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General Comment

Natural Resources Defense Council, Inc. (NRDC) Comments on: Regulatory Improvements for Decommissioning Power Reactors, Advance Notice Of Proposed Rulemaking, Request For Comment Docket ID NRC-2015-0070

Attachments

NRDC Comments on Regulatory Improvements for Decommissioning Power Reactors

Natural Resources Defense Council, Inc. (NRDC)

Comments on: Regulatory Improvements for Decommissioning Power Reactors, Advance Notice Of Proposed Rulemaking, Request For Comment

Docket ID NRC–2015–0070

NRDC

March 18, 2016

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NRDC

March 18, 2016

Via Electronic Mail

Secretary, U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
ATTN: Rulemakings and Adjudications Staff

RE: Regulatory Improvements for Decommissioning Power Reactors, Advance Notice Of Proposed Rulemaking; Request For Comment; Docket ID NRC–2015–0070.

Dear Sir/Madam:

The Natural Resources Defense Council (NRDC) writes today to comment on the Nuclear Regulatory Commission (NRC) *Regulatory Improvements for Decommissioning Power Reactors, Advance Notice Of Proposed Rulemaking; Request For Comment*; Docket ID NRC–2015–0070, 80 Fed. Reg. 72358-72373 (November 19, 2015) (hereinafter "ANPRM").

We begin by observing that attention to reactor decommissioning by the NRC came late in the nuclear era, after many of today's nuclear power plants were already in operation. The NRC's current objective of 2019 for completion of a rulemaking on reactor decommissioning is timely and overdue. As we note later in these comments (*see infra* at 20 for discussion and citation), we agree with the NRC's own recent adjudicatory reflections, "[t]he NRC has never promulgated comprehensive regulations governing the decommissioning of nuclear power reactors." It is past time the agency promulgate such comprehensive regulations. Decommissioning is an integral component of the nuclear energy lifecycle, and communities that host nuclear power plants need to know the rules of the road from the start of a reactor project to the end.

This issue of decommissioning is all the more important with respect to the fact that five reactor retirements since 2013 occurred without advance notice or pre-planning, and with respect to fact of growing challenges for the U.S. nuclear industry related to aging, reliability and safety, and economic competitiveness. Together these challenges will likely result in a growing number of reactors transitioning to decommissioning in the decades ahead.

I. NRDC Statement of Interest

NRDC is a national non-profit environmental organization with over one million combined members and activists. NRDC's activities include maintaining and enhancing environmental quality and monitoring federal agency actions to ensure that federal statutes enacted to protect human health and the environment are fully and properly implemented. Since 1970, NRDC has sought to improve the environmental, health, and safety conditions at the civil nuclear facilities licensed by the NRC and we will continue to do so. We are pleased at this opportunity to comment on this long overdue ANPRPM.

II. Summary of NRDC's Comments

A revised and comprehensive NRC regulatory basis for decommissioning is a key component of a necessary, greater national focus on the back end of the nuclear fuel cycle, including the remediation of radiologically contaminated sites and radioactive waste management. Decommissioning issues are pertinent to nuclear reactor design and operation, so as to minimize nuclear end-of-life-cycle environmental impacts, risk and cost.

NRDC agrees with the statement in the NRC's decommissioning ANPRM that: "During reactor decommissioning, the principal radiological risks are associated with the storage of spent fuel onsite." While the risk of zirconium fire is not the only radiological risk associated with decommissioning, such an event would have by far the largest impacts in terms of off-site radiological contamination. NRDC disputes that the risk of a radiological release from a decommissioning reactor is always significantly lower than that for an operating reactor, because risk is not just a function of whether the reactor is generating electricity or not, but also a function of facility maintenance, accident mitigation measures and security.

During decommissioning a large radiological source term is still present. Spent nuclear fuel is dangerous and highly toxic while fissioning in reactors and it remains so for millennia to follow. Spent fuel remains dangerous while resting in overpacked pools not designed for the length of time they will be used, including when a reactor has been shut down and decommissioning has commenced. We recommend no relaxation of health, worker safety or environmental exemptions –as have become common at the growing number of decommissioning sites – as long as spent fuel remains in the pools.

The ANPRM describes the intention of the NRC to improve the efficiency of decommissioning regulations but states that the proposed rulemaking is not based on safety concerns. We caution the NRC that, if not done right, safety concerns can emerge from this rulemaking process.

NRDC is supportive of a tiered approach for modifying emergency planning requirements. We recommend that the tiers be defined as: (1) the period immediately after cessation of power operations; (2) the period during removal of fuel from the reactor vessel; (3) the period when any spent fuel is still in wet pool storage; and (4) the period when all spent fuel is in dry cask storage. NRDC cautions against any erosion of emergency planning, physical security requirements, fitness for duty requirements, or training requirements until the final tier is achieved where the physical protection of dry cask storage creates a robust barrier to release of fission products.

Furthermore, NRDC comments that the NRC should maintain the Emergency Response Data System (ERDS) during decommissioning up to the final tier where all fuel is in dry cask storage. But – fully throughout decommissioning – NRDC comments that the NRC should require decommissioned reactor sites provide the public with real-time, online radiation data within the decommissioned plant site and in the emergency planning zone. Networks of radiation sensors can be set up and maintained at very low cost, and provide transparency for communities hosting decommissioning reactors with spent fuel for decades. This is not an extraordinary proposition. NRDC itself is working to develop citizen radiation monitoring capabilities and its well within the capacity of NRC to do the same.

An important aspect of decommissioning is determining how clean the area is. The NRC's release criteria for unrestricted release include a dose limit to an average member of the critical group and that the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). This limit cannot be measured directly. So a clear understanding of dose modeling is critical. Dose modeling helps to translate the dose release criteria to measurable concentrations of radioactivity in different environmental pathways.

