**Statement of**

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**on**

# Nuclear Reactor Decommissioning: Stakeholder Views

**Before the**
**Committee on Environment & Public Works**
**United States Senate**
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## Introduction

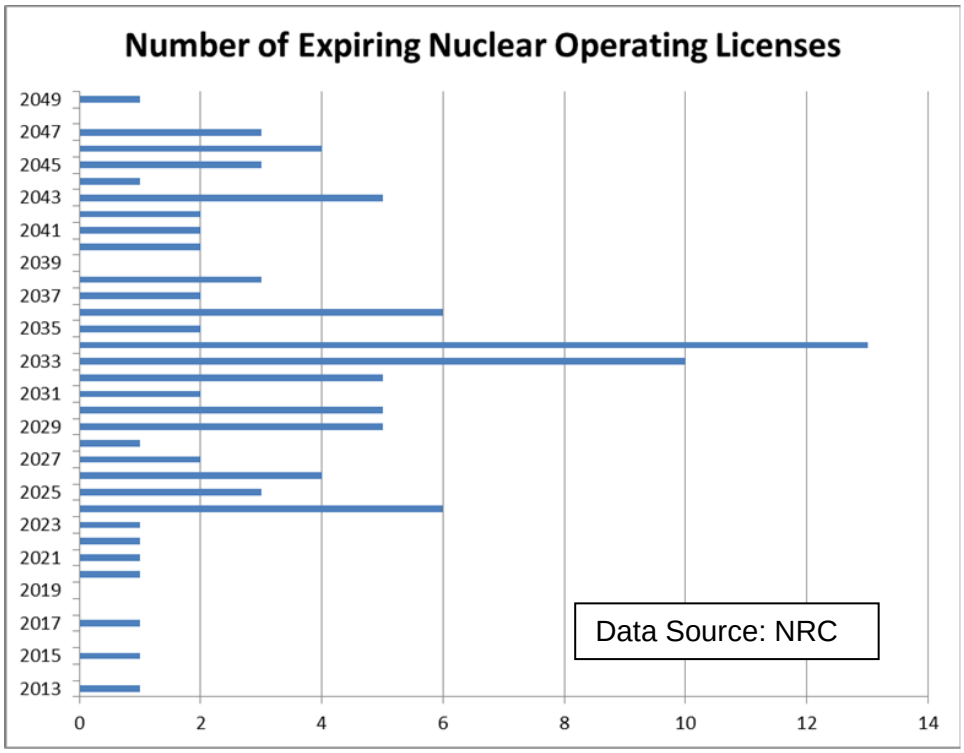
Chairman Boxer and Ranking Member Vitter, and members of the Committee, thank you for providing the Natural Resources Defense Council, Inc. (NRDC) this opportunity to present our views at this oversight hearing on the decommissioning of nuclear power plants.

NRDC is a national, non-profit organization of scientists, lawyers, and environmental specialists, dedicated to protecting public health and the environment. Founded in 1970, NRDC serves more than one million members, supporters and environmental activists with offices in New York, Washington, Los Angeles, San Francisco, Chicago, Montana and Beijing. NRDC has worked on nuclear issues for over four decades, and continues to be engaged in shaping U.S. law and policy on the nuclear fuel cycle.

## Summary of Comments

For the first three decades of the atomic age, federal and industry attention to nuclear matters was almost entirely directed at nuclear weapons production and commercial nuclear power generation. Disposal of spent nuclear fuel and the mounting radioactive by-products of nuclear weapons production, and the eventual decommissioning of commercial and defense facilities, were hardly on the radar screen.

It was not until the 1980s that serious interest, effort and money was devoted to the task of decommissioning and properly disposing of nuclear power plants themselves. The still ongoing spate of commercial nuclear reactor relicensing that commenced in the 1990s and has extended the life of most our domestic reactor fleet from 40 to 60 years unfortunately relieved some of the pressure to address the adequacy of industry plans and federal requirements for decommissioning. Indeed, it was only a few years ago that NRDC believed this topic would most urgently need addressing prior to the year 2030, as that date marks the period when the U.S. reactors that have received twenty-year license extensions—probably most of them by then—will begin reaching the sixty-year mark and presumably be shut down and eventually decommissioned, as illustrated in the chart below.




