

## H. 2502 & H 2490 -AN ACT RELATIVE TO EMERGENCY PLANNING

### TESTIMONY IN FAVOR

#### An Act relative to emergency planning

Presented by Rep. Peake and Ferrante

SECTION 1. In order to assess the present preparedness in Barnstable and Essex Counties and to determine the need for, and appropriateness of, any additional specific steps for a radiological accident at Pilgrim Nuclear Power Station and Seabrook Nuclear Power Plant, Massachusetts Emergency Management Agency shall report to the Governor and the Legislature by January first, two thousand eighteen, its findings, recommendations and proposed legislation and assessments where appropriate concerning:

1. The need for and appropriateness of additional specific state and local activities or programs beyond those required by the accepted radiological emergency preparedness plans or provided for under existing law, including but not limited to:

- a) Plume transport and dose assessment models;
- b) Radiological and meteorological monitoring equipment;
- c) Emergency Notification, Methods and Procedures;
- d) Emergency Communications;
- e) Public Information and Education;
- f) Emergency Facilities and Equipment;
- g) Accident Assessment;
- h) Protective Response, Sheltering: Assessment of Shelters in Barnstable County suitable in a radiological emergency;
- i) Protective Response, Evacuation: Evacuation Routes, Evacuation Time Estimates, Traffic Control, Impediment Removal, Security Patrols, Reception Centers, monitoring and decontamination capability, Mass Care Shelters, Ingestion Exposure pathway Protective Measures;
- j) Transportation for transportation dependent;
- k) Medical and Public Health Support;
- l) Relocation, Re-Entry, and Return Planning and Post Accident Operations;
- m) Exercises and Drills;
- n) Radiological Emergency Response Training;
- o) Responsibility for Planning Effort: development, Periodic review and Distribution of Emergency Plans; and
- p) Maps with prevailing wind speeds around the compass rose.

SECTION 2. Any such recommendations shall be developed in consultation with all concerned public and private parties and shall:

- (a) Take into account proven safety effectiveness;
- (b) Outline any proposed costs and the means for meeting such costs;
- (c) Consider related activities of the United States Nuclear Regulatory Commission or others; and
- (d) When appropriate, discuss alternatives and various implementation stages.

SECTION 3. If at any time following the development, review or approval of state and local radiological plans, the Governor determines that said plans are no longer adequate to protect the public health and safety, he/she shall notify the Federal Emergency Management Agency to secure withdrawal of the plans and call on Nuclear Regulatory Commission to revoke the operating license and begin the decommissioning process.

### PILGRIM WATCH TESTIMONY IN FAVOR

Pilgrim Watch (“PW”) is a non-profit citizens’ organization that serves the public interest on issues regarding the Pilgrim Nuclear Power Station specifically and on nuclear power in general. The organization is located at 148 Washington Street, Duxbury, Massachusetts, 02332. Its membership extends throughout the Commonwealth. PW is a participant at the Barnstable County Regional Emergency Planning Committee’s meetings on radiological emergency preparation for Barnstable County.

## **SUMMARY**

This bill directs Massachusetts Emergency Management Agency (MEMA) to assess the present state of preparedness in Barnstable and Essex Counties in the event of a radiological emergency at Pilgrim Station and Seabrook Station to determine the need for, and appropriateness of, any additional specific steps. MEMA is directed to report to the Governor and the Legislature by January first, two thousand eighteen, its findings, recommendations and proposed legislation and assessments where appropriate. The Bill outlines key emergency planning areas to be covered in the report. Section three directs the Governor if there is a finding that the radiological plans do not protect public health and safety to notify FEMA to withdraw the plans and ask NRC to revoke the operating license and begin decommissioning.

We wish to draw to your attention that radiological emergency planning is important during operations and post operations until the spent fuel leaves the site. Therefore, the value of assessing the present state of preparedness in Barnstable and Essex counties in the event of a radiological emergency at Pilgrim and Seabrook has value in protecting our citizens into the future, not simply when operations cease. We refer you to H 1147 presented by Representative Josh Cutler, [An Act relative to radiological emergency response funds](#).

