthermore, the NRC supplemented the 2020 analysis with FirstEnergy, PEG, PG&E, and TVA.

Comparatively, the licensees included in the 2020 analysis better represent the nuclear industry. This analysis includes three larger licensees—Duke Energy, Exelon, and PG&E, with 9.38, 17.35, and 2 units and revenues of $25 billion, $36 billion, and $17 billion, respectively—three medium licensees—Xcel, FirstEnergy, and TVA, with 3, 4, and 7 units and each have revenue of $11 billion—and two small licensees—Evergy and PEG with fewer than one and 3.10 units and revenues of $5 billion and $6 billion, respectively. As noted previously, 32 percent of reactor units (31 total) are partially owned by multiple companies. Evergy well represents the smaller licensees that have a partial stake in reactor units. In addition, this analysis includes 3 companies with reactors in deregulated markets—Exelon, FirstEnergy, and PEG—and 5 companies with reactors in regulated markets—Duke Energy, PG&E, Xcel, TVA, and Evergy. Together these companies represent plant sizes from 741 to 2,770 MW and these plants contain both single- and multi-unit locations.

3.4.3.2 Use of Single- vs. Multi-year Assessment Test

The Melicher method tests single-year affordability, rather than multi-year affordability. If a licensee can afford a one-time $50 million assessment, then it likely can afford five yearly assessments of $10 million; however, the converse is not necessarily true. A licensee that can afford a series of five $10 million assessments may not be able to afford a one-time $50 million assessment. Similarly, a licensee may be able to afford three yearly payments of $20 million, but not a fourth.

This time and payment schedule issue may be particularly important for small licensees (e.g., Evergy) and licensees with many reactor units (e.g., Exelon).

3.4.3.3 Appropriate Indicators of Affordability

Finally, the Melicher method may not use the most appropriate indicators and thresholds for assessing affordability to licensees. The 1998 Price-Anderson Act Report to Congress outlines shortcomings with the Melicher indicators, which remain in this updated study:

- EPS and cash flow per share are an arbitrary basis on which to evaluate licensees because the number of common stock shares issued varies arbitrarily. Additionally, companies have the option to buy back their own shares, and so can improve their income per share, for example, by reducing the number of shares outstanding without actually increasing their NI. Individual EPS are generally compared to the industry average ($2.68); however, five of the seven licensees have EPS below the industry average as their baseline before any assessment.

- ROCE suffers from a similar issue as EPS because the amount of debt and equity is a fluid value subject to management discretion.

- The Melicher method does not state a minimum threshold for acceptable cash flow, ROCE, or EPS. A threshold for interest coverage (2.0) has been applied but was not supported with a discussion of how or why it was selected.

3.4.4 Conclusions

The purpose of this analysis was to use the Melicher method to assess the affordability of various amounts of retrospective insurance premiums. The conclusions reached in this analysis parallel those found in the first analysis done by Professor Melicher in 1976 (and subsequent Reports to Congress) when he concluded that, “Evidence suggests that current cash flows for investor-owned electric licensees (entering into reactor ownership arrangements) seem adequate to meet possible retrospective premium assessments” (1983 Price-Anderson Act Report to Congress, Appendix H, p. 11). Given that the current annual assessment level is $20.496 million, the general conclusions Professor Melicher reached in 1976 remain the same in 2020 (i.e., licensees will be able to afford retrospective assessment payments).

The 1979 NRC study determined that assessments at the $10 million ($35 million in 2019$) level were manageable but that problems might arise at the $20 million ($70 million in 2019$), and higher, assessment levels. The 1983 Price-Anderson Act Report to Congress, using financial data, from 1981, demonstrated that assessments at the $50 million ($128 million in 2019$) level per reactor could pose major problems for all four of the licensees and especially for the two with more than one reactor each. It also showed how licensees began to experience financial hardship at assessment levels ranging between $10 and $20 million. That finding supported the 1979 NRC study's findings that recommended limiting the maximum assessments to $10 million per year, because higher assessments could cause financial hardship. The 1998 Price-Anderson Act Report to Congress concluded that the maximum annual assessment that all four licensees could afford ranged between $20 and $50 million (between $31 and $78 million in 2019$).

The updated analysis of eight current licensees is generally consistent with the conclusions from the 1998 Report to Congress. The maximum annual assessment that seven of the eight selected licensees could afford ranges between $20 and $50 million. Above $50 million, smaller licensees, and those licensees owning multiple reactor units may show signs of an inability to pay. There have previously been concerns about the ability of IPP facilities to pay retrospective premiums, but there does not appear to be a discerni~~a~~ble difference between IPP and utility companies in regard to their financial stability or ability to pay the retrospective premiums.

4 CONCLUSIONS AND RECOMMENDATIONS

Protection of the public has been a principal purpose of the Price-Anderson Act, along with removing barriers to the nuclear energy option as a private commercial endeavor. The statutory scheme of government indemnification and/or private insurance has been intended to assure the availability to the public of adequate funds in the event of a nuclear incident. Other benefits to the public include such features as emergency assistance payments, consolidation and prioritization of claims in one court, channeling of liability through the “omnibus” feature, and waiver of certain defenses in the event of a large accident. The system has removed the deterrent to private sector participation in nuclear power programs by reducing the probability of financial catastrophe for industry participants due to liability resulting from a nuclear accident. The structured payment system of billions of dollars created to meet the two objectives stated in the Price-Anderson Act has assured that significant funds are available to the public to satisfy claims if a nuclear event were to occur, enabled private sector participation in atomic energy, and operated for over 60 years with minimal cost to the taxpayer.

If a large accident were to occur, Congress recognized (initially in 1957, and through the various extensions of the Act) that a single utility reactor licensee probably could not meet the costs of such an accident. Similar acknowledgments have been heard throughout the extensions of the Price-Anderson Act. Further, the Price-Anderson Act has since 1975 specifically provided that, in the event of a nuclear incident involving damages in excess of the statutory public liability limit, Congress would review thoroughly the particular incident and take whatever action is deemed necessary and appropriate to protect the public from the consequences of a disaster of such magnitude.

As of October 2020, based on the number of large, operating commercial nuclear power reactors, the nuclear power industry is insured to a maximum per-incident dollar level of $13.4 billion under the Price-Anderson framework. This dollar figure results from adding maximum available primary insurance coverage of $450 million to maximum available retrospective premiums of $12.935 billion (i.e., 94 reactor units in October 2020 multiplied by $137.609 million [$131.056 million x 5-percent surcharge]). If the number of participating nuclear power reactor units decreases, the total amount of available funding will decrease, absent further changes to Price-Anderson. Nonetheless, even with a future reduction in participants, the aggregate amount of coverage will remain a large sum for the near ~~immediate~~ future.

As was discussed in detail in this report, the Price-Anderson system has functioned well in connection with the payment of claims arising out of the TMI accident in 1979, the only major accident situation where it was called upon (though only the primary layer of financial protection was engaged). Many nuclear suppliers express the view that without Price-Anderson coverage, they would not participate in the nuclear industry. Despite the expected early retirement of nuclear power reactors, Price-Anderson will continue to make a large sum of funds available to any victims of nuclear incidents for at least the next decade.

Overall, the staff has not identified any information that suggests discontinuing the Price-Anderson Act provisions would be warranted based on NRC’s public health and safety mission. The NRC staff therefore recommends that the same amount, type, and terms of public liability protection be provided for future and existing licensees.

Furthermore, because the Act has benefited from extensive public discussion and legislative modification over the years, creating an effective and balanced framework for financial protection, and because the Act provides the NRC a fair amount of discretion and flexibility in implementing that framework, only modest modifications need to be contemplated in connection with its continuation. The NRC will continue to address through agency action, including rulemaking when necessary, matters related to Price-Anderson implementation.

4.1 Recommendations

(1) A recommendation that the Congress continue the Price-Anderson Act, because the Act provides a valuable public benefit by establishing a system for the prompt and equitable resolution of public liability claims resulting from a nuclear incident. Consistent with previous renewals, it is further recommended to continue the Act for 10 years to allow Congress to be better able to consider substantial changes related to trends in decommissioning and in advanced reactor technologies that have begun and that are anticipated to continue within the nuclear power industry. Continuation of the Act would provide the same indemnification provisions for future nuclear licensees as are currently provided to existing nuclear licensees, and the existing financial protection and limit of public liability provisions should be maintained. Any changes in the Act should apply to both existing and new nuclear licensees.

(2) A recommendation, consistent with a recommendation in the previous Price-Anderson Report, that the Congress clarify its intent on the following issues that have been sources of uncertainty in implementing Price-Anderson. The clarifications should:

a. Address whether the prohibition on payment of punitive damages extends to every case where a defendant has entered into an indemnification agreement under Price-Anderson, or only to those where damages would exceed the non-governmental first and second layers of financial protection and actually involve the government paying for punitive damages, to resolve conflicting holdings from district courts described in more detail in Section 1.2.7 of this report.

b. Clarify that a nonprofit NRC licensee shall not be indemnified for legal costs incurred in connection with the settlement of a claim, to confirm the Commission's interpretation of the relationship between 42 U.S.C. 2210(h) and 42 U.S.C. 2210(k) described in more detail in Section 1.2.9 of this report.

(3) A recommendation that any modifications to the Price-Anderson Act should take into account U.S. obligations under the Convention on Supplementary Compensation for Nuclear Damage, which is described in more detail in Section 3.3 of this report.

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APPENDIX A
LISTING OF LITIGATION SURROUNDING THE PRICE-ANDERSON ACT AND THE SUMMARY RESULTS

A review of noteworthy litigation concerning the Price-Anderson Act follows. The review covers cases discussed elsewhere in this report, cases discussed in NRC annual reports on court litigation, and opinions that were both issued after 1998 and identified in LexisNexis[1] “Case Notes” to 42 U.S.C. 2210. This review excludes cases focused on DOE facilities and contractors for the most part.[2] The cases are ordered chronologically, according to the date of each opinion’s issuance.

A.1 *Duke Power Co. v. Carolina Envtl. Study Group*, 438 U.S. 59 (1978)

Plaintiffs sought a declaration that the Price-Anderson Act was unconstitutional. The Court first addressed the issue of standing. It decided this issue in plaintiffs’ favor, holding that their residency near a nuclear plant that posed the threat of immediate, adverse environmental effects constituted a sufficient interest to satisfy the “injury in fact” element for standing. The Court further reasoned that the redressability element of standing was satisfied, stating that, but for the protection of the Price-Anderson Act, Duke would not be able to construct the plants at issue.

On the merits of the case, plaintiffs argued that, by (1) impeding their access to compensation in the event of a nuclear accident and (2) limiting recovery to an amount without rational relationship to potential losses, the Price-Anderson Act abrogated their Fifth Amendment rights. The Supreme Court held that plaintiffs had failed to show that Congress acted in an arbitrary and irrational way, reasoning that the imposition of a statutory limit of public liability bore a rational relationship to Congress’s concern for promoting private nuclear power generation. The Court also held that the Price-Anderson Act did not unconstitutionally abridge plaintiff’s Fifth Amendment due process rights, because it provided a “reasonably just substitute” to the State tort law remedies it replaced.