But with the gradual drumbeat of retiring reactors in the past few years for varied aging, safety and economic reasons prior to the end of their licenses–SONGS in Southern California, the Kewaunee reactor in Wisconsin, Vermont Yankee in Vermont, and Crystal River in Florida – it is now timely for this Committee to take up the matter of decommissioning and press ahead on addressing some significant safety and regulatory flaws. In any event, between 2014 and 2050, nearly all of the current fleet of U.S. power reactors is slated for retirement unless there is another round of twenty year extensions, a prospect NRDC views with considerable skepticism and concern for public safety.

Just a top line examination of decommissioning reveals a host of serious issues and challenges. And, unfortunately, we do not have consensus among the Nuclear Regulatory Commission (NRC), industry, states and the public on the relative adequacy and protectiveness of existing requirements. Only a few large commercial power reactors have been decommissioned over the past two decades in the United States, and therefore our experience with the process is comparatively limited.

Moreover, it is apparent certain challenges will present themselves in each instance of decommissioning. In 2012 the *New York Times* reported the owners of 20 of the nation's aging nuclear reactors, including some whose licenses expire soon, have not saved nearly enough money for prompt and proper dismantling.[1] The Times noted that, if it turns out the reactors must

[1] See "As Reactors Age, the Money to Close Them Lags," Matthew L. Wald, March 20, 2012, found online at http://www.nytimes.com/2012/03/21/science/earth/as-nuclear-reactors-age-funds-to-close-them-

close before expiration of their operating licenses, the owners intend to let them sit like radioactive industrial relics for 20 to 60 years or even longer while interest accrues in the reactors' decommissioning accounts. States such as New York and Vermont have at various times expressed concern over this prospect. Further, there can be disagreements over the extent of and safest treatment for the contamination left onsite; there are no firm plans for safely removing each plant; ultimate destinations and transport routes for dismantled debris has not been identified for each plant; and the health and environmental limits for release of sites and license termination, including the time window noted above, have been contested. And that's just a first cut at the list of decommissioning issues and challenges.

Nearly two decades ago, Dr. Martin J. Pasqualetti, a professor of geography in the School of Geographical Sciences and Urban Planning at Arizona State University in Tempe, Arizona, and one of the first analysts to grapple with decommissioning's challenges, wisely observed this about the NRC's basic definition of decommissioning – "to remove nuclear facilities safely from service and to reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of license – masks a huge and never-ending duty involving not only technical but social problems."[2] We commend the Committee for holding this hearing and beginning a review of the adequacy of our federal decommissioning requirements. I will touch on what we feel are the two top line matters for this hearing – relaxing the rules on decommissioned reactors and the adequacy of funding.

**The Decommissioning Process**

In 2011 the NRC updated its planning process for decommissioning power reactors and nuclear material production and utilization facilities, and permits essentially three options. First, there is the decontamination (DECON) option, where all reactor and associated structures and components contaminated with radioactivity are either cleaned or removed and shipped to a licensed radioactive dump site, and the reactor location is returned to unrestricted use with all dispatch. The second option, we understand by far the most likely in most instances, is the safe storage (SAFSTOR) option, where the reactor is defueled but all associated parts of the facility are left in place for up to six decades for later decontamination. Finally, there is still an entombment (ENTOMB) option, where the facility is basically covered over and left forever, a final option we do not expect to see domestically. An extreme and challenging example of a version of the entombing option, at the contaminated Chernobyl Reactor in Ukraine, was recently well described in mixed media presentation by the New York Times.[3] The ENTOMB

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[2] See, *Decommissioning Nuclear Power Plants,* Martin J. Pasqueletti, in *Controlling the Atom in the 21st Century*, ed. O'Very, Paine, Reicher, 1994, Westview Press at 316.

[3] *See Chernobyl, Capping A Catastrophe*, Henry Fountain, Photographs by William Daniels, The New York Times, April 27, 2014, online at http://www.nytimes.com/interactive/2014/04/27/science/chernobyl-capping-a-

option was available in the United States for some of the early, small reactors that did not operate at high power levels or for extended periods so as to develop much of a radioactive footprint.

