## Rulemaking1CEm Resource

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| **Subject:** | Comment on ANPR-26, 50, 52, 73, and 140 - Regulatory Improvements for Decommissioning |
| **Attachments:** | NRC-2015-0070-DRAFT-0076.pdf |

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# PUBLIC SUBMISSION

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Regulatory Improvements for Power Reactors Transitioning to Decommissioning

**Comment On:** NRC-2015-0070-0007
Regulatory Improvements for Decommissioning Power Reactors; Extension of Comment Period

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## Submitter Information

**Name:** John Carlton-Foss
**Address:**
338 CONANT RD
Weston, MA, 02493
**Email:** JCFRSS@gmail.com

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## General Comment

About two years ago when I was still participating on the Program Committee for Harvard Business School Alumni of Boston, I entered into a debate on nuclear power stations with several others during a break in the committee meeting. My point of view prevailed: that risks were such that nuclear facilities had to be run as "squeaky clean" business and technical operations. This might run in to conflicts with financial goals, but it must prevail at all times. This and public inclusion in processes, decision making, and access to information are critically important. The NRC would do well to adopt this thinking and put it into practice if it wishes to retain its credibility.

Pilgrim Watch document is included by reference and attachment.

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## Attachments

PW COMMENT Docket ID NRC-2015-0070

Docket ID NRC-2015-0070
March 1, 2016

**PILGRIM WATCH COMMENT NRC -2015-0070: PROPOSED REGULATORY IMPROVEMENTS FOR DECOMMISSIONING POWER REACTORS**

Pilgrim Watch ("PW") is a non-profit citizens' organization that serves the public interest on issues regarding the Pilgrim Nuclear Power Station specifically and on nuclear power in general. The organization is located at 148 Washington Street, Duxbury, Massachusetts, 02332. Its membership extends throughout the Commonwealth.

The NRC's "proposed improvements" reduce, and in a number of cases effectively eliminate, what a licensee must do to protect public health and safety requirements (i) while there is still radioactive nuclear fuel in the reactor, (ii) while the spent fuel pool contains radioactive spent nuclear fuel – for up to perhaps forty or fifty years after plant closure, and for the potentially hundreds of years that all of spent nuclear fuel that the reactor ever generated remains in dry casks on-site.

The NRC's rationale provided is based on a number of erroneous assumptions, and relies on bits and pieces of methodologically flawed NRC documents, other secret NRC studies and industry guidance. It assumes low probability but high consequence events can be effectively ignored.

NRC ignored the risks – the vulnerability and consequences of a spent fuel pool fire, a canister drop during fuel transfer from the spent fuel pool, and from radioactive releases from dry casks.

The only "improvement" the draft rule provides would be to save industry money – again at the expense of public health and safety.

Pilgrim Watch's (PW) comments are indicated by "PW."

## A. Questions Related to Emergency Preparedness Requirements for Decommissioning Power Reactor Licensees (Section V)

The NRC plans to "complete" its proposed new rule by 2019. But in the past and even now the NRC is implementing its supposed "improvements" by granting exemptions from offsite emergency planning rules and guidance. Exemptions from required offsite emergency planning so far have been granted to Humboldt Bay, LaCrosse, Fort St. Vrain, Rancho Seco, Yankee Rowe, Trojan, Haddam Neck, Maine Yankee, Big Rock Point, Zion, Kewaunee, Crystal River Unit 3,

SanOnofre, and Vermont Yankee. Is NRC's request for public comment simply a meaningless exercise?

## Draft's False Assumptions Used to Justify Exemptions

1. **EP-1** *assumes* that, "*there are* ***no possible design-basis events at a decommissioning licensee's facility that could result in an offsite radiological release*** *exceeding the limits established by the EPA's early-phase protective action guidelines of 1 rem at the exclusion area boundary."*

**PW Comment**:

This assumption, *and its consequences*, are simply wrong. "Offsite radiological release" from spent fuel in pools, and to a lesser degree in casks, *are "possible design-basis events,"* and such releases could exceed EPA limits.

**Pools:** High-density, closed frame pools are vulnerable to a zirconium fire following water loss resulting from acts of malice, equipment malfunction, natural events, human error, cask drops during transfer.[1]+ It is incorrect to assume that nothing can go wrong. For example: Dresden 1 partially drained its SFP when a pipe burst and if not for a watchman observing water in the basement an accident with the potential of offsite radiological release exceeding the limits established by EPA. Lessons learned from Fukushima, and quickly forgotten and glossed over, advised Americans not to enter the 50-mile zone, in large measure due to fears of spent fuel pool release[2].

Also, the Vermont Yankee's PSDAR 5.0 ENVIRONMENTAL IMPACTS [Pg., 29] 5.1.9 Radiological Accidents, Section 4.3.9 of the GElS assessed the range of possible radiological accidents during decommissioning and separated them into two general categories; fuel related accidents and nonfuel related accidents. Fuel related accidents have the potential to be more severe and zirconium fire accidents, in particular, could produce offsite doses that exceed EPA's protective action guides. (Reference 14)

**Transfer:** A canister drop in the pool or on the reactor floor could cause offsite releases exceeding EPA's limits. It perhaps is a low probability event with high consequences and there have been near misses, even with so-called "failure proof cranes." For example at Vermont

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[1] References: Risks and Risk-Reducing Options Associated with Pool Storage of Spent Nuclear Fuel at the Pilgrim and Vermont Yankee Nuclear Power Plants-A report for the Massachusetts Attorney General, Dr. Gordon Thompson, May 25, 2006; Comments on the US Nuclear Regulatory Commission's Draft Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a US Mark I Boiling Water Reactor, Dr. Gordon Thompson, August 1, 2013; Environmental Impacts of Storing Spent Nuclear Fuel and High-Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Waste Confidence Decision and Environmental Impact Determination, Dr. Gordon Thompson, Feb 6, 2009. Documents available on NRC Electronic Library, ADAMS

[2] Fukushima the Story of a Nuclear Disaster, D. Lochbaum, E. Lyman, S. Stranahan, New Press, 2014, pgs., 80,87, 90,92-93,99,139-140.

Yankee, the brakes on the crane that lifts the loaded cask out of the spent fuel pool failed to work properly. The brakes didn't fail entirely but the cask dropped to an inch and a half above the floor. At Palisades in 2006, according to a U.S. Nuclear Regulatory Commission (NRC) inspection report, a container weighing 110 tons, fully loaded with high-level radioactive waste, dangled for 55 hours from a stuck crane above the reactor's irradiated fuel storage pool. Plant personnel, lacking proper knowledge about the crane, and without permission from plant management, mishandled the crane's emergency brake, increasing the risk of the heavy load crashing, out of control, back down into the pool. The falling container could have severely damaged the pool, draining the cooling water. A radioactive waste fire could have followed, resulting in tens of thousands of cancer deaths from radiation exposure to a distance of 500 miles downwind, according to a separate NRC report. Failure-proof equipment failed.

**Casks:** Although casks are far safer than spent fuel pools, they are not immune to events that could result in significant offsite radiological releases. Each cask contains approximately one-half the cesium-137 that was released at Chernobyl. The thin (0.5") stainless steel canisters may crack within 30 years; no current technology exists to inspect, repair or replace cracked canisters; and with limited monitoring, we will only know after they leak radiation[3]. Weapons readily available today can perforate the casks[4], see section on security.

**PW Comment – EPA Protective Action Guides (PAGS)**

EPA PAGS are not sufficiently protective of public health. PW agrees with an opinion of the Vermont Nuclear Decommissioning Citizens Advisory Panel NDCAP) that said, " [T]he EPA PAG dose guidelines are well in excess of the Vermont Department of Health (VDH) public dose limits for VY. In particular, the lowest EPA PAG dose guideline is 1000 to 5000 millirem projected over four days, while the VDH public dose limit is no more than 25 millirem in any year. The EPA PAGs are an unacceptable threshold for public dose from a dormant nuclear reactor, despite it being a facility storing very large quantities of radioactive material awaiting final disposal." Massachusetts radiological air emission standards are 10 millirem in any year.

2. **EP-2:** says "***The possibility of the spent fuel in the SFP reaching the point of a beyond-design-basis zirconium fire is highly unlikely*** *based on an analysis of the amount of time before*

[3] https://sanonofresafety.files.wordpress.com/2011/11/drycaskstorageissues2014-09-23.pdf

[4] Gordon R. Thompson, *Environmental Impacts of Storing Spent Nuclear Fuel and High- Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Waste Confidence Decision and Environmental Impact Determination* (Cambridge, Massachusetts: Institute for Resource and Security Studies, 6 February 2009). Tables also in Declaration of 1 August 2013 by Gordon R. Thompson: Comments on the US Nuclear Regulatory commission's Draft Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a US Mark I Boiling Water Reactor

*spent fuel could reach the zirconium ignition temperature during a SFP partial drain-down event, assuming a reasonably conservative adiabatic heat-up calculation*."[5]

**PW Comment**:
**Fuel Ignition:** The NRC's assumption that a spent fuel fire "is highly unlikely" is also wrong, even when limited to "a SFP partial drain-down event." The NRC effectively admits that there is some likelihood of a spent fuel fire even in this limited "partial drain-down" circumstance, and that the likelihood would be greater in other events.

The possibility of fuel ignition is not unlikely; and the consequences are so large that even a low probability becomes consequential and demands protective actions for the public

**Probability, pools are vulnerable**: Dr. Gordon Thompson explains in *Risks of pool storage of spent fuel at Pilgrim and Vermont Yankee - A Report for the Mass. Attorney General* ,May 2006, PG.18, that, "[T]he closed-form configuration of the high-density racks would create a major problem if water were lost from a spent-fuel pool. The flow of air through the racks would be highly constrained, and would be almost completely cut off if residual water or debris were present in the base of the pool. As a result, removal of radioactive decay heat would be ineffective. Over a broad range of water-loss scenarios, the temperature of the zirconium fuel cladding would rise to the point (approximately 1,000 degrees C where a self-sustaining, exothermic reaction of zirconium with air or steam would begin. **Fuel discharged from the reactor for 1 month could ignite in less than 2 hours, and fuel discharged for 3 months could ignite in about 3 hours**. Once initiated, the fire would spread to adjacent fuel assemblies, and could ultimately involve all fuel in the pool. A large, atmospheric release of radioactive material would occur. Ignition times are impacted by a variety of factors such as age of the fuel, the configuration of the fuel in the pool, etc."

**Consequences: Clear and Unacceptable**

MA Attorney General's 2006 Analysis

- Based on a 2006 analysis for the Massachusetts Attorney General, the offsite consequences in the event of water loss and a pool fire could be as much as $488 Billion dollars ($584 billion in 2015 dollars), 24,000 cancers and contamination hundreds of

[5] This process is analyzed in Comments on Draft Consequence Study, NRC-2013, Dr. Gordon Thompson, Aug 1, 2013, referenced above

miles downwind.[6] That estimate does not include costs associated with cleanup or demolition of downtown business districts, heavy industrial areas, or high-rise apartment buildings. Report to the Massachusetts Attorney General on the Potential Consequences of a Spent-Fuel-Pool Fire at the Pilgrim or Vermont Yankee Nuclear Plant. Jan Beyea, Ph.D. May 25, 2006 http://pbadupws.nrc.gov/docs/ML1209/ML12094A181.pdf

- Much of the damage from a pool fire is due to the release of Cesium-137.
- To make the risk meaningful, compare the inventory of Cs-137 in Pilgrim's pool and what was released at Chernobyl. Chernobyl = 2,403,000 curies Cs-137; Pilgrim's pool = 44,010,000 curies Cs-137; Pilgrim's Core= 5,130,000 curies Cs-137. A recent 2012 GAO Report[7] supports the foregoing consequence discussion.

NRC's Consequence Study Of A Beyond Design-Basis Earthquake Affecting The Spent Fuel Pool For A U.S. Mark I Boiling Water Reactor (October 2013)[8]

- NRC's study of spent fuel storage at Peach Bottom, a reactor in Pennsylvania similar to Pilgrim, showed that if even a small fraction of the inventory of a Peach Bottom reactor pool were released to the environment in a severe spent fuel pool accident, an average area of 9,400.00 square miles (Massachusetts = 6,692.824 square miles) would be rendered uninhabitable for decades, displacing as many as 4.1 million people (MA population=6,692,824).

3. EP-1 further says "*A **minimum of 10 hours is the time that was used in previously approved exemptions, which allows for onsite mitigative actions to be taken by the licensee or actions to be taken by offsite authorities in accordance with the comprehensive emergency management plans** (i.e., all hazards plans).*"

**PW**: Here, the NRC admits that it is already approving exemptions to what current emergency planning (but for the exemptions) purportedly require.

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[6] The Massachusetts Attorney General's Request for a Hearing and Petition for Leave to Intervene With respect to Entergy Nuclear Operations Inc.'s Application for Renewal of the Pilgrim Nuclear Power Plants Operating License and Petition for Backfit Order Requiring New Design features to Protect Against Spent Fuel Pool Accidents, Docket No. 50-293, May 26, 2006 includes a Report to The Massachusetts Attorney General On The Potential Consequences Of A Spent Fuel Pool Fire At The Pilgrim Or Vermont Yankee Nuclear Plant, Jan Beyea, PhD., May 25, 2006 (NRC Electronic Hearing Docket, Pilgrim 50-293-LR, 2—6 pleadings, MAAGO 05/26 (ML061640065) & Beyea (ML061640329)

[7] GAO -12-797, Spent Nuclear Fuel: Accumulating Quantities at Commercial Reactors Present Storage and Other Challenges, http://www.gao.gov/assets/600/593745.pdf

[8] Consequence Study Of A Beyond Design-Basis Earthquake Affecting The Spent Fuel Pool For A U.S. Mark I Boiling Water Reactor (October 2013) at 232 (Table 62) and 162 (table 33),Adams Accession NO ML13256A342)

These exemptions, and the proposed rule, incorrectly assume that the area impacted could be evacuated within 10 hours without: offsite notification sirens; training of emergency personnel; exercises; or any of the other elements of offsite radiological emergency planning.

Except for the NRC (and perhaps some licensees) no one believes that a potentially impacted area will be evacuated within 10 hours.

The absurdity of the Draft's "10 hour" assertion, even with all current emergency rules and planning in effect and much less without them is shown from consequence studies of spent fuel pool fires.

**PW** showed (Adams Accession Number ML 13267A234) that KLD's Evacuation Time Estimates (ETEs) are based on false assumptions and grossly underestimate evacuation times[9]. Pilgrim's ETE for example made a ludicrous estimate of 6 hours to evacuate the entire EPZ. Even with emergency planning that used credible assumptions, realistic ETEs would estimate evacuations to take far longer than current ETEs estimate; and obviously when there is no offsite planning in place, the times would be far greater.

Because the size of the area and number of people that would require evacuation, the EPZ should be expanded, not eliminated, until all spent fuel has been moved from the spent fuel pool into hardened and dispersed dry casks.

4. EP-1 describes the details of already-granted exemptions that the proposed "improvement" rules would itself allow: *"Licensees that have been granted exemptions, the EP regulations, as exempted, continue to require the licensees to, among other things, maintain an onsite emergency plan addressing the classification of an emergency, notification of emergencies to licensee personnel and offsite authorities, and coordination with designated offsite government officials following an event declaration so that, if needed, offsite authorities may implement protective actions using a comprehensive emergency management (all-hazard) approach to protect public health and safety. The* ***EP exemptions relieve the licensee*** *from the requirement to maintain formal offsite radiological emergency preparedness, including the 10-mile emergency planning zone."*

**PW**: What this really is about is excusing the licensee from all expenses incurred for offsite emergency planning and placing the entire burden on the state. It ignores that the only need for *offsite* emergency planning is what the license has done and will continue to do *on-site*.

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[9] PILGRIM WATCH'S 2.206 PETITION TO MODIFY, SUSPEND, OR TAKE ANY OTHER ACTION TO THE OPERATING LICENSE OF PILGRIM STATION UNTIL THE NRC CAN ASSURE EMERGENCY PREPAREDNESS PLANS ARE IN PLACE TO PROVIDE REASONABLE ASSURANCE PUBLIC HEALTH & SAFETY ARE PROTECTED IN THE EVENT OF A RADIOLOGICAL EMERGENCY. NRC Electronic Library Adams Accession Number ML 13267A234

As usual, the NRC is far more concerned about saving industry money by not requiring it bear what are nothing more than its own costs of operation, at the expense of the health and safety of a public that has already paid the licensee for the electric power.

## Responses to Specific Emergency Planning Questions

***EP-1a. What specific EP requirements in § 50.47 and appendix E to 10 CFR part 50 should be evaluated for modification, including any EP requirements not addressed in previously approved exemption requests for licensees with decommissioning reactors?***

**PW:** Current radiological emergency planning requirements, should not be lessened until all spent fuel is removed from the pool and placed in hardened dry casks. Instead, current emergency plans should be expanded to include the far larger area likely to be impacted – well beyond the 10-mile inhalation pathway and 50 mile ingestion zone. During Fukushima, due to the threat posed by Unit 4's spent fuel pool, a 50-mile evacuation for American residents was advised; and it was recognized that even a 50-mile evacuation zone might not be sufficient. If the wind shifted even Tokyo, 150 miles away could be affected.[10] All EP-related guidance should be revised to account for expanding the inhalation and ingestion zones.

One exception for modification is provision for potassium iodide. KI can be eliminated 90 or more days after defueling. The rule of thumb is that I-131 does not pose a threat in irradiated fuel that has been removed from an operating reactor core 90 or more days ago (roughly ten half-lives for the 8-day radionuclide).

Offsite planning also is required, to a lesser degree, when all the fuel is in dry casks until the fuel leaves the site.

**Money**: It takes money and other resources (time, labor) for offsite officials to remain trained and supplied. This is not money that local departments of emergency response in the smaller surrounding communities have available. It is only the presence of the reactor and the money the licensee provides that keeps emergency responders ready. If the formal requirements for radiological emergency services are removed, the funding that keeps the professionals in place and ready goes too. If a future radiological emergency occurs requiring offsite response, and the risk is NOT zero, then emergency responders will not be able to provide reasonable assurance for the public.