Finally, the lower court had held that the Price-Anderson Act constituted a violation of plaintiffs’ Fifth Amendment equal protection rights by imposing the costs of nuclear power on an arbitrarily chosen segment of society. The Supreme Court held that the “general rationality” of the Price-Anderson Act refuted this holding. Significantly, the Supreme Court upheld the constitutionality of the Price-Anderson Act.

A.2 *Silkwood v. Kerr-McGee Corp.*, 464 U.S. 238 (1984)

Plaintiff brought a suit against defendant plutonium processing plant operator for punitive damages in redress for harm resulting from exposure to radiation. The Supreme Court held that the Price-Anderson Act did not apply, because the defendant was not required to maintain the Price-Anderson Act financial protection at the time of the event. The Court relied on the legislative history of the Price-Anderson Act in also holding that State tort law remedies were not preempted by Federal regulation of the nuclear energy industry. The Court concluded that the

[1] A ~~leading~~ global provider of legal information and analytics with current collections of case law and ~~the~~ attorney-edited case notes.~~, “most current and valid collection of case law.”~~

[2] Where it is unclear whether the case involved DOE or NRC activities, the case has been included.

jury's award of punitive damages for harm resulting from exposure to radiation, and the State statute that supported the award, were not preempted by the Price-Anderson Act.

A.3 *In re TMI Litigation Cases Consol. II*, 940 F.2d 832 (3~~-~~d Cir. 1991)

Plaintiffs, thousands of residents and businesses in an area, sued the owners and operators of the TMI facility, stating tort law claims for injuries caused by radiation released during the 1979 accident. After defendants removed the case to Federal court, plaintiffs sought to remand to State court. Plaintiffs argued that the 1988 Amendments ~~unconstitutionally~~ exceeded Congress's authority in Article 3, Section 2 of the Constitution~~,~~ by creating a Federal forum for cases arising from State law alone. The court ruled that where Congress has the authority to legislate in a given area and substantively does so, a grant of Federal subject matter jurisdiction will survive an Article 3 challenge. The court held that the Price-Anderson Act, and its provision that "substantive rules of decision shall be derived from" State law satisfied this requirement, and that State law simply provides the content of and operates as Federal law in the context of the Price-Anderson Act. Moreover, the court held that, notwithstanding this provision, the Price-Anderson Act provided sufficient Federal elements to survive an Article 3 challenge by creating a cause of action and channeling liability through it. The 1988 Amendments' jurisdictional grant survived constitutional challenge and plaintiffs' motion to remand to State court was denied.

A.4 *In re TMI Metro. Edison Co.*, 67 F.3 d 1119 (3~~-~~d Cir. 1995)

Plaintiffs, thousands of residents and businesses in an area, sued the owners and operators of the TMI facility, stating tort law claims for injuries caused by radiation released during the 1979 accident. On interlocutory appeal, the court issued holdings on the standard of care and proof of causation and damages in Price-Anderson Act public liability actions.[3] On the former issue, the court held that the ALARA standard of care – found in the "General Provisions" and licensing chapter of Federal nuclear regulations – was superseded by Federal nuclear regulations found in 10 CFR 20.105 and 20.106, in the subpart covering "Permissible Doses, Levels, and Concentrations." The court opined that the ALARA standard of care is less precise and would afford the fact-finder greater discretion in determining whether a defendant owner or operator failed to meet the standard of care. With respect to the issue of proof of causation and damages, the court held that a particular plaintiff's actual exposure to radiation was relevant to proving causation and damages. However, exposure alone, without evidence as to whether the defendant owners and operators breached the applicable standard of care, did not entitle plaintiffs to recover.

A.5 *Gilberg v. Stepan Co.*, 24 F. Supp. 2d 325 (D.N.J. 1998)

Plaintiff sought damages in State court for harm caused to his land by chemical contamination resulting from thorium and thorium waste – "source" material and "byproduct" material under the Atomic Energy Act of 1954 – produced at a chemical manufacturing facility. Defendant removed the action to Federal court, arguing that plaintiff's injury arose from "an occurrence… [causing harm] arising out of or resulting from the…properties of source…or byproduct material," and thus from a nuclear incident for which the Price-Anderson Act provides defendant the right to remove to Federal court. However, the court interpreted the meaning of the word "occurrence" to be consistent with the definition provided for an "extraordinary nuclear occurrence." This interpretation required that an "occurrence" take place at a location specified in a Price-

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[3] A Price-Anderson Act public liability action is a suit for any legal liability arising out of or resulting from a nuclear incident or precautionary evacuation.

Anderson Act indemnity agreement. The court provided an extensive legislative history in arriving at its ruling that a nuclear incident must arise out of an event at the site of an activity that is covered by a Price-Anderson Act indemnification agreement. Applying this rule, the court held that, because no indemnification agreement covered the chemical manufacturing facility, the case presented no nuclear incident. The court held that it was thus improper to remove the case to Federal court as a Price-Anderson Act public liability action.

A.6 *Carey v. Kerr-McGee Chem. Corp.*, 60 F. Supp. 2d 800 (N.D. Ill. 1999)

Plaintiffs sued for property damage and medical monitoring costs, alleging that defendant corporation's chemical plant produced thorium tailings that contaminated plaintiffs' property. Defendants argued that plaintiffs' claims must be pleaded as a Price-Anderson Act public liability action and, thus, that defendants were subject to a standard of care set by Federal nuclear regulations. The court addressed whether plaintiffs' allegations described a nuclear incident under the Price-Anderson Act, and, specifically, the meaning of the word "occurrence" in the definition of a nuclear incident. The court discussed the definition of "occurrence" as applied in *Gilberg* (reviewed above), which required an event at the site of an activity covered by a Price-Anderson Act indemnification agreement. Contrary to the *Gilberg* decision, the court ruled that the Price-Anderson Act's plain language requires covering any happening or event that causes injury and arises out of the properties of nuclear material, regardless of whether the event occurred at the site of a Price-Anderson Act covered activity. Applying this definition, the court held that plaintiffs' State law claims for an injury resulting from thorium were, because the injury allegedly arose out of the properties of the nuclear material, preempted by the Price-Anderson Act's public liability action provision. The court further held that plaintiffs' tort claims would be decided according to the standard of care set by Federal nuclear regulations.

A.7 *Corcoran v. New York Power Auth.*, 202 F3d 530 (2d Cir. 1999)

Plaintiff estate of a deceased employee of a nuclear power plant asserted a wrongful death claim in a Price-Anderson Act public liability action against defendant operator of the plant, alleging that the operator negligently exposed decedent to nuclear radiation. Plaintiff argued that New York's notice of claim requirement, which would bar plaintiff's suit as untimely, was preempted by the Price-Anderson Act. The court held that New York's law was neither inconsistent with any provision of the Price-Anderson Act nor contrary to the Price-Anderson Act's purpose, affirming the dismissal of plaintiff's claim.

A.8 *El Paso Natural Gas Co. v. Neztsosie*, 526 U.S. 473 (1999)

Plaintiffs filed suit in Navajo Tribal Courts, claiming damages against the owners of abandoned uranium mines and mills for claimed adverse health effects. The owners sought a Federal court injunction against continuation of the Tribal court suits on the ground that "nuclear tort" claims arise exclusively under the Price-Anderson Act and lay outside the jurisdiction of Tribal courts. The lower courts refused injunctive relief and required the owners to exhaust their Tribal court remedies. The Supreme Court then took up the case. The Supreme Court decided that the usual doctrine requiring defendants in Tribal court to exhaust Tribal court remedies does not apply in the Price-Anderson Act context, which preempts State and Tribal law. The Court held that the mine and mill owners were entitled to insist that Federal courts, not Tribal courts, decide the question whether plaintiffs' claims fall under the Price-Anderson Act.

A.9 *Heinrich ex rel. Heinrich v. Sweet*, 62 F. Supp. 2d 282 (D. Mass. 1999)

Plaintiffs brought claims for harm suffered as a result of being subjected to boron neutron capture therapy without consent. The court ruled that the Price-Anderson Act's preemption of State tort claims turned on whether those claims arose from a "nuclear incident." Citing *Gilberg* (*Gilberg v. Stepan Co.*, 24 F. Supp. 2d 325 (D. N.J. 1998)), the court held that a nuclear incident is a release of radiation in connection with an activity at the site indemnified under the Price-Anderson Act. The court then decided that defendants' conduct was indemnifiable under their agreements with the NRC, and, thus, that plaintiffs' only legal recourse was through a Price-Anderson Act public liability action. Furthermore, the court ruled that the statute of limitations applicable in the State where each injury occurred would control in the public liability action.

A.10 *Massachusetts General Hospital v. United States*, No. 01-434 C (U.S. C~~our~~t. ~~of~~ Fed.~~eral~~ Claims)

Commented [A23]: Add the year to the case citations in paragraphs A.10, A.10.1, and A.10.2.

Plaintiff hospital claimed reimbursement for damages, attorney's fees, and costs incurred in *Heinrich v. Sweet*, above. Defendants in *Heinrich v. Sweet* invoked a 1959 Price-Anderson Act indemnity agreement in claiming reimbursement from the government for the substantial legal fees and costs incurred in that suit. The court rejected NRC's threshold argument, in a summary judgment motion, that the Price-Anderson Act does not cover what are, in essence, medical malpractice claims. Subsequently (after discovery), the government settled all claims and the court vacated its original liability ruling as moot.

A.10.1 *Massachusetts Institute of Technology v. United States*, No. 00-292 C (~~United States~~U.S. Ct.~~ourt~~ ~~of~~ Fed.~~eral~~ Claims)

This is a companion case to *Massachusetts General Hospital v. United States*, above. It was resolved identically to that case.

A.10.2 *Sweet v. United States*, No. 00-274 C (U.S. Ct.~~ourt~~ ~~of~~ Fed.~~eral~~ Claims)

This is a companion case to *Massachusetts General Hospital v. United States*, above. It was resolved identically to that case.

A.11 *Lokos v. Detroit Edison*, 67 F Supp 2d 740 (E.D. Mich.~~,~~ 1999)

Plaintiff, who lived and worked in proximity to a nuclear power plant, alleged that a Price-Anderson Act nuclear incident caused her to develop cancer. The court held that~~,~~ the plaintiff must show that Federal limits were exceeded at a given location and that plaintiff was exposed to that radiation, in order to establish a breach of duty on the defendant's part in a Price-Anderson Act public liability action. Plaintiff failed to make such a showing. The court issued summary judgment in favor of the defendant, holding that the plaintiff failed to show that defendant caused a release of radiation in exceedance of Federal nuclear regulations and thereby failed to show a breach of the applicable standard of care on the defendant's part.