The decommissioning process includes a Post Shutdown Decommissioning Activities Report (PSDAR), a listing of the tasks, schedule and estimated budget. The Final Status Survey Report (FSSR) is an inventory of the radioactively decontaminated pieces of the plant that require special handling. And the License Termination Plan (LTP) is the final document, and it presents the planned final state of the site and potential future uses (essentially, the extent of the cleanup and the manner in which any contamination will be left on site). The PSDAR, FSSR, and LTP are submitted by owners to the NRC and become publicly available. Detailed treatments of this process are found in the NRC's Decommissioning Planning, Final Rule.[4]

The process described above presents a host of sometimes conflicting policy goals. Nearly twenty years ago Dr. Pasqualetti identified eight fundamental decommissioning policy considerations that could, in some instances, work in opposition to one another:

- Minimizing radiological hazards for workers (health and safety);
- Minimizing radiological hazards for the general public (health, safety and long term environmental impacts);
- Leaving a cleared and decontaminated site for future non-nuclear purposes (land use, health and safety);
- Ensuring that decommissioning costs are as low as reasonable and practicable (economic);
- Maximizing economic benefits of operations, including those to stockholders, by operating power plants as long as possible (economics);
- Securing sufficient decommissioning funding (economics, ethics); and
- Meeting legal requirements (law).

With the operating reactor experience of the last two decades, and especially the last two years, NRDC also suggests a clarification as to how one might consider maximizing economic benefit in light of the safety considerations attendant to reactor aging. Keeping an aging reactor operating for financial reasons not only raises safety concern but the financial consideration of appropriate investment to ensure safe operations. In any event, we find those eight considerations a useful frame for considering current deficiencies in decommissioning power reactors.

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[4] 76 Fed. Reg. 35512 (June 17, 2011), found online athttp://pbadupws.nrc.gov/docs/ML1127/ML11272A154.pdf.

**Consideration # 1 – The Rules No Longer Apply**

Our primary concern with the decommissioning process is that both regulatory requirements and the agency's oversight regime are significantly scaled back when nuclear power reactors cease operation. Such waivers have been granted and are being sought even in the event that sizable quantities of spent nuclear fuel are left in pools for potentially decades.

The nuclear fuel cycle has a number of significant environmental and public safety impacts (not covered in this hearing). But chief among nuclear power's environmental impacts, in addition to severe nuclear accidents, is nuclear waste – specifically, the production of spent nuclear fuel. The nuclear fuel cycle produces a deadly and long-lasting byproduct: highly radioactive spent nuclear fuel. At high doses, radiation exposure will cause death.[5] At lower doses, radiation still has serious health effects, including increased cancer risks and serious birth defects such as mental retardation, eye malformations, and small brain or head size.[6]

And regarding these serious health consequences from exposure, spent nuclear fuel remains dangerous for millennia. The United States Court of Appeals for the D.C. Circuit described it thus: "radioactive waste and its harmful consequences persist for time spans seemingly beyond human comprehension. For example, iodine-129, one of the radionuclides expected to be buried at Yucca Mountain, has a half-life of seventeen million years." *Nuclear Energy Institute, Inc. et al., v. Environmental Protection Agency*, 373 F.3d 1251, 1258 (D.C.Cir. 2004), *citing*, Comm. on Technical Bases for Yucca Mountain Standards, Nat'l Research Council, *Technical Bases for Yucca Mountain Standards*, 18-19 (1995).

As NRDC has noted before this Committee and your colleagues in the Energy & Natural Resources Committee, there is no evidence that continued reliance on densely packed wet storage should be accepted as adequate in light of the health, safety and security risks that spent fuel pools pose. [7] This is true regardless of the local seismicity, population density, or other environmental factors that might create concern with the current storage configuration. NRDC and our colleagues at the Union of Concerned Scientists and many others noted President Obama's Blue Ribbon Commission for America's Nuclear Future was negligent in not recommending Congress statutorily direct movement of spent fuel from wet pools to hardened dry casks as soon as practical, *i.e.*, as soon as spent fuel has cooled sufficiently to permit safe dry

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[5] National Institutes of Health, Fact Sheet: http://www.nlm.nih.gov/medlineplus/radiationexposure.html (last visited December 9, 2013).

[6] *See* Environmental Radiation Protection Standards for Yucca Mountain, Nevada, 64 Fed. Reg. 46,976, 46,978 (Aug. 27, 1999).

[7] "Any event that results in the breach of a spent fuel pool or a dry cask, whether accidental or intentional, has the potential to release radioactive material to the environment" – National Academy of Sciences, Safety & Security of Spent Fuel Storage, 2006.

cask storage, generally about five to seven years following discharge from the reactor. We again urge Congress to act on this issue in comprehensive legislation or even in a stand-alone bill.