The decommissioning process cannot be excluded from the National Environmental Policy Act (NEPA) process. At a minimum, the billion-dollar operation that is decommissioning a power reactor is a major federal action affecting the environment and requires supplementation of an existing environmental impact statement. The generic NEPA coverage of the past is dated, stale, and misses a host of site specific opportunities. This NEPA supplemental document for each decommissioning site should be done in light of NRC requiring the licensee to submit a formal decommissioning plan that provides a complete roadmap that both the state and affected community can follow in such a massive undertaking. The Post-Shutdown Decommissioning Activities Report (PSDAR) now submitted within two years of final shutdown has been an inadequate process that is only generating needless and contentious disputes. A formal decommissioning plan, a NEPA supplement, and a necessary restoration of public and state hearing and intervention rights are necessary both to restore public trust and acceptance of NRC's regulatory oversight and the final assurance a site will be cleaned up and restored to productive use.

As noted, a role for the NEPA supplemental is to address site-specific issues for reactor decommissioning. Decommissioning will impact different communities in different ways, including issues related to environmental justice. Communities hosting nuclear power plants can and have changed dramatically over decades of reactor operations preceding decommissioning. The source terms in spent nuclear fuel pools will vary from decommissioning reactor to decommissioning reactor, along with the configuration of spent fuel pools. These site-specific issues point to the need for a close look at plans and risks with an opportunity for stakeholder input in the context of NEPA, and provide the framework for the role of State and local governments and non-governmental stakeholders in the decommissioning process.

The NRC needs to be explicit and have absolute clarity as to the viability and necessary amount of funding available to support the decommissioning process. As has been noted by others such as the Government Accountability Office, NRC's formula may not reliably estimate adequate decommissioning costs assurance. This cannot stand. Along with a thorough review that the financial assurance requirements are adequate to the task, we comment that NRC present a public, online dashboard for the decommissioning process where stakeholders can see if the owner of a reactor in their community is putting enough funds aside, and if investment is performing adequately to meet the needs of the cleanup. Such a process would do much to bolster public trust in the decommissioning process.

The ANPRM notes the objective for the draft regulatory basis of evaluating "the appropriateness of maintaining the three existing options (DECON, SAFSTOR, and ENTOMB) for decommissioning and the timeframes associated with those options." In a revised regulatory framework for decommissioning, the NRC should eliminate the ENTOMB option and fundamentally revise the SAFSTOR option. NRDC comments that SAFSTOR can simply become an expedient way to defer addressing important cleanup responsibilities thereby raising money for decommissioning costs that should have been there in the first instance, while putting what can be an extraordinary burden on states and affected communities by drawing out the decommissioning process.

The ANPRM is candid that the 60 year duration of decommissioning activities was chosen because it roughly corresponds to 10 half-lives for cobalt-60. We advise the commission that the timetable for decommissioning needs to be worked out with human lives and community livelihoods in mind and not just nuclear physics. And currently the NRC's approval of a PSDAR is not even required as part of the regulatory framework. NRDC comments that it is time for the NRC to step up and take back key responsibilities as regulator in decommissioning, established on a framework of maximum protection from risk –and a framework of public input and of transparency of information.

III. Background on Decommissioning

When a nuclear plant is retired, the facility must be decommissioned by safely removing it from service and reducing residual radioactivity to a level that permits release of the property and termination of the operating license. The purpose of decommissioning is to protect both public health and safety and the environment from accidental releases of remaining radioactivity.[1]

Currently there are three alternative decommissioning approaches within NRC's regulatory framework: DECON, SAFSTOR and ENTOMB. In DECON, all components and structures that are radioactive are cleaned or dismantled, packaged, and shipped to a low-level waste disposal site or they are stored temporarily on site. In SAFSTOR, the nuclear plant is kept intact and placed in protective storage for up to 60 years. This method, which involves locking the part of the plant that contains radioactive material and monitoring it with an on-site security force, essentially also uses time as a decontaminating agent by allowing the radioactive components to decay to stable elements. In ENTOMB, radioactive contaminants are permanently encased on site in structurally sound material such as concrete and appropriately maintained and

[1] Found online at https://www.princeton.edu/~ota/disk1/1993/9305/9305.PDF

monitored until the radioactivity decays to a level permitting restricted release of the property.[2]

NRDC notes that deliberately delaying the decommissioning and demolition of a plant, or conducting it in time separated stages, will result in a subsequent decrease in the radioactive inventory over time and can significantly reduce the quantities of materials with higher radioactivity levels. Because of the process of radioactive decay, the quantity of radioactivity decreases with time after plant shutdown, particularly for reactor components where ^{60}Co is dominant.[3] However, as commented below, the SAFSTOR option for decommissioning currently does not provide a clear regulatory framework with respect to the mitigation of exposure from allowance for natural decay of isotopes. Table 1 shows the approximate masses and activities of steel from active areas at various times after shutdown in a 1000 MW(e) PWR.[4] When comparing 5 and 25 years after shutdown, the amount of steel contaminated to levels higher than 0.1 Bq/g or 0.37 Bq/cm^2 decreases by about 50%. Further reductions may be made by decontamination.

Table 1 Effect of decay on masses and activity of steel from a 1000 MW(e) PWR

		Time after reactor shutdown					
		5 years of decay		25 years of decay		100 years of decay	
Surface activity (Bq/cm^2)	Average activity (Bq/g)	Mass (t)	Total activity (Bq)	Mass (t)	Total activity (Bq)	Mass (t)	Total activity (Bq)
37-370	10	800	8.0×10^9	440	4.4×10^9	240	2.4×10^9
3.7 - 37	1	1600	1.6×10^9	880	8.8×10^8	480	4.8×10^8
0.37 – 3.7	0.1	3200	3.2×10^8	1760	1.8×10^8	960	9.6×10^7

[2] Found online at http://www.nei.org/master-document-folder/backgrounders/fact-sheets/decommissioning-nuclear-energy-facilities
[3] Found online at http://www-pub.iaea.org/MTCD/publications/PDF/trs462_web.pdf
[4] Found online at http://www-pub.iaea.org/MTCD/publications/PDF/trs462_web.pdf

In the United States, 10 reactors have completed decommissioning and 16 reactors are in the decommissioning process. Fourteen out of the 16 plants in the decommissioning process are using the SAFSTOR option, and 2 are using the DECON option. Table 2 shows the decommissioning status for retired NRC-licensed reactors in the U.S.

