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June 30, 2016

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The Honorable Stephen G. Burns
Chairman
Nuclear Regulatory Commission
Rockville, MD 20852

Dear Chairman Burns:

I write to again request that the Nuclear Regulatory Commission (NRC) re-examine and address the risk to public safety posed by overcrowded spent-fuel pools at commercial reactor sites, particularly in light of two new reports that identified serious gaps in the NRC's previous analysis. A fire in a densely-packed spent-fuel storage pool could result in health and economic consequences comparable to those caused by an accident at an operating reactor,¹ including the displacement of more than ten million people and hundreds of billions of dollars in damages. These risks could be much reduced by transferring spent fuel to dry casks—which are more resilient against accidents or attacks—and by returning U.S. spent-fuel pools to open-frame, low-density configurations, which have a lower risk of fire. Both options would also avoid the kind of concerns recently raised at the Pilgrim Nuclear Power Station, where reports indicate that the deterioration of neutron-absorbing materials has increased the risk of an uncontrolled nuclear reaction in the densely packed spent-fuel pool. Unfortunately, the NRC has consistently underestimated the benefits to public safety of these options. Many of these concerns about the NRC's approach to spent-fuel storage were also recently highlighted in a new report from the National Academy of Sciences (NAS).²

I have repeatedly warned the NRC of the dangers posed by attacks on and accidents at spent-fuel storage facilities. On September 20, 2001, I wrote to the NRC to raise questions about the threat of terrorist attacks on nuclear reactors and spent-fuel pools, and two months later, I wrote to warn of the risk of spent-fuel fires in the event that these pools were drained. In March 2007, I led a letter from the Massachusetts Congressional Delegation urging the Commission to reverse its policy of prohibiting consideration of spent-fuel storage risks during licensing proceedings for nuclear power plants. More recently, in September 2013, I urged the NRC to

¹ "Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants," Nuclear Regulatory Commission, NUREG-1738, January 2001, <http://pbadupws.nrc.gov/docs/ML0104/ML010430066.pdf>.

² National Academy of Sciences, *Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Plants*, Phase 2 (Washington, D.C.: The National Academies Press, 2016).

revise its spent-fuel storage risk assessment, in light of its deeply flawed methodology, and to reconsider expedited transfer of spent nuclear fuel to dry casks.³ I also twice introduced legislation, the Dry Cask Storage Act, which would require plant operators to submit plans to transfer most spent fuel to dry casks and to move remaining fuel stored in pools to configurations that minimize the chances of fire in case of a loss of cooling water. The legislation would also expand emergency planning zones around nuclear reactors from 10 to 50 miles for any plant operator that fails to carry out plans for expedited transfer of spent-fuel.

In 2014, the NRC published its study on the consequences of a beyond-design-basis earthquake for spent fuel at a Mark I Boiling Water Reactor,⁴ and it had previously extended this analysis to other types of U.S. power reactors.⁵ The NRC cited the conclusions of this analysis to argue that the costs to licensees of transferring spent fuel to dry casks outweighed the public benefits. However, according to the NAS report, the NRC's study was flawed—specifically, it failed to consider a number of realistic threats to spent fuel pools, including terrorist attacks and sabotage by insiders, and it did not take into account some of the broader societal consequences of a radioactive release.⁶ These findings support many of the criticisms I raised in my September 2013 letter.

According to both the NAS report and additional results reported in a draft paper by Princeton physicists Frank von Hippel (one of the members of the NAS panel) and Michael Schoeppner, unrealistic assumptions and problematic methodologies in the NRC's 2014 analysis led it to drastically underestimate the benefits of transferring spent-fuel from pools to dry casks.⁷ In light of these facts, the NRC should fully implement NAS's recommendation that the NRC complete a comprehensive re-assessment of the "potential benefits of expedited transfer of spent fuel from pools to dry casks."⁸

