# Total Population Evacuation Zones and Damage Consequences with Nuclear Reactor Spent Fuel Fire Pool Incidents: Terrorist Attacks, Natural Disasters, Accidents/Malfeasance

**Testimony to Colorado Legislature, House Committee on Energy and Environment;**

**March 29, 2023 re: HB23-1247 and HB23-1080**

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The following graphics illustrate the radioactive contamination zones that could result from catastrophic incidents at nuclear reactor spent nuclear fuel (SNF) pools. Such incidents could result from:

- intentional terrorist or military attacks on the SNF cooling pools and interim storage facilities,
- natural disasters such as earthquakes/tsunami, as occurred at Fukushima, Japan
- flooding from large storms
- operator error/incompetence, as occurred with Chernobyl, Ukraine
- equipment or instrument failure/malfunction/degradation
- numerous other causes

I place the potential for intentional terrorist attack at the top of this list, since that scenario was considered by the 9/11 terrorists that attacked the World Trade Center and Pentagon. It is documented in the 9/11 Commission official report that those terrorists conducted reconnaissance on the Indian Points Nuclear plant near New York City on the Hudson River. Other targets were ultimately selected

I have personally conducted computer modelling of such a terrorist attack on the Indian Points plant, using computer consequence computer codes publicly available from DOE laboratories. One of the following graphics illustrates that such an attack could be easily conducted on the SNF cooling pools, for example by a commercial aircraft. An attached model graphic illustrates the tragic consequences of one scenario of a terrorist attack. The graphical results illustrate the toxic Cs-137 release from a spent fuel fire, and the mandatory evacuation zones.

Respected nuclear physicist scientists have also conducted computer modelling of spent nuclear fuel fires, caused by any of the above listed events. The following graphic displays of the huge radiological exposure consequences dramatically demonstrate that major human population centers can be made unhabitable for very long time frames. See the graphics, results of each model case is summarized below.

- Modelling of spent nuclear fuel pool fire at the Peach Bottom nuclear plant, located west of Philadelphia, depending upon the meteorological conditions at time of and after the fire is illustrated on three regional maps on different dates and meteorological conditions (these models were conducted by Professor Frank von Hippel and Michael Schoeppner of Princeton University; published in scientific journals). Take note of the red and orange colored geographical areas which are mandatory evacuation zones which span numerous Atlantic seaboard states, and millions of persons permanently displaced.

- Similar modelling of spent nuclear fuel fires by the same Princeton team of nuclear scientists was conducted for the Surry, Virginia nuclear power plant, located on the James River in southwest Virginia. Note that the mandatory evacuation zones include major metropolitan areas such as Washington, DC,

Baltimore, and as distant as New York and Boston, depending upon weather conditions. Population relocations can be as great at 49 million people.

- Professor Frank von Hippel was appointed to the National Academy of Sciences to Lesson Learned Investigation of the nuclear disaster at Fukushima, Japan. After that formal NAS report, von Hippel and colleagues published the above noted studies, as well as similar computer modelling of the Fukushima disaster, examining alternative meteorological scenarios that if they had occurred would have made Tokyo unhabitable. When the major radiological releases occurred, the winds were primarily from the west, moving the contamination seaward to the Pacific Ocean. The final attached graphic illustrates the case if the winds have been towards Tokyo, resulting upwards of 29 million people and contamination of an estimated 25,000 $km^2$.

**Closing Comment**:

These case studies illustrate the enormous risks and consequences to humans and their cities and environment of nuclear power and spent nuclear fuel. Currently, with only minor exceptions, all USA nuclear waste is stored in SNF cooling pools or on-stie storage casks. There is no plan by the U.S. government for permanent disposal which would require security and infallible containment for hundreds of thousands of years, longer than the human race and civilization has existed on this planet.

There is no other energy system that embodies these huge and essentially forever risks and consequences to life and the environment. We simply do not need to engage in these enormous risks and consequences. We already have proven and truly safe, low to zero carbon greenhouse gas technological options that can be put into action NOW. Nuclear power is not the answer, and given the above illustrated enormous risk and consequence scenarios every nuclear power plant and its associated nuclear wastes amounts to the functional equivalent of pre-positioned nuclear disasters, exceedingly vulnerable to malicious acts.

