PILGRIM WATCH

June 14, 2012

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Washington, D.C. 20555-0001
Via Email

SUBJECT: Fukushima Lessons Learned Tier 3 Recommendations- Spent Fuel Pool vs. Dry Storage; Reliable Hardened Vents & Filtration of Containment Vents; Emergency Planning Issues, Expanding Size EPZ, Pre-staging Potassium Iodide Beyond 10 Miles, Monitoring; and Relegating Recommendations To Backfits

Dear Mr. Skeen:

The NRC recently held public meetings concerning Tier 3 recommendations. Pilgrim Watch ("PW") provides the following comments about these important issues.

I. SPENT FUEL STORAGE - SPENT FUEL POOL VS. DRY CASKS

Pilgrim Watch April 2, 2012 submitted a Request for Hearing on EA-12-051, NRC's March 12, 2012 Order to Modify Licenses with regard to Reliable Spent Fuel Pool Instrumentation. The basis of that request is applicable here.

The April 24, 2012 public meeting focused on operational risks as an issue that decreases the value of transfer of irradiated spent fuel from spent fuel pools to dry casks. (ADAMS ML 12132A397, Slide 5) This is a totally bogus argument, as explained by comments submitted by David Lochbaum on behalf of the Union of Concerned Scientists on June 13, 2012. It is yet another red herring trotted out in an attempt by NRC and industry to avoid requiring industry to spend a dime to protect public safety. The facts are in, removing all spent fuel > 5 years out of reactor to dry casks is the only way to provide the public with reasonable assurance; arguments

against have no merit as demonstrated below.

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 domain[1]. NRC has made them a license condition for the Pilgrim plant[2]. 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 include[3]:

"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.

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

[2] 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

[3] NEI, 2006, page 13.

- 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 says[4]: "It is understood that not 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 plant[5]. 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.[6] UCS explains that:

[4] NEI, 2006, page 14.
[5] For additional information on the limitations of EDMGs, see: UCS, 2011.
[6] 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

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 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.

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 PW argues that 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; placing discussion to Tier 3, back-burner, is not acceptable.

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- Vulnerability[7]

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

[7] 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 1, Request Hearing, available NRC's EHD

steel superstructures. The superstructures and pools were not, however, specifically designed to 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 Facilities[8]

MODE OF ATTACK	CHARACTERISTICS	PRESENT DEFENSE
Commando-style by land	• Could involve heavy weapons/sophisticated tactics • Attack requiring substantial planning and resources	Alarms, fences, lightly-armed guards, with offsite backup
Commando-style by water	• 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	• Readily obtainable • Highly destructive if detonated at target	Vehicle barriers at entry points to Protected Area
Anti-tank missile	• Readily obtainable • Highly destructive at point of impact	None if missile is launched from offsite
Commercial aircraft	• More difficult to obtain than pre-9/11 • Can destroy larger, softer targets	None
Explosive-laden smaller aircraft	• Readily attainable • Can destroy smaller, harder targets	None
10-kilotonne nuclear weapon	• Difficult to obtain • Assured destruction if detonated at target	None

[8] 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.

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 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 Reactor[9]

Option	Passive or Active?	Does Option Address Fire Scenarios Arising From:		Comments
		Malice?	Other	
Re-equip pool with low-density, open-frame racks	Passive	Yes	Yes	• Will substantially reduce pool inventory of radioactive material • Will prevent auto-ignition of
Install emergency water sprays above pool	Active	Yes	Yes	• Spray system must be highly robust • Spraying water on overheated fuel can feed Zr-
Mix hotter (younger) and colder (older) fuel in pool	Passive	Yes	Yes	• Can delay or prevent auto-ignition in some cases • Will be ineffective if debris or residual water block air flow
Minimize movement of spent-fuel cask over pool	Active	No (Most	Yes	• Can conflict with adoption of low-density,

[9] 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

Deploy air-defense system (e.g., Sentinel and	Active	Yes	No	• Implementation requires presence of US military at site
Develop enhanced onsite capability for damage control	Active	Yes	Yes	• Requires new equipment, staff and training • Personnel must function in

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.

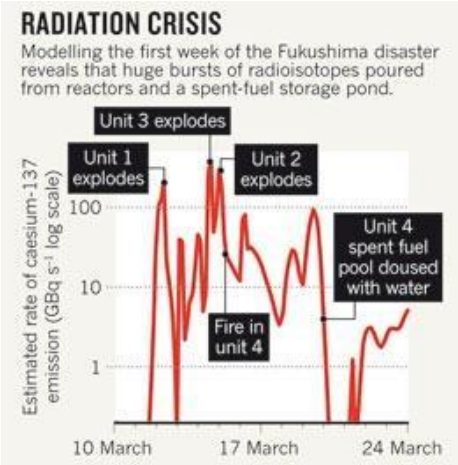
Fukushima- Lessons Learned

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 Nature[10] indicates that, contrary to government claims, pools used to store spent fuel played a significant part in the release of the long-lived

[10] Global data on Fukushima challenge Japanese estimates, Geoff Brumfeil, Nature 478, 435-436 , October 25,

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.



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[11].

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.

2011, available on line at http://www.nature.com/news/2011/111025/full/478435a.html

[11] 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

Direct experience from Fukushima shows events that could well be precursors to pool 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 makeup systems were inoperable for long periods. Ultimately keeping water in the pools relied entirely on jerry-rigged systems for water addition.

DC Court of Appeals

In a recent decision by the DC Court of Appeals, the court found that the NRC did not fully evaluate the risks associated with long-term storage of nuclear waste. The court vacated, showed no confidence, in the 2010 update to the NRC Waste Confidence Decision. The NRC relied on what seemed to be a faith-based methodology to conclude that highly radioactive nuclear waste can be left sitting in overcrowded giant swimming pools- some in the attic of the reactor, outside primary containment. Again NRC in its post Fukushima responses is relying on faith. Do we need an accident here for real action?

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. Placing this on the backburner, Tier 3, is inexcusable.

II. RELIABLE HARDENED VENTS & FILTRATION

Pilgrim Watch April 2, 2012 submitted a Request for Hearing on EA-12-050, NRC's March 12, 2012 Order to Modify Licenses with Regard to Reliable Hardened Containment Vents. The basis of that request is applicable here. NRC's placement of filtration and rupture discs on the back-burner delays unnecessarily its obligation to provide the public with reasonable assurance.

During the NRC May 2, 2012 Public Meeting Order EA-12-050 Mary Lampert asked the NRC technical staff a very simply question, whether they saw any down side to a combination rupture disc/filter. Robert Dennig, NRC's Branch Chief Technical Staff Containment and Vent Branch NRR responded, "No."[12]

FILTERS

A. Introduction

Install filtered vent systems. In an accident like the one at Fukushima, a filtered vent system could reduce the possibility of containment-building explosions, by releasing radioactive gases to the atmosphere through a large filter system. This system traps the most dangerous radioactive species, including cesium 137 and iodine 131, and prevents them from spreading beyond the containment building. A group of nuclear engineers at the University of California originally suggested this idea in 1977. Some countries -- including France, Sweden, and Germany -- have installed filtered vent system at their reactors; and Japan based on lessons learned from Fukushima is installing filtered vents on its reactors. (Bloomberg, Exhibit 6) The United States has lagged behind and not adopted filtered vents. The NRC has a second chance.

[12] The May 2, 2012 Meeting was not transcribed. On request Mary Lampert can provide affidavits from attendees and Robert Fretz, NRR/JLD.

A filtered vent system would also supplement the cooling options available to prevent and mitigate reactor core damage. "Feed and bleed" cooling options – where makeup water is supplied to the reactor vessel, removes decay heat from the reactor core as it warms up, and gets discharged through the safety/relief valves into the suppression pool within primary containment – need some means to remove heat from the primary containment. A filtered vent system enables the containment heat to be removed when other systems have failed to do so.

Fukushima and Pilgrim Watch's filings in Pilgrim Nuclear Power Station's license renewal proceedings (beginning June 1, 2011, available on the EHD) clearly showed the importance of requiring filtered DTV's in order to:

1. Protect public health in the event that it is necessary to vent.
2. Assure operators follow orders to open the vent. As in Japan, properly trained operators here are likely to decide not to open the DTV when they should because they fear the effects offsite of significant unfiltered releases.

The industry's two main arguments against filtering are:

1. The water in the suppression chamber (wetwell) is an effective filter system.
2. Filters are dangerous because of creating backpressure.

Both arguments are disingenuous.

B. Basis for Requiring Filters

NRC is petitioned to require that U.S. reactors install filtered DTV's in order to:

- Protect public health in the event that it is necessary to release.

- Assure operators follow orders to open the vent. As in Japan, properly trained operators here are likely to decide not to open the DTV when they should because they fear the effects offsite of significant unfiltered releases.

The industry's two main arguments against filtering are disingenuous. They include:

- The water in the suppression chamber (wetwell) is an effective filter system
- Filters are dangerous because of creating backpressure

1. Lessons Learned From Japan:

The Japanese have learned their lesson from Fukushima and Japan's power utilities plan to install vent systems with filters for nuclear reactors to reduce radioactive releases in the event of an accident; Americans impacted by U.S. BWR Mark I and Mark II reactors deserve the same protection.

Bloomberg - Japan to Install Vent System for Reactors after Fukushima Crisis , Bloomberg, Tsuyoshi Inajima, February 8, 2012 (PW Request Hearing EA-12-050, Exhibit 6, available NRC's EHD), reported that:

> Japan's power utilities plan to install vent systems with filters for nuclear reactors to reduce radioactive releases in the event of an accident, an industry group said.
>
> The system will cut emission of radioactive particles to less than one-thousandth of usual volumes, the Federation of Electric Power Companies, a group of 10 regional utilities, said in presentation materials at a government meeting yesterday. The companies will also install equipment to remotely vent steam and gas, it said.
>
> Meltdowns and the release of radiation at Tokyo Electric Power Co.'s Fukushima Dai-Ichi nuclear station after the March 11 earthquake and tsunami forced about 160,000 people to evacuate and made areas near the plant uninhabitable. Japan's utilities are trying to improve the safety of nuclear plants, with three of the country's 54 reactors on-line and no date set to resume commercial operations at the others.

2. Suppression Chamber (Wetwell) Insufficient Filter System

The US industry and TEPCO defended their decisions not to add filters to the DTVs by claiming that the water pool in the suppression chamber (wetwell) is as effective as some other kind of filter system that it could have installed when adding the DTVs.

This claim is incorrect. The FILTRA system installed at the Swedish Barsebäck nuclear power station, for example, was **in addition to** any filtration provided by the wetwell pool, not in place of it.[13] Barsebäck had boiling water reactors like in Fukushima and those in the US (the plant has since been decommissioned). Filters were also added to BWRs in Germany and Switzerland.

Furthermore, it's not clear how effective the filter effect of the wetwell on its own really is. A U.S. report from 1988 entitled "Filtered venting considerations in the United States[14]" writes:

> Within the United States, the only commercial reactors approved to vent during severe accidents are boiling water reactors having water suppression pools. The pool serves to scrub and retain radionuclides. The degree of effectiveness has generated some debate within the technical community. The decontamination factor (DF) associated with suppression pool scrubbing can range anywhere from one (no scrubbing) to well over 1000 (99.9 % effective). This wide band is a function of the accident scenario and composition of the fission products, the pathway to the pool (through spargers, downcomers, etc.), and the conditions in the pool itself. Conservative DF values of five for scrubbing in MARK I suppression pools, and 10 for MARK II and MARK III suppression pools have recently been proposed for

[13] The filtered venting system under construction at Barseback,1 Aug 1985 **...** A filter venting containment system, bearing the acronym FILTRA will be installed at the Swedish nuclear power plant Barseback. http://www.osti.gov/energycitations/product.biblio.jsp?osti_id=6309422

[14] Filtered Venting Considerations in the United States, R. Jack Oallman, L.G. (Jerry) Human, John (Jack) Kudrick:: http://www.osti.gov/energycitations/purl.cover.jsp?purl=/6945722-maXGrD/6945722.pdf (PW's Request Hearing EA-12-050, available NRC's EHD, as, Exhibit 7)

> licensing review purposes. These factors, of course, exclude considerations of noble gases, which would not be retained in the pool. (Emphasis added)

The decontamination factor of 5 for the Mark I containment (as used in units 1 through 5 of Fukushima Daiichi and the 23 in the U.S.) means that 80% of the radioactive substances (excluding noble gases) is retained, while 20% is released. The FILTRA system installed at 10 Swedish nuclear power plants and one in Switzerland is designed to ensure that in a severe accident 99.9% of core inventory is retained in the containment or the filters.

The difference between releasing up to 20% versus 0.1% is huge; it means up to 200 times more radioactivity is released in the system defended by TEPCO and U.S. BWR Mark I operators versus the enhanced system used in Europe and commercially available worldwide.

