

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE NUCLEAR REGULATORY COMMISSION

In the Matter of

EA-12-051

All Operating Boiling Water Licensees

With Mark 1 and Mark II Containments

April 2, 2012

PILGRIM WATCH REQUEST FOR HEARING REGARDING INSUFFICIENCY OF ORDER MODIFYING LICENSES WITH REGARD TO SPENT RELIABLE SPENT FUEL POOL INSTRUMENTATION

In accordance with 10 C.F.R § 2.309, Pilgrim Watch respectfully files a Request for Hearing challenging the adequacy of NRC's Issuance of Order to Modify Licenses With Regard To Spent Fuel Pool Instrumentation (EA-12-051) issued March 12, 2012.

Petitioners hereby submit the following contention:

Based on new and significant information from Fukushima, the Order To Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation issued March 12, 2012 (EA-12-051) is insufficient to protect public health, safety and property because it lacks a requirement for licensees to re-equip their spent fuel pools to low-density, open-frame design and storage of assemblies >5 years removed from the reactor core placed in dry casks.

I. Petitioners Have Standing:

A Petitioner is entitled to party status by establishing that they are "adversely affected by this Order." (Order at 11, Section V) Pilgrim Watch ("PW") is a non-profit citizens'

organization that serves the public interest in issues regarding the Pilgrim Nuclear Power Station, a Mark I BWR. The organization is located at 148 Washington Street, Duxbury, Massachusetts, 02332. Many of its members live within the immediate neighborhood of the reactor, and others either within the 10 -mile Emergency Planning Zone or within the 50-mile ingestion pathway. Mary Lampert who represents PW makes her residence and place of occupation and recreation within an approximate six (6) miles of Pilgrim Nuclear Power Station. Therefore, Petitioners believe that it has standing to intervene in this proceeding and, indeed, deserve to be afforded their due process with all formal hearing rights.

In addition, PW is a party to Pilgrim's license renewal adjudication proceedings; PW's May 2006 Request for Hearing was directed specifically towards safety issues regarding Pilgrim's spent fuel pool. Subsequent filings on the inadequacy of the Severe Accident Mitigation Analysis (SAMA) also involved documenting hazards associated with spent fuel pool storage. The Massachusetts Attorney General, also a party of Pilgrim's License Renewal Proceeding, focused its requests on spent fuel pool vulnerability and consequences, May 25, 2006 and June 2, 2011. PW intends to incorporate the MA AGO's May 25, 2006 and June 2, 2011 expert reports in its Request for Hearing, along with another report prepared by the MA AGO's expert filed in another proceeding. Therefore, it reasonably can be expected that PW will meaningfully contribute to the record.

PW submits that the public in communities surrounding Pilgrim NPS should be afforded their due process with all formal hearing rights to redress inadequacies of past and future modifications to containment in context of EA12-51.

The possible effect of any order that may be entered in the proceeding on the requestor's/petitioner's interest includes the following.

Petitioners believe that if Pilgrim is allowed to operate without a requirement for low-density, open-frame pool storage and dry cask storage for assemblies > 5 years old that there will be an unacceptable risk to the environment jeopardizing the health, safety, property and finances of Petitioners' members who live, recreate, conduct business and own property within the vicinity of the Pilgrim Nuclear Power Station. The Order's focus simply on spent fuel pool instrumentation fails to address the real problem. The Request for Hearing thereby addresses a significant public safety and environmental issue.

II. The Contention Is Within Scope of the Proceeding

This contention addresses a defect in the Order. NRC must consider new and significant information arising from the accident at Fukushima before finalizing the Order whether or not that information ultimately leads to modification of its requirements. "Regardless of its eventual assessment of the significance of the information, the [agency] ha[s] a duty to take a hard look at the proffered evidence." Marsh v Oregon Natural Resources Council, 490 U.S. 360, 385 (1989) (emphasis added)

The fundamental purpose of the National Environmental Policy Act, NEPA, 42 USC § 4332, is to "help public officials make decisions that are based on understanding of environmental consequences, and take decisions that protect, restore and enhance the environment." 40 CFR § 1500.1(c) (Emphasis added).