Recent safety problems at the Pilgrim Nuclear Power Station highlight the risks of storing spent nuclear fuel in densely-packed pools in a closed-frame configuration.⁹ Pilgrim's pool was designed to hold 880 fuel assemblies, but today it holds more than 3,300 — nearly 4 times that number. This method of dense-pack storage relies on neutron-absorbing panels made of Boraflex—a combination of boron carbide and silicone rubber—located between the fuel assemblies to prevent nuclear criticality. Unfortunately, Boraflex can deteriorate—a problem that has occurred at Pilgrim and other plants—raising the alarming prospect of a catastrophic release of radioactivity in the event that fission in the pools occurs. In short, overcrowded spent fuel pools are a disaster waiting to happen. Re-racking spent-fuel into a low-density open-frame

³ <http://www.markey.senate.gov/imo/media/doc/09-17-13EJMtoNRCspentfuelstudy.pdf>

⁴ "Consequence Study of a Beyond-Design-Basis Earthquake Affecting the Spent Fuel Pool for a U.S. Mark I Boiling Water Reactor," Nuclear Regulatory Commission, NUREG-2161, September 2014, <http://pbadupws.nrc.gov/docs/ML1425/ML14255A365.pdf>

⁵ "Staff Evaluation and Recommendation for Japan Lessons-Learned Tier 3 Issue on Expedited Transfer of Spent Fuel," Nuclear Regulatory Commission, COMSECY-13-0030, November 2013, <http://www.nrc.gov/reading-rm/doc-collections/commission/comm-secy/2013/2013-0030comsecy.pdf>

⁶ NAS, *Lessons Learned*, p. 155.

⁷ Frank N. von Hippel and Michael Schoeppner, "Reducing the Danger Fires in Spent Fuel Pools," Draft paper, June 11, 2016. Attached.

⁸ NAS, *Lessons Learned*, pp. 155-156.

⁹ Christine Legere, "Report: Panel at Pilgrim degrading," *Cape Cod Times*, May 14, 2016, <http://www.capecodtimes.com/article/20160513/NEWS/160519684>

system—or transferring it to dry casks—would significantly attenuate the risk of such a disaster. Unfortunately, by underestimating the benefits of alternate spent-fuel storage options, the NRC also has failed to address the risk of nuclear criticality.

Please provide answers to the following questions:

1. The NAS report recommended that the NRC “should perform a spent fuel storage risk assessment to elucidate the risks and potential benefits of expedited transfer of spent fuel from pools to dry casks.”¹⁰
 - a. Do you agree with this recommendation? If not, why not?
 - b. If you agree with this recommendation, when will the Commission initiate its assessment? When do you expect the assessment to be completed?

2. The NAS report recommended that the NRC “strengthen their capabilities for identifying, evaluating, and managing the risks from terrorist attacks,”¹¹ and that the NRC’s spent fuel storage risk assessment “should address accident and sabotage risks.”¹² These recommendations substantiate concerns I raised in my September 2013 letter. As I explained, the NRC limited its analysis to studying the risk of spent-fuel fires resulting primarily from a severe earthquake, and failed to consider the risk posed by terrorist attacks. Accounting for the risk of terrorism is vital in light of reports that ISIS terrorists responsible for the recent Paris and Brussels attacks conducted video surveillance of a high-ranking Belgian nuclear official.¹³ Without incorporating the risk of terrorism into its analysis, the NRC cannot adequately consider the full range of scenarios that could lead to a catastrophic spent-fuel fire, and cannot fully assess the benefits to public safety of taking steps to mitigate the risk of this eventuality.
 - a. Do you agree with the NAS recommendation that the NRC must fully account for the risk of terrorism and sabotage in its re-assessment of spent-fuel risks? If not, why not?
 - b. What steps, if any, is the NRC taking to strengthen its capabilities to identify, evaluate, and manage the risk of terrorist attacks on nuclear facilities, including spent-fuel storage sites?

3. As the Fukushima disaster demonstrated, a major release of radioactivity at a nuclear plant could have significant societal effects. These include psycho-social distress and more than 1,600 deaths¹⁴ resulting from large-scale disruptions and population relocations; the loss of economic activity caused by the shut-down of all nuclear power

¹⁰ NAS, *Lessons Learned*, pp. 155-156.