## **AUTHORITY**

Matters regarding nuclear reactors are under the authority of the federal government – US Nuclear Regulatory Commission (NRC) that in turn relies on FEMA’s assessment of whether plans provide reasonable assurance that public health and safety are protected. However, the Commonwealth has authority to enact radiological emergency planning measures that are more conservative than the federal governments.

## **ARGUMENT IN FAVOR**

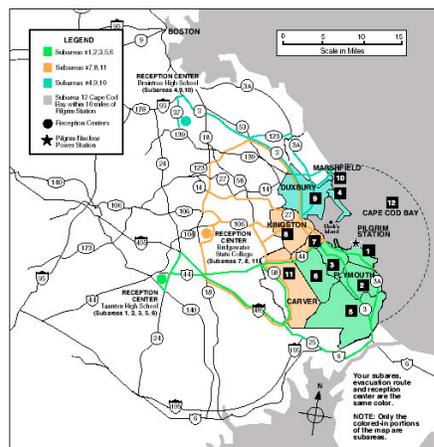
### **Current Radiological Plans**

Currently there are two emergency planning zones (EPZs) around Pilgrim Station- the Ingestion Exposure Pathway EPZ and the Plume Exposure Pathway EPZ; and, likewise, two for Seabrook Station.

**(1) The Ingestion Exposure Pathway** has a radius of about 50 miles from the reactor site. Predetermined protective action plans are in place for this EPZ and are designed to avoid or reduce dose from potential ingestion of radioactive materials. These actions include a ban of contaminated food and water. Barnstable County is in the Ingestion Pathway so that in a disaster at Pilgrim Station forage and cranberries, for example, will be monitored for contamination but not people. Twenty-eight of the thirty-four cities/towns in Essex County are in the ingestion pathway so in a disaster at Seabrook Station the cows will be monitored for contamination but not the people.

**(2) The Plume Exposure Pathway EPZ** has a radius of 10-miles from the reactor site. Protective action plans are in place designed to avoid or reduce dose from potential exposure of radioactive materials. These actions include sheltering, evacuation, and the use of potassium iodide where appropriate. Barnstable County and large portions of Essex County are outside the 10-mile zone - there are no plans for sheltering or evacuation.

Barnstable: On October 3, 2012, the Director of MEMA, Kurt Swartz, said at a Barnstable County Regional Emergency Planning Committee that he supported the need for enhanced planning but limited it to traffic management to discourage or, if required, prohibit Cape vehicles going over the bridges until EPZ evacuees completed evacuation.



### **Risk Extends Beyond 10-Miles**

MEMA's plan for Barnstable and large portions of Essex Counties rests on the false assumption that the risk of inhalation from radiation in a severe accident would not affect those outside the 10 mile EPZ. Expanding the EPZ to include Barnstable and Essex Counties recognizes that the impact of a severe accident spreads further than 10-miles. For example, on March 15, 2011 U.S.

NRC Chairman Greg Jazcko urged Americans within 50 miles of the Fukushima Daiichi plant to evacuate; a similar statement came from the U.S. State Department. Spent Fuel Pool Fire, Consequences: Per nuclear security experts at Princeton University, a major spent-fuel pool fire could contaminate as much as 38,610 square miles, forcing the evacuation of millions<sup>1</sup> -- far higher than NRC's 2013 estimate of 6,693 square miles<sup>2</sup>. A 2006 study conducted for the Massachusetts attorney general estimated a spent-fuel pool fire at Pilgrim would result in \$488 billion in damage, 24,000 cancers, and contaminate hundreds of square miles<sup>3</sup>. Although dry casks are safer, they are not invulnerable, especially to sabotage. Each cask contains ½ the Cesium-137 released in the Chernobyl accident. 10-mile EPZs were chosen when emergency planning was first required following the Three Mile Island accident. At that time, federal officials measured the distance from reactors to large population centers. 10-miles assured that planning would avoid dense populations, such as New York City. It had little to do with protecting public health and safety

Because Barnstable and Essex counties are at risk and there is no way to evacuate, this bill properly calls for reassessment to determine if the Commonwealth should provide protective actions for Barnstable and Essex Counties in a radiological disaster. Absent doing so would mean that public health and safety are not protected.