Table 2. Decommissioning status for retired NRC-licensed reactors

No	Reactor	Owner	Type	Location	End of operation	Status	Estimated date for closure
1	Big Rock Point	Consumers Energy	BWR	Charlevoix, MI	08/29/97	Decommissioned	12/30/2012
2	Haddam Neck	Connecticut Yankee Atomic Power	PWR	Haddam Neck, CT	12/09/96	Decommissioned	11/15/2007
3	Maine Yankee		PWR	Wiscasset, ME	12/06/96	Decommissioned	2005
4	Rancho Seco	Sacramento Municipal Utility	PWR	Sacramento, CA	06/07/89	Decommissioned	10/23/2009
5	Trojan	Portland General Electric	PWR	Portland, OR	11/09/92	Decommissioned	2005
6	Yankee Rowe	Yankee Atomic Electric Company	PWR	Franklin Co., MA	10/01/91	Decommissioned	
7	Pathfinder	Northern States Power	BWR	Sioux Falls, SD	09/16/67	Decommissioned	
8	Saxton	Saxton Nuclear Experimental Corp	PWR	Saxton, PA	05/01/72	Decommissioned	2005
9	Shippingpor t	Dusquesne Light Company	PWR	Shippingport, PA	10/01/82	Decommissioned	12/89
10	Shoreham	GE	BWR	Suffolk Co., NY	06/28/89	Decommissioned	05/95
11	Humboldt Bay	PG&E	BWR	Eureka, CA	07/02/76	DECON	2019
12	Zion – Units 1 & 2	Exelon	PWR	Zion, IL	02/13/98	DECON	12/31/2020
13	Crystal River – Unit 3	Duke	PWR	Crystal River, FL	02/20/2013	SAFSTOR	2074
14	Dresden – Unit 1	Exelon	BWR	Morris, IL	10/31/78	SAFSTOR	12/31/2036
15	Fermi – Unit 1	DTE Energy	Fast Breeder	Monroe Co., MI	09/22/72	SAFSTOR	10/01/2032
16	GE VBWR	GE	BWR	Sunol, CA	12/09/63	SAFSTOR	2019
17	Indian Point – Unit 1	Entergy	PWR	Buchanan, NY	10/31/74	SAFSTOR	10/01/2026

No	Reactor	Owner	Type	Location	End of operation	Status	Estimated date for closure
18	Kewaunee	Dominion	PWR	Carlton, WI	05/07/2013	SAFSTOR	2073
19	LaCrosse	Dairyland Power Cooperative	BWR	Genoa, WI	04/30/87	SAFSTOR	TBD
20	Millstone – Unit 1	GE	BWR	Waterford, CT	07/21/88	SAFSTOR	12/31/2056
21	Nuclear Ship Savannah	US Gov	PWR	Baltimore, MD	11/70	SAFSTOR	12/01/2031
22	Peach Bottom – Unit 1	Exelon	HTGR	Delta, PA	10/31/74	SAFSTOR	12/31/2034
23	San Onofre – Unit 1	Southern California Edison	PWR	San Clemente, CA	11/30/92	SAFSTOR	12/30/2030
24	San Onofre – Units 2 & 3	Southern California Edison	PWR	San Clemente, CA	06/12/13	SAFSTOR	12/31/2031
25	Three Mile Island – Unit 2	FirstEnergy	PWR	Middletown, PA	03/28/79	SAFSTOR	12/31/2036
26	Vermont Yankee	Entergy	BWR	Vernon, VT	12/29/2015	SAFSTOR	2073

IV. The Risk of Off-Site Radiological Release during Decommissioning

During the decommissioning of nuclear reactors, the highest-impact radiological risk is associated with zirconium fires at the storage of spent fuel onsite in wet pools. Until spent nuclear fuel is removed from the decommissioning plant site, a large radiological source term is still present. The risk of off-site release of fission products is not just a function of whether the reactor is operational, but also a function of facility maintenance, accident mitigation measures and security. NRDC's comments on decommissioning flow primarily from consideration of this risk, and mitigation measures to reduce this risk.

Spent fuel pool fires can be occurred due to a loss of pool water inventory caused by either accidents or terrorist attacks. While the probability of an accident can be estimated using a probabilistic risk assessment framework, the total probability of such an event cannot be know with certainty. The accident progression in a spent fuel pool fire is as follows:

- A Leak of the pool water or failure of the pool cooling pumps occurs;
- The water level of the pool falls below the top of the spent fuel, uncovering the fuel;
- Heat-up of the fuel ensues, and the fuel cladding initiates an oxidation reaction with water;
- This cladding oxidation reaction increases the temperature of the cladding further and causes the cladding to melt and catch fire, and explosive hydrogen gas is also produced;
- Radioactive aerosols and vapors disperse throughout the spent fuel pool building and outside of the reactor building; and
- A potentially very large inventory of Cs-137, radioactive iodine and other fission products is released to the atmosphere that can lead to the radiation exposure of nearby populations.

According to NRC assumptions for the high-density spent fuel pool zirconium fire involving a leak without mitigation measures, the maximum release is approximately 75%, which was used for the base case. A 90% and 10% release fractions are used for the high estimate and low estimate, respectively, to account for spent fuel pool variations and uncertainties in the accident progression.[5]

How would the consequences of spent fuel pool fires be different at different decommissioning reactor sites in terms of nearby populations and spent fuel pool packing? The table below shows consequence estimates for the five sites, for 3.5 and 35 MCi Cs-137 releases.[6]

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[5] NRC, "Staff Evaluation and Recommendation for Japan Lessons-Learned Tier 3 Issue on Expedited Transfer of Spent Fuel," COMSECY-13-0030, November 12, 2013

[6] Jan Beyea, Ed Lyman, Frank von Hippel, "Damages from a Major Release of 137Cs into the Atmosphere of the United States," Science and Global Security, 12:125–136, 2004.