This contention seeks compliance with NEPA and is based on the NRC's Order, 12-051. PW provides new and significant information that could affect the outcome of NRC's deliberations

III. The Contention Is Material to the Findings That the NRC Must Make

The issue raised in this contention is material to the findings the NRC must make to support the action that is involved in the proceeding. The deficiency highlighted in this contention has enormous independent health and safety significance.

IV. PW Provided a Concise Statement of Facts or Expert Opinion Supporting the Contention, Along With Appropriate Citations to Supporting Scientific or Factual Materials

The facts and expert opinion that support PW's contention are stated in: 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 that 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, Exhibit 1; *Risks of Pool Storage of Spent Fuel at Pilgrim Nuclear Power Station and Vermont Yankee, A Report for the Massachusetts Attorney General*, Dr. Gordon Thompson, May 2006, Exhibit 2; *New and Significant Information From the Fukushima Daiichi Accident In The Context of Future Operation of the Pilgrim Nuclear Power Plant, A Report for the Office of the Attorney General Commonwealth of Massachusetts*, Dr. Gordon Thompson, June 1, 2011, Exhibit 3; *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*, Prepared under the sponsorship of Texans for a Sound

Energy Policy, Dr. Gordon Thompson, February 6, 2009, Exhibit 4; *U.S. Nuclear Power Safety: One Year After Fukushima*, David Lochbaum & Edwin Lyman, Union Concerned Scientists, 2012¹; and referenced government and industry documents. In any hearing, PW expects to rely on expert testimony from Dr. Jan Beyea², David Lochbaum³, Dr. Edwin Lyman⁴, and Dr. Gordon Thompson⁵.

V. Sufficient Information to Show a Genuine Dispute with the NRC's Order

The expert reports relied upon show that the Order as written March 12, 2012 is insufficient to protect public health and safety and must be supplemented with a requirement for licensees to re-equip their spent fuel pools to low-density, open-frame design and storage of assemblies >5 years removed from the reactor core to the pool placed in dry casks.

¹ Available at: http://www.ucsusa.org/nuclear_power/nuclear_power_risk/safety/fukushima-anniversary-report.html

² Dr. Jan Beyea is a nuclear physicist who has studied the consequences of real and hypothetical nuclear accidents as well as strategies for mitigation. He is a regular member of panels and boards of the National Research Council of the National Academy of Sciences and an advisor to the Division of Engineering and Physical Sciences. Dr. Beyea's personal background is described in the *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 on NRC's EHD, Pilgrim Docket.

³ David Lochbaum is director of UCS's Nuclear Safety Project. A nuclear engineer by training, Lochbaum worked at nuclear power plants for 17 years; including many similar to the General Electric reactors at the Fukushima plant. He left the industry in the early 1990s after blowing the whistle on unsafe practices and joined UCS in 1996. He left UCS in 2009 to work for the NRC as a reactor technology instructor and returned to his post at UCS a year later. Lochbaum has authored numerous reports.

⁴ Dr. Edwin Lyman is a physicist with the Union of Concerned Scientists. Before joining UCS, Lyman was president of the Nuclear Control Institute, a Washington, D.C.-based organization focused on nuclear proliferation. From 1992 to 1995, he was a postdoctoral research associate at Princeton University's Center for Energy and Environmental Studies (now the Science and Global Security Program). He earned a doctorate degree in physics from Cornell University in 1992.

⁵ Dr. Gordon Thompson is currently the executive director of Institute for Resource and Security Studies in Cambridge, MA. In addition, he serves as Research Professor, George Perkins Marsh Institute, Clark University, Worcester, Massachusetts. He was educated in Australia and the UK, in engineering and science, obtaining his doctorate from Oxford University in 1973. Dr. Thompson has been based in the United States since 1979. Over the past three decades he has acquired wide experience with natural resource and international security issues. One of his major interests have been the environmental and security impacts of nuclear technologies. Dr. Thompson has coordinated multidisciplinary teams, organized international conferences and provided expert testimony in a variety of contexts. His CV is available on NRC's EHD, Massachusetts Attorney General's Request for Hearing May 25, 2006 and June 2, 2011.