## ANALYSIS

### I. BARNSTABLE COUNTY

#### A. Risk-Pilgrim

**Location:** Barnstable County is located ENE to SSW from Pilgrim Station. Based on 2001 annual wind frequencies from Pilgrim's onsite meteorological tower and from a trajectory done

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<sup>1</sup> Richard Stone, "Spent fuel fire on U.S. soil could dwarf impact of Fukushima," Science, May 24, 2016. (available at: <http://www.sciencemag.org/news/2016/05/spent-fuel-fire-us-soil-could-dwarf-impact-fukushima>)

<sup>2</sup> Consequence Study Of A Beyond Design-Basis Earthquake Affecting The Spent Fuel Pool For A U.S. Mark I Boiling Water Reactor (October 2013) at 232 (Table 62) and 162 (table 33), Adams Accession NO ML13256A342)

<sup>3</sup> The Massachusetts Attorney General's Request for a Hearing and Petition for Leave to Intervene With respect to Entergy Nuclear Operations Inc.'s Application for Renewal of the Pilgrim Nuclear Power Plants Operating License and Petition for Backfit Order Requiring New Design features to Protect Against Spent Fuel Pool Accidents, Docket No. 50-293, May 26, 2006 includes a Report to The Massachusetts Attorney General On The Potential Consequences Of A Spent Fuel Pool Fire At The Pilgrim Or Vermont Yankee Nuclear Plant, Jan Beyea, PhD., May 25, 2006 (NRC Electronic Hearing Docket, Pilgrim 50-293-LR, 2—6 pleadings, MAAGO 05/26 (ML061640065) & Beyea (ML061640329))

by Entergy's experts in its license renewal litigation,<sup>4</sup> the Cape was downwind roughly half the time, terrible odds for the Cape in the event of an accident at Pilgrim. We know that:

- Accidents happen on a particular day not on an annual average day.
- Fukushima showed that a severe accident can extend for weeks and months; during that extended time winds are variable spreading radiation over a far wider geographic area.
- Releases from Pilgrim blowing offshore towards Barnstable County will remain tightly concentrated due to water temperature and reduced turbulence until the winds blow the plume over land on the Cape.<sup>5</sup>

These facts are currently ignored.

If Barnstable County is downwind, common sense tells that radiological emergency plans should include Barnstable County in the early phase of the accident to prevent or limit exposure from airborne and from deposited material. MEMA currently includes Barnstable County in the ingestion pathway; therefore, it admits that radiation (gamma, alpha and beta) could impact the county in a severe accident at Pilgrim. Because radiation impacting crops and dairy products arrives airborne, it can be inhaled by the public. Further radiation released from Pilgrim, will not burrow deep into the ground immediately when it lands in Barnstable County; therefore, wind will re-suspend the radiation from where it landed back into the air risking additional damage from inhalation. Lessons learned from Chernobyl<sup>6</sup> and Fukushima show that inhalation is a real risk to the public who are more than 10 miles from the reactor.

**Direct Experience:** The EPZ is defined as the area with a radius of about 10 miles around a nuclear power plant; however direct experience from Fukushima and Chernobyl show that radiation resulting from a severe accident or intentional attack at a nuclear power plant will go beyond 10 miles.

Fukushima: Pilgrim is a carbon-copy of the Fukushima reactors. The United States Government advised Americans within 50 miles of Fukushima to evacuate; yet here we limit the advisory to

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<sup>4</sup>Testimony of Dr. Kevin R. O'Kula and Dr. Steven R. Hanna (Entergy's own meteorological experts) on Meteorological Matters Pertaining to Pilgrim Watch Contention 3, Entergy Exhibit 00001, pgs, 63,99, Pilgrim LRA Proceeding, 50-293-LR, 06-848-02-LR, January 3, 2011]

<sup>5</sup> Zager M, Tjernstrom M, Angevine W. 2004. New England coastal boundary layer modeling. In: AMS 16<sup>th</sup> Symposium on boundary Layers and Turbulence, August 2004, Portland, Maine. Angevine WM, Tjernstrom M, Senff CJ, White AB. 2004. Coastal Boundary layer Transport of urban pollution in New England In: 16<sup>th</sup> Symposium of boundary layers and turbulence Portland, Maine, 13<sup>th</sup> Symposium on Turbulence 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 App. Meteorology & Climatology 45: 137-154.