**Requested Legislative Actions**:

We must not, and need not build any new nuclear power plants in the USA or Colorado. Nuclear power and its associated nuclear wastes are fundamentally flawed and exceedingly dangerous technologies.

1. **Please remove all consideration of nuclear power from HB 23-1247**
2. **Vote in opposition of HB 23-1030 in its entirety.**

Thank you.

See attached six graphic illustrations:

1. Peach Bottom nuclear power plant (southeast Pennsylvania): four seasonal radiological contamination zones from hypothetical fire in spent fuel pool.
2. Peach Bottom nuclear power plant: April 2015 fire scenario of spent nuclear fuel pool
3. Peach Bottom nuclear power plant: July 2015 fire scenario of spent nuclear fuel pool
4. Surry, Virginia nuclear power plant: Feb 1, Apr 1 & Sept 1, 2015 spent fuel fire with resultant required population relocations
5. Fukushima Population relocations required with three meteorological conditions: actual 3/15/2011, and Wind Off Shore 4/9/2011, and Wind onto land 3/19/2011; with resultant required evacuation numbers and contamination areal extents.
6. Indian Point Nuclear Power Plant, on Hudson River near New York City; Radioactive Cesium-137 releases from a modelled spent nuclear fuel fire; resulting from a aircraft attack on the spent fuel cooling pool; total effective dose equivalent (TEDE) and zone of downwind contamination/evacuation-exclusion zone.