Illustrating the importance of this point, in a May 2, 2014 letter sent to NRC Chairman Allison Macfarlane, Senator Edward J. Markey (D-Mass.), this Committtee's Chairman Barbara Boxer (D-Calif.), and Senators Bernard Sanders (I-Vt.), Patrick Leahy (D-Vt.) and Kirsten Gillibrand (D-N.Y.) called on the NRC to halt the policy of issuing exemptions to emergency response regulations to decommissioning nuclear reactors which house decades-worth of spent nuclear fuel.[8]

The Senators noted the exemptions for compliance with the emergency response regulations – such as those that require evacuation zones and siren systems to warn of problems – have been granted to all of the ten reactor licensees that have requested them in the past. Moreover, the Senators pointed out licensees of reactors that are or will soon begin the decommissioning process (including San Onofre in California and Vermont Yankee) have already submitted a wide range of exemption requests from emergency response, security and other regulations to the NRC. Indeed, now Dominion's Kewaunee plant seeks the same set of waivers and this week a spokesman for the plant stated "[w]hat we are looking for is a waiver for requirements that really no longer are applicable."[9]

While industry suggests the requirements are no longer applicable, at the same time under its ongoing review of the long-term environmental and safety impacts of spent nuclear fuel (the Waste Confidence Generic EIS currently under review), NRC suggests spent nuclear fuel can be stored safely for at least 60 years beyond the licensed life of a nuclear power plant, but bases its

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[8] *See*, NSIR/DPR-ISG-02, *Interim Staff Guidance, Emergency Planning Exemption Requests For Decommissioning Nuclear Power Plants*, at 4. "The purpose of this interim staff guidance (ISG) is to provide guidance to U.S. Nuclear Regulatory Commission (NRC) staff in processing exemptions from the emergency preparedness (EP) requirements for nuclear power reactors that are undergoing the process of decommissioning … In the 1990s, the staff developed a thermal-hydraulic criterion for determining when reductions in EP requirements at decommissioning plants could be permitted. The criterion was used on a case-by-case basis to grant exemptions from certain EP requirements. The criterion was based on demonstrating that spent fuel stored in the SFP would sufficiently air-cool and would not reach the zirconium ignition temperature if the water in the pool were to be fully drained or there was at least ten hours to take action to recover SFP inventory and take ad hoc actions to protect the public. NUREG/CR-4982, "Severe Accidents in Spent Fuel Pools in Support of Generic Safety Issue 82", and NUREG/CR-6451, "A Safety and Regulatory Assessment of Generic BWR [boiling water reactor] and PWR [pressurized water reactor] Permanently Shutdown Nuclear Power Plants", provides temperatures associated with the self-initiation and propagation of zirconium fires." Online at http://pbadupws.nrc.gov/docs/ML1330/ML13304B442.pdf.

[9] Closed Kewaunee nuclear plant seeks relaxed safety standard; 5 US senators oppose change; Associated Press, Star Tribune, May 9, 2014 *see* at http://www.startribune.com/politics/national/258626001.html#undefined.

determination in significant measure on the assertion that emergency preparedness and security regulations remain in place during decommissioning.

Such is clearly not the case. Waivers from a protective regulatory regime, including relaxing the fifty mile Emergency Planning Zone, are inappropriate while spent nuclear fuel remains stored in densely packed pools. We concur with the Senators' and their letter cited above that accidents or attacks on spent fuel pools could trigger a spent fuel fire or explosive dispersal of radionuclides that would put neighboring populations at risk of experiencing harmful levels of exposure to radioactivity and potentially widespread economic damage from land contamination.

With those observations in mind, NRDC urges the Committee to write legislative language for a pilot project to address the total stranded spent fuel at closed reactor sites (currently 13 sites and soon to be more), where spent nuclear fuel would be stored in dry casks within one or more hardened buildings similar to the Ahaus facility in Germany. Potential volunteer sites that have in the past demonstrated "consent" to host spent nuclear fuel are operating commercial reactors. The utility of using existing commercial operating reactor sites rather than burdening new areas with spent nuclear fuel should be apparent: existing sites require far less new infrastructure, already have the capacity for fuel management and transportation and have the consent necessary for hosting nuclear facilities. And by keeping consolidated, interim-stored spent nuclear fuel under the guardianship of the nuclear industry that produced the waste in the first instance, Congress ensures careful progress continues with the repository program because all parties will know that it is necessary.