A.12 *Kennedy v. S. Cal. Edison Co.*, 268 F.3 d 763 (9th Cir. 2001)

Plaintiffs brought a “radiation tort” suit arising out of leukemia allegedly caused by radioactive “fuel fleas”[4] that escaped the San Onofre reactor site. After trial, a Federal district court jury found against plaintiffs. A panel of the court of appeals set aside the jury verdict on the ground of improper jury instructions. The court of appeals ruled that plaintiffs could prevail if they could show even a small probability – a 1 in 100,000 chance – that the fuel fleas had caused the leukemia. After the Justice Department filed an amicus brief, the court of appeals decided that plaintiffs’ evidence at most showed an infinitesimal or theoretical possibility of causation. This, the court held, did not justify a judgment for plaintiffs and rendered any technical defects in the jury instructions harmless.

A.13 *Wilhite v. Illinois Power Co.*, 139 F. Supp 2d 971 (C.D. Ill.~~,~~ 2001)

Plaintiff employee working at a nuclear power station filed a Price-Anderson Act public liability action for harm from exposure to radiation. The court granted defendant’s motion for summary judgment, holding that plaintiff’s injury was exclusively compensable by State workers’ compensation and could not be pursued as a Price-Anderson Act public liability action.

A.14 *Samples v. Conoco, Inc.*, 165 F. Supp. 2d 1303 (N.D. Fla.~~,~~ 2001)

Plaintiffs filed a class action suit in State court, making several claims that alleged environmental contamination associated with the industrial facilities owned by defendant corporations. Defendants removed the case to Federal court, where the plaintiffs moved to remand the case back to State court, arguing that the Federal court lacked subject matter jurisdiction. The Federal court remanded the case to State court, ruling that a Price-Anderson Act public liability action can only apply to “occurrences” where NRC licensees or DOE contractors are involved. The court explained that the Price-Anderson Act applies only where liability arises from the conduct of the nuclear energy and weapons industries. However, the defendants here were chemical companies. Thus, despite the fact that some of the alleged harm resulted from source material, the Federal court held that the Price-Anderson Act did not apply and remanded the case to State court.

A.15 *Finestone v. Fla. Power & Light Co.*, 319 F. Supp 2d 1347 (S.D. Fla.~~,~~ 2004)

Plaintiffs alleged, in a Price-Anderson Act public liability action, that their minor child developed neuroblastoma as a result of defendant nuclear plant’s negligent release of radiation. The court issued a ruling on the applicable standard of care, setting it as exclusively controlled by the specific dosage limitations in Federal nuclear regulations. Plaintiffs argued that, pursuant to Federal nuclear regulations, the applicable standard of care either depended on the injured party being a minor or required that doses to unrestricted areas be ALARA. The court held that plaintiffs’ construction of 10 CFR 20.1003 was meritless and that there was no separate standard of care for minor members of the public. The court also agreed with the decision in *In re TMI*, holding against using ALARA as a standard of care.

[4] “Fuel fleas” are microscopic particles of new or spent nuclear fuel.

A.16 *Hand v. Cargill Fertilizer, Inc.*, 157 F. App'x 230 (11th Cir. 2005)

Plaintiffs filed a State claim alleging the wrongful death of their mother. Their mother died as a result of leukemia allegedly caused by exposure to radiation from her husband's clothing. Her husband had been employed at a uranium extraction plant. The court held that the plaintiffs had not alleged exposure to radiation in excess of Federal nuclear regulatory limits, which control the standard of care in a Price-Anderson Act public liability action. Plaintiffs' allegation that defendant failed to monitor exposure, alone, was not sufficient to give rise to liability under the Price-Anderson Act, because the standard of care was set by Federal nuclear regulations' dosage levels.

A.17 *Wilcox v. Homestake Mining Co.*, 401 F. Supp. 2d 1196 (D.N.M.~~,~~ 2005)

Plaintiffs alleged that the groundwater near their homes had been contaminated by a local uranium milling facility, that defendants had never warned them of any health hazards, and that plaintiffs suffered personal harm as a result. The court held that plaintiffs' State law claims were encompassed by the Price-Anderson Act, and that their claims of fraud, intentional infliction of emotional distress, negligence, and medical monitoring could proceed as a Price-Anderson Act public liability action. However, the court dismissed claims of strict and absolute liability as inconsistent with the Price-Anderson Act.

A.18 *Koller v. Pinnacle West Capital Corp.*, 2007 U.S. Dist. LEXIS 9186 (D.~~C~~ Ariz.~~,~~ 2007)

Plaintiffs, a former employee of a nuclear power station and his spouse, made claims of negligence, strict liability, and loss of consortium. Plaintiffs contended that defendants breached their duties to advise of risks and to provide a safe workplace. The court held that plaintiffs' case could only proceed as a Price-Anderson Act public liability action and that State law governed the claim to the extent it was not inconsistent with the Price-Anderson Act. The court then dismissed plaintiffs' negligence and loss of consortium claims because of their reliance on standards of care differing from Federal regulations governing radiation exposure. The court noted that plaintiffs' reliance on *Silkwood v. Kerr-McGee* ~~-~~was misplaced, given that the case was decided prior to the passage of the 1988 Amendments. The court agreed with other Federal court decisions in holding that the 1988 Amendments, which require that State law provide the "substantive rules of decision" for Price-Anderson Act public liability actions "unless such law is inconsistent with the provisions of [PAA]," preempted States from imposing any standard of care different from that found in Federal nuclear regulations.

A.19 *June v. Union Carbide Corp.*, 577 F.3 d 1234 (10th Cir. 2009)

Plaintiffs resided in a community founded around uranium and vanadium milling and mining operations. They brought a Price-Anderson Act public liability suit for personal injury claims arising from alleged exposure to radioactive materials and resultant illnesses. The court, analyzing the Second and Third Restatement of Torts, required that plaintiff show that radiation, either alone or with multiple other factors, probably would have caused the complained-of illnesses in the absence of other causes. The court also held that asymptomatic "DNA damage and cell death" does not constitute a "bodily injury," a requirement of a Price-Anderson Act public liability action. The court held that plaintiffs failed to produce satisfactory evidence as to causation and affirmed summary judgment for the defendant.

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A.20 *Wilcox v. Homestake Mining Co.*, 619 F.3 d 1165 (10th Cir. 2010)

Plaintiffs brought a Price-Anderson Act public liability action, alleging that they developed cancer as a result of exposure to radiation from defendants' uranium mill. On review, the Federal appellate court applied New Mexico law, requiring that plaintiffs show but-for causation except in cases involving alternative liability or cases involving multiple, sufficient causes for an injury. In the latter case, the court required that the complained-of exposure would probably have caused the complained-of cancer. The court expanded on this standard, stating that in a toxic tort case the plaintiff must show a reasonable degree of medical probability – not a certainty – that exposure to a substance was or would have been a but-for cause of an injury. The court affirmed summary judgment for the defendants, holding that plaintiffs fell short of satisfying the causation element underlying their Price-Anderson Act public liability action by failing to allege or present evidence that defendants' radiation caused or would have caused their cancer symptoms.

A.21 *Cotroneo v. Shaw Env't & Infrastructure, Inc.*, 639 F.3 d 186 (5th Cir. 2011)

Plaintiffs brought claims under the Federal Price-Anderson Act and State law in New York State court, alleging injuries resulting from cleaning up radioactive materials at a Texas worksite, believed to be a DOE subcontractor. Defendant employer removed the case to the district court where the injury occurred, as permitted by the Price-Anderson Act. The court of appeals affirmed the lower court's summary judgment holding that plaintiffs had failed to present sufficient evidence to raise a genuine issue of fact as to whether there was a causal connection between radiation exposure and their claimed injuries. The district court had relied on a three-part test from Texas law governing the evidentiary value of epidemiological studies to show causation. However, the court of appeals reversed the district court in holding that State "offensive contact" claims must be included within plaintiffs' Price-Anderson Act public liability action. The court ruled that a public liability action is a suit in which a party asserts any legal liability arising out of an incident involving harm caused by the hazardous properties of radioactive materials. As plaintiffs' suit alleged injuries due to exposure to radiation, the court held that the offensive contact claims had to be treated as part of the public liability action, regardless of the latter's failure to survive summary judgment. The court of appeals held that plaintiffs' failure to show causation precluded the possibility of demonstrating a "nuclear incident" and remanded the case to be dismissed with prejudice.

A.22 *Cook v. Rockwell Int'l Corp.*, 790 F.3 d 1088 (10th Cir. 2015)

Plaintiff landowners filed claims under the Federal Price-Anderson Act and State nuisance law to recover damages for property value diminution resulting from activities at the Rocky Flats plant, which was a nuclear weapons production facility during the Cold War. At trial, a jury awarded the plaintiffs a verdict of $177 million in compensatory damages, $200 million in punitive damages, and $549 million in prejudgment interest. On appeal, the defendants argued that the trial court had erred in its instructions to the jury regarding the plaintiffs' burden of proof under the Price-Anderson Act with respect to a "nuclear incident," and the court of appeals vacated the district court's judgment and remanded the case for further proceedings. On remand, the plaintiffs abandoned their Price-Anderson Act claim, accepting the premise that they could not prove a nuclear incident, and argued that the judgment on their State law claim nevertheless remained intact. The district court disagreed, finding that the Price-Anderson Act preempted their State law nuisance claim and that the court of appeals mandate barred the plaintiffs from securing judgment on their nuisance verdict. On appeal, the court of appeals held that when plaintiffs did not prove a nuclear incident under the Price-Anderson Act, the Act did not preempt their nuisance claim because such an argument was forfeited, and, regardless of the procedural forfeit, nothing in the language or history of the Act precluded a nuisance claim when a nuclear incident was not shown.

APPENDIX B
HISTORICAL CLAIMS DATA FROM ANI

ANI's claims data from nuclear liability insurance is itemized in the following table for nuclear incidents reported from the inception of the Price-Anderson Act in 1957 through December 2018. The claims data includes both claims made against 10 CFR Part 140 required policies and other claims paid by ANI related to other nuclear liability insurance policies.

