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From: Mary Lampert [mailto:mary.lampert@comcast.net]
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To: RulemakingComments Resource
Subject: NRC 2012-0246 Pilgrim Watch Comment Regarding the NRC Proposed Waste Confidence Rule -Continued Storage Spent Nuclear Fuel [RIN 3150-AJ20-NRC 2012-0246]

Hello:

Attached Please find Pilgrim Watch Comment Regarding the NRC Proposed Waste Confidence Rule –Continued Storage Spent Nuclear Fuel [RIN 3150-AJ20-NRC 2012-0246], December 19, 2013. If you have difficulty downloading the document, please call Mary Lampert at 781-934-0389. Courtesy of receipt requested.

Happy holidays,

Mary

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Pilgrim Watch Comment Regarding the NRC Proposed Waste Confidence Rule – Continued Storage Spent Nuclear Fuel [RIN 3150-AJ20-NRC 2012-0246], December 19, 2013

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TABLE OF CONTENTS

RIN 3150-AJ20-NRC 2012-0246
Waste Confidence, Continued
Storage Spent Nuclear Fuel
Rulemaking.Comments@nrc.gov

Pilgrim Watch Comment Regarding the NRC Proposed Waste Confidence Rule –Continued Storage Spent Nuclear Fuel [RIN 3150-AJ20-NRC 2012-0246], December 20, 2013

Pilgrim Watch (Herein after "PW") provides comment regarding the Proposed Waste Confidence Rule and its supporting documents that apply to storage of spent fuel after the end of operator's licensed life. PW disagrees with the rulemaking's and supporting document's methodology, assumptions and conclusions.

I. INTRODUCTION

A. Background

For over three decades, the NRC has assumed that an offsite permanent repository would be available for licensees to send their spent fuel at the end of the reactor's operations. The assumption has never had any factual basis, and history has proved it was flatly wrong. Nonetheless, the faulty assumption has been embedded in NRC rules, effectively preventing state officials and the public from litigating spent fuel issues in licensing proceedings.

In 2012, the D.C. Circuit Court ruled that NRC could no longer presume the existence of a repository and must do an EIS to address the impacts on public health and safety if spent fuel is not deposited in a repository. NRC's DGEIS claims, absent support, that no serious impacts will occur from leaving the spent fuel onsite indefinitely. What NRC simply substituted is its offsite repository fantasy for another fantasy - waste could remain safely onsite in above ground storage indefinitely. This assumption defies commonsense and conflicts with the Nuclear Waste Policy Act (NWPA). The proposed rule that accompanies the DGEIS incorporates the latter's baseless conclusions, and would continue to prohibit any public intervention of spent fuel issues in future licensing decisions.

The Proposed Rule and Draft GEIS should be shredded. Rather, the NRC should do what the Court of Appeals ordered.

In *New York v. NRC,* 681 F.3d 471 (D.C. Cir. 2012), the Court ordered NRC to conduct a "full analysis" of "the potential environmental effects" of storing spent fuel onsite at nuclear plants "on a permanent basis." 681 F.3d at 479 NRC did not do the "full analysis." It simply assumed that permanent storage was safe. NRC must do a new EIS that complies with the Court's order, examines the probability that an environmentally justified offsite repository will be built and by what date. To do so, the NRC also must conduct a science-based analysis showing the public health and environmental consequences of spent fuel fire risks (including acts of malice) and spent fuel leaks that may occur if offsite storage is unavailable.

The NRC incorrectly changed the purpose of the GEIS from what the court ordered. The DC Circuit ordered NRC to do a GEIS as a prerequisite to licensing decisions that will result in the production of more spent fuel in the absence of a permanent repository (Ibid at 473). ***It ordered a specific and narrow focus. NRC changed and broadened it to a need to do the GEIS so that it will become the basis for a regulatory approach to temporary storage of spent fuel.***

Finally, the Proposed Rule and supporting documents are premature. The National Academies were asked by Congress to determine the adequacy of NRC's safety regulations in light of Fukushima, with specific emphasis on the advisability of spent fuel pool storage. PW believes NRC's fast moving train relative to continuing high density storage should be halted until NAS finishes its quality assurance review.

B. The Proposed DGEIS and Waste Confidence Rule

The proposed Waste Confidence Rule rests largely on supporting documents - the draft GEIS, seriously outdated referenced documents, and the NRC's Draft Consequence Study of a Beyond-Design-basis Earthquake Affecting the Spent Fuel Pool for a US Mark I Boiling Water Reactor. The document's methodology, assumptions and findings are faulty.

II. <u>WASTE CONFIDENCE GENERIC ENVIRONMENTAL STATEMENT, DGEIS</u>

PW does not support the DGEIS's environmental assessment of "small impact." The DGEIS' findings are not "real," but were concocted to reach a desired, not a correct, result. The lack of any legitimate basis for the findings results from, among other things, the following:

- The DGEIS treats environmental impacts generically. They should be evaluated on a site-specific basis. The potential impact on different reactors varies widely. The potential impact on a reactor like Pilgrim is far greater, in both consequences and likelihood, than NRC's "generic" conclusion.
- The draft rests on unsupported assumptions that support its "small impact" finding but it has no basis in reality.
- The draft assessed environmental impacts using a faulty and outdated Probabilistic Risk Assessment (PRA). NRC multiplied consequences by an unjustified low probability so that no matter how large the consequences, they are trivialized by NRC's choice of a "generic," infinitesimally small, probability of occurrence.
- NRC relied on consequence studies that used an unreliable and outdated consequence code - MACCS or MACCS2. David Chanin, who wrote the FORTRAN for the code while at Sandia said, "It is my firm belief that the MACCS2 cost model is so seriously flawed that even with reevaluation and modification of all its input parameters, its cost results should not be used unless for replicating prior studies."

A. ENVIRONMENTAL IMPACTS NEED TO BE CONSIDERED ON A SITE-SPECIFIC BASIS, NOT GENERICALLY

The purpose of the proposed action according to NRC is "to improve the efficiency of the NRC's licensing process by generically addressing the environmental impacts of continued storage." (DGEIS, ES.4) However, efficiency is not NRC's AEC mandate; instead it is to protect public health and safety. PW shows that the potential environmental impacts vary from site to site and must be considered on a site-specific basis, not generically. If they were addressed on a site by site basis, PW shows that the impact would be far from small.

No two reactors are alike - they vary on likely environmental impact after license termination

1. **Reactors vary in Location requiring site specific analysis:** Whether reactors are located in regulated or deregulated electric markets; their susceptibility to natural events, impact of climate change on each reactor; impact proximity to a marine environment; groundwater issues; proximity to high population centers; susceptibility to acts of malice; proximity to cultural and historic resources; accessibility to LLRW disposal; number safety violations varies regionally; likely impact on public and occupational health.

Examples:

a. <u>Economics</u> – <u>located in regulated or deregulated electric markets</u>:

Reactors in regulated markets can pass costs on to ratepayers; consequently licensees are more likely to make investments in maintenance, both before and after operations cease, lowering the risk that mechanical malfunctioning and degradation will result in negative environmental impacts. Conversely, merchant reactors in deregulated markets increasingly cannot compete with cheaper sources of electricity and are losing money. Therefore, those licensees are not making the necessary investments in maintenance and personnel while operating and have a higher probability of failures after operations cease resulting in negative impacts on the environment from degradation and mechanical malfunctioning. Pilgrim provides an example. In 2013, using USB's analysis, Pilgrim is losing $27 to $30 million dollars a year. In 2013 alone Pilgrim had 18 event reports and 10 times more shutdowns than any other reactor. On November 6, the NRC announced that it had dropped Pilgrim's performance rating because of shutdowns with complications, placing it among 15 plants in the country requiring more oversight. Only a few days later, the NRC told Entergy that Pilgrim's rating is likely to drop again next month, placing it among the 8 worst performers. Therefore it is reasonable to bet that the overall condition of its pool and support structures will not be in adequate condition to face the many challenges over the 60 years after license expiration, 2092. After operations cease, it is unrealistic to expect licensees to spend monies on a site that is not generating income; and there is no assurance either the licensee will be around. Who pays?

b. <u>Susceptibility to Natural Events- earthquakes, flooding, climate change</u>

(1) <u>Earthquakes:</u> Reactors vary from one another and individually over time in the likelihood of a severe earthquake. They should be examined individually. Pilgrim, for example, was once

rated the second *least* likely to be damaged by seismic activity, but in August 2011 it was re-ranked as the second *most* likely. Therefore the damage analyses from an earthquake made when the pool and its structures were built underestimate the risk after operations cease. NRC Chair, Dr. Macfarlane said to the New York Times[1] that:

> "As a geologist, I also know that geological knowledge is constantly changing… The American industry recently began a re-evaluation of its earthquake vulnerability after the United States Geological Survey released a new estimate of the prospects for earthquakes in the eastern United States. And there may be more revisions in the future." Matthew Wald reported that "she considers the industry's evaluation of earthquake vulnerability — an issue that was once believed to be settled when a nuclear power plant was licensed — to be inadequate."

(2) Flooding: Reactors vary in susceptibility to flooding. For example, the Prairie Island reactors are located on an island in the Mississippi River and the Three Mile Island reactors are located in an island on the Susquehanna River. The Columbia Washington Reactor is located close to the Columbia River, and Indian Point is located close to the eastern shore of the Hudson River. Reactors also vary in whether NRC has covered up a reactor's susceptibility to flooding. The Huffington Post[2] reported in September that,

> In a letter submitted Friday afternoon to internal investigators at the Nuclear Regulatory Commission, a whistleblower engineer within the agency accused regulators of deliberately covering up information relating to the vulnerability of U.S. nuclear power facilities that sit downstream from large dams and reservoirs. The letter also accuses the agency of failing to act to correct these vulnerabilities despite being aware of the risks for years.