Japan has shown that the U.S. industry's and NRC assumptions of the scrubbing effectiveness of the wetwell are wrong. Dr. Frank von Hippel explained over thirty years ago in a briefing to the NRC that,

> For accidents in which the damage is sufficient to open large pathways from the core to the containment, there will not be sufficient water available to trap the radioactive materials of concern, nor will the pathway be so torturous that a significant amount wills tick to surfaces before reaching the containment atmosphere. Similarly if the containment fails early enough, there will be insufficient time for aerosols to settle in the reactor building floor.[15]

Further, Dr. von Hipple concluded in *Second chances: Containment of a reactor meltdown,* Bulletin of Atomic Scientists, March 14, 2012[16] that:

[15] Bulletin of Atomic Scientists: Containment of a Reactor Meltdown, Frank von Hippel, March 15, 2011, note 16 (PW's Request Hearing EA-12-050, available NRC's EHD, as Exhibit 8)
[16] http://thebulletin.org/print/web-edition/features/second-chances-containment-of-reactor-meltdown

> The unspoken argument against requiring that US nuclear power plants be retrofitted with filtered vents was that the industry thought that they were already safe enough and that the expense would be wasteful. And, as today, the commission did not want to force the industry to do more than it was willing to do.
>
> In 2002, the NRC, despite alarming evidence that a pressure vessel had almost corroded through, refused to force an owner to shutdown the reactor for inspection before its regular refueling shutdown. After a review, the NRC's own inspector general concluded: "NRC appears to have informally established an unreasonably high burden of requiring absolute proof of a safety problem, versus lack of a reasonable assurance of maintaining public health and safety."
>
> We failed after Three Mile Island in 1979 to reform the Nuclear Regulatory Commission or force improved containment designs. The tragedy in Japan may have given us another opportunity

3. Backpressure- No Excuse

Industry has argued that filters would be dangerous due to backpressure. Not so. Their argument is about saving money, not safety. Backpressure is an issue, but not an obstacle. Backpressure is an issue that is repeatedly faced at nuclear reactors, and successfully managed. For example:

- In the flow path for water drawn from the condenser and returned to the reactor vessel (BWRs) and steam generators (PWRs), there are filter/demineralizer units that create a backpressure issue.
- In the flow path from the condenser to the offgas stack for BWRs, there are HEPA and charcoal filters that create a backpressure issue.
- In the flow path from the secondary containment of BWRS to the elevated release point, there are HEPA and charcoal filters that create a backpressure issue.

The filters impose backpressure because they introduce a resistance to the flow moving through the piping and ducting. To push the flow through the filters requires a differential pressure that would not be present if the filters were not there.

In the case of the condensate paths to the reactor vessel/steam generators, the filters require the condensate pumps installed between the condensers and filters to have greater

horsepower to make sure the flow goes through the filters. It costs more money up front to buy the larger motored pumps and then more money to operate them, but those costs are outweighed by the benefits of cleaner/purer water entering the reactor vessels/steam generators.

In the case of the torus vent, if one placed a filter in the existing 8-inch diameter hardened vent pipe, it would result in the pressure inside the containment having to rise to a higher value so as to be able to push the same amount of flow through the hardened vent. This is the backpressure effect. But any engineer worth his or her salt could easily design a system to work despite this effect. This is so by the examples cited. Look at the cases of the condensate filter/demineralizer and the HEPA/charcoal filters already installed at nuclear power plants. They also faced backpressure challenges. In the condensate case, designers did not squeeze the filter/demineralizers into the existing piping. Instead, the existing piping is connected to big metal tanks called demineralizer vessels. They are many feet in diameter and there are typically around 8 of them for a plant the size of Pilgrim. By having water in two pipes flow into larger vessels, the water pressure drops along the way. The backpressure effect is offset by increasing the size of the flow pathway.

In the HEPA/charcoal filter case, the designers did the same thing. The ducting/piping is connected to a larger vessel.

In the torus vent case, a competent designer could install a sand/water/whatever filter system between the connection to the torus and the elevated release point that enabled the desired flow rate to be processed successfully. We understand that it is a ridiculously simple exercise -- the controlling factors are the design containment pressure (which is fixed), the ambient air pressure (which is defined over a fairly narrow range), the specified flow rate

through the torus vent line, and the pressure drop across the selected filter media. With these values known, one can easily determine how large the container for the filter media needs to be in order to handle the specified flow rate within the prescribed differential pressure.

It is true that installing filters in the torus vent lines will cause higher pressure inside containment than if no filters were present; but, this is not a "show-stopper." Now, operators are instructed to open the torus vents when containment pressure reaches (x) pounds per square inch (psi). At (x) psi, the opened torus vents keeps the containment pressure below the value that could cause it to catastrophically fail. When the properly designed filters are installed in the torus vent lines, the procedures may need to be revised to guide the operators to open the vent valves at (y) psi (with y psi likely being slightly below x psi to accommodate the backpressure from the filters). With a properly designed filter, the pressure reduction - if any - will be negligibly small.

Therefore, the only reason that a filter could not be installed in the torus vent line is incompetence (capable engineers are unavailable) or cheapness (funds for the capable engineer or their designs is unavailable). We have the skill set to design such a filter system. We simply need the spine to make it happen; we trust NRC will have the spine after Fukushima.

4. Multiple Filtered Designs Available & In Use Today

FILTRA-MVSS (circled) at Forsmark 3, Sweden

One example: Westinghouse FILTRA-MVSS (multi-venturi scrubber system) is described as a passive, self-regulating system for filtered pressure relief of BWR/PWR reactor containments[17]. The system is passively actuated by means of a rupture disc. A typical design basis for the system is a total loss of AC power for 24 hours leading to loss of core cooling ability. This includes a total loss of electrical power from both the external grid and all plat-specific power back-up systems, as well as loss of steam turbine-driven core cooling pumps. It says that

It is designed on Swedish regulations requiring 99.9 % of the core inventory of radioactivity (excluding noble gasses) be retained in the containment or filtered in case of venting; and it has high decontamination factors for gas -carried particles, aerosols and elemental iodines. It is fully passive for at least 24 hours after initial venting and requires no startup time.

For a BWR, the FILTRA-MVSS would be connected to the hardened vent. The filter consists of several filtration steps, all of which are contained in the tank: the multi-venturi scrubber, a water pool, a moisture separator, and finally an optional metal fiber filter.

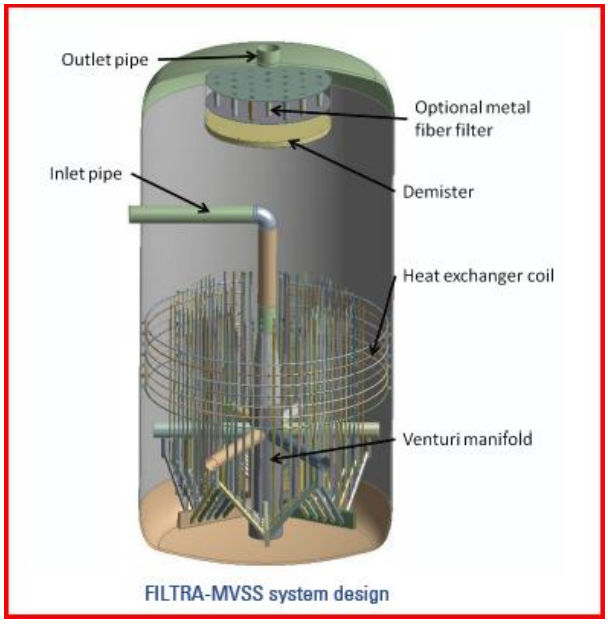
Westinghouse describes its benefits as:

- Passive design for at least 24-hours-no operator action required to activate system
- Very high removal efficiencies:
  - Aerosols > 99.00 % decontamination factor (D) > 10,000 with optional fiber filter for smallest particles
  - Elemental Iodine> 99.99% (DF> 10,000)
  - Organic Iodine: > 80% (DF>5)
  - Same DF for all flow rates
- Designed all seismic loads

[17] http://www.westinghousenuclear.com/Products_&_Services/docs/flysheets/NS-ES-0207.pdf

- Designed wide range postulated accidents
- Ability to avoid and cope with oxyhydrogen combustion
- May be used in feed-and-bleed mode for long-term core cooling

Experience: Westinghouse's FILTRA-MVSS in installed in 10 Swedish NPPs and one Swiss NPP.



FILTRA-MVSS system design

RUPTURE DISCS

A. There is a Substantial Basis for requiring rupture discs

1. **Order, EA-12-050, Attachment 2,** describes the *Requirements for Reliable Hardened Vent Systems at Boiling Water Reactors with Mark I and Mark II Containments*, it says that:

1.1 The design of the HCVS shall consider the following performance objectives:

1.1.1 The HCVS shall be designed to minimize the reliance on operator actions.

1.1.2 The HCVS shall be designed to minimize plant operators' exposure to occupational hazards, such as extreme heat stress, while operating the HCVS system.

1.1.3 The HCVS shall also be designed to minimize radiological consequences that would impede personnel actions needed for event response.

1.2 The HCVS shall include the following design features:

1.2.2 The HCVS shall be accessible to plant operators and be capable of remote operation and control, or manual operation, during sustained operations.

Nowhere is there mention of rupture discs that would satisfy the NRC's specified performance objectives.

2. Rupture Discs: The New York Times reported after Fukushima that[18] five years before the DTVs at the Fukushima Daiichi nuclear plant were disabled by the accident the DTVs were supposed to handle, engineers at a reactor in Minnesota warned American regulators about the very problem. One of the engineers, **Anthony Sarrack**, notified staff members at the NRC that the design of venting systems was seriously flawed at his reactor and others in the United States similar to the ones in Japan. He later left the industry in frustration because managers and regulators did not agree. As Mr. Sarrack said, and Fukushima proved,

> [T]he vents, which are supposed to relieve pressure at crippled plants and keep containment structures intact, should not be dependent on electric power and workers' ability to operate critical valves because power might be cut in an emergency and workers might be incapacitated.

Mr. Sarrack recommended rupture disks, relatively thin sheets of steel that break and allows venting without any operator command or moving parts when the pressure reaches a specified level. But the NRC gave into those in the industry that argued that if a

[18] *U.S. Was Warned on Vents before Failure at Japan's Plant,* NYT, Matthew Wald, May 18, 2011

disk is used that there would be not be a way to close the vent once pressure is relieved in order to hold in radioactive materials – put the "genie back in the bottle." Rather than requiring that such a "way" be provided, the NRC again saved the industry money, and effectively forgot that the major problem that needed to be faced was containment failure.

Rupture discs are provided, for example, on the Westinghouse FILTRA-MVSS described above and used in 10 Swedish reactors and one Swiss reactor.

In a 1988 document, Filtered Venting Considerations in the United States[19] (at 9), it was argued there that "[t]he main restriction by a rupture disc is the inability to vent the containment at low pressures. Postulated reasons for venting at low containment pressure include (a) to reduce driving force from the containment when anticipating vessel failure with an early drywell liner melt-through, b) to remove the containment hydrogen prior to vessel failure and early drywell liner melt- through, and (c) to reduce the containment pressure prior to a high pressure vessel failure to prevent an early containment overpressure failure."

If in fact this is an issue, an easy fix would be a bypass that would likely cost two more valves and extra pipe.

The 1988 document concluded that, "Obvious advantages of a rupture disc system include (a) suppression of venting during design basis accidents and (b) minimizing unnecessary or inadvertent venting."

[19] Filtered Venting Considerations in the United States, Oallman, Hulman, and Kudrick, OSTI (PW's Request Hearing EA-12-050, available NRC's EHD, as Exhibit 7)

Further, if the NRC had required a filtered vent, the problem of "clos[ing] the vent once pressure is relieved" would largely alleviate continued release of radioactive materials.

A rational requirement would require both filtering and redesign of the DTV venting system to include rupture discs

Further, the opening through containment created by a rupture disc in a filtered vent system is comparable to the containment bypass pathway created when steam generator tubes in pressurized water reactors fail. While the size of the opening may be larger for BWR filtered vent systems (unless multiple steam generator tubes fail), any radioactivity passing through that opening on the BWR passes through a filter before reaching the atmosphere. The flow passing through failed steam generator tubes on a PWR reach the atmosphere with no filtering. The NRC accepts the unfiltered releases through failed steam generator tubes; it should also accept filtered releases through BWR filtered vent systems.