Summary of claims activities under nuclear liability policies, 1957 through 2018

Claim No.	Incident Date or Claim Receipt	Closed	Active	Prop Damage	Bodily Injury	Loss of Life	Policy Type	Early Warning	In Suit	No Coverage	Paid Indemnity	Paid Expense	Paid Total
001	6/15/1962	X		X			Shipper	X			1,183.00	101.52	1,284.52
^002	1/4/1963	X		X			Facility	X			3,519.57	0.00	3,519.57
003	1/17/1963	X		X	X	X	Facility		X		300,000.00	28,763.48	328,763.48
004	6/27/1962	X		X			Facility	X			0.00	0.00	0.00
005	1/1/1962	X		X			Shipper		X		1,250.00	0.00	1,250.00
006	7/24/1964	X			X	X	Facility		X		70,000.00	6,403.25	76,403.25
007	6/12/1965	X			X		Facility	X			0.00	0.00	0.00
008	2/28/1966	X		X			Facility	X			183.00	80.13	263.13
009	5/20/1966	X		X			Facility	X			895.85	63.93	959.78
010	1/26/1965	X		X	X		Facility		X		1,500.00	11,012.36	12,512.36
011	8/8/1967	X			X		Facility			X	0.00	0.00	0.00
012	9/9/1968	X		X	X		Facility	X			0.00	1,460.41	1,460.41
013	11/13/1968	X		X	X		Facility	X			0.00	2,631.21	2,631.21
014	6/13/1963	X		X			Facility	X		X	0.00	105.58	105.58
015	5/1/1966	X			X		Facility		X		0.00	1,962.07	1,962.07
016	9/20/1969	X			X		Shipper		X		0.00	54,838.68	54,838.68
017	9/20/1969	X			X		Shipper		X		1,275.00	5,215.09	6,490.09
018	5/18/1972	X		X	X		Facility	X			25,099.26	10,199.67	35,298.93
019	5/15/1972	X		X			Shipper	X			5,077.25	33.86	5,111.11
020	12/1/1964	X			X	X	Shipper		X		10,000.00	18,850.90	28,850.90
021	1/1/1966	X			X	X	Shipper		X		6,500.00	11,520.42	18,020.42
022	5/5/1972	X			X		Facility	X			0.00	0.00	0.00
023	5/25/1973	X		X	X		Facility	X			0.00	0.00	0.00
024	12/21/1972	X		X	X		Facility	X			0.00	0.00	0.00
^025	3/12/1974	X		X			Facility	X			0.00	0.00	0.00
026	11/5/1974	X		X	X	X	Facility		X		595,632.12	1,099,189.78	1,694,821.90
^027	3/3/1975	X			X		Facility	X			0.00	450.00	450.00
028	10/28/1975	X			X	X	Shipper		X	X	0.00	0.00	0.00
029	6/2/1975	X			X	X	Shipper		X	X	0.00	0.00	0.00
^030	1/1/1969	X			X		Facility		X		0.00	7,002.98	7,002.98
^031	4/23/1976	X			X		Facility		X		0.00	4,683.11	4,683.11
^032	10/9/1975	X			X		Facility		X		0.00	11,972.91	11,972.91

Claim No.	Incident Date or Claim Receipt	Closed	Active	Prop Damage	Bodily Injury	Loss of Life	Policy Type	Early Warning	In Suit	No Coverage	Paid Indemnity	Paid Expense	Paid Total
^033	11/23/1977	X			X		Facility		X		385,000.00	205,104.56	590,104.56
^034	1/24/1978	X		X			Facility		X		0.00	6,839.17	6,839.17
^035	6/16/1977	X			X		Facility		X		0.00	1,886.88	1,886.88
^036	3/1/1978	X			X		Facility	X			0.00	0.00	0.00
^037	2/26/1978	X			X		Facility	X			0.00	0.00	0.00
^038	9/16/1975	X			X	X	Facility		X		1,000.00	27,217.31	28,217.31
^039	8/1/1977	X			X		Facility	X			0.00	217.02	217.02
^040	3/28/1979	X		X*	X**	X	Facility		X		41,657,828.24	29,398,814.62	71,056,642.86
^041	10/10/1977	X			X		Facility		X		0.00	3,636.21	3,636.21
^042	12/1/1972	X		X	X		Facility		X		0.00	83,878.30	83,878.30
^043	8/12/1976	X			X		Facility		X		26,500.00	21,671.23	48,171.23
^044	2/11/1976	X			X	X	Facility		X		0.00	5,249.68	5,249.68
^045	1/1/1973	X			X		Facility		X		0.00	95,263.86	95,263.86
^046	7/1/1978	X			X		Facility		X		15,000.00	38,579.36	53,579.36
047	1/1/1957	X		X			Shipper	X			0.00	0.00	0.00
048	3/15/1979	X			X		Shipper	X			0.00	0.00	0.00
^049	7/6/1979	X			X		Facility	X			0.00	0.00	0.00
^050	4/4/1979	X			X		Facility	X			0.00	0.00	0.00
051	5/16/1979	X			X	X	Shipper	X	X		0.00	0.00	0.00
052	1/1/1971	X			X		Facility	X			0.00	0.00	0.00
^053	7/9/1979	X			X		Facility	X			0.00	0.00	0.00
054	7/20/1979	X			X	X	Facility		X	X	0.00	0.00	0.00
^055	4/5/1979	X			X		Facility	X			0.00	0.00	0.00
^056	3/1/1978	X			X		Facility	X			0.00	0.00	0.00
^057	2/1/1978	X			X		Facility		X		0.00	0.00	0.00
^058	1/22/1979	X			X		Facility	X			0.00	0.00	0.00
^059	1/19/1978	X			X		Facility	X			0.00	629.24	629.24
^060	2/20/1975	X			X	X	Facility	X			0.00	0.00	0.00
^061	1/1/1976	X			X	X	Facility	X			0.00	0.00	0.00
^062	5/10/1976	X		X	X		Facility		X		0.00	22,812.54	22,812.54
^063	10/13/1977	X			X		Facility		X		14,400.00	75,931.10	90,331.10
^064	10/23/1978	X			X		Facility		X		7,500.00	6,729.69	14,229.69
^065	1/1/1969	X			X		Facility	X			0.00	200.00	200.00
066	12/26/1979	X			X	X	Shipper		X	X	0.00	0.00	0.00

Claim No.	Incident Date or Claim Receipt	Closed	Active	Prop Damage	Bodily Injury	Loss of Life	Policy Type	Early Warning	In Suit	No Coverage	Paid Indemnity	Paid Expense	Paid Total
^067	1/26/1976	X			X*		Facility		X		0.00	95,429.77	95,429.77
^068	4/6/1979	X			X		Facility		X		0.00	5,881.88	5,881.88
^069	1/1/1977	X					Facility		X		0.00	48,853.32	48,853.32
^070	3/23/1979	X			X		Facility		X		0.00	150,800.47	150,800.47
^071	5/21/1977	X			X		Facility		X		1,500.00	4,414.98	5,914.98
^072	10/6/1976	X			X		Facility	X			0.00	0.00	0.00
^073	12/1/1980	X			X		Facility	X			0.00	0.00	0.00
^074	5/2/1980	X					Facility		X	X	0.00	0.00	0.00
^075	5/27/1979	X			X		Facility	X			0.00	0.00	0.00
076	1/1/1974	X					Facility		X	X	0.00	0.00	0.00
^077	12/5/1970	X						X			0.00	0.00	0.00
^078	1/1/1980	X					Facility		X	X	0.00	0.00	0.00
079	1/1/1963	X			X	X	Shipper		X	X	0.00	0.00	0.00
080	11/30/1966	X			X		Facility		X	X	0.00	0.00	0.00
^081	3/17/1981	X			X		Facility	X			0.00	0.00	0.00
^082	11/26/1979	X			X		Facility		X		0.00	725.70	725.70
^083	3/5/1981	X			X		Facility		X		37,500.00	142,087.69	179,587.69
^084	11/20/1978	X			X		Facility		X		0.00	1,484.50	1,484.50
085	1/1/1966	X			X	X	Facility		X	X	0.00	0.00	0.00
086	7/24/1979	X			X		Shipper			X	0.00	0.00	0.00
087	9/1/1976	X		X	X		Shipper		X	X	0.00	0.00	0.00
^088	3/19/1981	X			X		Facility	X			0.00	0.00	0.00
^089	1/25/1982	X		X*			Facility		X	X	0.00	291,618.88	291,618.88
^090	5/1/1980	X		X			Facility		X		237,500.00	376,486.70	613,986.70
091	9/7/1981	X			X		Shipper	X			0.00	91.00	91.00
^092	1/1/1973	X			X	X	Facility		X		0.00	15,328.34	15,328.34
^093	3/1/1977	X			X	X	Facility		X		0.00	46,112.17	46,112.17
^094	1/1/1976	X			X	X	Facility		X		0.00	77,195.72	77,195.72
^095	1/1/1958	X			X	X	Facility		X		0.00	3,558.19	3,558.19
^096	9/1/1982	X		X			Facility	X			136,409.71	0.00	136,409.71
097	1/1/1966	X			X	X	Shipper		X	X	0.00	21,092.43	21,092.43
^098	12/4/1980	X			X		Facility		X		0.00	36,732.97	36,732.97
^099	2/25/1980	X			X		Facility		X		0.00	478,623.44	478,623.44
^100	2/15/1981	X			X	X	Facility		X		0.00	243,153.43	243,153.43

Claim No.	Incident Date or Claim Receipt	Closed	Active	Prop Damage	Bodily Injury	Loss of Life	Policy Type	Early Warning	In Suit	No Coverage	Paid Indemnity	Paid Expense	Paid Total
^101	4/4/1981	X			X		Facility		X		0.00	462,402.82	462,402.82
^102	3/4/1982	X			X		Facility		X		25,000.00	188,475.00	213,475.00
103	10/9/1980	X			X		Shipper		X	X	0.00	571.12	571.12
^104	1/19/1982	X			X		Facility		X	X	8,500.00	3,238.99	11,738.99
105	7/30/1983	X		X			Facility			X	120,000.00	0.00	120,000.00
106	4/8/1977	X		X			Shipper		X	X	720,661.25	343,458.17	1,064,119.42
107	1/1/1957	X		X			Shipper		X	X	0.00	0.00	0.00
^108	10/1/1983	X			X		Facility		X		0.00	1,413,215.00	1,413,215.00
^109	9/1/1974	X			X		Facility		X		0.00	27,711.77	27,711.77
^110	6/1/1976	X			X		Facility		X		0.00	3,286.04	3,286.04
^111	3/21/1981	X			X		Facility		X		0.00	23,390.62	23,390.62
^112	1/1/1977	X			X	X	Facility		X		0.00	2,695,522.86	2,695,522.86
^113	5/1/1981	X		X**	X**		Facility		X		500,000.00	9,786,544.01	10,286,544.01
^114	12/1/1980	X			X		Facility		X		0.00	365,515.23	365,515.23
^115	4/16/1983	X			X		Facility		X		0.00	3,109.04	3,109.04
^116	5/1/1985	X			X		Facility		X		0.00	658,498.89	658,498.89
^117	2/1/1983	X			X	X	Facility		X		0.00	362,064.48	362,064.48
^118	6/15/1984	X			X		Facility		X		0.00	215,252.96	215,252.96
119	1/1/1983	X		X	X		Facility		X		0.00	42,917.63	42,917.63
120	1/1/1978	X		X			Facility		X	X	0.00	118,355.76	118,355.76
121	1/1/1986	X		X			Facility, Shipper		X	X	14,687,633.50	23,574.32	14,711,207.82
^122	1/1/1983	X			X		Facility		X		0.00	244,501.06	244,501.06
^123	2/23/1984	X			X		Facility		X		0.00	132,816.88	132,816.88
^124	1/8/1986	X			X		Facility		X		0.00	4,282.71	4,282.71
^125	9/6/1984	X			X		Facility		X		0.00	74,779.66	74,779.66
^126	1/1/1984	X			X		Facility		X		0.00	89,083.51	89,083.51
^127	1/1/1984	X			X		Facility		X		0.00	170,020.98	170,020.98
^128	3/1/1985	X			X		Facility		X	X	0.00	2,177,410.12	2,177,410.12
129	11/22/1987	X		X			Facility	X			61,139.11	3,284.75	64,423.86
130	12/31/1987	X		X			Facility	X			78,718.47	13,251.34	91,969.81
^131	2/10/1985	X			X		Facility		X		0.00	60,869.31	60,869.31
^132	1/1/1979	X			X		Facility		X		0.00	45,669.59	45,669.59
^133	1/1/1985	X			X	X	Facility		X		0.00	13,563.64	13,563.64