¹¹ *Ibid.*, p. 91.

¹² *Ibid.*, p. 156.

¹³ Milan Schreuer and Alissa J. Rubin, “Video Found in Belgium of Nuclear Official May Point to Bigger Plot,” *New York Times*, February 18, 2016, <http://www.nytimes.com/2016/02/19/world/europe/belgium-nuclear-official-video-paris-attacks.html>

¹⁴ “Fukushima stress deaths top 3/11 toll,” *Japan Times*, February 20, 2014, <http://www.japantimes.co.jp/news/2014/02/20/national/post-quake-illnesses-kill-more-in-fukushima-than-2011-disaster>

plants in the country and the long-term evacuation of large geographic areas; and the loss of revenue from declining food exports from and tourism in contaminated regions.¹⁵ The Fukushima disaster also led to health problems, injuries, and casualties among clean-up workers,¹⁶ and there have been reports linking the radioactive release to elevated rates of thyroid cancer among children living in Fukushima prefecture.¹⁷ As such, to fully capture spent-fuel storage risks, the NAS report recommended that the NRC's analysis "[c]onsider societal, economic, and health consequences" of a spent-fuel fire, as well the direct risks of a radioactive release.¹⁸ Do you agree with this recommendation? If so, how and when does NRC plan to adopt this recommendation? If not, why not?

4. According to the NAS report, the NRC "has not carried out an independent examination of surveillance and security measures for protecting stored spent fuel," as recommended by the NAS's 2006 report.¹⁹ As such, the 2016 NAS report recommended that the NRC fulfill this recommendation, and that the NRC's analysis "should include an examination of the effectiveness of [the NRC's] programs for mitigating insider threats."²⁰
 - a. Why did the NRC fail to carry out the NAS's 2006 recommendation?
 - b. Does the NRC intend to carry out an independent examination, as recommended by both NAS studies? If not, why not?
 - c. Will this examination address insider threats, as the NAS recommends? If not, why not?
5. According to von Hippel and Schoeppner, the NRC's previous analysis of spent-fuel risks significantly underestimated the area from which the population would have to be relocated after a spent-fuel pool fire. The NRC's analysis found that a large release of radioactive cesium-137 from a spent-fuel pool would result in the relocation of people from an area of 30,000 square kilometers, an area larger than Massachusetts.²¹ By contrast, Von Hippel and Schoeppner's analysis showed that relocation would be required from an average of about 100,000 square kilometers.²² According to von Hippel and Schoeppner, this discrepancy may have resulted from the fact that the NRC's analysis assumed that the exposed population would benefit from some degree of shielding from the radiation. However, the Environmental Protection Agency (EPA) assumes no shielding in its recommended threshold for a radiation dose requiring

¹⁵ NAS, *Lessons Learned*, pp. 182-3; Von Hippel and Schoeppner, pp. 18-19.

¹⁶ Jonathan Soble, "Japan to Pay Cancer Bills for Fukushima Worker," *New York Times*, October 20, 2015, <http://www.nytimes.com/2015/10/21/world/asia/japan-cancer-fukushima-nuclear-plant-compensation.html>; Wendy Zukerman, "Fukushima men stood in radioactive water without boots," *New Scientist*, March 25, 2011, <https://www.newscientist.com/blogs/shortsharpscience/2011/03/fukushima-workers-stood-in-rad.html>;

¹⁷ Danielle Demetriou, "Fukushima disaster: Children cancer rates rise with 16 new cases," *The Telegraph*, February 17, 2016, <http://www.telegraph.co.uk/news/worldnews/asia/japan/12160794/Fukushima-disaster-Children-cancer-rates-rise-with-16-new-cases.html>

¹⁸ NAS, *Lessons Learned*, p. 173.