VI. There is a Substantial Basis for the Contention

A. Introduction

In a paper submitted to the Commission on October 3 (the “45-day paper”), the NRC staff informed the Commission about six potential recommendations arising from its meetings with external stakeholders that warranted consideration. The recommendation on spent fuel pools asked to transfer spent fuel to dry storage. This recognized that although the spent fuel in the pools at Fukushima did not result in fire, U.S. nuclear plants might not be so lucky.

U.S. plants typically contain several times as much spent fuel as the one at Fukushima’s Unit 4, and stored in a densely packed configuration that would be harder to cool in the event of a rapid loss of pool water. Pilgrim, for example, has 3,279 assemblies in its elevated pool that was originally designed for only 880 assemblies.

Stakeholders recommended that the spent fuel pool hazard be decreased by accelerating the transfer of irradiated fuel > 5 years out of the reactor in dry storage, thereby reducing the density of the fuel remaining in the pools.

NRC instead assigned accelerated transfer of spent fuel to dry storage issues to Tier 3 - placed it on the back burner. Moreover, the staff has “determined that the current regulatory approaches to these issues are acceptable” and will “review new information that becomes available as a result of specific ongoing activities to confirm this conclusion and gain additional insights.” (*US Nuclear Power Safety One Year after Fukushima*, UCS, Lyman & Lochbaum, viii)

The Fukushima accident shows that NRC’s assumptions about operator’s capability to mitigate an accident at Pilgrim NPP, or similar reactors, are unrealistically optimistic and that operator’s ability to carry out mitigative measures can be severely degraded in an accident

environment. Mitigative measures (extensive damage mitigative guidelines- EDMGs) are inadequate to address the range of reactor and spent fuel pool events that can occur at reactors in the U.S. and therefore there is a probability of a spent fuel pool fire. However, Fukushima showed that fuel in dry casks survived the earthquake and tsunami just fine.

B. The Order (EA-12-051) simply requires all licensees to have a “reliable means of remotely monitoring spent fuel pool water levels to support effective prioritization of event mitigation and recovery actions in the event of a beyond-design-basis external event.” (Order, pg., 7) Attachment 2 to the Order lists instrumentation design features. Implementation is required “no later than two (2) refueling cycles after submittal or the overall integrated plan...or December 31, 2016, whichever comes first.” (Order, pg., 8-9)

The Order incorrectly assumes that there are effective mitigation and recovery actions to prevent a pool fire in the event of beyond-design-basis external events. Specifically, the Order at 5 says that, “In the case of spent fuel pools, compliance with existing regulations and guidance presumptively provides reasonable assurance of safe storage of spent fuel.” (Order, pg., 5) PW will show why this is not so.

C. NRC’s Assumption That Operator’s Will Be Capable To Add Water To The Pool During an Accident is Overly Optimistic

The Order does not demonstrate what effectively can be done if the newly ordered spent fuel pool monitors show that: “(1) the level is (not) adequate to support operation of the normal fuel pool cooling system; (2) level is (not) adequate to provide substantial radiation shielding for a person standing on the spent fuel pool operating deck; and (3) level where the fuel remains covered and actions to implement make-up water addition should not longer be deferred.” (Order, Appendix 2)

Lesson from Fukushima

The earthquake and tsunami at Fukushima caused extensive damage at the site. As the resulting accident proceeded, hydrogen explosions produced further damage. Plant operators and other personnel were obliged to work in a highly disturbed environment where many items of equipment were non-functional and many parts of the affected plants were inaccessible. Operators encountered high radiation fields, high temperatures, smoke, debris, and steam. Supplies of electrical power and fresh water were interrupted for long periods. It does not require an earthquake or tsunami for a reactor like Pilgrim (a carbon-copy of the Fukushima reactors) to fail. Failure can occur from extreme natural events, acts of malice, loss of electrical power, serious design flaws, human error, lack of regulatory oversight and overconfidence.