***b. What existing NRC EP-related guidance and other documents should be revised to address implementation of changes to the EP requirements?***

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[10] Fukushima the Story of a Nuclear Disaster, D. Lochbaum, E. Lyman, S. Stranahan, Union Concerned Scientist, 2014, New Press, pgs., 84-85,87,88-89

**PW**: All Guidance and related documents need to be updated- current documents are not sufficiently protective. The documents providing the foundation/ assumptions in current emergency planning are outdated. These would include, for example:

- EPA PAGS need to be changed as they are not based on current understandings of health consequences from radiation exposure. (NAS BEIR VII
- **Meteorological Plume Model:** Planners incorrectly assume that winds blow in a straight-line and rely on an outdated straight-line Gaussian plume model that is not spatial or temporal. In order for a Gaussian model to be at all meaningful, the essential conditions include: non-zero wind speed; wind direction constant over time in downwind areas; release rate constant over time for the duration of the release; atmospheric stability constant over time in downwind area. But winds are variable especially near large bodies of water, river valleys and varied terrain[11]. Therefore basing protective action calls on a "key-hole" makes no sense and will result in planners issuing the wrong protective action- evacuation into a plume or no protective action call for those actually in a plume.
- MELCOR: updates required

Specific EP Guidance and documents need revision. They include, for example:

- **Expand EPZ**: Lessons learned from Fukushima: NRC advised Americans in Japan within 50 miles of Fukushima to evacuate; Tokyo, located about 140 miles south of Fukushima, announced that its tap water is contaminated with radioactive iodine and "hot spots" well beyond 50 miles in Japan has contaminated food and water; yet Pilgrim's ingestion zone is only 50 miles Japan. Japan is expanding its EPZ, yet the NRC has gone in the opposite direction for operating reactors and moved to eliminate offsite emergency planning post operation, despite the continued risk from spent fuel.
- **Notification, upgraded and required post operation:** (1) Public: Sirens are the primary method of public notification; however they are essentially outdoor warning systems and often cannot be heard above normal ambient noise by people who live and work inside. This is true in cooler climates where houses are insulated and outfitted with storm windows; in hot climates where air conditioners are standard; and in suburban and exurban areas where houses are set back on sizeable lots with generous landscaping that buffers sound. The following systems should be added: rapid dialing systems, electronic reader boards, low frequency dedicated radio capability and EAS be

[11]What's in the Black Box known as Emergency Dose Assessment, Stephen LaVie, Sr. Emergency Preparedness Specialist, Nuclear Security & Incident Response Division of Preparedness, and 2009 Report to National Radiological Emergency Planning Conference, Slide 2, Dispersion, NRC Electronic Library, Adams Accession Number ML091050257

required. (2) Emergency Workers: Currently their radios are not interoperable. They need to be upgraded to today's technology so that they can talk to one another within the EPZ and to other towns outside for mutual aid.

- **Shadow Evacuation, expanded**: Currently the Federal government incorrectly assumes that only 20% within the 10-mile EPZ told not to evacuate will do so and again only 20% of those within 10-15 miles from the reactor will evacuate. This assumption was proved false by a 2013 Telephone Survey on Cape Cod[12] that showed that if potentially affected respondents were asked "would you evacuate" "if they were an incident at the Pilgrim Nuclear Power Station," 70% (not the 20% assumed by the NRC or the 19% of the ETE) would do so; and if the respondents were told that the Cape is not in the Emergency Evacuation Zone if there were an incident at Pilgrim, 50% said that they would evacuate.

  Expanding the Shadow evacuation outside the EPZ and the voluntary evacuation inside the EPZ requires adjusting the assumptions in Evacuation Time Estimates[13]. Unless current plans come to grips and plan for and control the likelihood of spontaneous evacuation of the public beyond the federal guidance, those most at risk will be trapped in gridlock.
- **Reception Centers, upgraded and continued post-operation:** (1) Location- The key to any site used to for monitor and decontaminate citizens is that it is sufficiently distant from the reactor and placed according to meteorological analysis – in areas likely to be upwind. (2) Capacity- Plans assume that only one in five (20%) will go to the Reception Center and Reception Centers are only equipped with personnel and materials to handle 20%– despite NUREG 0654 (J-12) that states that Reception Centers should be capable of monitoring 100% of the population within 12 hours. This policy leaves 80% without an opportunity to be monitored and decontaminated risking their health and risking spreading contamination to heretofore "clean" areas via contaminated evacuees cars and persons. The 20% policy is based on the number of people who went to a reception center during a Florida hurricane. Public response to hurricanes and nuclear disasters that have no forewarning are very different.
- **Shelters, updated and continued post-operation:** Equip all shelters in the expanded EPZ with face masks; and educate the public where and how to shelter in the event of a

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[12] *KLD MEMO to John Giarrusso (MEMA) from Chris Chaffee (KLD) Regarding the Cape Cod Telephone Survey Results*, July 25, 2013

[13] PILGRIM WATCH'S 2.206 PETITION TO MODIFY, SUSPEND, OR TAKE ANY OTHER ACTION TO THE OPERATING LICENSE OF PILGRIM STATION UNTIL THE NRC CAN ASSURE EMERGENCY PREPAREDNESS PLANS ARE IN PLACE TO PROVIDE REASONABLE ASSURANCE PUBLIC HEALTH & SAFETY ARE PROTECTED IN THE EVENT OF A RADIOLOGICAL EMERGENCY, August 30, 2013

disaster – shelter in an area as distant from the roof as possible and away from all windows, gamma radiation can go through window glass.

- **Worker Safety, post operation**: Provide all emergency workers with protective gear, dosimetry and KI. KI can be dropped after 90 days. Locate the Radiological Emergency Workers Monitoring & Decontamination centers (REWMDS) further distant – preferably 20-25 miles away. There should be more than one center for each EPZ– so that there is an alternative site if the wind is blowing towards one of the centers or access routes clogged with evacuees.
- **Exercises, upgrade and maintain post-operation**: Add reality to the emergency exercises

***EP-1c. What new guidance would be necessary to support implementation of changes to the EP requirements?***

**PW**: Amend and update current guidance to include post-operations.

***EP-2: Rulemaking may involve a tiered approach for modifying EP requirements based on several factors, including, but not limited to, the source term after cessation of power operations, removal of fuel from the reactor vessel, elapsed time after permanent defueling, and type of long-term onsite fuel storage.***

***EP-2 a. What tiers and associated EP requirements would be appropriate to consider for this approach?***

**PW:** Tiers and associated EP requirements should be based on risk of offsite consequences- the risk is not zero and offsite consequences potentially huge.

Tier 1: Extends from the end of operations until all fuel is removed from the reactor vessel. EP requirements should be the same as during operations. Note that current EP requirements do not provide adequate protection of public health and need to be strengthened, as discussed in the foregoing.

Tier 2: Extends from the removal of fuel from reactor vessel to removal fuel from spent fuel pool to dry casks. EP requirements should be the same as Tier 1, excepting that there is no need to provide KI after 90 days from defueling

Tier 3: Extends from time fuel placed in dry casks until all fuel and Class C materials are removed from site. EP requirements can be lessened but not eliminated because of the risk of offsite consequences from a ruptured/leaking cask. Hostile action targeting a dry cask can cause significant release offsite-each cask contains ½ the CS-137 released at Chernobyl.

Regarding leaks, NRC/DOE have not figured out how to fix a leaking cask. The risk, and associated EP requirements, are greater in Tier 3-A than Tier 3B

- Tier 3 A: above ground casks-neither dispersed nor bermed, increasing success of a hostile action event
- Tier 3B: submerged casks or above-ground casks dispersed and bermed, decreasing success hostile action event

Tier 4: After all fuel and Class C material has been removed from site until license terminated. Remove EP requirements

***EP-2 b. What factors should be considered in establishing each tier****?*

Realistic assessments of the vulnerability and consequences of a spent fuel pool fire, cask drop during transfer, and cask leak. NRC's studies are not methodologically sound- see, for example, analyses listed in footnote[14].

***EP-2c. What type of basis could be established to support each tier or factor?***

**PW:** See response to EP2-b, and PW comments regarding false assumption in emergency planning at the beginning of this section.

***EP-2 d. Should the NRC consider an alternative to a tiered approach for modifying EP requirements? If so, provide a description of a proposed alternative.***

**PW:** No

***EP-3: Several aspects of offsite EP, such as formal offsite radiological emergency plans, emergency planning zones, and alert and notification systems, may not be necessary (PW Disputes) at a decommissioning site when beyond-design-basis events—which could result in the need for offsite protective actions—are few in number and highly unlikely to occur.***

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[14] Gordon R. Thompson, Environmental Impacts of Storing Spent Nuclear Fuel and High- Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Waste Confidence Decision and Environmental Impact Determination (Cambridge, Massachusetts: Institute for Resource and Security Studies, 6 February 2009). Gordon R. Thompson ,Consequence Study Of A Beyond Design-Basis Earthquake Affecting The Spent Fuel Pool For A U.S. Mark I Boiling Water Reactor (October 2013) at 232 (Table 62) and 162 (table 33),Adams Accession NO ML13256A342)Safety and Security of Commercial Spent Nuclear Fuel Storage, Public Report, National Academies of Sciences, April 2005, http://www.nap.edu/books/0309096472/html/
"Protecting U.S. Nuclear Facilities from Terrorist Attack: Re-assessing the Current 'Design Basis Threat' Approach, Univ Texas, http://sites.utexas.edu/nppp/files/2013/08/NPPP-working-paper-1-2013-Aug-15.pdf
San Onofre Dry Cask Storage Issues,
https://sanonofresafety.files.wordpress.com/2011/11/drycaskstorageissues2014-09-23.pdf

**PW**: Disagree with statement, see response to EP-1.

***EP-2a. Presently, licensees at decommissioning sites must maintain the following capabilities to initiate and implement emergency response actions: Classify and declare an emergency, assess releases of radioactive materials, notify licensee personnel and offsite authorities, take mitigative actions, and request offsite assistance if needed. What other aspects of onsite EP and response capabilities may be appropriate for licensees at decommissioning sites to maintain once the requirements to maintain formal offsite EP are discontinued?***

**PW**: First offsite EP should not be discontinued until the fuel leaves the site. The statements in EP-3a show that NRC recognizes that the probability of offsite releases requiring protective actions is not zero. NRC's recommendation to stop offsite planning simply shifts the burden of radiological emergency planning for the public offsite to the state and local community to save industry money and the Federal Government from emergency planning oversight expenses.

Emergency Response Data System (ERDS) must be maintained also.

The number of onsite EP workers should be maintained at the level during operations for Tier 1 and Tier 2 listed above and only slightly reduced in Tier 3.

***b. To what extent would it be appropriate for licensees at decommissioning sites to arrange for offsite assistance to supplement onsite response capabilities? For example, licensees at decommissioning sites would maintain agreements with offsite authorities for fire, medical, and law enforcement support.***

**PW**: It is not appropriate, unless those personnel are trained and equipped and the services are fully compensated on an annual basis to assure that they are prepared. Exercises with offsite personnel must be continued also. We suspect that NRC's recommendation is to simply shift the burden to the state and local community to save industry money. Local governments are already stretched and host community's finances dealt a severe blow from the loss of the operating reactor that involves loss of income from payments in lieu of taxes, worker reduction and its impact on local economy etc.

***c. What corresponding changes to § 50.54(s)(2)(ii) and 50.54(s)(3) (about U.S. Federal Emergency Management Agency (FEMA)-identified offsite EP deficiencies and FEMA offsite EP findings, respectively) may be appropriate when offsite radiological emergency plans would no longer be required?***

**PW**: The assumption in the question that offsite radiological emergency plans should not be required is false. Because licensees do not have sufficient funds to dismantle the site they will

enter a long SAFSTOR period with spent fuel onsite, perhaps for 100's of years. Offsite plans are required until all fuel and Class C materials have left the site.

***EP-4: Under § 50.54(q), nuclear power reactor licensees are required to follow and maintain the effectiveness of emergency plans that meet the standards in § 50.47 and the requirements in appendix E to 10 CFR part 50. These licensees must submit to the NRC, for prior approval, changes that would reduce the effectiveness of their emergency plans.***

***a. Should § 50.54(q) be modified to recognize that nuclear power reactor licensees, once they certify under § 50.82, "Termination of License," to have permanently ceased operation and permanently removed fuel from the reactor vessel, would no longer be required to meet all standards in § 50.47 and all requirements in appendix E? If so, describe how.***

**PW**: No. As explained in the foregoing, emergency plans and procedures are presently inadequate; the pool and ISFI are vulnerable with potential severe consequences; plans and procedures should be enhanced and the inhalation zone expanded to 50 miles. However, any changes in Tier 3 as described above must require NRC approval and opportunity for public comment.

Note:

It is the opinion of the Vermont Nuclear Decommissioning Citizens Advisory Panel NDCAP) that the owner of the U.S. Nuclear Regulatory Commission (NRC) License for the Vermont Yankee Nuclear Power Station (VY) continue to fund the VY Radiological Emergency Response Plan (RERP) at a level determined adequate by the Department of Public Safety with advice from the state agencies, towns and other parties potentially affected by, and likely to respond to, radiological releases from VY and other incidents. It is further recommended that this funding be scaled to the varying level of risk over the entire course of the decommissioning of VY until the U.S. NRC license is terminated, currently scheduled for 2072

The Vermont Attorney General's March 6, 2015 *Comment on Entergy's PSDAR Addendum* summarized the state's comments. It said, at 71: "Require Entergy to revise its analyses to reflect the current requirements under its license for maintaining an Emergency Planning Zone; and, Perform a NEPA-compliant analysis of any proposed reductions in the Emergency Planning Zone, including analyzing issues such as radiological spill control during dewatering operations and the potential environmental impacts from a terrorist attack that leads to a zirconium fire in the spent fuel pool or severely damages the torus where more than one million gallons of radioactive water will be stored until decontamination and dismantling."

***b. Should nuclear power reactor licensees, once they certify under § 50.82 to have permanently ceased operation and permanently removed fuel from the reactor vessel, be***

***allowed to make emergency plan changes based on § 50.59, "Changes, Tests, and Experiments," impacting EP related equipment directly associated with power operations? If so, describe how this might be addressed under § 50.54(q)***

**PW**: PW incorporates the comment by David Lochbaum, Union of Concerned Scientists that said:

> As presently structured, 10 CFR 50.59 would have limited applicability in deciding when licensees can make emergency plan changes on their own and when proposed changes require NRC review and approval. The questions that must be answered under 10 CFR 50.59 are tailored to reactor operation. There's very little content in the supporting documents (i.e., the Final Safety Analysis Report and other design and licensing basis documents) governing irradiated fuel stored in spent fuel pools and even less—close to nothing—on irradiated fuel in dry storage onsite. Consequently, nearly every proposed change could be screened out based on not affecting the probability or consequences of accidents and transients described in the FSAR. Conversely, nearly every proposed change could be screened in based on introducing a previously unanalyzed accident or consequence outcome. In order for 10 CFR 50.59 to play a meaningful role, licensees would have to develop a FSAR like document specifically tailored at identifying hazards during the decommissioning and identifying risk management measures. This FSAR-like document would need to be submitted to the NRC for approval, providing appropriate opportunity for public comment. That NRC approved document would provide the proper foundation for emergency planning measures— albeit at a lesser breadth and depth than needed during reactor operation—during the decommissioning period. If and only if this infrastructure was established would be it appropriate for 10 CFR 50.59 to determine when licensees can change emergency plans without prior NRC review and approval.

***EP-5: Under § 50.54(t), nuclear power reactor licensees are required to review all EP program elements every 12 months. Some EP program elements may not apply to permanently shut down and defueled sites; for example, the adequacy of interfaces with State and local government officials when offsite radiological emergency plans may no longer be required. Should § 50.54(t) be clarified to distinguish between EP program review requirements for operating versus permanently shut down and defueled sites? If so, describe how.***

**PW**: Same response as above

***EP-6: The Emergency Response Data System (ERDS) transmits key operating plant data to the NRC during an emergency. Under § 50.72(a)(4), nuclear power reactor licensees are required***

***to activate ERDS within 1 hour after declaring an emergency at an "Alert" or higher emergency classification level. Much of the plant data, and associated instrumentation for obtaining the data, would no longer be available or needed after a reactor is permanently shut down and defueled. Section VI.2 to appendix E of 10 CFR part 50 does not require a nuclear power facility that is shut down permanently or indefinitely to have ERDS. At what point(s) in the decommissioning process should ERDS activation, ERDS equipment, and the instrumentation for obtaining ERDS data, no longer be necessary?***

**PW**: Because pools and ISFIs are vulnerable with the potential for significant offsite releases, ERDS activation, ERDS equipment, and the instrumentation for obtaining ERDS data emergency need to be maintained to provide data to NRC, state and local officials.

***EP-7: Under § 50.72(a)(1)(i), nuclear power reactor licensees are 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. Notification of the lowest level of a declared emergency at a permanently shut down and defueled reactor facility may no longer need to be an immediate notification (e.g., consider changing the immediate notification category for a Notification of Unusual Event emergency declaration to a 1-hour notification). What changes to § 50.72(a)(1)(i) should be considered for decommissioning sites?***

**PW**: PW incorporates comment by David Lochbaum, Union of Concerned Scientists, that said:

> After 9/11, the NRC revised its regulations (see 10 CFR 73.58 online at http://www.nrc.gov/reading-rm/doc-collections/cfr/part073/part073-0058.html) to require that plant owners make decisions regarding about safety with proper consideration of potential security implications and vice-versa. This regulatory requirement is explained further in NRC Regulatory Guide 5.74 (online at http://pbadupws.nrc.gov/docs/ML0916/ML091690036.pdf.) The NRC must practice what it preaches and explicitly consider security in its safety decision making. Irradiated fuel remains a potential sabotage target whether it is in a reactor core, a spent fuel pool, or a dry canister. Safety considerations alone might justify radical changes to the protocols for notifying the NRC about onsite events. But security considerations cannot be ignored. The NRC must be promptly notified about an actual or potential sabotage attack on irradiated fuel either in spent fuel pools or dry storage at decommissioning sites. Not only may sabotage pose a hazard at that site, but it could conceivably be the initial gambit in a larger assault on NRC-licensed facilities. Whether that prompt notification requirement resides in 10 CFR 50.72 or elsewhere does not matter. What matters is that the requirement exists within NRC's regulations that licensees promptly notify the NRC about actual or potential sabotage of irradiated fuel at decommissioning sites.