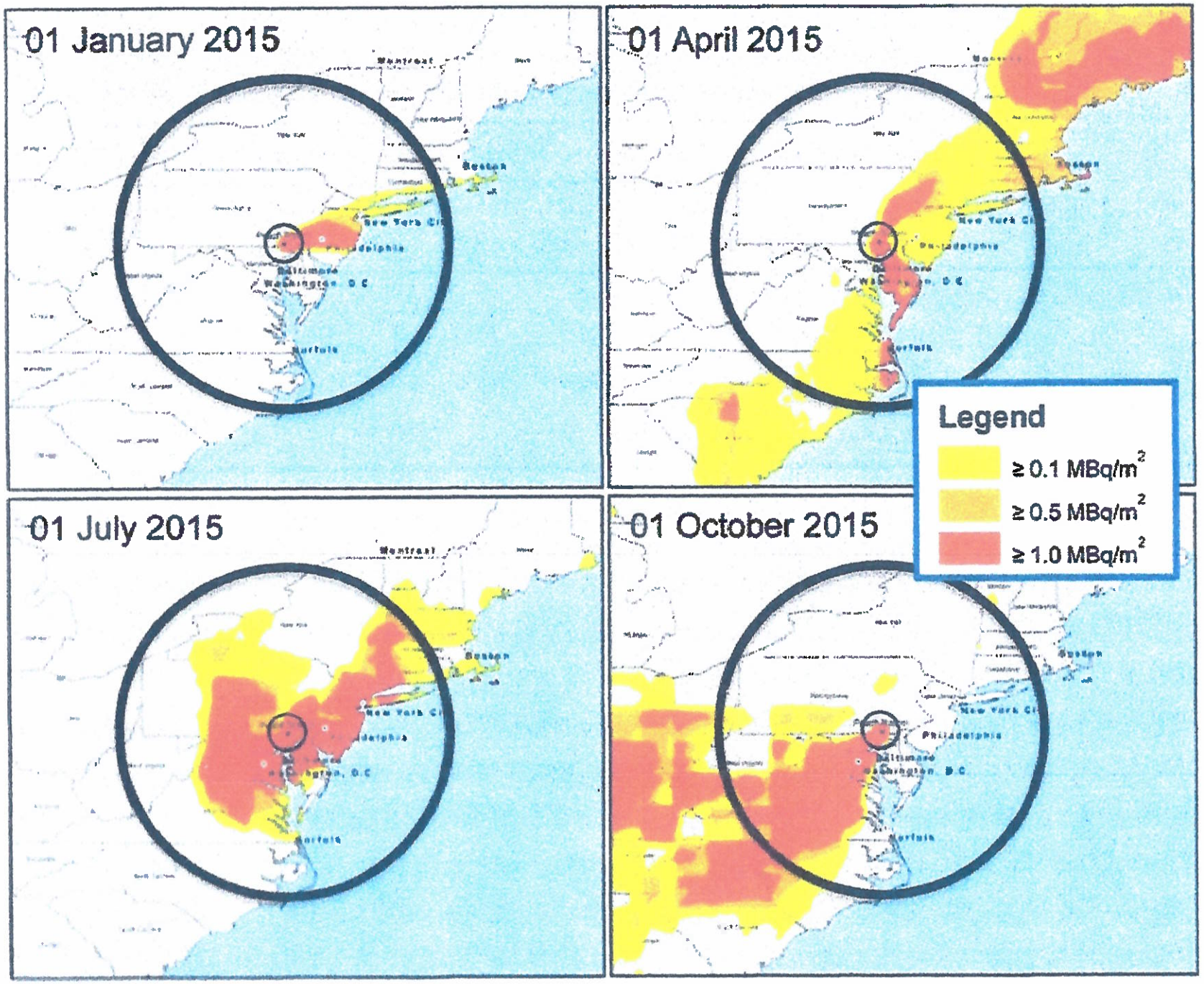