Dr. Gordon Thompson, *Report to the Attorney General Commonwealth of Massachusetts*, June 2, 2011, pg., 18 (Exhibit 3) showed that jury-rigged systems may fail to add water to an affected pool in sufficient quantity to prevent a pool fire. Therefore, reducing the probability of a pool fire should be NRC's priority. The most effective and reliable measure to prevent a pool fire would be to re-equip the pool with low-density, open frame- racks. A section of his report, *Adding water to spent-fuel pools*, explains that:

Early on, TEPCO tried dropping seawater from bags suspended from helicopters, and spraying water from police riot control vehicles and military fire trucks. Both approaches proved ineffective. Eventually, TEPCO brought a concrete pumping truck with a long boom to the site, and this proved effective in spraying water into spent-fuel pools.

This experience is directly relevant to the Pilgrim plant. As at other plants in the USA, EDMGs at Pilgrim cover measures that seek to mitigate damage if the plant experiences an attack or an accident. The EDMGs were drawn up by the Nuclear Energy Institute (NEI), which is an industry association. They were secret until NRC recently placed them in the public domain⁶. NRC has made them a license condition

⁶ Nuclear Energy Institute (NEI) "B.5.b Phase 2 &3 Submittal Guideline, NEI-06-12, Revision 2", December 2006.

for the Pilgrim plant⁷. The measures covered by these EDMGs at Pilgrim include measures for adding water to the spent-fuel pool.

Note that NRC placed the EDMGs into the public domain in response to the Fukushima accident. Thus, the newly-disclosed EDMGs add to the body of new and significant information that arises from the Fukushima accident.

In the newly-disclosed EDMGs, NEI calls for a capability to spray at least 200 gpm of water into the Pilgrim pool. This pool is high up in the reactor building. To accommodate this situation, NEI calls for the spray capability to include⁸:

“Capability to lift/locate the monitor nozzle such that the spray can be externally directed into the spent fuel pool (e.g., from an adjacent building roof, fire truck extension ladder). The lifting capability (e.g., crane or fire truck with extension ladder) may be located off-site as long as the site has confidence (e.g., through an MOU) that it will be available for use on-site within the required timeframe (i.e., 2 hours or 5 hours). This may require a modification to the lifting device to allow the monitor nozzle to be affixed.”

Presumably, the Pilgrim licensee has made an arrangement to bring a truck-mounted crane or a ladder fire truck to the site at short notice. This arrangement might work in some situations; however, there are several factors that could render the arrangement unworkable, including:

- This arrangement can never be realistically tested.
- An event that initiates or co-initiates the accident (e.g., earthquake, hurricane, ice storm, blizzard, attack) could also render the truck unavailable.
- A radioactive release from a reactor accident could produce radiation fields that render the truck unavailable, or preclude its use on the site.
- There seems to be no provision for a radiation-resistant TV camera to guide nozzle positioning, or for shielding of the truck/spray operators.
- There seems to be no recognition that spraying water on exposed spent fuel could, in some circumstances, exacerbate the accident by feeding a zirconium-steam fire.
- To some extent, NEI recognizes that its guidelines cannot guarantee that water can always be added to the pool. NEI says⁹: “It is understood that not

⁷ James S. Kim, NRC Staff Letter to Michael Balduzzi, Entergy Nuclear Operations, Subject: Pilgrim Nuclear Power Station- Conforming License Amendment to Incorporate the Mitigation Strategies Required by Section B.5.b. of Commission Order EA-02-026 and the Radiological Protection Mitigation Strategies Required by Commission Order EA-06-137 (TAC NO. MD4555), August 23, 2007

⁸ NEI, 2006, page 13.

⁹ NEI, 2006, page 14.

all conceivable scenarios can be mitigated by sprays. The objective is for each site to work to identify means to spray the pool.”

Findings and implications

Dr. Thompson stated conclusively that the foregoing leads to the following conclusions.