***EP-8: Under § 50.72(b)(3)(xiii), nuclear power reactor licensees are 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 (e.g., significant portion of***

***control room indication, emergency notification system, or offsite notification system). Certain parts of this section may not apply to a permanently shut down and defueled site (e.g., a major loss of offsite response capability once offsite radiological emergency plans would no longer be required). What changes to § 50.72(b)(3)(xiii) should be considered for decommissioning sites?***

**PW**: We dispute the premise in the question-offsite emergency plans are needed until fuel leaves the site. Licensees must still 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.

**Summary:** PW is not alone in its opinion. For example, the Vermont Dept. of Public Service petitioned the NRC, saying shrinking the EPZ to the footprint of the reactor site would "significantly hinder the State's ability to coordinate and execute an effective response to an emergency situation at the station." [Reformer 02.20.15]

In Congress, the Safe and Secure Decommissioning Act of 2014 (Boxer, Sanders, Markey) would prohibit the Nuclear Regulatory Commission (NRC) from issuing exemptions from its emergency response or security requirements for spent fuel stored at nuclear reactors that have permanently shut down until all of the spent nuclear fuel stored at the site has been moved into dry casks, which are a more secure and safe option for storage.

PW goes a step further because cask storage, although far safer, is not without risk. For example, the threat of terrorism has not decreased and is not expected to do so over the next decades.

## B. Questions Related to the Physical Security Requirements for Decommissioning Power Reactor Licensee

***PSR-1: Identify any specific security requirements in § 73.55 and appendices B and C to 10 CFR part 73 that should be considered for change to reflect differences between requirements for operating reactors and permanently shut down and defueled reactors.***

**PW:** Security should be enhanced, not weakened, for both spent fuel pools and ISFSIs. Both are vulnerable and the potential consequences of a successful attack catastrophic. PW's rationale follows

**The Threat, Vulnerability- Consequences - Ignored by NRC**

The threat against nuclear power plants is real. According to the 9/11 Commission report, the Sept. 11, 2001 terrorists initially considered attacking a nuclear power reactor.[15] According to a recent report *"Protecting U.S. Nuclear Facilities from Terrorist Attack: Re-assessing the Current 'Design Basis Threat' Approach,"*[16] prepared under a contract for the Pentagon by the Nuclear Proliferation Prevention Project (NPPP) at the University of Texas at Austin's LBJ School of Public Affairs finds that none of the 104 commercial nuclear power reactors in the United States are protected against a maximum credible terrorist attack, such as the one perpetrated on September 11, 2001, nor against airplane attacks, nor even against readily available weapons such as rocket propelled grenades and 50-caliber sniper rifles. The following table, prepared by Dr. Gordon Thompson for the Massachusetts Attorney General,[17] summarizes available means of attack. It shows that pools & ISFSIs are vulnerable.

| Mode Of Attack | CHARACTERISTICS | PRESENT DEFENSE |
|---|---|---|
| Commando-style by land | • Could involve heavy weapons/sophisticated tactics<br>• Attack requiring substantial planning and resources | Alarms, fences, lightly-armed guards, with offsite backup |
| Commando-style by water | • Could involve heavy weapons/sophisticated tactics<br>• Could target intake canal<br>• Attack may be planned to coordinate with a land attack | 500 yard no entry zone – marked by buoys – simply, "no trespassing" signs<br><br>Periodic Coast Guard surveillance by boat or plane |
| Land-vehicle bomb | • Readily obtainable<br>• Highly destructive if detonated at target | Vehicle barriers at entry points to Protected Area |
| Anti-tank missile | • Readily obtainable<br>• Highly destructive at point of impact | None if missile is launched from offsite |

[15] http://www.resilience.org/stories/2004-07-25/911-report-reveals-al-qaeda-ringleader-contemplated-ny-area-nuclear-power-plant-p

[16] http://sites.utexas.edu/nppp/files/2013/08/NPPP-working-paper-1-2013-Aug-15.pdf

[17] The Massachusetts Attorney General's Request for a Hearing and Petition for Leave to Intervene With respect to Entergy Nuclear Operations Inc.'s Application for Renewal of the Pilgrim Nuclear Power Plants Operating License and Petition for Backfit Order Requiring New Design features to Protect Against Spent Fuel Pool Accidents, Docket No. 50-293, May 26, 2006 includes a Report to The Massachusetts Attorney General On The Vulnerability of Pilgrim's Spent Fuel Pool- Risks and Risk-Reducing Options Associated with Pool Storage of Spent Nuclear Fuel at the Pilgrim and Vermont Yankee Nuclear Power Plants, Gordon Thompson, May 25, 2006

| | | |
|---|---|---|
| Commercial aircraft | • More difficult to obtain than pre-9/11<br>• Can destroy larger, softer targets | None |
| Explosive-laden smaller aircraft | • Readily attainable<br>• Can destroy smaller, harder targets | None |
| 10-kilotonne nuclear weapon | • Difficult to obtain<br>• Assured destruction if detonated at target | None |

**Aircraft:** An air attack is likely from a smaller, general-aviation aircraft laden with explosive material or simply a full load of fuel. The US General Accounting Office (GAO) expressed concern, in September 2003 testimony to Congress, about the potential for malicious use of general-aviation aircraft. The testimony stated:

> Since September 2001, TSA [the Transportation Security Administration] has taken limited action to improve general aviation security, leaving it far more open and potentially vulnerable than commercial aviation. General aviation is vulnerable because general aviation pilots are not screened before takeoff and the contents of general aviation planes are not screened at any point. General aviation includes more than 200,000 privately owned airplanes, which are located in every state at more than 19,000 airports. Over 550 of these airports also provide commercial service. In the last 5 years, about 70 aircraft have been stolen from general aviation airports, indicating a potential weakness that could be exploited by terrorists.[18]

GAO's concerns hold today.

GE Mark I reactor spent fuel pools are especially vulnerable. The roof over the pool is light-weight. It was designed to give in a reactor core accident so as to allow the radioactive plume to extend upwards into higher elevations. It is easily penetrable. These reactor's outer walls are approximately 2' reinforced concrete and the wall around the spent fuel pool is 5' thick. Attack by air or land with today's readily available weapons could penetrate the walls.

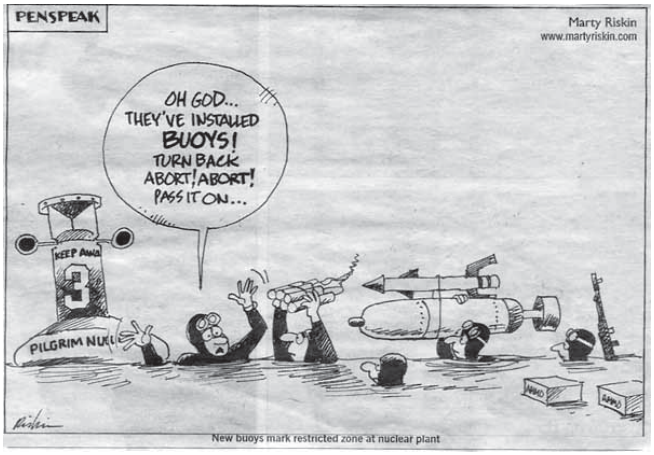
**Drones:** Drones pose a number of security concerns for spent fuel pools and ISFSIs. The concern is largely that drones could enhance tactical advantage. For example, drones could distract the security guard force during a ground attack, slowing their response or causing them to be mis-

[18] Gerald L. Dillingham, US General Accounting Office, testimony before the Committee on Commerce, Science and Transportation, US Senate, "Aviation Security: Progress Since September 11, 2001, and the Challenges Ahead", 9 September 2003

positioned to the advantage of the attackers; and drones could target the security cameras, motion sensors, etc. to mask ground attackers. The timelines for security force personnel to deploy and prevent attackers from successfully sabotaging key equipment are short. Anything that prevents timely and proper response by the guard force could be a problem.

**Water-Based Attack:** Reactors are located on bodies of water. The primary concerns regarding water-borne attacks are using a boat as a floating or submerged explosive bomb delivery vehicle targeting the spent fuel pool or ISFSI; and/or placing a charge up the intake canal; and using a boat as a commando transport vehicle.

**Pilgrim, an example -current status:** There is a 500-yard "exclusion zone," simply marked by buoys – the equivalent of "no-trespassing signs." It is not made impenetrable, and does not appear to be patrolled most of the time.



New buoys mark restricted zone at nuclear plant

The Coast Guard patrols; however the Coast Guard's resources are limited. Once the patrol leaves the site, a terrorist can strike. A floating boom is, or was going to be, placed across the mouth of the intake canal but this will not stop a submerged weapon. The "exclusion" zone was breached many times – sunbathers, fishermen, kayakers, and a large Norwegian sailboat anchored inside the exclusion zone overnight, with its lights on. Entergy called the Harbormaster but not until the following morning.

**Land-based security:** Is better but certainly not robust. Reactors do not have to be prepared to protect against rocket-propelled grenades and 50-caliber sniper rifles, both readily available.

**Cyber Attacks:** NRC's backgrounder on cyber-attacks[19] says that "Nuclear power facilities use digital and analog systems to monitor, operate, control, and protect their plants. "Critical digital assets" that interconnect plant systems performing safety, security, and emergency

[19] http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/cyber-security-bg.html

preparedness functions are isolated from the Internet. This separation provides protection from many cyber threats." Protection perhaps from many but not all.

A paper prepared for the Plymouth Nuclear Affairs Committee[20] provided a preliminary tutorial on cybersecurity. The following draws from that analysis.

Pilgrim, along with other sites, may have integrated their control systems with computer networks built from off-the-shelf commercial operating systems, such as Windows and Unix. This has made process control systems more vulnerable to attack over the internet.

NRC and licensees used to believe that the process control systems were not vulnerable to attack because: They assumed that Process Control Systems (PCS) were isolated from the internet; and PCS generally use proprietary protocols and hardware not compatible with ordinary computers and common network protocols like Ethernet and TCP/IP.

The Plymouth analysis reported on three in-cyber-attack incidents at US reactors. It said:

1. In 2003, the Slammer worm began exploiting vulnerability in Microsoft SQL servers. Within ten minutes, it had infected 75,000 servers worldwide—90% of vulnerable hosts. The design of Slammer was simple; it did not write itself to the hard drive, delete files, or obtain system control for its author. Instead, it settled in system memory and searched for other hosts to infect. Although Slammer carried no malicious payload, it still caused considerable disruption. It searched for new hosts by scanning random IP addresses. This generated a huge volume of spurious traffic, consuming bandwidth and clogging networks. The Slammer worm also infected computer systems at the Davis-Besse nuclear power plant. The worm traveled from a consultant's network, to the corporate network of First Energy Nuclear, the licensee for Davis-Besse, then to the process control network for the plant. The traffic generated by the worm clogged the corporate and control networks, thus for four hours and fifty minutes, plant personnel could not access the Safety Parameter Display System (SPDS), which shows sensitive data about the reactor core collected from coolant systems, temperature sensors, and radiation detectors—these components would be the first to indicate meltdown conditions. Although Slammer's scanning traffic did block sensors from providing digital readouts to control systems, it did not affect analog readouts on the equipment itself; plant technicians could still get reliable data from sensors by physically walking up to them and looking at them, though this process is slower than retrieving data over a network. Davis-Besse also had a firewall protecting its corporate network from the wider internet, and its configuration would have prevented a Slammer infection.

[20] Cybersecurity and PNNP: a Preliminary Tutorial, Richard Grassie prepared for the Nuclear Matters Committee-Plymouth, Massachusetts, Monthly Meeting, Monday 19 January 2015

However, a consultant had created a connection behind the firewall to the consultancy's office network, thereby inadvertently allowing Slammer to bypass the firewall and infect First Energy's corporate network. From there, it faced no obstacle on its way to the plant control network.

2. In 2006, a shutdown of Unit 3 at Browns Ferry nuclear plant occurred demonstrating that not just computers, but even critical reactor components, could be disrupted and disabled by a cyberattack. Unit 3 was manually shutdown after the failure of both reactor recirculation pumps and the condensate demineralizer controller, both of which devices were a kind of programmable logic controller (PLC) where the recirculation pumps were dependent on variable frequency drives (VFD) to modulate motor speed. Both kinds of devices have embedded microprocessors that can communicate data over Ethernet yet both devices are prone to failure in high traffic environments. The Browns Ferry control network produced more traffic than the PLC and VFD controllers could handle and they failed.
3. In 2008, Unit 2 of the Hatch nuclear power plant automatically shut down after an engineer applied a software update to a single computer on the plant's business network. The computer was used to collect diagnostic data from the process control network; the update was designed to synchronize data on both networks. When the engineer rebooted the computer, the synchronization program reset the data on the control network. The control systems interpreted the reset as a sudden drop in the reactor's water reservoirs and initiated an automatic shutdown. This innocent mistake demonstrates how malicious hackers could make simple changes to a business network that end up affecting a nuclear reactor—even if they have no intent to interfere with critical systems.
4. The Stuxnet attack against the Iranian nuclear program demonstrates the impact that a sophisticated adversary with a detailed knowledge of process control systems can have on critical infrastructures. Stuxnet is believed to have destroyed 984 centrifuges at Iran's uranium enrichment facility in Natanz. The Stuxnet worm targeted specific PCS components used in the Iranian centrifuge cascades. The PLCs controlled the frequency converters to modulate the speed at which the centrifuges spun. Stuxnet commanded the PLCs to speed up and slow down the spinning centrifuges, destroying some of them, while sending false data to plant operators to make it appear the centrifuges were behaving normally. It was found that Stuxnet's authors may have learned about vulnerabilities in the Siemens controllers at another site in the US, thus making process control systems made up of Siemens controllers vulnerable.

   The Stuxnet attack also demonstrates elements of the other cyberattack incidents mentioned above. First, it disrupted the systems that monitored physical components, like the Davis-Besse worm infection. Second, it interfered with programmable logic

controllers, like the Browns Ferry data storm. Third, it relied on there being some path from ordinary office computer to process control systems, as in the Hatch automatic shutdown. Moreover, it travelled between computers on worker's thumb drives and infected components prior to arrival along the various sources along the Iranian supply chain.

**The Plymouth analysis took away from these examples the following:**

1. First, skeptics claim that PCS are immune from attack since they are not connected to the internet. However, the Davis-Besse incident shows that this is a misconception, even operators who try to monitor and protect every connection cannot be sure they know about all of them. Stuxnet even traveled on portable thumb drives to infect computers that were not connected to the internet.
2. Skeptics argue that PCS are immune from attack since they are different from ordinary computers, however, all four incidents demonstrate that PCS have become interoperable with ordinary computers, making them vulnerable
3. Vulnerabilities are more complicated than both skeptics and alarmists realize. Alarmists often invoke the danger of hackers taking control of a power plant, but these incidents show how unintelligent computer viruses and even malfunctions in small devices can have big unexpected effects. This suggests that even though nuclear facilities are vulnerable to attack, a malicious hacker would have difficulty making sure an attack works precisely as planned.
4. States have developed significant knowledge and capabilities that make cyberattacks more precise, supplementing their methods with intelligence from other sources.

**The report concluded that:** In the absence of a workable, reliable and tested cybersecurity plan, PNPP has to be considered vulnerable along the same lines and in the same and possibly other manners mentioned for nuclear power plants above.

**Electromagnetic Pulse and Space Weather and the Strategic Threat to America's Nuclear Power Stations, American Leadership & Policy Foundation, June 2015**[21] showed that the effects of Electromagnetic Pulse (EMP) and space weather, or Geo-magnetic Disturbance (GMD), on components and processes such as supervisory control and data acquisition systems (SCADA), large power transformers (LPTs), computer hardware, Emergency Diesel Generators (EDGs), communications and logistics required for the safe operation of nuclear power stations and reactors suggest most designs, regardless of vintage, present a strategic risk to national security from meltdown if severely impacted by these phenomena. See the report.

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[21] file:///C:/Users/Mary/Documents/security/CYBER%20SECURITY/Electromagentic-Pulse-and-Space-Weather-Final-Report-2015.pdf

**ISFSI**

Cask designs vary in their susceptibility to attack. Holtec describes its Holtec HI-STORM 100U as follows:

> "Release of radioactivity from the HI-STORM 100U by any mechanical means (crashing aircraft, missile, etc.) is virtually impossible. The only access path into the cavity for a missile is vertically downward, which is guarded by an arched, concrete-fortified steel lid weighing in excess of 10 tons. The lid design, at present configured to easily thwart a crashing aircraft, can be further buttressed to withstand more severe battlefield weapons, if required in the future for homeland security considerations. The lid is engineered to be conveniently replaceable by a later model, if the potency of threat is deemed to escalate to levels that are considered non-credible today."

Casks that are not underground are especially vulnerable to attack. Therefore security requirements may vary depending on the cask storage design. Casks placed vertically on a pad are the most vulnerable - referred to as "candlepin bowling for terrorists."

Above ground casks are vulnerable from an air or land-based attack with weapons readily available today. [22] Yet, the NRC Commissioners voted to approve a staff proposal submitted on September 11 of this year and postpone the schedule for developing new requirements for protecting spent fuel in dry cask storage from sabotage by five years.[23]

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[22] The Massachusetts Attorney General's Request for a Hearing and Petition for Leave to Intervene With respect to Entergy Nuclear Operations Inc.'s Application for Renewal of the Pilgrim Nuclear Power Plants Operating License and Petition for Backfit Order Requiring New Design features to Protect Against Spent Fuel Pool Accidents, Docket No. 50-293, May 26, 2006 includes a Report to The Massachusetts Attorney General On The Vulnerability of Pilgrim's Spent Fuel Pool- Risks and Risk-Reducing Options Associated with Pool Storage of Spent Nuclear Fuel at the Pilgrim and Vermont Yankee Nuclear Power Plants, Gordon Thompson, May 25, 2006;Environmental Impacts of Storing Spent Nuclear Fuel and High-Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Waste Confidence Decision and Environmental Impact Determination, Dr. Gordon Thompson, February 6, 2009, pgs., 29, 47, 50, Tables 7-6, 7-7.

[23] http://pbadupws.nrc.gov/docs/ML1522/ML15229A231.pdf

Dr. Gordon Thompson analyzed the impact of the shaped charge as a potential instrument of attack.[24] The analysis shows that the cylindrical wall of the canister is about 1/2 inch (1.3 cm) thick, and could be readily penetrated by available weapons. The spent fuel assemblies inside the canister are composed of long, narrow tubes made of zirconium alloy, inside which uranium oxide fuel pellets are stacked. The walls of the tubes (the fuel cladding) are about 0.023 inch (0.6 mm) thick. Zirconium is a flammable metal.