V. Pilgrim's DTV- how it works- an example of what's wrong with the status quo

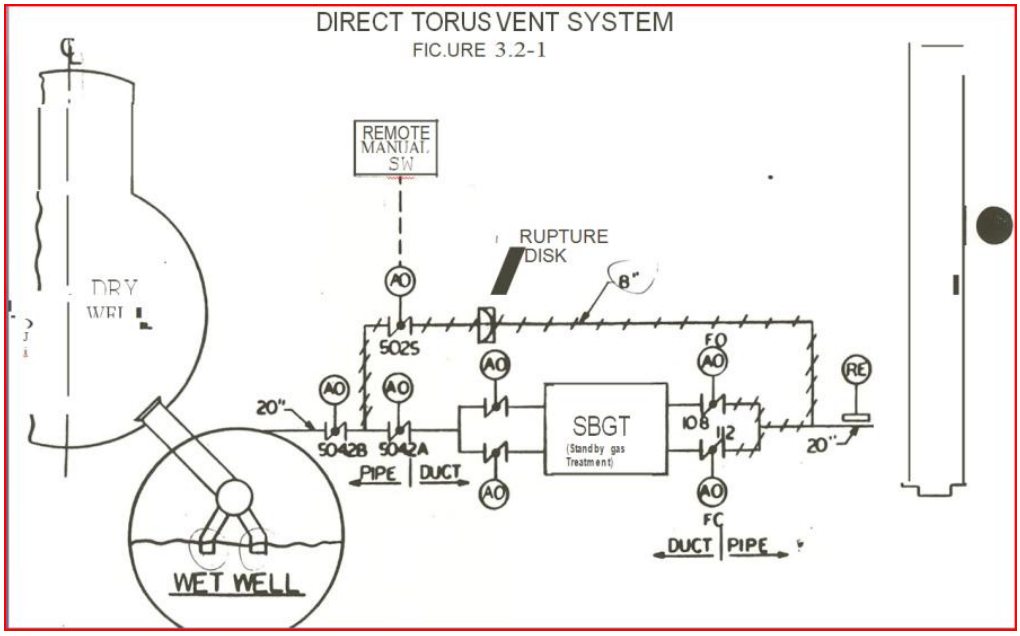
Pilgrim's DTV is described in Boston Edison's *Initial Assessment of Pilgrim Safety Enhancement, Section 3.2, Installation of DTVS* (Exh.,1) *Attachment to BECO letter 88-126, Section 3.2 Revision 1 "Installation of a Direct Torus Vent System (DTVS)* pages 14,-19B, Rev. 1 (7/25/88) (Exh., 2)

The Initial Assessment says:

> Pilgrim's DTVs provides a direct vent path from the torus air space to the main stack, in parallel with and bypassing the Standby Gas Treatment System (SGTS).

The DTVS provides a new 8" line branching off the existing torus purge exhaust line between the containment isolation valves (outside containment) with a reconnection to the existing torus purge exhaust line downstream of the SGTS. The new torus vent line is also provided with its own containment isolation valve and rupture disc, set to relieve at 30 psig.

The following diagram, that shows the branch line with its own containment isolation valve 5025 and Rupture Disc, is included in the attachment to BECO's letter. It will be noted that the Rupture Disc is downstream of valves AO-5042B and AO-5025, and that both of these values are normally closed and are designed to be opened either remotely from the control room or manually.[20]



The accompanying discussion in the BECO letter attachment says, among other things:

[20] Some initial reports indicated that the Fukushima DTV did not include "updates" that were present in US Mark I Reactors such as that at PNPS. Those reports were apparently not correct. Pilgrim Watch's understanding is that the Fukushima DTVs had been upgraded, and are essentially the same as that at PNPS (PW's Request Hearing EA-12-050, available NRC's EHD, as Exh. 2)

- The vent line provides a direct vent path from the torus to the main stack bypassing the SBGTS. The bypass is an 8" line (hatched line in diagram) –the upstream end is connected to the pipe between the primary containment isolation valves AO-5042 A & B. The downstream end of the bypass is connected to the 20" main stack line downstream of the SBGTS valves AON-108 and AON-112.
- An 8" butterfly valve (AO-5025), which can be remotely operated from the control room, is added downstream of 8" valve AO-5052B. This valve acts as the primary containment outboard isolation valve for the DTV line. Test connections are provided upstream and downstream of AO-5025.

- AO-5042B was replaced in 1988 with a DC solenoid valve (powered from essential 125 volt DC) so that it would operate without dependence on AC power. AO-5025 is also provided with a DC solenoid powered from a redundant 125 volt DC source. Both valves are normally closed and are closed in a "fail-safe" position. One inch nitrogen lines are added to provide nitrogen to valves AO-5042B and AO-5025.
- Valve AO-5025 is controlled by a remote manual key-locked control switch. During normal operation, power to AO-5025 DC solenoid will also be disabled by removal of fuses in the wiring to the solenoid valve to assure it cannot be inadvertently opened. The 7/25/88 document said that an additional fuse will be installed to power valve status indication for AO-5025 in the main control room.
- A rupture disc is included in the piping to provide a second leakage barrier. It is designed to open below containment design pressure, but will remain intact up to pressures equal to or greater than those which cause automatic containment isolation during accident conditions.

See also, Chairman Kenneth M. Carr, Responses to Concerns raised by W.R. Griffin, June 21, 1990, Enclosure 2 Possibility Of A Vacuum Breaker Remaining Open (Q.2 Response, pp.,2-3, 5) (PW's Request Hearing EA-12-050, available NRC's EHD, as Exh.,3)

- Each penetration consists of a vacuum breaker and an air operated butterfly valve in series. During normal operation, valves are closed; the vacuum breaker is maintained closed by the weight of the disc, and the butterfly valve is maintained closed by positive actuator air pressure.
- Therefore, during the entire positive pressure profile of the event, the penetration has two closed barriers in series. It is only during the end of the pressurization phase that the penetration is aligned into its vacuum breaker role. Because of this double barrier protection and the fact the both valves are not expected to change position during the pressurization phase of the event, the staff has concluded that failure of the penetration as a leak tight barrier is not credible and need not be considered in design basis.
- The fact the Pilgrim DTVS rupture disc is designed to rupture at 30 psi is not related to the NRC's recommendation that specified the venting pressure at the containment design pressure. The set pressure for the rupture disc does not control the venting pressure because there are two closed isolation valves in the flow path.
- These two valves are normally closed and will open manually by the operator if venting is needed. The maximum containment pressure at which the operators are expected to open the vent valve is 56 psig (not 60 psi), which is the NRC recommendation on venting pressure.
- The rupture disc is designed to serve as an additional leakage barrier at pressures below 30 psi. It is designed to open below the containment design pressure, but will be intact up to a pressure equal or greater that those pressures that cause an automatic containment isolation during an accident conditions. Therefore, its presence in the line can effectively eliminate the negative consequences of inadvertent actuation of the vent valves at pressures below 30 psi. The set pressure of 30 psi for the rupture disc satisfies these design objectives.
- The isolation valves, AO-5025 and AO-5042B, are designed with ac independent power supplies. These two valves are powered from essential dc power and are backed up with diverse nitrogen actuation capability. Therefore

> in case of an SBO event, the valves would be available for venting. The venting concept is mainly designed to slow overpressure transients of the containment. During some ATWS (anticipated transient without scram) events, the pressure in the containment will rapidly increase. Venting pressure could be reached in a matter of minutes rather than hours. Therefore venting may not prevent containment failure because of the high containment pressurization rate but would provide additional time to scram the reactor and delay the core melt.

In other words and greatly simplified, the DTV will vent excess pressure from the containment *only* if normally closed valves AO-5025 and AO-5042b can be opened.

At Fukushima, TEPCO was unable to open the normally closed valves in all three DTV's, and there is no redundancy.[21]

Pilgrim's control room has 2 key locked switches in series that have to be opened manually when the need to use the DTV occurs. If, as happened at Fukushima, the normally-closed isolation valves cannot be opened from the control room, the next step is to try to open the isolation valves manually – but this also proved impossible at Fukushima since radiation levels were too high.

Failed Valves: Pilgrim's DTV isolation valves appear to be essentially the same as those that failed at Fukushima. Supposedly "automatic" systems do fail (as they did at Fukushima) and manual systems may also (both mechanically and because radiation is too high to permit manual operation). Why is there no redundancy?

[21] Redundancy, of course, could have been provided at both Fukushima and Pilgrim, e.g., by a parallel vent line with a 50-55 psig rupture disc followed by a normally open valve that would be closed when pressures had dropped to an accept able level, but that would have cost the industry more money.

DC Batteries: *Pilgrim Nuclear Power Station Individual Plant Examination For Internal Events Per Gl-88-20, Volume 1*, Prepared by Boston Edison Co., September 1992 (Exh.4) says that:

- [T] he direct torus vent requires both DC batteries for operation (C.2-10)
- 125VDC Bus (Battery) "A" This bus is required for operation of the direct torus vent. (C.2-14)
- 125VDC Bus (Battery) "B" This bus is also required for operation of the direct torus vent. (Ibid)
- The containment torus venting system would be unavailable if one DC division is unavailable. (C-4-8)

CONCLUSION

It is not new that Pilgrim's, or any other BWR Mark I's, containment will not hold up if too much pressure builds up inside nor that U.S. Mark I's like their sister Fukushima reactors installed an unfiltered vent to let radioactive gases out in an accident. What is new are two significant pieces of information.

The first is that we now know that an unfiltered vent has unintended consequences beyond poisoning unnecessarily offsite neighborhoods – it makes operators hesitant to use the vent until perhaps too late, upping the probability of containment failure/explosions.

The second is the likely failure of the DTV itself absent being made completely passive by properly installing relief valves as described in the foregoing. Before Fukushima the DTV had not been tested. At Fukushima, DTV systems failed three times in their first real-world tests.

The final cost of the Fukushima disaster remains to be calculated, but it is clearly billions of dollars making these requested fixes cheap. The cost is fully justified; risk for the public will be reduced significantly. Citizens should not be faced with the equivalent of having been assured that we had life boats but not told either that crewman won't launch them or that that they don't float.

III. EMERGENCY PLANNING ISSUES

EPZ Size-KI-Monitoring

Expanding the size of the EPZ; stockpiling KI within 25 miles; and installing real-time combination radiation/ meteorological towers in appropriate offsite locations offsite, based on site-specific meteorological analysis, and linked to appropriate state health and emergency planning agencies are no-brainers and should not be placed on the back-burner (Tier 3) but required now.

A. EXPAND EPZ:

1. Introduction: NIRS and 37 other organizations submitted a formal Petition for Rulemaking to the NRC to expand emergency evacuation zones around U.S. nuclear reactors and make other improvements in emergency preparedness. (PRM-50-104, Docket ID NRC-2012-0046) The Petition was filed based on the widespread radioactive contamination caused by the Fukushima nuclear disaster (and Chernobyl before it) that makes clear that the current 10 mile Emergency Planning Zones in the U.S. are woefully inadequate to protect the American people. 150,000 people in Japan were evacuated from more than 25 miles away from Fukushima Daiichi, and hundreds of thousands more remain in contaminated areas. Yet 80% of the airborne radiation released by Fukushima blew over the Pacific Ocean rather than over populated areas. We can't

count on a favorable wind to protect the American people from a nuclear accident.

The Petition for Rulemaking, and rationale provided, would make major changes to existing emergency planning regulations that should be implemented now by the Task Force in response to Lessons Learned from Fukushima:

- Expand the current Emergency Planning Zone from 10 to 25 miles;
- Create a new Emergency Response Zone in a 25 to 50 mile radius from nuclear reactors;
- Expand the existing Ingestion Pathway Zone for interdiction of contaminated food, milk and water from 50 miles to 100 miles.

Instead, contrary to all logic, NRC and FEMA are shrinking the EPZ by changing to evacuating only 2-miles around the reactor and a small portion of the "key-hole" from 2-5 miles-perhaps expanding further depending on circumstances. Clearly this has nothing to do with public safety; but everything to do with the fact that areas around reactors have become densely populated with insufficient infrastructure to provide a timely evacuation.

2. Evidence Consequences Can Extend Beyond 10-Miles

a. Reactor Accident Consequences

CRAC-11 Report: Sandia National Laboratory's report from 1982, *Calculation of Reactor Accident Consequences* (referred to as the ―CRAC-2 report) calculated reactor accident accidents for US Nuclear Plants.[22] Sandia's calculations extended well beyond 10-miles and

[22] Calculation of Reactor Accident Consequences U.S. Nuclear Power Plants (CRAC-2), Sandia National Laboratory, 1982

were conservative.[23] Example: Core melt at Pilgrim NPS, would result in a 20 miles peak 1st year fatal radius; a 65 miles peak 1st year injury radius.

Chernobyl: The Chernobyl accident demonstrates that dangerously high levels of radiation can extend tens to hundreds of miles beyond the 10-mile radius and 50-mile ingestion pathway (i.e., the area within which people could be at risk if they eat or drink contaminated food or water. Exposure beyond 10-miles is not limited to ingestion. For example, Dr. Jean Temeck (FDA representative to NRC's KI Core Group Meeting, Tempe Arizona, March 4, 1999) said definitively that exposure to children after Chernobyl resulted from "a combination of inhalation and ingestion" in her speech to the NRC's KI Core Group, March 4, 1999.

