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Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Washington, DC 20555-0111

RE: Supplemental in Support of Emergency Enforcement Petition (10 CFR 2.206) Dated August 10, 2004 Regarding the Structural Vulnerability of the General Electric Boiling Water Reactor MARK I and MARK II Spent Nuclear Fuel Storage: National Academy of Sciences Report to Congress "Safety and Security of Commercial Spent Nuclear Fuel Storage"

Mr. Tam:

On behalf of the Nuclear Security Coalition (NSC), the undersigned petitioners submit the public version of the National Academy of Sciences (NAS) Report To Congress "Safety and Security of Commercial Spent Nuclear Fuel Storage" as supporting documentation of the emergency enforcement petition filed by the coalition on August 10, 2004 that regards emergency enforcement action for the structural vulnerability of the General Electric Boiling Water Reactor Mark I and II (BWR) Spent Nuclear Fuel Storage Pools to terrorist attack.

NAS released the public version of its classified report to Congress in April 2005. The redacted NAS report confirms the petitioners' findings and requested enforcement actions. The petitioners ask for prompt acceptance of the requested emergency enforcement actions based on the following statement of facts:

1. The NAS report findings are germane to the petitioners' requested emergency enforcement actions for all GE Boiling Water Reactor Mark I and II units.

NAS report states "*More than three years have passed since the September 11, 2001 attacks.*" [1]

NAS report states *"However, the Nuclear Regulatory Commission's analyses of spent fuel storage vulnerabilities have not yet been completed and actions to reduce vulnerabilities, such as those*

described in Chapter 3, on the basis of these analyses have not yet been taken. Moreover, some important additional analyses remain to be done. The slow pace in completing this work is of concern given the enormous potential consequences as described elsewhere in this report."[2]

NAS report states *"The committee does not know the reason for this delay, nor was it asked by Congress for an evaluation."*[3]

NAS report states "*It is important to recognize that with the exception of the Alvarez et al. (2003a) paper, all of the previous U.S. work reviewed by the committee has focused on safety risks, not security risks."*[4]

NAS report establishes its reference Boiling Water Reactor as the Dresden nuclear power station, a GE BWR Mark I.[5] NAS report states, "*This pool has approximately 3800 locations for storage of spent fuel assemblies, about 3,000 of which are occupied by four-and-one-third reactor cores (13 one-third-core offloads) in a pool approximately 35-feet wide, 40-feet long, and 39-feet deep (10.7 meters wide, 12.2 meters long, and 11.9 meters deep) with water capacity of almost 400,000 gallons (1.51 million liters). According to NRC staff, the total decay heat in the spent fuel pool is 3.9 megawatts (MW) ten days after a one-third-core offload. Heat loads can be substantially higher in spent fuel pools that contain a full-cord offload."*[6]

2. The NAS report confirms the petitioners' findings that "Nuclear Power Plants Are Critical National Infrastructure and Prime Targets."[7]

NAS RISK FINDING 2A states *"Spent fuel storage facilities cannot be dismissed as targets for such attacks because it is not possible to predict the behavior and motivations of terrorists, and because of the attractiveness of spent fuel as a terrorist target given the well known public dread of radiation."*[8]

NAS report states "*Terrorists view nuclear power plant facilities as desirable targets because of the large inventories of radionuclides they contain. The committee believes that knowledgeable terrorists might choose to attack spent fuel pools because: (1) at U.S. commercial power plants, these pools are less well protected structurally than reactor cores; and (2) they typically contain inventories of medium- and long-lived radionuclides that are several times greater than those contained in individual reactor cores."*[9]

3. The NAS report confirms the petitioners' findings that "Nuclear Power Plants and Irradiated Fuel Are Vulnerable to Attack."[10]

NAS report states "*A loss-of-pool-coolant event resulting from damage or collapse of the pool could have more severe consequences. Severe damage of the pool wall could potentially result from several types of terrorist attacks, for instance:*

(1) Attacks with large civilian aircraft.
(2) Attacks with high-energy weapons.
(3) Attacks with explosive charges."

The committee concluded that there are some scenarios that could lead to the partial failure of the spent fuel pool wall, thereby resulting in the partial or complete loss of pool coolant. A

zirconium cladding fire could result if timely mitigative actions to cool the fuel were not taken." [11]

NAS report states *"Hybrid attacks that combine aspects of both air and ground attacks also could be mounted by terrorists. These could deliver attacking forces directly to a spent fuel storage facility, bypassing the security perimeters and security personnel deployed to protect against a ground attack. The committee considered various scenarios for such attacks. The committee judges that some scenarios are feasible."*[12]

NAS FINDING 3B states *"under some conditions, a terrorist attack that partially or completely drained a spent fuel pool could lead to a propagating zirconium cladding fire and a release of large quantities of radioactive materials to the environment."*[13]