(3) Climate Change: Climate change is predicted to bring an increased number of severe storms and sea level rise. Sea level rise is predicted to be more extreme on the east coast and varies from location to location on the coast[3]. Therefore, where a reactor is located is important. For example, Pilgrim's ISFSI is located 25' above MSL and 100 yards from Cape Cod Bay. Over the short term to indefinite time frames, high storm waves on top of sea level rise will make

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[1] For New Nuclear Chief, Concerns Over Plant Safety, Matthew Wald, NYT, August 13, 212

[2] Flood Threat to Nuclear Plants Covered Up By Regulators, NRC Whistleblower Claims, Huffington Post, Sept., 14, 2013)

[3] Sea Level Rise Accelerating in U.S. Atlantic Coast, http://www.usgs.gov/newsroom/article.asp?ID=3256&from=rss_home (Released: 6/24/2012 1:00:00 PM)

flooding of the ISFSI far more probable than at an ISFSI located at higher elevation and not an issue at reactors located away from the coast.

c. Marine Environments

Reactors in marine environments have a higher probability of corrosion from exposure to chloride than, obviously, those not in marine environments. (IN 2013-07 April 16, 2013 Premature Degradation Spent Fuel Storage Cask Structures and Components from Environmental Moisture)

d. Reactors Vary In Proximity To Aquatic Resources & Special Status Species & Habitats

Each reactor differs in its proximity to special species & habitats and most significantly to compliance with environmental regulations. For example, Pilgrim's NUREG-1437, Sup 3 lists:

Table 2-4. Anadromous and Marine Threatened or Endangered Species

Scientific Name	Common Name	Federal Status	Massachusetts Status
	TURTLES		
Caretta caretta	loggerhead turtle	Threatened	Threatened
Chelonia mydas	green turtle	Threatened (endangered in FL)	Threatened
Dermochelys coriacea	leatherback turtle	Endangered	Endangered
Lepidochelys kempii	Kemp's ridley turtle	Endangered	Endangered
	WHALES		
Balaenoptera borealis	sei whale	Endangered	Endangered
Balaenoptera physalus	fin whale	Endangered	Endangered
Eubalaena glacialis	North Atlantic right whale	Endangered	Endangered
Megaptera novaengliae	humpback whale	Endangered	Endangered
Physeter catadon [a]	sperm whale	Endangered	Endangered
	FISH		
Acipenser brevirostrum	shortnose sturgeon	Endangered	Endangered
Acipenser oxyrinchus	Atlantic sturgeon	not listed	Endangered

[a] The sperm whale has two accepted scientific names: *Physeter catadon* and *P. macrocephalus*.
Source: FWS 2006b

Of particular concern at Pilgrim is the North Atlantic right whale, one of the rarest large whales in the world with a little more than 500 individuals remaining. Most of the Bay is critical habitat for right whales. In January 2013, there was an unusual sighting of a mother-calf right whale pair within Pilgrim's 500-yard safety exclusion zone. Reactors vary not only in proximity to aquatic resources and special status species and habitats but in their compliance to applicable regulations so that a generic approach is inappropriate. For example, Entergy's non-compliance with these regulations includes:

- No state CWIS permit, as required by 2006 regulations.
- Discharge violations: Since at least 1995, discharging toxic corrosion inhibitors without a state or federal permit; chlorine discharge limit violations in 5 of last 12 quarters.
- The joint EPA-DEP Clean Water Act "NPDES" permit expired 16 years ago; and although it has been "administratively extended" for 16 years, Entergy has violated its terms since 2000.
- The Massachusetts "Section 401 certification" of the NPDES permit is outdated and invalid, given unpermitted discharges of various pollutants and other violations.
- Since about 2000, no approved "marine monitoring plan" as required by NPDES permit.
- Since 2000, Entergy has refused to cooperate with the required technical advisory committee, which was set up as an "integral part" of the NPDES permit. Entergy is not meeting its obligations: without compliance with this critical provision, the permit is meaningless.
- Radioactive tritium is leaking into the groundwater which flows into Cape Cod Bay.
- State 2006 coastal zone management "federal consistency certification" is invalid.

NRC has taken no action to assure that these permits are updated with requirements followed despite its being brought forward in contentions during license renewal. The environmental impact, post-shutdown may well be entirely different at reactors in states that enforce regulations and at reactors that comply with regulations.

e. <u>Reactors Vary in Proximity to Historic and Cultural Resources:</u>

Pilgrim for example is in "America's Hometown" and 37 miles from Boston and its rich cultural, historic and educational institutions. The impact on these resources would be far greater than for a reactor located in a remote rural location.

f. <u>Groundwater Contamination:</u>

Some reactor sites are in environments that are particularly vulnerable to adverse effects of groundwater contamination. Groundwater contaminations from spent fuel pool leaks may affect known drinking water sources and impinge on Native American trust lands. Examples are Prairie Island and Columbia.

g. Proximity to High-Population Centers:

Environmental consequences vary considerably depending on the reactors proximity to high-population centers. Pilgrim and Indian Point are classic examples, with huge consequences of a spent fuel pool fire. The Massachusetts Attorney General in 2006 found Pilgrim's densely packed pool vulnerable and estimated that a spent fuel pool fire at Pilgrim would cost up to $488 billion dollars, result in 24,000 latent cancers, and could contaminate hundreds of miles downwind[4]. Boston, Providence, smaller cities, and densely populated suburbs are within 50 miles.

Further, in estimating environmental impact, it cannot be limited to 50 miles as the DGIS did in its analysis.[5] This points out yet another serious methodological weakness of the DGEIS and—by extension—the proposed rule.

h. Susceptibility to Acts of Malice:

Some reactors are more likely targets than others due to their symbolic value as a target and proximity to large population centers. Pilgrim is located in America's Hometown, a symbolic target, and a successful strike would impact a large population—Boston, Providence and beyond. Likewise, Indian Point is proximate to dense population clusters, notably New York City, and very close to West Point. What serious terrorist would chose to attack Wolf Creek in Kansas over Indian Point or Pilgrim?

BWR's are more susceptible to attack than PWR's due to the location of the pool outside primary containment, in the upper level of the reactor with a thin roof overhead. A small plane could easily penetrate the roof and cause a spent fuel pool fire[6].

[4] 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.

[5] National Academy of Sciences Safety and Security of Commercial Spent Nuclear Fuel Storage Public Report, National Academy of Sciences, April 2005, http://www.nap.edu/books/0309096472/html/ said, *Such (zirconium cladding) fires would create thermal plumes that could potentially transport radioactive aerosols hundreds of miles downwind under appropriate atmospheric conditions."* (NAS, p. 50)

The vulnerability of spent fuel pools to malicious attack is perhaps the single biggest issue that is missing from the draft GEIS. Spent fuel is building up at every reactor site in the country, stored in high-density pools that are vulnerable to attack and pose a risk of catastrophic fire. The NRC contemplates that these pools may remain in use for 60 years after operation ceases, where they will remain vulnerable to fires and attacks. Our government assumes that terrorists are not going away, either foreign or homegrown. According to the NRC, the risk of attacks need not be addressed in the GEIS because NRC security regulations ensure that reactor spent fuel pools are protected. This is not true. Reactors are not protected from an air attack. No reactor licensee in the U.S. has lowered risk by eliminating the use of high-density storage racks from fuel pools, or even lowered the density of fuel stored in pools. Thus, a serious environmental threat remains. Likewise casks are poorly defended and vulnerable to attack by airplane, vehicle bomb, perforation by shaped charge with or without incendiary device, or removal of overpack lid[7].

i. Reactors Vary in Accessibility to LLRW Disposal

The DGEIS section on Low-level Radioactive Waste Management (3.14.1) treats LLRW impact generically but some reactors, such as Pilgrim, are in states that are not part of any compact. Non-compact states will have onsite LLRW generated during operations, post operations and in decommissioning activities. LLRW will present environmental concerns different from reactors having access to disposal facilities. Also all reactor types are not the same. BWR's generate approximately twice the LLRW of PWRs.

j. The number of safety violations at U.S. reactors varies dramatically from region to region.

A congressional study awaiting release points to inconsistent enforcement. The authors of the report wrote, "NRC cannot ensure that oversight efforts are objective and consistent. (Uneven enforcement suspected at nuclear plants." (AP, Oct 16, 2013)

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[6] 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, Gordon R. Thompson, February 6, 2009, Ch. 7 and Tables 7-2 thru 8-2.

[7] Ibid at Table 7-8

k. Reactors Vary in Likely Impacts on Public and Occupational Health

(1) Radiation-linked diseases in communities near reactors vary and must be looked at on a site specific basis. Additional years of exposure from onsite storage will harm an already damaged population, even if the releases are at permissible levels. Both BEIR VII and previous nuclear worker studies show that the health effects of radiation are cumulative. See Morgenstern, H. and Ritz, B. Effects of Radiation and Chemical Exposures on Cancer Mortality Among Rocketdyne Workers: A Review of Three Cohort Studies. *Occupational Medicine: State of the Art Reviews*, Vol. 16, No. 2, April-June 2001, pages 219-238.

For example: Increases in radiation-linked disease in the communities around Pilgrim were in part attributed to operating with defective fuel; operating without the off-gas treatment system in the first years; poor management and practices culminating in the releases in June 1982 that coincided with weather conditions that held the releases over surrounding communties and parts of Cape Cod.

The cancers found in the communities around the power station were studied by Dr. Sidney Cobb and Dr. Richard Clapp and their results were published in a peer reviewed journal in 1987. They included elevated rates of Myelogenous Leukemia – a type of cancer most likely to be triggered by exposure to radiation.[8] This led to a case-control study carried out by the Massachusetts Department of Public Health that showed a fourfold increase in adult Leukemia between 1978 and 1983. The report stated "a dose-response relationship was observed in that the relative risk of leukemia increased as the potential for exposure to plant emissions also increased."[9]

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[8]An epidemiological analysis of five towns around Pilgrim shows a 60 percent increase in leukemia rate, excluding leukemias not caused by radiation exposure. - Sidney Cobb, et al. *Lancet*, 1987. The rate of myelogenous leukemia (the type most likely to be triggered by exposure to radiation) among males in the 5 towns around the Pilgrim reactor was found to be 2 1/2 times greater than the statewide average. *Leukemia in Five Massachusetts Coastal Towns,* Sydney Cobb, et al., Abstract for the American Epidemiologic Society, March 18, 1987; and *Leukemia near Massachusetts Nuclear Power Plant*, letter b Clapp, R.W., Cobb, S., Chan, C.K., Walker, B., *Lancet* 1987, No, 2:1324-5.

[9]Adults living and working within ten miles of the Pilgrim reactor had a fourfold increased risk of contracting leukemia between the years of 1978 and 1983 when compared with people living more than 20 miles away, according to a 1990 study by the Massachusetts Department of Public Health: *Southeastern Massachusetts Health Study 1978-1986*, Morris, M.S., Knorr, R.S., Massachusetts Department of Health, Oct. 1990. See also *Archives of Environmental Health*, 1996, Vol. 51(4), p. 266.

(2) Demographics: BEIR VII showed that the young, elderly, and females are more susceptible to radiation so that the demographics of these population groups on a site-specific basis must be accounted for in assessing health impacts on the public of normal and above-normal releases from spent fuel storage. The DGEIS did not do so.

(3) <u>Bio-Accumulation of Radionuclides in the Environment</u>

The history of releases into the environment varies from reactor to reactor. Its significance must be evaluated on a site-specific basis because the effects of radiation exposure are cumulative. Some types of nuclear power plant emissions stay radioactive for a long time and, because they can enter biological food chains, those materials can accumulate in the environment and adversely affect public health. Reports show that, "If radioactive emissions persist for years, decades or even centuries within the environment, then even modest reductions in annual discharges may not be sufficient to prevent an environmental build-up of those materials over time." *Estimates of Environmental Accumulations of Radioactivity Resulting from Routine Operation of New England Nuclear Power Plants (1973-84),* Dr. Richard W. England, Mr. Eric Mitchell, p. 4, A Report of the Nuclear Emission Research Project, Whittemore School of Business and Economics, University of New Hampshire, Durham, N.H., August 1987.