And while a diminished safety regime for spent fuel pools is a primary concern, there are other problematic manifestations of a relaxed regulatory scheme. For example, aging management measures adopted to support the 20 year renewal of reactor operating licenses apply during the period of extended reactor operation—but not during the potentially six decades of spent fuel pool storage that can ensue under the SAFSTOR option.[10] Our colleague David Lochbaum at the Union of Concerned Scientists detailed many and more of these concerns late last year in the comments to the NRC on the Draft Waste Confidence Generic EIS.[11]

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[10] NRC Inspection Manual Chapters 0350, "Oversight of Reactor Facilities in a Shutdown Condition Due to Significant Performance and/or Operational Concerns," and 0351, "Implementation of The Reactor Oversight Process at Reactor Facilities in an Extended Shutdown Condition for Reasons Other Than Significant Performance Problems," cover nuclear power reactors that have been shut down for lengthy periods, but which are expected to eventually resume operations. These manual chapters do not apply to permanently shut down reactors. Further, a review of the Inspection Manual Chapters and associated NRC Inspection Procedures identified only one procedure applicable to permanently shut down nuclear power reactors (NRC 1997a). It focused on spent fuel pools. This sole procedure was developed in response to the 1994 event at Dresden Unit 1. According to NRC, it is "estimated to require 32 onsite inspection hours semi-annually." (NRC 1997a), *Spent Fuel Pool Safety at Permanently Shutdown Reactors*, Inspection Manual Inspection Procedure 60801, found online at http://www.nrc.gov/reading-rm/doc-collections/insp-manual/inspectionprocedure/ip60801.pdf.

[11] See *Critique of the Analysis of Safety and Environmental Risks Posed by Spent Fuel Pool Leaks in the NRC's Draft Waste Confidence Generic Environmental Impact Statement***,** December 13, 2013,

Another example of a relaxed regulatory scheme concerns NRC's reliance on a volunteer, industry-run groundwater monitoring program. In the agency's ongoing "Waste Confidence" proceeding, NRC states "[l]icensees that have implemented a groundwater monitoring program consistent with the Nuclear Energy Institute Groundwater Protection Initiative are considered to have an adequate program for the purposes of the Decommissioning Planning Rule.[12] Therefore, based on results from a one-time, voluntary, industry created initiative at currently operating plants, NRC apparently considers the voluntary groundwater monitoring program to be adequate over the entire 60-year short-term storage period at shutdown plants. NRC should rethink this policy and alter it with all dispatch. The industry's Groundwater Protection Initiative is a voluntary measure that is currently not being routinely inspected by the NRC at either operating or permanently shut down nuclear power plants. As such, crediting a non-mandatory, non-inspected program with detecting and correcting leaks during the 60-year storage period is simply not credible, and not supported by the industry's failure to prevent leaks of tritium to groundwater from its existing reactors.

**Consideration #2 Is the Funding Adequate?**

Four nuclear power reactors (Crystal River 3 in Florida, Kewaunee in Wisconsin, and San Onofre Units 2 and 3 in California) permanently shut down over the last two years and the owner of another reactor (Vermont Yankee in Vermont) announced it would permanently shut down in the fourth quarter of this year.

Decommissioning, a painstaking and complicated process that by any measure can take decades, carries with it cost projections from $400 million to $1 billion per reactor.[13] The Times reported last year that Entergy Corporation is at least $90 million short of a projected $560 million cost of dismantling Vermont Yankee. But in a positive development, late last year Vermont's Governor Shumlin and Entergy, Vermont Yankee's operator, announced an agreement that, among other matters, sets a path for decommissioning Vermont Yankee as promptly as funds in the Nuclear Decommissioning Trust allow, rather than delaying decommissioning under SAFSTOR guidelines.[14] Entergy VY also committed in the agreement to prepare a site assessment and cost study by the end of this year. I have no doubt the testimony of the State today will shed more light on these developments.

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Declaration of David Lochbaum, online at http://www.cleanenergy.org/wp-content/uploads/LochbaumDeclaration.pdf.

[12] NRC Waste Confidence Generic Environmental Impact Statement, NUREG-2157, Draft Report for Comment, at 3-19, 3-20.