NAS FINDING 3B states *"There are two ways in which an attack on a spent fuel pool could spread radioactive contamination: mechanical dispersion and zirconium cladding fires. An explosion or high-energy impact directly on the spent fuel could mechanically pulverize and loft fuel out of the pool. This would contaminate the plant and surrounding site with pieces of spent fuel. Large-scale off-site releases of radioactive constituents would not occur; however, unless they were mobilized by a zirconium cladding fire that melted the fuel pellets and released some of their radionuclide inventory. Such fires could create thermal plumes that could potentially transport radioactive aerosols hundreds of miles downwind under appropriate atmospheric conditions."*[14]

4. The NAS report confirms the petitioners' findings that "Mark I and II BWRs Have a Particular Vulnerability."[15]

NAS FINDING 3C states *"The potential vulnerabilities of spent fuel pools to terrorist attacks are plant-specific. Therefore, specific vulnerabilities can only be understood by examining the characteristics of spent fuel storage at each plant. As described in Chapter 3, there are substantial differences in the designs of spent fuel pools that make them more or less vulnerable to certain types of terrorist attack."*[16]

NAS report at 2.2.1 AIR ATTACKS states "*consequences of such attacks are scenario and plant-design specific."*[17]

NAS report states *"In contrast, in boiling water reactors (BWR) designs, the reactor vessel is at a higher elevation, and the BWR reactor vessels are somewhat taller than PWR vessels. Consequently, BWRs have more elevated spent fuel pools; generally, well above grade.*[18]

NAS report conveys that NRC has stated: *"BWR spent fuel pools: MARK I and MARK II BWR plants are located above grade and are shielded by at least one exterior building wall. Some pools are also shielded by the reactor buildings. Some pools are also shielded by 'significant' surrounding structures, and some have supplemental floor and column supports."*[19]

NAS report states *"The vulnerability of a spent fuel pool to terrorist attack depends in part on its location with respect to ground level as well as its construction. Pools are potentially susceptible*

to attacks from above or the sides depending on their elevation with respect to grade and the presence of surrounding shielding structures."[20]

NAS report states that NRC *"analyses of spent fuel pool storage vulnerabilities were not completed by the time the committee finalized its information-gathering for this report, but the committee did receiving briefings on this work."*[21]

NAS report states *"A study in progress by Sandia National Laboratories for the NRC examined the consequences of an aircraft impact on an actual BWR power plant." "The results of these aircraft and assault studies are classified. The committee concluded that there are some scenarios that could lead to the partial or complete loss of pool coolant. A zirconium cladding fire could result if timely mitigative actions to cool the fuel were not taken."*[22]

NAS report states that the Sandia National Laboratory study is being conducted on the Dresden GE BWR MARK I.[23]

NAS report states that a zirconium cladding fire *"would create thermal plumes that could potentially transport radioactive aerosols hundreds of miles downwind under appropriate atmospheric conditions."*[24]

NAS report states that *"A zirconium cladding fire in the presence of steam could generate hydrogen gas over the course of the event." "The deflagration of hydrogen* (read detonation) *could enhance the release of radioactive material in some scenarios."*[25]

NAS FINDING 4E states *"Depending on the outcome of plant-specific vulnerability analysis described in the committee's classified report, NRC might determine that early movement of spent fuel pools into dry cask storage would be prudent…"*[26]

4. The NAS report confirms the petitioners' findings and requested enforcement action that "Options for Addressing Structural Vulnerability of Mark 1 & II BWRs Are Necessary."[27]

NAS FINDING 3C states *"It appears to be feasible to reduce the likelihood of a zirconium cladding fire following the loss-of-pool-coolant event using readily implemented measures."* [28]

NAS FINDING 4D states *"Dry cask storage for older, cooler spent fuel has two inherent advantages over pool storage: (1) It is a passive system that relies on natural air circulation for cooling; and (2) it divides the inventory of that spent fuel among a large number of discrete, robust containers. These factors make it more difficult to attack a large amount of spent fuel at one time and also reduce the consequences of such attacks.*[29]

NAS FINDING 4B states *"Additional steps can be taken to make dry casks less vulnerable to potential terrorist attacks" as well as "upgrades of requirements in 10 CFR 72 for dry casks"*[30]

NAS report states *"Certain types of cask systems could be protected against aircraft strikes by partial earthen berms. Such berms also would deflect the blasts from vehicle bombs."*[31]

NAS report states at POTENTIAL ADVANTAGES OF CASKS OVER POOLS that
"Less spent fuel is at risk"
"Potential consequences are lower"
"Recovery from attack would be easier"[32]

5. The NAS report confirms the petitioners' findings and requested emergency enforcement action that "The Public Should Be Involved In Addressing the Structural Vulnerability of Reactor Containments and Irradiated Fuel."[33]