It is known for example that the following radionuclides have been released from Pilgrim into neighboring communities: plutonium 239 (half life 24,400 years); neptunium 236 or 237 (half life ranging from 120,000 years to 2.1 million years); cesium 137 (half life 30.2 years); strontium 90 (half life 28.5 years); tritium (half life 12.3 years), and xenon (half life 9.17 hours). Xenon transforms after its emission into cesium 135, which persists almost indefinitely in the environment. Examples of previous releases have been reported in the Annual Radiological Environmental Monitoring Program Reports [REMP].[10] These releases include substances that

[10] For example, in June 1982, Pilgrim blew its filters and released contaminated resin material off site into surrounding communities. The licensee's own Radiological Environmental Monitoring Program Report for 1982 showed for example: Cesium-137, 1,000,000 times higher than expected in milk tested at the indicator sampling farm 12 miles west of the reactor and no elevation at the control station, 22 miles away; Cesium-137 again 1,000,000 times higher in vegetation samples from indicator farms .7 miles and 1.5 miles from the reactor. Plutonium 239/240: Radiological Environmental Reports (REMP) 1998, Plutonium found in indicator samples; and on Duxbury Beach: REMP 1999, Plutonium found Duxbury Beach; REMP 2000, Plutonium in indicator samples from Duxbury Beach, later excused by stating contamination must have resulted from a dirty beaker; REMP 2001 Plutonium Duxbury Beach; REMP from 2003 forward stopped testing for Plutonium on Duxbury Beach.

will remain active in the local environment for the foreseeable future and should be taken into account on a site specific basis when evaluating the impact of releases from continued storage of spent fuel in normal and accident scenarios. Reactors' past history of releases vary and require separate analysis.

2. Reactors Vary In Design, Condition, Maintenance, Regulatory Oversight

a. Design:

BWR Mark I and II reactors' spent fuel pools are located outside primary containment, elevated at the top of the reactor building with a thin and vulnerable roof overhead. They are vulnerable to an air attack even from a small aircraft, more so than a separate spent fuel pool that is partially submerged into the ground. The vulnerability of these high-density, closed frame spent fuel pools to acts of malice is the single biggest issue that is missing from the draft GEIS. They are vulnerable to attack and pose a risk of catastrophic fire.

The NRC says that these pools may remain in use for 60 years after the license expires, where they will remain vulnerable to fires. According to the NRC, the risk of attacks need not be addressed in the GEIS because NRC security regulations ensure that reactor spent fuel pools are protected. They are not. Reactors are vulnerable to air attack and readily available sophisticated weapons. No reactor licensee in the U.S. has eliminated the use of high-density storage racks from fuel pools, or even lowered the density of fuel stored in pools. Thus, a serious environmental threat remains and varies from site to site. But, although one cannot remove the threat of a malicious attack, NRC can require the fuel to be moved to dry casks and greatly reduce the environmental threat of a catastrophic fire. NRC's proposed rule fails to do so.

b. Condition/History of Maintenance:

A historically well-maintained reactor is likely to age better than one neglected and present less environmental risk over the 60 years after the license ends. For example, Pilgrim was poorly maintained in its early years. It was forced to shut down from 1987- 1990. In its later years, Entergy, unable to compete in a deregulated market with cheaper sources of electricity, cut maintenance and personnel. In 2013 alone Pilgrim had 18 event reports and 10 times more shutdowns than any other reactor. On November 6, the NRC announced that it had dropped

Pilgrim's performance rating because of shutdowns with complications, placing it among 15 plants in the country requiring more oversight. And only a few days later, the NRC told Entergy that Pilgrim's rating is likely to drop again next month, placing it among the 8 worst performers. Therefore leaks and malfunctioning of systems required to maintain the water in the spent fuel pool have a much higher probability of failure than a reactor that does not have a history of financial distress, cut backs in maintenance/ personnel, and mismanagement.

(1) History of Spent Fuel Pool Leaks: Leakage from spent fuel pools varies from site to site; and at many sites, it is significant, especially when taken together with leakage from other parts of the reactor. These cumulative impacts must be evaluated on a site-specific basis. NUREG/CR-7111[11] provides a summary of aging effects and their management in reactor spent fuel pools. It lists (at 7.1.2) 10 sites that have *identified l*eaks. At 7.2.1 it says that repairs in the reactor refueling cavity and spent fuel pool structures are difficult and sometimes impractical. Also, environmental impacts of leaks are likely to be more severe at reactors where NRC oversight has been weak or erratic. The NUREG shows the necessity to evaluate each individual reactor to determine the environmental impact from leaks.

[11] http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr7111/

7.1.2 Spent Fuel Pool Leakage

Leakage from the SFP has been identified at 10 sites involving 12 units (2 BWRs and 10 PWRs). The primary sources of leakage for BWRs have been small cracks in the liner or seam welds. The primary sources of leakage for PWRs have been cracks in the liner plate seam or plug welds, or structural attachment weld defects. For BWRs, the primary concern related to leakage from the SFP is the potential for corrosion of the cylindrical portion of the drywell shell and sand bed region of Mark I containments, reinforced concrete structures, the metallic pressure boundary, and support structures. In the case of PWRs, leakage of borated water may erode the concrete or produce corrosion of the concrete steel reinforcement, the metallic pressure boundary, supports, and carbon steel structures where borated water can accumulate. Leakage has primarily been identified in BWR plants through leakage from the leak chase system. Leakage in PWR plants has been identified by leakage from the leak chase system, seepage associated with cracks in concrete, the presence of white deposits on structures, the presence of moisture in the seismic gap between the fuel-handling building and auxiliary building, the presence of tritium in ground water, and contamination of protective clothing. Activities to address leakage in BWRs have primarily included walkdowns of accessible areas around the SFP. PWR activities to address leakage have included inspection

86

and clearing (as required) of the drainage systems, monitoring and analysis of leakage collected by the drainage system, visual inspections of accessible areas of the SFP liner and SFP concrete surfaces, and sampling of ground water for tritium. No assessments of the structural impact of leakage identified for BWRs has been reported because all of the plants indicated that the leakage was contained within the leak chase drainage system. Structural assessments of the PWRs have included periodic visual inspections; obtaining concrete cores to assess the condition of the concrete and the embedded concrete steel reinforcement; baseline inspections according to American Concrete Institute (ACI) 201.1R-08, "Guide for Conducting a Visual Inspection of Concrete in Service" (Ref. 118), and ACI 349.3R-02, "Evaluation of Existing Nuclear Safety-Related Concrete Structures" (Ref. 119); application of NDE techniques; and laboratory testing of the effect of borated water on concrete and concrete steel reinforcement. SFP leakage has been more common for PWRs, the leakage related to BWRs has been confined to the leakage collection system, and the borated water can potentially impact the structures it contacts. Additional information related to leakage of borated water from SFPs is provided below.

7.2.1 Reactor Refueling Cavity and Spent Fuel Pool Leakage

Repairs in reactor refueling cavity and SFP structures are difficult and sometimes impractical. Their leakage, however, could be stabilized or controlled through technology that could help reduce the porosity of or eliminate "pinholes" in liner weldments. Assembling operating experience related to the various types of coatings being used by licensees to stop the leakage of borated water through cracks in the reactor refueling cavity and SFP stainless steel liners is the first step to help identify coatings with good performance histories. This information would be useful in developing an improved basis for evaluating proposed plans by licensees to reduce or eliminate the reactor refueling cavity and SFP leakage through application of coating materials. Development of procedures for the repair of reactor refueling cavity and SFP leakage at seam welds (e.g., adhesive steel tape) or plug welds (e.g., composite patches) would also be beneficial with respect to reducing or eliminating leakage.

(2) <u>The number of safety violations at U.S. reactors varies dramatically from region to region,</u> pointing to inconsistent enforcement, according to a congressional study awaiting release. The authors of the report wrote, "NRC cannot ensure that oversight efforts are objective and consistent." (Uneven enforcement suspected at nuclear plants. *AP*, Oct. 16, 2013.)

3. Reactors Vary In Inventory of Spent Fuel

(a) DOE's Inventory : DOE's *Inventory and Description of Commercial Fuels in the US,* March 31, 2011[12] shows how reactors vary. DOE looks at: fuel types; fuel cladding: some better than others (primarily there are 4 cladding alloy types: Zirconium 2, improved Zirc 4, M5, Zirlo, optimized Zirlo [DOE, p. 6, Table 5]). Wet storage, varies by density and geometry; dry storage, varies by location and vendor; license termination dates vary; ranges of burnup vary (DOE, pg., 25, Table 7). Therefore the potential environmental impacts will vary from reactor to reactor. For example: Individual reactors are making increasing use of high burnup fuel. Each reactor varies. High burnup fuel has more tritium, which is notoriously hard to clean up if it contaminates groundwater. The time spent fuel is stored in pools and dry casks varies from one reactor to the next. Therefore NRC's generic assumption about the time the fuel can be stored in the pool and dry casks before it must be moved makes no sense.

(b) Reactors vary in number of spent fuel assemblies that are defective and/or damaged. Therefore the potential storage challenges and environmental impact will differ.

For example: Pilgrim has operated, and most likely will continue to operate with defective fuel assemblies. Pilgrim began operations in 1972 with defective fuel. The Massachusetts Department of Public Health's Southeastern Massachusetts Health Study 1978-1986 stated, "Pilgrim, which began operations in 1972, had a history of emissions during the 1970s that were above currently acceptable EPA guidelines as a result of a fuel rod problem." *Southeastern Massachusetts Health Study 1978-1986*, Morris M.S., Knorr R.S., Executive Summary, Massachusetts Department of Health (October, 1990). In the March 2005 and April 2006 Pilgrim SALP (Systematic Assessment of Licensee Performance, performed by the NRC) Reports, NRC Resident Inspector, William Raymond, stated that Pilgrim operated in 2004 and 2005 with defective radioactive fuel – that is, fuel with perforated cladding. Fuel cladding provides the first barrier to prevent radionuclides from getting out and harming workers and the public. Degraded fuel is an ongoing issue for the industry. NRC Commissioner Merrifield has admitted nearly 1/3 reactors now have failed fuel, and the trend is increasing, not decreasing. *Briefing on Nuclear Fuel Performance,* Transcript, p.4, (February 24, 2005), http://www.nrc.gov.

[12] http://sti.srs.gov/fulltext/SRNL-STI-2011-00228.pdf

Use of degraded fuel varies and will impact the environment by increasing exposure to the public, workers and natural resources. For example, according to the NRC, "a plant operating with 0.125 percent pin-hole fuel cladding defects showed a general five-fold increase in whole-body radiation exposure rates in some areas of the plant when compared to a sister plant with high-integrity fuel (<0.01 percent leaks). Around certain plant systems the degraded fuel may elevate radiation exposure rates even more." United States Nuclear Regulatory Commission, Information Notice No. 87-39, *Control Of Hot Particle Contamination At Nuclear plants*, (August 21, 1987).