1. Fukushima showed clearly that the operators’ capability to mitigate an accident at the Pilgrim or a similarly designed reactor can be severely degraded in the accident environment.
2. EDMGs are inadequate to mitigate the range of fuel-damage events that could occur at the Pilgrim plant¹⁰. This is based on NEI’s EDMGs on adding water to spent-fuel pools.
3. Due to inadequacies in the EDMGs, it is clear that there is a substantial probability of a spent-fuel-pool fire during a reactor accident at the Pilgrim plant resulting from a variety of external and internal factors.

Adding Water to BWR Spent Fuel Pools Forces A Choice - Either Sacrifice Reactor or Pool

The Union of Concerned Scientists identified another problem with adding water to spent fuel pools in beyond-design events in boiling water reactors with Mark I and Mark II containment designs.¹¹ UCS explains that:

At these facilities, the spent fuel pool is located within the reactor building, and all the emergency pumps that protect the reactor core from overheating are located in this building’s basement. Water evaporating from a boiling spent fuel pool would, after condensing, drain to that basement. In addition, if the rate at which water was sprayed into a spent fuel pool exceeded the rate at which water was draining from it, the pool would overflow and drain to the basement as well. Such an artificial tsunami could wreak as much havoc as did the natural tsunami at Fukushima by submerging

¹⁰ For additional information on the limitations of EDMGs, see: UCS, 2011.

¹¹ U.S. Nuclear Power Safety: One Year After Fukushima, David Lochbaum & Edwin Lyman, Union Concerned Scientists, 2012, pg., 24. http://www.ucsusa.org/nuclear_power/nuclear_power_risk/safety/fukushima-anniversary-report.html

and thus disabling vital emergency equipment. In other words, the operators could be forced to choose between two evils: (1) turn on the water sprays to save the spent fuel, but risk losing the reactor core; or (2) save the reactor core by not turning on the water sprays, but risk losing the spent fuel. The operators have to be provided with better options than picking which irradiated fuel to sacrifice.

VII. Supplement Order Requiring Low-Density, Open-Frame Pool Storage

The foregoing shows that Order EA-12-051 is inadequate to protect public health and safety because NRC's assumptions about U.S. operator's capability to mitigate an accident at Pilgrim NPP, or similar reactors, are unrealistically optimistic and that operator's ability to carry out mitigative measures can be severely degraded in an accident environment. Therefore the Order must be supplemented as part of Tier 1 to include a requirement for open-frame, low-density pool storage and place assemblies > 5 years out of the reactor in dry casks.

Rationale

A. Problem: Densely-packed spent fuel pools

Spent fuel pools were designed to be temporary and to store only a small fraction of what they currently hold. Example: Pilgrim Nuclear Power Plant's spent fuel pool was designed to hold 880 assemblies. The NRC allowed Pilgrim to amend its license to hold 3,859 assemblies in the same place by packing the assemblies closer together. This enabled Pilgrim to continue generating waste without an offsite storage option in order to complete their current license (June 2012) and not expend monies for dry casks. The licensee stated that during license renewal it intends only to remove the requisite number of assemblies from the pool to make room for the next download - leaving the pool densely packed, unless required to do otherwise.

B. Risk: Spent Fuel Pool Fires- Vulnerability¹²

Several events could cause a loss of pool water including leakage, evaporation, siphoning, pumping, aircraft impact, accidental or deliberate drop of a fuel transport cask, reactor failure, or an explosion from inside or outside. The probability of external events causing pool water events has increased; because of an increased threat of terrorism, post 9/11, and increased occurrence of extreme storm events resulting from climate change.

The spent fuel pool is designed to remain intact following an earthquake but it is not designed to withstand aircraft impacts and explosive forces. GE Mark I BWR's are especially vulnerable because the pool is located outside primary containment in the attic of the reactor with a thin roof overhead, easily penetrated by a small plane or helicopter loaded with explosives or simply fuel. PWR pools likewise are vulnerable. Reliance on increased airport security is insufficient to prevent an attack.