Fukushima: A sampling of news reports:

> Catastrophic nuclear accidents such as the core meltdowns in Chernobyl and Fukushima are more likely to happen than previously assumed," said *Science Daily*, about the report by scientists at the Max Planck Institute for Chemistry in Mainz, Germany. Based on "the number of nuclear meltdowns that have occurred," they "calculated that such events may occur once every 10 to 20 years." And impacts would be global--like Chernobyl and Fukushima. Their computer analyses, said *Science Daily*, found for the leading radioactive poison discharged in a nuclear plant accident, Cesium-137, some 8% can be expected to fall within 50 kilometers (31.0685 mi) of the accident site, 50% beyond 1,000 kilometers (621.371 mi.) and 25% beyond 2,000 kilometers (1242.742 mi.) "These results underscore that reactor accidents are likely to cause radioactive contamination well beyond national borders," said *Science Daily*.
>
> (http://www.sciencedaily.com/releases/2012/05/120522134942.htm)

[23] The federal study, CRAC II used census data from 1970; assumed the entire 10-mile EPZ would be evacuated within at most six hours after the issuance order; assumed aggressive medical treatment for all victims of acute radiation exposure in developing numbers for early fatalities and used a now obsolete correlation between radiation dose and cancer risk that underestimated the risk by a factor of 4 relative to current models; sampled only 100 weather sequences out of over eight thousand (an entire year's worth), a method that underestimates the peak value over the course of a year by 30%.

High dosage of cesium found in soil outside Fukushima no-go zone-(Mainichi Japan) October 5, 2011

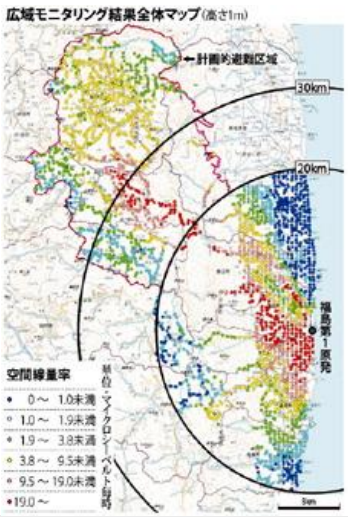
A worker from the Japan Atomic Energy Agency measures radiation levels in a sandbox at the Fukushima University-affiliated kindergarten in Fukushima on May 8, 2011. (Mainichi)

TOKYO (Kyodo) -- High levels of radioactive cesium were found in an independent study in a Fukushima city district, prompting a citizens group and others involved to urge the government on Wednesday to promptly designate the area as one of the contamination hot spots for possible evacuation and ensure proper decontamination.

Up to 307,000 becquerels of cesium per kilogram of soil was detected in the Sept. 14 survey triple that of the benchmark above which the government requires tainted mud to be sealed by concrete. The contamination is believed to have been caused by radiation leaked by the Fukushima Daiichi nuclear plant crippled in the March 11 earthquake and tsunami disaster.

The readings are comparable to the high levels in special regulated zones where evacuation was required after the 1986 Chernobyl accident, said the citizens group, Citizens Against Fukushima Aging Nuclear Power Plants.

It urged the government to designate the area as one of the hot spots, where residents are urged to evacuate, albeit not mandatory, due to accumulation of radiation in certain districts and would be eligible for state assistance if they decide to do so.



A government map displaying radiation levels in the area around the Fukushima No. 1 Nuclear Power Plant.

Kobe University professor Tomoya Yamauchi, who was in charge of the study that tested soil samples from five locations in and around the district, noted that decontamination conducted in some of the areas tested has not yet succeeded in reducing radiation back to the same levels prior to the March accident.

The Japanese government currently has designated two categories of evacuation zones -- the 20-kilometer no-go zone around the Fukushima Daiichi plant, and hot spots outside the zone where radiation level is expected to top 20 millisieverts a year.

The city of Fukushima is about 60 km from the crippled plant.

Panel proposes widening nuclear evacuation perimeter to 30 km (18 miles)

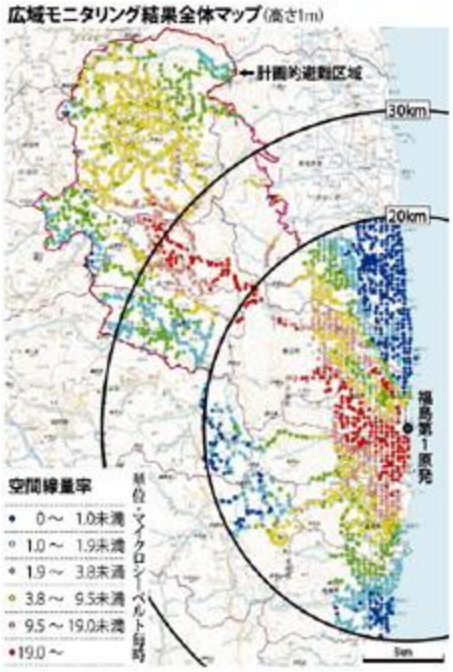
Residents dressed in clothing to protect them from radiation prepare to board a bus on Aug. 26 ahead of temporary visits to their homes within three kilometers of the crisis-hit Fukushima No. 1 Nuclear Power Plant. (Mainichi)

TOKYO (Kyodo) -- The secretariat of the Nuclear Safety Commission of Japan proposed on Thursday expanding the maximum evacuation perimeter around a nuclear power plant to a 30-kilometer radius from the current 10 km in the event of a future nuclear accident.

The secretariat also proposed newly designating a 5-km radius around a nuclear plant as a zone from which people should immediately be evacuated following a plant accident.

The proposal was shown to the commission's working group reexamining evacuation rules for nuclear accidents in the wake of the disaster at the Fukushima Daiichi nuclear power plant in Fukushima Prefecture triggered by the massive earthquake and tsunami in March.

While 44 municipalities fall within the current 10-km radius from a nuclear power plant, the proposed expansion increases the number to 135 including heavily populated prefectural capital cities such as Mito, Kyoto and Kagoshima.



A government map displaying radiation levels in the area around the Fukushima No. 1 Nuclear Power Plant.

The central and local governments are thus likely to drastically review their preparations for a nuclear accident if the proposal is put into effect, analysts said.

The proposal also includes stocking iodine tablets in advance within a 50-km radius (31 miles) from a nuclear plant to prevent the exposure of the thyroid gland to radiation.

http://ajw.asahi.com/article/0311disaster/fukushima/AJ201201070039

Government envisioned Tokyo evacuation in worst-case scenario
January 07, 2012 Asahi Shimbun

In a worst-case scenario, the central government would have requested the evacuation of Tokyo and everyone within a 250-kilometer radius of the damaged Fukushima No. 1 nuclear power plant.

Goshi Hosono, minister in charge of the nuclear disaster, on Jan. 6 unveiled the emergency plan, which was personally drawn up two weeks after the Great East Japan Earthquake by Shunsuke Kondo, chairman of the Japan Atomic Energy Commission.

The plan would have ordered mandatory evacuations of everyone within a 170-km radius of the plant. Evacuations would have been voluntary for those living between 170 km and 250 km from the plant, including the Japanese capital.

After the March 11 earthquake, Hosono, then special adviser to Prime Minister Naoto Kan, asked Kondo to produce reports on possible scenarios at Kan's behest.

Hosono said the government had not disclosed the report, which had been submitted on March 25, out of concern over public reaction.

"We had refrained from publicizing it because we were afraid that it could cause the public to grow excessively worried," he said.

He also said the government took into consideration the possibility that the No. 1 reactor at the plant would explode, even though chances were slim at that time.

The worst-case scenario imagined the melting of 1,535 fuel assemblies, an equivalent of fuel used for two reactors, kept in a spent fuel storage pool at the No. 4 reactor.

Although the No. 4 reactor had been shut down for maintenance before March 11, the roof of the building housing the reactor was blown off by a hydrogen explosion on March 15, leaving the spent fuel storage pool exposed to the atmosphere.

The building housing the No. 1 reactor had already been destroyed by a hydrogen explosion on March 12, after a blackout and failure of emergency power sources to cool the reactors.

The scenario envisioned that if another hydrogen explosion took place at the No. 1 reactor, workers would be forced to flee and suspend recovery operations, resulting in an enormous amount of radioactive material released from the pool in two weeks.

The report also predicted the extent of soil contamination of areas required to evacuate in light of standards set after the 1986 Chernobyl accident in Ukraine.

The scenario said areas within a 170-km radius of the plant would have been contaminated with 1,480 kilobecquerels per square meter, a level that requires mandatory evacuation.

Areas where the government would have requested voluntary evacuations were predicted to have 555 kilobecquerels per square meter, extending to a 250-km radius, which included Tokyo and surrounding areas.

If the release of cesium was limited to an equivalent of one reactor, the mandatory evacuation zone would have been a radius of 110 km and recommended evacuation a radius of 200 km.

The report said it would have taken several decades for radiation levels to decrease naturally in the mandatory and voluntary evacuation zones.

The report also said high radiation levels could have extended beyond the 250-km radius, and people in those areas would have also been advised to relocate.

High levels of radioactive cesium detected in Yokohama-(Mainichi Japan) February 4, 2012

YOKOHAMA (Kyodo) -- High levels of radioactive cesium were found in an area that used to be used as a waterway near an elementary school in Yokohama's Seya Ward, Yokohama city officials said Friday.

Local officials detected 6.85 microsieverts per hour of radioactive cesium in the air about 1 centimeter above the ground and found that nearby soil contained 62,900 becquerels of the element per kilogram.

The city government sees the high radiation levels to be likely caused by the nuclear crisis at the Fukushima Daiichi power plant and plans to decontaminate the area, the officials said.

While the area is close to the elementary school, it is closed off by a fence, the officials said. "The radiation dose on the elementary school premises is not high but we will examine the situation in detail," an official said.

> Officials of Seya Ward checked the area Friday after being notified the previous day by residents who had conducted their own measurement.
>
> (Mainichi Japan) February 4, 2012

Last there is ample evidence of food contamination spreading far beyond 50 miles.

Jet Fuel Fires: In the event of aircraft related attack resulting in radiological release, fire and smoke from burning jet fuel can carry radioactivity to higher altitudes and subsequently disperse radioactivity far beyond the 10-mile emergency zone.

b. Spent Fuel Pool Accident Consequences

License Renewal Adjudications Pilgrim, ENVY, Indian Point: Vulnerability analyses of spent fuel pools show that spent fuel pools are not immune to accidents resulting from equipment failure, personnel mishaps, or acts of malice. The consequences of a spent fuel pool accident are likely to exceed the consequences from a core accident because of the far greater amount of radioactivity in the pool.[24] For example, at Pilgrim the inventory of long-lived radionuclides, such as Cesium-137, in the spent fuel pool is eight times that in the reactor core. For reference, consider that the 1986 Chernobyl accident released 2,403,000 curies of C-137; whereas Pilgrim's core, for example, during license extension will have 5,130,000 curies of C-137; and at Pilgrim the inventory of long-lived radionuclides, such as Cesium-137, in the spent fuel pool is eight times that in the reactor core.[25] However emergency planners ignore accidents in spent fuel pools

[24] 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.

[25] Ibid

despite analyses performed by the Massachusetts and New York Attorney General's Offices in license renewal adjudication cases.

National Academy of Sciences: Prior to the filings of the Massachusetts and New York State Attorney Generals in license renewal, the National Academy of Sciences, *Safety and Security of Commercial Spent Nuclear Fuel Storage Public Report*, April 2005, said that if a terrorist attack on the spent fuel pool leads to a zirconium cladding fire; it could result in large amounts of radioactive material spreading hundreds of miles.

> "Finding 3B … a terrorist attack that partially or completely drained a spent fuel pool could lead to a propagating zirconium cladding fire and the release of large quantities of radioactive materials to the environment. Details are provided in the committee's classified report." NAS, 6
>
> "Such (zirconium cladding) fires would create thermal plumes that could potentially transport radioactive aerosols hundreds of miles downwind under appropriate atmospheric conditions." NAS, 50
>
> "The excess cancer estimates …to between 2,000 and 6,000 cancer deaths." NAS, 45

Brookhaven Report: A 1997 Brookhaven National Lab Report (―A Safety and Regulatory Assessment of Generic BWR and PWR Permanently Shutdown Nuclear Power Plants‖) claims that a disaster from a spent fuel pool could make an area up to 2,790 square miles around the plant uninhabitable.

Waste Confidence Rule: Bases of rule unsupported found by DC Appeals Court.

c. Spent Fuel Pool Fire Accompanied by a Reactor Accident

A spent fuel pool fire accompanied by a reactor accident is a credible event and releases would exceed 10- miles. At typical US nuclear power plants the spent-fuel pool may be located

outside but immediately adjacent to the reactor's containment and share some essential support systems with the reactor; or the pool may be inside the main reactor building and again share some essential support systems with the reactor. Thus, it is important to consider potential interactions between the pool and the reactor in the context of accidents. There could be at least three types of interaction. First, a pool fire and a core-damage accident could occur together, with a common cause. For example, a severe earthquake could cause leakage of water from the pool, while also damaging the reactor and its supporting systems to such an extent that a core-damage accident occurs. Second, the high radiation field produced by a pool fire could initiate or exacerbate an accident at the reactor by precluding the presence and functioning of operating personnel. Third, the high radiation field produced by a core-damage accident could initiate or exacerbate a pool fire, again by precluding the presence and functioning of operating personnel. Many core-damage sequences would involve the interruption of cooling to the pool, which would call for the presence of personnel to provide makeup water or spray cooling of exposed fuel. The third type of interaction was considered in a license-amendment proceeding in regard to expansion of spent-fuel-pool capacity at the Harris nuclear power plant.