(c) Boraflex Degradation - Variable: *NRC Generic Letter 94-04 Boraflex Degradation in Spent Fuel Storage racks, June 26, 1996:* Only some licensees use Boraflex as a neutron absorber in its spent fuel racks and some may not have the capability to maintain a 5-percent sub-criticality margin because of current or projected future Boraflex degradation. When Boraflex is exposed to gamma radiation, the material shrinks and is subject to tears or gaps in the material. A second factor that may impact storage rack service life occurs when Boraflex is subjected to long-term exposure to gamma irradiation in the wet pool environment, the silicon polymer matrix becomes degraded and silica filler and boron carbide are released. The boron carbide loss can result in a significant increase in the reactivity of the storage racks. (GL, p. 3) Reactors with Boraflex present potential environmental impacts; and reactors vary in attention to mitigation for this problem. Plants with Boraflex are listed in the GL.

B. ASSUMPTIONS (1.8.3): THE DRAFT GEIS ASSUMPTIONS USED TO EVALUATE THE POTENTIAL ENVIRONMENTAL IMPACTS OF CONTINUED STORAGE ARE FACTUALLY UNSUPPORTED

In addition to failing to treat environmental impacts on a site specific basis, the DGIS relied upon false and unsupported assumptions. If you take away the unsupported assumptions, NRC's findings fall apart. The unsupported assumptions include:

- Institutional controls will indefinitely remain in place and be at same level of regulatory control as currently exists today.
- The analyses in the draft GEIS are based on current technology and regulations.

- All spent fuel will be removed from spent fuel pools to dry storage by the end of the short-term storage time-frame (60 years)—Pilgrim NPS 2092.
- Spent fuel canisters will be replaced approximately once every 100 years. For Pilgrim on 2192, 2292, 2392 and so on.
- ISFSIs and Dry Transfer Systems (DTS) facilities will also be replaced every 100 years.
- A DTS will be built at each ISFSI location for fuel repackaging.

What's Wrong with the Assumptions?

1. DGIS Assumption: Institutional Controls/Current Technology & Regulations would be in place and be at same level of regulatory control as currently exists today.

Institutional controls/current technology & regulations are not consistently followed today. There is no reason to believe that they will be in the future—especially into a future of 300 or more years.

Examples where regulations are not consistently followed today:

a. A report, "*Safety Culture is not Possible without Regulatory Compliance*" Paul Blanch, September 2013[13] shows that the NRC has neither identified nor enforced, and licensees have not complied with NRC regulations so that the assumption that institutional controls would be in place and enforced does not hold in the future anymore than today.

> Nuclear professionals, members of the public, Congress, Non-Government Organizations (NGOs), and concerned non-industry stakeholders agree on one issue: **nuclear plant safety is paramount and must be the number one priority.** However, the actions, and inactions, of the Nuclear Regulatory Commission (NRC), Nuclear Energy Institute (NEI), and nuclear plant owners, have led to financial considerations taking priority over nuclear safety. The current focus on nuclear safety via what the industry and its regulator call "safety culture," unless redefined and clarified, is a dead end. To truly achieve nuclear safety, "regulatory compliance and enforcement " must be the frame used to gauge Nuclear Safety Culture.
>
> This paper provides my unique perspective on the nuclear "Safety Culture" and regulatory compliance, based on what I have observed during more than 45 years working in the nuclear industry. The reality is clear. The NRC and nuclear industry are focused on "Safety Culture" as a primary contributor to nuclear safety, ignoring the actual issue: that NRC has neither identified nor enforced, and licensees have not complied with NRC regulations.

[13] http://allthingsnuclear.org/wp-content/uploads/2013/09/20130900-blanch-regulatory-compliance-report-.pdf

b. The Union of Concerned Scientists reports that fire poses a very significant safety risk and NRC issued fire safety regulations in 1980 and an alternate set in 2004. But thirty years later, nearly half of the licensees do not comply with the regulations. The NRC is playing with fire and not enforcing its own regulations.[14]

c. UCS's third annual review of the Nuclear Regulatory Commission's performance in policing the U.S. nuclear power industry:[15] The report takes the NRC to task for its failure to consistently enforce its own regulations, effectively leaving long-term holes in the safety net that is supposed to protect the public from the inherent hazards of nuclear power. According to the report, the NRC's lax oversight "reflects a poor safety culture," including a disconnection between the NRC's workforce and its senior management, with managers tending to downplay safety problems and react negatively when workers point them out.

d. As discussed in the foregoing, there is evidence of regulators covering up problems during operations. There is basis for projecting that the same will hold true after operations have ceased.

For example: "In a letter submitted Friday afternoon to internal investigators at the Nuclear Regulatory Commission, a whistleblower engineer within the agency accused regulators of deliberately covering up information relating to the vulnerability of U.S. nuclear power facilities that sit downstream from large dams and reservoirs. The letter also accuses the agency of failing to act to correct these vulnerabilities despite being aware of the risks for years." (Flood Threat to Nuclear Plants Covered Up By Regulators, NRC Whistleblower Claims, Huffington Post, Sept.14, 2013)

e. As shown in the foregoing, federal, state and NRC requirements are not followed to protect Cape Cod Bay and its aquatic resources, special status species & habitats.

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[14] http://www.ucsusa.org/assets/documents/nuclear_power/ucs-nrc-fire-regulations-5-2-13.pdf

[15] http://www.ucsusa.org/nuclear_power/making-nuclear-power-safer/who-is-responsible/nrc-and-nuclear-power-safety-annual.html

f. It is absurd to rely on a "crystal ball" to project assurance into the distant future. NRC cannot rely on its "crystal ball." It is one thing to make future projections based on actual past history. But there is no long history here to rely upon to make projections about future decades and centuries. No reactors have operated more than 45 years. There is no assurance that the same or equivalent regulatory bodies will exist 100, 200 300 years or more into the future. Simply by looking back to institutions and technology in 1713, 1813, and 1913 shows the absurdity of the assumption that institutional controls/current technology & regulations would be in place and be at same level of regulatory control as currently exists today.

2. DGIS Assumption: Analyses in the draft GEIS are based on current technology and management practices.

The assumption is wrong on its face. Much of the technology on which it relies does not currently exist; and no one should be foolish enough to assume that management practices principally focused on generating electricity will remain unchanged when current management no longer exists and all that remains is long-term storage of spent nuclear fuel. Whatever minor experience industry might now have is too short to project over the hundreds of years that the DGEIS is projecting.

3. DGEIS Assumption: All spent fuel would be removed from spent fuel pools to dry storage by the end of the short-term storage time-frame (60 years)

The public is not relying on NRC's crystal ball. NRC fails to provide factual support and analyses for this assumption. There is no analysis regarding the probability that a repository will be successfully sited, built, and ready and willing to accept spent fuel from every licensee by the end of the short term. There is nothing in experience or history, on which any realistic assumption must be based, that supports this unrealistic assumption.

4. **DGEIS Assumption: A DTS would be built at each ISFSI location for fuel repackaging & (DTS) facilities would also be replaced every 100 years, along with casks and cask pads.** Idaho National Lab report, INL/EXT-12-26218/FCRD-UFD-2012-000115 *Dry Transfer Systems for Used Nuclear Fuel* , B. Carlsen & M. Bard Raap, May 2012[16] pointed out

[16] http://www.inl.gov/technicalpublications/Documents/5516346.pdf

that a DTS is costly and if the Blue Ribbon's recommendation to develop one or more consolidated facilities were implemented in a timely fashion, the potential need for DTSs at ISFSIs would significantly decrease. There is no assurance that DTEs will ever be required and installed at ISFSIs—let alone replaced every 100 years.

2.3.1 At-Reactor ISFI Sites

A routine need for any of the dual purpose canisters to be opened at ISFSI sites is unlikely. The only foreseeable reason to open these canisters would be if there was an indication that the canister (confinement boundary) might be compromised. Due to the numerous ISFSI sites, UNF management strategies that would require a DTS at these sites should be avoided. The costs of multiple DTS facilities or the complexity and cost of designing a mobile DTS that could be deployed at these sites would be prohibitive. In the event that there is a need for limited repackaging or retrieval of fuel at these sites, it could likely be accommodated by the existing pools. UNF at ISFSI sites that is presently in storage-only packages could, for example, be transferred into dual-purpose canisters or transportable casks prior to decommissioning of the site pools.

Table 2-1. Summary of DTS Needs.

Potential Need for Dry Transfer Capability	Operating Reactor Sites	ISFSI-only Sites	CSF Site(s)	Final Disposal Site	Fuel Examination Facility Site
Research, Development, and Demonstration					
Transfer fuel into examination facility	NA	NA	NA	NA	high
Retrieve and Inspect Fuels from DCSS	low	medium	medium	NA	high
Repackaging					
Standardization of Packaging	NA	NA	medium	NA	NA
Planned Periodic Repackaging	NA	NA	medium	NA	NA
Mitigation and/or Recovery	low	medium	medium	medium	NA
Incompatibilities with Future Requirements	low	NA	medium	medium	NA
Flexibility for long-term UNF Management	low	NA	medium	NA	NA

Legend
Need for a DTS not anticipated
transfer capability is essential and no other practical options
other options available but DTS may be preferable
other equivalent or preferable options available

However, assuming that neither consolidated facilities nor permanent storage facilities are available, DTSs would be needed for age-related degradation of casks and unplanned events such as malicious attacks. Also a DTS would be needed if a site became available to repack assemblies in casks not suitable for transport.

The unanswered questions are: who is going to pay for all of this replacement; will the NRC of 2192 (one hundred years after the end of Pilgrim's short-term time frame) require them; and even if required will NRC enforce the requirement, even if it can find some distant offspring of a current licensee? Judging from NRC's response to lessons learned from Fukushima, there is a consistent pattern that when industry finances clash with public safety, NRC sides with industry's economic interests.

5. Money: The DGIS assumptions assume that the licensee will pay for the maintenance, personnel and new equipment purchases required such as the DTS. Nearly every licensee is a limited liability corporation. In deregulated markets, the merchant plants cannot compete with cheaper sources of electricity. Pilgrim, Vermont Yankee, and Fitzpatrick, for example, are in financial distress now, cutting personnel and maintenance. What basis is there to assume that licensees (or their parent corporations, which are shielded from liability) will invest monies that they do not have; and what basis is there to assume that these plants will not declare bankruptcy, leaving no party responsible? Actually there can be no basis. This summer, based on a 2.206 Enforcement Petition regarding the economic distress of Fitzpatrick, Pilgrim, and Vermont Yankee and its safety implications (G20130211), NRC Staff sent a request for information to Entergy to determine particulars regarding their economics. Entergy complained and NRC withdrew its request saying that it agreed with Entergy that economic inquiries were against previous practice[17]. Moreover between closure and decommissioning there is a long time period. The decommissioning funds cannot be tapped for spent fuel management; the licensee has losses but no profits; so who does NRC believe is going to pay monies required for safe storage?