Claim No.	Incident Date or Claim Receipt	Closed	Active	Prop Damage	Bodily Injury	Loss of Life	Policy Type	Early Warning	In Suit	No Coverage	Paid Indemnity	Paid Expense	Paid Total
^134	9/14/1987	X			X		Facility		X		0.00	66,535.84	66,535.84
^135	11/1/1987	X		X			Facility	X			12,217.68	0.00	12,217.68
^136	5/21/1987	X			X		Facility		X		0.00	554,310.15	554,310.15
^137	1/1/1980	X			X	X	Facility		X		0.00	306,879.54	306,879.54
138	1/1/1967	X		X**	X**	X	Shipper		X		0.00	4,288,401.04	4,288,401.04
^139	4/11/1988	X			X		Facility		X	X	0.00	27,792.61	27,792.61
140	10/24/1989	X		X			Shipper			X	0.00	0.00	0.00
141	2/9/1990	X		X			Facility	X			0.00	18,337.00	18,337.00
142	3/24/1989	X			X		Worker		X		0.00	292,173.36	292,173.36
^143	1/1/1974	X			X		Facility		X		0.00	42,395.38	42,395.38
144	1/1/1986	X		X**	X**	X	Facility, Shipper		X		80,000,000.00	103,006,775.64	183,006,775.64
145	1/1/1973	X					Facility			X	0.00	0.00	0.00
146	1/1/1991	X			X	X	Shipper		X	X	0.00	0.00	0.00
^147	8/27/1991	X		X			Facility	X			219,629.70	3.00	219,632.70
148	1/1/1990	X		X			Facility			X	0.00	0.00	0.00
^149	6/3/1988	X			X	X	Facility		X	X	0.00	28,116.03	28,116.03
^150	9/25/1989	X			X		Facility		X		0.00	426,884.49	426,884.49
^151	1/1/1972	X			X	X	Facility		X		4,350,000.00	6,486,048.70	10,836,048.70
^152	3/26/1990	X			X		Facility		X		0.00	0.00	0.00
153	4/6/1990	X			X		Shipper		X		0.00	177,040.68	177,040.68
154	3/4/1992	X		X			Facility			X	0.00	0.00	0.00
^155	1/1/1972	X			X		Facility		X		0.00	135,947.54	135,947.54
^156	1/1/1974	X			X		Facility		X		0.00	125,166.79	125,166.79
^157	1/1/1983	X			X	X	Facility		X		0.00	16,279.35	16,279.35
158	6/12/1991	X		X	X		Shipper		X	X	0.00	0.00	0.00
^159	10/21/1991	X			X		Worker, Facility			X	0.00	44,486.36	44,486.36
160	2/28/1990	X			X		Worker		X		0.00	41,600.16	41,600.16
^161	7/5/1990	X			X		Facility		X		0.00	432,116.14	432,116.14
^162	10/25/1989	X			X		Facility		X		0.00	148,740.40	148,740.40
^163	7/1/1985	X			X		Facility		X		0.00	2,680,165.59	2,680,165.59
164	8/20/1990	X			X		Shipper		X		0.00	13,125.95	13,125.95
^165	3/1/1982	X			X		Facility		X		0.00	57,438.89	57,438.89

Claim No.	Incident Date or Claim Receipt	Closed	Active	Prop Damage	Bodily Injury	Loss of Life	Policy Type	Early Warning	In Suit	No Coverage	Paid Indemnity	Paid Expense	Paid Total
^166	1/1/1973	X			X	X	Facility		X	X	0.00	133,733.03	133,733.03
^167	1/1/1972	X			X		Facility		X		0.00	19,024.27	19,024.27
^168	9/1/1959	X			X	X	Facility		X	X	0.00	2,504,153.90	2,504,153.90
^169	6/1/1985	X			X	X	Facility		X	X	0.00	2,016,669.83	2,016,669.83
^170	1/1/1982	X			X		Facility		X		0.00	6,949,568.52	6,949,568.52
^171	10/1/1974	X			X		Facility		X	X	0.00	8,453.86	8,453.86
^172	10/1/1981	X			X		Facility		X		0.00	21,897.78	21,897.78
173	1/1/1980	X			X		Facility		X		0.00	250,000.00	250,000.00
^174	1/1/1973	X			X	X	Facility		X	X	0.00	559,151.12	559,151.12
175	4/1/1990	X			X		Worker, Facility		X		0.00	234,285.83	234,285.83
^176	10/11/1994	X			X		Facility		X		0.00	190,741.66	190,741.66
^177	1/1/1983	X			X		Facility		X		0.00	17,927.64	17,927.64
^178	1/1/1983	X			X		Facility		X	X	0.00	38,241.20	38,241.20
^179	1/1/1982	X			X	X	Facility		X	X	0.00	172,660.15	172,660.15
180	10/7/1994	X			X		Worker		X		0.00	1,788,269.94	1,788,269.94
^181	1/1/1982	X			X	X	Facility		X	X	0.00	140,620.06	140,620.06
^182	1/1/1966	X			X		Facility		X		0.00	688,056.99	688,056.99
^183	1/1/1981	X			X	X	Facility		X		0.00	5,743,967.11	5,743,967.11
^184	1/1/1984	X			X		Facility		X		0.00	519,777.36	519,777.36
185	1/1/1960	X			X***	X	Facility		X		0.00	250,000.00	250,000.00
^186	1/1/1983	X			X	X	Facility		X		0.00	2,535.48	2,535.48
^187	1/1/1985	X			X		Facility		X		0.00	11,071.42	11,071.42
^188	1/1/1963	X		X	X		Facility		X	X	0.00	488,990.09	488,990.09
^189	1/1/1991	X		X			Facility		X	X	0.00	0.00	0.00
190	1/1/1990	X		X			Facility		X	X	0.00	0.00	0.00
^191	1/1/1978	X		X	X**	X**	Facility		X	X	0.00	64,588,410.04	64,588,410.04
^192	1/1/1979	X			X		Facility		X	X	0.00	38,044.62	38,044.62
193	6/18/1997	X			X		Worker		X		0.00	508,256.70	508,256.70
^194	1/1/1989	X		X			Facility			X	0.00	1,155.00	1,155.00
^195	1/1/1960	X		X	X		Facility		X	X	0.00	6,730.38	6,730.38
196	7/23/1995	X			X		Worker		X		0.00	34,018.15	34,018.15
^197	7/1/1976	X			X		Worker		X		0.00	208,623.18	208,623.18
198	1/1/1990	X		X	X		Facility		X		0.00	278,984.80	278,984.80

Claim No.	Incident Date or Claim Receipt	Closed	Active	Prop Damage	Bodily Injury	Loss of Life	Policy Type	Early Warning	In Suit	No Coverage	Paid Indemnity	Paid Expense	Paid Total
^199	9/16/1995	X			X		Worker		X		0.00	8,042.33	8,042.33
^200	1/1/1989	X			X	X	Worker	X			0.00	1,057.45	1,057.45
^201	1/1/1991	X			X	X	Facility		X		0.00	69,680.78	69,680.78
202	1/1/1976	X		X			Facility	X			0.00	12,876.23	12,876.23
203	7/22/1998	X			X		Facility		X		0.00	1,556.40	1,556.40
204	4/19/1999	X			X	X	Worker	X			0.00	823.20	823.20
^205	1/1/1970	X			X		Worker	X			0.00	300.00	300.00
^206	3/1/1975	X			X		Worker		X		0.00	61,761.66	61,761.66
^207	1/1/1970	X			X		Worker		X		0.00	299,009.39	299,009.39
208	6/5/2002	X		X			Facility		X		0.00	1,051,861.44	1,051,861.44
209	1/1/1992	X			X		Shipper		X		0.00	53,224.23	53,224.23
210	1/1/1972	X		X			Facility		X		0.00	106,689.54	106,689.54
^211	3/1/1994	X			X		Facility		X		0.00	3,497,517.66	3,497,517.66
^212	1/1/1988	X			X	X	Facility		X		0.00	2,400,459.95	2,400,459.95
213	1/1/1961	X		X			Facility		X		250,000.00	3,383,249.77	3,633,249.77
214	1/1/2002	X			X		Shipper		X		0.00	2,646,585.64	2,646,585.64
215	1/1/2004	X		X			Facility		X		75,000.00	750,084.04	825,084.04
^216	8/4/2003	X			X		Worker		X		0.00	191,482.06	191,482.06
217	7/22/2005	X		X			Facility		X		3,270,000.00	3,549,169.39	6,819,169.39
^218	11/1/1998	X		X*			Facility		X		0.00	10,621,100.60	10,621,100.60
^219	1/1/2002	X			X		Worker		X		0.00	490,406.51	490,406.51
^220	2/23/2006	X		X			Facility	X			53,862.02	3,031.70	56,893.72
^221	2/10/2004	X			X		Worker		X		0.00	191,705.10	191,705.10
^222	5/1/1991	X			X		Worker	X			0.00	548.00	548.00
^223	1/1/1987	X			X		Facility		X		0.00	579,380.54	579,380.54
^224	4/12/2008	X			X		Worker	X			0.00	1,887.00	1,887.00
^225	8/31/1991	X			X		Facility		X		0.00	48,468.78	48,468.78
^226	4/28/2007	X			X		Worker		X		0.00	886.90	886.90
^227	1/1/1977	X		X	X		Facility		X		0.00	84,967.64	84,967.64
^228	1/25/1982	X		X	X		Facility		X		0.00	44,101.90	44,101.90
^229	1/1/2006	X			X	X	Worker		X		0.00	111,633.70	111,633.70
230	1/1/2004	X		X			Facility	X			0.00	600.00	600.00
^231	1/1/1974	X			X		Worker		X		0.00	497,832.18	497,832.18
^232	10/21/1982	X			X		Worker	X			0.00	8,278.40	8,278.40

Claim No.	Incident Date or Claim Receipt	Closed	Active	Prop Damage	Bodily Injury	Loss of Life	Policy Type	Early Warning	In Suit	No Coverage	Paid Indemnity	Paid Expense	Paid Total
^233	1/1/1998	X			X		Facility	X			0.00	7,051,675.73	7,051,675.73
234	2/17/2010	X		X**	X**	X	Facility		X		0.00	68,344,317.41	68,344,317.41
235	7/26/2011	X		X**	X**	X	Facility		X		0.00	2,078,884.13	2,078,884.13
^236	9/21/2009	X			X		Worker		X		0.00	114,773.79	114,773.79
^237	1/1/1986		X		X		Facility		X		0.00	15,821.30	15,821.30
^238	6/1/1998		X		X		Facility		X		0.00	8,431.10	8,431.10
^239	3/1/2014	X			X		Facility	X			0.00	2,094.40	2,094.40
^240	6/29/2015	X			X		Worker, Shipper		X		0.00	4,869,660.17	4,869,660.17
241	11/14/1966		X	X			Shipper		X		0.00	132,849.63	132,849.63
242	3/21/2005		X		X		Worker	X			0.00	1,263.60	1,263.60
243	1/1/1963		X	X*			Shipper		X		0.00	2,262.40	2,262.40
								TOTAL			147,974,614.73	374,300,586.46	522,275,201.19

** Class action for pure economic loss unassociated with physical harm.*
*** Class action for physical harm to persons or property.*
**** Class action for alleged non-consensual human radiation experiments.*
^ Claims made against 10 CFR Part 140 required policies.