Table 3. Estimates of economic losses ($ billions) and cancer deaths.

Site	Release (MCi)	Total costs	Condemned property	Other losses[30]	Temporary relocation	Decontamination[31]	Cancer deaths[32]
Catawba	3.5	71	10	32	0	29	3,100
	35.0	547	145	192	11	199	7,650
Indian	3.5	145	43	42	5	56	1,500
point	35.0	461	282	85	8	86	5,600
LaSalle	3.5	54	2	23	1	27	2,100
	35.0	270	10	121	7	131	6,400
Palo Verde	3.5	11	1	5	0	5	600
	35.0	80	24	26	2	29	2,000
Three-Mile	3.5	171	13	65	6	87	2,300
Island	35.0	568	278	134	11	144	7,000
Averages	3.5	91					1,900
	35.0	385					5,700

Resulting cancer deaths described at the column of the table depend on nearby population densities of the sites. The figure below shows the cumulative populations within a given radius out to 1600 km from each of these nuclear power plants.[7]

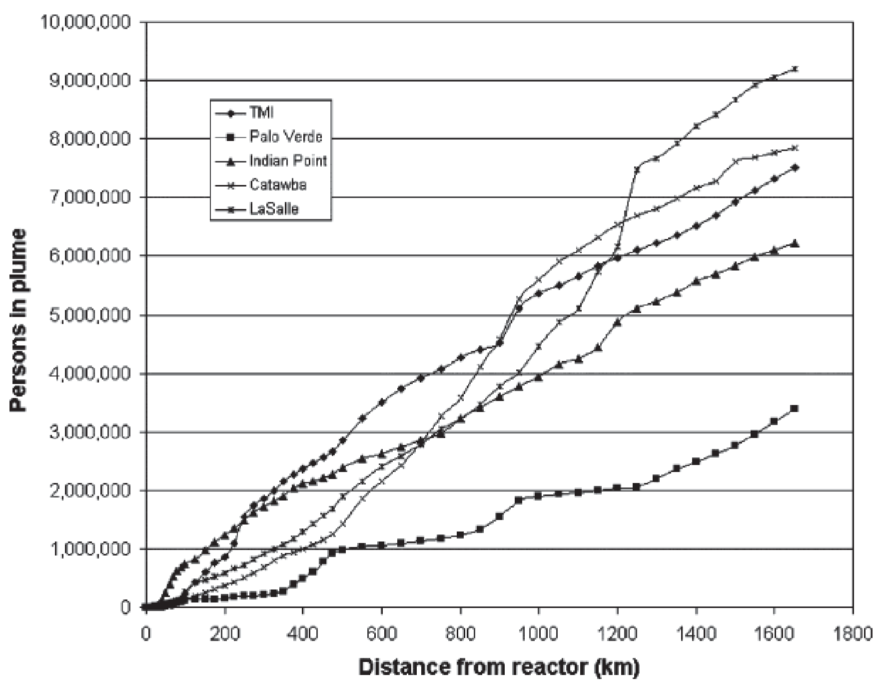


Figure 1. Cumulative population as a function of distance from five U.S. nuclear power plants multiplied by a plume-width factor of 0.038.

[7] Jan Beyea, Ed Lyman, Frank von Hippel, "Damages from a Major Release of 137Cs into the Atmosphere of the United States," Science and Global Security, 12:125–136, 2004.

The table below shows consequence estimates for the Peach Bottom site in terms of spent fuel pool packing, i.e. whether dense packing (high-dense pool) or not (low-dense pool).[8] According to the table, the U.S. NRC estimates spent fuel pool fire consequences from high-density pool fire to be about 40 times than low-density pool fire and 10-100 times worse than Fukushima.

Table 4. U.S. NRC's estimated consequences from spent fuel pool fire

	High-density pool	Low-density pool	Fukushima-Daiichi
Release (PBq)	925	4	6-20
Cancer deaths	43,100	1,100	~1000
Area evacuated (km^2)	46,600	221	1,100
Population displaced	10.9 million	72,000	165,000

This dense-packing is to provide additional space for normal storage pool of spent fuel by spacing a spent fuel assembly about a half of the original spacing by enclosing each spent fuel assembly in a metal box whose walls contain neutron-absorbing boron. However the partitions of the walls would block the horizontal circulation of cooling air if the pool water were lost.[9]

V. A Tiered Approach to Emergency Preparedness, Security and Workforce Management

In contrast to the current system of *ad hoc* exemptions, NRDC is supportive of a tiered approach for modifying emergency planning requirements. We recommend that the tiers be defined as: (1) the period immediately after cessation of power operations; (2) the period during removal of fuel from the reactor vessel; (3) the period when any

[8] Frank von Hippel, "The large costs and small benefits of reprocessing," Updated for KAIST graduate students hosted by the Partnership for Global Security (PGS) and the US-Korea Institute at SAIS, Washington DC, 20 January 2016.
[9] Robert Alvarez et al., "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States," Science and Global Security, 11:1-51, 2003.

spent fuel is still in wet pool storage; and (4) the period when all spent fuel is in dry cask storage. NRDC cautions against any erosion of emergency planning, physical security requirements, fitness for duty requirements, or training requirements until the final tier is achieved where the physical protection of dry cask storage creates a more robust barrier to release of fission products. The primary factor to be evaluated in this tiered approach is the risk of off-site radiological release due to zirconium fire.

Within the first two tiers, the period immediately after cessation of nuclear power operations and the period during de-fueling, the emergency preparedness requirements, formal offsite radiological emergency plans, emergency planning zones, alert and notification systems should be maintained during these tiers as for an operating reactor. Physical security requirements and fitness for duty requirements should similarly be maintained during these tiers as for an operating reactor. Prior to de-fueling, power reactor licensees should continue to be required to classify and declare an emergency, assess releases of radioactive materials, notify licensee personnel and offsite authorities, take mitigating actions, and request offsite assistance if needed. During the first two tiers, licensees at decommissioning sites should maintain existing agreements with offsite authorities for fire, medical, and law enforcement support that are were in place prior to cessation of nuclear power operations. These first two tiers are distinguished by existing NRC oversight governing distinct power reactor activities, but in terms of accident safeguards and preparedness, these first two tiers would regulated in continuous manner from before cessation of operations with respect to the risk of severe accident and offsite release of radiological materials.