Contrary to NRC, pools are not robust structures. For example, the National Academy of Sciences *Safety and Security of Commercial Spent Nuclear Fuel Storage Public Report*, April 2005 stated at 6 that, "The potential vulnerabilities of spent fuel pools to terrorist attack are plant specific ... there are substantial differences in the designs of spent fuel pool that make them more or less vulnerable to certain types of attack." And, at 41, "The spent fuel pool, (GE Mark I BWR reactors) is located in the reactor building well above ground level. Most designs have thin steel superstructures. The superstructures and pools were not, however, specifically designed to

¹² See for example, *Risks of Pool Storage of Spent Fuel at Pilgrim Nuclear Power Station and Vermont Yankee, A Report for the Massachusetts Attorney General*, Dr. Gordon Thompson, May 2006, Exhibit 2

resist terrorist attacks.” So that contrary to NRC, GE Mark I Boiling Water reactors, such as Pilgrim, Vermont Yankee and Oyster Creek NPS are especially vulnerable to attack.

Some Potential Modes of Attack on Civilian Nuclear Facilities¹³

MODE OF ATTACK	CHARACTERISTICS	PRESENT DEFENSE
Commando-style by land	<ul style="list-style-type: none"> • Could involve heavy weapons/sophisticated tactics • Attack requiring substantial planning and resources 	Alarms, fences, lightly-armed guards, with offsite backup
Commando-style by water	<ul style="list-style-type: none"> • Could involve heavy weapons & sophisticated tactics • Could target intake canal • Attack may be planned to coordinate with a land attack 	500 yard no entry zone – marked by buoys – simply, “no trespassing” signs Periodic Coast Guard surveillance by boat or plane
Land-vehicle bomb	<ul style="list-style-type: none"> • Readily obtainable • Highly destructive if detonated at target 	Vehicle barriers at entry points to Protected Area
Anti-tank missile	<ul style="list-style-type: none"> • Readily obtainable • Highly destructive at point of impact 	None if missile is launched from offsite
Commercial aircraft	<ul style="list-style-type: none"> • More difficult to obtain than pre-9/11 • Can destroy larger, softer targets 	None
Explosive-laden smaller aircraft	<ul style="list-style-type: none"> • Readily attainable • Can destroy smaller, harder targets 	None
10-kilotonne nuclear weapon	<ul style="list-style-type: none"> • Difficult to obtain • Assured destruction if detonated at target 	None

Densely packed pools like Pilgrim’s are especially prone to fire. To avoid criticality of assemblies placed close together, neutron absorbing panels are placed between the assemblies.

The extra panels will restrict air and water circulation if there is a water loss. Further, if the

¹³ 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, Prepared under the sponsorship of Texans for a Sound Energy Policy, Dr. Gordon Thompson, February 6, 2009, Table 7-4, pg., 80, Exhibit 4. Note “Commando-style by water” added by Petitioner.

equipment collapses, as might occur in a terrorist attack, air and water flow to the stacked assemblies would be obstructed causing a fire, according to a NRC report.

C. Consequences

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 and Vermont Yankee’s 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 that 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, Exhibit 1. The following table from that report shows that the consequences are potentially catastrophic and justify action by NRC as requested herein.

**Estimates of Costs and Latent Cancers Following Releases
Of Cesium-137 from Pilgrim’s Spent-Fuel Pool**

	10% release C-137	100% release C-137
Cost (billions)	\$105-\$175 billion	\$342-\$488 Billion
Latent Cancers	8,000	24,000

D. Mitigation: NRC’s most recent Waste Confidence update (December 2010) said that “Mitigative measures imposed since September 11, 2001 provides high assurance that the spent fuel in both spent fuel pools and dry storage casks will be adequately protected.” Further it states that, “...it had adopted the important recommendations for the NAS report relevant to spent fuel pools.” However there is no demonstration that each reactor site has adopted the recommendations; and, most important, the effectiveness of those recommendations is unsupported. Recommendations by the National Academy of Sciences *Safety and Security of*

Commercial Spent Nuclear Fuel Storage Public Report, April 2005 to reduce risk, do not eliminate it.