APPENDIX C
LISTING OF EACH PRICE-ANDERSON ACT REPORT SUBMITTED TO CONGRESS SINCE 1957

Prior to this report, the NRC has submitted to Congress the following reports related to the need for continuation or modification of the Price-Anderson provisions of the Atomic Energy Act of 1954:

- AEC Study of the Price-Anderson Indemnity Act (February ~~15,~~ 1965) [No online, publicly available version identified to date].

- AEC staff study of the Price-Anderson Act (January 1974) [No online, publicly available version identified to date].

- The Price-Anderson Act – The Third Decade: Report to Congress (October 1983), https://www.nrc.gov/docs/ML0727/ML072760026.pdf.

- The Price-Anderson Act – Crossing the Bridge to the Next Century: A Report to Congress (October 1998), https://www.nrc.gov/docs/ML1217/ML12170A857.pdf.

APPENDIX D
CURRENTLY OPERATING NUCLEAR POWER REACTORS

Appendix D presents data on nuclear power reactors that were operating in the United States as of October 2020 (NRC, 2021 a) (NEI, 2020b) (EIA, 2019).

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Arkansas Nuclear One, Unit 1	London, AR (6 MI WNW of Russellville, AR)	Entergy Operations, Inc.	Entergy Nuclear Operations, Inc.	12/6/1968	5/21/1974	12/19/1974	6/20/2001	5/20/2034	2568	Regulated	Utility
Arkansas Nuclear One, Unit 2	London, AR (6 MI WNW of Russellville, AR)	Entergy Operations, Inc.	Entergy Nuclear Operations, Inc.	12/6/1972	9/1/1978	3/26/1980	6/30/2005	7/17/2038	3026	Regulated	Utility
Beaver Valley Power Station, Unit 1	Shippingport, PA (17 MI W of McCandless, PA)	Energy Harbor Nuclear Generation LLC and Energy Harbor Nuclear Corp.	Energy Harbor Corp.	6/26/1970	7/2/1976	10/1/1976	11/5/2009	1/29/2036	2900	Deregulated	IPP
Beaver Valley Power Station, Unit 2	Shippingport, PA (17 MI W of McCandless, PA)	Energy Harbor Nuclear Generation LLC and Energy Harbor Nuclear Corp.	Energy Harbor Corp.	5/3/1974	8/14/1987	11/17/1987	11/5/2009	5/27/2047	2900	Deregulated	IPP

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Braidwood Station, Unit 1	Braceville, IL (20 MI SSW of Joliet, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	12/31/1975	7/2/1987	7/29/1988	1/27/2016	10/17/2046	3645	Deregulated	IPP
Braidwood Station, Unit 2	Braceville, IL (20 MI SSW of Joliet, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	12/31/1975	5/20/1988	10/17/1988	1/27/2016	12/18/2047	3645	Deregulated	IPP
Browns Ferry Nuclear Plant, Unit 1	Limestone County, AL (10 miles S of Athens, AL and 32 MI W of Huntsville, AL)	Tennessee Valley Authority	Tennessee Valley Authority	5/10/1967	12/20/1973	8/1/1974	5/4/2006	12/20/2033	3952	Regulated	Utility
Browns Ferry Nuclear Plant, Unit 2	Limestone County, AL (10 miles S of Athens, AL and 32 MI W of Huntsville, AL)	Tennessee Valley Authority	Tennessee Valley Authority	5/10/1967	6/28/1974	3/1/1975	5/4/2006	6/28/2034	3952	Regulated	Utility
Browns Ferry Nuclear Plant, Unit 3	Limestone County, AL (10 miles S of Athens, AL and 32 MI W of Huntsville, AL)	Tennessee Valley Authority	Tennessee Valley Authority	7/31/1968	7/2/1976	3/1/1977	5/4/2006	7/2/2036	3952	Regulated	Utility
Brunswick Steam Electric Plant, Unit 1	Southport, NC (20 MI S of Wilmington, NC)	Duke Energy Progress, LLC	Duke Energy	2/7/1970	9/8/1976	3/18/1977	6/26/2006	9/8/2036	2923	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Brunswick Steam Electric Plant, Unit 2	Southport, NC (20 MI S of Wilmington, NC)	Duke Energy Progress, LLC	Duke Energy	2/7/1970	12/27/1974	11/3/1975	6/26/2006	12/27/2034	2923	Regulated	Utility
Byron Station, Unit 1	Byron, Il (17 MI SW of Rockford, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	12/31/1975	2/14/1985	9/16/1985	11/19/2015	10/31/2044	3645	Deregulated	IPP
Byron Station, Unit 2	Byron, Il (17 MI SW of Rockford, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	12/31/1975	1/30/1987	8/2/1987	11/19/2015	11/6/2046	3645	Deregulated	IPP
Callaway Plant	Fulton, MO (25 MI ENE of Jefferson City, MO)	Union Electric Co.	AmerenUE	4/16/1976	10/18/1984	12/19/1984	3/6/2015	10/18/2044	3565	Regulated	Utility
Calvert Cliffs Nuclear Power Plant, Unit 1	Lusby, MD (40 MI S of Annapolis, MD)	Calvert Cliffs Nuclear Power Plant, LLC – Owner Exelon Generation Company, LLC – Operator	Exelon Corporation, LLC	7/7/1969	7/31/1974	5/8/1975	3/23/2000	7/31/2034	2737	Deregulated	IPP
Calvert Cliffs Nuclear Power Plant, Unit 2	Lusby, MD (40 MI S of Annapolis, MD)	Calvert Cliffs Nuclear Power Plant, LLC – Owner Exelon Generation	Exelon Corporation, LLC	7/7/1969	8/13/1976	4/1/1977	3/23/2000	8/13/2036	2737	Deregulated	IPP

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
		Company, LLC – Operator									
Catawba Nuclear Station, Unit 1	York, SC (18 MI S of Charlotte, NC)	Duke Energy Carolinas, LLC	Duke Energy	8/7/1975	1/17/1985	6/29/1985	12/5/2003	12/5/2043	3469	Regulated	Utility
Catawba Nuclear Station, Unit 2	York, SC (18 MI S of Charlotte, NC)	Duke Energy Carolinas, LLC	Duke Energy	8/7/1975	5/15/1986	8/19/1986	12/5/2003	12/5/2043	3411	Regulated	Utility
Clinton Power Station, Unit 1	Clinton, IL (23 MI SSE of Bloomington, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	2/24/1976	4/17/1987	11/24/1987	N/A	9/29/2026	3473	Deregulated	IPP
Columbia Generating Station	Richland, WA (20 MI NNE of Pasco, WA)	Energy Northwest	Energy Northwest	3/19/1973	4/13/1984	12/13/1984	5/22/2012	12/20/2043	3544	Regulated	Utility
Comanche Peak Nuclear Power Plant, Unit 1	Glen Rose, TX (40 MI SW of Fort Worth, TX)	Comanche Peak Power Company LLC – Owner Vistra Operations Company LLC – Operator	Vistra Energy Corp.	12/19/1974	4/17/1990	8/13/1990	N/A	2/8/2030	3612	Deregulated	IPP