Upon permanent removal of fuel from the reactor vessel the third tier, emergency preparedness requirements, formal offsite radiological emergency plans, emergency planning zones, alert and notification systems, physical security requirements and fitness for duty requirements should be re-oriented to focus on mitigating risk of off-site radiological release from spent fuel pool fires. NRC should require the licensee to implement emergency planning and preparedness based on plume modeling of the source term from the spent fuel inventory within the storage pool, including site-specific fuel burnup, pool racking, pool construction, and regional meteorological and population data. Physical security requirements should be adapted to focus on greater protection of the spent fuel pool given changes to personnel and procedures across the plant site after cessation of reactor operations. For this tier, the emergency planning zone size and regulatory allowances for changes to activities or procedures impacting emergency planning-related equipment would have as a basis the calculated consequences of a zirconium fire in a spent fuel pool at the decommissioning reactor.

In the third tier of the decommissioning process, the period when any spent fuel is still in wet pool storage, nuclear power reactor licensees should continue to be required to review all emergency planning program elements every 12 months to ensure protection of plant workers, regional populations and the environment from the consequences of a zirconium fire. With respect to emergency planning, licensees should maintain interfaces with State and local government officials to support emergency planning and disaster response based on the source term plume modeling from a spent fuel pool zirconium fire.

Within this third tier, nuclear power reactor licensees would continue to be required to make an immediate notification to the NRC for the declaration of any of the emergency classes specified in the licensee's NRC-approved emergency plan pertaining to a zirconium fire in the spent fuel pool. Additionally, nuclear power reactor licensees would continue to be required to make an 8-hour report of any event that results in a major loss of emergency assessment capability, offsite response capability, or offsite communications capability specific to the spent nuclear fuel pool and its supporting infrastructure and security configuration, including the decommissioning plant as a functioning system.

Furthermore, NRC should maintain the Emergency Response Data System (ERDS) during decommissioning up to the final tier where all fuel is in dry cask storage. But – fully throughout decommissioning – NRC should require decommissioned reactor sites provide the public with real-time, online radiation data within the decommissioned plant site and in the emergency planning zone. As described below, networks of radiation sensors can be set up and maintained at very low cost, and provide transparency for communities hosting decommissioning reactors with spent fuel for decades.

When the fourth tier is reached during the decommissioning process, at which time all spent fuel has been removed from wet pool to dry cask, emergency preparedness requirements, formal offsite radiological emergency plans, emergency planning zones, alert and notification systems can be re-assessed in light of more robust protection of the residual source term after cessation of operations of the nuclear reactor.

VI. Dose Modeling and Radiation Monitoring for Regulation of Decommissioning

An important aspect of decommissioning is determining how clean the area is. The NRC and the U.S. Environmental Protection Agency (EPA) are the two principal federal agencies responsible for the cleanup and decommissioning of radioactively contaminated sites. These agencies have their own methods of determining a cleanup. The NRC has adopted unrestricted use radiological criteria for license termination of 25 mrem (0.25 mSv) per year total effective dose equivalent to an average member of the critical group from all pathways including groundwater and drinking water sources. The NRC also requires licensees to demonstrate that residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).[10] The EPA's release criteria are risk-based rather than dose-based. Specifically, the EPA uses an acceptable lifetime excess cancer risk of 10E-6 to 10E-4 to assess whether a site should be released or not.[11]

These quantities cannot be measured directly. So NRDC comments that clear understanding of dose modeling is critical. Dose modeling analysis helps to translate the dose- or risk- based release criteria (e.g., mSv/y or mrem/y) into measurable concentrations of radioactivity (e.g., Bq/Kg or pCi/g). Dose modeling can also be used to translate known radionuclide concentration at a site into an annual dose/risk value. Dose modeling analysis should be conducted using environmental pathway analysis and modeling of dose/risk impacts, or exposures, to a human receptor representing a

[10] Found online at http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/30/060/30060319.pdf
[11] Found online at https://www.orau.org/documents/ivhp/PhD-Dissertation-E-Abelquist-7-29.pdf

specific critical group of the potentially exposed population. Environmental pathway analysis includes:

i. Direct radiation from equipment;
ii. Internal radiation from inhaled radioactive aerosols; and
iii. External radiation from radioactive aerosols in premise

Radiation monitoring should have a special importance in the entire decommissioning process. Radiation monitoring should be a key component in the process of reactor dismantlement, decontamination and cleaning of equipment, facilities and buildings as well as radioactive waste disposal. All personnel working in radiological designated areas at a decommissioned reactor wear a personal dosimeter. These dosimeters, however, only provide a retrospective measure of dose received by an individual and give no indication of the instantaneous dose or dose rates that an individual has/is being exposed to. Therefore, as stated above, NRC should require that reactors undergoing a decommissioning process to provide the public with real-time, online radiation data within the decommissioned plant site and in the emergency planning zone. Radiation monitoring should be done by involving the communities living within the emergency planning zone of the reactor. Radiation monitoring stations can be established on a community-by-community basis. In order to establish a proper monitoring system, NRC should address the following critical questions:

- How many monitoring stations should be established and where should they be located?
- Who should do the monitoring and how should they be selected?
- What kind of radiation detector and real-time communication system should be selected?
- How should the radiation data be presented and disseminated to the public?
- How will readings above normal background levels be handled?
- What kind of education and training should the communities receive to prepare them to conduct the monitoring?