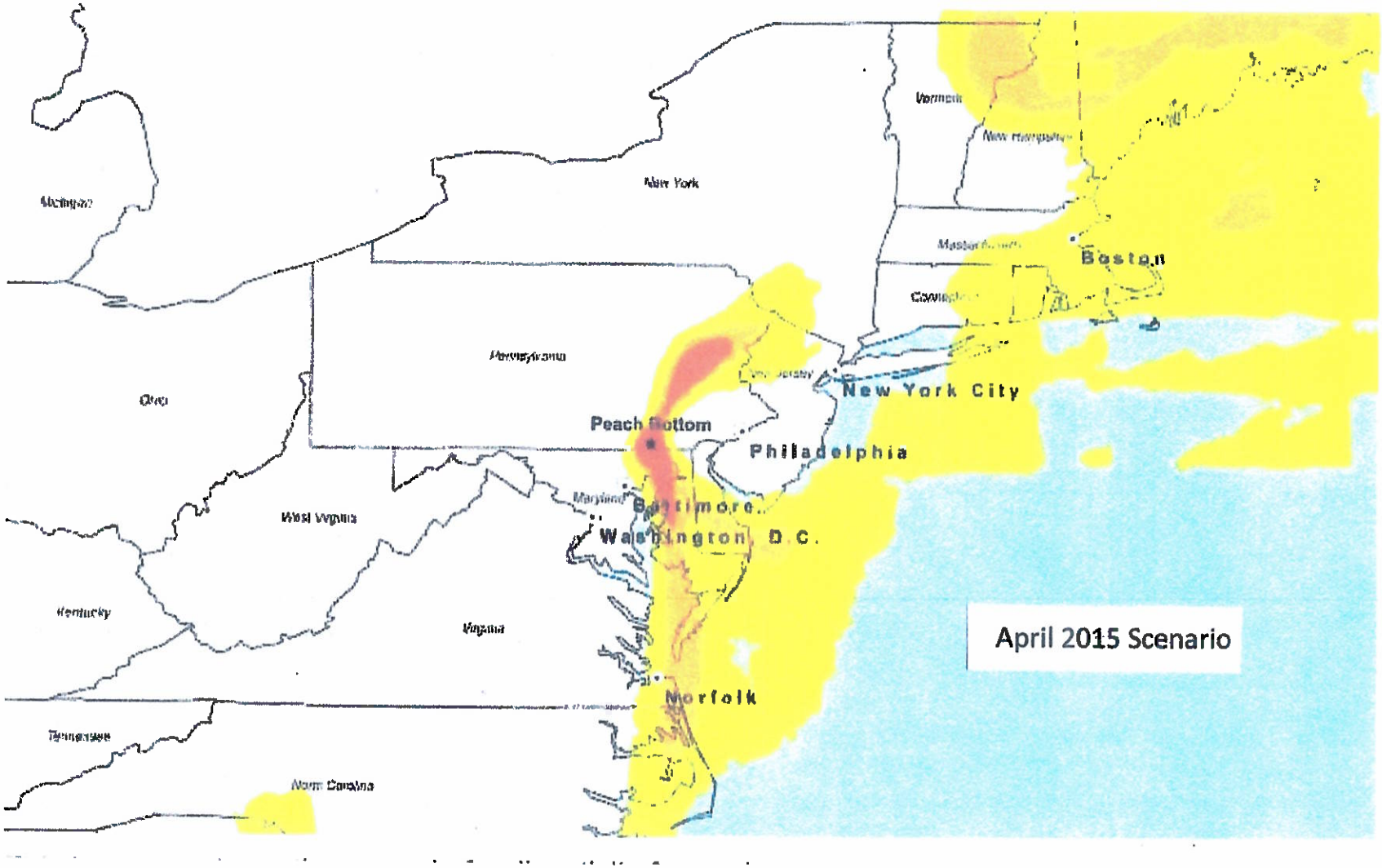