**Table 7-7: Performance of US Army Shaped Charges, M3 and M2A3**

| Target Materia | Indicator | Type of Shaped Charge | |
|---|---|---|---|
| | | M3 | M2A3 |
| Reinforced concrete | Maximum wall thickness | 60 in | 36 in |
| | Depth of penetration in | 60 in | 30 in |
| | Diameter of hole | • 5 in at entrance | • 3.5 in at entrance |
| | Depth of hole with second | 84 in | 45 in |
| Armor plate | Perforation | At least 20 in | 12 in |
| | Average diameter of hole | 2.5 in | 1.5 in |

**Notes:** (a) Data are from: Army, 1967, pp 13-15 and page 100. (b) The M2A3 charge has a mass of 12 lb., a maximum diameter of 7 in, and a total length of 15 in including the standoff ring. (c) The M3 charge has a mass of 30 lb., a maximum diameter of 9 in, a charge length of 15.5 in, and a standoff pedestal 15 in long.

[24] Gordon R. Thompson, *Environmental Impacts of Storing Spent Nuclear Fuel and High- Level Waste from Commercial Nuclear Reactors: A Critique of NRC's Waste Confidence Decision and Environmental Impact Determination* (Cambridge, Massachusetts: Institute for Resource and Security Studies, 6 February 2009). Tables also in Declaration of 1 August 2013 by Gordon R. Thompson: Comments on the US Nuclear Regulatory commission's Draft Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a US Mark I Boiling Water Reactor

**Table 7-8: Types of Atmospheric Release from a Spent-Fuel-Storage Module at an ISFSI as a Result of a Potential Attack**

| Type of Event | Module Behavior | Relevant Instruments and Modes of Attack | Characteristics of Atmospheric Release |
|---|---|---|---|
| Type I: Vaporization | • Entire module is vaporized | • Module is within the fireball of a nuclear-weapon explosion | • Radioactive content of module is lofted into the atmosphere and amplifies fallout from nuclear explosion |
| Type II: Rupture and Dispersal (Large) | • MPC and overpack are broken open<br>• Fuel is dislodged from MPC and broken apart<br>• Some ignition of zircaloy fuel cladding may occur, without sustained combustion | • Aerial bombing<br>• Artillery, rockets, etc.<br>• Effects of blast etc. outside the fireball of a nuclear weapon explosion | • Solid pieces of various sizes are scattered in vicinity<br>• Gases and small particles form an aerial plume that travels downwind<br>• Some release of volatile species (esp. cesium-137) if incendiary effects occur |
| Type III: Rupture and Dispersal (Small) | • MPC and overpack are ruptured but retain basic shape<br>• Fuel is damaged but most rods retain basic shape<br>• No combustion inside MPC | • Vehicle bomb<br>• Impact by commercial aircraft<br>• Perforation by shaped charge | • Scattering and plume formation as for Type II event, but involving smaller amounts of material<br>• Little release of volatile species |
| Type IV: Rupture and Combustion | • MPC is ruptured, allowing air ingress and egress<br>• Zircaloy fuel cladding is ignited and combustion propagates within the MPC | • Missiles with tandem warheads<br>• Close-up use of shaped charges and incendiary devices<br>• Thermic lance<br>• Removal of overpack lid | • Scattering and plume formation as for Type III event<br>• Substantial release of volatile species, exceeding amounts for Type II release |

One type of scenario for an atmospheric release from a dry cask would involve mechanical loading of the module in a manner that creates a comparatively small hole in the canister. The loading could arise, for example, from the air blast produced by a nearby explosion, or from the impact of an aircraft or missile. If the loading were sufficient to puncture the

canister, it would also shake the spent fuel assemblies and damage their cladding. A hole with an equivalent diameter of 2.3 mm, radioactive gases and particles released would result in an inhalation dose (CEDE) of 6.3 rem to a person 900 m downwind from the release. Most of that dose would be attributable to release of two-millionths (1.9E-06) of the MPC's inventory of radioisotopes in the "fines" category.

Another type of scenario for an atmospheric release would involve the creation of one or more holes in a canister, with a size and position that allows ingress and egress of air. In addition, the scenario would involve the ignition of incendiary material inside the canister, causing ignition and sustained burning of the zirconium alloy cladding of the spent fuel. Heat produced by burning of the cladding would release volatile radioactive material to the atmosphere. Heat from combustion of cladding would be ample to raise the temperature of adjacent fuel pellets to well above the boiling point of cesium.

**Potential for Release from a Cask and Consequences:** Dr. Thompson observes that**:** Casks are not robust in terms of its ability to withstand penetration by weapons available to sub-national groups. A typical cask would contain 1.3 MCi of cesium-137, about half the amount of cesium-137 released during the Chernobyl reactor accident of 1986. Most of the offsite radiation exposure from the Chernobyl accident was due to cesium-137. Thus, a fire inside an ISFSI module, as described in the preceding paragraph, could cause significant radiological harm.

**NRC (in) action:** Despite the vulnerability of pools and ISFSIs, NRC is lessening or delaying safety requirements.

Security Drills: NRC issued changes in notification for security drills, ironically on September 11.[25] In SECY-04-0083, "Final Report on the Pilot Expanded Force-on-Force Exercise Program with Lessons Learned and Recommendations for Future Activities," dated May 14, 2004, the staff recommended that licensees be given an 8-week, but no more than a 12-week notification prior to an NRC-conducted FOF inspection so that licensees would not have too long to prepare. But on September 11, 2015 the staff proposed that the notification window be increased again to 9-15 months so that the inspections could be included in the regular periodic notice of all upcoming inspections that are sent to licensees, which according to the staff would "minimize disruptions to the NRC and licensees without impacting the integrity of the inspection program." And on October 6, the four sitting NRC commissioners voted unanimously to approve the change. If, as David Lochbaum (UCS) pointed out, "if the NRC could only schedule a real attack 15 months in advance, we'd be all set."

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[25] Proposed Revision to the Notification Process For Force-On-Force Inspections, Sept 11, 2015. BRC Electronic Library, http://pbadupws.nrc.gov/docs/ML1523/ML15231A232.pdf

Delaying safety requirements for dry casks: In a second decision on September 11, 2015 the Commissioners voted to approve another staff proposal to postpone the schedule for developing new requirements for protecting spent fuel in dry cask storage from sabotage by five years

***PSR-2: The physical security requirements protecting the spent fuel stored in the SFP from the design basis threat (DBT) for radiological sabotage are contained in 10 CFR part 73 and would remain unchanged by this rulemaking. However:***

*a.* ***Are there any suggested changes to the physical security requirements in 10 CFR part 73 or its appendices that would be generically applicable to a decommissioning power reactor while spent fuel is stored in the SFP (e.g., are there circumstances where the minimum number of armed responders could be reduced at a decommissioning facility)? If so, describe them.***

**PW**: No, instead security needs to be enhanced. We note with dismay that the NRC commissioners voted to approve a staff proposal submitted on September 11, 2015 (irony in that date) to postpone the schedule for developing new requirements for protecting spent fuel in dry cask storage from sabotage by five years. (Commissioner Jeff Baran wanted a 1-year delay but was outvoted.) This move will delay the effective date of the rule from the end of 2018 to the end of 2023. There are a number of good reasons for implementing this rule sooner rather than later, but perhaps the most important one is that the current rules do not provide adequate protection of dry casks from certain types of terrorist attack scenarios, as the NRC has acknowledged publicly. It shows NRC's lack of concern in public safety.

***b. Which physical security requirements in 10 CFR part 73 should be generically applicable to spent fuel stored in a dry cask independent spent fuel storage installation?***

**PW**: All.

*c.* ***Should the DBT for radiological sabotage continue to apply to decommissioning reactors? If it should cease to apply in the decommissioning process, when should it end****?*

**PW**: The DBT for radiological sabotage should continue to apply to decommissioning reactors. It should end only when the fuel leaves the site.

***PSR-3: Should the NRC develop and publish additional security-related regulatory guidance specific to decommissioning reactor physical protection requirements, or should the NRC revise current regulatory guidance documents? If so, describe them.***

**PW**: Develop and publish additional security rules- rules can be enforced, unlike guidance, and the rule-making process requires public input.

***PSR-4: What clarifications should the NRC make to target sets in § 73.55(f) that addresses permanently shut down and defueled reactors?***

**PW**: Sent fuel in pools and ISFSIs

***PSR-5: For a decommissioning power reactor, are both the central alarm station and a secondary alarm station necessary? If not, why not? If both alarm stations* are considered *necessary, could the secondary alarm station be located offsite?***

**PW**: Both necessary and both onsite- an additional backup offsite may not be a bad idea.

***PSR-6: Under § 73.54, power reactor licensees are required to protect digital computer and communication systems and networks. These requirements apply to licensees licensed to operate a nuclear power plant as of November 23, 2009, including those that have subsequently shut down and entered into decommissioning.***

a. ***Section 73.54 clearly states that the requirements for protection of digital computer and communications systems and networks apply to power reactors licensed under 10 CFR part 50 that were licensed to operate as of November 23, 2009. However, § 73.54 does not explicitly mention the applicability of these requirements to power reactors that are no longer authorized to operate and are transitioning to decommissioning. Are any changes necessary to § 73.54 to explicitly state that decommissioning power reactors are within the scope of § 73.54? If so, describe them.***

   **PW**: § 73.54 now does not explicitly mention the applicability of these requirements to power reactors that are no longer authorized to operate and are transitioning to decommissioning but it does not exclude them. A simple amendment should clarify that they apply until all fuel leaves the site.

b. ***Should there be reduced cyber security requirements in § 73.54 for decommissioning power reactors based on the reduced risk profile during decommissioning? If so, what would be the recommended changes?***

   **PW**: No recommended changes because risk remains until fuel leaves the site.

## *C. Questions Related to Fitness for Duty (FFD) Requirements for Decommissioning Power Reactor Licensees*

*The NRC's regulations at § 26.3 lists those licensees and other entities that are required to comply with designated subparts of 10 CFR part 26, "Fitness for Duty Programs."* ***Part 26 does not apply to power reactor licensees that have certified under § 50.82 to have permanently***

***shut down and defueled**. The questions on fitness for duty (FFD) have been listed in this document using the acronym "FFD" and sequential numbers.*

*FFD-1: Currently, holders of power reactor licenses issued under 10 CFR part 50 or 10 CFR part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," must comply with the physical protection requirements described in § 73.55 during decommissioning. Under § 73.55, each nuclear power reactor licensee shall maintain and implement its Commission-approved security plans as long as the licensee has a 10 CFR part 50 or 52 license. Furthermore, § 73.55(b)(9) requires the licensee to establish, maintain, and implement an insider mitigation program (IMP) that contains elements from various security programs, including the FFD program described in 10 CFR part 26. Each power reactor licensee has committed within its security plan to using NEI 03-12, "Security Plan Template," revision 7, as the framework for developing its security plans to meet the requirements of § 73.55. NEI 03-12, which was endorsed by NRC Regulatory Guide (RG) 5.76, "Physical Protection Programs at Nuclear Power Reactors (Safeguards Information (SGI))," letter dated November 10, 2011, states that the IMP is satisfied when the licensee "implements the elements of the IMP, utilizing the guidance provided in RG 5.77, `Insider Mitigation Program.' " The NRC is in the process of revising RG 5.77 in order to clarify those FFD elements needed for the IMP.*

*a.* ***Should the NRC pursue rulemaking to describe what provisions of 10 CFR part 26 apply to decommissioning reactor licensees or use another method of establishing clear, consistent and enforceable requirements****? Describe other methods, as appropriate.*

**PW**: Due to the vulnerability and potential consequences from a spent fuel pool fire and an ISFSI, Fitness for Duty Programs must apply until the fuel leaves the site. Part 26 would require a simple amendment to make it clear. FFD is a program that nuclear reactor owners are required to implement to assure that all personnel who have access to their power plants are drug and alcohol free and have no psychological impairments that might comprise the safety. In the aftermath of accidents like those at Three Mile Island and Chernobyl, which were definitely caused and influenced by operator error, and with terrorism around the globe at an all-time high, the question of who is working at our nuclear power plants is important.

*b****. As an alternative to rulemaking, should the drug and alcohol testing for decommissioning reactors be described in RG 5.77, with appropriate reference to the applicable requirements in 10 CFR part 26? This option would be contingent on an NEI commitment to revise NEI 03-12 to include the most recent revision to RG 5.77*** *(which would include the applicable drug and alcohol testing provisions) and an industry commitment to update their security plans with the revised NEI 03-12.*

**PW**: Due to the vulnerability and potential consequences from a spent fuel pool fire and an ISFSI, Fitness for Duty Programs must apply until the fuel leaves the site. Part 26 would require a simple amendment to make it clear

*c.* ***Describe what drug and alcohol testing requirements in 10 CFR part 26 are not necessary*** *to fulfill the IMP requirements to assure trustworthiness and reliability.*

**PW**: All need to apply – see foregoing responses.

*d.* ***Should another regulatory framework be used****, such as a corporate drug testing program modelled on the U.S. Department of Health and Human Services' Mandatory Guidelines for Federal Workplace Drug Testing or the U.S. Department of Transportation's drug and alcohol testing provisions in 49 CFR part 40? If this option is proposed, describe how (i) the laboratory auditing, quality assurance, and reporting requirements would be met by the proposal; (ii) licensees would conduct alcohol testing; and (iii) the performance objectives of 10 CFR 26.23(a), (b), (c), and (d) would be met.*
*FFD-2: On March 31, 2008, the NRC published a final rule in the* ***Federal Register*** *(73 FR 16966) adding subpart I, "Managing Fatigue," to 10 CFR part 26. The addition of subpart I in the revised rule provides reasonable assurance that the effects of fatigue and degraded alertness on an individual's ability to safely and competently perform his or her duties are managed commensurate with maintaining public health and safety. The fatigue management provisions also reduce the potential for worker fatigue (e.g., that associated with security officers, maintenance personnel, control room operators, emergency response personnel, etc.) to adversely affect the common defense and security. The 2008 rule established clear and enforceable requirements for operating nuclear power plant licensees and other entities for the management of worker fatigue. Power reactor licensees that had permanently shut down and defueled were not considered within the scope of that rulemaking effort.*

**PW**: The document says that, "This is because the scope of activities at a facility undergoing decommissioning is much less likely to create a public health and safety concern due to the significantly reduced risk of a radiological event." This statement is incorrect. As discussed by PW in the foregoing, significant risk of a pool fire remains until the pool is emptied; there are risks of cask drops during transfer; and ISFSIs also are at risk of releases.

*a.* ***Should any of the fatigue management requirements of 10 CFR part 26, subpart I, apply to a permanently shut down and defueled reactor****? If so, which ones?*

**PW**: All should apply.

*b. Based on the lower risk of an offsite radiological release from a decommissioning reactor, (PW DISPUTES) compared to an operating reactor,* ***should only specific classes of workers, as identified in § 26.4(a) through (c), be subject to fatigue management requirements***

*(e.g., security officers or certified fuel handlers)? Please provide what classes of workers should be subject to the requirements and a justification for their inclusion*.

**PW**: All workers subject to the requirements based on foregoing PW discussion of risk.

c. **Should the fatigue management requirements of 10 CFR part 26, subpart I, continue to apply to the specific classes of workers identified in response to question b above, for a specified *period of time*** *(e.g., until a specified decay heat level is reached within the SFP, or until all fuel is in dry storage)? Please provide what period of time workers would be subject to the requirements and the justification for the timing.*

**PW**: Risk remains until all fuel leaves the site so fatigue management requirements needed until that time.

d. ***Should an alternate approach to fatigue management be developed*** *commensurate with the plant's lower risk profile? (PW Disputes that lower risk is such to justify changing fatigue management) Please provide a discussion of the alternate approach and how the measures would adequately manage fatigue for workers*.

**PW**: No

## *E. Questions Related to the Current Regulatory Approach for Decommissioning Power Reactor Licensees*

**PW** incorporates in response to this section the following report in its entirety, *Vermont Yankee's Decommissioning As an Example of Nationwide Failures of Decommissioning Regulation,* March 23, 2015, *Fairewinds Energy Education*[26]*;* and Donna Gilmore's *Response To Joint Application Of SCE & SDG&E Re: 2014 Songs Units 2 And 3 Decommissioning Cost Estimates And Other Related Decommissioning Issues* January 9, 2015[27]

PW also recognizes that the current regulatory approach is outdated for four principle reasons. (1) NRC now recognizes that spent fuel may remain onsite indefinitely, no longer can it be assumed, as before, that spent fuel management post-operations would be a short-term issue. (2) It cannot be assumed that site restoration will be quick and not costly. The proliferation, for example, of tritium leaks around the country and examples of costly cleanup at now decommissioned sites (Rowe, Maine, Connecticut Yankee, for example) show that cleanup is likely to be costly. (3) LLC licensees in market economies present a new challenge- costs cannot simply be passed on to ratepayers; and the LLC structure

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26 https://static1.squarespace.com/static/54aac5e4e4b0b6dc3e1f6866/t/55f8257ae4b01d461c066e78/1442325882832/260405905-Vermont-Yankee-s-Decommissioning-2015-3-23-Fairewinds-Energy-Education.pdf

27 https://sanonofresafety.files.wordpress.com/2011/11/a1412007-donna-gilmores-response-to-joint-application-pdf-a.pdf

guarantees that there are no other entities within the corporate structure to go to when the DTF runs short and the job is not completed.