Local Meteorology/Geology Likely To Contain/Concentrate, Not Disperse/Dilute, Plume

The likely spread of radiation beyond 10- miles that necessitates protective action for the public requires planners to understand current meteorological understanding concerning the flow of air in coastal areas, river valleys, lake regions, and hilly terrain. Winds are variable in these locations and the spread of a concentrated release of radiation may be carried at a far greater distance. Examples:

Sea Breeze (applies to any large body of water – ocean/lake): There is a misconception that the sea breeze is generally a highly beneficial phenomenon that disperses and dilutes the plume concentration and thereby lowers the projected doses downwind from the release point. However, if the same meteorological conditions (strong solar insolation, low synoptic-scale winds) that are conducive to the formation of sea breezes at a coastal site occurred at a non coastal location, the resulting vertical thermals developing over a pollution source would carry contaminants aloft. In contrast, at a coastal site, the sea breeze draws contaminants downward across the land and inland subjecting the population to larger doses.

Behavior Plumes over Water: Planning should, but does not, reflect understanding of the flow of air over and around large bodies of water. As an example at Pilgrim, located on New England's Coastline, winds initially headed out to sea will remain tightly concentrated due to reduced turbulence over water until the winds blow the puffs back over land.[26] This can lead to hot spots of radioactivity in unexpected places - beyond 10 miles that should be instructed and prepared to take protective actions. For example, the compacted plume could be blown ashore to Cape Cod, directly across the Bay from Pilgrim and heavily populated in summer. The summer population is about 600,000, the year round about 210,000. However because the Cape is outside the 10 - mile EPZ, there are no plans to evacuate or shelter the population in the event of a radiological disaster at Pilgrim.

[26] Zager M, Tjernstrom M, Angevine W. 2004, New England coastal boundary layer modeling. In: AMS 16th Symposium on boundary Layers and Turbulance, August 2004, Portland, Maine. Angevine WM. Tjernstrom M, Senff CJ, White AB. 2004. Coastal Boundary layer Transport of urban pollution in New England In: 16th Symposium of boundary layers and turbulence Portland, Maine, 13th Symposium on Turbulance and diffusion, August 2004, Portland, Maine. Angevine WM. Tjernstrom M, Zager M. 2006. Modeling of the Coastal Boundary Layer and Pollutant Transport in New England, J. of Appl. Meteorol. & Climatol. 45: 137-154. Scire JS, Strimaitis DG, Yamatino RJ. 2000 A User's Guide for the CALPUFF Dispersion Model (Version 5). Concord MA: Earth Tech, Inc.

Diffusion at Valley Sites – Gravity Drainage:[27] With no solar heating at night, the earth cools. Higher elevations cool faster; cool air flows towards warmer air in the valley. This flow is known as gravity drainage. In the absence of other influences, the drainage, compacted plume, will head downriver.

Summary: The aforementioned evidence indicates that NRC should enhance emergency preparedness regulation and guidance by requiring the necessary changes so that they reflect that the plume exposure pathway extends beyond 10-miles.

B. POTASSIUM IODIDE

There is a need to stockpile KI beyond 10-miles, as appreciated by Congress and ironically by NRC in their very own studies. In fact Japan has learned its lessons and planning to stockpile KI in communities beyond 10 miles-only the U.S. appears not to learn lessons from previous accidents going back to TMI.

1. Federal studies indicate that the consequences of an accident can spread well beyond 10-miles. *Calculation of Reactor Accident Consequences U.S. Nuclear Power Plants (CRAC-II), Sandia National Laboratory*, 1982 states: The consequences of a core melt at Pilgrim NPS, for example, would result in a 20 miles peak 1st year fatal radius; a 65 miles peak 1st year injury radius; and 23,000 peak cancer deaths.

[27] The State Of New York's Motion For Summary Disposition On Use Of Straight Line Gaussian Air Dispersion Model For The Environmental Impact Analysis Of Significant Radiological Accidents At Indian Point And NYS Contention 16/16A, (DPR-26, DPR-64) August 28, 2009, Declaration of Bruce A. Egan, Sc.D., explains that concentrated radiation can spread at distances far greater than 10-miles along river valleys.

These estimates are conservative. The federal study, CRAC II (colon deleted) used census data from 1970; assumed the entire 10-mile EPZ would be evacuated within at most six hours after the issuance order; assumed aggressive medical treatment for all victims of acute radiation exposure in developing numbers for early fatalities and used a now obsolete correlation between radiation dose and cancer risk that underestimated the risk by a factor of 4 relative to current models; sampled only 100 weather sequences out of over eight thousand (an entire year's worth), a method that underestimates the peak value over the course of a year by 30%.

2. NRC's site specific consequence plume models are inaccurate because they use a steady-state straight-line Gaussian plume distribution model when instead variable trajectory models are needed due to the complexity of winds at reactor sites resulting from the sea-breeze or lake effect and wind variability resulting from hills, river valleys, and building clusters. Use of the appropriate variable trajectory models would demonstrate that plumes and consequences extend further than currently projected, thereby justifying KI distribution beyond 10 miles.

3. The reason to provide KI in the 10-20 mile zone is because of the possibility of inhalation during an accident of significant consequence. For example, Dr. Temeck (FDA representative to NRC's KI Core Group Meeting, Tempe Arizona, March 4, 1999) stated that exposure to children after Chernobyl resulted from "a combination of inhalation and ingestion."

4. NRC's NUREG-1633 points out that radioactive iodide can travel hundreds of miles on the winds. An increase in cancer caused by Chernobyl was detected in Belarus, Russia and Ukraine. Notably, this increase, seen in areas more than 150 miles from the site, continues to this day and primarily affects children who were 0-14 years old at the time of the accident…the vast majority of the thyroid cancers were diagnosed among those living more than 31 miles from the

site. The 2001 figures showed 11,000 thyroid cancers at 31 miles. Again, "Exposure to children after Chernobyl resulted from "a combination of inhalation and ingestion."

5. NRC's NUREG/CR 1433 said that for children, the following dangers might occur from the inhalation of nuclear materials after a massive core-melt atmospheric accident (like Chernobyl):

Approximate Dangers of a Core-Melt Atmospheric Accident for Children

Distance in Miles	Mean Thyroid Dose (rem) for Exposed Children Outdoors*	Probability of Thyroid Damage to Exposed Children Located Outdoors if not Protected by Stable Iodine (like KI)
1	26,000	100%
5	11,600	100%
10	6,400	100%
25	2,200	**80%**
50	760	**26%**
100	200	7%
150	72	2%
200	32	1%

6. Stockpiling KI is endorsed by health professionals across the nation and world.

KI is recommended, for example, by: U.S. Food and Drug Administration; World Health Organization; American Thyroid Association; American Academy of Pediatrics; International Agency Atomic Scientists; National Academy of Sciences; National Council on Radiation Protection; Federation of American Physics; Physicians for Social Responsibility; Union of Concerned Scientists; and locally for example the Massachusetts Medical Society (MMS) July 22, 2002 adopted a policy which calls for providing thyroid-blocking agents to all Massachusetts communities for protection against radioiodine. Further we know that nations around the world have routinely stockpiled potassium iodide for many years.

7. Stockpiling KI is not difficult to implement. Is stockpiling and distributing KI really all that difficult? No. Each state has an emergency management structure already in place – from the state down to the local community. Some states and some local communities have existing KI Plans and Procedures out to 10 miles; it is not difficult to extend the plan an additional 10 miles. The Commonwealth of Massachusetts already passed legislation to stockpile communities on Cape Cod, the Islands and Cape Ann – located outside the 10-mile Emergency Planning Zones of Pilgrim NPS and Seabrook NPS.

States already provide KI to emergency workers and institutionalized populations-- so a procedure is already in effect that triggers who shall make the "official" call to administer KI, when and how.

Schools and other institutions have medical release forms that permit administering medication to minors in the absence of a guardian/parent. They simply have to add KI to that permission form. A master list can be created of the names of public school children at the same time the medical permission form is completed and a procedure established to obtain consent from non-public school minors. Files can be kept up-to-date and ready to transfer to shelters and Reception Centers, if needed.

It is not difficult to determine where to stockpile: schools, shelters, correctional facilities, group homes, Reception Centers, other institutions and finally, to provide a stockpile for citizen's personal use and for workers at their place of work. The stockpile for personal use can be kept at the local Fire Station, for example. It is open 24-hours a day. The workplace stockpile can be sent, quite obviously, to the place of work.

Public education is the key to any public health program. We all agree it is work that must be done in a healthy society for the benefit of all. While others have lost the will to stay on course, we continue to have the will to implement this critical section on our behalf.

8. The NRC's dogged Opposition to Stockpiling KI

For example, the NRC opposed the enactment of Section 127; NRC staff consistently has opposed stockpiling potassium iodide going back decades; and worse NRC staff has provided misinformation to another Government agency and to the public on the subject of potassium iodide (KI). For example: On November 1, 2005, William F. Kane, Deputy Executive Director for Reactor and Preparedness Programs, sent a letter to Dr. Robert Claypool of the Department of Health and Human Services. It seriously distorted the findings of the report on KI issued in 2004 by the National Research Council of the National Academies of Science (NAS). The essence of the NRC letter to HHS was that in the event of a radiological emergency that releases radioiodines, the only pathway of concern beyond the 10-mile radius is the ingestion pathway, that this can be addressed by testing and interdiction of milk and other foods, and that distribution of KI beyond the 10-mile radius is therefore unnecessary. The NRC letter claims to base its conclusions on the NAS report, and even declares that "the Academy raised questions about the usefulness of expanded distribution of KI." The NRC letter quoted with approval one sentence from the NAS report, from page 159, while omitting the four preceding sentences, which were essential if the meaning of the quoted sentence was to be understood correctly. NRC's letter quoted simply,

> KI is also effective for protection against the harmful thyroid effects of radioiodine ingested in contaminated milk and other food, but food testing and interdiction programs in place throughout the United States are more effective preventive strategies for ingestion pathways.

The four preceding sentences in the NAS report that NRC artfully omitted read,

> In the event of nuclear accidents or as a result of nuclear terrorism, radioiodine could be released to the environment. Because iodine concentrates in the thyroid gland, exposure to radioiodine by inhalation of contaminated air or ingestion of contaminated milk and other foods can lead to radiation injury to the thyroid, including risk of thyroid cancer and other thyroid diseases. Thyroid radiation exposure from radioiodine can be limited by taking stable iodine. KI is a chemical compound that contains iodine and can be used to protect the thyroid gland from possible radiation injury by reducing the amount of radioiodine concentrated by the thyroid after inhalation of radioiodine.

Far from having "raised questions regarding the usefulness of expanded distribution of KI," as the NRC letter claimed, the NAS report made clear that depending on site-specific factors, KI might be desirable beyond the 10-mile EPZ, since the 10-mile radius does not necessarily correspond to the actual risk presented. See Recommendation 2, from p. 160, of the section on "Benefits of and Risks Posed by Potassium Iodide Distribution":

> KI distribution should be included in the planning for comprehensive radiological incident response programs for nuclear power plants. KI distribution programs should consider pre-distribution, local stockpiling outside the emergency planning zone (EPZ), and national stockpiles and distribution capacity. [Boldface in the original.]

And, from p. 161 of the NAS report, is its conclusion on "Implementation Issues Related to Potassium Iodide Distribution and Stockpile Programs":

> Conclusion: A strategy is needed whereby local planning agencies could develop geographic boundaries for a KI distribution plan based on site-specific considerations because conditions and states vary so much that no single best solution exists. [Boldface in the original.] KI distribution planning in the United States has focused on the Nuclear Regulatory Commission's early-phase Emergency Planning Zone (EPZ) of a 10-mile radius. However, the EPZ provides only a basis for planning. A specific incident might call for protective actions to be restricted to a small part of the EPZ or require that they be implemented beyond the EPZ as well. See Chapters 5 and 7 for details.

By saying "no single best solution exists," the NAS report is stating, in unmistakable terms, that applying the standard 10-mile radius to all situations is inappropriate. But the NRC letter strives to give exactly the opposite impression.

Similar NRC deception is shown in the use of the quotation from page 81 of the NAS report. (This is the passage in the letter beginning with “Exposure to radioactive iodine is possible through the ingestion pathway..." and ending with "... “That also eliminates the need for the use of KI by the general public as a protective action.") The last sentence of the quoted passage sounds dispositive indeed, but what the NRC letter neglects to mention is that this is from a section of the report, beginning on p. 79, that is entitled "Intermediate Phase Planning," and refers only to the period after the plume has passed, when inhalation is no longer an issue.