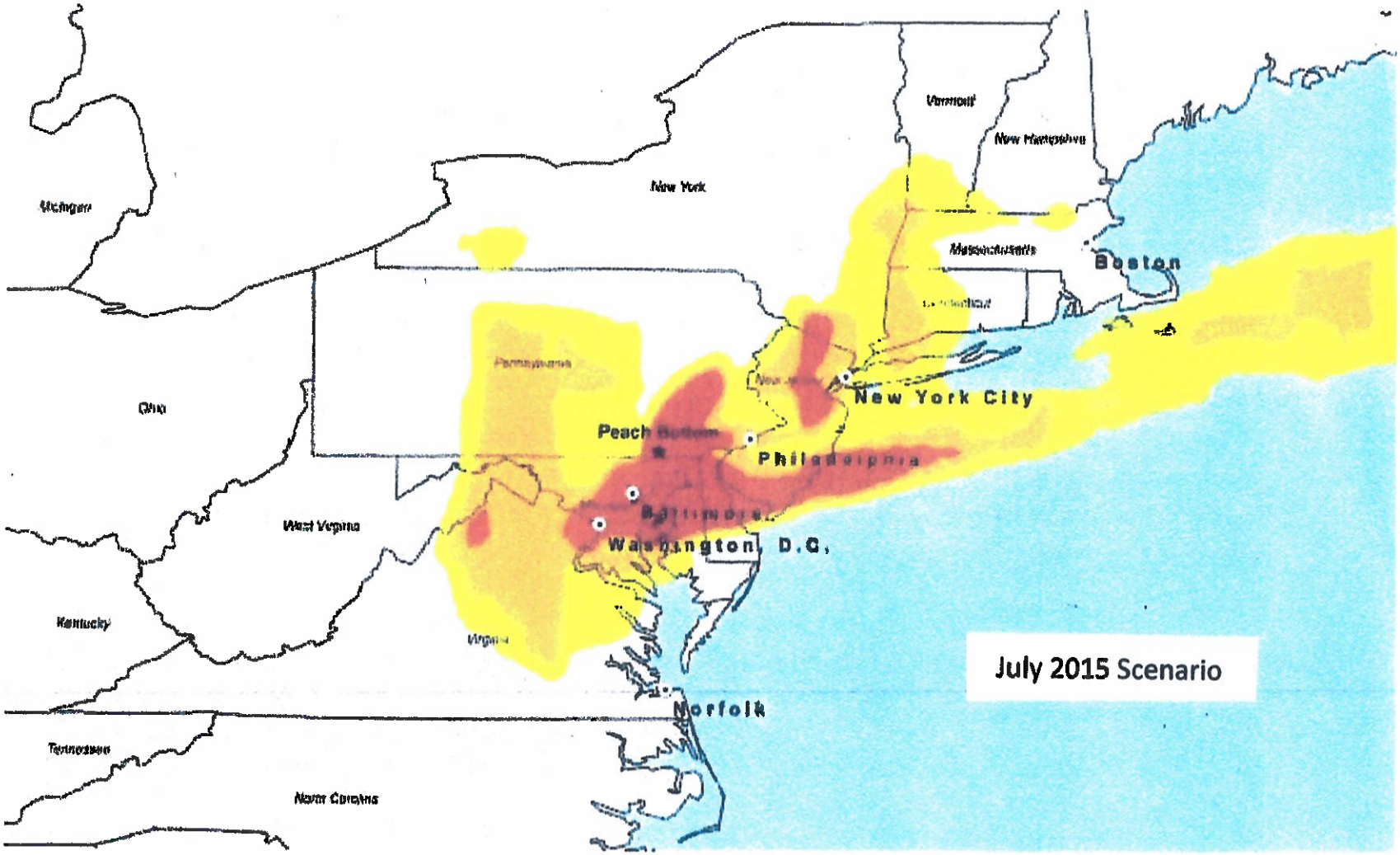

**Figure 6.** Contamination areas from a hypothetical fire in a high-density spent fuel pool at the Peach Bottom Nuclear Power Plant in Pennsylvania releasing 1600 PBq of cesium 137 on four dates in 2015.

Von Hippel's co-authors are Michael Schoeppner, a former postdoctoral researcher at Princeton's SGS, and Edwin Lyman, a senior scientist at the Union of Concerned Scientists.




This image captures the spread of radioactivity from a hypothetical fire in a high-density spent fuel pool at the Peach Bottom Nuclear Power Plant in eastern Pennsylvania. In this scenario, several major cities would be affected by contamination. Based on the guidance from the US Environmental Protection Agency and the experience from the Chernobyl and Fukushima accidents, populations in the red and orange areas would have to be relocated for many years, and many in the yellow area would relocate voluntarily. The contamination area projection is based on actual weather patterns that occurred in April 2015.

Credit: Graphic courtesy of Michael Schoeppner, Princeton University, Program on Science and Global Security. Other lead authors: Prof. Frank von Hippel, Princeton University, Science and Global Security and National Academy of Sciences special committee on Fukushima ; Edwin Lyman, Union of Concerned Scientists, Cambridge, MA/Washington, DC. As published: https://m.phys.org/news/2017-05-nuclear-greatly-underestimate-potential-disaster.html