**Figure 1. Entergy Corporation's Corporate Structure as it applies to Entergy Merchant Reactors, Entergy Nuclear Operations and Entergy Nuclear Power Marketing#**

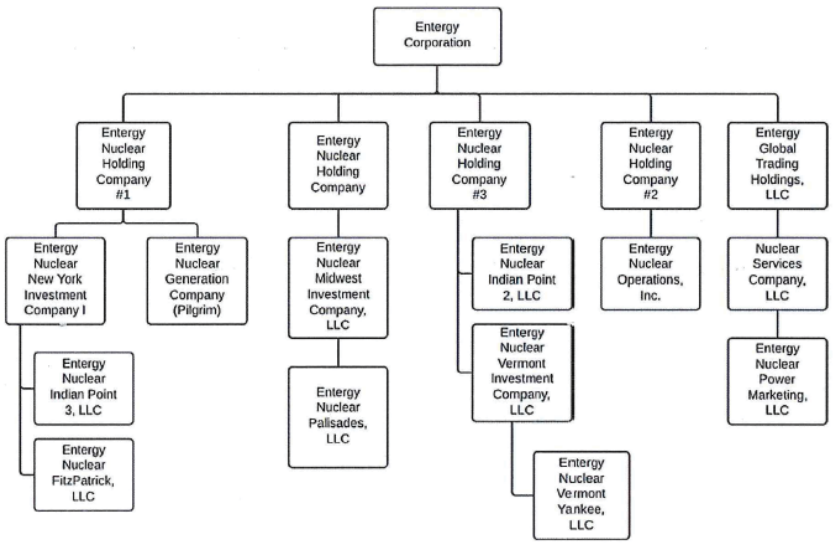
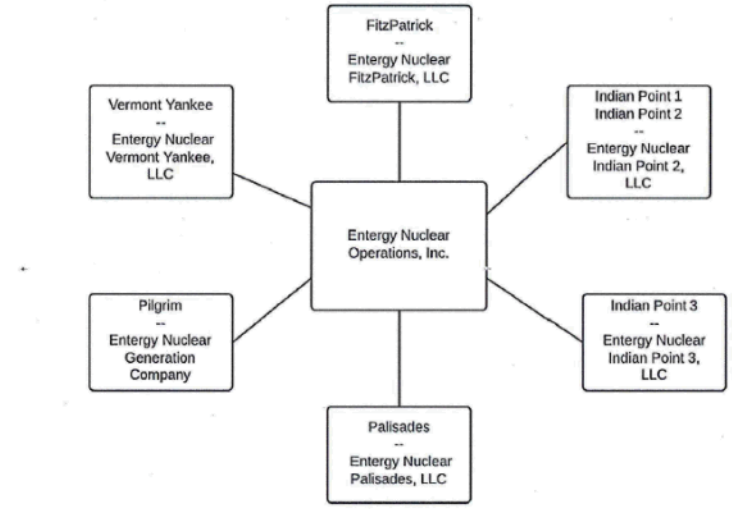



**Figure 2. Operation of Entergy's Merchant Reactors by Entergy Nuclear Operations**




(4) In 1996 NRC in effect deregulated its decommissioning rules. Prior to that decommissioning was considered a major federal action under NEPA; the licensee had to prepare detailed plans and commitments; NRC inspectors were onsite; and there were full public hearings. It all disappeared after 1996. As an example Yankee Rowe's PSDAR was over 300 pages whereas Vermont Yankee's was around 30.

**REG-1:** ***a. Should the current options for decommissioning—DECON, SAFSTOR, and ENTOMB—be explicitly addressed and defined in the regulations instead of solely in guidance documents, and how so?***

**PW:** Yes, options should be addressed in regulations so that they will be enforced and go through the public comment process. Safstor should be dropped as an option. As explained by Fairewinds, "Nuclear Regulatory Commission should remove the SAFSTOR 60-year option from 10 CFR §50.75. Although decommissioning and dismantlement may not be entirely feasible in a short amount of time at some rare locations, the economics show that allowing 60-years before decommissioning is merely a hidden nuclear power subsidy that has been memorialized into nuclear law in an effort to shift costs from the federal government's regulation of energy companies to the residents of the states in which the nuclear plants have been built. Fairewinds believes that the methods used by the NRC to accrue decommissioning trust funds at all nuclear facilities, not just power reactors, needs to be completely revised to reflect the actual costs without allowing additional time for delayed cleanup. Present NRC methodology effectively creates a generational transfer of costs and risks." Entomb should be avoided.

**b.** ***Should other options for decommissioning be explored? If so, what other technical or programmatic options are reasonable and what type of supporting documents would be most effective for providing guidance on these new options or requirements?***

**PW:** See response to a, above.

**c.** ***The NRC regulations state that decommissioning must be completed within 60 years of permanent cessation of operations****. A duration of 60 years was chosen because it roughly corresponds to 10 half-lives for cobalt-60, one of the predominant isotopes remaining in the facility. By 60 years, the initial short-lived isotopes, including cobalt-60, will have decayed to background levels. In addition, the 60-year period appears to be reasonable from the standpoint of expecting institutional controls to be maintained. Completion of decommissioning beyond 60 years will be approved by the NRC only when necessary to protect public health and safety.* ***Should the requirements be changed so that the timeframe for decommissioning is something other than the current 60-year limit? Would this change be dependent on the method of decommissioning chosen, site specific characteristics, or some other combination of factors?*** *If so, please describe.*

**PW**: Sixty years is too long. (1) During that time period, radionuclides in the ground can spread increasing the area and cost to cleanup and risking offsite migration. (2) Delayed dismantlement places an economic burden on the host community and surrounding area. The property is not suited for other income producing development. Decommissioning brings about 1000 workers and their wallets to the community for perhaps 10 years providing an

economic cushion or transition for the host community that has lost its major economic engine. (3) Reactors structured as LLCs (like Pilgrim) may simply walk away when the DTF is spent, leaving the state to pick up the tab. (4) The real reason 60 years is provided is because the licensees were never required to put aside sufficient funds.

Sixty years has nothing to do with reduction of radioactivity- that is an excuse. Fairewinds explained (at 4-5) that:

> "The nuclear industry vehemently argues that SAFSTOR really is not a financial mechanism, and claims instead that it is a method by which to protect corporation personnel from exposure to increased doses of radiation by waiting 60 years to decommission the plant. While it is true radioactive material decays over time, the benefits of dose reduction are largely accrued during the first 10 years after a nuclear plant shut downs. Cobalt-60 is the primary isotope causing significant exposure to personnel during the first 10 years after shutdown. Since Cobalt-60 has a 5-year half-life, only 25% of Cobalt-60 remains after 10 years. Therefore, the benefit of waiting to decommission for 10 years is that radiation exposure to workers from Cobalt-60 will be reduced by 75%, due to radioactive decay over that first decade. The latest claim made by the nuclear industry is that by waiting 60 years, the collective exposure to nuclear personnel should be minimized to slightly more than 300 Rem. Truthfully, the actions of the nuclear industry while nuclear plants are operating belie industry claims regarding dose reduction to personnel. An illustrative example occurred in 2014 during a routine outage at the Entergy owned Palisades nuclear plant in Michigan. Entergy had shut down Palisades for routine maintenance and its regularly scheduled refueling outage. With long-standing and chronic aging management problems, Entergy finally decided to make a major repair while still maintaining an extraordinarily short refueling outage schedule. Entergy thus exposed 192 of its employees and independent contractors to very high levels of radiation in order to get the Palisades nuclear plant back into operation again as quickly as possible. The exposure to Entergy employees and contractors at the end of the three week long rushed outage was approximately 115 Person-rem.1 However, once Palisades was again generating electricity, profits were also flowing to Entergy. While the nuclear industry continues to claim that employee and contractor exposure should be minimized during decommissioning to a collective maximum of 300 Rem during or after 60-years of SAFSTOR, the same industry has no remorse regarding high levels of radiation exposure when returning a nuclear plant to the profitable status of generating electricity leads to a collective 115 Rem exposure in only three weeks. It is apparent then the nuclear industry and the NRC have used the SAFSTOR option to create a double standard for dose reduction during decommissioning compared to operation."

*REG-2: The licensee submits to the NRC a PSDAR…Although the NRC will determine if the information is consistent with the regulations, NRC approval of the PSDAR is not required. However, should the NRC determine that the informational requirements of the regulations are not met in the PSDAR, the NRC will inform the licensee, in writing, of the deficiencies and require that they be addressed before the licensee initiates any major decommissioning activities… the licensee is required to submit a license amendment request for NRC review and approval, which provides an opportunity for public comment and/or a public hearing. Unless the NRC staff approves the license amendment request, the licensee is not to conduct the requested activity. Consistent with Commission direction, the NRC staff is seeking comment on the appropriate role for the NRC in reviewing and approving the licensee's proposed decommissioning strategy and associated planning activities."*

a. ***Is the content and level of detail currently required for the licensee's PSDAR, adequate? If not, what should be added or removed to enhance the document?***

**PW:** The content and level of detail currently required for the licensee's PSDAR is NOT adequate. NRC approval of the PSDAR should be required; a draft document issued; public comment solicited before finalization of the document and NRC approval.

**(1)** NRC should require cost figures in the PSDAR to include tables showing the annual increase in decommissioning costs over the entire 60-year Safstor period and rate of DTF growth-making referenced notes of assumptions used regarding the rates in the tables. *NRC Questions and Answers on Decommissioning - Financial Assurance*[28] explains that using the range of cost escalation rates based on NUREG-1307, the increase in cost over 20 years would range from 2.5 (5% annually) to 5.6 (9% annually) times today's estimated cost, not counting costs that are not included in the formula, such as soil contamination. The rates of increase in decommissioning cost are higher than general inflation. These growths in costs are consistent with the 5-6% increase in Entergy's estimated Vermont Yankee costs between 2008 and 2014. Using the NRC's estimates, the costs of decommissioning will increase at least 12 times (5% annual rate) to about 78 times (9% annual rate) over fifty years.

**(2)** NRC should require Site Characterization done ***before*** the PSDAR's Cost Estimates: NRC has directed "the cost of remediating known environmental contamination should be included (soil, groundwater, surface water, etc.) in the PSDAR. NRC Regulatory Guide 1.185 at 8. To meet this requirement, detailed site characterization must be performed before the cost estimates. The analysis must be made available to the NRC, state and public. NRC must

[28] http://pbadupws.nrc.gov/docs/ML1119/ML111950031.pdf pg., 7, Q.20.

require soil samples at depths greater than three feet and require licensee to remove contaminated soil for offsite disposal. If soil is not remediated beyond three feet below grade, contamination could reach groundwater and migrate offsite. Adequate characterization is required for an accurate estimation of the scope of the work and resulting costs of decommissioning.

**(3)** NRC should require cost estimates for spent fuel management that justifies any assumption of when the fuel will leave the site**.** The number simply cannot be pulled out of a hat. Entergy at Vermont assumed the fuel would magically disappear offsite by 2052. This was not challenged by NRC. But the GAO has stated that an interim storage facility requires congressional action because "new legislative authority is needed for developing interim storage that is not tied to Yucca Mountain[29]." Interim storage requires congressional action before it can be implemented - congressional action that has not yet even been proposed and that would be "challenging" to get passed even if it were proposed. Also, technical challenges exist such as transporting high-burnup fuel (which reactors like Vermont Yankee have), as well as the political and societal challenges that have historically proved insurmountable. The NRC itself recognized this possibility in its recently issued Continued Storage Rule, which includes an analysis of onsite spent nuclear fuel storage under an "indefinite timeframe to address the possibility that a repository never becomes available." NUREG-2157 at iii. Given the NRC's acknowledgement that spent fuel might be stored onsite at plants like Pilgrim or Vermont Yankee indefinitely, the NRC cannot allow Entergy to assume that all fuel will be removed by 2052 or some other arbitrary number. Costs for indefinite storage that need to be estimated include the cost to change the pad and casks every 100 years and hot cell technology capability onsite.

**(4)** NRC must require analysis long term financial viability/responsibility of the licensee: NRC analysis required and provided to the public of the long term financial viability/responsibility of the licensee- this is especially important for licensees in market economies and licensees that are limited liability companies such as Entergy Nuclear Operations. NRC vague, non-documented, and hollow assurances at VY, for example, that some other entity of the corporation (example Entergy Corporation) will pay are not acceptable. Further there is no reason to assume that the NRC will require a licensee, such as Entergy, to maintain any contingency fund. Vermont had similar "guarantees" totaling $70 million. However NRC granted Entergy's request to cancel these lines of credit[30].

**(5)** NRC must require Analysis long term financial viability/responsibility of the cask/pad providers: NRC analysis required and provided to the public of the long term financial viability/responsibility of the cask vendor especially if the vendor has assumed responsibility

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[29] GAO 15-141, Spent Nuclear Fuel Management at 20 (October 2014), available at http://www.gao.gov/assets/670/666454.pdf

[30] December 19, 2014, NRC Electronic Library, Accession No. ML 14365A041

of monitoring and maintaining its casks. Is the vendor an LLC and if so what entity would be responsible if the LLC does not have the funds?

**(6)** NRC must prohibit the licensee from withdrawing money from the DTF for items that fail to meet the NRC's definition of decommissioning, including, at a minimum the following from lessons learned at Vermont Yankee:

a) Settlement agreements with the state or host community
b) Emergency preparedness costs
c) Insurance
d) Property taxes
e) Replacement of structures during SAFSTOR
f) Any costs associated with offsite buildings that are not radiologically contaminated
g) Lobby fees

**(7)** Spent fuel management costs**:** Currently NRC is allowing exemptions to use the DTF for spent fuel management; many members of the public and some states are objecting. PW sees argument both pro and con. Pro: (i) Allowing the exemption has encouraged licensees to transfer the assemblies from the pool to dry casks, a far safer alternative. Also it reduces the O&M costs for the licensee once the pool is emptied; and (ii) it will be cheaper to move to dry cask storage earlier than later placing less of a drain on the DTF. Therefore exemptions provide a safety win for the public and a financial win for the licensee. Con: (i) Allowing use of DTF funds encourages licensees during operations to keep fuel pools overcrowded (increasing the probability of a fire) to save O&M costs knowing that they can use the DTF when they shut down; and (ii) it draws down already insufficient decommissioning funds, less to grow through investments.

**A solution: Requirement that NRC shall only allow exemptions for use of the DTF for spent fuel management activities if (and only if) there is a binding agreement that the licensee will put monies received from DOE suits back into the DTF to replenish what they took out.**

The PSDAR's cost estimate must show the funding source for: a) the construction of a Dry Fuel Transfer Station; (b) the purchase of new casks and all other labor and material costs for transferring the fuel every 100 years, and replacement of the pad; (c) and, the costs of maintaining security at the site indefinitely.

**(8)** Workers: The PSDAR must estimate the number of personnel onsite to accomplish work-wet spent fuel operation, fire protections, monitoring of structure system and component integrity, and radiological environmental monitoring; and identify what external resources (local, state, or federal) that the licensee will rely on to protect health and safety of the public during the various phases of post-shutdown activities and the cost estimate to reimburse the external resources.

**(9)** The PSDAR must describe the planned radiological monitoring program and its cost.

***b. Should the regulations be amended to require NRC review and approval of the PSDAR before allowing any "major decommissioning activity," as that term is defined in § 50.2, to commence? What value would this add to the decommissioning process?***

**PW**: Yes decommissioning is a major federal action; in order for NRC to fulfill its obligation to protect public health, safety and the environment it must exercise its responsibility by reviewing and approving the PSDAR prior to work commencing. Practically we know that once the licensee has taken actions, it is unlikely that NRC will require the licensee to expend resources to reverse course.

NEPA Analysis: Before the NRC allows a licensee to proceed with decommissioning, the NRC must perform the required NEPA analysis of potential environmental impacts associated with the specific PSDAR and related filings. Neither the licensee nor NRC can assume that all environmental impacts are "bounded" by previously issued environmental impact statements. Such factors not bounded by previous environmental analysis would include, for example:

1) Spent fuel that may be stored indefinitely at each reactor site;
2) Recreational activities bordering the reactor site;
3) Changes in threatened or endangered species over the next 60 years that will increase due to human activity, climate change, and other factors;
4) Climate change impacts, overall;
5) Addressing known and unknown contamination and the environmental effects of any delay during the SAFSTOR period in addressing such leaks, including the fact that migration will increase the area that is contaminated;
6) Economic impacts to the surrounding area resulting for a licensee's decision to use SAFSTOR. Regulations implementing NEPA (such as 40 C.F.R. § 1508.8) require the NRC to analyze the economic impacts of major federal actions significantly affecting the environment (delaying productive use of the land,, as well as 60 years of downward pressure on property values and area development due to hesitancy to invest in an area that is slated for a major industrial deconstruction project with attending noise, aesthetic, and other concerns).

***REG-3: a. Should the current role of the States, members of the public, or other stakeholders in the decommissioning process be expanded or enhanced, and how so?***

**PW**: Yes the States should, along with the NRC, be authorized to perform a full audit the decommissioning trust fund expenditures every 5 years throughout the decommissioning process. This is especially important with licensees that have agreement with the state's to split any leftover funds, and also in the case of Entergy owned reactors because TLG is a fully

Entergy owned subsidiary – same would hold for any time the licensee owner also owns the contractor. The cost of the audit should be borne by the licensee.

Second Adjudicatory Hearings need to be available so that parties have more than hearings an opportunity to be heard. Full adjudicatory hearings should be permitted to address state and stakeholder's concerns with the PSDAR and other issues that may arise. Funding needs to be provided for qualified parties litigating. In order for the public's right to intervene to be meaningful, NRC must subsidize public intervenors cost of participation; at the very least, the full cost of witness fees.

***b. Should the current role of the States, members of the public, or other stakeholders in the decommissioning process for non-radiological areas be expanded or enhanced, and how so? Currently, for all non-radiological effluents created during the decommissioning process, licensees are required to comply with EPA or State regulations related to liquid effluent discharges to bodies of water.***

**PW**: Yes, it should be expanded to include adjudicatory hearings. Reimbursement by the licensee to state agencies and stakeholders with standing for monitoring and litigation fees.

***c. For most decommissioning sites, the State and local governments are involved in an advisory capacity, often as part of a Community Engagement Panel or other organization aimed at fostering communication and information exchange between the licensee and the public. Should the NRC's regulations mandate the formation of these advisory panels?***

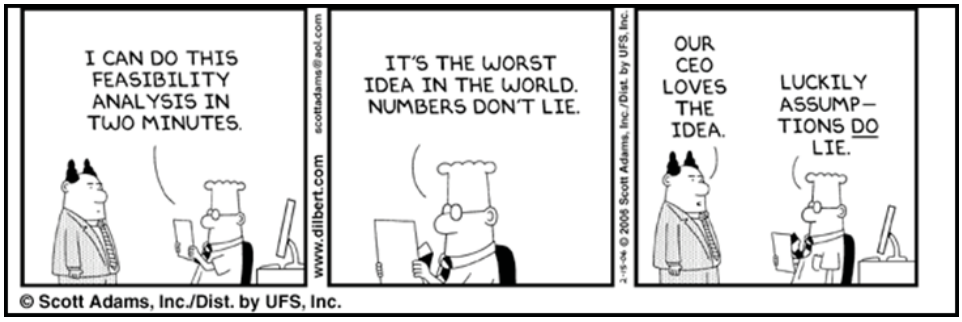
**PW:** Yes. Membership: Include representatives from appropriate state agencies; local officials or their designees from host community and surrounding EPZ communities; representative or designee from the county in which the reactor is located and adjacent counties; representatives from citizen groups.