¹⁹ National Academy of Sciences, "Safety and Security of Commercial Spent Nuclear Fuel Storage: Public Report" (Washington, D.C.: The National Academies Press, 2006), <http://www.nap.edu/catalog/11263/safety-and-security-of-commercial-spent-nuclear-fuel-storage-public>

²⁰ NAS, *Lessons Learned*, p. 104.

²¹ NAS, *Lessons Learned*, Table 7.2, p. 182.

²² Von Hippel and Schoeppner, Table 3.

population relocation. By unjustifiably relaxing this assumption and assuming that the population would be shielded from radiation, the NRC's analysis increased the contamination threshold for requiring relocation by a factor of 2.5 to 5.

- a. Are von Hippel and Schoeppner correct to attribute the discrepancy between their analysis of the relocation area following a spent-fuel fire and the NRC's analysis to the NRC's use of a shielding factor?
 - b. If yes, why did the NRC assume a shielding factor, when the EPA recommendation does not assume one? Please provide copies of all documents, emails, or other correspondence written or received by the NRC staff, Commissioners, or Commissioner staff that discuss the decision to assume a shielding factor when conducting the spent-fuel storage risk evaluation.
 - c. In future analyses, will the NRC use the EPA's recommendation for an unshielded threshold radiation dose requiring population relocation? If not, why not?
6. According to von Hippel and Schoeppner, the NRC's estimation of economic losses from a radioactive release is unjustifiably lowered by the assumption that the entire area out of which the population would be relocated could be decontaminated by a factor up to 15 within a year.²³ As they note, "Achievement of such a rapid and effective decontamination is not consistent with the experience in Japan."²⁴ Four years after the Fukushima nuclear disaster, tens of thousands of people still could not return to their homes despite tens of billions of dollars spent on decontamination.²⁵ Furthermore, the NRC's own 2001 analysis argued that the long-term consequences of a spent-fuel fire would "decrease very slowly because cesium-137 has a half-life of approximately 30 years."²⁶ After the NRC's decontamination assumptions were challenged by New York State, the Commission acknowledged that "real-world data emerging from the Fukushima accident will provide significantly more relevant modern-day sources for assessing the decontamination times and costs of a severe reactor accident with offsite consequences."²⁷
- a. Do you agree that assuming such a rapid and deep rate of decontamination is not consistent with the experience from the Fukushima accident? If not, why not?
 - b. Will the NRC revise its decontamination rate assumptions to reflect the substantial costs and lengths of time associated with the clean-up effort following the Fukushima nuclear meltdowns? If not, why not?
7. According to both the NAS report and von Hippel and Schoeppner's analysis, the NRC's rules for regulatory cost-benefit analysis rely on other assumptions that reduce the estimated benefits of expedited transfer of spent-fuel.²⁸ Specifically, the NRC excludes

²³ Ibid, p. 18.

²⁴ Von Hippel and Schoeppner, p. 18.

²⁵ Julie Makinen, "After 4 years, Fukushima nuclear cleanup remains daunting, vast," *Los Angeles Times*, March 11, 2015, <http://www.latimes.com/world/asia/la-fg-fukushima-nuclear-cleanup-20150311-story.html>

²⁶ NUREG-1738, January 2001, p. x.

²⁷ Von Hippel and Schoeppner, p. 18.

²⁸ NAS, *Lessons Learned*, p. 181; von Hippel and Schoeppner., p. 17.

from consideration any consequences of a radioactive release beyond 50 miles, despite the fact that the vast majority of affected people would fall outside this narrow radius. The NRC also uses an outdated dollar value for avoided radiation doses that has not been updated since 1995. When NRC staff relaxed these assumptions to conduct sensitivity analyses, the estimated costs of spent-fuel fires grew by a factor of five. If you add the increased relocation area had the NRC not added a shielding factor to the EPA's guidance for threshold doses—and had the NRC not assumed that virtually all the relocated population could return home within less than a year—the cost-benefit analysis would have shown that the benefits to the public of expedited transfer would exceed the costs to the utilities.