VII. National Environmental Policy Act (NEPA) Implications for Decommissioning

NEPA's "twin aims" are to force every agency "to consider every significant aspect of the environmental impact of a proposed action," and to "inform the public that it has indeed considered environmental concerns in its decision-making process." *Balt. Gas & Elec. Co. v. NRDC*, 462 U.S. 87, 97 (1983). NEPA requires federal agencies to prepare an Environmental Impact Statement ("EIS") for all "major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(C). Among other issues, an EIS must analyze the "environmental impact of the proposed action" and reasonable alternatives. *Id*. This includes considering the risks that the proposed action may result in a catastrophic environmental impact, the consequences of such an outcome, and reasonable alternatives for mitigating such consequences. e*.g*., *New York et al. v. NRC*, 681 F.3d 471, 478 (D.C. Cir. 2013) ("Under NEPA, an agency must look at both the probabilities of potentially harmful events and the consequences if those events come to pass."); *Limerick Ecology Action, Inc.v. NRC*, 869 F.2d 719, 741 (3d Cir. 1989) (alternatives to mitigate the effects of severe accidents "must be given careful consideration" in the NEPA process).

The renewal of a nuclear power plant operating license is a major federal action significantly affecting the quality of the human environment, and thus a new EIS is required. *New York,* 681 F.3d at 476; *see also* 10 C.F.R. § 51.95(c). In addition, an agency must supplement an EIS in the event of "significant new circumstances," or new "information relevant to *environmental concerns and bearing on the proposed action or its impacts."* 40 C.F.R. § 1502.9(c)*; Deukmejian v. NRC*, 751 F.2d 1287, 1298 (D.C. Cir. 1984) (emphasis added). Thus, the decommissioning of a nuclear power reactor – a billion dollar cleanup operation that takes more than a decade to perform in the best of cases – cannot be excluded from the NEPA process. *See C.A.N. v. NRC*, 59 F.3d. 284, 292-93 (1st Cir. 1995). Currently, subsequent to its rewriting of the decommissioning rules 1996, NRC last attempt to bound the decommissioning process was with a generic supplemental NEPA analysis concluded in 2002. *See Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, Supplement 1, *Regarding the*

Decommissioning of Nuclear Power Reactors; NUREG-0586, Supplement 1, Vols. 1 and 2; November 2002, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0586/s1/v1/. In that NEPA review, NRC states its limited analysis was a supplement to the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities* issued in 1988 (NUREG-0586), prepared because of technological advances in decommissioning operations, experience gained by licensees, and changes made to NRC regulations since the original decommissioning GEIS in 1988.

The purpose of NRC's 2002 generic supplement was explicit: "to provide an analysis of environmental impacts from decommissioning activities that can be treated generically so that decommissioning activities for commercial nuclear power reactors conducted at specific sites will be bounded, to the extent practicable, by this and appropriate previously issued environmental impact statements." NUREG-0586, Supplement 1 at 1-1. NRC further states in a public presentation: "if the environmental impacts that are identified have not been considered in existing environmental assessments, the licensee must address the impacts in a request for a license amendment regarding the activities. The licensee also must submit a supplement to its environmental report that relates to the additional impacts. The NRC will review this environmental assessment or supplement to the environmental statement in conjunction with its review of the license amendment request." *See* http://www.nrc.gov/waste/decommissioning/faq.html (last visited Mar. 17, 2016).

How this has played out in practice is not adequate. As just one example and only using the most recent, the decommissioning of Vermont Yankee has been host to a swathe of serious, contentious disputes over exemptions from safety requirements and alleged misuse of the decommissioning trust fund for radiological cleanup. Put succinctly in one its rulings, the NRC's own Atomic Safety & Licensing Board acknowledged while ruling against Vermont, "[t]he NRC has never promulgated comprehensive regulations governing the decommissioning of nuclear power reactors." *In the Matter of, Entergy Nuclear Vermont Yankee, LLC, and Entergy Nuclear*

Operations, Inc. (Vermont Yankee Nuclear Power Station), LBP-15-18 at 3. The Board further noted that "… the NRC has historically granted regulatory exemptions for permanently decommissioned reactors. Under the Atomic Energy Act of 1954, a petitioner such as Vermont may request a hearing to challenge an License Amendment Request. The extent to which Vermont can challenge exemption-related issues is less clear. Because the Act does not list exemption requests as agency actions subject to a hearing, the Commission has concluded that petitioners generally cannot seek hearings on exemptions." *Id*. at 4.

This is a situation that must change and a more straightforward regulatory structure, with complete rules, NEPA compliance and hearing rights are a necessity, especially in light of the suite of reactor closures sure to arrive over the next several decades. Notably, we agree that an entirely new NEPA EIS of a reactor site for decommissioning would be unnecessary and likely duplicative, but after nearly 3 decades since the original generic EIS and nearly 15 years since the last supplemental and generic analysis, there will be ample need for *site specific* supplemental NEPA analysis that analyzes the relevant impacts and compares reasonable available alternatives (not to the act of decommissioning itself but comparisons and analysis of the timeline and cleanup options) and mitigation strategies available for the decommissioning process. *See* NEPA, 42 U.S.C. §4321, *et seq*.; *see also* 40 C.F.R. §1502.14 and § 51.10-125 and App A. CEQ's regulations governing implementation of NEPA direct that Federal agencies "shall to the fullest extent possible….(b)…emphasize *real environmental issues and alternatives*…(e) Use the NEPA process to identify and assess the *reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions* upon the quality of the human environment." 40 C.F.R. §1500.2 (emphasis added).

As one obvious example why such a supplemental analysis is necessary, since 2002 the affected areas around dozens of reactor sites could have changed enormously in terms population, economic interests, and competing water or development impacts (and in other ways not foreseen). Compounding this problem could be the continued use of the SAFSTOR option, which has the option of essentially freezing the site and its contaminated areas and significant cleanup challenges in place for nearly 60 years, with enormous state and community costs in so doing. Further, this NEPA supplemental can have a key role in addressing the wide range of site-specific issues for reactor decommissioning. Decommissioning, whether done over a shorter or longer time frame, will impact different communities in different ways, including issues related to environmental justice. As noted above, communities hosting nuclear power plants can and have changed dramatically over decades of reactor operations. The source term in spent nuclear fuel pools will vary from decommissioning reactor to decommissioning reactor along with the types of fuel (high burnup or otherwise), along with the configuration of spent fuel pools. These site-specific issues point to the need for a close look at plans and risks with an opportunity for stakeholder input, and provide the framework for the role of State and local governments and non-governmental stakeholders in the decommissioning process.