## *F. Questions Related to the Application of Backfitting Protection to Decommissioning Power Reactor Licensees*

**PW:** The problem is that backfitting as it is applied will never increase public safety. Backfitting[31] was the subject of a case- *The Union of Concerned Scientists vs U.S. Nuclear Regulatory Commission.* The unfortunate decision concluded that the NRC could consider costs of backfits that would go beyond "adequate protection." However adequate protection did not mean absolute protection-instead whatever the NRC said it was. The result was any new requirements would have to make a showing of substantial safety enhancements and meet the cost benefit test. Cost benefit analyses allowed by the NRC assure that substantial safety enhancement will never be shown-not because the mitigative measures would not do so

[31] Fukushima The Story of a Nuclear Disaster, Union of Concerned Scientist, D. Lochbaum, E. Lyman, S. Stranahan, New Press, 2014, pgs., 193-

but because of the false assumptions and outdated computational tools (MACCS2, for example) used in the computations.




Backfitting requires a complete overhaul on the way NRC and industry do PRAs.

What's wrong with PRAs as now performed?

1. **PRAs Incapable of Dealing with Unknowns- Qualitative Analyses Required:** NRC Chairman Allison M. Macfarlane in her prepared remarks at the 2013 NRC RIC, March 12, 2013 made the point by saying that, "The famed physicist Niels Bohr quipped, 'prediction is very difficult, especially about the future.' I've spent a lot of time studying and writing about this subject…it is unwise to think we can confidently predict what lies ahead." NRC is unwise to think that it can confidently predict the probability of offsite releases post-shutdown.
2. **PRAs Underestimate Probability:** Consequence analysis multiplies the probability of an accident by the consequences. By multiplying large consequence values by very low probability, the consequence values appear unrealistically very low. Probabilistic modeling that uses a low probability number can, and likely will, underestimate the deaths, injuries, and economic impact likely from a severe accident. No matter how high the potential consequence values may be, if they are multiplied by a low probability number, the consequence figures on which decisions are based become far less startling assuring fixes are not justified.
3. **PRAs Do Not Model Aqueous Discharges:** In the event of a severe spent fuel accident post shutdown, there will be enormous aqueous radioactive releases and damage. This liquid discharges result from direct contamination from water pumped into a spent fuel pool and then leaked outside and transported through subsurface water, sediments, soils and groundwater, plus atmospheric fallout on the waters - resulting in three sources of contamination in the waters. Current NRC economic consequences take no account of aqueous discharges, to say nothing of their effect on either the local or long-distance marine economies. The importance of including aqueous discharges in PRAs was recognized by the Commission.[32] But the Commission also should do something about it to assure they are included in modeling.

[32] SECY-11-0089, Enclosure 1, pg., 29; http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2011/2011-0089scy.pdf; and Commission Voting Record, Decision Item SECY-11-

4. **PRAs Limit Duration of Accidents to (1-4) days:** There is no rational basis for the NRC/industry assumption that an accident will last only a day (usual industry practice) and in any event not more than 4 days (MACCS2 code's maximum limit). The MACCS2 code limits the total duration of a radioactive release to no more than four (4) days, if the user chooses to use four plumes occurring sequentially over a four day period (IPLUME 3)[33]. Licensees, for example, have chosen not to take that option and limited analyses to a single plume having a total duration of one day.[34] In any case either a day or a four-day plume is plainly of insufficient duration in light of the fact, for example, that ruptured casks cannot be fixed.[35]
5. **PRAs Limit Radioactive Releases to Gamma and Small Fraction Cs-137:** There is no rational basis for the NRC/industry assumption that the only radioactive release that needs to be considered is an atmospheric (forget about aqueous). Limiting releases is designed to minimize consequences and industry's potential mitigation costs.
6. **PRAs Limit Radioactive Release Concentration by Use Straight-Line Gaussian Plume Instead of Meteorological Models for Complex Terrains:** Similarly, there is no rational basis for the NRC/industry assumption that a radioactive release will only affect a very limited geographic area defined by an outdated straight-line Gaussian plume. The atmospheric dispersion model embedded in the MACCS2 code is a steady-state, straight-line Gaussian plume model that assumes meteorological conditions that are steady in time and uniform spatially across the study region. The plume model is not appropriate for sites located near large bodies of water, river valleys and varied topography. It underestimates the area likely to be affected in a severe accident and the dose likely to be received in those areas. Variable plume models such as AERMOD or CALPUFF are appropriate, and readily available. The NRC knows this. For example NRC made a presentation to the National Radiological Emergency Planning Conference[36] concluded that the straight-line Gaussian plume models cannot accurately predict dispersion in a complex terrain and are therefore scientifically defective for that

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0089, September 21, 2011, http://www.nrc.gov/reading-rm/doc-collections/commission/cvr/2011/2011-0089vtr.pdf

[33] NUREG/CR-6613 Code Manual for MACCS2: Volume 1, User's Guide, 2-2

[34] The MACCS2 uses a Gaussian plume model with Pasquill-Gifford dispersion parameters (Users code 5-1). Its equation is limited to plumes of 10 hour duration.

[35] Dr. Kris Singh, CEO, Holtec International said that, "...It is not practical to repair a canister if it were damaged... You will have… millions of curies of radioactivity coming out of canister… A canister that develops a microscopic crack (all it takes is a microscopic crack to get the release), to precisely locate it… And then if you try to repair it (remotely by welding)…the problem with that is you create a rough surface which becomes a new creation site for corrosion down the road. I don't advocate repairing the canister. However, dry handling of the cask and fuel is important to avoid disturbing the properties of the cask, cladding, fuel, and related hardware that would occur if the materials were rewetted and rapidly cooled. However, there is no dry handling facility available in the nation that is large enough to handle these canisters. …and removal of a welded storage cask lid is problematic. There is no dry handling (hot cell) mobile facility designed for this purpose and one may not even be feasible." [35] Technical Workshop on the Impacts of Dry-Storage Canister Designs on Future Handling, Storage, Transportation, and Geological Disposal of Spent Nuclear Fuel in the United States, NWTRB, November 18-19, 2013.

[36] What's in the Black Box, Dispersion, Prepared for 2009 National Radiological Emergency Planning Conference, Stephen F. LaVie, Sr. Emergency Preparedness Specialist, Nuclear Security and Incident Response, Division of Preparedness and Response, Adams Accession No. ML091050257

purpose [ADAMS - ML091050226, ML091050257, and ML091050269 (page references used here refer to the portion attached, Part 2, ML091050257).] Most reactors, if not all, are located in complex terrains. In the presentation, NRC said that the "most limiting aspect" of the basic Gaussian Model, is its "inability to evaluate spatial and temporal differences in model inputs" [Slide 28]. Spatial refers to the ability to represent impacts on the plume after releases from the site e.g., plume bending to follow a river valley or sea breeze circulation. Temporal refers to the ability of the model to reflect data changes over time, e.g., change in release rate and meteorology [Slide 4]. Because the basic Gaussian model is non-spatial, it cannot account for the effect of terrain on the trajectory of the plume – that is, the plume is assumed to travel in a straight line regardless of the surrounding terrain. Therefore, it cannot, for example, "'curve' a plume around mountains or follow a river valley." NRC 2009 Presentation, Slide 33. Further NRC says that it cannot account for transport and diffusion in coastal sites subject to the sea breeze. The NRC says that the sea breeze causes the plume to change direction caused by differences in temperature of the air above the water versus that above the land after sunrise. If the regional wind flow is light, a circulation will be established between the two air masses. At night, the land cools faster, and a reverse circulation (weak) may occur [Slide 43]. Turbulence causes the plume to be drawn to ground level [Slide 44]. The presentation goes on to say that, "Additional meteorological towers may be necessary to adequately model sea breeze sites" [Slide 40].Significantly, the NRC 2009 Presentation then discussed the methods of more advanced models that *can* address terrain impact on plume transport, including models in which emissions from a source are released as a series of puffs, each of which can be carried separately by the wind, (NRC 2009 Presentation Slides 35, 36). This modeling method is similar to CALPUFF. Licensees are not required, however, to use these models in order to more accurately predict where the plume will travel to base protective action recommendations. Likewise, EPA has recognized the need for complex models. For example EPA's November 2005 Modeling Guideline (Appendix A to Appendix W) lists EPA's "preferred models" and the use of straight line Gaussian plume model, called ATMOS, is not listed. Sections 6.1 and 6.2.3 discuss that the Gaussian model is not capable of modeling beyond 50 km (32 miles) and the basis for EPA to recommend CALPUFF, a non - straight line model.[37] DOE, too, recognizes the limitations of the straight-line Gaussian plume model. They say for example that Gaussian models are inherently flat-earth models, and perform best over regions of transport where there is minimal variation in terrain. Because of this, there is inherent conservatism (and simplicity) if the environs have a significant nearby buildings, tall vegetation, or grade variations not taken into account in the dispersion parameterization.[38]

7. **PRAs Underestimate Cleanup/Decontamination:** Clean-up and Decontamination is an enormously expensive job, extending over decades. They are the "Elephant in the Room." Hosing down buildings and plowing under fields does not clean-up or decontaminate. The NRC cannot continue to ignore: that there is no cleanup-standard;

[37] http://www.epa.gov/scram001/guidance/guide/appw_05.pdf

[38] The MACCS2 Guidance Report June 2004 Final Report, page 3-8:3.2 Phenomenological Regimes of Applicability

that clean-up cannot possibly take just one year; that it has given no consideration to what can and must be done to the tons of contaminated wastes; that clean-up after a nuclear explosion is not comparable to clean-up after a nuclear reactor accident; and that forests, wetlands and water simply cannot be cleaned and will re-contaminate areas. The cost formula used in the MACCS2 underestimates costs likely to be incurred. The current NRC approved consequences models:

- Underestimate both the size of the area likely to be contaminated, and the extent of contamination. Size of area contaminated minimized by assuming a straight-line Gaussian plume model; extent of contamination minimized by, ignoring aqueous discharges, and ignoring that an accident can persist over many weeks and months
- Underestimate the volume of waste; and that there are no available safe disposal options is ignored. In fact waste disposal is not modeled.
- Underestimate the time that decontamination will take. Technologies to cleanup have not been developed; current cleanup methods used in Japan and assumed in US models do not work- hosing down buildings and plowing under fields. They are based on nuclear weapons cleanup that is a different from cleanup after a nuclear reactor accident[39]. Many radionuclides, like Cs-137, have long half-lives.
- Ignore that the technologies needed for cleanup have not even been developed.
- Ignore that forests, wetlands, and bodies of water essentially cannot be cleaned up or decontaminated.
- Ignore there is not even a cleanup standard.

**8. PRAs Minimize Health Costs & Evacuation Time Estimates:** The health costs resulting from a severe spent fuel accident directly depend on who was exposed and for how long, and the latter in turn depends on whether evacuation was timely and successful.

Evacuation Time Estimates (ETEs): With no apparent complaint from the NRC, licensees consistently use faulty, in some cases almost ludicrous, assumptions about who should

[39] The MACCS2 cleanup assumptions used by NRC and industry are directly based on WASH-1400; WASH-1400, in turn, was based on clean up after a nuclear explosion. Cleanup after a nuclear bomb explosion is not comparable to clean up after a nuclear reactor accident; Entergy's apparent assumption that the two are comparable severely underestimated cleanup costs. Nuclear explosions result in larger-sized radionuclide particles; reactor accidents release small sized particles. Decontamination is far less effective, or even possible, for small particle sizes. Nuclear reactor releases range in size from a fraction of a micron to a couple of microns; whereas nuclear bomb explosions fallout is much larger- particles that are ten to hundreds of microns. These small nuclear reactor releases can get wedged into small cracks and crevices of buildings. WASH-1400's nuclear weapon clean up experiments involved cleaning up fallout involving large mass loading where the there was a small amount of radioactive material in a large mass of dirt and demolished material. Only the bottom layer will be in contact with the soil and the massive amount of debris can be swept up with brooms or vacuums resulting in a relatively effective, quick and cheap cleanup that would not be the case with a nuclear reactors fine particulate. A weapon explosion results in non-penetrating radiation so that workers only require basic respiration and skin protection. This allows for cleaning up soon after the event. In contrast a reactor release involves gamma radiation and there is no gear to protect workers from gamma radiation. Therefore cleanup cannot be expedited and decontamination is less effective with the passage of time.

evacuate and how long it will take them (to say nothing of the far greater number of individuals who will, and in many cases probably should, try) to evacuate. Pilgrim's 2012 KLD Evacuation Time Estimate unrealistically concluded that the entire EPZ would be evacuated in (6) hours[40]. If realistic evacuation times and assumptions regarding evacuation were used, the analyses would show far fewer will evacuate in a timely manner, and the inevitable result will be increased health-related costs.

The standard KLD time estimates used are based on NUREG/CR-7002 and telephone surveys. These documents contain multiple incorrect assumptions. Examples include: the population will follow a staged evacuation ignoring the public's almost instant ability to communicate; a straight-line Gaussian plume defines the evacuation "key-hole" where the public knows winds are variable and will act accordingly; and they assume only a 20% shadow evacuation out to 15 miles from reactor and the rest of the population will not attempt to evacuate. The Cape Cod Telephone Survey showed that 70% would evacuate if they were told that there was a disaster at Pilgrim and 50% if they were told not to evacuate. The respondents went out to 25 miles, not 15 miles. [41]

Further the KLD's do not take into consideration the many variables that would slow evacuation: shadow evacuation; evacuation time estimates during inclement weather coinciding with high traffic periods such as commuter traffic, traffic during peak commute times, holidays, summer beach/holiday traffic; notification delay delays because notification is largely based on sirens that cannot be heard indoors above normal ambient noise with windows closed or air conditioning systems operating.

Health Effects Radiation: Having artificially reduced the potential number of potentially effected (not only through inaccurate evacuation times but also by assuming that only those in a small geographic areas will potentially be effected and only for a short time), the NRC economic consequences analysis goes on intentionally to further underestimate the cost, not only in dollars but also in human suffering.

The effects of radiation exposure on public health after an accident rarely are immediately evident. The latency period for cancers, diseases and reproductive disorders extends over many years. Lessons learned from previous accidents and the most recent report by the National Academies of Sciences (BEIR VII), and studies by Cardis and the Techna River Cohort, all show that the assumptions in the MACCS2 concerning health impact are outdated and underestimate health effects.

a. Value of Life: NRC value assigned to life is far lower than other federal agencies. Other agencies value life at $ 5-9 million. For example EPA values a life lost at $6.1 million (U.S.E.P.A., 1997, The Benefits and Costs of the Clean Air Act, 1970 to 1990, Report to US Congress

[40] KLD Pilgrim Evacuation Estimate December 12, 2012 Final Report KLD-TR-510, NRC Electronic Library ADAMS, Accession Number ML13023A031

[41] KLD MEMO to John Giarrusso (MEMA) from Chris Chaffee (KLD) Regarding the Cape Cod Telephone Survey Results, July 25, 2013

(October), pages 44-45). The GAO reported that it is hard to justify below $5 million whereas NRC remains at $3 million.

b. $2000/person-rem conversion rate: The population dose conversion factor of $2000/person-rem used by licensees in the code, and allowed by NRC, to estimate the cost of the health effects generated by radiation exposure is based on a deeply flawed analysis and seriously underestimates the cost of the health consequences of severe accidents.

This conversion factor is inappropriate. It does not take into account the significant loss of life associated with early fatalities from acute radiation exposure that could result from some severe accident scenarios. Neither does it properly estimate the generation of stochastic health effects by failing to take into account the fact that some members of the public exposed to radiation after a severe accident will receive doses above the threshold level for application of a dose- and dose-rate reduction effectiveness factor (DDREF).

The NRC approved $2000/person-rem conversion factor is apparently intended to represent the cost associated with the harm caused by radiation exposure with respect to the causation of "stochastic health effects," that is cancers and not deterministic effects, commonly known as radiation sickness[42] The value was derived by NRC staff by dividing the Staff's estimate for the value of a statistical life, $3 million (presumably in 1995 dollars, the year the analysis was published) by a risk coefficient for stochastic health effects from low-level radiation of $7x10^{-4}$/person-rem, as recommended in Publication No. 60 of the International Commission on Radiological Protection (ICRP). (This risk coefficient includes nonfatal stochastic health effects in addition to fatal cancers.) But the use of this conversion factor in SAMA analyses is inappropriate in two key respects and as a result underestimates the health-related costs associated with severe accidents.

First, the $2000/person-rem conversion factor is specifically intended to represent only stochastic health effects (e.g. cancer), and not deterministic health effects "including early fatalities which could result from very high doses to particular individuals."[43] However, for some of the severe accident scenarios evaluated, large numbers of early fatalities could occur representing a significant fraction of the total number of projected fatalities, both early and latent. This is consistent with the findings of the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437).[44] Therefore, it is inappropriate to use a conversion factor that does not include deterministic effects. According to NRC's guidance, "the NRC believes that regulatory issues involving deterministic effects and/or early fatalities would be very rare, and can be addressed on a case-specific basis, as the need arises."[45] How for example can this be justified in a spent fuel pool fire accident?

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[42] U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, "Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy," NUREG-1530, 1995, p. 12

[43] U.S. NRC (1995), op cit., p. 1.

[44] U.S. NRC, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Vol. 1, May 1996, Table 5.5.

[45] U.S. NRC, "Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy (1995), op cit., p. 13.

Second, the $2000/person-rem factor, as derived by NRC, also underestimates the total cost of the latent cancer fatalities that would result from a given population dose because it assumes that all exposed persons receive dose commitments below the threshold at which the dose and dose-rate reduction factor (DDREF) (typically a factor of 2) should be applied. However, for certain severe accident scenarios considerable numbers of people would receive doses high enough so that the DDREF should not be applied.[46] This means, essentially, that for those individuals, a one-rem dose would be worth "more" because it would be more effective at cancer induction than for individuals receiving doses below the threshold. To illustrate, if a group of 1000 people receive doses of 30 rem each over a short period of time (population dose 30,000 person-rem), 30 latent cancer fatalities would be expected, associated with a cost of $90 million, using NRC's estimate of $3 million per statistical life and a cancer risk coefficient of $1x10^{-3}$/person-rem. If a group of 100,000 people received doses of 0.3 rem each (also a population dose of 30,000 person- rem) a DDREF of 2 would be applied, and only 15 latent cancer fatalities would be expected, at a cost of $45 million. Thus a single cost conversion factor, based on a DDREF of 2, is not appropriate when some members of an exposed population receive doses for which a DDREF would not be applied.