- a. In light of the fact that the NRC's own sensitivity analysis indicates that a large spent-fuel fire could result in the evacuation of an area the size of Massachusetts, why does the NRC only consider the benefits of reduced accident consequences within a 50 mile radius? Does the NRC intend to revise this assumption? If not, why not?
 - b. According to an NRC staff estimate, the value for 2015 of avoided radiation doses would be \$5100/rem.²⁹ Yet in documents used to support its regulatory decision-making, the NRC still uses a value of \$2000/rem, one that has not been updated since 1995. Why has the NRC failed to update this value for more than twenty years? Does it intend to do so? If so, when? If not, why not?
 - c. Please provide copies of all documents, emails, or other correspondence written or received by the NRC staff, Commissioners, or Commissioner staff that discuss the decision to use the value of \$2000/rem in the NRC's 2014 spent-fuel risk analysis.
8. The NAS study and Von Hippel and Schoepper further note that under NRC rules, if the risk of prompt and cancer fatalities in the vicinity of a nuclear accident falls below a certain threshold, the NRC is not required to undertake a cost-benefit analysis of strategies for mitigating that risk. As a result of this rule, even though a spent-fuel fire could displace millions of people and result in untold economic damage, the NRC would not be required to evaluate the costs and benefits of strategies to mitigate such an event because it would not necessarily produce a significantly higher risk of fatalities in the immediate vicinity of the plant. To address this obvious deficiency, the NAS Study and von Hippel and Schoeppner cite experts who have suggested that the NRC should amend its rules by “set[ting] a limit on the probability that a large number of people would suffer long-term displacement as a result of a major radiological release.”³⁰ If this threshold were met, the NRC would then conduct a cost-benefit analysis. Do you agree with this suggestion? If so, please provide a detailed description, including a timeline, for how the NRC plans to implement it. If not, why not?
9. In a May 2014 letter to the NRC, Senators Boxer, Sanders, Leahy, Gillibrand, and I urged the NRC to cease providing decommissioned reactors with exemptions from its

²⁹ “Reassessment of NRC's Dollar Per Person-Rem Conversion Factor Policy” NUREG-1530, Rev. 1, Draft Report for Comment, August 2015, p. 25, <http://www.nrc.gov/docs/ML1523/ML15237A211.pdf>.

³⁰ NAS, *Lessons Learned*, p. 166; von Hippel and Schoeppner, p. 20.

emergency response and security regulations, as it has done repeatedly in the past.³¹ While there may be little reason to maintain emergency preparedness requirements on parts of a nuclear plant that no longer pose a threat of radiological release, spent-fuel pools clearly do not meet that criterion. In fact, decommissioning may actually *increase* the risk of spent-fuel fires. As the NAS report noted, “During plant decommissioning, the [spent-fuel] pool may be filled to near capacity and some plant safety systems may be inoperable.”³² Furthermore, the NAS study noted that under certain conditions, an attack on or severe accident at a spent-fuel pool could drain the pool “to just above the level of the racks in a matter of hours.”³³ In that circumstance, the absence of adequate emergency response procedures could drastically reduce our ability to restore cooling, resulting in a catastrophic fire. As such, by exempting decommissioned plants from security and emergency response rules wholesale, the NRC is allowing the industry to lower the barriers between dangerous spent nuclear fuel and a vulnerable public. Do you agree that the danger of accidents at or attacks on spent-fuel pools at decommissioned reactors warrants, without exception, the application of all emergency response and security regulations that are designed to protect against, respond to, or mitigate accidents or attacks on the spent-fuel pools? If not, why not?

I appreciate your attention to this important matter. Please provide your responses to this letter no later than July 30, 2016. For any questions or concerns, please contact Dr. Michal Freedhoff (Michal.Freedhoff@markey.senate.gov) or Dr. Gene Gerzhoy (Gene.Gerzhoy@markey.senate.gov).

Sincerely,



Edward J. Markey
United States Senator

³¹ http://www.markey.senate.gov/imo/media/doc/2014-5-1_NRC_fuel.pdf

³² NAS, *Lessons Learned*, p. 185.

³³ NAS, *Lessons Learned*, p. 57.