Thus, this NEPA supplemental document should be done in light of NRC requiring the licensee submit a formal decommissioning plan that provides a complete roadmap that both the state and affected community can follow in this massive undertaking. The Post-Shutdown Decommissioning Activities Report (PSDAR) now submitted within two years of final shutdown has been an inadequate process that is only generating needless and contentious disputes (again, NRC need only review its own pleading files with respect to the disputes with the State of Vermont to see this in stark form). While NRC asserted in its last set of 1996 revisions to the decommissioning regulations that its rules will prohibit the licensee from performing any major decommissioning activity that results in significant environmental impacts not previously reviewed (*see* Final Rule, *Decommissioning of Nuclear Power Reactors*, 61 Fed. Reg. 39278, July 29, 1996)), with the removal of hearing rights such a decision cannot be challenged. The ASLB's Vermont decision (LBP-15-18) only clarifies the gap between what the states and public have called for and what the agency seems willing to allow.

NRC further asserted that when the licensee submits the PSDAR, the licensee must specifically include a section discussing how the planned activities fit within the envelope of environmental effects included in either the FGEIS (NUREG– 0586, August 1988) or the facility's site-specific environmental impact statement – and the licensee must notify NRC if the intended decommissioning activity is inconsistent with the PSDAR. *Id*. None of this suffices in comparison to a formal decommissioning plan that is accompanied by a NEPA supplemental analysis. Requirement of meaningful site specific NEPA analysis and a thorough decommissioning plan will go far in providing a necessary restoration of public trust. Further providing a full reinstitution of hearing and intervention rights on this supplemental analysis will go a long way to restore acceptance of NRC's regulatory oversight and the final assurance a site will be cleaned up and restored to productive use.

VIII. The Regulatory Role for Financial Assurance

Five nuclear power reactors (Crystal River 3 in Florida, Kewaunee in Wisconsin, San Onofre Units 2 and 3 in California, Vermont Yankee in Vermont) permanently shut down over the last few years and owners of other reactors (Pilgrim in Massachusetts and Oyster Creek in New Jersey, Fitzpatrick in New York) announced they would permanently shut down in the next few years.

Decommissioning, a painstaking and complicated process that by any measure can take decades, carries with it cost projections from $400 million to well over $1 billion per reactor. The New York Times reported in 2012 that Entergy Corporation was more than $90 million short of a (then) projected $560 million cost of dismantling Vermont Yankee. 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-. This was consistent with NRC's Staff's own 2009 estimate of an $87 million funding shortfall.[12] More recently, the State of Vermont has raised concerns regarding the Entergy's planned uses for the decommissioning trust fund.[13]

NRDC shares Vermont's concerns that current decommissioning funding mechanisms could prove insufficient to fully decommission the power reactors due to come off line in the next several years (or even if not insufficient, then prematurely depleted by inappropriate use). The United States Government Accountability Office (GAO) issued a report on this issue in 2014 where its top line findings were:[14]

- "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

[12] *See* http://pbadupws.nrc.gov/docs/ML0934/ML093410582.pdf

[13] In the State's November 5, 2015 filing, Vermont alleges that "Entergy Nuclear Operations, Inc. and Entergy Nuclear Vermont Yankee LLC (collectively, Entergy), however, have filed a multitude of separate requests to use the Vermont Yankee Nuclear Decommissioning Trust Fund (Decommissioning Fund or Fund) for purposes other than radiological decommissioning. Considered together, Entergy's actions threaten to undermine the radiological decommissioning work that is the very purpose of the Fund. Unless the Commission intervenes, Entergy will divert hundreds of millions of dollars from their intended purpose." Vermont Petition at 1, found online in NRC's Electronic Hearing Docket, https://adams.nrc.gov/ehd/view.

[14] See *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.

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 relatively 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 current regulatory scheme is even capable of addressing 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 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 propose a draft Decommissioning Rule in wherein (1) NRC requires a substantial increase in the strength and timeliness of the financial assurance monitoring regime so that decommissioning funds will not operate at shortfalls; and (2) a clear prohibition on the use of decommissioning funds for purposes outside of NRC's defined scope. Moreover, the Commission should adopt the State of 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.

IX. Eliminating the ENTOMB and Revising the SAFSTOR Options for Decommissioning

The decommissioning ANPRM notes the objective for the draft regulatory basis of evaluating "the appropriateness of maintaining the three existing options (DECON, SAFSTOR, and ENTOMB) for decommissioning and the timeframes associated with those options." In a revised regulatory framework for decommissioning, NRDC comments that the NRC should eliminate the ENTOMB option and revise the SAFESTOR option. The ENTOMB option is essentially predicated on cessation of reactor operations caused by a severe accident, and is inappropriate to consider within this regulatory framework. SAFSTOR as it is currently constituted can simply become an expedient way to defer addressing important cleanup responsibilities, thereby potentially raising money for decommissioning costs through return on investment that should have been in place at cessation of operations, while putting what can be an extraordinary burden on states and affected communities by drawing out the decommissioning process.

The ENTOMB option is defined by the NRC as a "method of decommissioning, in which radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombed structure is maintained and surveillance is continued until the entombed radioactive waste decays to a level permitting termination of the license and unrestricted release of the property. During the entombment period, the licensee maintains the license previously issued by the NRC." NRC's definition of ENTOMB implicitly refers to engineered efforts to contain radioactive debris from the Chernobyl Unit 4 reactor following the accident in Ukraine in April, 1986. A large concrete shelter was constructed around the destroyed reactor by October, 1986, in part to enable continued operation of the adjacent reactor units. Structural flaws in this original entombment of the Unit 4 reactor have led to the need to build a second entombment structure, the "New Safe Confinement," which is scheduled to complete in 2017.