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Comanche Peak Nuclear Power Plant, Unit 2	Glen Rose, TX (40 MI SW of Fort Worth, TX)	Comanche Peak Power Company LLC – Owner Vistra Operations Company LLC – Operator	Vistra Energy Corp.	12/19/1974	4/6/1993	8/3/1993	N/A	2/2/2033	3612	Deregulated	IPP
Cooper Nuclear Station	Brownville, NE (23 MI S of Nebraska City, NE)	Nebraska Public Power District	Nebraska Public Power District	6/4/1968	1/18/1974	7/1/1974	11/29/2010	1/18/2034	2419	Regulated	Utility
Davis-Besse Nuclear Power Station, Unit 1	Oak Harbor, OH (21 MI ESE of Toledo, OH)	Energy Harbor Nuclear Generation LLC and Energy Harbor Nuclear Corp.	Energy Harbor Corp.	3/24/1971	4/22/1977	7/31/1978	12/8/2015	4/22/2037	2817	Deregulated	IPP
Diablo Canyon Nuclear Power Plant, Unit 1	Avila Beach, CA (12 MI WSW of San Luis Obispo, CA)	Pacific Gas & Electric Co.	Pacific Gas & Electric Company	4/23/1968	11/2/1984	5/7/1985	Application Withdrawn	11/2/2024	3411	Regulated	Utility
Diablo Canyon Nuclear	Avila Beach, CA (12 MI WSW of San	Pacific Gas & Electric Co.	Pacific Gas & Electric Company	12/9/1970	8/26/1985	3/13/1986	Application Withdrawn	8/26/2025	3411	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Power Plant, Unit 2	Luis Obispo, CA)										
Donald C. Cook Nuclear Plant, Unit 1	Bridgman, MI (13 M S of Benton Harbor, MI)	Indiana Michigan Power Co.	Indiana Michigan Power Company	3/25/1969	10/25/1974	8/28/1975	8/30/2005	10/25/2034	3304	Deregulated	IPP
Donald C. Cook Nuclear Plant, Unit 2	Bridgman, MI (13 M S of Benton Harbor, MI)	Indiana Michigan Power Co.	Indiana Michigan Power Company	3/25/1969	12/23/1977	7/1/1978	8/30/2005	12/23/2037	3468	Deregulated	IPP
Dresden Nuclear Power Station, Unit 2	Morris, IL (25 M SW of Joliet, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	1/10/1966	12/22/1969	6/9/1970	10/28/2004	12/22/2029	2957	Deregulated	IPP
Dresden Nuclear Power Station, Unit 3	Morris, IL (25 M SW of Joliet, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	10/14/1966	1/12/1971	11/16/1971	10/28/2004	1/12/2031	2957	Deregulated	IPP
Edwin I. Hatch Nuclear Plant, Unit 1	Baxley, GA (20 MI S of Vidalia, GA)	Southern Nuclear Operating Co.	Southern Nuclear Operating Company	9/30/1969	10/13/1974	12/31/1975	1/15/2002	8/6/2034	2804	Regulated	Utility
Edwin I. Hatch Nuclear Plant, Unit 2	Baxley, GA (20 MI S of Vidalia, GA)	Southern Nuclear Operating Co.	Southern Nuclear Operating Company	12/27/1972	6/13/1978	9/5/1979	1/15/2002	6/13/2038	2804	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Fermi, Unit 2	Newport, MI (25 MI NE of Toledo, OH)	DTE Electric Company	DTE Electric Company (DTE)	9/26/1972	3/20/1985	1/23/1988	12/15/2016	3/20/2045	3486	Deregulated	Utility
Grand Gulf Nuclear Station, Unit 1	Port Gibson, MS (20 MI S of Vicksburg, MS)	Entergy Operations, Inc.	Entergy Nuclear Operations, Inc.	9/4/1974	11/1/1984	7/1/1985	12/1/2016	11/1/2044	4408	Regulated	Utility
H. B. Robinson Steam Electric Plant, Unit 2	Hartsville, SC (26 MI NW of Florence, SC)	Duke Energy Progress, LLC	Duke Energy	4/13/1967	7/31/1970	3/7/1971	4/19/2004	7/31/2030	2339	Regulated	Utility
Hope Creek Generating Station, Unit 1	Hancocks Bridge, NJ (18 MI SE of Wilmington, DE)	PSEG Nuclear, LLC	PSEG Nuclear, LLC	11/4/1974	7/25/1986	12/20/1986	7/20/2011	4/11/2046	3902	Deregulated	IPP
Indian Point Nuclear Generating, Unit 3	Buchanan, NY (24 MI N of New York, NY)	Entergy Nuclear Operations, Inc.	Entergy Nuclear Operations, Inc.	8/13/1969	12/12/1975	8/30/1976	9/17/2018	4/30/2025	3216	Deregulated	IPP
James A. FitzPatrick Nuclear Power Plant	Scriba, NY (6 MI NE of Oswego, NY)	Exelon Generation Co., LLC	Exelon Corporation, LLC	5/20/1970	10/17/1974	7/28/1975	9/8/2008	10/17/2034	2536	Deregulated	IPP
Joseph M. Farley	Columbia, AL (18 MI E of Dothan, AL)	Southern Nuclear Operating Co.	Southern Nuclear	8/16/1972	6/25/1977	12/1/1977	5/12/2005	6/25/2037	2775	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Nuclear Plant, Unit 1			Operating Company								
Joseph M. Farley Nuclear Plant, Unit 2	Columbia, AL (18 MI E of Dothan, AL)	Southern Nuclear Operating Co.	Southern Nuclear Operating Company	8/16/1972	3/31/1981	7/30/1981	5/12/2005	3/31/2041	2775	Regulated	Utility
LaSalle County Station, Unit 1	Marseilles, IL (11 MI SE of Ottawa, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	9/10/1973	4/17/1982	1/1/1984	10/19/2016	4/17/2042	3546	Deregulated	IPP
LaSalle County Station, Unit 2	Marseilles, IL (11 MI SE of Ottawa, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	9/10/1973	12/16/1983	10/19/1984	10/19/2016	12/16/2043	3546	Deregulated	IPP
Limerick Generating Station, Unit 1	Limerick, PA (21 MI NW of Philadelphia, PA)	Exelon Generation Co., LLC	Exelon Corporation, LLC	6/19/1974	8/8/1985	2/1/1986	10/20/2014	10/26/2044	3515	Deregulated	IPP
Limerick Generating Station, Unit 2	Limerick, PA (21 MI NW of Philadelphia, PA)	Exelon Generation Co., LLC	Exelon Corporation, LLC	6/19/1974	8/25/1989	1/8/1990	10/20/2014	6/22/2049	3515	Deregulated	IPP
McGuire Nuclear Station, Unit 1	Huntersville, NC (17 MI N of Charlotte, NC)	Duke Energy Carolinas, LLC	Duke Energy	2/23/1973	5/27/1981	12/1/1981	12/5/2003	6/12/2041	3469	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
McGuire Nuclear Station, Unit 2	Huntersville, NC (17 MI N of Charlotte, NC)	Duke Energy Carolinas, LLC	Duke Energy	2/23/1973	5/27/1983	3/1/1984	12/5/2003	3/3/2043	3469	Regulated	Utility
Millstone Power Station, Unit 2	Waterford, CT (3.2 MI WSW of New London, CT)	Dominion Energy Nuclear Connecticut, Inc.	Dominion Generation	12/11/1970	9/26/1975	12/26/1975	11/28/2005	7/31/2035	2700	Deregulated	IPP
Millstone Power Station, Unit 3	Waterford, CT (3.2 MI WSW of New London, CT)	Dominion Energy Nuclear Connecticut, Inc.	Dominion Generation	8/9/1974	1/31/1986	4/23/1986	11/28/2005	11/25/2045	3650	Deregulated	IPP
Monticello Nuclear Generating Plant, Unit 1	Monticello, MN (30 MI NW of Minneapolis, MN)	Northern States Power Company – Minnesota	Northern States Power Company Minnesota doing business as Xcel Energy	6/19/1967	9/8/1970	6/30/1971	11/8/2006	9/8/2030	2004	Regulated	Utility
Nine Mile Point Nuclear Station, Unit 1	Scriba, NY (6 MI NE of Oswego, NY)	Nine Mile Point Nuclear Station, LLC – Owner Exelon Generation Company,	Exelon Corporation, LLC	4/12/1965	12/26/1974	12/1/1969	10/31/2006	8/22/2029	1850	Deregulated	IPP

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
		LLC – Operator									
Nine Mile Point Nuclear Station, Unit 2	Scriba, NY (6 MI NE of Oswego, NY)	Nine Mile Point Nuclear Station, LLC – Owner Exelon Generation Company, LLC – Operator	Exelon Corporation, LLC	6/24/1974	7/2/1987	3/11/1988	10/31/2006	10/31/2046	3988	Deregulated	IPP
North Anna Power Station, Unit 1	Mineral (Louisa County), VA (40 MI NW of Richmond, VA)	Virginia Electric & Power Co.	Dominion Generation	2/19/1971	4/1/1978	6/6/1978	3/20/2003	4/1/2038	2940	Regulated	Utility
North Anna Power Station, Unit 2	Mineral (Louisa County), VA (40 MI NW of Richmond, VA)	Virginia Electric & Power Co.	Dominion Generation	2/19/1971	8/21/1980	12/14/1980	3/20/2003	8/21/2040	2940	Regulated	Utility
Oconee Nuclear Station, Unit 1	Seneca, SC (30 MI W of Greenville, SC)	Duke Energy Carolinas, LLC	Duke Energy	11/6/1967	2/6/1973	7/15/1973	5/23/2000	2/6/2033	2568	Regulated	Utility
Oconee Nuclear Station, Unit 2	Seneca, SC (30 MI W of Greenville, SC)	Duke Energy Carolinas, LLC	Duke Energy	11/6/1967	10/6/1973	9/9/1974	5/23/2000	10/6/2033	2568	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Oconee Nuclear Station, Unit 3	Seneca, SC (30 MI W of Greenville, SC)	Duke Energy Carolinas, LLC	Duke Energy	11/6/1967	7/19/1974	12/16/1974	5/23/2000	7/19/2034	2568	Regulated	Utility
Palisades Nuclear Plant	Covert, MI (5 MI S of South Haven, MI)	Entergy Nuclear Operations, Inc.	Entergy Nuclear Operations, Inc.	3/14/1967	3/24/1971	12/31/1971	1/17/2007	3/24/2031	2565.4	Deregulated	IPP
Palo Verde Nuclear Generating Station, Unit 1	Wintersburg, AZ (50 MI W of Phoenix, AZ)	Arizona Public Service Company	Arizona Public Service Company	5/25/1976	6/1/1985	1/28/1986	4/21/2011	6/1/2045	3990	Regulated	Utility
Palo Verde Nuclear Generating Station, Unit 2	Wintersburg, AZ (50 MI W of Phoenix, AZ)	Arizona Public Service Company	Arizona Public Service Company	5/25/1976	4/24/1986	9/19/1986	4/21/2011	4/24/2046	3990	Regulated	Utility
Palo Verde Nuclear Generating Station, Unit 3	Wintersburg, AZ (50 MI W of Phoenix, AZ)	Arizona Public Service Company	Arizona Public Service Company	5/25/1976	11/25/1987	1/8/1988	4/21/2011	11/25/2047	3990	Regulated	Utility
Peach Bottom Atomic Power Station, Unit 2	Delta, PA (17.9 MI S of Lancaster, PA)	Exelon Generation Co., LLC	Exelon Corporation, LLC	1/31/1968	10/25/1973	7/5/1974	5/7/2003	8/8/2053	4016	Deregulated	IPP

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Peach Bottom Atomic Power Station, Unit 3	Delta, PA (17.9 MI S of Lancaster, PA)	Exelon Generation Co., LLC	Exelon Corporation, LLC	1/31/1968	7/2/1974	12/23/1974	5/7/2003	7/2/2054	4016	Deregulated	IPP
Perry Nuclear Power Plant, Unit 1	Perry, OH (35 MI NE of Cleveland, OH)	Energy Harbor Nuclear Generation LLC and Energy Harbor Nuclear Corp.	Energy Harbor Corp.	5/3/1977	11/13/1986	11/18/1987	N/A	11/7/2026	3758	Deregulated	IPP
Point Beach Nuclear Plant, Unit 1	Two Rivers, WI (13 MI NNW of Manitowoc, WI)	NextEra Energy Point Beach, LLC	NextEra Energy, Inc. with principal subsidiaries Florida Power & Light Co. and NextEra Energy Resources, LLC	7/19/1967	10/5/1970	12/21/1970	12/22/2005	10/5/2030	1800	Deregulated	IPP
Point Beach Nuclear Plant, Unit 2	Two Rivers, WI (13 MI NNW of Manitowoc, WI)	NextEra Energy Point Beach, LLC	NextEra Energy, Inc. with principal	7/25/1968	3/8/1973	10/1/1972	12/22/2005	3/8/2033	1800	Deregulated	IPP

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
			subsidiaries Florida Power & Light Co. and NextEra Energy Resources, LLC								
Prairie Island Nuclear Generating Plant, Unit 1	Welch, MN (28 MI SE of Minneapolis, MN)	Northern States Power Co. Minnesota	Northern States Power Company Minnesota doing business as Xcel Energy	6/25/1968	4/5/1974	12/16/1973	6/27/2011	8/9/2033	1677	Regulated	Utility
Prairie Island Nuclear Generating Plant, Unit 2	Welch, MN (28 MI SE of Minneapolis, MN)	Northern States Power Co. Minnesota	Northern States Power Company Minnesota doing business as Xcel Energy	6/25/1968	10/29/1974	12/21/1974	6/27/2011	10/29/2034	1677	Regulated	Utility
Quad Cities Nuclear Power Station, Unit 1	Cordova, IL (20 MI NE of Moline, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	2/15/1967	12/14/1972	2/18/1973	10/28/2004	12/14/2032	2957	Deregulated	IPP