<sup>6</sup> 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."

10-miles and Barnstable County is left out. The widespread radioactive contamination caused by the Fukushima nuclear disaster 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

Chernobyl: The Chernobyl accident, which rendered about a thousand square miles uninhabitable (about 100 square miles permanently), released to the environment only a fraction of the radioactive material currently stored at Pilgrim. The 1986 Chernobyl accident released 2,403,000 curies of Cesium-137; whereas Pilgrim's core, for example, during license renewal will have 5,130,000 curies C-137, and the inventory of long-lived radionuclides such as C-137 in the spent fuel pool is eight times the reactor core.<sup>7</sup> Thus, it is entirely conceivable that a significant radiological release from Pilgrim could render a large portion of the Commonwealth, including Barnstable County, uninhabitable.

**Research:** Research sponsored by the Massachusetts Attorney General, the National Academies of Sciences and NRC show that dangerous levels of radiation requiring protective actions (sheltering & evacuation) can impact Barnstable County. For example:

Research Regarding Spent Fuel Pool Accidents: Pilgrim currently stores a huge amount of highly radioactive used spent fuel assemblies onsite in a spent fuel pool located outside primary containment in the attic of the reactor building with a thin roof overhead. Pilgrim's spent fuel pool's vulnerability to a serious accident was analyzed in detail by the MA AGO. An accident could result from mechanical failure, human error or acts of malice placing Barnstable County and the Commonwealth at grave risk.

(a) Report prepared for the Massachusetts Attorney General, May 2006 estimated the cost of a spent fuel pool fire at Pilgrim up to \$488 billion dollars, resulting in 24,000 latent cancers and spreading hundreds of miles.<sup>8</sup>

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<sup>7</sup> 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.

<sup>8</sup> Ibid. 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.

(b) Prior to the MA AGO's Report, the National Academy of Sciences issued a report for Congress, *Safety and Security of Commercial Spent Nuclear Fuel Storage, Public Report*, April 2005 found that,

Finding 2A: Terrorists view nuclear power plant facilities as desirable targets because of the large inventories of radionuclides they contain.” reactors designed like Pilgrim are the most vulnerable because their spent fuel pools are outside primary containment, in the attic of the reactor and vulnerable from three sides; 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.

Finding 3B Such (zirconium cladding) fires would create thermal plumes that could potentially transport radioactive aerosols hundreds of miles downwind under appropriate atmospheric conditions. NAS, p.50

**(c.) NRC's Consequence Study of A Beyond Design-Basis Earthquake Affecting The Spent Fuel Pool For A U.S. Mark I Boiling Water Reactor (October 2013)<sup>9</sup>**

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

**(d) Dr. Frank von Hippel & Michael Schoeppner (Princeton University) Reanalysis of NRC's Study**

A more recent study by Frank von Hippel and Michael Schoeppner of Princeton University found that a **major fire could contaminate as much as 100,000 square kilometers (38,610 square miles) of land and force the evacuation of millions<sup>10</sup>**. It would dwarf the accident at Fukushima resulting in trillion-dollar consequences.