[13] "As Reactors Age, the Money to Close Them Lags," Matthew L. Wald, March 20, 2012, link in note 1.

[14] "Governor Shumlin, Attorney General Sorrell, and Entergy VY Announce End to Current Disputes and Path to Decommissioning and Site Restoration of Vermont Yankee Without Undue Delay After 2014 Closure," http://www.entergy.com/news_room/newsrelease.aspx?NR_ID=2825.

In any event, NRDC has concerns that current decommissioning funding mechanisms will prove insufficient to fully decommission the power reactors due to come off line in the next several years. The United States Government Accountability Office (GAO) issued a report where its top line findings were:[15]

- "NRC's formula may not reliably estimate adequate decommissioning costs. According to NRC, the formula was intended to estimate the "bulk" of the decommissioning funds needed, but the term "bulk" is undefined, making it unclear how NRC can determine if the formula is performing as intended. In addition, GAO compared NRC's formula estimates for 12 reactors with these reactors' more detailed site-specific cost estimates calculated for the same period. GAO found that for 5 of the 12 reactors, the NRC formula captured 57 to 76 percent of the costs reflected in each reactor's site-specific estimate; the other 7 captured 84 to 103 percent.

- The results of more than one-third of the fund balance reviews that NRC staff performed from April 2008 to October 2010 to verify that the amounts in the 2-year reports match year-end bank statements were not always clearly or consistently documented. As an example of inconsistent results, some reviewers provided general information, such as "no problem," while others provided more detail about both the balance in the year-end bank statement and the 2-year report. As of October 2011, NRC did not have written procedures describing the steps that staff should take for conducting these reviews, which likely contributed to NRC staff not always documenting the results of the reviews clearly or consistently.

- NRC has not reviewed licensees' compliance with the investment standards the agency has set for decommissioning trust funds. These standards specify, among other things, that fund investments may not be made in any reactor licensee or in a mutual fund in which 50 percent or more of the fund is invested in the nuclear power industry. As a result, NRC cannot confirm that licensees are avoiding conditions described in the standards that may impair fund growth. Without awareness of the nature of licensees' investments, NRC cannot determine whether it needs to take action to enforce the standards."

With our limited national experience in decommissioning power reactors, we view this as an evolving concern. We also note it is unclear to us whether NRC's Decommissioning Planning Rule has directly addressed persistent shortfalls in the decommissioning trust funds, especially in instances where there is subsurface and groundwater site contamination. When coupled with the notable and heretofore unacknowledged costs of remediating subsurface and groundwater contamination at numerous sites, it seems apparent the decommissioning trust funds could in some instances be exhausted long before full decommissioning has been accomplished. Adding

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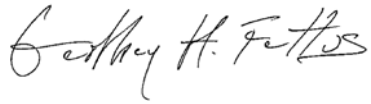
[15] *NRC's Oversight of Nuclear Power Reactors' Decommissioning Funds Could Be Further Strengthened*, GAO-12-258: published April 5, 2012, publicly released: May 7, 2012; online at http://www.gao.gov/products/GAO-12-258.

to this uncertainty funds for decommissioning is the fact that over 40 reactors operate in merchant power markets, where long-term financial assurances are not in place as had been the case for U.S. reactors already entering into decommissioning.

Put bluntly, a plausible risk exists that States and their taxpayers could be placed in a position where they may foot significant portions of the bill to decommission, decontaminate and restore the reactor sites and degraded resources, and accept blighted and unproductive areas in their midst for generations that have been granted waivers for essential security and environmental safeguards. Rather than leave this burden to the States, we urge the Commission to revise the Decommissioning Final Rule in accordance with the State of New York's 2010 comments,[16] wherein NRC was urged to increase the strength and timeliness of the financial assurance monitoring regime so that decommissioning funds will not operate at shortfalls. Moreover, the Commission should adopt New York's wise suggestion that the formula by which decommissioning costs are estimated for each successive reactor should take into account "site-specific" factors such as the presence of contamination so that the ultimate costs will not be borne by States and their citizens.

We look forward to continuing to work with the Committee and all the parties at the table on this issue. I am happy to answer any questions.



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[16] See *Supplemental Comments Submitted By The State Of New York Concerning The Nuclear Regulatory Commission's Proposed Decommissioning Rulemaking;*November 30, 2010, found online at http://pbadupws.nrc.gov/docs/ML1033/ML103350167.pdf.