C. DGEIS: ENVIRONMENTAL IMPACTS BASED ON FAULTY PROBABILISTIC RISK ASSESSMENT (PRA)

In addition to failing to evaluate impacts on a site specific basis and relying on unsupported and absurd assumptions, the DGEIS used an outdated and faulty PRA to reach its conclusions, which defy common sense.

[17] Senators Edward Markey & Bernie Sanders Letter to Chairman Allison Macfarlane, November 14, 2013

NRC evaluated environmental impacts using probabilistic risk assessment, multiplying the probability of an accident with the consequences of the accident. Because NRC used an outdated and unsupported low probability and minimized consequences, the environmental impacts were assessed as small over the three time frames, with the exception of historic and cultural resources, for which it could not determine the impact over the long and indefinite storage time frames.

For example, NRC determined that "The consequences for severe (or beyond-design-basis) accident, if one occurs, could be significant and destabilizing. The impact determinations of these accidents, however, are made with consideration of the low probability of events….a high-consequence low-probability event, like a severe accident, could still result in a small impact determination, if the risk is sufficiently low." (DGIS, 4-68)

NRC's evaluation of environmental impacts – consequences – relied on "cherry-picked" studies that used pre-Fukushima probabilities and assumptions, and antiquated consequence codes: MACCS and MACCS2. It is as if NRC started with the answer and worked backwards to get the predetermined result.

DGEIS' PRA—What's wrong?

1. Probability and Probabilistic Modeling

The probability of an accident relied upon is outdated and ignores qualitative factors.
NRC Chair Macfarlane explained in her Notation Vote to SECY-12-107, pp. 3-4 that: [18]

> Postulated frequencies of accidents at nuclear power facilities in the U.S. are often expressed anywhere from one in 1,000 years to one in 1,000,000 years (but) it's important to recognize that the world has seen three severe accidents at nuclear facilities in the past 33 years, or essentially one every 10 years, on average... The existing record for severe accidents at nuclear facilities worldwide over the past three decades versus the theoretical performance of nuclear power facilities in the U.S., highlights our struggle to assign uncertainties to these types of quantitative

[18] http://www.nrc.gov/reading-rm/doc-collections/commission/cvr/2012/2012-0157vtr.pdf

> measurements. (If) current agency guidance while performing cost-benefit analysis…include(d) the potential costs of offsite releases similar to those experienced in Japan after the Fukushima accident, for instance…Any postulated changes to the way the agency addresses the evaluation of economic consequences of accidents would clearly increase the costs averted side of the equation and move the results in the direction of being more cost-beneficial.

Qualitative factors are ignored in the DGEIS analysis and as a consequence they do not account for unknowns such as human error, meteorology, future sea level rise, manufacturing defects, corrosion rates, etc. Chairman Macfarlane explained in the Notation Vote that,

> These uncertainties are best done qualitatively (and) [t]he uncertainties in attempting to quantify an accident frequency should be offset by defense-in-depth. Being a geologist, I have an acute appreciation for the challenge of predicting the Earth's behavior. Since the earth is constantly changing and our recorded knowledge represents one millionth of the Earth's history, there is much we do not know. In light of this, we must be wise in balancing confidence in our engineering prowess with the humble recognition that natural systems have repeatedly demonstrated the ability to confound us. The staff (SECY-12-107) also points out the large uncertainties involved in estimating the economic consequences given a large release of radioactive material using the existing economic consequences framework. An increase in either the event frequency or economic consequences of a severe accident at a nuclear power facility could easily push a filtered vent (in the Notation Vote context) into cost beneficial space.

If NRC treated uncertainties qualitatively, it "could easily push" the environmental impacts from small or moderate to large.

Kamiar Jamali's *Use of Risk Measures in Design and Licensing Future Reactors,*[19] explained further that "PRA" uncertainties are so large and so unknowable that it is a huge mistake to use a single number coming from them for any decision regarding adequate protection. "Examples of these uncertainties include probabilistic quantification of single and common-cause hardware or software failures, occurrence of certain physical phenomena, human errors of omission and commission, magnitudes of source terms, radionuclide release and transport, atmospheric

[19] Kamiar Jamali, *Use of Risk Measures in Design and Licensing Future Reactors,* Reliability Engineering and System Safety 95 (2010) 935-943. Jamali is DOE Project Manager for Code Manual for MACCS2.

dispersion, biological effects of radiation, dose calculations, and many others." (Jamali, Pg., 935) (Emphasis added)

Probability analysis has other pitfalls. PRAs do not consider human error. More important, PRAs project into the future and assume (based on very little real experience) that there is a likelihood that an accident scenario will occur in hundreds, if not thousands, of years is vanishingly small. But no reactors have operated more than 45 years, and there have been at least six severe accidents.[20] The uncertainty inherent in predicting the future must be respected by making certain that appropriate and up-to-date assumptions are used in the analysis. NRC did not do this.

2. Consequences of Accidents: Underestimated

NRC's analysis referenced and relied upon previous studies/reports that were outdated. They did not incorporate lessons learned from Fukushima and used outdated consequence codes to estimate environmental impacts of severe accidents.

a. In the event of a severe accident at Pilgrim's location, there will be enormous aqueous radioactive releases and damage. The NRC's approved consequence analysis code (MACCS/MACCS2) ignores aqueous releases. Fukushima shows their huge impact on environmental resources.
b. NRC assumes that an accident will last only a day (that is also the usual industry practice) and in any event not more than 4 days (MACCS2 code's maximum limit). Fukushima showed accidents can extend for weeks and months, greatly increasing environmental impact.
c. NRC and the industry assume that the only radioactive release that needs to be considered is an atmospheric (forget about aqueous) release from the core (forget about the spent fuel pool), and even then only noble gasses and a small fraction of the Cs-137 in a core need be taken into consideration.
d. Similarly, there is no rational basis for the NRC DGEIS and referenced studies to assume that a radioactive release will only affect a very limited geographic area defined by an outdated straight-line Gaussian plume; and only out to 50 miles.

[20] Including the 1961 fatal accident at SL-1

e. Clean-up and Decontamination is an enormously expensive job, extending over decades. Hosing down buildings and plowing fields under does not clean up or decontaminate. The NRC cannot rely on reports that continue to ignore: that there is no clean-up standard; that clean-up can take more than one year; that it has given no consideration to what can and must be done to the tons of contaminated soils and other 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.

f. <u>The MACCS2 code</u> that referenced documents used 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 applicability, the code is manipulated to intentionally minimize potential consequences, to ignore real health costs, and to assign a too low cost to the value of a human life, compared to other agencies such as EPA. It uses essentially useless evacuation time estimates; the user chooses the input parameters into the model and chooses to average the code's inputs by a mean instead of using the 95th percentile.

   David Chanin, who wrote the MACCS/MACCS2 code's FORTRAN and SAND96-0957, finds the economic cost model "seriously flawed":

   > I have spent much time thinking of a way to―jigger the inputs so that the cost model of MACCS2 could be used in a sensible way. As the person who coded it into MACCS and then refined it for MACCS2, and also the person who wrote SAND96-0957, I think what you are attempting is impossible. The economic cost model in MACCS2 was included (at request of sponsors) only for historical reasons to allow comparison of its cost estimates to those of previous studies. It is my firm belief that the MACCS2 cost model is so seriously flawed that even with reevaluation and modification of all its input parameters, its cost results should not be used unless for replicating prior studies. When I was involved with the MACCS2 project (from 1991-1996, and also later in 2000-2001) the NRC had no interest in implementing the cost model of SAND96-0957 into MACCS2. I could have done it without a lot of work, but they weren't interested.[21] (PWA00004, August 23, 2006)

[21] EHD, Pilgrim 50-293-LR, Intervenor Exhibits, PWA00004, August 23, 2006

Mr. Chanin also explained[22] that the MACCS2 code was not held to the QA requirements of NQA-a (American Society of Mechanical Engineering, QA Program Requirements for Nuclear Facilities, 1994). Rather it was 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)]. What this means is that all steps of the code development have **not** been documented and tested, and hand calculations have not verified the code's implementation of major transport and exposure pathways for a subset of the radionuclide library. (*Ibid.*) Mr. Chanin says further that, "If errors are later found in authorization basis calculations, an <u>Unreviewed Safety Question (USQ) could be raised</u>, and continued operation of the facility would then require a demonstration that the facility's safety basis was adequate." (Emphasis added.) Further, Mr. Chanin explains the importance of this point in his concluding remarks in The Development of MACCS2, Lessons Learned, prepared for the Energy Facilities Contractor Operating Group Safety Analysis Working Group, Annual Workshop, April 29–May 5, 2005, Santa Fe, NM.

> [T]he QA distinctions between an NQA-1 "licensing code" and a "research code" like MACCS2 have been emphasized in light of the fact that MACCS2 calculations are being used to support the Severe Accident Mitigation Alternatives (SAMA) analyses required for the license renewal of commercial nuclear power plants. It seems to me that the code's QA shortcomings and the lack of input justifications are again being ignored.

The analysis described above applies to use of the code in studies referenced for support by the DGEIS and in turn the Waste Confidence decision.

Also NRC adapted the MELCOR code, version 1.8.6, to examine the physical and chemical phenomena directly associated with a pool fire. (Section 6 NRC's Draft Consequence Study) Dr. Thompson[23] at 20 explains that,

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[22] Ibid, PWA00004,"The Development of MACCS2: Lessons Learned," [written for:] *EFCOG Safety Analysis Annual Workshop Proceedings*, Santa Fe, NM, April 29–May 5, 2005)

[23] Comments of the US NRC's Draft Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a US Mark I Boiling Water Reactor, by Dr. Gordon Thompson, submitted to the NRC's Cindy Bladey, Chief of Rules, Announcements, and Directives Branch, Office of Administration August 1, 2013, by Diane Curran (of Harmon, Curran, Speilberg & Eisenberg LLP).

1. MELCOR has no capability to model the deformation of fuel cladding as temperature rises. Yet, NUREG-1738 predicted that cladding would balloon and burst in a temperature range of 700–850°C. That outcome could reduce heat transfer and promote ignition of cladding. NRC says that these effects would not be significant, but rests that claim on secret, unpublished studies.[45]
2. Radioactive heat transfer is an important consideration in pool-fire modeling. Yet MELCOR employs a simplified approach to modeling this mode of heat transfer. In this context, NRC says:[46] "It should be noted that there is a temperature gradient within each ring, and MELCOR attempts to model a multidimensional geometry with a simplified two-surface radiation model."

Dr. Thompson also questions NRC's input assumptions. (Thompson, pp. 20-23) For example, how closely does the pool layout assumed by NRC correspond with actual practice in the nuclear industry?