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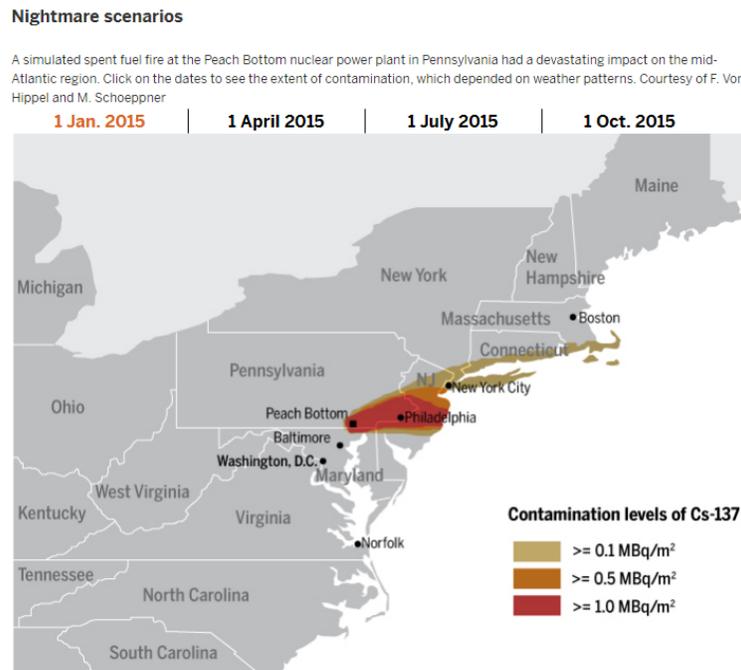
<sup>9</sup> Consequence Study Of A Beyond Design-Basis Earthquake Affecting The Spent Fuel Pool For A U.S. Mark I Boiling Water Reactor (October 2013) at 232 (Table 62) and 162 (table 33), Adams Accession NO ML13256A342)

<sup>10</sup> Richard Stone, "Spent fuel fire on U.S. soil could dwarf impact of Fukushima," *Science*, May 24, 2016. (available at: <http://www.sciencemag.org/news/2016/05/spent-fuel-fire-us-soil-could-dwarf-impact-fukushima>)

The researchers noted that NRC’s 2013 study, referenced above, did not evaluate the risk of terrorism or insider sabotage as it considered spent-fuel pool safety; neither did it consider the consequences of property contamination more than 50 miles from the reactor site, even though a broader release is clearly possible. Also, NRC used outmoded statistical estimates for the value of human life; did not incorporate potential tourism loses after an accident, or consider the potential costs to the economy if a major accident forced multiple reactors to be shut down.

The Princeton researchers did not use the computer model (MACCS2) that NRC used at Peach Bottom but instead used HYSPLIT, a program able to design more sophisticated scenarios based on historical weather data for the whole region.

The researchers focused on Cs-137, a radioisotope with a 30-year half-life that has made large tracts around Chernobyl and Fukushima uninhabitable. They assumed a release of 1600 petabecquerels, which is the average amount of Cs-137 that NRC estimates would be released from a fire at a densely-packed pool. It’s also approximately 100 times the amount of Cs-137 spewed at Fukushima. They simulated the release on the first day of each month.



**Meteorological Research:** Planning should, but does not, reflect new understanding of the flow of air over and around New England’s Coastline. Releases from Pilgrim blowing offshore

towards Barnstable County will remain tightly concentrated due to water temperature and reduced turbulence until the winds blow the plume over land on the Cape.<sup>11</sup> This fact is currently ignored.

**Research on Administration Potassium Iodide:** Federal legislation, Section 127 of the Bioterrorism Act, not yet implemented called for the distribution of Potassium Tablets within a 20-mile radius of nuclear power plants and the decision of the Massachusetts Legislature to offer KI to communities so requesting KI on Cape Cod and Cape Ann suggests that the area of impact could be beyond the 10-mile EPZ.

### **B. Cape Cod – No Escape**

In the event of a severe accident at Pilgrim with offsite releases triggering protective action for the EPZ, the Sagamore and Bourne Bridge will be closed to outgoing traffic so as not to interfere with and any outbound traffic would feed directly into traffic leaving the core from Plymouth and Carver. Traffic jams are inevitable and vehicles do not provide protection from radiation.

## **II. ESSEX COUNTY**

Essex County consists of the following cities and towns; but only Amesbury, Merrimac, Newbury, Newburyport, Salisbury and West Newbury are in the 10-mile EPZ. However the other towns are at risk for the same reasons discussed above for Barnstable County

Amesbury	Danvers	Nahant
Beverly	Essex	Newbury
Gloucester	Georgetown	North Andover
Haverhill	Groveland	Rockport
Lawrence	Hamilton	Rowley
Lynn	Ipswich	Salisbury
Methuen	Lynnfield	Saugus
Newburyport	Manchester-by-the-	Swampscott
Peabody	Sea	Topsfield
Salem	Marblehead	Wenham
Andover	Merrimac	West Newbury
Boxford	Middleton	

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<sup>11</sup> Zager M, Tjernstrom M, Angevine W. 2004. New England coastal boundary layer modeling. In: AMS 16<sup>th</sup> Symposium on boundary Layers and Turbulence, 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, 13<sup>th</sup> Symposium on Turbulence 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 App. Meteorology & Climatology 45: 137-154.