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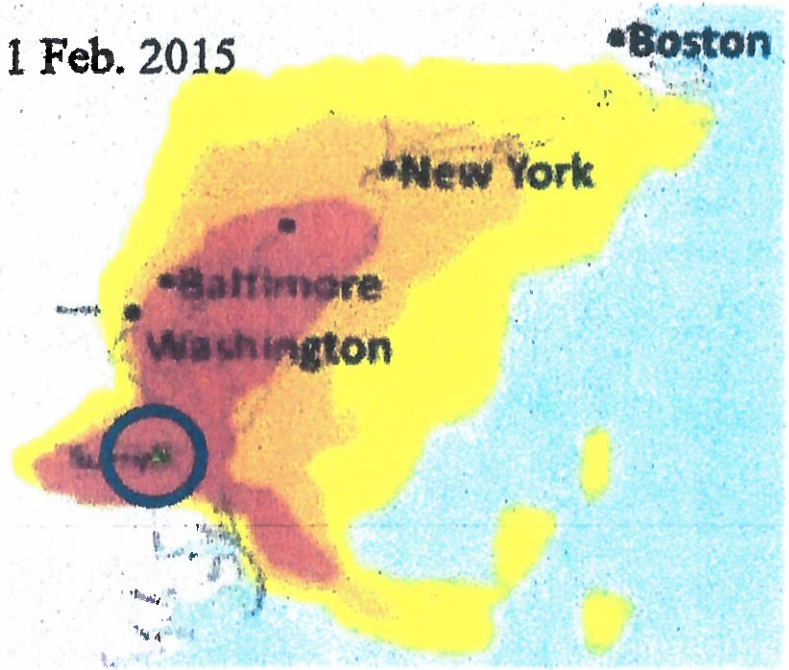
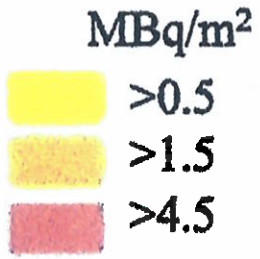
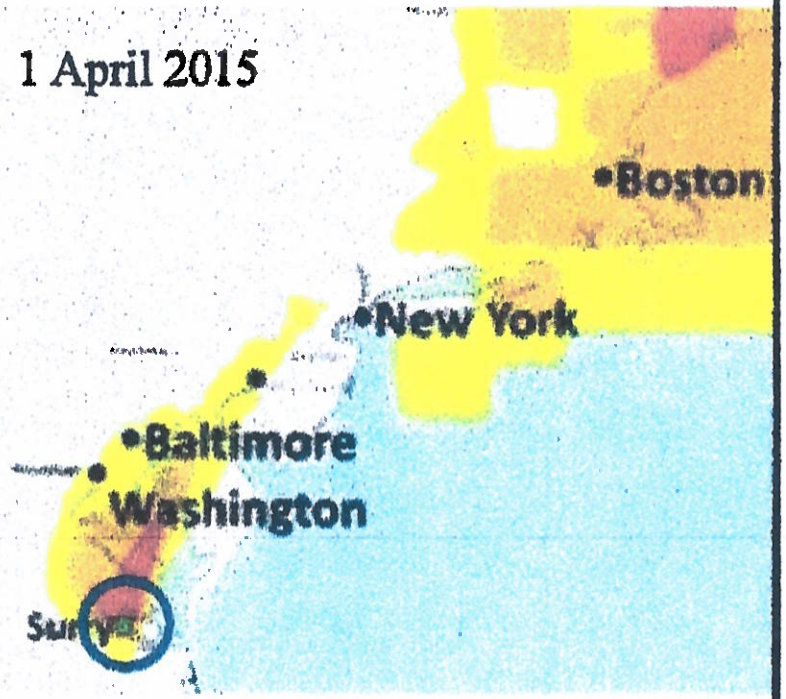
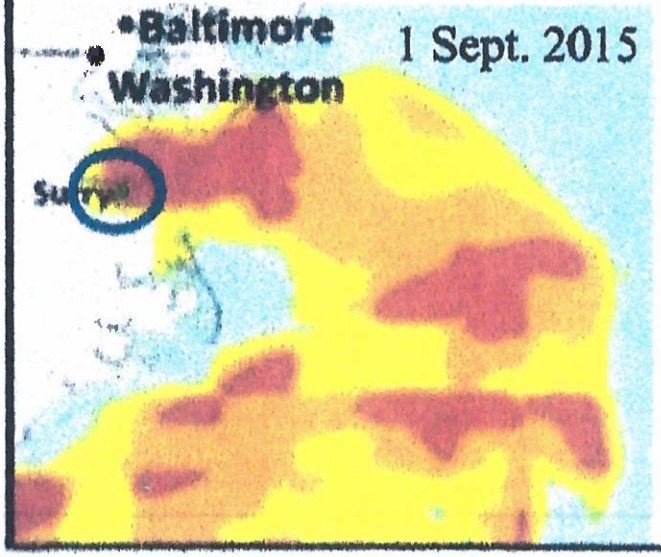
Credit: Graphic courtesy of Michael Schoeppner, Princeton University, Program on Science and Global Security. Other lead authors: Prof. Frank von Hippel, Princeton University, Science and Global Security and National Academy of Sciences special committee on Fukushima ; Edwin Lyman, Union of Concerned Scientists, Cambridge, MA/Washington, DC. As published: https://m.phys.org/news/2017-05-nuclear-greatly-underestimate-potential-disaster.html