NAS RECOMMENDATION states NRC "*should improve sharing of pertinent information on vulnerability and consequence analysis… on a timely basis."*[34]

NAS report states *"The committee believes that the public is an important audience for the work being carried out to assess and mitigate vulnerabilities to spent fuel storage facilities. While it would be inappropriate to share all information publicly, more constructive interaction with the public and independent analysts could improve the work being carried out, and also increase public confidence in the NRC and industry decisions and actions to reduce the vulnerability of spent fuel storage to terrorist threats."* [35]

6. The NAS report confirms the "Actions Sought by the Petitioners."[36]

NAS FINDING 3E states *"additional work on specific issues is needed urgently."* [37]

NAS RECOMMENDATION that NRC *"should take appropriate actions to address any significant vulnerabilities that are identified*."[38]

NAS RECOMMENDATION that NRC *"should ensure that operators take prompt and effective measures to reduce the consequences of loss-of-pool-coolant events…"* [39]

7. Petitioners request NRC to issue a Director's Decision in support of the petition and in a timely fashion given NAS has identified that "work on specific issues is needed urgently."

Congress asked NAS to address the vulnerability issue and recommendations within 6 months in its Fiscal Year 2004 Energy and Water Development Conference Report issued 11/18/2003. http://www7.nationalacademies.org/ocga/laws/PL108_137.asp

Request 1 of the report was finished and provided to Congress in July 2004.
Request 2 states that the committee began work on its public version August 12-13, 2004. On August 10, 2004, NRC received the aforementioned emergency enforcement petition from the Nuclear Security Coalition. The committee met again in October 28-29, 2004 to continue work to develop a public version and was briefed by NRC, and again November 29-30, 2004 and again January 24-25, 2005.[40] The redacted version was finally released to the public in April 2005, 8 months after its report to Congress after overcoming Commission opposition to release of redacted language.

The August 10, 2004 petition requests NRC to establish the following timeline:

i) Issue a Demand for Information to all Mark I and II operators to conduct a 6-month study of options for addressing spent nuclear fuel vulnerabilities and present the findings at a national conference attended by public stakeholders;

ii) Develop a comprehensive plan that accounts for addressing vulnerabilities within 12-months with the issuance of Orders

Sincerely,

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Attachment:

To view the public version of the NAS report "Safety and Security of Commercial Spent Nuclear Fuel Storage" > http://www.nirs.org/reactorwatch/security/securityhome.htm <

Cc:
Senator Harry Reid
Department of Homeland Security
National Academy of Sciences
Roy Zimmerman, NRC NSIR
Glenn Tracey, NRC NSIR
Robert Alveraz, et al

END NOTES

[1] "Safety and Security of Commercial Spent Nuclear Fuel Storage," National Research Council of the National Academy of Sciences, Public Version, April, 2005, p. 75
[2] NAS Ibid, p. 75
[3] NAS Ibid, p. 75
[4] NAS Ibid, p. 46
[5] NAS Ibid, Acknowledgements, p. vii.
[6] NAS Ibid, p.40
[7] Emergency Enforcement Petition (10 CFR 2.206), Nuclear Security Coalition to US NRC, August 10, 2004, Petition Annex, p. 4. > http://www.nirs.org/reactorwatch/security/bwrfuelpool2206annex08102004.pdf <
[8] NAS Ibid, p. 4
[9] NAS Ibid, p. 36
[10] NSC 2.2206 Petition Annex, p.11.
[11] NAS Ibid, p. 48
[12] NAS Ibid, p. 33
[13] NAS Ibid. p. 6
[14] NAS Ibid. p. 50
[15] NSC 2.206 Petition Annex, p. 16
[16] NAS Ibid, p. 6
[17] NAS Ibid, p. 11
[18] NAS Ibid, p.42
[19] NAS Ibid, p. 43
[20] NAS Ibid, p. 43
[21] NAS Ibid, p. 46
[22] NAS Ibid, p. 49
[23] NAS Ibid, p. 50
[24] NAS Ibid, p. 50
[25] NAS Ibid, p. 54

[26] NAS Ibid, p. 8
[27] NSC 2.206 Petition Annex, p. 16.
[28] NAS Ibid, p. 57
[29] NAS Ibid, p. 70
[30] NAS Ibid, p. 7
[31] NAS Ibid, p. 68
[32] NAS Ibid, p. 68
[33] NSC 2.206 Petition Annex, p. 22.
[34] NAS Ibid, p. 9
[35] NAS Ibid, p. 9
[36] NSC 2.206 Petition Annex, August 10, 2004 p. 22
[37] NAS Ibid, p. 6
[38] NAS Ibid, p. 6
[39] NAS Ibid, p. 6
[40] NAS Ibid, p. 85