### **III. RADIOLOGICAL EMERGENCY PLANS AND STANDARD OPERATING PROCEDURES FOR BARNSTABLE & ESSEX COUNTIES NEED TO BE DEVELOPED WITH STAKEHOLDER INPUT- STATE, LOCAL OFFICIALS AND THE PUBLIC.**

**Key elements of the Plan would include the following.**

1. **Emergency Personnel:** Identifying roles; training; equipping (communication equipment, protective gear-face masks, KI, dosimetry) and establishing a Radiological Emergency Workers Decontamination Site.
2. **Notification:** A protocol needs to be developed describing how and when MEMA will notify Town Emergency Management Directors and when they in turn shall notify workers and the public. The model for the EPZ is a logical one to copy. Appropriate equipment needs to be identified and provided as necessary - note that the equipment is multi-purpose or all-hazards. Example: Emergency Alert System (EAS), radio and TV; sirens (Fire Stations); Rapid Dialing Telephone Systems in towns that have them; portable message boards; loud speakers for beach and harbor personnel.
3. **Sheltering with KI – only feasible initial protective action:** In the event of a radiological emergency at Pilgrim NPS, the public should be instructed to shelter; take KI to protect the thyroid from being saturated with radioactive iodine; and remain inside the shelter until directed otherwise.
4. **Evacuation:** After the call to shelter ends, the public should be directed to evacuate. When leaving the shelter, the public should be provided with N-95 masks or, absent masks, directed to cover their exposed skin and mouth to prevent exposure to re-suspended radioactive particulates. Evacuation should be directed to pre-designated and prepared Reception Centers for monitoring and decontamination, as required, reunification with family, and directions to MassCare Shelters and interim lodging.
5. **Exercises:** Preparedness assessed periodically to test readiness so that “glitches” can be addressed prior to an event.
6. **Public Education:** The Calendar prepared for the EPZ, appropriately adjusted, would serve as a model. It is on MEMA’s website.

### **IV. SUMMARY**

Reassessment of planning is appropriate. We contend that public safety is best protected by including measures to protect the public from exposure to airborne contamination and continuing to test food and water for contamination in a nuclear accident in consideration of the foregoing. Heretofore, Federal and state regulators (NRC, FEMA, MEMA, and MDPH) have incorrectly assumed otherwise. This ignores current scientific understanding regarding potential releases and the distance that they can travel in a nuclear reactor accident and real-world experience from Fukushima and Chernobyl. The Commonwealth knows better from state- funded research;<sup>12</sup> and we can do better.

Absent extending plume exposure pathway radiological emergency planning procedures for Barnstable and Essex Counties there is no reasonable assurance for public health and safety and no basis for the Commonwealth to support continued operation of the reactors. At the same time, recognizing that the risk of significant offsite release remains until the fuel is out of the spent fuel pool, and to a lesser degree onsite in dry storage, requires the licensee to maintain funding of radiological emergency planning until the fuel leaves the site.

Respectfully submitted,

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<sup>12</sup>Examples: Dr. Gordon Thompson's and Dr. Jan Beyea's expert sworn testimony for the MA AGO. *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, in 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 . Dr. Bruce Egan, Project Manager for the development of models of the effects of complex sea breeze circulations on air quality on Cape Cod for Massachusetts Department of Public Health. This project involved the adaptation of the meteorological model, MM5, to a fine grid resolution and the use of this program to drive SCIPUFF, and CALMET/CALPUFF and ISC; and the effects of sea breezes on emissions from both elevated and ground level sources were simulated Massachusetts Department of Public Health contracted with Dr. J.D. Spengler and Dr. G.J. Keeler of Harvard University to study the wind patterns around Pilgrim Station - J.D. Spengler and Dr. G.J. Keeler, Feasibility of Exposure Assessment for the Pilgrim Nuclear Power Plant, Prepared for Massachusetts Department of Public Health, May 12, 1988.