A better way to estimate the cost equivalent of the health consequences resulting from a severe accident would be simply to sum the total number of early fatalities and latent cancer fatalities, as computed by the MACCS2 code, and multiply by not a $3 million figure but a higher life valuation, in line with other federal agencies. It is not reasonable to distinguish between the loss of a "statistical" life and the loss of a "deterministic" life when calculating the cost of health effects. The NRC does so. Why? The only apparent reason is to save the industry money.

c. Health Impacts Ignored: Wrongly, the NRC analysis does not even consider cancer incidence. Neither does it consider many other potential health effects from exposure in a severe radiological event (National Academy of Sciences, BEIR VII Report, 2005).

d. Recent Studies Ignored: The NRC's SAMA analyses need to be based on current research. Recent studies published on radiation workers (Cardis et al. 2005[47]) and by the Techa River cohort (Krestina et al (2005[48]) show a marked increase in the value of cancer mortality risk per unit of radiation at low doses (2-3 rem average). Both studies give similar values for low dose, protracted exposure, namely (1) cancer death per Sievert (100 rem). Using the results of the study by Cardis et al. and use of the risk numbers derived from the Techa River cohort a number of additional SAMAs would become cost effective.

e. Indirect health costs ignored: They include, for example, medical expenditures for treatment, losses in time and economic productivity, liability resulting from radiation health

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[46] The default value of the DDREF threshold is 20 rem in the MACCS2 code input

[47] Elizabeth Cardis, "Risk of cancer risk after low doses of ionising radiation: retrospective cohort study in 15 countries." *British Medical Journal* (2005) 331:77. Referenced Beyea

[48] Krestinina LY, Preston DL, Ostroumova EV, Degteva MO, Ron E, Vyushkova OV, et al. 2005.Protracted radiation exposure and cancer mortality in the Techa River cohort. Radiation Research 164(5):602-611.

related illness and death, and caregivers evacuating and leaving patients unattended, as at Fukushima. All of these are economic consequences.

**9. PRAs Ignore Additional Economic Consequences:** Lessons learned from Fukushima demonstrate that the MACCS2's assumptions of what economic variables to model are too limited and serve to underestimate offsite economic consequences**.** In addition to those already discussed, any realistic analysis of economic consequences would have to consider the following.

a. Indirect economic effects or the "multiplier effects ignored:" Depending on the business done inside the building contaminated, the regional and national economy could be negatively impacted. A resulting decrease in the area's real estate prices, tourism, and commercial transactions could have long-term negative effects on the region's economy.

b. Economic infrastructure ignored: The MACCS2 considers the costs of farm and non-farm decontamination and the value of farm and nonfarm wealth; however, nowhere in the economic consequences analysis is there any discussion of the loss of, and costs to remediate the economic infrastructure that make business, tourism and other economic activity possible. Economic infrastructure is the basic physical and organizational structures needed for the operation of a society or enterprise, or the services and facilities necessary for an economy to function. The term typically, and as used by PW, refers to the technical structures that support a society, such as roads, water supply, sewers, power grids telecommunications, and so forth. Viewed functionally, infrastructure *facilitates* the production of goods and services; for example, roads enable the transport of raw materials to a factory, and also for the distribution of finished products to markets. Also, the term may also include basic social services such as schools and hospitals

c. Other economic costs ignored: The economic consequences should, but does not, include the business value of property and the incurred costs such as costs required from job retraining, unemployment payments, and inevitable litigation. Further, one of the cited general criticisms of the MACCS2 Code is that "the economic model included in the code models only the economic cost of mitigative actions.[49]"

**10. PRAs Allow User to Manipulate the Code:** The MACCS2 code used by industry (with the NRC's approval) to model economic consequences of a severe accident is, at best severely limited in what it can do and what it cannot. Even in those areas where the MACCS2 code has some capability, the NRC cannot continue to allow industry to manipulate the way in which it uses the code to intentionally minimize potential consequences; ignore real health costs; create essentially useless evacuation time estimates; choose the input parameters into the model; and choose to average the code's inputs by a mean and not the 95$^{th}$ percentile.

[49] 1997 MACCS2 User Guide

In order to ensure realistic cost-benefit analyses, the NRC cannot continue to allow as a matter of policy licensees to choose how they will use the MACCS2 code. Section 6.10 of the 1997 User Guide, Generation of Consequence Distributions, explains. It says, "Under the control of parameters supplied by the user on the EARLY and CHRONC input files, the EARLY and CHRONC modules can calculate a variety of different consequence measures to portray the impact of a facility accident on the surrounding region. *The user has total control over the results that will be produced."*[50] (Emphasis added)

11. **MACCS2 Computer Code Used in PRA's Not Quality Assured**.[51] The MACCS & MACCS2 codes were developed for research purposes not licensing purposes –for that reason they were not held to the QA requirements of NQA-a (American Society of Mechanical Engineering, QA Program Requirements for Nuclear Facilities, 1994). Rather they were developed using following the less rigorous QA guidelines of ANSI/ANS 10.4. [American Nuclear Standards Institute and American Nuclear Society, *Guidelines for the Verification and Validation of Scientific and Engineering Codes for the Nuclear Industry*, ANSI/ANS 10.4, La Grange Park, IL (1987). Further the biggest reason for *not* using the MACCS2 economic cost model is that there is no written explanation of *exactly* how it works, and how it interacts with the long-term dose accumulation models

**12. SOARCA Code Used in PRAs Unreliable:** NRC developed this code to estimate offsite radiological health consequences for potential severe reactor accidents. SOARCA analyzed the potential consequences of severe accidents at the Surry Power Station near Surry, Va. and the Peach Bottom Atomic Power Station near Delta, Pa. Peach Bottom is a reactor similar to Pilgrim. It used the outdated and fundamentally flawed MACCS2 computer code and as a result its main findings are not credible.

SOARCA concluded that: Existing resources and procedures can stop an accident, slow it down or reduce its impact before it can affect public health; even if accidents proceed uncontrolled, they take much longer to happen and release much less radioactive material than earlier analyses suggested; and the analyzed accidents would cause essentially zero immediate deaths and only a very, very small increase in the risk of long-term cancer deaths.

The findings are not credible for all the reasons discussed in the foregoing. Unfortunately SOARCA is being relied upon by the NRC today. For example, NRC staff's current recommendation to the NRC Commission to not require filters on vents, a reversal of its previous recommendation, is based on SOARCA. Not only are SOARCA's conclusions not credible but the code does not look at offsite economic consequences in a severe accident.

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[50] User Guide for MACCS2, the Code Manual for MACCS2: Volume 1, User's Guide, SAND97-0594, which was written in 1997. Chanin, D.I., and M.L. Young, Code Manual for MACCS2:Volume 1, User's Guide, SAND97-0594 Sandia National Laboratories, Albuquerque, NM, (1997)

[51] Chanin, D.I. (2005), "The Development of MACCS2: Lessons Learned," [written for:] *EFCOG Safety Analysis Annual Workshop Proceedings*, Santa Fe, NM, April 29–May 5, 2005. Full text: the development of maccs2.pdf (154 KB), revised 12/17/2009. http://chaninconsulting.com/index.php?resume.

**Summary: Computational tools and assumptions used in backfits guarantee the right answer for industry and the wrong answer for the public. The NRC first must overhaul PRAs.**

## *G. Questions Related to Decommissioning Trust Funds*

***DTF 1. Should the regulations in §§ 50.75 and 50.82 be revised to clarify the collection, reporting, and accounting of commingled funds in the decommissioning trust fund, that is in excess of the amount required for radiological decommissioning and that has been designated for other purposes, in order to preclude the need to obtain exemptions for access to the excess monies?***

**PW:** Wholesale changes in funding regulations are required to preclude the absurd situation that we have now. Especially problematic: The formula is generic not site specific, as it should be; decommissioning is narrowly defined to include only a fraction of the decommissioning process, removal of radioactivity to release the site; and licensees are allowed to dip into the funds for other purposes.

1. **Site specific-not generic:** Decommissioning Trust Fund requirements cannot be based on generic formulas. Instead they must be site specific. Each site is unique.

2. **Decommissioning definition broadened**: The regulations should be revised to define decommissioning more broadly. Currently NRC defines decommissioning only to include removal of radioactivity so the license may be terminated. It does not include what everyone assumes decommissioning means-removal of radioactivity, spent fuel management and site restoration. Even NRC admits that the amount of financial assurance prescribed in the narrow formulas do not represent the total costs of decommissioning.

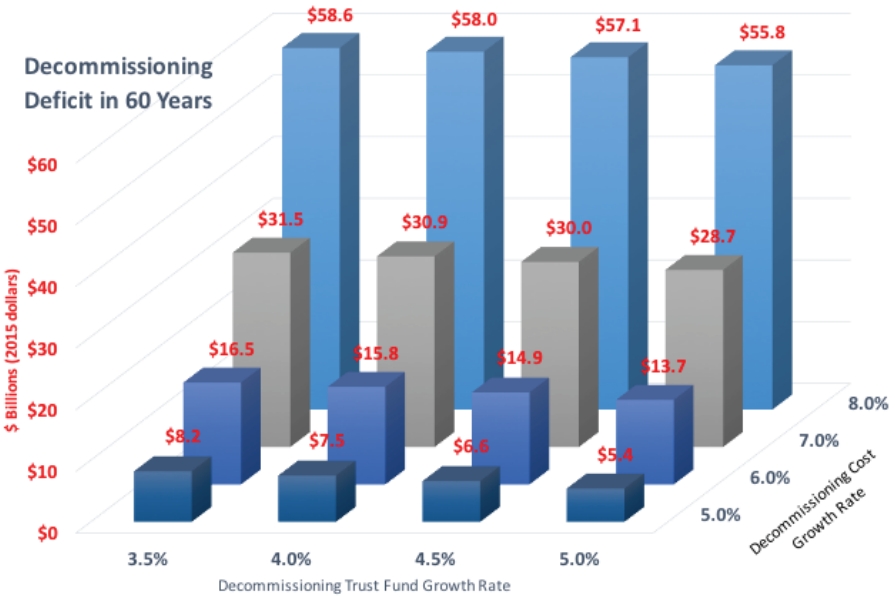
Removal Radioactivity  Spent Fuel  Site Restoration  Other

Change the definition to include all "four buckets" and then specify the collection, reporting, and accounting of all DTF funds required to decommission the site – removal of radioactivity, spent fuel management, site restoration, miscellaneous.

3**. Annual reporting** must show how much is in each "bucket"- radioactivity, spent fuel management, site restoration, itemized miscellaneous; and estimates provided annually over the SAFSTOR period--- accounting for varying decommissioning growth rate estimates and decommissioning cost growth estimates. Growth rates and decommissioning cost estimates require references and justification.

The NRC estimates that decommissioning costs will increase 2.3 times (5% annual rate) to 5.6 times (9% annual rate) over a twenty year period. (*NRC Questions and Answers on Decommissioning - Financial Assurance*[52]) These growths in costs, for example, are consistent with the 5-6% increase in Entergy's estimated Vermont Yankee costs between 2008 and 2014. Using the NRC's estimates, the costs of decommissioning will increase at least 12 times (5% annual rate) to about 78 times (9% annual rate) over fifty years. Decommissioning Trust Fund growth can be estimated and so far appears to be 3%-5%.

Putting this together, for example, would look something like this for Pilgrim Station. This is type of information the NRC, state and public require to have reasonable assurance the money will be there.




3. **Site Restoration**: To clarify the reporting of funds for site restoration, NRC cannot continue to allow licensees to do a characterization of the site towards the end of the SAFSTOR period. It must be done at the beginning-prior to approval of the PSDAR. The decision to delay characterization calls into question all of the cost estimates that a licensee provides. Without a full site characterization, there is no way to estimate what it will ultimately cost to clean-up the site. Long half-life radioactive materials are expected to be found in soils at reactors. These include 5,730-year half-life carbon-14, 100-year half-life nickel-63, 29-year half-life strontium-90, 30-year half-life cesium-137, 13.5-year half-life europium-152, and 12.3-year half-life hydrogen. See Abelquist, Eric W., Decommissioning Health Physics, A Handbook for MARSSIM Users (2d Ed. 2014). These radioactive materials and hard-to-detect radionuclides were found in the decommissioning of both Maine Yankee and Connecticut Yankee in addition to transuranics, radioisotopes of plutonium, curium, neptunium, and americium. See Letter

[52] http://pbadupws.nrc.gov/docs/ML1119/ML111950031.pdf pg., 7, Q.20.

from Thomas L. Williamson, Maine Yankee Director of Nuclear Safety and Regulatory Affairs to NRC (Jan. 16, 2002) (ADAMS ML020440651). Carbon-14, for example, has been a major issue in the decommissioning of other sites such as Yankee Rowe and is expected to be a concern in the decommissioning of future sites such as San Onofre.

4**. Spent Fuel Management Costs:** NRC has already set a precedent by allowing nuclear plant owners to dip into decommissioning money (defined as only covering radioactivity, not spent fuel management) for spent fuel storage at: Kewaunee plant in Wisconsin, San Onofre 1 and 2 in California, Crystal River 3 in Florida, Vermont Yankee in Vernon, and Zion 1 and 2 reactors in Illinois.

What are the benefit of using decommissioning funds?

- It is in the interest of the licensee to empty the pools soon after closure to reduce O&M costs.
- It is in the interest of the public to empty the pools as soon as possible in order to reduce the risk of a pool fire and pool leaks; and it is cheaper to remove the fuel earlier than later leaving a larger amount in the fund.

What is wrong with this de facto policy, as it is now structured?

- It encourages operating plants to wait until post operations to empty the pools so the cost will not come out of its O&M budget. The public believes, as explained in the foregoing, that the risk of a spent fuel pool fire is not zero; the probability of a fire increases in high density, closed frame pools; and dry cask storage is far safer.
- Allowing use of the DTF lowers the amount in the fund leaving less to grow from investments.

A partial solution

An NRC regulation that requires the licensee to replace the amount taken out of the fund for spent fuel management with money received from DOE resulting from law suits as a condition of using the proceeds from the DTF for spent fuel management purposes.

Spent Fuel management Costs must include indefinite onsite storage: NRC's updated waste confidence decision speculates on spent fuel being onsite for 300 years yet approved, for example, Vermont Yankee's assertion that it will be gone by 2057. Waste management costs cannot be based on a date pulled out of the hat. Any date reported for when the spent fuel and GTC waste will leave the site must be documented and all waste management costs provided up to that date- including the estimate cost for hot cell, changing the pad and casks every 100 years.

**Miscellaneous Costs**: Some are legitimate and others clearly not such as Entergy's requests to dip into Vermont Yankee's DTF for lobby fees, legal fees, settlements. The rule would have to specify what can be included as legitimate decommissioning costs.

5. **NRC has not adjusted its requirements to LLC licensees located in market economies:** NRC must figure out a way to hold the parent corporation accountable for shortfalls when the LLC runs out of money so that the states are not left holding the bag. States need to be provided with enforceable and signed documentation between NRC and the parent corporation.

Hollow assurances by NRC will not suffice, such as we saw in Vermont. At a February 19, 2015 hearing, NRC officials assured Vermonters that Entergy would not be allowed to walk away from its legal obligations. The NRC made similar reassurances in a later statement to the press: "We're not going to just let them walk away. Even if it involved working with the Department of Justice to go after the parent company," said NRC spokesperson Neil Sheehan. "Even if the company dissolves, they still have assets. Entergy owns a transmission company . . . and they own other nuclear power plants other than this.[53]"

But Entergy had already publicly said that it expects litigation between the State of Vermont and the company over any shortfall. See VTDigger.org, *Entergy Makes First Withdrawal from Decommissioning Fund,* "If the fund comes up short, [the Entergy representative] said there would be litigation between the state and the company as to how to pay for it."[54]

If such lawsuits fail, or succeed in a pyrrhic way because even the parent company is not solvent at that point, the State of Vermont could be left with a radiologically contaminated site and spent nuclear fuel within its borders.

NRC must change its regulations to protect states and the public.

*DTF-2: The regulation at § 50.82(a)(8)(i)(A) states that decommissioning trust funds may only be used by licensees if their withdrawals "are for expenses for legitimate decommissioning activities consistent with the definition of decommissioning in § 50.2." …**"legitimate decommissioning activities" include only those activities whose expenses are related to removing a nuclear facility or site safely from service and reducing residual radioactivity to a level that permits license termination and release of the property for restricted or unrestricted use… "should not be used for: (1) The maintenance and storage of spent fuel in the spent fuel pool, (2) the design, construction, or decommissioning of spent fuel dry***

[53] VTDigger.org, Residents Seek Assurance from Feds on Vermont Yankee Decommissioning (Feb. 22, 2015), http://vtdigger.org/2015/02/22/residents-seekassurance-feds-vermont-yankee-decommissioning

[54] See VTDigger.org, Entergy Makes First Withdrawal from Decommissioning Fund, http://vtdigger.org/2015/02/11/entergy-makes-first-withdrawal-decommissioningfund/

***storage facilities directly related to permanent disposal, (3) other activities not directly related to radiological decontamination or dismantlement of the facility or site." …Finally, guidance also exists that provides examples of activities outside the scope of decommissioning including, "(1) the maintenance and storage of spent fuel, (2) the design and/or construction of a spent fuel dry storage facility, (3) activities that are not directly related to supporting long-term storage of the facility, or (4) any other activities not directly related to radiological decontamination of the site."***

a**. What changes should be considered for §§ 50.2 and 50.82(a)(8) to clarify what constitutes a legitimate decommissioning activity?**

**PW**: As explained in DTF-1, legitimate decommissioning activities must be expanded from its current definition of including only those activities whose expenses are related to removing a nuclear facility or site safely from service and reducing residual radioactivity to a level that permits license termination and release of the property for restricted or unrestricted use to including all activities - removing residual activity, site restoration, and spent fuel management – funds specifically allocated for each activity provided.

b*. Regulations in § 50.82(8)(ii) states that* ***3 percent of the decommissioning funds may be used during the initial stages of decommissioning for decommissioning planning activities****. What should be included or specifically excluded in the definition of "decommissioning planning activities?"*

**PW**: It cannot include expenditures for activities that are not part of decommissioning- like payment property taxes or lobbying fees. It seems reasonable to allow payment for preparation of the PSDAR and site testing to determine the extent and location of contamination. The exact expenditures must be itemized and made available to the NRC, State and public. This is important in states that have agreement with the licensee to split any monies leftover after decommissioning. Also Entergy is using TLG- an Entergy owned subsidiary.