This sort of game-playing with words on an issue affecting the health and safety of American children, has been repeated time again by Patricia Milligan (sometimes under the pen-name of Patricia M. Sullivan), Senior Advisor for Emergency Preparedness, US Nuclear Regulatory, at stakeholder meetings on emergency planning and most recently at public hearings on re-licensing in Plymouth, Massachusetts.

This deception goes back a long way. For example, at a public meeting on November 5, 1997, a senior NRC staff official apologized to FEMA officials for having "misrepresented" FEMA's position on KI.

It will likewise be recalled that the NRC Commissioners, after authorizing publication of "NUREG-1633," a staff analysis of KI, in the summer of 1998, ordered it withdrawn from circulation after scathing comments from state health officials alerted the Commissioners to its numerous misstatements and distortions. This NRC document, 40 pages long, managed not to

mention the FDA's finding that KI was "safe and effective." The staff twice attempted to secure Commission approval of a revised version of the document, and twice failed, after which the Commissioners ordered work on the document to stop.

No doubt those Commissioners who were around at the time also recall that the Commission was forced to apologize to a Member of Congress for having supplied him with an inflated number for the cost of a nationwide KI program. Supposedly it was an honest mistake of multiplication, though it is baffling that anyone who succeeded in completing elementary school could have multiplied 70 (the number of nuclear sites) by 80,000 (the average number of residents in the EPZ) by $.50 (the estimated cost of two KI pills) and come up with a figure of $3,250,000.

9. Lessons Learned from Fukushima, examples:

Japan Times, Fukushima children found to have thyroid irregularities, Kyodo News, 2011/10/05

A test conducted among children from within the no-go zone of the crippled Fukushima Daiichi nuclear plant and nearby towns has revealed hormonal and other thyroid irregularities, the **Kyodo News reported**.

The Japan Chernobyl Foundation and Shinshu University Hospital conducted the testing of 130 children up to the age of 16, including month-old babies. Out of this number, 10 were found to have thyroid irregularities.

The testing discovered that 8 of the 10 children were found with abnormal thyroid hormone levels while two children were diagnosed with “slightly high blood concentrations of a protein called thyroglobulin”.

Of the ten children found with irregularities, 3 used to live in the no-go zone of the damaged plant, 1 from an area within the 20 to 30 kilometers from the plant, and 6 came from more distant towns.

Minoru Kamata of the Japan Chernobyl Foundation said that while the children are not considered “ill”, it would be necessary to put them into long-term observation.

The Foundation undertook the test until the end of August in Nagano where these children have been living after they were evacuated from the crippled nuclear plant.

The March 11 quake and tsunami caused a nuclear accident in Fukushima Daiichi power plant which has since dispensed radioactive materials into the environment. It is said that radioactive iodine is likely to accumulate in the thyroid glands of babies and children which increases the possibility of cancer in later years.

Evacuee kids' thyroids need monitoring, Japan Times, Oct 5, 2011
Kyodo

NAGANO — Hormonal and other irregularities were detected in the thyroid glands of 10 out of 130 children evacuated from Fukushima Prefecture, a Nagano Prefecture-based charity dedicated to aid for the victims of the 1986 Chernobyl nuclear accident said Tuesday.

The Japan Chernobyl Foundation and Shinshu University Hospital did blood and urine tests on youngsters aged up to 16, including babies under age 1, for about a month through the end of August in Chino, Nagano, when the children stayed there temporarily after evacuating from Fukushima.

No clear link has been established between the children's condition and the radiation from the crippled Fukushima No. 1 nuclear plant, according to the nonprofit organization.

"At present, we cannot say the children are ill, but they require long-term observation," said Minoru Kamata, chief of the foundation.

As a result, one child was found to have a lower-than-normal thyroid hormone level and seven had thyroid stimulation hormone levels higher than the norm. The remaining two were diagnosed with slightly high blood concentrations of a protein called thyroglobulin, possibly caused by damage to their thyroid glands. Three of the 10 children used to live within the 20-km no-go zone around the nuclear plant and one was from the so-called evacuation-prepared area.

Japan Officials Failed to Hand Out Radiation Pills in Quake's Aftermath, Yuka Hayashi, Mainichi Daily News, Oct 5, 2011

TOKYO—Government officials failed to distribute to thousands of people pills that could have minimized radiation risks from the March nuclear accident, government documents show.

The disclosure is the latest evidence of government neglect of emergency procedures in the chaotic days after the disaster, in which an earthquake and tsunami damaged the Fukushima Daiichi nuclear plant.

Packaged pills of potassium iodide at a shelter in Miharu on March 20.

The Fukushima area and some municipalities surrounding the stricken plant had ample stocks of potassium iodide, like most local communities near nuclear reactors around the world. That is a relatively safe compound that can prevent thyroid cancer, the most common serious outcome of a major nuclear accident.

Government disaster manuals require those communities to wait for the central government to give the order before distributing the pills. Though Japan's nuclear-safety experts recommended dispensing pills immediately, Tokyo didn't order pills be given out until five days after the March 11 accident, the documents show.

By then, most of the nearly 100,000 residents evacuated had gone to safer areas and the release of radiation from the plant had subsided from its earlier peaks.

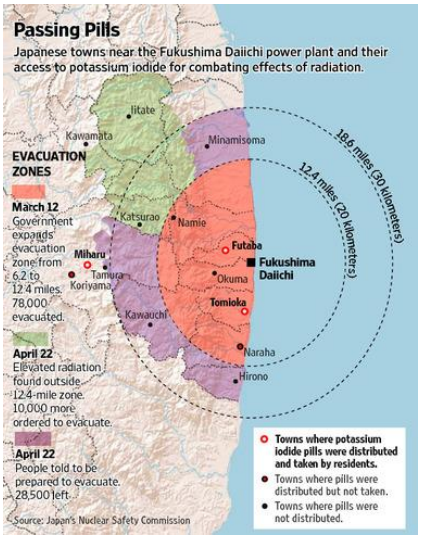
Potassium iodide, which blocks radioactive iodine from entering the thyroid gland, is most effective when taken just before exposure, or within two hours after. It has little effect when administered days after the release of radiation.

In interviews with The Wall Street Journal, several national and local government officials and advisers blamed the delay on a communications breakdown among

different government agencies with responsibilities over various aspects of the disaster.

They also cited an abrupt move by the government shortly after the accident, when local officials raised sharply the level of radiation exposure that would qualify an individual for iodine pills and other safety measures, such as thorough decontamination.

"Most of our residents had no idea we were supposed to take medication like that," said Juichi Ide, general-affairs chief of Kawauchi Village, located about 20 miles from the plant. "By the time the pills were delivered to our office on the 16th, everyone in the village was gone."



Mr. Ide said the boxes containing pills, also known as KI, for Kawauchi's 3,000 residents still sit in its now-empty village hall.

The towns closest to the plant had pills in stock, and two of them—Futaba and Tomioka—did distribute them to residents without awaiting word from Tokyo. Two communities farther away from the plant, Iwaki and Miharu, handed out KI pills to their residents based on their own decisions. While Iwaki residents were told to hold off until the government gave instructions, those in Miharu took the pills, leading late to a reprimand from prefectural officials.

Japanese radiation experts say results of subsequent tests among Fukushima residents suggest few had been exposed to dosages large enough to raise the risk significantly of developing thyroid disease, even without the medication.

Still, officials from two government bodies—the Nuclear Safety Commission and the Nuclear and Industrial Safety Agency—are asking why the residents weren't given the pills known to be highly effective, particularly among young children.

A NISA official said the agency is investigating the case.

"It was very clear to us experts what we needed to worry about the most was to provide protection against the risk of thyroid cancer among children," said Gen Suzuki, a physician specializing in radiation research who was summoned to the Nuclear Safety Commission following the March 11 accident as a member of its emergency advisory team. "I had simply assumed local residents had been given potassium iodide."

When he learned recently that wasn't the case, Mr. Suzuki said he was "flabbergasted."

The NSC, a national government-policy advisory body, recently posted on its website a hand-written note dated March 13 as proof that it recommended distribution and ingestion of the pills.

NISA, the main nuclear-regulatory body charged with administering the government's nuclear-disaster headquarters, says the note never came.

Kenji Matsuoka, director of the Nuclear Emergency Preparedness Division at NISA, said the agency was still investigating the case of the lost memo. "We are sorry if the message was lost because of the chaos at the disaster headquarters," he said. "Our priority at that time was getting people out as quickly as possible."

Officials in Fukushima prefecture in charge of distributing potassium iodide to local communities say they waited in vain for instructions from the government's disaster headquarters, headed by then-Prime Minister Naoto Kan.

The failure to disburse the preventive pills follows other examples of how the Japanese government failed to implement available measures aimed at protecting local residents from the harms of radiation.

Some local officials have accused the government of failing to share the data from its radiation-projection systems, which, they said, resulted in their evacuating residents into highly contaminated areas.

Others blame the authorities for taking weeks before asking some residents outside the initial evacuation zones to evacuate, despite signs of radioactive dangers. The government was widely criticized for declaring food, including beef, to have been safely tested, only to find later that contaminated meat had been sold in grocery stores.

Potassium iodide is an inexpensive and readily available substance that governments and local communities with nuclear reactors typically have on hand. Following the Chernobyl accident in 1986, Poland gave 10.5 million children at least one dose of KI soon after the accident, with very few reports of resulting side effects. In the U.S., Congress passed a law in 2002 promoting distribution of the pills to communities near nuclear plants, but the law hasn't been implemented.

Japan's NSC recently posted on its website a document dated March 13 stating Fukushima residents aged 40 or younger should be given potassium iodide, if radiation screening confirmed they received certain levels of exposure. The commission says the document was sent to NISA, the coordinator of disaster response, at 10:46 a.m. that day, two days before the worst day of the accident on March 15, when explosions of two reactors sent thick radioactive plumes across many towns of Fukushima prefecture.

As with most of the correspondence between government officials following the accident, the statement was sent to disaster headquarters in Tokyo by fax, rather than via e-mail. An NSC representative stationed in that office then handed a copy to a NISA official, according to Hideaki Tsuzuku, director of the radiation-protection and accident-management division at the NSC. "It's not for us to know what kind of judgment was made and action was taken after that," he said in an interview.

NISA's Mr. Matsuoka says the agency can't confirm whether a NISA official received the memo, adding that an investigation into the case continues.

NISA issued an instruction March 16 for residents of towns within 20 kilometers of the plant to take KI pills, nearly four days after the government issued an evacuation order for those same towns.

People close to the situation say the delay may have been caused in part by an abrupt change in the standard used in determining what level of radiation exposure would trigger distribution of the pills. According to official disaster manuals written before the accident, anyone who showed radiation readings of 13,000 counts per minute—a measure for external exposure, as opposed to the more commonly used benchmark of sieverts, which measures health effects—was to be given KI pills, as well as a thorough decontamination, including showering and a change of clothes.

On March 14, Fukushima prefecture raised that cutoff to 100,000 cpm. Once the level was raised, people registering between 13,000 and 100,000 were given wet wipes to clean off the top layer of their clothing. They were not given pills.

During March, roughly 1,000 residents registered readings of 13,000 cpm or higher—102 had readings above 100,000 cpm.

"When they told us they wanted to raise the screening level, we instantly knew we had a serious level of contamination," said Mr. Suzuki, the NSC adviser. "They were implicitly telling us they had more people than they could handle logistically, amid the shortage of water, clothing and manpower."

Naoki Matsuda, a professor of radiation biology at Nagasaki University and an adviser to the Fukushima prefecture government, recalled a meeting with prefectural staff after a day of screening local residents on March 14. They reported gauges on radiation monitors set for 13,000 cpm going off repeatedly. "It was very clear the previous level of 13,000 cpm wouldn't work," Mr. Matsuda wrote in an essay posted on the university's website. "We discussed how the staff should turn off alarm sounds

and refrain from wearing protective suits and face masks in order not to fan worries among residents."

The NSC was initially cautious about allowing the higher screening benchmark. On March 14, it issued a statement advising Fukushima to stick to the current level of 13,000 cpm, noting that level is equivalent to a thyroid-gland exposure level at which the International Atomic Energy Agency recommends disbursing KI. The World Health Organization advocates one-tenth of that level for giving the medication to children.

The NSC relented on March 20, after the prefecture used the new benchmark for days. In a statement, the commission noted 100,000 cpm was permissible according to the IAEA's screening standard in the initial stage of a nuclear emergency.

Before the government's March 16 order to disburse the iodine pills, two towns located near the plants, Futaba and Tomioka, with a combined population of 22,500, independently ordered some of their residents to take the pills that were in their stock, according to town officials.

Those in other nearby towns never did so, including Namie, where contamination was later confirmed to be worst among Fukushima communities.

In all, after the government's March 16 order, the prefecture delivered to all communities located within 50 kilometers of the plant enough KI pills and powder to be given to 900,000 people. Most were untouched.