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Quad Cities Nuclear Power Station, Unit 2	Cordova, IL (20 MI NE of Moline, IL)	Exelon Generation Co., LLC	Exelon Corporation, LLC	2/15/1967	12/14/1972	3/10/1973	10/28/2004	12/14/2032	2957	Deregulated	IPP
R.E. Ginna Nuclear Power Plant	Ontario, NY (20 MI NE of Rochester, NY)	R.E. Ginna Nuclear Power Plant, LLC	Exelon Corporation, LLC	4/25/1966	9/19/1969	7/1/1970	5/19/2004	9/18/2029	1775	Deregulated	IPP
River Bend Station, Unit 1	St. Francisville, LA (24 MI NNW of Baton Rouge, LA)	Entergy Operations, Inc.	Entergy Nuclear Operations, Inc.	3/25/1977	11/20/1985	6/16/1986	12/20/2018	8/29/2045	3091	Regulated	Utility
St. Lucie Plant, Unit 1	Jensen Beach, FL (10 MI SE of Ft. Pierce, FL)	Florida Power & Light Co.	NextEra Energy, Inc. with principal subsidiaries Florida Power & Light Co. and NextEra Energy Resources, LLC	7/1/1970	3/1/1976	12/21/1976	10/2/2003	3/1/2036	3020	Regulated	Utility
St. Lucie Plant, Unit 2	Jensen Beach, FL (10 MI SE of Ft. Pierce, FL)	Florida Power & Light Co.	NextEra Energy, Inc. with principal	5/2/1977	4/6/1983	8/8/1983	10/2/2003	4/6/2043	3020	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
			subsidiaries Florida Power & Light Co. and NextEra Energy Resources, LLC								
Salem Nuclear Generating Station, Unit 1	Hancocks Bridge, NJ (18 MI SE of Wilmington, DE)	PSEG Nuclear, LLC	PSEG Nuclear, LLC	9/25/1968	12/1/1976	6/30/1977	6/30/2011	8/13/2036	3459	Deregulated	IPP
Salem Nuclear Generating Station, Unit 2	Hancocks Bridge, NJ (18 MI SE of Wilmington, DE)	PSEG Nuclear, LLC	PSEG Nuclear, LLC	9/25/1968	5/20/1981	10/13/1981	6/30/2011	4/18/2040	3459	Deregulated	IPP
Seabrook Station, Unit 1	Seabrook, NH (13 MI S of Portsmouth, NH)	NextEra Energy Seabrook, LLC	NextEra Energy, Inc. with principal subsidiaries Florida Power & Light Co. and NextEra Energy	7/7/1976	3/15/1990	8/19/1990	3/12/2019	3/15/2050	3648	Deregulated	IPP

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
			Resources, LLC								
Sequoyah Nuclear Plant, Unit 1	Soddy-Daisy, TN (16 MI NE of Chattanooga, TN)	Tennessee Valley Authority	Tennessee Valley Authority	5/27/1970	9/17/1980	7/1/1981	9/24/2015	9/17/2040	3455	Regulated	Utility
Sequoyah Nuclear Plant, Unit 2	Soddy-Daisy, TN (16 MI NE of Chattanooga, TN)	Tennessee Valley Authority	Tennessee Valley Authority	5/27/1970	9/15/1981	6/1/1982	9/28/2015	9/15/2041	3455	Regulated	Utility
Shearon Harris Nuclear Power Plant, Unit 1	New Hill, NC (20 MI SW of Raleigh, NC)	Duke Energy Progress, LLC	Duke Energy	1/27/1978	10/24/1986	5/2/1987	12/17/2008	10/24/2046	2948	Regulated	Utility
South Texas Project, Unit 1	Bay City, TX (90 MI SW of Houston, TX)	STP Nuclear Operating Co.	STP Nuclear Operating Company	12/22/1975	3/22/1988	8/25/1988	9/28/2017	8/20/2047	3853	Deregulated	IPP
South Texas Project, Unit 2	Bay City, TX (90 MI SW of Houston, TX)	STP Nuclear Operating Co.	STP Nuclear Operating Company	12/22/1975	3/28/1989	6/19/1989	9/28/2017	12/15/2048	3853	Deregulated	IPP
Surry Power Station, Unit 1	Surry, VA (17 MI NW of Newport News, VA)	Virginia Electric & Power Co.	Dominion Generation	6/25/1968	5/25/1972	12/22/1972	3/20/2003	5/25/2032	2587	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Surry Power Station, Unit 2	Surry, VA (17 MI NW of Newport News, VA)	Virginia Electric & Power Co.	Dominion Generation	6/25/1968	1/29/1973	5/1/1973	3/20/2003	1/29/2033	2587	Regulated	Utility
Susquehanna Steam Electric Station, Unit 1	Salem Township, Luzerne Co., PA (70 MI NE of Harrisburg, PA)	Susquehanna Nuclear, LLC	Talen Energy Corporation	11/3/1973	7/17/1982	6/8/1983	11/24/2009	7/17/2042	3952	Deregulated	IPP
Susquehanna Steam Electric Station, Unit 2	Salem Township, Luzerne Co., PA (70 MI NE of Harrisburg, PA)	Susquehanna Nuclear, LLC	Talen Energy Corporation	11/3/1973	3/23/1984	2/12/1985	11/24/2009	3/23/2044	3952	Deregulated	IPP
Turkey Point Nuclear Generating Unit No. 3	Homestead, FL (20 MI S of Miami, FL)	Florida Power & Light Co.	NextEra Energy, Inc. with principal subsidiaries Florida Power & Light Co. and NextEra Energy Resources, LLC	4/27/1967	7/19/1972	12/14/1972	6/6/2002	7/19/2052	2644	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Turkey Point Nuclear Generating Unit No. 4	Homestead, FL (20 MI S of Miami, FL)	Florida Power & Light Co.	NextEra Energy, Inc. with principal subsidiaries Florida Power & Light Co. and NextEra Energy Resources, LLC	4/27/1967	4/10/1973	9/7/1973	6/6/2002	4/10/2053	2644	Regulated	Utility
V.C. Summer Nuclear Station, Unit 1	Jenkinsville, SC (26 MI NW of Columbia, SC)	Dominion Energy South Carolina, Inc.	Dominion Generation	3/21/1973	11/12/1982	1/1/1984	4/23/2004	8/6/2042	2900	Regulated	Utility
Vogtle Electric Generating Plant, Unit 1	Waynesboro, GA (26 MI SE of Augusta, GA)	Southern Nuclear Operating Co.	Southern Nuclear Operating Company	6/28/1974	3/16/1987	6/1/1987	6/3/2009	1/16/2047	3625.6	Regulated	Utility
Vogtle Electric Generating Plant, Unit 2	Waynesboro, GA (26 MI SE of Augusta, GA)	Southern Nuclear Operating Co.	Southern Nuclear Operating Company	6/28/1974	3/31/1989	5/20/1989	6/3/2009	2/9/2049	3625.6	Regulated	Utility
Waterford Steam Electric Station, Unit 3	Killona, LA (25 MI W of New Orleans, LA)	Entergy Operations, Inc.	Entergy Nuclear Operations, Inc.	11/14/1974	3/16/1985	9/24/1985	12/27/2018	12/18/2044	3716	Regulated	Utility

Plant Name, Unit Number	Location	Licensee	Parent Company Utility Name	Construction Permit Issued	Operating License Issued	Commercial Operation	Renewed Operating License Issued	Operating License Expires	Licensed MW(t)	Regulated vs. Non-Regulated	Utility vs. IPP
Watts Bar Nuclear Plant, Unit 1	Spring City, TN (60 MI SW of Knoxville, TN)	Tennessee Valley Authority	Tennessee Valley Authority	1/23/1973	2/7/1996	5/27/1996	N/A	11/9/2035	3459	Regulated	Utility
Watts Bar Nuclear Plant, Unit 2	Spring City, TN (60 MI SW of Knoxville, TN)	Tennessee Valley Authority	Tennessee Valley Authority	1/24/1973	10/22/2015	10/19/2016	N/A	10/22/2055	3411	Regulated	Utility
Wolf Creek Generating Station, Unit 1	Burlington (Coffey County), KS (28 MI SE of Emporia, KS)	Wolf Creek Nuclear Operating Corp.	Wolf Creek Nuclear Operating Corporation	5/17/1977	6/4/1985	9/3/1985	11/20/2008	3/11/2045	3565	Regulated	Utility

NRC FORM 335 (12-2010) NRCMD 3.7 U.S. NUCLEAR REGULATORY COMMISSION **BIBLIOGRAPHIC DATA SHEET** *(See instructions on the reverse)*	1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.) **NUREG/CR-XXXX**
2. TITLE AND SUBTITLE **The Price-Anderson Act: 2021 Report to Congress** Public Liability Insurance and Indemnity Requirements for an Evolving Commercial Nuclear Industry	3. DATE REPORT PUBLISHED: MONTH **Month** YEAR **20xx** 4. FIN OR GRANT NUMBER
5. AUTHOR(S) H. Arceneaux, J. Archibald, E. Aquino, P. Bailey, J. Cleland, E. Gormsen, E. Kurz, W. McGlinn, and D. Ryder.	6. TYPE OF REPORT Technical 7. PERIOD COVERED (Inclusive Dates)

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

ICF
9300 Lee Highway
Fairfax, VA 22031

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above", if contractor, provide NRC Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address.)

Division of Rulemaking, Environmental, and Financial Support
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

10. SUPPLEMENTARY NOTES

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11. ABSTRACT (200 words or less)

This report fulfills the mandate of Subsection 170(p) of the Atomic Energy Act of 1954, as amended, which requires that the Commission submit to Congress by December 31, 2021, a detailed report on the continuation or modification of Section 170 of the Act, the Price-Anderson provisions. Part 1 presents an overview of the Price-Anderson system. Part 2 examines the issues that the Commission is required by statute to study (i.e., condition of the nuclear industry, state of knowledge of nuclear safety, and availability of private insurance). Part 3 covers other issues of interest and importance to Congress and to the public, such as international agreements relevant to the Price-Anderson Act and the potential financial burden of increasing retrospective premium assessments. Part 4 contains conclusions and recommendations. Part 5 is the list of references. This report includes four appendices: Appendix A, Listing of Litigation Surrounding the Price-Anderson Act and the Summary Results; Appendix B, Historical Claims Data from ANI; Appendix C, Listing of Each Price-Anderson Act Report Submitted to Congress Since 1957; and Appendix D, Currently Operating Nuclear Power Reactors.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)	13. AVAILABILITY STATEMENT
Financial protection Indemnity Insurance Price-Anderson Act Public liability	unlimited 14. SECURITY CLASSIFICATION *(This Page)* unclassified *(This Report)* unclassified 15. NUMBER OF PAGES 16. PRICE

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

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NUREG/CR-XXXX The Price-Anderson Act: 2021 Report to Congress Month20xx