# Relocation areas (orange and red) for spent fuel fire in a dense-packed pool at the Surry, VA nuclear power plant




| Date | Population relocated (millions) | | |
|---|---|---|---|
| | 4.5 MBq/m² | 1.5 MBq/m² | 0.5 MBq/m² |
| 1 Feb. 2015 | 12 | 41 | 49 |
| 1 April 2015 | 0.8 | 10 | 26 |
| 1 Sept. 2015 | 0.7 | 1.2 | 3 |
| 12-mo. ave | **3** (NRC: 3.5) | **8** | **16**[7] |

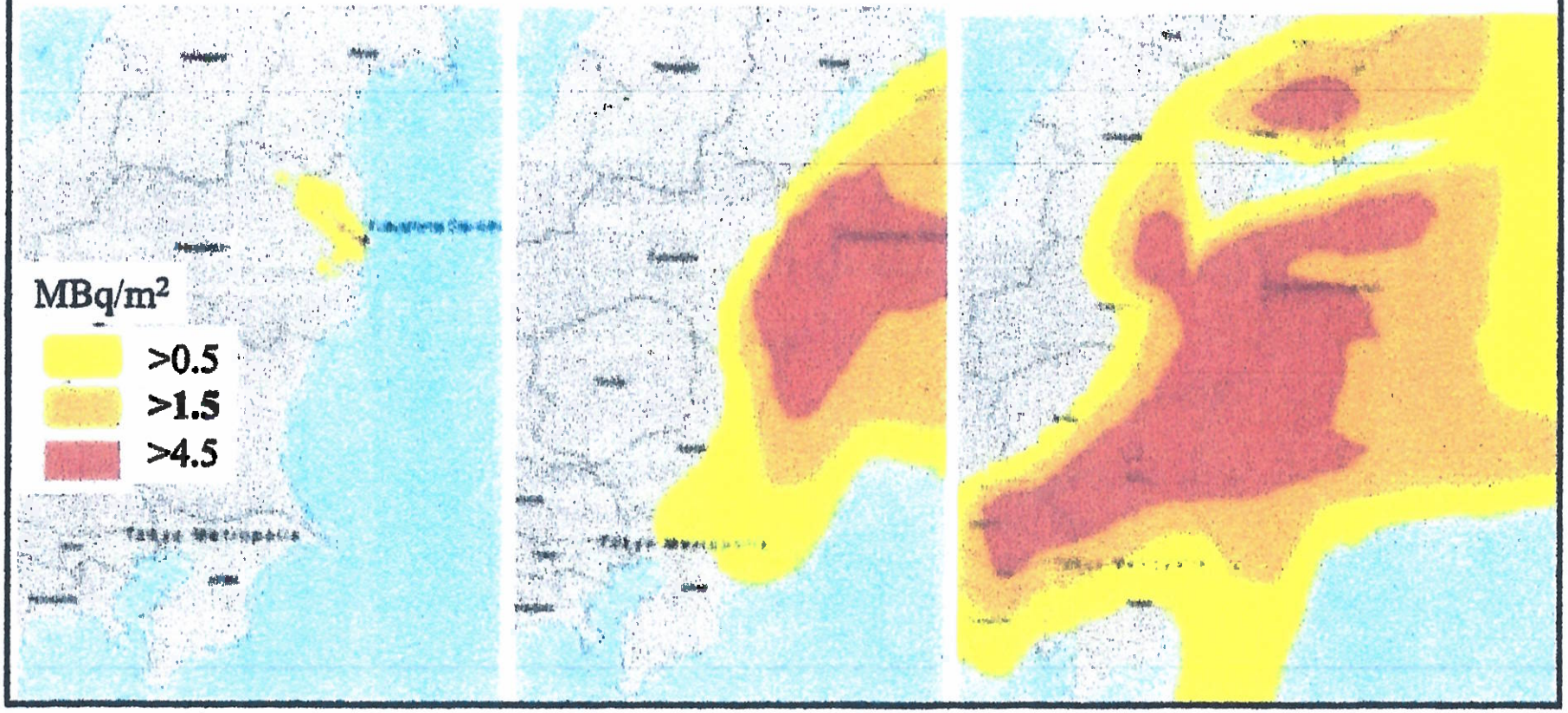
# Fukushima population relocated if ≥ 1.5 MBq/m² Cs-137 contamination (orange)