Summary

The foregoing is not a complete list of NRC's deceptions; and they continue. The President of Ambex, the supplier to NRC for KI, testified at a the May 2, 2012 Public Meeting of Task Force recommendations that there was not ample supply of KI stockpiled in the country, as claimed by NRC; further even if there was an ample supply it could not be transported to where it was needed and distributed to provide timely administration, as required.

C. MONITORING

Installing real-time combination radiation/ meteorological towers in appropriate offsite locations offsite, based on site-specific meteorological analysis, and linked to appropriate state

health and emergency planning agencies are no-brainers and should not be placed on the back-burner (Tier 3) but required now.

1. Plume Modeling – the key-hole: Currently, the NRC, FEMA, State Emergency Management Agencies and KLD [the primary contractor for preparing Evacuation Time Estimates] base regulation, guidance and time estimates on outdated and simplistic assumptions for plume transport models that do not reflect conditions at many, if not all, reactor sites. Offsite monitors are required so that emergency planning can be based on fact not myth.

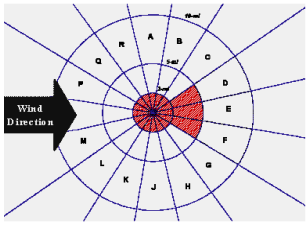
Currently, guidance and regulations use steady-state, straight-line plume transport models. The plume supposedly functions much like a beam from a flashlight; this incorrectly assumes that radiation moves in a relatively narrow plume with a size and shape like a key-hole[28]. However actual wind and weather conditions are variable and complex affected by sea/lake breezes, terrain, river valleys, location/clustering of buildings, and variable precipitation. Radiation in an accident will travel in a complex and variable manner at sites at

[28] **NUREG 1887: RASCAL version 3.0.5** is a code, developed in 2007 by NRC. It is currently in use by NRC's emergency operations center for making dose projections for atmospheric releases during radiological emergencies. It uses the **straight-line Gaussian plume** in the "near field" and simply a 2-dimensional puff model in the "far field." Neither the NUREG nor the workbook [NUREG 1889] provides a precise distance for what constitutes the near or far field. Regarding the straight-line Gaussian plume, the NUREG at 4.12 admits that, "…the meteorological *conditions are assumed to be horizontally homogeneous and stationary*. This means that the wind direction and speed responsible for transporting the plume from the release point to the receptor and the turbulence responsible for diffusion are assumed not to change with location throughout the model domain. It also means that the meteorological *conditions do not change as a function of time* during the release and time required for transport. Together, *these assumptions constrain the usefulness of the straight–line plume model* to estimating concentrations and doses at receptors near the release point for short-duration releases; at longer distances another model is required." **Regarding adjusting wind field for topography**, the NUREG counsels that, "If the meteorological stations reporting data are well placed with respect to major topographic features, the wind fields developed by interpolation will give reasonable puff trajectories. However, *with one meteorological station or a small number of stations, the wind fields may not properly reflect the effects of topography*." **Regarding Meteorological Input data** (6.3), the NUREG warns that, "The adjusted wind field is most accurate near stations and along trajectories that pass near stations. Wind fields are less accurate elsewhere. Thus, *it is desirable to have wind data near the release point and, if possible, at downwind locations.*" In summary, RASCAL 3.0.5 rests of 1970's technology; it is a simplistic model.[Emphasis added]

these locations.[29] Therefore the "key-hole" concept has no basis in reality. It is a figment of planers imagination.

Example: NUREG-0654 FEMA-REP 1 Rev. 1 Supp.3- Appendix I states that,

> The guidance in this document…emphasizes that the preferred initial action to protect the public from a severe reactor accident is to evacuate immediately about 2 miles in all directions from the plant and about 5 miles downwind from the plant, unless conditions make evacuation dangerous. Persons in the remainder of the plume exposure pathway emergency planning zone (EPZ) should be directed to go indoors and listen to the Emergency Alert Stations while the situation is further assessed. P.3



[29] See: State Of New York's Motion For Summary Disposition On Use Of Straight Line Gaussian Air Dispersion Model For The Environmental Impact Analysis Of Significant Radiological Accidents At Indian Point And NYS Contention 16/16A,(DPR-26, DPR-64) August 28, 2009 and accompanying Declaration Of Bruce A. Egan, Sc.D., Statement of Material Facts not in Dispute, and Exhibits, NRC Electronic Library, Adams Accession Number ML 092610906; Pilgrim Watch Answer Opposing Entergy's Motion for Summary Disposition of Pilgrim Watch Contention 3, June 2007- Adams Accession Number ML071840568; Declaration Dr. Bruce Egan, June 2007 attached to Pilgrim Watch's Answer - Adams Accession Number ML071840568; Pilgrim Watch Petition for Review of LBP-07-13, Memorandum and Order (Ruling On Motion To Dismiss Petitioner's Contention 3 Regarding Severe Accident Mitigation Alternatives), 2-1 Decision, October 30, 2007-Adams Accession Number ML083240599; Pilgrim Watch's Brief in Response to CLI-09-11 (Requesting Additional Briefing), Adams Accession Number ML091830846; Pilgrim Watch's Brief in Response to Entergy's Response to CLI-09-11, Adams Accession Number ML091950452;Pilgrim Watch's Brief in Response to NRC Staff's Initial Brief in Response to CLI-09-11, Adams Accession Number ML091950450; What's in the Black Box, Dispersion, Prepared for 2009 National Radiological Emergency Planning Conference, Stephen F. LaVie, Sr. Emergency Preparedness Specialist, Nuclear Security and Incident Response, Division of Preparedness and Response, Adams Accession No. ML091050257

2. Meteorological Data: Licensees are not required by the NRC to use complex plume models and meteorological data from multiple weather stations; instead they are allowed to base inputs to their simplistic straight-line Gaussian plume model from the single or perhaps two meteorological towers onsite. The on-site "met tower" only tells what the wind direction is onsite but not what happens to the plume as it travels offsite. Computerized combination weather-radiation monitors located appropriately in offsite communities are needed and readily available.[30] Only when NRC requires that licensees have such monitors placed in appropriate offsite locations, determined by a meteorological site-specific analysis, will protective action calls be based on fact.[31]

3. Implications for emergency planning: By relying on the straight –line Gaussian model to construct a "key hole" planners are likely to make the wrong call - send citizens into a plume; tell folks to stay put when should evacuate; or tell them to evacuate when they should shelter. Complex plume models appropriate to these sites are readily available today and must be required by NRC. For example, the CALPUFF model is appropriate for simulating transport and dispersion in wind fields that change with space and time (Scire, et al., 2000a). It is often coupled to CALMET (Scire, et al., 2000b), a model that computes the needed wind and

[30] Ibid

[31] NUREG 1857: "**Regarding adjusting wind field for topography**, the NUREG counsels that, "If the meteorological stations reporting data are well placed with respect to major topographic features, the wind fields developed by interpolation will give reasonable puff trajectories. However, *with one meteorological station or a small number of stations, the wind fields may not properly reflect the effects of topography*." **Regarding Meteorological Input data** (6.3), the NUREG warns that, "The adjusted wind field is most accurate near stations and along trajectories that pass near stations. Wind fields are less accurate elsewhere. Thus, *it is desirable to have wind data near the release point and, if possible, at downwind locations.*" In summary, RASCAL 3.0.5 rests of 1970's technology; it is a simplistic model."[Emphasis added]

dispersion fields from meteorological data. CALPUFF may also be coupled to a full mesoscale meteorological flow model such as MM5.[32]

Although the "key hole" is contradicted by actual weather analysis; it allows for limited resources to appear adequate – providing false assurance and guaranteeing that communities will be caught short in a disaster. Example: Pilgrim's Radiological Emergency Response Plan and Standard Operating Procedures say that school busses housed in upwind EPZ communities and other emergency resources may be directed to downwind EPZ community/communities at the time of the emergency call. Because "downwind" and "upwind" communities are a fiction in Pilgrim's coastal environment where winds are highly variable, the so-called "upwind" communities will be left high and dry and there will be needless chaos and suffering because adequate resources were not pre-arranged to respond from communities well outside the Emergency Planning Zone.

4. NRC, DOE, EPA, The National Research Council of the National Academies, State Officials, Nuclear Trade Groups, & Air Dispersion Modeling Community Agree That Straight Line Gaussian Plume Models Cannot Account For the Effects of Complex Terrain on the Dispersion of Pollutants from A Source

NRC

Since the 1970s, the USNRC has historically documented advanced modeling technique concepts and potential need for multiple meteorological towers appropriately located in offsite communities, especially in coastal site regions. But ignored implementing its' own advice.

[32] Ibid, Egan Declarations

In 2009, the NRC made a presentation to the National Radiological Emergency Planning Conference[33] concluded that the straight-line Gaussian plume models cannot accurately predict dispersion in a complex terrain and are therefore scientifically defective for that purpose.[ADAMS - ML091050226, ML091050257, and ML091050269 (page references used here refer to the portion attached, Part 2, ML091050257).]

Most reactors, if not all, are located in complex terrains. In the presentation, NRC said that the "most limiting aspect" of the basic Gaussian Model, is its "inability to evaluate spatial and temporal differences in model inputs" [Slide 28]. Spatial refers to the ability to represent impacts on the plume after releases from the site e.g., plume bending to follow a river valley or sea breeze circulation. Temporal refers to the ability of the model to reflect data changes over time, e.g., change in release rate and meteorology [Slide 4].

Because the basic Gaussian model is non-spatial, it cannot account for the effect of terrain on the trajectory of the plume – that is, the plume is assumed to travel in a straight line regardless of the surrounding terrain. Therefore, it cannot, for example, "'curve' a plume around mountains or follow a river valley." NRC 2009 Presentation, Slide 33. However, many reactors are located near mountains or along river valleys. Further it cannot account for transport and diffusion in coastal sites subject to the sea breeze. Sea breeze also applies to any other large bodies of water. The sea breeze causes the plume to change direction caused by differences in temperature of the air above the water versus that above the land after sunrise. If the regional wind flow is light, a circulation will be established between the two air masses. At night, the land

[33] Ibid

cools faster, and a reverse circulation (weak) may occur [Slide 43]. Turbulence causes the plume to be drawn to ground level [Slide 44].

The presentation goes on to say that, "Additional meteorological towers may be necessary to adequately model sea breeze sites" [Slide 40].

Significantly, the NRC 2009 Presentation then discussed the methods of more advanced models that *can* address terrain impact on plume transport, including models in which emissions from a source are released as a series of puffs, each of which can be carried separately by the wind, (NRC 2009 Presentation Slides 35, 36). This modeling method is similar to CALPUFF. Licensees are not required, however, to use these models in order to more accurately predict where the plume will travel to base protective action recommendations.

The NRC recognized as early as 1977 that complex terrain presented special problems that a model must address if the air dispersion analysis is to be accurate.[34] For example: NRC, Regulatory Guide 1.111, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors* (July 1977) (Draft for Comment) says that, "Geographic features such as hills, valleys, and large bodies of water *greatly* influence dispersion and airflow patterns. Surface roughness, including vegetative cover, affects the degree of turbulent mixing." (Emphasis added).

<u>This is not new information; knowledge of the inappropriateness of straight-line Gaussian plume in at complex sites goes back a long way within NRC. For example:</u>

[34] Ibid

1972: NRC Regulatory Guide 123 (Safety Guide 23) On Site Meteorological Programs 1972, states that, "at some sites, due to complex flow patterns in non-uniform terrain, additional wind and temperature instrumentation and more comprehensive programs may be necessary."

1977: NRC began to question the feasibility of using straight line Gaussian plume models for complex terrain. *See* U.S.NRC, 1977, Draft for Comment Reg. Guide 1.111 at 1c (pages 1.111-9 to 1.111-10)

1983: In January 1983, NRC Guidance [**NUREG-0737, Supplement 1 "Clarification of TMI Action Plan Requirements," January 1983 Regulatory Guide 1.97- Application to Emergency Response Facilities; 6.1 Requirements],**suggested that changes in on-site meteorological monitoring systems would be warranted if they have not provided a reliable indication of monitoring conditions that are representative within the 10-mile plume exposure EPZ.