D. SPENT FUEL POOL LEAKS

1. Environmental Impacts

The Draft GEIS considers only human health impacts and not environmental impacts in general. To begin with, it does not address impacts to the non-human environment. Contamination that is too low to cause disease in humans may affect plants and animals, and even small leaks may grow. In the past, the casual acceptance of leakage has undermined public trust in the NRC.

2. Water Quality

The Draft GEIS does not address impacts to drinking water quality. Instead, it discounts them. For instance, while NRC notes that onsite contamination in excess of drinking water standards exists, it minimizes the significance of these instances because the contamination has not migrated offsite. Given that (a) the NRC's goal is to release all decommissioned sites for unrestricted use, and (b) 10 C.F.R. § 20.1402 requires reduction of radiological emissions from decommissioned sites to 25 mrem from all sources including drinking water, the impact of contamination caused by spent fuel pool leakage to drinking water must be addressed.

3. Past Leaks

The GEIS underestimates the likely frequency of past leaks and does not fully consider the consequences of such leaks. NRC failed to adequately assess the likelihood of future leaks because it did not consider at least two important past leaks. A Yankee Rowe leak released approximately 2 million gallons of contaminated water. Some of this leakage made its way into the Deerfield River.[24] In 1997, ground water samples taken by Brookhaven National Labs (BNL) revealed concentrations of tritium at twice the allowable federal drinking water limits. Some samples taken later were 32 times the standard. The tritium was found to be leaking from the High Flux Beam Reactor's spent fuel pool into the aquifer that provides drinking water for nearby Suffolk County residents.[25] DOE's and BNL's investigation of this incident concluded that the tritium had been leaking for as long as 12 years without their knowledge.[26]

4. Leak Detection

NRC's leak detection analysis fails to consider difficulties associated with leak detection, especially with long-term, low-volume leaks. Several spent fuel pool leaks have gone undetected for prolonged periods of time despite NRC's assurance that measures are in place to ensure timely detection. This undercuts NRC's conclusion that it is unlikely for leaks to occur and go undetected long enough to result in significant impacts to the environment. The Yankee Rowe and BNL leaks went undetected for longer than one year and perhaps as long as twelve years. At Salem, a leak thought to be only a few gallons per day turned out to be about 100 gallons per day. The volume and significance of this leak were NOT detected by the spent fuel pool water level instrumentation or the installed leak detection system because of a clogged drain in the monitoring system.[27]

5. No Quantitative Assessment

NRC's analysis of pool leak impacts is devoid of any quantitative assessment. The Draft GEIS does not consider the numerical limits of impactful spent fuel pool leaks in terms of volume and duration. A quantitative analysis of spent fuel pool leak detection is necessary for a forward-looking spent fuel pool leak analysis, as required by the Court in *New York v. NRC*.

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[24] *See* Yankee Atomic Electric Company (YAEC). 2006. *Groundwater Protection – Data Collection Questionnaire*. Rowe, MA. July 19. Online at http://pbadupws.nrc.gov/docs/ML0620/ML062080156.pdf.

[25] *See* General Accounting Office (now called the Government Accountability Office) (GAO), Department of Energy: *Information on the Tritium Leak and Contractor Dismissal at the Brookhaven National Laboratory*. GAO/RCED-98-26 (1997). Online at http://pbadupws.nrc.gov/docs/ML1209/ML120960692.pdf.

[26] *Ibid.*

[27] *See* NRC, Spent Fuel Pool Leakage to Onsite Groundwater, Information Notice 2004-05 (March 3, 2004). Online at http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/2004/in200405.pdf

6. Inapplicable Regulations and Guidelines

The Draft GEIS inappropriately relies on inapplicable regulations and guidelines. NRC incorrectly relied on spent fuel pool monitoring requirements that are only applicable during the movement of spent fuel from one storage facility to another. NRC also incorrectly relied on groundwater monitoring and inspection programs that are not mandatory or not applicable.

7. Inadequate Regulatory Program

NRC failed to consider the inadequacy of its regulatory program to detect future leaks. NRC failed to consider the significant reduction in regulatory oversight and regulation of spent fuel storage that occurs after reactors shut down. NRC also failed to consider the future implications of the probability and consequences of past leaks, leak detection difficulties, and difficulties that arise with monitoring and inspections. Therefore, NRC failed to properly determine the significant impacts of spent fuel pool leaks because it did not conduct a forward-looking analysis.

Summary Comments, DGEIS

NRC should go back to the drawing-board with a new EIS. Instead of assuming that spent fuel can be stored safely forever, NRC should examine the problem, and provide a proper analysis regarding:

- The probability that a repository for spent fuel will be successfully sited.
- The probability that a successfully sited repository will actually contain radiation and the consequences if it does not.
- The real public health and environmental consequences that may occur if a repository is not sited and storage remains on site, using: site specific analyses; credible and supported assumptions; and PRA using quantitative factors, supplemented by qualitative factors, and a consequence code updated from lessons learned at Fukushima.

III. NRC'S DRAFT CONSEQUENCE STUDY OF A BEYOND-DESIGN-BASIS EARTHQUAKE AFFECTING THE SPENT FUEL POOL FOR A US MARK I BOILING WATER REACTOR

The second document supporting the DGEIS and the Proposed Waste Confidence Rule is 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* (herein after "Earthquake Study"). Although the Proposed Rule explains that the Earthquake Study is not referenced in the DGEIS, it is for all practical purposes basic to the rule. In fact it was developed side-by-side to justify the DGEIS' and Proposed Rule's conclusions.

The proposed Rule admits that "<u>the staff is aware of the conclusions in the draft Study and worked closely with the authors who developed the draft Study to prepare the relevant sections of the draft GEIS</u>":

> The DGEIS does not specifically reference the draft "Consequence Study Of A Beyond Design-Basis Earthquake Affecting The Spent Fuel Pool For A U.S. Mark 1 Boiling Water Reactor"…If the NRC publishes a final study before the final GEIS is published, it will be added to the final GEIS. Although it did not specifically reference the draft Study in the DGEIS, <u>the staff is aware of the conclusions in the draft Study and worked closely with the authors who developed the draft Study to prepare the relevant sections of the draft GEIS.</u> The conclusions of the draft Study do not contradict the conclusions in the DGEIS and are consistent with the consequences reported in previous studies on spent fuel pool accidents. (Draft Rule, p. 56783, emphasis added)

Therefore it is important to understand that the draft Earthquake Study is not a credible scientific document to provide any basis for the DGEIS's and Proposed Rule's conclusions. While the study purports to be a broad scientific inquiry into pool fire phenomena, instead it is a very narrow study that ignores basic pool fire phenomena, important pool fire accident contributors, and avoids evaluation of all mitigation strategies.

Statements in the so-called Earthquake Study are unsupported by analysis. It says that a severe earthquake causing complete draining of a fuel pool is the primary source of risk to a spent fuel pool, assumes that the risk of pool fire is low and assumes that open-rack low-density pool storage is not any safer without even studying it.

Highlights – What's Wrong with the Earthquake Study?

1. **Pretence of considering low-density storage:** The Study does not consider the risk implications of reverting to low-density, open-frame racks. Its authors did not model scenarios that compared the current high-density closed frame design to the safer low-density, open frame design. They compared only a full pool to one with total water loss. They studied only water loss, not geometry—closed or open frame. The reason, NRC explains, is that replacing storage racks would be expensive. NRC's mandated role is to protect public health and safety, not industry's finances.

2. **Limited consideration of water-loss scenarios:** The Study focuses its analysis only on water-loss scenarios that involve total drainage. By so doing, the Study ignores a substantial part of the pool-fire risk. For example, the Study makes no effort to determine how the presence of residual water could affect fuel ignition, despite the fact that NUREG 1738 (October 2000) reversed NRC's position that total drainage was most severe. Consideration of partial water loss would substantially increase the estimated risk.

   There have been several accidents due to other causes where spent fuel pools experienced a partial drain-down. In 1984, a ruptured refueling cavity seal drained 200,000 gallons at the Connecticut Yankee nuclear plant. In 1986 an inflatable seal at the Hatch plant in Georgia failed, causing 140,000 gallons to drain from its spent fuel pool. BWR pools typically hold about 400,000 gallons of water.

3. **Limited consideration of initiating events:** The Study considers only one type of initiating event—an earthquake. That narrow focus reflects a pre-determined conclusion that earthquake is the dominant contributor to the risk of a pool fire.

4. **No consideration of attack:** The Study ignores the potential for an attack on a pool or adjacent reactor to initiate a pool fire. NAS Study after 09/11 showed that a terrorist attack on spent fuel pools was a credible event. Yet, the probability of an attack with a substantial likelihood of success is at least equal to the probability of the severe earthquake that the Study does consider.

Table IV-1[28]

Some Potential Modes and Instruments of Attack on a Nuclear Power Plant

Attack Mode/Instrument	Characteristics	Present Defenses at US Plants
Commando-style attack	• Could involve heavy weapons and sophisticated tactics • Successful attack would require substantial planning and resources	Alarms, fences and lightly-armed guards, with offsite backup
Land-vehicle bomb	• Readily obtainable • Highly destructive if detonated at target	Vehicle barriers at entry points to Protected Area
Small guided missile (anti-tank, etc.)	• Readily obtainable • Highly destructive at point of impact	None if missile launched from offsite
Commercial aircraft	• More difficult to obtain than pre-9/11 • Can destroy larger, softer targets	None
Explosive-laden smaller aircraft	• Readily obtainable • Can destroy smaller, harder targets	None
10-kilotonne nuclear weapon	• Difficult to obtain • Assured destruction if detonated at target	None

[28] Declaration by Dr. Gordon R. Thompson: *Comments on the US NRC's Draft Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a US Mark I Boiling Water Reactor*, August 1, 2013

Table IV-2[29]

The Shaped Charge as a Potential Instrument of Attack

Category of Information	Selected Information in Category
General information	• Shaped charges have many civilian and military applications, and have been used for decades • Applications include human-carried demolition charges or warheads for anti-tank missiles • Construction and use does not require assistance from a government or access to classified information
Use in World War II	• The German MISTEL, designed to be carried in the nose of an un-manned bomber aircraft, is the largest known shaped charge • Japan used a smaller version of this device, the SAKURA bomb, for kamikaze attacks against US warships
A large, contemporary device	• Developed by a US government laboratory for mounting in the nose of a cruise missile • Described in detail in an unclassified, published report (citation is voluntarily withheld here) • Purpose is to penetrate large thicknesses of rock or concrete as the first stage of a "tandem" warhead • Configuration is a cylinder with a diameter of 71 cm and a length of 72 cm • When tested in November 2002, created a hole of 25 cm diameter in tuff rock to a depth of 5.9 m • Device has a mass of 410 kg; would be within the payload capacity of many general-aviation aircraft
A potential delivery vehicle	• A Beechcraft King Air 90 general-aviation aircraft can carry a payload of up to 990 kg at a speed of up to 460 km/hr • The price of a used, operational King Air 90 in the USA can be as low as $0.4 million

[29] Ibid

Table IV-3[30]

Performance of US Army Shaped Charges, M3 and M2A3

Target Material	**Indicator**	**Value for Stated Type of Shaped Charge**	
		Type: M3	**Type: M2A3**
Reinforced concrete	Maximum wall thickness that can be perforated	150 cm	90 cm
	Depth of penetration in thick walls	150 cm	75 cm
	Diameter of hole	• 13 cm at entrance • 5 cm minimum	• 9 cm at entrance • 5 cm minimum
	Depth of hole with second charge placed over first hole	210 cm	110 cm
Armor plate	Perforation	At least 50 cm	30 cm
	Average diameter of hole	6 cm	4 cm

Notes:
(a) Data are from US Army Field Manual FM 5-25: Army, 1967, pp 13-15 and page 100. (b) The M2A3 charge has a mass of 5 kg, a maximum diameter of 18 cm, and a total length of 38 cm including the standoff ring.
(c) The M3 charge has a mass of 14 kg, a maximum diameter of 23 cm, a charge length of 39 cm, and a standoff pedestal 38 cm long.