**Actual Fukushima accident** (3/15/2011)
Evacuated: 88,000
from 1,100 km²

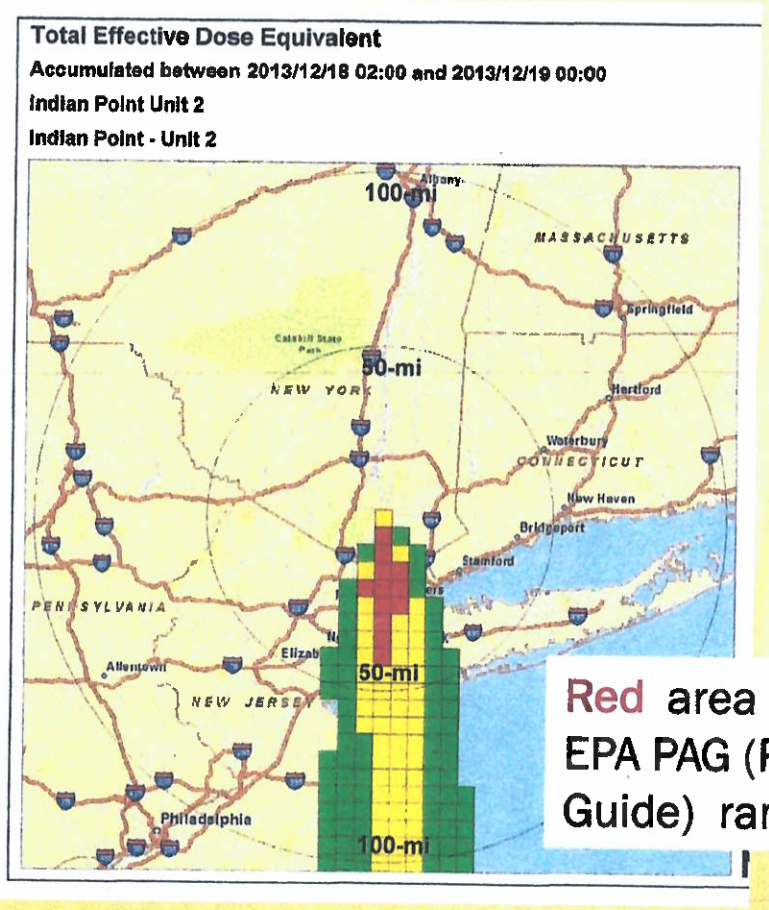
**Hypothetical fire in spent fuel pool #4**
**HYSPLIT calculations, historical weather**

**Wind off shore**(4/9/2011)
Evacuated: 800,000
from 2,600 km²

**Wind onto land** (3/19/2011)
Evacuated: 29,000,000
from 25,000 km²



# INDIAN POINT SPENT FUEL FIRE - TERRORIST ATTACK MODELED CONTAMINATION ZONES; TOTAL EFFECTIVE DOSE EQUIVALENT- (immed.)




After First 22 hours of release

Red area exceeds 100% EPA PAG (Protective Action Guide) range –evacuation

15 MCi of Cs-137 release from high density SNF pool of Unit # 2; just after full core off-load; 24 hour duration; northerly wind, 6 to 9 mph

Small circle is area of contamination assessed by NRC, 50 miles.
Larger circle area of contamination assessed by BIT (Andrews) study, model out to 100 miles.

Green area: 0.05 to 0.5 rem
Yellow area: 0.5 to 5 rem
Red area: > 5 rem

R. D. Andrews, RASCAL 4.3 model, independent study, Jan 2012.