1996: The NRC acknowledged the inadequacy of simple straight-line Gaussian plume models to predict air transport and dispersion of a pollutant released from a source in a complex terrain when it issued RTM-96, *Response Technical Manual,* which contains simple methods for estimating possible consequences of various radiological accidents. In the glossary of that document, the NRC's definition of "Gaussian plume dispersion model" states that such models have important limitations, including the inability to "deal well with complex terrain." NUREG/BR-0150, Vol.1 Rev.4, Section Q; ADAMS Accession Number ML062560259,

2004: A NRC research paper, *Comparison of Average Transport and Dispersion Among a Gaussian, A Two- Dimensional and a Three-Dimensional Model,* Lawrence Livermore National Laboratory, October, 2004 at 2. ("Livermore Report") had an important caveat added to the

Report's summary about the scientific reliability of the use of a straight-line Gaussian model in complex terrains: ". . . [T]his study was performed in an area with smooth or favorable terrain and persistent winds although with structure in the form of low-level nocturnal jets and severe storms. In regions with *complex terrain*, particularly if the surface wind direction changes with height, *caution should be used*. **Livermore Report** at 72. (emphasis added)

2005: In December, 2005, as part of a cooperative program between the governments of the United States and Russia to improve the safety of nuclear power plants designed and built by the former Soviet Union, the NRC issued a Procedures Guide for a Probabilistic Risk, related to a Russian Nuclear Power Station. The Guide, prepared by the Brookhaven National Laboratory and NRC staff, explained that atmospheric transport of released material is carried out assuming Gaussian plume dispersion, which is "generally valid for flat terrain." However, the Guide the caveat that in "specific cases of plant location, such as, for example, a mountainous area or a valley, more detailed dispersion models may have to be considered." *Kalinin VVER-1000 Nuclear power Station Unit 1 PRA, Procedures Guide for a Probabilistic Risk Assessment,* NUREG/CR- 6572, Rev. 1 at 3-114; excerpt attached as Exhibit 8, full report available at http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6572.

2007: NRC revised their Regulatory Guide 1.23, Meteorological Monitoring Programs for Nuclear Power Plants. On page 11, the section entitled *Special Considerations for Complex Terrain Sites* says that,

> At some sites, because of complex flow patterns in nonuniform terrain, additional wind and temperature instrumentation and more comprehensive programs may be

necessary. For example, the representation of circulation for a hill-valley complex or a site near a large body of water may need additional measuring points to determine airflow patterns and spatial variations of atmospheric stability. Occasionally, the unique diffusion characteristics of a particular site may also warrant the use of special meteorological instrumentation and/or studies. The plant's operational meteorological monitoring program should provide an adequate basis for atmospheric transport and diffusion estimates within the plume exposure emergency planning zone [i.e., within approximately 16 kilometers (10 miles)].[35]

These excerpts from Regulatory Guide 1.23 demonstrate that the NRC recognizes there are certain sites, such as those located along river valleys (like Indian Point and Vermont Yankee) and those located in coastal areas (like Pilgrim and Seabrook) that multiple meteorological data input sources are needed for appropriate air dispersion modeling. Not simply one or two meteorological towers onsite. Since, for the reasons discussed above, the straight-line Gaussian plume model is incapable of handling complex flow patterns and meteorological data input from multiple locations, Regulatory Guide 1.23 demonstrates NRC's recognition that it should not be used at any site with complex terrain.

EPA

Likewise, EPA recognized the need for complex models. For example: EPA's 2005 Guideline on Air Quality Models says in Section 7.2.8 *Inhomogenous Local Winds* that,

[35] For example, if the comparison of the primary and supplemental meteorological systems indicates convergence in a lake breeze setting, then a "keyhole" protective action recommendation (e.g., evacuating a 2-mile radius)

> In very rugged hilly or mountainous terrain, along coastlines, or near large land use variations, the characterization of the winds is a balance of various forces, such that the assumptions of steady-state straight line transport both in time and space are inappropriate. (Fed. Reg., 11/09/05).

EPA goes on to say that, "In special cases described, refined trajectory air quality models can be applied in a case-by-case basis for air quality estimates for such complex non-steady-state meteorological conditions." This EPA Guideline also references an EPA 2000 report, *Meteorological Monitoring Guidance for Regulatory Model Applications*, EPA-454/R-99-005, February 2000. Section 3.4 of this Guidance for coastal Locations, discusses the need for multiple inland meteorological monitoring sites, with the monitored parameters dictated by the data input needs of particular air quality models. EPA concludes that a report prepared for NRC [36] provides a detailed discussion of considerations for conducting meteorological measurement programs at coastal sites, reactors on large bodies of water. Most important, EPA's November 2005 Modeling Guideline (Appendix A to Appendix W) lists EPA's "preferred models" and the use of straight line Gaussian plume model, called ATMOS, is not listed. Sections 6.1 and 6.2.3 discuss that the Gaussian model is not capable of modeling beyond 50 km (32 miles) and the basis for EPA to recommend CALPUFF, a non - straight line model.[37]

DOE

DOE, too, recognizes the limitations of the straight-line Gaussian plume model. They say for example that Gaussian models are inherently flat-earth models, and perform best over regions

[36] Raynor, G.S.P. Michael, and S. SethuRaman, 1979, *Recommendations for Meteorological Measurement Programs and Atmospheric Diffusion Prediction Methods for Use at Coastal Nuclear Reactor Sites.* NUREG/CR-0936. U.S. Nuclear Regulatory Commission, Washington, DC.

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

of transport where there is minimal variation in terrain. Because of this, there is inherent conservatism (and simplicity) if the environs have a significant nearby buildings, tall vegetation, or grade variations not taken into account in the dispersion parameterization.[38]

National Research Council

Tracking and Predicting The Atmospheric Dispersion of Hazardous Material Releases Implications for Homeland Security, Committee on the Atmospheric Dispersion of Hazardous Material Releases Board on Atmospheric Sciences and Climate Division on Earth and Life Studies, National Research Council of the National Academies, 2003.

This report provides the recent history of dispersion model development. It summarizes the findings of the National Academies workshop by the same title that had the purpose of examining "how meteorological observations and dispersion models can be used by emergency managers in the context of an atmospheric release of hazardous chemical, biological or nuclear (C/B/N) agents". The workshop participants included atmospheric scientists from academia, government laboratories and the private sector as well as emergency management officials and first responders, and experts in related fields.

The report discusses how the analytical Gaussian models were used in the 1960s and tested against limited field experiments in flat terrain areas performed in earlier decades.

In the 1970s the US passed the Clean Air Act which required the use of dispersion models to estimate the air quality impacts of emissions sources for comparison to regulatory limits. This resulted in the development and testing of advanced models for applications in

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

complex terrain settings such as in mountainous or coastal areas. In the 1980s, further advances were made with Lagrangian puff models and with Eulerian grid models. Gaussian models moved beyond the simple use of sets of dispersion coefficients to incorporate Monin-Obukhov and other boundary layer similarity measures which are the basis of contemporary EPA models used for both short range and long range transport applications. Helped enormously by advances in computer technologies, in the 1990s, significant advances were made in numerical weather prediction models and also further improve dispersion models through the incorporation of field experiment results and improved boundary layer parameterization. The decade starting with the year 2000 has seen improved resolution of meteorological models such as MM5 and the routine linkage of meteorological models with transport and dispersion models as exemplified by the real time forecasts of detailed fine grid weather conditions available to the public at Olympic events. Computational Fluid Dynamics (CFD) models which involve very fine grid numerical simulations of turbulence and fluid flow began to see applications in atmospheric dispersion studies. The next decade will see routine application of CFD techniques to complex flows associated with emergency response needs.

The nuclear industry does not show evidence of keeping up with these technological advances. For use in modeling air quality concentrations, the NRC uses straight-line Gaussian dispersion algorithms that date back to the 1960s. Complex flow situations such as those associated with flow around high terrain features or that would incorporate sea breeze circulations are not simulated. For emergency response applications, the NRC does not seem to require any advanced modeling to be installed at nuclear power plants. The agency research groups have access to advanced simulation models but how these might be used for training purposes or for real time emergency response purposes is not apparent in the literature.

According to the report, emergency responders have a number of observational and modeling needs that are not well satisfied by existing services. Although it may never be possible to provide a "perfect" atmospheric dispersion prediction for any hazardous release, the committee believes that with more effective application of available tools and development of new technologies and capabilities, the atmospheric science community could play a larger role in addressing this critical national security concern.

A copy of the Executive Summary and selected sections are available from NAS.

Nuclear Utility Groups

Nuclear utility Meteorological Data Users Group (NUMUG): At the 1994 American Nuclear Society Topical Meeting Environmental Transport and Dosimetry Aug 31-Sept 3, 1993, Charleston, SC, a paper titled *An Atmospheric Dispersion Model for Emergency Response, K. Jerry Allwine (Pacific Northwest Laboratory, Richland, Washington) NUMUG 1994* said in its introduction that,

> Predicting the dispersion of accidental releases of material to the atmosphere in regions of nonuniform terrain can be very challenging. Wind patterns can be highly variable in time and space, because of the synoptic influences, the influences of nonhomogenous surfaces (sea breeze, heat inland), and terrain-induced processes such as slope flows, channeling, blocking, mountain-valley winds, stagnations, layered flows. During the nighttime terrain effects can dominate the atmospheric motion, especially near the surface. Consequently, an important component of any emergency response model is the wind model which must reasonably represent the winds in complex terrain using a limited number of input wind observations that are

generally not of sufficient coverage to completely define the winds in the modeling domain.

State Authorities - example

New York State Office of Attorney General: State of New York's Motion for Summary Disposition on Use of Straight Line Gaussian Air Dispersion Model For The Environmental Impact Analysis of Significant Radiological Accidents at Indian Point and NYS Contention 16/16A, DPR-26, DEPR-64, August 28, 2009

Aubrey Godwin, Director, Arizona Radiation Regulatory Agency Public Meeting on the Review of Emergency Preparedness Regulations and Guidance for Commercial Nuclear Power Plants (8/31 - 9/1/05), at 17 regarding the keyhole said that,

> …everyone recognizes that wind shifts and it does not matter where you are in the country…So, effectively you're going to have to add 360 before (the event is) over with and I think you need to be prepared for that and plan for that…Then there is the other condition that happened during Three Mile Island when the Commission was advising the state to evacuate and they asked in which direction and they said downwind and it was pointed out the wind wasn't blowing. So you need to think more than just downwind. You need to think of 360 degrees and I hope that the Commission and the staff recognize that you need to look beyond the keyhole effect…

Atmospheric Scientists & Meteorologists

For over three decades atmospheric scientists and meteorologists have been identifying problems in the use of models similar to ATMOS for such settings. Example: Steven R. Hanna, Gary A. Briggs, Rayford P. Hosker, Jr., National Oceanic and Atmospheric Administration, Atmospheric Turbulence and Diffusion Laboratory, *Handbook on Atmospheric Diffusion* (1982)).

The inability of a simple Gaussian plume model to accurately predict air transport and dispersion in complex terrains is such a basic flaw that it is discussed in a textbook for a college-level introductory course in environmental science and engineering (Environmental Science and Engineering, J. Glynn Henry & Gary W. Heinke, (Prentice-Hall 1989) at 528 (Chapter 13 authored by William J. Moroz). In listing the assumptions that are made to develop a simple straight line Gaussian plume model, the textbook warns that:

> The equation is to be used over relatively flat, homogeneous terrain. It should not be used routinely in coastal or mountainous areas, in any area where building profiles are highly irregular, or where the plume travels over warm bare soil and then over colder snow or ice covered surfaces.

4. **Real-Time Monitoring Equipment in Use Today:** The Commonwealth of Massachusetts Department of Public Health started a program of off-site real-time air monitoring program recognizing the need to have actual data to look back for epidemiological purposes and forward for emergency planning.

6. Lessons Learned from Fukushima: The following article shows the importance of offsite computerized weather and radiation monitors. In Japan the population fled North, assuming winds were blowing to the South. In reality they evacuated into the very areas that the plume was blowing.

Japan Held Nuclear Data, Leaving Evacuees in Peril, NYT, August 8, 2011, NORIMITSU ONISHI and MARTIN FACKLER

> FUKUSHIMA, Japan — The day after a giant tsunami set off the continuing disaster at the Fukushima Daiichi nuclear plant, thousands of residents at the nearby town of Namie gathered to evacuate.
>
> Given no guidance from Tokyo, town officials led the residents north, believing that winter winds would be blowing south and carrying away any radioactive emissions. For three nights, while hydrogen explosions at four of the reactors spewed radiation into the air, they stayed in a district called Tsushima where the children played outside and some parents used water from a mountain stream to prepare rice.
>
> The winds, in fact, had been blowing directly toward Tsushima — and town officials would learn two months later that a government computer system designed to predict the spread of radioactive releases had been showing just that.

IV. POSTPONING ISSUES TO TIER 3-

IMPLICATIONS BACKFIT VS. ORDER

Backfitting: If the Commission decides that the above discussed issues presently in Tier 3 and not Orders and instead treat them as backfits then these key measures cannot be adopted unless they pass a cost-benefit test.

And since the guidelines for how the NRC conducts cost-benefit analyses are rooted in a *pre-Fukushima* way of thinking and assumptions, there is little chance that any regulatory action

based on a post-Fukushima understanding of risk, modeling and offsite consequences would pass the test.

This is because the NRC put on the back burner modifying the cost-benefit analysis guidelines to incorporate lessons learned from Fukushima *before* using such an analysis to assess cost and benefits of recommended upgrades to safety requirements until *after* all the other recommendations have been addressed. This has created a pattern of circular reasoning. Absent changes to make them orders at this stage, the public's interest is adversely affected and likely to remain so, if these are relegated to a backfit.

Respectfully submitted

(Electronically signed)

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