## *H. Questions Related to Offsite Liability Protection Insurance Requirements for Decommissioning Power Reactor Licensees*

**PW**: Price Anderson provides insufficient funds and it does not cover cleanup and waste disposal costs.[55] Because of the risks presented by a spent fuel pool fire and its potential

[55] http://environmentalnewsstand.com/Environmental-NewsStand-General/Public-Content/agencies-struggle-to-craft-offsite-cleanup-plan-for-nuclear-power-accidents/menu-id-608.html; documents obtained by *Inside EPA* (Part 1 and Part 2) under the Freedom of Information Act (FOIA, Part 1, July 27, 2010 Draft White Paper, developed by Jeff Blizzard (USEPA).

consequences offsite (Spent fuel pool fire offsite consequences estimated in 2006 by MA AGO up to $488 billion), a cask drop during transfer and a breach of a cask, liability protection is required and the current amount significantly raised.

*LPI-1:* ***Most permanently shut down and defueled power reactor licensees have requested exemptions from § 140.11(a)(4) to reduce the required amount of primary offsite liability insurance coverage from $375 million to $100 million and to withdraw from the secondary insurance pool****. As noted above, these licensees are no longer within the category of licensees that are legally required under the PAA to have these amounts of offsite liability insurance. The technical criteria for granting these exemptions are based on the determination that there are no possible design-basis events at a licensee's facility that could result in an offsite radiological release exceeding the limits established by the EPA's early-phase Protective Action Guidelines of 1 rem at the exclusion area boundary. In addition, the exemptions are predicated on the licensee demonstrating that the heat generated by the spent fuel in the SFP has decayed to the point where the possibility of a zirconium fire is highly unlikely.* ***(PW Disputes****) Specifically, if all coolant were drained from the SFP as the result of a highly unlikely beyond design-basis accident, the fuel assemblies would remain below a temperature of incipient cladding oxidation for zirconium based on air-cooling alone. For a postulated situation where the cooling configuration of a highly unlikely beyond design basis accident results in an unknown cooling configuration of the spent fuel, analysis should demonstrate that even with no cooling of any kind (conduction, convection, or radiative heat transfer), the spent fuel stored in the SFP would not reach the zirconium ignition temperature in fewer than 10 hours starting from the time at which the accident was initiated.* ***The NRC has considered 10 hours sufficient time to take mitigative actions to cool the spent fuel. (PW disputes, see below)****Based on this discussion:*

*a.* ***Should the NRC codify the current conservative exemption criteria (i.e., 10 hours to take mitigative actions) that have been used in granting decommissioning reactor licensees exemptions to § 140.11(a)(4)?***

**PW**: No the current exemption is not conservative.

1. There is no basis to assume that there will be 10 hours in which to take mitigative actions. As cited earlier, Dr. Gordon Thompson explains in *Risks of pool storage of spent fuel at Pilgrim and Vermont Yankee - A Report for the Mass. Attorney General* May 2006, PG.18, that, "[T]he closed-form configuration of the high-density racks would create a major problem if water were lost from a spent-fuel pool. The flow of air through the racks would be highly constrained, and would be almost completely cut off if residual water or debris were present in the base of the pool. As a result, removal of radioactive decay heat would be ineffective. Over a broad range of water-loss scenarios, the temperature of the zirconium fuel cladding would rise to the point (approximately 1,000

degrees C where a self-sustaining, exothermic reaction of zirconium with air or steam would begin. **Fuel discharged from the reactor for 1 month could ignite in less than 2 hours, and fuel discharged for 3 months could ignite in about 3 hours**. Once initiated, the fire would spread to adjacent fuel assemblies, and could ultimately involve all fuel in the pool. A large, atmospheric release of radioactive material would occur. Ignition times are impacted by a variety of factors such as age of the fuel, the configuration of the fuel in the pool, etc.")

a. The radiation field would be such as to prevent mitigative actions.
b. Adding water to a spent fuel pool fire likely would result in an exothermic reaction.
c. Casks: Technology used for other stainless steel components cannot be used to repair canisters containing nuclear fuel waste.[56] The NRC stated that if one of the canisters becomes defective (e.g. 75% through-wall stress corrosion cracks), there is no way to repair or replace the canister; especially if the spent fuel storage and transfer pools are demolished, as licensees have done when decommissioned. To replace canisters, the only fuel-handling method currently available to the commercial nuclear generating industry is to bring a cask [or canister] back into a spent fuel pool for reopening. Dr. Kris Singh, CEO, Holtec International said that,

> ...It is not practical to repair a canister if it were damaged... You will have… millions of curies of radioactivity coming out of canister… A canister that develops a microscopic crack (all it takes is a microscopic crack to get the release), to precisely locate it… And then if you try to repair it (remotely by welding)…the problem with that is you create a rough surface which becomes a new creation site for corrosion down the road. I don't advocate repairing the canister.
>
> However, dry handling of the cask and fuel is important to avoid disturbing the properties of the cask, cladding, fuel, and related hardware that would occur if the materials were rewetted and rapidly cooled. However, there is no dry handling facility available in the nation that is large enough to handle these canisters. …and removal of a welded storage cask lid is problematic[57]. There is no dry handling (hot cell) mobile facility designed for this purpose and one may not even be feasible.[58]

The consequences of the spent fuel pool fire are huge- in 2006 dollars a spent fuel pool fire at Pilgrim was estimated for the MA Attorney General to be up to 24,000 latent cancers and $488

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[56] EPRI Extended Storage: Research Perspective, John Kessler, EPRI Used Fuel and High-Level Waste Management Program, NWTRB Meeting, September 14, 2011 http://www.nwtrb.gov/meetings/2011/sept/kessler.pdf
[57] Viability of Existing INL Facilities for Dry Storage Cask Handling, Rev. 1, April 30 2013, Randy Bohachek, et al., Idaho National Lab http://energy.gov/sites/prod/files/2013/12/f5/INLFacilitiesDry%20StorHBUFViabilRptR1b.pdf
[58] Technical Workshop on the Impacts of Dry-Storage Canister Designs on Future Handling, Storage, Transportation, and Geological Disposal of Spent Nuclear Fuel in the United States, NWTRB, November 18-19, 2013

billion dollars- far in excess of the current coverage. And, significantly, Price Anderson does not even cover cleanup and waste disposal- the Elephants in the Room.

***b. As an alternative to codifying the current conservative exemption criteria (i.e., 10 hours to take mitigative actions), should the NRC codify a requirement to allow decommissioning reactor licensees to generate site specific criteria (i.e., time period to take mitigative actions) based upon a site specific analysis****?*

**PW:** The so-called current conservative exemption criteria (10 hours to take mitigative action) is not conservative, period. Expanded liability assurance is what is needed-not less**.** However it is also clear that the probability of an accident varies from site to site – for example spent fuel pools in elevated pools like Mark I BWRs are more vulnerable than out-of-reactor on the ground pools; and Holtec Hi-Storm-U casks are less vulnerable to terrorist attack than casks stored vertically on a pad. Mitigative actions vary site to site. However NRC approved PRAs use false assumptions so any risk assessment done using the current computational tools will be bogus. See discussion of PRAs in section F, backfitting. Simply raise the liability cap. Acknowledge what the public knows- risks are not zero. The consequences offsite would be huge as shown in license renewal adjudication for Pilgrim and Vermont by the Massachusetts Attorney General in 2006 and in Indian Points license Renewal Adjudication by the New York Attorney General (LeMay and Chanin Testimonies).

***c. The use of $100 million for primary liability insurance level is based on Commission policy and precedent from the early 1990s. The amount established was a qualitative value to bound the claims from the Three Mile Island accident. Should this number be adjusted?***

**PW**: Yes it should be <u>significantly</u> increased; and cleanup and waste disposal costs included-not simply damages.

***d. What other factors should be considered in establishing an appropriate primary insurance liability level (based on the potential for damage claims) for a decommissioning plant once the risk of any kind of offsite radiological release is highly unlikely?***

**PW:** The risk of a spent fuel pool fire, cask drop during transfer or sabotage attack on the ISFI or cask leak are not zero. Densely packed, closed frame configurations in BWR Mark 1's increase the probability of a spent fuel pool fire. The consequences are huge. Probability is irrelevant with high consequences. Also the NRC's and industry's probability estimates are based on false assumptions and inputs and underestimate risk, discussed in the foregoing. The long-term financial viability of LLCs have to be considered.

## *I. Questions Related to Onsite Damage Protection Insurance Requirements for Decommissioning Power Reactor Licensees*

***The questions on onsite damage protection insurance (ODI) have been listed in this document using the acronym "ODI" and sequential numbers.***
***ODI-1: The requirements of § 50.54(w)(1) call for each power reactor licensee to have insurance to provide minimum coverage for each reactor site of $1.06 billion or whatever amount of insurance is generally available from private sources, whichever is less. The insurance would be used, in the event of an accident at the licensee's reactor, to provide financial resources to stabilize the reactor and decontaminate the reactor site, if needed.***
***The requirements in § 50.54(w)(1) do not distinguish between a reactor authorized to operate and a reactor that has permanently shut down and defueled. With the permanent cessation of reactor operations and the permanent removal of the fuel from the reactor core, operating reactor accidents are no longer possible. Therefore, the need for onsite insurance at a decommissioning reactor to stabilize accident conditions or decontaminate the site following an accident, should be significantly lower compared to the need for insurance at an operating reactor. (PW disputes- Spent fuel pool contains more radioactivity than the core) Based on NRC policy and precedent, permanently shut down and defueled reactor licensees have requested exemptions from § 50.54(w)(1). The exemption granted to a permanently shut down reactor licensee permits the licensee to reduce the required level of onsite property damage insurance from the amount established in § 50.54(w)(1) to $50 million. The***
***NRC has previously determined that $50 million bounds the worst radioactive waste contamination event (caused by a liquid radioactive waste storage tank rupture) once the heat generated by the spent fuel in the SFP has decayed to the point where the possibility of a zirconium fire in any beyond design-basis accident is highly unlikely, (PW-not zero) and in any case, there is sufficient time to take mitigative actions. (PW-_no assurance) The technical criteria used in assessing the possibility of a zirconium fire, as discussed in question LPI-1 above, is also used for exemptions from § 50.54(w)(1). Based on this discussion:***

***a. Should the NRC codify the current exemption criteria that have been used in granting decommissioning reactor licensees exemptions from § 50.54(w)(1)? If so, describe why.***

**PW**: No. In the event of a spent fuel pool fire, cask drop or ISFSI release the consequences onsite have a potential to be very significant-exceeding $50 million. DTF funds are already insufficient. Who will pay to cleanup? It is a very significant question for LLC's. It is hardly fair for NRC to transfer the risk to the states and responsibility to try to clean-up the site and deal with the waste.

b***. The use of $50 million insurance level for bounding onsite radiological damages is based on a postulated liquid radioactive waste storage tank rupture using analyses from the early 1990s. Should this number be adjusted? If so, describe***

**PW**: Yes the figure should be adjusted by significantly increasing the number.

The consequences from a spent fuel pool fire, cask drop or cask rupture/leak far exceed a postulated liquid radioactive waste storage tank rupture. Further cleanup costs increase annually, as NRC and industry acknowledge, and cannot be based on a 1990 figure.

***c. Is the postulated rupture of a liquid radioactive waste storage tank an appropriate bounding postulated accident at a decommissioning reactor site once the possibility of a zirconium fire has been determined to be highly unlikely?***

**PW**: No – the suggestion is absurd. A spent fuel pool fire, cask drop in the pool during transfer, sabotage and rupture of a cask are the appropriate bounding accidents- they are credible accidents of highest consequence. Insure against the worst not the least consequence.

## *J. General Questions Related to Decommissioning Power Reactor Regulations*

***GEN-1: Section 50.51, "Continuation of License," states in paragraph (b)(1) that all permanently shut down and defueled reactor licensees shall continue to take actions to maintain the facility, and the storage and control and maintenance of spent fuel, in a safe condition beyond the license expiration date until the Commission notifies the licensee in writing that the license is terminated. The NRC has recently focused on the licensee's maintenance of long lived, passive structures and components at decommissioning reactors. The NRC expects that many long-lived, passive structures and components may generally not have performance and condition characteristics that can be readily monitored, or could be considered inherently reliable by licensees and do not need to be monitored under § 50.65(a)(1). There may be few, if any, actual maintenance activities (e.g., inspection or condition monitoring) that a licensee conducts for such structures and components. Treatment of long-lived, passive structures and components under the maintenance rule is likely to involve minimal preventive maintenance or monitoring to maintain functionality of such structures and components in the original licensing period. The NRC is interested in the need to provide reasonable assurance that certain long-lived, passive structures and components (e.g., neutron absorbing materials, SFP liner) are maintained and monitored during the decommissioning period while spent fuel is in the SFP.***
***Based on the discussion above, what regulatory changes should be considered that address the performance or condition of certain long-lived, passive structures and components needed to provide reasonable assurance that they will remain capable of fulfilling their intended functions during the decommissioning period?***

**PW:** Continued monitoring and maintenance of long-lived, passive structures and components at decommissioned reactors is part of NRC's AEA mandate to protect public health and safety; it follows that NRC require a sufficient number of trained and qualified personnel to perform these duties. The draft's description says that "*The NRC expects that many long-lived, passive structures and components may generally not have performance and condition characteristics that can be readily monitored, or could be considered inherently reliable by licensees and do not need to be monitored under § 50.65(a)(1). There may be few, if any, actual maintenance*

*activities (e.g., inspection or condition monitoring) that a licensee conducts for such structures and components. Treatment of long-lived, passive structures and components under the maintenance rule is likely to involve minimal preventive maintenance or monitoring to maintain functionality of such structures and components in the original licensing period."* Emphasis added) This should indicate the importance that NRC change course and require spent fuel pools be emptied ASAP.

Monitoring and Maintenance in General: Throughout the different phases of decommissioning, licensees should, at a minimum, maintain current monitoring levels as required, for example by NEI 07-07, and required by NRC to prevent radioactivity migrating offsite unmonitored until NRC license termination. This is necessary since radioactive materials will remain for decades before decontamination and dismantling. For example, to protect the environment and public health, monthly sampling from all onsite groundwater monitoring wells and all drinking water wells, if they exist, should continue through license termination, and split samples from those wells should be provided to the state's department of public health for independent confirmatory analysis. In addition, the licensee should continue to perform radiological environmental monitoring of the pathways to the public, direct gamma radiation, soils, sediments, fish and other flora and fauna as conducted during operation of the facility until radioactive materials stored onsite are removed by decontamination, dismantling, and licensed disposal. Splits of those samples also should be provided to the state along with direct gamma radiation measurements by dosimeter. States must be provided split samples from the final status surveys that are intended to document that soil and structure remediation will allow release of the site for unrestricted use at NRC license termination. In addition, staffing for onsite fire protection must continue.

***GEN-5: The NRC is attempting to gather information on the costs and benefits of the changes in the regulatory areas discussed in this document as early as possible in the rulemaking process. Given the topics discussed, please provide estimated costs and benefits of potential changes in these areas from either the perspective of a licensee or from the perspective of an external stakeholder.***

***a. From your perspective, which areas discussed are the most beneficial or detrimental?***

**PW:** Recommendations made by PW on the following topics that are most beneficial to protect public health, safety, environment, economics include changes to: Current Regulatory Approach; Decommissioning Trust Funds; Security, Offsite Emergency Planning; Liability Insurance; and Backfitting-based on overhaul PRA

***b. From your perspective, assuming you believe changes are needed to the NRC's reactor decommissioning regulatory infrastructure, what are the factors that drive the need for changes in these regulatory areas? If at all possible, please provide specific examples (e.g., expected savings, expectations for efficiency, anticipated effects on safety, etc.) about how these changes will affect you.***

**PW:** Changes PW recommended in this comment to the regulatory structure must be made to protect public health, the environment and consumer's pocketbooks. For example: (1) NRC must undertake a NEPA-compliant comprehensive analysis of all potential environmental and economic impacts of licensee's post-closure plans to protect public health, safety and the environment.[59] (2) Changes required to address state and public concerns about whether LLC licensee's in market economies will exist decades from now when radiological decontamination and dismantlement begins. If at any point those licensees fail to pay for all of the radiological decommissioning and spent fuel management that is needed at the site, the State's and public's concern is that uncovered costs may ultimately fall upon the citizens. The NRC has a legal duty to ensure that this does not occur but NRC has neglected to satisfy this obligation with anything other than hollow assurances. (3) Regulations must deal with spent fuel remaining onsite indefinitely to protect public health and also to assure the licensee has monies for hot cell technology and to pay to change the pad and casks every 100 years, as required.

***c. Are there areas that are of particular interest to you, and for what reason?***

**PW**: See above.

***d. Please provide any suggested changes that would further enhance benefits or reduce risks that may not have been addressed in this ANPR.***

**PW:** Add section to discuss requirement for a NEPA-compliant comprehensive analysis of all potential environmental and economic impacts of licensee's post-closure plans. A supplemental environmental impact statement is needed to comply with 10 CFR 10.92. Add section to discuss challenges presented by licensees in market economies; add indefinite storage spent fuel onsite.

## VI. Public Meeting

***The NRC will conduct a public meeting to discuss the contents of this ANPR and to answer questions from the public regarding the contents of this ANPR.***

**PW Comment**: One public meeting is insufficient. Meetings must be held around the country and without question in states with sites that have ceased operations. The location of the meeting must be in the host communities.

Respectfully submitted,

Mary Lampert

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[59] See State of Vermont's PSDAR Comments, Office of the Attorney General William Sorrell (March 6, 2015) III, pages 40-53.

Pilgrim Watch
148 Washington Street
Duxbury, MA 02332
Tel. 781-934-0389
Email: mary.lampert@comcast.net