For example:

- Reconfiguring the Pool or Checker-Boarding: Shifting the fuel around will be useless if there is partial drainage of the water or if debris blocks air flow in a drained pool. Low density open frame racking is the only way to go.
- Spray cooling systems installed in the pool: If water is lost from a spent fuel pool recently discharged fuel can ignite in a period as short as 1-2 hours. Actual period depends on the time since the reactor shutdown for refueling. There is at present no pre-engineered means of spraying water into a drained pool to keep the fuel temperature below the ignition point. Human access with hoses could be precluded by fire or high radiation fields generated as part of the attack, or by other disabling mechanisms such as chemical weapons. Sophisticated attackers might attack the reactor and the pool, using the radiation field from the damaged reactor to preclude access to the pool. Once ignition had occurred, spraying water into the pool would feed the fire through the exothermic steam-zirconium reaction. A massive and probably impractical flow of water would be needed to overcome the effect.
- Dry Casks: The National Academy stated that dry casks were less vulnerable to attack because casks are passive; casks are located at or below ground level making attack more difficult; the fuel is more spread out. However, the Academy cautioned that casks are still vulnerable to attack and suggested, “..... simple steps that could be taken to reduce the likelihood of releases of radioactive material from dry casks in the event of a terrorist attack - such as spreading the casks further apart, constructing mounds around the casks.”

Mitigation - Summary:

Table 8-2 Selected Options to Reduce the Risk of a Spent-Fuel-Pool Fire at a Commercial Reactor¹⁴

Option	Passive or Active?	Does Option Address Fire Scenarios Arising From:		Comments
		Malice?	Other Events?	
Re-equip pool with low-density, open-frame racks	Passive	Yes	Yes	<ul style="list-style-type: none"> • Will substantially reduce pool inventory of radioactive material • Will prevent auto-ignition of fuel in almost all cases
Install emergency water sprays above pool	Active	Yes	Yes	<ul style="list-style-type: none"> • Spray system must be highly robust • Spraying water on overheated fuel can feed Zr-steam reaction
Mix hotter (younger) and colder (older) fuel in pool	Passive	Yes	Yes	<ul style="list-style-type: none"> • Can delay or prevent auto-ignition in some cases • Will be ineffective if debris or residual water block air flow • Can promote fire propagation to older fuel
Minimize movement of spent-fuel cask over pool	Active	No (Most cases)	Yes	<ul style="list-style-type: none"> • Can conflict with adoption of low-density, open-frame racks
Deploy air-defense system (e.g., Sentinel and Phalanx) at site	Active	Yes	No	<ul style="list-style-type: none"> • Implementation requires presence of US military at site
Develop enhanced onsite capability for damage control	Active	Yes	Yes	<ul style="list-style-type: none"> • Requires new equipment, staff and training • Personnel must function in extreme environments

¹⁴ 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, Prepared under the sponsorship of Texans for a Sound Energy Policy, Dr. Gordon Thompson, February 6, 2009, Table 82, pg., 88, Exhibit 4

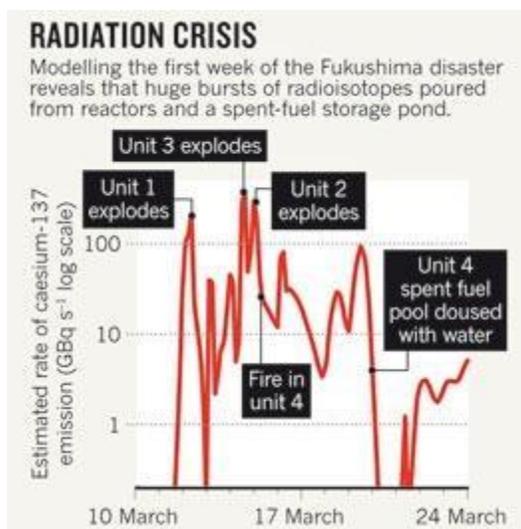
Mitigation Providing Real On-Site Waste Confidence: The Massachusetts and NY Attorney Generals, Pilgrim Watch and a host of public interest groups and officials across our country have called for NRC to step up to the plate and prioritize and *require* low density pool storage and hardened, dispersed dry cask storage as an interim and safer measure until a scientifically acceptable offsite permanent storage option becomes available. Second, dry cask storage on site must be recognized for what it is – a major federal action- and therefore an EIS must be required before permitting the construction of Independent Spent Fuel Storage Installations at reactor sites- as affirmed by the 9th Circuit Court.