5. **No analysis of risk linkages among pools and reactors:** The Study identifies the potential for risk linkages, but does not properly analyze them. For example, the Study does not analyze a situation in which onsite radioactive contamination and other impacts of a reactor core melt would preclude mitigating actions that might prevent a pool fire. Yet, the probability of a core melt at an adjacent reactor is at least equal to the probability of the severe earthquake that the Study does consider. Thus, the Study significantly under-estimates pool-fire risks.

6. **No Analysis** of **Cask Drops:** Goutam Bagchi, NRR, in a February 12, 2001 08:25 AM email to Diane Jackson and George Hubbard, NRR, regarding the SFP Study: Structural and Seismic questions said:

[30] Ibid

Cask Drop Effect:

NUREG/CR-5176, "Seismic Failure and Cask Drop Analysis of the Spent Fuel Pools at Two Representative Nuclear Power Plants" describes the FEM analysis of Robinson and Vermont Yankee plants. The drop was considered on the side walls. The model considered cask drops on top of walls that are approximately 4.5 ft thick by 40 ft deep acting as a deep beam spanning about 55 ft. Various cask designs (largest 110 tons) were used. The result is extensive damage to concrete and large areas of reinforcement yielding. Statement on Page 7-4, "...pool walls similar to those of both the Vermont Yankee and Robinson plants would suffer severe damage as a result of the worst-case cask drops."

Cask drops inside the pool:

There is no analysis of this case in the NUREG. If the pool floor slab is assumed to be supported on unyielding foundation, the cask would probably not go through the floor, but cause local impact zone failure - considerable water leaking into the foundation. If the slab is not directly supported by the foundation, a 110 ton cask dropped from 4 ft height would go through the slab based on very approximate energy balance. The potential energy of the 110 ton drop from 4 ft height is 0.9 million ft-lbs, but the available resistance energy (calculated as work done by the punching shear in 4.5 ft thick concrete slab on a generous shear area and high shear stress) is about a tenth of that required. The travel of the cask though water before impact will hardly dissipate any energy - in the order of 1 to 5% or less. The claim that the cask will not go through a typical spent fuel pool slab not supported by the foundation will have to be validated by credible analysis.

7. **Misleading statements regarding mitigating actions:** The feasibility and effectiveness of mitigation, such as the ability to provide make-up water to the pool. But the Study only considers "human reliability" and equates human error problems to mitigation failure. The Study acknowledges its limitation for considering only one variable. It ignores, for example, analyzing the effectiveness of spray systems and answering whether in fact they are installed and have been tested in all reactor pool and ignores the possibility that radiation fields and other onsite impacts of a reactor core melt could preclude mitigation for an extended period. Despite limiting mitigation to human reliability, the Study makes unsupported unequivocal statements about the feasibility of mitigation that reflects pre-determined conclusions.

8. **Duration:** NRC claims that the probability of a spent fuel pool problem causing water loss that could go longer than 7 days is negligible, indicating that lessons were not learned from Fukushima. There, radiation levels precluded personnel from full access to the site for a long period of time, and the full consequences remain un-mitigated.

9. **NRC uses the MELCOR code to model phenomena related to a pool fire**—including heat transfer, cladding ignition, and fire dynamics. Yet, the validity of MELCOR for this type of analysis, and the appropriateness of NRC's input assumptions, has not been tested. For example, independent analysts point to MELCOR's simplified treatment of radioactive heat transfer.

10. **NRC staff failed to perform a relative risk comparison with dry casks.** There is not a peep from the NRC on this topic.

11. **No mention that the dry casks** at the Fukushima Dai-Ichi site remained unscathed.

12. **The Study assumes there is no risk to casks** (Chapter 10) but provides no empirical justification. Casks, like spent fuel pools, are vulnerable. (Table IV-1, p., 32 above) For example, Holtec Hi-Storm 100's can be breached from a shaped charge delivered from either onsite or from off-site. The Performance of US Army Shaped Charges, M3 and M2A3 were described in Table IV-3.[31])

Target Material	Indicator	Value for Stated Type of Shaped Charge	
		Type: M3	Type: M2A3
Reinforced concrete	Maximum wall thickness that can be perforated	150 cm	90 cm
	Depth of penetration in thick walls	150 cm	75 cm
	Diameter of hole	• 13 cm at entrance • 5 cm minimum	• 9 cm at entrance • 5 cm minimum
	Depth of hole with second charge placed over first hole	210 cm	110 cm
Armor plate	Perforation	At least 50 cm	30 cm
	Average diameter of hole	6 cm	4 cm

Holtec Hi-Storm 100 casks have a 0.5" (1.27 cm) steel canister and a concrete outer wall measuring 26.75" (67.945 cm). The assemblies are protected by **68.445 cm**, easily penetrable based on the capability of a shaped charge. Consequences: We know that a typical BWR cask contains approximately half the Cesium-137 that was released at Chernobyl.

13. **The Study never asked the important question: "Which is safer, pools or casks?"** The report did not specifically answer this question but facts contained in the report actually lead to the conclusion that dry cask storage is safer and more secure than cramming more spent fuel rods into pools that weren't designed to accommodate that much material. The Study

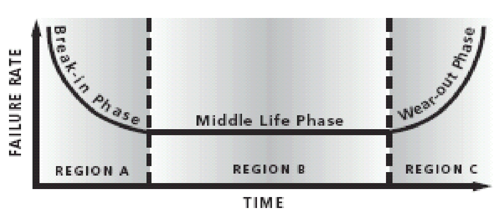
[31] Ibid

says that a fire in a densely packed spent fuel pool at the Peach Bottom plant could contaminate thousands of square miles with radioactive material, force the long-term displacement of millions of people, and cause tens of thousands of cancer deaths. Also the Earthquake Study failed to evaluate plants closer to major urban areas than Peach Bottom, such as the Indian Point plant near New York City or Pilgrim near Boston and Providence where the consequences of a similar event could be even greater.

However, the Study shows that removing spent fuel older than five years from the pool could reduce the amount of radioactive cesium released by factor of 80, the number of cancers by a factor of 10, and the total amount of land that would be uninhabitable by a factor of 50. The bottom line—reinforced by the details in the NRC study—is that the public is better protected by reducing the amount of spent fuel storage in pools at U.S. reactors by moving it to dry storage. Doing so is an important defense-in-depth measure, which would significantly reduce the radiological risk to the public from spent fuel pool fires.

14. **No analysis of age degradation of the pool and refueling cavity for the 60 years following license expiration.** Pilgrim for example was built in the late 60's when Lyndon Johnson was President and the NRC Confidence Decision assumes that the pool would have structural integrity through 2092. There is neither industry experience to rely on nor any other basis for that determination. Engineers explain the aging phenomenon by using what is known as the "Bathtub Curve." The curve is a graph of failure rate according to age. The failure rate is relatively high in the beginning when "kinks" are being worked out; it flattens out during the middle life phase; and it rises again sharply in the end-of-life or at the "wear-out phase." On average, 20 to 30 years usually marks the beginning of the wear-out phase. And the rate of corrosion is not linear over time.

Figure 1 The Bathtub Curve



Source: NASA, 2001.

15. **The cost benefit analysis in the earthquake study was done prematurely** because: (a) The analysis was done using pre-Fukushima MELCOR code prior to updating it based on Fukushima; (b) The National Academy has been called in by the U.S. Congress to determine the adequacy of NRC's safety regulation in light of the ongoing Fukushima nuclear disaster, with a specific emphasis on the advisability of current spent nuclear fuel pool practices at U.S. power reactors. It seems to me that members of Congress should halt the NRC's fast moving train, relative to its continuing approval of high-density SNF pool storage, until the Academy finishes its quality assurance review.

IV. NRC REFERENCED STUDIES

NRC referenced studies for spent fuel pool fires (Appendix F) in the DGEIS fail to include readily available assessments by independent experts, including studies authored by the Chairman of the NRC Allison Macfarlane; but instead NRC relied on outdated and inadequate studies performed by the NRC or its government contractor Brookhaven.

The faults and defects of the selected documents relied upon by NRC are analyzed in full by Dr. Gordon R. Thompson in *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*, February 6, 2009 (pages 19-21 and 22-26); and in his *Comments on the US Nuclear Regulatory Commission's Draft Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark I BWR*, August 1, 2013 (Section 3, A Brief History of Pool Fire Analysis).

Perhaps, NRC also relied on other studies of spent fuel fire risk not referenced. It is possible that NRC managed to find secret studies of spent fuel fire risk that they could not find for GAO when asked to produce them. The August 2012 GAO Report said, "NRC could not easily identify, locate or access…because it does not have an agency-wide mechanism to ensure that it can identify and locate such classified studies[32]."

[32] GAO-12-797, Spent Nuclear Fuel; Accumulating Quantities at Commercial Reactors Present Storage and Challenges, August 2012, highlights

V. PROPOSED WASTE CONFIDENCE RULE FINDINGS[33]

Both the DGEIS and the Earthquake Study are key documents that provide the basis for the Proposed Waste Confidence Rule. Although the Proposed Rule explains that the Earthquake Study is not referenced in the DGEIS, it is for all practical purposes one of its foundations. It was developed side-by-side with the Proposed Rule to justify its conclusions. The authors admit that "the staff is aware of the conclusions in the draft Study and worked closely with the authors who developed the draft Study to prepare the relevant sections of the draft GEIS." (Draft Rule, p. 56783, emphasis added) PW's analyses of both the DGEIS and draft Earthquake Study show precisely why the draft rule by extension has no factual basis and why PW disagrees with its findings.