The ENTOMB option is essentially predicated on cessation of reactor operations caused by a severe accident, and is inappropriate to consider as a basis for rulemaking. Should a severe nuclear accident occur in at an NRC-licensed reactor resulting in the need to supplement primary and secondary containment with a protective structure, the full impacts of such an event would plausibly fall well outside of NRC authority, and involve multiple federal, state and local decision-making and negotiated actions. Simply put, long-term maintenance of a protective structure to contain radioactive debris is not reactor decommissioning. And clearly ENTOMB would not be an appropriate option for decommissioning of a reactor that ceased operation in a controlled and planned manner. Therefore, the NRC should eliminate the ENTOMB option in revised decommissioning rulemaking.

The NRC defines the SAFSTOR option as: "A method of decommissioning in which a nuclear facility is placed and maintained in a condition that allows the facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use." In NUREG 0586 ("Final Generic Environmental Impact Statement on decommissioning nuclear facilities," 1988 and Supplement 1, 2002), a rationale for the SAFSTOR option is given:

> There are several advantages to using the SAFSTOR option of decommissioning. A substantial reduction in radioactive material as a result of radioactive decay during the storage period reduces worker and public doses below those of the

> DECON alternative. Since there is potentially less radioactive waste, less waste-disposal space is required. Moreover, the costs immediately following permanent cessation of operations are lower than costs during the first years of DECON because of reduced amounts of activity and a smaller work force. (p. 3-19)

In this formulation of its regulatory oversight the impacts of decommissioning on the communities hosting the nuclear power plant are utterly disregarded. Full freedom is given to the licensee whether to begin decommissioning activities immediately follow cessation of activities or indefinitely to delay such activities. Furthermore, such assumptions about worker and public doses and radioactive waste volume need to be revisited in light of additional experience with the decommissioning process, and the application of new technologies and processes to decommissioning.

There is no basis in Radiation Protection that led to the arbitrary conclusion that 60 years is an acceptable amount of time to wait to decommission a nuclear power plant. While it is true that radioactive material decays over time, the benefits of dose reduction are largely accrued during the first 10 years after a nuclear plant shut downs. Co-60 is the primary isotope causing significant exposure to personnel during the first 10 years after shutdown. Since Co-60 has 5-year half-life, only 25% of Co-60 remains after 10 years[15]. Moreover, dose and waste issues can be site-specific to a degree that requires individual adjudication. Importantly, no regulatory framework exists causing the licensee to expediently move spent nuclear fuel from wet pool to hardened dry cask storage.

The SAFSTOR option should revised in a new regulatory framework for decommissioning; as it stands this option is essentially a deferral of the DECON option at the discretion of the licensee, resulting in longer-term risk of off-site release of radioactive materials from zirconium fires, and lengthening the period of time in which the public cannot repurpose the former nuclear reactor site for economic development and community uses.

[15] Found online at http://www.leg.state.vt.us/jfo/envy/2015-03-23%20Post-Shutdown%20Decommissioning%20Activities%20Report.pdf

X. Public Participation

The current decommissioning regulatory scheme bars the public and the affected states from meaningful roles in the process. One need only look at Vermont's frustration over the past few years, a situation well known to the NRC. This is not a new complaint. On January 31, 2013, Christopher Paine, then Director of NRDC's Nuclear Program, at the request of the Commission submitted for consideration *The Big Moat, How NRC Rules Suppress Meaningful Public Participation In NRC Regulatory Decision-making*. One of the insights Mr. Paine offered into the problematic NRC hearing process was his reminder that a former chief of the Atomic Safety and Licensing Board, B. Paul Cotter, Jr., outlined the value of public participation in 1981: "(1) Staff and applicant reports subject to public examination are performed with greater care; (2) preparation for public examination of issues frequently creates a new perspective and causes the parties to reexamine or rethink some or all of the questions presented; (3) the quality of staff judgments is improved by a hearing process which requires experts to state their views in writing and then permits oral examination in detail…and (4) Staff work benefits from [prior] hearings and Board decisions on the almost limitless number of technical judgments that must be made in any given licensing application." – "Memorandum to Commissioner Ahearne on the NRC Hearing Process," May 1, 1981, at 8. as quoted in E. R. Glitzenstein, "The Role of the Public in the Licensing of Nuclear Power Plants," in *Controlling the Atom in the 21st Century*, D.P. O'Very, C. E. Paine, and D.W. Reicher, eds. Westview Press, 1994, at 161.

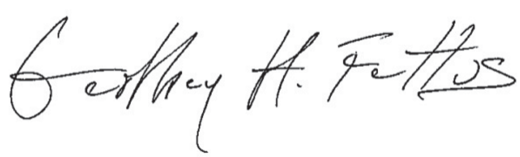
Mr. Paine further went on to note that much more recently, in 2008, Judge Michael Farrar, an NRC Judge for over thirty years, reaffirmed the valuable contribution public participation can make to the licensing process: "The Petitioners were instrumental in focusing the Board's attention on the troubling matters discussed above. That they did so is a testament to the contribution that they, and others like them, can make to a proceeding. Moreover, in doing so they often labor under a number of disadvantages." *In the Matter of Shaw Areva Mox Services* (Mixed Oxide Fuel Fabrication Facility), LB-08-11, Docket No. 70-3098-MLA, at 49 (June 27, 2008) (Farrar, J., concurring).

In the NRC's efforts to "streamline" or make "more efficient" its rules, the agency can lose the thread of trenchant observations. Public involvement and acceptance of the multi-billion dollar enterprise that is nuclear power reactor decommissioning is not a burden – it's a crucial priority. NRC should take this opportunity to write comprehensive rules that engage the public and provide for meaningful opportunities for public input and for public impacts on the decommissioning process.

XI. Conclusion

The observations we provide today we hope will guide the agency as it drafts a thorough, transparent decommissioning rule that is protective of public health and the needs of communities that surround the reactor sites across the country. We appreciate the opportunity to comment. If you have any questions, please do not hesitate to contact NRDC.

Sincerely,



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