FUKUSHIMA- LESSONS LEARNED

New and significant information from Fukushima provides real-world information that has improved our understanding of what had theoretically been predicted. Prior to the Fukushima accident, there was no direct experience with a spent-fuel fire. During the accident, it appears that there has not been a full-scale fire. However, it appears that there was fuel damage in at least Unit 4, and there may have been an episode of steam-zirconium reaction at that pool.

For example: A recent study published by Nature¹⁵ indicates that, contrary to government claims, pools used to store spent fuel played a significant part in the release of the long-lived environmentally contaminant caesium-137. Radioactive fuel recently removed from a fourth reactor was being held in a storage pool at the time of the quake, and on 14 March the pool overheated, possibly sparking fires in the building over the next few days.

¹⁵ Global data on Fukushima challenge Japanese estimates, Geoff Brumfeil, Nature 478, 435-436 , October 25, 2011, available on line at <http://www.nature.com/news/2011/111025/full/478435a.html>



The new analysis claims that the spent fuel being stored in the unit 4 pool emitted copious quantities of caesium-137. Japanese officials have maintained that virtually no radioactivity leaked from the pool. Yet Stohl's model clearly shows that dousing the pool with water caused the plant's caesium-137 emissions to drop markedly (see '[Radiation crisis](#)'). The finding implies that much of the fallout could have been prevented by flooding the pool earlier. The analysis has been posted online for open peer review by the journal *Atmospheric Chemistry and Physics*¹⁶.

We know also that the pools at Fukushima were not densely packed as they are in the US. Last we know that the fuel in dry casks onsite remained unharmed by the violent earthquake and tsunami; that was hardly the case of the reactors that housed the spent fuel pools.

Direct experience from Fukushima shows events that could well be precursors to pools fires. At Fukushima, water may have been lost from pools from sloshing, leaking, and or displacement by debris. Pool structures may have experienced earthquake damage. Cooling and

¹⁶ *Atmos. Chem. Phys. Discuss*, 11, 28319-28394, 2011, available online at: www.atmos-chem-discuss.net/11/28319/2011/doi:10.5194/acpd-11-28319-2011

makeup systems were inoperable for long periods. Ultimately keeping water in the pools relied entirely on jerry-rigged systems for water addition.

VIII. Conclusion

Based on new and significant information from Fukushima, the Order To Modify Licenses With Regard To Reliable Spent Fuel Pool Instrumentation issued March 12, 2012 (EA-12-051) is insufficient to protect public health, safety and property because it lacks a requirement for licensees to re-equip their spent fuel pools to low-density, open-frame design and storage of assemblies >5 years in dry casks. Indeed this has been evident for a long time; further study is simply a needless delay tactic.

Respectfully submitted,

(Signed electronically)

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April 2, 2011

ATTACHMENTS

Exh. 1: 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

Exh. 2: Risks of Pool Storage of Spent Fuel at Pilgrim Nuclear Power Station and Vermont Yankee, a Report for the Massachusetts Attorney General, Dr. Gordon Thompson, May 2006

Exh. 3: New and Significant Information From the Fukushima Daiichi Accident In The Context of Future Operation of the Pilgrim Nuclear Power Plant, A Report for the Office of the Attorney General Commonwealth of Massachusetts, Dr. Gordon Thompson, June 1, 2011

Exh. 4: 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, Prepared under the sponsorship of Texans for a Sound Energy Policy, Dr. Gordon Thompson, February 6, 2009