PW Disagrees with NRC's Proposed Rule Findings and Supports the Following Alternatives

1. PW disagrees with NRC's finding that spent fuel can be stored safely in pools over the short term, 60 years after the license to operate ends—when some fuel may be 160 years old. Instead, PW supports the alternative of requiring dry cask storage of spent fuel rather than the continued use of spent fuel pools for spent fuel that is more than 5 years out of reactor. There is an abundance of technically competent documents supporting this alternative, ignored by NRC's draft[34]. Given the breadth and weight of scientific support for the proposition that there are significant environmental benefits from dry cask storage for all fuel more than 5 years old, this reasonable alternative must be studied more thoroughly in the Commission's review of "*all* reasonable alternatives." 40 C.F.R. § 1502.14(a)

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[33] Federal Reg.,Vol. 78, No. 178, Friday, Sept 13, 2013, p. 56776

[34] See, for example: Robert Alvarez, Jan Beyea, Klaus Janberg, Jungmin Kang, Ed Lyman, Allison Macfarlane, Gordon Thompson, and Frank N. von Hippel, *Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States* (Science and Global Security, 11:1–51, 2003) [deleted superscript 3]; Robert Alvarez, *Spent Nuclear Fuel Pools in the U.S.: Reducing the Deadly Risks of Storage.* Institute for Policy Studies, May 24, 2011; 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, by Dr. Gordon Thompson, February 6, 2009; Report to the Massachusetts Attorney General on the Potential Consequences of a Spent Fuel Pool Fire at the Pilgrim or Vermont Yankee Nuclear Plant, by Jan Beyea, PhD., May 25, 2006; Risks and Risk Risk-Reducing Options Associated with Pool Storage of Spent Nuclear Fuel at the Pilgrim and Vermont Yankee Nuclear Power Plants: A report for the Office of the Attorney General Commonwealth of Massachusetts, by Dr. Gordon Thompson, May 25, 2006.

NRC's finding that storage in either spent fuel pool or dry cask was safe for 60 years after the termination of a license failed to consider that spent fuel pools vary in density, geometry, vulnerability, mitigation capabilities and consequences. NRC ignored or seriously downplayed the following.

<u>Dry Casks are Safer than Spent Fuel Pools</u>

- Casks have the advantage of passive cooling via airflow, unlike pools, which require mechanical functioning and human intervention to provide flow of cool water to cover the assemblies. Therefore casks are less vulnerable to natural disaster and sabotage.
- Pools are not protected by redundant emergency makeup and cooling systems or housed in robust containment structures having reinforced concrete walls several feet thick. Pilgrim's pool, like other Mark I BWRs' has two feet thick external walls, where the primary containment is five feet thick. The roof is very thin, as it is designed to give in an accident.
- Casks can withstand environmental disasters that pools cannot. At Fukushima the casks survived at 9.0 earthquake and the tsunami that flooded them.
- Pools are attractive terrorist targets, not studied by the NRC in preparing the proposed rule. Casks are less vulnerable, also, because terrorists would have to target several casks to have the same amount of radiation released as the pool. Casks could be far safer if NRC required the casks to be spread out and surrounded by earthen berms.
- Pool Accidents: NRC's economic consequence analyses (inexplicably for any reason other than the potential cost to the industry of dealing with the issue) continue to ignore the consequences of a spent fuel accident. No rational analysis could do so.
- The importance of a spent fuel accident is illustrated by pointing to Pilgrim, where a spent fuel pool fire could release more than 44,010,000 curies of Cs-137, an amount 8 times more than a core release. Further, a spent fuel pool fire would result in releases going higher into the air and significantly impacting locations at greater distance with denser populations. Dr. Beyea estimated for the MA AGO the cost of a 10% release from a spent pool fire to be between \$105 and \$175 billion; and that a 100% release of C-137 would cost somewhere between <u>\$342 and \$488 billion</u>. (Beyea, p. 10). Entergy's LRA SAMA, based on currently

approved NRC models, considered only the release of a relatively small amount of C-137 from the reactor core[35].

- Vulnerability: A wealth of government and independent reports show high-density, closed-frame spent fuel storage pools are vulnerable to catastrophic fires that may be caused by accidents or intentional attacks. NRC's safe storage finding does not qualify as a generic licensing determination under the AEA or NEPA.

Pool Fires (Appendix F):

- NRC incorrectly finds the probability of a pool fire to be so low that it concludes such an event is "inconsequential." However, because the consequences are so huge, irrespective of the odds of a fire any risk is unacceptable.
- NRC ignored or down-played water loss that can result from acts of malice, an accidental plane crash, an earthquake, a cask drop, accidental fires or explosions, or a severe accident in an adjacent reactor, and ignored the collapse of a spent fuel pool whereas Fukushima Unit 4 shows that it is a real possibility.
- NRC incorrectly assumes that water loss is complete and ignores the greater risk of a partial drain-down, worse because the leftover water in the bottom of the pool, blocking air convection flow to help cool the assemblies, will lead to a faster build up of heat. Back in October 2000, NUREG-1738 reversed NRC's longstanding false position that total instantaneous drainage of a pool is the most severe case of drainage; nevertheless the staff of NRC continues to forget what they once knew.
- NRC incorrectly downplays the risks of pool fires assuming that the surrounding populations will be successfully evacuated. But NRC provides exemptions to licensees to do away with emergency planning as soon as 12 to18 months post reactor shutdown.
- Further, PW showed in its 2.206 Enforcement Petitions that NRC/FEMA's findings of adequacy of the KLD Estimates systems for notifying the public are insufficient.[36] So that even before emergency planning is officially ended, reasonable assurance is not provided.

[35] 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, by Jan Beyea, Ph.D., May 25, 2006.

- There is a substantial reduction in risk to the population if fuel is transferred to casks. "The risk reduction is undeniable: the contaminated land area is reduced from 9,400 square miles to 170 square miles and the number of people displaced from their communities for a long time drops from 4,100,000 to 81,000.[37]"
- NRC knows that dry casks are safer than pools. In its Lessons Learned from Fukushima, NRC issued Orders regarding spent fuel pools but none for dry casks. The danger presented by spent fuel is the reason that the NRC recommended that all Americans within 50 miles of Fukushima be evacuated.

Costs of Expedited Transfer of Fuel from Pool to Casks

Is expedited transfer more expensive? The short answer is that it shouldn't be. All spent fuel generated in the past and for the foreseeable future will eventually be transferred to dry casks located at reactor sites or centralized facilities. The only question is when. The total number of casks and size of the related facilities will be the same, whether or not transfer to dry casks is expedited or dragged out. Again, the only unanswered question is when the casks and pads will be built. There is no reason to think they will be cheaper 50-60 years after license termination.

EPRI, 2012 Technical Report, *Impacts Associated with Transfer of Spent Nuclear Fuel from Spent Fuel Storage Pools to Dry Storage After Five Years of Cooling* estimated the cost to U.S. industry as a whole at $3.5 billion to $3.9 billon. The costs for all such transfers pale in comparison to the estimated cost of a spent fuel pool fire at Pilgrim: one reactor, $488 billion. EPRI's estimates include purchasing casks; cask loading operations; dry storage facilities; annual operations and maintenance; construction, or expansion.

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[36] 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) and Amendment And Supplement To 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 (Nov 22, 2013)

[37] David Lochbaum, Director, Nuclear Safety Project, Union of Concerned Scientists, Testimony before the Senate Committee on Energy and Natural Resources, July 20, 2013 http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=89dbc888-171c4f77-Becf-83a0055fcfb9

2. Cask storage is far safer than pool storage but not without its pitfalls. **PW disagrees with NRC's <u>unqualified</u> finding that spent fuel can be stored safely in dry casks placed on pads both over the short term, 60 years after the license to operate ends and for the interim period (100-300 years) and for the extended period (300 yrs and beyond) by simply changing the casks and pad every 100 years. Instead, PW supports the alternative of requiring specific safety requirements for dry cask storage**. For example:

- Casks must be required to be located over the short, long, and indefinite periods at higher elevations to avoid flooding, especially along coasts, because of climate change and sea level rise. Placing casks at higher elevations is especially important in marine locations where chloride has the potential of inducing stress corrosion cracking of austenitic stainless steel[38] and corrosion of concrete, impacting both cask over-packs and pads.
- Casks need to be outfitted with monitors for both temperature and radiation, although not required now.
- Casks need to be protected from the elements by placement in buildings, especially in areas with snow and ice storms and a building would limit line of sight attacks,
- Offsite emergency planning must be required with compensation for offsite radiological emergency planning expenses while waste is onsite.
- There simply is no way to project on a generic basis that casks and pads will last 100 years. There is no history to base it upon.

NRC assumes that casks (both the inner canister and outer over-pack) and cask pads only need to be replaced every 100 years. This is contradicted by NRC's own statement that, "Dry casks are licensed or certified for 20 years, with possible renewals of up to 40 years. This shorter licensing term means the casks are reviewed and inspected, and the NRC ensures the licensee has an adequate aging management program to maintain the facility[39]." NRC provides no proof that casks can go an additional 60 years before replacement. NRC assumes that there will be Dry Transfer Systems to perform the "change of clothes" since pools will be dismantled during decommissioning 60 years after reactor shutdown. But there is no showing that assemblies will

[38] IN 2012-20 Potential Chloride Induced Stress Corrosion Cracking of Austenitic Stainless Steel and Maintenance of Dry Cask storage System Canisters. (ML 1231a440)
[39] http://www.nrc.gov/waste/spent-fuel-storage/faqs.html

not degrade making transfer unsafe. This is especially true with high-burnup fuel that has spent more time in the reactor core and is more radioactive and thermally hotter. NRC has not provided the cost for the transfer operation nor indicated who will pay.

3. **PW supports NRC studying the alternative of not allowing continued production of spent fuel until NRC sufficiently shows that there is a safe and environmentally acceptable permanent waste repository to receive additional fuel generated.** This consideration was found reasonable by the U.S. Court of Appeals for DC. The Circuit Court explicitly recognized it as reasonable in New York v NRC, 681 F.3d 471, 474 (D.C. Cir.2012). It said, "The lack of progress on a permanent repository has caused considerable uncertainty regarding the environmental effects of temporary SNF storage and the reasonableness of continuing to license and relicense nuclear reactors." Because the GEIS is intended to support the environmental review of licensing actions and license renewal actions regarding environmental impacts of storing spent nuclear fuel, NEPA requires that NRC examine the cessation of further generation of spent fuel until a permanent, safe, and adequate nuclear waste disposal facility exists. What NRC did instead was simply assume, with no factual basis, that all nuclear waste will be removed from the nation's nuclear power plants within 60 years after the plants are closed.

4. **PW supports the need for NRC to address the environmental impacts of continued storage for the period after plant shutdown in site-specific licensing reviews, as discussed above.** The rationale is simple. Reactors vary in location, design, history, and oversight by the responsible parties.

5. **PW supports NRC going back to the drawing board to perform a sufficient scientifically defensible document.**

Respectfully submitted,

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